LONDON-WEST MIDLANDS ENVIRONMENTAL STATEMENT

Volume 2 | Community Forum Area report

CFA7 | Colne Valley

November 2013

VOL 2

ES 3.2.1.7

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Department for Transport

High Speed Two (HS2) Limited has been tasked by the Department for Transport (DfT) with managing the delivery of a new national high speed rail network. It is a non-departmental public body wholly owned by the DfT.

A report prepared for High Speed Two (HS2) Limited:

ARUP ATKINS CAPITA ERM

ineco Mott MacDonald PARSONS BRINCKERHOFF TEMPLE URS

High Speed Two (HS2) Limited,
Eland House,
Bressenden Place,
London SW1E 5DU

Details of how to obtain further copies are available from HS2 Ltd.

Telephone: 020 7944 4908

General email enquiries: HS2enquiries@hs2.org.uk

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Structure of the HS2 Phase One Environmental Statement

The Environmental Statement (ES) documentation comprises:

- Non-technical summary (NTS) – which provides a summary in non-technical language of the Proposed Scheme, the likely significant environmental effects of the Proposed Scheme, both beneficial and adverse, and the means to avoid or reduce the adverse effects;
- Volume 1: Introduction to the Environmental Statement and the Proposed Scheme – This describes High Speed Two (HS2), and the environmental impact assessment process, the approach to consultation and engagement, details of the permanent features and generic construction techniques as well as a summary of main strategic and route-wide alternatives and local alternatives (prior to 2012) considered;
- Volume 2: Community forum area reports and map books – 26 reports and associated map books providing a description of the scheme and of environmental effects in each area;
- Volume 3: Route-wide effects – provides an assessment of the effects of the Proposed Scheme where it is not practicable to describe them within the CFA descriptions in Volume 2;
- Volume 4: Off-route effects – provides an assessment of the off-route effects of the Proposed Scheme;
- Volume 5: Appendices and map books – contains supporting environmental information and associated map books; and
- Glossary of terms and list of abbreviations – contains terms and abbreviations, including units of measurement, used throughout the ES documentation.

1 Introduction

1.1 Introduction to HS2

1.1.1 High Speed Two (HS2) is a new high speed railway proposed by the Government to connect major cities in Britain. Stations in London, Birmingham, Leeds, Manchester, South Yorkshire and the East Midlands will be served by high speed trains running at speeds of up to 360kph (225mph).

1.1.2 HS2 is proposed to be built in two phases. Phase One, the subject of this ES, will involve the construction of a new railway line of approximately 230km (143 miles) between London and Birmingham. Construction will begin in 2017 and the line will become operational by 2026; with a connection to the West Coast Main Line (WCML) near Lichfield and to the existing HS1 railway line in London.

1.1.3 During Phase One beyond the dedicated high speed track, high speed trains will connect with and run on the existing WCML to serve passengers beyond the HS2 network to destinations in the north. A connection to HS1 will also allow some services to access that high speed line through east London and Kent and connect with mainland Europe via the Channel Tunnel.

1.1.4 Phase Two will involve the construction of lines from Birmingham to Leeds and Manchester; with construction commencing approximately 2023, and planned to be operational by 2033.

1.1.5 Section 4 of Volume 1 describes the anticipated operational characteristics of HS2, including the anticipated frequency of train services. As Volume 1 shows, the frequency of trains is expected to increase over time and to increase further upon opening of Phase Two. In assessing the environmental effects of the Proposed Scheme the anticipated Phase 2 operational frequency has been used. For further detail of the anticipated operation of the Proposed Scheme in the Newton Purcell to Brackley area (CFA14), see Section 2.4.

1.1.6 The Government believes that the HS2 network should link to Heathrow and its preferred option is for this to be built as part of Phase Two. However, the Government has since taken the decision to pause work on the Heathrow link until after 2015 when it expects the Airports Commission to publish its final report on recommended options for maintaining the country's status as an international aviation hub.

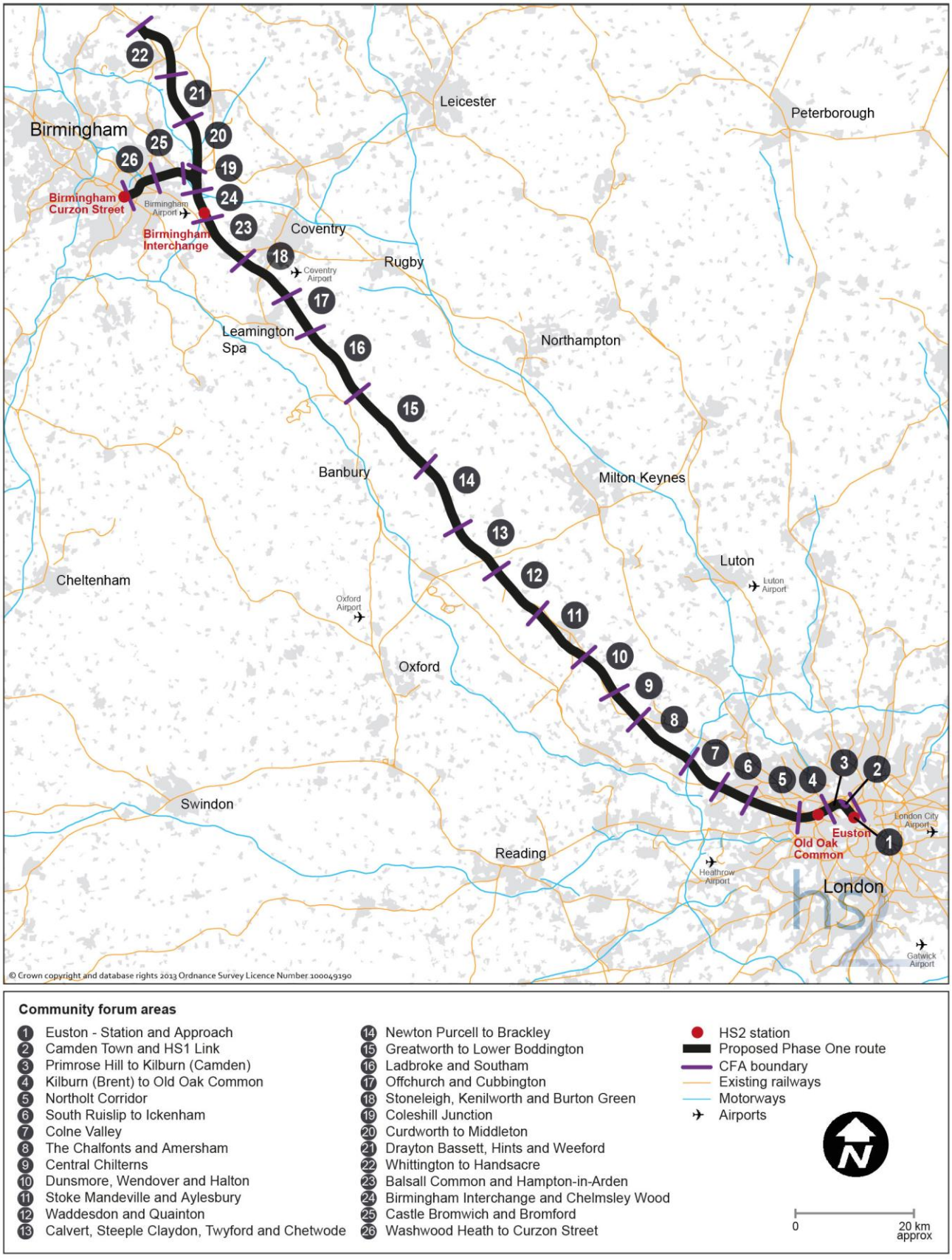
1.1.7 For consultation and environmental assessment purposes, the proposed Phase One route has been divided into 26 community forum areas (CFA), as shown in Figure 1. This has enabled wider public engagement on the Proposed Scheme design and on the likely adverse and beneficial effects.

1.2 Purpose of this report

1.2.1 This CFA report presents the likely significant effects of the construction and operation of the Proposed Scheme on the environment within CFA7 (Colne Valley). The report describes the mitigation measures that are proposed for the purpose of

avoiding, reducing or managing the likely significant adverse effects of the Proposed Scheme on the environment within CFA7.

Figure 1: HS2 Phase One route and community forum areas



1.3 Structure of this report

1.3.1 This report is divided into the following sections:

- Section 1 – an introduction to HS2 and the purpose and structure of this report.
- Section 2 – overview of the area, description of the Proposed Scheme within the area and its construction and operation, and a description of the main local alternatives.
- Sections 3-13 – an assessment for the following environmental topics:
  - agriculture, forestry and soils (Section 3);
  - air quality (Section 4);
  - community (Section 5);
  - cultural heritage (Section 6);
  - ecology (Section 7);
  - land quality (Section 8);
  - landscape and visual assessment (Section 9);
  - socio-economics (Section 10);
  - sound, noise and vibration (Section 11);
  - traffic and transport (Section 12); and
  - water resources and flood risk (Section 13).

1.3.2 Each environmental topic section comprises: an introduction to the topic; a description of the environmental baseline within the area; the likely significant environmental effects arising during construction and operation of the Proposed Scheme; and proposed mitigation measures for any significant adverse effects.

1.3.3 Environmental effects have been assessed in accordance with the methodology set out in Volume 1, the Scope and Methodology Report (SMR) (see Volume 5: Appendix CT-001-000/1) and the SMR Addendum (see Volume 5: Appendix CT-001-000/2).

1.3.4 Where appropriate, potential climate change impacts and adaptation measures are discussed in the relevant environmental topic section. Volume 1 and Section 6A of the SMR Addendum also include additional information about climate change adaptation and resilience.

1.3.5 The maps relevant to Colne Valley are provided in a separate corresponding document entitled Volume 2: CFA7 Map Book, which should be read in conjunction with this report.

1.3.6 The Proposed Scheme described in this report is that shown on the Map Series CT-05 (construction) (Volume 2, CFA7 Map Book) and CT-06 (operation) (Volume 2, CFA7

Map Book). There is some flexibility during detailed design to alter the horizontal and vertical alignments and other details within the limits shown on the plans and sections submitted to Parliament and as set out in the hybrid Bill, and this flexibility is included within the scope of the environmental assessment. Further explanation is provided in Volume 1, Section 1.4.

1.3.7 In addition to the environmental topics covered in Sections 3-13 of this report, electromagnetic interference is addressed in Volume 1 and climate (greenhouse gas emissions and carbon), and waste and material resources are addressed in Volume 3. An assessment of potential environmental effects beyond the CFA has also been undertaken and this 'off-route' assessment is reported in Volume 4.

2 Overview of the area and description of the Proposed Scheme

2.1 Overview of the area

2.1.1 The Colne Valley area covers approximately 5.7km of the Proposed Scheme in the London Borough of Hillingdon (LBH) and the districts of South Bucks, Chilterns and Three Rivers. The area extends from Harvil Road in the south-east, over the Colne Valley lakes to the M25 in a broadly north-westerly direction. The Proposed Scheme will pass through the parishes of Denham and Chalfont St Peter. The area also includes land within the Greater London Authority and Hertfordshire County that is not defined by parish boundaries.

2.1.2 As shown in Figure 2, South Ruislip to Ickenham CFA (CFA6) lies to the south-east of the Colne Valley area and the Chalfonts and Amersham CFA (CFA8) lies to the north-west.

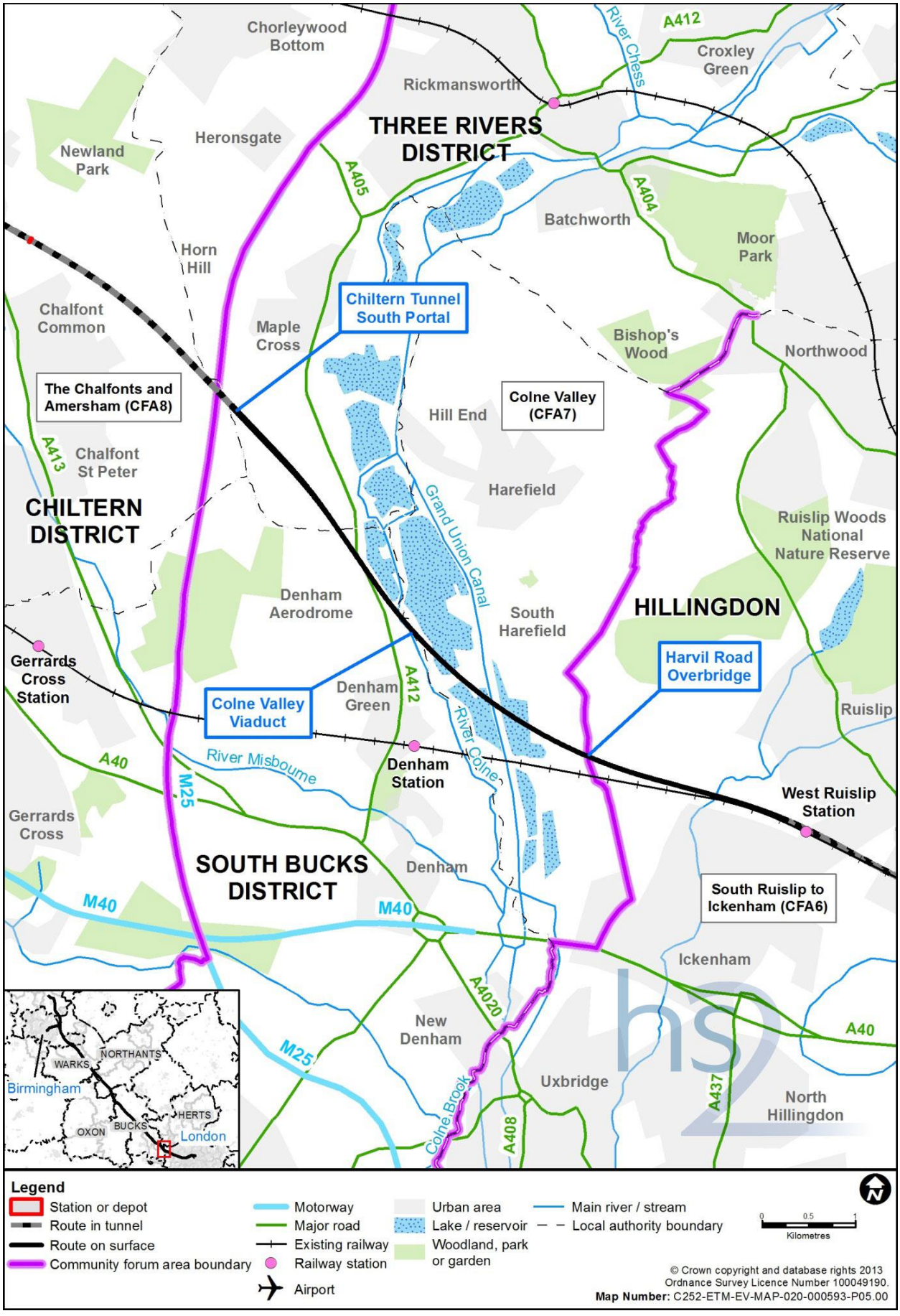
Settlement, land use and topography

2.1.3 The Colne Valley area sits between the suburban fringe of London and the rural fringe of the Chilterns. Agricultural land is interspersed with urban development linked to commuter towns and villages. Urban areas include Ickenham, Denham and Denham Green between 250m to 1.4km to the south of the Proposed Scheme. West Hyde, Harefield and South Harefield are between 350m to 1.4km to the east of the Proposed Scheme and Maple Cross lies 650m to the north of Chalfont Lane. Chalfont St Peter, in CFA8, is 1.2km to the west of the M25.

2.1.4 The Colne Valley Regional Park that covers an area of approximately 110km² and includes the Mid Colne Valley Site of Special Scientific Interest (SSSI) is focused around the Colne Valley lakes, the Grand Union Canal and the River Colne and defines the central character of this area (see Map Series CT-10, Volume 2, CFA7 Map Book). This mosaic of water features runs in a north-south direction and constitutes the remnants of gravel abstraction in the valley bottom. The lakes are divided by spurs of land that have become heavily wooded and which screen direct views around the area. The majority of these water features are now used for a range of leisure activities including sailing, fishing, water skiing, walking and bird watching.

2.1.5 Either side of the central wetland area the land use is predominantly arable but interspersed with urban fringe development and other recreational facilities, notably golf courses and the Denham Aerodrome.

Figure 2: Area context map



Key transport infrastructure

2.1.6 The A412 Denham Way/North Orbital Road runs centrally through the area in a north-south direction and is parallel to the M25 motorway which forms the western boundary of the area (see Figure 2). A number of smaller local roads cross the Colne Valley, including Moorhall Road and Copper Mill Lane (see Figure 2, Area Context Map and Map Series CT-10, Volume 2, CFA7 Map Book) both of which link the A412 with Harefield and South Harefield. The south-eastern boundary of the Colne Valley area is Harvil Road which runs broadly north-south, linking Ickenham with Harefield.

2.1.7 The existing Chiltern Main Line is located to the south of the Proposed Scheme and runs in an east-west direction. The Grand Union Canal, which is navigable, runs north-south through the centre of the area and forms part of the mosaic of water features. The majority of users of the canal are recreational users.

2.1.8 The Colne Valley area is crossed by a number of significant public rights of way (PRoW). These include the Colne Valley Trail, Grand Union Canal Walk and the Hillingdon Trail, all of which follow the course of the canal (see Map Series CT-06 in Volume 2, CFA7 Map Book). In the west, the Old Shire Lane Circular Walk and the South Bucks Way cross the arable farmland on the western side of the Colne Valley and link Horn Hill and Chalfont St Peter in CFA8 with the wetlands of the Colne Valley. A number of footpaths also cross the spurs of land that separate the Colne Valley lakes, linking recreational facilities with local populations.

Socio-economic profile

2.1.9 To provide a socio-economic context for the area, data for the following demographic character areas (DCA) is used: Denham Green, South Harefield, and Maple Cross & West Hyde. In total, the population of the DCA is approximately 7,300. The area's labour market outperforms England's as a whole; unemployment at 5.5% is lower than the national level of 7.4%, while 72.2% of the population aged 16-74 is economically active compared to the national figure of 69.9%. There are approximately 6,000 people who work within the area[1].

Notable community facilities

2.1.10 The main shops and services are located in the village of Denham Green, Denham, Harefield, South Harefield and Maple Cross (see Map Series CT-10, Volume 2, CFA7 Map Book). Denham Green is the closest to the Proposed Scheme and its main thoroughfare, the A412 Denham Way/North Orbital Road, comprises a small range of convenience shops, a post office, pharmacy, estate agents and a number of restaurants and cafes. There is one primary school, Tilehouse Combined School, which has approximately 180 pupils aged 4 to 11. The village has one doctor's surgery, a dentist, an independent physiotherapy practice that specialises in treating children and a nursing home. There are a range of community facilities including Denham Village Memorial Hall and St Mark's Church and Hall.

[1] A DCA represents a community that, depending on the area, may consist of a local ward, neighbourhood or village(s).
data comes from the Office for National Statistics (2011) Population Census. DCA unemployment rates are aggregated in this section whereas in Section 10.3 they are provided for each DCA.

2.1.11 Harefield is the largest settlement along this section of the Proposed Scheme. Its High Street comprises a good range of shops and services, St Marys Church and Hall, The King's Arms and The Harefield public houses. Close to the High Street are a public library and Harefield Infant and Junior School. There is one secondary school, The Harefield Academy, which caters for 11-18 year olds. There is a dentist and doctor's surgery in Harefield (Fray's Dental Centre and Harefield Health Centre).

2.1.12 South Harefield and Denham village are much smaller settlements and have fewer services. There is a small range of convenience shops, Harefield Community Centre and two churches in Denham village.

2.1.13 Maple Cross is in the northern part of the area and has a number of convenience stores, a post office, Maple Cross Junior Mixed and Nursery School and the Maple Cross and West Hyde Community Centre.

Recreation, leisure and open space

2.1.14 Informal and formal recreation spaces are provided by the Mid Colne Valley SSSI (including Broadwater Lake), Savay Lake, the Grand Union Canal, Northmoor Hill Wood Nature Reserve, Fray's Nature Reserve and Denham Country Park (see Map Series CT-10 in Volume 2, CFA7 Map Book). These all form part of the wider Colne Valley Regional Park, which stretches from Staines in the south to Rickmansworth in the north and from Ickenham and Harefield in the east to Chalfont St Peter in the west. The regional park is made up of lakes, reservoirs, rivers, canals, woodland and arable farm land, interspersed with urban areas and linked by a network of PRoW.

2.1.15 Other main recreational facilities include Hillingdon Outdoor Activity Centre (HOAC) a water sports and activity centre for all ages, the Denham Aerodrome, the Denham Waterski Club and the Buckinghamshire, Denham and Uxbridge golf clubs. There are several playgrounds and informal open spaces in the area.

2.1.16 There are seven Conservation Areas within the Colne Valley. These include Denham (South Bucks), Denham Lock (Hillingdon), Harefield Village (Hillingdon), Denham Place and Village, Coppermill Lock (Hillingdon), Coppermill Lock (Three Rivers) and Widewater Lock (Hillingdon).

Policy and planning context

Planning framework

2.1.17 Volume 1, Section 2.8 sets out policy and legislative framework under which the Proposed Scheme is being taken forward. Given that the Proposed Scheme is being developed on a national basis to meet a national need it is not included or referred to in many local plans. Nevertheless, in seeking to consider the Proposed Scheme in the local context, relevant local plan documents and policies have been considered in relation to environmental topics.

2.1.18 This area falls within three planning policy regions London, East of England and the South East of England.

2.1.19 The London Plan[2] is the overall strategic plan for London and relates to the LBH section of the Colne Valley area. It sets out a fully integrated economic, environmental, transport and social framework for the development of the capital to 2031 and forms part of the development plan for Greater London. London boroughs' local plans need to be in general conformity with the London Plan and its policies guide decisions on planning applications by councils and the Mayor.

2.1.20 Finally the East of England Plan was formally revoked[3] in January 2012. It has therefore not been considered in this assessment.

