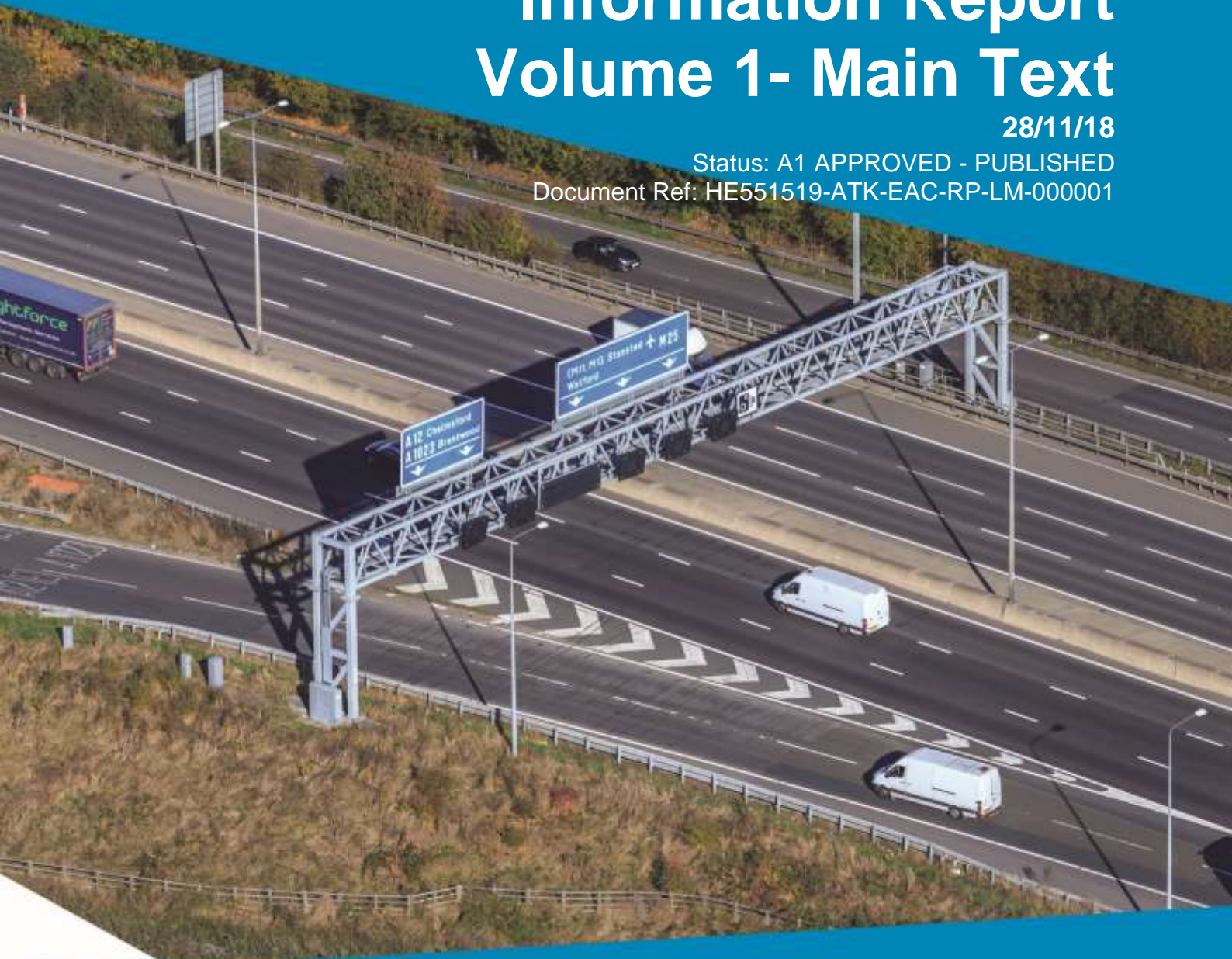


Regional Investment Programme M25 Junction 28 Improvement Preliminary Environmental Information Report Volume 1- Main Text

28/11/18

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Table of contents

Chapter	Pages
Volume 1	10
Chapters 1 - 4	10
1. Chapter 1 - Introduction	11
1.1 Overview of the project	11
1.2 Purpose of the Preliminary Environmental Information Report (PEIR)	12
1.3 Preliminary design pre-application consultation	14
1.4 Competent experts	15
2. Chapter 2- The Project	16
2.1 Need for the project	16
2.2 Project objectives	16
2.3 Key environmental constraints	17
2.4 Project description	18
2.5 Construction, operation and long-term management	19
2.6 Preliminary Outline Environmental Design	20
3. Chapter 3 – Assessment of Alternatives	21
3.2 Alternative development options	21
3.3 Option selection	23
3.4 Preferred option	24
4. Chapter 4 – Environmental Assessment Methodology	26
4.2 EIA stages	26
4.3 Baseline	27
4.4 Study area	27
4.5 Design and mitigation process	27
4.6 Assessment years and scenarios	28
4.7 Identification of potential impacts	28
4.8 Assessment of significance	29
4.9 Cumulative effects	31
4.10 Major accidents and disasters	32
4.11 Dealing with uncertainty	32
4.12 Transboundary impact screening	33
4.13 Habitat Regulations Screening	33
4.14 Health Impact Assessment	33
Volume 1	34
Chapters 5 - 15	34
5. Air Quality	35
5.1 Introduction	35
5.2 Study area	35

5.3	Planning and policy context	36
5.4	Methodology	37
5.5	Consultation	40
5.6	Baseline conditions	40
5.7	Potential impacts	49
5.8	Potential mitigation measures	53
5.9	Residual impacts	54
5.10	Cumulative effects	54
5.11	NPS compliance	55
5.12	Summary	55
6.	Noise and Vibration	57
6.1	Introduction	57
6.2	Study area	57
6.3	Planning and policy context	58
6.4	Methodology	58
6.5	Consultation	62
6.6	Baseline conditions	62
6.7	Potential impacts	64
6.8	Potential mitigation measures	67
6.9	Residual Impacts	69
6.10	Cumulative effects	70
6.11	NPS compliance	70
6.12	Summary	70
7.	Biodiversity	72
7.1	Introduction	72
7.2	Study area	72
7.3	Planning and policy context	73
7.4	Methodology	73
7.5	Consultation	86
7.6	Baseline conditions	86
7.7	Potential impacts	108
7.8	Potential mitigation measures	114
7.9	Residual impacts	121
7.10	Cumulative effects	124
7.11	NPS compliance	124
7.12	Summary	125
8.	Road Drainage and the Water Environment	127
8.1	Introduction	127
8.2	Study area	127
8.3	Planning and policy context	127

8.4	Methodology	127
8.5	Consultation	129
8.6	Baseline conditions	129
8.7	Potential impacts	131
8.8	Potential mitigation measures	133
8.9	Residual impacts	135
8.10	Cumulative effects	135
8.11	NPS compliance	137
8.12	Summary	138
9.	Landscape and Visual	139
9.1	Introduction	139
9.2	Study area	139
9.3	Planning and policy context	139
9.4	Methodology	140
9.5	Consultation	145
9.6	Baseline conditions	147
9.7	Potential impacts	150
9.8	Potential mitigation measures	154
9.9	Residual impacts	155
9.10	Cumulative effects	157
9.11	NPS compliance	158
9.12	Summary	159
10.	Geology and Soils	161
10.1	Introduction	161
10.2	Study area	161
10.3	Planning and policy context	162
10.4	Methodology	162
10.5	Consultation	171
10.6	Baseline conditions	171
10.7	Potential impacts	181
10.8	Potential mitigation measures	183
10.9	Residual impacts	185
10.10	Cumulative effects	185
10.11	NPS compliance	186
10.12	Summary	186
11.	Cultural Heritage	188
11.1	Introduction	188
11.2	Study area	188
11.3	Planning and policy context	188
11.4	Methodology	188

11.5	Consultation	192
11.6	Baseline conditions	192
11.7	Potential impacts	197
11.8	Potential mitigation measures	200
11.9	Residual impacts	200
11.10	Cumulative effects	201
11.11	NPS compliance	202
11.12	Summary	203
12.	Materials and Waste	204
12.1	Introduction	204
12.2	Study area	204
12.3	Planning and policy context	204
12.4	Methodology	204
12.5	Consultation	209
12.6	Baseline conditions	209
12.7	Potential impacts	212
12.8	Potential mitigation measures	212
12.9	Residual impacts	214
12.10	Cumulative effects	214
12.11	NPS compliance	214
12.12	Summary	214
13.	People and Communities	215
13.1	Introduction	215
13.2	Study area	215
13.3	Planning and policy context	215
13.4	Methodology	215
13.5	Consultation	227
13.6	Baseline conditions	228
13.7	Potential impacts	231
13.8	Potential mitigation measures	237
13.9	Residual impacts	238
13.10	Cumulative effects	238
13.11	NPS compliance	239
13.12	Summary	239
14.	Climate	242
14.1	Introduction	242
14.2	Study area	242
14.3	Planning and policy context	245
14.4	Methodology	245
14.5	Consultation	250

14.6	Baseline conditions	250
14.7	Potential impacts	254
14.8	Residual impacts	262
14.9	Cumulative effects	262
14.10	NPS compliance	263
14.11	Summary	264
15.	Assessment of Cumulative Effects	266
15.1	Introduction	266
15.2	Methodology	266
15.3	Potential impacts	274
16.	Summary	281
17.	References and Glossary	286
17.1	General References	286
17.2	Chapter 5 Air Quality	287
17.3	Chapter 6 Noise and Vibration	288
17.4	Chapter 7 Biodiversity	288
17.5	Chapter 8 Road Drainage and the Water Environment	290
17.6	Chapter 9 Landscape and Visual	290
17.7	Chapter 10 Geology and Soils	291
17.8	Chapter 11 Cultural Heritage	293
17.9	Chapter 12 Materials and Waste	293
17.10	Chapter 13 People and Communities	294
17.11	Chapter 14 Climate Change	294
17.12	Chapter 15 Assessment of Cumulative Effects	296

Tables

Table 1.1: Structure and contents of the PEIR	13
Table 3.1: Strategic options	21
Table 3.2: Option identification	22
Table 3.3: Option selection	23
Table 4.1: Significance of effects	30
Table 4.2: Descriptors of the significance of effect categories	30
Table 5.1: Relevant human health air quality criteria	36
Table 5.2: Description of AQMAS	42
Table 5.3: Connect Plus annual mean NO ₂ diffusion tube monitoring results (µg/m ³)	43
Table 5.4: Highways England diffusion tube monitoring results (NO ₂)	44
Table 5.5: Annual mean NO ₂ concentrations from continuous monitoring stations (µg/m ³), 2013 – 2017	45
Table 5.6: Annual mean PM ₁₀ monitoring results (µg/m ³), 2013 – 2017	45
Table 5.7: Number of exceedances of 24-hour mean PM ₁₀ Objective 2013 – 2017	46
Table 5.8: Annual mean PM _{2.5} monitoring results (µg/m ³), 2013 – 2017	46
Table 5.9: Bias adjusted annual mean NO ₂ diffusion tube monitoring Results (µg/m ³)	46
Table 5.10: Selected human health receptor locations included at Option Selection Stage	50
Table 5.11: Estimated annual mean NO ₂ concentrations at selected receptors	51
Table 5.12: Estimated annual mean PM ₁₀ concentrations at selected	51
Table 5.13: Regional emission calculations	52
Table 5.14: Overall evaluation of local air quality significance	53
Table 6.1: Classification of Magnitude for Noise Impacts (from DMRB Vol11 S3 Pt7 HD 213/11)	59

Table 6.2: LOAELs and SOAELs for all receptors (based upon current guidance from Highways England)	60
Table 6.3: Operational noise levels of significance at residential receptors (Daytime) as used in results of previous appraisal as reported at Options Selection Stage	62
Table 6.4: Operational noise levels of significance at non-residential receptors (Daytime) as used in results of previous appraisal as reported at Options Selection Stage	62
Table 6.5: Location and distances of NIAs from the Scheme (information as obtained from Extrim Noisemap Viewer and online mapping sources)	63
Table 6.6: Short-term traffic noise reporting table (DMRB A1.1)	65
Table 6.7: Long-term traffic noise reporting table (DMRB A1.2)	65
Table 6.8: Significance in the opening year	66
Table 6.9: Significance in the future year compared with do-minimum opening year	67
Table 7.1: Electrofishing survey locations	75
Table 7.2: London Invasive Species Initiative (LISI) categories	82
Table 7.3: Resource valuation	83
Table 7.4: Significance of effects	86
Table 7.5: Summary of statutory designated sites within the study area	87
Table 7.6: Summary of non-statutory designated sites within the Study Area	87
Table 7.7: Ancient woodland	91
Table 7.8: Summary of the findings	98
Table 7.9: Terrestrial invertebrate records	99
Table 7.10: Protected / notable bird species within the Scheme	103
Table 7.11: Invasive species records identified during the desk study	107
Table 8.1: WFD surface water	130
Table 8.2: Cumulative developments	136
Table 9.1: Landscape sensitivity and typical examples	141
Table 9.2: Visual sensitivity and typical descriptors	142
Table 9.3: Magnitude and nature of landscape impact and typical descriptors	143
Table 9.4: Magnitude of visual impact and typical descriptors	144
Table 9.5: Typical descriptors of significance of effects categories	145
Table 9.6: Typical descriptors of the significance of effect categories	145
Table 9.7: Summary of visual impact magnitude	152
Table 9.8: Summary of visual impact significance	153
Table 9.9: list of development projects for the landscape or visual cumulative effect assessment	157
Table 9.10: Summary of NPS provisions relevant to this chapter	158
Table 10.1: Land quality estimation of the level of risk by comparison of consequence and probability	163
Table 10.2: Description of the classified risks	163
Table 10.3: Land Contamination Impact Assessment based on change in contamination risk	164
Table 10.4: Criteria for classifying the value and/or sensitivity of environmental resources/ hazard	165
Table 10.5: Classification of magnitude of impact	166
Table 10.6: Criterion for determining the impact significance of effects	166
Table 10.7: Classification of significance of effects	166
Table 10.8: Assessment of magnitude of impact on BMV land	168
Table 10.9: Value/sensitivity of receptors – agricultural land	169
Table 10.10: Magnitude of impact – agricultural land	169
Table 10.11: Summary of anticipated geology on site	174
Table 10.12: Environment Agency and BGS aquifer designations	176
Table 10.13: Pollution incidents to controlled waters	179
Table 10.14: Cumulative effects	186
Table 11.1: Value of heritage assets	189
Table 11.2: Magnitude of impact	190
Table 11.3: Significance of effects	191
Table 11.4: Construction impacts	198
Table 11.5: Operation impacts	200
Table 11.6: Cumulative effects	201
Table 12.1: Material resources and waste topics scoped in and out of further assessment	205
Table 12.2: Criteria for classifying the magnitude of environmental effects	207
Table 12.3: Regional material resources baseline	210
Table 12.4: Waste arising baseline	211
Table 12.5: Waste infrastructure baseline	212
Table 12.6: Potential impacts	214
Table 13.1: Impact to private dwellings assessment criteria	216

Table 13.2: In-combination amenity affect impact assessment criteria	217
Table 13.3: Criteria for assessing receptor sensitivity / value	217
Table 13.4: Criteria for assessing magnitude of impact	218
Table 13.5: Significance of impact assessment criteria	219
Table 13.6: Community facilities assessment criteria	220
Table 13.7: Sensitivity of local businesses	220
Table 13.8: Magnitude of impact on local businesses	221
Table 13.9: Development land impact assessment criteria	221
Table 13.10: Sensitivity of NMU receptors	222
Table 13.11: NMU journey length & local travel patterns magnitude criteria	222
Table 13.12: Driver stress assessment criteria	226
Table 13.13: Driver stress - Dual-carriageway roads	226
Table 13.14: Magnitude of impact on human health receptors	227
Table 13.15: Vehicle Travellers: Views from the road	234
Table 13.16: Motorised travellers: Driver stress	235
Table 13.17: Summary of potential construction phase impacts	236
Table 13.18: Summary of potential operational phase impacts	236
Table 13.19: Construction phase residual impacts	239
Table 13.20: Operational phase residual impacts	240
Table 14.1: Construction Phase Assessment Boundary	243
Table 14.2: Operation Phase Assessment Boundary	243
Table 14.3: Exclusions from the Assessment Boundary	243
Table 14.4: Typical climate variables and related hazards	248
Table 14.5: Vulnerability Rating Matrix	249
Table 14.6: UK national emissions (2016)	251
Table 14.7: Writtle climate (1981 to 2010)	253
Table 14.8: Weather extreme records: South-East and Central Southern England	253
Table 14.9: Operation Stage Emissions for 2022 and 2037	255
Table 14.10: Comparison of Scheme to UK Government Carbon Budgets	255
Table 14.11: Comparison of Scheme to UK Transport Sector Forecast Emissions	256
Table 14.12: Typical climate impacts on road infrastructure	257
Table 14.13: Climate vulnerability assessment: Road infrastructure, London	259
Table 14.14: Construction emissions mitigation measures	260
Table 14.15: Operation emissions mitigation measures	261
Table 14.16: Selected impact mitigation measures for roads	261
Table 14.17: Findings of the scoping phase: climate vulnerability	264
Table 15.1: Zone of influence / Study area	266
Table 15.2: Hierarchy of 'Other Development'	270
Table 15.3: Significance Criteria	271
Table 15.4: Proposed developments to be considered in the cumulative effects assessment	273
Table 15.5: Cumulative effects assessment	275
Table 16.1: Summary of impacts	282

Figures

Figure 1.1: Scheme location	12
Figure 3.1: Option 5F (the Scheme)	25
Figure 5.1: Windrose for London City Airport meteorological station (2015)	49
Figure 14.1: Location of 25km grid box (ID: 1629)	244
Figure 14.2: Location of Thames river basin	245
Figure 14.3: Forecast UK Transport Sector Emissions	252

Volume 1

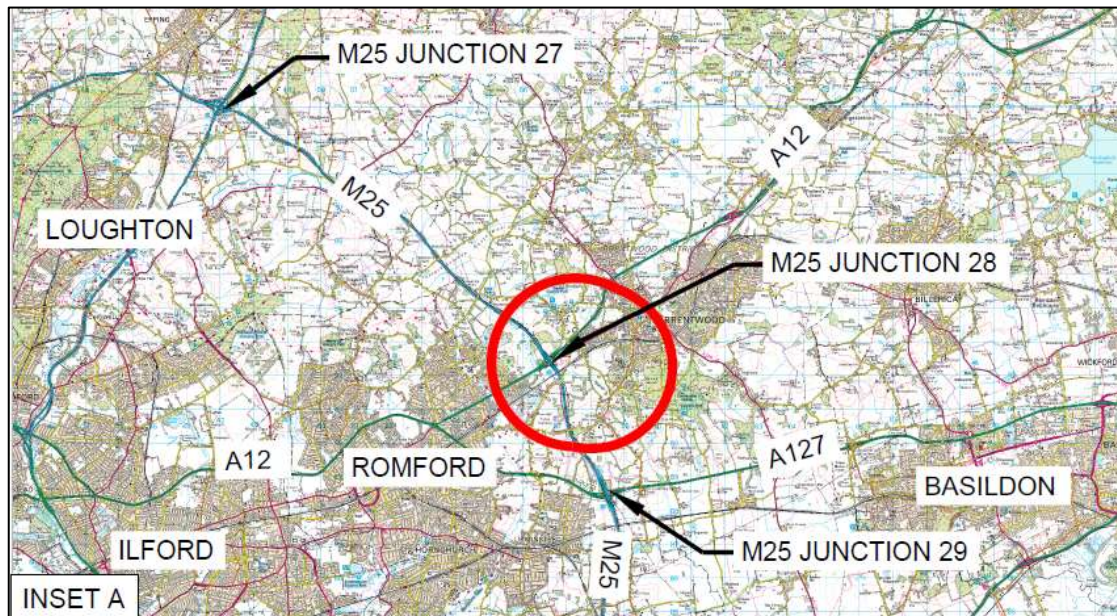
Chapters 1 - 4

1. Chapter 1 - Introduction

1.1 Overview of the project

- 1.1.1 In December 2014, the Department for Transport (DfT) published its Road Investment Strategy (RIS) for 2015-2020, announcing £15 billion to invest in England's strategic road network between 2015 and 2020. The RIS sets out the list of schemes that are to be delivered by Highways England over the period covered by the RIS (2015 - 2020). Highways England responded to the RIS with the Highways England Delivery Plan (2015) and a number of schemes have been identified to be constructed within the plan period, including the improvement of M25 Junction 28 (the Scheme).
- 1.1.2 As shown in Figure 1.1, the Scheme is located between Brentwood and Romford, on the border of London Borough of Havering and Brentwood Borough Council. Junction 28 is one of the major improvement projects planned within the south east and will provide better access towards Essex and London, as well as connecting Brentwood, Chelmsford, Colchester and Suffolk with London and other key destinations. Construction is scheduled to begin by March 2020.
- 1.1.3 The Scheme was announced by Highways England in July 2017 and comprises the following elements:
- A new two-lane loop road with hard shoulder, for traffic travelling from M25 to A12;
 - Works on A12 eastbound to maintain existing access to Maylands Golf Course;
 - An overbridge at A12 eastbound exit road to allow the proposed loop road to join the A12 eastbound carriageway;
 - Work on merging of 2 lanes on the loop road prior to it joining the A12;
 - Widening of the M25 anti-clockwise carriageway to provide proposed exit road; and
 - A bridge over the M25 anti-clockwise entry road to facilitate new loop road.
- 1.1.4 The Scheme converts the use of the existing hard shoulder over the M25 viaduct to the proposed deceleration lane and associated diverge configuration. The diverge commences to the north of the existing structure, consequently requiring no works to the existing railway structure and the existing M25 viaduct. Following the diverge nose it begins to turn into the adjacent land, north-east of the existing junction. The existing circulatory/M25 northbound merge will be realigned to pass under the proposed link. The horizontal alignment continues in a loop while the vertical profile starts to decline from the proposed structure on an embankment following the existing topography downhill towards the A12.
- 1.1.5 The Scheme is a Nationally Significant Infrastructure Project (NSIP). Highways England is therefore required to apply for a 'Development Consent Order' (DCO) for the Scheme.
- 1.1.6 The overseeing organisation and project sponsor is Highways England and the designer is Atkins.

Figure 1.1: Scheme location



1.2 Purpose of the Preliminary Environmental Information Report (PEIR)

- 1.2.1 The Scheme has been identified as a NSIP by the Planning Inspectorate as it meets the thresholds set out in the Highway and Railway NSIP Order 2013. A planning consent for a NSIP takes the form of a DCO. The DCO combines a grant of planning permission with a range of other separate consents. Further information on the legislative and policy framework is included in the PEIR Volume 2 Appendix A.
- 1.2.2 The Planning Inspectorate's Advice Note Seven 'Environmental Impact Assessment: Process, Preliminary Environmental Information and Environmental Statements, Republished December 2017' recommends that Preliminary Environmental Information (PEI) is prepared by the applicant.
- 1.2.3 Under Provision 12 'Consultation Statement Requirements' of the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (EIA Regulations) PEI is defined as:
- Information referred to in regulation 14(2) which- has been compiled by the applicant; and
 - Is reasonably required to assess the environmental effects of the development (and of any associated development).
- 1.2.4 The PEI is documented in a Preliminary Environmental Information Report (PEIR). The purpose of the PEIR is to enable specialist and non-specialist consultees from the community and other stakeholders to understand the potential pre-mitigation environmental effects of the proposed development. Effects have been predicted for each environmental assessment topic to inform consultee responses at the DCO pre-application consultation stage. The Scheme design is currently being developed and baseline environmental information, such as surveys, are still ongoing. The PEIR provides a preliminary assessment of the principal environmental issues and may be subject to change as the detailed environmental

impact assessment of the Scheme progresses. The PEIR describes the Scheme at preliminary design stage and its environmental effects, timescales for delivery, alternatives considered, and uncertainties and assumptions.

1.2.5 For each environmental topic, the PEIR:

- Describes the study area, environmental baseline data collection work undertaken to date;
- Describes the existing baseline environment, based on the primary and secondary data collection to date;
- Identifies further work that is ongoing, or that is likely to be undertaken, to complete the Environmental Impact Assessment (EIA);
- Provides an assessment of the likely significant environmental impacts of the Scheme based on currently available information; and
- Describes the range of mitigation measures that will be considered to avoid, reduce/mitigate or offset the potential environmental impacts.

1.2.6 The PEIR structure is set out in Table 1.1 below and divided as follows:

- PEIR Volumes 1-3:
 - PEIR Volume 1: Main text including Scheme information, alternatives considered, environmental assessments for each environmental topic, glossary and references;
 - PEIR Volume 2: Appendices describing the study areas, planning legislation and policy, methodology and relevant tables for each environmental topic; and
 - PEIR Volume 3: Figures including plans for environmental assessment topic chapters in PEIR Volume 1.
- PEIR summary:
 - PEIR Summary – A separate document summarising the environmental assessment and preliminary findings for each topic including an environmental context plan.

Table 1.1: Structure and contents of the PEIR

PEIR Summary
PEIR Volume 1 – Main Text
Chapter 1 – Introduction
Chapter 2 – The Project
Chapter 3 – Assessment of Alternatives
Chapter 4 – Environmental Assessment Methodology
Chapter 5 – Air Quality
Chapter 6 – Noise and Vibration
Chapter 7 – Biodiversity
Chapter 8 – Road Drainage and the Water Environment
Chapter 9 – Landscape
Chapter 10 – Geology and Soils

Chapter 11 – Cultural Heritage
Chapter 12 – Materials and Waste
Chapter 13 – People and Communities
Chapter 14 – Climate
Chapter 15 – Assessment of Cumulative Effects
Chapter 16 – Summary
References
Abbreviations and Glossary

PEIR Volume 2 – Appendices

PEIR Volume 3 – Figures

1.3 Preliminary design pre-application consultation

- 1.3.1 Pre-application consultation with key stakeholders and the local community is an important requirement of the DCO planning process. It provides an opportunity for interested parties to comment on the proposals while they are at a formative stage, and for potential issues to be taken into account and, where necessary, address the issues before the application is submitted for examination.
- 1.3.2 The Environmental Scoping Report was published on the Planning Inspectorate (PINS) website in November 2017. A Scoping Opinion was received from PINS in December 2017 which incorporated feedback from the statutory consultation bodies. A response to Scoping Opinion comments from PINS is included in PEIR Volume 2 Appendix C.
- 1.3.3 Highways England published a Report on Consultation in November 2017. Consultation on the Statement of Community Consultation (SoCC) for the Scheme was undertaken in October and November 2018.
- 1.3.4 In accordance with Regulation 12 of the Infrastructure Planning (EIA) Regulations 2017 (as amended), the SoCC sets out how Highways England will consult with the local community on the PEIR, and the Scheme, the consultation programme and methods of communication.
- 1.3.5 Following consultation, Highways England will take account of all comments and suggestions received from consultees in relation to the proposed development and the PEIR. Comments will be integrated into further EIA work to be documented in the Environmental Statement (ES) and submitted as part of the DCO application to the Planning Inspectorate in 2019.
- 1.3.6 The DCO application will also include a Consultation Report that will document the outcomes of the consultation and how it has informed the design development of the Scheme.

1.4 Competent experts

- 1.4.1 In accordance with the EIA Regulations and Highways England guidance, the coordination of the environmental assessment process and inputs into each environmental topic area have been undertaken by a team of competent and qualified specialists. These specialists work in close collaboration with the design engineers responsible for the design of the Scheme, as part of an iterative design, consultation and assessment process. This process maximises the opportunity to avoid or reduce adverse environmental effects at source and to identify mitigation measures to address those effects that cannot be avoided or reduced at source.

2. Chapter 2- The Project

2.1 Need for the project

- 2.1.1 Junction 28 plays a vital role connecting the M25 with the A12, as well as providing local access to Brentwood via the A1023 (Brook Street). It is a heavily used junction which features a roundabout mainly controlled by traffic lights. Up to 7,500 vehicles per hour currently travel through the roundabout at peak times. It is already operating at saturated capacity, with motorists regularly experiencing congestion and delays. Research shows that traffic in the area is expected to increase by up to 30% by 2037, with more than 9,000 vehicles per hour travelling through the roundabout at peak times.
- 2.1.2 Without intervention, there will be further deterioration in traffic conditions:
- Delays will be at least 5 times greater; and
 - Average speeds will be reduced by 25%.
- 2.1.3 The roundabout also caters for traffic accessing Brentwood via the A1023 (Brook Street). Although the Scheme is not directly focused on Brook Street, the proposed improvements to Junction 28 will deliver some benefits for customers using the A1023. The A1023 (Brook Street) arm of the roundabout is the only one not controlled by traffic lights. After leaving the roundabout, motorists pass through traffic lights at the Nags Head Lane and Mascalls Lane junctions.
- 2.1.4 During peak times, these junctions operate over capacity and queues of traffic regularly develop along Brook Street and often back on to the roundabout. These queues can also lead further back on to the M25 north and A12 east entry and exit roads.
- 2.1.5 In recent years, there have also been a number of incidents at Junction 28, which create delays and congestion along the M25, A12 and local roads.

2.2 Project objectives

- 2.2.1 The objectives for the Scheme were developed in agreement with the Department for Transport and local authorities. The Scheme objectives are set out below:
- Increase capacity and reduce congestion and delays by providing an improved link from M25 to A12;
 - Reduce the incident rate and resulting disruption by increasing the capacity of the roundabout;
 - Improve safety on the roundabout by reducing traffic levels and redesigning the existing layout;
 - Cater for future traffic demands to enable development and economic growth;
 - Minimise the impact on local air quality and noise by smoothing traffic flow; and
 - Protect access for non-motorised users (pedestrians and cyclists) and improve conditions wherever possible.
- 2.2.2 Alongside the objectives for the Scheme, Highways England aims to:

- Minimise environmental impact as measured in accordance with Design Manual for Roads and Bridges (DMRB); and
- Where possible improve air quality with regard to vehicle emission generally, and specifically at the existing declared Air Quality Management Areas (AQMA).

2.2.3 In addition, Highways England sets out its own approach to meeting the key performance indicators identified within the RIS of “no net loss of biodiversity by 2020”. The Highways England Delivery Plan 2015-2020 also sets targets to mitigate noise in at least 1,150 Noise Important Areas (NIAs) between 2015/2016 and 2019/2020. This document also demonstrates the ability of the project to meet the requirements within Highways England licence, specifically in relation to the environment.

2.2.4 Highways England published ‘The Road to Good Design’ in January 2018, which sets out design principles for delivering projects with the aspiration to ‘deliver safer, better, beautiful roads which connect people and connect our country’.

2.3 Key environmental constraints

2.3.1 A plan showing the key environmental constraints is provided as Figure A-3 in Volume 3.

2.3.2 The Scheme is within a predominantly rural setting in a narrow strip of Green Belt between the edge of the settlement of Brentwood just to the east and Romford further to the west.

2.3.3 Brentwood Borough Council have declared three Air Quality Management Areas (AQMAs):

- One for the eastern half of the junction, Brook Street, Brentwood and the A12;
- A second, approximately 3.2 km to the north east and the area encompasses the Bean Interchange between the A2 and A296 which comprises parts of Warescot Road, Hurstwood Avenue and Ongar Road, Brentwood and the A12, and
- The third area comprises parts of Ongar Road, Ingrave Road, High Street and Shenfield Road, Brentwood in proximity to Wilsons Corner (the junction of the A128 and A1203) approximately 2.5 km to the east of the junction.

2.3.4 The London Borough of Havering has declared a Borough wide AQMA covering areas to the west of the Scheme.

2.3.5 Monitoring by the Department for Environment, Food and Rural Affairs (Defra) recorded elevated nitrogen dioxide (NO₂) concentrations on the A12.

2.3.6 There are a number of noise important areas (NIAs) within the area, with one centred on Junction 28. The existing traffic on the M25 and A12 result in noise and air quality problems in the area.

2.3.7 There are eight Grade II and II* Listed Buildings within the Scheme area. The Nags Head is a Grade II Listed Building located 600 m along Brook Street to the east of the junction. The Golden Fleece Inn and the Moat House (Grade II*) are

located 1 km to the east of the junction. A Weald Park is a Registered Park and Garden located 800 m to the north of the junction.

- 2.3.8 There are no designations for landscape quality but there are a number of Ancient Woodlands around the junction. Lower Vicarage Wood and Vicarage Wood are both designated Ancient Woodland and located approximately 400 m and 800 m respectively to the north east from the junction. The Manor Local Nature Reserve (LNR) is located approximately 1 km to the north west of the junction. The Ingrebourne Valley Site of Metropolitan Importance (SMI) is located directly west of the junction.
- 2.3.9 The area surrounding the junction is Grade 3 Agricultural Land Classification (ALC) and there is a former landfill site immediately to the north west of Junction 28 within Grove Farm.
- 2.3.10 Two waterbodies cross the site, the Ingrebourne River which flows adjacent to A12 and the Weald Brook which flows north to south to the west of the M25 and both have associated fluvial flood plains.

2.4 Project description

Scheme overview

- 2.4.1 The Scheme comprises upgrading Junction 28, which is the junction located between the M25 anti-clockwise and the A12 in Essex and includes the provision of a dedicated link for this right-turn movement and minor improvements of the existing roundabout.
- 2.4.2 The Scheme converts the use of the existing hard shoulder over the M25 viaduct to the proposed deceleration lane and associated diverge configuration. The diverge commences to the north of the existing structure, consequently requiring no works to the existing railway structure and the existing M25 viaduct. Following the diverge nose it begins to turn into the adjacent land, north-east of the existing junction. The existing circulatory/M25 northbound merge will be realigned to pass under the proposed link. The horizontal alignment continues in a loop while the vertical profile starts to decline from the proposed structure on an embankment following the existing topography downhill towards the A12.

Non-motorised user provisions

- 2.4.3 Footways exist on the A12 and A1023. On the northern side of the A12, west of the M25 Junction 28 roundabout, a footway provides access to the vicinity of the roundabout and then to the southern side of the A12 via an uncontrolled crossing of the A12 entry slip and exit slip road. This then connects with a shared use path (SUP) to the southern side of the A12/A1023. SUPs exist on the A1023 immediately east of the M25 Junction 28 roundabout junction, through the southern side of the junction via one uncontrolled and one controlled crossing point. This SUP then continues along the southern side of the A12 west of the roundabout towards Harold Wood providing a connection to National Cycle Network Route (NCNR) 136.
- 2.4.4 A further SUP exists on the northern side of the A12 in the vicinity of Harold Wood but this is discontinuous and does not provide a direct route to the roundabout junction on the northern side of the A12. Therefore, the only direct SUP access to and from the roundabout is currently via the SUP to the southern side of the A12.

A grade separated crossing exists in the vicinity of Harold Wood to facilitate crossing movements of the A12.

- 2.4.5 Route 136 of the NCNR crosses the A12 approximately 1 km west of the junction. It is a largely traffic free route connecting the village of Noak Hill and Dagnam Park north of the A12 south to Upminster and the Thames at Rainham via Harold Hill and Hornchurch and passing through parks and green spaces. It can therefore be assumed that local cyclists from Brentwood, Romford and areas in between will likely travel to and from this route and access it from the vicinity of the A12.

Accidents and incidents

- 2.4.6 Junction 28 experiences a high number of accidents and incidents. While the majority of these accidents involve damage and slight injuries only, in many cases these result in significant disruption to traffic and unreliable journey times. This is compounded with the junction operating at capacity during peak times, and hence limited ability to remain open and available in the event of an accident or incident on the gyratory.

2.5 Construction, operation and long-term management

Construction

- 2.5.1 A number of existing structures on site are proposed for demolition and extension, including existing gantries. Based on current preliminary design, the principal construction elements of the Scheme are likely to include the following, these are illustrated on the General Arrangement Plans (Figure A-1 in Volume 3):
- Provision of earthwork slopes at approximately a 1:3.5 gradient as indicated in the general arrangement plan (Figure A-1 in Volume 3);
 - Two multi-span bridges passing over the existing watercourses (Weald Brook and River Ingrebourne) with the abutments no less than 8 m from the edges of the watercourse. This will reduce the likelihood of needing to realign the watercourses and thereby reduce impacts on the existing river banks and floodplain. However, some realignment of the section of the River Ingrebourne parallel to the A12 is likely to be required to facilitate road and embankment construction; and
 - A bridge to carry the new loop road over the M25 on-slip road, with an extension to provide access for landowners. Retaining walls will also be provided at this location to facilitate this access.

- 2.5.2 Currently the estimated total volume of excavation for the construction of the project is estimated to be approximately 67,500 m³. Major alterations to existing highways structures are not anticipated to be required to deliver the Scheme.

- 2.5.3 Construction of the Scheme is planned to commence in March 2020 for a period of approximately two years.

Operation, long-term management and decommissioning

- 2.5.4 Operation of the Scheme is planned to commence from Spring 2022 and the ongoing maintenance of the Scheme will be the responsibility of Highways

England. The Scheme has an indefinite design life, and therefore decommissioning will not be addressed in the environmental assessments.

- 2.5.5 The proposed draft DCO site boundary identified by a red line boundary (known as the 'Order limits') has been established and includes all works proposed by the Order including both the NSIP and any of the associated development. A draft plan of the red line boundary is provided in Figure A-2 in Volume 3.

Decommissioning

- 2.5.6 In view of the indefinite design life of the Scheme, further consideration will be given to decommissioning in the ES. The focus of the Scheme will be to minimise disruption to the local environment including:

- Local communities;
- Grove Farm and Maylands Golf Course;
- Local wildlife;
- Nearby watercourses; and
- Traffic.

- 2.5.7 These elements will be considered fully in the next stage of design and the stakeholders and local community consultation.

2.6 Preliminary Outline Environmental Design

- 2.6.1 The following preliminary environmental design and mitigation measures are being considered for incorporation into the Scheme:

- Planting of new vegetation to help integrate the junction into the landscape and improve habitat connectivity through the provision of wildlife corridor links with the surrounding areas;
- The use of open span bridges to allowing existing natural channel and platform to be retained, and reducing impact of scheme on floodplain process;
- Existing straight channel with uniform profile realigned to a more natural plan and cross-sectional form, regenerating a section of more natural river habitat. Backwaters and floodplain scrapes to create still water habitat and some connectivity with floodplain; and
- Potential habitat creation and enhancement for great crested newts and reptiles.

3. Chapter 3 – Assessment of Alternatives

- 3.1.1 A staged approach was undertaken in developing options for the Scheme. Firstly, a number of high-level, strategic solutions were developed; more detailed scheme options were then developed and assessed.
- 3.1.2 The more detailed scheme options were assessed in terms of technical feasibility, safety, engineering, value for money and environmental considerations.
- 3.1.3 This chapter provides a summary of the options assessed at each stage.

Development of alternatives Strategic Options

- 3.1.4 A range of strategic options which could potentially be considered to address key problems at Junction 28 were identified. The options considered are set out in Table 3.1.

Table 3.1: Strategic options

Strategic Option	Brief Description
Option 1 – Do Minimum	This focuses on short term measures to reduce safety concerns and issues on the gyratory. Primarily it is concerned with introducing traffic signals on the A1023 Brook Street approach (currently uncontrolled), lane markings and signage.
Option 2 - Local access and demand management	This would consider options to change or reduce demand at the junction, for instance with new access strategies to and from Brentwood such as closing A1023 Brook Street and creating a new access on the A12.
Option 3 - Enhanced public transport	Improved bus and rail provision between key destinations (Brentwood, Havering, London, Chelmsford etc., including future Cross Rail).
Option 4 - Highway junction improvements	Junction capacity improvements to cater high demands for M25 anticlockwise to A12 Essex movements.
Option 5 - Do Maximum – Full junction improvements	Junction capacity improvements to cater all the high volume dominant movements between M25 and A12 including heavy right turn movements.
Option 6 - Strategic road network classification	A wider strategic option that would consider reviewing the classification of the Strategic Road Network (SNR) alongside future considerations for a Lower Thames Crossing. For examples, this may look to make best use/enhance the A13/A130, A12 and A127 corridors.

3.2 Alternative development options

- 3.2.1 Based on an assessment; which involved scoring these Strategic Options against the Early Assessment Sifting Tool (EAST) and the Scheme’s objectives, a number of variants were developed. Each of these options were designed to provide a new free flow link for right turning traffic between the M25 motorway anticlockwise and the A12 east. The options identified at the Options Identification stage were refined to best manage the impacts against the identified constraints and risks, and to develop affordable options. These are set out in Table 3.2.

Table 3.2: Option identification

Option	Brief Description
Do-Minimum	Focuses on short term measures with signal optimisation at Junction 28.
Option 1 - Hamburger through-about	Provides additional connectivity from the M25 anticlockwise to A12 eastbound and M25 clockwise to A12 westbound. This includes signal-controlled junctions where the proposed link roads bypass through the centre of an existing circulatory with a Hamburger configuration. This option requires the centre of the existing circulatory to be raised, a new structure, and reconfiguration of the existing M25 viaduct columns.
Option 2 - Northern loop	Provides additional connectivity from M25 anti-clockwise to A12 eastbound via a proposed link road. This proposed link road exits the M25 after Nag's Head Lane and under the existing railway embankment. The proposed link then crosses the A12 and M25 on new structures before merging with the A12 eastbound before Wigley Bush Lane over-bridge.
Option 3 - Satellite roundabout	Provides a satellite roundabout to the south-west of the existing junction. In doing so, it reduces the number of conflict points at the existing junction thus improving capacity. This option requires a new structure, diversion of the A12 in both directions, reconfiguration of the A12 westbound on-slip to include a structure over the diverted A12, and a culvert over Weald Brook.
Option 4 - Compact northern loop	Provides additional connectivity from M25 anticlockwise to A12 eastbound via a proposed link road. The proposed link requires a structure parallel to and then over the M25 before merging with the A12 eastbound before Wigley Bush Lane over-bridge.
Option 5 - Single cloverleaf	Provides additional connectivity from M25 anti-clockwise to A12 eastbound via a proposed loop road in the form of a cloverleaf. The proposed loop requires a structure parallel to the M25 and exits the existing highway boundary to the north-west before looping round to join the A12 eastbound.
Option 6 - Southern link	Provides additional connectivity from the M25 anticlockwise to A12 eastbound via a proposed link road. The proposed link requires several structures and extensive land take.
Option 7A - Do-Maximum, double cloverleaf	Incorporates all infrastructure associated with Option 5. Furthermore, this option provides additional connectivity from the A12 westbound to M25 anti-clockwise. The option achieves this via an additional proposed loop road in the south-west corner of the existing junction. The proposed loop diverges from the A12 westbound before the alignment is raised over the existing circulatory, existing A12 and the loop proposed in Option 5 on a structure before merging to the M25 anticlockwise. Further realignment of the existing M25 anti-clockwise on-slip will be required for this option to accommodate the merging of the A12 westbound to M25 anti-clockwise traffic in the most compact layout possible. The proposed link requires several structures and extensive land take.
Option 7B - Do-Maximum, cloverleaf plus northbound link	Incorporates all infrastructure associated with Option 5. Furthermore, this option provides additional connectivity from the A12 westbound to M25 anti-clockwise. The option achieves this via an additional proposed link road. The proposed link diverges from the A12 westbound immediately after the existing junction, before crossing over the existing A12 on a structure then heading towards, and ultimately merging with the M25 anti-clockwise at the existing ground level. The proposed link requires several structures, a culvert of the Weald Brook and extensive land take.

3.3 Option selection

3.3.1 Based on an assessment process which involved scoring these options identified in Table 3.2 against criteria and the Highways England and EAST, three variants of “option 5” were shown to offer the greatest value in achieving the project objectives and deliverables and have been depicted in Figure 3.1, 3.2 and 3.3.

3.3.2 All three options diverted traffic away from the roundabout, hosted a new dedicated loop road between the M25 and the A12, but each option required a different approach to achieve this. These are set out in Table 3.3.

Table 3.3: Option selection

Option	Brief Description
Option 5B	Single lane loop road, widening existing M25 bridge over Junction 28. This option would involve: <ul style="list-style-type: none"> • Works on the M25 with the likely closure of the hard shoulder; • Narrow lanes on the M25; and • Speed restriction over a long period during construction.
Option 5C	Single lane loop road, widening short section of M25. This option was identified as having least impact in disrupting traffic across the network during construction.
Option 5F	Two lane loop road, widening short section of M25. This option would require minimum disruption on the A12 eastbound and westbound carriageways during construction.

3.3.3 The rejected options are included in Table 3.4 with the reason for rejection.

3.3.4 An environmental assessment of these options was undertaken to inform final option selection which included a consideration of all the environmental topics set out in this PEIR. All options had similar potential impacts in relation to air quality and noise, however Option 5B had an overall lower environmental impact than options 5C and 5F due to a smaller scheme footprint. However, in order to support a high traffic load in the upcoming years, two options were rejected as summarised in Table 3.4.

Table 3.4: Rejected long list options

Option name	Reason for Rejection
Option 5B	Single lane loop road, widening existing M25 bridge over Junction 28. Option 5B involves a departure from standard relating to the sub-standard distance between the successive diverges on the M25 anti-clockwise carriageway. This presents a significant concern over operational safety of the road user.
Option 5C	Single lane loop road, widening short section of M25. However, this option was identified as having least impact in disrupting traffic across the network during construction but option 5C also features a larger loop road than Option 5F, as moving the diverge further north along the M25 avoids the need to widen the existing M25 structures and addresses adverse safety and operational issues related to successive diverges.

3.4 Preferred option

3.4.1 Taking into account transport performance, environment, economics and social aspects, Option 5F was selected as the preferred option. This was primarily because the 2-lane configuration of this option would be the optimum solution in relation to network resilience, maintenance requirements and avoiding disruption to traffic.

3.4.2 Figure 3.1 shows Option 5F, as it was presented at the preferred route announcement in August 2017. Since then the Scheme design has been developed, and while the scheme alignment has not changed the need to realign the A12 has been avoided. Therefore, it is noted that item four on Figure 3.1 has been revoked and does not feature in the current Scheme.

3.4.3 Option 5F, as shown in Figure 3.1, has therefore been taken forward forming the basis of this PEIR and will be assessed as part of the ES. This option was selected as achieving the Scheme objectives, and balancing the needs of road users, the community, the environment and businesses. Option 5F is recommended as the preferred option based on the following:

- Performs strongest in achieving the primary objective of improving journey times, particularly in the longer term beyond the 2037 design year;
- Options 5B and 5C are one lane options and forecast traffic volumes are expected to approach and exceed capacity beyond the design year. It is noted that two lanes cannot be provided on the Option 5B alignment;
- Option 5F can be constructed without the significant disruption to traffic on the M25 motorway as expected under Option 5B (which requires widening of the M25 viaduct over the Junction 28 roundabout);
- Option 5B involves a departure from standard relating to the sub-standard distance between the successive diverges on the M25 anti-clockwise carriageway. This presents a significant concern over operational safety of the road user;
- Option 5F provides greater network resilience through having a second lane on the new link;
- Option 5F offers a two-lane link that is expected to be more advantageous in terms of maintenance and avoiding disruption to traffic;
- Provides a strong BCR of 6.1 despite the additional cost associated with providing a second lane on the new link to cater longer term forecast demand flows;
- All options have similar implications on the environment including impacts on biodiversity (Ingrebourne SMI), landscape, water, cultural heritage and air quality due to similar footprints, Option 5F would have the least impact on the noise environment; and
- Option 5F is selected over Option 5B based on the foregoing reasons, and that it also has the highest overall weighted Value Management score and was shown to be the preferred option noted as part of the public consultation.

Figure 3.1: Option 5F (the Scheme)



4. Chapter 4 – Environmental Assessment Methodology

- 4.1.1 EIA is a process for identifying the likely environmental effects (positive and negative) of proposed developments, and their significance, before development consent is granted.
- 4.1.2 The aim of EIA is to ensure the following:
- A thorough assessment of likely effects of a proposed development on the environment;
 - Consideration of mitigation measures and alternatives in light of potential environmental effects; and
 - Assessment of the cumulative effects of proposed development.
- 4.1.3 Through the EIA process, the Scheme should incorporate measures to prevent, reduce or offset any significant, adverse environmental effects of the proposals, and enhance the beneficial effects. The findings of the assessment are presented in an Environmental Statement (ES).
- 4.1.4 The purpose of the ES is to help the decision maker, statutory consultees, other stakeholders and the public to properly understand the predicted effects and the scope for reducing them, before a decision is made as to whether to permit the development activity. For the Scheme, the DCO application for Highways England will be supported by an ES produced in accordance with the EIA Regulations.
- 4.1.5 The EIA Regulations impose procedural requirements for carrying out EIA for NSIPs which fall to be considered as ‘EIA development’. The ES is the document that reports on the likely impacts on the environment resulting from the proposed development. The ES must, as a minimum, comply with Schedule 4, Part 2 of the EIA Regulations. Advice published by the Planning Inspectorate states that the ES should clearly explain the processes followed, the forecasting methods used, and the measures envisaged to prevent, reduce and where possible offset any significant adverse effects. This has been undertaken in respect of the PEIR and will continue to be carried out throughout the EIA process.

4.2 EIA stages

- 4.2.1 The stages in the EIA process prior to an application for a DCO being submitted are:
1. Existing data review;
 2. Screening to determine the need for an EIA;
 3. Scoping to identify significant issues to be covered in the assessment, determine the subject matter of the assessment and determine the methodologies for undertaking the EIA. Baseline surveys are conducted as part of the assessment to establish the existing environmental conditions in the study area;
 4. Providing information related to the assessment and the project to the statutory and non-statutory stakeholders (referred to as consultees) and the public so that the parties can make informed contributions to

the development of the proposals and the EIA process taking into account the concerns raised by the consultees;

5. Assessment and Iteration to assess the likely significant impacts of the project (including alternatives) on people, environment and communities, identify mitigation measures, if any, through design modifications and environmental management during the project life cycle comprising of construction and operation; and re-assess the residual effects of the mitigated development; and
6. Preparation of an ES and a Non-Technical Summary (NTS).

4.3 Baseline

- 4.3.1 The existing baseline conditions are defined to enable the changes or impacts that would result from the Scheme to be assessed. The identification of the baseline requires the description of the existing environmental conditions and a prediction of how it is likely to change in the absence of the Scheme.
- 4.3.2 The description of the baseline conditions should clearly identify receptors that could be affected by the Scheme and their 'value' or 'sensitivity' to potential changes.

4.4 Study area

- 4.4.1 Study areas have been defined individually for each environmental topic, according to the geographic scope of the potential impacts relevant to that topic or of the information required to assess those impacts. Appropriate study areas have been considered for each environmental topic by the specialist(s) undertaking that assessment and are defined in the topic specific chapters based on recognised professional guidance where this is available together with the geographic scope of the potential effects relevant to the topic. The study areas are defined within each relevant chapter of this report.

4.5 Design and mitigation process

- 4.5.1 The design process allows mitigation measures to be incorporated in the proposals. This is termed "embedded mitigation". Where potentially significant adverse environmental effects have been identified during the assessment process, developing appropriate mitigation will be an iterative part of design development following the hierarchy below:
 - Avoidance – incorporate measures to avoid the effect, for example, alternative design options or modifying the construction programme to avoid environmentally sensitive periods;
 - Reduction – incorporate measures to lessen the effect such as implementing a code of construction practice to reduce the potential impacts from construction activities; and
 - Compensation – to be considered in the circumstances where mitigation at the affected location is not possible to avoid or reduce a significant effect, such as offsite provision of new ecological habitat.
- 4.5.2 In addition, it may be possible to include 'enhancement' i.e. provision of measures over and above those needed to mitigate the adverse impacts, and/or maximising

the opportunities for beneficial impacts from the proposals. Environmental effects of the proposals that remain after mitigation measures are taken into consideration (whether embedded in the design or provided as additional mitigation after an assessment of the proposals), are referred to as 'residual effects'. Therefore, the key outcome of the EIA assessment is the significance of the residual effects after mitigation or enhancement. Each topic chapter sets out the residual effects of the Scheme (as indicated in the structure above).

4.6 Assessment years and scenarios

- 4.6.1 The assessment of effects compares a scenario with the Scheme operational against the scenario without the Scheme over time including how the baseline scenario would evolve to form the 'future baseline scenario'
- 4.6.2 The presence and absence of the Scheme are referred to as the 'Do Something' and 'Do Minimum' scenarios respectively. The 'Do Minimum' scenario represents the future baseline without the Scheme in place with other changes elsewhere within the Strategic Network but no construction of new infrastructure at M25 J28. The 'Do Something' scenario is the scenario with the Scheme in place.
- 4.6.3 Depending on the topic, the effects are assessed for the 'Do Minimum' and 'Do Something' scenarios, during construction, in the opening year and in a future assessment year. For example, assessments might be undertaken for 15 years after opening, or the worst year in the first 15 years of operation.
- 4.6.4 The current implementation strategy proposes that, subject to the DCO being approved by the Secretary of State, main construction works would commence in 2020. The main works would be completed such that the Scheme would become operational in 2022-2023. It is assumed that the Scheme will be used to its maximum capacity from opening, however it is likely that there will be a period of growth in throughput over a number of years before the maximum capacity is reached.
- 4.6.5 Topic specific chapters of this PEIR set out the environmental assessments of the construction and operational effects of the Scheme. The environmental assessment will include consideration of effects arising from the construction and operation of the Scheme. An indefinite design life has been assumed, and the environmental assessment process will therefore not include consideration of decommissioning activities at the end of operational life of the Scheme.

4.7 Identification of potential impacts

- 4.7.1 Schedule 4 Part 1 Regulation 20, of the EIA Regulations requires.
- 4.7.2 'A description of the likely significant effects of the development on the environment, which should cover the direct effects and any indirect, secondary, cumulative, short, medium and long-term, permanent and temporary, positive and negative effects of the development, resulting from:
- The existence of the development;
 - The use of natural resources;
 - The emission of pollutants, the creation of the nuisances and the elimination of waste; and

- The description by the applicant of the forecasting methods used to assess the effects on the environment.

4.7.3 A range of environmental topics may be affected by the Scheme. Impacts may be negative or positive, temporary or permanent. They may also be described as:

- **Direct or Primary Impacts:** caused by activities which are an integral part of the proposals resulting in a change in environmental conditions, such as construction works causing an increase in dust concentrations in the air;
- **Indirect or Secondary Impacts:** due to activities that affect environmental conditions or the receptors, which in turn affects other aspects of the environment or receptors;
- **Cumulative:** comprising multiple effects from different sources within the proposals (synergistic or interrelationships), or cumulatively with other developments (additive), on the same receptors; and
- **Residual:** effects that remain after the positive influence of mitigation measures are taken into account.

4.7.4 Each of these impacts can persist over a period of time and can be considered as:

- **Short term:** effects that would last for a limited duration, for example, noise generated during construction of the Scheme; and
- **Long term:** permanent effects from the operation of the Scheme.

4.8 Assessment of significance

4.8.1 The significance of an environmental effect is typically a function of the 'value' or 'sensitivity' of the receptor and the 'magnitude' or 'scale' of the impact. Combining the environmental value of the resource or receptor with the magnitude of change produces a significance of effect category. In arriving at the significance of effect, the assessor also considers whether the effect is direct, indirect, secondary, cumulative, short, medium or long-term, permanent or temporary, positive or negative.

4.8.2 Methods and requirements specific to each assessment topic are set out in the relevant topic chapters (Chapters 5 to 14), however, the proposed general approach will be adopted in accordance with relevant guidance and best practice.

4.8.3 With the receptors identified and their sensitivity classified, the potential impacts of the proposed works to these aspects, for construction and operation where appropriate, will be determined and the magnitude of the impact determined.

4.8.4 In accordance with guidance in DMRB Volume 11, Part 5, for each topic the assessment will combine the magnitude of the impacts and the sensitivity of the resources/receptors that could be affected in order to classify the effect (see Table 4.1) to establish their significance (from very large to neutral). General descriptors for the significance of effect are provided in Table 4.2.

Table 4.1: Significance of effects

Environmental Value (Sensitivity)	Magnitude of impact (degree of change)					
	Major	National	Major	High Local	Major	Low Local
Very high	Very large	Large or very large	Moderate or large	Slight	Neutral	Very high
High	Large or very large	Moderate or large	Slight or moderate	Slight	Neutral	High
Medium	Moderate or large	Moderate	Slight	Neutral or slight	Neutral	Medium
Low	Slight or moderate	Slight	Neutral or slight	Neutral or slight	Neutral	Low
Negligible	Slight	Neutral or slight	Neutral or slight	Neutral	Neutral	Negligible

Table 4.2: Descriptors of the significance of effect categories

Significance Category	Typical descriptors of effect
Very Large	Only adverse effects are normally assigned this level of significance. They represent key factors in the decision-making process. These effects are generally, but not exclusively, associated with sites or features of international, national or regional importance that are likely to suffer a most damaging impact and loss of resource integrity. However, a major change in a site or feature of local importance may also enter this category.
Large	These beneficial or adverse effects are considered to be very important considerations and are likely to be material in the decision-making process.
Moderate	These beneficial or adverse effects may be important but are not likely to be key decision-making factors. The cumulative effects of such factors may influence decision-making if they lead to an increase in the overall adverse effect on a particular resource or receptor.
Slight	These beneficial or adverse effects may be raised as local factors. They are unlikely to be critical in the decision-making process but are important in enhancing the subsequent design of the project.
Neutral	No effects or those that are beneath levels of perception, within normal bounds of variation or within the margin of forecasting error.

4.8.5 The classification of effects also considers the following descriptors:

- Adverse, neutral or beneficial;
- Permanent or temporary;
- Duration/frequency or likelihood;
- Direct or indirect;
- Secondary; or
- Cumulative.

4.8.6 The duration of the effect will be assessed to be either temporary or permanent where:

- Temporary (e.g. demolition and construction phase):
 - Short term (< 5 years);
 - Medium term (5-10 years); or
 - Long term (> 10 years); and
- Permanent (e.g. once the proposed works are completed and operational).

4.8.7 Whilst the criteria derived vary between disciplines, from a very formal set of criteria based on nationally recognised standards for air quality, to more qualitative criteria derived to assess landscape impact or heritage, each topic assessment has adopted the common terminology alongside any topic-specific guidance, and professional judgement to assess the significance of effects. Where an alternative basis of assessment applies, this is explained in the appropriate chapters.

4.9 Cumulative effects

4.9.1 Schedule 4, Part 1, Regulation 20, of EIA Regulations requires an ES to include the assessment of cumulative effects. Cumulative effects are the result of multiple actions on environmental receptors. There are principally two types of cumulative impact:

- The combined action of a number of different environmental topic specific impacts upon a single resource/receptor (synergistic or interrelationships); and
- The combined action of a number of different projects, in combination with the project being assessed, on a single resource/receptor (additive).

4.9.2 Further details on the scope of the cumulative assessment is provided in Chapter 15.

4.9.3 Schedule 3 Regulation 14(b) of the EIA Regulations refers to the cumulation of impacts with other development. Therefore, the environmental effects of the Scheme will also be assessed in combination with the effects of other projects as part of the EIA process, where relevant information is available. What projects that should be considered as part of a 'cumulative' assessment for these purposes is not defined in the EIA Directive or Regulations and there is no standard approach to the assessment of cumulative effects, with different projects adopting different approaches. The Planning Inspectorate's Advice Note 17 has been used as a basis for identifying categories of development that should be considered in the cumulative assessment.

4.9.4 The cumulative assessment for the Scheme within this PEIR therefore includes developments which fall into the following categories but are not necessarily limited to:

- Trunk road and motorway projects which have been confirmed (i.e. gone through the statutory processes);
- Development projects with valid planning permissions as granted by the Local Planning Authority, and for which formal EIA is a requirement or for

which non-statutory environmental impact assessment has been undertaken;

- Applications for consent which have been made, but which have not yet been determined (see thresholds below);
- Allocated sites in emerging or adopted Local Plans; and
- Other types of application which could have implications for the project.

4.9.5 Using these categories, developments have been identified with reference to local knowledge, published information and consultation with local planning authorities in the area.

4.9.6 Preliminary environmental information for the cumulative effects assessment is provided in each individual topic chapter and the PEIR Volume 1 Chapter 15 Assessment of Cumulative Effects.

4.10 Major accidents and disasters

4.10.1 In line with the new requirements for major accidents and disasters outlined in Article 3(1) of the EIA Directive, the ES will consider:

- Vulnerability of the Scheme to risks of major accidents and/or disasters; and
- Any consequential changes in the predicted effects of that Scheme on environmental topics.

4.10.2 In considering these elements of vulnerability, the ES will:

- Apply professional judgement in consultation with the Overseeing Organisation to develop Scheme specific definitions of major events. It should be noted that there is no definition of 'major' in this context;
- Identify any 'major' events that are relevant to and can affect the Scheme. Major events shall include both man-made and naturally occurring events. Not all events warrant assessment and evidence should be provided to support the view that they should be classified as major events;
- Where Major events are identified, describe the potential for any change in the assessed significance of the Scheme on relevant environmental topics in qualitative terms. Report the conclusions of this assessment within the individual environmental topics; and
- Clearly describe any assumed mitigation measures, to provide an evidence base to support the conclusions and demonstrate that likely effects have been mitigated/managed to an acceptable level.

4.10.3 Major events will be reported within the relevant environmental topic chapters in the ES. Due to the proximity of the Scheme to existing railway, overhead electricity line, and a high-pressure gas main infrastructure, these will be considered in the ES within the relevant topic chapters.

4.11 Dealing with uncertainty

4.11.1 EIA is an iterative process, and the Scheme may include somewhat uncertain aspects. At the time that the ES is submitted, it is proposed that no aspects of design would vary so much as to represent effectively different schemes. The EIA

would ensure it addresses the potential for a range of impacts resulting from any undecided parameters.

- 4.11.2 The Rochdale Envelope principle would be applied in accordance with the Planning Inspectorate's Advice Note 9: Using the Rochdale Envelope (Planning Inspectorate, 2012). The ES will assume the 'worst case' clearly explaining any elements of the Scheme yet to be finalised, with justification. Where flexibility is sought in the scheme design, the maximum potential adverse impacts of the Scheme will be assessed. The ES will confirm maximum and other dimensions of the Scheme, and that any changes to the development within such parameters would not result in significant impacts not previously identified and assessed.

4.12 Transboundary impact screening

- 4.12.1 EIA Regulation 32 requires PINS to notify other European Economic Area (EEA) States and publicise an application for development consent if it is of the view that the proposed development is likely to have significant effects on the environment of another EEA Member State, and where relevant to consult with the EEA State affected. No transboundary effects are anticipated due to distance and the likely magnitude of impacts from the Scheme.

4.13 Habitat Regulations Screening

- 4.13.1 In accordance with the requirements of PINS Advice Note 10: Habitats Regulations Assessment, screening has been undertaken at options stage. The screening indicated that a Habitats Regulations Assessment is not required for this Scheme as there are no European sites with 2 km or sites with bats as the main qualifying feature within 30 km of the Scheme. There are also no sites upstream or downstream or crossed by the Scheme. This will be confirmed with Natural England as part of the Preliminary Design Stage.

4.14 Health Impact Assessment

- 4.14.1 The assessment of the effect of the Scheme on Population and Human Health is a requirement under the 2017 EIA regulations. These aspects are incorporated into the assessments for other topics including Air Quality and Noise. Coverage of health in the ES will not equate to a full Health Impact Assessment (HIA) but will be informed by good practice guidance for HIA. Human health in the ES will principally be assessed in the People and Communities chapter, using the sub-topics scoped into this chapter as a basis for the assessment. Health effects will also be considered in each topic chapter as relevant to that assessment, for example, Air Quality and the effects of the Scheme on health issues relating to air quality.

Volume 1

Chapters 5 - 15

5. Air Quality

5.1 Introduction

- 5.1.1 This chapter provides the preliminary assessment for air quality, based upon information available as of September 2018. It identifies the air quality study area, methodology, presents the baseline conditions, identifies the potential impacts on air quality associated with the Scheme during construction and operation, and presents mitigation measures that are recommended to mitigate any potentially significant adverse effects.
- 5.1.2 The following factors have been specifically taken into account in this preliminary assessment:
- The assessment has been based on the air quality assessment of the Scheme as assessed at Option Selection Stage (Option 5F), as the final design and traffic modelling have not yet been completed;
 - The study area for this preliminary assessment is based on preliminary traffic modelling which has been updated since the Option Selection Stage;
 - Details of changes in traffic during the construction phase are currently not known, but will be assessed once this information is available; and
 - The results from the Option Selection Stage are presented. These will be updated in the final ES when a final design is confirmed and the associated traffic model is completed.

5.2 Study area

- 5.2.1 The air quality assessment study area is defined in accordance with the Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3, Part 1 HA 207/07 'Air Quality' (DfT,2007).
- 5.2.2 The air quality study area for assessing the potential effects of construction dust during the construction phase is defined as the area within 200 m of the construction site, as set out in DMRB HA 207/07 (paragraph 3.45).
- 5.2.3 The air quality study area for assessment of construction traffic and during the operational phase is determined in accordance with traffic change criteria set out in the DMRB HA 207/07 which defines affected road networks (ARN) for local (paragraph 3.12) and regional (paragraph 3.20) air quality assessments. An air quality assessment is required for local air quality where there are receptors identified within 200 m of the ARN.
- 5.2.4 The Scheme is situated within the administrative boundaries of Brentwood Borough Council and London Borough of Havering. For the purposes of this assessment, the air quality study area is based on preliminary outputs of strategic traffic modelling. The provisional ARN includes the area within 200 m of the Scheme extent, including the M25 Junction 28, the M25 north and south of Junction 28 and the A12. The provisional ARN and thus the air quality study area is the same as that presented at the Option Selection Stage. The ARN will be reviewed in the ES on the basis of the final strategic traffic modelling to be undertaken to inform the Preliminary Design Stage.

5.3 Planning and policy context

Air quality criteria

- 5.3.1 There are two sets of ambient air quality criteria for the protection of public health: legally binding, mandatory limit values set by the European Union (EU); and objectives set out in the Air Quality Strategy for England, Scotland, Wales and Northern Ireland (AQS) (Defra, 2007) which local authorities are required to work towards achieving. Both sets of criteria are implemented in Air Quality Regulations (The Air Quality Standards Regulations 2010 (SI 2010/1001) (The National Archives, 2010) for EU limit values, and The Air Quality (England) Regulations (SI 2000/928) (The National Archives, 2000) as amended ((SI 2002/3043) (The National Archives, 2002) for AQS objectives)). Air quality criteria relevant to the air quality assessment are summarised in Table 5.1, and for nitrogen dioxide (NO₂) and particulate matter (PM₁₀) are the same criteria for both the EU limit values and the AQS objectives.

Table 5.1: Relevant human health air quality criteria

Pollutant	Criteria
NO ₂	1-hour mean concentration should not exceed 200 µg/m ³ more than 18 times a year
	Annual mean concentration should not exceed 40 µg/m ³
PM ₁₀	24-hour mean concentration should not exceed 50 µg/m ³ more than 35 times a year
	Annual mean concentration should not exceed 40 µg/m ³

Table Source: Defra (2007) The Air Quality Strategy for England, Scotland, Wales and Northern Ireland

Ecological criteria

- 5.3.2 The EU has set a critical level for annual mean concentrations of nitrogen oxides (NO_x) to protect sensitive vegetation. This is included in the Air Quality Standards Regulations (SI 2010/1001). Assessment of compliance with this critical level is undertaken at locations more than 20 km from towns with more than 250,000 inhabitants or more than 5 km from other built-up areas, industrial installations or motorways or major roads with traffic counts of more than 50,000 vehicles per day. UK statutory nature conservation agencies' (Natural England) policy is to apply the limit value of 30 µg/m³, on a precautionary basis, as a benchmark only in all designated conservation sites, including 'Ramsar' sites, Special Protection Areas (SPAs), Special Areas of Conservation (SACs) and Sites of Special Scientific Interest (SSSIs).
- 5.3.3 Critical loads for nitrogen deposition have been set by the United Nations Economic Commission for Europe (UNECE). A critical load is a quantitative estimate of an exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur, according to present knowledge. Critical loads vary by type of habitat and species. The critical load for deposition (eutrophication) is given as a range and is quoted in units of kg/ha/year. A single critical load is quoted for acidification, in units of kq/ha/year.

Dust deposition

- 5.3.4 There are no national standards or guidelines for dust deposition currently set for the UK, nor by the European Union or World Health Organisation (WHO). This is mainly due to the difficulty in setting a standard that would need to relate to dust being a perceptual problem rather than being specifically related to health effects. Typically, assessments use an indicative threshold for the 'likelihood of complaint' for instance, in residential areas this would be a dust deposition flux (as an average measured over a month using a passive deposition gauge) of 200 mg/m²/day or greater.
- 5.3.5 Appendix E in Volume 2 summarises the legislation, regulatory and policy framework applicable to air quality.

5.4 Methodology

Overview

- 5.4.1 The air quality assessment at Option Selection Stage was undertaken in line with DMRB HA207/07 and associated IANs, and has consisted of:
- Discussion of existing baseline conditions;
 - Identification of sensitive receptors and AQMAs, and production of constraints maps;
 - Assessment of the likely changes in local air pollutant concentrations at selected human health receptors during operation;
 - Assessment of the likely changes in regional emissions during operation; and
 - Identification of the need for mitigation measures where appropriate.

Existing Air Quality Information

- 5.4.2 A summary of existing air quality has been provided which updates the information previously collated for the scoping report and updated accordingly.

Constraints map

- 5.4.3 A constraints map (Figure B-1 in Appendix B) for the Scheme air quality study area has been produced, based on the latest available information. The constraints map includes: affected roads, 200 m boundary from affected roads, sensitive receptors, AQMA boundaries and exceedance areas of air quality criteria without and with the Scheme where known.

Effects on local air quality during construction

- 5.4.4 A qualitative assessment of impacts on air quality from construction has not yet been undertaken due to the limited information currently available on the proposals for construction of the Scheme.

Effects on local and regional air quality during operation

- 5.4.5 An air quality assessment has been undertaken principally following the guidance given in the DMRB and associated IANs. A detailed assessment has been undertaken using dispersion modelling software to calculate NO₂ and PM₁₀ concentrations at selected human health receptors in the Scheme opening year, due to the complexity of the Scheme and the potential for significant effects. A simple level of assessment was undertaken for regional emissions of NO_x, PM₁₀ and CO₂ for the opening and design years.
- 5.4.6 PM_{2.5} was not included in the assessment as there is not considered to be a risk of the annual mean air quality criterion being exceeded. This is explained in more detail in Appendix E in Volume 2. However, measured concentrations at nearby monitoring sites are included in the baseline conditions section for information.
- 5.4.7 The key scenarios included in the assessment at the Option Selection Stage were:
- Base year (2014) for model verification purposes;
 - Projected base year (2022);
 - Opening year for both the without (Do-Minimum (DM)) and with Scheme (Do-Something (DS)) (2022); and
 - Design year DM and DS (2037) - regional emissions only.
- 5.4.8 Traffic data was provided from the Scheme VISSIM traffic model (provided by Atkins transport planners) for the air quality assessment at Option Selection Stage to enable the ARN for the local and regional air quality assessments to be determined.
- 5.4.9 An affected road for the purposes of a local air quality assessment is defined in DMRB HA 207/07 (Para 3.12) as a road that meets any of the following criteria:
- Road alignment will change by 5 m or more; or
 - Daily traffic flows (two way) will change by 1,000 annual average daily traffic (AADT) or more; or
 - Heavy Duty Vehicle (HDV) flows (two way) will change by 200 AADT or more; or
 - Daily average speed (two way) will change by 10 km/hr or more; or
 - Peak hour speed will change by 20 km/hr or more.
- 5.4.10 An affected road for the purposes of a regional air quality assessment is defined in DMRB HA 207/07 (Para 3.20) as a road that meets any of the following criteria:
- A change of more than 10% AADT; or
 - A change of more than 10% to the number of HDVs; or
 - A change in daily average speed of more than 20 km/hr.
- 5.4.11 The changes are applied to roads, rather than modelled links, and so where relevant are determined under two-way traffic conditions.

Local air quality

- 5.4.12 The local air quality assessment was undertaken using the Atmospheric Dispersion Modelling System (ADMS) Roads dispersion modelling software. Representative receptors were selected for the local air quality assessment and included those closest to the ARN. Sensitive human health receptors for the purposes of air quality assessment are defined in HA 207/07 (paragraph 3.13) and include residential properties, locations of susceptible populations e.g. schools, hospitals and care homes for the elderly, or any other location where a member of the public may be exposed to an air pollutant for the relevant regulated time period.
- 5.4.13 The traffic data required for input into the dispersion model included: AADT, the percentage of HDV, and speeds which were input as a speed category, as determined in accordance with IAN 185/15 on speed banding. Data was provided for the am, pm, inter and off-peak periods. Other information required for input included the road geometry including orientation, length, and width of links, and local meteorological data.
- 5.4.14 The output from the model was used to provide estimates of the contribution from road traffic emissions to annual mean concentrations of NO_x and PM₁₀ at discrete receptors. These incremental concentrations were combined with estimates of background concentrations, to account for other sources of air pollution, to derive total annual mean concentrations. Background concentrations were derived from Defra's background maps and were checked with monitored data at background sites in the area where available, to ensure the mapped estimates were appropriate. No adjustment was considered to be necessary, at Options Selection Stage.
- 5.4.15 Concentrations of NO₂ were derived from NO_x concentrations using Defra's NO_x to NO₂ calculator version 5.1, June 2016, the latest available at the time of the assessment. The annual mean NO₂ and PM₁₀ concentrations were verified with comparison against available ratified monitoring data and adjusted where appropriate, with reference to Defra's LAQM.TG (16).
- 5.4.16 In addition, an assessment was undertaken in accordance with IAN 170/12 v3 on the assessment of future NO_x and NO₂ projections on long term trends, to account for future year uncertainties in emissions.
- 5.4.17 Evaluation of compliance with EU limit values was undertaken in accordance with IAN 175/13 (DfT, 2013b).
- 5.4.18 Evaluation of the significance of the effect of the Scheme on local air quality was undertaken in accordance with IAN 174/13 (DfT, 2014).

Regional emissions

- 5.4.19 An assessment of regional emissions of NO_x, PM₁₀ and CO₂ was undertaken in accordance with DMRB HA 207/07 to determine the pollutant emissions for the ARN. Emissions calculations was undertaken using emission rates derived from IAN 185/15 on speed banding. The key scenarios for assessment were:
- Base year (2014);
 - Opening year (2022), for both the without (DM) and with Scheme (DS) cases; and

- Design year (2037), for both the DM and DS cases.

Assumptions and limitations

5.4.20 Any air quality model has inherent areas of uncertainty, including:

- The traffic data used in the air quality model;
- The suitability of emissions data;
- Simplifications in model algorithms and empirical relationships that are used to simulate complex physical and chemical processes in the atmosphere;
- The suitability of background concentrations; and
- The suitability of meteorological data.

5.4.21 Uncertainty associated with traffic data have been minimised by using a validated traffic model.

5.4.22 Uncertainties associated with emissions data have been minimised by using the most up to date speed-band emission factors available, and by applying IAN 170/12 v3 for long term trends.

5.4.23 Uncertainties associated with model algorithms and empirical relationships have been minimised by using algorithms and relationships that have been independently validated and judged as fit for purpose.

5.4.24 Another uncertainty is with using historical meteorological data to estimate future concentrations. The key limiting assumption is that conditions in the future will be the same as in the past; however, in reality no two years are the same. In line with best practice, the base year meteorology (as used in the model verification and adjustment process) has been used in future year modelling to allow any adjustments to be applied in future cases.

5.5 Consultation

5.5.1 Brentwood Borough Council and the London Borough of Havering Environmental Health Officers have been consulted in relation to current AQMAs and to obtain relevant air quality data. Further consultation with the local authorities will be undertaken at ES stage to ensure all relevant receptors are included in the assessment.

5.6 Baseline conditions

5.6.1 Information on existing ambient air quality i.e. baseline conditions, and identification of potential air quality constraints to the Scheme have been determined through reference to the following sources:

- Air Quality Management Area (AQMA) mapping (Defra, 2017a);
- Department for Environment, Food and Rural Affairs (Defra) Pollution Climate Mapping (PCM) model data for the latest available year (2015);
- Highways England project specific nitrogen dioxide (NO₂) diffusion tube survey data (Connect Plus, 2017);

- Local Authority Local Air Quality Management (LAQM) Reports (London Borough of Havering, 2017; Brentwood Borough Council 2017);
- Ordnance Survey (OS) base mapping to identify locations of sensitive receptors (residential properties, schools, hospitals and elderly care homes); and
- Figure B-1 in Appendix B which shows the air quality constraints within the Scheme study area.

Pollutants

5.6.2 The air pollutants of concern in the context of the local air quality assessment for the Scheme are nitrogen dioxide (NO₂) and fine particulate matter (PM₁₀), as these pollutants are most likely to be present in ambient air at concentrations close to or above statutory limit values at receptors near to roads. In addition, the regional assessment of vehicle emissions associated with the Scheme considers oxides of nitrogen (NO_x), PM₁₀ and carbon dioxide (CO₂). Air quality criteria are provided in Table 5.1. PM_{2.5} is not required to be assessed as discussed in Appendix E in Volume 2, however information on measured concentrations is provided in this section for information purposes. Further information on pollutants is provided below.

Nitrogen Dioxide

5.6.3 NO₂ is a secondary pollutant produced by the oxidation of nitric oxide (NO). NO and NO₂ are collectively termed NO_x. About a quarter of the UK NO_x emissions are from road transport. The majority of NO_x emitted from vehicles is in the form of NO, which oxidises rapidly in the presence of ozone (O₃) to form NO₂. In high concentrations, NO₂ can affect the respiratory system and can also enhance the response to allergens in sensitive individuals. Additionally, there is an increasing awareness of an association between long-term average concentrations (chronic exposure) of NO₂ and mortality (COMEAP, 2015). NO does not have any observable effect on human health at the range of concentrations found in ambient air.

Particulate matter

5.6.4 The principal sources of 'primary' polluting particles are combustion processes, which include traffic and industry. Road transport produces 13% of primary PM₁₀ emissions in the UK, of which the majority of emissions are from diesel engines. Finer fractions of particulate matter appear to be associated with a range of symptoms of ill health including effects on the respiratory and cardiovascular systems, on asthma and on mortality.

Carbon dioxide (CO₂)

5.6.5 CO₂ is a greenhouse gas and is used as an indicator of the wider scale, non-local effects of transport schemes. CO₂ does not affect human health or ecology at ambient levels and so is not significant as a local pollutant but is important for its national and international role in climate change.

Other pollutants

- 5.6.6 National assessments have demonstrated that there is no risk of exceedance of the air quality objectives set for 1,3-butadiene, benzene, carbon monoxide, lead or sulphur dioxide due to emissions from traffic anywhere in the UK. These pollutants are therefore not considered further as there is not considered to be a potential for significant effects associated with these pollutants.
- 5.6.7 In addition to these air pollutants, dust may be generated during the construction phase in areas adjacent to the Scheme. Dust per se is not considered as a local air pollutant but may cause a perceived loss of amenity and can give rise to soiling (dust deposition).

Local Air Quality Management

- 5.6.8 There are three AQMAs designated within the Brentwood Borough Council administrative area. All of these AQMAs have been declared for exceeding the annual mean NO₂ objective. The Scheme is within AQMA No. 2 for Brook Street. Based on the indicative ARN it is unlikely that the other AQMAs will be affected. The other AQMAs within this borough were revoked in 2017.
- 5.6.9 London Borough of Havering has declared its entire borough an AQMA for exceeding the annual mean NO₂ AQS objective and the 24-hour mean PM₁₀ AQS objective. The Scheme is also located within this AQMA.
- 5.6.10 Details of the AQMAs are provided in Table 5.2 and shown in Figure B-1 in Volume 3.

Table 5.2: Description of AQMAs

Local Authority	Name	Air Quality Criteria Exceeded	Description
Brentwood Borough Council	AQMA No. 2	NO ₂ annual mean	The AQMA comprises parts of Brook Street, Brentwood and the A12.
	AQMA No. 4	NO ₂ annual mean	An area encompassing the Bean Interchange between the A2 and A296. The AQMA comprises parts of Warescot Road, Hurstwood Avenue and Ongar Road, Brentwood and the A12.
	AQMA No. 7	NO ₂ annual mean	The AQMA comprises parts of Ongar Road, Ingrave Road, High Street and Shenfield Road, Brentwood in proximity to Wilsons Corner (the junction of the A128 and A1203).
London Borough of Havering	Havering AQMA	NO ₂ annual mean PM ₁₀ 24-hour mean	An area encompassing the entire Borough of Havering.

Defra pollution climate mapping (PCM)

- 5.6.11 Defra's PCM model outputs are used in annual reporting to the EU regarding compliance with the limit values. This model provides projections of roadside NO₂ concentrations across the UK in the years 2017 to 2030 for the development of the

UK plan for tackling roadside nitrogen dioxide concentrations and annual reporting to the EU regarding compliance with the limit values. The modelled roadside concentration comprises a background component together with a roadside increment.

- 5.6.12 Not all roads are included within the PCM model. In the vicinity of the air quality study area, Defra's PCM model only includes the A12 east and west of Junction 28 and the A1023 Brook Street. For 2015, the most recent reference year of the model, there were roadside exceedances of the annual mean NO₂ EU limit value of 40 µg/m³ on the A12 both east and west of Junction 28, but not on the A1023. However by the opening year, the roadside concentrations were projected to be below the EU limit value. Defra PCM links for 2015 are illustrated in Figure B-1.

Air quality monitoring

- 5.6.13 Air quality monitoring data from continuous monitoring stations (CMS) and passive diffusion tubes in and close to the air quality study area are described below.

Highways England Air Quality Monitoring

- 5.6.14 Connect Plus have measured NO₂ concentrations using diffusion tubes at a number of sites around the M25 on behalf of Highways England. The survey commenced in September 2013. One of the sites (CP7) is located close to the Scheme. The annual mean NO₂ concentrations for this monitoring site between September 2014 and 2015 are tabulated in Table 5.3. The results show that measured pollutant concentrations at site CP7 exceeded the NO₂ annual mean AQS objective during all three monitoring periods. Site CP7 is located at the junction of Brook Street (A1023) with the M25 Junction 28, with relevant exposure within 50 m.

Table 5.3: Connect Plus annual mean NO₂ diffusion tube monitoring results (µg/m³)

Site ID	X	Y	Sept 2013-Sept 2014	Sept 2014-Sept 2015	Sept 2015-Sept 2016
CP7	556913	192380	40.2	40.8	46.9

- 5.6.15 Highways England also conducted a six month diffusion tube survey between February and August 2016 to inform the assessment of the Scheme. The survey consisted of 25 diffusion tubes located near to Junction 28 at predominantly roadside sites. The results have been annualised, following analysis of data from three urban background continuous monitoring stations within 50 miles of the Scheme (Redbridge Ley Street, Thurrock, and Barking and Dagenham Scrattons Farm) in accordance with LAQM (TG(16)) to represent a full data capture for the year 2015, which will be the base year for the air quality assessment at Preliminary Design Stage. The annualised results were then adjusted using a factor of 0.91 derived from Defra's bias adjustment spreadsheet (version 09/17) for diffusion tubes prepared by Staffordshire Scientifics Group using 20% triethanolamine (TEA) in water. The results are provided in Table 5.4 and Figure B-1. The results show that the NO₂ annual mean AQS objective of 40 µg/m³ was exceeded at two sites in 2015. Both sites (HE01 (~5 m from road edge), and HE22 (~10 m from road edge)) are located on Brook Street close to M25 Junction 28 and within the Brentwood Borough Council AQMA No.2.

Table 5.4: Highways England diffusion tube monitoring results (NO₂)

Site ID	HE Site ID	X	Y	Unadjusted 2016 average (Feb – Aug)	2015 adjusted NO ₂ concentration (µg/m ³)
HE01	M25J28I_001_0116	557030	192496	65.2	58.0
HE02	M25J28I_002_0116	557531	192749	43.5	36.9
HE03	M25J28I_003_0116	557043	191854	31.4	27.9
HE04	M25J28I_004_0116	557162	191987	31.7	28.2
HE05	M25J28I_005_0116	556788	191618	29.9	26.6
HE06	M25J28I_006_0116	557956	192219	26.8	23.8
HE07	M25J28I_007_0116	557001	193790	30.4	27.0
HE08	M25J28I_008_0116	555057	194239	21.0	18.9
HE09	M25J28I_009_0116	553977	194554	23.0	20.5
HE10	M25J28I_010_0116	554061	193978	31.1	27.5
HE11	M25J28I_011_0116	554371	193091	22.8	20.3
HE12	M25J28I_012_0116	554868	192605	23.5	20.9
HE13	M25J28I_013_0116	556000	191900	41.8	37.2
HE14	M25J28I_014_0116	555631	191678	40.6	36.1
HE15	M25J28I_015_0116	555801	191784	43.1	38.4
HE16	M25J28I_016_0116	557925	192992	32.1	28.6
HE17	M25J28I_017_0116	557313	190348	40.1	36.5
HE18	M25J28I_018_0116	557724	190420	27.0	24.0
HE19	M25J28I_019_0116	557744	190009	27.9	24.8
HE20	M25J28I_020_0116	555392	192385	23.5	21.0
HE21	M25J28I_021_0116	557693	193181	33.4	29.7
HE22	M25J28I_022_0116	556933	192382	50.9	45.4
HE23	M25J28I_023_0116	557416	192880	34.4	29.3
HE24	M25J28I_024_0116	557177	193141	25.6	22.6
HE25	M25J28I_025_0116	553917	191852	25.2	22.5

Values in **bold** exceed the AQS objective

Local Authority air quality monitoring

Continuous Monitoring

5.6.16 Table 5.5 below provides the annual mean NO₂ concentrations from the CMS sites within Brentwood Borough Council and London borough of Havering between 2013 and 2017. The results show that NO₂ concentrations were below the annual mean AQS objective of 40 µg/m³ at both Rainham and Brentford Council Office CMS, however exceedances were recorded at Romford CMS in 2014 and 2017.

The 1-hour mean AQS objective was met in all years at all sites other than one exceedance at Romford in 2017.

5.6.17 Table 5.5 below provides the annual mean NO₂ concentrations from the CMS sites within Brentwood Borough Council and London borough of Havering between 2011 and 2016. The results show that NO₂ concentrations were below the annual mean AQS objective of 40 µg/m³ at both Rainham and Brentwood Council Office CMS, however exceedances were recorded at Romford CMS in 2014 and 2016. The 1-hour mean AQS objective was met in all years at all sites.

Table 5.5: Annual mean NO₂ concentrations from continuous monitoring stations (µg/m³), 2013 – 2017

Site ID	Local Authority	Site Type	X, Y	2013	2014	2015	2016	2017
BRW1 Council Office	Brentwood Borough Council	Urban Background	559860, 193617	25.0	22.5	24.0	24.5	22.2
HV1 Rainham	London Borough of Havering	Roadside	553127, 182506	30.2	35.3	32.0	34.0	34.3
HV3 Romford	London Borough of Havering	Roadside	551108, 188257	34.0	57.5 *	35.0	38.0	40.0

-data not available / monitoring not undertaken; * data capture below 75%.
Exceedances of annual mean NO₂ UK AQS objective are highlighted in bold.
Data have been sourced from local authority reports and London Air Quality Network.

5.6.18 Table 5.6 provides the ratified annual mean PM₁₀ concentrations from the CMS in London borough of Havering between 2013 and 2017. Table 5.7 shows the number of exceedances of 24-hour mean PM₁₀ objective at the CMS in London borough of Havering between 2013 and 2017. PM₁₀ concentrations were below both the annual mean and daily mean AQS objectives in all years at both sites.

Table 5.6: Annual mean PM₁₀ monitoring results (µg/m³), 2013 – 2017

Site ID	Local Authority	Site Type	X, Y	2013	2014	2015	2016	2017
HV1 Rainham	London Borough of Havering	Roadside	553127, 182506	-	19.0	18.0	19.0	18.0
HV3 Romford	London Borough of Havering	Roadside	551108, 188257	24.0	25.0	24.0	15.0	19.0

- data not available / monitoring not undertaken;
Data have been sourced from local authority reports and London Air Quality Network.

Table 5.7: Number of exceedances of 24-hour mean PM₁₀ Objective 2013 – 2017

Site ID	Local Authority	Site Type	X, Y	2013	2014	2015	2016	2017
HV1 Rainham	London Borough of Havering	Roadside	553127, 182506	-	3	3	6	4
HV3 Romford	London Borough of Havering	Roadside	551108, 188257	6	11	9	5	-

- data not available / monitoring not undertaken;
Data have been sourced from local authority reports and London Air Quality Network.

5.6.19 Table 5.8 provides the ratified annual mean PM_{2.5} concentrations from the CMS in London Borough of Havering between 2013 and 2017. PM_{2.5} concentrations were below the annual mean AQS objective of 25 µg/m³ in all years for which data was available.

Table 5.8: Annual mean PM_{2.5} monitoring results (µg/m³), 2013 – 2017

Site ID	Local Authority	Site Type	X, Y	2013	2014	2015	2016	2017
HV1 Rainham	London Borough of Havering	Roadside	553127, 182506	-	12.0	11.0	12.0	12.0

- data not available / monitoring not undertaken;
Data have been sourced from local authority reports and London Air Quality Network.

Passive Monitoring

5.6.20 Passive monitoring of NO₂ using diffusion tubes has been undertaken by both local authorities. A summary of the Brentwood Borough Council and London borough of Havering monitoring data from 2013 to 2017 (where available) at sites close to the Scheme are presented in Table 5.9 and Figure B-1. Annual mean NO₂ concentrations exceeded the AQS objective of 40 µg/m³ at a number of sites in Brentwood Borough Council and London Borough of Havering, including in 2017. One of these exceedances is located in the study area (BRW 5) located between the A12 westbound off slip and Brook Street. Other exceedances to note include HAV37 adjacent to the A12 just west of the study area and BRW 40 and BRW 41 adjacent to the A1023 towards the urban centre of Brentwood.

Table 5.9: Bias adjusted annual mean NO₂ diffusion tube monitoring Results (µg/m³)

Site ID	Site Type	X, Y	2013	2014	2015	2016	2017
Brentwood Borough Council							
BRW 1/2/3	Urban Background	559861,193617	29.3	22.7	23.2	24.5	25.3
BRW 5	Roadside	556887,192412	45.9	40.0	42.7	46.0	47.0
BRW 6	Roadside	557014,192493	37.7	33.1	38.1	39.3	37.6

Site ID	Site Type	X, Y	2013	2014	2015	2016	2017
BRW 7	Roadside	557118,191978	27.5	24.5	26.0	26.6	29.6
BRW 8	Roadside	559691,193912	44.2	35.6	35.6	40.5	36.5
BRW 9	Roadside	559643,193889	40.5	32.1	32.7	33.5	35.1
BRW 10	Roadside	559699,193948	45.8	36.2	36.6	41.2	40.0
BRW 11	Roadside	559604,194035	34.2	28.0	32.8	37.0	35.5
BRW 12	Roadside	559187,193658	32.3	26.9	27.4	30.6	28.2
BRW 14	Roadside	559148,193660	44.0	33.4	35.0	38.0	37.1
BRW 15	Roadside	559085,193601	26.4	20.7	21.9	23.2	22.7
BRW 16	Urban Background	557379,192900	32.5	26.7	27.2	29.1	31.4
BRW 17	Roadside	557632,193151	29.7	24.5	26.5	30.3	29.6
BRW 18	Urban Background	557826,193333	26.7	23.2	23.5	25.4	26.3
BRW 19	Roadside	558769,194873	33.1	26.7	26.1	29.6	29.2
BRW 20	Kerbside	558818,194913	43.6	28.0	31.5	39.0	36.6
BRW 21	Roadside	558681,194799	29.6	23.9	23.6	26.5	27.1
BRW 22	Roadside	558683,194894	38.3	33.0	31.6	35.1	34.5
BRW 23	Roadside	558742,194928	43.2	35.9	34.5	38.9	39.5
BRW 24	Roadside	558624,194695	30.8	25.2	25.5	28.5	27.9
BRW 25	Roadside	558482,194547	32.7	27.2	26.5	30.8	32.9
BRW 26	Roadside	562278,196649	35.4	28.3	29.6	29.9	32.1
BRW 28	Urban Background	564446,199509	29.0	22.6	24.2	25.5	31.7
BRW 29	Roadside	564617,199849	30.4	23.6	27.1	27.5	28.2
BRW 30	Roadside	564654,199898	34.5	26.8	29.0	32.4	30.0
BRW 31	Roadside	565186,200071	32.4	24.1	26.6	27.3	27.5
BRW 32	Urban Background	556964,192288	34.9	30.0	32.6	33.1	35.8
BRW 33	Urban Background	559139,195012	28.1	22.1	23.5	26.0	23.7
BRW 34	Roadside	557719,193226	30.2	25.1	26.4	28.7	29.8
BRW 36	Rural	556603,194628	18.7	15.8	15.8	16.9	18.7
BRW 37	Roadside	558800,194947	93.5	76.8	71.6	86.1	88.8
BRW 38	Roadside	563659,198314	24.9	21.7	19.6	21.2	20.6
BRW 39	Roadside	562412,189153	34.6	26.9	29.5	38.3	31.0
BRW 40	Kerbside	559191,193681	-	-	41.0	41.7	44.1
BRW 41	Kerbside	559292,193710	-	-	45.8	36.4	45.6
London Borough of Havering							
HAV2, 5, 6	Urban Centre	551488,188993	55.8	54.0	51.7	55.9	51.1
HAV1, 7, 8	Urban Centre	551108,188257	44.0	40.6	39.0	40.7	40.3
HAV3	Urban Background	551726,183462	28.6	32.9	28.3	29.0	31.7

Site ID	Site Type	X, Y	2013	2014	2015	2016	2017
HAV4	Urban Background	553724,187560	19.5	24.5	20.1	26.0	20.1
HAV9, 10, 11	Urban Centre	551629,188296	-	33.3	30.7	33.1	29.6
HAV12	Roadside	552096,189619	-	36.8	37.4	43.0	41.6
HAV13, 14, 15	Roadside	550607,189685	-	39.1	39.4	41.7	40.5
HAV 16, 17, 18	Roadside	551414,187802	-	34.2	34.7	36.5	39.8
HAV19, 20, 21	Kerbside	549837,191109	-	45.6	44.8	44.8	49.2
HAV22, 23, 24	Urban Background	553707,190817	-	25.8	26.6	28.3	30.4
HAV25	Urban Background	553727,193161	-	23.3	22.9	24.7	26.6
HAV26	Urban Background	549532,189777	-	21.1	22.7	23.8	27.3
HAV27, 28, 29	Kerbside	550942,187420	-	47.8	47.6	52.3	54.1
HAV30	Urban Background	549318,189384	-	21.8	24.8	24.0	29.1
HAV31	Industrial	550197,187908	-	26.1	27.1	29.1	30.6
HAV32, 33, 34	Kerbside	553410,190558	-	51.6	55.0	53.2	52.9
HAV35	Urban Background	554204,193795	-	23.4	24.2	27.7	27.2
HAV36	Rural	551755,193022	-	15.7	21.1	21.8	23.9
HAV37	Kerbside	555723,191750	-	49.8	48.2	55.3	55.3
HAV 38	Roadside	553434,191656	-	22.2	21.5	24.8	25.3
HAV39	Roadside	551616,190622	-	31.1	33.3	31.3	38.8
HAV40	Roadside	553174,190306	-	48.1	49.5	45.1	52.1
HAV41	Roadside	552517,189826	-	43.0	45.0	46.2	49.6
HAV42	Kerbside	550623,188890	-	32.3	31.4	31.7	31.6
HAV43	Roadside	556072,186539	-	35.0	38.2	35.9	35.6
HAV44	Kerbside	553952,189731	-	37.7	37.1	37.9	36.7
HAV45	Kerbside	552327,187422	-	37.2	35.7	40.7	37.7
HAV46	Kerbside	552441,182337	-	32.9	31.3	34.5	33.0
HAV47	Roadside	554730,189487	-	48.5	42.0	46.5	42.3
HAV48	Urban Background	550602,189990	-	27.3	28.4	30.7	37.8
HAV49	Roadside	550722,183294	-	29.1	26.8	27.9	28.0
HAV50	Kerbside	551526,182672	-	38.3	41.1	42.2	46.1
HAV51	Urban Background	551180,189432	-	26.5	24.3	24.1	24.9
HAV52	Roadside	554741,190626	-	37.5	34.3	37.3	47.8
HAV53, 54, 55	Urban Background	553671,192074	-	25.3	22.9	23.6	-
HAV56	Kerbside	552047,182357	-	49.9	40.4	48.1	44.1
HAV57	Urban Centre	551420,188526	-	63.1	59.0	62.9	61.0
HAV58, 59, 60	Urban Centre	551397,188509	-	84.7	75.2	69.1	71.7

5.7 Potential impacts

5.7.1 The Scheme has the potential to affect local air quality, both during construction and operation.

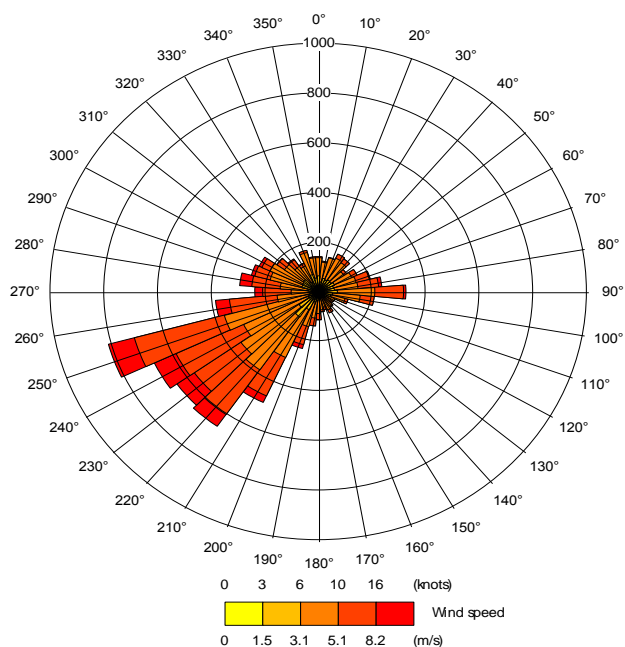
Construction

Dust emissions

5.7.2 There is the potential for elevated dust deposition and soiling at properties within 200 m of the indicative construction site boundary due to the works, if dust raising activities are not effectively controlled and mitigated. The level and distribution of dust emissions would vary according to the duration and location of activity, weather conditions, and the effectiveness of suppression measures.

5.7.3 The prevailing winds recorded at London City Airport meteorological station (approximately 18.5 km south west of the Scheme) are from the south-west as shown in the windrose in Figure 5.1. The highest windspeeds are also recorded from this direction. This suggests that the wind is more likely to transport dust raised on site towards the north east of the construction works. Figure B-2 in Volume 3 shows the area potentially likely to be affected by construction dust. Receptors to the north east of the construction works include properties near Brook Street, and Vicarage Wood ancient woodland.

Figure 5.1: Windrose for London City Airport meteorological station (2015)



Construction Traffic

5.7.4 An increase in vehicle movements is expected during the construction period, as a result of workers and heavy goods vehicles (HGVs) travelling to and from site. At this stage, the numbers of expected vehicle movements are not yet known, so cannot be quantitatively assessed. It is also not yet known if existing traffic will need to be diverted during the construction phase, or if any traffic management

measures will be required, so no assessment has been undertaken to date. However, any impact would be expected to be less than that during operation. This will be examined once information related to changes in traffic movements is available.

Operation

Local air quality

- 5.7.5 Concentrations have been estimated for the opening year at six selected human health receptors. Details of the receptors are provided in Table 5.10, and locations shown on Figure B-1. The estimated pollutant concentrations at human health receptors assessed at Option Selection Stage are provided in Table 5.10 and Table 5.11 for annual mean NO₂ and PM₁₀ concentrations respectively.
- 5.7.6 Concentrations of NO₂ were estimated in accordance with IAN 170/12 v3 (LTTE6), as this approach was considered the most realistic for estimating future concentrations, taking into account long term trends. Concentrations of both NO₂ and PM₁₀ were compared with relevant UK AQS objectives to determine whether there are likely to be any exceedances.
- 5.7.7 There are not expected to be any exceedances of the NO₂ annual mean AQS objective in any scenario. The highest annual mean NO₂ concentration was estimated at receptor 2, with a concentration of 31.9 µg/m³ in all scenarios. All changes in NO₂ concentrations expected with the Scheme are expected to be imperceptible.
- 5.7.8 There are not expected to be any exceedances of the PM₁₀ annual mean AQS objective, and all changes are expected to be imperceptible.

Table 5.10: Selected human health receptor locations included at Option Selection Stage

Receptor		X	Y
1	61 Brook Street, Brentwood, CM14 5NA	557024	192497
2	The Poplars, 60 Brook Street, Brentwood, CM14 5ND	556960	192279
3	Southern façade of Holiday Inn Brentwood, Brook Street, Brentwood, CM14 5NF	557183	192614
4	Northern façade of Holiday Inn Brentwood, Brook Street, Brentwood, CM14 5NF	557177	192691
5	63 Brook Street, Brentwood, CM14 5NA	557013	192492
6	Grove Farm, Brook Street, Brentwood, CM14 5NG	556627	192397

Table 5.11: Estimated annual mean NO₂ concentrations at selected receptors

Receptor ID	Receptor Co-ordinates		2014	LTT Adjusted 2022 Annual Mean NO ₂ Concentrations (µg/m ³) [1]		Difference between Projected Do-Something and Do-Minimum Concentration
	X (m)	Y (m)	Mean NO ₂ Concentration (µg/m ³)	Do-Minimum	Do-Something	
1	557024	192497	35.3	27.6	27.5	-0.1
2	556960	192279	41.5	31.9	31.9	0.0
3	557183	192614	28.8	22.1	22.0	-0.1
4	557177	192691	29.2	22.3	22.3	0.0
5	557013	192492	34.4	26.8	26.7	-0.1
6	556627	192397	40.9	30.7	30.7	0.0

[1] LTTE6=Long Term Trend. Estimated NO₂ concentrations were adjusted using a Gap Factor based on the LTTE6 factor calculated by the Highways England's "INTERIM Highways Agency Alternative Long Term Gap Analysis Calculator v1.1".

Table 5.12: Estimated annual mean PM₁₀ concentrations at selected receptors

Receptor ID	Receptor Co-ordinates		Annual Mean PM ₁₀ Concentrations (µg/m ³)			Difference between Projected Do-Something and Do-Minimum Concentration
	X (m)	Y (m)	Base Year 2014	Do-Minimum 2022	Do-Something 2022	
1	557024	192497	21.0	19.4	19.4	0.0
2	556960	192279	21.6	19.6	19.6	0.0
3	557183	192614	20.1	18.6	18.6	0.0
4	557177	192691	20.3	18.8	18.8	0.0
5	557013	192492	20.9	19.3	19.3	0.0
6	556627	192397	21.5	19.6	19.7	0.1

Compliance risk assessment

- 5.7.9 Compliance with the EU Air Quality Directive has been considered using the principles in IAN 175/13 where Defra PCM model links coincide with the model domains to aid the assessment of significance of effect.
- 5.7.10 Defra Air Quality Plans were published in 2017, which aid the consideration of compliance. The closest PCM links to the air quality study area, are the A12 east and west of Junction 28 and the A1023 Brook Street. The majority of these links are located within the Eastern (UK0029) UK ambient air quality reporting zone, however parts of the A12, further west of Junction 28 are included in the Greater London Urban Area (UK0001) UK ambient air quality reporting zones.

- 5.7.11 According to the PCM datasets none of the roads within the air quality study area are expected to exceed the NO₂ annual mean EU limit value in the opening year of the Scheme (2022). The maximum annual mean NO₂ concentrations for these links in the PCM model are 21.3 µg/m³ for Brook Street and 31.2 µg/m³ for the A12, which are below the EU limit value.
- 5.7.12 Based on the illustrative receptor modelling there is not expected to be an increase in annual mean NO₂ concentrations at any receptor with the Scheme. The Scheme is therefore considered to be at low risk of not achieving compliance with the EU Air Quality Directive.

Regional air quality

- 5.7.13 Regional emissions of NO_x, PM₁₀ and CO₂ have been calculated for the study area. Regional emissions of all pollutants are expected to increase with the Scheme between 10% and 17% in 2022, corresponding with a 20% increase in vehicle kilometres travelled. Similarly, emissions are expected to increase between 12% and 20% in 2037 in line with a 21% increase in vehicle kilometres travelled.
- 5.7.14 Relative to the base year, emissions of CO₂ are expected to increase in 2022 and 2037, but by considerably less than the overall increase in vehicle kilometres travelled. Emissions of PM₁₀ are expected to decrease by 2022, but then increase by 5% in 2037 relative to the base year. Emissions of NO_x are expected to decrease by more than half by 2037 as a result of improvements in vehicle technology.
- 5.7.15 The results of the regional assessment for the Scheme are presented in Table 5.13.

Table 5.13: Regional emission calculations

Year	Scenario / Change	NO _x (Kg/yr)	PM ₁₀ (Kg/yr)	CO ₂ (T/yr)	Veh kms travelled/yr
2014	Base	31592.3	1753.1	11190.0	111339.1
2022	Do-Minimum	12508.9	1463.0	10878.6	129759.6
	Do-Something	14548.7	1615.9	12716.4	155426.7
	Change with Do-Something	2039.8	152.9	1837.8	25667.1
	% Change from Do-Minimum	16%	10%	17%	20%
	% Change from Base	-54%	-8%	14%	40%
2037	Do-Minimum	9658.1	1654.0	12525.8	154710.6
	Do-Something	11565.8	1844.4	14663.0	186960.2
	Change with Do-Something	1907.7	190.4	2137.2	32249.6
	% Change from Do-Minimum	20%	12%	17%	21%
	% Change from Base	-63%	5%	31%	68%

Significant effects

Construction

5.7.16 Any air quality effects due to construction would be temporary and could be suitably minimised by the application of standard and appropriate mitigation measures. On this basis, there is unlikely to be a significant effect on air quality due to the construction of the Scheme.

Operation

5.7.17 In accordance with the IAN 174/13, Table 5.14 outlines the evaluation of local air quality significance of the Scheme. It can be seen that the Scheme is not expected to have a significant effect on human health receptors. Table 5.12 outlines the evaluation of local air quality significance of the Scheme.

Table 5.14: Overall evaluation of local air quality significance

Key Criteria Questions	Yes/No
Is there a risk that environmental standards will be breached?	No. No receptors are expected to exceed the annual mean NO ₂ or PM ₁₀ AQS objectives, either with or without the Scheme. There are not expected to be any Defra PCM links in the air quality study area that exceed in 2022 and changes in concentrations would not result in exceedances in 2022 or beyond. There is not expected to be a compliance risk due to the Scheme.
Will there be a large change in environmental conditions?	No. There are no large changes expected in the opening year. All changes are imperceptible.
Will the effect continue for a long time?	No.
Will many people be affected?	No.
Is there a risk that designated sites, areas, or features will be affected?	No. There are none located within the air quality study area.
Will it be difficult to avoid or reduce or repair or compensate for the effect?	n/a
On balance is the overall effect significant?	On balance, the overall conclusion is that there would not be a significant adverse effect.

5.8 Potential mitigation measures

Construction

5.8.1 Mitigation measures to control dust emissions during construction would be included in the Construction Environmental Management Plan (CEMP) prior to construction of the Scheme. The precise measures would depend on the intended construction methods and the potential degree of dust generation at each site. Such measures may include but not necessarily be limited to:

- Regular water-spraying and sweeping of unpaved and paved roads to minimise dust and remove mud and debris;

- Using wheel washes, shaker bars or rotating bristles for vehicles leaving the site where appropriate to minimise the amount of mud and debris deposited on the roads;
- Sheeting vehicles carrying dusty materials to prevent materials being blown from the vehicles whilst travelling;
- Enforcing speed limits for vehicles on unmade surfaces to minimise dust entrainment and dispersion;
- Ensuring any temporary site roads are no wider than necessary to minimise their surface area;
- Damping down of surfaces prior to their being worked; and
- Storing dusty materials away from site boundaries and in appropriate containment (e.g. sheeting, sacks, barrels etc.).

5.8.2 If necessary monitoring parameters and a programme will be established.

Operation

5.8.3 The assessment at Option Selection Stage indicated that there are not expected to be any significant adverse effects with the Scheme for the human health receptors. This will be investigated and confirmed at the Preliminary Design Stage using an updated traffic model and the latest air quality tools and information. If necessary, mitigation options will be examined and monitoring parameters and a programme will be established.

5.9 Residual impacts

Construction

5.9.1 Any air quality effects due to construction would be temporary and could be suitably minimised by the application of standard and appropriate mitigation measures. On this basis, there is unlikely to be a significant effect on air quality due to the construction of the Scheme.

Operation

5.9.2 The results from the Option Selection Stage assessment noted that in accordance with IAN 174/13, the Scheme is not expected to have a significant effect on human health. As no mitigation measures are proposed, the residual impacts will be the same as those without mitigation.

5.10 Cumulative effects

5.10.1 Committed developments in the area are provided in Chapter 15 (Assessment of Cumulative Effects). During construction none of these are likely to affect receptors within the air quality study area for construction, hence there are unlikely to be any cumulative air quality effects arising during the construction phase.

5.10.2 At Option Selection Stage, specific committed developments were not accounted for in the air quality assessment. However, the traffic model at Preliminary Design Stage will include additional traffic from all relevant committed development. The air quality assessment at the ES stage will therefore take into consideration

cumulative effects during operation. The status of committed developments in the area will also be reviewed at Preliminary Design Stage.

5.11 NPS compliance

- 5.11.1 In line with the national guidance discussed in the Planning and Policy section, the NPS requires a judgement to be made as to the risk of a project affecting the UK's ability to comply with the Air Quality Directive (paragraphs 5.3 to 5.15). Modelling undertaken at the Options Selection Stage indicates that the Scheme is not expected to result in a significant adverse effect on air quality.
- 5.11.2 In addition, there are not expected to be any Defra PCM links that exceed EU limit values in the air quality study area in the opening year. There is not expected to be a compliance risk to the UK's ability to comply with the Air Quality Directive. The Scheme is therefore expected to be compliant with the NPS.

5.12 Summary

- 5.12.1 There are two AQMAs which are likely to be affected by the Scheme. These AQMAs are located at Brook Street and to the north and west of the M25 Junction 28 (Brentwood Borough Council AQMA No. 2, and London Borough of Havering AQMA respectively). It is not anticipated that other AQMAs will be affected as a result of the Scheme, but this will be confirmed at Preliminary Design Stage.
- 5.12.2 Baseline air quality monitoring data indicates that there are multiple exceedances of the annual mean AQS objective for NO₂ within the air quality study area (notably adjacent to M25 Junction 28 and A12). In addition, there are modelled exceedances of the annual mean NO₂ EU limit value on the A12 within the Defra PCM mapping, although these are projected to be below the EU limit value by the opening year.
- 5.12.3 Some construction activities such as earthworks and track out from any unpaved roads are likely to generate dust which has the potential to temporarily affect nearby properties if uncontrolled. With the application of standard and appropriate mitigation measures, any adverse effects would be minimised, such that there is unlikely to be a significant effect on air quality.
- 5.12.4 Changes in traffic during the construction phase have the potential to affect local air quality at receptors near to any affected roads. Data is not currently available to undertake a qualitative assessment, however, any effect on air quality would be temporary and is likely to be less than the effect of the Scheme during operation.
- 5.12.5 The assessment of the Scheme indicates that there are not expected to be any exceedances of the annual mean NO₂ or PM₁₀ AQS objectives in the opening year both with and without the Scheme. The estimated magnitude of change at all receptors is expected to be imperceptible.
- 5.12.6 There are not expected to be any Defra PCM links in the air quality study area that exceed EU limit values in 2022 and changes in concentrations would not result in exceedances in 2022 or beyond. There is therefore not expected to be a compliance risk due to the Scheme. The Scheme is not expected to lead to a significant impact on local air quality.
- 5.12.7 It should be noted that the results presented in this PEIR are based on air quality modelling using traffic data from the Option Selection Stage that is to be

superseded as the Preliminary Design Stage progresses. The determination of the overall Scheme significance will therefore be revisited during preparation of the ES.

6. Noise and Vibration

6.1 Introduction

6.1.1 This chapter provides the preliminary assessment for noise and vibration. It identifies the noise and vibration study area, methodology, presents the baseline conditions, identifies the potential noise and vibration impacts associated with the Scheme during construction and operation, and identifies mitigation measures that may be required to mitigate any potentially significant adverse effects.

6.2 Study area

6.2.1 The study area for the assessment of noise and vibration effects is defined in the DMRB Volume 11, Section 3, Part 7 HD 213/11 Noise and Vibration as 600 m from the carriageway edge of any proposed new routes or existing routes to be bypassed or improved, and 600 m from any other affected routes within 1 km of the proposed new routes or altered existing routes. An affected route is defined as where it is calculated that there is a possibility of a change of 1dB $L_{A10,18h}$ in the short term or 3dB $L_{A10,18h}$ in the long term (assessed between the opening year and the future year).

6.2.2 The DMRB provides the following methodology for identifying the size and extents of the study area:

1. Identify the start and end points of the physical works associated with the road project;
2. Identify the existing routes that are being bypassed or improved and any proposed new routes between the start and end points (for each option);
3. Define a boundary 1 km from the carriageway edge of each of the options identified in (2) above;
4. Define a boundary 600 m from the carriageway edge around each of the options identified in (2) above and also 600 m from any other affected routes within the boundary defined in (3) above. The total area within these 600 m boundaries is termed the 'calculation area';
5. Identify any affected routes beyond the boundary defined in (3) above; and
6. Define a boundary 50 m from the carriageway edge of routes identified in (5) above.

6.2.3 Based on the above, the detailed noise calculation area (within 600 m of any affected route that is within 1 km of the Scheme) has been determined.

6.2.4 Determination of the affected routes, and consequently the study area, may be constrained by the geographical extent, and area of validity, of the traffic modelling made available for the Scheme appraisal. The study area for the noise impact assessment will be determined, once the strategic traffic model has been finalised.

6.3 Planning and policy context

6.3.1 Appendix F in Volume 2 summarises the legislation, regulatory and policy framework applicable to noise and vibration.

6.4 Methodology

6.4.1 A baseline noise surveys will be undertaken within the study area to establish the current noise climate. This will include monitoring positions at Brentwood and Harold Park, where the majority of residential buildings in the project area are located, as well as sparsely populated locations around Junction 28. The locations for baseline noise monitoring will be confirmed once suitable and accessible sites have been identified.

6.4.2 A construction noise and vibration assessment will be completed in accordance with the prediction methodology described in BS5228:2009 +A1:2014 Code of practice for noise and vibration control on construction and open sites. The predictions will be based on plants lists and equipment usage patterns for the main construction activities and phases indicated on the construction schedule. Threshold levels from BS5228 Part 1 and Part 2 will be used to determine whether a significant effect has the potential to occur at receptors, which will be influenced by the existing baseline conditions. Impact significance and the need for mitigation will be determined by taking into account the predicted impact levels, existing conditions, guidance within BS5228, current Highways England Guidance and the duration of the construction activities.

6.4.3 Road traffic noise modelling has been undertaken for the Scheme during Option Selection stage and the results of this preliminary assessment are discussed in Section 6.7. Further noise modelling will be undertaken using updated traffic data at ES stage, to permit an assessment in line with a "detailed" level of assessment as defined within the DMRB, which consists of the following elements:

- Prediction of daytime ($LA_{10,18h}$) noise levels in the short-term (Scheme opening) and the long-term (future assessment year);
- Prediction of night-time noise levels in the long-term;
- Noise contour plots showing the predicted changes in noise level throughout the study area;
- Assessment of noise levels at traffic links located in the wider area; and
- Assessment of traffic nuisance impacts.

6.4.4 Ordnance Survey base mapping and Address base data will be used to establish the relevant noise sensitive receptors within the appropriate calculation area. This will include residential noise sensitive receptors and non-residential noise sensitive receptors, such as schools, hospitals and places of worship. Calculations will then be undertaken using the commercially available noise mapping software *Noise map 5* to permit a quantitative assessment to be undertaken.

6.4.5 The results of this quantitative assessment will then be used to inform the completion of WebTAG worksheets (including calculation of net present value for noise) and Appraisal Summary, Tables and would be reported in accordance with TAG Unit A3 Environmental Impact Appraisal, Chapter 2 Noise Impacts. The Transport Analysis Guidance (TAG) assessment will be reported separately, and

quantitative outputs for reporting within the Appraisal Summary Table will be generated where provision of suitable traffic data allows.

6.4.6 At the DMRB ‘Detailed’ level of assessment, the following three comparisons are required to be made to determine the impact of the scheme in both the short term, and the long term.

- Do-minimum scenario in the opening year (2022) against Do-something scenario in the baseline year (2022): short term impact comparison
- Do-minimum scenario in the opening year (2022) against Do-something scenario in the future assessment year (2037): long term impact comparison
- Do-minimum scenario in the opening year (2022) against Do-minimum scenario in the future assessment year (2037): long term impact comparison.

6.4.7 DMRB provides classifications for the magnitude of changes in predicted road traffic noise as outlined below:

- A change in road traffic noise of 1dB(A) (Do-minimum to Do-something in the baseline year) is the smallest that is considered perceptible in the short term;
- A change in road traffic noise of 3dB(A) (Do-minimum in the baseline year to Do-something in the future assessment year) is considered to be perceptible in the long term;
- The magnitudes of impact in the short and long term are therefore considered differently within the DMRB methodology. For road traffic noise the classification of magnitude of change is reproduced from DMRB in Table 6-1 below for both the short and long terms.

Table 6.1: Classification of Magnitude for Noise Impacts (from DMRB Vol11 S3 Pt7 HD 213/11)

Short Term Impact Classification	Change Road Traffic Noise Level dB LA10,18 hour	Long Term Impact Classification
No Change	0 dB	No Change
Negligible	> 0 dB and < 0.9 dB	Negligible
Minor	≥ 1 dB and < 2.9 dB	
Moderate	≥ 3 dB and < 4.9 dB	Minor
Major	≥ 5 dB and < 9.9 dB	Moderate
	≥ 10 dB	Major

6.4.8 Noise levels predicted at noise sensitive receptors in the opening year and future assessment year of the Scheme will be appraised for significance of effect, with reference to the definition of adverse and significant adverse effects as detailed within the explanatory note to the Noise Policy Statement for England (NPSE), as based on the following concepts:

- NOEL - no observed effect level. This is the level below which no effect can be detected. In simple terms, below this level, there is no detectable effect on health and quality of life due to the noise;

- LOAEL - lowest observed adverse effect level. This is the level above which adverse effects on health and quality of life can be detected; and
- SOAEL - significant observed adverse effect level. This is the level above which significant adverse effects on health and quality of life occur.

6.4.9 The assessment of operational noise levels will establish the following:

- Locations where the LOAEL is exceeded;
- Locations where the existing road traffic noise levels are below the SOAEL and are predicted to exceed the SOAEL as a result of the Scheme; and
- Locations where existing road traffic noise levels are above the SOAEL and are increased by at least 1dB LA10,18h due to the Scheme.

6.4.10 Potential locations requiring noise mitigation based on the findings of previous assessments will be reviewed at an early stage in this Preliminary Design stage to allow mitigation measures to be incorporated in the design of the Scheme. Noise mitigation may be required under the following conditions:

- Noise sensitive receptors that are predicted to experience noise increases as a result of the Scheme;
- To mitigate noise levels in areas with existing high noise levels, such as NIAs, which is a stated objective of the overarching Road Investment Strategy (RIS) scheme programme, and
- To avoid adverse effects at ecologically sensitive areas.

6.4.11 Detailed noise modelling will be undertaken with potential noise mitigation in place, based on traffic projections from appropriate strategic traffic modelling to permit the degree of accuracy as would be required for such detailed mitigation design. This will include any existing noise mitigation measures that will be retained or replaced by the Scheme. The proposed mitigation measures will be reviewed based on the results of the detailed noise modelling.

6.4.12 The thresholds assigned to the LOAEL and the SOAEL for both the construction and operational elements of the scheme will be set based upon current guidance set out by Highways England, as detailed in Table 6.2 below.

Table 6.2: LOAELs and SOAELs for all receptors (based upon current guidance from Highways England)

Noise Source	Time Period	LOAEL	SOAEL	Notes
Construction Noise	Day (0700-1900 weekday and 0700-1200 Saturdays)	Exceeds existing $L_{Aeq,T}$ noise level	Threshold level determined as per BS 5228:2009 + A2014 Section E3.2	LOAEL is set at a level where construction noise becomes the dominant source. SOAEL is set where construction noise exceeds BS5228 thresholds.
	Night (2300-0700)	Exceeds existing $L_{Aeq,T}$ noise level	Threshold level determined as per BS 5228:2009 + A2014 Section E3.2	Existing noise level shall be determined based on ambient noise monitoring, noise model prediction or estimation based on published noise level datasets (for example Defra Noise Mapping)

Noise Source	Time Period	LOAEL	SOAEL	Notes
	Evening and weekends (time periods not covered above)	Exceeds existing $L_{Aeq,T}$ noise level	Threshold level determined as per BS 5228:2009 + A2014 Section E3.2	
Construction Vibration	All time periods	0.3mm/s PPV	1.0mm/s PPV	LOAEL is set at the lowest level of perception, SOAEL is set where levels can be tolerated with prior warning (ref BS5228:2).
Operational Noise	Day (06:00-24:00)	55dB $L_{A10,18h}$ (façade) 50dB $L_{Aeq,16h}$ (free-field)	68dB $L_{A10,18h}$ (façade) 63dB $L_{Aeq,16h}$ (free-field)	The daytime LOAEL is based on the Onset of Moderate Community Annoyance, and the daytime SOAEL is based on the onset of cardiovascular health effects (ref. WHO Guidelines for Community Noise) and the Noise Insulation Regulation Threshold. The slightly lower Noise Insulation Threshold should be used for consistency with other parts of the DMRB methodology.
	Night	40dB $L_{night, outside}$ (free-field)	55dB $L_{night, outside}$ (free-field)	The night time LOAEL is defined using the WHO Night Noise Guidelines, and the night time SOAEL is equivalent to the levels above which cardio vascular health effects become the major public health concern(ref. WHO Night Noise Guidelines).
Operational Vibration	Day/Night	n/a	n/a	Response to operational vibration is closely related to response to operational noise. Assessors shall use the comparison of operational noise levels against LOAEL and SOAEL to inform the assessment of operational vibration levels against LOAEL and SOAEL

6.4.13 The previous assessment phase of the Scheme, the results of which are reported in Section 6.7, used the thresholds for adverse effects and significant adverse effects shown in Table 6.3 and Table 6.4 below, and are not the same as current Highways England guidance as detailed in Table 6.2 above.

6.4.14 The results presented in section 6.7 of this PEIR are based on noise modelling using traffic data from the Option Selection Stage which will be superseded as the Preliminary Design Stage progresses. The determination of the overall Scheme significance will therefore be reviewed during preparation of the ES.

Table 6.3: Operational noise levels of significance at residential receptors (Daytime) as used in results of previous appraisal as reported at Options Selection Stage

Effect level	Free-field DB $L_{Aeq,16H}$	FAÇADE DB $L_{A10,18H}$
Adverse effects (LOAEL)	≥ 46	≥ 51
Significant effects (SOAEL)	≥ 63	≥ 68

Table 6.4: Operational noise levels of significance at non-residential receptors (Daytime) as used in results of previous appraisal as reported at Options Selection Stage

Effect level	Free-field DB $L_{Aeq,16H}$	FAÇADE DB $L_{A10,18H}$
Adverse effects (LOAEL)	≥ 46	≥ 51
Significant effects (SOAEL)	≥ 63	≥ 68

6.5 Consultation

6.5.1 At ES stage the Local Authority will be consulted to discuss the assessment approach, to identify areas with existing noise and vibration concerns, and to establish the presence of any further noise sensitive receptors that should be included in the assessment from other proposed or committed developments.

6.6 Baseline conditions

6.6.1 Information regarding the existing ambient noise climate i.e. baseline conditions, and identification of potential noise impact constraints to the Scheme has been determined through reference to the following sources:

- Ordnance Survey base mapping to identify locations of residential and non-residential noise sensitive receptors (residential properties, schools, hospitals and elderly care homes);
- Natural England's MAGIC website (MAGIC, 2017) to identify boundaries of designated ecological sites that may be considered as sensitive to noise;
- Extrium Noise Map Viewer (2012) showing Defra Noise Important Area (NIA) mapping; and
- Extrium Noise Map Viewer (2012) showing Defra Strategic Noise Mapping for Environmental Noise Directive (Directive 2002/49/EC) and the Environmental Noise (England) Regulations 2006 (as amended) (2015).

Noise sensitive receptors

6.6.2 The Scheme is located between Romford and Brentwood, which are separated by agricultural land and the M25. Road traffic noise from the M25 and the A12 is the dominant source of ambient noise in the study area. The land use within 600 m of the M25 Junction 28 is generally agricultural and commercial, with the closest business located 55 m from the junction on Brook Street. Maylands Golf Course is located approximately 600 m from the existing junction layout.

- 6.6.3 The closest residential areas to the Scheme are Grove Farm (immediately to the north west of J28), The Poplars (50 m) and Nag's Head Lane (250 m). Further residential communities are located at Brook Street (600 m), Harold Park (800 m), Wigley Bush Lane (850 m), and South Weald (1.1 km). These are areas of mixed residential and commercial land use.
- 6.6.4 Non-residential noise sensitive receptors identified within proximity of the proposed design options at M25 Junction 28 include Harold Park Baptist Church, St Peters Church, St Peter's C of E Primary School, and Holiday Inn Brentwood.

Noise climate

- 6.6.5 Based on aerial imagery it is expected that road traffic noise from the M25 and the A12 are the main noise source influencing noise levels in the study area. A railway operating between Stratford and Shenfield is also to the south of the study area (approximately 290 m south of Junction 28), influencing noise levels to the south of the Harold Park and Brook Street residential areas.
- 6.6.6 A noise survey will be undertaken during the design development phase to ascertain the baseline noise levels at noise sensitive receptors within the study area of the Scheme. The final design of the Scheme will be used to further inform the production of the Preliminary Design Stage noise model.
- 6.6.7 The measured noise levels obtained during the baseline noise survey will be supplemented with information from publicly available online mapping sources. Strategic noise maps were published during 2015 by Defra for both major road and railways sources to meet the requirements of the Environmental Noise Directive (Directive 2002/49/EC) and the Environmental Noise (England) Regulations 2006 (as amended).
- 6.6.8 The 'Important Areas' for noise (NIAs) were identified to highlight any particular constraints for the Scheme. NIAs are the locations where the 1% of the population most affected by the highest noise levels from major roads and railways are located according to the strategic noise mapping undertaken by Defra. The summary of the NIAs are listed in Table 6.5 below.

Table 6.5: Location and distances of NIAs from the Scheme (information as obtained from Extrim Noisemap Viewer and online mapping sources)

NIA ID	Source of noise	Distance in metres
5750*	Road	on Junction 28 (approx. 12m)
13448	Road	260
5749	Road	400
5752	Rail	810
RI_596	Road	920
13446	Road	1000

- 6.6.9 The locations of the NIAs in proximity to the Scheme are shown in the Environmental Constraints Map in Appendix A and are also shown in Appendix C Figures C-1 and C-2.

6.7 Potential impacts

Construction

- 6.7.1 The main construction activities that are likely to take place included; site preparation, demolition, earthworks, retaining wall construction and road works. All activities have the potential to cause some disturbance at nearby sensitive receptors. Demolition works and piling works (for new viaducts and retaining walls) are likely to cause some of the highest noise levels dependent on the methods chosen. If closure of the motorway or A12 is required to undertake any part of the works then the potential for adverse noise impacts at night would be high. This would also be coupled with the potential wider impacts of re-routed traffic at night-time.
- 6.7.2 A construction programme detailing the specific activities that will take place, phasing and duration of each activities, and a plant list are not yet available for the Scheme.
- 6.7.3 The need for temporary noise mitigation during the construction phase will be determined at ES stage by undertaking a BS5228-1:2009+A1:2014 assessment once the required information becomes available. The assessment will take into account the following factors:
- The ambient noise environment at the closest noise sensitive receptors to the construction works;
 - The distance between the nearest noise sensitive receptor and the construction works;
 - The duration and time of day that the construction works occur; and
 - The noise produced by the plant or equipment involved in the construction activities, which is influenced by the sound power of the equipment and its usage pattern.
- 6.7.4 An increase in vehicle movements is expected during the construction period, as a result of workers and heavy goods vehicles (HGVs) travelling to and from site. At this stage the numbers of expected vehicle movements are not yet known, so cannot be quantitatively assessed. It is also not yet known if existing traffic will need to be diverted during the construction phase. Consequently, it is not possible to undertake a construction traffic noise impact assessment at this time, however, the impacts from this will be assessed once the required information becomes available at detailed design stage.

Operation

- 6.7.5 Once the Scheme is operational, the noise climate could be affected (positively or negatively) by changes in vehicle activity (flows, speeds and composition). Additionally, noise levels at nearby receptors could also be affected by any changes to the distance between carriageways and noise sensitive receptors, as a result of changes to the horizontal and vertical road alignment for the operational Scheme.
- 6.7.6 Detailed predictions have been carried out for a total of 2526 residential receptor identified within the study area; together with a total of 11 non-residential noise sensitive receptors, including schools, churches, and a hotel.

- 6.7.7 The predictions below are based on the Option Selection stage assessment of the Scheme, (then referred to as Option 5F). Minor alterations and refinements have subsequently been made to the Scheme which will be fully assessed once the design and traffic forecast outputs are finalised. For the purpose of this report, it is considered that the impacts predicted at Option Identification provide a suitable indication of those impacts which might be reasonably predicted for the Scheme.
- 6.7.8 The Stage 2 Environmental Assessment Report (Highways England, 2017) detailed the opening and long-term impacts for each of the Scheme options. For opening impacts, comparison is made between the do-something and do-minimum scenarios in 2022; for the long-term impacts, comparison is made between the do-something scenario in 2037, and the do-minimum scenario in 2022.
- 6.7.9 Table 6.6 below shows the noise changes for all modelled receptors within the detailed calculation area in the short-term (opening year), categorised into the noise change bands corresponding to the magnitude impact ratings, as required by DMRB as provided in Table 6.6.

Table 6.6: Short-term traffic noise reporting table (DMRB A1.1)

Change in noise level		Number of dwellings	Number of other sensitive receptors
Increase in noise level, L _{A10, 18h}	0.1 - 0.9	943	2
	1 - 2.9	0	0
	3 - 4.9	0	0
	>=5	0	0
No change	= 0	919	5
Decrease in noise level, L _{A10, 18h}	0.1 - 0.9	660	4
	1 - 2.9	4	0
	3 - 4.9	0	0
	>=5	0	0

Table Source: As reported at Option Selection Stage

- 6.7.10 Table 6.6 above demonstrates that the majority of receptors within the study area are expected to experience a negligible change in noise level due to the Scheme in the short-term. There are four receptors that could expect at least a 'minor' decrease in noise, with no properties benefitting from 'moderate' or 'major' decreases. No receptors are expected to experience a 'minor', 'moderate' or 'major' increase in noise. Figure C-2 in Appendix C illustrates the impacts for the Scheme in the opening year.
- 6.7.11 Table 6.7 below shows the noise changes for all modelled receptors within the detailed calculation area in the long-term (future year) categorised into the noise change bands.

Table 6.7: Long-term traffic noise reporting table (DMRB A1.2)

Change in noise level		Number of dwellings	Number of other sensitive receptors
Increase in noise level, L _{A10, 18h}	0.1 - 2.9	208	0
	3 - 4.9	0	0

Change in noise level		Number of dwellings	Number of other sensitive receptors
	5 - 9.9	0	0
	>=10	0	0
No change	= 0	152	0
Decrease in noise level, LA10, 18h	0.1 - 2.9	2166	11
	3 - 4.9	0	0
	5 - 9.9	0	0
	>=10	0	0

Table Source: As reported at Option Selection Stage

- 6.7.12 Table 6.7 above demonstrates that all of the receptors within the study area are expected to experience a negligible change in noise level due to the Scheme in the long-term. Figure C-2 in Appendix C illustrates the impacts for the Scheme over the long-term.
- 6.7.13 This section describes the significance of effects from the operation of the Scheme options. The effects are summarised in Table 6.8 and Table 6.9 which show the significance for both residential and non-residential properties. The assessment includes significance for both the opening and future years. The impact categories used vary from ‘less than LOAEL’ to ‘between LOAEL and SOAEL’, and ‘above SOAEL’.
- 6.7.14 Table 6.8 below summarises the changes in significance of effects due to the scheme on opening.

Table 6.8: Significance in the opening year

	Opening year significance					
	Residential (daytime)			Non-residential (daytime)		
	Number of properties do minimum	Number of properties do something	Difference	Number of properties do minimum	Number of properties do something	Difference
Less than LOAEL	472	483	11	2	2	0
Between LOAEL and SOAEL	1890	1881	-9	7	7	0
Above SOAEL	164	162	-2	2	2	0

Table Source: As reported at Option Selection Stage

- 6.7.15 Table 6.8 above shows that in the opening year there are predicted to be 11 more residential properties that would experience noise levels less than the lowest observed adverse effect level threshold due to the Scheme. There would be a total of 162 properties expected to experience noise levels above the significant effect level threshold, which constitutes 2 less properties compared with the Do Minimum scenario.

6.7.16 Table 6.9 below summarises the changes in significance of effects due to the Scheme in the future year, compared with the do-minimum in the opening year.

Table 6.9: Significance in the future year compared with do-minimum opening year

	Future year significance					
	Residential (daytime)			Non-residential (daytime)		
	Number of properties do minimum	Number of properties do something	Difference	Number of properties do minimum	Number of properties do something	Difference
Less than LOAEL	472	624	152	2	4	2
Between LOAEL and SOAEL	1890	1747	-143	7	5	-2
Above SOAEL	164	155	-9	2	2	0

Table Source: As reported at Option Selection Stage

6.7.17 Table 6.9 above shows that in the future year, the number of properties expected to experience a noise level less than lowest observed adverse effect level has increased by 152, with 143 fewer properties experiencing noise levels above the lowest observed adverse effect level threshold. A total of 155 properties are expected to experience noise levels above the significant effect level threshold, which constitutes 9 fewer properties compared with the Do Minimum scenario in the opening year.

6.8 Potential mitigation measures

Construction

- 6.8.1 To mitigate any potential noise problems during the construction phase, the construction contractor will consult with the Environmental Health Departments at the relevant Local Planning Authorities to obtain guidance on their requirements for managing and controlling noise and vibration from construction works.
- 6.8.2 A Construction Environmental Management Plan (CEMP) will be developed and implemented by the contractor and approved by the Local Authorities prior to the commencement of construction works. The CEMP will outline the following:
- Environmental management and responsibilities;
 - Monitoring and auditing processes;
 - Procedures that will be used to complete different construction activities;
 - Complaints response procedures; and
 - Community and stakeholder liaison processes.
- 6.8.3 The contractor may also be able to submit a Section 61 application under the Control of Pollution Act 1974 for some construction works, especially if night-time working is proposed.

- 6.8.4 The contractor will be required to join (if not already a member) the Considerate Contractors Scheme that is recognised by industry and the Government for encouraging firms to be sensitive to the environment.
- 6.8.5 The contractor will keep local residents and other affected parties informed of the progress of the works, including when and where the noisiest activities will be taking place and how long they are expected to last. All noise complaints should be effectively recorded, investigated and addressed.
- 6.8.6 In addition, the contractor will use the following good working practices that will minimise impacts to local residents and ecological receptors:
- All vehicles and plant should be fitted with effective exhaust silencers which should be maintained in good and efficient working order;
 - All compressors and generators should be 'sound reduced' models fitted with properly lined and sealed acoustic covers which should be kept closed whenever the machines are in use;
 - All ancillary pneumatic percussive tools should be fitted with mufflers or suppressors as recommended by the manufacturers which should be kept in a good state of repair;
 - Machines in intermittent use should be shut down when not in use or where this is impracticable, throttled down to a minimum;
 - The site compound and static machines should be sited as far as is practicable from noise sensitive buildings;
 - Where practicable, plant with directional noise characteristics should be orientated to minimise noise at nearby properties;
 - Plant should be certified to meet the current EU legislation and should be not be louder than the noise levels provided in Annex C and D of BS5228-1;
 - Where appropriate, temporary noise barriers or other noise containment measures should be installed to minimise construction noise levels;
 - The loading or unloading of vehicles and the movement of equipment or materials should be undertaken in a manner that minimises noise generation;
 - Concrete mixers should not be cleaned by hammering the drums; and
 - When handling materials, care should be shown not to drop materials from excessive heights.
- 6.8.7 In addition to the above good working practices, where piling is required, the piling method will be selected carefully to minimise noise and vibration impacts at receptors. Where practicable, piling methods that result in low levels of vibration, such as rotary bored piling will be used. Methods that cause much higher levels of vibration, such as percussive piling, can cause cosmetic damage to buildings within 50 m of the construction works and will be avoided wherever possible.
- 6.8.8 Even with appropriate mitigation in place, it may not be possible to eliminate all noise impacts. However the implementation of best practice control measures, considerate working hours as well as frequent and open communications with stakeholders will reduce the residual impact of construction noise and vibration.

Operation

- 6.8.9 The assessment of the Scheme indicates that significant adverse effects exceeding DMRB criteria or exacerbating the number of properties exposed to noise level thresholds which might be considered to be significant in magnitude, are not expected as a direct result of the Scheme, consequently no mitigation requirements are considered this stage of the assessment.
- 6.8.10 Mitigation requirements will be reappraised at ES stage in light of the design development and updated traffic forecast model predictions. Even if the detailed assessment concludes there are no exceedances of threshold criteria which would result in the requirement for mitigation, there may be opportunity to include optional mitigative measures which would improve conditions in key areas, this will be further explored during the development phase.
- 6.8.11 Noise mitigation with regard to road traffic noise can consist of noise barriers, earth bunds, or low noise road surfacing, and may include any existing noise mitigation in situ that will be retained by the Scheme.
- 6.8.12 At this stage of assessment, it is expected that all new or modified roads proposed by the Scheme will be resurfaced with a low noise road surface. According to the DMRB, usage of a low noise road surface can reduce road traffic noise levels by up to 3.5dB $L_{A10,18h}$, but the levels of reduction achieved when compared against pre-scheme levels would depend on the surfacing in situ prior to the Scheme. Additionally, the M25 is a significant contributor to road traffic noise levels within the project area, so the full reduction of noise from low noise surfacing may not be fully realised in some areas unless the M25 is also resurfaced.
- 6.8.13 Further assessment of potential mitigation requirements and options will be undertaken during the detailed design phase. This will permit a robust appraisal of the suitability and viability of different mitigation options, if required.

6.9 Residual Impacts

Construction

- 6.9.1 Frequent and open communication with local residents will reduce the potential for impacts to occur and complaints to arise during the construction phase.
- 6.9.2 Temporary environmental noise barriers can reduce noise levels by up to 10dB, however, this depends on the barrier's dimensions and the position of the nearest receptors relative to the construction site. Once baseline noise monitoring results and construction phase information are available, further assessment will be undertaken to establish whether temporary environmental noise barriers would provide any significant noise reduction.

Operation

- 6.9.3 The use of mitigation measures may assist in reducing noise at locations already experiencing high road traffic noise levels, such as within NIAs, and at locations where predicted road traffic noise levels are predicted above the SOAEL.
- 6.9.4 As mentioned above, the use of low noise road surfacing can reduce noise levels by up to 3.5 dB $L_{A10,18h}$. Usage of low noise road surfacing has been included in

the appraisal of the impacts of the Scheme for new and modified roads. At this stage, no further use of low noise road surfacing is envisaged.

- 6.9.5 Environmental noise barriers can also achieve reductions in noise of up to 10dB depending on the length and height of the barrier and its position relative to the receptors and the Scheme. The benefits of environmental noise barriers will be investigated further during the detailed design stage once updated traffic data is available.
- 6.9.6 Section 6.7 shows that the scheme is not expected to result in any adverse impacts in accordance with DMRB criteria and is expected to result in a decrease in the number of noise sensitive receptors exceeding the threshold level for significant effect (SOAEL).

6.10 Cumulative effects

- 6.10.1 The traffic model used in the assessment takes into account the effects of major residential and employment developments proposed in the wider area, as these will affect traffic volumes. The impact of these developments is therefore considered in the operation phase assessment.
- 6.10.2 No cumulative effects are expected to arise for the smaller residential developments as detailed within Table 15.1.

6.11 NPS compliance

- 6.11.1 In line with the national guidance discussed in the planning and policy section, the Scheme aims to avoid significant adverse effects from noise and vibration as far as possible and to use mitigation measures to reduce significant adverse and adverse impacts (paragraphs 5.186 to 5.200 in the NN NPS). To date, this has been achieved by noise modelling different option variants of the Scheme in previous assessment stages to determine what impacts may occur and where, and which areas may require mitigation.
- 6.11.2 As the design of the preferred option progresses, the following activities will be undertaken in order to meet the national policy objectives:
- Further examination of locations where potentially notable increases in noise are predicted at locations currently experiencing significant adverse noise levels to determine the feasibility of reducing noise for these areas; and
 - Incorporation of mitigation measures to improve road traffic noise levels at NIAs wherever possible.

6.12 Summary

- 6.12.1 In order to meet the requirements for a Preliminary Design Stage noise and vibration assessment, baseline noise surveys will be undertaken at several locations within the study area to establish the prevailing noise climate. A construction noise and vibration assessment, using the BS 5228 methodology, will be completed to identify any impacts arising from the construction phase.
- 6.12.2 A "simple" DMRB noise assessment undertaken during the previous design phase highlighted the requirement for the project to proceed to a "detailed" DMRB

assessment during the Preliminary Design Stage to confirm the level of operational noise impact for the preferred option. The detailed noise modelling will incorporate new traffic data obtained from a strategic traffic model and any new mitigation measures incorporated into the design.

- 6.12.3 The results of the "simple" assessment indicated that in the opening year of the Scheme, a very small number of properties experiencing a "minor" decrease in noise upon the Scheme opening is predicted. Results also showed that fewer properties were predicted noise levels that would cause a significant adverse effect with the Scheme in situ.
- 6.12.4 Long-term changes in noise level due to the Scheme were predicted to be negligible, and fewer properties were predicted noise levels that would cause a significant adverse effect with the Scheme in situ.
- 6.12.5 When the detailed noise modelling has been undertaken for the latest Scheme design, the results from the detailed noise modelling will be assessed against the impact magnitude thresholds stated in the DMRB, and significance criteria for impacts to human health. Any existing noise mitigation measures incorporated into the Scheme design and the need for additional mitigation measures will be reviewed based on these results.

7. Biodiversity

7.1 Introduction

- 7.1.1 This chapter provides the preliminary assessment for biodiversity. It identifies the key legislation and policy, presents the study area, methodology and baseline conditions, identifies the potential impacts on biodiversity resources associated with the Scheme during construction and operation, and provides measures to mitigate or compensate for any potentially significant adverse effects.
- 7.1.2 The assessment is based on preliminary information available at the time of writing the report, and may change as a result of design changes, consultation and further ecological surveys.

7.2 Study area

- 7.2.1 The study, as defined in the Preliminary Design Stage Scoping Report, was identified by determining the predicted Ecological Zone of Influence (EZoI) encompassing all of the predicted impacts and potentially adverse effects of the Scheme on biodiversity resources. The EZoI also includes potentially beneficial effects associated with the Scheme as a result of habitat creation and the establishment of new ecological networks.
- 7.2.2 The extent of the EZoI was based on information available for the Scheme at the time, including activities associated with construction and operation, and an initial review of aerial imagery, which displayed the composition of the landscape surrounding the Scheme.
- 7.2.3 The EZoI was used to inform the extent of the desk study and field surveys. It includes the Scheme boundary (i.e. the red line boundary, as shown on Figure D-1 in Appendix D), but due to the relative importance of some biodiversity resources and the mobility of some species, the study area has been extended from the Scheme boundary to obtain information on biodiversity resources at difference spatial extents, as follows):
- 30 km for Special Areas of Conservation (SACs) where bats are one of the qualifying species (DMRB guidance recommends this wide search area due to the mobility of bats (Highways England, 2008));
 - 2 km for other statutory designated sites (other SACs¹, Special Protection Areas (SPAs)², Wetlands of International Importance (Ramsar sites), Sites of Special Scientific Interest (SSSIs), National Nature Reserves (NNRs) and Local Nature Reserves (LNRs);
 - 1 km for non-statutory designated sites and ancient woodland;
 - 5 km for records of bat roosts outside SACs;
 - 500 m for water bodies that may potentially be used as breeding ponds by great crested newts;
 - 2 km for notable habitats, and all other notable or legally protected species, and invasive species; and

¹ Including candidate SACs (cSACs).

² Including potential SPAs (pSPAs).

- 50 m for veteran trees.

7.2.4 The survey area for the extended Phase 1 habitat survey included accessible land within the Scheme boundary and, where accessible, adjacent land up to 50 m.

7.2.5 The extent of the EZoI has been reviewed and re-defined throughout the assessment as the preferred options have been selected and from results of the desk study and field surveys.

7.3 Planning and policy context

7.3.1 Appendix G in Volume 2 summarises the legislation, regulatory and policy framework applicable to biodiversity.

7.4 Methodology

7.4.1 The following sections summarises the methodologies of the various ecological surveys undertaken within the Scheme area.

Desk study

7.4.2 In May 2017, up-to-date ecological records of the following were obtained from Greenspace Information for Greater London (GiGL), Essex Field Club (EFG), and Essex Wildlife Trust (EWT):

- Records of non-statutory designated sites, including locally designated SINCS³ in Greater London and LWSs in Essex; and
- Records of notable⁴ and legally protected⁵ species (fauna and flora); and
- Records of invasive plant species listed under Schedule 9 of the Wildlife and Countryside Act 1981 (as amended), or London Invasive Species Initiative (LISI) Species of Concern.

7.4.3 The Multi-Agency Geographic Information for the Countryside (MAGIC) website (MAGIC, 2017) was reviewed for information on designated sites of nature conservation importance (statutory sites only). These included:

- Internationally designated SACs, SPAs, and Ramsar sites;
- Nationally designated SSSI and NNR; and
- Locally designated LNRs.

7.4.4 MAGIC (2017) was also used to identify notable habitats⁶ and ancient woodland. The Woodland Trust website⁷ was used to identify veteran trees listed on their Ancient Tree inventory.

7.4.5 Ordnance Survey (OS) maps were used to initially identify the presence of water bodies within 500 m of the Scheme, for confirmation during field surveys, in order to establish if the land within and immediately surrounding the Scheme could be used as terrestrial habitat for great crested newts (*Triturus cristatus*). This species

³ SINCS in Greater London are classified into four categories: Sites of Metropolitan Importance (SMI); Sites of Borough Importance Grade 1 (SBI Grade 1); Sites of Borough Importance Grade 2 (SBI Grade 2); and Sites of Local Importance (SLI).

⁴ Notable species are those determined as Species of Principal Importance (SPI), listed under Section 41 of the NERC Act (2006); any species listed in an IUCN Red Data Book; Amber and Red-listed bird species, and any other species listed under a local BAP (London BAP, LB Havering BAP or Essex BAP), or as national or county rare or scarce.

⁵ Legally protected under wildlife legislation summarised in Appendix G in Volume 2.

⁶ Notable habitats are those determined as Habitats of Principal Importance (HPI), listed under Section 41 of the NERC Act (2000).

⁷ <https://ati.woodlandtrust.org.uk>

typically uses suitable terrestrial habitat up to 500 m from a breeding pond (English Nature, 2001). However, there is a notable decrease in great crested newt abundance beyond a distance of 250 m from a breeding pond (Natural England, 2004).

- 7.4.6 The Havering Nature Conservation and BAP (2004) and Essex BAP (2011) were reviewed for details of priority habitats and species within those plans that may potentially be affected by the Scheme. A review of local planning policy relevant to the Scheme was also undertaken as part of the desk study.

Habitat Survey

Extended Phase 1 Habitat Survey

- 7.4.7 An extended Phase 1 habitat survey was undertaken in June 2017 within the survey area following the current good practice guidance (CIEEM, 2012). The Phase 1 habitat survey was used to map the habitats within and immediately adjacent to the Scheme boundary based on the Joint Nature Conservation Committee guidance (JNCC, 2010).

National Vegetation Classification (NVC) survey

- 7.4.8 A detailed vegetation survey of potentially notable habitats within the Scheme boundary was carried out during August 2017. These habitats included semi-improved neutral grassland at three locations: grassland north of Grove Farm and south of Alder Wood; a woodland ride between Weald Brook and Alder Wood in the northern extent of the Scheme boundary; and grassland west of Weald Brook. Two woodlands were also surveyed: Alder Wood and Grove Wood. Reference was made to guidelines published in the National Vegetation Classification, User's handbook (JNCC, 2006). Plant names recorded during the survey follow The New Flora of the British Isles, Third Edition (Stace, 2010).
- 7.4.9 The NVC uses different sized quadrats depending on the type of vegetation to be sampled. The grassland was sampled using standard plots of 2 m x 2 m and woodland used two quadrats types: a 50 m x 50 m quadrat to assess the canopy and within that area, two 4 m x 4 m quadrats taken to assess the ground flora. Typically, five sets of quadrats were used within each location identified above, so that 15 quadrats were used in total to identify the species within the grassland and 10 (large) and 20 (smaller) quadrats were used to identify the species within the woodlands.

Arboricultural survey

- 7.4.10 An arboricultural survey of the study area will be carried out during the Preliminary Design Stage.

Notable and protected species surveys

Notable plants

- 7.4.11 A search for notable plant species was undertaken during the Extended Phase 1 habitat survey and NVC Survey described above.

Invertebrates

Aquatic invertebrates

- 7.4.12 Macroinvertebrate sampling was carried out on 19th September 2017 at single sampling points located in the Weald Brook and River Ingrebourne.
- 7.4.13 The method used to sample invertebrates followed the standard four-minute combined kick-sampling technique, adhering to Environment Agency guidelines (Environment Agency, 1999). The surveys were undertaken by two people at all times for safety reasons. In outline, the sampling methodology comprised:
- Thirty seconds of netting of any surface-active insects, such as pond skaters (*Hemiptera: Gerridae*) and whirligig beetles (*Coleoptera: Gyridae*);
 - Three minutes of active kicking and disturbing substrates and sediment with additional sweeping of vegetation where present; and
 - Thirty seconds of hand searching for invertebrates, such as those adhering to submerged logs, stones or other debris, for example leeches (*Hirudinea*) and caddisfly larvae (*Trichoptera*).
- 7.4.14 Care was taken to ensure that all habitats and micro-habitats, both typical and atypical, were proportionally represented in the sample, and that surface-active insects and species adhered to submerged logs and stones were included.
- 7.4.15 Samples were preserved in methylated spirits and stored at a laboratory. After the samples were sorted, the recovered macroinvertebrates were identified to family level, and the relative abundance of each taxon was recorded.

Terrestrial invertebrates

- 7.4.16 An invertebrate scoping survey was carried out within land north-west of the junction within the Scheme boundary, based on a single visit on 27th March 2018. The scoping survey was carried out to assess the potential of the habitats present to support notable species or assemblages of notable species.

Fish

- 7.4.17 Two survey sites, on each of the Weald Brook and River Ingrebourne, were surveyed for fish. The locations were selected following a reconnaissance visit undertaken on 23rd August 2017. The survey site locations are provided in Table 7.1 below.

Table 7.1: Electrofishing survey locations

Site / watercourse name	Upstream limit of the electrofishing survey (NGR)	Downstream limit of the electrofishing survey (NGR)	Distances from proposed works
River Ingrebourne	TQ 56595 92313	TQ 56509 92260	Within the Scheme boundary: <ul style="list-style-type: none"> • In the section of the river proposed to be re-aligned.
Weald Brook	TQ 56323 92421	TQ 56360 92331	Within the Scheme boundary:

Site / watercourse name	Upstream limit of the electrofishing survey (NGR)	Downstream limit of the electrofishing survey (NGR)	Distances from proposed works
			<ul style="list-style-type: none"> • 260 m south of the proposed northern loop road crossing the brook. • 150 m north of the proposed southern crossing point.

- 7.4.18 Stop nets were positioned at the upstream and downstream limits of each survey. Electrofishing involved a three-catch removal method, in which each of the three electro-fishing ‘runs’ ran downstream to upstream. All fish captured on each run were transferred to water-filled buckets until the surveys were completed on a site-by-site basis. Between each run, time was allowed for the water to clear following disturbance of the substrate.
- 7.4.19 Upon completion of surveys at each site, the fish were identified to species level, measured (fork length or total length to the nearest mm depending on the species), and counted, before being released back into the site from which they were captured.
- 7.4.20 The physical characteristics of the watercourses were recorded during the survey.

Amphibians

Great crested newt Habitat Suitability Index survey

- 7.4.21 Three ponds within 250 m of the Scheme (P1-3) identified during the desk study were surveyed using the Habitat Suitability Index (HSI) assessment method on 8th June 2017. The HSI survey followed guidance set out in Oldham *et al.* (2000). A survey area of 250 m from the Scheme boundary was selected due to the fact that abundant suitable terrestrial habitat exists within 250 m of the ponds identified and based the decrease in abundance of individuals as the distance from the pond increases. Therefore, only very low numbers of great crested newts are expected to utilise terrestrial habitats at a distance greater than 250 m from breeding ponds.
- 7.4.22 Two additional ponds (P4 and P5) were identified just over 250 m from the Scheme boundary that were connected to pond P2 by suitable terrestrial habitat. Both these ponds are located to the west of P2 within Maylands golf course. These ponds were also subject to HSI survey on 5th April 2018 due to their location immediately adjacent to the survey area and presence of suitable connecting habitat.
- 7.4.23 A further two ponds were identified during the desk study within 250 m of the Scheme within land on the eastern side of the M25 and to the north of the A12. These ponds were not surveyed as they are isolated from any suitable terrestrial habitat affected by the Scheme. The motorway was considered to present a major barrier to the movement of great crested newts therefore isolating potential great crested newt populations to the east of the M25 from suitable terrestrial habitat affected by the Scheme. Other ponds identified during the desk study were found not to exist on the ground during the extended Phase 1 habitat survey.