2.1.21 The area falls within the within the LBH, South Bucks, Three Rivers and Chiltern District Councils. Relevant local planning policy documents include:

- Buckinghamshire County Council Structure Plan (1991)[4];
- Buckinghamshire County Council Minerals and Waste Core Strategy Development Plan Documents (DPD) (MWCS) (2012)[5];
- Chiltern District Council Core Strategy (2011)[6];
- Chiltern District Council Local Plan Consolidated Policies (2011)[7];
- Hertfordshire County Council Waste Core Strategy 2011-2026 (2007)[8];
- Hertfordshire County Council Hertfordshire Minerals Local Plan Review 2002-2016 (2007)[9];
- Hertfordshire County Council Mineral Consultation Area in Hertfordshire SPD (2008)[10];
- London Borough of Hillingdon Local Plan: Part 1 – Strategic Policies (2012) (previously known as Core Strategy)[11];
- London Borough of Hillingdon, Unitary Development Plan (UDP) Saved policies (2007)[12];
- South Bucks District Council Core Strategy Development Plan Document (DPD) (2011)[13];
- South Bucks District Council Local Plan Consolidated (September 2007 and February 2011)[14];

[2] Greater London Authority (2011) *The London Plan: Spatial Development Strategy for Greater London*
[3] The Regional Strategy for the East of England (Revocation) Order 2012
[4] Buckinghamshire County Council (1991) *Buckinghamshire Structure Plan 1991-2011*: Saved Policies
[5] Buckinghamshire County Council (2012) *Minerals and Waste Core Strategy Development Plan Document*
[6] Chiltern District Council (2011) *Core Strategy for Chiltern District*
[7] Chiltern District Council (2011) *Chiltern District Local Plan*, Adopted September 1997. Consolidated September 2007 and November 2011
[8] Hertfordshire County Council (2012) *Waste Core Strategy*
[9] Hertfordshire County Council (2007) *Hertfordshire Minerals Local Plan Review 2002-2016*, Adopted march 2007
[10] Hertfordshire County Council (2007) *Supplementary Planning Document, Mineral Consultation Areas in Hertfordshire*
[11] London Borough of Hillingdon (2011) *Hillingdon Core Strategy*, Submission Draft
[12] London Borough of Hillingdon (1998) *Adopted Unitary Development Plan*, Saved Policies
[13] South Bucks District Council (2011) *Core Strategy Development Plan Document*
[14] South Bucks District Council (1999) *South Bucks District Local Plan*, Adopted March 1999, Consolidated September 2007 and February 2011

- Three Rivers District Council Core Strategy (2011)[15];
- Three Rivers District Council Development Management Policies Local Development Document (2013)[16]; and
- Three Rivers District Council Local Plan 1996-2011 Updated Policies (2011)[17].

2.1.22 There are a number of key planning and environmental designations in the area, including Air Quality Management Areas (AQMA) (see Map AQ-01-007, Volume 5, Air Quality Map Book), listed buildings and conservation areas (see Map Series CT-10, Volume 2, CFA7 Map Book).

2.1.23 Emerging policies are not considered within this report. However it should be noted that during 2013 the LBH intends to prepare and consult on various components of Part 2 of the Hillingdon Local Plan which will consist of the Development Management Policies, Site Specific Allocations and an associated Proposals Map.

2.1.24 South Bucks District Council has also noted its intention to produce Development Management and Townscape Character DPD over the coming year but that has yet to be adopted and as such is not considered within this assessment.

2.1.25 The Local Development Framework Delivery DPD (Development Management Policies), which is expected to be adopted in late 2014/early 2015, will replace many of the existing Saved Policies from the Chiltern Local Plan.

Committed and proposed development

2.1.26 Developments with planning permission or sites allocated in adopted development plans, on or close to the Proposed Scheme, are shown on Map Series CT-13 (Volume 5, Planning Map Book) and listed, Volume 5: Appendix CT-004-000. Except where noted otherwise, in Volume 5: Appendix CT-004-000, it has been assumed that these developments will have been completed by 2017. These are termed 'committed developments' and have been taken into account for the purpose of assessing the likely significant environmental effects of the Proposed Scheme. Where these developments have a particular relevance to an assessment topic, this is noted in the future baseline section for that topic. The following development is relevant to several topics assessments in this area.

2.1.27 There is one major development in the Colne Valley area as shown on Maps CT-13-011 to CT-13-013 (Volume 5, Cross Topic Appendix 1 Map Book) Ref: 11/01260/CM. This is an application for the extension of the time period for commencement of existing planning permission (SBD/8214/02) for the extraction of minerals, infilling with waste and restoration to agriculture at Denham Park Farm, Denham Green, Buckinghamshire.

2.1.28 The planning permission for this development has to be commenced no later than August 2017 with an operational life of approximately 20 years. As such it is a possible

[15] Three Rivers District Council (2011) *Core Strategy*
[16] Three Rivers District Council (2013) *Development Management Policies Local Development Document Proposed Submission*, July 2012, Track changes Version Main and Additional Modifications
[17] Three Rivers District Council (2011) *Three Rivers Local Plan 1996-2011*, Word Version following the adoption of the Core Strategy in October 2011

cumulative scheme between 2017-2026 during construction of the Proposed Scheme and post-2026 during operation of the Proposed Scheme. It is considered to be a receptor for the operation of the Proposed Scheme but also potentially to give rise to cumulative construction impacts with the Proposed Scheme on its neighbours. It is referred to in those topic sections where such a cumulative impact has been identified.

2.1.29 Planning applications yet to be determined and sites that are proposed allocations in development plans that have yet to be adopted, on or close to the Proposed Scheme, are termed 'proposed developments'. These are listed, Volume 5 Appendix CT-004-000. They are not included in the assessment. The progress of these proposals is being monitored by HS2 Ltd.

2.2 Description of the Proposed Scheme

2.2.1 The following section describes the main features of the Proposed Scheme in the Colne Valley area, including the main environmental mitigation measures. Further generic information on typical permanent features is provided in Volume 1, Section 5. Similarly, a general description of the approach to mitigation is set out in Volume 1, Section 9.

2.2.2 The Proposed Scheme will require some land on a permanent basis, key features of which are illustrated in Maps CT-06-019 to CT-06-023 (Volume 2, CFA7 Map Book). Land that will also be required, but only on a temporary basis for construction, is set out in Section 2.3.

2.2.3 In general, features are described from south to north along the route (and east to west for features that cross HS2).

2.2.4 Since the draft ES was published the following changes have been introduced to permanent features of the Proposed Scheme:

- additional environmental mitigation measures have been incorporated into the Proposed Scheme including habitat creation within the lakes in the Colne Valley;
- a new access road to the Denham Park Quarry from Tilehouse Lane;
- an area of sustainable placement of excavated material has been added to the east of Harvil Road; and
- refinement of the design of crossings at the River Colne and Newyears Green Bourne.

Overview

2.2.5 The Proposed Scheme through the Colne Valley area will be approximately 5.7km in length. It will commence from the boundary of the existing Harvil Road alignment, north of Ickenham and will proceed north-west on a viaduct through the Colne Valley, passing west of South Harefield and east of Denham Green, over the Grand Union Canal, Mid Colne Valley SSSI, River Colne, a number of lakes and A412 Denham Way/North Orbital Road.

2.2.6 The route will then continue in a north-west direction passing west of West Hyde in a series of cuttings and embankments before entering the Chiltern tunnel via the Chiltern tunnel south portal, immediately east of the M25. The Proposed Scheme will leave this area in a tunnel at the M25, between junctions 16 and 17, east of Chalfont St Peter (see Maps CT-06-019 to CT-06-023, Volume 2, CFA7 Map Book).

Colne Valley viaduct and approach embankments

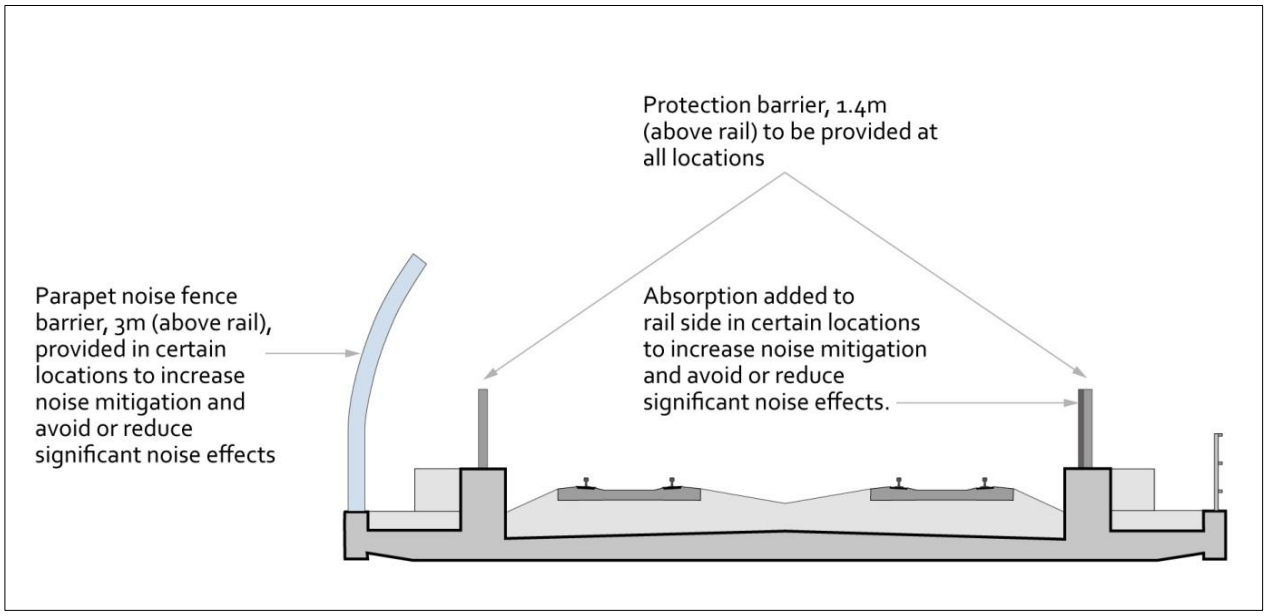
2.2.7 The Proposed Scheme will leave CFA6 under the realigned Harvil Road overbridge and will continue north-west on the Colne Valley south embankment which will be approximately 190m long and up to 10m high. The Proposed Scheme will continue on the Colne Valley viaduct and then onto the Colne Valley north embankment which will be approximately 290m long and up to 12m high. This section of the Proposed Scheme will extend from the west of Harvil Road to north of Bridleway DEN/3. Key features of this section which is approximately 3.9km long, will include (see Maps CT-06-019 to CT-06-023, Volume 2, CFA7 Map Book):

- a sustainable placement area will be used to permanently deposit approximately 500,000m3 of surplus excavated materials from CFA6. The area, which will be approximately 850m long, up to 315m wide and up to 3m in height, will be located to the north of the Proposed Scheme, south-east of South Harefield. The sides of the sustainable placement area will be designed to tie into the existing landform. On completion, hedgerows will be replanted on their existing alignments and the land returned to agriculture. Three further associated sustainable placement areas are located in the Ickenham to South Ruislip area (see CFA6 report);
- the Ickenham auto-transformer feeder station[18] will be located just west of Harvil Road, to the south of the Proposed Scheme, with an associated access from Harvil Road. This is located mainly in the Colne Valley area and partly within CFA6;
- a balancing pond for railway drainage to the south of the Proposed Scheme with an associated access track;
- an area of planting to the north of the Ickenham auto-transformer feeder station, approximately 150m south of the Proposed Scheme to provide ecological compensation for the loss of woodland and wetland vegetation from the Colne Valley; and
- a viaduct approximately 3.4km long, starting approximately 190m west of Harvil Road and which will vary between 11m to 15m above the ground/water level. The viaduct will carry the Proposed Scheme over the Colne Valley, passing above the Harefield No.2 Lake, Grand Union Canal, Savay Lake, Moorhall Road, Korda Lake, Long Pond, the River Colne and the A412 Denham Way/North Orbital Road. The viaduct will have a solid 1.4m high protection barrier adjacent to the tracks on each side. In addition the barrier will be

[18] HS2 trains will draw power from overhead power line, requiring feeder stations and connections to the 400kV National Grid network. In addition to feeder stations, smaller auto-transformer stations will be required at more frequent intervals. One National Grid feeder station, one auto-transformer feeder station and one auto-transformer station will be required in the local area.

modified on the southern/western side from the south approach embankment as far as the Grand Union Canal to act as an absorptive noise fence barrier. For the remainder of the western side of the viaduct there will be a 3m high noise fence barrier alongside the 1.4m high protection barrier. An aerial visualisation of the Colne Valley viaduct at year 15 of operation (2041) is shown in Figure LV-15-002 (Volume 2, CFA7 Map Book).

Figure 3: Schematic cross-section of Colne Valley viaduct illustrating 3m barrier along the western edge



- a high pressure gas main diversion approximately 400m to the north and west of Harvil Road, crossing the Proposed Scheme between the Colne Valley viaduct piers;
- realignment of approximately 140m of Newyears Green Bourne, to avoid a viaduct pier;
- an area of integrated landscape and ecological mitigation between the boundary of Dew's Lane and Harvil Road to provide compensation for the loss of woodland as a result of the realignment of the National Grid overhead power line, as well as to screen views of the viaduct from nearby properties;
- widening of Dew's Lane, including improvement works to the junction of Dew's Lane with Harvil Road;
- a new access road to HOAC from Dew's Lane;
- strips of planting along both sides of Dew's Lane and along the new access road to HOAC, to replace the existing vegetation along the road;
- a strip of reedbed wetland vegetation along the northern and southern edges of Harefield No.2 Lake to compensate land lost from the Mid Colne Site of Metropolitan Importance (SMI);

- a replacement floodplain storage area to the north-east of the Proposed Scheme, approximately 200m north of Dew's Lane. This area will be excavated to approximately 1m below existing ground level and re-graded[19];
- a new National Grid feeder station located approximately 250m north-east of the Proposed Scheme and 350m north-east of HOAC, with associated access track from Harvil Road;
- diversion of 275kV overhead cables from their original alignment (50m north of HOAC) to a new alignment which will cross the Proposed Scheme east of Harvil Road, having been diverted along the southern side of the Chiltern Main Line across the Uxbridge Golf Course, over Harvil Road, northwards over the Proposed Scheme and then back in a north-westerly direction to the National Grid feeder station north-east of HOAC. This will involve the removal of five steel frame electricity pylons and the installation of new pylons;
- areas of planting around the National Grid feeder station and extensions to two existing copses, to screen the feeder station from the residents of South Harefield and surrounding properties;
- an area of grassland to the south of the National Grid feeder station to mitigate the loss of potential terrestrial great crested newt habitat;
- a replacement floodplain storage area to the north-east of the Proposed Scheme, north-east of HOAC, which will be excavated to approximately 1m below existing ground level and re-graded;
- reinstatement of existing planting under the Colne Valley viaduct along the Grand Union Canal and on areas of land to the north of Savay Lake, up to and including Moorhall Road;
- a strip of reedbed along the eastern edge of Harefield Lake, approximately 350m east of the Proposed Scheme and 100m north of Moorhall Road to compensate for the loss of wetland habitat from the Mid Colne SSSI and SMI;
- a replacement floodplain storage area, approximately 120m west of the Proposed Scheme, along the western bank of the River Colne. This will be excavated to approximately 1m below existing ground level and re-graded;
- reinstatement of existing planting in the land between Korda Lake and Harefield Lake;
- a localised realignment of River Colne around the Colne Valley viaduct piers which will be approximately 170m in length, to avoid a viaduct pier being located in the river;
- an area of ecological mitigation located to the west of the Proposed Scheme and River Colne, east of A412 Denham Way/North Orbital Road and

[19] All replacement floodplain storage areas will be re-graded to tie back into existing ground level and returned to agriculture, wherever the farming practices are compatible with the land use.

Battlesford Wood, for the enhancement of existing vegetation to offset the loss of woodland from the Proposed Scheme;

- an area of ecological mitigation located at the eastern end of Broadwater Lake, approximately 350m east of the Proposed Scheme and River Colne, to create a series of islands for nesting birds;
- a strip of planting to allow the regeneration of willow and alders along the River Colne, on the south-western boundary of Broadwater Lake to mitigate the loss of woodland and provide additional habitat for nesting birds;
- a number of balancing ponds for railway drainage, located to the west and east of the Proposed Scheme, north of the River Colne up to Bridleway DEN/3. The ponds will be located at approximately 200m intervals to discharge surface water runoff into the River Colne and its tributaries;
- reinstatement of existing planting along the viaduct up to the boundary of A412 Denham Way/North Orbital Road;
- a strip of reedbed along the western boundary of Broadwater Lake to compensate for the loss of wetland habitat from the Mid Colne SSSI and SMI;
- realignment of Bridleway DEN/3 around the southern end of the Colne Valley north embankment. The approaches to the realigned route will be planted to integrate the structure into the landscape;
- noise fence barriers approximately 600m in length and 3m high on the west side of the Proposed Scheme along the top of the approach embankment and then continuing along the base of the cutting, starting from the end of Colne Valley viaduct northwards;
- noise fence barriers approximately 250m in length and 3m high on the east side of the Proposed Scheme along the top of the approach embankment, starting from the end of Colne Valley viaduct northwards;
- strips of planting along the Colne Valley north embankment and Tilehouse Lane to mitigate views of the railway and overbridge from the surroundings;
- an area of planting in a field bounded by Tilehouse Lane, Bridleway DEN/3, Little Halings Wood and a field between Little Halings Wood and Juniper Wood to maintain connectivity to the surrounding ancient woodland and to compensate for the loss of vegetation from the Mid Colne SSSI; and
- passive provision for HS2 Phase Two Heathrow spur, this includes the provision of an underground box structure, passing primarily under the Colne Valley north embankment to allow the possible future provision of the Heathrow spur without impacting on the operational capacity of HS2 Phase One.

2.2.8 Construction activities within this section will be managed from eight satellite compounds, in seven locations, including the Colne Valley viaduct and south embankment, Colne Valley viaduct, Colne Valley viaduct storage, Colne Valley viaduct

jetty storage, Colne Valley viaduct laydown, Colne Valley viaduct north launch, Colne Valley viaduct north embankment and the Ickenham auto-transformer feeder station satellite compounds (see Section 2.3).

Tilehouse Lane cutting, West Hyde embankment and Chiltern tunnel south cutting

2.2.9 The Proposed Scheme will continue north-west from the Colne Valley north embankment and enter the Tilehouse Lane cutting which will be approximately 710m long and up to 11m deep. It will then continue onto the West Hyde embankment which will be approximately 690m long and up to 10m high and enter the Chiltern tunnel south cutting which will be approximately 215m long and up to 16m deep. This section of the Proposed Scheme will extend from approximately 150m north of Bridleway DEN/3 to approximately 200m south of the M25. Key features of this section, which is approximately 1.6km long, will include (see Maps CT-06-021 to CT-06-022, Volume 2, CFA7 Map Book):

- landscape earthworks on the north-east side of the Proposed Scheme from north of Bridleway DEN/3 up to approximately 450m east of the M25 to provide noise screening.
- landscape earthworks to the south-west of the Proposed Scheme from north of Bridleway DEN/3 up to approximately 100m east of the M25, to provide visual screening of the railway from the surrounding areas;
- a strip of planting along the eastern side of A412 Denham Way/North Orbital Road up to the junction with Chalfont Lane to provide visual screening for the residents of West Hyde;
- a balancing pond for railway drainage located east of the Proposed Scheme, north of Bridleway DEN/3 and west of A412 Denham Way/North Orbital Road, with an associated access road from A412;
- strips of planting along the east and western boundary of Tilehouse Lane cutting to screen views of the railway from the surroundings;
- new retaining wall structures to the west and east of the Proposed Scheme, between the HS2 Phase One railway and Phase Two Heathrow spur alignment. The structures will support the Proposed Scheme as the Phase Two Heathrow spur alignment diverges from the Phase One alignment. The retaining wall will be required where the difference in level between the Heathrow spur and the Proposed Scheme is such that normal grading of earthworks is insufficient. This will ensure the future provision of the Phase Two Heathrow spur without impacting on the operational capacity of Phase One of HS2;
- an overbridge up to approximately 1m above existing ground level, providing a realignment of Tilehouse Lane and Bridleway Rickmansworth 004 over the Proposed Scheme. The approaches to the overbridge will be planted to integrate the structure into the landscape and a new access road to Denham Park Farm Quarry site from Tilehouse Lane overbridge will be provided;

- land drainage areas to the east of the Proposed Scheme, 20m north of Tilehouse Lane and 20m west of A412 Denham Way/North Orbital Road;
- West Hyde auto-transformer station located at railway level, approximately 2m above existing ground level and approximately 400m east of the M25 with an associated access track from Chalfont Lane;
- strips of planting along the eastern and western boundary of West Hyde embankment to screen views of the railway and West Hyde auto-transformer station from the surroundings;
- a significant area of grassland mitigation to the eastern side of the Proposed Scheme, to the west of the A412 Denham Way/North Orbital Road and south Chalfont Lane to provide an extensive green space and opportunity for habitat creation as part of the restoration of the construction site; and
- areas of planting around the Chiltern tunnel south cutting, south of the M25, to screen views of the portal from the surrounding residents.

2.2.10 Construction of this section will be managed from the Colne Valley viaduct main compound and the Chiltern tunnel south portal satellite compound (see Section 2.3).

Chiltern tunnel south portal and Chiltern tunnel

2.2.11 From the Chiltern tunnel south cutting, the Proposed Scheme will continue north-west into the Chiltern tunnel south portal located approximately 200m east of the M25, between junctions 16 and 17. The Proposed Scheme will enter the Chiltern tunnel from the portal and will run in the tunnel for approximately 100m before leaving this area. Key features of this section, which is approximately 200m long, will include (see Map CT-06-022, Volume 2, CFA7 Map Book):

- Chiltern tunnel south portal will be located east of the M25 including a porous portal[20] and portal building. An approximately 550m^2 hard-standing area will be provided next to the tunnel portal building for maintenance and emergency access and egress from the tunnel;
- an access road connecting the tunnel portal to Chalfont Lane;
- widening of Chalfont Lane, including improvement works to the junction of Chalfont Lane with A412 Denham Way/North Orbital Road, to allow for the construction and the future maintenance of the Proposed Scheme;
- a strip of planting along the western side of the A412 Denham Way/North Orbital Road from its junction with Chalfont Lane up to its approach to Maple Cross to provide visual screening;
- landscape earthworks and planting along the northern side of Chalfont Lane, to screen views of the railway from the residents of Maple Cross;

[20] Porous portals are perforated structures at tunnel portals (entrances), usually formed of concrete and designed to allow the passage of air from the tunnel. These are required to reduce both air pressure changes and the noise generated when a high speed train associated with the Proposed Scheme, enters or leaves a tunnel

- an associated land drainage area to the north of Chalfont Lane;
- realignment of Bridleway CSP/44, from the east side of the M25 and south of Chalfont Lane bridge, around the western side of the Chiltern tunnel south portal and cutting;
- a new Scottish and Southern Energy (SSE) substation located 100m north of Chalfont Lane, east of the M25 with associated access road from Chalfont Lane;
- areas of planting extending from the western end of Chalfont Lane along the east side of the M25 and on the west side of the M25, to the south of Hornhill Road, to screen views of the Proposed Scheme from the local residents of Horn Hill; and
- twin bore tunnels which will be circular in cross-section and measure approximately 8.8m in internal diameter. Within this CFA the depth of the tunnels will vary between approximately 10m and 15m below ground level depending on surface topography.