7.4.24 The HSI survey for ponds P2 and P3 was repeated on 5th April 2018 to identify any change in conditions since the previous survey. Pond P3 had been dry at the time of survey in 2017 but was found to contain water in 2018.

Great crested newt eDNA survey

7.4.25 Water sampling was undertaken of ponds P1 and P2 for traces of great crested newt environmental DNA (eDNA). The survey was conducted by an appropriately licensed ecologist on 8th June 2017. The sampling was undertaken within two weeks of receipt of eDNA kits, which were delivered on 5th June 2017. On completion of the field surveys, the kits were sent for laboratory analysis on 12th June 2017.

7.4.26 The eDNA survey was conducted in accordance with the protocol provided with the eDNA test equipment. All ponds sampled were less than 1 ha in size, therefore only one eDNA kit was required to analyse each pond. All laboratory work was conducted in accordance with the Technical Advice note for field and laboratory sampling of great crested newt environmental DNA (Biggs et al., 2014), with samples analysed using a Real Time qPCR.

Great crested newt population estimate survey

7.4.27 A great crested newt population estimate survey was carried out over six visits for each of the following ponds: P1, P2, P3, P4 and P5, between 5th April and 17th May 2018. The survey was undertaken in accordance with the guidelines produced by Langton, Beckett and Foster (2001), and during the optimal survey period (mid-April to mid-June). Pond P3 was only successfully surveyed on four visits, as it had dried out by visit five.

7.4.28 The surveys were all undertaken by two surveyors, including at least one surveyor who held a great crested newt survey licence. The following three survey methods were undertaken:

- Egg-searching – examining submerged vegetation around the pond perimeter for folds where great crested newt eggs may be present;
- Torching - walking around the pond perimeter after dusk and scanning the water with a high powered torch for adult great crested newts within the shallow margins of the pond; and
- Bottle-trapping – setting traps made from 2 litre plastic drinks bottles (with the top cut off and inverted to form a funnel entrance to the bottle trap) set on canes around the pond perimeter. Traps were set in the evening and checked the following morning for any trapped great crested newts.

7.4.29 A population size class was assigned to each pond, according to the survey protocol in Sewell et al. (2013). Under this protocol, the following population size classes are recognised:

- Small – peak count⁸ of up to 10 individuals;
- Medium – peak count of between 11 and 100 individuals; and
- Large – peak count of over 100 individuals.

⁸ Notable habitats are those determined as Habitats of Principal Importance (HPI),

Reptiles

- 7.4.30 Reptile surveys were carried out over seven visits from 10th August to the 18th September 2017. The method used for the surveys followed guidelines published by Gent & Gibson (1998) and Froglife (1999).
- 7.4.31 Prior to the survey, on the 7th July 2017, 98 artificial reptile refugia ‘mats’ (1 m x 0.5 m pieces of roofing felt) were placed in areas of suitable reptile habitat within the Scheme boundary and around the north, east and south boundaries. Refugia mats were placed within the survey area in excess of the minimum guidance which stipulates ‘between five to ten refuges per hectare’ (Froglife, 1999), to maximise the survey effort.
- 7.4.32 During each survey, the surveyor walked slowly around the survey area and checked the refugia mats and any other natural refugia such as rubble and wood for the presence of reptiles. The date, weather, start and finish temperature, reptile species recorded, number of individuals and age (i.e. adult/juvenile) were all recorded on each occasion.

Breeding birds

- 7.4.33 A breeding bird survey was undertaken by two surveyors on three separate visits between May and July 2017, and an additional two visits were undertaken in March and April 2018 to account for any early breeding activity. The method used was based on the territory mapping technique, which is similar to that used in the British Trust for Ornithology’s Common Bird Census (Marchant 1983; Bibby et al, 1992). The territory mapping method means that the distribution of bird territories within the Scheme boundary can be determined, and from this, a count of the number breeding pairs for each species can be derived.
- 7.4.34 The survey area included land within and up to 50 m from the Scheme boundary. On each visit, the survey area was walked following a route that allowed the surveyors to observe bird activity within at least 50 m of the Scheme. During each visit, the location and species of all birds encountered (including both those seen and those heard) were recorded on a map using standard British Trust for Ornithology (BTO) symbols. Additional information was recorded on bird activity, such as singing or signs of breeding activity, using standard map symbols as stated in Marchant (1983).
- 7.4.35 Once all visits were complete, the survey data was collated to determine the approximate location and numbers of breeding pairs for territorial and semi-colonial species and to give an indicative total for the survey area as a whole for non-territorial species.
- 7.4.36 The value of the survey area for breeding birds was assessed on a scale from local to national importance. This was attained by counting the numbers of breeding species utilising the survey area (Fuller, 1980). Fuller originally proposed that 25 to 49 species should be allocated to a level of ‘local importance’. However, there have since been declines in bird species generally, therefore this adaptation of Fuller’s scale is typically used:
- Local importance – up to 24 breeding species;
 - District importance 25 – 49 breeding species;
 - County importance 50 – 69 breeding species;

- Regional importance 70 – 84 breeding species; and
- National importance 85+ breeding species.

Barn owl

- 7.4.37 A barn owl (*Tyto alba*) survey was undertaken in 2017, which involved an inspection of the properties within the Scheme boundary according to best practice guidance (Barn Owl Trust, 2012). In addition, during bat surveys within the Scheme boundary, any signs of barn owls were also noted and recorded. The surveys were undertaken from dusk into the night and also at dawn, which are periods when barn owls are typically active and foraging.
- 7.4.38 In addition to the surveys, an assessment was also undertaken at a landscape scale including the suitability of the habitats present within the Scheme boundary to support barn owl foraging and nesting, and any potential hazard issues associated with collision risk.

Bats

Preliminary Roost Assessment – external survey

- 7.4.39 An external inspection was undertaken in July 2017 of ten accessible buildings within the Scheme boundary to assess their potential to support roosting bats. Binoculars were used where appropriate, but most external inspections were carried out visually.
- 7.4.40 Each building was given a bat roosting potential rating of either high, medium, low or negligible in accordance with Bat Surveys for Professional Ecologists Good Practice Guidelines' (Collins, 2016).

Emergence/re-entry surveys

- 7.4.41 The external surveys identified two buildings with moderate potential to support roosting bats. Therefore, two bat emergence/re-entry surveys were required for the buildings in accordance with good practice guidelines. The emergence/re-entry surveys focussed on the external features identified as having potential for roosting bats, with three experienced surveyors positioned at strategic locations to provide adequate coverage of each of the buildings.
- 7.4.42 Surveyors were equipped with professional bat detectors. During the surveys, two Wildlife Acoustics EM3+ detectors and one Wildlife Acoustics EM Touch detector were utilised.
- 7.4.43 Bat sightings and behaviour was recorded, along with the time of the record, species, and whether they emerged from or returned to the buildings. The dusk survey began 15 minutes before dusk and ended 1.5 hours after dusk. The dawn survey commenced 1.5 hours before dawn and finished 15 minutes after dawn.

Ground level tree assessment

- 7.4.44 All trees within the Scheme boundary were assessed for bat roosting potential. Trees were inspected from ground level on 1st August 2017 and 21st March 2018, using binoculars and torches where appropriate, to look for gaps, cracks, splits or woodpecker holes that could potentially be used by roosting bats. Trees were also searched for evidence for roosting bats. These signs included:

- Droppings;
- Urine staining;
- Dead bats; and
- Scratches and oily deposits on feature entrances.

7.4.45 All identifiable features on trees with the potential to support roosting bats were catalogued and photographed and identified for further (climbed) inspection if necessary.

7.4.46 Each tree was given a bat roost category according to the scoring system provided in Collins (2016).

Climbed tree inspections

7.4.47 The ground level tree inspections undertaken in August 2017 and March 2018 identified 50 trees that required a climbed tree inspection to confirm the presence/likely absence of bat roosts. Climbing tree inspections were undertaken in 2017 and 2018. Where possible, each tree was climbed and inspected using an endoscope and a high-powered torch. Signs of bats were searched for and recorded.

Activity transects

7.4.48 The habitats within the Scheme boundary have moderate suitability to support foraging/commuting bats. Therefore, six bat activity transects were conducted monthly within the Scheme boundary from May to October 2017 in accordance with good practice guidelines. Dusk transects began at sunset and lasted approximately two hours. A dusk to dawn survey was undertaken in June 2017. All transects were carried out using Echo Meter 3+ bat detectors and Echo Meter Touch bat detectors.

7.4.49 The surveyors walked a pre-determined transect route. The route was designed to incorporate and represent all areas and habitat types within the Scheme boundary. The route included 16 static positions; 5 minutes was spent at each static position before moving on to the next position. Two static detectors were also deployed each month at different locations along each transect and left to record bat activity for at least five days.

7.4.50 Bat calls were noted in the field and recorded onto a memory card (EM3+ detector). Sonograms of bat calls were subsequently analysed using Analook software. Each call was tagged with the appropriate species for the entire survey data. A five-minute label count of the data was then analysed in Excel. It is recognised that the frequency of calls do not equal the number of bats, as it may indicate the same bat foraging within the same area.

Hazel dormouse

7.4.51 A hazel dormouse (*Muscardinus avellanarius*) survey, using dormouse nest tubes, was undertaken following the guidance in English Nature's (now Natural England) publication 'The Dormouse Conservation Handbook (Bright *et al*, 2006). Fifty nest tubes were set out in the woodland and hedgerows within and around the Scheme boundary.

- 7.4.52 The nest tubes were put in place on the 30th May 2017 and following a settling-in period, the tubes were inspected for dormice or any evidence of dormice such as nests or feeding remains, on 21st June 2017, 25th July 2017, 31st August 2017, 21st September 2017 and 25th October 2017.
- 7.4.53 Using the guidance produced by Chanin and Woods (2003), the survey visits meet the minimum required for an adequate survey effort to determine likely absence if no hazel dormice are recorded, based on the assumption of a final visit being undertaken in November 2017.

Badger

- 7.4.54 The Scheme was surveyed in 2017 for the presence of badgers (*Meles meles*) which included recording the presence of setts, hairs, footprints, pathways, latrines and feeding signs to plot the patterns of movement of the badgers. Where pathways were confirmed as badger pathways, i.e. there was a clear link to a sett or there was additional evidence of badger activity nearby (such as dung pits, feeding signs or hairs/footprints), these were also noted.
- 7.4.55 Where setts were found, their status and level of activity was noted. Sett status is broadly categorised as follows:
- Main sett – typically continuously used with numerous signs of activity around. Also have a large number of holes and conspicuous spoil mounds;
 - Annexe sett – usually located close to a main sett and connected to it by well used paths. Annexe's may not be continuously occupied;
 - Subsidiary sett – lesser used setts comprising a few holes and without associated well used paths. Subsidiary setts are not continuously occupied; and
 - Outlier sett – one or two holes without obvious paths. These setts are used infrequently.
- 7.4.56 The level of activity is considered to be:
- Well used – clear of debris, trampled soil mounds and signs of obvious activity;
 - Partially used – some associated debris at the entrance and signs of activity within the vicinity, (i.e. badger pathways); and
 - Disused – partially or completely blocked entrances.

Otter and water vole

- 7.4.57 The watercourses within and up to 1 km upstream and downstream of the Scheme boundary (where access was available) were surveyed on 25th May 2017, 27th September 2017 and 9th May 2018 for signs of otter (*Lutra lutra*) and water vole (*Arvicola amphibious*), and the potential of the watercourses to support these species. The surveys were undertaken at the optimal time for otter and water vole surveys and within periods without rain so any signs of these species such as latrines or spraints would be visible.
- 7.4.58 The survey included a search for otter footprints, paths, feeding remains, spraints (droppings) and holts (resting places). In addition, camera traps were installed

along the River Ingrebourne and Weald Brook from 3rd September to 27th October 2017, to identify if otter were moving along the watercourses. The otter survey was undertaken in accordance with methodology in Chanin (2003a and 2003b).

7.4.59 The survey included a search for signs of water vole, including droppings, burrows, latrines, feeding remains, and footprints. The water vole survey followed the standard guidance as set out in the Water Vole Mitigation Handbook (Dean *et al*, 2016).

Invasive species surveys

7.4.60 During the Extended Phase 1 Habitat Survey and NVC survey, a search was made within the Scheme boundary for invasive plants subject to legal control, listed on Schedule 9 of the Wildlife and Countryside Act 1981 (as amended). A summary of relevant legislation is provided in Appendix G in Volume 2.

7.4.61 In addition, during the Extended Phase 1 Habitat Survey and other field surveys for notable and protected species, observations from within the Scheme boundary of invasive animal species listed on Schedule 9 of the Wildlife and Countryside Act 1981 (as amended) were also recorded.

7.4.62 Species of plants and animals identified as Species of Concern by London Invasive Species Initiative (LISI) were also recorded during field surveys within the Scheme boundary. These species are specific to the London area and categorised as a means of prioritisation for land managers, as summarised in Table 7.2 below.

Table 7.2: London Invasive Species Initiative (LISI) categories

LISI Species of Concern category	Description
1	Species not currently present in London but present nearby or of concern because of the high risk of negative impacts should they arrive.
2	Species of high impact or concern present at specific sites that require attention (control, management, eradication etc).
3	Species of high impact or concern which are widespread in London and require concerted, coordinated and extensive action to control/eradicate.
4	Species which are widespread for which eradication is not feasible but where avoiding spread to other sites may be required.
5	Species for which insufficient data or evidence was available from those present to be able to priorities
6	Species that were not currently considered to pose a threat or have the potential to cause problems in London.

Assessing value of resources and receptors

7.4.63 Nature conservation resources have been valued following the framework provided in IAN 130/10 Ecology and Nature Conservation: Criteria for Impact Assessment (Highways England, 2010). This is presented in Table 7.3 below. The evaluation was based on the information available from the desk study and field surveys, and used professional judgement, as well as accepted criteria (e.g.

diversity, rarity and naturalness) (Ratcliffe, 1977) for valuing nature conservation resources in a geographical context.

Table 7.3: Resource valuation

Examples of resource valuation based on geographical context
<p>International or European Value</p> <p>Natura 2000 sites including: Sites of Community Importance (SCIs); SPAs; potential SPAs (pSPAs); SACs; candidate or possible SACs (cSACs or pSACs⁹); and Ramsar sites. Biogenetic Reserves, World Heritage Sites (designated for their nature conservation value), and Biosphere Reserves.</p> <p>Areas which meet the published selection criteria for those sites listed above but are not themselves designated as such¹⁰.</p> <p>Resident, or regularly occurring, populations of species which may be considered at International or European level¹¹ where:</p> <ul style="list-style-type: none"> • The loss of these populations would adversely affect the conservation status or distribution of the species at this geographic scale; or • The population forms a critical part¹² of a wider population at this scale; or • The species is at a critical phase¹³ of its life cycle at this scale.
<p>UK or National Value</p> <p>Designated sites including: SSSIs; including Marine Protected Areas (MPAs); Marine Conservation Zones (MCZs); and NNRs.</p> <p>Areas which meet the published selection criteria e.g. JNCC (1998) for those sites listed above but which are not themselves designated as such¹⁴.</p> <p>Areas of key/priority habitats identified in the UK BAP; including those published in accordance with Section 41 of the Natural Environment and Rural Communities (NERC) Act (2006) and those considered to be of principal importance for the conservation of biodiversity (HPIs)¹⁵.</p> <p>Areas of Ancient Woodland e.g. woodland listed within the Ancient Woodland Inventory¹⁶.</p> <p>Resident, or regularly occurring, populations of species which may be considered at International, European, UK or National level¹⁷ where:</p> <ul style="list-style-type: none"> • The loss of these populations would adversely affect the conservation status or distribution of the species at this scale; or • The population forms a critical part¹⁸ of a wider population at this scale, or

⁹ pSACs are sites which have been formally advised to the UK government but have not yet been submitted to the European Commission. These sites should be valued at European level on the basis that they meet the relevant selection criteria for a SAC but are not yet designated as such.

¹⁰ Valuation to be made in consultation with Statutory Environmental Body (SEB, in this Scheme Natural England).

¹¹ Valuation to be made in consultation with SEB. Such species include those listed within Council Directive 79/409/EEC on the conservation of wild birds or animal/plant species listed within Council Directive 92/43/EEC.

¹² Valuation to be made in consultation with SEB. Such population include sub-populations that are essential to maintenance of metapopulation dynamics e.g. critical emigration/immigration links between otherwise discrete populations.

¹³ Seasonal activity or behaviour upon which survival or reproduction depends.

¹⁴ Valuation to be made in consultation with SEB.

¹⁵ Valuation to be made in consultation with SEB as such listings do not in themselves indicate intrinsic value, but instead indicate a conservation priority.

¹⁶ Valuation to be made in consultation with SEB, and with use of professional judgement as listing does not in itself indicate intrinsic nature conservation value.

¹⁷ Valuation to be made in consultation with SEB as such listings do not in themselves indicate intrinsic value. Such species include those listed within Council Directive 79/409/EEC on the conservation of wild birds or animal/plant species listed within Council Directive 92/43/EEC. Species which may be considered at the UK or National level means: birds, other animals and plants which receive legal protection on the basis of their conservation interest (those listed in the Wildlife and Countryside Act 1981 (as amended), SCH 1, 5 and 8); species listed for their principle importance for biodiversity (in accordance with the Natural Environment and Rural Communities Act 2006 Section 41 [England]; and priority species listed within the UKBAP or species listed within Red Data Books.

¹⁸ Valuation to be made in consultation with the SEB. Such populations include sub-populations that are essential to the maintenance of metapopulation dynamics e.g. critical emigration/immigration links between otherwise discrete populations.

Examples of resource valuation based on geographical context

- The species is at a critical phase¹⁹ of its life-cycle at this scale.

Regional Value

Areas of key/priority habitats identified in the Regional BAP (where available); areas of key/priority habitat identified as being of Regional value in the appropriate Natural Area Profile (or equivalent); areas that have been identified by regional plans or strategies as areas for restoration or re-creation of priority habitats (for example South West Nature Map); and areas of key/priority habitat identified within Highways England's Biodiversity Plan.

Resident, or regularly occurring, populations of species which may be considered at an International, European, UK or National level²⁰²¹ and key/priority species listed within the Highway England Biodiversity Plan where:

- The loss of these populations would adversely affect the conservation status or distribution of the species at this scale; or
- The population forms a critical part²² of a wider population; or
- The species is at a critical phase²³ of its life cycle.

County or Unitary Authority Area Value

Designated sites including: SINCs; LWSs; and LNRs designated in the county or unitary authority area context²⁴.

Areas which meet the published selection criteria for those sites listed above but which are not themselves designated as such²⁵.

Areas of key/priority habitats identified in the Local BAP; and areas of habitat identified in the appropriate Natural Area Profile (or equivalent).

Resident, or regularly occurring, populations of species which may be considered at an International, European, UK or National level²⁶²⁷ where:

- The loss of these populations would adversely affect the conservation status or distribution of the species across the County or Unitary Authority Area; or

¹⁹ A seasonal activity or behaviour upon which survival or reproduction depends.

²⁰ Valuation to be made in consultation with the SEB. Such species include those listed within Council Directive 79/409/EEC on the conservation of wild birds or animal/plant species listed within Council Directive 92/43/EEC.

²¹ Valuation to be made in consultation with the SEB as such listings do not in themselves indicate intrinsic value. Such species include those listed within Council Directive 79/409/EEC on the conservation of wild birds or animal/plant species listed within Council Directive 92/43/EEC. Species which may be considered at the UK or National level means: birds, other animals and plants which receive legal protection on the basis of their conservation interest (those listed in the Wildlife and Countryside Act 1981 (as amended), SCH 1, 5 and 8); species listed for their principle importance for biodiversity (in accordance with the Natural Environment and Rural Communities Act 2006 Section 41 [England]); and priority species listed within the UKBAP or species listed within Red Data Books.

²² Valuation to be made in consultation with the SEB. Such populations include sub-populations that are essential to the maintenance of metapopulation dynamics e.g. critical emigration/immigration links between otherwise discrete populations.

²³ A seasonal activity or behaviour upon which survival or reproduction depends.

²⁴ Valuation to be made in consultation with county ecologist or equivalent, with reference made to the criteria for designation. In terms of Kent, areas which are important for the conservation of wildlife are termed Local Wildlife Sites (LWSs).

²⁵ Valuation to be made in consultation with county ecologist or equivalent.

²⁶ Valuation to be made in consultation with the SEB. Such species include those listed within Council Directive 79/409/EEC on the conservation of wild birds or animal/plant species listed within Council Directive 92/43/EEC.

²⁷ Valuation to be made in consultation with the SEB as such listings do not in themselves indicate intrinsic value. Such species include those listed within Council Directive 79/409/EEC on the conservation of wild birds or animal/plant species listed within Council Directive 92/43/EEC. Species which may be considered at the UK or National level means: birds, other animals and plants which receive legal protection on the basis of their conservation interest (those listed in the Wildlife and Countryside Act 1981 (as amended), SCH 1, 5 and 8); species listed for their principle importance for biodiversity (in accordance with the Natural Environment and Rural Communities Act 2006 Section 41 [England]); and priority species listed within the UKBAP or species listed within Red Data Books.

Examples of resource valuation based on geographical context

- The population forms a critical part²⁸ of a wider population; or
- The species is at a critical phase²⁹ of its life cycle.

Local Value

Designated sites including LNRs designated in the local context³⁰.

Trees that are protected by TPOs.

Areas of habitat; or populations/communities of species considered to appreciably enrich the habitat resource within the local context (such as veteran trees), including features of value for migration, dispersal or genetic exchange.

Table Source: IAN 130/10 <http://www.standardsforhighways.co.uk/ha/standards/ians/pdfs/ian130.pdf>

Biodiversity assessment

- 7.4.64 A detailed assessment³¹ will be undertaken of impacts on specific biodiversity resources. This assessment will incorporate guidance from Design Manual for Roads and Bridges (DMRB) Volume 11: Environmental Assessment, IAN 130/10 and the Chartered Institute for Ecology and Environmental Management (CIEEM) Guidelines for Ecological Impact Assessment in the UK and Ireland (CIEEM, 2016).
- 7.4.65 The assessment will include an initial characterisation of the potential impacts on biodiversity resources, and take into account both Scheme impacts and those that may occur to adjacent and more distant biodiversity resources, including:
- Direct loss of habitats (including temporary loss);
 - Fragmentation or isolation of habitats;
 - Changes to the local hydrology, water quality and/or air quality;
 - Direct mortality or injury to wildlife through construction activities, and
 - Disturbance to species from noise, light or other visual stimuli.
- 7.4.66 Effects resulting from impacts on biodiversity resources would be determined significant if those impacts change the structure and functions of designated sites, notable habitats, or ecosystems; or the conservation status of habitats and species.
- 7.4.67 Effects are identified at the geographic scale at which they become significant depending on the value of the affected resource and the characteristics of the impact. The residual significance of effects takes into account any mitigation or compensation provided.
- 7.4.68 At this stage, details of the mitigation and compensation measures that would combine to form the necessary mitigation have not yet been finalised. Therefore, a

²⁸ Valuation to be made in consultation with the SEB. Such populations include sub-populations that are essential to the maintenance of metapopulation dynamics e.g. critical emigration/immigration links between otherwise discrete populations.

²⁹ A seasonal activity or behaviour upon which survival or reproduction depends.

³⁰ Valuation to be made in consultation with county ecologist or equivalent, with reference made to the criteria for designation.

³¹ According to DMRB Volume 11, Section 2, Part 1 General Principles and Guidance of Environmental Impact Assessment

precautionary approach has been taken to identifying the residual significance of effects and it is likely that some may be reduced through mitigation by design or other measures.

7.4.69 Residual effects on nature conservation resources are categorised on the five-point scale in-line with IAN 130/10 shown in Table 7.4 below. Application will rely on professional judgement by experienced ecologists.

Table 7.4: Significance of effects

Sensitivity / Value	Criteria
Very large	An impact on one or more receptor(s) of International, European, UK or National Value.
Large	An impact on one or more receptor (s) of Regional Value.
Moderate	An impact on one or more receptor(s) of County or Unitary Authority Area Value.
Slight	An impact on one or more receptor (s) of Local Value.
Neutral	No significant impacts on key nature conservation receptors.

Table Source: IAN 130/10 <http://www.standardsforhighways.co.uk/ha/standards/ians/pdfs/ian130.pdf>

7.5 Consultation

7.5.1 The Environment Agency has been consulted during initial stakeholder engagement. Further consultation will be undertaken with environmental organisations, in order to ensure their input is incorporated into the impact assessment, the final design of the Scheme and its associated mitigation and compensation. These will include (but not be limited to):

- Natural England,
- Environment Agency
- Forestry Commission; and
- County ecologists or equivalent; and
- Local Wildlife Trusts.

7.5.2 Consultation will continue with these organisations throughout the Preliminary Design stage.

7.6 Baseline conditions

7.6.1 The following sections summarise the baseline ecological conditions relevant to the Scheme. Detailed ecological surveys reports will be provided with the ES.

Designated sites

7.6.2 The location of designated sites located within 2 km of the Scheme are shown on Figure D-1 (2 Sheets) in Volume 3. One LNR (The Manor) is present within 2 km of the Scheme boundary. Table 7.5 below provides more information on this LNR.

Table 7.5: Summary of statutory designated sites within the study area

Site Name	Description	Distance and Direction from Scheme	Area	Grid Reference
The Manor LNR	A historic landscape made up of acid and neutral grassland, along with ancient and secondary woodland. A wide and diverse range of habitats comprise ponds, hedgerows and lakes which support great crested newt and stag beetle (<i>Lucanus cervus</i>).	0.3 km north west	60 ha	TQ555923

7.6.3 Forty-two non-statutory designated sites (LWSs in Essex and SINC in Greater London) were identified within 2 km of the Scheme boundary (see Table 7.6 below), including one Site of Metropolitan Importance (SMI)³²: Ingrebourne Valley SMI, located within the Scheme boundary.

Table 7.6: Summary of non-statutory designated sites within the Study Area

Site Name	Description	Distance and Direction from Scheme	Area	Grid Reference
Ingrebourne Valley SMI	One of the most natural river corridors in London, with nationally important wetlands at the lower end and ancient alder woods further upstream.	The Scheme resides in part of the SINC.	263 ha	TQ538842
The Oaks LWS	The wood is dominated by pedunculate oak (<i>Quercus robur</i>). This section is bounded by earthbunds and ditches, indicating an old, possibly ancient status for this section, although the remainder of the wood is recent in origin.	Adjacent to the Scheme (east of the M25)	14 ha	TQ566930
Lower Vicarage Wood LWS	A large ancient wood dominated by overgrown hornbeam (<i>Carpinus betulus</i>) coppice with frequent standards of pedunculate oak. There is little understorey and ground flora, largely due to intense deer browsing.	Adjacent to the Scheme (north of A12/east of M25)	4.2 ha	TQ569929
Jermains Wood LWS	An ancient wood with a good range of plants and animals.	Adjacent to the Scheme (south of the A12).	7.3 ha	TQ570908
Jackson's Wood and Tyler's Shaw LWS	Either side of the watercourse in Jackson's Wood hornbeam coppice dominates along with scattered ash and pedunculate oak standards	0.09 km south-east.	4.4 ha	TQ574908

³² Within Greater London, SINC are sub-divided into Sites of Metropolitan Importance (SMI); Sites of Borough Importance (SBI) - Grade 1 or Grade 2; and Sites of Local Importance (SLI).

Site Name	Description	Distance and Direction from Scheme	Area	Grid Reference
Tylers Hall Pond SBI Grade 2	A large pond with a good range of aquatic plants	0.08 km south	0.9 ha	TQ566913
Vicarage Wood LWS	Ancient woodland dominated by overgrown hornbeam coppice with pedunculate oak.	0.1 km north	4.2 ha	TQ570932
Duck Wood Site of Borough Importance (SBI) Grade 1	A large ancient wood, with a series of fine ponds, managed as a nature reserve by the London Wildlife Trust.	0.2 km west	10 ha	TQ555923
Dagnam Park and Hatter's Wood SMI	An historic landscaped park with many high-quality wildlife habitats, including ancient woodland, a variety of grassland, and ponds.	c. 0.3 km north-west	75 ha	TQ550930
Romford to Harold Wood Railsides SBI Grade 2	Havering's railsides form a network of valuable undisturbed habitats, acting as corridors for wildlife moving around the borough.	0.4 km west	28 ha	TQ531894
Tylers Common SBI Grade 1	A large common with a good range of wildlife habitats, with some uncommon plants.	0.4 km south-west	29 ha	TQ566905
Foxburrow Wood LWS	Site has suffered losses due to the expansion of the M25. It previously comprised hornbeam-oak-birch (<i>Betula pendula</i>) wood over a ground cover dominated by bracken. Now, large parts appear to lack a high canopy, comprising young growth with occasional oaks.	0.6 km south	6.9 ha	TQ575902
Foxburrow Wood, Upminster SBI Grade 2	Ancient woodland	0.6 km south	2.2 ha	TQ573902
St Faith's/Honeypot Lane Meadows LWS	The site comprises extensive grassland, hedgerow and streamside habitat. The meadows are separated by a network of substantial hedgerows forming well connected corridors of scrubby habitat.	0.6 km north-east	16 ha	TQ586937
Warley Country Park LWS	Much of the western part of this site is developing woodland and scrub interspersed by grassy glades. To the east is an area of more densely shading plantation habitat with pedunculate oak and ash (<i>Fraxinus excelsior</i>).	0.6 km south-east	25 ha	TQ584924
Shoulder of Mutton Wood Site of Local Importance (SLI)	A small ancient woodland, popular for informal recreation.	0.8 km west	2.2 ha	TQ551919

Site Name	Description	Distance and Direction from Scheme	Area	Grid Reference
Weald Country Park LWS	The site comprises the majority of Weald Country Park, with the only exclusions being the heavily managed visitor areas to the south of the main lake and a number of woodland sections dominated by conifers. The park can be divided into three distinct section: the northern woods, eastern old parkland and western meadowland.	0.7 km north	139 ha	TQ570947
Warley Place LWS	The site comprises the Essex Wildlife Trust's Warley Place nature reserve and two adjacent meadows.	0.9 km east	10 ha	TQ583909
Coombe Wood LWS	The western part of the site is characterised by silver birch, scattered pedunculate oak and sweet chestnut (<i>Castanea savtiva</i>). Rhododendron (<i>Rhododendron</i> sp.) dominates the shrub layer whilst bluebells (<i>Hyacinthoides non-scripta</i>) are abundant in the ground flora.	0.9 km south east	7.9 ha	TQ579901
Bachelor's Walk Wood LWS	Site comprises two sections of streamside woodland. The northern section has a canopy dominated by hornbeam coppice with pedunculate oak standards whilst alder is found by the stream.	0.9 km east	1.4 ha	TQ582916
La Plata Grove LWS	A variety of tree species for the high canopy of this woodland. Those characteristics of this site include pedunculate oak, ash and common lime (<i>Tilia x europaea</i>), whilst alder (<i>Alnus glutinosa</i>) is found near the stream on the western side of the site.	0.9 km east	1.7 ha	TQ588933
Carter's Brook and Paine's Brook SBI Grade 2	Two streams lined with woodland and grassland, forming a valuable green corridor across the north of Havering.	0.9 km south-west	12 ha	TQ541929
Long Wood and Sage Wood SBI Grade 1	A sizeable area of ancient woodland, providing access to nature for many people in the north of Havering.	1 km west	4.3 ha	TQ544922
Bourningwood Fields SBI Grade 2	A colourful, flower-rich pasture surrounded by fine hedges.	1.3 km south west	7ha	TQ557906
Tomkyns East Pastures SBI Grade 1	Grassland, woodland and scrub.	1.1 km south	6.6 ha	TQ571897

Site Name	Description	Distance and Direction from Scheme	Area	Grid Reference
Holly Wood LWS	Tall pedunculate oak, sycamore, beech (<i>Fagus sylvatica</i>) and ash are the characteristic tree species of this site. A fenced and secluded pond area towards the northern end of the site provides greater habitat diversity to the site.	1.2 km south-east	4.6 ha	TQ590926
St. Charles Nature Reserve LWS	The main canopy is dominated by ash and pedunculate oak. Beneath is a lower sub including hornbeam, whilst hazel, holly (<i>Ilex aquifolium</i>) and hawthorn are species found in the shrub layer. Alder grows alongside a small channel running through the site along with coppices small-leaved lime.	1.2 km north-east	0.4 ha	TQ587942
Hall Lane Verge and Montrose Pastures SBI Grade 2	Secondary woodland and road verge	1.2 km south-west	3.5 ha	TQ561899
Forge House Paddocks and Fishing Lake SBI Grade 2	Flower-rich fields and a number of ponds combine to provide some varied wildlife habitats.	1.3 km north-west	7.7 ha	TQ543936
Holden's Wood LWS	A wide variety of tree and shrub species are found throughout this large, undulating woodland. Many ground flora species of interest are also present.	1.3 km east	20 ha	TQ591909
Clement's Wood LWS	The site comprises both ancient and secondary woodland. Hazel (<i>Corylus avellana</i>) and sycamore (<i>Acer pseudoplatanus</i>) coppice along with holly dominate the southern part of the site. The western margin has streamside alder whilst some parts of the wood are characterised by pedunculate oak and ash standards over a shrub layer that includes elder (<i>Sambucus nigra</i>) and hawthorn (<i>Crataegus monogyna</i>).	1.3 km east	8.5 ha	TQ586919
Locksmith Wood LWS	Most of the site comprises ancient woodland, although the central rectangular compartment is a recent plantation.	1.6 km north	5.1ha	TQ560951
High Wood LWS	Ancient and secondary woodland.	1.5 km north-east	4.9 ha	TQ582949
Chequers Road Wood SBI Grade 2	Secondary woodland alongside a road.	1.5 km north-west	0.6 ha	TQ544939

Site Name	Description	Distance and Direction from Scheme	Area	Grid Reference
Parker's Shaw LWS	Much of the central part of Parker's Shaw has been replanted with sweet chestnut standards. Whilst bramble (<i>Rubus fruticosus agg</i>) forms some dense ground cover, bluebell and yellow archangel (<i>Lamium galeobdolon</i>) are also found within the ground flora.	1.7 km south-east	1.6 ha	TQ582895
Weald Brook Wood LWS	The site comprises a strip of possibly ancient streamside woodland with an artificial southern margin.	1.8 km north	1.7 ha	TQ547950
St Mary the Virgin Churchyard, Great Warley LWS	A mix of species typical of neutral and acid grassland are to be found in the churchyard site.	1.8 km south-east	0.4 ha	TQ588899
Upminster Lodge Farm Horse Field SBI Grade 1	Horse paddock.	1.8 km south	1.7 ha	TQ566891
Hill View SBI Grade 2	Grassland and secondary woodland.	1.9 km south	1 ha	TQ573889
St Thomas' Churchyard, Noak Hill SBI Grade 2	A churchyard with neutral and acidic grassland with a diversity of wild flowers, mosses and fungi.	1.9 km north-west	0.5 ha	TQ541940
Gilstead Wood LWS	A small stand of old hornbeam may attain ancient woodland status, but the majority of this wood is mature recent woodland.	2 km north	2.2ha	TQ557955
Little Warley Common/Warley Gap Woods LWS	Former wood-pasture, now broadleaved woodland, with a flora typical of broadleaved woods on sandy, acid soils.	2 km east	11 ha	TQ594908

Ancient woodland

7.6.4 There are 19 ancient woodlands within 2 km of the Scheme, which are listed in Table 7.7 below.

Table 7.7: Ancient woodland

Site Name	Distance and Direction from Site	Area	Grid Reference
Vicarage Wood	Adjacent to the Scheme	5.8 ha	TQ569929
Jacksons Wood	0.1 km east	4.4 ha	TQ574908
Vicarage Wood	0.1 km north	4.2 ha	TQ570933
The Osiers	0.3 km north-east	4.2 ha	TQ554935
Duck Wood	0.2 km west	6.4 ha	TQ555923
Unknown name	0.5 km north-east	3.4 ha	TQ555931

Site Name	Distance and Direction from Site	Area	Grid Reference
Unknown name	0.6 km south	2.1 ha	TQ573902
Coombe Green Wood	0.7 km south	15.6 ha	TQ576903
Shoulder of Mutton Wood	0.7 km east	1.8 ha	TQ551918
Shoulder of Mutton Wood	0.9 km east	0.2 ha	TQ551920
Holdens Wood	1.3 km east	12.6 ha	TQ591908
Unknown name	1.3 km east	1.6 ha	TQ585918
Hatters Wood	1.3 km north-east	12 ha	TQ546929
Unknown name	1.5 km east	0.1 ha	TQ586921
Locksmith Wood	1.5 km north	4.9 ha	TQ560951
Unknown name	1.6 km east	1.5 ha	TQ588920

Veteran trees

7.6.5 The desk study found no veteran trees within the Woodland Trust Ancient Tree Inventory within 50 m of the Scheme. Further survey for veteran trees will be undertaken as part of the arboricultural survey to be carried out during the Preliminary Design Stage.

Habitats

Buildings

7.6.6 A range of buildings are present within the Scheme boundary that are referred to as Buildings 1 to 10. A description of each building is given below, and the location of each building is shown on the Phase 1 Habitat Map in Volume 3.

- Building 1 - Barn type converted residential building with wood cladding and a tiled roof;
- Building 2 - Barn type converted residential building with wood cladding and a tiled roof;
- Building 3 - A residential building of brick with a pitched tiled roof;
- Buildings 4 to 9 - Similar buildings constructed of corrugated material; and
- Building 10 - A breeze block substation with a pitched roof.

7.6.7 Scattered around the buildings were a number of caravans and various types of shipping containers.

Bare ground

7.6.8 Bare ground extended around the commercial buildings (Buildings 4-9). The ground was made up of an aggregate and earth type formation compressed to create a hardstanding to allow for the use of vehicles to cross. Another small area of bare ground was noted adjacent to the M25 consisting of a mix of sub and top soil.

Fence

- 7.6.9 Running almost in parallel to the M25 was a chain-linked fence which was approximately 2.4 m high and acting as a deer proof barrier.

Amenity grassland

- 7.6.10 There were two distinct areas of amenity grassland within the Scheme boundary. One area was located around the residential houses (Buildings 1-3) and the second made up the fairways on the adjacent Maylands golf course. The species within these areas of amenity grassland were typical of a hard-wearing grassland surface and dominated by perennial rye-grass (*Lolium perenne*). Other species that were occasional included: cock's-foot (*Dactylis glomerata*), creeping bent (*Agrostis stolonifera*), common cat's-ear (*Hypochaeris radicata*), common mouse-ear (*Cerastium fontanum ssp .vulgare*), daisy (*Bellis perennis*), selfheal (*Prunella vulgaris*), vervain (*Verbena officinalis*), white clover (*Trifolium repens*), and yarrow (*Achillea millefolium*).

Poor semi-improved grassland

- 7.6.11 The poor semi-improved grassland is located on road verges and agricultural land in the south and east extents of the Scheme boundary. This habitat is typically dominated by tussock forming grasses that included cock's-foot and false oat-grass (*Arrhenatherum elatius*) such as along the edges of the golf course, or by common bent (*Agrostis capillaris*). A range of forbs occurred occasionally within the grassland and included cleavers (*Galium aparine*), common bird's-foot-trefoil (*Lotus corniculatus*), common field-speedwell (*Veronica persica*), common mouse-ear, common ragwort (*Senecio jacobaea*), red clover (*Trifolium pratense*), smooth tare (*Vicia tetrasperma*), spear thistle (*Cirsium vulgare*) and yarrow (*Achillea millefolium*).

Semi-improved neutral grassland

- 7.6.12 There were extensive areas of semi-improved grassland within the Scheme boundary. Some areas were similar in composition with the poor semi-improved grassland (with a dominance of common bent) such as the grassland to the west of Weald Brook, but within the sward was a greater diversity of forb species. In areas where grass was less dominant there was an acid grassland composition that included biting stonecrop (*Sedum acre*), lesser stitchwort (*Stellaria graminea*), parsley piert (*Aphanes arvensis agg.*), sheep's sorrel [agg.] (*Rumex acetosella*) and tormentil (*Potentilla erecta*), the one acid grassland indicator, sneezewort (*Achillea ptarmica*), which was the exception was growing near the M25 adjacent to tall ruderal vegetation.
- 7.6.13 In the main, the dominant species were common bent, creeping bent (*Agrostis stolonifera*), crested dog's-tail (*Cynosurus cristatus*), marsh foxtail (*Alopecurus geniculatus*), meadow barley (*Hordeum secalinum*), meadow foxtail (*Alopecurus pratensis*), smaller cat's-tail (*Phleum bertolonii*), sweet vernal grass (*Anthoxanthum odoratum*), tall fescue (*Festuca arundinacea*) and Yorkshire-fog (*Holcus lanatus*). The forbs that typically occurred occasionally included: agrimony (*Agrimonia eupatoria*), common bird's-foot-trefoil, common centaury (*Centaureum erythraea*), common fleabane (*Pulicaria dysenterica*), common knapweed (*Centaurea nigra*), Common mouse-ear, common sorrel (*Rumex acetosa*), corn mint (*Mentha arvensis*), lady's bedstraw (*Galium verum*), meadow buttercup

(*Ranunculus acris*), meadow vetchling (*Lathyrus pratensis*) and yarrow, with grey sedge (*Carex divulsa*) and hairy sedge (*Carex hirta*). One area of grassland was very distinctive due to the local abundance of common fleabane. This area was located immediately to the north of Grove Farm.

- 7.6.14 Early goldenrod (*Solidago gigantea*) was establishing in areas where soils had become exposed.

Tall ruderal

- 7.6.15 Within the Scheme were discrete patches of tall ruderal vegetation typically located close to the M25. These patches included a range of species, including michaelmas-daisy (*Aster* sp.), annual mercury (*Mercurialis annua*), black horehound (*Ballota nigra*), black medick (*Medicago lupulina*), black nightshade (*Solanum nigrum*), common poppy (*Papaver rhoeas*), goat's-rue (*Galega officinalis*), hedge mustard (*Sisymbrium officinale*), hemlock (*Conium maculatum*), mugwort (*Artemisia vulgaris*), Oxford ragwort (*Senecio squalidus*), scarlet pimpernel (*Anagallis arvensis*), swine-cress (*Coronopus squamatus*), upright hedge-parsley (*Torilis japonica*), weld (*Reseda luteola*), winter-cress (*Barbarea vulgaris*) and great horsetail (*Equisetum telmateia*).
- 7.6.16 On the western side of the Weald Brook were extensive areas of early goldenrod. this species was also present on the eastern side of the Weald Brook growing in more discrete patches.

Semi-natural broadleaved woodland

- 7.6.17 Located in the central sector of the Scheme close to the residential dwellings is Grove Wood. Grove Wood has a canopy dominated by pedunculate oak (*Quercus robur*) with ash (*Fraxinus excelsior*), beech (*Fagus sylvatica*), hornbeam (*Carpinus betulus*), wild cherry (*Prunus avium*) and silver birch (*Betula pendula*). The shrub layer was quite sparse with the occasional hazel (*Corylus avellana*) and patches of bramble (*Rubus fruticosus* agg.). The ground flora contained a number of woodland species that included bluebell (*Hyacinthoides non-scripta*), dog's mercury (*Mercurialis perennis*), enchanter's-nightshade (*Circaea lutetiana*), foxglove (*Digitalis purpurea*), garlic mustard (*Alliaria petiolata*), greater stitchwort (*Stellaria holostea*), wood sage (*Teucrium scorodonia*), broad buckler-fern (*Dryopteris dilatata*) and wood false-brome (*Brachypodium sylvaticum*).
- 7.6.18 Along the entire length of the Weald Brook is a strip of woodland with a canopy layer made up of alder (*Alnus glutinosa*), ash, blackthorn (*Prunus spinosa*), dog rose (*Rosa canina* agg.), elder (*Sambucus nigra*), field maple (*Acer campestre*), hawthorn (*Crataegus monogyna*), hazel, hornbeam, pedunculate oak and white willow (*Salix alba*). The ground flora had patches of common nettle (*Urtica dioica*) and a scattering of woodland species that included male fern (*Dryopteris filix-mas* agg.), wood false-brome, dog's mercury, greater stitchwort, moschatel (*Adoxa moschatellina*), wood speedwell (*Veronica montana*) and remote sedge (*Carex remota*).
- 7.6.19 To the east of the M25, immediately north of the A12 is a narrow woodland following the banks of the River Ingrebourne. The dominant tree species was alder, and the ground flora was dominated by grasses including rough meadow grass (*Poa trivialis*), Yorkshire fog and creeping bent with occasional wood false-brome.

- 7.6.20 Further east along the River Ingrebourne, the woodland widens to broadleaved woodland with a canopy dominated by old coppiced hornbeam with occasional pedunculate oak. The ground flora was very sparse due to deer browsing. This woodland is a part of Lower Vicarage Wood LWS.
- 7.6.21 In the very north of the Scheme is a small section of broadleaved woodland which was similar in composition to Grove Wood

Broadleaved plantation woodland

- 7.6.22 In the north of the Scheme is Alder Wood, a broadleaved plantation divided down the centre by a wayleave for an overhead electric line. This plantation was dominated by semi-mature ash, and the main shrub species was hawthorn. There was a very distinctive browse line throughout the plantation due to browsing by deer, mainly fallow deer (*Dama dama*), and no obvious regeneration of trees. The ground flora had an abundance of both dog's mercury and wood false brome with occasional wood sedge (*Carex sylvatica*). Where the canopy had opened up, patches of early goldenrod had established, which seemingly had not been browsed by deer. The northern end of the wood was increasingly dominated by hawthorn. To the southern end of the woodland was a small wet ditch, which ran into Weald Brook.
- 7.6.23 To the east of Alder Wood is an embankment of the M25 planted with broadleaf trees. This plantation was separated from Alder Wood by a chain-link fence. The woodland was younger in age than the ash plantation of Alder Wood, and more diverse in structure due to protection from deer browsing. Species included: wild cherry, ash, hazel, bramble, hawthorn, hornbeam, wood avens (*Geum urbanum*), sycamore (*Acer pseudoplatanus*), dog's-mercury, herb-robert (*Geranium robertianum*), ivy (*Hedera helix*), hedge woundwort (*Stachys sylvatica*) and wood false-brome. The ground flora was noticeably taller and there was abundant seedling regeneration and no obvious browse lines.
- 7.6.24 At the southern end of Lower Vicarage Wood is a small stand of hybrid black-poplar (*Populus x canadensis* agg.) broadleaved plantation, located on the north side of the River Ingrebourne.

Mixed plantation woodland

- 7.6.25 In the south east corner of Grove Wood is a stand of mixed woodland dominated by a plantation of Scots pine (*Pinus sylvestris*) with occasional pedunculate oak, wild cherry, silver birch, and hornbeam.

Dense scrub

- 7.6.26 Dense scrub forms a belt of vegetation along the River Ingrebourne south of Grove Wood. The dominant species recorded was blackthorn, which forms thickets of vegetation. Frequently occurring was hawthorn with occasional pedunculate oak and field maple. The ground flora was typically quite sparse with occasional patches of bramble, and a range of ruderal vegetation, including willowherbs (*Epilobium* sp.), spear thistle (*Cirsium vulgare*) and common nettle.
- 7.6.27 Dense scrub is also present forming a linear belt immediately north of the A12 to the west of the M25 and is present on the verges of the M25 within Junction 28.

Scattered scrub

- 7.6.28 Occurring occasionally on the edge of the dense scrub or woodland were a few scattered hawthorn.

Scattered broadleaved trees

- 7.6.29 Around the edges of the woodlands were the occasional mature/over mature pedunculate oak.

Standing water

- 7.6.30 There was only one pond within the Scheme (P1), at Grove Wood. A further two ponds (P2 and P3) were identified within 250 m of the Scheme boundary. The pond P1 at Grove Wood was heavily shaded by the canopy of the trees leaving the pond with no marginal vegetation. This pond was approximately 100 m² in size with shallow draw down zones.

Running water

- 7.6.31 Weald Brook flows from north to south through the Scheme, and morphologically has a range of meanders along the entire length within the Scheme. The average width of the brook is approximately 3 m. The water was fairly shallow (0.5 m) at the time of survey, with a very low flow rate at many woodland piles crossing the water course creating miniature wooded dams. The base of the banks had been browsed by deer leaving very little to no vegetation. The banks are approximately 1.5 m high and vary from almost vertical to 45 degrees. The banks and the brook were heavily shaded by the belt of woodland which flanks the brook for its entire length within the Scheme boundary.
- 7.6.32 The River Ingrebourne flows from east to west and is more open. The river is a similar width to the Weald Brook but has been engineered (probably by past road schemes) to be completely straight with no meanders. The banks of the River Ingrebourne in contrast to the Weald Brook are very shallow in gradient, gradually tapering back. The flow appeared to be quite fast running over a gravel bottom and in-stream features such as pools and riffles were present along its length within the Scheme boundary.

Wet ditch

- 7.6.33 A wet ditch is present within the Scheme boundary, which flows along the southern edge of Alder Wood into the Weald Brook. The ditch was virtually devoid of vegetation except for creeping bent, except where it reaches the Weald Brook, where there were patches of water mint (*Mentha aquatica*).

Dry ditch

- 7.6.34 A dry ditch is present to the west of the Weald Brook which may have formed the boundary of an old field system. A dry ditch is also present in the north of Scheme which leads to a culvert. There is also a dry ditch around the northern edge of the poplar plantation at the southern end of Lower Vicarage Wood.

Species-rich defunct hedgerow

- 7.6.35 Between Grove Wood and Alder Wood is a defunct hedgerow. Species present within the hedgerow included: hawthorn, elder, pedunculate oak, blackthorn,

hornbeam and field maple. A large dead pedunculate oak is present at the approximate mid-point of the hedgerow.

Species poor intact hedgerow

7.6.36 Parallel with the anticlockwise on-slip from Junction 28 to the M25 is a planted hedgerow dominated by hawthorn with occasional ash, field maple, oak and bramble. A mature pedunculate oak is present within the hedgerow.

Vegetation communities

7.6.37 The NVC survey identified three homogeneous areas of semi-improved grassland at the following locations:

- Grassland north of Grove Farm and south of Alder Wood;
- Woodland ride east of Weald Brook and west of Alder Wood; and
- Grassland west of Weald Brook.

7.6.38 The woodland ride was well grazed by deer and in many places short, resembling more of a regularly maintained grassland.

7.6.39 All three grassland areas surveyed were classified as MG6b *Lolium perenne* - *Cynosurus cristatus* grassland, *Anthoxanthum odoratum* sub-community. However, the grassland west of Weald Brook returned a range of NVC community types and the lowest coefficients suggesting the field surveys have not identified a particularly strong fit for any one community.

7.6.40 The total count for species occurring in the semi-improved grassland was 59 species. Of these species, four were considered to be abundant to frequent which included: common bent, crested dog's-tail, Yorkshire fog and common fleabane. All other species were occasional to rare.

7.6.41 The total count for species occurring in the woodland across the Scheme was 32 species. Of these 11 species were identified as ancient woodland indicators (AWI) and included wood meadow-grass (*Poa nemoralis*), bluebell, moschatel, violet (*Viola* sp.), wood speedwell, pendulous sedge (*Carex pendula*), remote sedge, wood sedge, field maple, hornbeam and wild cherry. The constant species included ash, hawthorn and dog's mercury. All other species were frequent to rare.

7.6.42 Grove Wood and Alder Wood are very different in terms of their vegetation community types, as one is an ash plantation and the other a native oak woodland.

7.6.43 The total count for species occurring in Alder Wood was 24 species. Of these, two woody species were constant: ash and hawthorn. The only ground flora constant was dog's mercury. The results indicate the community is W8d *Fraxinus excelsior* - *Acer campestre* - *Mercurialis* woodland, *Hedera helix* sub-community, with a looser connection with *Fagus sylvatica* - *Mercurialis perennis* W12 woodland.

7.6.44 The total count for species occurring in Grove Wood was 26 species with pedunculate oak as the only constant. The results indicate that this woodland is the community W10 *Quercus robur* - *Pteridium aquilinum* - *Rubus fruticosus* woodland.

7.6.45 Table 7.8 below provides a summary of the findings from the NVC survey.

Table 7.8: Summary of the findings

Section	NVC result (best fit)
Semi-improved grassland (all three sections of grassland)	MG6b
Alder Wood	W8d
Grove Wood	W10

Notable and protected species

Notable plants

- 7.6.46 To the east of the M25 and to the north of the A12 was a patch of a dozen plants of pennyroyal (*Mentha pulegium*), although it is unclear if this population is native. Pennyroyal is a species listed under Schedule 8 of the Wildlife and Countryside Act 1981 (as amended).

Invertebrates

Aquatic invertebrates

- 7.6.47 The biotic scores for water quality are 'moderate' at the River Ingrebourne and 'poor' at the Weald Brook. While there are some pollution sensitive species present, the invertebrate assemblage is likely to be suppressed by the shading at both sites, resulting in a lack of aquatic macrophytes, and by the slow flow rate and high sediment content in the Weald Brook.
- 7.6.48 The baseline results for the Community Conservation Index assessment shows both sites have low conservation value, but the site at the River Ingrebourne scores higher than the Weald Brook and is close to having moderate conservation value.
- 7.6.49 The LIFE scores indicated that the Weald Brook has an invertebrate assemblage more typical of slower flowing streams with the River Ingrebourne having species typical of a faster flow.
- 7.6.50 The baseline results for PSI scores show both sites to be classed as sedimented, with the Weald Brook showing a higher degree of sedimentation than the River Ingrebourne.

Terrestrial invertebrates

- 7.6.51 Table 7.9 below identifies records of notable terrestrial invertebrates within 2 km of the Scheme, which were obtained during the desk study.

Table 7.9: Terrestrial invertebrate records

Common name	Scientific name	Frequency	Distance and direction of closest records	Date of most recent record	WCA Schedule 5	SPI	London BAP
Scarce emerald damselfly	<i>Lestes dryas</i>	2	c. 716m north west	2012			•
Stag beetle	<i>Lucanus cervus</i>	4	c. 0.8km	2004		•	•
Alder flea weevil	<i>Orchestes testaceus</i>	1	Within 1km	1987		•	
Small heath	<i>Coenonympha pamphilus</i>	307	4 records within the Scheme	2016		•	•
Wall	<i>Lasiommata megera</i> Wall	18	Within the Scheme	2001		•	•
White-letter hairstreak	<i>Satyrrium w-album</i>	128	4 records within the Scheme	2016	•	•	•
Knot grass	<i>Acronicta rumicis</i>	3	c. 1.64km east	2013		•	•
Mouse moth	<i>Amphipyra tragopoginis</i>	2	c. 1.64km east	2013		•	•
Latticed heath	<i>Chiasmia clathrata</i>	17	1 record within the Scheme	2014		•	•
Shaded broad-bar	<i>Scotopteryx chenopodiata</i>	49	1 record within the Scheme	2016		•	•
White ermine	<i>Spilosoma lubricipeda</i>	2	c. 350m north	2011		•	•
Blood-vein	<i>Timandra comae</i>	5	c. 150m south-west	2014		•	•
Cinnabar	<i>Tyria jacobaeae</i>	47	2 records within the Scheme	2016		•	•
Large nutmeg	<i>Apamea anceps</i>	1	2.6km	1985		•	
Garden tiger	<i>Arctia caja</i>	1	2.9km (10km accuracy)	1972	•	•	•
Mottled rustic	<i>Caradrina morpheus</i>	1	2.6km	1985		•	
Small phoenix	<i>Ecliptopera silaceata</i>	1	2.6km	1985		•	
Jersey tiger	<i>Euplagia quadripunctaria</i>	6	1.7km	2014			•
Ghost moth	<i>Hepialus humuli</i>	2	2.6km (10km accuracy)	1985		•	

- 7.6.52 The terrestrial invertebrate scoping survey found suitable habitat exists within the Scheme boundary for stag beetle (*Lucanus cervus*) and alder flea-weevil (*Orchestes testaceus*), which are SPI. There is considered to be high potential for these species to occur within woodland and scrub habitats. Elm (*Ulmus* species) was not found to be present within the Scheme boundary, and therefore based on the absence of suitable habitat for the SPI white-letter hairstreak butterfly (*Satyrrium w-album*), this species is not considered to be present.
- 7.6.53 The mature trees and shrubs within the Scheme boundary, particularly along Weald Brook but also in hedges, fields and on woodland edges, are considered to have high potential for notable invertebrates, particularly deadwood invertebrates (saproxylics) as well as canopy invertebrates.
- 7.6.54 Grove Wood and Alder Wood are considered to have at least moderate potential for notable invertebrates. The woodland ponds within Grove Wood are considered to have moderate potential for notable aquatic and wetland invertebrates.
- 7.6.55 Some of the pasture habitat is considered to have moderate potential for notable invertebrates.

Fish

- 7.6.56 A total of 243 individual fishes comprising five different species were caught or seen during the River Ingrebourne surveys. With the exception of three chub (*Squalius cephalus*) ranging from 66 mm to 135 mm fork length, all other species captured during surveys in the River Ingrebourne were those that are classed by the Environment Agency as being minor species. Minnow (*Phoxinus phoxinus*) was the most abundant fish species comprising 75% of the total catch and stone loach (*Barbatula barbatula*) was the least abundant fish species comprising < 1% of the total catch.
- 7.6.57 A total of only six individual fishes comprising just two different species were caught during the Weald Brook surveys. Five of the fish caught were bullhead (*Cottus gobio*) and one was three-spined stickleback (*Gasterosteus aculeatus*). Both species are classed as minor species by the Environment Agency.

Amphibians

Great Crested Newt

- 7.6.58 The nearest record for great crested newts identified during the desk study is from c.180 m to the west of the Scheme from 2009. However, biological records provided by GiGL did not provide a precise location or map for this record. Essex Wildlife Trust data indicated that a small-medium-sized meta-population of great crested newts with numbers ranging from 1-10 individuals per pond, was identified c.1 km to the west of the Scheme.
- 7.6.59 Two European Protected Species Mitigation (EPSM) licences for great crested newts were identified 1 km to the west of the Scheme. These licences ran from 2012 to 2013 (EPSM2011 - 2843) and 2012 to 2015 (EPSM2012 - 4454).
- 7.6.60 Five ponds were identified during the desk study within 250 m of the Scheme boundary. Two of these ponds are located within lane to the east of the M25 and north of the A12, and are considered to be isolated from suitable terrestrial habitat affected by the Scheme. A sixth pond identified in the garden of the residential house at Grove Farm, and a seventh within land north of Grove Farm were found

to no longer exist during field surveys. Pond P1 is situated within the Scheme at Grove Wood. Pond P2 is situated c.100 m to the west of the Scheme, adjacent to Maylands golf course. Pond P3 was situated c.100 m to the south of the Scheme within an area of scrub on a farm. Ponds P4 and P5 are located approximately 400 m to the west of P2 within Maylands golf course.

- 7.6.61 Pond P1 was assessed as having a *below average* HSI score and the results of the eDNA survey were negative for great crested newt presence. This pond was excluded from further surveys.
- 7.6.62 Pond P2 was assessed as having an *average* HSI score and results of the eDNA survey were positive for great crested newt. It was included in the population estimate survey and found to have a *medium* population size, with a peak count of 22 individuals.
- 7.6.63 Pond P3 was found to be dry at the time of the first HSI survey on 8th June 2017 but was re-surveyed on 5th April 2018. P3 was given an *average* HSI score and included in the population estimate survey. The pond was found to have a *small* population of great crested newts, with a peak count of 2 individuals.
- 7.6.64 Pond P4 was given a *good* HSI score during the survey conducted on 5th April 2018 and was included in the population estimate survey. It was found to have a *small* population of great crested newts, with a peak count of 6 individuals.
- 7.6.65 Pond P5 was given an *excellent* HSI score during the survey conducted on 5th April 2018, and during subsequent population estimate survey was found to have a *medium* population size, with a peak count of 21 individuals.
- 7.6.66 A metapopulation of great crested newts is confirmed to be present overlapping the north-west of the Scheme and utilising at least three ponds for breeding. The peak count for the metapopulation (data from the three ponds combined) for any one survey visit was 29 individuals. The Scheme boundary has a range of habitats including woodland and semi-improved grassland all considered to be optimal habitat for great crested newts to commute and forage. Therefore, any suitable habitat within the range of Ponds P2, P4 and P5 could be used by great crested newts.
- 7.6.67 A small population of great crested newts is present to the south of the A12, centred on Pond P3. This pond is 60 m from the A12 westbound on-slip from Junction 28 but isolated by the road from the major works proposed to the north of the A12 by the road.

Reptiles

- 7.6.68 The desk study provided records for grass snake (*Natrix sp*) within 200 m of the Scheme and slow worm (*Anguis fragilis*) within 1.4 km. In addition, adder (*Vipera berus*) were recorded at Tylers Common, 1 km to the south of the Scheme. Grass snake were recorded on Weald Brook which is within the Scheme boundary.
- 7.6.69 Two common lizards (*Zootoca vivipara*) were recorded during reptile surveys within the Scheme boundary, and evidence of breeding was found by the presence of a juvenile lizard recorded within the Scheme boundary during September 2017. No other reptile species were recorded. The common lizards were recorded in the northern section of the Scheme, one on the golf course side of Weald Brook and the other within grassland within the Scheme boundary.

Birds

Breeding birds

- 7.6.70 The desk study identified records of the notable bird species kingfisher (*Alcedo atthis*) and little egret (*Egretta garzetta*), both from the Weald Brook within the Scheme. Records of the notable species tree pipit (*Anthus trivialis*), lesser spotted woodpecker (*Dryobates minor*) and black redstart (*Phoenicurus ochruros*) were identified from within 2 km of the Scheme. Habitats present within the Scheme boundary have the potential to support these species. Many records of common and widespread species were also returned from the data search.
- 7.6.71 During breeding bird surveys, the greatest number of breeding birds were located within the scrub running either side of Weald Brook. The wooded habitats to the north and south of the Scheme, and the pockets of scrub interspersed within the grassland habitat to the west of Weald Brook supported relatively moderate numbers of breeding birds. The areas of open grassland were the least favoured habitat with predominantly foraging and commuting behaviour observed only.
- 7.6.72 The locality of breeding bird territories reflects the distribution of suitable habitats within the Scheme. Weald Brook supported a greater diversity of habitats than the rest of the Scheme which was heavily grazed by deer and generally lacked nesting opportunities. The habitats surrounding the brook comprised scrub, woodland and tall ruderal habitat, which including the running water from the brook itself appeared to support the most breeding bird species within the Scheme. Weald Brook also had good connectivity through the Scheme and to the wider landscape, which has encouraged kingfishers to utilise the full extent of this habitat.
- 7.6.73 The woodlands were also heavily affected by deer grazing, which significantly reduced the amount of nesting habitat available, reducing the distribution of common and widespread scrub nesting birds such as blackcap (*Sylvia atricapilla*), dunnock (*Prunella modularis*), chiffchaff (*Phylloscopus collybita*) and blackbird (*Turdus merula*).
- 7.6.74 A total of 31 species were considered to be breeding within the survey area during the bird surveys. According to Fuller's scale (1980), the Scheme is therefore of *district* importance for breeding birds (district importance between 25 - 49 breeding species). An indicative territory map of breeding species is provided in the breeding bird technical report. Four species identified had an estimated breeding population of 10 or more pairs: Blue tit (*Cyanistes caeruleus*), common whitethroat (*Sylvia communis*), great tit (*Parus major*) and wren (*Troglodytes troglodytes*).
- 7.6.75 Six notable species, or those with a higher level of legal protection under Schedule 1 of the Wildlife and Countryside Act 1981 (as amended), were recorded (see Table 7.10 below).

Table 7.10: Protected / notable bird species within the Scheme

Common Name	Scientific Name	Number of Territories Present within the Scheme	Sch1	SPI	LBAP	Red List ³³	Amber List ³³
Dunnock	<i>Prunella modularis</i>	6		•			•
Kingfisher	<i>Alcedo atthis</i>	1	•				•
Reed bunting	<i>Emberiza schoeniclus</i>	2					•
Song thrush	<i>Turdus philomelos</i>	3		•		•	
Starling	<i>Sturnus vulgaris</i>	1		•		•	

7.6.76 Kingfisher was the only species recorded, which is listed under Schedule 1. A kingfisher was recorded foraging along Weald Brook and although no breeding activity was noted, it was considered to be breeding either within the Scheme or nearby as kingfisher were frequently seen within the Scheme, commuting along the brook. The banks of the brook were also steep and earthy, with the potential to support nesting kingfisher.

Barn owl

7.6.77 No records for barn owl were identified during the desk study from within the Scheme boundary, the nearest being 1.6 km to the east of the Scheme.

7.6.78 No evidence of barn owl was recorded within any of the buildings within the Scheme boundary. The buildings within the industrial yard were steel framed structures which were heavily disturbed by human activity. The residential buildings within the south-eastern corner of Grove Farm were also similarly disturbed and no access points suitable for barn owl were recorded.

7.6.79 The Scheme is located within proximity to two major roads in the A12 and M25. Although main roads account for the majority of barn owl casualties, several habitats with the potential to support hunting barn owl were located within the Scheme. Habitats comprised woodland, grassland, and a brook, which are likely to support a good number of rodent species. No evidence of foraging barn owl was recorded during the seven bat activity surveys, which were undertaken for two hours after sunset (when barn owls are typically active), between May and October (inclusive). However, tawny owls (*Strix aluco*) were recorded within Grove Wood.

Bats

7.6.80 The following records for bats within 5 km of the Scheme were identified during the desk study. Noctule (*Nyctalus noctula*), soprano pipistrelle (*Pipistrellus pygmaeus*) and common pipistrelle (*Pipistrellus pipistrellus*) have been recorded within 1.2 km

³³ Birds of Conservation Concern, based on the UK Red List for Birds, published in The full details of this assessment can be found in Eaton et al. (2015).

of the Scheme. Lesser noctule (*Nyctalus leisleri*), Natterer's bat (*Myotis nattereri*) and brown long-eared bat (*Plecotus auritus*) have been recorded within 1.7 km of the Scheme. Serotine (*Eptesicus serotinus*), Daubenton's bat (*Myotis daubentonii*) and Nathusius's pipistrelle (*Pipistrellus nathusii*) were recorded 2 km from the Scheme.

7.6.81 MAGIC returned two records of EPSM licences within 2 km of the Scheme:

- EPSM2012-4100 (Common pipistrelle) - 09/02/2012 to 01/03/2014 - c. 1 km west of the Scheme; and
- 2015-9990-EPS-MIT (Common pipistrelle and brown long-eared bat) - 18/05/2015 to 31/07/2016 - c. 1.5 km east of the Scheme.

7.6.82 No statutory sites, designated for bats were located within 30 km of the Scheme.

7.6.83 No evidence of roosting bats was recorded for any of the trees or the buildings within the Scheme. However, following climbing inspections, a total of 54 trees within the Scheme were considered to hold either high, moderate, low or negligible potential to support roosting bats as follows (according to Collins, 2016):

- High potential – 7 trees;
- Moderate potential – 18 trees; and
- Low potential – 22 trees; and
- Negligible potential – 7 trees.

7.6.84 The static detector and bat transect surveys identified seven species of bat using habitats within the Scheme boundary to commute or forage. Bat activity was primarily focused on the woodland and scrub edge habitat with linear features. The Weald Brook and the western edge and glade of Alder Wood supported the main commuting activity through the Scheme. Common pipistrelle was the species most frequently recorded within the Scheme boundary, predominantly utilising these habitats. Although soprano pipistrelle activity was slightly less frequent, the habitat utilisation was similar, primarily using the woodland and scrub edges for foraging and commuting.

7.6.85 Leisler's bat activity was predominantly focused around Alder Wood, particularly along the glade. Most of this data was returned from the static detectors, returning 114 calls in June. This activity was likely down to foraging Leisler's bat, utilising the woodland.

7.6.86 Noctule were not recorded using the habitats within the Scheme boundary and were only seen commuting high above the Scheme across the landscape. This is behaviour typical of noctule.

7.6.87 Low numbers of Brandt's bat (*Myotis brandti*), myotis species, brown long-eared bat and Nathusius's pipistrelle were also recorded along the western edge of Alder Wood and Weald Brook. These species were picked up infrequently, and are considered to be using the linear features for commuting throughout the Scheme and the wider landscape.

Hazel dormouse

7.6.88 The desk study returned no records for hazel dormouse within 2 km of the Scheme.

7.6.89 No evidence of hazel dormouse was recorded during the surveys undertaken. Due to heavy grazing by, primarily, fallow deer and the domination of large trees, the woodland within the Scheme boundary is considered unsuitable to support hazel dormice, as there is no understorey, scrub or bramble habitat that would provide a means for dormice to move around the habitat, as well as a food source. The habitat along Weald Brook is more suitable due to the presence of scrub and hazel (a primary food source of hazel dormice), but no signs were recorded in this section of the Scheme.

Otter and water vole

7.6.90 The desk study identified records of water vole from the River Ingrebourne within the Scheme boundary, dated 2002. In addition, there are records of water vole 1.2 km from Scheme.

7.6.91 No signs of water vole were recorded during the surveys undertaken. However, water voles have been recorded within the Scheme in the past, on the River Ingrebourne. A potential water vole burrow was recorded on Weald Brook near its confluence with the River Ingrebourne (grid reference TQ 56439 92222). However, as no other evidence of water voles was recorded elsewhere, it is considered likely that the burrow was excavated by either rat (*Rattus norvegicus*) or signal crayfish (*Pacifastacus leniusculus*) which have also been recorded in the watercourses. Additional signal crayfish burrows were identified on the River Ingrebourne south of the A12.

7.6.92 The River Ingrebourne was considered to be more suitable for water voles, with bank vegetation suitable for providing a foraging source. However, bank profiles were typically shallow which is less suitable for the creation of burrows. In addition an extensive culverted bridge (over 100 m in length) was present on the eastern extent of the river. This is likely to restrict movement of water voles.

7.6.93 The desk study identified one record of an otter sighting from the River Ingrebourne within the Scheme, and a record from 2014 of otter 500 m to the south of the Scheme.

7.6.94 No evidence of otter holts was recorded within the Scheme. However, an otter spraint was recorded on the River Ingrebourne (grid reference TQ 56629 92350), under the bridge of the driveway from Grove Farm to the A12 off-slip to Junction 28, during aquatic invertebrate surveys in August 2017. The subsequent deployment of camera traps did not identify any sightings of otters using the watercourses.

7.6.95 The Weald Brook is predominantly devoid of vegetation due to shading from trees. However, areas of scrub were present along the Weald Brook which could provide suitable shelter for otters.

Badger

7.6.96 The desk study identified over 60 records of badgers within 2 km of the Scheme, the nearest being within the Scheme boundary at Grove Wood.

7.6.97 There were a number of direct observations of badger within the Scheme boundary, which included a badger cub recorded on 25th May 2017 during the bat transect survey. The cub was spotted foraging along the western edge of Grove Wood.

- 7.6.98 In addition, badgers were recorded on camera traps set up on the southern watercourse between 3rd September and 27th October 2017 as part of the otter survey.
- 7.6.99 An active main badger sett is present within Grove Wood. The sett was comprised of 17 entrances, of which three showed very recent activity. Many of the other entrances appeared less well used. The tunnels associated with the sett entrances ran in predominantly in a southerly direction. Despite the size of the sett and activity around the holes, no latrines or 'snuffle' holes were recorded within the Scheme boundary.
- 7.6.100 An outlier sett was recorded within the north-western section of Alder Wood. The sett comprised of three inactive holes surrounding a large pedunculate oak facing in all directions. Evidence of low activity was present in comparison to the main sett, prompting the classification of outlier.
- 7.6.101 A disused outlier sett, within the Scheme boundary, was recorded within the south-western corner of Lower Vicarage Wood. The sett did not appear to have been used in the last 12 months due to the collapsed nature of the hole entrance and lack of any badger signs. This outlier is potentially connected to the main sett in Grove Wood by the River Ingrebourne culvert running beneath the M25, which would be passable by badgers during low water flows.
- 7.6.102 There were numerous mammal paths crossing the Scheme. It was not possible to determine which paths were used by badgers and which were used by deer.

Other mammals

- 7.6.103 Records of fallow deer identified during the desk study include sightings of up to 100 individuals. Fallow deer were regularly recorded during survey work in large numbers across all areas of the Scheme.
- 7.6.104 The desk study identified records of the following other mammal species from within 2 km of the Scheme: harvest mouse (*Micromys minutus*), hedgehog (*Erinaceus europaeus*), water shrew (*Neomys fodiens*), weasel (*Mustela nivalis*) and yellow-necked mouse (*Apodemus flavicollis*). Three records of harvest mouse were returned, with the nearest approximately 1.5km to the north and the most recent from 1999. Three records of hedgehog were returned, with the nearest approximately 0.5 km to the south-west and the most recent from 2013.

Non-native invasive species

Flora

- 7.6.105 The desk study identified records of 10 invasive species listed on Schedule 9 of the Wildlife and Countryside Act 1981 (as amended) from within 2 km of the Scheme. These include: water fern (*Azolla filiculoides*), alexanders (*Smyrniolobos olusatrum*), cotoneaster (*Cotoneaster* spp.), curly waterweed (*Lagarosiphon major*), giant hogweed (*Heracleum mantegazzianum*), giant knotweed (*Fallopia sachalinensis*), Himalayan balsam (*Impatiens glandulifera*), Japanese knotweed (*Fallopia japonica*), Japanese rose (*Rosa rugosa*), and rhododendron (*Rhododendron ponticum*).
- 7.6.106 Records of 18 species listed as species of concern by LISI were also identified from within 2 km of the Scheme. These species and Schedule 9 species identified are listed in Table 7.11 below.

Table 7.11: Invasive species records identified during the desk study

Common Name	Scientific Name	Records within 2km	WCA Schedule 9 species	LISI Species of Concern Category
Water Fern	<i>Azolla filiculoides</i>	1	•	
Alexanders	<i>Smyrniolobos olusatrum</i>	1	•	
Butterfly-bush	<i>Buddleja davidii</i>	4		3
Canadian Waterweed	<i>Elodea canadensis</i>	2		4
Cherry Laurel	<i>Prunus laurocerasus</i>	3		3
Cotoneaster	<i>Cotoneaster</i> spp.	4	•	2
Curly Waterweed	<i>Lagarosiphon major</i>	3	•	
Evergreen Oak	<i>Quercus ilex</i>	8		5
False-acacia	<i>Robinia pseudoacacia</i>	6		4
Few-flowered Garlic	<i>Allium paradoxum</i>	3		2
Giant Hogweed	<i>Heracleum mantegazzianum</i>	2	•	3
Giant Knotweed	<i>Fallopia sachalinensis</i>	1	•	5
Goat's-rue	<i>Galega officinalis</i>	10		4
Green Alkanet	<i>Pentaglottis sempervirens</i>	2		6
Himalayan Balsam	<i>Impatiens glandulifera</i>	11	•	3
Japanese Knotweed	<i>Fallopia japonica</i>	8	•	3
Japanese Rose	<i>Rosa rugosa</i>	3	•	
Least Duckweed	<i>Lemna minuta</i>	1		4
Parrot's-feather	<i>Myriophyllum aquaticum</i>	6		3
Rhododendron	<i>Rhododendron ponticum</i>	10	•	3
Snowberry	<i>Symphoricarpos albus</i>	6		2
Turkey Oak	<i>Quercus cerris</i>	9		3

7.6.107 Only one non-native invasive species as listed under Schedule 9 of the Wildlife and Countryside Act 1981 (as amended) was recorded during field surveys which was Himalayan balsam. This species was recorded on the River Ingrebourne either side of the culvert going under the M25.

7.6.108 In addition, two LISI Species of Concern, goat's-rue (*Galega officinalis*) and Himalayan balsam, were recorded. Goat's rue is present within tall ruderal habitat adjacent to the M25.

7.6.109 Another potentially invasive non-native species that was recorded within the Scheme is early goldenrod. This species is identified as invasive under the Non-Native Species Secretariat website, and it has formed extensive stands in

particular down the western side of the Weald Brook and is likely to be spreading impacting mainly on the grassland flora.

Invasive Fauna

7.6.109.1 The following species listed on Schedule 9 of the Wildlife and Countryside Act 1981 (as amended), were recorded during survey undertaken within the Scheme:

- A ring-necked parakeet (*Psittacula krameri*) territory was recorded along Weald Brook;
- Chinese muntjac (*Muntiacus reevesi*) were recorded several times on a camera trap along the River Ingrebourne. In addition, 20 records of Chinese muntjac were identified during the desk study. The nearest record was approximately 0.7 km to the west of the Scheme;
- Grey squirrel (*Sciurus carolinensis*) was recorded within the Scheme; and
- Signal crayfish was recorded in the Weald Brook during surveys of the Scheme. Burrows for this species was also observed on this watercourse, and on the River Ingrebourne south of the A12. Remains of a signal crayfish were also observed in a pedunculate oak during climbing inspections for bat roosts.

7.7 Potential impacts

Designated sites

Statutory sites

- 7.7.1 The Manor LNR is located approximately 300 m from the Scheme. This site is considered to be of county value under IAN 130/10 guidance (refer to Section 7.4). Due to this distance and the nature of the designations (i.e. not water dependent), although there may be hydrological links via groundwater or surface water, no direct impacts are anticipated on the conservation objectives of this designated site.
- 7.7.2 No indirect impacts are anticipated, as the designated site does not support features that would be impacted by noise or visual disturbance. Air quality and lighting impacts are also unlikely to extend 300 m from the Scheme. The impacts from air quality changes and lighting will be reassessed as the design develops, and potential effects will be assessed further in the ES.

Non-statutory sites

- 7.7.3 The northern section of the Ingrebourne Valley SMI lies within the Scheme and is considered to be of county value under IAN 130/10 guidance (refer to Section 7.4). The Scheme will result in a permanent and direct impact on this designated site through a loss of habitat as a result of construction, changes to habitats including the River Ingrebourne, and changes to local hydrology and water quality. There will also be temporary impacts related to the proposed construction from clearance of habitat for working areas, compound sites and access roads.
- 7.7.4 A section of the River Ingrebourne will be permanently removed to allow for realignment of the eastbound off-slip of the A12. The river channel will be diverted to the north of the new slip road.

- 7.7.5 Without mitigation these impacts will be negative and on a feature of county value. The effect is considered to be of moderate significance.
- 7.7.6 The following additional non-statutory designated sites are adjacent to the Scheme:
- The Oaks LWS;
 - Lower Vicarage Woods LWS;
 - Jer mains Wood LWS; and
 - Jackson's Wood/Tyler's Shaw LWS.
- 7.7.7 The sites are considered to be of county value under IAN 130/10 guidance (refer to Section 7.4). No direct impacts to these sites are anticipated at this stage. However, it is probable that indirect, temporary, reversible impacts may arise due to the proximity of the working area to the sites. These impacts are likely to be in relation to ground and surface water pollution, noise and visual disturbance as a result of the construction works. Overall, without mitigation, it is considered that the effect of the Scheme will be of slight significance on these sites.
- 7.7.8 The Air Quality chapter (Chapter 5) within this report will detail any potentially significant impacts from air pollution that may affect designated sites within 2 km to the Scheme.

Ancient woodland

- 7.7.9 Lower Vicarage Wood is an ancient woodland site located adjacent to the Scheme. Ancient woodland is an irreplaceable resource and is considered to have national value. This woodland is also a LWS and includes lowland mixed deciduous woodland HPI. Therefore, Lower Vicarage Wood is considered to be of national value.

Veteran trees

- 7.7.10 Currently, no potential impacts on ancient trees are identified. However, further survey is required to confirm the presence or absence of veteran trees, and any potential impacts on them.

Habitats

- 7.7.11 All valuations for notable habitats will be confirmed in consultation with Natural England.
- 7.7.12 The semi-natural broadleaved woodland within the Scheme boundary at Grove Wood and alongside the Weald Brook is HPI, and forms part of the Ingrebourne Valley SMI, which is considered to be of county value. Similarly, the Weald Brook and River Ingrebourne within the Scheme boundary are HPI and form part of the SMI so are also considered to be of county value.
- 7.7.13 Semi-improved neutral grassland, plantation woodland, hedgerows, scattered broadleaved trees and ponds outside of the SMI or other designated sites are considered to be of local value under IAN 130/10 guidance (refer to Section 7.4) as they enrich the habitat resource within a local context.
- 7.7.14 The Scheme is likely to result in the direct loss of semi-improved grassland and vegetation along the watercourses, and broadleaved plantation woodland at Alder

Wood. This impact will be permanent and non-reversible in some areas, but temporary and reversible in other areas, typically grassland which will be used for access routes. The total extent of habitat loss is not known at this stage due to the location of temporary construction areas not being confirmed. It is considered that, without mitigation, the effect of the Scheme will be of moderate significance on the Weald Brook and River Ingrebourne due to the impact of shading of habitat at the river crossings, and the value of these watercourses. The effect of the Scheme on all other habitats within the Scheme boundary is expected to be of slight significance.

- 7.7.15 The Air Quality chapter (Chapter 5) within this report will detail any potentially significant impacts from air pollution that may affect habitats associated with the Scheme.

Notable and protected species

Notable plants

- 7.7.16 The pennyroyal is a notable plant species considered to be of local value under IAN 130/10 guidance (refer to Section 7.4). The location of temporary construction areas and access routes are not known at this stage and as such the potential remains for this plant to be damaged as a result of the Scheme. This negative impact could be permanent or temporary and reversible and without mitigation, would result in an adverse effect of slight significance.

Invertebrates

Aquatic invertebrates

- 7.7.17 The Weald Brook has been assessed as being of local value for aquatic invertebrates, whilst the River Ingrebourne is of county value.
- 7.7.18 The Scheme involves works on both watercourses and there will be direct impacts on the invertebrate assemblages, although these are expected to be temporary and reversible on completion of the channel works. Impacts will arise from the loss of habitat and changes to hydrology and water quality. There will be longer term impacts on invertebrates in the River Ingrebourne due to the proposed realignment, but it is anticipated that assemblages will re-establish once the realignment is complete and vegetation has sufficiently recolonised.
- 7.7.19 As such it is considered that, without mitigation, there will be an effect of slight significance on the aquatic invertebrate assemblages within the Weald Brook and moderate significance on the aquatic invertebrate assemblages within the River Ingrebourne.

Terrestrial invertebrates

- 7.7.20 There is potential for several SPI including stag beetle and alder flea-weevil to be present within the Scheme boundary. In addition, the Scheme area is considered suitable to support other notable species, particularly those associated with mature and veteran trees and shrubs, and dead timber. This assemblage of species within the Scheme is considered to be of county value and the potential populations of stag beetle or alder flea-weevil are considered to be of county value.

- 7.7.21 The Scheme will potentially lead to the loss of habitat which supports notable invertebrates either as shelter, a food source or as material for egg laying. This impact is considered to be direct, negative and permanent although in some areas temporary. Impacts to woodland would be minimised through mitigation. However, the construction of the Scheme will likely involve some works which could impact stag beetle and other wood associated species, should they be present.
- 7.7.22 In addition, depending on the timing of the works, there could be direct impacts on eggs or larvae which could have a knock-on effect on the population of the invertebrate species. This impact could be irreversible, permanent and negative depending on the size of the populations present within the Scheme.
- 7.7.23 At this stage it is considered that the Scheme could have an effect of moderate significance on terrestrial invertebrates.

Fish

- 7.7.24 Low numbers of 'minor' fish species were recorded in both watercourses and the assemblage of fish is considered to be of local value. The River Ingrebourne supported more fish species and there will be direct, negative impacts on these species and the habitats they use as a result of the Scheme due to the removal of section of the river. A small section of the Weald Brook will be straightened and as such similar direct impacts will also arise. These impacts will be temporary and reversible.
- 7.7.25 The creation of a meander and the realignment of the River Ingrebourne has the potential to create more suitable habitat for fish species, providing them with areas to shelter and spawn. As such it is considered that in the long term the scheme will have a positive, direct, permanent impact on fish species in the two watercourses.
- 7.7.26 Without mitigation, there will be temporary negative effects of the Scheme on fish populations of slight significance, but it is considered that following establishment of the realigned river there will be a positive effect of slight significance.

Amphibians

- 7.7.27 Great crested newts are known to occur in ponds approximately 400 m to the west of the Scheme. In addition, the presence of great crested newts has been identified in pond (P2) within the Scheme which is considered to be part of a wider meta-population with the populations to the west. The wider meta-population of great crested newt in the north-west of the Scheme is considered to be of county value.
- 7.7.28 A population of great crested newts is also present to the south of the Scheme, centred around a pond within agricultural land 60 m south of the A12.
- 7.7.29 No direct impacts on any breeding ponds are anticipated as a result of the Scheme. Pond P2 may be in a temporary construction area, but direct impacts on the pond avoided. However, as habitat within the Scheme on the western side of the Weald Brook is suitable for supporting great crested newts, there is the potential for a direct, negative, non-reversible impact to occur on individual newts due to injury and harm from construction activities. There will also be an indirect, permanent impact as a result of the loss of terrestrial habitat. It is considered that the effect of the Scheme on great crested newts will be of moderate significance.

Reptiles

- 7.7.30 Low numbers of common lizard were within the Scheme boundary. In addition, other species such as grass snake have been recorded historically within the Scheme boundary. Reptiles are potential widespread in low numbers across the Scheme. The populations of reptiles using the habitats within the Scheme boundary are considered to be of local value.
- 7.7.31 There is the potential for reptile species to be harmed during clearance of vegetation and during construction works due to the movement of vehicles, installation of compounds and access routes and the construction activities themselves. This potential impact would be negative, direct, non-reversible and permanent. In addition, there will be the permanent loss of foraging and shelter habitat as a result of the construction of the Scheme which would be a negative and indirect impact.
- 7.7.32 The effect of the Scheme, without mitigation, on reptiles is considered to be of slight significance.

Birds

- 7.7.33 The assemblage of breeding bird species within the Scheme is considered to be of county value. The Scheme will result in the direct, permanent and non-reversible impacts to bird species as a result of the loss of breeding habitat and potential harm to nesting birds during construction works. These impacts are predominantly associated with the scrub habitat running along the Weald Brook. The level of impact will vary with impacts greater in the areas where habitat is to be lost. Displacement of bird species to other areas of habitat is likely to occur as result of noise and visual disturbance from the works, but this impact will be temporary and bird species will continue to use the habitats associated with the Scheme for breeding upon completion of the works.
- 7.7.34 A kingfisher was recorded along Weald Brook, although there was no evidence of it breeding within the area of works. This species is listed on Schedule 1 of the Wildlife and Countryside Act 1981 (as amended) and as such protected from disturbance as well as damage to its nest. This population is considered to be of county value. If kingfishers are nesting along the watercourses there is the potential for a negative, temporary and direct impact to occur to this species.
- 7.7.35 Overall, without mitigation, it is considered that the Scheme will have an effect of moderate significance on breeding birds.

Bats

- 7.7.36 No bat roosts have been identified within the Scheme boundary, but surveys recorded seven species using the habitats within the Scheme for foraging and commuting. The assemblage of bats using the Scheme is considered to be of local value.
- 7.7.37 The main commuting and foraging area is along the Weald Brook. The Scheme will result in the loss of habitat in this area. This impact on bats would be indirect and negative. This loss could act as a barrier for bats moving around the area. In addition, the majority of the habitat loss will be temporary. The new bridges over the watercourses will be designed to allow access for bats to continue to commute through the Scheme.

- 7.7.38 There is the potential for disturbance to bat species should night working be undertaken and lights used. Lighting could impact foraging and commuting bat species, making some areas of the Scheme less suitable. This impact would be direct, negative and temporary should night working be undertaken.
- 7.7.39 Operational lighting may also impact bat species if directed onto key commuting/ foraging routes. This impact would be direct, negative and permanent.
- 7.7.40 Overall, without mitigation, it is considered that the effect of the Scheme on bat species will be of slight significance.

Hazel dormouse

- 7.7.41 No evidence of hazel dormice were recorded within the Scheme boundary and the habitats present are considered to be sub-optimal due to extensive grazing by deer. Therefore, no impacts are anticipated on this species as a result of the Scheme.

Otter and water vole

- 7.7.42 Evidence of otter was recorded on the River Ingrebourne which indicates that the river is part of an otter's territory, but no holts were recorded. Both the river and Weald Brook are considered to be suitable to support foraging and commuting otters. Any population of otters using the habitats within the Scheme boundary is considered to be of county value.
- 7.7.43 Due to the loss of a section of the River Ingrebourne, which forms part of an otter's territory, there will be the permanent loss of otter territory within the Scheme. However, the new section of the Ingrebourne River to be created will likely become part of the otter territory and a new commuting route once established. The impact on otters will be negative, indirect and temporary. There will also be short term disturbance impacts to foraging and commuting otters during the construction phase. The effect of the Scheme is considered to be of moderate significance.
- 7.7.44 No evidence of water voles was recorded on either watercourse and as such no impacts to this species are anticipated as a result of the Scheme.

Badger

- 7.7.45 A main badger sett was recorded within Grove Wood and badgers have been recorded on camera traps moving along River Ingrebourne. An outlier sett was also recorded in the northern wood. The badger population is considered to be of local value. There will be no direct impacts on the badger setts as a result of the Scheme. However, the Scheme will result in both temporary and permanent loss of habitat which supports foraging badgers. There will also be noise and disturbance related indirect impacts and potential for harm to badgers foraging within the Scheme during construction. This will be a particular issue when works are being carried out along the River Ingrebourne as this is an important area for foraging and commuting badgers.
- 7.7.46 These potential impacts will be indirect, and the effect of the Scheme, without mitigation, will be of slight significance in relation to badgers.

7.7.47 Given the current proximity of the M25 and the A12 to the badger sett and tolerance afforded to the existing levels of noise and lighting associated with the roads, no operational related impacts are anticipated as a result of the Scheme.

Other mammals

7.7.48 A number of other animal species have been recorded within the wider area around the Scheme including hedgehogs and harvest mice. Fallow deer were regularly recorded within the Scheme during ecological surveys. These populations of other mammalian species using the Scheme are considered to be of local value.

7.7.49 As with the other mammal species identified in this assessment the Scheme is likely to result in the loss of habitat which supports these species and cause noise and visual disturbance. Due to the habitat clearance and construction works, there is also the potential for direct harm. However, it is anticipated that species such as fallow deer will leave the area of works due to disturbance. The overall effect of the scheme on these species is therefore considered to be of slight significance.

7.7.50 The fallow deer are currently having a negative impact on the habitats within the Scheme, in particular the woodland and Weald Brook due to extensive grazing and poaching of the brook banks. As such there may be a wider beneficial effect to habitats and other species from their temporary displacement from Scheme.

Non-native invasive species

Flora

7.7.51 Himalayan balsam has been recorded on the River Ingrebourne in an area which is due to be impacted by the Scheme. As a result there is the risk that Himalayan balsam could be spread through works to the river. This impact would be negative, direct and permanent if no action was undertaken to prevent its spread.

7.7.52 Goats rue and goldenrod were also recorded within the Scheme. The construction phase will result in the spread of these species within the Scheme due to soil/ground disturbance and vehicle movements. This impact would be negative, direct and permanent if no action was undertaken to prevent the spread of these species.

7.8 Potential mitigation measures

General

7.8.1 The approach to mitigation for impacts on natural conservation resources will follow the mitigation hierarchy, as follows:

- Avoid – impacts will be avoided through measures incorporated into the design and good working practices;
- Mitigate – impacts will be reduced where possible to a level that the effect on the nature conservation resource is not significant though measures implemented through the design, construction and operation phases;
- Compensate – impacts that are unavoidable and where mitigation does not reduce the effect to a level that is not significant will be compensated

for through creation or provision of new resources, such as habitat or places of shelter for animals.

- 7.8.2 The above measures will reduce impacts on nature conservation resources to a level where the overall effect on the resource is not significant. Any additional measures to improve the biodiversity value are considered to be enhancements. Such enhancements are important in terms of achieving a net gain overall in biodiversity.
- 7.8.3 Net gains can be achieved in two ways – an increase in the size of a resource (area of habitat, numbers of individuals in a population, or distribution of the population), or an increase in the quality (condition) of the resource (e.g. variety of species or structure within a habitat, presence of invasive species, etc.). For the purpose of measuring net gain, condition of a resource is measured against published criteria (ref). Either or a combination of both of size or quality will result in an increase in value.
- 7.8.4 Biodiversity resources will be taken into account during the design of the Scheme, so that potential impacts can be avoided or mitigated for through appropriate design. Compensation measures will be included in the design where necessary. The Scheme will be designed to minimise the extent of habitat loss, particularly within Ingrebourne Valley SMI, and HPI. The design will also maintain and enhance habitat connectivity and commuting routes for animal species.
- 7.8.5 Measures to avoid or mitigate for impacts on nature conservation resources during the construction phase will be set out in the Construction Environmental Management Plan (CEMP) which will be produced by the contractor. This document will include measures to be put in place such as the provision of briefings and tool box talks for staff, timing of works, protecting animals from harm within the construction area, and precautionary methods of working (PMW). An Ecological Clerk of Works (ECoW) will be appointed by the contractor monitor the works against the CEMP.
- 7.8.6 Pollution prevention measures will also be put in place to avoid affecting water quality in the watercourses during the construction phase.
- 7.8.7 In order to ensure the appropriate creation and long term management of new biodiversity resources provided as mitigation, compensation or enhancements, an Ecological Management Plan (EcMP) will be produced that will include details of management works, monitoring and maintenance measures required post-construction.

Designated sites

- 7.8.8 During construction, habitats within the Ingrebourne Valley SMI will be retained and protected as far as possible.
- 7.8.9 Where the loss of habitat from the designated site is unavoidable, then suitable compensatory measures will be provided. This may include the creation of an equal or greater area of similar habitat to that lost. The compensation habitat will be adjacent to, or as close to the relevant designated site as possible. If suitable land for habitat creation is not available close to the designated site, then compensation habitat will be created at an alternative suitable site.
- 7.8.10 Decisions on the location of land habitat compensation will take into account the feasibility and affordability of acquiring new land outside the Scheme boundary,

the options for return of the land to the landowner, and the requirement for access for future maintenance. The Ecological Management Plan (EcMP) will include measures to ensure effective establishment and continued management of the compensatory habitat.

- 7.8.11 As compensation for the loss of habitat from the SMI, woodland habitat will be created using a mixture of suitable native tree species. This will be planted within suitable habitat outside the SMI boundary. The new woodland would be maintained to ensure successful establishment and ongoing management would be provided under the EcMP, to ensure that adequate compensation is achieved for the loss of habitat from the SMI.
- 7.8.12 The grassland retained between the new loop road and the Weald Brook will be subject to management as part of the EcMP. This would include a suitable mowing regime (or grazing if feasible), and control of weed species including early goldenrod. Early goldenrod will be controlled elsewhere within the SMI to reduce its continued spread.
- 7.8.13 The diverted section of the River Ingrebourne will be created as much as possible with meanders and other natural features. This may include a series of sinuous bends. If it is appropriate to create a meander within Grove Wood, planted Scots pine trees will be preferentially removed, and the meander will be created within this area, rather than the remainder of the wood.
- 7.8.14 The following compensation measures will be considered and applied where possible to the Weald Brook to compensate for the shading of the watercourse:
- Creation of a new meander and backwater on the river;
 - Coppicing of selected trees and shrubs to reduce shading on the river;
 - Fencing off a section of the river to prevent access by deer, which will reduce impacts of poaching and browsing of coppice regrowth; and
 - Selected re-profiling of the banks of the river to provide opportunities for nesting kingfishers, and to allow marginal plants to establish.
- 7.8.15 On both the Weald Brook and the River Ingrebourne, in-channel features such as dead wood, and pool and riffle sequences will be incorporated where possible. Management of Himalayan balsam will also be undertaken throughout the Scheme.
- 7.8.16 The CEMP will include measures to ensure that storage of materials, construction traffic, dust and pollution do not adversely impact on retained habitats within the SMI.
- 7.8.17 The long-term management of the Ingrebourne Valley SMI will be incorporated into the EcMP. This will include measures to maintain the Weald Brook and River Ingrebourne corridors, and Grove Wood, to maintain features provided for mitigation and compensation.
- 7.8.18 Direct impacts on adjacent LWS and ancient woodland should be avoided. The location of the adjacent LWS would be identified in the CEMP, which will include mitigation for indirect impacts such as pollution control and protection against damage, such as fencing and buffer areas.

- 7.8.19 Mitigation measures will be implemented as set out in the Air Quality Chapter (Chapter 5) to reduce the significance of any potential effects caused by air pollution.

Ancient woodland and veteran trees

- 7.8.20 To avoid significant effects on ancient woodland or any veteran trees, avoidance measures and protection of the sites from disturbance and accidental incursion will be set out in the CEMP.
- 7.8.21 The location of ancient woodland and veteran trees will be identified in the CEMP, which will include mitigation for indirect impacts such as pollution control and protection against damage, such as fencing and buffer areas.

Habitats

- 7.8.22 Potential impacts on habitats within the SMI and adjacent designated sites or ancient woodland are identified above. There would be loss of habitat outside of the SMI from the semi-improved grassland north of Grove Wood and the road verges of the A12 and M25, comprising of poor semi-improved grassland, woodland, and dense and scattered scrub.
- 7.8.23 New hedgerow planting will be provided along the edge of the M25 proposed new slip road as compensation for loss of woodland and scrub habitats on the motorway verge. New hedgerow planting would use a range of species of local provenance to create a species rich hedgerow. The new hedgerow would be maintained to ensure successful establishment and ongoing management would be provided under measures detailed in the EcMP. During establishment, measures will be adopted to protect young saplings due to the potential for deer browsing.
- 7.8.24 Adjacent habitats will be protected against indirect impacts under measures provided in the CEMP, such as pollution control, fencing and buffer areas.

Notable and protected species

Notable plants

- 7.8.25 A survey will be undertaken to plot the locations of notable plant species within the Scheme prior to construction. These areas will then be marked out so that they can be avoided during the construction phase. Should any notable plant species be located in areas where works cannot be avoided then they will be translocated to other more suitable areas within the Scheme. This mitigation will be detailed in the CEMP, and any further management or monitoring set out in the EcMP.

Invertebrates

- 7.8.26 Key areas for notable terrestrial invertebrate species will be identified and where possible avoided during the construction phase of the Scheme. Compensation for habitat loss within the designated sites will take into account notable invertebrates so that their habitat requirements are provided. Mitigation measures during construction will be addressed in the CEMP, and additional enhancements and management requirements will be set out in the EcMP.
- 7.8.27 The measures proposed for fish species in the section below will also benefit aquatic invertebrate species. No specific mitigation measures for these species

have been identified for the construction phase of the Scheme. Pollution prevention measures will help to minimise impacts to these species.

Fish

- 7.8.28 Longitudinal connectivity of the watercourses should be maintained through the avoidance of permanent barriers/ obstacles which might prevent the movement of any fish species/ life stages.
- 7.8.29 The new sections of watercourse will be designed with the aim to increase channel heterogeneity. Different aquatic life and life stages require different habitat features and by ensuring a diverse physical habitat within and adjacent to the river channel more spawning, foraging and refuge habitat for different species can be provided. Features such as meanders, backwaters, riffles, boulders, large woody debris/ flow deflectors will be considered when designing the new sections.
- 7.8.30 The potential for bank re-profiling will also be considered as a more gently sloping bank this can improve channel holding capacity and dissipate energy by allowing the river to naturally spill out of the main channel earlier. The shallow gradient banks also provide refuge and foraging opportunities for other wildlife. Consideration will be given to adding scrapes within the flood plain to increase holding capacity during periods of high / flood flow and create important refuge habitat for fish and other wildlife.
- 7.8.31 Coppicing of selected trees and scrub along Weald Brook will also be undertaken to provide a mixture of shaded and unshaded areas, which will benefit fish species. The locations will be selected by an experienced ecologist.
- 7.8.32 A fish rescue undertaken by a suitably experience ecologist will be undertaken for the duration of the in-channel works to ensure that any fish found can be safely caught and returned to unaffected sections of the watercourses. In addition, any pumps to be used for dewatering activities will have mesh installed over their ends to prevent fish species from being sucked into the pumps.
- 7.8.33 The works on the River Ingrebourne will be undertaken outside of the main spawning season (March to June) to avoid impacts to the fish population.
- 7.8.34 Pollution prevention measures provided in the CEMP would mitigate for the potential impacts of pollution from construction and operation on fish.

Amphibians

- 7.8.35 Given the confirmed presence of great crested newts within and in close proximity to the Scheme, works that may affect great crested newts will be undertaken under a EPS mitigation licence from Natural England.
- 7.8.36 As compensation for the impacts on great crested newts, new ponds will be constructed in areas connected to existing breeding ponds increasing the area of habitat available. These measures will be incorporated into the design and EcMP to ensure habitat features are appropriate and can be maintained in suitable condition for great crested newts to breed..
- 7.8.37 Exclusion and translocation of great crested newts may be required, depending on the feasibility of provision of new habitats. Vegetation clearance will be carried out under a Precautionary Method of Working (PMW) as detailed in the CEMP.

- 7.8.38 The population of great crested newts south of the A12, centred around P3 will be protected through the adoption of a PMW, set out in the CEMP, during works near the pond. No loss or temporary damage of terrestrial habitat is expected.

Reptiles

- 7.8.39 To avoid direct harm to reptile species construction activities such as vegetation clearance and the removal of refugia will be undertaken under a PMW as detailed in the CEMP.
- 7.8.40 Hibernacula will be incorporated into the design and constructed within the Scheme boundary to provide additional shelter and foraging opportunities. These hibernacula will be constructed from log piles and stones located within the Scheme boundary, including improvements to existing log piles. Hibernacula will be raised or partially buried within the ground, with the most suitable locations benefitting from both sun and shade.

Birds

- 7.8.41 To avoid impacts on nesting birds, vegetation clearance will be undertaken outside of the bird breeding season (March to August inclusive). Where this is not achievable, then a PMW will be adopted to ensure that no bird nests are disturbed or destroyed. Such vegetation removal will be supervised by a competent ornithologist and if any active bird nests are identified, works will be stopped and the bird nest clearly marked off with a suitably sized buffer. Only once confirmed that the young have fledged would works continue within the buffered area. These measures will be set out in the CEMP.
- 7.8.42 To help encourage woodland bird species, further nesting and foraging opportunities will be created by preventing deer access to sections of the wood, allowing for ecological succession of the woodland habitat to take place without being inhabited by deer. Sections of deer exclusion fencing will be incorporated into the design, to create specific deer exclusion areas. The fencing will allow for small species such as hedgehogs to pass underneath but prevent all species of deer from entering.
- 7.8.43 Due to the presence of a kingfisher territory within the Scheme boundary, the bank of Weald Brook will be managed in a way to support nesting kingfishers. A suitable section of bank will be reprofiled to create an angle that will allow a kingfisher to drop and enter flight immediately.
- 7.8.44 Starling nest boxes will be installed to help to encourage starling to breed within the Scheme, as only one starling territory was recorded within the Scheme. Additional bird nesting boxes will be installed on suitably mature trees, at least 5 m above ground. Nest boxes will provide further nesting opportunities for birds within the Scheme.

Bats

- 7.8.45 The number of trees to be removed within the Scheme boundary will be kept to a minimum, avoiding trees with either low, moderate or high potential where possible. Tree removal will follow a PMW set out in the CEMP, that incorporates the following mitigation measures:

- Tree removal will be undertaken in either spring (mid-March to the end of April) or autumn (September to late October), to avoid the periods before the young are weaned and independent and the hibernation period; and
- Although no bat roosts have been identified during surveys undertaken to date, and trees identified with moderate to high potential that need to be removed, will be inspected by a bat licenced ecologist prior to the removal. Following inspection, if no bats are identified, tree removal (including any of low potential) will be done following best practice guidelines (Collins 2016) and soft felling techniques. The limbs and trunk of the tree will be lowered either together or in separate compartments, gently to the ground. The tree will then be left for 24 hours, to allow any bats that may still be present to escape. In the unlikely event that a bat is discovered within a tree during this process, all works will stop immediately any a suitable licenced bat ecologist will be contacted to reassess the situation.

7.8.46 To encourage bats to roost within the woodlands within the Scheme boundary, bat boxes will be installed in each of the eastern and western sections of Alder Wood and in Grove Wood at suitable locations identified by an ecologist. Bat boxes will be installed on suitable retained mature trees, approximately 5 m above ground. Boxes will face in a southerly direction, although in each wood a cluster of three boxes will be placed facing different directions to help create a variety of micro habitats. Bat boxes will be maintained under the EcMP for the Scheme.

7.8.47 New woodland planting incorporated into the design will create an extensive area of foraging habitat for bats in the long term. Deer exclusion areas will allow colonization of scrub and ground flora. This would increase the number of night flying invertebrates, creating a substantial food source within the Scheme for foraging bats.

7.8.48 Night working will be avoided where possible. Due to the proximity of suitable foraging and commuting habitats surrounding the proposed development, measures to reduce light spill into adjacent habitat will be incorporated into the CEMP.

7.8.49 Operational lighting will be sensitively designed through an appropriate lighting strategy that will take into account the requirements of bats and other nocturnal species. The underpasses of the loop road will not be lit where possible, to avoid disturbance to bats, and to encourage bats to pass under the loop road.

Hazel dormouse

7.8.50 No mitigation measures are recommended for hazel dormice as they have not been identified within the Scheme boundary.

Otter and water vole

7.8.51 The Scheme will result in the loss of a section of the River Ingrebourne, although a new section will be created to the north. This new section will be designed as naturally as possible to provide suitable foraging and commuting habitat for otters. The design will include resting areas for otters and scrub planting so as to provide shelter for this species. This design will also benefit water voles should they colonise the River Ingrebourne in the future.

- 7.8.52 Selective coppicing of trees along Weald Brook and suitable deer exclusion measures will be implemented to allow for aquatic plants to colonise the channel and the banks to become colonised by aquatic and marginal species. This would provide more suitable habitat for both otter and water voles within the Scheme boundary.
- 7.8.53 Pollution prevention measures provided in the CEMP would mitigate for the potential impacts of pollution from construction and operation on otters and water voles using the water courses.

Badger

- 7.8.54 To ensure that badgers are not adversely impacted by the Scheme, sufficient connectivity for badgers commuting between the main sett in Grove Wood and the outlier in Alder Wood will be maintained as part of the design of the structures crossing over the Weald Brook. Additionally, access for badgers to the box culvert where the River Ingrebourne flows under the M25 will be maintained.
- 7.8.55 To minimise impacts on badgers during the construction phase, suitable buffer zones will be set up around the setts and appropriate signage provided. This will ensure construction activities do not disturb setts, and materials are not stored within buffer zones. Where works are unavoidable close to setts then a PMW will be followed, or the works undertaken under licence. Night-time working will consider the presence of badgers commuting and foraging across the working area, and any open excavations will be suitably fenced to prevent badgers falling in. These measures will be detailed in the CEMP.
- 7.8.56 Operational lighting will be sensitively designed to avoid disturbance of badgers.

Other mammals

- 7.8.57 The mitigation measures identified in the sections above will also ensure that impacts to other mammal species that use habitats within the Scheme boundary are avoided or minimised. The enhancements will also benefit these species.
- 7.8.58 Temporary fencing will be installed around the construction area, and any open excavations, to prevent harm to deer or other mammals using the area.

Non-native invasive species

- 7.8.59 A method statement for the management and removal of Himalayan balsam will be produced and incorporated into the CEMP.
- 7.8.60 Where possible, goldenrod will be removed from the Scheme to allow for the grassland and scrub to expand, therefore benefiting foraging and sheltering faunal species. Due to the large amount of goldenrod present, chemical removal may be appropriate. The method for removing the goldenrod will form part of the EcMP and include future management of the plant within the Scheme.
- 7.8.61 The CEMP will also include measures for the appropriate management and humane removal of invasive species of animals, such as signal crayfish, should they be encountered during construction works.

7.9 Residual impacts

Designated sites

- 7.9.1 Due to the mitigation and compensation measures incorporated into the design, the Scheme is considered to potentially have a long-term neutral to beneficial effect on the Ingrebourne Valley SMI as the impact from the fallow deer will be reduced and the watercourse condition will be improved. Construction related impacts will be mitigated through implementation of the measures outlined in the CEMP. However, there will be temporary residual effects on the SMI of moderate significance, due to the loss of habitat, primarily from woodland, scrub, semi-improved grassland and the shading of watercourses. This is expected to be significant until compensatory measures, such as woodland planting, grassland management and enhancements of the watercourses become established.

Ancient woodland and veteran trees

- 7.9.2 There will be no direct impacts to ancient woodland. Based on the incorporation of mitigation measures to avoid indirect impacts, no residual effects on ancient woodland are expected.
- 7.9.3 Further survey is required to confirm if there are any residual effects on veteran trees.

Habitats

- 7.9.4 Whilst the extent of habitat loss for temporary construction areas is not known at this stage it is considered that the mitigation and compensation measures will result in an effect on habitats within the Scheme and outside of designated sites of neutral significance. Additional enhancement measures will improve the quality of habitats within the Scheme in the long term resulting in a long-term slight beneficial effect.

Notable and protected species

Notable plants

- 7.9.5 The mitigation measures will ensure that adverse impacts to notable plant species are avoided and as such the residual impact will be of neutral significance.

Invertebrates

- 7.9.6 Implementation of the mitigation and compensation measures will result in an effect on invertebrates within the Scheme of neutral significance. The habitat enhancements are anticipated to result in a residual impact of slight beneficial significance for aquatic and terrestrial invertebrate species.

Fish

- 7.9.7 The proposed mitigation measures will ensure that there are no direct impacts to fish species during the construction phase of the scheme. As such there will be a residual impact with an effect of neutral significance.
- 7.9.8 The enhancement measures proposed will improve the condition of the two watercourses, providing additional shelter and spawning opportunities for fish species resulting in a long-term slight beneficial effect.

Amphibians

- 7.9.9 The proposed approach for great crested newts will, if feasible, result in additional breeding habitat and improved terrestrial habitat within the Scheme boundary. This is likely to benefit not only the great crested newt population in the pond adjacent to the Scheme but also the wider meta-population. As such it is considered that although there will be temporary negative effect of slight significance due to the loss of a small proportion of the habitat available to the metapopulation, the residual impacts, once new habitats are established, will have an effect of moderate beneficial significance. There is no residual effect on the great crested newt population adjacent to the Scheme south of the A12.

Reptiles

- 7.9.10 Through the implementation of the mitigation measures the impacts to reptile species will be reduced and as such the effect of the residual impacts will be of neutral significance.
- 7.9.11 The habitat enhancements that include the addition of hibernacula are also likely to benefit reptile species within the Scheme boundary.

Birds

- 7.9.12 The implementation of mitigation measures during the construction phase will ensure that no breeding birds are directly impacted by the Scheme, and compensation measures, including re-profiling of the Weald Brook should provide new opportunities for nesting kingfishers. It is anticipated that some displacement is likely to occur, however, due to the availability of surrounding nesting habitat, and compensation measures, it is considered that the residual impact will have an effect of neutral significance.
- 7.9.13 The habitat enhancement measures will provide additional shelter and nesting opportunities for bird species within the Scheme boundary.

Bats

- 7.9.14 No bat roosts are located within the Scheme boundary. The adoption of the proposed mitigation measures will ensure that indirect impacts to bats in relation to disturbance will be avoided during construction. The residual impact will have an effect of neutral significance.
- 7.9.15 The habitat enhancement measures will provide improved foraging areas in the form of a new wooded area and also roosting opportunities within the woodlands.

Hazel dormouse

- 7.9.16 No residual impact on this species is anticipated as they have not been recorded within the Scheme boundary.

Otter and water vole

- 7.9.17 There will be temporary disturbance and loss of part of an otter territory due to the diverting of the River Ingrebourne. The proposed enhancement for otters and fish will improve the condition of the two watercourses within the Scheme boundary, providing a better-quality habitat for otters on completion of the Scheme and resulting in beneficial effects.

- 7.9.18 Water voles have not been identified within the Scheme boundary, but the enhancement measures will improve the condition of Weald Brook and River Ingrebourne for this species should they colonise the area post-construction.

Badger

- 7.9.19 The mitigation measures proposed will ensure that there is no direct harm to badgers or the badger setts within the Scheme boundary. The residual impact of the Scheme will therefore have an effect of neutral significance.

Other mammals

- 7.9.20 The proposed mitigation and enhancement measures will ensure that there are no direct or indirect impacts on other mammal species and in the longer term there may be beneficial impacts on these species due to increased habitat and shelter opportunities.
- 7.9.21 Deer exclusion fencing will reduce the area of the Scheme boundary in which fallow deer will be able to roam. This has been implemented to provide wider benefits to habitats and protected/notable species. The wider area will still be accessible to fallow deer and as such this restriction will have an effect of neutral significance.
- 7.9.22 Overall it is considered that there will be a residual impact of neutral significance on other mammal species as a result of the Scheme.

Non-native invasive species

- 7.9.23 Through the implementation of the method statement for invasive species in the CEMP, and removal of early goldenrod set out in the EcMP, there may be a beneficial effect on habitats within the Scheme as a whole. There will also be an effect of neutral significance due to management of signal crayfish during the construction phase as mitigation is unlikely to eradicate this species completely from the watercourses.

7.10 Cumulative effects

- 7.10.1 The London Borough of Havering Local Plan Proposals Map identifies areas suitable for wind energy development including land for large, medium or small wind development sites within 500 m to the west of the Scheme. Construction of a wind energy development at this location has the potential for cumulative impacts in combination with the Scheme on designated sites (in particular Ingrebourne Valley SMI), as well as bats and great crested newts.
- 7.10.2 Without adequate mitigation there could potentially be an effect on the populations of great crested newts in proximity to the Scheme of moderate significance, and an effect on bat populations in proximity to the Scheme of slight significance. Mitigation and enhancement measures as detailed for this Scheme may reduce cumulative effects, especially if additional measures are applied for later developments (and suitable maintenance of habitat areas is ensured), to a level that is not significant.

7.11 NPS compliance

- 7.11.1 The assessment for this Scheme has considered potential impacts set out in the Biodiversity and Ecological Conservation section (paragraphs 5.20 - 5.38) of the National Policy Statement for National Networks (NPS), as summarised below.
- 7.11.2 This report provides a preliminary assessment of the significance of effects of the Scheme on nature conservation resources (i.e. internationally, nationally and locally designated sites of nature conservation importance, legally protected species, notable habitats and other notable species identified as being of principle importance for the conservation of biodiversity).
- 7.11.3 It is considered that the potential mitigation and compensation options being proposed for this Scheme demonstrate a strong effort to take opportunities to conserve and advance biodiversity. This is in line with the Government's biodiversity strategy, as set out in Biodiversity Strategy 2020: A Strategy for England's Wildlife and Ecosystem Services.
- 7.11.4 In addition, it is considered that the potential mitigation and compensation options being proposed for this Scheme comply with the bullet points listed in paragraph 5.36 of the NPS:
- "During construction, they will seek to ensure that activities will be confined to the minimum areas required for the works;
 - During construction and operation, best practice will be followed to ensure that risk of disturbance or damage to species or habitats is minimised (including as a consequence of transport access arrangements);
 - Habitats will, where practicable, be restored after construction works have finished;
 - Developments will be designed and landscaped to provide green corridors and minimise habitat fragmentation where reasonable; and
 - Opportunities will be taken to enhance existing habitats and, where practicable, to create new habitats of value within the Scheme landscaping proposals, for example through techniques such as the 'greening' of existing network crossing points and the habitat improvement of the network verge."
- 7.11.5 Arboricultural surveys of the Survey Area will be carried out during the Preliminary Design Stage. In accordance with the NPS (paragraph 5.32), any loss of ancient woodland and ancient and veteran trees will be avoided and minimised as far as possible.

7.12 Summary

- 7.12.1 The baseline information gathered to date has covered the predicted EZoI of the Scheme. This has included a desk study and ecological surveys of habitats, flora, and notable and protected species
- 7.12.2 Based on the preliminary environmental assessment carried out for this report, it has been established that, although the Scheme will have significant temporary adverse effects of a temporary nature on the SMI and a population of great crested newts, the Scheme has the potential to have neutral to beneficial residual effects on these and other nature conservation resources including designated sites, habitats and species. This is due to the incorporation of mitigation measures during construction to avoid or reduce impacts and compensation measures built

into the design. Compensation measures will include remodelling of the watercourses, the Weald Brook and River Ingrebourne to provide meanders, and provision of new habitats. Existing habitats will also be enhanced through measures to control invasive species, manage deer browsing, and increase the habitat suitability for notable species.

- 7.12.3 Further consultation with relevant stakeholders will be undertaken at ES stage, which will guide the final mitigation and compensation strategy for the Scheme. However, it is considered that the mitigation and compensation proposals that have been described in this chapter have taken into consideration the requirements of the NPS, by enhancing existing habitats, creating new habitats and minimising habitat fragmentation.

8. Road Drainage and the Water Environment

8.1 Introduction

- 8.1.1 This chapter provides the preliminary assessment for road drainage and the water environment. It identifies the road drainage and water environment study area, methodology, presents the baseline conditions, identifies the potential road drainage and water environment impacts associated with the Scheme during construction and operation, and presents mitigation measures that are recommended to mitigate any potentially significant adverse effects.
- 8.1.2 The assessment methodology followed is in accordance with the guidance provided in the Design Manual for Roads and Bridges (DMRB) HD45/09 (Highways England, 2009) and WEBTAG (Transport Appraisal Guidance (TAG) Unit A3 (DfT, December 2015) (Chapter 10 Tables 13 - 17)).
- 8.1.3 Generic and specific effects on the water environment during the construction phase and the operational phase are identified and assessed.
- 8.1.4 The chapter is based on readily available information that has previously been presented in the Scoping Report and the Stage 2 Environmental Assessment Report. However, the baseline reported in the Option Identification stage, was revisited during the scoping stage, in order to confirm any updates to baseline / existing conditions.

8.2 Study area

- 8.2.1 For the purposes of this assessment, the study area is defined as 1 km from the M25 Junction 28. A 1 km study area was chosen as research indicates that impacts associated with soluble pollutants will be sufficiently diluted beyond 1 km, thereby reducing any potential impact (DMRB, HD45/09, Highways England, 2009). For groundwater, the potential zone of impact will be assessed on the underlying Water Framework Directive (WFD) groundwater body.
- 8.2.2 As the environmental assessment develops and the potential effects of the Scheme are better understood, the study area may extend further in order to gather data for relevant surface or groundwater bodies.

8.3 Planning and policy context

- 8.3.1 Appendix H in Volume 2 summarises the legislation, regulatory and policy framework applicable to road drainage and the water environment.

8.4 Methodology

Surface watercourses

- 8.4.1 The information has been assessed against the methodology guidance presented in the Highways Agency Design Manual for Roads and Bridge (DMRB) (HD45/09) and WebTAG. The WebTAG assessment has been carried out in accordance with TAG UNIT A3 Environmental Impact Appraisal Department for Transport May 2014 Transport Analysis Guidance. It was considered appropriate to use WebTAG for assigning the importance and potential magnitude of impact at this preliminary assessment stage. WebTAG provides a qualitative assessment using professional

judgment in the absence of quantitative data which would normally be available at detailed design stage.

- 8.4.2 WebTAG provides guidance for appraising the impact of transport proposals on the built and natural environment. It provides an appraisal framework for analysing the key information of relevance to the water environment.
- 8.4.3 At the ES stage, the assessment for the ES will use drainage information and Annual Average Daily Traffic (AADT) data to establish potential impacts of the Scheme on the water environment within the study area and the requirement for mitigation measures to adequately reduce the risk. The potential ecological impacts of routine runoff on surface water will also be assessed using the Highways Agency Water Risk Assessment Tool (HAWRAT) as advised in the DMRB (HD45/09) (Highways England, 2009). Spillage risk tests will also be undertaken in accordance with the DMRB (HD45/09).
- 8.4.4 A WFD compliance assessment is required for new developments and schemes to demonstrate that schemes will not result in a deterioration in status (or potential) of any water body, or prevent the water body from meeting good status (or potential) in the future (2021 or 2027).
- 8.4.5 The EA is the competent authority for WFD. However, as the Scheme has the potential to also affect other watercourses, not just WFD or designated as Main River, the lead local flood authority (Brentwood Borough Council) also has a duty to ensure the Scheme complies with WFD legislation.
- 8.4.6 A WFD preliminary assessment was undertaken as part of the Option Selection stage. This assessment has been updated and full details of the scoping WFD assessment are presented in Appendix E.

Groundwater

- 8.4.7 At the time of reporting, it is unknown if discharge to ground will be required and the suitability of this method. Once confirmed, the assessment of the potential pollution impacts from runoff to groundwater may be required. This will be in accordance with Method C as outlined in DMRB (HD45/09).

Flood risk

- 8.4.8 The Flood Risk Assessment (FRA) will be carried out in accordance with the requirements of the NPPF, Defra (2012) and its accompanying Technical Guidance (Defra, 2014), and the Environment Agency's Climate change allowances for planners' NPPF supporting guidance (EA, 2017). All sources of flood risk will be assessed.

WFD

- 8.4.9 The approach to the WFD compliance assessment will follow the Planning Inspectorate's guidance on preparation of WFD assessments for a NSIP (Planning Inspectorate, 2017). It will be based on a format that was originally developed in close consultation with the EA for a large transport infrastructure scheme (HS2, 2016). This format was subsequently promoted by the EA as an example of best practice, particularly for large schemes that affect many waterbodies. It captures the core requirements of a compliance assessment whilst being transparent and simple to interpret. The assessment can be readily updated, creating a clear audit

trail of WFD compliance as the scheme progresses through its lifecycle from options assessment to design and environmental permitting.

8.5 Consultation

- 8.5.1 Consultation has been undertaken with the Environment Agency. Key issues raised by the Environment Agency included concerns associated with the crossings over Weald Brook and the Ingrebourne River. However, the Environment Agency were encouraged to see consideration is being given on how to undertake the Scheme in an environmentally sympathetic way, and with the potential to integrate river realignment and crossings with other mitigation and enhancement measures.
- 8.5.2 The Environment Agency welcome that a detailed FRA and a WFD detailed assessment and any necessary further stages of assessment would be prepared for the Scheme.
- 8.5.3 Consultation with regulators (principally the Environment Agency and Lead Local Flood Authorities) will continue throughout the design process to ensure that the Scheme is designed to be compliant with the objectives of the WFD and that feasible opportunities for improvements to the water environment are integrated into the Scheme.

8.6 Baseline conditions

- 8.6.1 This section sets out the baseline conditions of the water environment. At this stage, a high-level desk-based assessment has been undertaken using publicly available spatial data under the Open Government Licence (2016) and from open sources including the Environment Agency (EA) (EA, 2013).

Surface watercourses

- 8.6.2 Waterbodies within the study area fall within the Thames River Basin District (RBD) as set out within the Thames River Basin Management Plan (RMBP) (Defra, 2015). The locations can be found on Figure E-1 in Appendix E.
- 8.6.3 One assessed WFD (2000/60/EC) surface waterbody has been identified within the study area. This is the River Ingrebourne (GB106037028130), and currently crosses Junction 28, running parallel and north of the A12. It flows south and at Putwell Bridge where the Weald Brook (designated as a Main River) joins it. The Weald Brook lies to the west of the M25 and runs parallel to the motorway.
- 8.6.4 The scoping stage WFD preliminary assessment focuses on the waterbodies directly impacted, whereas this chapter provides an overview of the water environment as a whole.
- 8.6.5 Table 8.1 provides details of the River Ingrebourne. Although the current overall status for this waterbody is moderate, the requirement of the WFD is for all watercourses to meet good status or potential by 2027.

Table 8.1: WFD surface water

Receptor	Classification (2015) chemical status	Classification (2015) ecological status	Overall waterbody status
River Ingrebourne (GB106037028130)	Good	Moderate	Moderate

8.6.6 There are other surface watercourses that are not classified under the WFD or as a Main River within the study area. However, as these lie within a WFD catchment, they contribute to the WFD overall quality and status.

8.6.7 These non-WFD watercourses will be identified and assessed as part of the Environmental Statement (ES).

Lakes and other surface water features

8.6.8 There are no WFD designated lakes within the study area and therefore these were scoped out and were not considered further.

8.6.9 The impact on hydraulically isolated ponds has been assessed within the biodiversity chapter (Chapter 7) and will therefore not be considered here. If it is established that there are hydraulic links to the ponds at the next stage, further assessment will be made of the potential impacts of road drainage. However, it is assumed that drainage will be mitigated before discharge to receiving water bodies and this is most likely to be sufficient for the ponds too.

Groundwater

8.6.10 The Scheme area is underlain by superficial aquifers, including Alluvium associated with watercourses (Ingrebourne River and Weald Brook) and Head. Groundwater within the Alluvium is likely to be in continuity with the rivers.

8.6.11 There are no designated WFD groundwater bodies within the study area.

8.6.12 There are no Source Protection Zones (SPZ) within the study area and therefore these were scoped out and were not considered further.

Abstractions and discharges

8.6.13 The EA website (EA, 2013) indicates there are numerous surface and groundwater abstractions within the study area. Details of these abstractions are considered within the soils and geology chapter (Chapter 10) and to avoid duplication these are not considered within this chapter.

8.6.14 Based on the Highways Agency Drainage Data Management System (HADDMS) there are highway outfalls across the study area. The status of these and the implications for the scheme will be assessed as part of the ES.

Flood risk

Fluvial and tidal flood risk

8.6.15 Flood zones 2 and 3 are within the study area. These flood zones are associated with both the River Ingrebourne and Weald Brook watercourses. The flood zones within the study area are not currently derived from detailed river modelling,

therefore the flood extents are only indicative. Work will be undertaken to improve the predicted flood extents.

Surface water flood risk

8.6.16 Across the study area, surface water flooding risk is variable, ranging from low to high. The main surface water flood risk areas are the floodplains of the River Ingrebourne and Weald Brook, and their minor tributaries. The flood maps suggest that surface water ponding occurs on the land surrounding Junction 28 and the A12, possibly the existing culverts and bridges across the watercourses.

Groundwater flood risk

8.6.17 With reference to the Preliminary Sources Study Report (Highways England, April 2017), there is potential for groundwater flooding across the study area.

Aquatic ecology

8.6.18 Aquatic ecology has been considered in the Biodiversity chapter (Chapter 7).

Designated sites

8.6.19 There are no statutory designated sites which are likely to be affected by water within the study area. Designated sites will not be considered further in the context of water resources.

8.7 Potential impacts

Construction

8.7.1 Temporary impacts during construction have the potential to affect the water environment through (but not limited to) the following:

- The excavation of materials, and the subsequent deposition of soils, sediment, or other construction materials;
- Damage to bed and banks of watercourses at crossing points due to construction techniques;
- The spillage of fuels or other contaminating liquids;
- The mobilisation of contamination following the disturbance of contaminated ground or groundwater;
- Runoff from construction sites to surface water bodies;
- Disturbance of non-native invasive species - construction activities can result in the spread along surface water bodies and their riparian zone; and
- De-watering - local changes to groundwater levels associated with pumping out of subterranean works areas (e.g. deep foundations) and the disposal of pumped water to surface waterbodies.

8.7.2 These impacts could result in sediment and/or other contaminants entering watercourses or groundwater affecting the quality of the water which could have implications for abstractions and WFD compliance.

- 8.7.3 The construction of the Scheme will impact flood risk due to encroachment into Flood Zone 3. The eastbound A12 slip road leading to Junction 28 will result in a loss of floodplain storage on the Ingrebourne River. The loop road crosses the Weald Brook twice and there may be a minor loss of floodplain storage. The current proposals for multi-span bridges will aim to minimise the loss. Potential areas for floodplain compensation storage have been identified to mitigate the loss of storage.
- 8.7.4 Consultation with the lead local flood authorities (LLFAs) will be required to ensure sustainable drainage mitigation is incorporated into the design so as to not increase surface water flood risk in the areas highlighted in the baseline.

Operation

Surface watercourses and groundwater

- 8.7.5 During operation roads are designed to drain freely to prevent build-up of standing water on the carriageway whilst avoiding exposure to or causing flooding. Contaminants deposited on the road surface are quickly washed off during rainfall. Where traffic levels are high the level of contamination increases and therefore, the potential for unacceptable harm being caused to the receiving water also increases (HD45/09).
- 8.7.6 There are potential impacts to surface and groundwater quality and flow volumes owing to the increase in impermeable area and additional risks associated with road runoff and pollution that can lead to deterioration in water quality.
- 8.7.7 On all roads, there is also a risk that a spillage may lead to an acute pollution incident. Where spillages do reach a surface watercourse the pollution impact can be severe, but is usually of short duration, typical of an acute pollution impact. If groundwater is polluted the impact can be long lasting and difficult, if not impossible, to remediate (HD45/09).
- 8.7.8 In addition, potential surface water abstractions downstream could be affected by the additional discharge. These potential water quality effects would be mitigated as part of standard drainage designs for the Scheme, to obtain relevant permissions and consents.
- 8.7.9 All river crossings will involve the construction of a new structure, either single span bridge or culvert; or modification to (e.g. extension) of existing bridge or culvert. This can lead to disruption of the natural hydraulic and sediment transport processes or act as a barrier to fish passage and movement of other wildlife. WFD classified surface water bodies and Main Rivers that are crossed by the arterial road network (A12, M25 and associated slips roads) will have open span structures that limit the impact of the Scheme on channel and floodplain function in a way that complies with the WFD Directive.
- 8.7.10 Realignments of watercourses to accommodate scheme components can lead to loss of naturalised reaches. Additionally, modifications (widening, deepening, straightening or realigning) to channel upstream and downstream of crossings are commonly required (to align the channel with the new crossing). Bed or bank protection may also be used to manage erosion that can add to the loss of naturalised reaches. If deep foundations are required, there is potential to protrude into groundwater and modify flow paths.

Flood risk

8.7.11 The operation and management of the Scheme is not likely to have an adverse impact on flood risk.

8.8 Potential mitigation measures

Construction

8.8.1 Construction mitigation is likely to include, but not be limited to the following.

- Measures within the Construction Environmental Management Plan (CEMP) to control and prevent polluted run-off;
- All works are undertaken with regard to Pollution Prevention Guidelines (PPGs)³⁴. These detail good practice advice for undertaking works which may have the potential to cause water pollution;
- Temporary works sites, haul roads and other associated works should be designed and maintained to minimise impact;
- Where temporary watercourse diversions are required or in-channel working, specific mitigation may be needed to ensure the temporary design is in line with the WFD and that temporary impacts are minimised;
- Close communications with the Environment Agency will be established on groundwater matters;
- Areas which may generate contaminated water would need to be bunded and have water discharged to self-contained units with treatment facilities. There would be no discharge to groundwater;
- Tests would be undertaken to ensure contaminated material is identified, isolated and reworked or removed to special landfill to avoid any leachate problems;
- Floodplain working will be minimised as far as possible;
- Temporary land-take required for construction will include adequate areas of land set aside for robust control measures, for example sustainable drainage control;
- Sustainable drainage solutions incorporated, aiming to return groundwater to its source. Other mitigation may need to be considered to maintain groundwater levels; and
- For construction work which has drainage implications, the proposed drainage system should comply with the National Standards, such as Schedule 3 under the Flood and Water Management Act 2010. In addition, the development consent order, or any associated planning obligations, will need to make provision for the adoption and maintenance

³⁴ Pollution Prevention Guidelines (PPGs) with particular reference to PPG1 (general guide to the prevention of water pollution), PPG3 (use and design of oil separators in surface water drainage systems), PPG5 (works near or liable to affect watercourses) and PPG6 (working at construction and demolition sites). The PPGs contain a mix of regulatory requirements and good practice advice. They have been withdrawn by the Environment Agency but are still considered good practice advice to avoid pollution of watercourses. All of the PPGs are available from <http://webarchive.nationalarchives.gov.uk/20140328084622/http://www.environment-agency.gov.uk/business/topics/pollution/39083.aspx>

of any Sustainable Drainage Systems (SuDS), including any necessary access rights to property.

Operation

8.8.2 Operational mitigation is likely to include, but not limited to the following. These measures have not yet been fully factored into the assessment of potential impacts. Design mitigation principles guiding WFD compliance are detailed in the WFD scoping assessment (Highways England, 2017):

- Pollution treatment measures are likely to be needed where a risk of pollution has been identified. Where possible, SuDS will be used, in line with National SuDS Guidance to collect and treat road drainage. Preference will be for discharges to ground with appropriate SuDS;
- Road runoff should be infiltrated in the same catchment as it is generated to minimise impacts on the water balance;
- Facilities will also be required to deal with accidental spillages occurring on the carriageway, particularly at high risk points, such as junctions and roundabouts, to allow for containment and removal of pollutants from the system;
- Single span structures are the preferred type of crossing because they minimise impact on the water environment if designed appropriately. They will be designed and constructed in such a way as to minimise disruption to the river and riparian zone. Abutments should be set well back from the bank edge to allow the river to function naturally and to maintain a wildlife corridor along the banks;
- Culverts present a higher risk (than single span structures). They are therefore not a preferred method of watercourse crossing from the perspective of protecting and improving the water environment. However, where they may be the only feasible technical solution, environmentally sensitive culvert design should be followed, including but not limited to minimising the length and adopting an open arc structure that avoids disturbing the natural bed of the river rather than a box culvert;
- The current design does include components (e.g. realignments and bank protection) that have the potential to cause minor or localised adverse effects. However, mitigation in accordance with the design principles set out in the scoping WFD report (Highways England, 2017) would minimise these adverse effects; and
- The current Scheme also includes components with potentially beneficial effects on the water environment. In particular, proposed realignments present an opportunity to restore sections of channel to more natural form and function, including the creation of wet-woodland habitat which in turn, improves the ecological diversity. Compensation for floodplain loss may be required at some locations. Assessment of impact of any flood compensation land will be required, with level for level compensation being the normal practice.

8.9 Residual impacts

Construction

- 8.9.1 With the adoption of mitigation measures it is considered there will be no residual significant effects on surface water quality during construction.

Operation

- 8.9.2 Although the loop road crosses the Weald Brook twice and there may be a minor loss of floodplain storage, the current proposals for multi-span bridges will aim to minimise the loss of floodplain storage and potential areas for floodplain compensation storage have been identified to mitigate the loss of storage. Therefore, it is considered that with the adoption of mitigation measures, there will be no permanent residual significant effects on the water environment.
- 8.9.3 The design does include components (e.g. realignments and bank protection) that have the potential to cause minor or localised adverse effects. However, mitigation in accordance with WFD design principles would minimise these adverse effects.
- 8.9.4 The Scheme also includes components with potentially beneficial effects on the water environment. In particular, proposed realignments present an opportunity to restore sections of channel to more natural form and function, including the creation of wet-woodland habitat which in turn, improves the ecological diversity.

8.10 Cumulative effects

- 8.10.1 The increase from one drainage outfall alone may not make a significant difference to a receiving watercourse, however the cumulative effect of outfalls, or the effects of their construction, may affect water quality across the catchment.
- 8.10.2 As identified in the baseline conditions, there are highway outfalls across the study area. The status of these and the cumulative effects will be assessed as part of the ES. Overall, it is assumed that drainage will be new or upgraded, with appropriate mitigation and therefore there is potential for there to be a minor beneficial effect.
- 8.10.3 Typically, new developments increase impermeable area and run-off. They can potentially cause drainage pathways to be altered and can provide an increased source of pollution to shared water receptors.
- 8.10.4 For all schemes in the vicinity, identified in Table 15.1 in Chapter 15, drainage strategies should be in place or proposed for these developments. These separate systems should accommodate temporary drainage requirements during the construction phases and appropriate mitigation that should ensure minimal impacts to water quality through construction and operational phases. It is therefore concluded that there will be no significant adverse cumulative effects during construction or once operational.
- 8.10.5 Table 8.2 identifies six of the developments outlined in Table 15.1 that could have potential cumulative impacts. The magnitude of cumulative impact for the remaining 10 developments during both construction and operation is considered neutral and significance negligible as no connectivity to the receptors identified for the scheme are in hydraulic connectivity to this development. Therefore, these have not been assessed at this stage.

Table 8.2: Cumulative developments

Proposal	Magnitude of Impact	Description of impact
Crossrail Approx. 400 m from site	Construction: negligible with neutral significance. Operationally: potentially moderate adverse.	If construction were to take place at the same time as construction of the Scheme, there could be potential cumulative effects to water quality to the Ingrebourne River which is adjacent to the development. If the construction footprint (including construction compounds) extends upstream this could also have an impact on the Weald Brook as this is upstream of the development and is in direct hydraulic connectivity to the Ingrebourne River.
Gypsy and Traveller Site at The Caravan Park, Putwell Bridge Approx. 500 m from site	Operationally: potentially moderate adverse. Neutral and significance negligible.	Impacts include (but not limited to) excavation, the deposition of soils, sediment, or other construction materials, spillage of fuels or other contaminating liquids, the mobilisation of contamination following disturbance of contaminated ground or groundwater, or through uncontrolled site runoff.
Small, Medium, Large Wind Development Sites Approx. 500 m from site	Neutral and significance negligible.	Any unrestricted dewatering during construction or diversion flows arising from the construction could impact flood risk in these watercourses. Providing adherence to best practice guidance and the adoption of good working practices and strict adherence to the Environment Agency Pollution Prevention Guidelines (PPGs).
Cycleway Proposals Approx. 500 m from site	Construction: negligible with neutral significance. Operational: potentially moderate adverse	The development programme is unknown at the time of reporting. The nature of this development (a railway) would suggest a low polluting potential. However, as the development already crosses the Ingrebourne River, and the J28 Scheme would create another crossing, operationally.
Change of use of land to burial grounds including removal of existing agricultural buildings and erection of two pavilion buildings for associated usage, hard and soft landscaping, new access to A12 and internal roads and paths, parking, and workshop area for storage of associated equipment, tools and materials. Approx. 500 m from site	Construction: negligible with neutral significance. Operationally: neutral and significance negligible.	
022 Land at Honey Pot Lane Brentwood The proposal is for 250 residential units Approx. 1,850 m from site	Construction: negligible with neutral significance	If construction were to take place at the same time as construction of the Scheme, there could be potential cumulative effects to water quality to the Ingrebourne River which is crossed by this development.

Proposal	Magnitude of Impact	Description of impact
		<p>This may be due to construction of culverts, excavation, the deposition of soils, sediment, or other construction materials, spillage of fuels or other contaminating liquids, the mobilisation of contamination following disturbance of contaminated ground or groundwater, or through uncontrolled site runoff. Any unrestricted dewatering during construction or diversion flows arising from the construction could impact flood risk in these watercourses. providing adherence to best practice guidance and the adoption of good working practices and strict adherence to the Environment Agency Pollution Prevention Guidelines (PPGs).</p>

8.11 NPS compliance

- 8.11.1 In line with the NPS NN requirements, the Road Drainage and Water Environment chapter of the ES will ascertain the existing status of, and carry out an assessment of the impacts of the Scheme on, water quality, water resources and physical characteristics.
- 8.11.2 The NPS NN also states that development proposals should have regard to the relevant RBMP and the requirements of the WFD (including Article 4.7) and its daughter directives, including those on priority substances and groundwater. A WFD Compliance Assessment will be prepared and appropriate design and mitigation measures will be incorporated into the Scheme to facilitate WFD compliance.
- 8.11.3 The principles of how developments are to be assessed by the with respect to pollution control and other environmental protection regimes are detailed in paragraphs 4.48 to 4.56. Key requirements are that any discharges or emissions from a proposed scheme may be subject to separate regulation under the pollution control framework or other consenting and licensing regimes and relevant permissions will need to be obtained for such activities with permit applications submitted at least 6 months prior to submission of a Development Consent Order (DCO).
- 8.11.4 With regard to flood risk and surface water drainage, the NPS NN supports the NPPF (DCLG, 2012). In line with the Flood Risk section of the NPS NN, the Scheme would be subject to a FRA that considers all sources of flood risk. The FRA would be informed by consultation with the Environment Agency and relevant Lead LLFA. The FRA would also be informed by the results of any hydrological and hydraulic modelling undertaken to define baseline flood risk, quantify any scheme impacts on this baseline, and to inform the design of any necessary flood risk management measures.
- 8.11.5 Paragraph 5.91 in the NN NPS outlines that the National Planning Policy Framework (paragraphs 155 to 156) makes clear that inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk. But where development is necessary, it should be made safe

without increasing flood risk elsewhere. The guidance supporting the National Planning Policy Framework explains that essential transport infrastructure, which has to cross the area at risk, is permissible in areas of high flood risk, subject to the requirements of the Exception Test.

- 8.11.6 A drainage strategy would also be prepared that centres on the application of SuDS, appropriate to local conditions, to manage surface water runoff.
- 8.11.7 NPS NN encourages pre-application discussions with all relevant regulators to begin as early as possible. Discussions with stakeholders has begun.

8.12 Summary

- 8.12.1 In summary, although there will be minor loss of floodplain storage, the current proposal for multi-span bridges will aim to minimise this potential impact and potential areas for floodplain compensation storage have been identified to mitigate the loss. These areas of floodplain loss and potential compensation areas are currently being investigated as part of the preliminary design and will be reported as part of the environmental assessment that will be reported in the ES. It is considered that with the adoption of mitigation measures, there will be no permanent residual significant effects on the water environment.
- 8.12.2 With regards to WFD compliance, the Scheme is not expected to result in deterioration at the water body scale and should not prevent future attainment of good status under the WFD.

9. Landscape and Visual

9.1 Introduction

- 9.1.1 This chapter provides the preliminary assessment of the potential landscape and visual effects. It identifies the study area, methodology, presents the baseline conditions, identifies the potential impacts on landscape and visual receptors associated with the Scheme during construction and operation, and presents mitigation measures that are recommended to mitigate any potentially significant adverse effects.
- 9.1.2 This chapter highlights the key landscape and visual effects of the Scheme at this preliminary design stage and should be read in conjunction with Appendix F of this document which includes further details of relevant policies and legislation (Tables F.1 to F.3), landscape assessment and visual impacts (Tables F.4 and F.5) and a collection of figures (Figures F-1 to F-8).

9.2 Study area

Landscape scope

- 9.2.1 It is recognised that potentially significant landscape effects would be restricted to the land required or directly adjacent to the Scheme. In the context of available OS mapping and aerial photography, a study area of 1.5 km from the perimeter of the Scheme was adopted at this preliminary stage of assessment to identify potentially significant landscape effects.
- 9.2.2 Any effects on landscape receptors located beyond the 1.5km study area are considered unlikely to be significant and have therefore been scoped out from further assessment at this stage. This will be confirmed at ES stage by producing a ZVI and conducting further consultation with LB of Havering and Brentwood Council.

Visual scope

- 9.2.3 The visibility towards the location of the Scheme is restricted by a network of intervening hedgerows, woodland belts and woodland areas, as well as by the existing approaches to the junction including the A12 and M25 roads. Visibility is also further restricted by landform around the junction that broadly slopes down towards the junction from adjacent areas.
- 9.2.4 When considering the scale of the Scheme in the context of natural and man-made screening elements present around the M25 Junction 28 (including landform) a study area of 1.5 km from the perimeter of the Scheme was adopted at this preliminary stage of assessment to identify potentially significant visual effects.
- 9.2.5 Any effects on visual receptors beyond the study area are considered unlikely to be significant and have therefore been scoped out from further assessment.

9.3 Planning and policy context

- 9.3.1 Appendix I in Volume 2 summarises the legislation, regulatory and policy framework applicable to landscape and visual.

9.4 Methodology

Overview

9.4.1 The Landscape and Visual Impact Assessment (LVIA) has followed guidelines produced by the relevant professional bodies concerned with transport related schemes and landscape and visual impact assessment, specifically Highways England's Interim Advice Note IAN 135/ 10 (Landscape and Visual Effects Assessment), and the Landscape Institute's Guidelines for Landscape and Visual Impact Assessment Third Edition (GLVIA 3), published by the Landscape Institute and Institute of Environmental Management and Assessment (2013).

Study area

9.4.2 Assessment was based on the preliminary geometric layout of the Highways design of the Scheme, and adopted a 1.5 km study area from the perimeter of the Scheme as:

- The proposals have the capacity to change the landscape character at a local level; and
- There would be a change in visual amenity for several highly sensitive visual receptors including residential properties and open access land, although the changes are set within the context of existing landscape elements that include highways infrastructure. Refer to 9.6.21 for further information.

Desk studies

9.4.3 Desk studies were undertaken to inform and supplement the site survey, and were tailored to meet the requirements of the project.

9.4.4 Landscape impact assessment is the process whereby the different elements that form the landscape are recorded and assessed. This process was applied at local, regional and national levels, and allowed an impression of the Scheme area to be formed, and provided knowledge of designated areas and cultural values associated with the area. The study also identified the local and wider landscape character, together with the natural and cultural/ social factors that have influenced the development of the landscape.

9.4.5 In terms of visual impact assessment, the study of contoured Ordnance Survey mapping and aerial photographs identified potential screening features (generally tree lines, woodland blocks or urban areas/ large individual buildings) for later verification on site. Potential visual receptors such as residential properties, Public Rights of Way (PRoW), and recreation or amenity areas were also noted for more detailed assessment on site.

Field survey

9.4.6 A site visit was undertaken by a Landscape Architect in February 2017 to verify and expand upon the results of the desk studies. The survey was undertaken to confirm and supplement the desk study data with current information which may not have been reflected by reports, mapping, or aerial photographs. As with the desk studies, the survey was tailored to meet the requirements of the project, bearing in mind the project objectives and the level of reporting required.

- 9.4.7 The process was supported by a comprehensive photographic record representing the landscape and viewpoints as seen by a person at each location (recording the viewpoint position, direction of view, and date of the photograph) and annotated mapping completed during the survey; this information respectively be found in Figures 7.5 and 7.6 to 7.8 in Appendix F.
- 9.4.8 Where access to the land was not possible, professional judgement was used to estimate of the nature of the view and number of receptors affected from the nearest areas with public access, and to make a judgement about the degree of change in the view that would be caused by the Scheme.

Assessment

- 9.4.9 To form part of the baseline against which the change in the landscape or view brought about by the Scheme could be assessed, landscape and visual receptors were categorised and grouped according to assumed sensitivities dependent on the character of the receptor. Judgements were also made regarding the impact that the proposed Scheme would likely have on receptors in terms of the degree of change (i.e. the magnitude of the impact) likely to be apparent in the landscape or experienced in views.
- 9.4.10 Impact significance was then determined by respectively assessing the sensitivity of receptors against the magnitude or degree of change in the landscape or view resulting from the Scheme. Impacts can be adverse, neutral, or beneficial, and assessment is derived using professional judgement which relies on the consistent reasoning set out in current guidance, including IAN 135/10 and GLVIA3.
- 9.4.11 Landscape or visual effects are considered significant when moderate or higher-level effects have been identified.

Sensitivity of landscape and visual receptors

- 9.4.12 The identification of various categories of landscape and visual receptors and the assumed sensitivity of each forms part of the baseline against which the change in the landscape or view brought about by the Scheme can be assessed. Receptor sensitivity depends on the character of the receptor and the type of change likely to arise from the Scheme.

Landscape sensitivity

- 9.4.13 The outputs from the landscape character assessment (i.e. landscape characteristics, their condition and value) were considered to assess their sensitivity to changes arising from the Scheme. Indicative criteria used to categorise landscape sensitivity are provided in Table 9.1, below.

Table 9.1: Landscape sensitivity and typical examples

Sensitivity	Typical descriptors and examples
High	<p>Landscapes which by nature of their character would be unable to accommodate change of the type proposed. Typically, these would be;</p> <ul style="list-style-type: none"> • Of high quality with distinctive elements and features making a positive contribution to character and sense of place. • Likely to be designated, but the aspects which underpin such value may also be present outside designated areas, especially at the local scale.

Sensitivity	Typical descriptors and examples
	<ul style="list-style-type: none"> • Areas of special recognised value through use, perception or historic and cultural associations. • Likely to contain features and elements that are rare and could not be replaced.
Moderate	<p>Landscapes which by nature of their character would be able to partly accommodate change of the type proposed. Typically, these would be;</p> <ul style="list-style-type: none"> • Comprised of commonplace elements and features creating generally unremarkable character but with some sense of place. locally designated, or their value may be expressed through non-statutory local publications. • Containing some features of value through use, perception or historic and cultural associations. • Likely to contain some features and elements that could not be replaced
Low	<p>Landscapes which by nature of their character would be able to accommodate change of the type proposed. Typically, these would be;</p> <ul style="list-style-type: none"> • Comprised of some features and elements that are discordant, derelict or in decline, resulting in indistinct character with little or no sense of place. • Not designated. • Containing few, if any, features of value through use, perception or historic and cultural associations. • Likely to contain few, if any, features and elements that could not be replaced.

Table Source: IAN 135/10, Annex 1, Table 2

Visual sensitivity

9.4.14 Visual receptors are the people who live in or visit the landscape, and who will experience views of the Scheme. Visual receptors were categorised by their sensitivity, and included people in their homes, users of PRoW and other areas of open space or recreational landscapes, people at work and people travelling along roads or railway lines. Indicative criteria used to categorise the sensitivity of visual receptors are provided in Table 9.2, below.

Table 9.2: Visual sensitivity and typical descriptors

Sensitivity	Typical criteria
High	<ul style="list-style-type: none"> • Residential properties. • Users of Public Rights of Way or other recreational trails (e.g. National Trails, footpaths, bridleways etc.). • Users of recreational facilities where the purpose of that recreation is enjoyment of the countryside (e.g. Country Parks, National Trust or other access land etc.).
Moderate	<ul style="list-style-type: none"> • Outdoor workers • Users of scenic roads, railways or waterways or users of designated tourist routes. • Schools and other institutional buildings, and their outdoor areas.
Low	<ul style="list-style-type: none"> • Indoor workers • Users of main roads (e.g. trunk roads) or passengers in public transport on main arterial routes. • Users of recreational facilities where the purpose of that recreation is not related to the view (e.g. sports facilities).

Table Source: IAN 135/10, Annex 2, Table 1

- 9.4.15 Due to the number of possible visual receptors, only the more sensitive receptors were selected for specific investigation and in general, views from receptors of low sensitivity (such as from industrial estates and quarries for example) were omitted from the study. Figure F-5 in Appendix F shows the locations of those visual receptors selected for specific investigation and also panoramic photographs of viewpoints from some of these receptors (Figures 7.6 to 7.8 in Appendix F).
- 9.4.16 Although distant views from outside of the study area may be possible, it is considered that any effects on these viewpoints are unlikely to be perceptible given the distance involved.
- 9.4.17 The views experienced by on-road vehicle travellers have not been examined in depth, as it is considered that the highway infrastructure is a part of the visual experience expected by vehicle travellers. Further detail is provided in sections 13.4.31 to 13.4.36 in Chapter 13 People and Communities.

Magnitude of landscape and visual impacts

- 9.4.18 The identification of the degree of change (i.e. impact magnitude) in the landscape or in views experienced by visual receptors also forms part of the baseline against which the landscape and visual impacts of the Scheme can be assessed.

Magnitude of landscape impact

- 9.4.19 The Scheme was reviewed alongside the baseline data to identify sources of potential impacts on the landscape in order to determine subsequent landscape effects. The assessment of landscape impacts was undertaken by the same landscape professional who undertook and co-ordinated the baseline assessment/evaluation.
- 9.4.20 Effects on landscape character were assessed by considering the components that define character and their sensitivity to the type, scale and duration of the proposed change, taking into account any mitigation measures.
- 9.4.21 Based on consideration of the Scheme, the magnitude of landscape impacts (either adverse or beneficial) are estimated using the indicative criteria provided in Table 9.3, below.

Table 9.3: Magnitude and nature of landscape impact and typical descriptors

Magnitude of Impact	Typical criteria descriptors
Major Adverse	Total loss or large-scale damage to existing character or distinctive features and elements, and/or the addition of new but uncharacteristic conspicuous features and elements.
Moderate Adverse	Partial loss or noticeable damage to existing character or distinctive features and elements, and/or the addition of new but uncharacteristic noticeable features and elements.
Minor Adverse	Slight loss or damage to existing character or features and elements, and/ or the addition of new but uncharacteristic features and elements.
Negligible Adverse	Barely noticeable loss or damage to existing character or features and elements, and/or the addition of new but uncharacteristic features and elements.

Magnitude of Impact	Typical criteria descriptors
No Change	No noticeable loss, damage or alteration to character or features or elements.
Negligible Beneficial	Barely noticeable improvement of character by the restoration of existing features and elements, and/or the removal of uncharacteristic features and elements, or by the addition of new characteristic elements.
Minor Beneficial	Slight improvement of character by the restoration of existing features and elements, and/or the removal of uncharacteristic features and elements, or by the addition of new characteristic elements.
Moderate Beneficial	Partial or noticeable improvement of character by the restoration of existing features and elements, and/or the removal of uncharacteristic and noticeable features and elements, or by the addition of new characteristic features.
Major Beneficial	Large scale improvement of character by the restoration of features and elements, and/or the removal of uncharacteristic and conspicuous features and elements, or by the addition of new distinctive features.

Table Source: IAN 135/10, Annex 1, Table 1

Magnitude of visual impact

- 9.4.22 The Scheme was reviewed alongside the baseline data to identify sources of potential visual impacts in order to determine subsequent visual effects. The assessment of visual impacts was undertaken by the same landscape professional who undertook and coordinated the baseline assessment/ evaluation.
- 9.4.23 Effects on visual receptors were assessed by considering the scale and duration of the proposed change, taking into account any mitigation measures.
- 9.4.24 The magnitude of visual impacts are assessed using the indicative criteria in Table 9.4, below.

Table 9.4: Magnitude of visual impact and typical descriptors

Magnitude of Impact	Typical criteria descriptors
Major	The project, or a part of it, would become the dominant feature or focal point of the view.
Moderate	The project, or a part of it, would form a noticeable feature or element of the view which is readily apparent to the receptor.
Minor	The project, or a part of it, would be perceptible but not alter the overall balance of features and elements that comprise the existing view.
Negligible	Only a very small part of the project would be discernible, or it is at such a distance that it would form a barely noticeable feature or element of the view.
No Change	No part of the project, or work or activity associated with it, is discernible.

Table Source: IAN 135/10, Annex 2, Table 2

Significance of landscape and visual impacts

- 9.4.25 The significance of both landscape and visual impacts are derived by respectively assessing the sensitivity of the landscape or visual receptor against the magnitude of the landscape or visual impact of the Scheme, bearing in mind the likely

effectiveness of potential mitigation measures. This is illustrated by the significance matrix presented as Table 9.5, below.