2.2.12 Construction of this section will be managed from the Chiltern tunnel main compound and the Chiltern tunnel south portal satellite compound (see Section 2.3).

2.2.1 The route will then continue into CFA8 in the Chiltern tunnel.

2.3 Construction of the Proposed Scheme

2.3.1 This section sets out the strategy for the construction of the Proposed Scheme in the Colne Valley area including:

- overview of the construction process;
- description of the advance works;
- description of the engineering works to build the railway;
- construction waste and material resources
- commissioning the railway; and
- indicative construction programme (see Section 2.3).

2.3.2 The assessment presented in this ES is based on the construction arrangements as described in this section.

2.3.3 In addition to the land that will be required permanently by the Proposed Scheme (see Section 2.2) land will be required on a temporary basis for construction. Key temporary construction features are illustrated on the construction maps series CT-05 (Volume 2, CFA7 Map Book). Following construction works, land required temporarily will be prepared for its eventual end use, which will include being returned to its pre-construction use wherever reasonably practicable.

2.3.4 A guide to standard construction techniques is provided in Volume 1, Section 6. In instances for which more than one possible construction technique might be possible,

this section specifies which technique has been assumed for the purposes of the assessment.

Overview of the construction process

2.3.5 Building and preparing the railway for operation will comprise the following general stages:

- advance works including site investigations further to those already undertaken, preliminary mitigation works and preliminary enabling works;
- civil engineering works including establishment of construction compounds, site preparation and enabling works, main earthworks and structure works, site restoration and removal of construction compounds;
- railway installation works including establishment of construction compounds, infrastructure installation, connections to utilities, changes to the existing rail network and removal of construction compounds; and
- system testing and commissioning.

2.3.6 General provisions that will guide the construction process are set out in more detail in Volume 1, Section 6.4 and the draft CoCP (see Volume 5: Appendix CT-003-000) including:

- the approach to environmental management during construction and the role of the Code of Construction Practice (draft CoCP, Section 3);
- working hours (draft CoCP, Section 5.2);
- the management of construction traffic (draft CoCP, Section 14); and
- the handling of construction materials (draft CoCP, Section 3.3).

Advance works

2.3.7 General information about advance works can be found in Volume 1, Section 6.4. Advance works will be required before commencing construction works and will typically include:

- further detailed site investigations and surveys for proposed construction compounds;
- further detailed environmental surveys;
- advance mitigation works including, where appropriate, contamination remediation, temporary habitat creation and translocation and built heritage survey and investigation;
- site establishment with temporary fence construction; and
- utility diversions, including the diversion of the National Grid overhead power lines in the Colne Valley, as shown on Map CT-05-019 (Volume 2, CFA7 Map Book). This will involve the establishment of a local construction compound managed by National Grid.

Engineering works

2.3.8 Construction of the railway will require engineering works along the entire length of the route and within land adjacent to the route. This will comprise of two broad types of engineering work:

- civil engineering works such as earthworks and erection of bridges and viaducts; and/or
- railway installation works such as laying ballast or slabs and tracks and/or installing power supply and communications features.

2.3.9 The construction of the scheme will be subdivided into sections, each of which will be managed from compounds. The compounds will act as the main interface between the construction work sites and the public highway, as well as performing other functions as described below. Compounds will either be main compounds or satellite compounds, which are generally smaller. Some compounds will be used for civil engineering works and others for railway installation works and in some cases for both.

2.3.10 In the Colne Valley area there are two main compounds and seven civil engineering satellite compounds and two railway installation satellite compounds (both of which will continue to use compounds previously established for the civil engineering works).

2.3.11 Figure 2 shows the management relationship for civil engineering works compounds and Figure 3 for the railway installation works compounds. Details about individual compounds are provided in subsequent sections of this report.

General overview of construction compounds

2.3.12 Main compounds will be used for core project management staff (i.e. engineering, planning and construction delivery), commercial and administrative staff. These management teams will directly manage some works and/or coordinate satellite compounds which will manage other works. In general, main compounds will contain:

- space for the storage of bulk materials (aggregates, structural steel and steel reinforcement);
- space for the receipt, storage and loading/unloading of excavated material either onto or off the site;
- an area for the fabrication of temporary works equipment and finished goods;
- fuel storage;
- plant and equipment storage; and
- necessary operational parking.

2.3.13 Satellite construction compounds will be used as the base to manage specific works along a section of the route. They will usually provide office accommodation for limited numbers of staff, local storage for plant and materials, limited car parking for staff and site operatives and welfare facilities.

2.3.14 Some compounds will also accommodate additional functions as listed below. Where this is the case they will be included in the description of the compound:

- railheads will connect with the existing railway network for the delivery of materials for the construction of the rail systems, further details are provided in Section 2.3.34;
- construction sidings will connect with the existing railway network to enable loading and unloading to and from trains delivering material to the HS2 site or removing excavated material, further details are provided in the relevant area reports;
- roadheads will require an area of land adjacent to the compound for the storage and loading and unloading of bulk earthworks materials which are moved to and from the site on public highways;
- living accommodation for the construction workforce;
- In addition, areas adjacent to some compounds will be used for the storage of topsoil stripped as part of the works prior to it being used when the land is reinstated; and
- Further information on the function of compounds, including general provisions for their operation including security fencing, lighting, utilities supply, site drainage, codes of worker behaviour are set out in Volume 1, Section 6 and the draft CoCP, Section 5).

Construction traffic routes

2.3.15 The movement of construction vehicles carrying materials, plant, other equipment and workforce (or moving empty) will take place both within the construction sites, on public roads and via the rail network. The construction compounds will provide the interface between the construction works and the public highway or rail network and the likely road routes to access compounds are described in subsequent sections below.

2.3.16 Movements between the construction compounds and the worksites will be on designated haul roads within the site, often along the line of the Proposed Scheme or running parallel to it.

Figure 4: Schematic of site compounds for civil engineering works

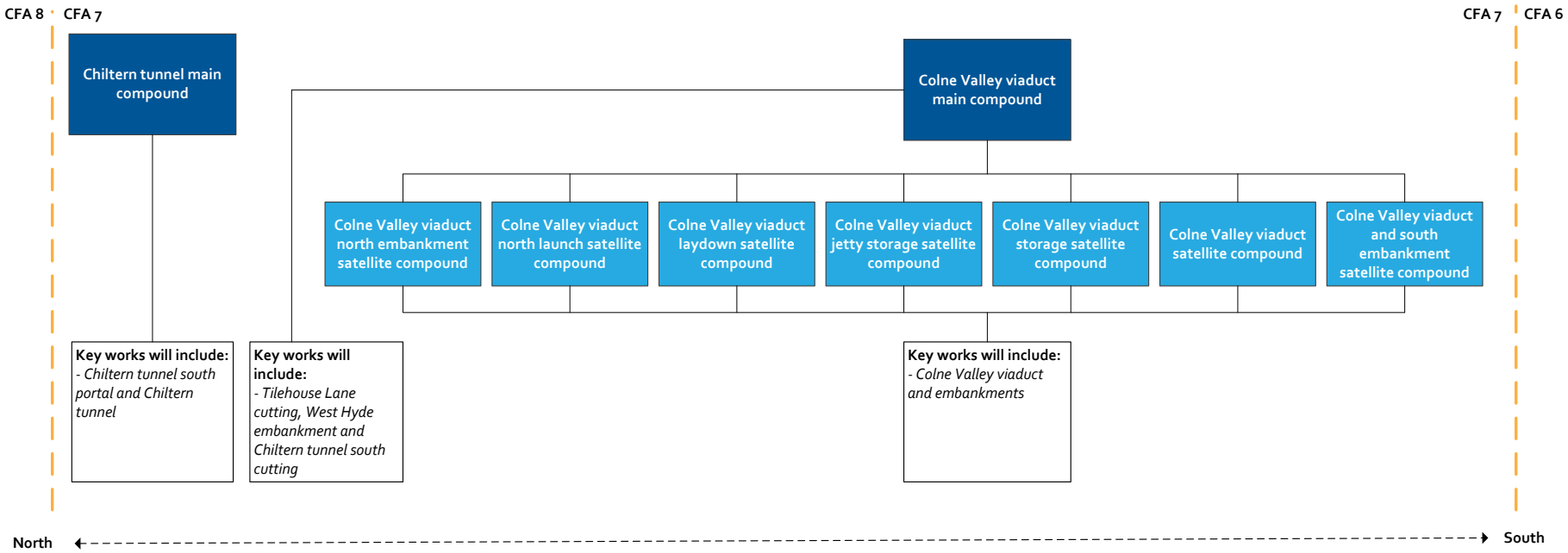
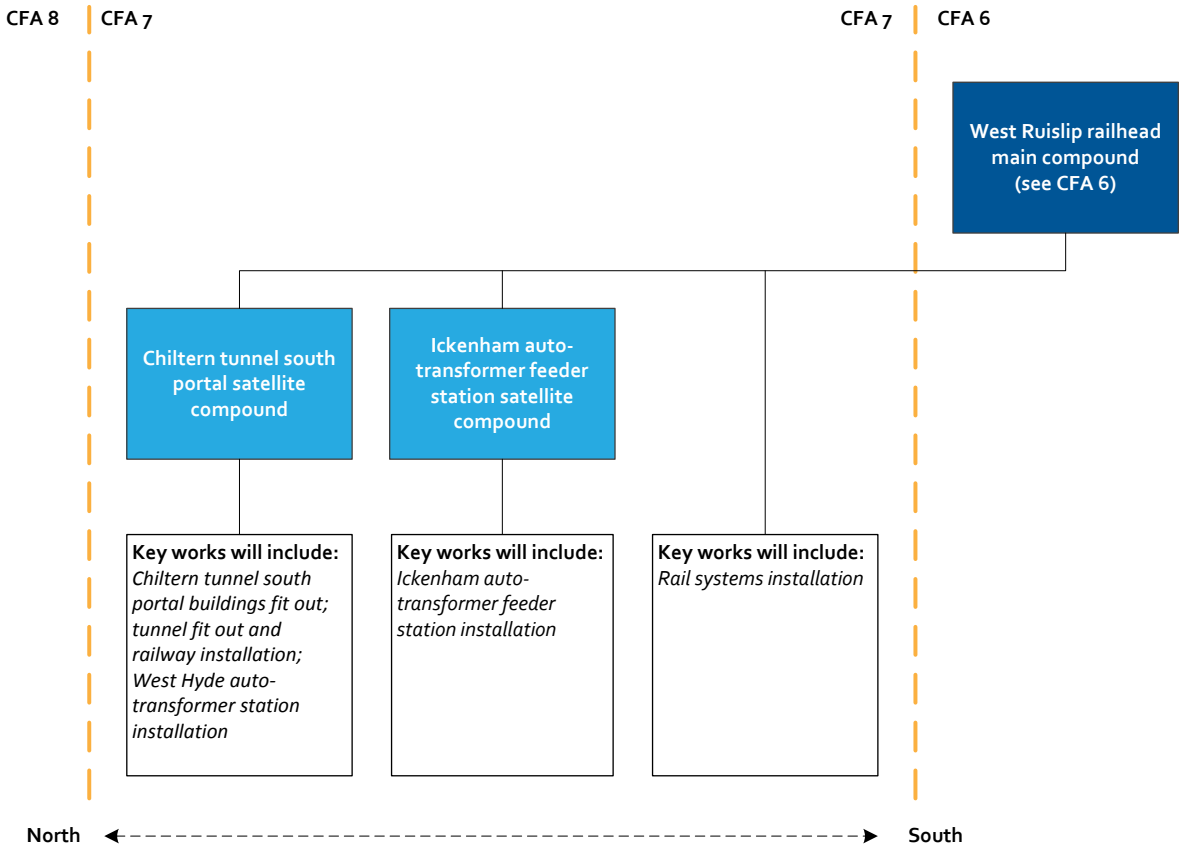


Figure 5: Schematic of site compounds for railway installation works



West Ruislip railhead main compound

2.3.17 This compound is located within CFA6 but it will provide support to all rail installation works satellite compounds for the construction of the Proposed Scheme throughout this area. The West Ruislip railhead main compound is incorporated within the Northolt tunnel and earthworks main compound (see CFA6 report).

2.3.18 The railway systems installation works will include track, overhead power line, communications equipment and traction power supply. The installation of track in the twin bore tunnels will be slab track. The installation of track in open areas will be of standard ballast or slab track configuration.

2.3.19 Works in this area will take approximately one year, commencing in 2022.

2.3.20 The track will be laid in a northerly direction away from the West Ruislip railhead main compound in this area. Prior to the railway systems installation commencing, adequate civil engineering work will need to be completed to allow a continuous track laying sequence.

2.3.21 The railway systems installation will have its own mobile welfare facilities for the site staff.

Colne Valley viaduct construction

2.3.22 Construction of the Colne Valley viaduct and approach embankments will be managed from the following satellite compounds, described in further detail below:

- Colne Valley viaduct main compound;
- Colne Valley viaduct and south embankment satellite compound;
- Colne Valley viaduct satellite compound;
- Colne Valley viaduct storage satellite compound;
- Colne Valley viaduct jetty storage satellite compound;
- Colne Valley viaduct laydown satellite compound;
- Colne Valley viaduct north launch satellite compound; and
- Colne Valley viaduct north embankment satellite compounds.

2.3.23 The viaduct and approach embankments will take approximately four years to construct. Volume 1, Section 5.9 describes a typical viaduct. The construction of the Colne Valley viaduct will differ from a typical viaduct in that it will be constructed in three sections. The eastern section, from the southern end as far as the Grand Union Canal, will be constructed using the launched construction method (see Volume 1, Section 6.16). The mid-section will be constructed using the in-situ construction method. The western section could be constructed by either the in-situ construction method (see Volume 1, Section 6.16) or by a combination of the launched and in-situ construction methods. The impacts of these methods have been considered to be broadly similar for the purposes of this assessment.

2.3.24 The sections of the viaduct to be constructed above water will require a temporary jetty to provide construction access and a working platform which will be installed along the northern side of the viaduct. Along these sections temporary cofferdams will be installed around the perimeter of the pile caps to provide a dry working area to enable installation of the piles and pile caps.

2.3.25 To construct the viaduct it will be necessary to install piled foundations within Source Protection Zone 1 (SPZ1) therefore a piling method will be chosen to mitigate contamination of ground water.

Colne Valley viaduct main compound

2.3.26 This compound (see Map CT-05-022, Volume 2, CFA7 Map Book) will be used for civil engineering works only, between Harvil Road, the east of Denham Green and south of Maple Cross. The compound will:

- be operational for approximately five years and three months, commencing in 2017;
- support approximately 75 workers each day throughout much of the civil engineering works period but will increase to a maximum of 200 workers each day during the peak period of activity;
- provide overnight accommodation for between approximately 55 to 90 people for an estimated period of four years and three months;
- be accessed via the M25, the A412 Denham Way/North Orbital Road and Chalfont Lane (light goods vehicles only) or alternatively via Chalfont Lane and the temporary M25 slip roads from the east and the M40, A40, A412 and Chalfont Lane from the west; and
- provide main compound support to seven satellite compounds, as illustrated in Figure 2.

2.3.27 Works in this section of the Proposed Scheme will be carried out in the following broad phases:

- site clearance and enabling works;
- building demolition;
- culverts and drainage;
- cuttings, embankments and landscaping earthworks;
- construction of bridges, retaining walls and viaducts;
- highway and footpath construction and reinstatement; and
- permanent fencing.

2.3.28 In addition to the Colne Valley viaduct, this compound will also be used to construct Tilehouse Lane cutting, West Hyde embankment and the Chiltern tunnel south cutting which will take approximately three years and nine months, four years and three months to construct respectively. Volume 1, Section 5.2 describes typical

cuttings and embankments and Section 6.8 describes the associated construction activities.

2.3.29 Demolitions will be required at the following locations.

Table 1: Colne Valley viaduct main compound demolitions

Description	Location
Three outbuildings associated with Weybeards Cottages	In land to the south of Weybeards Cottages on the eastern side of the A412 Denham Way/North Orbital Road
Two Scottish and Southern Electricity (SSE) pylons (PMA222, PMA223)	Immediately east of the M25

2.3.30 Realignment of two roads will be required:

- permanent realignment of Tilehouse Lane, approximately 150m to the west of the existing road, across a new overbridge; and
- temporary closure of Chalfont Lane and diversion via A412 Denham Way/North Orbital Road, Hornhill Road and a temporary link road west of M25 for a period of approximately five years and six months whilst the Colne Valley viaduct and Chiltern tunnel (civil engineering works) main compounds are operational. Chalfont Lane will be permanently reinstated on its original alignment following construction.

2.3.31 Alternative routes for four PRoW will be required:

- a temporary alternative route for Bridleway DEN/3 to the south of its existing alignment via A412 Denham Way/North Orbital Road, DEN/P and Tilehouse Lane for a period of approximately three years and six months, adding an additional 1km. It will then be permanently diverted approximately 150m to the south, adding an additional 270m to allow provision for the future construction of the Heathrow spur without any impact to this PRoW;
- a temporary alternative route for Bridleway DEN/2, 500m to the south of its existing alignment along the boundary of Juniper Wood for a period of approximately five years and six months, adding an additional 1.2km. It will then be permanently reinstated along the original alignment;
- temporary closure of Bridleway CSP/44 for a period of approximately five years and six months. It will then be permanently reinstated along the original alignment; and
- temporary closure of Bridleway Rickmansworth 004 which currently runs east/west to the north of Tilehouse Lane for a period of five years and six months. It will then be permanently reinstated 250m to the south across the new Tilehouse Lane overbridge, adding an additional 400m.

2.3.32 Diversion of six utilities and the installation of six new utilities will be required, the key ones being:

- protection of National Grid high pressure gas mains across A412 Denham Way/North Orbital Road;
- removal of 8 inch National Grid high pressure gas main and capped by the side of A412 Denham Way/North Orbital Road;
- protection of Affinity Water Northmoor pumping station off the A412 Denham Way/North Orbital Road (adjacent to River Colne);
- temporary realignment of the 132kV SSE overhead power line along the eastern site of the M25, with permanent realignment below ground along the existing alignment;
- permanent new 33kV supply, connecting electricity to the Proposed Scheme at West Hyde auto-transformer station; and
- permanent new SSE supply connecting electricity power to Chiltern tunnel south portal building.

2.3.33 Temporary diversion of the private access to Denham Park Farm quarry site will be required during different phases of the construction of the Proposed Scheme.

2.3.34 No watercourse realignments will be required.

Colne Valley viaduct and south embankment satellite compound/Ickenham auto-transformer feeder station satellite compound

2.3.35 This compound (see Map CT-05-019, Volume 2, CFA7 Map Book) will be used for civil engineering and railway installation works and will be located west of Harvil Road. The compound will extend into CFA6. Following the civil engineering works, the compound will become Ickenham auto-transformer feeder station satellite compound for the railway installation phase of works. The compound will:

- be in place for six years and six months. During this period there will be civil engineering works for approximately three years, commencing in 2018, followed by a one year period of inactivity before the railway installation works that will last for approximately two years and six months, commence in 2022;
- support approximately 40 workers each day throughout much of the civil engineering works period but will increase to a maximum of approximately 55 workers each day during the peak period of activity and support approximately 35 workers each day throughout much of the railway installation works period but will increase to a maximum of approximately 60 workers each day during the peak period of activity;
- not provide overnight worker accommodation;
- be accessed via the A40, B467 Swakeleys Road and Harvil Road and/or via the M40, A40, A412 Denham Way/North Orbital Road, Moorhall Road and Harvil Road from the west;

- be managed from the Colne Valley viaduct main compound for the civil engineering works and the West Ruislip railhead main compound in CFA6 for the railway systems installations works; and
- have a roadhead for the receipt, storage and transfer of earthworks material route wide (see Map CT-05-019, Volume 2 CFA7 Map Book).

2.3.36 Works in this section of the Proposed Scheme will be carried out in the following broad phases:

- site clearance and enabling works;
- embankments and landscaping earthworks;
- construction of viaducts; and
- permanent fencing.

2.3.37 The key railway systems installation works in this section of the Proposed Scheme will be the installation of Ickenham auto-transformer feeder station. Volume 1 Section 5.17 describes a typical power supply and Section 6.23 describes the associated construction activities.

Colne Valley viaduct satellite compound

2.3.38 This compound (see Map CT-05-019, Volume 2, CFA7 Map Book) will be used for civil engineering works only from the west of Harvil Road to south of South Harefield. The compound will:

- be operational for approximately three years and nine months, commencing in 2018;
- support approximately 15 workers each day throughout much of the civil engineering works period;
- not provide overnight worker accommodation;
- be accessed via the A40, B467 Swakeleys Road and Harvil Road and/or via the M40, A40, A412 Denham Way/North Orbital Road, Moorhall Road and Harvil Road from the west; and
- be managed from Colne Valley viaduct main compound.

2.3.39 Works in this section of the Proposed Scheme will be carried out in the following broad phases:

- site clearance and enabling works;
- building demolition;
- jetty construction (for construction access);
- construction of the viaduct; and
- permanent fencing.

2.3.40 Demolitions will be required at the following locations.

Table 2: Colne Valley viaduct satellite compound demolitions

Description	Location
An outbuilding opposite Dew's Farm Cottages	Dew's Lane
Residential property at Dew's Farm and three associated outbuildings	Dew's Lane
Three community buildings associated with HOAC	In the northern section of the HOAC site at the western end of Dew's Lane
National Grid pylon (ZC044)	Adjacent to Harefield Moor
National Grid pylon (ZC045)	Adjacent to the woodland block called The Alders
National Grid pylon (ZC046)	Adjacent to Grand Union Canal
National Grid pylon (ZC047)	Adjacent to Grand Union Canal
National Grid pylon (ZC048)	Adjacent to Grand Union Canal

2.3.41 No road diversions will be required.

2.3.42 Alternative routes for the following two PRoW will be required:

- a temporary alternative route for Footpath U34, to the east for a period of approximately three years and nine months, adding a negligible distance. It will then be permanently diverted around Colne Valley south embankment adding an additional 400m; and
- a temporary alternative route for the Grand Union Canal western tow path, to the east for a period of approximately three years and nine months adding an additional 600m. It will then be permanently reinstated along its existing alignment.

2.3.43 Realignment of ten utilities will be required, the key ones being:

- protection of Thames Water sewerage pressured mains adjacent to HOAC and connecting to Harefield pumping station;
- temporary realignment of 275kV National Grid overhead power lines over the Colne Valley, 80m to the west of its existing alignment, for a period of approximately three years and nine months, with permanent realignment of approximately 1km via the southern side of the Chiltern Main Line, across the Uxbridge Golf Course, over Harvil Road, northwards over the Proposed Scheme and then back in a north-westerly direction to the National Grid feeder station north-east of HOAC; and
- protection of Affinity Water Blackford pumping station off Moorhall Road.

2.3.44 Diversion of two watercourses will be required:

- a permanent diversion of the Newyears Green Bourne which will require a realignment of approximately 140m to the west around the Colne Valley viaduct piers; and
- a permanent diversion of the River Colne which will require a realignment of approximately 170m to the south around the Colne Valley viaduct pier.

Colne Valley viaduct storage satellite compound

2.3.45 This compound (see Map CT-05-020, Volume 2, CFA7 Map Book) will be used for civil engineering works only, between south of South Harefield and the north of Denham Green. The compound will:

- be operational for approximately three years and nine months, commencing in 2017;
- support approximately 40 workers each day throughout much of the civil engineering works period;
- not provide overnight worker accommodation;
- be accessed via the M40, A40, A412 Denham Way/North Orbital Road and Moorhall Road; and
- be managed from the Colne Valley viaduct main compound.

2.3.46 Works in this section of the Proposed Scheme will be carried out in the following broad phases:

- site clearance and enabling works;
- jetty construction (for construction access);
- construction of the viaduct; and
- permanent fencing.

Colne Valley viaduct jetty storage satellite compound

2.3.47 This compound (see Map CT-05-020 Volume 2, CFA7 Map Book) will be used for civil engineering works only, between south of South Harefield and the north of Denham Green. The compound will:

- be operational for approximately two years and nine months, commencing in 2018;
- support approximately 40 workers each day throughout much of the civil engineering works period;
- not provide overnight worker accommodation;
- be accessed via the M40, A40, A412 Denham Way/North Orbital Road and Moorhall Road; and
- be managed from Colne Valley viaduct main compound.

2.3.48 Works in this section of the Proposed Scheme will be carried out in the following broad phases:

- site clearance and enabling works;
- jetty construction (for construction access);
- construction of the viaduct; and
- permanent fencing.

Colne Valley viaduct laydown satellite compound

2.3.49 This compound (see Map CT05-021, Volume 2, CFA7 Map Book) will be used for civil engineering works only, between the north of Denham Green and south of Tilehouse Lane. The compound will:

- be operational for approximately two years and three months, commencing in 2019;
- support approximately 15 workers each day throughout much of the civil engineering works period;
- not provide overnight worker accommodation;
- be accessed via A412 Denham Way/North Orbital Road northwards to the M25 junction 17 or via the A412, Chalfont Lane and the temporary M25 slip roads; and
- be managed from the Colne Valley viaduct main compound.

2.3.50 Works in this section of the Proposed Scheme will be carried out in the following broad phases:

- site clearance and enabling works;
- construction of the viaduct; and
- permanent fencing.

Colne Valley viaduct north launch satellite compound.

2.3.51 This compound (see Map CT-05-021, Volume 2, CFA7 Map Book) will be used for civil engineering works only, between the north of Denham Green and south of Tilehouse Lane. The compound will:

- be operational for approximately two years and nine months, commencing in 2018;
- support approximately 35 workers each day throughout much of the civil engineering works period;
- not provide overnight worker accommodation;

- be accessed via the A412 Denham Way/North Orbital Road, A40 and the M40 to the west and/or Chalfont Lane from the M25 via the temporary the M25 slip roads and A412 from the east; and
- be managed from the Colne Valley viaduct main compound.

2.3.52 Works in this section of the Proposed Scheme will be carried out in the following broad phases:

- site clearance and enabling works;
- construction of the viaduct; and
- permanent fencing.

Colne Valley viaduct north embankment satellite compound

2.3.53 This compound (see Map CT-05-021, Volume 2, CFA7 Map Book) will be used for civil engineering works only, between the north of Denham Green and south of Tilehouse Lane. The compound will:

- be operational for approximately four years, commencing in 2017;
- support approximately 40workers each day throughout much of the civil engineering works period but will increase to a maximum of approximately 195 workers each day during the peak period of activity;
- not provide worker accommodation;
- be accessed via the A412 Denham Way/North Orbital Road, A40 and the M40 to the west and/or Chalfont Lane from the M25 via the temporary M25 slip roads and A412 from the east; and
- be managed from Colne Valley viaduct main compound.

2.3.54 Works in this section of the Proposed Scheme will be carried out in the following broad phases:

- site clearance and enabling works;
- construction of embankments and landscape earthworks; and access roads; and
- permanent fencing.

Chiltern tunnel main compound/Chiltern tunnel south portal satellite compound

2.3.55 This compound (see Map CT-05-022, Volume 2, CFA7 Map Book) will be used for civil engineering works between Chalfont Lane and Juniper Wood in this area and construction of the Chiltern tunnel as far as Mantle's Wood in CFA9. After the completion of the civil engineering works, the compound will reduce in size to form the Chiltern tunnel south portal satellite compound for the railway installation works. The compound will:

- be in place for eight years. During this period there will be civil engineering works for approximately five years and nine months, commencing in 2017 and railway installation works that will last for approximately three years and nine months, commencing in 2021. There will be an overlap of one year and three months between the civil engineering and railway installation works;
- support approximately 255 workers each day throughout much of the civil engineering works period but will increase to a maximum of 310 workers each day during the peak period of activity. Throughout the rail systems installation works period it will support approximately 50 workers each day, increasing to a maximum of 120 workers each day during the peak period of activity;
- support 24 hour working during the Chiltern tunnel construction period;
- provide overnight living accommodation for approximately 95 to 140 people for an estimated period of five and a half years;
- be accessed via the A412 Denham Way/North Orbital Road, A40 and the M40 to the west and/or Chalfont Lane from the M25 via the temporary M25 slip roads and A412 from the east; and
- be managed from the West Ruislip railhead main compound for the railway systems installation works.

2.3.56 Works in this section of the Proposed Scheme will be carried out in the following broad phases:

- site clearance and enabling works;
- cutting and landscape earthworks;
- ground monitoring;
- pre-casting of concrete ring segments;
- tunnel portal construction;
- bored tunnel construction;
- installation of concrete ring segments;
- mining of cross passages;
- slab track;
- walkways;
- tunnel drainage;
- processing and removal of material from tunnel excavation;
- permanent fencing;
- rail systems installation; and
- landscaping and planting.

2.3.57 The compound will be used to manage construction of the Chiltern tunnel south portal and the Chiltern tunnel that will be approximately 13.5km long of which 200m is within this area. The complete Chiltern tunnel will take approximately five years and nine months to construct for the civil engineering works. Volume 1, Section 5.5 describes a typical tunnel and Section 6.12 describes the associated construction activities.

2.3.58 The compound will be used to manufacture the concrete ring segments for the tunnel linings.

2.3.59 No demolitions, PRoW, utility or watercourse diversions will be required.

2.3.60 For the duration of the construction programme, temporary slip roads onto the M25 will be provided to serve this compound. Chalfont Lane will be temporarily closed to through traffic but local access will be maintained to Sunnyhill Road. Through traffic will be temporarily diverted via a new local road which will be created to the west of the M25 and linked to Shire Lane and Hornhill Road.

2.3.61 Key railway systems installation works in this section of the Proposed Scheme will be:

- installation of West Hyde auto-transformer station that will take approximately one year and three months;
- fit out of Chiltern tunnel south portal buildings that will take approximately two years and nine months; and
- fit out of tunnel and railway systems within Chiltern tunnel that will take approximately two years and nine months.

2.3.62 Volume 1 Section 5.17 describes a typical power supply and Section 6.23 describes the associated construction activities.

Construction waste and material resources

2.3.63 Forecasts of the amount of construction, demolition and excavation waste (CDEW) and worker accommodation site waste produced during the construction of the Proposed Scheme in the Colne Valley area have been prepared and are presented, Volume 5: Appendix WM-001-000.

2.3.64 The majority of excavated material generated across the Proposed Scheme will be reused as engineering fill material or in the environmental mitigation earthworks of the Proposed Scheme, either with or without treatment.

2.3.65 Based on the mitigation earthworks design approach adopted for the Proposed Scheme, local excess or shortfall of excavated material within the Colne Valley area will be managed with the aim of contributing to an overall balance of excavated material on a route-wide basis. This overall balance of excavated material is presented in Volume 3, Section 14.

2.3.66 Sustainable placement of inert surplus excavated material will be used where the material cannot be reused beneficially along or locally beyond the route and where it cannot be removed by either rail or along the construction corridor. One area of sustainable placement will be used within the Colne Valley area to permanently

dispose of surplus excavated material generated in the South Ruislip to Ickenham area (CFA6) from the Proposed Scheme. This will avoid the introduction of a large volume of additional construction traffic to routes that are already likely to experience significant environmental effects during construction. The sustainable placement area of surplus excavated material is located south-east of South Harefield

2.3.67 This sustainable placement area will also improve an area of land that is currently unavailable for agriculture due to its past use as a landfill site; once the land is restored this will be returned to agricultural use and replanted with hedgerows to mirror their existing layout.

2.3.68 The quantity of surplus excavated material originating from the Colne Valley area that will require off-site disposal to landfill as excavation waste is shown in Table 3. This is the forecast quantity of contaminated excavated material that is chemically unsuitable for reuse within the Proposed Scheme.

2.3.69 The quantities of demolition, construction and worker accommodation site waste that will be reused, recycled and recovered (i.e. diverted from landfill) have been based on the performance of similar projects as follows:

- demolition waste: 90%;
- construction waste: 90%; and
- worker accommodation site waste: 50%.

2.3.70 The quantities of estimated construction, demolition and excavation wastes that will require off-site disposal to landfill are shown in Table 3.

Table 3: Estimated quantity of waste going to off-site disposal

Waste type	Estimated material quantities that will be generated (tonnes)	Estimated quantity of waste for off-site disposal to landfill (tonnes)
Excavation	2,746,951	0
Demolition	9,088	909
Construction	55,140	5,514
Worker accommodation sites	259	130
TOTAL	**2,811,424**	**6,545**

2.3.71 The assessment of the likely significant environmental effects associated with the disposal of CDEW and worker accommodation waste has been undertaken for the Proposed Scheme as a whole (see Volume 3, Section 14).

Commissioning of the railway

2.3.72 Commissioning is the process of testing the infrastructure to ensure that it operates as expected. This will take place in the period prior to opening. Further details are provided in Volume 1, Section 6.26.

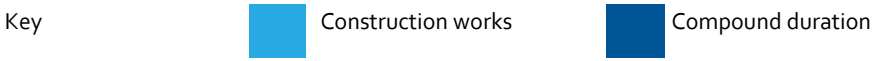
Construction programme

2.3.73 A construction programme that illustrates indicative periods for each core construction activity in this area is provided in Figure 6.

Figure 6: Indicative construction programme

Construction activity	2016 quarters				2017 quarters				2018 quarters				2019 quarters				2020 quarters				2021 quarters				2022 Quarters				2023 quarters				2024 quarters				2025 quarters			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Advance works																																								
Advance works																																								
Civil engineering works																																								
Colne Valley viaduct and south embankment satellite compound																																								
Colne Valley south embankment																																								
Colne Valley viaduct satellite compound																																								
Colne Valley viaduct section 1																																								
Colne Valley viaduct storage satellite compound																																								
Colne Valley viaduct section 2																																								
Colne Valley viaduct north launch satellite compound																																								
Colne Valley viaduct section 3																																								
Colne Valley viaduct north embankment satellite compound																																								
Colne Valley north embankment																																								
Heathrow spur west chord box structure																																								
Colne Valley viaduct main compound																																								
Tilehouse Lane cutting																																								
Tilehouse Lane overbridge																																								
Heathrow spur northbound retaining wall																																								
Heathrow spur southbound retaining wall																																								
Shire Lane culvert																																								
West Hyde embankment																																								

West Hyde auto-transformer station	
Chiltern tunnel south cutting	
Chiltern tunnel main compound	
Chiltern tunnel south portal	
Rail infrastructure and systems works	
West Ruislip railhead main compound	See CFA 6
High speed railway installation	
Ickenham auto-transformer feeder station satellite compound	
Ickenham auto-transformer feeder station installation	
Chiltern tunnel south portal satellite compound	
Chiltern tunnel south portal buildings fit out	
Tunnel fit out and railway installation	
West Hyde auto-transformer station installation	
Commissioning	
Commissioning **(until end 2026)**	



2.4 Operation of the Proposed Scheme

Operational specification

2.4.1 Volume 1, Section 4.4 describes the envisaged operational characteristics of Phase One of HS2 as a whole and how they may change when Phase Two is also operational.

HS2 services

2.4.2 It is anticipated that initially there will be 11tph each way passing through the Colne Valley area in the morning and evening peak hours and fewer during other times. The first trains of the day will leave the terminus stations no earlier than 05:00 Monday to Saturday (and 08:00 on Sundays) and the last will arrive no later than midnight.

2.4.3 It is anticipated that with Phase One in place the frequency of services could rise to 14tph each way during peak hours, and that with Phase Two in place the frequency could rise to 18tph each way during peak hours. The assessment of sound, noise and vibration has taken into account the frequency during Phase Two.

2.4.4 In this area, trains will run at speeds up to 360kph (225mph). The trains will be either single 200m long trains or two 200m long trains coupled together, depending on demand and time of day.

Maintenance

2.4.5 Volume 1, Section 4.3 describes the maintenance regime for HS2.

2.4.6 The intention is that inspections of the route will take place on a regular basis, at night when the railway is not operating. There will be routine preventative maintenance, including grinding and milling of the rails to keep them in good condition, and more periodic heavy maintenance as necessary.

2.4.7 Railway maintenance vehicles will be parked either at the Calvert infrastructure maintenance depot, or in the defined maintenance loops along the route.

Operational waste and material resources

2.4.8 Forecasts of the amount of operational waste that will be produced annually during operation of the Proposed Scheme have been prepared and are presented, Volume 5: Appendix WM-001-000.

2.4.9 Railway station and train waste refers to waste that will arise at each station. It will include waste from station operations and passenger waste removed from trains at terminating stations. This has only been reported for areas along the route in which these stations will be located.

2.4.10 Rolling stock maintenance waste is that which will be generated by the relevant train operating company at rolling stock maintenance facilities. This has only

been reported for the areas along the route in which these facilities will be located.

2.4.11 Track maintenance waste and ancillary infrastructure waste (for example waste from depots, signalling locations, operations and maintenance sites) has been estimated using an average waste generation rate per kilometre length of total track. For this reason, both track maintenance waste and ancillary infrastructure waste has been reported for each area along the route.

2.4.12 The quantity of operational waste that will be reused, recycled and recovered (i.e. diverted from landfill) has been based on landfill diversion performance information from Network Rail and other sources as follows:

- railway station and trains 60%;
- rolling stock maintenance 80%;
- track maintenance 85%; and
- ancillary infrastructure 60%.

2.4.13 On this basis, approximately 83 tonnes of operational waste will be reused, recycled and recovered during each year of operation of the Proposed Scheme in the Colne Valley area. Approximately 17 tonnes will require disposal to landfill (see Table 4).

Table 4: Operational waste forecast for the Proposed Scheme

Waste source	Estimated quantity of waste generated per annum (tonnes)	Estimated quantity of waste for disposal to landfill per annum (tonnes)
Railway station and train	0	0
Rolling stock maintenance	0	0
Track maintenance	92	14
Ancillary infrastructure	8	3
TOTAL	**100**	**17**

2.4.14 The assessment of the likely significant environmental effects associated with the disposal of operational waste has been undertaken for the Proposed Scheme as a whole (see Volume 3, Section 14).

2.5 Community forum engagement

2.5.1 HS2 Ltd's approach to engagement on the Proposed Scheme is set out in Volume 1.

2.5.2 A series of community forum meetings and discussions with individual landowners, organisations and action groups were undertaken. Community forum meetings were held on:

- 21st March 2012 at Denham Grove (De Vere Hotel)21;
- 14th June 2012 at the Denham Grove (De Vere Hotel);
- 13th September 2012 at Colne Valley Park Visitor Centre;
- 8th November 2012 at Colne Valley Park Visitor Centre;
- 21st February 2013 at Colne Valley Park Visitor Centre; and
- 26th September 2013 at the Colne Valley Park Visitor Centre.

2.5.3 In addition to HS2 Ltd representatives, attendees at these community forum meetings typically included local residents (and residents' groups), public representatives, representatives of local authorities and parish and district councils, action groups, affected landowners and other interested stakeholders.

2.5.4 The main themes to emerge from these meetings were:

- the impact upon the A412 Denham Way/North Orbital Road which is used as a diversion route when the M25 is closed;
- the option for tunnelling under the lakes;
- the approach to the noise survey and assessment;
- the impact on Moorhall Road which is the link between Harefield and Denham station;
- the interaction between Proposed Scheme and small aircraft using Denham Aerodrome;
- the ability of HOAC to continue to provide outdoor community activities during the construction of the viaduct and when the service is operational;
- the additional impact of the feeder station on this assessment process; and
- the mineral extraction proposed in the vicinity of Denham Park Farm and the effect of traffic movements during construction.

2.5.5 In addition to the engagement through the community forums, the draft Environmental Statement and Design Refinement consultations were launched on 16th May 2013 for a period of eight weeks and closed on the 11th July 2013.

[21] Denham Grove (De Vere Hotel) was formerly known as Durdent Court.

As part of these consultations, members of local communities and other interested parties were notified, provided with information and invited to engage on issues pertinent to the draft Environmental Statement and the development of the scheme. Details of the local consultation events were provided on HS2 Ltd website, social media, posters at local venues, national and regional advertising and to properties within 1km of the Proposed Scheme. In the Colne Valley area consultations on the draft Environmental Statement and on the Design Refinement were held on 21st June 2013 at the Denham Village Hall, Denham.

2.5.6 HS2 Ltd staff attended the events, including engineers and environmental specialists, for members of the public to speak to.

2.5.7 Responses from the draft Environmental Statement consultation have been analysed and an overview of those received and how the Environmental Statement has taken account of responses is contained in the Draft Environmental Statement Consultation Summary Report (Volume 5: Appendix CT-008-000).

2.6 Route section main alternatives

2.6.1 The main strategic alternatives to the Proposed Scheme are presented in Volume 1. The main local alternatives considered for the Proposed Scheme within the local area are set out within this section.

2.6.2 Since April 2012, as part of the design development process, a series of local alternatives have been reviewed within workshops attended by engineering, planning and environmental specialists. During these workshops, the likely significant environmental effects of each design option have been reviewed. The purpose of these reviews has been to ensure that the Proposed Scheme draws the right balance between engineering requirements, cost and potential environmental impacts.

2.6.3 For alternatives considered for the sustainable placement area please refer to the CFA6 report.

Position of the Colne Valley viaduct

2.6.4 The Proposed Scheme will pass on a viaduct over the Colne Valley Regional Park, including parts of the Mid Colne Valley SSSI, the A412 Denham Way/North Orbital Road and adjacent to local properties including listed buildings, notably Savay Farm and the locally listed Dew's Farm which will be demolished under the Proposed Scheme.

2.6.5 The viaduct will curve away from the Chiltern Main Line, passing over the HOAC, the Grand Union Canal, Moorhall Road, the southern part of the Mid Colne Valley SSSI, the River Colne and between the settlements of South Harefield and Denham Village.

2.6.6 The viaduct was part of the scheme announced in January 2012, however, the alignment has been moved approximately 60m at its centre point to the north-east in the Proposed Scheme compared with the January 2012 announced route to reduce its environmental impact.

2.6.7 The viaduct crosses the River Colne and alternative options were considered in order to try and reduce the potential impacts of this crossing. Three horizontal alignments were considered for the position of the viaduct. These include:

- Option A: the January 2012 announced route;
- Option B: the Proposed Scheme, a moderate straightening of the viaduct, moving it approximately 60m north-east at its centre point; and
- Option C: a minor straightening of the viaduct, moving it approximately 25m north-east at its centre point.

2.6.8 All three options would result in construction and operational impacts on ecology including impacts to parts of the SSSI and the River Colne. There would also be visual impacts from all the options. However, Option B provided environmental benefits compared with Option A and C because it reduced the number of piers in the channel of the River Colne to one, rather than six and three respectively for Options A and C. Therefore, Option B will have reduced impacts for both ecology and water. All options would alter the position of the piers placed within the SSSI however there was not considered to be a significant difference in terms of the impact because all the alternative alignments have a similar construction and operational footprint within the SSSI.

2.6.9 The various alignment options would also affect the property impacts at the southern end of the viaduct. Option B will have a reduced direct impact on the buildings affected at the HOAC site compared with Options A and C. However, it will also cause an additional demolition at Dew's Farm which would not have been required under Option A or C. This property would still have been affected under Option A and C because it would have been close to the viaduct under these options.

2.6.10 Option B has been taken forward in the Proposed Scheme because it will have less impact on the River Colne and overall was considered a better environmental outcome. The options for the river crossing and associated river diversion are described below.