Table 9.5: Typical descriptors of significance of effects categories

Landscape/ Visual Receptor Sensitivity	Magnitude of impact (degree of change)				
	Major	Moderate	Minor	Negligible	No change
High	Large or Very Large	Moderate or Large	Slight or Moderate	Slight	Neutral
Moderate	Moderate or Large	Moderate	Slight	Neutral or Slight	Neutral
Low	Slight or Moderate	Slight	Neutral or Slight	Neutral or Slight	Neutral

Table Source: adapted from IAN 135/10, Annex 1, Table 3 and Annex 2, Table 3

9.4.26 Typical descriptors of the significance levels in the matrix are provided for landscape impacts in Table 9.3, above, and for visual impacts in Table 9.6, below.

Table 9.6: Typical descriptors of the significance of effect categories

Significance	Typical descriptors of effect
Very large beneficial	The project would create an iconic new feature that would greatly enhance the view
Large beneficial	The project would lead to a major improvement in a view from a highly sensitive receptor.
Moderate beneficial	The proposals would cause obvious improvement to a view from a moderately sensitive receptor, or perceptible improvement to a view from a more sensitive receptor.
Slight beneficial	The project would cause limited improvement to a view from a receptor of medium sensitivity, or would cause greater improvement to a view from a receptor of low sensitivity.
Neutral	No perceptible change in the view.
Slight adverse	The project would cause limited deterioration to a view from a receptor of medium sensitivity, or cause greater deterioration to a view from a receptor of low sensitivity.
Moderate adverse	The project would cause obvious deterioration to a view from a moderately sensitive receptor, or perceptible damage to a view from a more sensitive receptor.
Large adverse	The project would cause major deterioration to a view from a highly sensitive receptor, and would constitute a major discordant element in the view.
Very large adverse	The project would cause the loss of views from a highly sensitive receptor, and would constitute a dominant discordant feature in the view.

Table Source: IAN 135/10, Annex 2, Table 4

9.5 Consultation

9.5.1 The Scheme provides an opportunity to introduce environmental design measures and/ or mitigation measures designed to help reduce adverse effects and provide

landscape and visual enhancements where possible. This is expected to be particularly relevant in the area between Grove Farm and Maylands Golf Course, where the loop lane and the overbridge at the A12 eastbound exit road would be introduced.

- 9.5.2 Consultation with the appropriate stakeholders will therefore be undertaken to ensure that the Scheme is designed with appropriate mitigation proposals that reflect the impacts and sensitivities of the respective receptors.
- 9.5.3 Stakeholder consultation will be undertaken to agree the location of viewpoints to be photographed, the location and number of photomontages, and the extent of the visual envelope. The relevant Local Planning Authorities, i.e. Brentwood Borough Council and London Borough of Havering, and the local community will be consulted.
- 9.5.4 Post-consultation, consideration will be given to any comments received to assist in the decision-making process and inform further design work, after which the Option Identification LVIA will be updated in accordance with the Scoping Report, and presented as part of the EIA which is to be submitted alongside the application for a DCO for the Scheme.
- 9.5.5 In its final format, the LVIA will consider the effects of the Scheme on both the landscape as an environmental resource and on people's visual amenity, and as well as identifying and describing the likely landscape and visual effects of the Scheme, it will also determine the likely significance of these effects.
- 9.5.6 Following recommendations made by Essex County Council through the EIA scoping process the study area for the final, the detailed Landscape and Visual Impact Assessment (LVIA) will be extended from 1.5 km to 2 km from the perimeter of the Scheme, and the LVIA at ES stage will also consider the potential effects of the Scheme on the following additional receptors that were scoped out of the preliminary assessment:
- Landscape effects on Warley (1.6 km to the south east), St Faith's and Weald Country Park;
 - Landscape effects on Weald Park (Grade II) Registered Park and Garden (1.5 km to the north east);
 - Visual effects on employees at Telecommunications Head Office and nearby residential properties in Brentwood (2 km east);
 - Visual effects on Boyles Court, Grade II Listed Building;(1.5 km south);
 - Visual effects on residential receptors to the north east including Lake House, Colmar Farm, Colmar, Park Farm and Halfway House (1.8 km to the north east);
 - Visual effects on residential receptors located on Nag's Head Lane linking Brook Street area with Tyler's Common to the south of Junction 28 (1.5 km south); and
 - Visual effects on residential receptors to the north east of the M25 in South Weald situated along Wigley Bush Lane (1.3 km to the north east).

9.6 Baseline conditions

Landscape baseline

Landscape designations

- 9.6.1 The study area lays partially within the Green Belt, adopted by the London Borough of Havering and Brentwood Borough Council. Local landscape designations are shown in Figure 7.1 in Appendix F.
- 9.6.2 Thames Chase Community Forest, bisected by the M25, lies to the south of Junction 28 and abuts the A12 to the west of the junction and the A1023/ Brook Street to the east of the junction.
- 9.6.3 The Manor (Local Nature Reserve) is located wholly within the study area across two sites - the smaller site lays c.1,000 m directly west of the existing junction, the larger lays c.1,300 m to the northwest.
- 9.6.4 Two Scheduled monuments are located within the study area:
- Dagnam Park Farm moated site, Noak Hill, Romford, c.1,750 m to the northwest of Junction 28; and
 - Slight univallate hillfort 300 m west of Calcott Hall Farm, c.2, 400 m to the northeast of Junction 28.
- 9.6.5 Weald Park, a Grade II Registered Park & Garden located c.800 m to the north of Junction 28, lies within the study area, as do approximately 62 Listed Buildings, of which:
- 5 No. are Grade II* Listed; and
 - 57 No. are Grade II Listed.
- 9.6.6 Landscape designations, along with Areas of Ancient Semi-Natural Woodland, as formally defined by Natural England, are also present.

Existing published landscape character assessments

- 9.6.7 Local topography and landscape character areas are respectively illustrated by Figures 7-3 and 7-2 in Appendix F.
- 9.6.8 The Scheme area is within Northern Thames Basin National Character Area (111) as defined by Natural England, and within the Weald Wooded Farmland and Great Warley Wooded Farmland landscape character areas as defined by the Braintree, Brentwood, Chelmsford, Maldon and Uttlesford Landscape Character Assessment (Chris Blandford Associates, Sept 2006).
- 9.6.9 In summary, the landscape of the M25 north of Junction 28 and the land to the northwest of Brentwood is characterised by wooded rolling hills and slopes, narrow, tree-lined roads, and swathes of relatively open commons; a sense of tranquillity exists away from main road corridors as illustrated in Figure 7-4 in Appendix F.
- 9.6.10 The M25 south of Junction 28 and the land to the southwest of Brentwood is characterised by strongly undulating wooded farmland/ wooded hills with extensive patches of woodland, small-scale field patterns with mature tree lined field boundaries, and narrow, quiet and sinuous rural lanes connecting small-scale settlements. Noise and movement associated with the M25 and A127 road

corridors is apparent, and a strong sense of place and orientation is provided by views towards London and North Kent across the Thames Chase Community Forest.

Local landscape character

- 9.6.11 The M25/ A12 junction is set within blocks of Ancient and semi-natural Woodland, small-scale pastoral and arable fields bounded by hedgerows with intermittent trees, and by linear woodland belts. Semi-mature woodland belts are largely present along the entry and exit slip roads of the M25, as well as along the A12 east and west of the junction towards the fringes of the built-up areas of Brentwood (approximately 700 m to the north-east of the junction) and Romford (approximately 800 m to the south-west of the junction) respectively.
- 9.6.12 Between these urban areas, there are some linear settlements along local road corridors, specifically along Nag's Head Lane to the south of the junction, and mixed-use development areas along the A1023/ Brook Street to the east of the junction. Several land uses typically associated with suburban areas are also present, for example Maylands Golf Course (west of the junction) and Thames Water Sewage Works (south of the junction).
- 9.6.13 Most of the inner perimeter of the Junction 28 roundabout is filled with the existing mature woodland, although some localised areas of scrub vegetation are evident.

Landscape sensitivity

- 9.6.14 Statutory and local designations are present within the landscape, as are features of value such as strongly undulating wooded farmland, and extensive areas of woodland with some narrow rural lanes. Some of these features, such as woodland areas, field patterns, and landform, would be difficult to replace if lost to the Scheme.
- 9.6.15 The landscape character is defined by commonplace landscape elements and features, but maintaining, a sense of place, created by rolling hills and slopes, and by more open Commons with occasional long vistas from elevated locations.
- 9.6.16 The nature of the landscape character is therefore considered able to partly accommodate change of the type proposed by the Scheme and consequently, the sensitivity of the landscape to change is judged to be Moderate.

Visual baseline

Visual setting

- 9.6.17 The visibility towards the location of the Scheme is restricted by a network of intervening hedgerows, woodland belts and woodland areas, as well as by the existing approaches to the junction from the A12 and M25. Visibility is also further restricted by landform around the junction, which broadly slopes down towards the junction from adjacent areas.
- 9.6.18 There are several woodlands adjacent to Junction 28 and along the road corridors that screen, either fully or partially, views of the junction. The views are additionally screened by the local variations of terrain, the road corridors of the M25 and A12, existing railway line, and by the overlapping network of hedgerows with trees.

9.6.19 Views from the north of the M25 Junction 28 and the land to the northwest of Brentwood comprise:

- Open views to wooded horizons;
- Long-distance views across farmland enclosed by patches of woodland; and
- Unfolding views, moving through the undulating landscape and patches of woodland.

9.6.20 Views from the south of Junction 28 and the land southwest of Brentwood comprise:

- Panoramic, open views across the M25 road corridor over the Thames Chase to London and North Kent;
- Views to wooded horizons;
- Open views to the southern edge/ fringe of the Brentwood urban area; and
- Short-distance, framed views within woodland clearings.

Sensitivity of visual receptors

9.6.21 Using the indicative criteria used to categorise the sensitivity of visual receptors provided in Table 9.2, above, most of the visual receptors identified by the Option Identification LVIA were of high sensitivity:

- Residents of Boyles Court Farm, Dark Lane, south east of Junction 28;
- Residents of Grove Farm, immediately adjacent to Junction 28;
- Residents of Maylands Cottages, to the west of Junction 28;
- Residents of Harold Park, to the west of Junction 28;
- Residents of Oak Farm, west of Junction 28;
- Residents of May Cottage and Freeman's Cottage, between the A12 and the A1023/ Brook Street, between Junction 28 and the western edge of Brentwood;
- Residents of French's Farm, off Wigley Bush Lane east of Junction 28;
- Residents of properties along Spital Lane, Wingrave Crescent, and Leonard Way, Brentwood;
- Residents of properties along Nags Head Lane, south of Junction 28;
- Users of the bridleway (a linear receptor with significant changes in elevation and view along its length) following Nag's Head Lane and along the crest of the M25 cutting, south of Junction 28.
- Users of open access land, including Tyler's Common to the south of Tyler's Hall Farm and open access land near Harold Court; and
- Patrons of Maylands Golf Course to the north west of Junction 28.
- Non-Motorised Users (NMU's) of the public footpaths located along:
 - The A1023/ Brook Street, south east of Junction 28; and

- The Wigley Bush Lane overbridge, east of Junction 28.

9.6.22 Visual receptors identified as being of low sensitivity were:

- Employees and users of businesses between the A12 and the A1023/ Brook Street, between Junction 28 and the western edge of Brentwood, comprising;
 - The Holiday Inn hotel, including conference/ spa facilities;
 - The Brentwood Garden Centre;
 - The Mizu restaurant;
 - The Shell service station;
 - The Sausage-Steak-Baguettes fast food stand; and
 - The Vauxhall car showroom/ sales centre.
- Users of the A12 dual carriageway to the west of Junction 28.

9.7 Potential impacts

9.7.1 Landscape or visual effects are considered significant when moderate or higher-level effects have been identified.

Landscape impacts

9.7.2 Potential landscape impacts of the Scheme are summarised below, and described in detail in Table F-4 in Appendix F.

9.7.3 It is expected that the relatively small scale of the Scheme would not result in significant effects for landscape character at the national level. The effects on the local landscape character will be particularly focused around the Grove Farm, Alder Wood and Maylands Golf course.

9.7.4 The area around the junction has undulating topography; therefore, the introduction of entry and exit slip roads is likely to result in landform alteration as earthworks balancing cut and fill will be required. The field pattern will be altered between the Grove Farm and the Maylands Golf Course.

9.7.5 The key landscape effects expected from implementation of the Scheme are loss of vegetation, alteration to the landform and field pattern, as well as the introduction of man-made features. The Scheme will directly affect Alder Wood as the alignment cuts through a section of this Semi-Natural Woodland, and considerable loss of trees is expected along the entry and exit slip roads along both the M25 and the A12.

9.7.6 The Scheme would also likely affect the existing levels of tranquillity in the local area. All these changes combined may potentially affect the local landscape character.

Magnitude of landscape impacts

9.7.7 While both landform and the degree of vegetation cover would generally preclude impacts on the landscape character to the north, east and south, both the construction and the operation of the loop and slip roads to the west of Junction 28 would cause noticeable damage to field patterns, and partial loss/ noticeable

damage to the distinctive landscape element of Alder Wood and to areas of vegetation local to the highway corridor.

- 9.7.8 The magnitude of these permanent landscape impacts during both construction and operation is judged likely to be Moderate Adverse.

Significance of landscape impacts

- 9.7.9 The significance of the impact of the Scheme on the landscape during both construction and operation is likely to be Moderate Adverse, as there will be partial loss or noticeable damage to distinctive landscape features and elements.

Visual impacts

- 9.7.10 Visual effects will occur during both the construction and operational stage. The magnitude and visual significance of these effects vary between the visual receptors located around the junction. The potential visual impacts of the Scheme are summarised below, and described in more detail in Table F.5 in Appendix F.

Construction phase effects

- 9.7.11 During construction, effects are likely to occur from the introduction of construction machinery, compounds, and vegetation removal potentially creating new sightlines and views of the existing junction.
- 9.7.12 The visual receptors will also be affected by views of heavy goods vehicle (HGVs) and other tall machinery used within the construction site. However, the potential visual effects of construction activities would be temporary, short term, and reversible.
- 9.7.13 It is expected that the greatest construction impact will occur in the area between Grove Farm and Maylands Golf Course, where the loop lane and the overbridge at the A12 eastbound exit road would be introduced. It is expected that widening of the existing road corridors and the introduction of entry and exit slip roads would be less visible due to a sequential progress of construction works.
- 9.7.14 Construction phase effects are expected to arise from:

- Earthmoving operations;
- The formation of temporary spoil areas;
- Road formation/ construction;
- Creation of new earthworks; and
- Proposed overbridges/ structures.

Operational phase effects

- 9.7.15 Existing views will also be affected through the introduction of new elements of the Scheme, and are expected to arise from:
- The introduction of large scale infrastructure features such as earthworks and entry/ exit slip roads;
 - Changes to street lighting;
 - New signage and gantries, and;

- The introduction of environmental design measures, including planting and seeding.

9.7.16 The operational visual impacts of the Scheme will be long term and permanent, although it is expected that the proposed planting will mature gradually following the construction.

Magnitude of visual impacts

9.7.17 Judgements have been made regarding the impact that the Scheme would likely have on visual receptors in terms of the degree of change (i.e. the magnitude of the impact) likely to be experienced in views; a summary is provided in Table 9.7, below.

Table 9.7: Summary of visual impact magnitude

Visual receptor(s)	Magnitude of construction phase impacts	Magnitude of operational phase impacts
Residents of Boyles Court Farm	Minor	Negligible
Residents of Grove Farm	Major	Major
Residents of Maylands Cottages	Major	Major
Residents of Harold Park	Negligible	Negligible
Residents of Oak Farm	Moderate	Moderate
Residents of May Cottage and Freeman's Cottage	Moderate	Moderate
Residents of French's Farm	Moderate	Minor
Residents of properties along Spital Lane, Wingrave Crescent, and Leonard Way	Moderate	Negligible
Residents of properties along Nags Head Lane	Negligible	Negligible
Users of the bridleway following Nag's Head Lane and along the crest of the M25 cutting	Moderate	Moderate
Users of open access land, including Tyler's Common to the south of Tyler's Hall Farm and open access land near Harold Court	Negligible	Negligible
Patrons of Maylands Golf Course	Major	Major
Users of the public footpaths located along the A1023/ Brook Street;	Negligible	Negligible
Users of the public footpaths located along the Wigley Bush Lane overbridge	Moderate	Moderate
Employees and users of the Holiday Inn hotel, including conference/ spa facilities	Moderate	Negligible

Visual receptor(s)	Magnitude of construction phase impacts	Magnitude of operational phase impacts
Employees and users of the Brentwood Garden Centre	Moderate	Moderate
Employees and users of the Mizu restaurant	Moderate	Moderate
Employees and users of the Shell service station	Moderate	Moderate
Employees and users of the Sausage-Steak-Baguettes fast food stand	Moderate	Moderate
Employees and users of the Vauxhall car showroom/ sales centre	Moderate	Negligible
Users of the A12 dual carriageway to the west of Junction 28	Major	Moderate

Significance of visual impacts

9.7.18 Visual impact significance is determined by assessing the sensitivity of receptors against the magnitude or degree of change of view resulting from the Scheme; a summary is provided in Table 9.8, below.

Table 9.8: Summary of visual impact significance

Visual Receptor(s)	Significance of construction phase impacts	Significance of operational phase impacts
Residents of Boyles Court Farm	Slight Adverse	Slight Adverse
Residents of Grove Farm	Very Large Adverse	Very Large Adverse
Residents of Maylands Cottages	Very Large Adverse	Very Large Adverse
Residents of Harold Park	Slight Adverse	Slight Adverse
Residents of Oak Farm	Moderate Adverse	Moderate Adverse
Residents of May Cottage and Freeman's Cottage	Moderate Adverse	Moderate Adverse
Residents of French's Farm	Moderate Adverse	Moderate Adverse
Residents of properties along Spital Lane, Wingrave Crescent, and Leonard Way	Moderate Adverse	Slight Adverse
Residents of properties along Nags Head Lane	Neutral	Neutral
Users of the bridleway following Nag's Head Lane and along the crest of the M25 cutting	Moderate Adverse	Moderate Adverse

Visual Receptor(s)	Significance of construction phase impacts	Significance of operational phase impacts
Users of open access land, including Tyler's Common to the south of Tyler's Hall Farm and open access land near Harold Court	Slight Adverse	Slight Adverse
Patrons of Maylands Golf Course	Very Large Adverse	Very Large Adverse
Users of the public footpaths located along the A1023/ Brook Street;	Neutral	Neutral
Users of the public footpaths located along the Wigley Bush Lane overbridge	Moderate Adverse	Moderate Adverse
Employees and users of the Holiday Inn hotel, including conference/ spa facilities	Slight Adverse	Neutral
Employees and users of the Brentwood Garden Centre	Slight Adverse	Slight Adverse
Employees and users of the Mizu restaurant	Slight Adverse	Slight Adverse
Employees and users of the Shell service station	Slight Adverse	Slight Adverse
Employees and users of the Sausage-Steak-Baguettes fast food stand	Slight Adverse	Slight Adverse
Employees and users of the Vauxhall car showroom/ sales centre	Slight Adverse	Neutral
Users of the A12 dual carriageway to the west of Junction 28	Slight Adverse	Slight Adverse

9.8 Potential mitigation measures

9.8.1 Preliminary environmental design or mitigation measures that have the potential to be incorporated into the Scheme have been as follows:

- Where possible there may be potential to provide mitigation measures for screening consisting of planting or mounds;
- Where the field pattern is affected it should be reinstated where possible, through the addition of woodland copses, tree belts, or planting of hedgerow with trees;
- Where earth mounding or cuttings are proposed their profile should be modelled to fit with the local landscape character. Shallow gradients of slopes and shallow crests of embankments and cuttings would be in keeping;
- The Scheme may give an opportunity for opening up or screening of the views into and from the altered sections of the network where appropriate;

- Introduction of new vegetation could help absorb the junction into the landscape and improve habitat connectivity through the provision of wildlife corridor links with the surrounding areas; and
- New planting should include native broad-leaved species appropriate to the locations favouring long lived tree species located at a safe distance from the road but also hedgerows and woodland edge planting, located outside constraints of sight lines, to improve landscape quality and safety.

9.8.2 The preliminary Environmental Design shown in Figure J-1, Appendix J illustrates how these environmental design or mitigation measures could be addressed during the detailed design stage of the Scheme by providing:

- Sufficient planting such that the total area of new planting would be greater than the total area of existing planting likely to be lost as a result of the Scheme; and
- Planting that connects and strengthens existing landscape features, such as hedgerows, and woodland blocks.

9.8.3 Specific landscape elements that could comprise mitigation measures illustrated in Figure J-1, Appendix J are:

- Woodland/ Linear Belts of Trees & Shrubs linking the A12 eastbound carriageway west of the M25 to the anti-clockwise carriageway of the M25 north of Junction 28, running north along the north-west verge of the new loop road encircling Grove farm, and along the eastern edge of Alder Wood;
- Woodland/ Linear Belts of Trees & Shrubs along the A12 eastbound carriageway directly west of the M25, to the south of the River Ingrebourne realignment;
- Woodland infill and hedgerow planting along the A12 eastbound carriageway west of the M25;
- Hedgerow planting along both the A12 east & westbound carriageways, east of the M25; and
- Woodland/ Linear Belts of Trees & Shrubs on new embankments, wherever possible.

9.9 Residual impacts

9.9.1 At the design year (15 years after opening) when mitigation will be fully effective, there are likely to be residual significant landscape impacts as the Scheme will have introduced local changes into the landscape pattern, and there are likely to be ongoing visual effects, including an increase in the visual intrusion of the junction and the introduction of new elements into existing views. However, careful consideration at the detailed design stage should be able to reduce the significance of any residual impacts to a minimum.

Landscape impacts

9.9.2 Junction 28 of the M25 is set within blocks of Ancient and semi-natural Woodland, small-scale pastoral and arable fields bounded by hedgerows with intermittent trees, and by linear woodland belts. Semi-mature woodland belts are largely

present along the entry and exit slip roads of the M25, as well as along the A12 east and west of the junction towards the fringes of the built-up areas of Brentwood (approximately 700 m to the north-east of the junction) and Romford (approximately 800 m to the south-west of the junction).

- 9.9.3 Both the construction and operational phases of the Scheme would likely result in noticeable disruption to field patterns, and partial loss/ noticeable damage to the distinctive landscape elements of Alder Wood and areas of vegetation local to the highway corridor.
- 9.9.4 During both construction and operation, the significance of the landscape impact of the Scheme may be considered Moderate Adverse as the proposals would have an adverse impact on characteristic landscape features or elements.

Significant visual impacts

- 9.9.5 The visibility of the Scheme is restricted by a network of intervening hedgerows, woodland belts and woodland areas, as well as by the existing approaches to the junction from the A12 and M25. Visibility is also further restricted by landform around the junction, which broadly slopes down towards the junction from adjacent areas.
- 9.9.6 Both the construction and operational phases of the Scheme would likely affect existing views through the introduction of new highways infrastructure into the landscape, and by removal of existing vegetation to facilitate the proposals.
- 9.9.7 The operational visual impacts of the Scheme will be long term and permanent, although it is expected that the proposed planting will mature gradually following the construction.
- 9.9.8 During the construction phase only, the following visual receptors are expected to experience significant visual effects as a result of the Scheme:
- 9.9.9 Moderate Adverse visual impacts are expected for:
- Residents of properties along Spital Lane, Wingrave Crescent, and Leonard Way.
- 9.9.10 During both the construction and operational phases, the following visual receptors are also expected to experience significant visual effects:
- 9.9.11 Very Large Adverse visual impacts are expected for:
- Residents of Grove Farm;
 - Residents of Maylands Cottages; and
 - Patrons of Maylands Golf Course.
- 9.9.12 Moderate Adverse visual impacts are expected for:
- Residents of Oak Farm;
 - Residents of May Cottage and Freeman's Cottage;
 - Residents of French's Farm;
 - Users of the bridleway following Nag's Head Lane and along the crest of the M25 cutting; and

- Users of the public footpaths located along the Wigley Bush Lane overbridge.

9.9.13 However, incorporation of further mitigation measures including appropriate landscaping at the detailed design stage should reduce the significance of these residual impacts. This will be assessed fully in the ES once detailed design information is available.

9.10 Cumulative effects

9.10.1 Fifteen potential development sites are located within or adjacent to the study area (see Table 15.1). Of these, three have been identified for inclusion into a high-level assessment of potential cumulative landscape and visual effects as they have either been identified for development by adopted local development plans, or have been granted planning consent. The remaining twelve sites have not been considered by this report as the sites are either identified for development by local development plans that are currently at draft status only, or have yet to be granted planning consent.

Table 9.9: Provisional list of development projects for the landscape or visual cumulative effect assessment

Planning reference	Development summary	Approx. distance from Scheme
Brentwood Replacement Local Plan 2005; and Havering Core Strategy and Development Control Policies DPD 2008.	Crossrail.	400 m
Brentwood Borough Council (adopted).	Cycleway Proposals	500 m
Planning application – permitted P1742.14.	Change of use of land to burial grounds including removal of existing agricultural buildings and erection of two pavilion buildings for associated usage, hard and soft landscaping, new access to A12 and internal roads and paths, parking, and workshop area for storage of associated equipment, tools and materials.	500 m

9.10.2 Cumulative landscape effects as a result of development of the three sites listed in Table 9.9 above may include impacts:

- On the fabric of the landscape as a result of removal of or changes in individual landscape elements or features, and the introduction of new elements or features;
- On aesthetic aspects of the landscape - for example its scale, sense of enclosure, diversity, pattern and colour, and/ or on its perceptual or experiential attributes, such as a sense of naturalness, remoteness, or tranquillity; and

- On the overall character of the landscape, as a result of changes in the landscape fabric and/ or in aesthetic or perceptual aspects.

9.10.3 Cumulative visual effects may occur where:

- An observer is able to see two or more of the development sites from one viewpoint, either in combination (i.e. within the observers arc of vision at the same time without moving his/ her head) or in succession (i.e. where the observer would have to turn his/ her head to see the various developments); and/ or
- Where an observer has to move to another viewpoint to see the same or different developments. These sequential effects may be frequent (i.e. where features appear regularly and with short time lapses between instances depending of speed of travel and distances between viewpoints) or occasional (where longer time lapses between appearances would occur because the observer is moving very slowly and/ or where there are larger distances between viewpoints).

9.10.4 Two of the development sites noted in Table 9,9, above (Crossrail and the cycleway proposals), are allocated for development in the adopted local development plans, but no details regarding the development of these sites are available for assessment. Although further assessment when details are available would be required to confirm, professional judgement and experience would suggest that should development of these sites (should they proceed) would unlikely have any significant cumulative landscape or visual effects as any loss or damage to existing landscape character, features or elements would likely be set within the context of these linear sites only, and that only a very small part of the development would likely be discernible or would be at such a distance that it would form a barely noticeable feature or element in views.

9.10.5 Regarding the permitted change of use of land from agriculture to burial grounds, it is considered that the removal of existing agricultural buildings and erection of two pavilion buildings, along with associated hard and soft landscaping and new access on to the A12, would also be unlikely to have any significant cumulative landscape and visual effects, as there would likely be no noticeable loss or damage to existing landscape character, features or elements, and while the development may be perceptible, it is considered unlikely that development would alter the overall balance of features and elements that comprise existing views.

9.11 NPS compliance

9.11.1 Planning policy for NSIP’s, specifically in relation to landscape and visual resources, is contained in the overarching NN NPS (paragraphs 5.143 to 5.161) where guidance is provided on those matters to be considered in the assessment. This guidance summarised in Table 9.10 below. The assessment and Scheme is considered to be compliant with the NPS.

Table 9.10: Summary of NPS provisions relevant to this chapter

Summary of NPS provision	How and where considered in the PEIR
Where the development is subject to EIA, the applicant should undertake an assessment of any likely significant	The Option Identification LVIA will be updated and presented as part of the EIA which is to be submitted

Summary of NPS provision	How and where considered in the PEIR
landscape and visual impacts in the EIA and describe these in the ES.	alongside the application for a DCO for the Scheme.
The landscape and visual assessment should include reference to any landscape character assessment and associated studies, as a means of assessing landscape impacts relevant to the proposed project.	The existing published landscape character assessments are referred to in Section 9.6.
The applicant's assessment should also take account of any relevant policies based on these assessments in local development documents in England	Relevant planning policy is referred to in Section 9.3 and national policy summarised in this table.
The applicant's assessment should include any significant effects during construction of the project and/or the significant effects of the completed development and its operation on landscape components and landscape character (including historic landscape characterisation)	Assessment of effects on the landscape and landscape elements are described in Section 9.7.
The assessment should include the visibility and conspicuousness of the project during construction and of the presence and operation of the project and potential impacts on views and visual amenity. This should include any noise and light pollution effects, including on local amenity, tranquillity and nature conservation	Assessments of effects on visual resources are described in Section 9.7. The details of the lighting during construction and operation are not certain at this stage, but assumptions have been made based on experience of similar projects and good working practice during the construction and operational phases. Noise is considered in the Noise & Vibration Chapter.

9.12 Summary

- 9.12.1 This chapter reports on the key landscape and visual effects associated with the preliminary design proposals to upgrade Junction 28 of the M25.
- 9.12.2 The Scheme has the capacity to change the landscape character at a local level, and to bring about changes in visual amenity for a number of sensitive visual receptors.
- 9.12.3 The potential impacts of the Scheme are considered significant when landscape or visual effects of moderate or higher-level significance have been predicted.

Significant Landscape Impacts

- 9.12.4 Both the construction and operational phases of the Scheme would likely cause noticeable disruption to field patterns, and partial loss/ noticeable damage to the distinctive landscape elements of Alder Wood and areas of vegetation local to the highway corridor.
- 9.12.5 During both construction and operation, the significance of the landscape impact of the Scheme is considered to be Moderate Adverse as the proposals would have an adverse impact on characteristic landscape features or elements.

Significant Visual Impacts

- 9.12.6 Both the construction and operational phases of the Scheme would likely affect existing views through the introduction of new highways infrastructure into the landscape, and by removal of existing vegetation to facilitate the proposals.
- 9.12.7 The operational visual impacts of the Scheme will be long term and permanent, although it is expected that the proposed planting will mature gradually following the construction.
- 9.12.8 During both the construction and operational phases, several visual receptors are expected to experience significant visual effects ranging from very large to moderate in magnitude. However, incorporation of further mitigation measures including appropriate landscaping at the detailed design stage should reduce the significance of these residual impacts. This will be assessed fully in the ES once detailed design information is available:

Further Assessment

- 9.12.9 As part of the iterative design process, following consultation and the subsequent fixing of the engineering and environmental designs, a more detailed LVIA will be carried out to consider impacts during construction and during operation in the winter of year 1 and the summer of year 15 after opening of the Scheme.
- 9.12.10 In addition, following recommendations made by Essex County Council through the EIA scoping process, the study area for the ES stage LVIA will be extended from 1.5 km to 2 km and will also consider the potential effects of the Scheme on several additional receptors.

10. Geology and Soils

10.1 Introduction

10.1.1 This provides the preliminary assessment for geology and soils, including those soils used for agricultural purposes. It identifies baseline conditions, outlines the method of the assessment, identifies the potential impacts on geology and soils associated with the Scheme during construction and operation, and presents mitigation measures that are recommended to mitigate any potentially significant adverse effects.

10.1.2 This geology and soils chapter assesses the following topics:

- Direct impacts on agricultural soils as a valuable resource, including loss of Best and Most Versatile (BMV) agricultural land (excluding woodland) and deterioration of soil quality;
- Effects associated with pre-existing soil and groundwater contamination, for example mobilising contamination, introducing new or changing existing contamination migration pathways, or changing the types of contamination receptors;
- Effects associated with the potential for polluting substances used during the construction phase such as the accidental loss/spillage of fuels and oils;
- Physical effects such as changes in topography, aggressive ground and ground stability in the study area; and
- Cumulative effects which may arise as a result of the Scheme's potential impacts interrelating with impacts of other proposed developments in the vicinity; and
- The expected significant effects arising from the vulnerability of the proposed development to major accidents or disasters relevant to the Scheme.

10.1.3 This chapter discusses the potential impacts associated with the Scheme and the anticipated presence of contamination upon hydrology and hydrogeology as receptors. Chapter 8 (Water and Drainage) discusses the potential impacts of the Scheme on the water environment as a resource and considers the risks associated with potential flooding from groundwater and surface water. For consideration of the re-use of soils and generation of waste soils, refer to Chapter 12 (Materials and Waste).

10.1.4 Direct impacts on geology as a valuable resource (for example mineral resource sterilisation, damage or loss of SPA and geological SSSIs, or revealing new geological exposures of scientific interest) were scoped out of the assessment during the scoping stage and are therefore not included in the assessment.

10.2 Study area

10.2.1 The study area has been determined by the extent of likely impacts from the proposed development. Given the nature of the soil, geology and hydrogeology surrounding the Scheme and the potential area of impact from land contamination from the proposed works, the assessment of geology and soils, including

agricultural soils, has adopted a study area extending 250 m from the Scheme boundary. This 250 m buffer zone is considered suitable as: (i) any potential contaminant linkages (PCL) are unlikely to extend past the immediate works area; (ii) the proposed works do not involve large-scale dewatering. Impacts if they are to occur are expected to be limited in extent due to the relatively low permeability of the geology underlying the Scheme (London Clay/Alluvium) as such wide-ranging effects are not expected. Figure G-1 in Volume 3 shows the Scheme boundary and the geology and soils study area.

10.3 Planning and policy context

10.3.1 Appendix J in Volume 2 summarises the legislation, regulatory and policy framework applicable to geology and soils.

10.4 Methodology

10.4.1 The assessment of the potential impacts of the Scheme with regards to geology and soils has been undertaken in two stages:

- Stage 1 - land contamination risk assessment; and
- Stage 2 - impact assessments.

10.4.2 The preliminary risk assessment has been largely qualitative, with only limited ground investigation data currently available. A programme of ground investigation is currently being planned. The ground investigation results will be used to complete the risk assessments and to confirm mitigation measures that have been suggested within Section 10.9 of this report. .

10.4.3 It is envisaged that the ground investigation will:

- Target areas of identified potential contamination sources;
- Provide an assessment of geological boundaries, thickness of strata and geotechnical testing to provide geotechnical parameters for design;
- Characterise the groundwater regime within the study area;
- Sample identified surface water receptors to derive site specific environmental quality standards;
- Determine the extent and nature of any fill materials (Made Ground) which may be present; and
- Determine the aggressivity of the ground towards buried concrete.

10.4.4 Potential impacts on existing ground conditions due to the Scheme have been identified in accordance with the EIA: A guide to good practice and procedures (Department for Communities and Local Government, 2006).

Stage 1 - Land contamination risk assessment

10.4.5 The approach adopted for the land contamination risk assessment is based on the guidance document CLR11 (Environment Agency & Defra, 2004) and the Good Practice Guide to EIA as described in Table 10.1 below. These documents are considered key guidance in the UK and provide a technical framework for the application of a risk management process through the steps described below.

- 10.4.6 A desk study review of available information was undertaken to develop a Preliminary Conceptual Site Model (PCSM), which describes the linkages between potential contamination hazards/sources, pathways and receptors relevant to the scheme. Where all three are present, or considered likely to be present, these are described as Pollutant Contaminant Linkages (PCLs) which can then be subject to the risk assessment process. PCSMs have been created for the baseline, construction and operational phases of the Scheme.
- 10.4.7 Where PCLs have been identified within the PCSMs, consideration has been given to whether these would be appropriately mitigated through design and/or the development of a remediation strategy and its subsequent validation as necessary. The residual risks have been determined and assessed based on estimation of likelihood and consequence. These will be further assessed following the proposed ground investigation.
- 10.4.8 The NHBC and Environment Agency report R&D66 (NHBC & Environment Agency, 2008) provides guidance on the development and application of the consequence and probability matrix (as presented in Table 10.1 below) for contaminated land risk assessment.

Table 10.1: Land quality estimation of the level of risk by comparison of consequence and probability

		Consequence			
		Severe	Medium	Mild	Minor
Probability	Very High Risk	Very High Risk	High Risk	Moderate Risk	Moderate / Low Risk
	High Risk	High Risk	Moderate Risk	Moderate / Low Risk	Low Risk
	Moderate Risk	Moderate Risk	Moderate / Low Risk	Low Risk	Very Low Risk
	Moderate / Low Risk	Moderate / Low Risk	Low Risk	Very Low Risk	Very Low Risk

Table Source: NHBC and Environment Agency report R&D66

- 10.4.9 The potential risk to a receptor is a function of the probability of, and the consequence of a PCL being realised. Probability (likelihood of an event occurring) considers both the presence of the hazard and the receptor and the integrity of the exposure pathway. Consequence considers both the potential severity of the hazard and the sensitivity of the receptor (Appendix J in Volume 2, Tables J.1 and J.2 provides the definitions for the classification of probability and consequence).
- 10.4.10 Based on R&D66 the descriptions of the classified risks are provide in Table 10.2 below.

Table 10.2: Description of the classified risks

Risk	Risk Descriptions
Very High Risk	There is a high probability that severe harm could arise to a designated receptor from an identified hazard at the site without remediation action or there is evidence that severe harm to a designated receptor is already occurring. Realisation of that risk is likely to present a substantial liability to

Risk	Risk Descriptions
	the site owner / or occupier. Investigation is required as a matter of urgency and remediation works likely to follow in the short-term.
High Risk	Harm is likely to arise to a designated receptor from an identified hazard at the site without remediation action. Realisation of the risk is likely to present a substantial liability to the site owner/or occupier. Investigation is required as a matter of urgency to clarify the risk. Remediation works may be necessary in the short-term and are likely over the longer term.
Moderate Risk	It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, and if any harm were to occur it is more likely, that the harm would be relatively mild. Further investigative work is normally required to clarify the risk and to determine the potential liability to site owner/occupier. Some remediation works may be required in the longer term.
Moderate / Low Risk	It is possible that harm could arise to a designated receptor from an identified hazard, however it is likely that at its worst, this harm if realised would be relatively mild. Further investigative work is normally required to clarify the risk and to determine the potential liability to site owner/occupier. Some remediation works may be required in the longer term however these are likely to be minor.
Low Risk	It is possible that harm could arise to a designated receptor from identified hazard, but it is likely at worst, that this harm if realised would normally be mild. It is unlikely that the site owner/or occupier would face substantial liabilities from such a risk. Further investigative work (which is likely to be limited) to clarify the risk may be required. Any subsequent remediation works are likely to be relatively limited.
Very Low Risk	It is a low possibility that harm could arise to a designated receptor, but it is likely at worst, that this harm if realised would normally be mild or minor.

Table Source: NHBC and Environment Agency report R&D66

Stage 2 - Impact assessment

Land contamination impact assessment methodology

10.4.11 The land contamination impact assessment is based on the risk assessment (Stage 1 land contamination risk assessment) to assess the magnitude of impact as described in Table 10.3 below. For example, if the risk is deemed moderate during baseline conditions, but is deemed high during construction, there is a one step increase of risk. If the risk during construction is very high risk and during operation it reduces to moderate risk, this is a two step decrease in risk rating.

Table 10.3: Land Contamination Impact Assessment based on change in contamination risk

Classification of significance	Effect
Major adverse	An increase in contamination risk from the existing baseline conditions of 4 or 5 risk levels in the risk matrix, e.g. land that has a very low contamination risk in the baseline becomes a high or very high risk.
Moderate adverse	An increase in contamination risk from the existing baseline conditions of 2 or 3 risk levels in the risk matrix, e.g. land that has a low contamination risk in the baseline becomes a moderate or high risk.

Classification of significance	Effect
Minor adverse	An increase in contamination risk from the existing baseline conditions of 1 risk level in the risk matrix, e.g. land that has a low contamination risk in the baseline becomes a moderate/low risk.
Negligible	Negligible change in contamination risks.
Minor beneficial	A reduction in contamination risk from the existing baseline conditions of 1 risk level in the risk matrix, e.g. land that has a moderate/low contamination risk in the baseline becomes a low risk.
Moderate beneficial	A reduction in contamination risk from the existing baseline conditions of 2 or 3 risk levels in the risk matrix, e.g. land that has a high contamination risk in the baseline becomes a moderate/low or low risk.
Major beneficial	A reduction in contamination risk from the existing baseline conditions of 4 or 5 risk levels in the risk matrix, e.g. land that has a very high contamination risk in the baseline becomes a low or very low risk.

Table Source: NHBC and Environment Agency report R&D66 Table 6.5

Soils and geology (resource /hazard) impact assessment methodology

10.4.12 The value of a receptor (soils and geology) is considered when determining consequence of an effect in the impact assessment. The value and/or sensitivity of each of the receptors is determined using the classifications and criteria given in Table 10.4.

Table 10.4: Criteria for classifying the value and/or sensitivity of environmental resources/ hazard

Value/Sensitivity	Criteria	Examples
High	Attribute possesses key characteristics which contribute significantly to the distinctiveness, rarity and character of the site/receptor. Attribute has a very low capacity to accommodate the proposed change.	Buildings, including services and foundations but of high historic value or other sensitivity e.g. statutory designations, schools, residential dwellings. Major topographic, ground stability, soil compaction or erosion hazards present at the site.
Medium	Attribute possesses key characteristics which contribute significantly to the distinctiveness, rarity and character of the site/receptor. Attribute has a low capacity to accommodate the proposed change.	Buildings, including services and foundations. Moderate topographic, ground stability, soil compaction or erosion hazards present at the site.
Low	Attribute only possesses characteristics which are locally significant. Attribute has some tolerance to accommodate the proposed change.	Infrastructure (roads, bridges, railways). No topographic, ground stability, soil compaction or erosion hazards present at the site.

Table Source: DMRB Volume 11, Section 2, Part 5 (DMRB, 2008)

10.4.13 Following determination of the value of receptors, the magnitude of potential construction phase and operational phase impacts is determined based on the criteria defined in Table 10.5.

Table 10.5: Classification of magnitude of impact

Classification of magnitude	Criteria
High	Total loss of major alterations to one or more of the key elements, features or characteristics of the baseline. The post-development situation will be fundamentally different.
Medium	Partial loss or alteration to one of more of the key elements or characteristics of the baseline. The post-development situation will be partially changed.
Low	Minor loss or alteration to one or more of the key elements, features or characteristics of the baseline. Post-development, the change will be discernible, but the underlying situation will remain similar to the baseline.
Negligible	Very minor loss or alteration to one of more of the key elements, features or characteristics of the baseline, such that post-development, the change will be barely discernible, approximating to the “no change” situation.

Table Source: DMRB Volume 11, Section 2, Part 5

10.4.14 The overall potential significance of effects is then defined using the matrix presented in Table 10.6, which describes the relationship between the value /sensitivity of the resource as defined in Table 10.4 and magnitude of impact as defined in Table 10.5.

Table 10.6: Criterion for determining the impact significance of effects

		Magnitude of impact			
		High	Medium	Low	Negligible
Value / Sensitivity of environmental resource/hazard	High	Major	Major/Moderate	Moderate	Minor / Negligible
	Medium	Major/ /Moderate	Moderate	Moderate / Minor	Minor
	Low	Moderate	Moderate / Minor	Minor	Negligible

Table Source: DMRB Volume 11, Section 2, Part 5

10.4.15 The description of the potential significance of effects is provided in Table 10.7.

Table 10.7: Classification of significance of effects

Classification of Significance	Effect
Major adverse	Complete permanent change in topography which impacts the local community.

Classification of Significance	Effect
	Significant soil erosion, soil compaction or ground instability that is permanent in nature. Land contamination identified such that it meets the statutory definition of Contaminated Land defined under Part 2A which
Moderate adverse	Partial long term (> 10 years) change in topography which impacts the local community. Moderate soil erosion, soil compaction, or ground instability that is either permanent or long term in nature.
Minor adverse	Limited medium term (5 to 10 years) change in topography which impacts the local community. Limited medium-term soil erosion, soil compaction, or ground instability.
Negligible	No measurable impact on topography, soil erosion, soil compaction, or ground instability or impacts that are only temporary in nature (< 5 years).
Minor beneficial	Limited medium term (5 to 10 years) change in topography which has a positive impact on the local community. Limited medium-term reduction in existing soil erosion, soil compaction, or ground instability issues.
Moderate beneficial	Partial long term (> 10 years) change in topography which has a positive impact on the local community. Moderate permanent or long-term reduction in existing soil erosion, soil compaction, or ground instability issues.
Major beneficial	Complete permanent change in topography which has a positive impact on the local community. Significant permanent reduction in existing soil erosion, soil compaction or ground instability issues.

Table Source: Based on criteria provided in DMRB Volume 11, Section 2, Part 5

10.4.16 Following the classification of an effect a clear statement has been made as to whether the effect is significant or not. Major and moderate effects are considered to be significant, and minor and negligible effects are considered to be not significant. However, professional judgement is also applied where appropriate.

Agricultural soils

10.4.17 The assessment of agricultural soils follows the approach of the DMRB, Volume 11, Section 3, Part 6 (DMRB, 2001). This identifies six main areas that need to be covered in any assessment of effects on agricultural land. These are; agricultural land quality, designated agricultural areas, land take, type of husbandry, severance and major accommodation works for access, water supply and drainage.

10.4.18 No fieldwork has been completed for agricultural soils at this stage, therefore the presence of BMV land has been assessed using data from a published soil map.

10.4.19 The significance criteria address both magnitude of impact and sensitivity of the resource and consideration of the characteristics of the impact and the receptor, namely:

- Type of impact - direct or indirect;
- Nature of impact - beneficial, adverse or negligible;
- Duration of impact - short or long term, reversible or not; and
- Frequency of impact - continuous or intermittent, changing with time or constant.

10.4.20 There is no nationally recognised set of criteria for assessing the impact of infrastructure schemes on agricultural land and loss of BMV soils and so a bespoke system has been developed to reflect the issues significant to this Scheme.

10.4.21 Agricultural land in ALC Grades 1, 2 and 3a is considered to be of high sensitivity, agricultural land in ALC Subgrade 3b is considered to be of medium sensitivity and land in ALC Grades 4 and 5 is considered to be of low sensitivity.

Best and Most Versatile Soils

10.4.22 The Ministry of Agriculture Fisheries and Food (MAFF) Agricultural land classification (ALC) Grades 1, 2 and 3a are considered to be of high sensitivity. ALC Subgrade 3b is considered to be of medium sensitivity and ALC Grades 4 and 5 is considered to be of low sensitivity (MAFF, 1988) as defined in paragraph 112 and Annex 2 of the NPPF and Natural England's Technical Information Note 049 (Natural England, 2012).

10.4.23 Magnitude of impact of the Scheme on agricultural soils is assessed on the scale presented in Table 10.8 below, based on likely loss of BMV land.

Table 10.8: Assessment of magnitude of impact on BMV land

Magnitude	Criteria
Major	The identified impacts are predicted to result in a loss of >20 ha of BMV land.
Moderate	The identified impacts are predicted to result in the loss of between 5 ha and 20 ha of BMV land.
Minor	The identified impacts are predicted to result in a loss of between 1 ha and 5 ha of BMV land.
Negligible	The identified impacts are predicted to result in the loss of <1 ha BMV land.

Table Source: Natural England's Technical Information Note 049

Agricultural Land Use

10.4.24 The sensitivity of agricultural holdings can be assessed as 'High', 'Medium', 'Low' or 'Negligible' as shown in Table 10.9. The magnitude of the predicted impact on agricultural holdings may be assessed as 'High', 'Medium', 'Low' or 'Negligible' following the criteria given in Table 10.9 below.

10.4.25 In general terms, larger farm holdings have a greater capacity to absorb impacts and are less sensitive. However, the scale of the land holding is reflected in the magnitude of impact and the percentage land-take from the farm. For example, the loss of 100 hectares from a 400-hectare (1,000 acre) farm would be a high impact (25%), whereas the same land-take from a 1,000-hectare farm would be low (10%).

10.4.26 Criteria for the assessment of magnitude of impact are given in Table 10.10.

Table 10.9: Value/sensitivity of receptors – agricultural land

Value/sensitivity	Receptors
High	<p>Farm types in which the operation of the enterprise is dependent on the spatial relationship of land to key infrastructure, and where there is a requirement for frequent and regular access between the two, or dependent on the existence of the infrastructure itself, e.g.:</p> <ul style="list-style-type: none"> • Dairying, in which milking cows must travel between fields and the parlour at least twice a day; • Irrigated arable cropping and field-scale horticulture, which are dependent on irrigation water supplies; • Intensive livestock or horticultural production which is undertaken primarily within buildings, often in controlled environments; • High value cropping such as fruit.
Medium	<p>Farm types in which there is a degree of flexibility in the normal course of operations, e.g.:</p> <ul style="list-style-type: none"> • Combinable arable farms; • Grazing livestock farms (other than dairying).
Low	<p>Large agricultural holdings. Farm types and land uses undertaken on a non-commercial basis. Agricultural land which is currently unfarmed. Land farmed on an annual grazing licence or other short-term agreement, i.e. where the long term-tenure of the affected land is not secure.</p>
Negligible	Non-agricultural land, including woodland, access tracks and hard-standing.

Table Source: Natural England's Technical Information Note 049

Table 10.10: Magnitude of impact – agricultural land

Impact magnitude	Key agricultural issues			
	Land-take	Severance	Infrastructure	Nuisance (e.g. noise/dust)
Major	>20% of all land farmed.	No access available to severed land.	Direct loss of farm dwelling, building or structure.	Nuisance discontinues land use or enterprise.
Moderate	>10% to 20% of all land farmed.	Access available to severed land via the public highway.	Loss of or damage to infrastructure affecting land use.	Nuisance necessitates change to scale or nature of land use or enterprise.
Minor	> 5% to 10% of all land farmed.	Access available to severed land via private way.	Infrastructure loss/damage does not affect land use.	Nuisance does not affect land use or enterprise.
Negligible	5% or less of all land farmed.	No new severance.	No impact on farm infrastructure.	No nuisance on land use or enterprise.

Table Source: Natural England's Technical Information Note 049

10.4.27 Significance is the product of the sensitivity of receptors and magnitude of impact. The significance of effects within this assessment is measured according to .

Assumptions and limitations

Assessment assumptions and limitations

10.4.28 The following assumptions have been adopted in the assessment:

- Shallow ground disturbance such as stripping of top soil/Made Ground, intrusive ground investigation works, stockpiling, excavation of drainage/utility conduits either temporary/permanent during the construction phase could be anywhere within the Scheme boundary;
- Piling and deeper earthworks are likely to be required as part of the Scheme;
- There will be areas used for storage of vehicles during the operational phase, which could be anywhere within the Scheme boundary;
- There will be areas used for storage of hazardous materials containers during the operational phase, which could be anywhere within the Scheme boundary; and
- No large-scale dewatering is expected to occur during the construction works.

Proposed development

10.4.29 The Scheme design at this preliminary stage includes the following elements:

- Minor cutting to grade along the northern verge of the eastbound A12 mainline to A12-to-M25 Junction 28 off-slip. This A12 eastbound to M25 Junction 28 off-slip comprises two embankments, with a viaduct structure between them bringing traffic over Weald Brook;
- Construction of a new on-slip to the M25 anticlockwise carriageway from the existing roundabout at Junction 28. This comprises a cutting in a historical landfill, construction of a retained section, and a cutting in natural ground before continuing at grade as it merges with the existing M25 anticlockwise mainline;
- Construction of a new off-slip from the M25 anticlockwise carriageway, forming the first section of the proposed cloverleaf alignment. This comprises widening of the M25 anticlockwise carriageway and construction of a viaduct structure between the existing M25 mainline and embankment founded immediately north of the historical landfill; an additional viaduct carries the cloverleaf over Weald Brook onto new embankment;
- Continuing south from this embankment, minor earthworks to grade transitions into new embankment founding a viaduct structure over Weald Brook and forming the A12 eastbound on-slip; and
- Potential works on the existing cutting north of the A12 eastbound mainline immediately west of the M25 Junction 28 roundabout.

10.4.30 Where potential sources of contamination have been identified, contaminants are assumed to be present.

- 10.4.31 Some limited GI data from historical intrusive investigations within the Scheme boundary and wider study area will be included in the assessment. However, the data are insufficient to establish baseline land contamination conditions within the Scheme boundary.
- 10.4.32 For the purposes of the BMV land assessment, permanent land take is assumed to include the surfaced road, service strips and land acquired for landscaping, attenuation ponds etc. There is a narrow strip of land take, comprising 0.2 ha, where the Weald Brook emerges from under the M25, but this is under woodland and not included in the assessment of potential for loss of BMV agricultural land.

10.5 Consultation

- 10.5.1 Consultations with the Environment Agency have been undertaken and further consultations are planned.
- 10.5.2 The Environment Agency will also be consulted prior to undertaking the ground investigation and following the development of relevant risk assessments to agree the most appropriate construction method to protect controlled waters if required. Agricultural landowners will be consulted about the impact of the Scheme on their holdings and appropriate forms of mitigation.

10.6 Baseline conditions

Current setting

- 10.6.1 Features which currently occupy the site are: The highway boundary of the M25 (orientated north-west to south-east) and A12 (orientated south-west to north-east); a cleared strip of land associated with a National Grid overhead powerline; a residential property at Grove Farm; a waste management facility; open fields; Weald Brook; woodland; a small segment of the Maylands Golf and Country Club; land currently used as a gypsy and traveller site; and a railway line.
- 10.6.2 The wider study area comprises: open space; agricultural fields; five farms (Putwell Bridge Farm and Oak Farm, the Poplars, Frenches Farm and Colmar Farm); Maylands Golf and Country Club; The Nags Head Lane sewage treatment works (STW); residential properties (within the village of Brook Street, Romford and along Nags Head Lane); and some commercial land-use.
- 10.6.3 Sensitive land use designations within the study area include Ancient Woodland, Areas of Adopted Green Belt and Nitrate Vulnerable Zones (Defra, 2018).

Topography

- 10.6.4 The natural topography at the site appears to be variable. North of the A12, the M25 passes the toe of a hill at Vicarage Wood, with ground level rising to the north from approximately 35 m above Ordnance Datum (AOD) to approximately 70 m AOD at the crest of the hill some 850 m to the north of the centre of junction 28. Ground level begins to rise again further west from Weald Brook towards Maylands Golf Club, up to 45 m AOD at the western extent of the Scheme. Slopes to the south of the junction are shallower, with ground levels between 35 m AOD and 50 m AOD, with the low points around the A12 and the Ingrebourne River.

Site history

10.6.5 A review of historical maps and other historical land use information has been undertaken. The historical maps within the Envirocheck report (Landmark, 2016) date from 1868 to 2016 have been summarised in Appendix J, Table J-3. Locations of any military camps, strategic sites or security sites were either removed or replaced by false fields (or clouds on aerial photographs) between 1878 and 1981. Therefore, these features typically associated with the presence of unexploded ordnance (UXO), are generally not available on publicly sourced historical maps.

On-site

- 10.6.6 The earliest available maps (1868) show that the site contains an unnamed road following a similar alignment to the present day A12.
- 10.6.7 In 1961, the electricity pylons associated with the present day overhead power line are mapped.
- 10.6.8 In 1968 a large roundabout had been constructed at the location of the current Junction 28. The A12 is now also shown in its current configuration, however the M25 has not yet been constructed and the roundabout connects only the A12 and Brook Street (A1023).
- 10.6.9 Between 1978 and 1984 the M25 has been constructed and is shown in its current configuration. In addition, field boundaries and a small pond which once occupied the area of the Brook Street Landfill are no longer present on the maps.

Off site

- 10.6.10 The 1868 mapping shows the wider study area to be occupied by open fields and several woodlands, shown in the area north of the A12 (present day location). The village of Brook Street is shown as a small settlement around a set of crossroads, which are the present-day Brook Street (A1023) and Mascalls Lane/Spital Lane. The railway line to the south of Junction 28 is shown in its current configuration.
- 10.6.11 By 1920 the sewage treatment works are shown off Nags Head Lane, in the south west of the study area.
- 10.6.12 By 1938 further development is shown to have continued along Nags Head Lane to the south of Junction 28 and in Harold Park west of Junction 28.
- 10.6.13 An aerial photograph in 1947 indicates expansion of the sewage treatment works. Significant development of Brook Street village and the Harold Park suburb of Romford, located in the east and west of the study area respectively, is shown by 1967.
- 10.6.14 In 1974 a 'garage' is mapped in the location of the present-day Shell South Weald fuel station east of Junction 28.
- 10.6.15 The Esso fuel station in Harold Park, located in the west of the study area is shown in its present-day configuration until 1999. There appear to have been no significant changes to the study area since 1999.

Unexploded ordnance (UXO)

10.6.16 No bombs are recorded to have fallen within 250 m of the site (Bombsight, 2013).

10.6.17 A UXO Pre-Desk Study Assessment (Zetica, 2017) identifies the study area as having a moderate UXO hazard level. Based on the recommendations therein, a detailed UXO desk study of the Scheme will be obtained prior to any earthworks commencing.

Geology

Structural geology

10.6.18 The Scheme is located within the London Basin, with the north-east to south-west trending axial trace of the London Basin Syncline located approximately within 1-2 km to the south of Junction 28 (Royse et al., 2012).

10.6.19 Information taken from the BGS GeoIndex (BGS, 2017a) suggests that the closest major fault to the Scheme is situated 11 km to the south-west, however, faulting may be more extensive than the BGS data anticipates (Royse et al., 2012).

Artificial deposits

10.6.20 Made Ground is expected beneath the site associated with the construction of localised infrastructure, in particular the M25, A12 and the railway line and embankments. Made Ground is also expected in areas of infilled historical pits/ponds and within historical landfill sites.

10.6.21 The historical ground investigations following construction of the M25 (Structural Soils, 2006) (May Gurney, 2006) identified Made Ground in 29 No. out of 38 No. exploratory holes. In 18 No. of the exploratory holes, the thickness of Made Ground encountered exceeded 2.0 m. The maximum thickness of Made Ground encountered was 7.6 m, associated with an embankment immediately east of the Junction 28 roundabout, however superficial deposits at this location may have been misinterpreted as Made Ground.

Superficial deposits

10.6.22 Geological mapping (BGS, 1996) suggests that localised superficial deposits of Head are expected at the site and Alluvium deposits are anticipated at the locations of the Ingrebourne River, Weald Brook and their tributaries.

10.6.23 Borehole records (BGS, 2017b) identified Head deposits under Made Ground on-site, with a maximum thickness of 3.0 m encountered in BH16 and in WS2926. Possible Alluvium was reported on-site with a maximum thickness of 0.7 m in BH26 and WS2726. Up to 2.8 m of Alluvium have been reported for exploratory boreholes within the wider study area (BGS, 2017b).

Bedrock geology

10.6.24 The underlying solid bedrock is anticipated to comprise the London Clay Formation. The full thickness of the London Clay Formation was not proven within any of the exploratory holes within the study area. Several boreholes on site have proven the London Clay Formation to 30 m below ground level (bgl).

10.6.25 The Claygate Member comprises the uppermost beds of the London Clay Formation and is not expected to be present on site but is expected to be present within the wider study area.

Summary of geology

10.6.26 A summary of anticipated geology from published maps and encountered in historical ground investigations is presented in Table 10.11 below:

Table 10.11: Summary of anticipated geology on site

Unit	Maximum encountered thickness (m)	Location	Description
Made Ground (Landfill)	Unknown	Brook Street Landfill, located north-west of the centre of the Junction 28 roundabout.	Materials deposited in Brook Street Landfill. The Environment Agency records the landfill as having received inert material. Therefore, the Made Ground is likely to be of variable composition including materials such as glass, concrete, bricks, tiles and stones.
Made Ground (associated with infrastructure and infill)	7.6	Made Ground is anticipated along the M25, A12, railway and infilled ponds.	Highly variable materials associated with construction or infilling of ground. Made Ground in these locations will likely comprise reworked superficial deposits and materials from the London Clay Formation.
Alluvium	4.9	Restricted to within approximately 50m of the Weald Brook, and the Ingrebourne river.	Normally soft to firm consolidated, compressible silty clay, but can contain layers of silt, sand, peat and basal gravel. A stronger, desiccated surface zone may be present.
Head	3.0	Found within close proximity to the Ingrebourne river, Weald Brook and their tributaries.	Gravel, sand and clay depending on upslope source and distance from source. Poorly sorted and poorly stratified deposits. Essentially comprises sand and gravel, locally with lenses of silt, clay or peat and organic material.
London Clay Formation	29.7+ (base unproven)	Found throughout the areas of proposed works. Underlies Made Ground and superficial deposits (where present).	Mainly comprises bioturbated or poorly laminated, fissured, blue-grey or grey-brown (when weathered), slightly calcareous, silty to very silty clay, clayey silt and sometimes silt, with some layers of sandy clay. Thin interbedded fine sands are present in the uppermost beds (Claygate Member). The upper portions of the London Clay Formation are moderately to highly weathered (BGS, 2017c)

Ground stability

10.6.27 The 1:50,000 scale ground stability maps provided within the Envirocheck report (Landmark, 2016) have been used to inform the potential for ground stability hazards on-site, these are summarised below:

- Ground dissolution is not shown to present a ground stability hazard within the study area.
- The Scheme is in an area with a very low potential for collapsible ground.

- Most of the site has a moderate potential for shrinking or swelling clay to cause a stability hazard, which is likely associated with the London Clay Formation.
- The potential for running sand as a ground stability hazard varies between very low (where Made Ground or Head Deposits are anticipated) and low (where Alluvium is anticipated).
- The potential for compressible ground as a ground stability hazard is deemed moderate where Alluvium is anticipated and low where Made Ground is anticipated.
- The potential for landslides as a ground stability hazard is shown to vary across the study area, with the hazard potential shown as very low across most of the Scheme. Areas where earthworks or man-made slopes associated with the A12 and M25 are present are shown to present a moderate to low potential for landslides as a ground stability hazard. Head deposits are associated with historical downhill movement of material. There may be a low angle shear surface or a series of shears within the top part of the London Clay Formation (Ellison et al, 2004), which presents a zone of potential displacement occurring.

Chemical attack on concrete

10.6.28 Made Ground, Alluvium and the London Clay Formation are anticipated to have elevated concentrations of sulphates and sulphides which can have detrimental impacts on concrete structures.

Services

10.6.29 Known services which traverse the Scheme include:

- National Grid overhead powerline to the west of the M25;
- A British Pipeline Agency (BPA) sub surface pipeline, following approximately the same route as the National Grid overhead power line;
- A NG high pressure gas main, crosses the Scheme, running approximately parallel to the M25 to the east of Junction 28; and
- A railway line (Great Eastern Main Line), running approximately parallel to the A12 to the south of Junction 28.

Hydrogeology

Aquifer designations

10.6.30 Perched groundwater is thought to be present in Made Ground, the superficial deposits and potentially in the upper, more weathered and more permeable layers of the London Clay Formation.

10.6.31 Aquifer designations for the superficial deposits and bedrock geology within the study area are presented in [Table 10.12](#) (Landmark, 2016).

Table 10.12: Environment Agency and BGS aquifer designations

Unit	Environment Agency Designation
Made Ground	No designation
Alluvium	Secondary A aquifer
Head Deposits	Secondary (undifferentiated) aquifer
London Clay Formation (Claygate Member)	Secondary A aquifer
London Clay Formation	Unproductive stratum.
<p>Notes</p> <p>Secondary A Aquifer: “permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers”.</p> <p>Secondary (undifferentiated) Aquifer: “has been assigned in cases where it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type”.</p> <p>Unproductive Strata: “rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.”</p>	

10.6.32 The Scheme is underlain by Secondary aquifers associated with Alluvium and Head deposits. Groundwater within the Alluvium is likely to be in continuity with the rivers.

10.6.33 The Claygate Member is not present on-site and is present 200 m up-gradient within the study area. and the London Clay Formation beneath most of the Scheme is designated as an Unproductive stratum. Therefore, negligible groundwater flow is anticipated, laterally or vertically within the London Clay Formation underlying the Scheme. This stratum has been proven to depths of 30 m bgl on-site.

Groundwater

10.6.34 During historical investigations (May Gurney, 2006) (Structural Soils, 2006), groundwater was occasionally observed within the Made Ground and superficial deposits and within the London Clay Formation.

10.6.35 Groundwater levels recorded in historical ground investigations were typically between 0.9 and 7.2 m bgl within the Made Ground, superficial deposits and weathered London Clay Formation. Groundwater levels within the unweathered London Clay Formation were typically deeper, varying between 2.8 m bgl and 28.6 m bgl.

Groundwater abstraction

10.6.36 There are no abstraction licences located within the study area (Landmark, 2016). No groundwater SPZs are present within 250 m of the study area (Defra, 2018).

Groundwater Vulnerability Zones

10.6.37 The majority of the Scheme does not pass through a Groundwater Vulnerability Zone (GVZ). However, deposits of Alluvium present underneath Junction 28 and extending to the south-west are designated as a Minor Aquifer High GVZ (Defra, 2018).

Hydrology

Surface water

- 10.6.38 Watercourses that cross the A12 and M25 within the Scheme include the Ingrebourne river and Weald Brook. The course of the Ingrebourne river has been modified during construction of the A12 and subsequent M25 highways.
- 10.6.39 Other surface water features present within the study area, include several drainage ditches and ponds to the west and to the north-east of the Junction 28 roundabout.

Surface water abstractions

- 10.6.40 No licensed surface water abstractions are operating within the study area (Landmark, 2016).

Agricultural land use and soils

- 10.6.41 Permanently or temporarily land take could potentially be proposed for the Scheme. Permanent land-take will include the surfaced road, service strips and land acquired for landscaping, attenuation ponds etc. Temporary land-take will include construction compounds, haul roads and land disturbed by utility diversion works. Flood mitigation works will locally affect agricultural soils through lowering of ground levels to create compensatory floodplain.
- 10.6.42 There is no detailed published soil map of the land around Junction 28. The only available map is the 1:250,000 soil map of South East England (Soil Survey of England and Wales, 1983). This shows most soils to be the Windsor series of slowly permeable, seasonally waterlogged (Wetness Class IV) clayey soils over London Clay Formation. Head deposits on valley sides may contain the Wickham and Lawford series with heavy clay loam topsoils, but even these are slowly permeable and seasonally waterlogged (Wetness Class III to IV) and pass onto London Clay Formation. The narrow floodplain of the Weald Brook contains wet, clayey Alluvium. The Brook Street Landfill was once operated on Grove Farm and is now restored to grassland.
- 10.6.43 The 1:250,000 Provisional ALC Map available online (Defra, 2018), provides only a broad indication of land quality and should not be used definitively on sites smaller than 80 ha in size. Moreover, the published map does not subdivide Grade 3 into Subgrades 3a and 3b and so cannot be used definitively in areas that are marginal to BMV. The area around Junction 28 is shown as an area of Grade 3 (good to moderate quality).
- 10.6.44 Although the subgrades are not shown on the map, it is possible to apply the ALC classification to the published soil information. Windsor soils have clay topsoils, are slowly permeable within 40 cm (Wetness Class IV) and cannot be better than Subgrade 3b. Likewise, Wickham and Lawford soils, with heavy clay loam topsoils are slowly permeable within 40 to 60 cm (Wetness Class III to IV) also cannot be better than Subgrade 3b. Strips of Alluvium are in Subgrade 3b and Grade 4.
- 10.6.45 It is possible that there are small pockets of lighter, better drained soils but these will be of small extent and would not affect the overall assessment of the area being of non-BMV quality (subgrade 3b or higher).

Current agricultural land use

- 10.6.46 There are two holdings within the north west quadrant of Junction 26, that own land inside the red line boundary of “the loop”. These are Grove Farm and land belonging to Glebelands Estate Limited.
- 10.6.47 The land on both holdings is rough grassland that is currently not actively managed agriculturally. No alternative activities are taking place that would prevent it being farmed again and so, for the purposes of this assessment, it is still classed as agricultural.
- 10.6.48 Small areas of agricultural land in the south west and north east quadrants of Junction 28 may be affected by flood mitigation works and utility diversions.
- 10.6.49 None of the study area is within Defra's Countryside Stewardship Scheme (Defra, 2018), which is the main grant aided agri-environment Scheme for England.

Land contamination

Historical site investigation geo-environmental data

- 10.6.50 Contamination test results for seven soil samples from test pits and boreholes located within the central reserve and verges of the M25 and A12 (Structural Soils, 2006) have been compared to relevant GAC for human health risk assessment, for indicative purposes only. No exceedances were reported from any of the seven soil samples, however, due to the location and limited number of the soil samples, this is not considered to be representative of conditions present within the Scheme.

Landfill sites and other potentially infilled land

- 10.6.51 There is one known historical landfill site within the study area. Brook Street Historical Landfill is on-site within the north-west quadrant of Junction 28, recorded to have accepted inert waste associated with the construction of the M25, from an unknown date until 1983.
- 10.6.52 No authorised active landfill sites are present.
- 10.6.53 Potential infilled land (water features) noted from 1961 have been identified:
- Beneath the current M25 alignment in the northern extent of the site;
 - 180 m to the west of the M25, immediately north of the waste transfer site;
 - 460 m to the north of the centre of Junction 28 within an open field; and
 - 540 m to the north-west of the centre of Junction 28 beneath the existing M25 alignment.

Fuel stations

- 10.6.54 The former South Weald Service Station was located on-site in the south-east quadrant of Junction 28 (Landmark, 2016). The extent of decommissioning undertaken on the former Brook Street Service Station is unknown.
- 10.6.55 One operational fuel station is situated in the study area. Shell South Weald is present on-site, in the south-east quadrant of Junction 28 (Google, 2018).

Other potentially contaminative land uses

10.6.56 Other potentially contaminative current and historical activities within the study area include road runoff from both the M25/A12, an electrical substation, garage services, vehicle service and repair garages, MOT centre, vehicle cleaning services, G&R Skips and Recycling waste disposal and management facilities (present in the location of former Brook Street Landfill and receives building and construction material), a railway line, a sewage treatment works and associated tanks (although this is outside of the 250 m study area, it is a significant land use) and farms.

Pollution incidents

10.6.57 Thirteen pollution incidents with impacts to controlled waters have been recorded within the study area, of which three occurred on site (Landmark, 2016). A summary of the three incidents on-site are provided in [Table 10.13](#).

Table 10.13: Pollution incidents to controlled waters

Incident Severity	Pollutant Type	Year	Distance and orientation from centre of scheme
Category 3 - Minor	Sewage	1999	40 m to the east
Category 3 - Minor	Oils	1989	60 m to the west
Category 3 - Minor	Chemicals	1994	101 m to the north-east

10.6.58 Due to the age of the pollution incidents, and the minor nature of these, the pollutants are not expected to remain in significant concentrations.

10.6.59 On a previous site walkover (17/10/17), visual evidence of contamination was reports in the vicinity of the pipeline.

Potential sources of contamination

10.6.60 In summary, the identified sources of potential contamination within the Scheme include:

- Brook Street historical landfill;
- Made Ground/ infill of unknown material expected in areas of existing development (i.e. along the M25, A12, embankments and railway) and potentially infilled water features;
- Land uses including fuel stations (one former and one active); electrical substation, sewage treatment works, waste disposal and management facility, railway line, vehicle service garages, farms and associated agricultural activities, vehicle cleaning services; and
- Possible contamination from BPA sub-surface pipeline.

10.6.61 Potential contaminants of concern include a range of inorganic and organic contaminants including heavy metals, hydrocarbons, polycyclic aromatic hydrocarbons (PAH), total petroleum hydrocarbons (TPH), solvents, asbestos, polychlorinated biphenyls (PCBs), herbicides and pesticides.

Potential receptors

10.6.62 Potential contamination receptors have been categorised as human health, controlled waters or structural receptors. No ecological receptors have been identified.

10.6.63 Potential human health receptors include:

- On-site workers (maintenance workers and those at the waste management facility and on agricultural land);
- On-site and off-site residents; and
- Off-site workers and visitors at industrial, agricultural and commercial premises and adjacent recreational facilities (golf course).

10.6.64 On-site construction workers.

10.6.65 It is anticipated that exposure to members of the public using the highway will be limited, therefore they have not been considered in this assessment.

10.6.66 Potential controlled waters receptors comprise:

- Groundwater bodies beneath the site and within the vicinity, including localised deposits of Alluvium (Secondary A aquifer) and Head deposits (Secondary (undifferentiated) Aquifer); and
- On and off-site surface water receptors, including the Ingrebourne River and Weald Brook.

10.6.67 Potential structural receptors include:

- Underground services including the National Grid high pressure gas main and BPA pipeline;
- Piles and foundations; and
- On-site and off-site property (including residential, industrial, agricultural and commercial).

Potential pathways

10.6.68 Based on the identified potential sources and the findings of the historical ground investigation reports plausible exposure pathways for the identified human health receptors may include but are not limited to:

- Inhalation, ingestion and dermal contact with contaminants in soil and soil-derived dust/fibres;
- Inhalation, ingestion and dermal contact with contaminants within perched water and shallow groundwater;
- Migration and accumulation of ground gases followed by inhalation or ignition causing asphyxiation and/or explosion; and
- Inhalation of vapours from soil and/or groundwater.

10.6.69 Pathways to the identified controlled waters receptors may include but are not limited to:

- Surface water run-off into drains, culverts, and local watercourses including: the Ingrebourne river and Weald Brook;

- Leaching / vertical migration of contaminants in soils into underlying shallow groundwater;
- Lateral migration of landfill leachate; and
- Lateral migration of contamination in shallow groundwater to surface waters, particularly where services and foundations create preferential pathways for lateral migration.

10.6.70 Potential pathways to the identified structural receptors include but are not limited to:

- Chemical attack from aggressive chemical constituents in soil or groundwater; and
- Migration of ground gases or vapours along preferential pathways including permeable ground, services trenches and service entry points and accumulation in enclosed spaces such as services ducts or access points.

10.7 Potential impacts

10.7.1 The Scheme design at this preliminary stage includes the following elements:

- Minor cutting to grade along the northern verge of the eastbound A12 mainline to A12-to-M25 Junction 28 off-slip. This A12 eastbound to M25 Junction 28 off-slip comprises two embankments, with a viaduct structure between them bringing traffic over Weald Brook;
- Construction of a new on-slip to the M25 anticlockwise carriageway from the existing roundabout at Junction 28. This comprises a cutting in a historical landfill, construction of a retained section, and a cutting in natural ground before continuing at grade as it merges with the existing M25 anticlockwise mainline;
- Construction of a new off-slip from the M25 anticlockwise carriageway, forming the first section of the proposed cloverleaf alignment. This comprises widening of the M25 anticlockwise carriageway and construction of a viaduct structure between the existing M25 mainline and embankment founded immediately north of the historical landfill; an additional viaduct carries the cloverleaf over Weald Brook onto new embankment;
- Continuing south from this embankment, minor earthworks to grade transitions into new embankment founding a viaduct structure over Weald Brook and forming the A12 eastbound on-slip; and
- Potential works on the existing cutting north of the A12 eastbound mainline immediately west of the M25 Junction 28 roundabout.

Land contamination

10.7.2 The construction phase could potentially introduce new sources of contamination and may also introduce new pathways for migration of existing contamination without appropriate mitigation. The following construction phase activities may contribute to the creation of new PCLs:

- Potential disturbance and mobilisation of contamination present within the ground;
- Creation of confined spaces, such as manholes and service chambers/ducts, within which ground gas has the potential to accumulate;
- Piling for any proposed bridge foundations and gantries;
- Potential for increased runoff during earthworks with a high sediment (contamination) load to potentially impact surface water receptors; and
- Any dewatering activities (if required) have the potential to mobilise contaminated groundwater and enhance lateral migration of contamination within the superficial and bedrock aquifers and potentially into surface watercourses.

10.7.3 During the operational phase, it is anticipated that no new pathways are likely to be created. However, accidents and incidents have the potential to introduce new sources. The OEMP for the Scheme will address how these incidents will be managed and detail the emergency management procedures to be implemented in such an event. Further details are provided in Chapter 8 (Road Drainage and the Water Environment).

10.7.4 If no mitigation measures are implemented, impacts are likely, with the implementation of mitigation measures through design and through the construction phase, potential impacts to human health, controlled waters and property receptors during construction are likely to be negligible.

10.7.5 During the operational phase, with mitigation measures incorporated no impact is anticipated.

Geology and geomorphology

10.7.6 The Scheme could potentially effect geology and geomorphology across the study area and will affect the topography within the Scheme boundary. This is discussed in detail in Chapter 9 (Landscape and Visual).

10.7.7 Construction activities and land clearance have the potential to increase soil erosion and degrade soil quality. The Scheme could also impact the ground in areas where geological stability hazards have been identified.

10.7.8 Potential impacts during the operational phase include changes to physical properties and ground instability.

Agricultural soils

10.7.9 During the construction phase, the approximate areas of agricultural land (not including woodland) that may be acquired are:

- Approximately 5 ha for temporary works (construction compounds and laydown);
- Approximately 5 ha for highway works;
- Approximately 18 ha for mitigation and or construction compounds; and
- Approximately 7 ha for flood mitigation works and drainage ponds.

- 10.7.10 Therefore potentially 35 ha of agricultural land may be taken in the construction phase, of which, 28 ha is temporary land-take and will be returned to the owners following development. Around 7 ha of agricultural land will be permanently taken. This includes 5 ha for the new road and 2 ha of permanent severance of grassland belonging to Glebelands Estates between “the loop” and the Ingrebourne River.
- 10.7.11 Noise and dust will not affect the agricultural land as no livestock or crops are present.
- 10.7.12 A minor construction impact may be an interference to local field drainage systems on the surrounding land.