The Colne Valley viaduct crossing of the River Colne and associated river diversion

2.6.11 The Proposed Scheme will pass on a viaduct over the River Colne in the vicinity of Denham Green and the Mid Colne Valley SSSI to the north of Moorhall Road. The piers of the viaduct will be spaced approximately every 40m along the length of the viaduct which will result in the placement of a pier directly in the

existing river channel. When combined with the pile cap beneath the pier structure this will affect the entire width of the watercourse.

2.6.12 The alignment of the viaduct as presented in the January 2012 announced scheme has been altered as described previously; this reduced the numbers of piers in the river from six to one. The aim of this change in alignment is to reduce impacts on the River Colne. Whilst this has been achieved the remaining pier in the River required consideration of further mitigation options.

2.6.13 Six options were considered to address the effects arising from the pier in the channel. These were:

- Option A: the January 2012 announced route with the changed horizontal alignment as described previously and presented in the Draft ES; 40m pier spacing and a pier located in the channel of the River Colne;
- Option B: a single 90m viaduct span over the River Colne allowing the watercourse to remain in its original location;
- Option C: a 450m river diversion to the west of its current alignment, whilst retaining the original section of river as backwater channel;
- Option D: a 250m river diversion to the west of its current alignment, whilst retaining the original section of river as backwater channel;
- Option E: a 420m river diversion to the west of its current alignment, whilst retaining the original section of river as backwater channel; and
- Option F: the Proposed Scheme, comprising a 170m long localised diversion of the existing channel. This would alter and narrow a short section of the River Colne to allow it to pass between two piers.

2.6.14 Option A would generate increased flow rates as the water would have to pass between the pier and the banks resulting in significantly higher flood risk to in the immediate area and surroundings. This would be likely to result in erosion of the existing river banks and adverse impacts on the habitats and species in the vicinity, many of which would be associated with the Mid-Colne SSSI. Without further mitigation this was not considered a feasible option on environmental grounds.

2.6.15 In addition, as the pile cap for the viaduct pier would be as wide as the existing channel Option A would still require a temporary diversion of the river during construction.

2.6.16 Option B would allow the original channel to be retained, maintaining the existing conditions within the river and associated biodiversity. However the design of the viaduct would need to be changed as the longer span would need a much deeper vertical section, approximately 7m deep. This would be necessary to provide structural support for the longer span. This would have

increased visual impacts on the surrounding area including the SSSI and recreational lakes. In particular, adopting a different design for this section of the viaduct would create a non-uniform appearance and increased visual intrusion. There would be ecological benefits from this option; however, these benefits would be reduced as a result of the construction method that would be required. This is because in order to build the longer span the proposed construct method would have to change and temporary supports would be needed in the river. This would impact on the river channel. The larger structure and the change in construction method would also increase the costs of the project. For these reasons this option was not adopted.

2.6.17 Of the longer river diversion Options C and E, construction impacts on the land identified for diversion, including parts of the SSSI, would be greater than Option A due to the increased length of river diversion. Over a number of years this habitat would regenerate and the retention of the backwater channel would allow a new wetland habitat to develop. Option C would require slightly more vegetation to be cleared from the adjacent ancient woodland during construction of the diverted channel, although during operation for both options there would be no increased risk to flooding as the flow rates within the river are maintainable.

2.6.18 Option D would be the shortest of the diversion routes and is broadly similar in terms of construction and operational impacts to that of Options C and E although the vegetation to be removed would be considerably less during construction and the rivers meander would follow more closely to its original condition, thereby maintaining more of the existing character of the watercourse.

2.6.19 For Options C, D and E all of the river diversions would pass through areas of higher ground. The result of this is that the river channel would be lower than existing ground level, by up to 8m. In this situation to meet principles of good river restoration and design and WFD objectives extensive earthworks and vegetation removal would be required to create a naturalised channel. This in itself would increase the amount of land required for these options and consequently have additional environmental impacts on the SSSI. Therefore, given these constraints it was unlikely that the longer channel diversions would be as ecological valuable as the existing channel. Consequently trying to maximise the retention of the existing channel under Option F was preferred.

2.6.20 Option F involves a realignment of the existing river channel to enable it to pass between two piers under the viaduct. This presented the smallest construction footprint in relation to the diversion options C, D and E and so will reduce the impact on the SSSI and associated species as well as avoiding the adjacent ancient woodland.

2.6.21 As the channel is narrowed slightly in Option F, flow rates are likely to increase through this section of the River potentially affecting flood risk. Therefore an

area of adjacent land has been included to mitigate this effect as appropriate. With this in place effects associated with this option during operation will not be significant.

2.6.22 Option F was included in the Proposed Scheme because it will have fewer impacts on the River Colne itself and fewer impacts on the surrounding SSSI and ancient woodland. Detailed design of the river diversion will be completed with the Environment Agency to ensure that they address the Environment Agency requirements with respect to the hydraulic capacity, flood risk, ecology and hydromorphology.

Height of the Colne Valley viaduct

2.6.23 The Proposed Scheme includes a viaduct over the Colne Valley. The viaduct height will vary from approximately 11m to 15m above ground/water level through this section of the route.

2.6.24 The viaduct was part of the scheme announced in January 2012, however, the alignment has been moved approximately 60m to the north-east in the Proposed Scheme compared with the January 2012 announced route. The operators of Denham Aerodrome raised concerns about the possibility of aircraft from the aerodrome colliding with the viaduct structure and proposed that the height of the viaduct be lowered.

2.6.25 HS2 Ltd has undertaken a safety assessment of the proposed alignment in response to the concerns raised by the Aerodrome and do not consider that there is a risk. Therefore, lowering the height of the viaduct will not be necessary to allow the safe operation of the Aerodrome and altering the vertical alignment has not been investigated further. This decision was predominately based on health and safety requirements rather than environmental considerations. Environmental constraints were considered in the initial decision to include a viaduct over the Colne Valley as part of the work to develop the scheme consulted upon in 2011 and contained within the route announced in January 2012.

Tunnel under the Colne Valley

2.6.26 The Colne Valley Community Forum requested that a tunnel be constructed to pass beneath the lakes between Ruislip and the M25. This would be considered preferable by the community because it would avoid above ground disturbance from construction and would remove visual and noise impacts during construction and operation.

2.6.27 HS2 Ltd acknowledges that there would be environmental benefits if a tunnel was proposed however, the use of the viaduct to cross the Colne Valley was based on a combination of practical, financial and safety considerations. The lakes are large former gravel pits and the ground beneath falls well below the water level. This means that tunnelling would likely be more difficult and expensive than elsewhere on the route.

2.6.28 Consequently it was determined early in the project that tunnelling was not appropriate and an option for tunnelling has not been re-visited in detail as part of the work since the announcement of the scheme in January 2012.

2.6.29 HS2 Ltd maintains that in order to pass beneath the lakes at sufficient depth it would not be feasible for the Proposed Scheme to meet the surface again before reaching the southern portal of the Chiltern tunnel. The consequence of this is that a tunnel under the Colne Valley would need to be an extension of the Chiltern tunnel. This longer tunnel would require more extensive provision for fire safety and emergency public evacuation in the event of a train failure or fire, such as a third tunnel bore and/or an emergency intervention station in the middle of the extended tunnel length. This would in itself introduce additional potentially significant adverse effects and additional cost.

2.6.30 A long tunnel option from the edge of London and heading north under the Colne Valley and into the Chiltern tunnel would also mean that all excavated tunnelling material would have to be extracted and transported from either the north end of the Chiltern tunnel in the Chilterns AONB or at the south end of the tunnel in central London.

2.6.31 For these reasons, tunnelling beneath the Colne Valley has not been considered in detail since January 2012 and has not been incorporated into the Proposed Scheme.

Location of the Chiltern tunnel portal

2.6.32 The Proposed Scheme includes a tunnel portal east of the M25 for the Chiltern bored tunnel.

2.6.33 In the scheme announced in January 2012 the location of the southern portal of the Chiltern tunnel would have impacted on the piled bridge foundations of the Chalfont Lane overbridge to the M25. Four alternatives were assessed as a result of identifying this impact:

- Option A: the January 2012 announced route;
- Option B: increase the separation between the two bores within the tunnel, i.e. move one bore to the south of the underground structure and the other north of it;
- Option C: the Proposed Scheme, move both bores to the west; and
- Option D: move both bores to the east.

2.6.34 Option A was not considered feasible because of the impact on the bridge foundations and the additional work this would involve. All three of the other options (B, C and D) would be similar in terms of environmental impacts. Option C was chosen as it will avoid the need for a highways diversion to Chalfont Lane and avoid potential impacts to the overhead power lines on the eastern side of the M25.

2.6.35 For these reasons Option C was included in the Proposed Scheme.

Porous tunnel portal

2.6.36 The Proposed Scheme includes a porous tunnel section at the southern end of the bored Chiltern tunnel, located within the section of cutting adjacent to the M25. The scheme in January 2012 did not identify the need for a porous portal and this has been identified as part of the design development of the scheme. The purpose of the porous portal is to maintain passenger comfort and to reduce the pressure transient created by a train when it enters/exits the tunnel and the associated impact on local receptors. Two options were considered:

- Option A: the Proposed Scheme, with the porous portal at the southern end of the tunnel, external to it; and
- Option B: that the porous portal is contained within the tunnel length.

2.6.37 To achieve the reduction in air pressure the porous portal needs to allow air to pass through it. It therefore needs to be exposed to the surface in some way. Placing the portal within the tunnel structure in this location would make it impossible to achieve this, as it would be located directly under the M25. Consequently Option B was not considered feasible in this situation and was not assessed in detail.

2.6.38 However, locating the porous portal at the base of the cutting for the Proposed Scheme, as with the January 2012 announced route, results in a reduced visual impact, thereby addressing the primary concern of the Community Forum.

2.6.39 For these reasons Option A was adopted for the Proposed Scheme.

The National Grid overhead power line diversion over the Colne Valley

2.6.40 The Proposed Scheme includes a diversion to the National Grid overhead power line that currently crosses the lake used by HOAC for sailing activities. The scheme in January 2012 did not identify the need for diversion and this has been identified as part of the subsequent development of the scheme design.

2.6.41 The purpose of the diversion is so that the existing overhead power line does not conflict with the Colne Valley viaduct as it crosses the lake. Two options were considered:

- Option A: the Proposed Scheme, which is an above ground diversion of the National Grid overhead power line. The diversion will be from the south of the Chiltern Main Line and run eastwards across the Denham Quarry Lake, the Uxbridge Golf Course and Harvil Road. The diversion will then turn north, across the Proposed Scheme at Newyears Green Covert and then returning west across the Harvil Road. It will then rejoin the existing overhead alignment north-east of HOAC and next to the proposed National Grid feeder station; and

- Option B: a part buried and part overhead option that begins above ground south of the Chiltern Main Line. This option crosses Denham Quarry Lake to the aggregate storage site at the western end of Skip Lane. From here the buried cable diversion route would run northwards under the Chiltern Main Line, along the eastern side of the HOAC lake and under Dew's Lane before re-emerging north-east of HOAC, next to the National Grid feeder station where it ties into the existing overhead power line.

2.6.42 Both options would require a temporary overhead diversion approximately 80m west of the existing alignment during the construction phase of the Colne Valley viaduct.

2.6.43 Option A, being an above ground diversion, has a greater landscape and visual impact over Option B although the existing landform, the Chiltern Main Line and intervening linear vegetation along the Grand Union Canal and other water bodies goes someway to screening this within the local environment. In landscape and visual terms both options benefit from the removal of the overhead power lines that cross the HOAC lake.

2.6.44 Option A also passes close to and would affect the setting of a number of cultural heritage assets. In addition an area of land would have to be cleared for this Option resulting in ecological impacts.

2.6.45 Option B would be shorter and has a reduced impact in terms of landscape, visual, cultural heritage and ecological impacts but it has a significantly greater cost and long term maintenance issues in relation to the buried element of this Option.

2.6.46 Depending on the exact construction method for Option B, it could result in more intrusive construction impacts arising from burying the cables and the space separation required for this type of power line.

2.6.47 In addition Option B would be closer to other works required under the Proposed Scheme including a number of road crossings. This would result in work being undertaken close to the new power line (which would have to be in place in advance of these works). This would result in greater safety and construction issues when compared to Option A.

2.6.48 Due to the significant costs and construction issues associated with Option B and the relative screening provided by existing vegetation and the Chiltern Main Line it was decided to include Option A within the Proposed Scheme.

The Northolt tunnel boring machine (TBM) power supply

2.6.49 A power supply connection is required for the TBM used to construct the Northolt tunnel, the portal of which is located in the adjacent CFA6 area. The power supply, either as an overhead power line or as a buried cable route will be required from south of the A40 at Fray's Farm, on the boundary between the

Colne Valley area and CFA6. The alignments of Options A to F listed below are located wholly or partially in this area.

2.6.50 The power supply will require two separate route options to ensure resilience of supply during construction and operation.

2.6.51 The following options were considered:

- Option A: a buried cable route running within the tow path on the eastern side of the Grand Union Canal between the A40 and the Chiltern Main Line and then diverting east to the West Ruislip tunnel portal. This option will go through Fray's Valley Local Nature Reserve (in CFA7);
- Option B: an overhead power line route following the alignment of the disused railway between the A40 and the aggregate storage site at the western end of Skip Lane and then diverting east to the West Ruislip tunnel portal. This option will go through Fray's Farm Meadow SSSI and Fray's Valley Local Nature Reserve (both in CFA7);
- Option C: an overhead power line route from the A40, across Fray's Farm Meadow SSSI and Fray's Valley Local Nature Reserve and Uxbridge Golf Course to the aggregate storage site at the western end of Skip Lane and then diverting east to the West Ruislip tunnel portal;
- Option D: the Proposed Scheme (along with Option F), a variation on Option C that avoids Fray's Farm Meadow SSSI and is buried through the Uxbridge Golf Course and under the ancient woodland at Pinnocks Wood. It passes around the edge of the Uxbridge Golf Course to the aggregate storage site at the western end of Skip Lane before diverting east to the West Ruislip tunnel portal;
- Option E: a buried cable option passing along the A40, the B467 Swakeleys Road and Harvil Road to the Chiltern Main Line then diverting east to the West Ruislip tunnel portal; and
- Option F: the Proposed Scheme (along with Option D), a buried cable option passing along the A40, the B467 Swakeleys Road and Breakspear Road South to the Chiltern Main Line then diverting east to the Northolt tunnel portal.

2.6.52 Option A was not included within the Proposed Scheme as it would have had an impact during construction on the tow path for the Grand Union Canal and associated recreational activities. It would have also passed through Fray's Valley Local Nature Reserve resulting in a direct impact upon it.

2.6.53 Option B and C would also have passed through the Fray's Valley Local Nature Reserve and in addition would pass through Fray's Farm Meadow SSSI. For this reason they were not included within the Proposed Scheme. Option D would

avoid these impacts although it would result in a temporary impact on Uxbridge Golf Course.

2.6.54 Option D was included as one of the two power supply routes as it will avoid the SSSI and Local Nature Reserve impacted in Option C but in avoiding the SSSI the buried cable section of this alignment is needed to remove direct impacts on the ancient woodland of Pinnocks Wood. Therefore, this option was preferred compared with options A, B and C.

2.6.55 Option E was discounted due to the impacts this buried cable option would have during construction on traffic using Harvil Road, including the construction vehicles. In addition this option was longer than others and would be more costly.

2.6.56 Option F was included as one of the two power supply routes as it will avoid impacts to traffic on Harvil Road, avoid impacts to designated environmental sites, avoid use of Network Rail land and is a more direct alignment than Option E.

2.6.57 To ensure power supply and provide resilience, two supplies are required during construction and operation. Option D and Option F have been included within the Proposed Scheme to achieve this. It is intended that Option F will be delivered through existing powers outside of the hybrid Bill process.

M25 temporary slip roads

2.6.58 The Proposed Scheme includes the provision of a pair of temporary slip roads onto the M25 north of Chalfont Lane between the existing junctions 16 and 17, for the sole use of construction traffic during the construction phase of the Proposed Scheme.

2.6.59 The alternative option for site access to the main construction compounds for the Colne Valley viaduct and Chiltern tunnel, would have been be off Chalfont Lane, onto the A412 Denham Way/North Orbital Road. Under this option delivery vehicles would either exit the M25 at Junction 17 and travel south on the A412 through Maple Cross, or vehicles would travel north on the A412 through Denham. This would have a significant impact on traffic volumes through these communities. To avoid this impact the option of a new temporary junction on the M25 was included within the Proposed Scheme.

3 Agriculture, forestry and soils

3.1 Introduction

3.1.1 This section provides a description of the current baseline for agriculture, forestry and soils and an assessment of the likely impacts and significant effects as a result of the construction and operation of the Proposed Scheme. Consideration is given to the extent and quality of the soil and land resources underpinning the primary land use activities of farming and forestry and the physical and operational characteristics of enterprises engaged in these activities. Consideration is also given to diversification associated with the primary land uses and to related land-based enterprises, notably equestrian activities.

3.1.2 The quality of agricultural land in England and Wales is assessed according to the Agricultural Land Classification (ALC) system which classifies agricultural land into five grades from excellent quality Grade 1 land to very poor quality Grade 5 land. Grade 3 is subdivided into Subgrades 3a and 3b. The main issue in the assessment of the impacts on agricultural land is the extent to which land of best and most versatile (BMV) agricultural quality (Grades 1, 2 and 3a) is affected by the Proposed Scheme.

3.1.3 Forestry is considered as a land use feature and the impacts have been calculated quantitatively. The qualitative effects on forestry land and woodland are addressed principally in the ecology and landscape and visual assessments (see Sections 7 and 9).

3.1.4 Soil attributes, other than for food and biomass production, are identified in this section but the resulting function or service provided is assessed in other sections, notably cultural heritage, ecology and landscape and visual assessment (see Sections 6, 7 and 9).

3.1.5 The main issue for farm holdings is the disruption by the Proposed Scheme of the physical structure of agricultural holdings and the operations taking place upon them, during both its construction and operational phases. Key engagement has been undertaken with farmers and landowners affected by the Proposed Scheme to obtain factual information on the scale and nature of the farm and forestry operations and related farm-based uses.

3.1.6 Details of published and publically available information used in the assessment, and the results of surveys undertaken within this area are contained, Volume 5: Appendix AG-001-007.

3.2 Scope, assumptions and limitations

3.2.1 The assessment scope, key assumptions and limitations for the agriculture, forestry and soils assessment are set out in Volume 1, the SMR (see Volume 5:

Appendix CT-001-000/1) and the SMR Addendum (see Volume 5: Appendix CT-001-000/2). This report follows the standard assessment methodology.

3.2.2 The study area for the agriculture, forestry and soils assessment covers all of the land that will be required for the construction and operation of the Proposed Scheme. The resources and receptors that are assessed within this area are agricultural land, forestry land and soils; together with farm and rural holdings. The assessments of the impacts on agricultural land quality and forestry land are made with reference to the prevalence of BMV land and forestry in the general locality, taken as a wider 4km corridor centred on the Proposed Scheme.

3.2.3 Common assumptions that have been applied to the Proposed Scheme, such as the restoration of agricultural land to pre-existing quality, the handing back of land used temporarily to the original landowner and the non-replacement of capital items demolished, are set out in Volume 1. There are no assumptions or limitations that are specific to the assessment in this area.

3.3 Environmental baseline

Existing baseline

3.3.1 This section sets out the main baseline features that influence the agricultural and forestry use of land within this area. These include the underlying soil resources which are used for food and biomass production, as well as providing other services and functions for society and the associated pattern of agricultural and other rural land uses.

Soils and land resources

Topography and drainage

3.3.2 The main topographical features within the study area are described in the landscape and visual assessment (Section 9).

3.3.3 The arterial drainage in this area is provided by the River Colne which, together with the Grand Union Canal and the Colne Valley lakes, defines the central character of the area. This mosaic of water features runs in a north-south direction. Many of the lakes are the remnants of gravel abstraction and are divided by spurs of land that have become heavily wooded. These water bodies mark the lowest altitudes of the section at around 40m above Ordnance Datum (AOD). Above these water bodies, the valley sides rise to higher ground reaching around 80m AOD at the Chiltern tunnel south portal just east of the M25. The Chiltern Hills rise further to the west.

Geology and soil parent materials

3.3.4 The main geological features within the study area are described in the land quality assessment (Section 8). The principal underlying geology mapped by the

British Geological Survey[22] comprises clay, silt and sand of the London Clay and Lambeth Group in the south-east and around Harefield and south-west at Denham, with Seaford and Newhaven Chalk Formations arising through the Colne Valley. There is a small intrusion of the Lambeth Group between the viaduct and the M25, close to Tilehouse Lane.

3.3.5 Across most of the section, superficial river terrace deposits of Taplow, Gerrards Cross and Shepperton Gravels overlie the bedrock geology.

Description and distribution of soil types

3.3.6 The characteristics of the soils are described by the Soil Survey of England and Wales[23] and shown on the National Soil Map[24]. The soils are grouped into associations of a range of soil types. They are described in more detail, Volume 5 and their distribution is shown on Map AG-02-007 (Volume 5, Agriculture, Forestry and Soils Map Book).

3.3.7 The National Soil Map shows the study area to have two distinct soil types. To the east of the Grand Union Canal, the soils are described as slowly permeable, seasonally wet loamy and clayey soils. West of the canal the soils are described as freely draining loamy soils.

3.3.8 Wickham 4 and Essendon soils occur east of the Grand Union Canal and are characterised by silty clay loam topsoils overlying clay and are imperfectly to poorly drained, of Wetness Class[25] (WC) III or IV, due to their location around the water courses and flood plains. If drainage is possible, they can be improved to WC II, moderately well drained. The Essendon soils are slightly to moderately stony and have a greater sand component in upper horizons. Sonning 1 soils are also mapped to the east of the canal but are stony, coarse textured and occur on very steep slopes.

3.3.9 The Grand Union Canal and surrounding wetlands are marked by alluvial soils of the Frome and Fladbury 3 associations with typically silty and clayey soil textures though Fladbury 3 soils tend to be stoneless, whereas Frome soils become increasingly stony with depth. Adjacent to the Frome association, the Park Gate and Hamble 2 association soils are mapped over the flattest land in the section. These soils develop over river terrace deposits and are typically deep, stoneless and silty. The Hamble 2 soils, although close to the waterway on low lying land, are well drained due to underlying gravels. Park Gate soils are typically seasonally waterlogged.