Potential mitigation measures

Design measures

- 10.7.13 The ground investigation will be carried out to inform the design and confirm the appropriate mitigation measures provided in table 10.8.5. The objectives of the ground investigation are listed in 10.4.3.
- 10.7.14 The data gathered from the ground investigation will help inform an appropriate Materials Management Plan (MMP) and Site Waste Management Plan (SWMP) (if required). Further information is provided in Chapter 12 (Material and Waste).
- 10.7.15 Piling Risk Assessments may be required (particularly within proximity to Brook Street Landfill). These will assess where preferential pathways might be created that could allow the migration of landfill/soil gas or vapours.
- 10.7.16 Geotechnical risks will be managed in accordance with HD 22/08 and the ground investigation will provide information to ensure that the potential for ground collapse or settlement is understood and that adequate foundation solutions are designed. Following the ground investigation, the subsequent ground investigation report will be used to inform the geotechnical design report. The design report will include stability analyses and design calculations for new and modified earthworks and structures, ensuring their short and long-term stability.

10.8 Potential mitigation measures

Mitigation

10.8.1 Mitigation measures may include:

- Health and safety Risk Assessment Method Statements (RAMS) and Personal Protective Equipment (PPE) for the protection of construction workers in accordance with the Control of Substances Hazardous to Health (COSHH) Regulations;
- Implementation of appropriate dust suppression measures to prevent migration of contaminated dust and fibres as appropriate, as set out in Chapter 5 (Air Quality);
- Working method statements during construction to manage groundwater and surface water appropriately and ensure that there is no run-off from the works, any material/waste stockpiles, and storage containers into adjacent surface watercourses; in accordance with DEFRA and the Environment Agency’s Pollution Prevention Guidance;

- Stockpile management (such as water spraying and avoiding over stockpiling to reduce compaction of soil and loss of integrity) and timely removal of stockpiled soil to prevent windblown dust and run-off;
- Implementation (if deemed appropriate from the findings of the ground investigation) of a MMP or Site Waste Management Plan (SWMP);
- Limiting the area of earthworks at any one time to reduce temporary effects on topography, soil compaction and erosion;
- Limiting the duration of soil exposure and timely reinstatement of vegetation or hardstanding to prevent soil erosion;
- Implementing appropriate pollution incident control measures e.g. plant drip trays and spill kits;
- Implementing appropriate and safe storage of fuel, oils and equipment during construction;
- If unexpected contamination is encountered during proposed earthworks, further assessment will be required. Following assessment further mitigation measures such as remediation or removal of contamination may be required; and
- The completion of a detailed UXO desk study may be required to further assess the UXO hazard level within the Scheme, and the completion of a UXO survey prior to any ground investigation.

10.8.2 If unexpected contamination is encountered during proposed earthworks, further assessment will be required. Following assessment further mitigation measures such as remediation or removal of contamination may be necessary. If not remediated, laying of a clean capping layer may be required in areas of proposed soft landscaping.

10.8.3 Most of the scheme area will be hardstanding, except for soft landscaping along embankments, which will prevent direct contact and minimise the generation of dust. Therefore, direct contact and ingestion pathways and infiltration should be minimised during the operational phase.

10.8.4 Drainage design will consider the risks from any residual contamination and may be required to use lined drainage systems in areas where contamination may be left in-situ (see Chapter 8 Road Drainage and the Water Environment).

10.8.5 The Scheme will be operated in accordance with the relevant regulations and best practice guidance in applying Best Available Techniques and pollution prevention.

10.8.6 There is no mitigation for the loss of agricultural land or land-take. Financial compensation will be a matter for the District Valuer and is outside the scope of the assessment.

10.8.7 Engineered and other mitigation measures to minimise construction impacts on agricultural soils will be agreed with land owners and tenants before and during the construction process. Essential further measures to those listed above are:

- Demarcation of the construction working corridor once defined, in order to prevent disturbance to adjacent land;
- Diversion or restoration of existing land drainage systems affected by the engineering works;

- Restoration of land occupied or disturbed during the construction process that is not permanently acquired for engineering and landscaping to a condition equivalent to its original. It will be subject to an aftercare period (duration to be agreed), during which time problems with settlement, drainage and weed infestation will be rectified; and
- The quality and quantity of soil on-site will be maintained by implementing appropriate techniques for stripping, stockpiling and reinstatement, in accordance with Defra's 2009 Code of Practice for the Sustainable Use of Soils on Construction Sites.

10.8.8 Land occupied or disturbed during the construction process that is not permanently acquired for engineering and landscaping will be restored to a condition equivalent to its original.

10.8.9 On flood mitigation land, where the level of the ground is lowered, topsoil should be replaced.

Monitoring

10.8.10 The ground investigation specification has been drafted which allows for the installation of groundwater and ground gas monitoring wells and a subsequent preliminary monitoring programme to establish baseline conditions.

10.8.11 Any disturbed land restored to farming will be subject to a five-year aftercare period, during which time any problems with settlement, drainage and noxious weeds will need to be rectified.

10.9 Residual impacts

10.9.1 Residual impacts typically refer to the long-term effects of the Scheme and relate to the completed, operational development. Impacts are assessed taking into account any mitigation measures and a consideration of their positive or negative influence.

10.9.2 It is anticipated that with the incorporation of mitigation measures during construction and within the design no residual impacts and / or beneficial impacts are expected due to the Scheme.

10.10 Cumulative effects

10.10.1 Cumulative impacts may occur from interaction with other committed and planned developments in the vicinity of the Scheme.

10.10.2 The cumulative impacts upon geology and soils will be assessed as part of the ES process. Developments that have been identified within the study area are listed in Table 15.1 and will be considered as part of the cumulative assessment.

10.10.3 Of the developments presented in Table 15.1, only the gypsy and traveller site at the Caravan Park, Putwell Bridge, located within the red line boundary, is likely to cause cumulative effects. The proposed development does not include large scale groundworks. However, the proposed development has the potential to introduce new receptors for the construction and operational phases of the Scheme.

10.10.4 [Table 10.14](#) below outlines the developments identified within the study area and if cumulative effects with the Scheme are considered likely.

Table 10.14: Cumulative effects

Proposal	Council area/ Region	Documentation	Cumulative effects
Crossrail (Elizabeth Line) Approx. 400 m from site	Brentwood and Havering	Brentwood Replacement Local Plan 2005 & Draft Local Plan 2016 Havering Core Strategy and Development Control Policies DPD 2008	None expected. All improvement works scheduled to be completed by mid-2018 and the line operational end 2018. No new receptors introduced.
Gypsy and Traveller Site at The Caravan Park, Putwell Bridge Approx. 500 m from site	Havering	LB Havering (Proposals Map Changes July 2017)	Cumulative impacts possible due to proximity to the Scheme. Although, intrusive works are not expected there is a low risk of environmental-related cumulative impacts. The Traveller Site will also introduce new receptors.

10.11 NPS compliance

10.11.1 The Scheme aims to comply with the NPS (paragraphs 5.162 to 5.185) by leaving the Scheme area in better condition than prior to development and will aim to adhere to the following:

- Detailed design will aim to minimise environmental impacts and to improve quality of life, as well as aim to identify opportunities to deliver environmental benefits;
- Economic and other benefits of BMV agricultural land have been considered during the development of the Scheme; and
- The new and existing development should be prevented from contributing to, or being put at unacceptable risk from, or being adversely affected by, water pollution.

10.11.2 The mitigation measures outlined in Section 10.9 including further ground investigation should be adhered to and considered throughout all stages of the Scheme to ensure compliance with NPS guidance.

10.12 Summary

10.12.1 This chapter has considered the effects of the Scheme on geology and soils in accordance with the regulatory policy framework presented in Section 10.3

10.12.2 With respect to land contamination, the assessment of baseline conditions, and the magnitude of the potential impact of the Scheme has been assessed as significant. However, with the application of appropriate mitigation measures, the preliminary assessment indicated that the impact of the Scheme on the identified receptors will be not significant (minor adverse to minor beneficial). The preliminary assessment indicates that the operational phase will have a negligible to moderate beneficial effect and has therefore been assessed as being significant (beneficial).

10.12.3 With respect to geology / geomorphology and agricultural soils, the preliminary assessments indicate that the construction phase and the operational phase will have a minor adverse (slight adverse) to negligible effect, which is not significant.

11. Cultural Heritage

11.1 Introduction

11.1.1 This chapter provides the preliminary assessment for cultural heritage. It identifies the cultural heritage study area, methodology, presents the known historic environment baseline conditions, identifies the potential impacts on heritage assets (both designated and non-designated) associated with the Scheme during construction and operation, and presents mitigation measures that are recommended to mitigate any potentially significant adverse effects.

11.2 Study area

11.2.1 A 500 m study area surrounding the Scheme has been applied as indicated on Figures H-1 and H-2 in Appendix H. This distance was established by professional judgement and relevant guidance, in particular guidance recommended by the Design Manual for Roads and Bridges (DMRB), Volume 11, Section 3, Part 2 HA 208/07 Cultural Heritage.

11.3 Planning and policy context

11.3.1 Appendix K in Volume 2 summarises the legislation, regulatory and policy framework applicable to cultural heritage.

11.4 Methodology

11.4.1 This chapter assesses both the construction and operational impacts and effects of the Scheme on the cultural heritage resource. The known cultural heritage resource, both designated and non-designated, has been identified within both the Scheme and study area in order to allow for an assessment of the potential impacts of the Scheme and to help inform the potential for the survival of hitherto unidentified archaeological remains within the Scheme boundary. A gazetteer of all cultural heritage assets is appended in Appendix H, together with Figures H-1 and H-2 showing their locations within the study area.

11.4.2 The historic environment comprises designated and non-designated heritage assets and other features or remains of historic interest as follows:

- World Heritage Sites;
- Scheduled Monuments;
- Listed Buildings;
- Registered Parks and Gardens;
- Conservation Areas;
- Registered Battlefield;
- Buildings and structures of historic interest (not listed);
- Known archaeological sites and areas of archaeological potential;
- Archaeological Priority Areas or Archaeological Priority Zones;
- National Trust Inalienable Land; and

- Findspots.

11.4.3 The methodology for assessing potential impacts and/or effects on the historic environment and the assets set out above is determined through identifying an asset's value and assessing the degree of change that the Scheme would have on a heritage asset. This is in line with the guidance provided in the DMRB which can be found in Volume 11, HA 208/07, Annex 5.

11.4.4 Following such guidelines, this provides a score ranging from Very High, High, Medium, to Low or Negligible in terms of heritage value. Table 11.1 sets out the criteria for assessing the value of heritage assets, as identified in the DMRB Volume 11, Section 3, Part 2 HA 208/07 Cultural Heritage.

Table 11.1: Value of heritage assets

Value	Description	Example
Very High	Internationally important or significant heritage assets.	World Heritage Sites, or buildings recognised as being of international importance.
High	Nationally important heritage assets generally recognised through designation as being of exceptional interest and value.	Grade I and II* Listed Buildings, Grade I and II* Registered Parks and Gardens, Scheduled Monuments, Protected Wreck Sites, Registered Historic Battlefields, Conservation Areas with notable concentrations of heritage assets and undesignated assets of national or international importance.
Medium	Nationally or regionally important heritage assets recognised as being of special interest, generally designated.	Grade II Listed Buildings, Grade II Registered Parks and Gardens, Conservation Areas and undesignated assets of regional or national importance, including archaeological remains, which relate to regional research objectives or can provide important information relating to particular historic events or trends that are of importance to the region.
Low	Assets that are of interest at a local level primarily for the contribution to the local historic environment.	Undesignated heritage assets such as locally listed buildings, undesignated archaeological sites, undesignated historic parks and gardens etc. Can also include degraded designated assets that no longer warrant designation.
Negligible	Elements of the historic environment which are of insufficient significance to merit consideration in planning decisions and hence be classed as heritage assets.	Undesignated features with very limited or no historic interest. Can also include highly degraded designated assets that no longer warrant designation.
Unknown	The importance of an asset has not been ascertained.	

Table Source: DMRB Volume 11, Section 3, Part 2 HA 208/07 Cultural Heritage.

11.4.5 The scale of change the Scheme would have on the significance of the asset is assessed by determining the magnitude of impact.

11.4.6 Table 11.2 identifies the criteria for establishing the magnitude of impacts on heritage assets.

Table 11.2: Magnitude of impact

Magnitude of Impact	Description of Nature of Change
Major Adverse	<p>Substantial harm to, or loss of an asset’s significance as a result of changes to its physical form or setting.</p> <p>For example, this would include demolition, removal of physical attributes critical to an asset, loss of all archaeological interest or the transformation of an asset’s setting in a way that fundamentally compromises its ability to be understood or appreciated. The scale of change would be such that it could result in a designated asset being undesignated or having its level of designation lowered.</p>
Moderate Adverse	<p>Less than substantial harm to an asset’s significance as a result of changes to its physical form or setting.</p> <p>For example, this could include: physical alterations that remove or alter some elements of significance, but do not substantially alter the overall significance of the asset; notable alterations to the setting of an asset that affect our appreciation of it and its significance; or the unrecorded loss of archaeological interest.</p>
Minor Adverse	<p>Limited harm to an asset’s significance as a result of changes to its physical form or setting.</p> <p>For example, this could include: physical changes that alter some elements of significance but do not noticeably alter the overall significance of the asset; and small-scale alterations to the setting of an asset that hardly affect its significance.</p>
Negligible	<p>Very minor changes to setting or form of the asset.</p>
No Change/ Neutral	<p>No appreciable change to an asset’s significance.</p>
Minor Beneficial	<p>Limited improvement of an asset’s significance as a result of changes to its physical form or setting.</p> <p>For example, this could include: physical changes that reveal or conserve some elements of significance but do not noticeably alter the overall significance of the asset; or small-scale alterations to the setting of an asset that improve our ability to appreciate it.</p>
Moderate Beneficial	<p>Notable enhancement of an asset’s significance as a result of changes to its physical form or setting.</p> <p>For example, this could include: physical alterations that conserve or restore elements of significance; notable alterations to the setting of an asset that improve our appreciation of it and its significance; or changes in use that help safeguard an asset.</p>
Major Beneficial	<p>Substantial enhancement of an asset’s significance as a result of changes to its physical form or setting.</p> <p>For example, this could include: major changes that conserve or restore elements of high significance; alterations to the setting of an asset that very substantially improve our appreciation of it and its significance; or changes in use that safeguard an asset, e.g. by taking it off the At Risk Register.</p>

Table Source: DMRB Volume 11, Section 3, Part 2 HA 208/07 Cultural Heritage.

11.4.7 Table 11.3 shows how the significance of effect is determined. This combines the value of the heritage asset and the scale of change (impact) to provide the measure of effect.

Table 11.3: Significance of effects

Value/ Sensitivity	Magnitude of impact				
	Major	Moderate	Minor	Negligible	No change
Very high	Very large	Large or very large	Moderate or large	Slight	Neutral
High	Large or very large	Moderate or large	Slight or moderate	Slight	Neutral
Medium	Moderate or large	Moderate	Slight	Neutral or slight	Neutral
Low	Slight or moderate	Slight	Neutral or slight	Neutral or slight	Neutral
Negligible	Slight	Neutral or slight	Neutral or slight	Neutral	Neutral

Table Source: DMRB Volume 11, Section 3, Part 2 HA 208/07 Cultural Heritage.

- 11.4.8 Generally, only moderate to major adverse or beneficial effects are considered to be ‘significant’.
- 11.4.9 This assessment presents the baseline data and makes a preliminary assessment of the likely effects on heritage assets. It takes into account the Option Identification Environmental Study document findings and recommendations, the EIA Scoping Report, and historic environment datasets and report.
- 11.4.10 Historic environment baseline data was collected from the following sources:
- Essex Historic Environment Record (EHER);
 - Greater London Historic Environment Record (GLHER);
 - Historic England's National Heritage List for England (NHLE); and
 - Secondary sources which have primarily been discussed in the desk-based assessment in Appendix H.
- 11.4.11 The EHER, GLHER and NHLE data was ordered in September 2017 in order to provide an updated dataset as the previous data requested for the Option Identification stage was outdated at the point of producing the preliminary design stage deliverables. A gazetteer of designated and non-designated heritage assets which are located within the Scheme and study area, is presented in Appendix H and Figures H-1 and H-2. Heritage assets are referred to by their unique ID which, for designated assets, are their NHLE entry numbers, and for non-designated assets by their preferred HER ID (prefixed with “MLO”, “DLO” and “MEX”).
- 11.4.12 In order to understand the archaeological potential of the Scheme and study area, an archaeological desk-based assessment (DBA) (AOC Archaeology Group, Forthcoming) was commissioned, and is currently being produced. An interim copy of this report has been used to inform this assessment, and will form part of the evidence base for ES, with copies submitted as an Appendix to the ES.

11.5 Consultation

- 11.5.1 Public consultation on the Scheme options was carried out between December 2016 – January 2017. No specific concerns regarding the historic environment were raised.
- 11.5.2 Consultation with Cultural Heritage specific stakeholders including the Archaeological Officers at Greater London Archaeology Advisory Service and Essex County Council will be undertaken at ES stage, in order to assist and inform in the preliminary design proposals and need for mitigation.
- 11.5.3 A summary of this consultation will be outlined in the ES, following additional assessments and preliminary on-site investigations.

11.6 Baseline conditions

Topographical and geological conditions

- 11.6.1 The study area occupies a gently undulating ground profile, with topography sloping downhill, from c. 50 aOD in the east, to c. 45 aOD in the west, with a decrease in elevation to c. 30 m aOD at Weald Brook.
- 11.6.2 The bedrock geology within the Scheme and study area is dominated by the London Clay Formation which is sedimentary bedrock formed approximately 48 to 56 million years ago in the Palaeogene Period in a local environment which would have previously been dominated by deep seas.
- 11.6.3 Superficial deposits comprise alluvium along the Weald Brook and Ingrebourne River, with clay, silt, sand and gravel Head deposits record adjacent to both these water courses and the A12. These superficial deposits formed up to three million years ago in the Quaternary Period in a local environment previously dominated by subaerial slopes. Sand and gravel Glaciofluvial Deposits, and Diamicton of the Lowestoft Formation have also been identified along the western edge of the study area at Harold Hill.

Designated heritage assets

- 11.6.4 Figure H-1 and H-2 in Appendix H show the locations of designated and non-designated heritage assets located within the study area.
- 11.6.5 The study area contains 11 designated heritage assets. These comprise:
- One Grade II registered park and garden;
 - Two Grade II* listed buildings;
 - Six Grade II listed buildings; and
 - Two Conservation Areas.
- 11.6.6 Effects upon the built heritage and historic landscape resource were initially scoped out of further assessment, following site visits undertaken in May and August 2018, and on the basis of professional judgment that these assets were located exclusively in areas that are effectively screened from the scheme and would not be materially affected by the proposed works. However, following feedback from PINS it is proposed that a detailed supplementary setting assessment is undertaken to further look at the potential impacts to these listed

buildings and historic landscapes as part of the ES in order to demonstrate that the scheme is unlikely to have significant effects.

Non-designated heritage assets

- 11.6.7 Fifty-six non-designated heritage assets have been identified within the study area. These assets include the London to Colchester Roman Road, a medieval woodland, as well as post-medieval domestic and agricultural buildings, and post-medieval parkland.

Prehistoric evidence (-AD 43)

- 11.6.8 There are no known prehistoric remains within the Scheme boundary. However, GLHER designates part of the Scheme an Archaeology Priority Zone (APZ), which extends along the Weald Brook (DLO33196). This has been designated due to the underlying geological alluvial deposits have the potential to overlie prehistoric deposits. Alluvial deposits can be particularly conducive to the preservation of paleoenvironmental features which can be useful for dating purposes. Further Archaeological Priority Zones of Gravel Head Deposits (DLO33197) and Gravel Sand Deposits (DLO33198) are similarly designated for the potential for prehistoric deposits to be buried beneath gravel deposits. These areas are located c. 280 m to the west of the southern extent of the Scheme and c. 150 m north of the eastern extent of the Scheme boundary respectively
- 11.6.9 Fieldwalking along the route of the Epping – Horndon Gas Pipeline (MEX1036570) recovered artefacts such as pottery and flint of possible prehistoric date. The survey crossed the Scheme boundary to the east of Junction 28 and west of Vicarage Close. The EHER, however, records that most of these artefacts were recovered as findspots for single artefacts and were not given HER numbers and so the provenance of these findspots is not known. This suggests that the locus of prehistoric activity was outside of the area where the pipeline intersects with the current Scheme and study area.
- 11.6.10 Current evidence indicates a lack of known heritage assets of prehistoric date within the study area, but the GLHER's designation of an APZ along Ingrebourne River and Weald Brook indicates geological conditions which may be conducive the survival of such remains. On this basis there is considered to be medium potential for prehistoric remains within the APZ (DLO33196) in the west of the Scheme but low potential for such remains throughout the rest of the Scheme.

Roman evidence (AD 43 – AD 410)

- 11.6.11 The Roman Road from London to Colchester (MLO106812; MEX2262) has been designated by GLHER as an Archaeological Priority Area (DLO33238) and is located within the Scheme. The road follows the course of the A12 to the west of Junction 28 and then along Brook Street A1023 to the west of the junction. The GLHER notes the potential for road side settlement and human burials associated with the road.
- 11.6.12 The only definitely Roman asset recorded in the study area is a findspot of a Roman finger ring (MEX2346) recovered at Hillside Walk, Brentwood c. 254 m southeast of the Scheme boundary.
- 11.6.13 Place-name evidence suggest that Tylehyrste, at Tylers Common Upminster (MLO23390), may indicate the presence of a Roman building in the area. The

HER notes that Tylehyrste is generally translated as ‘wood with earth for making tiles’. The name Tylehyrste is recorded in a document from AD 1062, and as the earliest date of tile manufacture following the Roman period is the 14th century, suggests that the area is either a previously unknown Saxon tile works or refers to the presence of residual Roman tiles. Tylehyrste is located within the study area, c. 455 m to the west of the southern extent of the Scheme boundary.

- 11.6.14 Aside from the find of the ring, no Roman archaeology has been recorded within the study area. However, as the Roman road from London to Colchester (DLO33238; MLO106812; MEX2262) passes through the study area the potential for Roman remains cannot be discounted. On this basis, there is considered to be medium potential for Roman remains within the Roman road APA (DLO33238) in the west of the Scheme but low potential for Roman remains throughout the rest of the Scheme.

Early medieval (AD 410 – AD 1066)

- 11.6.15 There are no early medieval heritage assets recorded within the Scheme area. The settlement of Tylehyrst (MLO12476), also discussed above, is mentioned in a document dated AD 1062 and therefore was likely established by the early medieval period. The location of the settlement is now called Tylers Farm and is located c. 455 m west of the of the southern extent of the Site boundary. Jackson’s Wood (MEX1036734), c. 107 m to the southeast of the southern extent of the study area, is a coppice surrounded by a wood bank, which is double ditched in places. It has been suggested that it was originally associated with Tylehyrst (Hay, 1995).
- 11.6.16 Cotswold Archaeology undertook a desk-based assessment in 2014 for Maylands Golf Course (ELO14836). The assessment identified the remains of an early medieval woodland at Cock Wood c. 30 m west of the Scheme boundary at its northern extent.
- 11.6.17 Given the limited evidence for early medieval remains in the study area and the general paucity of remains of these dates generally, there is considered to be low potential for early medieval archaeological remains to survive within the Scheme boundary.

Medieval evidence (1066-AD 1500)

- 11.6.18 There are no heritage assets of medieval date recorded within the Scheme boundary. The Golden Fleece Inn (1197231) and Moat House (129743) are both Grade II* Listed Buildings within the study area which have their origins in the medieval period. The Golden Fleece Inn at Brook Street, c. 280 m south of the eastern extent of the Scheme boundary, originally dates to 14th century. It was originally a house but is now used as a public house and was subject to substantial alterations and additions in the 16th, 18th, 19th and 20th centuries. In 1986 a portion of wall plaster was removed and the timbers were recorded (MEX40795; EEX40796) which revealed that the 14th century western cross wing had originally formed the eastern wing of a 14th century hall which is no longer extant (Milton 1988: 263).
- 11.6.19 The current Moat House (129743), which lies c. 348 m to the south of the eastern extent of the Scheme boundary, is primarily of post-medieval date with the earliest phases dating to the early 16th century but with later additions. The house was previously surrounded by a moat which is now dry and fragmentary. The house, at

the time the moat itself was in use, was thought to have been the residence of Henry Roper, Gentleman Pursuivant to Queen Katherine of Aragon and thus was likely established in the medieval period.

- 11.6.20 The EHER records the settlement of South Weald (MEX1032780) as a number of parcels of land located between the modern settlement of South Weald, in the south, and Coxtie Green in the north. The modern settlement is designated as a Conservation Area (DEX22821). Weald Park (1000747) which also lies in this area is a Grade II Registered Park and Garden and Conservation Area (DEX22829). The medieval settlement of South Weald included a Manor House, Vicarage, Church House and Parish Church. It appears to have consisted of a small village focused on the church complex and surrounded by small farms, including the manorial holding at Calcott. In 1086 the manors of Calcott and South Weald covered an area of 2.5 hides and it is suggested that the rest of the parish was forested. In the early 1270s the assizes of bread and ale, the return of writs, free warren and right of gallows was held by Waltham Abbey, though Calcott had its own jurisdiction. The original vicarage (MEX1032782) was built after 1275 and included 12 acres of glebe land. The vicarage was rebuilt before 1640 and again in 1718. A new vicarage was built on another site in 1825.
- 11.6.21 Weald Park (1000747), while primarily designated as a late 17th century / early 18th century park and woodland, has its origins as a deer park which was formed in the 12th century when South Weald was under the jurisdiction of Waltham Abbey. Following the Dissolution, the estate was sold to Sir Brian Tuke.
- 11.6.22 The very eastern extent of Dagnam Park (MLO104464) extends within the study area at a distance of c. 394 m from the northern extent of the Scheme boundary. Hatters Wood in the west of the park, and beyond the study area, has existed since at least 1293. At this time, the manor of Dagenhams and Cockerels are recorded as being held by John of Weald.
- 11.6.23 A medieval hospital at Near Shenfield Road (MEX2254) was located c. 250 m south of the eastern extent of the Scheme, on the corner of Brook Street and Spital Lane. It was first recorded in 1201 and appears to have been a leper hospital and later a free chapel dedicated to St John the Baptist.
- 11.6.24 Medieval settlement is known within the study area to the east, northeast, northwest and southwest of the Scheme. As such there is considered to be medium potential for archaeological remains of medieval date to survive within the Scheme boundary. However, it should be noted that the concentrations of settlement during this period as identified by the HERs lie beyond the Scheme boundary. As such it is likely that any medieval remains which do survive will be located beyond the major settlements and are thus most likely to be related to agricultural or woodland management of the area.

Post-medieval evidence (AD 1500 – AD 1900)

- 11.6.25 The only post-medieval assets recorded within the Scheme boundary on the HERs are ditches encountered during excavations undertaken for the M25-Tank 1741 and Strip Widening (MEX1049359). Five ditches were encountered and the largest was noted to correspond to a large curving north to south boundary shown on the first edition Ordnance Survey (OS) map.
- 11.6.26 Maps predating the Ordnance Survey show the place names of the sites described above, such as Weald or South Weald, Brook Street, Dagenham and Brentwood.

However, the maps are at such a scale that they do not provide much detail in terms of land use for the Scheme itself.

- 11.6.27 The 1881 six inch to the mile OS map was surveyed in 1866. Land within the Scheme boundary is primarily shown as open with a few copses of trees and containing the Roman Road. The Eastern Railway line and a few minor roads are also shown running through the Scheme boundary. In the vicinity of Junction 28 itself, the map records buildings at The Grove (AOC1) to the northwest of the junction, a non-designated 19th Century farmhouse building which is still present within the Scheme boundary (Figure 6). Buildings to the northeast of the associated woodland share a similar footprint to those shown on the modern OS mapping. However, the 1881 OS map indicates buildings to the south of this that are not shown on modern mapping. To the west of Junction 28, five buildings are shown at Putwell Farm (AOC2) on the 1881 OS map where only two are shown on the modern OS map. Most of these appear to underlie the current A12 slip roads but some extended south of the road corridor within the Scheme boundary. No other built features are depicted within the Scheme boundary.
- 11.6.28 Post-medieval assets in the study area include a number of Listed Buildings. These include Tylers Hall Farm House (1079905) and a timber-framed range of outbuildings associated with it (1183938), located to the south-west of the study area, both of which are Grade II Listed and date to the later 18th century. Stony Hills Farm (1297215) is a Grade II mid-17th to 20th century timber framed farmhouse located within the south-eastern extent of the study area.
- 11.6.29 Listed Buildings on or just off of Brook Street, within the eastern leg of the study area, include Nos 17, 19 and 21 Brook Street (1205707), the Bull Inn (12972259), and the Nag's Head Inn (1197190) Numbers 17, 19 and 21 Brook Street were originally constructed as a house but have since been split into three cottages; it dates to the early 16th century. The Bull Inn is a public house which dates to c. 1600.
- 11.6.30 Weald Park (1000747) is partially located within the study area and lies c. 120 m to the east of the northern extent of the Scheme boundary. It originated as a medieval deer park and following the Dissolution, the estate and park passed through several owners. In the late 17th century it came into the ownership of Erasmus Smith. Smith and his successors made several improvements to the hall and grounds and a 1738 plan records a series of formal walled gardens around the hall, a Belvedere tower and an extensive formal park land. In the 1750s the estate was sold to the Towers and they extended the park to the north and deformalized the water and walled gardens. In the mid-20th century Weald Park became a country park. The gardens and pleasure grounds survive to the east of the site of Weald Hall, demolished 1951, as earthworks. The park land is located to the north of the site of the hall.
- 11.6.31 Dagnam Park (MLO104464) also lies partially within the study area. It has origins within the medieval period, developed throughout the post-medieval period and passed to London County Council in the mid-20th century. Also within the study area is Tylers Common (MLO1045644), the last substantial area of common ground in Havering, located to the south of the Scheme boundary.
- 11.6.32 Non-designated buildings of post-medieval date in the study area include buildings shown on maps of 1618 at Greenway Harold Park (MLO15564) and Settle Road (MLO14553) in Romford. Other non-designated assets of post-medieval date

include a findspot comprising three sherds of pottery including a red earthenware flattened rim sherd, a red earthenware rim sherd from a large dish and a red earthenware base sherd. These were all discovered near Front Park during the Epping-Horndon Gas Pipeline Survey (MEX1035531) and are thought to be 17th century in date. A Victorian silt trap (MEX40800) has been recorded at London Road in Brook Street. All other post-medieval assets (MEX1036733; MEX1036735; MEX1036737; MEX1036739; MEX1036759) are areas of woodland recorded by a Report on Essex County Council Woodlands in 1995.

11.6.33 Given the above, is it judged that there may be medium potential for remains of post-medieval date to survive with the Scheme boundary.

Modern evidence (post 1900)

11.6.34 There are no changes shown within the Scheme boundary on the 1920 OS map. The 1946 OS map, survey in 1938, shows unroofed buildings (AOC3) to the west of The Grove (AOC1) and along the northern edge of the A12 (AOC4). Harold Park housing estate to the south of the A12 and beyond the Scheme boundary is also shown under construction. A single roofed building (AOC5) appears to the north of the A12 and Putwell Farm (AOC2). The unroofed buildings are not shown on the 1961 OS map (not illustrated) although the roofed building is shown to have been extended to the east. The 1961 OS map also shows a circular structure added to the farm buildings at Putwell Farm. The 1968 OS plan (not illustrated) indicates that upgrades to the A12 had been undertaken and the roundabout constructed at Brook Street. Several of the buildings at Putwell Farm (AOC2) and the modern buildings on the opposite side of the A12 (AOC5) are not shown and were evidently removed as part of the upgrade. The M25 is first shown on the 1985 OS map (not illustrated).

11.6.35 Modern assets in the study area primarily relate to the sites of Second World War remains and woodlands recorded during the 1995 survey. A boundary post is recorded at Nags Head Lane (MEX105292) opposite the entrance to a sewage works.

11.6.36 Second World War remains include an Alan Williams Turret (destroyed) at Brook House (MEX1035529), a spigot mortar emplacement (destroyed) at Brook Street (MEX1035530) and a road barrier (destroyed) adjacent to the Golden Fleece Inn, Brook Street (MEX1035531). Modern woodlands are located at Island Wood (MEX1036731), Bridge Wood (MEX1036732), Jermaines Wood (MEX1036735) and Pipeline Wood (MEX1036738). Jermaines Wood and Pipeline Wood share a boundary with the Scheme boundary.

11.7 Potential impacts

11.7.1 In accordance with the DMRB methodology, potential impacts on the cultural heritage resource are defined as changes to the historic environment resource caused by the mitigated Scheme. The type of impacts that can occur include:

- Direct physical impacts, such as partial destruction or total loss of a heritage asset;
- Settings impacts which include non-physical changes to the character and significance of assets arising from works such as alteration of lines of sights, removal of screening, air and noise pollution; and

- Indirect impacts, or secondary impacts, is an impact arising from the Scheme via a complex route, where the connection between the Scheme and the impact is complicated, unpredictable or remote.

11.7.2 In accordance with the methodology outlined in Section 11.4, the assessment of impacts upon known assets will involve establishing the value of the affected heritage asset and the sensitivity of the asset to change. The magnitude of impact is then calculated based on those factors, and using the matrix set out in DMRB guidance together with professional judgement, the significance of effect on each heritage asset is determined.

11.7.3 The Environmental Statement will include a full impact analysis of known heritage assets within the Scheme boundary and study area which will allow the significance of effect to be determined. It is anticipated that further detailed design and construction elements will be known at that stage. Assets identified in the EIA Scoping phase have been included below.

11.7.4 For the purpose of this report, impacts have been separated into construction and operation impacts.

Construction

11.7.5 During construction, direct physical impacts are likely to occur as a result of earthmoving operations, creation of site compounds, road formation/construction; and construction of proposed overbridges and other structures. Setting impacts are likely occur due to of the introduction of construction machinery, compounds and vegetation removal with the potential to create new sightlines and views of the M25 Junction 28.

11.7.6 The potential effects of construction activities upon setting would be temporary, short term and reversible, however, direct physical impacts are usually permanent in nature.

11.7.7 The following known heritage assets will be affected by the construction of the Scheme; the assets, their likely significance, impacts and the resultant effect are also listed for each assets which is outlined below in Table 11.4.

Table 11.4: Construction impacts

Site Reference Number	Site Name	Value	Impact	Impacted by/ Nature of impact	Effect
DLO33238	London to Colchester Roman Road (APA)	Medium	Moderate Adverse	Partial truncation due to realignment of slip road.	Moderate Adverse
DLO33196	Alluvial Deposits (Geology) (APZ)	Medium	Moderate Adverse	Truncation/loss of asset due to realignment of slip road.	Moderate Adverse
MLO104464	Post-medieval park at Dagnam	Low	Minor Adverse	Temporary setting impacts during construction of the junction and compound access.	Slight Adverse

Site Reference Number	Site Name	Value	Impact	Impacted by/ Nature of impact	Effect
AOC1	The Grove (group of farm buildings)	Low	Minor Adverse	Temporary setting impacts during construction of the junction and compound access.	Moderate Adverse Effect
AOC3	Unroofed enclosure/building west of The Grove	Negligible	Major Adverse	Truncation/loss of asset due to realignment of slip road.	Slight Adverse Effect
AOC4	Unroofed enclosure/building north of A12	Negligible	Major Adverse	Truncation/loss of asset due to realignment of slip road.	Slight Adverse Effect
1297215	Stony Hills Farm	Medium	Minor Adverse	Temporary setting impacts due to construction of the scheme as there is visibility to the motorway from the asset.	Slight Adverse Effect

11.7.8 There is also potential for undiscovered archaeological remains to be encountered during construction. Whilst further assessment is required to establish the location, extent, condition and significance of any such remains, at present it is not felt that these remains would be demonstrably of equivalent significance to assets of International or National importance, and as such significant effects are not anticipated.

11.7.9 A programme of archaeological evaluation is currently being devised to investigate the potential buried archaeological remains which are likely to be affected by the Scheme.

Operation

11.7.10 During operation, the Scheme will have no further physical effects on buried archaeological remains, as these effects will occur entirely during construction.

11.7.11 Operational effects are long term and permanent and the following impact assessment is given prior to mitigation. It is, however, expected that a programme of mitigation will take place where setting impacts are anticipated. Mitigation could include planting which will mature gradually following construction. Where possible the Scheme will aim to introduce design measures to remove these impacts and/or mitigation measures to help reduce the effects providing enhancements where possible. A re-assessment of impacts will be required for the ES, following the submission of detailed mitigation design measures.

11.7.12 Table 11.5 below lists the known heritage asset that will be impacted by the operation of the Scheme however, further assets may be added to this following the completion of a detailed settings assessment during the production of the ES.

Table 11.5: Operation impacts

Site Reference Number	Site Name	Value	Impact	Impacted by/ Nature of impact	Effect
AOC1	The Grove (group of farm buildings)	Low	Moderate Adverse	Permanent changes to the setting of The Grove due to the operation of junction elements at a decreased distance to the structure. This would result in an increase in noise and visual intrusions.	Slight Adverse

11.8 Potential mitigation measures

11.8.1 The planning policies and guidance as set out in Section 11.3 above, require a mitigation response to potential impacts on the historic environment in order to avoid, minimise or offset such impacts as appropriate.

11.8.2 Recommended potential mitigation measures, which are outlined only and subject to change, are as follows:

- The Scheme shall seek to avoid direct impacts on known heritage assets during enabling and construction works. This can be achieved through careful design, including well designed screening, in order to site works away from heritage assets; and
- A programme of archaeological investigation will be undertaken in areas affected by the Scheme, including construction compounds and access routes, where there is considered to be potential for significant archaeological remains to survive. The scope and extent of such investigations should be developed in consultation with the Archaeological Officers of the Greater London Archaeology Advisory Service and Essex County Council, and subject to a Written Scheme of Investigation for their approval. This work will comprise geophysical survey in the first instance, with an archaeological watching brief on all geotechnical investigations in order to ascertain the palaeoenvironmental potential of the study area; and
- Based on the results of the archaeological investigation Greater London Archaeology Advisory Service and Essex County Council will decide on a mitigation strategy of preservation by record. This could comprise a watching brief or full archaeological evaluation.

11.9 Residual impacts

11.9.1 Residual impacts have been defined as those environmental effects predicted to remain after the application of any necessary mitigation. Significant impacts are those that have an irreversible effect and that cannot be altered once operational. Only broad conclusions on residual impacts can be presented at this stage due to limited information currently available in relation to construction of the Scheme. A detailed impact assessment will be undertaken once this information is available and following all on site surveys and investigations to determine the full scope and

extent of potential impacts on the historic environment. Conclusions at this stage of the assessment are as follows:

- In relation to this Scheme and the construction impacts outlined in Table 11.4, where buried archaeological remains are directly impacted by construction, and has subsequently been excavated and recorded, there is unlikely to be any residual impacts as these remains will have been mitigated through a programme of archaeological fieldwork; and
- Operation of the Scheme is likely to have a lower residual impact on heritage assets or their settings when compared to those set out in Table 11.5. At present one potentially moderate adverse effect has been identified as a result of the Scheme's operation. However, as previously discussed this impact assessment is given as a worst-case scenario prior to mitigation and the detailed mitigation design measures should where possible seek to reduce or remove these impacts. It is anticipated that these moderate adverse effects will be either reduced or possibly even removed following full implementation of mitigation measures.

11.10 Cumulative effects

11.10.1 The cumulative effects are those that result from the additive impacts of both the Scheme's components, and any past, present or future developments within the surrounding landscape. These effects should be considered both during the construction and operation stages.

11.10.2 This assessment of cumulative effects will be undertaken as part of the ES, following a programme of archaeological evaluation of the Scheme, which will be implemented to further understand the impact of the Scheme.

11.10.3 Of those developments identified within the study area, and the surrounding region, the proposed developments detailed in Table 11.5 may add to the Scheme's impacts and will be considered as part of a comprehensive cumulative assessment in the ES, following the completion of archaeological fieldwork.

11.10.4 A preliminary assessment of cumulative effects indicates that, as it is intended to mitigate impacts to below ground heritage assets either through preservation in situ or through a programme of archaeological excavation and recording, it is likely that no cumulative effects will result from the construction of the Scheme in conjunction with the construction of other schemes, on below ground archaeology.

11.10.5 Cumulative effects on the setting of heritage assets, principally The Grove, may result from the operation of the Scheme and surrounding developments (particularly the small, medium and large wind developments and Crossrail), however it is not thought that this effect would be significant in EIA terms.

Table 11.6: Cumulative effects

Proposal	Council area/ Region	Documentation
Crossrail	Brentwood and Havering	Brentwood Replacement Local Plan 2005 Brentwood Draft Local Plan 2016

Proposal	Council area/ Region	Documentation
		Havering Core Strategy and Development Control Policies DPD 2008
Gypsy and Traveller Site at The Caravan Park, Putwell Bridge	Havering	LB Havering (Proposals Map Changes July 2017)
Small, Medium, Large Wind Development Sites	Havering	LB Havering (Proposals Map Changes July 2017)
Cycleway Proposals	Brentwood	Brentwood Borough Council (adopted)
Land at Oak Farm Maylands Fields Romford: change of use of land to burial grounds including removal of existing agricultural buildings and erection of two pavilion buildings for associated usage, hard and soft landscaping, new access to A12 and internal roads and paths, parking, and workshop area for storage of associated equipment, tools and materials.	Havering	Planning application – permitted P1742.14.
032 Housing development Proposal for 150 residential units	Brentwood	Brentwood Draft Local Plan 2016 (expected adoption date 2017) Supporting Document: Site Allocation Maps 2016

11.11 NPS compliance

11.11.1 Paragraphs 5.126 and 5.127 of the National Policy Statement (NPS) state the following:

- 5.1.26 “Where the development is subject to EIA, the applicant should undertake an assessment of any likely significant heritage impacts of the proposed project as part of the EIA and describe these in the ES.”
- 5.1.27 “The applicant should describe the significance of any heritage assets affected, including any contribution made by their setting. The level of detail should be proportionate to the asset’s importance and no more than is sufficient to understand the potential impact of the proposal on their significance. As a minimum, the relevant Historic Environment Record should have been consulted and the heritage assets assessed using appropriate expertise. Where a site on which development is proposed includes or has the potential to include heritage assets with archaeological interest, the applicant should include an appropriate desk-based assessment and, where necessary, field evaluation.”

11.11.2 The information provided in this assessment and in the subsequent ES is considered to provide an opportunity for the Secretary of State to assess impacts in the required manner and will therefore be NPS compliant.

11.12 Summary

- 11.12.1 The assessment has shown that there is potential for adverse effects on non-designated heritage assets within the Scheme boundary and study area. These effects include a total of three potentially significant effects during construction, comprising three moderate effects upon assets within the Scheme boundary. A moderate significant effect is predicted on the Grove Farm buildings during operation. It is therefore recommended that a detailed impact assessment is required as part of the following EIA stages alongside a review and input into the mitigation design proposals to reduce or possibly even remove these significant effects where possible.
- 11.12.2 Further consultations with the local planning authority will be undertaken to further inform the understanding of the heritage assets and the Scheme effects. Once the impact assessment and consultation have been completed, a programme of mitigation can be developed as required.

12. Materials and Waste

12.1 Introduction

- 12.1.1 This chapter outlines the methodology that will be used to identify and assess the likely impacts of material resources use and waste generation associated with Scheme, during construction, demolition and excavation (CD&E) and operation.
- 12.1.2 Material resources are defined, as per IAN 153/11, as “the materials and construction products required for the construction, improvement and maintenance of the trunk road network. Material resources include primary raw materials such as aggregates and minerals, and manufactured construction products. Many material resources will originate off-site, purchased as construction products, and some will arise on-site such as excavated soils or recycled road planning’s”.
- 12.1.3 Waste is defined in line with the Waste Framework Directive (2008/98/EC) as “any substance or object which the holder discards or intends or is required to discard”.
- 12.1.4 There was insufficient design detail available at the time of production of this document to undertake an assessment of the impacts from material resources and waste, and as such this will be undertaken and detailed in the Environmental Statement.

12.2 Study area

- 12.2.1 For material resources and waste, the study area extends outside of the Scheme boundary. The study areas below have been defined using professional judgement and experience from previous road schemes.
- 12.2.2 For material resources, the study area includes the demand for key construction materials within the Eastern England and Greater London regions. As part of the material resources assessment, Mineral Safeguarding Areas (MSAs), within the red line boundary of the Scheme, will be reviewed.
- 12.2.3 For waste, the study area for CD&E arisings and infrastructure capacity is the county of Essex.
- 12.2.4 The study area for hazardous CD&E arisings is the county of Essex with the study area for hazardous CD&E infrastructure capacity being national. This is explained further in section 12.6.

12.3 Planning and policy context

- 12.3.1 Appendix L in Volume 2 summarises the legislation, regulatory and policy framework applicable to materials and waste.

12.4 Methodology

Proposed level and scope of assessment

- 12.4.1 A Detailed Assessment, as defined in IAN 153/11, is considered necessary to assess the impacts of material resources and waste arisings from the Scheme.
- 12.4.2 There is currently insufficient detail at this stage of the Scheme design development to carry out an assessment and the assessment will be undertaken

at the ES stage. The section below describes the process that will be followed to undertake the assessment.

- 12.4.3 During the operational phase of the Scheme, it is envisaged that there will be minimal material use and waste generation. Material resources used would likely be due to planned and unplanned maintenance. Most wastes would likely be non-hazardous municipal type wastes for example; paper, food, packaging, other litter materials and non-hazardous / inert materials waste from planned and unplanned maintenance. There may also be small quantities of hazardous wastes including; bituminous materials containing coal tar, waste electrical and electronic equipment (WEEE), oils, etc. As a result, the operational phase of the Scheme has been scoped out of the assessment.
- 12.4.4 Whilst not mandatory, it is best practice to produce a Site Waste Management Plan (SWMP) and a Construction Environmental Management Plan (CEMP) during each stage of the design. A SWMP is a live document which includes the anticipated types and quantities of waste generated on-site, and the actions undertaken to minimise waste generation. It should be updated throughout a Scheme’s development. A CEMP is an overarching environmental management document. Its purpose is to identify stakeholder requirements, ensure compliance with legislation, and minimise potential adverse environmental impacts during construction via mitigation measures. It is proposed that both a SWMP and a CEMP will be produced, and cross referenced within the ES for the Scheme.
- 12.4.5 Table 12.1 summarises aspects that are scoped in and out of the assessment for material resources and waste and which will be detailed in the ES.

Table 12.1: Material resources and waste topics scoped in and out of further assessment

Effects	Scoped In/ Out	Comment/ Justification
Change in demand for key construction materials during the CD&E phases.	✓	Assessment required to identify and evaluate the impacts of the Scheme against the national demand for key construction materials during the CD&E phases.
Change in demand for key construction materials during the operational phase.	✗	Minimal impact is envisaged during the operational stage of the Scheme due to minimal material resource use (associated with planned/ unplanned maintenance). Data related to operational material resource use by highway schemes is not readily available and as such will not be assessed.
Change in baseline waste arisings during the CD&E phases.	✓	Assessment required to identify and evaluate the impacts of waste arisings from the Scheme against the waste arisings baseline during the CD&E phases.
Change in baseline waste arisings during the operational phase.	✗	Minimal impact is envisaged during the operational phase of the Scheme due to minimal waste generation. Data related to waste generated by highway schemes is not readily available and as such will not be assessed.
Change in capacity of waste infrastructure during the CD&E phase.	✓	Assessment required to identify and evaluate the impacts of waste arisings from the Scheme against the regional waste infrastructure baseline during the CD&E phases.
Change in capacity of regional waste	✗	Operational waste arisings from the Scheme will not be assessed as it is envisaged that this will be minimal and

Effects	Scoped In/ Out	Comment/ Justification
infrastructure during the operational phase.		no data related to waste generated by highway schemes is readily available. Therefore, an assessment will not be made of the potential effect of the operational waste arisings on operational waste infrastructure.

Table Source: Atkins

12.4.6 The general methodology and criteria described below will be applied to determine the significance of the effects associated with material resources and wastes during the CD&E phases of the Scheme.

12.4.7 The following tasks are proposed:

- Ongoing review of relevant waste legislation, national, regional and local planning policies and guidance;
- Review the proposed construction materials, their quantities, and estimate the quantities and types of wastes to be generated during the CD&E phases. Given the nature of the Scheme, operational wastes will be limited and as such will not be assessed;
- Review the proposed route and evaluate the impacts on any MSAs within the redline boundary;
- Identify and evaluate the impacts of the Scheme against the regional demand for key construction materials, the regional CD&E waste arisings and infrastructure capacity and the regional hazardous CD&E waste arisings and national hazardous CD&E infrastructure capacity; and
- Identify opportunities to reduce, re-use, recover and/ or recycle materials and wastes through a review of the Scheme (including proposed building materials and construction methods and design, where available) and in accordance with industry best practice.

12.4.8 The assessment will be undertaken in accordance with IAN 153/11 which provides guidance on the identification and assessment of impacts associated with the use of material resources and waste arisings for construction and improvement schemes.

12.4.9 There are several assumptions applicable to the proposed assessment methodology which are outlined below, including:

- Should a detailed construction programme not be available, it will be assumed that material resource use and waste generation will be spread equally across the construction period;
- Any new/ unused equipment will be fed back into the supply chain for use on alternative Schemes and as such will be excluded;
- All material quantities will be converted into tonnes using industry standard conversion rates;
- All material resources will be grouped according to main material types, as shown in Table 12and
- The main limitation is the availability of data within the timeframes of the ES submission i.e. the availability of Bill of Quantities (or equivalent).

12.4.10 The results of the assessment will be tabulated and presented in the ES. The tables will show:

- The total estimated material resource use and the estimated material resource use per annum; and
- The total estimated waste arisings per annum.

12.4.11 Additional detail will be provided in the SWMP which will be prepared and cross referenced in the ES, and will contain a more detailed breakdown of waste types.

12.4.12 Table 12.2 below summarises how magnitude and sensitivity effects have been defined with regards to material resources, waste arisings and infrastructure capacity. Sensitivity of key construction materials (i.e. generating capacity) cannot be assessed due to a lack of publicly available data. Due to anticipated minimal impact, operational material resource use and waste generated will not be assessed.

Table 12.2: Criteria for classifying the magnitude of environmental effects

Level	Sensitivity Criteria	Magnitude Criteria
Very High	<p>The Scheme meets one or more of the following criteria:</p> <ul style="list-style-type: none"> • One or more MSA within the red line boundary of the Scheme has been sterilised rendering it inaccessible for future use; • Very high volumes of waste generated such that it may have a high impact on estimated CD&E waste infrastructure (greater than or equal to 15% of the non-hazardous infrastructure baseline); and <p>Very high volumes of hazardous waste generated such that it may have a high impact on estimated hazardous waste infrastructure (greater than or equal to 1.5% of the hazardous infrastructure baseline).</p>	<p>The Scheme meets one or more of the following criteria:</p> <ul style="list-style-type: none"> • High volumes of key construction materials required such that it has a high impact on current market demand, greater than or equal to 15% of the material baseline (for any one material); • Generation of very large volumes of CD&E waste, greater than or equal to 15% of the non-hazardous arisings baseline; and <p>Generation of very large volumes of hazardous waste, greater than or equal to 1.5% of the hazardous arisings baseline.</p>
High	<p>The Scheme meets one or more of the following criteria:</p> <ul style="list-style-type: none"> • One or more MSA within the red line boundary of the Scheme has been sterilised rendering it inaccessible for future use; • High volumes of waste generated such that it may have a high impact on estimated CD&E waste infrastructure (greater than or equal to 10% but less than 15% of the non-hazardous infrastructure baseline); and • High volumes of hazardous waste generated such that it may have a high impact on estimated hazardous waste infrastructure 	<p>The Scheme meets one or more of the following criteria:</p> <ul style="list-style-type: none"> • Significant volumes of key construction materials required such that it has a high impact on current market demand, greater than or equal to 10% but less than 15% of the material baseline (for any one material); • Generation of large volumes of CD&E waste, greater than 10% but less than 15% of the non-hazardous arisings baseline; and • Generation of large volumes of hazardous waste, greater than 1% but less than 1.5% of the hazardous arisings baseline.

Level	Sensitivity Criteria	Magnitude Criteria
	(greater than or equal to 1% but less than 1.5% of the hazardous infrastructure baseline).	
Medium	<p>The Scheme meets one or more of the following criteria:</p> <ul style="list-style-type: none"> • One or more MSA within the red line boundary of the Scheme has been impacted by the Scheme; • Moderate volumes of waste generated such that it may have a moderate impact on estimated CD&E waste infrastructure (greater than or equal to 5% but less than 10% of the non-hazardous infrastructure baseline); and • Moderate volumes of hazardous waste generated such that it may have a moderate impact on estimated hazardous waste infrastructure (greater than or equal to 1% but less than 1.5% of the hazardous infrastructure baseline). 	<p>The Scheme meets one or more of the following criteria:</p> <ul style="list-style-type: none"> • Moderate volumes of key construction materials required such that it has a moderate impact on current market demand, greater than or equal to 10% but less than 15% of the material baseline (for any one material); • Generation of medium volumes of CD&E waste, greater than 5% but less than 10% of the non-hazardous arising baseline; and • Generation of moderate volumes of hazardous waste, greater than 0.5% but less than 1% of the hazardous arisings baseline.
Low	<p>The Scheme meets one or more of the following criteria:</p> <ul style="list-style-type: none"> • No MSAs are affected by the scheme • Low volumes of waste generated such that it may have a low impact on estimated CD&E waste infrastructure (greater than or equal to 1% but less than 5% of the non-hazardous infrastructure baseline); and • Low volumes of hazardous waste generated such that it may have a low impact on estimated hazardous waste infrastructure (greater than or equal to 0.1% but less than 0.5% of the national hazardous baseline). 	<p>The Scheme meets one or more of the following criteria:</p> <ul style="list-style-type: none"> • Low amounts of key construction materials required such that it has a low impact on current market demand, greater than or equal to 1% but less than 5% of the material baseline (for any one material); • Generation of low volumes of CD&E waste, greater than or equal to 1% but less than 5% of the non-hazardous arisings baseline; and • Generation of low volumes of hazardous waste, greater than or equal to 0.1% but less than 0.5% of the hazardous arisings baseline.
Negligible	<p>The Scheme meets one or more of the following criteria:</p> <ul style="list-style-type: none"> • No MSAs are affected by the Scheme; • Negligible volumes of waste generated such that it may have a negligible impact on estimated CD&E (less than 1% of the non-hazardous infrastructure baseline); and • Negligible volumes of hazardous waste generated such that it may have a negligible impact on 	<p>The Scheme meets one or more of the following criteria:</p> <ul style="list-style-type: none"> • Negligible amounts of key construction materials required such that it has a negligible impact on current market demand, less than 1% of the material baseline (for any one material); • Generation of negligible volumes of CD&E waste, less than 1% of the non-hazardous arisings baseline; and

Level	Sensitivity Criteria	Magnitude Criteria
	estimated hazardous waste infrastructure (less than 0.1% of the hazardous infrastructure baseline).	<ul style="list-style-type: none"> Generation of negligible volumes of hazardous waste, less than 0.1% of the hazardous arisings baseline.

Table Source: Atkins

12.4.13 The assessment of significance combines the magnitude and sensitivity of the environmental effects to determine whether the effects are major, moderate, minor, negligible or no change, as shown in Tables 4.1 and 4.2 in Chapter 4. Very large to moderate effects are considered to have the potential to be significant, while slight and neutral effects are not considered to be significant.

12.4.14 The results of the significance assessment will be tabulated and presented in the ES. The tables will show:

- The estimated percentage change in material resource use against the baseline;
- The in the number of impacted / sterilised MSAs;
- The estimated percentage change in waste arisings against the waste arisings baseline;
- The estimated percentage change in waste arisings against the waste infrastructure capacity baseline; and
- The potential significant material resource and waste effects (i.e. sensitivity, magnitude and overall significance).

12.5 Consultation

12.5.1 Essex County Council, as the applicable author/ owner of the Essex County Council and Southend-on-Sea Borough Council Waste Local Plan (2017) will be consulted on the proposed assessment methodology.

12.5.2 East London Waste Authority will also be consulted on the proposed assessment methodology. The Authority is responsible for the management of waste in East London, including Havering.

12.6 Baseline conditions

12.6.1 Desk based information has been gathered identify the existing baselines that may be impacted material resources and the generation of waste from the Scheme.

12.6.2 The baseline for material resources and waste are presented below.

Material resources baseline

12.6.3 The Scheme is situated on the borders of the Greater London and East of England regions. The two regions have been selected to produce the baseline in line with the proximity principle.

12.6.4 The regional baseline data for material assets has been sourced from the Mineral Products Association Profile of the UK Mineral Products Industry 2018 report.

12.6.5 The material resources data detailed in [Table 12.3](#) are based on the main construction materials as identified from previous road improvement schemes. Note, that the number, type and size of construction developments vary from year to year and the demands for construction materials may also fluctuate. The data should therefore be considered representative.

Table 12.3: Regional material resources baseline

Construction Material	Regional Baseline
	Tonnes per Annum (tpa)
Aggregates	18,300,000*
Concrete	12,050,000**
Asphalt	5,100,000
* Combined figure including; crushed rock, sand and gravel.	
**Converted from m3 using a 1m3 to 2.41 tonnes, source: https://www.traditionaloven.com/building/masonry/concrete/convert-cubic-metre-m3-concrete-to-tonne-metric-t-concrete.html .	

Data Source: Mineral Products Association Profile of the UK Mineral Products Industry 2018

Mineral Safeguarding Areas baseline

- 12.6.6 The redline boundary of the Scheme falls within the county of Essex and the London Borough of Havering (within Greater London).
- 12.6.7 The Essex Minerals Local Plan (adopted 2014), shows that there are no MSAs that would be impacted by the Scheme.
- 12.6.8 The London Borough of Havering Local Aggregate Assessment (2014), shows that there are no MSAs that would be impacted by the Scheme.

Waste arisings baseline

- 12.6.9 The CD&E waste generated by the Scheme, will be primarily non-hazardous and inert, with small quantities of hazardous waste (e.g. associated with sealants, paints, solvents and contaminated soil).
- 12.6.10 The baseline for non-hazardous CD&E waste arisings has been calculated using the Environment Agency Waste Integrator Tool 2016 (filtered by CD&E waste for Essex) and Essex County Council & Southend-on-Sea Waste Local Plan (2017), as shown in [Table 12.5](#).
- 12.6.11 It is acknowledged that both Greater London and Thurrock are situated within the vicinity of the Scheme, however only waste infrastructure within Essex has been considered, given there is typically a net importation of waste into Essex from Greater London and smaller waste authorities that border Greater London.
- 12.6.12 The non-hazardous baseline figure has been calculated using the total CD&E waste arisings in Essex in 2016 in accordance with the Waste Data Interrogator in addition to the following:
- It has been assumed that the capacity for CD&E waste stated in the Essex and Southend-on-Sea Waste Local Plan will grow linearly up to the end of the plan in 2032;

- The Waste Local Plan is based on net self-sufficiency; therefore, it is assumed by the end of the plan period arisings will equate projected capacity; and
- As a result, the mean annual growth in capacity has been added to the 2016 WDI figure for 5 years from 2016 to 2021 (the construction phase start date) to produce an estimated arisings figure for 2021.

12.6.13 The baseline for hazardous CD&E arisings has been calculated using the hazardous CD&E arisings of Essex in 2016. The data is taken from the Environment Agency Hazardous Waste Integrator Tool (2016) filtered by hazardous construction waste.

12.6.14 The total CD&E waste arisings for Essex will fluctuate year on year based on the number, type and size of construction schemes underway. This in turn is heavily influenced by factors such as the economic situation, investment levels and legislative and policy variations. This data should therefore be considered representative.

Table 12.4: Waste arising baseline

Waste Stream	Tonnes per Annum (tpa)	Baseline year
Non-Hazardous CD&E (regional)	6,446,361*	2021
Hazardous CD&E (regional)	35,618	2016

Table Source: Environment Agency Waste Integrator Tool 2016, Essex County Council & Southend-on-Sea Waste Local Plan (2017) and Environment Agency Hazardous Waste Integrator Tool 2016

Waste infrastructure baseline

12.6.15 The regional non-hazardous CD&E waste infrastructure capacity, has been calculated using the Environment Agency Waste Data Interrogator 2016 and Essex County Council & Southend-on-Sea Waste Local Plan (2017) as shown in [Table 12.6](#).

12.6.16 The non-hazardous baseline has been calculated using the total CD&E waste received in Essex in 2016 as per the Waste Data Interrogator plus the following calculation:

- It has been assumed that the capacity for CD&E waste stated in the Essex and Southend-on-Sea Waste Local Plan will grow linearly up to the plans end in 2032; and
- Therefore, the mean annual growth in capacity has been added to the 2016 WDI figure for 5 years from 2016 to 2021 (the construction phase start date) to produce an estimated infrastructure capacity figure for 2021.

12.6.17 Hazardous waste treatment is specialised, therefore a proportion of any hazardous CD&E generated by the Scheme is likely to be treated outside Essex. Within the Essex and Southend-on-Sea Waste Local Plan 2017, it is stated that ‘Hazardous waste is not subject to net self-sufficiency within this Plan due to the specialist nature of the facility type and the relatively small quantities generated within the Plan area.’

12.6.18 As result of the above, the baseline for hazardous CD&E infrastructure capacity is the hazardous CD&E received by England 2016. The data is taken from the Environment Agency Hazardous Waste Integrator Tool (2016) filtered by hazardous construction waste.

Table 12.5: Waste infrastructure baseline

Waste Stream	Tonnes per Annum (tpa)	Baseline year
Non-Hazardous CD&E (regional)	8,363,799*	2021
Hazardous (national)	894,863	2016

Table Source: Environment Agency Waste Integrator Tool 2016, Essex County Council & Southend-on-Sea Waste Local Plan (2017) and Environment Agency Hazardous Waste Integrator Tool 2016

12.7 Potential impacts

12.7.1 Receptors which have the potential to be impacted by material resources use and waste generation, are defined as:

- The market for key construction materials, which are to be used throughout the Scheme;
- MSAs as defined by the Essex Minerals Local Plan 2014;
- The waste arisings baseline - the amount of waste that is predicted to be produced during the CD&E phases of the Scheme and
- The predicted capacity of waste infrastructure both regionally (non-hazardous and inert) and nationally (hazardous).

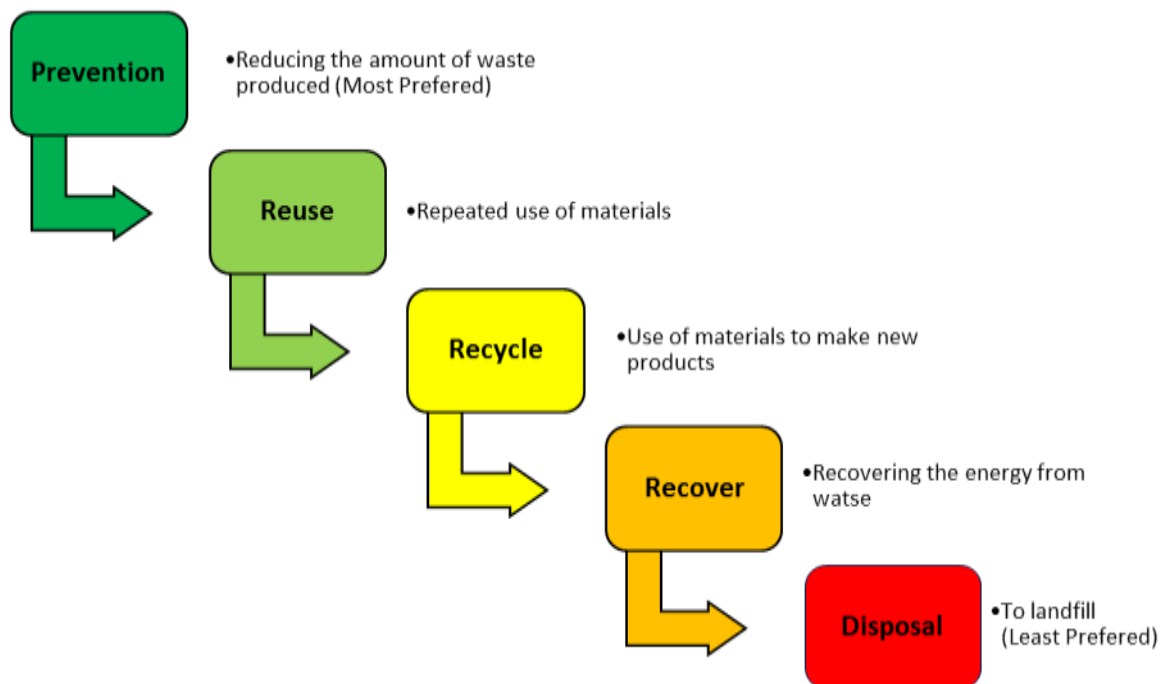
12.7.2 During the operational phase of the Scheme, it is envisaged that there will be minimal material resource use and waste generation. Material resources used would likely be due to planned and unplanned maintenance. Most wastes would likely be non-hazardous municipal type wastes for example; paper, food, packaging, other litter materials and non-hazardous/inert materials waste from planned and unplanned maintenance. There would also be very small quantities of hazardous wastes including; bituminous materials, waste electrical and electronic equipment (WEEE), oils, etc. As a result, the operational phase of the Scheme has been scoped out of the assessment.

12.8 Potential mitigation measures

12.8.1 Throughout the design process and following the assessment of significance, mitigation measures associated with material resources use and waste generation will be identified.

12.8.2 The Scheme will aim to prioritise waste prevention, followed by preparing for re-use, recycling and recovery and lastly disposal to landfill as per the internationally recognised waste hierarchy shown in [Figure 12.1: Waste Hierarchy](#)

Figure 12.1: Waste Hierarchy



- 12.8.3 Although every effort will be made (through the design process) to maximise resource efficiency, it is inevitable that waste will be generated during each construction phase of the Scheme. This will have an impact on the regional waste infrastructure and regional waste arisings.
- 12.8.4 The design of the Scheme will ensure that wastage is minimised throughout its lifecycle. During the design stage, the potential effects should be addressed using the following mitigation measures which will then follow through to the construction phase:
- Management of waste within the context of the waste hierarchy;
 - Management of waste in accordance with local and national policy and legislation and, where applicable, guidance documents;
 - Safe management of the waste generated, as determined by its physical and chemical characteristics (e.g. bulky or hazardous wastes);
 - Use of material resources and the management of waste in accordance with the Proximity Principle, which promotes the procurement of materials and management of wastes locally; and
 - Management of waste to ensure a minimum of 70% of construction and demolition waste is recovered from the scheme in line with the Waste Management Plan for England 2013.
- 12.8.5 The overall aim of the process of identifying mitigation measures is to achieve a high reuse, recycling and recovery rate throughout all phases of the Scheme.
- 12.8.6 Implementing mitigation measures will achieve:
- Reduced impacts to the environment and human health;
 - Reduced energy and carbon impacts;
 - Increase the overall sustainability of the Scheme; and

- Reduce costs associated with waste storage, collection and disposal.

12.8.7 Further detail relating to mitigation measures will be provided as part of the ES.

12.9 Residual impacts

12.9.1 The residual impact cannot be calculated at present as the data required (material resources use and waste arisings) is not available. Therefore, the potential impacts, as outlined in the sections above, should be considered representative of the residual impacts of the Scheme at this stage.

12.10 Cumulative effects

12.10.1 A review of relevant planning applications will be carried out as part of the ES to assess the cumulative impacts of other proposals which may affect material resources and identified waste receptors.

12.11 NPS compliance

12.11.1 The NN NPS outlines the importance of managing resources and wastes to prevent and minimise environmental impacts (paragraphs 5.39 to 5.66). Mitigation measures should be adopted and considered throughout all stages of the Scheme. Mitigation measures are inclusive of but not limited to, the implementation of the waste hierarchy, the correct management of waste both on-site and off-site and identifying the appropriate waste infrastructure for waste treatment and disposal.

12.12 Summary

12.12.1 Table 12.6 below outlines the potential impacts likely to occur because of the Scheme for material resources and waste during the construction and operational phases. A lower impact is envisaged during the operational stage of the Scheme compared to the construction phase, due to minimal material resources use (associated with planned/ unplanned maintenance) and waste generation (through littering and planned/ unplanned maintenance) and through the EIA scoping process, have been scoped out of further assessments.

Table 12.6: Potential impacts

Effects	Construction	Operation	Comments
Waste	✓	✗	Design to ensure wastage is minimised throughout lifecycle. Waste to be used as a resource where practicable and designed out where possible.
Material resources	✓	✗	Assessment to identify and evaluate the impacts of the Scheme against national demand for key construction materials and raw material resources. In addition, assess the impact of the Scheme on MSAs.

Table Source: Atkins

13. People and Communities

13.1 Introduction

13.1.1 An assessment of 'People and Communities' has been undertaken in accordance with the guidance set out in IAN 125/15 (DfT, 2015) and combining the topics included within both DMRB Vol 11, Section 3, Parts 6 (Land Use), 8 (Pedestrians, Cyclists, Equestrians and Community Effects) and 9 (Vehicle Travellers). The chapter assesses the potential effects of the Scheme's construction and operation on local community receptors, comprising:

- Private dwellings;
- Community assets;
- Local businesses;
- Development land;
- Non-motorised users (NMU) - pedestrians, cyclists and equestrians;
- Vehicle travellers (VT) - drivers and passengers of both public and private vehicles; and
- Human health.

13.2 Study area

13.2.1 In the absence of prescriptive guidance the study area has been defined as areas within the Scheme's red line boundary plus a 500 m buffer extending beyond this boundary. Using professional judgement and knowledge of the Scheme, this threshold is considered likely to capture all relevant effects resulting from the Scheme. However, the extent of this study area may be revised during the assessment process subject to its findings and the findings of other environmental assessment topics which may inform the People and Communities assessment, such as landscape and visual impact, transport, noise and vibration and air quality.

13.3 Planning and policy context

13.3.1 Appendix M in Volume 2 summarises the legislation, regulatory and policy framework applicable to people and communities.

13.3.2 In addition, future changes in land use, for which planning permission has been granted may also be relevant to the assessment of a scheme. For example, where a proposed scheme would run close to an area reserved for housing development it should be recognised that more residences would be affected by noise, visual intrusion, etc. than the current assessment suggests. Alternatively, planned development could reduce the landscape quality of an area, for example.

13.4 Methodology

13.4.1 The assessment uses published guidance provided in DMRB Volume 11 Section 3 to consider the impacts of the Scheme on people and communities. There is no relevant guidance with regards to simple and detailed assessments for people and

communities and the assessments will be undertaken in line with the methodology in the DMRB and additional guidance identified below.

13.4.2 The assessment includes a range of potential impacts. The method of assessment for these potential impacts varies according to the nature of each impact and receptor type. Assessment criteria is presented below for the assessment of the following receptors:

- Private dwellings;
- Community assets;
- Local businesses;
- Development land;
- Non-motorised users (NMU); and
- Vehicle travellers (VT); and
- Human health

13.4.3 In each case, the proposed methodology makes use of guidance provided in DMRB Volume 11 where applicable. The value of each of the potential receptors varies according to the nature of the receptor. Value shall be considered on a case by case basis as part of the impact assessment process. Factors contributing to perceived value include issues such as level of use and available alternatives.

Private dwellings: Land take and severance

13.4.4 Dwellings are identified through a desk-based study of properties in the study area. The baseline will be confirmed by a site visit to be undertaken at ES stage. Guidance for assessing impacts from the demolition of private property and associated land-take is provided in DMRB Section 3, Part 6 (Land Use), however this does not include sufficient detail upon which to base assessment criteria beyond approximate number of units that may be lost. All dwellings, including their access and curtilage, are considered to be receptors of high sensitivity. Loss of access to a dwelling without the provision of an alternative access is considered equivalent to demolition; re-provision of access via a longer or otherwise poorer route is considered equivalent to large loss of curtilage; re-provision of access along a broadly equivalent route is considered equivalent to small loss of curtilage. Demolition, loss of land, and alterations to access are considered Land Take effects. Impact is assessed according to the criteria set out in Table 13.1.

Table 13.1: Impact to private dwellings assessment criteria

Impact Description	Magnitude	Significance
Loss of land, access or substantially poorer replacement access to 5+ dwellings.	Major (adverse)	Large (adverse): Significant at a community level
Loss of land, access or substantially poorer replacement access to 1-4 dwellings; small loss of curtilage for 5+ dwellings or large loss of curtilage for 1-4 dwellings.	Moderate (adverse)	Moderate (adverse): Locally significant
Re-provided but less advantageous access for 1-4 dwellings or small loss of curtilage for 1-4 dwellings.	Minor (adverse)	Slight (adverse): Not significant

Impact Description	Magnitude	Significance
Negligible loss of curtilage or broadly comparable re-provided access for 1-4 dwellings.	Negligible (adverse)	Neutral adverse: Not significant

Table Source: Atkins 2018, adapted using professional judgement from DMRB Vol 11 Section 3 Part 6 and DMRB Volume 11 Section 2 Part 5)

Private dwellings: Amenity

13.4.5 Construction of the Scheme has the potential to adversely affect amenity for residents of properties near the Scheme. Amenity effects will be assessed elsewhere in the ES; however, where a property or properties are likely to receive a combination of two or more significant traffic or amenity effects, the People and Communities chapter will consider the likely impact of these effects on residents and the local community. Impact is assessed according to the criteria set out in Table 13.2.

Table 13.2: In-combination amenity affect impact assessment criteria

Impact Description	Magnitude	Significance
Adverse or beneficial alteration in amenity (including two or more significant amenity effects) for 5+ dwellings.	Major (adverse or beneficial)	Large (adverse or beneficial): Locally significant
Adverse or beneficial alteration in amenity (including two or more significant amenity effects) for 1-4 dwellings.	Minor (adverse or beneficial)	Slight (adverse or beneficial): Not significant

Table Source: Adapted from DMRB guidance

Community assets: Land take and severance

13.4.6 Advice on assessing impacts from the loss of land used by members of the public is included in Section 3 (Environmental Assessment Techniques), Part 6 (Land Use). DMRB guidance requires assessment of the impact of loss of land used by the community. It requires the undertaking of sufficient assessment to identify the location, status and importance of land used by the public. In order to assess this, guidance requires assessors to obtain information about the number of users. It is suggested that in many cases it will be necessary to visit the Scheme site and, depending on its importance, either make an estimate of usage or undertake a formal count. The site visit should take place on one or more 'typical' days (for example, a weekday during the school term or at the weekend). The assessment in this chapter is undertaken based on a desk-based study; a site visit may be required at ES stage.

13.4.7 The sensitivity or value of land used by the community is classified as either High, Medium, Low or Negligible. The value is determined by professional judgement and the criteria for assessing receptor value is set out in Table 13.3.

Table 13.3: Criteria for assessing receptor sensitivity / value

Sensitivity / Value	Criteria
High	Community facility or recreational asset that provides a valuable service to the community, a community group, or individual or is otherwise considered to be of high value to the community.

Sensitivity / Value	Criteria
	Frequent or continuous use of a resource, no suitable equivalent alternative resources used by the receptor are reasonably available.
Medium	Community facility or recreational asset which is one of several facilities providing the same of similar service to the community, community group, or individual, or is otherwise considered to be of medium value to the community. Moderate or occasional use of a resource, limited equivalent alternative resources used by the receptor are reasonably available.
Low	Community facility or recreational asset which is one of many providing the same of similar service to the community, community group, or individual, or is otherwise considered to be of low value to the community. Low or infrequent use of a resource, suitable alternative resources are readily available.
Negligible	Community facility or recreational asset which does not provide an essential service to the community, community group, or individual, or is otherwise considered to be of negligible value to the community. Very infrequent use of resource, multiple equivalent or better alternatives are freely and easily available.

Table Source: Atkins own methodology 2018

13.4.8 The magnitude of impact will be assessed based upon professional judgement, taking into account any agreed mitigation. The criteria used to determine the magnitude of any change in baseline conditions is presented in Table 13.4 below. The magnitude of change is primarily derived from the following:

- Geographical scale of impact;
- Duration of impact; and
- Whether the impact is reversible or irreversible.

13.4.9 Professional judgement will be used to assign the correct level of impact.

Table 13.4: Criteria for assessing magnitude of impact

Magnitude	Criteria
Major	A substantial part of the receptor will be lost. Loss is long term or irreversible.
Moderate	A substantial part of the receptor will be lost. Loss is short term. Or Some of the receptor will be lost. Loss is long term or irreversible.
Minor	A small part of the receptor will be lost. Loss is long term. Or A very small part of the receptor will be lost. Loss is irreversible.
Negligible	A small part of the receptor will be lost. Loss is short term. Or

Magnitude	Criteria
	A very small part of the receptor will be lost. Loss is long term but reversible.

Table Source: Atkins own methodology 2018

13.4.10 The relationship between the sensitivity of the receptor and the magnitude of impact of the Scheme determines the significance of the impact as illustrated in Table 13.5. Effects are either adverse or beneficial. Very large, large and moderate impacts are considered significant, whilst slight or neutral impacts are not significant.

Table 13.5: Significance of impact assessment criteria

Sensitivity of receptor	Magnitude of impact				
	Major	Moderate	Minor	Negligible	No change
Very high	Very large	Large or very large	Moderate or large	Slight	Neutral
High	Large or very large	Moderate of large	Slight or moderate	Slight	Neutral
Medium	Moderate or large	Moderate	Slight	Neutral or slight	Neutral
Low	Slight or moderate	Slight	Neutral or slight	Neutral or slight	Neutral
Negligible	Slight	Neutral or slight	Neutral or slight	Neutral	Neutral

Table Source: DMRB Volume 11, Section 2, Part 5, HA 205/08

Community assets: Amenity

- 13.4.11 The scheme may result in changes in amenity experienced at community facilities or land used by the community. Amenity and traffic effects (including air quality, noise, vibration, and visual impact caused either directly by the Scheme itself or by changes in traffic flows brought about by the Scheme) will be considered individually in detail elsewhere in the ES. The People and Communities chapter considers instances where users of a community facility or land used by the community may experience a combination of such effects, leading to a cumulative reduction in amenity.
- 13.4.12 This chapter provides a qualitative assessment of the potential impact of the Scheme on the amenity of community facilities and land used by the community during construction and operation. This assessment draws upon the conclusions of the traffic, air quality, noise, vibration and visual impact assessments.
- 13.4.13 The method for the assessment of magnitude is based on a bespoke set of assessment criteria, which have been developed using professional judgement to assign a level of significance to effects arising from the impacts, based on the criteria set out in Table 13.6.

Table 13.6: Community facilities assessment criteria

Impact Description	Magnitude
Substantial and permanent changes in environmental amenity for a large number of people.	Major (adverse or beneficial)
A substantial change to a modest number of people's environmental amenity or a moderate change in many people's environmental amenity. Impacts can be temporary or permanent but do not significantly affect the overall functioning of the land use in the longer term.	Moderate (adverse or beneficial)
A detectable but non-material change to environmental amenity for a small or large number of people. Changes might be noticeable, but the beneficial or adverse impacts fall within the range of normal variation.	Minor (adverse or beneficial)
Changes that are unlikely to be noticeable (i.e. well within the scope of natural variation).	Negligible (adverse or beneficial)

Table Source: Adapted from DMRB guidance

13.4.14 The relationship between the sensitivity of the receptor and the magnitude of impact of the Scheme determines the significance of the impact as illustrated in Table 13.5. Effects are either adverse or beneficial. Very large, large and moderate impacts are considered significant, whilst slight or neutral impacts are not significant.

Local businesses

13.4.15 The Scheme has potential to affect existing local businesses. Possible impacts include isolation or disruption to access and changes in local amenity, which may diminish trading conditions. In order to assess possible effects on local businesses, a schedule of properties that could reasonably be affected by the Scheme has been compiled based upon desktop research.

13.4.16 Having identified potential receptors, likely impact is assessed according to a qualitative approach, evaluating the Scheme's potential impact (and the duration of any impact), during both construction and operation, on each receptor. The assessment will consider the likely effects arising from each impact, the magnitude of any identified effect, and the sensitivity of a receptor to each impact.

13.4.17 The relative sensitivity of local business receptors to potential impacts such as demolition, land take, and disruption to access is assessed in line with the definitions provided in Table 13.7 below.

Table 13.7: Sensitivity of local businesses

Receptor sensitivity	Definition
High	Business viability likely to be permanently jeopardised by a short disruption to access or worsening of trading conditions.
Medium	Business profitability may be harmed by a short or medium term disruption to access or worsening of trading conditions.
Low	Business could continue to operate without substantial injury if affected by a disruption to access or worsening of trading conditions.

Table Source: Atkins own methodology 2018

13.4.18 Magnitude of impacts on local businesses is classified as High, Medium, Low, or Negligible, in line with the definitions provided in Table 13.8 below.

Table 13.8: Magnitude of impact on local businesses

Impact magnitude	Definition
Major	The Scheme would have a very adverse/beneficial effect on the function or operation of the business for a prolonged period of time.
Moderate	The Scheme would have a very adverse/beneficial temporary effect on the function or operation of the business for a short period of time (e.g. <3 months during peak construction period); or The Scheme would have a modest adverse/beneficial effect on the function or operation of the business for a prolonged period of time.
Minor	The Scheme would have a modest adverse/beneficial temporary effect on the function or operation of the business for a short period of time (e.g. <3 months during peak construction period); or The Scheme would have a slight adverse/beneficial effect on the function or operation of the business for a prolonged period of time.
Negligible	The Scheme would have little or no adverse/beneficial effect on the function or operation of the business.

Table Source: Atkins own methodology 2018

13.4.19 Significance is the product of the sensitivity of receptors and magnitude of impact and is determined according to Table 13.5 above.

Development land

13.4.20 Assessment of the effects of the Scheme on development land is based upon guidance set out in DMRB, Volume 11, Section 3, Part 6, Chapter 5: Effects on Development Land. This guidance suggests that the environmental assessment should take account of, as far as is practicable, future changes in land use due to new development which would be likely to occur in the absence of a scheme. This should be done by considering the impact of a scheme's land-take on any sites covered by local planning authorities' land use planning designations.

13.4.21 In order to assess potential effects of the scheme on development land, a desk based review of local planning policy and associated mapping and a search of planning consents has been undertaken in order to identify potential 'receptors'. The impact of the Scheme is then assessed using a descriptive approach that considers potential 'land-take' from allocated or consented sites and the effect the Scheme may have on allocated or consented sites nearby. This assessment considers the extent to which the Scheme would support, depart from, or hinder planning policy aims. The significance of impact on development land is assessed according to Table 13.9 below.

Table 13.9: Development land impact assessment criteria

Assessment Score	Contribution to Achievement of Policy Objectives
Significant Beneficial	The scheme substantially contributes to the achievement of or is consistent with the intended use of identified development land.
Beneficial	The scheme partially contributes to the achievement of or is consistent with the intended use of identified development land.

Assessment Score	Contribution to Achievement of Policy Objectives
Neutral	The scheme does not affect the intended use of identified development land or equally benefits and hinders achievement of the intended use.
Adverse	The scheme partially hinders or is inconsistent with the intended use of identified development land.
Significant Adverse	The scheme substantially hinders or is inconsistent with the intended use of identified development land.

Table Source: Atkins own methodology 2018, adapted using professional judgement from DMRB Vol 11 Section 3 Part 5

Non-motorised Users (NMU): Journey length & local travel patterns

13.4.22 Existing and proposed routes and Public Rights of Way (PRoW) used by NMUs that may be affected by the Scheme have been identified through a desk based assessment and are supported by the findings of user surveys undertaken in 2014, to determine the sensitivity according to the criteria in Table 13.10.

Table 13.10: Sensitivity of NMU receptors

Sensitivity value	Criteria
High	Frequent or continuous use of a resource, no suitable equivalent alternative resources used by the receptor are reasonably available.
Medium	Moderate or occasional use of a resource, limited equivalent alternative resources used by the receptor are reasonably available.
Low	Low or infrequent use of a resource, suitable alternative are readily available.
Negligible	Very infrequent use of resource, multiple equivalent or better alternatives are freely and easily available.

Table Source: Adapted from DMRB guidance

13.4.23 The way in which the Scheme might affect the duration or distance of pedestrians' and others' journeys, existing local travel patterns is established, and the routes likely to be affected and the number of NMUs likely to experience changes in journey times on these routes is reported. Particular attention is given to impacts on vulnerable groups. Impact magnitude is determined according to the criteria outlined in Table 13.11.

Table 13.11: NMU journey length & local travel patterns magnitude criteria

Magnitude of impact	Criteria
Major	<p>People are likely to be deterred from making trips to an extent sufficient to induce reorganisation of their habits. Considerable hindrance will be caused to people trying to make their existing journeys for a prolonged period of time, due to, for example:</p> <ul style="list-style-type: none"> • Pedestrian at-grade crossing of a new road carrying over 16,000 vehicles; • An increase in length of journeys of over 500 m; or • Three or more of the hindrances set out under 'Low' or two or more hindrances set out under 'Medium'.

Magnitude of impact	Criteria
Moderate	<p>Some residents, particularly children and elderly people, are likely to be dissuaded from making trips. Other trips will be made longer or less attractive, for example:</p> <ul style="list-style-type: none"> • Two or more of the hindrances set out under 'Low' are applied to single trips; or • Pedestrian at-grade crossing of a new road carrying between 8,000 - 16,000 vehicles per day (AADT); or • Journeys will be increased by 250 m - 500 m.
Minor	<p>In general the current journey pattern is likely to be maintained, but there will probably be some hindrance to movement, for example:</p> <ul style="list-style-type: none"> • Pedestrian at-grade crossing of a new road carrying below 8,000 vehicles per day (AADT); or • A new bridge will need to be climbed or subway traversed; or • Journeys will be increased by up to 250 m.

Table Source: Adapted from DMRB guidance

13.4.24 Significance is the product of the sensitivity of receptors and magnitude of impact and is determined according to Table 13.5 above.

Non-motorised Users (NMU): Changes in amenity

13.4.25 Amenity is defined as the relative pleasantness of a journey. In assessing amenity for the routes used by pedestrians and others, a descriptive approach, based on knowledge of the baseline and scheme, is employed which gives an overall indication of the change in amenity and the number of journeys affected. Other factors are taken into account where applicable, such as footpath width and distance from traffic, barriers between pedestrians and traffic, and the quality of street furniture and planting. For ramblers, changes in the quality of landscape or townscape is also relevant. For cyclists, the assessment considers positive factors, such as the clear signage of alternative routes for cyclists, and subways or cycle crossings, and negative factors such as junctions where cyclists and vehicles are not separated. For equestrians, landscape quality is generally an important factor, as may some of those affecting cyclists, depending on the existing and proposed provision for riders. Safety for equestrians crossing a route is a particularly important consideration. The impacts are classified according to the criteria used for community assets in Table 13.6.

Non-motorised Users (NMU): Severance

13.4.26 Changes in journey length and journey times and amenity for pedestrians and others may be such that they affect, adversely or beneficially, the degree to which a locality is subject to 'community severance'. Community severance is defined here as the separation of residents travelling by non-motorised means from facilities and services they use within their community caused by new or improved roads or by changes in traffic flows. In addition to changes in community severance caused by changes in pedestrians' and others' ability to travel in the locality of a scheme, severance may sometimes be caused by the demolition of a community facility or the loss of land used by members of the public.

13.4.27 In accordance with DMRB Volume 11 Section 3 Part 8, new severance is described using a three point scale, viz, Slight, Moderate or Severe severance.

13.4.28 Generally, in cases of slight severance current journey pattern is likely to be maintained, but there will probably be some hindrance to movement. In cases of moderate severance some residents, particularly children and elderly people, are likely to be dissuaded from making trips. Other trips will be made longer or less attractive. In cases of severe severance, people are likely to be deterred from making trips to an extent sufficient to induce a re-organisation of their habits. This would lead to a change in the location of centres of activity or in some cases to a permanent loss of a particular community. Alternatively, considerable hindrance would be caused to people trying to make their existing journeys.

13.4.29 These descriptions are coupled with an estimate of the numbers of people affected, their location and the community facilities from which they are severed. On this basis, no prescriptive tables for sensitivity, magnitude, or significance are proposed.

Vehicle travellers: Views from the road

13.4.30 The assessment of travellers' views is based on the guidance in DMRB 11.3.9 and TAG Unit 4.1 Social Impact Appraisal (November 2014) in the Department of Transport's TAG Guidance.

13.4.31 'View from the road' is taken to be the extent to which travellers, including drivers, are exposed to the different types of scenery through which a route passes. Aspects considered are:

- The types of scenery or the landscape character;
- The quality of the landscape;
- Features of particular interest or prominence in the view; and
- The extent to which travellers may be able to view the scene.

13.4.32 The extent to which travellers may be able to view landscape is considered according to the following categories:

- No View: road in steep cutting or contained by earth bunds, environmental barriers or adjacent structures;
- Restricted View: frequent cuttings or structures blocking the view;
- Intermittent View: road generally at ground level with shallow cuttings or barriers at intervals; and
- Open View: view extending over many miles or only restricted by existing landscape features.

13.4.33 The effects of the Scheme on traveller's views from existing routes and from the carriageway of the Scheme itself will be assessed according to the TAG Social Impact Appraisal guidance. The effect on traveller's views shall be categorised in one of the following three ways:

- Neutral: little or no effect for most views from the road or improvements on some views are generally balanced by deterioration in others;

- Beneficial: views from the road would be, on balance, a change for the better; and
- Adverse: views from the road would be, on balance, a change for the worse.

13.4.34 In terms of significance, using the seven-point scale, the significance of effect upon traveller's views will be assessed according to the TAG Social Impact Appraisal guidance:

- "The assessment is likely to be slight (beneficial or adverse) where the numbers of travellers affected is low (less than 500 a day, say);
- The assessment is likely to be large (beneficial or adverse) where the numbers of travellers affected is high (more than 10,000, say);
- The assessment is likely to be moderate (beneficial or adverse) in all other cases."

13.4.35 Where necessary, adjustments to the significance assessment will be made according to the sensitivity of receptors and magnitude of change as outlined above.

Vehicle travellers: Driver stress

13.4.36 Driver stress is defined in the DMRB as the adverse mental and psychological effects experienced by a driver traversing a road network. The level of stress experienced by a driver may be affected by several factors including; road layout and geometry, surface riding characteristics, junction frequency and speed and flow per lane. Reduction in achievable vehicle speeds resulting from congestion may result in substantially increased journey times, introducing a degree of severance and increasing driver stress.

13.4.37 There are three main components of driver stress include:

- Driver frustration - caused by an inability to drive at a speed consistent with the standard of the road, and increases as speed falls in relation to expectations;
- Driver fear - the main factors are the presence of other vehicles, inadequate sight distances and the likelihood of pedestrians, particularly children, stepping into the road. Fear is highest when speeds, flows and the proportion of heavy vehicles are all high, becoming more important in adverse weather conditions; and
- Driver uncertainty - caused primarily by signing that is inadequate for the individual's purposes.

13.4.38 The measurable aspect of driver stress is associated with frustration due to delays. The assessment estimates levels of stress based on peak hourly flow and average journey speed estimated for the Transport Assessment, in accordance with DMRB guidance (Table 13.12) and assigns a level of sensitivity based on existing stress levels and an impact based on the projected change in stress levels. The level of driver stress has been determined through a qualitative assessment of the above factors, under a three-point descriptive scale, as recommended under DMRB guidance, as Low, Moderate or High. If construction phase traffic flow data is not available, the assessment will assign a level of driver

stress by applying professional judgement based on information regarding the presence of construction plant, route diversions and other potential construction impacts. Significance is the product of the sensitivity of receptors and magnitude of impact and is classified according to Table 13.5 above.

Table 13.12: Driver stress assessment criteria

Average motorway peak hourly flow per lane, flow units/hour	Average motorway journey speed, km/h		
	Under 75	75-95	Over 95
Under 75	High	Moderate	Low
1200-1600	High	Moderate	Moderate
Over 1600	High	High	High

Table Source: DMRB Volume 11 Section 3 Part 9

Table 13.13: Driver stress - Dual-carriageway roads

Average peak hourly flow per lane, in flow Units/1 hour	Average Journey Speed Km/hr		
	Under 60	75-95	Under 60
Under 1200	High*	Moderate	Low
1200-1600	High	Moderate	Moderate
Over 1600	High	High	High

* "Moderate in urban areas"

Table Source: DMRB Volume 11 Section 3 Part 9

Human health

- 13.4.39 The assessment of human health will be based on established good practice guidance on health impact assessment developed by the English Department of Health, Public Health England, the Department for Communities and Local Government, the Devolved Countries in the UK; as well as professional associations such as the Faculty of Public Health, the Institute of Environmental Management and Assessment (IEMA). Guidance from international agencies and associations such as the International Finance Corporation and the International Association for Impact Assessment will also be considered.
- 13.4.40 The World Health Organisation (WHO) definition of health used by public health professions within the UK and internationally are that health is ‘*a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity*’ and is “*the extent to which an individual or group is able to realise aspirations and satisfy needs, and to change or cope with the environment. Health is therefore a resource for everyday life, not the objective of living; it is a positive concept, emphasizing social and personal resources, as well as physical capacities*”.
- 13.4.41 Human health is underpinned by several determinants which span environmental, social and economic aspects. These include: population change, employment and economy, housing and shelter, transport and connectivity, learning and education, crime and safety, social capital and community cohesion, health and social care and public services, shops and retail amenities, spirituality, faith and traditions;

arts and cultural activities; leisure and recreation; lifestyle and daily routines; governance and public policy, energy and waste; and land and spatial.

13.4.42 The following assessment methodology and the assigning of sensitivity, magnitude and significance has been developed. The methodology is based on knowledge from previous similar schemes, desk-based analysis of baseline public health and socio-economic characteristics of the wider study area, scientific literature on health effects, stakeholder consultation and EIA scoping responses, national and local health priorities, national and international regulatory standards, and national and local policies.

13.4.43 The assessment methodology that will be used to assess the following population and human health sub-topics are as follows:

- Health outcomes: communicable disease, non-communicable disease, physical injury, mental health and wellbeing and nutritional disorders; and
- Health determinants: population change, employment and economy, housing and shelter, transport and connectivity, learning and education, crime and safety, health and social care and public services, shops and retail amenities, social capital and community cohesion, spirituality, faith and traditions; arts and cultural activities; leisure and recreation; and lifestyle and daily routines.

13.4.44 The assigning of sensitivity, magnitude and significance is based on professional judgment and informed by the findings of the health relevant assessments which will be reported in the ES. Magnitude of impact on health receptors will be classified as Major, Moderate, Low, or Negligible, in accordance with the definitions provided in Table 13.14.

Table 13.14: Magnitude of impact on human health receptors

Magnitude of impact	Criteria
Major	An impact that is expected to have major adverse or beneficial health effects, typically following one or more of the following: a large change in health risk (increase or decrease), affecting a large number of people, long-term in duration, permanent and irreversible.
Moderate	An impact that is expected to have a moderate adverse or beneficial health effect, typically following one or more of the following: a moderate change in health risk (increase or decrease), affecting a moderate number of people, short-term in duration, intermittent and reversible.
Minor	An impact that is expected to have a minor adverse or beneficial health effect, typically following one or more of the following: a low change in health risk (increase or decrease), affecting a small number of people, temporary or short-term in duration, intermittent and reversible.
Negligible	An impact that is unlikely to have an effect on population or human health.

Table Source: Adapted from DMRB guidance and Atkins methodology 2018.

13.5 Consultation

13.5.1 In accordance with DMRB Volume 11 Section 3 guidance, consultation will be undertaken with Local Authorities (London Borough of Havering and Brentwood Borough Council) and stakeholders likely to be affected by the Scheme at ES stage. The formal public consultations required for the Scheme will form part of

this process. The aim of consultation will be to confirm the people and communities receptors identified within the study area baseline, to ascertain their level of usage by members of the community, to obtain more information on anticipated impacts of the Scheme, and to assist in identifying suitable mitigation measures for adverse effects.

13.6 Baseline conditions

Private dwellings

13.6.1 The following properties are within the study area:

- At Grove Farm, north west of Junction 28 and accessed via the M25 anticlockwise slip road and the east bound slip road off the A12 entering to the roundabout;
- Dwellings in Harold Park, off Roman Road, to the west of Junction 28;
- A dwelling, The Poplars, and farm buildings south east of Junction 28;
- Dwellings fronting Nags Head Lane to the south west of Junction 28;
- Two dwellings either end of the South Weald service station, one of which is adjacent to the Junction 28 roundabout;
- Properties in the Brook Street area;
- Properties along Wigley Bush Lane and Weald Park Way, to the north east of the junction; and
- Putwell Bridge Caravan Park, south of the A12 Colchester Road to the west of Junction 28, which has permission for change of use to a burial ground (see Development land below).

Community assets

13.6.2 The Maylands Golf Club and Henderson Sports and Social Club are located in Harold Park approximately 700 m and 1 km respectively to the north west of Junction 28. Part of Maylands Golf has been acquired by Highways England and therefore falls partly within the study area. The Poolman swimming pool and Spirit Health Club are within 500 m of the Scheme to the south east (see above). All are private sport/leisure facilities.

13.6.3 In addition, there is a cluster of community facilities and services which may be public or private located along Brook Street outside of the study area.

13.6.4 The centre of Romford, approximately 4.6 miles to the west of Junction 28 along a shared use path (SUP) adjacent to the southern side of the A12, is considered to be within reasonable cycling distance (< 5 miles) of the Scheme. Romford hosts all of the local services and amenities expected within a town centre. The eastern part of the town, Harold Park, extends to approximately 800 m from Junction 28 along the A12 and includes shops and services at the junction with Willow Way and along Colchester Road and Harold Court Road.

Local businesses

13.6.5 The following local businesses are within the study area:

- Farm buildings south west of Junction 28;
- The South Weald Service station, comprising a Shell petrol station and Mizu Noodle Bar restaurant, east of Junction 28 at the junction of A1023 Brook Street and Roman Road;
- Commercial properties in the Brook Street area including the Brentwood Garden Centre, Poolman swimming pool and Spirit Health Club; and
- Commercial properties along Wigley Bush Lane and Weald Park Way, to the north east of the junction, including Colmar Farm Riding Centre.

13.6.6 Brentwood, the centre of which is approximately 2.1 miles east of Junction 28, is home to the following uses:

- Restaurants, public houses and a hotel (Holiday Inn Brentwood, Harvester, The Bull Public House, Marygreen Manor Hotel and Restaurant, The Nags Head Public House);
- Retail (Londis Convenience Store, Car Showrooms, Wickes);
- Employment (BT office, industrial area on Hubert Road to the south of A1023);
- Services (post office on Brook Street); and
- Leisure (Warley Country Park).

Development land

13.6.7 Brentwood and Havering both safeguard land along the Great Eastern Mainline for Crossrail in their respective adopted Local Plans. Brentwood Borough Council proposes a cycleway approximately 500 m to the south of the junction, which intersects with the red line boundary of the Scheme in the south west quadrant and when crossing the M25 to the south of the junction. Havering's emerging Local Plan identifies one small, two medium and one large potential wind development sites within the red line boundary of the Scheme in the junction's north west quadrant. However, this proposal has not yet been adopted and may be subject to change.

13.6.8 Havering's emerging Local Plan identifies one small, two medium and one large potential wind development sites within the red line boundary of the Scheme in the junction's north west quadrant. However, this proposal has not yet been adopted and may be subject to change. Havering's emerging Local Plan allocates land at the Caravan Park, Putwell Bridge as a Gypsy and Traveller site. However, this proposal has not yet been adopted and may be subject to change.

13.6.9 There is one significant permitted planning application within the study area, for the change of use of land south of the A12 Colchester Road and west of Harold Park to burial grounds (P1742.14). The application includes land currently occupied by the Putwell Bridge Caravan Park.

Non-motorised Users (NMU)

13.6.10 Results of NMU surveys (2014) show that NMUs use both the carriageway and traffic-free routes - footways, SUPs and PRoW near Junction 28. However, overall usage is low.

- 13.6.11 Footways exist on the A12 and A1023. On the northern side of the A12, west of the Junction 28 roundabout, a footway provides access to the vicinity of the roundabout and then to the southern side of the A12 via an uncontrolled crossing of the A12 entry slip and exit slip road. This connects with an SUP to the southern side of the A12/A1023.
- 13.6.12 SUPs exist on the A1023 immediately east of Junction 28, through the southern side of the junction via one uncontrolled and one controlled crossing point. A SUP continues along the southern side of the A12 west of the roundabout towards Harold Wood providing a connection to NCNR 136.
- 13.6.13 A cycle crossing at grade within the southern portion of the roundabout at Junction 28 provides a connection east to west between Brentwood and Harold Park, continuing along Brook Street and Colchester Road. Accident data for the period 01/11/2008 to 30/04/2014 shows that no collisions involved NMUs. However, a number of rear-shunt or side-swipe accidents were recorded in the immediate vicinity of, and on, the roundabout. This indicates that cyclists using the carriageway are likely to be at risk of collision if changes to lanes and directions result in driver confusion.
- 13.6.14 The other paths in the study area are to the south east of Junction 28 near Boyles Court Farm, south west of the junction near the sewage works on Nag's Head Lane, and north east of the junction, as well as footpaths along streets in the Brook Street area of Brentwood.
- 13.6.15 There are two PRoW within the study area. One is a bridleway on the south side of Nag's Head Lane, running to west and east of the M25 then away from the M25 to the east, and the other is a footpath to the south east of Junction 28, 300 m from the red line boundary at its closest point. Colmar Farm Riding Centre, within the study area approximately 1.3 km to the north east of the junction on Weald Park Way, could be expected to generate equestrian trips within the vicinity.
- 13.6.16 Footpaths crossing the area of land to be used by the Scheme provide pedestrian links between Brook Street, Brentwood and Harold Park, Romford and other neighbouring areas.

Vehicle travellers: Views from the road

- 13.6.17 In general, views over the surrounding landscape from the road for VT on the study area's road network are intermittent and comprise a mixture of agricultural, residential and commercial properties, planted vegetation and engineering structures. The key VT routes in the study area, the M25 and A12, contain a varying degree of screening elements that obscure or block views completely.
- 13.6.18 The view from the M25, which crosses over the top of the Junction 28 roundabout north west to south east, is screened by vegetation on the east and west on both approaches to the junction. Far distance views of the undulating landscape of Essex, comprising agricultural land and wooded areas, are afforded when traveling clockwise on the M25 above the junction. When traveling along the motorway south of the junction, the road drops down to travel underneath the Great Eastern Mainline railway bridge and various overhead structures are a prominent feature.
- 13.6.19 Views looking from the slip roads towards the Junction 28 roundabout, positioned below the M25 and above the A12, are of a planted wooded area. General views

away from the roundabout are of planted vegetation and trees, with intermittent views of agricultural land. The M25 anticlockwise entry slip road has a partial view of a small residential property and scrap yard to the west. A partial view of the adjacent petrol station is visible from the eastern portion of the roundabout. A partial view of a dwelling house can be seen from the south-eastern portion of the roundabout.

- 13.6.20 Views from A12, which runs below the Junction 28 roundabout south west to north east, are restricted by vegetation to the north and south of the carriageway. General views at the junction and the approach from the A12 are of planted vegetation and trees with intermittent views of agricultural land. When traveling beneath the junction, views are of planted vegetation, elevated earthworks and retaining walls. Travel along the west and east of the junction (Colchester Road and Brentwood bypass respectively) provides intermittent views of open land either side of the road, screened by planted vegetation, trees and woods.
- 13.6.21 The A1023 Brook Street east of the Junction 28 roundabout allows for intermittent views either side of the road, which include open land, commercial and residential properties. The road is screened by planted vegetation and trees.

Vehicle travellers: Driver stress

- 13.6.22 M25 Junction 28 is a major national and inter urban regional transport artery which plays a critical role providing access between the M25 and the A12, particularly the A12 towards Essex. It is therefore intrinsically linked to the performance of the surrounding highway network.
- 13.6.23 High levels of demand combined with limited capacity on the gyratory section due to the capacity of the signalised intersections result in delays and accidents. The north east quadrant of the M25 has high volumes of traffic and often experiences severe congestion, featuring in the top 10 percentile of all UK roads in terms of vehicle hour delay. This causes disruption and delays to the surrounding road network when emergency closures and lane closures of the motorway, gyratory and the Dartford Crossing are imposed.
- 13.6.24 Junction 28 experiences a high number of accidents and incidents, with a total of 48 recorded between 01/11/2008 and 30/04/2014. While the majority of these accidents were minor, in many cases these result in significant disruption to traffic and unreliable journey times.

13.7 Potential impacts

Private dwellings: Land take and severance

- 13.7.1 The dwellings within the Grove Farm property, which are considered of high sensitivity, are most exposed to the Scheme. Permanent land take will be required, although there will be no loss of access or demolition. Given the extent of the land take, the location of the construction compounds or access alterations are not known at this stage, a precautionary approach to the assessment predicts a moderate negative magnitude of impact, spanning the construction and operational phases of the scheme, of moderate adverse significance.

Private dwellings: Amenity

- 13.7.2 The Scheme has potential to result in nearby residential receptors experiencing impacts relating to visual, air quality or noise and vibration during both construction and operation. These will be explored in more detail within each topic assessment. The Air Quality assessment (Chapter 5) identified no significant air quality impacts during either phase.
- 13.7.3 The Landscape and Visual Impact Assessment (Chapter 9) anticipates significant adverse visual construction impacts for properties along Spital Lane, Wingrave Crescent and Leonard Way, private dwellings at Grove Farm, Maylands Cottages, May Cottage and Freeman's Cottage, Oak Farm and French's Farm. The Noise and Vibration assessment (Chapter 6) found that during the construction phase, noise and vibration may have an adverse impact on private dwellings near the scheme. This will be confirmed once baseline noise monitoring results and construction phase information enable determination of whether temporary environmental noise barriers will sufficiently mitigate the effects. Therefore, at this stage no significant in-combination construction impacts have been identified.
- 13.7.4 During the operational phase, significant adverse visual impacts are anticipated for private dwellings at Grove Farm, Maylands Cottages, May Cottage and Freeman's Cottage, Oak Farm and French's Farm. However, private dwellings are anticipated to be positively affected in terms of air quality or noise and vibration. Therefore, no significant in-combination amenity impacts have been identified for the operational phase.

Community assets: Land take and severance

- 13.7.5 The Scheme will involve some land take to the eastern extent of the Maylands Golf Course, which is located north west of Junction 28 beyond Grove Farm. As a private leisure facility, the Golf Course is considered a receptor of low sensitivity. It is considered to have a minor to moderate magnitude of impact due to the permanency and irreversible nature of the development, although it is considered not to impact a large proportion of the local population. There are likely to be some construction phase impacts for a limited period of a slight to moderate level causing some disruption to the use of the golf course adjacent to the area of land take. There may also be operational impacts such as visual amenity, which could be mitigated through screening from vegetation.

Community assets: Amenity

- 13.7.6 Users of community assets are likely to experience changes in amenity during construction and operation of the Scheme. Significant community asset amenity impacts identified by the relevant specialist assessments are limited to a visual impact on patrons of Maylands Golf Course spanning the construction and operational phases of the Scheme. Most users may be expected to be 'transitory' - not exposed to altered amenity for prolonged lengths of time - and the number of total users is estimated to be relatively small. Impacts are therefore anticipated to be of minor negative magnitude, and therefore neutral not significant, during both phases.

Local Businesses

- 13.7.7 The Scheme is not anticipated to affect local businesses' trading conditions owing to the distance of the local businesses from the Scheme and lack of direct impacts such as land take or disruption to access. No effects are anticipated.

Development land

- 13.7.8 The scheme is not expected to require any land take from the permitted burial ground south of the A12, so magnitude of impact is minor and thus no significant effects are anticipated.
- 13.7.9 The red line boundary intersects the proposed cycleway, although it is not particularly sensitive owing to the uncertain timescales for delivery of the cycleway and the existence of other cycle routes in the area. If the cycleway were delivered prior to the construction of the Scheme, it could experience an adverse, non-significant, impact in the form of temporary diversion or disruption during the construction phase. No operational phase impacts are anticipated.
- 13.7.10 The potential wind development sites to the north west of the junction have not yet been adopted. The proposed loop road divides sites and the Scheme may require temporary land take for accommodation or flood mitigation works. However, it is unlikely that this would materially affect the operation of the sites, if developed. The significance of effects during construction and operational phases would therefore be neutral and not significant.

Non-motorised Users: Journey length and local travel patterns

- 13.7.11 Road side paths, the cycle crossing, bridleways and footpaths provide amenity to recreational users and those travelling between the surrounding villages to access services, facilities, and Grove Farm. Overall NMU usage is relatively low; the Transport Audit identified on average 108 cyclist movements and 70 pedestrian movements per day between 7am and 7pm. Equestrian movements, although not audited, are unlikely to be significant in quantum. However, this could represent latent demand. Whilst no NMU collisions were recorded between 01/11/2008 and 30/04/2014, a number of rear-shunt or side-swipe accidents were recorded in the immediate vicinity of, and on, the roundabout. NMUs are thus deemed to be a receptor of low sensitivity.
- 13.7.12 Although paths are expected to remain open during construction, the proposed scheme has the potential to affect the Junction 28 footpath and cycleway crossing and footpaths along Colchester Road, and hence the amenity experienced by users. There is the potential for journey length to increase as a result of construction work, subsequent traffic and NMU delays. Overall the construction impact will be temporary and is deemed of minor negative magnitude. This results in a slight adverse effect and not significant.
- 13.7.13 During its operational phase, the Scheme's design will seek to protect access for cyclists and pedestrians. Thus, NMUs will experience an overall neutral, insignificant, effect.

Non-motorised Users: Changes in amenity

- 13.7.14 NMUs are likely to experience changes in amenity during construction and operation of the Scheme. Significant amenity impacts identified by the relevant

specialist assessments are limited to moderate adverse visual impacts spanning the construction and operational phases of the Scheme for users of the bridleway following Nag's Head Lane and along the crest of the M25 cutting, and users of the public footpath located along the Wigley Bush Lane overbridge.

13.7.15 As total usage is low, other paths are available in the study area, and most users are 'transitory' - not exposed to altered amenity for prolonged lengths of time - impacts are anticipated to be of minor negative magnitude, and therefore neutral, not significant, during both phases.

Non-motorised Users: Severance

13.7.16 It is likely that there will be some temporary impact on community severance due to changes to paths, particularly affecting access to Grove Farm and services and facilities in the surrounding suburban areas. However, accessibility is expected to be restored during the Scheme's operational phase. Based on the qualitative, descriptive assessment methodology that severance will be described using a three point scale: slight, moderate or severe severance, the low usage of paths and potential impacts result in an overall slight severance assessment

Vehicle travellers: Views from the road

13.7.17 Existing views from the road are intermittent. The Scheme is likely to hinder views from the Junction 28 roundabout, slip roads, M25, A12 and local roads due proposed bridges and embankments. Removal of vegetation may further impact views.

13.7.18 Although the adverse visual impact will affect a large number of vehicular trips per day, which TAG guidance suggests should be considered of moderate/high significance, this is mediated by consideration of the limited pre-development views available to travellers and the minor magnitude of change. As such, it is considered that the Scheme is likely to give rise to a slight adverse significance of effect, outlined for the key roads in Table 13.15.

Table 13.15: Vehicle Travellers: Views from the road

Road	View by phase (sensitivity or value)			Impact magnitude	Significance
	Existing	Construction	Operation		
A12	Intermittent – medium sensitivity	Restricted , with visual horizontal intrusion for bridge and earthwork construction & linear view along hard shoulder of construction works for new lanes, bridge and earthworks.	Restricted , with a new linear view for new slip lane and bridge.	Minor	Slight adverse: not significant
M25	Intermittent – medium sensitivity	Restricted/Intermittent , with visual horizontal intrusion of construction works to construct bridge & linear view along hard shoulder of construction works for new lane and various earthworks.	Restricted & Intermittent , with new visual horizontal intrusion of a bridge & linear view	Minor	Slight adverse: not significant

Road	View by phase (sensitivity or value)			Impact magnitude	Significance
	Existing	Construction	Operation		
			of slip and bridge.		

Table Source: Atkins

Vehicle Travellers: Driver Stress

13.7.19 Motorised traffic flows estimated for 2014 on the M25 near Junction 28 indicate that existing levels of driver stress are moderate, as outlined in Table 13.15.

13.7.20 Driver stress is anticipated to be temporarily adversely impacted by construction of the Scheme, resulting in a slight adverse effect. Driver stress is likely to be reduced following completion of the Scheme due to the junction's enhanced capacity to cater for traffic, reduced queueing, congestion and risk of conflicts and collisions. However, in the longer term the trend for increased vehicle flows means that driver stress is expected to have return to moderate levels by 2037 – 15 years into the operation phase of the Scheme (Table 13.16). Thus, the overall operational phase impact magnitude is negligible and the significance of effect is neutral.

Table 13.16: Motorised travellers: Driver stress

Driver stress measures	Phase		Impact magnitude
	Existing (2014 – baseline)	Operational (2037 – 15 years into operation) Operation	
Average peak hourly flow per lane (flow units/hour)	1106	1549	Negligible
Average journey speed (kph)	95	88	
Estimated level of driver stress	Moderate	Moderate	

Table Source: Atkins

Human health

13.7.21 The Scheme has the potential to impact public health during construction through individual and combined impacts relating to traffic, air quality, noise, vibration, drainage/water environment, geology and soils, and visual impact. There may also be some disruption to lifestyles and daily routines for example travelling to school, work or retail amenities due to construction traffic and activity, congestion and potential decreased connectivity to public and commercial services.

13.7.22 There may be some benefits to local employment and the wider economy through the construction jobs created and the associated procurement of road building materials from businesses in the region and the districts in and around the Scheme. During construction the majority impacts are likely to be temporary and of short duration.

13.7.23 During operation, the Scheme may lead to some increase in air pollution and noise however, it is likely to benefit communities from reduced congestion, improved road journey times, improved road safety and improved connectivity by foot and cycle.

13.7.24 Human health has not been assessed in detail in this PEIR however, a full assessment will be undertaken in the ES.

Summary

13.7.25 Table 13.17 and Table 13.18 summaries the potential impacts of the Scheme in the construction and operational phases respectively. One significant potential impact has been identified: on private dwellings at Grove Farm, in the form of permanent land take which spans the construction and operational phases.

Table 13.17: Summary of potential construction phase impacts

Receptor and sensitivity	Magnitude of impact	Significance
Private dwellings: land take and severance High	Moderate negative	Moderate adverse: Significant
Private dwellings: amenity N/A	None	Not significant
Community assets: land take and Severance Low	Moderate negative	Slight adverse: not significant
Community assets: amenity N/A	Minor negative	Not significant
Local businesses N/A	None	None
Development land N/A	N/A	Neutral: not significant
NMUs: journey length & local travel patterns Low	Minor negative	Slight adverse: not significant
NMUs: changes in amenity N/A	Minor negative	Low: not significant
NMUs: severance N/A	N/A	Slight severance
VT: views from the road Medium	Minor	Slight adverse: not significant
VT: driver stress Medium	Minor	Slight adverse: not significant

Table Source: Atkins

Table 13.18: Summary of potential operational phase impacts

Receptor and sensitivity	Magnitude of impact	Significance
Private dwellings: land take and severance High	Moderate negative	Moderate adverse: significant
Private dwellings: amenity	None	Not significant

Receptor and sensitivity	Magnitude of impact	Significance
N/A		
Community assets: land take and Severance Low	Moderate negative	Slight adverse: not significant
Community assets: amenity N/A	Minor negative	Not significant
Local businesses N/A	None	None
Development land N/A	N/A	Neutral
NMUs: journey length & local travel patterns Low	Negligible	Neutral: not significant
NMUs: changes in amenity N/A	Minor negative	Low: not significant
NMUs: severance N/A	N/A	Slight severance
VT: views from the road Medium	Minor negative	Slight adverse: not significant
VT: driver stress Medium	Negligible	Neutral: not significant

Table Source: Atkins

13.8 Potential mitigation measures

13.8.1 The following mitigation measures are already embedded within the current Scheme design:

- The protection of existing NMU access arrangements to reduce severance during the operational phase of the Scheme; and
- Land take during the construction and operational phases has been limited to that required.

13.8.2 The design will also need to take account of any mitigation measures for Grove Farm and the retention of access across their land holding.

13.8.3 Monitoring and mitigation will be implemented otherwise where negative impacts are identified by this assessment, and through consultation with the public and key stakeholders, including landowners and the local councils.

13.8.4 Construction phase mitigation measures are likely to include:

- Completion of a CEMP, which will outline best practice construction methods to reduce disruption;
- Programming of construction works so that affected footpaths and cycleways remain open for part or all of the construction works, and so that other routes can serve as diversions for those affected;
- Seeking to ensure, where possible, continuation of access to severed parcels of land (such as around Grove Farm);

- In the event of route diversions, positioning of clear signage to show temporary diversions for affected roads, footpaths and cycleways, and notification of users by signs displayed along sections to be closed at least one month in advance of the construction works; and
- Measures identified within other topic assessments (such as noise and vibration and air quality) to reduce negative amenity impacts to NMUs, private dwellings and community assets.

13.8.5 Operational phase mitigation measures are likely to include:

- Measures identified within other topic assessments (such as noise and vibration, landscape, and air quality), for example, landscaping to provide screening and reduce noise levels where possible.

13.8.6 Future monitoring requirements will be determined by the outcome of further detailed survey work and consultation with key stakeholders and the public, and set out at a later stage.

13.8.7 There may be the need for some mitigation measures to alleviate impacts on human health such as potentially limiting hours of operations. These will be explored further in the ES.

13.9 Residual impacts

13.9.1 The construction phase mitigation measures outlined above are anticipated to result in a reduction in adverse effects on amenity, driver stress, NMUs and development land (proposed cycleways), whilst the operational phase measures are anticipated to reduce the adverse effects of the Scheme on the private dwellings at Grove Farm. Although reduced, the adverse effects of the Scheme on each receptor are anticipated to remain within the significance classification identified before mitigation. The exception to this is NMU severance, where mitigation measures are considered to reduce the construction phase significance of effects from slight adverse to neutral.

13.9.2 Residual impacts for construction and operational phases are summarised in Table 13.19 and Table 13.20 respectively. Slight adverse residual impacts are anticipated to VTs, NMUs, development land, community assets and private dwellings during the construction phase, and to private dwellings, community assets' and NMU amenity, and VTs' view from the road during the operational phase. None of these impacts are significant. One significant adverse residual impact is identified – the land take affecting private dwellings at Grove Farm, during both the construction and operational phases of the Scheme.

13.10 Cumulative effects

13.10.1 The outcome of the Scheme in relation to people and communities is affected by significant effects identified within the other environmental topics (such as noise and vibration, and air quality). This has been included in the assessment of in-combination amenity impacts in this chapter.

13.10.2 Other cumulative effects relate to the effects of any concurrent development in the vicinity. Two potential cumulative effects are identified. The potential wind farm sites within Maylands Golf Course, if developed during the construction phase of the Scheme, may exacerbate negative impacts to this community asset. However,

the cumulative effect would be temporary and not significant. The proposed cycleways to the south of the Scheme, if completed before the proposed scheme is operational, could act to reduce negative amenity or severance impacts on NMUs. All proposed cumulative developments are listed in Table 15.1 in Chapter 15.

13.11 NPS compliance

13.11.1 This assessment has taken account of the NN NPS. It is considered that the Scheme is fully compliant with the relevant NN NPS strategic objectives and policies and principles outlined in Section 2, as follows:

- In delivering junction improvement, the Scheme will contribute to enhancing the existing national road network to improve journey quality, reliability and safety;
- The Scheme will improve quality of life, accessibility and inclusivity, link up communities, and reduce community severance; and
- The Scheme incorporates measures to avoid and mitigate environmental and social impacts, including on land, access to open spaces, PRoW and opportunities for sport and recreation where applicable.

13.12 Summary

13.12.1 The expected effects of the Scheme, following mitigation measures, are summarised in Tables 13.19 and 13.20. The assessment has identified one significant adverse residual impact of the Scheme’s construction and operation on the local community, in the form of land take affecting private dwellings in the north west quadrant of the junction. Mitigation for this moderate adverse impact will be implemented with respect to consultation with property owners, and is likely to include financial compensation, ensuring continuation of access to severed parcels of land, and restoration and return of land occupied temporarily during the construction phase.

13.12.2 The Scheme is not anticipated to have any other significant impacts – beneficial or adverse - on people and communities in its construction or operational phases. Minor adverse residual impacts are anticipated to VTs, NMUs, development land, community assets, private dwellings and agricultural land during the construction phase, and to private dwellings, community assets’ and NMU amenity, and VTs’ view from the road during the operational phase.

13.12.3 In terms of the potential impacts on human health, whilst there may be some during the construction phase, these have the potential to be mitigated. A full assessment of the impacts on human health will be detailed in the ES.

Table 13.19: Construction phase residual impacts

Receptor	Impact before mitigation	Proposed mitigation	Significance of residual impact
Private dwellings: land take and severance	Moderate adverse: significant	<ul style="list-style-type: none"> • Continuation of access to severed parcels of land • Financial compensation 	Moderate adverse: significant

Receptor	Impact before mitigation	Proposed mitigation	Significance of residual impact
Private dwellings: amenity	Not significant	Already included (see other specialist topic chapters)	Not significant
Community assets: land take and Severance	Slight adverse: not significant	Continuation of access to severed parcels of land	Slight adverse: not significant
Community assets: amenity	Low: not significant	Already included (see other specialist topic chapters)	Low: not significant
Local businesses	None	None	None
Development land	Neutral: not significant	None	Neutral: not significant
NMUs: journey length & local travel patterns	Slight adverse: not significant	<ul style="list-style-type: none"> • CEMP • Programming of construction works Provision of information on route disruptions	Slight adverse: not significant
NMUs: changes in amenity	Slight adverse: not significant	<ul style="list-style-type: none"> • CEMP • Programming of construction works Provision of information on route disruptions	Slight adverse: not significant
NMUs: severance	Slight severance	<ul style="list-style-type: none"> • CEMP • Programming of construction works • Continuation of access to severed parcels of land Provision of information on route disruptions	Slight severance
VT: views from the road	Slight adverse: not significant	None	Slight adverse: not significant
VT: driver stress	Slight adverse: not significant	<ul style="list-style-type: none"> • CEMP • Programming of construction works Provision of information on route disruptions	Slight adverse: not significant

Table 13.20: Operational phase residual impacts

Receptor	Impact before mitigation	Proposed mitigation	Significance of residual impact
Private dwellings: land take and severance	Slight adverse: not significant	None	Slight adverse: not significant

Receptor	Impact before mitigation	Proposed mitigation	Significance of residual impact
Private dwellings: amenity	Not significant	None	Not significant
Community assets: land take and Severance	Not significant	None	Not significant
Community assets: amenity	Low: not significant	None	Low: not significant
Local businesses	None	None	None
Development land	Not significant	None	Not significant
NMUs: journey length & local travel patterns	Neutral: not significant	None	Neutral: not significant
NMUs: changes in amenity	Slight adverse: not significant	None	Slight adverse: not significant
NMUs: severance	Slight severance	None	Slight severance
VT: views from the road	Slight adverse: not significant	None	Slight adverse: not significant
VT: driver stress	Neutral: not significant	None	Neutral: not significant

14. Climate

14.1 Introduction

- 14.1.1 This chapter provides a preliminary assessment of the Scheme's effects on climate and its vulnerability to climate change. It identifies the study area, describes the methodology, presents baseline conditions, identifies potential impacts and presents suggested mitigation measures.
- 14.1.2 This chapter has been divided into two sub-sections in order to address the climate change requirements outlined in The Town and Country Planning (Environmental Impact Assessment) Regulations 2017 (SI 2015/517), which state that the assessment should consider both:
- The potential effects of the Scheme on climate, in particular the magnitude of greenhouse gases (GHGs) emissions emitted during both construction and operation; and
 - The vulnerability of the Scheme to climate change, in particular the impacts of extreme weather (caused by climate change) during operation and construction and adaptation to mitigate the effects of these impacts.
- 14.1.3 It should be noted that for Effects on Climate, insufficient design detail is available to undertake an assessment of the construction phase at the time of preparing this chapter. This PEIR presents calculated operation phase emissions and uses these to indicate potential significant effects of the Scheme. A full assessment will be undertaken and presented as part of the Environmental Statement.

14.2 Study area

Effect of the Scheme on Climate

- 14.2.1 The assessment quantifies the emissions of GHGs from the Scheme to the atmosphere, as well as identifying opportunities for emissions reductions.
- 14.2.2 The timescale of the assessment covers:
- Construction, as a single time period;
 - Operation in the Opening Year; and
 - Operation in the Design Year.
- 14.2.3 As many emissions will result from upstream and off-site activities, such as materials production, the study area is not limited to the geographic extent of the Scheme area.
- 14.2.4 The specific elements of the Scheme, referred to as 'life cycle modules', included within the assessment boundary are described in Table 14.1 and Table 14.2. The study area has been determined based on Highways England guidance, the boundaries and scopes of Highways England's Carbon Tool, and PAS 2080:2016 'Carbon Management in Infrastructure', which is the technical standard for measuring and managing GHG emissions from infrastructure.

Table 14.1: Construction Phase Assessment Boundary

Life cycle module		Assessment Boundary
Materials		Emissions from the production of construction materials, including primary raw material extraction, manufacturing and intra-manufacturing transportation.
Transport		Direct vehicle emissions from the transportation of construction materials from the primary site of manufacturing to site.
Construction Processes	Construction plant use	Direct and well-to-tank emissions from the operation of construction plant on-site. The boundary is the same as that used for the noise assessment (Chapter 6).
	Other construction energy use	On-/off-site construction worker facilities (temporary offices, etc) emissions (from lighting, heating, etc).
	Construction water use	Emissions from all activities for the treatment and supply of water to site.
	Construction waste transportation	Direct vehicle emissions from the transportation of bulk construction waste from the construction site to the primary processing site, as per the waste assessment (Chapter 12).
	Construction waste off-site processing	Emissions from the processing of bulk construction waste, as per the waste assessment (Chapter 12).
	Employee commuting	Direct vehicle emissions from the transportation of workers to the site for the duration of the construction works.

Table 14.2: Operation Phase Assessment Boundary

Life Cycle Module	Assessment Boundary For Draft Issue to HE
Road User Carbon	Direct emissions from vehicles using the Scheme, as outlined in DMRB, Volume 11, Section 3, Part 1 Air Quality: HA 207/07.
Maintenance / Refurbishment	Emissions from the ongoing maintenance, repair, replacement and refurbishment activities. This potentially includes the same modules/activities as in the construction phase.
Operational Energy Use	Emissions from the generation and supply of electricity to operate lighting and technology on the Scheme.

14.2.5 The life cycle modules listed in [Table 14.3](#) have been excluded from the assessment on the basis that the associated emissions are either negligible, or the module is not applicable to the Scheme.

Table 14.3: Exclusions from the Assessment Boundary

Life Cycle Module	Reason for Exclusion For Draft Issue to HE
Preliminary studies and consultations	This module includes a range of office activities and travel from a number of locations. Therefore, to quantify this stage by assumptions would be largely meaningless. It has been assumed

	that emissions for this phase are minimal in comparison to both construction and in-use emissions.
Direct operational emissions	Direct emissions from the infrastructure itself will be negligible.
Operational water use	There is no specific water use for the operation of the Scheme.
Other operational processes	There are no operational processes relevant to the Scheme emissions other than the use of the Scheme by traffic and infrastructure energy.
End of life stages	There are no plans to decommission the Scheme so no end of life activities will take place.
Offsetting	Carbon offsetting – including vegetation for sequestration, solar PV for electricity export, or financial support of low-carbon projects – is specifically excluded from the study. Any carbon savings achieved through offsetting should be reported separately.

Vulnerability of the Scheme to climate change

14.2.6 The Scheme is described in Chapter 2 of this document. Figure 14.1 shows the location of the Scheme alongside the Met Office UK Climate Projections 25 km gridded data, which is the source of climate change information used in this chapter. Figure 14.2 shows the location of the Scheme within the broader context of the Thames river basin as the Scheme may be at risk of localised fluvial flooding.

Figure 14.1: Location of 25km grid box (ID: 1629)

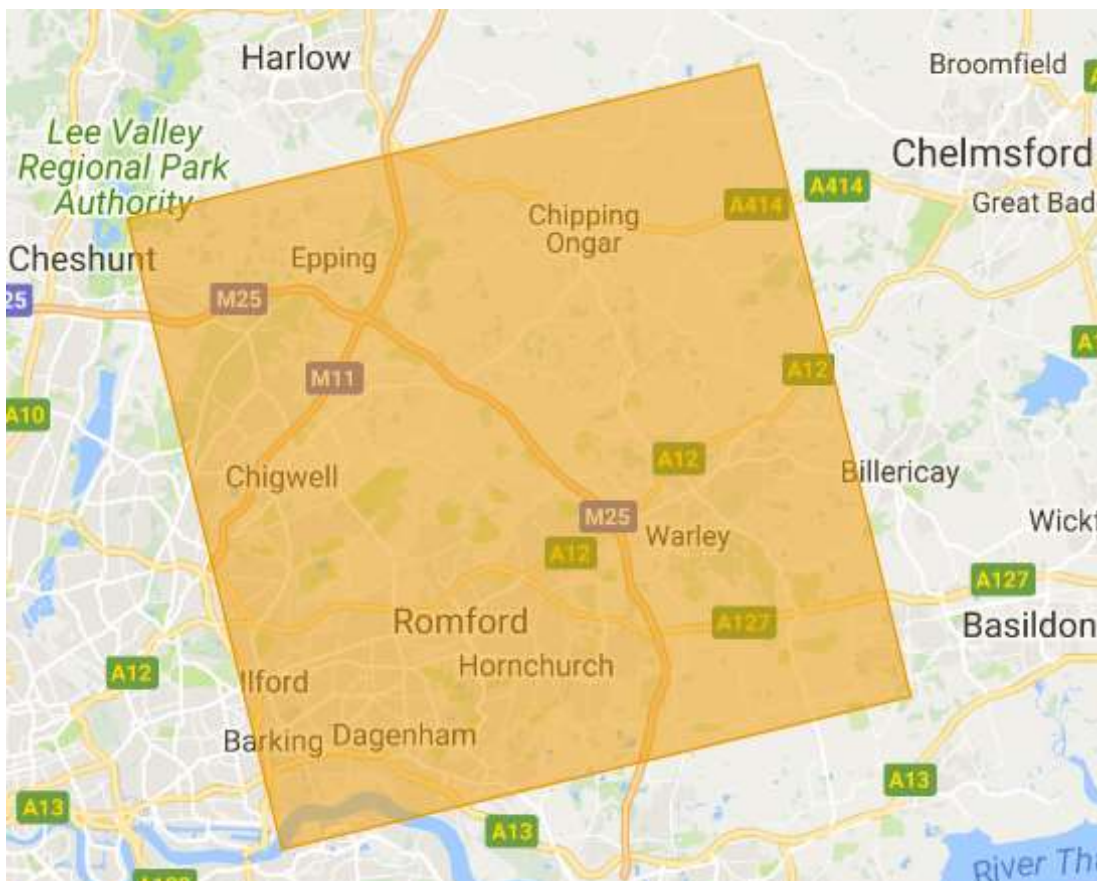


Figure 14.2: Location of Thames river basin



14.3 Planning and policy context

14.3.1 Appendix N in Volume 2 summarises the legislation, regulatory and policy framework applicable to climate.

14.4 Methodology

Effect of the Scheme on Climate

14.4.1 There is currently no guidance in the Design Manual for Roads and Bridges (DMRB) for what type or level of assessment is required regarding the effects of a scheme on climate. For this assessment, a proportionate approach has been adopted which focuses on capturing the principal contributing factors to the effects on climate and assessing the significance of these.

14.4.2 It is key to note that whilst Effects on Climate is a wide-ranging topic in terms of potential sources, it is simple in terms of its receptors and impacts because:

- There is only one receptor, the atmosphere;
- There is only one direct impact, global warming; and
- All units of CO₂e can be considered to have the same impact no matter where they are emitted.

14.4.3 Therefore, assessment of the effects of the Scheme on climate is limited to quantification of the magnitude of emissions, from individual sources and in total, and comparison of these to the baseline. Different GHGs have different global

warming potentials, and to account for this they will be reported throughout this assessment as their carbon dioxide equivalent (CO_{2e}) value.

- 14.4.4 The goal of the assessment is to calculate the emissions anticipated to be generated by the Scheme to:
- Determine the magnitude of the Scheme's effect on climate, in comparison with the Do Minimum Scenario;
 - Assess the significance of the effect on climate by considering it in context with UK carbon reduction targets; and
 - Enable identification of emissions hot spots within the 'Do Something' scenario to inform identification of appropriate mitigation measures.
- 14.4.5 Emissions calculations are carried out by multiplying activity data by an emission factor associated with the activity being measured. Activity data is a quantitative measure of an activity that results in emissions during a given period of time, (e.g. kilometres driven, kWh electricity consumed, tonnes waste sent to landfill). An emission factor is a measure of the mass of emissions relative to a unit of activity.
- 14.4.6 There is currently insufficient design information available to conduct a fully quantitative assessment at this stage. A partial assessment is presented in this PEIR, with further detail to be provided in the ES.

Calculating Construction Emissions

- 14.4.7 A quantification of construction phase emissions has not been possible in this PEIR.
- 14.4.8 As part of the full assessment to be presented in the ES, construction emissions will be calculated using HE's Carbon Tool. This uses pre-populated carbon conversion factors to calculate emissions from various material and non-material sources under the following categories:
- Bulk materials;
 - Earthworks;
 - Fencing, barriers and road restraint systems;
 - Drainage;
 - Road pavements;
 - Street furniture;
 - Civil structures and retaining walls;
 - Fuel, electricity and water use;
 - Business and employee transport; and
 - Waste.
- 14.4.9 The assessment will then identify emission hotspots (those items accounting for >1% of total construction phase emissions) and assess the significance of emissions against the third carbon budget period's total budget.

Calculating Operational Emissions

- 14.4.10 Operational emissions are calculated separately from Highway England's Carbon Tool, which is focused specifically on construction-phase emissions. Road user carbon emissions have been modelled in accordance with DMRB, Volume 11, Section 3, Part 1 Air Quality: HA 207/07. Emissions are calculated using Defra's Emissions Factors Toolkit (v8), which takes account of DfT fleet projections including conventional vehicles (petrol and diesel) as well as hybrid and electric vehicles.
- 14.4.11 There is no operational energy use or maintenance and repair data available for the Scheme. Published data from other highway schemes³⁵ shows that, proportionally, emissions from operational energy use and maintenance works equate to between 0.05 and 0.29% of in-use traffic emissions. 0.29% of road user emissions has been applied as a reasonable worst-case operation and maintenance figure, based on this limited data set.

Emissions Analysis and Significance Assessment

- 14.4.12 The emissions calculated for the Do Something scenario of the Scheme will be compared against the Do Minimum scenario baseline for the assessment years. The difference between these emissions can be considered to be the impact of the Scheme.
- 14.4.13 There is no accepted technical or policy guidance on how to determine the significance of a project's effects on climate. However, the National Networks National Policy Statement (NN NPS) acknowledges that the emissions from the construction and operation of a road scheme are likely to be negligible compared to total UK emissions, and are unlikely to materially impact the UK Government's ability to meet its carbon reduction targets: *'it is very unlikely that the impact of a road project will, in isolation, affect the ability of Government to meet its carbon reduction plan targets'*.
- 14.4.14 For this reason, it is considered unlikely that Scheme emissions will be of a quantity great enough to cause a significant effect on climate.
- 14.4.15 However, due to the global scale, long-term duration and cumulative and irreversible nature of the impact, the effects on climate of the Scheme are still considered important. Highways England is committed to reducing emissions where practicable, and therefore emissions have been quantified and presented as part of the ES.
- 14.4.16 Following the determination of emissions, mitigation measures to reduce emissions will be suggested.

Vulnerability of the Scheme to Climate Change

Scoping phase

Step one: Identify receptors and analysis of legal requirements

- 14.4.17 During this stage, relevant receptors have been identified which may be affected by climate change with consideration for:

³⁵ Welsh Government (2016). M4 Corridor around Newport, Environmental Statement: Volume 3, Appendix 2.4 Carbon Report

- The impact of extreme weather and changes in climate on the project over its lifetime;
- The impact of the project on the climate resilience of wider (social, environmental and economic) systems over time (reflecting on the climate change issues associated with other relevant assessment areas of the EIA); and
- These receptors are likely to comprise both known (for example, receptors affected by historical flooding gleaned from literature review) and unknown (new) receptors.

14.4.18 This stage also includes the assessment and definition of the policy context.

Stage two: Climate vulnerability assessment

14.4.19 A climate vulnerability assessment has been undertaken to clearly identify the primary receptors that are vulnerable and the nature of this vulnerability over the life of the project. These vulnerabilities will then inform the detailed assessment phase.

14.4.20 The vulnerability of a project to extreme weather and climate change depends on:

- The typical sensitivity of the type of the project to climate variables and hazards; and
- The geographic exposure of the project to climate variables and hazards.

14.4.21 The climate vulnerability assessment was informed by a qualitative sensitivity analysis and an assessment of exposure from an evolving baseline. The sensitivity analysis focused on identifying the typical climate sensitivities for receptors to relevant climate variables and climate-related hazards, such as those outlined in Table 14.4. The level of exposure of the primary receptors was then determined based on an expert understanding of observed climate, scenarios for projected future climate and a literature review of climate hazards associated with the prescribed changes.

Table 14.4: Typical climate variables and related hazards

Climate variable	Climate-related hazard
Average (air) temperature change (annual, seasonal, monthly)	Sea level rise (plus local land movements), storm surge/tide
Extreme (air temperature (frequency and magnitude)	Water availability/drought
Average precipitation (annual, seasonal, monthly)	Flood (coastal and fluvial)
Extreme rainfall (frequency and magnitude)	Subsidence and ground stability
Average wind speed change (annual, seasonal, monthly)	Fog
Gales and extreme winds (frequency and magnitude)	Storms (tracks and intensity), including storm surge
Humidity	Snow, ice and hail
Solar radiation	Storms and lightning

14.4.22 A categorisation was then assigned to each climate variable/hazards in relation to each receptor based on the following scale:

- **High:** High climate sensitivity/exposure;
- **Moderate:** Moderate climate sensitivity/exposure; and
- **Low:** No significant climate sensitivity/exposure.

14.4.23 This was a qualitative assessment informed by expert opinion and a supporting literature review. The vulnerability of primary receptors to relevant climate variables and hazards was then determined using the vulnerability matrix below (Table 14.5). High and selected Moderate vulnerabilities will then be taken forward to the detailed assessment stage.

Table 14.5: Vulnerability Rating Matrix

Sensitivity	Exposure		
	low	Moderate	High
Low	Low	Low	Low
Moderate	Low	Moderate	Moderate
High	Low	Moderate	High

Detailed assessment phase

Step three: Baseline conditions

14.4.24 In support of the climate risk assessment an evolving climate baseline will produce a profile of key climate variables and hazards and how they are expected to change over the life of the project. The evolving baseline will be based on local/regional Met Office observed extreme weather and climate data, UKCP09 climate projections (with consideration for the associated uncertainty) and other relevant sources of climate risks data and information (Highways England, 2016). Note, this methodology will adopt UKCP18 climate projections once they are made available next year.

Step four: Impact assessment

14.4.25 A detailed impact assessment will be undertaken, as required, for selected Moderate and High climate vulnerabilities identified. The foundation for this assessment will be a qualitative assessment based on expert judgment, engagement with project stakeholders and a review of relevant literature. This process will however be supplemented with quantitative data and information where available.

14.4.26 The assessment will focus on identifying and appraising the specific impact of relevant climate variables and hazards on primary project receptors over the life of the project. Taking account of the contribution of incorporated measures to climate resilience, this assessment will outline the level of climate resilience of each receptor to significant climate variable/hazards based on the following rankings:

- **High** - A strong degree of climate resilience, remedial action or adaptation may be required but is not a priority;

- **Moderate** - A moderate degree of climate resilience, remedial action or adaptation is suggested; and
- **Low** - A low level of climate resilience, remedial action or adaptation is required as a priority.

Step five: Avoidance, minimisation, adaptation and compensation measures

14.4.27 Recommendations for supplementary climate change adaptation measures for all Low and selected Moderate level of climate resilience will be identified. The identification of possible measures will focus on:

14.4.28 Adaptation actions:

- Design;
- Operational and maintenance;
- Planning; and
- Financial.

14.4.29 Adaptive capacity building:

- Information;
- Supportive social structures; and
- Supportive governance.

14.5 Consultation

Effect of the Scheme on Climate

14.5.1 No specific consultation is proposed.

Vulnerability of the Scheme to climate change

14.5.2 In identifying receptors with High or Medium vulnerabilities to climate change and extreme weather, technical advice will be sought from relevant Highways England staff (i.e. local route managers or similar), local authority and the Environment Agency (EA) flood officer to inform the vulnerability assessment and to seek their advice as to the development of appropriate mitigation measures.

14.6 Baseline conditions

Effect of the Scheme on Climate

14.6.1 Baseline conditions are defined by the:

- Total background emissions from all sources, i.e. all UK emissions, at all scales; and
- Predicted total emissions occurring for both the Opening Year (2022), and the Design Year (2037), assuming the Scheme is not constructed, i.e. the 'Do Minimum' scenarios.

National Emissions Baseline

14.6.2 It is estimated that total global GHG emissions from all sources currently amount to approximately 50 billion tonnes of CO₂e³⁶. However, it is not considered representative to compare any UK scheme against this, as any scheme will always be negligible. Instead, it is considered most appropriate to use the national baseline for comparison as its magnitude is more relevant and UK specific. The total UK emissions for 2016 (the last reported year) were 467.9 million tonnes of CO₂e³⁷. The breakdown of this by sector, by final user is shown in Table 14.6.

Table 14.6: UK national emissions (2016)

Sector (by final user)	Emissions (Million tonnes of CO ₂ e)	% of total
Transport	125.8	26.9%
Energy Supply	120.2	25.7%
Business	81.5	17.4%
Residential	69.8	14.9%
Agriculture	46.5	9.9%
Waste management	19.9	4.3%
Industrial Processes	10.5	2.2%
Public	8.2	1.8%
Land Use, Land Use Change and Forestry (LUKUCF)	-14.6	-3.1%
Total	467.9	100%

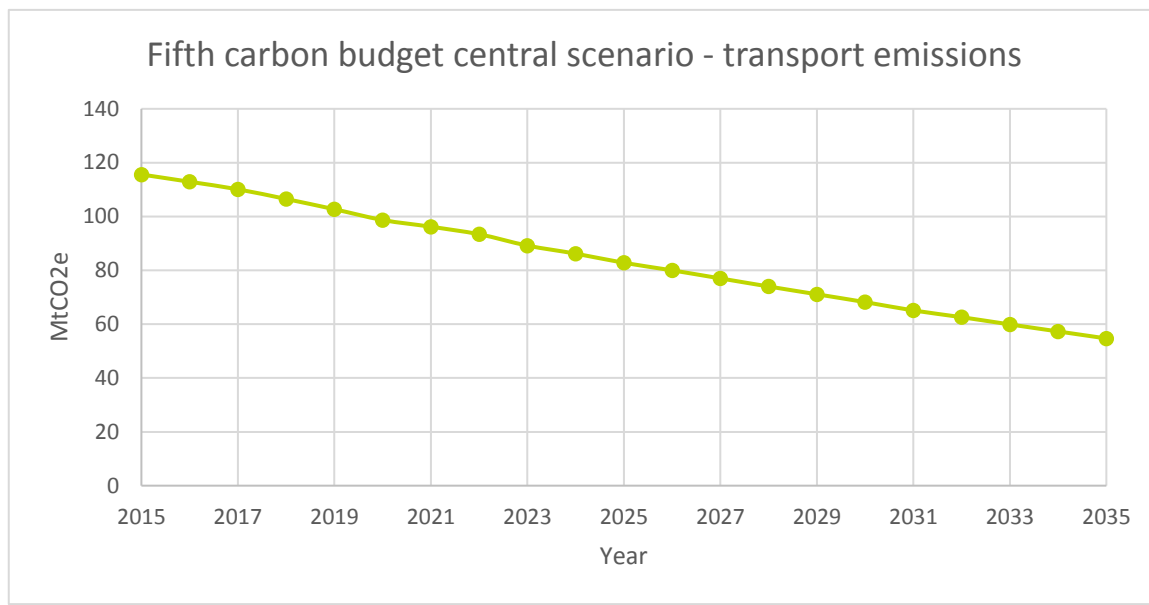
Table Source: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/680473/2016_Final_Emissions_statistics.pdf

14.6.3 The dataset for the fifth UK carbon budget central scenario includes forecasts of emissions for different sectors. [Figure 14.3](#) below presents the annual reduction in transport sector emissions (including shipping and domestic aviation) required to support the achievement of the carbon budgets.

³⁶ <http://themasites.pbl.nl/publications/pbl-2017-summary-trends-in-global-co2-and-total-greenhouse-gas-emissions-2983.pdf>

³⁷ www.UK.gov 2017 Final UK greenhouse gas emissions national statistics

Figure 14.3: Forecast UK Transport Sector Emissions



Source: adapted from the Fifth Carbon Budget Central Scenario Dataset (2016)

Scheme Emission Baseline

14.6.4 The calculated emissions for the Do Minimum scenario cover the following life cycle modules:

- Road user carbon emissions;
- Maintenance and refurbishment of the Scheme; and
- Operational energy use for the Scheme.

14.6.5 Only these life cycle modules are included as they are the only stages relevant to an operational highway.

Road user carbon

14.6.6 The user carbon emissions for the Do minimum scenarios have been modelled in accordance with DMRB, Volume 11, Section 3, Part 1 Air Quality: HA 207/07. They are as follows:

- 2022 Opening Year: 10,910 tCO₂e
- 2037 Design Year: 12,562 tCO₂e

14.6.7 The data show an expected 15% increase in emissions between the Opening and Design Years. This is a result of an increase in vehicle kilometres travelled.

Operational Energy Use and Maintenance

14.6.8 Applying 0.29% of road user emissions as a reasonable worst-case value, the Scheme’s Do-Minimum scenario emissions for operational energy use and maintenance can be estimated as:

- 2022 Opening Year: 10,879 x 0.29% = 32 tCO₂e
- 2037 Design Year: 12,526 x 0.29% = 36 tCO₂e

Total Baseline Emissions

14.6.9 Based on the addition of the above, the total Scheme baseline emissions for the Do-Minimum scenarios are estimated to be as follows:

- 2022 Opening Year: 10,910 tCO₂e
- 2037 Design Year: 12,562 tCO₂e

Vulnerability of the Scheme to climate change

14.6.10 This section describes the baseline conditions, including a description of current local climate, past extreme weather events and projected changes in climate. In the detailed assessment phase, a comprehensive data and literature review will be produced that takes account of the latest science and evidence to capture recent and projected changes in climate and evidence of recent impacts related to extreme weather events.

14.6.11 Table 14.7 provides a summary the local climate, whilst Table 14.8 provides a summary of weather extreme records for south east and central Southern England.

Table 14.7: Writtle climate (1981 to 2010)

	Average Maximum Temperature (°C)	Average Minimum Temperature (°C)	Days of air frost (days)	Sunshine (hours)	Seasonal Rainfall (mm)	Days of rainfall >= 1 mm (days)	Monthly mean wind speed at 10m (knots)
Winter	8	1	32	182	145	30	n/a
Spring	14	4	19	189	79	18	n/a
Summer	22	11	12	278	82	18	n/a
Autumn	15	7	6	362	90	18	n/a
Annual	15	6	1	395	99	17	n/a

Table Source: <https://www.metoffice.gov.uk/public/weather/climate>. Winter is defined as December to February, Spring is March to May, Summer is June to August and Winter is September to November.

Table 14.8: Weather extreme records: South-East and Central Southern England

Variable	Value	Date	Location
Highest daily maximum temperature (°C)	38.5	10 August 2003	Faversham
Lowest daily maximum temperature (°C)	-19.5	14 January 1982	Lacock (Wiltshire)
Highest 155-minute total rainfall (UK)	169mm	14 August 1975	Hampstead (Greater London)

Table Source: <https://www.metoffice.gov.uk/public/weather/climate-extremes/#?tab=climateExtremes>

14.6.12 The UK Climate Projections 2009 summarises the projected changes in climate for London by the 2050s for the high emissions scenario as described below:

- The central estimate of increase in winter mean temperature is 2.5°C; it is very unlikely to be less than 1.4°C and is very unlikely to be more than 3.8°C. A wider range of uncertainty is from 0.9°C to 3.8°C.
- The central estimate of increase in summer mean temperature is 3.1°C; it is very unlikely to be less than 1.4°C and is very unlikely to be more than 5.2°C. A wider range of uncertainty is from 1.1°C to 5.2°C.
- The central estimate of increase in summer mean daily maximum temperature is 4.3°C; it is very unlikely to be less than 1.7°C and is very unlikely to be more than 7.4°C. A wider range of uncertainty is from 1.2°C to 7.4°C.
- The central estimate of increase in summer mean daily minimum temperature is 3.3°C; it is very unlikely to be less than 1.6°C and is very unlikely to be more than 5.7°C. A wider range of uncertainty is from 1.2°C to 5.7°C.
- The central estimate of change in annual mean precipitation is 0%; it is very unlikely to be less than -5% and is very unlikely to be more than 5%. A wider range of uncertainty is from -5% to 5%.
- The central estimate of change in winter mean precipitation is 16%; it is very unlikely to be less than 2% and is very unlikely to be more than 35%. A wider range of uncertainty is from 0% to 35%.
- The central estimate of change in summer mean precipitation is -19%; it is very unlikely to be less than -43% and is very unlikely to be more than 9%. A wider range of uncertainty is from -43% to 16%.

14.6.13 In the detailed assessment phase UKCP09 gridded data relevant to the study area will be presented.

14.7 Potential impacts

Effect of the Scheme on Climate

Construction Effects

14.7.1 The total construction phase emissions cannot yet be quantified due to lack of design data. However, it is known that the construction stage of the Scheme would have an overall adverse effect on climate, as it would give rise to emissions. These emissions would arise from the production of materials to be used in construction and those emitted onsite through construction activities (for example from emissions from diesel-fuelled construction plant).

14.7.2 Construction emissions will be calculated and presented as part of the ES.

Operation Impacts

14.7.3 The calculated operation phase emissions for the Do Something scenario, compared with the Do Minimum, are shown in [Table 14.9](#).

Table 14.9: Operation Stage Emissions for 2022 and 2037

Life Cycle	Emissions (tCO ₂ e)					
	2022 Do-Minimum	2022 Do-Something	Difference	2037 Do-Minimum	2037 Do-Something	Difference
Road User Carbon	10,879	12,716	+1,838	12,526	14,663	+2,137
Maintenance and Operation	32	37	+5	36	43	+6
Total Emissions	10,910	12,753	+1,843	12,562	14,706	+2,143

14.7.4 The Do Something scenario of the Scheme will generate an additional 1,843 tCO₂e in the Opening Year, and 2,143 tCO₂e in the Design Year compared with the Do Minimum. This is an increase in annual operational emissions of 17% for both years and corresponds to an increase in vehicle kilometres travelled

Comparison to UK Carbon Budgets

14.7.5 Highways England is committed to reducing GHG emissions wherever practicable and to supporting the UK Government in meeting its carbon reduction targets. Table 14.10 shows the proportion of the relevant carbon budgets that the Scheme would contribute, multiplied over the 5-year budget period. Table 14.11 shows how the Scheme compares as a proportion of the transport sector’s annual emissions as forecast in the fifth carbon budget central scenario.

Table 14.10: Comparison of Scheme to UK Government Carbon Budgets

Project Stage	Scheme tCO ₂ e per Carbon Budget Period	Relevant Carbon Budgets	UK Carbon Budget tCO ₂ e	Scheme Proportion of Budget
Construction	To be presented in the ES	3 rd carbon budget period	2,544,000,000	To be presented in the ES
Opening Year Operation	9,216	4 th carbon budget period	1,950,000,000	0.0005%
Design Year Operation	10,143	Beyond 5 th carbon budget	Not yet published by UK Government	-

Table 14.11: Comparison of Scheme to UK Transport Sector Forecast Emissions

Project Stage	Annual Scheme tCO ₂ e	Relevant Year	Forecast Transport Sector Emissions ³⁸	Scheme Proportion of Forecast Transport Sector Emissions
Construction	To be presented in the ES	2020	98,700,000	To be presented in the ES
Opening Year Operation	1,058	2022	93,400,000	0.001%
Design Year Operation	822	2037	Not yet published by UK Government	-

Significant Effects

- 14.7.6 Emissions have been calculated to contribute 0.0005% to overall carbon budgets and 0.001% to forecast emissions for the transport sector. It is considered that this magnitude of emissions from the Scheme will not have a significant effect on climate, in line with the position set out in the NN NPS.
- 14.7.7 However, although the emissions are shown as negligible against the UK national budgets, any increase in emissions will contribute to the UK’s ability to meet its targets. Mitigation measures to further reduce the Scheme’s impact are therefore proposed in section 14.8.

Vulnerability of the Scheme to climate change

Receptors

- 14.7.8 The potential impacts of changes in different climate variables (and impacts associated with extreme weather) on the Scheme receptors are identified in this section. Receptors may be summarised as roads and supporting infrastructure, including bridges, embankments, earthworks and drainage.

Potential impacts of climate on road infrastructure

- 14.7.9 As summarised in Table 14.10, these receptors are all susceptible to damage or disruption from climate-related hazards. However, not all climate-related impacts are threats and there are also likely to be opportunities brought about by climate change. This section describes the likely potential impacts (and opportunities) of climate change and extreme weather events on road infrastructure using relevant literature and expert opinion.
- 14.7.10 The weather can have a significant negative impact on the road network, which can often be running close to or at capacity in parts of the UK. In addition to landslips, the key impacts are associated with surface water and river flooding (see Chapter 8) as well as increased thermal loadings on roads and control equipment.