3.3.10 As the land rises to the north and west Marlow soils become prominent with intrusions of Wick 3 and Coombe 1 soils from the north. All are developed in ancient river terrace drift which gives rise to their flinty sandy clay loam, sandy

[22] British Geological Survey (2013) http://bgs.ac.uk/geologyofbritain/home/html; Accessed 14/08/13.
[23] Soil Survey of England and Wales, (1984), *Soils and their Use in South East England*.
[24] Cranfield University (2001) *The National Soil Map of England and Wales* 1:250,000 scale.
[25] The Wetness Class of a soil is classified according to the depth and duration of waterlogging in the soil profile and has six bands.

silt loam or sandy loam over clayey profiles. The soils become chalky or sandy at depth and are well drained WC I.

Soil and land use interactions

Agricultural land quality

3.3.11 The principal soil/land use interaction in the study area is the quality of the agricultural land resource. The ALC is based on the identification of physical limitations to the agricultural capability of land resulting from the interactions of soil, climate and the site.

3.3.12 The main soil properties which affect the cropping potential and management requirements of land are texture, structure, depth, stoniness and chemical fertility. Together they influence the functions of soil and affect drainage, workability and water availability for crops, with agricultural land quality mainly determined by soil wetness and/or droughtiness limitations.

3.3.13 The two distinct soil characteristics within the Colne Valley area are the silty clay loam topsoils over clay around the water bodies which are wet and slowly permeable and the slightly coarser, sandy clay loam, sandy silt loam or sandy loam topsoils over clay loam and clay subsoils that represent better draining soils on hill and valley sides. Overall, however, no soil depth or chemical limitations are encountered.

3.3.14 Climate in this area does not place any overarching limitation upon land quality but the interactions of climate with soil characteristics are important in determining any wetness and droughtiness limitations of the land. The local agro-climatic data have been interpolated from the Meteorological Office's standard 5km grid point data set for three points within the area and are set out, Volume 5 AG-001-007. The data show average temperatures and rainfall to be moderate to moderately high. The resulting Field Capacity Day (FCD) regime[26] at 145 is shorter than average for lowland England and is considered favourable for land work.

3.3.15 Gradient (slope) and micro relief (landform undulations) are not considered limiting in the Colne Valley area. Flooding is limited to the floodplains of the River Colne through the centre of the area and its tributaries. The valley is occupied by the Grand Union Canal in the south and land quality could downgrade to Subgrade 3b or Grade 4 in some places. A detailed assessment of flood risk is provided in Section 13.

3.3.16 Overall, the deep, clay loam or silty clay loam Wickham 4 and Park Gate soils are moderately to poorly permeable and can be moderately to poorly drained (WC III or IV). Under the local climatic conditions, the typical soil profile

[26] FCD is a meteorological parameter which estimates the duration of the period when the soil moisture deficit is zero. Soils usually return to field capacity (zero deficit) during the autumn or early winter and the field capacity period, measured in days, ends in the spring when evapotranspiration exceeds rainfall and a moisture deficit begins to accumulate and opportunities for mechanised fieldwork are then possible.

(described, Volume 5) is classified as Subgrade 3b. Where the Wickham 4 and Park Gate soils have a medium silty clay loam topsoil texture, they are assessed as Subgrade 3a. Where calcareous Park Gate and Coombe 1 soils are found, the grading improves to Subgrade 3a or Grade 2 for heavy and medium silty clay loam topsoils respectively.

3.3.17 The Marlow soils demonstrate a slight droughtiness limitation to Grade 2. The profiles are permeable and typically of WC I but water retention by the clay components of the soil profile ensure that droughtiness is not severe.

3.3.18 The Essendon series profile reveals evidence of waterlogging and poor permeability to WCIII or IV which combines with sandy loam or sandy clay loam topsoil to give a workability limitation to Subgrade 3a.

3.3.19 Department for Environment, Food and Rural Affairs (Defra) mapping[27] shows that there is generally a moderate likelihood of encountering BMV land in the locality, which makes such land a resource of medium sensitivity in this area.

Other soil interactions

3.3.20 Soil fulfils a number of functions and services for society in addition to those of food and biomass production which are central to social, economic and environmental sustainability. These are outlined in sources such as the Soil Strategy for England[28] and The Natural Choice: securing the value of nature[29] and include:

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

3.3.21 Forestry resources represent a potentially multifunctional source of productive timber, landscape amenity, biodiversity and carbon storage capacity. The value and sensitivity of the resources are assessed in Section 7.

3.3.22 The floodplains of the River Colne and its tributaries and the valley occupied by the Grand Union Canal represent the functional flood environment, as described in Section 13 with the soils functioning as water stores for flood attenuation, as well as providing a habitat for ecology.

[27] Defra (2005) *Likelihood of Best and Most Versatile Agricultural Land.*
[28] Defra (2009) *Soil Strategy for England.*
[29] Defra (2011) *The Natural Choice: securing the value of nature.*

3.3.23 The presence of soil-borne cultural assets is detailed in Section 6. Palaeolithic stone artefacts and Lower to Middle Palaeolithic flint tools have been found in the Thames Terrace gravel deposits and crop marks in an area east of the M25, north of Denham Park Farm suggesting potential Neolithic to Bronze Age activity. Deposits potentially containing evidence for Mesolithic activity in the area of Dew's Farm have also been found.

Land use

Land use description

3.3.24 Agricultural land use in this area is split into two distinct types with mainly arable cropping to the west of the Colne Valley and pasture to the east. To the north and east of Harvil Road there is a large dairy farm that occupies most of the land between Harvil Road and the Colne Valley water bodies. To the west, alongside the M25, large-scale arable farming is undertaken.

3.3.25 A number of environmental designations potentially influence land use within the study area. All of the study area is a nitrate vulnerable zone (NVZ) which is an area in which nitrate pollution is a potential problem. Statutory land management measures apply which seek to reduce nitrogen losses from agricultural sources to water.

3.3.26 Forest cover within the area (at 19% of land use) is greater than the national average (10%) with substantial forestry resources occurring to the west of the Broadwater Lake nature reserve and to the east and west of the M25.

Number, type and size of farms

3.3.27 There are three farms in the study area[30]. These are a mixture of owner-occupation and tenancies. Some of the land to the east of the Colne Valley is rented from LBH and much of the arable land to the west of the valley is owned by investment companies and let, though some of the land is owner-occupied. The boundaries of the holdings are shown on Maps AG-01-011 to AG-01-013a (Volume 5, Agriculture, Forestry and Soils Map Book) along with the location of the main farm buildings.

3.3.28 Field drainage is common on the eastern side of the study area but not on the gravelly soils to the west. No farms undertake routine field irrigation of crops.

3.3.29 Table 5 sets out the sensitivity of individual holdings to change which is determined by the extent to which they have the capacity to absorb or adapt to impacts and in turn is determined primarily by their nature and scale. In general terms, larger holdings have a greater capacity to change enterprise mix and scale, can better absorb impacts and are less sensitive. Units that rely on the use of buildings (such as intensive livestock, dairy farms and horticultural units) are less able to accommodate change and have a higher sensitivity. Smaller (less intensively used) units, such as pony paddocks associated with residential

[30] Dew's Farm, on Dew's Lane is a residential holding and not a working farm.

properties, have a low sensitivity. The holding/reference name provides a unique identifier and relates to Map Series AG-01-011 to AG-01-013a (Volume 5, Agriculture, Forestry and Soils Map Book) and Appendix AG-001-007, Volume 5.

Table 5: Summary characteristics of holdings

Holding reference/name	Holding type	Holding size (ha)	Diversification	Agri-environment	Sensitivity to change
CFA07/1 Park Lodge Farm	Dairy	240	None	None	High
CFA07/2 Home Farm	Arable and beef cattle	1,200	None	None	Medium
CFA07/3 Denham Park Farm	Arable	126[31]	None	None	Medium

Future baseline

Construction (2017)

3.3.30 No committed developments have been identified in this local area that will materially alter the baseline conditions in 2017 for agriculture, forestry and soils. A planning consent for gravel extraction at Denham Park Farm has recently been commenced and extends to some 41ha with the land restored to agriculture following extraction. The ALC of this land has been assessed and there will be a temporary impact on 2ha of Grade 2 and 10ha of Subgrade 3a agricultural land. Thus, in 2017 there is the possibility that this development will have reduced the amount of BMV land in the area by 12ha, which is inconsequential. The single farm affected (Denham Park Farm) will lose the use of this land whilst the extraction and restoration occurs.

Operation (2026)

3.3.31 By 2026 the gravel extraction development at Denham Park Farm will still be underway. On completion the land will be restored to agriculture. Subject to good standards of land restoration, there will be no net reduction in BMV agricultural land in the study area.

3.4 Effects arising during construction

Avoidance and mitigation measures

3.4.1 During the development of the design, the following measures have been incorporated to avoid or mitigate impacts on agriculture, forestry or soils during construction:

[31] An extant planning consent has commenced which will reduce the size of the holding temporarily to 85ha.

- replacement field access incorporated into the Harvil Road realignment; and
- agricultural access incorporated into the access overbridge at Tilehouse Lane.

3.4.2 In addition, there is a need to avoid or reduce environmental impacts to soils during construction. It is an essential element of the construction process that the soil resources from the areas required temporarily and permanently are stripped and stored so that land required temporarily for construction purposes which is currently in agricultural use can be returned to that use, where agreed and to its pre-existing agricultural condition.

3.4.3 Subject to the adoption of good practice techniques in handling, storing and reinstating soils on land where agricultural or forestry uses are to be resumed, there will be no reduction in the long term capability which would downgrade the quality of disturbed land. Some land with heavier textured soils may require careful management during the aftercare period to ensure this outcome.

3.4.4 Compliance with the draft CoCP will avoid or reduce environmental impacts during construction. Of particular relevance to agriculture, forestry and soils are the following measures (see Volume 5: Appendix CT-003-000):

- the reinstatement of agricultural land which is used temporarily during construction to agriculture, where this is the agreed end use (draft CoCP: Section 6);
- the provision of a method statement for stripping, handling, storing and replacing agricultural and woodland soils to reduce risks associated with soil degradation on areas of land to be returned to agriculture and woodland following construction, based on detailed soil survey work to be undertaken prior to construction. This will include any remediation measures necessary following the completion of works (draft CoCP, Section 6);
- a requirement for contractors to pay due consideration to the impacts of extreme weather events and related conditions which may affect agriculture, forestry and soil resources during construction (draft CoCP, Section 5);
- arrangements for the maintenance of farm and field accesses affected by construction (draft CoCP, Section 6);
- the protection and maintenance of existing land drainage and livestock water supply systems, where reasonably practicable (draft CoCP, Sections 6 and 16);
- the protection of agricultural land adjacent to the construction site, including the provision and maintenance of appropriate stock-proof fencing, where reasonably practicable (draft CoCP, Sections 6 and 9);

- the adoption of measures to control the deposition of dust on adjacent agricultural crops (draft CoCP, Section 7);
- the control of invasive and non-native species and the prevention of the spread of weeds generally from the construction site to adjacent agricultural land (draft CoCP, Section 9);
- the adoption of measures to prevent, as far as reasonably practicable, the spread of soil-borne, crop and animal diseases from the construction area (draft CoCP, Sections 6 and 9); and
- liaison and advisory arrangements with affected landowners, occupiers and agents, as appropriate (draft CoCP, Sections 5 and 6).

Assessment of impacts and effects

3.4.5 The cessation of existing land uses will be required in the area to construct and operate the Proposed Scheme. This includes not only the land on which permanent works will be sited but also that required temporarily to facilitate the delivery of those permanent works.

3.4.6 All of the land required to implement the Proposed Scheme will, therefore, be affected during the construction phase. The land required for the construction and operation of the Proposed Scheme will, in places, sever and fragment individual fields and operational units of agricultural and forestry land. This will result in potential effects associated with the ability of affected agricultural interests to continue to access and effectively use residual parcels of land. There may also be the loss of, or disruption to, buildings and operational infrastructure such as drainage. The scheme design seeks, however, to minimise this structural disruption[32] and to incorporate inaccessible severed land as part of environmental mitigation works.

3.4.7 The timing and duration of various construction elements are set out in Section 2.3. Where land is restored to agricultural use it will be subject to a further period of five years of managed aftercare to ensure stabilisation of the soil structure, where appropriate.

3.4.8 In addition, a sustainable placement area for surplus excavated material from the Proposed Scheme has been identified in this area. The landforms created will be designed to be returned to agriculture on completion of the works (including replacement of existing hedgelines on their current alignment).

[32] Structural disruption is disruption to the existing structure of farm holdings, principally from severance and the loss of key farm holdings.

Temporary effects during construction

Impacts on agricultural land

3.4.9 During the construction phase, the total area of agricultural land used will be approximately 251.8ha as shown in Table 6. Of this total, 121.5ha will be restored and available for agricultural use following construction.

Table 6: Agricultural land required for the construction of the Proposed Scheme

Agricultural land quality	Area required (ha)	Percentage of agricultural land	Area to be restored (ha)
Grade 1	0	0	0
Grade 2	80.7	32	42.1
Subgrade 3a	63.4	25	17.6
BMV subtotal	144.1	57	59.7
Subgrade 3b	107.7	43	61.8
Grade 4	0	0	0
Grade 5	0	0	0
Total agricultural land	**251.8**		**121.5**

3.4.10 The disturbance during construction of approximately 144.1ha of land of BMV quality is assessed as an impact of medium magnitude, comprising between 20% and 60% of the agricultural land requirement. As BMV land in this area is a receptor of medium sensitivity the effect is assessed as a moderate adverse effect of the Proposed Scheme, which is significant.

3.4.11 Following construction the land required temporarily will be primarily reinstated to its pre-existing agricultural condition. It is estimated that there will not be any significant surplus of topsoil or subsoil material arising from the Proposed Scheme in the area.

Nature of the soil to be disturbed

3.4.12 The sensitivity of the soils is greatest in relation to those which will be disturbed by construction activity and returned to an agricultural or other rural land-based use upon completion of the Proposed Scheme. The quantum of each disturbed soil type is less important than the sensitivity of particular soils to the effects of handling during construction and reinstatement of land.

3.4.13 Successful soil handling is dependent upon movements being undertaken under appropriate weather and ground conditions using the appropriate equipment. The principles of soil handling are well established and set out in advisory material such as Defra's Code of Practice for the Sustainable Use of Soils[33]

[33] Defra (2009) *Construction Code of Practice for the Sustainable Use of Soils on Construction Sites*

which will be followed throughout the construction period. The poorly draining Wickham 4 and Essendon soils are more susceptible to compaction and smearing when moved in wet conditions or by inappropriate equipment and need particularly careful handling to avoid damage to soil structure. The better draining Marlow and Coombe 1 soils to the west of the study area will be more resilient to handling.

3.4.14 Compliance with the draft CoCP will ensure the magnitude of impact on soil is low and significance of effect is negligible.

Impacts on holdings

3.4.15 Land may be required from holdings both permanently and temporarily (i.e. the latter just during the construction period). In most cases the temporary and permanent land requirement will occur simultaneously at the start of the Proposed Scheme and it is the combined effect of both that will have the most impact on the holding. In due course some agricultural land will be restored and the impact on individual holdings will reduce, but the following assessment focuses on the combined effect during the construction phase. The residual permanent effects are discussed at the end of this section.

3.4.16 The effects of the Proposed Scheme on individual agricultural and related interests during the construction period are summarised in Table 7. This table shows the total area of land required on a particular holding in absolute terms and as a percentage of the total area farmed. It also shows the area of land that will be returned to the holding following the construction period. The scale of effect is based on the proportion of the holding required rather than the absolute area of land. The holding/reference name provides a unique identifier and relates to Map Series AG-01 (Volume 5, Agriculture, Forestry and Soils Map Book) and Appendix AG-0001-007, Volume 5.

3.4.17 The effects of severance during construction are judged on the ease and availability of access to severed land. For the most part these will be same during and post construction but occasionally they will differ between the two phases. The disruptive effects, principally of construction noise and dust, are assessed according to their effects on land uses and enterprises. Full details of the nature and significance of effects are set out, Volume 5: Appendix AG-001-007. Where the area of land summed by ALC grade differs from the area of land summed by holding, the difference is because some holdings are affected in more than one CFA area and some holdings include non-agricultural land. Where holdings are affected in more than one CFA the combined impact has been reported in the CFA report where the main holding is located.

Table 7 Summary of temporary effects on holdings during construction

Holding reference/name	Total area required	Construction severance	Disruptive effects	Scale of construction effect	Area to be restored
CFA07/1 Park Lodge Farm	82.8ha (35%), but approximately 16.5ha is unsuited to agriculture due to ground contamination so the effective loss is 66.3ha (28%). High impact.	During sustainable placement workings there will be considerable severance to the east but some of this land is unsuited to cropping or grazing due to ground contamination therefore limited severance. Low impact.	Negligible	Major adverse due to the proportion of the holding removed and high sensitivity.	42.5ha
CFA07/2 Home Farm	161ha (13%). Medium impact.	Holding severed but accessible from public highway. Medium impact.	Negligible	Moderate adverse due to the proportion of the holding required and severance	66.8ha
CFA07/3 Denham Park Farm	(Excluding 16.5ha already required for gravel extraction): 14.3ha (11%) of holding. Medium impact.	Severed land accessible from public highway. Medium impact	Negligible	Moderate adverse due to the proportion of the holding required and severance.	2.1ha

3.4.18 Overall, it is considered that all three holdings will experience temporary major or moderate adverse effects during construction which are significant.

3.4.19 Park Lodge Farm will be particularly affected by the impact of sustainable placement of surplus excavated material which will affect some 24.5ha of the Farm in both this area and into CFA6. However, some of the land that will be affected is presently unavailable for agricultural production due to landfill contamination. This land should become re-available for agricultural production following appropriate restoration and subject to clarification from the Food Standards Agency will be a beneficial effect of the Proposed Scheme; however, this has not been assumed for this assessment.

3.4.20 No farm enterprises that are sensitive to noise or vibration emitted during the construction phase, for example intensive poultry houses, have been identified near to the Proposed Scheme.

Cumulative effects

3.4.21 The gravel extraction at Denham Park Farm will remove 41.0ha from CFA07/3 and will reduce the size of the holding from 126ha to 85ha. The Proposed Scheme will require a total of 30.8ha from Denham Park Farm of which 16.5ha is already subject to the planning permission for gravel extraction. Thus the effective loss of agricultural land from the holding is 14.3ha. The temporary loss of 14.3ha of agricultural land to the Proposed Scheme for the reduced-sized holding, will remain as an impact of medium magnitude, which is a significant adverse effect. The development does not result in cumulative effects on forestry or soil resources.

Permanent effects from construction

Impacts on agricultural and forestry land

3.4.22 Land used for the construction of the Proposed Scheme will fall into a number of categories when work is complete, as follows:

- part of the operational railway and kept under the control of the operator;
- returned to agricultural use (with restoration management);
- used for drainage or flood compensation which may also retain some agricultural use; or
- used for ecological and landscape mitigation.

3.4.23 Following construction and restoration, the area of agricultural land that will be permanently required will be 130.3ha, as shown in Table 8.

Table 8: Agricultural and forestry land required permanently

Agricultural land quality	Total area required (ha)	Percentage of agricultural land
Grade 1	0	0
Grade 2	38.6	30
Subgrade 3a	45.8	35
BMV subtotal	84.4	65
Subgrade 3b	45.9	35
Grade 4	0	0
Grade 5	0	0
Total	130.3	
Non-agricultural forestry land	24.9	

3.4.24 The permanent loss of 84.4ha of BMV agricultural land is assessed as an impact of high magnitude, comprising more than 60% of the agricultural land requirement. As stated previously, BMV land in this area is a receptor of medium sensitivity so the permanent effect on BMV land is assessed as major/moderate adverse which is significant.

3.4.25 Some areas of agricultural land that are required for the construction of the Proposed Scheme will revert to land for ecological and landscape mitigation and will be removed from mainstream agricultural production. These areas include a significant opportunity for habitat creation and green space, between the M25, the A412 Denham Way/North Orbital Road and Chalfont Lane. Grassland, open water and scattered trees are likely to be created. None of this land will return to agriculture and it has been included in the figures of land required permanently listed previously.

3.4.26 In total some 4ha of agricultural land will also be engineered to provide additional flood compensation capacity and will be subject to marginal downgrading in agricultural land quality. For the purposes of this assessment it is assumed that this land will be available for agricultural production.

3.4.27 The total amount of forestry land required to implement the Proposed Scheme will comprise 24.9ha[34], out of a total permanent land requirement of approximately 368.8ha (7%) and is an impact of medium magnitude. As forestry is assessed as having a low sensitivity to change in this area the quantitative effect is assessed as minor adverse and is not significant. Insofar as forestry land may have some non-commercial value, for example in ecological or landscape terms, the qualitative assessment of this loss is addressed in the relevant sections.

Impacts on holdings

3.4.28 The permanent residual effects from the construction of the Proposed Scheme on individual agricultural and related interests are summarised in Table 9. The land required column refers to the area of land permanently required to operate the Proposed Scheme (in absolute terms and as a percentage of the overall area farmed). The scale of effect is based on the proportion of land required. The effects of severance are judged on the ease and availability of access to severed land once construction is completed. The impact on farm infrastructure refers mainly to the loss of or damage to farm capital, such as property, buildings and structures, and the consequential effects on land uses and enterprises. Full details of the nature and scale of effects are set out, Volume 5: Appendix AG-001-007, Section 4.

[34] Forestry Commission (2001) *National Forest Inventory, Woodland and Ancient Woodland* (as updated).

Table 9: Summary of permanent construction effects on holdings

Holding reference/name	Land required	Severance	Infrastructure	Scale of effect
CFA07/1 Park Lodge Farm	43.8ha (18%) Medium	Negligible	Negligible	Major/moderate adverse due to the proportion removed and high sensitivity
CFA07/2 Home Farm	94.2ha (8%) Low	Severed land accessible from public highway Medium	Negligible	Moderate adverse due to the proportion of the holding required and severance
CFA07/3 Denham Park Farm	12.2ha (10%) Medium	Severed land accessible from public highway Medium	Negligible	Moderate effect due to the proportion of the holding removed and severance

3.4.29 Overall, it is likely that all three holdings will experience moderate or major/moderate permanent adverse effects from the construction of the Proposed Scheme which is significant. Although financial compensation will be available, there can be no certainty that this will be used to reduce the above adverse effects by the purchase of replacement land. Therefore, the above assessment should be seen as the worst-case scenario which could be reduced if the owner and/or occupier is able and chooses to use compensation payments to replace assets.