³⁸ This assumes that the transport sector continues to emit 26.9% of the UK’s total emissions, as in 2016, for the different budget periods

- 14.7.11 Currently 6,600 km of the road network is located in areas susceptible to flooding (ASC, 2016b). The cost of disruption from widespread flooding in 2007 was £200 million and a flood event of this disruptive scale could be possible on an annual basis by the 2080s (Chatterton et al., 2011).
- 14.7.12 Warmer summer temperatures will increase thermal loading on bridges and pavements causing expansion, bleeding and rutting which will need repairing. Repairs cannot be performed until temperatures reduce. The 2003 and 2006 heatwaves provide a useful temporal analogue of this impact (Willway et al., 2008; Defra, 2012b). Cold weather (including snow and ice) is currently a major cause of damage and disruption, causing 16% of all weather-related delays to the strategic road network in England between 2006 and 2014 (ASC, 2014). This is likely to reduce in the future, along with reduced winter maintenance costs (Arvidsson and Chapman, 2011).
- 14.7.13 Wind effects road operations as high sided vehicles can become unstable in gusts of wind over 45 mph, this is particularly significant on exposed sites such as bridges (ASC, 2016b). High winds can also damage roadside furniture, such as traffic signs, and blow nearby vegetation onto the road. There is no evidence for increased incidence (due to climate change) and most failures of objects (such as road signs) are considered to be due to inadequate foundations (Galbraith et al., 2005).

Table 14.12: Typical climate impacts on road infrastructure

Aspect	Impact: Precipitation (high and increasing)	Impact: Precipitation (low and decreasing)	Impact: Temperature (high and increasing)	Impact: Wind
Roads	<ul style="list-style-type: none"> • Flooding • Loss of strength of layer materials • Damage to structure and surfaces • Erosion of unpaved shoulders • Traffic disruption and congestion 	<ul style="list-style-type: none"> • Damage to thin surfaces and asphalt • More rapid binder deterioration 	<ul style="list-style-type: none"> • Ageing of bituminous binders • Softening, deformation and damage to bitumen in asphalt • Expansion and buckling of concrete roads and structures • Reduced visibility and operational disruption (fires) 	<ul style="list-style-type: none"> • Accumulation of debris • Wind-loading of structures
Bridges and culverts	<ul style="list-style-type: none"> • Increased river scour 		<ul style="list-style-type: none"> • Expansion and buckling of concrete roads and structures 	<ul style="list-style-type: none"> • Wind-loading of structures
Earthworks	<ul style="list-style-type: none"> • Increased slope instability • Soil saturation 	<ul style="list-style-type: none"> • Earthworks failure due to desiccation 		<ul style="list-style-type: none"> • Erosion

Aspect	Impact: Precipitation (high and increasing)	Impact: Precipitation (low and decreasing)	Impact: Temperature (high and increasing)	Impact: Wind
	<ul style="list-style-type: none"> Erosion of surface Undercutting Excessive vegetation growth 	<ul style="list-style-type: none"> Damage to vegetation and more difficult to establish erosion protection measure 		
Subgrade soils	<ul style="list-style-type: none"> Soil softening, erosion collapse and settlement Deformation of rigid structures 	<ul style="list-style-type: none"> Shrinkage and cracking 		
Drainage	<ul style="list-style-type: none"> Blockages Water accumulation Erosion and scour of structures and surfaces Softening of subsurface materials 	<ul style="list-style-type: none"> Erosion, silting and sedimentation 	<ul style="list-style-type: none"> Expansion, cracking and erosion Loss of vegetation 	
Construction	<ul style="list-style-type: none"> Difficult working conditions Excessive moisture in materials Reduced working periods and increased delays Water damage 	<ul style="list-style-type: none"> More dust Evaporation of construction water 	<ul style="list-style-type: none"> Enhanced reactions when cement Stabilising and drying of concrete Difficult working conditions Damage and disruption (fires) 	<ul style="list-style-type: none"> Difficult working conditions More dust Evaporation of construction water
Operation and maintenance	<ul style="list-style-type: none"> Additional damage and maintenance requirement Reduced opportunities maintenance Operational disruption 			

Climate vulnerability assessment

14.7.14 This section presents the findings of the scoping phase (Table 14.13). The sector (road infrastructure) sensitivity and the regional (London) geographic exposure to extreme weather and climate change has been appraised to determine the level of climate vulnerability in this scoping phase. This assessment is based on a review of supporting literature and expert review.

Table 14.13: Climate vulnerability assessment: Road infrastructure, London

Climate variable/hazard	Regional exposure	Sector sensitivity	Climate vulnerability
Average (air) temperature change (annual, seasonal, monthly)	High	Low	Low
Extreme (air) temperature (frequency and magnitude)	High	Moderate	Moderate
Average precipitation (annual, seasonal, monthly)	High	Low	Low
Extreme rainfall (frequency and magnitude)	High	High	High
Average wind speed change (annual, seasonal, monthly)	Moderate	Low	Low
Gales and extreme winds (frequency and magnitude)	Moderate	High	Moderate
Humidity	Moderate	Low	Low
Solar radiation	Moderate	High	Moderate
Sea level rise (plus local land movements), storm surge/tide	Low	High	Low
Water availability/drought	High	Low	Low
Flood (coastal and fluvial)	High	High	High
Subsidence and ground stability	Moderate	High	Moderate
Fog	Moderate	Moderate	Moderate
Storms (tracks and intensity), including storm surge	Low	High	Low
Snow, ice and hail	Moderate	High	Moderate
Storms and lightning	Moderate	Moderate	Moderate

Potential mitigation measures

Effect of the Scheme on climate change

14.7.15 Emissions will be mitigated by applying Highways England’s carbon reduction hierarchy:

- Avoid / prevent:
 - Maximise potential for re-using and / or refurbishing existing assets to reduce the extent of new construction required; and
 - Explore alternative lower carbon options to deliver the project objectives (i.e. shorter route options with smaller construction footprints).
- Reduce:
 - Apply low carbon solutions (including technologies, materials and products) to minimise resource consumption during the construction, operation, user’s use of the project, and at end-of-life; and

- Construct efficiently, using techniques (e.g. during construction and operation) that reduce resource consumption over the life cycle of the project;
- Remediate:
 - After addressing steps 1 and 2 projects will identify, assess and integrate measures to further reduce carbon through on or off-site offsetting or sequestration.

14.7.16 Potential mitigation measures relevant to the construction and operation stages of the Scheme are suggested below.

Table 14.14: Construction emissions mitigation measures

Life cycle module		Mitigation measures
Materials		Reduction of materials consumption should be carried out in accordance with the mitigation measures outlined in the Materials and Waste Chapter (Chapter 12). In addition, consideration should be given to alternative low carbon materials e.g. recycled aggregates, cement substitution etc.
Transport		Materials transportation should be reduced and/or avoided by minimising the quantity of materials required, as per A1-3 above. Additionally, where possible detailed design and procurement measures should be specified to minimise the necessity to source materials from long distances.
Construction Processes	Construction plant use	Construction plant emissions should be minimised by designing for efficient construction processes as part of design development. During construction plant emissions should be managed via the Construction Environmental Management Plan (CEMP), which should specify plant operator efficiency requirements.
	Construction water use	Construction water consumption should be minimised by designing for efficient construction processes as part of design development. During construction mains water consumption should be managed via the CEMP, which should specify reduction and reuse measures.
	Construction waste transportation	Reduction of waste generation should be carried out in accordance with the mitigation measures outlined in the Materials and Waste Chapter (Chapter 12).
	Construction waste off-site processing	Waste treatment/disposal should be carried out in accordance with the mitigation measures outlined in the Materials and Waste Chapter (Chapter 12).
	Employee commuting	Local contractors should be used where possible, reducing the distance driven by employees.

14.7.17 Operational emissions can be mitigated by designing a Scheme which minimises emissions from traffic and operational energy use. Potential mitigation measures for reducing in-use emissions are shown in Table 14.15.

Table 14.15: Operation emissions mitigation measures

Life Cycle Module	Mitigation Measures
Road user carbon	Mitigation of in-use emissions should be explored based on examination of traffic management scenarios over the network. Inclusion of Non-Motorised User (NMU) routes would encourage the utilisation of alternative means of transport, and help achieve the goal of creating a more integrated and sustainable transport network, whilst reducing emissions.
Maintenance and repair	The mitigation measures detailed in Table 14.12 for the construction stage are also application to ongoing maintenance and repair.
Operational energy use	Operational energy use should be minimised by designing for use of low energy lighting and traffic management systems, specification of controls that minimise on-time, and use of low carbon energy sources, where practicable.

Vulnerability of the Scheme to climate change

14.7.18 Table 14.16 summarises some potential mitigation measures for reducing vulnerability of road infrastructure receptors to climate impacts. During the detailed assessment phase (input into the ES) we will engage with the project teams, including engineers, to identify the provision of appropriate mitigation measures for High (and selected Medium) impacts.

Table 14.16: Selected impact mitigation measures for roads

Aspect	Proposed measure(s)
Roads and supporting infrastructure	Higher degree of compaction Appropriate structural designs, surfaces and construction Use different (harder) binders in asphalt Changes to concrete mixes and reinforcing Raise riding surface and appropriate drainage Accounting for climate risks in maintenance regimes Use of heat resistant surfacing materials Replacement of bridge expansion joints Provide shade for roads, footpaths and cycleways
Earthworks	Higher degree of compaction Appropriate drainage Appropriate structural design Maintenance Slope stabilisation measures Green infrastructure (deep-rooted, drought resistant vegetation) Isolation of susceptible soils Construct at in-service moisture conditions
Drainage	Appropriate structural design and construction Strengthen embankments and cuttings Modify extreme rainfall return periods in design Maintenance

Aspect	Proposed measure(s)
	Increase culvert and bridge openings Concrete and reinforcement Green/blue infrastructure
Construction	More night-time construction to avoid undue heat stress for construction workers Construct in dry season Greater use of unslaked lime Modified and innovative construction techniques Water efficiency measures Dust management plan
Operation and maintenance	Adequate resources and capacity in place Local community maintenance programmes More regular maintenance and preventative action Underpinning the efficiency and effectiveness of incorporated climate change adaptation measures Emergency planning for climate impacts Early warning systems and evacuation routes Monitoring and evaluation of asset resilience to inform climate change adaptation decision-making The incorporation of adaptation measures to existing assets during planned maintenance and repairs Water efficiency measures

Table Source: Various

14.8 Residual impacts

Effect of the Scheme on climate change

- 14.8.1 Due to the embedded nature of the mitigation measures proposed, some of which have already been incorporated into the design (for example, selection of route length) and some of which are yet to be incorporated, it is not practicable to complete a quantitative assessment of ‘before’ and ‘after’ mitigation. Rather, the assessment shows a snapshot of the current design.

Vulnerability of the Scheme to climate change

- 14.8.2 Current design standards and operational and maintenance practices are expected to provide a degree of resilience to climate risks. Design, construction and operational climate change adaptation measures may however be required to provide an appropriate degree of climate resilience over the life of the Scheme.

14.9 Cumulative effects

Effect of the Scheme on climate change

- 14.9.1 The effects of GHG emissions are essentially cumulative; it is their concentration in the atmosphere, not the actual level of emissions, that determines the warming effect (i.e. it is the ‘stock’ rather than the ‘flow’ which is important). In addition, it is the global excess of emissions from human activities all over the world that

contributes to the overall effect on climate, not only local emissions. For this reason, the impact of the Scheme should be considered in the context of overall emissions from the UK and globally. Compared with global emissions the scale of the impact of the Scheme is negligible. However, the overall effect on climate of GHG emissions is made up of many small emissions sources, of which this project would contribute.

Vulnerability of the Scheme to climate change

14.9.2 The Scheme may have an impact on the climate resilience of other projects and stakeholders. Also, climate change adaptation measures create wider cumulative impacts on other projects and stakeholders. These impacts may be positive or negative. The ES will consider the cumulative impacts for other projects and stakeholders in a climate change adaptation context.

14.10 NPS compliance

Effect of the Scheme on climate change

14.10.1 The NN NPS (paragraphs 5.16 to 5.19) acknowledges that the emissions from the construction and operation of a road scheme are likely to be negligible compared to total UK emissions, and are unlikely to materially impact the UK Government's ability to meet its carbon reduction targets. However, the NN NPS requires evidence of the emissions impact of a scheme, an assessment of the emissions against the Government's carbon budgets, and evidence of mitigation measures. The assessment presented in this chapter provides the required evidence and assessment against targets.

Vulnerability of the Scheme to climate change

14.10.2 Paragraphs 4.36 to 4.47 of the NN NPS how climate change adaptation should be considered in the environmental assessment. Section 10(3)(a) of the Planning Act requires the Secretary of State to have regard to the desirability of mitigating, and adapting to, climate change in designating an NPS.

14.10.3 New developments should be planned to avoid increasing vulnerability to climate change and to ensure that risks can be managed through suitable adaptation measures.

14.10.4 In compliance with the NN NPS the environment statement will take into account of:

- The potential impacts of climate change using the latest UK Climate Projections available;
- Identify appropriate risk mitigation or adaptation measures; and
- Demonstrate that there are no critical features of the design which may be seriously affected by climate change.

14.11 Summary

Effect of the Scheme on climate change

14.11.1 A quantitative assessment has not been possible for the construction phase of the Scheme due to unavailability of design data. This will be presented in the ES.

14.11.2 In terms of operation phase emissions, the Do Something scenario of the Scheme will generate an additional 1,843 tCO_{2e} in the Opening Year, and 2,143 tCO_{2e} in the Design Year compared with the Do Minimum due to an increase in vehicle kilometres travelled. This would contribute 0.0005% to the overall UK carbon budget annually, based on the Opening Year (4th carbon budget period). In line with the conclusions drawn in the NN NPS, it is not deemed that the Scheme would have a significant effect on climate.

Vulnerability of the Scheme to climate change

14.11.3 Table 14.17 outlines the findings from the climate vulnerability assessment. The following climate variables/hazards have been identified as High or Medium vulnerabilities for road infrastructure in London:

- Extreme (air) temperature (frequency and magnitude);
- Extreme rainfall (frequency and magnitude);
- Gales and extreme winds (frequency and magnitude);
- Solar radiation;
- Flood (coastal and fluvial);
- Subsidence and ground stability;
- Fog;
- Snow, ice and hail; and
- Storms and lightning.

Table 14.17: Findings of the scoping phase: climate vulnerability

Effects	Scoped in (✓) / out (✗)		Comment/Justification
	Construction	Operation	
Average (air) temperature change (annual, seasonal, monthly)	✗	✗	Low climate vulnerability
Extreme (air) temperature (frequency and magnitude)	✓	✓	Moderate climate vulnerability
Average precipitation (annual, seasonal, monthly)	✗	✗	Low climate vulnerability
Extreme rainfall (frequency and magnitude)	✓	✓	High climate vulnerability
Average wind speed change (annual, seasonal, monthly)	✗	✗	Low climate vulnerability

Effects	Scoped in (✓) / out (✗)		Comment/Justification
	Construction	Operation	
Gales and extreme winds (frequency and magnitude)	✓	✓	Moderate climate vulnerability
Humidity	✗	✗	Low climate vulnerability
Solar radiation	✓	✓	Moderate climate vulnerability
Sea level rise (plus local land movements), storm surge/tide	✗	✗	Low climate vulnerability
Water availability/drought	✗	✗	Low climate vulnerability
Flood (coastal and fluvial)	✓	✓	High climate vulnerability
Subsidence and ground stability	✓	✓	Moderate climate vulnerability
Fog	✓	✓	Moderate climate vulnerability
Storms (tracks and intensity), including storm surge	✗	✗	Low climate vulnerability
Snow, ice and hail	✓	✓	Moderate climate vulnerability
Storms and lightning	✓	✓	Moderate climate vulnerability

15. Assessment of Cumulative Effects

15.1 Introduction

- 15.1.1 Without prejudice to the findings of the forthcoming EIA, the cumulative effects chapter of the PEIR brings together the initial findings of each of the environmental topic areas, identifying and assessing the cumulative effects of the Scheme.
- 15.1.2 This assessment draws upon the guidance provided within the DMRB Volume 11, Section 2, Part 5: 'Assessment and Management of Environmental Effects' and the Planning Inspectorate (PINS) 'Advice Note Seventeen: Cumulative Effects Assessment' (December 2015), which are considered to represent best practice for cumulative effects assessments in relation to DCO projects.
- 15.1.3 As set out in IEMA Guidance (2011), in-combination (synergistic) and cumulative (additive) effects are defined as:
- Intra-projects effects or 'in-combination effects' (synergistic): These effects occur between different environmental topics within the same proposal and as a result of the development's direct effects i.e. combined effects from a single project (the inter-relationship between different environmental factors); and
 - Inter-project effects or 'cumulative effects' (additive): These effects occur as a result of the combined action of a number of different projects (defined as 'other development') cumulatively with the project being assessed and on a single resource or receptor i.e. cumulative effects from the other developments (with the project being assessed).

15.2 Methodology

In-combination (synergistic) effects

Study area

- 15.2.1 The study area for the assessment of in-combination effects of the Scheme reflects the study areas, also termed the spatial Zones of Influence (ZOI), identified within the relevant topic chapters of this PEIR (Chapters 5 to 14) as set out in Table 15.1.

Table 15.1: Zone of influence / Study area

Environmental topic	Zone of influence \ Study area
Air quality	<ul style="list-style-type: none"> • 200 m from roads affected by changes in traffic during construction; and • 200 m from the DCO boundary and other affected roads during operation.
Noise and Vibration	<ul style="list-style-type: none"> • For construction effects, 300 m from the construction footprint of the site and roads used by construction traffic. • For operational effects, 600 m from the carriageway edge of any proposed new routes or existing routes to be bypassed or improved, and 600 m from any other affected routes within 1 km of the proposed new routes or altered existing routes.

Environmental topic	Zone of influence \ Study area
Biodiversity	<ul style="list-style-type: none"> • 30 km for Special Areas of Conservation (SACs) where bats are a qualifying feature; • 5 km for bats; • 2 km for statutory designated sites of nature conservation importance, including European designated sites and nationally designated sites: (SAC, SPA, Ramsar, NNR, LNR) • 2 km for non-statutory LWSs and Roadside Nature Reserves (RNRs); • 1 km for notable habitats, ancient woodland, notable or legally protected species and invasive plant species; • 500 m for waterbodies; and, • 50 m for veteran trees.
Road Drainage and the Water Environment	<ul style="list-style-type: none"> • As a minimum, the catchment of any watercourses crossed by the Scheme; • Groundwater – assessed on the underlying Water Framework groundwater body; and • For cumulative effects any surface water outfalls originating from the scheme that outfall into the same watercourse will be considered. Any other developments that have the potential to discharge into the same watercourse or cross the same watercourse as the Scheme will also be considered.
Landscape	<ul style="list-style-type: none"> • Landscape effects within 1 km from the perimeter of the Scheme; and • Visual effects within 1 km from the edge of the Scheme.
Geology and Soils	<ul style="list-style-type: none"> • Within 500m of the DCO boundary.
Cultural Heritage	<ul style="list-style-type: none"> • Within 500m of the DCO boundary.
Materials and Waste	<ul style="list-style-type: none"> • For material resources, the study area includes the demand for key construction materials nationally; and • For waste, the study area includes the waste arisings and waste infrastructure capacity within the county of Essex (with the exception of hazardous waste which is considered at a national level).
People and Communities	<ul style="list-style-type: none"> • Within 500m of the DCO boundary
Climate Change	<ul style="list-style-type: none"> • Climate Change impact is in itself a cumulative effect of all human actions (including development) and therefore deemed not assessable at this inter and intra project scale. • Due to the inherent cumulative effects of Climate Change, in-combination effects these will be picked up in the environmental topic chapters e.g. Ecology, Road Drainage and the Water environment, Air Quality etc. and are therefore already assessed. For this reason, Climate Change has been excluded from the CEA to avoid repetition .The vulnerability of the Scheme to climate change includes the location of the Scheme alongside the Met Office UK Climate Projections 25 km gridded data (see Figure 14.1). Figure 14.2 shows the location of the Scheme within the broader context of the Thames river basin as the Scheme may be at risk of localised fluvial flooding.

Methodology

- 15.2.2 The methodology for the in-combination effects follows DMRB Volume 11, Section 2, Part 5: Assessment and Management of Environmental Effects.
- 15.2.3 The assessment methodology for in-combination effects requires the identification of impact interactions associated with the Scheme on key environmental receptors. This ensures that the ES will not be a series of separate assessments collated into one document, but rather a comprehensive assessment drawing together all the environmental effects of the proposals.
- 15.2.4 The effects will be identified within the technical topic chapters (chapters 5-14) in the ES and will be assessed to identify potential in-combination effects using professional judgement and a qualitative assessment approach.
- 15.2.5 The receptors to be considered in the ES will be sub-divided into the following groups:
- Human - residents, including community and private assets, sensitive receptors and vulnerable groups;
 - Human - all travellers, i.e. vehicle travellers, cyclists, and pedestrians;
 - Ecological receptors – protected species and existing habitats;
 - The water environment;
 - Heritage assets;
 - Geology and soils; and
 - Landscape and townscape;
- 15.2.6 Within these broad groups, individual receptors or groups of receptors that could be affected by the proposals will also be considered. The potential effects acting upon these receptors are primarily changes in traffic, noise, air quality, visual effects, and the physical environment (i.e. water, ecology, heritage). The assessment considers residual effects after mitigation has been taken into account, with the exception of Landscape which considers the time required for the mitigation to be established (15 years) from the opening year. Receptors that are significantly adversely affected by two or more residual effects have then been identified and the range of effects likely to impact upon specific groups of receptors is described.
- 15.2.7 Combined effects of moderate adverse or beneficial and above will be considered significant.
- 15.2.8 As in-combination effects assessments require detailed assessments from the previous chapters it is not included here in the PEIR.

Cumulative (additive) effects

Study area

- 15.2.9 The study area for the identification of 'other developments' for inclusion in the assessment of cumulative effects is based upon thresholds and spatial areas. These thresholds and spatial areas are based upon professional judgement and taking into account the nature and location of the Scheme and the ZOIs for individual environmental topics.

- 15.2.10 The thresholds and spatial areas have been defined as follows, recognising that larger, more significant, developments will have wider ranging environmental effects than smaller and more local developments:
- NSIPs – All projects listed on the PINS programme of Projects - 10 km from the DCO boundary;
 - Regionally Significant Projects – all regionally important projects included in the traffic model – 3 km from the DCO boundary;
 - Major development – within and 1.5 km from the DCO boundary; and
 - Minor development – within the DCO boundary.
- 15.2.11 Nationally significant projects are those that are listed on the PINS Programme of Projects.
- 15.2.12 The definition of a Regionally Significant Project, is a project that has been included within the traffic model and therefore deemed to be of regional significance. This is in line with the traffic model for the Scheme. It is not considered appropriate to align the assessment with the complete scale of the transport model for the Scheme as this includes data from across the whole country, selected significant major developments within the whole of Brentwood Borough Council and London Borough of Havering as well as accounting for general growth.
- 15.2.13 Major development and Minor development has been defined in accordance with Article 2 of the Town and Country Planning Development Management Procedure (England) Order 2015. Thresholds for a major development includes more than 10 new houses, a site area of 0.5 ha and all mineral and waste developments.
- 15.2.14 For the cumulative effects assessment, the study area reflects that used in the Traffic Model, ensuring that the list of ‘other developments’ align with the ‘other development’ included in the traffic model.
- 15.2.15 The assessment of cumulative effects is based on a topic-by-topic identification of where the ZOIs for the Scheme and ZOIs for ‘other developments’ overlap, and therefore have potential for cumulative effects.

Methodology

- 15.2.16 To enable a reasonable and proportionate assessment, the following selection criteria has been used to identify and determine ‘other development’ which could result in potential cumulative effects with the Scheme in accordance with Table 3 in Advice Note 17:
- Projects on the Infrastructure Planning Commission’s (IPC)1 Programme of Projects;
 - Trunk road and motorway projects which have completed the statutory planning processes, including those under construction;
 - Other development projects under construction or with valid planning permissions, and for which formal EIA is a requirement or for which non–statutory EIA has been undertaken;
 - Applications for consent which have been made, but which have not yet been determined;

- Projects identified in the relevant emerging or adopted Development Plans, with appropriate weight given as they move closer to adoption, recognising that information on these proposals may be limited at present; and
- Projects identified in other plans and programmes which set the framework for future development consents/approvals, where such development is reasonably likely to come forward.

15.2.17 The developments in the above categories will only be considered in the assessment if they are considered to be ‘reasonably foreseeable’ and ‘committed’, in line with the guidance in DMRB Volume 11, Section 2, Part 5 HA 205/08.

15.2.18 The ‘other developments’ identified will then be grouped into tiers in accordance with PINS Advice Note. This grouping reflects the likely degree of certainty attached to each development, with Tier 1 being the most certain and Tier 3 being the least certain and most likely to have limited publicly available information to guide the assessment. A description of the tiers is provided in Table 15.2.

Table 15.2: Hierarchy of ‘Other Development’


Tier	Likely Degree of Certainty	
Tier 1	<ul style="list-style-type: none"> a) Under construction b) Permitted application(s) whether under the Planning Act 2008 or other regimes but not yet implemented. c) Submitted application(s) whether under the Planning Act 2008 or other regimes but not yet determined. 	Decreasing level of detail likely to be available 
Tier 2	<ul style="list-style-type: none"> a) Projects on the Planning Inspectorate’s Programme of Projects where a Scoping Report has been submitted. 	
Tier 3	<ul style="list-style-type: none"> a) Projects on the Planning Inspectorate’s Programme of Projects where a Scoping Report has not been submitted. b) Identified in the relevant Development Plan (and emerging Development Plans – with appropriate weight being given closer to adoption) recognising that information on any relevant proposals will be limited. c) Identified in other plans and programmes (as appropriate) which set the framework for future development consents/approvals where such development is reasonable likely to come forward. 	

Table Source: PINS advice note 17

15.2.19 Rather than reporting every interaction, the methodology for the assessment of cumulative effects concentrates on the main significant effects, and aims to differentiate between permanent, temporary, direct, indirect and secondary effects, positive or negative.

15.2.20 Where significant cumulative effects, beyond those identified as residual effects from the Scheme in isolation, have been identified, additional mitigation measures are recommended.

15.2.21 The significance of cumulative effects on each environmental receptor group has then been made based on the balance of scores and using professional judgement.

Traffic related effects

- 15.2.22 Several environmental topic assessments have a basis in information relating to the road network and quantity of traffic. For the operation phase, the information used is derived from a traffic model. The traffic model used for the Scheme operation is based on the Lower Thames Crossing model. This takes in data from across the South East region including all the traffic generated by the operation of major development likely to come forward before, during and after the Scheme has been built.
- 15.2.23 The topics that make significant use of the traffic model are Air Quality and Noise and Vibration (Chapters 5 and 6 respectively). Certain information from the traffic model will also influence People and Communities (Chapter 13), for example, calculations for driver’s stress.
- 15.2.24 For these chapters and assessments, cumulative effects will inherently be assessed using a wider range of development information than more localised effects and assessments.

Significance criteria

- 15.2.25 The assessment of significance of in-combination and cumulative effects has been undertaken in accordance with guidance in DMRB Volume 11, Section 2, Part 5 (HA205/08). The value and magnitude of impact has been determined by the criteria set within the individual topic chapters of this ES and applied to any residual effects. The description of significance also takes account of the guidance in PINS Advice Note 17 to consider the capacity of environmental resources and receptors to accommodate any changes that are likely to occur. Paragraph 3.4.8 states that consideration should be given to the following:
- The duration of effect, i.e. temporary or permanent;
 - The extent of effect, e.g. the geographical area of an effect;
 - The type of effect, e.g. whether additive (e.g. loss of two areas of woodland of 1 ha, resulting in 2 ha cumulative woodland loss) or synergistic (e.g. two discharges combine to affect a species which is not affected by a single discharge);
 - The frequency of the effect;
 - The ‘value’ and resilience of the receptor affected; and
 - The likely success of mitigation.
- 15.2.26 Table 15.3 provides typical descriptors of effects in determining the significance of effect category for the combined and cumulative effects assessment. Effects are considered to be significant if moderate, large or very large.

Table 15.3: Significance Criteria

Significance Category	Typical descriptors of effects resulting from the in-combination or cumulative effects of the scheme.
Very Large (Adverse or Beneficial)	Effects that the decision-maker must take into account as the receptor/resource is irretrievably compromised. Effects would be: <ul style="list-style-type: none"> • Permanent and far reaching for receptors of very high value. • Key factor in decision making proves

Significance Category	Typical descriptors of effects resulting from the in-combination or cumulative effects of the scheme.
	<ul style="list-style-type: none"> • Damaging impact for site or feature of international, national or regional importance • May include major change in a site or feature of local importance
Large (Adverse or Beneficial)	<p>Effects that may become key decision-making issue. Effects would be:</p> <ul style="list-style-type: none"> • Permanent and far reaching for receptors of high value; • Localised for a receptor of very high value; and • Temporary for receptor of very high value. <p>Very important consideration and material in the decision-making process,</p>
Moderate (Adverse or Beneficial)	<p>Effects that are unlikely to become issues on whether the project design should be selected, but where future work may be needed to improve on current performance. Effects would be:</p> <ul style="list-style-type: none"> • Permanent and far reaching for receptors of medium value; • Localised for receptors of high value; and • Temporary for a receptor of high value. <p>Effects may be important, but are not likely to be key decision-making factors</p>
Slight (Adverse or Beneficial)	<p>Effects that are locally significant. Effects would be:</p> <ul style="list-style-type: none"> • Permanent and far reaching for receptors of low value; • Localised for receptors of medium value; and • Temporary for a receptor of medium value. <p>Unlikely to be critical in the decision-making process</p>
Neutral	<p>Where the positive or negative effects of the Scheme or the combined effects of the Scheme in association with other existing or more than likely / near certain future major developments would balance.</p> <p>No effects or those that are beneath levels of perception, within normal bounds of variation or within the margin of forecasting error.</p>

Table Source: Based on Table 2.6 of DMRB Volume 11 Section 2 Part 5 HA 205/08

Interaction with other projects

15.2.27 The traffic model will take account of the operational effects of major developments in the area and the wider surrounding region.

Trunk Road projects

15.2.28 The following proposed major highway interventions are also consented within the study area:

- A12 J19 Chelmsford to J25/A120 interchange widening scheme- anticipated start date in March 2020. Work is currently being undertaken on the preferred route with a second public consultation intended in Autumn 2017; and
- Lower Thames Crossing- the preferred route was announced in April 2017. The new crossing is anticipated to increase capacity by an additional 70% by connecting Essex and Kent; and

- M25 J25 improvements – the construction start date is anticipated in 2020-2021.

15.2.29 None of the above have completed the statutory planning process, with the exception of M5 J30/A13 which has been completed.

15.2.30 The main source of data for the cumulative effects assessment will be the outcomes and information obtained from the individual environmental topic assessments. The assessment of cumulative effects arising from the Scheme options in combination with other schemes will primarily constitute a desk-top study of planning documents broadly covering the location of schemes (if any are identified) considered relevant to the assessment.

Table 15.4: Proposed developments to be considered in the cumulative effects assessment

Proposal	Council area / Region	Documentation
Crossrail Approx. 400 m from site	Brentwood and Havering	Brentwood Replacement Local Plan 2005 Brentwood Draft Local Plan 2016 Havering Core Strategy and Development Control Policies DPD 2008
Gypsy and Traveller Site at The Caravan Park, Putwell Bridge Approx. 500 m from site	Havering	LB Havering (Proposals Map Changes July 2017)
Small, Medium, Large Wind Development Sites Approx. 500 m from site	Havering	LB Havering (Proposals Map Changes July 2017)
Cycleway Proposals Approx. 500 m from site	Brentwood	Brentwood Borough Council (adopted)
Change of use of land to burial grounds including removal of existing agricultural buildings and erection of two pavilion buildings for associated usage, hard and soft landscaping, new access to A12 and internal roads and paths, parking, and workshop area for storage of associated equipment, tools and materials. Approx. 500 m from site	Havering	Planning application – permitted P1742.14.
001A & 001B Land north of Highwood Close including St Georges Court, Brentwood 52 dwellings Approx. 2,800 m from site	Brentwood	Brentwood Draft Local Plan Site Allocation Maps 2016
010 Sow and Grow Nursery, Ongar Road, Pilgrims Hatch 37 dwellings Approx. 3,300 m from site boundary	Brentwood	Brentwood Draft Local Plan Site Allocation Maps 2016
013B Warley Training Centre, Essex Way, Warley 50 dwellings Approx. 2,300 m from site	Brentwood	Brentwood Draft Local Plan Site Allocation Maps 2016

Proposal	Council area / Region	Documentation
022 Land at Honeypot Lane Brentwood The proposal is for 250 residential units Approx 1,850 m from site	Brentwood	Request for Screening Opinion - Environmental Impact Assessment Brentwood Draft Local Plan Site Allocation Maps 2016
039 Westbury Road Car Park, Westbury Road, Brentwood 22 dwellings Approx. 2,100 m from site	Brentwood	Brentwood Draft Local Plan Site Allocation Maps 2016
040 Chatham Way/ Crown Street Car Park, Brentwood 26 dwellings Approx. 2,600 m from site	Brentwood	Brentwood Draft Local Plan Site Allocation Maps 2016
041 Land at Hunter House, Western Road, Brentwood 22 dwellings Approx. 2,400 m from site	Brentwood	Brentwood Draft Local Plan Site Allocation Maps 2016
081 Council Depot, The Drive, Warley 68 dwellings Approx. 2,700 m from site	Brentwood	Brentwood Draft Local Plan Site Allocation Maps 2016
099 Victoria Court, Victoria Road, Brentwood 40 dwellings Approx. 2,600 m from site	Brentwood	Brentwood Draft Local Plan Site Allocation Maps 2016
100 Baytree Centre, Brentwood 200 dwellings Approx. 2,800 m from site	Brentwood	Brentwood Draft Local Plan Site Allocation Maps 2016
032 Housing development Proposal for 150 residential units Approx. 650 m from site	Brentwood	Brentwood Draft Local Plan 2016 (expected adoption date 2017) Supporting Document: Site Allocation Maps 2016
Minor	Effects that are locally significant.	
Not significant	Effects that are beyond the current forecasting ability or are within the ability to absorb such change.	

Table Source: DMRB, Volume 11, Section 2, Chapter 3 (DMRB Table 2.6)

15.3 Potential impacts

15.3.1 The following table presents the preliminary cumulative effects assessments from each of the topic chapters.

Table 15.5: Cumulative effects assessment

Environmental topic	Construction Cumulative Effects	Operational Cumulative Effects
Air Quality	<p>In-combination Any air quality effects due to construction would be temporary and could be suitably minimised by the application of standard and appropriate mitigation measures. On this basis, there is unlikely to be a significant effect on air quality due to the construction of the Scheme.</p> <p>Cumulative During construction none of these are likely to affect receptors within the air quality study area for construction, hence there are unlikely to be any cumulative air quality effects arising during the construction phase.</p>	<p>In-combination The Scheme is not expected to have a significant effect on human health. As no mitigation measures are proposed, the residual impacts will be the same as those without mitigation.</p> <p>Cumulative The traffic model at Preliminary Design Stage will include additional traffic from all relevant committed development. The air quality assessment at the ES stage will therefore take into consideration cumulative effects during operation. The status of committed developments in the area will also be reviewed at Preliminary Design Stage.</p>
Noise and Vibration	<p>In-combination Temporary environmental noise barriers can reduce noise levels by up to 10dB, however, this depends on the barrier's dimensions and the position of the nearest receptors relative to the construction site. Once baseline noise monitoring results and construction phase information are available, further assessment will be undertaken to establish whether temporary environmental noise barriers would provide any significant noise reduction.</p> <p>Cumulative Not assessed at this stage.</p>	<p>In-combination The use of mitigation measures such as low noise road surfacing and environmental noise barriers. The benefits of environmental noise barriers will be investigated further during the detailed design stage once updated traffic data is available.</p> <p>Cumulative The traffic model used in the assessment takes into account the effects of major residential and employment developments proposed in the wider area, as these will affect traffic volumes. The impact of these developments is therefore considered in the operation phase assessment.</p> <p>No cumulative effects are expected to arise for the smaller residential developments as detailed within Table 15.1.</p>
Biodiversity	<p>In-combination Construction related impacts will be mitigated through implementation of the CEMP. There may be significant temporary residual effects on Ingrebourne Valley SMI. The extent of habitat loss for temporary construction areas is not known at this stage but is anticipated to have a residual neutral effect. Potential temporary adverse effect on amphibians due to habitat loss.</p>	<p>In-combination The Scheme is considered likely to have a long-term neutral to beneficial effect on the Ingrebourne Valley SMI. Long term improvements to habitat quality at Weald Brook and River Ingrebourne are anticipated. Consequently, slight beneficial effects are likely for aquatic and terrestrial invertebrate species. Fish habitats are also likely to see long term improvements. Long term moderate residual benefits for amphibians.</p>

Environmental topic	Construction Cumulative Effects	Operational Cumulative Effects
	<p>Neutral effects during construction after mitigation are anticipated for all other assessed species and habitats.</p> <p>Cumulative</p> <p>The London Borough of Havering Local Plan Proposals Map identifies areas suitable for wind energy development including land for large, medium or small wind development sites within 500 m to the west of the Scheme. Construction of a wind energy development at this location has the potential for cumulative impacts in combination with the Scheme on designated sites (in particular Ingrebourne Valley SMI), as well as bats and great crested newts.</p>	<p>Overall a beneficial effect is likely as a result of habitat compensation areas.</p> <p>Cumulative</p> <p>Without adequate mitigation, there could potentially be an effect on the populations of great crested newts in proximity to the Scheme of moderate significance, and an effect on bat populations in proximity to the Scheme of slight significance. Mitigation and enhancement measures as detailed for this Scheme may reduce cumulative effects, especially if additional measures are applied for later developments (and suitable maintenance of habitat areas is ensured), to a level that is not significant.</p>
Road Drainage and the Water Environment	<p>In-combination</p> <p>With the adoption of mitigation measures it is considered there will be no residual significant effects on surface water quality during construction.</p> <p>Cumulative</p> <p>For all schemes in the vicinity, identified in Table 15.1 in Chapter 15, drainage strategies should be in place or proposed for these developments. These separate systems should accommodate temporary drainage requirements during the construction phases and appropriate mitigation that should ensure minimal impacts to water quality through construction and operational phases. It is therefore concluded that there will be no significant adverse cumulative effects during construction or once operational.</p>	<p>In-combination</p> <p>With the adoption of mitigation measures, there will be no permanent residual significant effects on the water environment.</p> <p>The design does include components (e.g. realignments and bank protection) that have the potential to cause minor or localised adverse effects. However, mitigation in accordance with WFD design principles would minimise these adverse effects.</p> <p>The Scheme also includes components with potentially beneficial effects on the water environment. In particular, proposed realignments present an opportunity to restore sections of channel to more natural form and function, including the creation of wet-woodland habitat which in turn, improves the ecological diversity.</p> <p>Cumulative</p> <p>Six of the developments outlined in Table 15.1 could have potential cumulative impacts. The magnitude of cumulative impact for the remaining 10 developments during both construction and operation is considered neutral and significance negligible as no connectivity to the receptors identified for the scheme are in hydraulic connectivity to this development. Therefore, these have not been assessed at this stage.</p>
Landscape and Visual Effects	<p>In-combination</p> <p>The construction phase of the Scheme would likely result in noticeable disruption to field patterns, and partial loss/ noticeable</p>	<p>In-combination</p> <p>The operational phase of the Scheme would likely result in noticeable disruption to field patterns, and partial loss/ noticeable damage to the</p>

Environmental topic	Construction Cumulative Effects	Operational Cumulative Effects
	<p>damage to the distinctive landscape elements of Alder Wood and areas of vegetation local to the highway corridor.</p> <p>During construction, the significance of the landscape impact of the Scheme may be considered Moderate Adverse as the proposals would have an adverse impact on characteristic landscape features or elements.</p> <p>During the construction phase, the following visual receptors are expected to experience significant visual effects as a result of the Scheme:</p> <p>Moderate Adverse visual impacts are expected for:</p> <ul style="list-style-type: none"> • Residents of properties along Spital Lane, Wingrave Crescent, and Leonard Way. <p>During the construction phase, the following visual receptors are also expected to experience significant visual effects:</p> <p>Very Large Adverse visual impacts are expected for:</p> <ul style="list-style-type: none"> • Residents of Grove Farm; • Residents of Maylands Cottages; and • Patrons of Maylands Golf Course. <p>Moderate Adverse visual impacts are expected for:</p> <ul style="list-style-type: none"> • Residents of Oak Farm; • Residents of May Cottage and Freeman's Cottage; • Residents of French's Farm; • Users of the bridleway following Nag's Head Lane and along the crest of the M25 cutting; and • Users of the public footpaths located along the Wigley Bush Lane overbridge. 	<p>distinctive landscape elements of Alder Wood and areas of vegetation local to the highway corridor.</p> <p>During operation, the significance of the landscape impact of the Scheme may be considered Moderate Adverse as the proposals would have an adverse impact on characteristic landscape features or elements.</p> <p>The operational visual impacts of the Scheme will be long term and permanent, although it is expected that the proposed planting will mature gradually following the construction.</p> <p>During the operational phase, the following visual receptors are also expected to experience significant visual effects:</p> <p>Very Large Adverse visual impacts are expected for:</p> <ul style="list-style-type: none"> • Residents of Grove Farm; • Residents of Maylands Cottages; and • Patrons of Maylands Golf Course. <p>Moderate Adverse visual impacts are expected for:</p> <ul style="list-style-type: none"> • Residents of Oak Farm; • Residents of May Cottage and Freeman's Cottage; • Residents of French's Farm; • Users of the bridleway following Nag's Head Lane and along the crest of the M25 cutting; and • Users of the public footpaths located along the Wigley Bush Lane overbridge. <p>Cumulative</p> <p>Of the three developments assessed at this stage, it is suggest that the development of Crossrail and the cycleway would be unlikely have any significant cumulative landscape or visual effects as any loss or damage to existing landscape character, features or elements would likely be set within the context of these linear sites only, and that only a very small part of the development would likely be discernible or would be at such a distance that it would form a barely noticeable feature or element in views.</p> <p>Regarding the permitted change of use of land from agriculture to burial grounds, it is considered that the removal of existing agricultural buildings</p>

Environmental topic	Construction Cumulative Effects	Operational Cumulative Effects
		and erection of two pavilion buildings, along with associated hard and soft landscaping and new access on to the A12, would also be unlikely to have any significant cumulative landscape and visual effects.
Geology and Soils	<p>In-combination The construction phase could potentially introduce new sources of contamination and may also introduce new pathways for migration of existing contamination without appropriate mitigation. Through the construction phase, potential impacts to human health, controlled waters and property receptors during construction are likely to be negligible.</p> <p>Construction activities and land clearance have the potential to increase soil erosion and degrade soil quality. The Scheme could also impact the ground in areas where geological stability hazards have been identified.</p> <p>Therefore potentially 35 ha of agricultural land may be taken in the construction phase, of which, 28 ha is temporary land-take and will be returned to the owners following development. A minor construction impact may be an interference to local field drainage systems on the surrounding land.</p> <p>Cumulative Not assessed at this stage.</p>	<p>In-combination Potential impacts during the operational phase include changes to physical properties and ground instability.</p> <p>Around 7 ha of agricultural land will be permanently taken. This includes 5 ha for the new road and 2 ha of permanent severance of grassland belonging to Glebelands Estates between “the loop” and the Ingrebourne River.</p> <p>It is anticipated that with the incorporation of mitigation measures during construction and within the design no residual impacts and / or beneficial impacts are expected due to the Scheme.</p> <p>Cumulative Only the Gypsy and Traveller Site at the Caravan Park, Putwell Bridge, located within the red line boundary, is likely to cause cumulative effects. The proposed development does not include large scale groundworks. However, the proposed development has the potential to introduce new receptors for the construction and operational phases of the Scheme. Crossrail is not anticipated to have cumulative effects. All improvement works scheduled to be completed by mid-2018 and the line operational end 2018. No new receptors introduced.</p>
Cultural Heritage	<p>In-combination Where buried archaeological remains are directly impacted by construction, and has subsequently been excavated and recorded, there is unlikely to be any residual impacts as these remains will be have been mitigated through a programme of archaeological fieldwork.</p> <p>Cumulative It is anticipated that no cumulative effects will result from the construction of the Scheme in conjunction with the construction of other schemes, on below ground archaeology post mitigation.</p>	<p>In-combination At present one potentially moderate adverse effect has been identified as a result of the Scheme's operation. It is anticipated that these moderate adverse effects will be either reduced or possibly even removed following full implementation of mitigation measures.</p> <p>Cumulative Cumulative effects on the setting of heritage assets, principally The Grove, may result from the operation of the Scheme and surrounding developments (particularly the small, medium and large wind developments and Crossrail), however it is not thought that this effect would be significant</p>

Environmental topic	Construction Cumulative Effects	Operational Cumulative Effects
Materials and Waste	<p>In-combination Receptors which have the potential to be impacted by material resources use and waste generation, are defined as:</p> <ul style="list-style-type: none"> • The market for key construction materials, which are to be used throughout the Scheme; • MSAs as defined by the Essex Minerals Local Plan 2014; • The waste arisings baseline - the amount of waste that is predicted to be produced during the CD&E phases of the Scheme and • The predicted capacity of waste infrastructure both regionally (non-hazardous and inert) and nationally (hazardous). <p>Cumulative A review of relevant planning applications will be carried out as part of the ES to assess the cumulative impacts of other proposals which may affect material resources and identified waste receptors.</p>	<p>In-combination Scoped out of assessment. Cumulative A review of relevant planning applications will be carried out as part of the ES to assess the cumulative impacts of other proposals which may affect material resources and identified waste receptors.</p>
People and Communities	<p>In-combination It is anticipated that there will be moderate adverse effect on private dwellings (land take and severance) on the private dwellings at Grove Farm. Slight adverse residual impacts are anticipated to VTs, NMUs, development land, community assets and private dwellings during the construction phase. Cumulative Two potential cumulative effects are identified. The potential wind farm sites within Maylands Golf Course, if developed during the construction phase of the Scheme, may exacerbate negative impacts to this community asset. However, the cumulative effect would be temporary and not significant.</p>	<p>In-combination Slight adverse residual impacts are anticipated to private dwellings, community assets' and NMU amenity, and VTs' view from the road during the operational phase. No significant residual effects anticipated. Cumulative The proposed cycleways to the south of the Scheme, if completed before the proposed scheme is operational, could act to reduce negative amenity or severance impacts on NMUs.</p>
Climate Change	<p>In-combination Effect of the Scheme on climate change: Due to the embedded nature of the mitigation measures proposed, some of which have already been incorporated into the design (for example, selection of route length) and some of which are yet to be incorporated, it is not practicable to complete a quantitative assessment of 'before' and 'after' mitigation. Rather, the assessment shows a snapshot of the current design.</p>	

Environmental topic	Construction Cumulative Effects	Operational Cumulative Effects
	<p>Vulnerability of the Scheme to climate change: Current design standards and operational and maintenance practices are expected to provide a degree of resilience to climate risks. Design, construction and operational climate change adaptation measures may however be required to provide an appropriate degree of climate resilience over the life of the Scheme.</p> <p>Cumulative Effect of the Scheme on climate change: The effects of GHG emissions are essentially cumulative; it is their concentration in the atmosphere, not the actual level of emissions, that determines the warming effect (i.e. it is the ‘stock’ rather than the ‘flow’ which is important). In addition, it is the global excess of emissions from human activities all over the world that contributes to the overall effect on climate, not only local emissions. As such, emissions assessment considered in the EIA will inherently consider the cumulative impacts of other proposals, and the wider UK emissions.</p> <p>Vulnerability of the Scheme to climate change: The Scheme may have an impact on the climate resilience of other projects and stakeholders. Also, climate change adaptation measures create wider cumulative impacts on other projects and stakeholders. These impacts may be positive or negative. The ES will consider the cumulative impacts for other projects and stakeholders in a climate change adaptation context.</p>	

16. Summary

- 16.1.1 This PEIR represents the preliminary assessment stage in the EIA process and sets out the methodology for the assessment of the environmental impacts which have potential to arise due to construction and operation of the Scheme. This PEIR sets out the basis for a comprehensive assessment of the environmental effects of both of these elements of the Scheme, the results of which will be presented in the ES.
- 16.1.2 A summary of the environmental impacts for each environmental topic is presented in Table 16.1.

Table 16.1: Summary of impacts

Topic	Environmental impacts	Mitigation to reduce the impact	Significance of effect
Air Quality	Construction: dust from construction activities and increase in vehicle movement.	Good practices measures in the CEMP including; water-spraying and sweeping of unpaved roads, wheel washes, sheeting vehicles, speed limits, damping down surfaces, and suitable storage. Implementing a travel plan to minimise traffic movements.	To be provided in the ES.
	Operation: regional emissions of pollutants (NO _x , PM ₁₀ and CO ₂) are expected to increase.	No significant impacts are expected from the Scheme but further mitigation options will be examined for the ES.	
Noise and Vibration	Construction: increased noise levels from demolition works and piling, earthworks, retaining wall construction, vehicle movements and road works.	Good practise measures in the CEMP including; fitting vehicles with exhaust silencers, using 'sound reduced' machinery, using mufflers, installing noise barriers, limit working hours. Undertake monitoring and auditing procedures.	To be provided in the ES.
	Operation: increased noise levels from changes in vehicle activity and distance between carriageways.	No significant impacts are expected as a direct result of the Scheme but mitigation requirements will be examined further in the ES. Noise barriers, earth bunds or low noise road surfacing maybe retained by the Scheme.	
Biodiversity	Construction: loss of habitat to the northern section of the Ingrebourne Valley SMI, change of habitat, hydrology and water quality to the River Ingrebourne, noise and visual disturbance on The Oaks LWS Lower Vicarage Woods LWS, Jermain's Wood LWS and Jackson's Wood/Tyler's Shaw LWS as well as on badgers, loss of semi-improved grassland, the watercourses and broadleaved plantation woodland at Alder Wood, potential impacts on habitats for aquatic and terrestrial invertebrates, amphibians, reptiles, fish, otters and badgers, loss of breeding habitat and potential harm to nesting birds species, lighting could impact on foraging and commuting bat species and the spread of Himalayan balsam and goats rue and goldenrod. There could be potential impacts on Lower	Good practise measures in the CEMP including; precautionary methods of working (PMW) to minimise risk to individual animals of protected species where licences are not required, avoiding sensitive seasons for notable or protected species and putting in place pollution prevention measures, compensation for loss of habitat, enhance and restore retained habitats, avoid areas of notable plants, management to avoid spread of invasive species, vegetation clearance to be undertaken outside of the bird breeding season and bird and bat boxes in the Scheme area will be installed. A method statement for the management and removal of Himalayan balsam will be developed.	Ranging from certain, permanent and non-reversible to indirect, temporary, reversible impacts.

Topic	Environmental impacts	Mitigation to reduce the impact	Significance of effect
	Vicarage Wood, an ancient woodland site and on pennyroyal in storage areas and access routes.	An EMP will ensure the appropriate creation and long term management of features.	
	Operation: lighting may impact bat species if directed onto key commuting / foraging routes. The creation of the new meander along the river will potentially create more suitable habitat for fish and invertebrate species.		Ranging from direct, negative, certain and permanent to slight, positive significance.
Road Drainage and the Water Environment	Construction: excavation of materials, deposition of soils, sediment or other construction materials, damage to bed and banks of watercourses, spillage of contamination liquids, runoff from construction site, disturbance of non-native invasive species and de-watering impacts on groundwater levels.	Good practice measures in the CEMP. All works undertaken with regard to the PPGs. Specific mitigation for temporary watercourse diversion. Close communications with the Environment Agency. Sustainable drainage solutions incorporated into the design using National SuDS techniques. Bunding and testing will be implemented where required. Pollution spillage cleaning facilities will be installed.	Temporary
	Operation: contamination from road run off during rainfall, surface and groundwater quality and flow from increased impermeable area, pollution incidents from spillages and disruption of natural hydraulic and sediment transport process from bridge constructions.		To be provided in the ES.
Landscape	Construction and Operation: landform alteration from earthworks on entry and slip roads, loss of vegetation and lower levels of tranquillity in the local area.	Environmental design measures outlined in the LVIA including; planting, install screening and plant on mounds, model mounds and cuts to fit in with local landscape.	Moderate to adverse
Visual	Construction: introduction of new machinery, compounds, earthworks and vegetation removal will create new sightlines and views of existing junction		Temporary, short term and reversible
	Operation: introduction of new entry/ exit slip road, changes to street lighting, new signage and gantries and new vegetation planting.	Negligible to major	
Geology and Soils	Construction: the introduction of new sources of contamination as well as disturb and mobilise existing sources of contamination, introduction of new pathways for migration of existing contamination such as excavation and exposure of contaminated soil, remobilisation of contaminants through soil disturbance and the creation of preferential pathways for surface water run-off, groundwater and ground	Good practice measures in the CEMP including; installation of dust suppression measures, installation of pollution prevention measures, stockpile management, limiting area of earthworks, limiting soil exposure duration, implementing safe storage of fuels, oils and equipment and monitoring.	Negligible to minor beneficial, Impacts on Topography are Minor adverse and not significant.

Topic	Environmental impacts	Mitigation to reduce the impact	Significance of effect
	gas; changes in topography from earthworks and the construction of new infrastructure including soil erosion, compressible ground, collapsible ground, running sands aggressive ground and shrinking or swelling clays;	Data gathered from the ground investigation on the condition of soils within the Scheme area will also help inform an appropriate MMP and SWMP. A GIR will be produced, and used to inform the Geotechnical Design Report GDR.	
	Operation: pollution incidents introducing new contamination sources.	Good practice measures in the OEMP will address how incidents are managed.	Negligible to moderate beneficial
Cultural Heritage	Construction: physical impacts from earthmoving, creation of site compounds road construction and overbridge construction. Potential to encounter undiscovered archaeological remains.	Avoid direct impacts during enabling and construction works including, careful design, screening and site works away from heritage assets. A programme of archaeological evaluation will investigate the potential buried archaeological remains. This will comprise geophysical survey in the first instance, with an archaeological watching brief on all geotechnical investigations in order to ascertain the palaeoenvironmental potential of the study area	Temporary, short term and reversible, however, physical impacts are usually permanent.
	Operation: permanent changes to the setting of The Grove at a decreased distance to the structure.		Permanent
Materials and Waste	Construction: waste produced during CD&E, hazardous CD&E waste.	Design out waste at early design stages and ensure materials used are to industry standards specifications, locally sources and reused, reclaimed or recycled using the WRAP guidelines. Preparation of a MMP, SWMP and good practice measures in the CEMP including; no over ordering of material, clear defined skips and marked waste areas and trained staff. Select waste contractors who are registered with the EA.	To be provided in the ES.
	Operation: waste produced from littering and planned/unplanned maintenance.	WEEE wastes are stored and collected separately. Preparation of an environmental management plan that incorporates waste and is continually updated.	To be provided in the ES.
Climate Change Effects of the Scheme on climate change	Construction: there is a one-off impact of 23% in comparison to one year of in-use emissions for the do-something scenario.	Undertake the following activities; reduction of materials consumption (as per Chapter 11), use alternative carbon materials, limit materials transportation distance, minimise construction water consumption, minimise construction waste and use suitable waste treatment / disposal.	To be provided in the ES.

Topic	Environmental impacts	Mitigation to reduce the impact	Significance of effect
	<p>Operation: there is an on-going annual impact of 0.29% in comparison to one year of in-use emissions based on the first year of the Scheme being operational. In-use traffic emissions as the largest aspect, show a 17% increase for the Scheme over the do-minimum scenario.</p>	<p>Best practice replacement design, use of low energy lighting and traffic management systems and explore in-use emissions management options.</p>	<p>To be provided in the ES.</p>
<p>Climate Change Vulnerability of the Scheme to climate change</p>	<p>Construction: precipitation or high temperatures can provide difficult working conditions, excessive moisture in materials, reduce working periods, water damage, and wind can produce more dust.</p>	<p>Undertake the following activities; more night-time construction to avoid undue heat stress for construction workers, undertake construction in the dry season, use of unslaked lime and the use of water efficiency measures. Prepare and implement a dust management plan.</p>	<p>To be provided in the ES.</p>
	<p>Operation: extreme weather conditions can create additional damage and maintenance requirements, reduced opportunities maintenance and operational disruption.</p>	<p>Ensure adequate resources and capacity in in place, undertake regular monitoring, maintenance and preventive actions. Implement emergency planning for climate impacts as well as install early warning systems and evaluation routes. Incorporate additional measures into existing assets during planned maintenance and repairs.</p>	<p>To be provided in the ES.</p>

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Acronyms, Abbreviation and Descriptions

Acronyms and Abbreviations	Description
°C	Degrees Celsius
AADT	Annual Average Daily Traffic
ADMS Roads	A comprehensive software tool for investigating air pollution problems due to networks of roads that may be in combination with industrial sites
AIES	Assessment of Implications on European Sites
ALC	Agricultural Land Classification
APA	Archaeological Priority Area
AQAP	Air Quality Action Plan
AQMA	Air Quality Management Area
AQS	Air Quality Strategy
ARN	Affected Road Network
AURN	Automatic Urban and Rural Network
BAP	Biodiversity Action Plan
BGS	British Geological Survey
BMV	Best and Most Versatile
BNL	Basic noise level
CD&E	Construction, Demolition and Excavation
CEA	Cumulative Effects Assessment
CEMP	Construction Environmental Management Plan
CMS	Continuous Monitoring Stations
CO ₂	Carbon Dioxide
COSHH	Control of Substances Hazardous to Health
CRTN	Calculation of Road Traffic Noise
CSM	Conceptual Site Model
dB	Decibel
DCLG	Department for Communities and Local Government
DCO	Development Consent Order
DECC	Department for Energy and Climate Change
Defra	Department for Environment, Food and Rural Affairs
DfT	Department for Transport

Acronyms and Abbreviations	Description
DM	Do-Minimum
DMRB	Design Manual for Roads and Bridges
DS	Do-Something
EA	Environment Agency
EAR	Environmental Assessment Report
EAST	Early Assessment and Sifting Tool
EEA	European Economic Area
EHER	Essex Historic Environment Record
EIA	Environmental Impact Assessment
EQS	Environmental Quality Standards
ES	Environmental Statement
ESR	Environmental Study Report
EZol	Ecological Zone of Influence
FRA	Flood Risk Assessment
GAC	Generic assessment criteria
GHG	Greenhouse gas
GLHER	Greater London Historic Environment Record
GI	Ground Investigation
GLAAS	Greater London Archaeological Advisory Service
GLVIA	Guidelines for Landscape and Visual Impact Assessment
GQRA	Generic quantitative risk assessments
HAGDMS	Highways Agency Geotechnical Data Management System
HAWRAT	Highways Agency Water Risk Assessment Tool
HDV	Heavy Duty Vehicle/Heavy Delivery Vehicle
HE	Highways England
HER	Historic Environment Record
HGV	Heavy Goods Vehicle
HIA	Health Impact Assessment
HLC	Historic Landscape Character
HPI	Habitats of Principal Importance
HRA	Habitats Regulation Assessment

Acronyms and Abbreviations	Description
IAN	Interim Advice Note
JNCC	Joint Nature Conservation Committee
LAQM.TG	Local Air Quality Management Technical Guidance
LAQN	London Air Quality Network
LLFA	Lead Local Flood Authorities
LOAEL	Lowest Observed Adverse Effect Level
LDF	Local Development Framework
LNR	Local Nature Reserve
LWS	Local Wildlife Site
MAFF	Ministry of Agriculture, Fisheries and Food
MAGIC	Multi-Agency Geographic Information for the Countryside
MAFF	Ministry of Agriculture, Fisheries and Food
MPI	Major Project Instruction
MT	Motorised Travellers
NPPG	National Planning Practice Guidance
NCA	National Character Area
NCNR	National Cycle Network Route
NE	Natural England
NHBC	National House Building Council
NHLE	National Heritage List for England
NIA	Noise Important Area
NMU	Non-Motorised User
NN NPS	National Networks National Policy Statement
NNR	National Nature Reserves
NO ₂	Nitrogen Dioxide
NO _x	Nitrogen Oxide
NOEL	No Observed Effect Level
NPPF	National Planning Policy Framework
NPPG	National Planning Practice Guidance
NPSE	Noise Policy Statement for England
NPSNN	National Policy Statement for National Networks

Acronyms and Abbreviations	Description
NSIP	Nationally Significant Infrastructure Project
OS	Ordnance Survey
PCF	Project Control Framework
PCL	potential contaminant linkages
PCM	Pollution Climate Mapping
PCSM	Preliminary Conceptual Site Model
PEIR	Preliminary Environmental Information Report
PINS	Planning Inspectorate
PM ₁₀	Particulate Matter with a diameter of 10 micrometres or less
PPE	Personal Protective Equipment
PPG	Planning Practice Guidance
PRoW	Public Right of Way
PSSR	Preliminary Sources Study Report
RBD	River Basin District
RBMP	River Basin Management Plan
RIS	Road Investment Strategy
SAC	Special Areas of Conservation
SBI	Site of Borough Importance
SEB	Statutory Environmental Bodies
SLI	Shoulder of Mutton Wood Site of Local Importance
SMI	Site of Metropolitan Importance
SNCI	Sites of Nature Conservation Importance
SOAEL	Significant Observed Adverse Effect Level
SPA	Special Protection Areas
SPI	Species of Principal Importance
SPZ	Source Protection Zone
SoCC	Statement of Community Consultation report
SSSI	Site of Special Scientific Interest
SUP	Shared use path
SuDs	Sustainable Drainage Systems
SWMP	Site Waste Management Plan

Acronyms and Abbreviations	Description
TAG	Transport Analysis Guidance
TIN	Technical Information Note
UAEL	Unacceptable Adverse Effect Levels
UXO	Unexploded Ordnance
VISSIM	Traffic in Cities - Simulation Model {in German}
WEEE	Waste electrical and electronic equipment
WFD	Water Framework Directive
WHO	World Health Organisation
WMO	World Meteorological Organisation
ZVI	Zone of Visual Influence

Glossary

Term	Description
ADMS Roads	A comprehensive software tool for investigating air pollution problems due to networks of roads that may be in combination with industrial sites
Affected Road Network	The parts of the road network that would be affected by a change in traffic levels as the result of a transport scheme
Agricultural Land Classification	A framework for classifying land according to the extent to which its physical or chemical characteristics impose long term limitations on agricultural use. Agricultural land is classified into five categories according to versatility and suitability for growing crops. The top three grades, Grade 1, 2 and 3a, are referred to as 'Best and Most Versatile' land.
Air Quality Management Area	An area identified where the National Air Quality Objectives are not likely to be achieved. The Local Authority is required to produce a Local Air Quality Action Plan to plan how air quality in the area is to be improved.
Air Quality Strategy	The Air Quality Strategy sets out air quality objectives and policy options to further improve air quality in the UK from today into the long term.
Annual Average Daily Traffic	The number of vehicles travelling on a particular stretch of road on an average day.
Appraisal Summary Table	A table that appraises the performance of each option against economic, environmental, social and distributional sub-impacts and is used to directly inform the Value for Money assessment for the Economic Case.
Archaeological Priority Area	An area where there is significant known archaeological interest or potential for new discoveries. They are used to highlight where development may affect heritage assets.
Area of Outstanding Natural Beauty	An area outside a National Park designated for conservation due to its natural beauty.
At grade	On the same level, for example, an at grade junction is two or more roads meeting or crossing on the same level.

Term	Description
Best and Most Versatile	Defined as Grades 1, 2 and 3a of the Agricultural Land Classification as land which is most flexible, productive and efficient in response to inputs and which can best deliver future crops for food and non-food uses such as biomass, fibres and pharmaceuticals.
Biodiversity Action Plan	An internationally recognized program addressing threatened species and habitats and is designed to protect and restore biological systems. The original impetus for these plans derives from the 1992 Convention on Biological Diversity.
British Geological Survey	A partly publicly-funded body which aims to advance geoscientific knowledge of the United Kingdom landmass and its continental shelf by means of systematic surveying, monitoring and research.
Calculation of Road Traffic Noise	Method of calculating (and measuring) road traffic noise levels for new and altered highways.
Campaign to Protect Rural England	A national charity dedicated to the protection of rural England, protecting the local countryside where there is threat and enhancing it where there is opportunity. They aim to limit urban sprawl and ribbon development.
Client Scheme Requirements	The objectives of the M25 J28 scheme.
Conceptual Site Model	Serves to conceptualize the relationship between contaminant sources and receptors through consideration of potential or actual migration and exposure pathways.
Congestion Reference Flow	The maximum achievable hourly throughput of traffic on a particular stretch of road, expressed in terms of AADT.
Conservation Area	An area of special environmental or historic interest or importance, of which the character or appearance is protected by law against undesirable changes (Section 69 of the Planning (Listed Buildings and Conservation Areas) Act 1990).
Construction Environmental Management Plan	A plan by the contractor describing how the environmental impacts of construction activities of a project will be minimised and mitigated.
Contaminated Land Report 11	The Model Procedures for the Management of Land Contamination (CLR 11) have been developed to provide the technical framework for applying a risk management process when dealing with land affected by contamination. The process involves identifying, making decisions on, and taking appropriate action to deal with land contamination in a way that is consistent with government policies and legislation within the UK.
Continuous Monitoring Site	An air quality monitoring station that houses analysers that continuously monitor the concentrations of air pollutants.
Control of Substances Hazardous to Health	Under the Control of Substances Hazardous to Health Regulations 2002, employers need to either prevent or reduce their workers' exposure to substances that are hazardous to their health.
County Wildlife Site	A non-statutory conservation designation in the UK which affirms a site's importance and value for wildlife in its county context. The designation is classified by Natural England as being a 'Local Site' designation, though sites can also be of a regional and national importance.
Defence Infrastructure Organisation	The arm of the Ministry of Defence (MoD) responsible for building, maintaining and servicing the MoD estate.
Defra	Defra is the government department responsible for environmental protection, food production and standards, agriculture, fisheries and rural communities in the United Kingdom of Great Britain and Northern Ireland.

Term	Description
	Defra is a ministerial department, supported by 33 agencies and public bodies.
Department for Transport	Government department responsible for the transport network in England, and for aspects of the transport network in the devolved administrations.
Design, Build, Finance and Operate	A single contractor is appointed to design and build a project and then to operate it for a period of time. The contractor finances the project and leases it to the client for an agreed period (perhaps 30 years) after which the development reverts to the client.
Design Manual for Roads and Bridges	A series of 15 volumes that provide standards, advice notes and other published documents relating to the design, assessment and operation of trunk roads, including motorways in the United Kingdom, and, with some amendments, the Republic of Ireland.
Development Consent Order	The means of applying for consent to undertake a Nationally Significant Infrastructure Project (NSIP). NSIPs include, for example, major energy and transport projects.
Disasters	A sudden accident or a natural catastrophe that causes great damage or loss of life.
Early Assessment and Sifting Tool	A decision support tool that has been developed to quickly summarise and present evidence on options in a clear and consistent format. It provides decision makers with relevant, high level, information to help them form an early view of how options perform and compare. The tool itself does not make recommendations and is not intended to be used for making final funding decisions.
Ecological Zone of Influence	the area in which there may be ecological features subject to impacts and subsequent effects as a result of the Scheme, including those that would occur as a result of habitat loss, and those that would occur through disturbance, such as noise.
English Heritage	Charity that cares for the National Heritage Collection of state-owned historic sites and monuments across England, under licence from Historic England.
Environment Agency	A non-departmental public body with responsibilities relating to the protection and enhancement of the environment in England.
Expressway/Expressway Standard	A road with high quality performance and safety standards, as described in the July 2013 Action for Roads report.
Habitats of Principal Importance	Under Section 41 of the Natural Environment and Rural Communities (NERC) Act, the Secretary of State is required to publish a list of habitats which are of principal importance for the conservation of biodiversity in England. Fifty-six habitats of principal importance are included on the S41 list. These are all the habitats in England that were identified as requiring action in the UK Biodiversity Action Plan and continue to be regarded as conservation priorities in the subsequent UK Post-2010 Biodiversity Framework.
Historic England	Publicly funded body that champions and protects England's historic places, including Stonehenge and Avebury; also known as the Historic Buildings and Monuments Commission for England.
Interim Advice Note	Contrains specific guidance, which shall only be used in connection with works on motorways and trunk roads in England, subject to any specific implementation instructions contained within an IAN.

Term	Description
Local Air Quality Management Technical Guidance	A technical guidance document designed to support local authorities in carrying out their duties under the Environment Act 1995 and subsequent Regulations. These duties require local authorities to review and assess air quality in their area from time to time.
Local Geological Site	Are non-statutory sites that have been identified by local geoconservation groups as being of importance.
Local Nature Reserve	A statutory designation made under Section 21 of the National Parks and Access to the Countryside Act 1949, and amended by Schedule 11 of the Natural Environment and Rural Communities Act 2006, by principal local authorities. A Local Nature Reserve must be of importance for wildlife, geology, education or public enjoyment.
Limit Values	Refers to airborne concentrations of chemical substances and represent conditions under which it is believed that nearly all workers may be repeatedly exposed, day after day, over a working lifetime, without adverse health effects.
Local Enterprise Partnership	A voluntary partnership set up between local authorities and businesses to drive local economic growth and job creation activities. There are 39 LEPs across England.
Mineral Consultation Area	An area identified in order to ensure consultation between the relevant minerals planning authority, the minerals industry and others before certain non-mineral planning applications made within the area are determined.
Mineral Safeguarding Area	An area designated by Minerals Planning Authorities which covers known deposits of minerals which are desired to be kept safeguarded from unnecessary sterilisation by non-mineral development.
Ministry of Agriculture, Fisheries and Food	A UK government department created by the Board of Agriculture Act 1889. The Ministry was dissolved in 2002, at which point its responsibilities were merged into the Department for Environment, Food and Rural Affairs (Defra).
Ministry of Defence	Government department responsible for the defence of the UK and its overseas territories, including the maintenance of the armed forces.
Motorised Travellers	A person who travels by a motorised vehicle which is a vehicle that is fitted with an engine or a motor e.g. mobility scooter.
Multi-Agency Geographic Information for the Countryside	A web-based interactive map to bring together information on key environmental schemes and designations in one place. Multi-Agency Geographic Information for the Countryside (MAGIC) is a partnership project involving six government organisations who have responsibilities for rural policy-making and management.
National Character Area	The subdivision of England into 159 distinct natural areas. Each area is defined by a unique combination of landscape, biodiversity, geodiversity, history, and cultural and economic activity. Their boundaries follow natural lines in the landscape rather than administrative boundaries.
National Infrastructure Plan	Document published by the UK Government, setting out its strategy for meeting the infrastructure needs of the UK economy.
National Nature Reserve	Reserves established to protect some of the most important habitats, species and geology in the United Kingdom, and to provide 'outdoor laboratories' for research. There are currently 224 NNRs in England with a total area of over 94,400 hectares - approximately 0.7% of the country's land surface. Natural England manages about two thirds of England's NNRs. The remaining reserves are managed by organisations

Term	Description
	approved by Natural England, for example, the National Trust, Forestry Commission, RSPB, Wildlife Trusts and local authorities.
National Vegetation Classification	The National Vegetation Classification was commissioned in 1975 by the Nature Conservancy Council (NCC) to provide a comprehensive and systematic catalogue and description of the plant communities of Britain. It has now been accepted as a standard, not only by the nature conservation and countryside organisations, but also by forestry, agriculture and water agencies, local authorities, nongovernmental organisations, major industries and universities.
Nationally Significant Infrastructure Project	A project of a type and scale defined under the Planning Act 2008 and by order of the Secretary of State relating to energy, transport, water, waste water and waste generally. These projects require a single development consent. Planning permission, listed building consent and scheduled monument consent amongst others are not required for Nationally Significant Infrastructure Projects.
National Trust	Charity that cares for historic houses, gardens, ancient monuments, countryside and other sites across England, Wales and Northern Ireland, including the Stonehenge landscape.
Natural England	Executive non-departmental public body responsible for the natural environment.
Non-Motorised User	Cyclists, pedestrians (including wheelchair users), and equestrians using the public highway.
Noise Important Area	Areas where the 1% of the population that are affected by the highest noise levels from major roads are located according to the results of Defra's strategic noise maps.
Outstanding Universal Value	To be included on the UNESCO World Heritage List, sites must be deemed to be of 'outstanding universal value'.
Pollution Climate Mapping	A collection of models designed to fulfil part of the United Kingdom's EU Directive (2008/50/EC) on ambient air quality and cleaner air for Europe, requirements to report on the concentrations of particular pollutants in the atmosphere. There is one model per pollutant, each with two parts: a base year model and a projections model. The Pollution Climate Mapping model provides outputs on a 1x1 km grid of background conditions plus around 9,000 representative road side values. The Mapping is also used for scenario assessment and population exposure calculations to assist policy developments and provides model runs to support the writing of Time Extension Notification applications for PM10 and NOx.
Project Control Framework	A joint Department for Transport and Highways England approach to managing major projects. The Framework comprises a standard project lifecycle; standard project deliverables; project control processes and governance arrangements.
Public Right of Way	A way over which the public have a right to pass and repass. The route may be used on foot, on (or leading) a horse, on a pedal cycle or with a motor vehicle, depending on its status. Although the land may be owned by a private individual, the public may still gain access across that land along a specific route. Public rights of way are all highways in law.
Publicly Funded Structure	A structure in which the initial capital costs of the scheme are (principally) met through sources from government funding.
Road Investment Strategy	The long-term strategy to improve England's motorways and major A roads. The first RIS (known as RIS1) was published in 2014 and covers

Term	Description
	the period 2015-2020. A second RIS (RIS2) was published in 2015, and covers the post-2020 period.
Royal Horticultural Society	The UK's leading gardening charity dedicated to advancing horticulture and promoting gardening.
Royal Society for the Protection of Birds	A charitable organisation that works to promote conservation and protection of birds and the wider environment through public awareness campaigns, petitions and through the operation of nature reserves throughout the UK.
Scheduled monument	A 'nationally important' archaeological site or historic building, given protection against unauthorised change and included in the Schedule of Monuments kept by the Secretary of State for Culture, Media and Sport. The protection given to scheduled monuments is given under the Ancient Monuments and Archaeological Areas Act 1979.
The Scheme	The M25 J28 Scheme.
Sites of Nature Conservation Importance	Locally important sites of nature conservation adopted by local authorities for planning purposes.
Site of Special Scientific Interest	A conservation designation denoting to a protected area in the United Kingdom. The Sites are protected by law to conserve their wildlife or geology.
Site Waste Management Plan	A Site Waste Management Plan should describe how materials will be managed efficiently and disposed of legally during the construction of the works, explaining how the re-use and recycling of materials will be maximised. This involves estimating how much of each type of waste is likely to be produced and the proportion of this that will be re-used or recycled on site, or removed from the construction site for re-use, recycling, recovery or disposal. It is the joint responsibility of the client and the principal contractor to ensure that a Site Waste Management Plan is in place before construction begins and to ensure that it is enforced.
Source Protection Zone	Areas of land around over 2000 groundwater sources such as wells, boreholes and springs used for public drinking water supply. The zones show the risk of contamination from any activities that might cause pollution in the area. The closer the activity, the greater the risk. There are three main zones (inner, outer and total catchment) and a fourth zone of special interest, which is occasionally applied to a groundwater source. The zones are used in conjunction with the Groundwater Protection Policy to set up pollution prevention measures in areas which are at a higher risk, and to monitor the activities of potential polluters nearby.
Special Area of Conservation	Areas of strictly protected sites designated under the EC Habitats Directive (92/43/EEC) on the conservation of natural habitats and of wild fauna and flora. The listed habitat types and species are those considered to be most in need of conservation at a European level (excluding birds).
Special Protection Area	Areas of strictly protected sites classified in accordance with Article 4 of the EC Birds Directive (2009/147/EC) on the conservation of wild birds. They are classified for rare and vulnerable birds (as listed on Annex I of the Directive), and for regularly occurring migratory species.
Strategic Economic Plan	A document produced by a Local Enterprise Partnership setting out its plans for the future and the funding that will be required to deliver these plans.

Term	Description
Strategic Road Network	The network of approximately 4,300 miles of motorways and major 'trunk' A roads across England, managed by Highways England.
Transport Analysis Guidance	Guidance produced by DfT on the process of appraisal of transport interventions.
Tree Preservation Order	A Tree Preservation Order is made by a Local Planning Authority to protect specific trees or a particular area, group or woodland from deliberate damage and destruction. TPOs can prevent the felling, lopping, topping, uprooting or otherwise wilful damaging of trees without the permission of the Local Planning Authority.
Unexploded Ordnance	An explosive weapon (bombs, shells, grenades, land mines, naval mines, cluster munition, etc.) that did not explode when they were employed and still pose a risk of detonation, sometimes many decades after they were used or discarded.
Vulnerability	The quality or state of being exposed to the possibility of being attacked or harmed, either physically or emotionally.
Water Framework Directive	The Water Framework Directive (2000/60/EC) is a EU directive which aims to achieve good status of all water bodies (surface waters, groundwaters and the sites that depend on them, estuaries and near-shore coastal waters) and the prevent any deterioration. It has introduced a comprehensive river basin management planning system to protect and improve the ecological quality of the water environment. It is underpinned by the use of environmental standards.
World Heritage Site	A site listed by UNESCO because of its special natural or cultural value.
Zone of Theoretical Visibility	A map, usually digitally produced, showing areas of land within which a development is theoretically visible.

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