Cumulative effects

3.4.30 The gravel extraction at Denham Park Farm is a temporary activity and the agricultural land affected is proposed to be restored to agriculture. In such circumstance there will be no permanent effect from the gravel extraction on the agricultural holdings affected and no cumulative impact to assess.

3.4.31 The development does not result in any other cumulative effects on forestry or soil resources.

Other mitigation measures

3.4.32 Mitigation in other topics that might provide benefits for soils and forestry is discussed in those Sections. Mitigation will incorporate climate change adaptation and resilience measures, as far as practicable.

Summary of likely significant residual effects

3.4.33 Once the construction process is complete and land required temporarily has been restored, the area of land removed from agricultural use will be 130.3ha, of which 84.4ha is BMV agricultural land. This is a major/moderate adverse residual effect which is significant.

3.4.34 Three holdings have been identified that will experience significant permanent effects though all are likely to remain as agricultural businesses. The possible purchase of replacement land using compensation payments has the potential to reduce the effects on individual holdings so they are no longer significant.

3.5 Effects arising from operation

Avoidance and mitigation measures

3.5.1 No measures are required to mitigate operational effects of the Proposed Scheme on agriculture, forestry and soils.

Assessment of impacts and effects

3.5.2 Potential impacts arising from the operation of the Proposed Scheme will include:

- noise emanating from moving trains and warning signals; and
- the propensity of operational land to harbour noxious weeds.

3.5.3 The potential for significant effects on sensitive livestock receptors from noise has been assessed. No likely significant effects have been identified.

3.5.4 The propensity of linear transport infrastructure to harbour and spread noxious weeds is not only a consequence of the management of the highway and railway land but also of the readiness of weed spread onto such land from adjoining land which could be exacerbated with the effects of climate change. The presence of noxious weeds, ragwort in particular, will be controlled through the adoption of an appropriate management regime which identifies and remedies areas of weed growth which might threaten adjoining agricultural interests.

Summary of likely significant residual effects

3.5.5 No significant residual effects on agriculture, forestry and soils have been identified for the operation of the Proposed Scheme.

4 Air quality

4.1 Introduction

4.1.1 This section of the report provides an assessment of the impacts and likely significant effects on air quality arising from the construction and operation of the Proposed Scheme, covering nitrogen dioxide (NO_2), fine particulate matter (PM_{10} and $PM_{2.5}$)[35] and dust.

4.1.2 With regard to air quality, the main potential effects are anticipated to result from the emissions of the above pollutants from construction activities, equipment and road traffic. Dust emissions will be associated with demolition, site preparation works, construction of the tunnel portal and the use of haul routes within the construction compounds and sustainable placement area.

4.1.3 Detailed reports on the air quality data and assessments for this area, as well as relevant maps are contained in the Volume 5 Appendices. These include:

- Volume 5: Appendix AQ-001-007;
- Map AQ-01-007 (Volume 5, Air Quality Map Book); and
- Map AQ-02-007-01 (Volume 5, Air Quality Map Book).

4.1.4 Maps showing the location of the key environmental features can be found in the Volume 2 Map Books.

4.2 Scope, assumptions and limitations

4.2.1 The assessment scope, key assumptions and limitations for the air quality assessment are set out in Volume 1, the SMR (Appendix CT-001-000/1), the SMR Addendum (Appendix CT-001-000/2) and appendices presented, Volume 5 (AQ-001-007). This report follows the standard assessment methodology.

4.2.2 The study area for the air quality assessment has been determined on the basis of where impacts on air quality may occur from construction activities, from changes in the nature of traffic during construction and operation or where road alignments have changed.

4.2.3 The assessment of impacts arising from construction dust emissions has been undertaken using the methodology based on that produced by the Institute of Air Quality Management (IAQM)[36]. It is important to note that this methodology provides a means of assessing the scale and significance of effects that is partly dependent on the approximate number of receptors within close proximity to the dust generating activities. In doing so, it assigns a lower scale of effect to cases where the number of properties is small, e.g. fewer than 10 within 20m of dust generating activities. Thus, a single property very close to a construction site cannot experience a significant effect using this methodology. The assessment presented here reaches a conclusion that

[35] $PM_{2.5}$ and PM_{10} describe two size fractions of airborne particles that can be inhaled and therefore are of concern for human health. The designations refer to particles of size less than 2.5 and 10 microns in diameter.
[36] IAQM (2012) *Guidance on the assessment of the impacts of construction on air quality and the determination of their significance*

incorporates this concept of significance being dependent on the number of people affected. However, in cases where fewer than 10 properties are within 20m of the construction activity, it will still be the case that mitigation in accordance with the CoCP will be applied.

4.2.4 The assessment of construction traffic impacts has used traffic data that is based on an estimate of the average daily flows in the peak month throughout the construction period (2017-2026). However, the assessment assumes 2017 vehicle emission rates and 2017 background pollutant concentrations. The reason for this is that both pollutant emissions from exhausts and background pollutant concentrations are expected to reduce year by year as a result of vehicle emission controls, and so the year 2017 represents the worst case for the assessment. Furthermore, it has been assumed that the changes in construction traffic will occur for the whole year. In many cases, this represents a conservative assumption, as the duration of the proposed construction works may be much shorter.

4.3 Environmental baseline

Existing baseline

4.3.1 The environmental baseline reported in this section represents the environmental conditions identified within the study area. The air quality in the vicinity of the Colne Valley where the Proposed Scheme related impacts may occur is primarily within air quality standards. However, elevated concentrations occur around the M25 motorway and to the south of the study area in the vicinity of Heathrow and the M4 motorway.

4.3.2 Estimates of background air quality have been obtained from Defra background maps[37] for 2012. These data are estimated for 1km grid squares for NO_x, NO2, PM10 and PM2.5. These reflect the presence of the M4 and M25 motorways, Heathrow airport and London conurbation, showing elevated concentrations around these areas. Elsewhere, average background pollutant concentrations are within relevant air quality standards. Further details regarding the air quality monitoring are shown, Volume 5: Appendix AQ-001-007.

4.3.3 LBH, South Bucks and Three Rivers Councils all conduct routine monitoring at several locations. However, this monitoring focuses on those areas adversely affected by the M4, M25 and Heathrow, or in urban locations that are away from the Proposed Scheme and which will not be affected by scheme related traffic. On this basis, the monitoring data are not relevant to this assessment and have not been considered.

4.3.4 AQMA have been declared by LBH, South Bucks and Three Rivers Councils, as a result of NO_2 concentrations being in excess of the annual average air quality standard (40µg/m^3) (see Map AQ-01-007 (Volume 5, Air Quality Map Book)). Whilst some of these are relatively close to the Proposed Scheme, they will not be directly affected by construction activities, traffic or by operational traffic.

4.3.5 Receptors in the area are primarily those residential properties close to construction activity and alongside roads where traffic flows will change as a consequence of

[37] Defra (2011) 2010 *Based Background Maps for NOx, NO2, PM10 and PM2.5*. Available online at: http://laqm.defra.gov.uk/maps/maps2010.html; Accessed July 2013

construction activity or realignment of roads. Notable receptors in close proximity to construction activity are residential properties at Dew's Farm Cottages, The Tilehouse, Cedar Grange, Denham Grove (De Vere Hotel), Weybeards Cottages and properties on Sunnyhill Road, off Chalfont Lane.

4.3.6 The Mid Colne Valley SSSI ecological receptor is crossed by the route (see Map CT-10-011, Volume 2, CFA7 Map Book) and is sensitive to dust deposition and nitrogen deposition. Fray's Meadow SSSI is next to the A40 and is potentially affected by the NO_x emitted by the additional traffic movements on this road generated by construction.

Future baseline

4.3.7 The data used for the air quality assessment take account of predicted changes in traffic, which are derived from a combination of regional traffic growth factors and consideration of major locally consented schemes, as described in Traffic and Transport, Section 12. In this way, the assessment accounts for cumulative effects.

4.3.8 Appendix CT-004-000 identifies developments with planning permission or sites allocated in adopted development plans, on or close to the Proposed Scheme. These are termed 'committed developments' and will form part of the future baseline for the assessment of effects from the construction and operation of the Proposed Scheme.

4.3.9 The potential cumulative impact from committed developments on air quality acting in conjunction with the effects from the construction and operation of the Proposed Scheme have been considered as part of this assessment. This has been achieved by including changes in traffic predicted as a result of the committed developments within the traffic data used for the air quality assessments for construction and operation, in which the future air quality baselines are defined as the 'without Proposed Scheme scenarios' at each stage.

Construction (2017)

4.3.10 Future background pollutant concentrations have been sourced from Defra background maps for 2017 which predict NO2 and PM10 levels in 2017 to be lower than in the 2012 baseline.

Operation (2026)

4.3.11 Future background pollutant concentrations have been sourced from Defra background maps for 2026 which predict NO2 and PM10 levels in 2026 to be lower than in the 2012 baseline.

4.4 Effects arising during construction

Avoidance and mitigation measures

4.4.1 Emissions to atmosphere will be controlled and managed during construction through the route-wide implementation of the CoCP, where appropriate. The draft CoCP includes a range of mitigation measures that are accepted by the IAQM as being suitable to reduce impacts to as low a level as reasonably practicable. It also makes provision for the preparation of Local Environmental Management Plans (LEMP) which will set out how the project will adapt and deliver the required environmental

and community protection measures within each area through the implementation of specific measures required to control dust and other emissions from activities in the area.

4.4.2 The assessment has assumed that the general measures detailed in Section 7 of the draft CoCP (Volume 5: Appendix CT-003-000) will be implemented. These include:

- contractors being required to manage dust, air pollution, odour and exhaust emissions during construction works;
- inspection and visual monitoring after consultation with the local authorities to assess the effectiveness of the measures taken to control dust and air pollutant emissions;
- cleaning (including watering) of haul routes and designated vehicle waiting areas to suppress dust;
- keeping material stockpiles away from sensitive receptors where reasonably practicable taking into account the prevailing wind direction relative to sensitive receptors;
- using enclosures to contain dust emitted from construction activities; and
- undertaking soil spreading, seeding and planting of completed earthworks as soon as reasonably practicable following completion of earthworks.

Assessment of impacts and effects

Temporary effects

4.4.3 Impacts from the construction of the Proposed Scheme could arise from dust-generating activities and emissions from construction traffic. As such, the assessment of construction impacts has been undertaken for human receptors sensitive to dust and exposure to NO2 and PM10, as well as ecological receptors sensitive to dust and nitrogen deposition.

4.4.4 An assessment of construction traffic emissions has also been undertaken for two scenarios in the construction period, a without the Proposed Scheme scenario and a with the Proposed Scheme scenario.

4.4.5 In the Colne Valley area, there will be the potential for dust emission at demolition sites, construction sites and at the sustainable placement area. In particular, areas of construction activity will be located at the Chiltern tunnel south portal, the Colne Valley viaduct and where cuttings and embankments are required along the route. The haul route used for the disposal of excavated material is also a potential source of dust.

4.4.6 Given the mitigation contained within the draft CoCP, including the use of LEMP to minimise the impacts at receptors close to the haul route, the assessment of impacts on all receptors arising from dust emissions has concluded that they will be negligible in magnitude and that the effect will not be significant. The basis for this conclusion can be found, Volume 5: Appendix AQ-001-007, which describes the magnitude of the emissions and their proximity to receptors.

4.4.7 Construction activity could also affect local air quality through the additional traffic generated on local roads as a result of construction traffic routes and changes to traffic patterns arising from temporary road diversions.

4.4.8 Examination of the changes in traffic flows for 2017 along the affected roads has identified some roads that meet the criteria set out in Volume 1 of the SMR (Appendix CT-001-000/1) for an assessment. This assessment found that there will be substantial adverse impacts along Swakeleys Road, between Harvil Road and the A40, at a number of receptors assessed for NO_2 (for more information see Volume 5, Appendix AQ-001-007). It identified that there will be negligible impacts at a number of receptors for PM10 and PM2.5. The moderate impacts are significant effects for receptors, although of limited spatial extent and population exposure.

4.4.9 The assessment has also found that increases in NO_x concentrations in the Mid Colne Valley SSSI within 100m from the road would give rise to potentially significant effects. No significant effects from nitrogen were identified. The increase in NO_x concentrations is relatively small, in comparison to the background, will be of limited duration and will affect a small part of the SSSI. This is not likely to be a significant effect on the integrity of the SSSI.

4.4.10 A potentially significant effect was also identified in respect of NO_x concentrations on those parts of Fray's Farm Meadows SSSI within 200m of the road, taking into account background concentrations of NO_x and a potentially significant effect in respect of nutrient nitrogen deposition was predicted within 50m of the road. The increase in nitrogen deposition is potentially significant only for a very small fraction of the SSSI and will be of limited duration. It is highly unlikely to be a significant effect on the integrity of the SSSI. Only a small part of the SSSI at its southern extent is adjacent to the A40 in any event and most of its southern boundary is approximately 100m from the roadside. The increase in NO_x concentrations are relatively small in comparison with background concentrations and affect only a small part of the SSSI. It is highly unlikely that this impact could affect the integrity of the SSSI and is therefore not significant.

Permanent effects

4.4.11 There are no permanent effects anticipated to arise during construction of the Proposed Scheme.

Other mitigation measures

4.4.12 No other mitigation measures during construction are proposed in relation to air quality in this area.

Cumulative effects

4.4.13 The construction dust assessment has considered the potential cumulative air quality effects of the Proposed Scheme and other committed developments. The traffic data used for the assessment include the traffic changes expected from the committed developments and therefore their impacts have been included within the assessment.

Summary of likely significant residual effects

4.4.14 The methods outlined within the draft CoCP to control and manage potential effects of construction dust are considered effective in this location and no significant residual effects are considered likely. Receptors on Swakeleys Road will experience substantial adverse effects for NO_2 concentrations as a result of construction traffic movements.

4.4.15 Properties on Swakeleys Road between Harvil Road and the A40 are expected to experience temporary substantial adverse impacts related to NO_2 concentrations during construction that will be significant.

4.5 Effects arising from operation

Avoidance and mitigation measures

4.5.1 No mitigation measures are proposed during operation in relation to air quality in the area.

Assessment of impacts and effects

4.5.2 Impacts from the operation of the Proposed Scheme will relate to changes in the volume, composition and distribution of road traffic. There are no direct atmospheric emissions from the operation of trains that will cause an impact on air quality and these have therefore not been assessed.

4.5.3 The assessment of operational traffic emissions has been undertaken for two scenarios in the operation year 2026, a without the Proposed Scheme scenario and a with the Proposed Scheme scenario. The traffic data include the additional traffic from any future committed developments.

4.5.4 Traffic data in the Colne Valley area have been screened to identify roads that require further assessment and to confirm the likely effect of the change in emissions from vehicles using those roads in 2026.

4.5.5 No roads met the criteria for further assessment outlined in the SMR (Appendix CT-001-000/1) and therefore, no significant effect associated with the scheme is predicted.

Other mitigation measures

4.5.6 No other mitigation measures are proposed in relation to air quality in this area during operation.

Cumulative effects

4.5.7 The traffic data used for the assessment include the traffic changes expected from the committed developments and therefore their impacts have been included within the assessment

Summary of likely significant residual effects

4.5.8 No significant residual effects are anticipated for air quality in this area during operation of the Proposed Scheme.

5 Community

5.1 Introduction

5.1.1 This section reports the impacts and likely significant effects on local communities resulting from the construction and operation of the Proposed Scheme.

5.1.2 Key issues concerning the community assessment for this study area comprise:

- impacts on users of HOAC;
- loss of land within Colne Valley Regional Park;
- temporary re-routing of the Colne Valley Trail, Hillingdon Trail and South Bucks Way where they will be intersected by the construction activity and the temporary closure of part of Old Shire Lane circular walk; and
- impacts on users of Denham Waterski Club.

5.1.3 Further details of the community assessments and write-ups of open space surveys and recreational PRoW surveys undertaken within this area are contained, Volume 5: Appendix CM-001-007.

5.1.4 Significantly affected community resources are shown on Maps CM-01-023 to CM-01-025 (Volume 5, Community Map Book).

5.1.5 The current assessment draws upon information gathered from local and regional resources including HOAC, Buckinghamshire County Council and Denham Waterski Club.

5.2 Scope, assumptions and limitations

5.2.1 The assessment scope, key assumptions and limitations for the community assessment are set out in Volume 1, the SMR (see Volume 5: Appendix CT-001-000/1) and the SMR Addendum (see Volume 5: Appendix CT-001-000/2). This report follows the standard assessment methodology.

5.2.2 Construction worker accommodation will be located at Colne Valley viaduct main compound and the Chiltern tunnel main compound. Construction worker impacts on community resources are considered at a route wide level in Appendix CM-002-000. The assessment takes into account the number of workers, the type and location of accommodation, working hours, facilities provided on construction compounds, experience from other large projects (such as HS1) and the measures contained in the draft CoCP. On this basis it is concluded that there will be no significant effects associated with construction worker accommodation.

5.3 Environmental baseline

Existing baseline

5.3.1 Baseline data on community resources was collected up to 1km from the centre line of the Proposed Scheme and, additionally, up to 250m from the area of land required for construction.

5.3.2 The study area includes the area of land required both temporarily and permanently for the construction and operation of the Proposed Scheme together with a wider corridor within which receptors or resources could be affected by a combination of significant residual effects, such as noise, vibration, construction dust, poor air quality and visual intrusion. In addition, the study area has regard to the proposed routeing of construction traffic and takes account of catchment areas for community facilities which could be affected where crossed by the Proposed Scheme. This area includes land between Harvil Road and Moorhall Road, land around A412 Denham Way/North Orbital Road and land surrounding West Hyde and Maple Cross. The area is part of the suburban fringe of London and includes the settlements of South Harefield, Denham Green, West Hyde and Maple Cross and incorporates the Colne Valley Regional Park.

Harvil Road to Moorhall Road

5.3.3 The area between Harvil Road and Moorhall Road is dominated by the lakes of the Colne Valley and intervening woodland and fields. A small housing estate is located at the junction between Harvil Road and Moorhall Road at the southern edge of South Harefield. There are also several properties including Dew's Farm and Dew's Farm Cottages outside the village, which are located on the east bank of Harefield No.2 Lake in the Colne Valley. Community facilities located near South Harefield include HOAC, Uxbridge Golf Club and Bayhurst Wood Country Park.

A412 Denham Way/North Orbital Road

5.3.4 The A412 Denham Way/North Orbital Road passes through the villages of Denham Green and Denham Garden Village. The villages are located to the south-west of South Harefield on the western bank of the Broadwater Lake. Shops and services are located in the vicinity of Denham Way, where the A412 passes through the villages. Other community facilities include village halls, public houses, St Mark's Church and Hall on Green Tiles Lane, Tilehouse County School, Denham Medical Centre on Queen Mother's Drive, Denham Green Dental Practice on Penn Drive and a post office off Denham Green Close. Denham Waterski Club is located on A412. A number of PRoW pass through the Colne Valley Regional Park including the Colne Valley Trail and Hillingdon Trail along the banks of the Grand Union Canal as well as Old Shire Lane Circular Walk and the South Bucks Way.

West Hyde and Maple Cross

5.3.5 West Hyde and Maple Cross are small settlements on the western banks of the lakes and north-west of Harefield. West Hyde is the smaller of the two settlements and is centred on Chalfont Lane and Old Uxbridge Road. There are some community facilities within West Hyde and Maple Cross. These are all located on Old Uxbridge Road and include St Thomas Church and its associated churchyard, the Royal Oak public house, allotments south of Chalfont Lane and the West Hyde and Maple Cross Youth Centre.

5.3.6 Maple Cross is situated between the M25 and A412 Denham Way/North Orbital Road. Maple Cross has some community facilities including shops, Maple Cross Junior Mixed Infants (JMI) and Nursery School, public houses and playing fields.

Future baseline

Construction (2017)

5.3.7 Volume 5: Appendix CT-004-025/1 provides details of the developments which are assumed to have been implemented by 2017. No committed developments have been identified in this area that will materially alter the baseline conditions in 2017 for the community.

Operation (2026)

5.3.8 The review of future baseline conditions has not identified any additional committed developments, within the study area, which will be completed by the year of operation.

5.4 Effects arising during construction

Avoidance and mitigation measures

5.4.1 The following measures have been incorporated into the scheme design as part of the design development process to avoid or minimise the adverse environmental impacts during construction:

- the configuration of the Colne Valley viaduct laydown satellite compound will reduce impacts on Denham Waterski Club; and
- areas of sustainable placement in this area and CFA6 to avoid effects on Harvil Road, Swakeleys Road and the A40 Western Avenue.

5.4.2 The draft CoCP includes a range of provisions that will help mitigate community effects associated with construction within this area, including:

- appointment of community relations personnel (draft CoCP, Section 5);
- community helpline to handle enquires from the public (draft CoCP, Section 5);
- sensitive layout of construction sites to minimise nuisance (draft CoCP, Section 5);
- where reasonably practicable, maintenance of PRoW for pedestrians, cyclists and equestrians around the perimeter of construction compounds and across entry and exit points (draft CoCP, Section 5);
- a requirement for contractors to pay due consideration to the impacts of extreme weather events and related conditions which may affect community resources during construction (draft CoCP, Section 5);
- specific measures in relation to air quality and noise will also serve to reduce impacts for the neighbouring communities including discretionary noise insulation for sensitive community resources and, in special circumstances, temporary rehousing (draft CoCP Sections 7 and 13); and
- where reasonably practicable, the avoidance of large goods vehicles operating adjacent to schools during drop off and pick up periods (CoCP, Section 14).

Assessment of impacts and effects

5.4.3 Details of all assessments of community resources are included, Volume 5: Appendix CM-001-007. Each assessment form presents information that explains the rationale for determining the rating for sensitivity of the affected community resource, magnitude of impact and the assessment of significance.

Harvil Road to Moorhall Road

Temporary effects

Residential property

5.4.4 Residents on B467 Swakeleys Road (between the junction with the A40 and the junction with Harvil Road) are predicted to experience in-combination effects from traffic, air quality and noise. These effects are significant effects due to increase in HGV movements from construction traffic. The duration of peak construction traffic is described in Section 12, Traffic and transport. In addition, there are predicted to be significant effects on air quality and noise associated with the increase in construction traffic. The combination of these effects will result in a major adverse effect on the amenity of residents along this route, which is significant. This section of road is the border between two study areas and therefore this effect occurs in both areas, CFA6 and CFA7.

Community infrastructure

5.4.5 HOAC provides water-based and land-based outdoor activities all year round. Users include local people, education groups, community groups and those with disabilities for whom specific facilities are in place. In addition to providing a sub-regional role, the activity centre is embedded within the local community, serving local schools, local people and clubs and providing volunteering opportunities. The activity centre also has a role beyond recreation, providing training for new and existing instructors. There are no other centres providing similar services to those provided by HOAC in neighbouring local authority areas.

5.4.6 The Colne Valley viaduct will cross the HOAC site. The construction of the viaduct will require placement of piers within the site, including approximately ten in the adjoining 18ha lake, where water based activities take place. The erection of viaduct piers at approximately 40m intervals from a parallel construction jetty, the works to replace overhead electricity lines and the scale and duration of the construction works will mean that all the lake used by HOAC will be closed during the construction period. The works on the National Grid overhead power lines will take place in advance of the construction of the viaduct and take approximately six months, starting in summer 2016. The duration of construction of the viaduct is approximately five years which comprises approximately six months to replace the overhead electricity lines and approximately four and a half years to construct the viaduct.

5.4.7 The location of the Colne Valley viaduct will result in the demolition of three HOAC buildings (see permanent effects) and in combination with the Colne Valley viaduct satellite compound will enclose some of the remaining buildings on two sides, divide the site in two and occupy land across the existing entrance to the site. The location of the satellite construction compound will affect the ability to enter and exit the activity

centre and is sited on the existing HOAC car parking area which is used by coaches. Provision has been made for alternative access into the site, although part of the road will be shared with construction traffic.

5.4.8 The land required for construction of the Proposed Scheme will result in closure of the lake and impair the land based activities of HOAC during the construction period. This is considered to be a major adverse effect and is therefore significant.

5.4.9 If HOAC remains open, it is predicted to experience in-combination effects as a result of the proximity of construction activity. The combination of visual effects and noise effects is considered to create a major adverse effect affecting the amenity of HOAC and is therefore significant. However, the combination of land required for construction and changes to amenity means the centre is unlikely to operate during the five year construction period.

5.4.10 The construction impact will be for a temporary duration however there is the potential that if HOAC was unable to continue to operate from its existing location during this period there would be a longer impact on the operation of HOAC as it is likely that it would take time to re-establish to its current level of activity.

Permanent effects

Residential property

5.4.11 Construction works for the Colne Valley viaduct will require the demolition of a residential property at Dew's Farm and its outbuildings along with an outbuilding opposite Dew's Farm Cottages. The permanent loss of one dwelling is a minor adverse effect and is therefore not considered to be significant at a community level.

Community infrastructure

5.4.12 The construction of the Colne Valley viaduct will require placement of piers in the 18ha Harefield No 2 Lake where HOAC water based activities take place. The introduction of piers in the lake will constrain water based activities being allocated to the most appropriate part of the lake. This allocation of these water based activities is influenced by the weather conditions (primarily wind conditions) which will be affected by the new structures in the lake. The numbers of groups, ability of groups and types of activities also determine which parts of the lake are used. HOAC advises that the introduction of the viaduct in the lake will affect the flow of the wind which has implications for sailing, as well as affecting visibility, which they believe could restrict the areas of the lake that are available for use. It is considered that the use of part of this community resource will be impaired during the operation of the Proposed Scheme.

5.4.13 The piers for the viaduct will also be placed on land that is part of the HOAC site and will require the demolition of three buildings. The area is currently used for land-based outdoor activities at HOAC.

5.4.14 The land required permanently to construct the Proposed Scheme is considered to result in both the current water-based and land-based operations of HOAC being impaired. It is therefore considered to be a major adverse effect and is significant.

A412 Denham Way/North Orbital Road

Temporary effects

Community infrastructure

5.4.15 The construction of the piers for the Colne Valley viaduct will require land to the north-east of the A412 Denham Way/North Orbital Road, off which the Denham Waterski Club is accessed. The construction works will be undertaken to enable access to be maintained to the water ski club through the implementation of traffic management measures. The nearby jetty used to construct the Colne Valley viaduct will require a small amount of land that forms part of the car park for the club. However, any impact on the capacity and operation of the car park will be avoided through the configuration of the compound and its fencing. This is not considered to result in a significant effect.

5.4.16 The construction works are predicted to result in a change in amenity for users of Denham Waterski Club through a combination of effects. The in-combination effects are significant noise effects at the club house and significant visual effects associated with views south, west and north from the club of the construction activity. The club house is used for instruction and tuition, as well as being the focus for events and therefore changes to this environment are considered to affect the club. The effects are likely to coincide for a period of approximately one and a half years. The combination of these effects is considered to result in a moderate adverse effect and is therefore significant.

Open space and recreational public rights of way

5.4.17 The Colne Valley Regional Park (see Section 2) will be crossed by the Colne Valley viaduct. The effects on ecology and landscape are considered elsewhere in this report (see Sections 7 and 9). The construction of the viaduct will result in land being required for the Colne Valley viaduct storage and jetty satellite compounds (off Moorhall Road) and Colne Valley viaduct laydown satellite compound (off the A412 Denham Way/North Orbital Road, south-west of West Hyde House) for approximately three years and nine months. The construction works for piling and erection of the viaduct piers and decking will, in parallel, also take approximately two and a half years within the Regional Park.

5.4.18 Providing opportunities for countryside recreation and encouraging community participation are key objectives for Colne Valley Regional Park (through its Community Interest Company). The Park is accessible to communities in west London as well as providing a recreational resource for nearby communities. Although land within the park will be required for two and a half years, it is considered that the park is sufficiently large that the construction works will not affect the ability of the park to retain its function. Therefore it is considered that there will not be a significant effect on the Colne Valley Regional Park.

5.4.19 The study area, including Colne Valley Regional Park, has a number of PRoW through it (see Map Series CT-06-Volume 2, CFA7 Map Book). These include the Colne Valley Trail and Hillingdon Trail along the banks of the Grand Union Canal, the Old Shire Lane Circular Walk and the South Bucks Way, as well as other informal routes. Those routes that will be intersected by the construction of the Proposed Scheme will be

re-routed, either temporarily or permanently and therefore no significant effects on recreational PRoW are predicted. Impacts on the Grand Union Canal have been avoided through the placement of piers on either bank rather than in the canal.

5.4.20 The section of the Old Shire Lane Circular Walk from the junction with the A412 Denham Way/North Orbital Road near West Hyde House, west and north-west, to its intersection with the M25 runs alongside areas of construction activity including the Chiltern tunnel main construction compound. This part of the walk is approximately 2.5km in length. Part of this route will be temporarily diverted to the south of the existing route, adding 1.2km to the route. The section of the route that heads north toward the crossing of the M25 at Chalfont Lane will be closed during the construction period for five and a half years. This requirement for land to construct the Proposed Scheme is considered to result in a moderate adverse effect on the Old Shire Lane Circular Walk and therefore its users, which is significant. In addition, the users of the remaining section of the route within this study area are predicted to experience a change in amenity when using the alternative route, principally as a result of the views of and noise from, the construction activity.

Permanent effects

5.4.21 Construction works for the Colne Valley viaduct will require the demolition of three outbuildings associated with residential property at Weybeards Cottages. The impact of the permanent loss of these outbuildings is assessed as a negligible effect and not considered to be significant.

West Hyde and Maple Cross

Temporary effects

5.4.22 No significant temporary effects have been identified.

Permanent effects

5.4.23 No significant permanent effects have been identified.

Cumulative effects

5.4.24 No temporary or permanent cumulative effects have been identified for any of the areas during construction.

Other mitigation measures

5.4.25 The assessment has concluded there are significant adverse effects arising during construction in relation to community resources.

5.4.26 HS2 Ltd has, and will continue to engage with HOAC regarding the impact of the Proposed Scheme and the options for HOAC during construction. The options could include for example, continuing to explore potential refinements to the construction approach during detailed design, combined with restrictions on activities during the construction period. HS2 Ltd is aware that it is HOAC's preference to be relocated from their existing location and this is being discussed within the on-going dialogue. HS2 Ltd will continue to work closely with HOAC, and other relevant stakeholders, and remains committed to seeking to agree a solution with HOAC to allow the facility to continue to operate during the construction period.

Summary of likely significant residual effects

5.4.27 At HOAC, land used for water-based and land-based activities will be temporarily required during construction. The Proposed Scheme will also require land permanently at the site. Effects on the amenity of users during the construction period are also predicted, if the site remains open during construction. However, overall it is unlikely that HOAC will continue to operate during the construction phase and this effect will therefore be significant

5.4.28 The amenity of residents along sections of Harvil Road will be temporarily affected in locations between the junction with Swakeleys Road north to Harvil Farm and at South Harefield, just south of the junction with Moorhall Road. The users of Denham Water Ski Club will experience a change in amenity due to construction activity and the operation of the Proposed Scheme that will be significant.

5.4.29 The land required for construction will result in the closure of part of Old Shire Lane Circular Walk. Due to the length of the alternative route users will be significantly affected.

5.5 Effects arising from operation

Avoidance and mitigation measures

5.5.1 The alignment of the route through the study area reduces adverse environmental impacts during operation on the Colne Valley Regional Park and Grand Union Canal.

5.5.2 Noise fence barriers have also been included as part of the Proposed Scheme to reduce noise effects as identified in Section 11 (sound, noise and vibration).

Assessment of impacts and effects

Colne Valley

5.5.3 Residents of approximately five properties next to Denham Grove (De Vere Hotel), off Tilehouse Lane are predicted to experience in-combination effects due to the operation of the Proposed Scheme. The combined effects are significant operational noise and significant visual effects. The combination of these effects will result in a major adverse effect on the amenity of residents, which is significant.

5.5.4 The construction assessment has identified that it is unlikely that HOAC can continue to operate at their existing location during the construction period. In the event that it does prove possible for HOAC for continue to operate during construction as a result of on-going discussions or alternatively, HOAC is re-established on its existing location after construction then there will be an impact during the operation of the Proposed Scheme. This will include changes to the areas used for their on-site activities and storage and restrictions on the use of the lake, affecting water-based activities as a result of the Colne Valley viaduct.

5.5.5 In addition there are significant operational noise effects and significant visual effects predicted from the operation of the Proposed Scheme. The combination of these effects will result in a major adverse effect on the amenity of users and staff at HOAC during operation of the Proposed Scheme which is significant.

Cumulative effects

5.5.6 No significant cumulative effects have been identified.

Other mitigation measures

5.5.7 In the event that HOAC is using its existing site during the operation of the Proposed Scheme (which will depend on the solution agreed for the construction impacts) other mitigation will be needed to ensure that the current function of HOAC is retained. This will include replacement storage facilities and appropriate alternative facilities for on-site activities such as climbing/camping where these are affected by noise from the railway.

5.5.8 This will form part on the on-going discussions with HOAC, and other relevant stakeholders, and HS2 Ltd remains committed to seeking to agree a solution with HOAC to allow the facility to continue to operate.

Summary of likely significant residual effects

5.5.9 In the event that HOAC is operating at its existing site, there will be an effect on the amenity of users and staff. The amenity of residential properties next to Denham Grove (De Vere Hotel) will also be affected.

6 Cultural heritage

6.1 Introduction

6.1.1 This section of the report provides a description of the current baseline for heritage assets and reports the likely impacts and significant effects resulting from the construction and operation of the Proposed Scheme. Consideration is given to the extent and heritage value (significance) of assets including archaeological and palaeo-environmental remains, historic buildings and the built environment and historic landscapes.

6.1.2 With regard to heritage assets, the main issue is the extent to which designated and non-designated assets are affected by the Proposed Scheme. Impacts on assets as a result of the Proposed Scheme will occur largely through physical removal and alterations to the structures and changes to setting.

6.1.3 Maps showing the location of the key environmental features can be found in Map Series CT-10 (Volume 2, CFA 7 Map Book). The location of all designated and non-designated heritage assets can be found on Map CH-01-023 to CH-01-025a-L1 and CH-02-011 (Volume 5, Cultural Heritage Map Book). Detailed reports on the cultural heritage character and surveys undertaken within the study area are contained in the Volume 5 Appendices. These include:

- Appendix CH-001-007 – Baseline report;
- Appendix CH-002-007 – Gazetteer of heritage assets;
- Appendix CH-003-007 – Impact assessment table; and
- Appendix CH-004-007 – Survey reports.

6.1.4 Throughout this section, assets within the study areas are identified with a unique reference code, i.e. CVA001. Further detail on these assets can be found in the gazetteer, Volume 5: Appendix CH-002-007.

6.1.5 Engagement has been undertaken with Buckinghamshire and Hertfordshire County Archaeological Advisors with regard to the nature of the cultural heritage assets within the study area.

6.2 Scope, assumptions and limitations

6.2.1 The assessment scope, key assumptions and limitations for the cultural heritage assessment are set out in Volume 1 and in the SMR (see Volume 5: Appendix CT-001-000/1) and the SMR Addendum (see Volume 5: Appendix CT-001-000/2). This report follows the standard assessment methodology.

6.2.2 The setting of all designated heritage assets lying within the Zone of Theoretical Visibility (ZTV) of the Proposed Scheme has been considered. The study area within which a detailed assessment of all assets, designated and non-designated, has been carried out, is defined as the land required, temporarily and permanently, to construct the Proposed Scheme plus 500m.

6.2.3 The cultural heritage methodology includes the consideration of the intra-project effects of a number of technical topic assessments, for example, landscape and visual, ecology and water resources and flood risk. Consequently, these interactions have been included in the assessment of impacts and effects.

6.2.4 In undertaking the assessment the following limitations were identified:

- the light imaging, ranging and detection (LiDAR)[38] data examined did not encompass the full extent of the study area; and
- all areas of survey as identified in the archaeological risk model[39] were not available for survey.

6.2.5 However, non-intrusive field surveys were undertaken in a number of areas to provide data regarding the nature of sub-surface archaeological assets. Information from other sources of data, including the historic environment record (HER) and local archives was utilised to provide information relating to the potential archaeological assets that may be present.

6.3 Environmental baseline

Existing baseline

6.3.1 In compiling this assessment, documentary baseline data was collected from a variety of sources as set out, Volume 5: Appendix CH-001-007.

6.3.2 In addition to collation of these baseline data the following surveys were undertaken:

- walkover and site reconnaissance from areas of public access or in locations where access was granted. This was undertaken to understand the character and form of heritage assets and the historic landscape, to review the setting of assets and to identify previously unknown assets;
- desk-top review of remote sensing data including LiDAR, aerial photographs and hyperspectral data (see Volume 5: Appendix CH-004-007); and
- a programme of non-intrusive surveys including geophysical surveys (see Volume 5: Appendix CH-004-007).

Designated assets

6.3.3 A single designated heritage asset is located partially or wholly within the land required, temporarily or permanently, for construction of the Proposed Scheme (see Maps CH-01-023 to CH-01-025a-L1, Volume 5, Cultural Heritage Map Book) at Battlesford Wood ancient woodland of high value (CVA045).

6.3.4 The following designated assets are located within the ZTV of construction activities (see Maps CT-10-011 to CT-10-013a, Volume 2, CFA7 Map Book and Map CH-02-11, Volume 5, Cultural Heritage Map Book):

[38] A remote sensing technique using lasers to produce 3d surface mapping.
[39] The archaeological risk model is an approach that enables the identification of those areas of the Proposed Scheme where archaeological assets are known or suspected and provides a mechanism for the prioritisation of the programme of survey.

- one scheduled monument of high value, a mound with ditch and outer bank to the south of Savay Farm (CVA023);
- four Grade I listed buildings of high value including St Mary's Church in South Harefield (CVA062), Breakspear House in South Harefield (CVA063), St Mary's Church in Denham (within asset grouping CVA013) and The Savay at Savay Farm (within asset grouping CVA023);
- four Grade II* listed buildings of high value including the Dovecote at Breakspear House in South Harefield (CVA064), a footbridge over the River Colne to the north of Denham Court (CVA015), Hills House in Denham (within asset grouping CVA013) and the Almshouse, Harefield (within asset grouping CVA068);
- two conservation areas of high value due to the presence of Grade I or II* listed buildings within them including Denham (asset grouping CVA013) and Harefield (asset grouping CVA068);
- three conservation areas that can be considered of high value in their association with the Grand Union Canal (a high value asset) at Denham Lock (CVA004), Blackjacks and Coppermill Lock (CVA086) and Widewater Lock (CVA037);
- 44 Grade II listed buildings of moderate value. Of these 16 are in Denham and 17 in Harefield. The others include the former film studios at Denham Green (CVA036) and structures associated with the Australian Military Cemetery in Harefield (CVA059 and CVA060);
- two Grade II registered parks and gardens of moderate value at Denham Place (CVA001) and Harefield Place (CVA055); and
- 14 areas of ancient woodland of high value at Juniper Wood (CVA067), Oakend Wood (CVA051), Denham Marsh Wood (CVA041), Great Halings Wood (CVA056), Northmoor Hill Wood (CVA052), Nightingale Wood (CVA039), Holly Hill Woods (CVA038), Battlesford Wood (CVA045), Old Park Wood (CVA090), Nockhill Wood (CVA065), Ladywalk Wood (CVA101), The Pinnocks Wood (CVA105), Clay Pit Wood (CVA109) and Scarlet Spring (CVA110).

Non-designated assets

6.3.5 One non-designated asset of high value lies wholly or partially within the land required, temporarily and permanently, for construction of the Proposed Scheme. This is the Grand Union Canal (CVA102).

6.3.6 The following non-designated assets of moderate value lie wholly or partially within the land required, temporarily or permanently, for construction of the Proposed Scheme (see Maps CH-01-023 to CH-01-025a-L1, Volume 5, Cultural Heritage Map Book):

- Thames Terrace gravel deposits which are likely to contain Palaeolithic stone artefacts as indicated by finds of Palaeolithic tools throughout the study area during gravel extraction and road construction (CVA044);

- deposits potentially containing evidence for Mesolithic activity in the area of Dew's Farm (CVA021);
- Dew's Farm, a locally listed building and possible former medieval manorial site (CVA022); and
- late Iron Age to early medieval activity including a Romano-British agricultural site identified at Denham Park Farm and Chenies (CVA076).

6.3.7 The following identified non-designated assets of low value lie wholly or partially within the land required, temporarily or permanently, for the construction of the Proposed Scheme (see Maps CH-01-023 to CH-001-025a-L1, Volume 5, Cultural Heritage Map Book):

- the Uxbridge High Street Branch Railway (CVA003);
- site of a World War II pillbox (CVA012);
- site of a World War II pillbox (CVA017);
- the Great Western and Great Central Joint Railway (CVA020);
- Mesolithic flint working site at Dew's Pit (evidence has probably already been removed during mineral extraction) (CVA029);
- site of a late 19th century garden at the Fishery (CVA034);
- site of 19th century gardens at Denham Grove (De Vere Hotel) (CVA073);
- area of suspected prehistoric archaeology indicated by cropmarks at Tilehouse Lane but where trial trenching proved inconclusive (CVA080);
- site of a World War II searchlight battery at Corner Hall (CVA084); and
- Old Shire Lane (a possible Roman road) and associated hedgerows (CVA094).

6.3.8 All non-designated heritage assets within 500m of the land required, temporarily or permanently, for construction of the Proposed Scheme are listed in the gazetteer, Volume 5: Appendix CH-002-007 and identified on Maps CH-01-023 to CH-01-025a-L1 (Volume 5, Cultural Heritage Map Book). There are no non-designated built heritage assets that require consideration of their settings.

Cultural heritage overview

6.3.9 The study area lies within the Colne Valley. The Proposed Scheme will include a tunnel portal site near the boundary with the adjacent CFA8 area on the east facing slopes of the valley. The route transitions quickly from embankment in the south onto viaduct across the valley floor which has been subject to extensive gravel extraction in the 20th century.

6.3.10 Human activity through all periods in this study area has largely been concentrated on lighter, more easily worked and better drained soils, particularly over the Terrace Gravels and better draining upper slopes adjacent to, or within the Colne Valley. Further details of the geology of the area are contained, Volume 5: Section 8, Land Quality.

6.3.11 The Colne Valley terrace deposits form part of the wider Thames Valley terrace deposits which have been shown to exhibit a high potential for Palaeolithic and later deposits. The Upper Palaeolithic is defined by the appearance of modern humans in Britain (circa 30,000 to 10,000 BC) and the Colne Valley has yielded evidence of human activity from this period. This has included numerous Palaeolithic finds recovered during gravel extraction and road construction.

6.3.12 At Denham, a scatter of characteristic Upper Palaeolithic tools were found, including a flint core from which a number of long-blade fragments and flakes had been removed. One of these refitted to the core which is a strong indication that this knapping debris was found in-situ and had been quickly buried in peat following discard. The long-blade industry is considered a marker of the final stages of the Palaeolithic or Epipalaeolithic periods, around 10,700 to 9,800 years BC. Nearby, the discovery of a wild boar tusk and bone of a similar age, within the Colne Valley but outside the study area, may indicate on-site butchering. The overlying peat deposits were radiocarbon dated to approximately 9,000 years BC. Elsewhere, at the Sanderson site between the Rivers Colne and Colnbrook, large flint flakes which may be of Upper Palaeolithic origin were recovered amongst an Early Mesolithic assemblage.

6.3.13 Three Ways Wharf, an archaeological site on a low-lying gravel ridge in the River Colne floodplain, approximately 3km south-east of the Proposed Scheme at Uxbridge, has yielded evidence of human activity during the sub-arctic conditions of the Younger Dryas (a 1,000 year cold period around 10,000 years BC immediately prior to the onset of the Holocene[40]). During this cold episode the region would have been a tundra landscape occupied by arctic mammals such as horse, reindeer, arctic hare and arctic fox. Human hunters in this tundra landscape left evidence of their activities, which at Three Ways Wharf comprised the residues of tool-making and use, collectively revealed as in-situ stone and animal remains.

6.3.14 Evidence from the latest Upper Palaeolithic/Early Mesolithic periods has also been identified at Three Ways Wharf. One scatter comprised a Late Glacial long-blade stone industry associated with horse and reindeer remains radiocarbon dated to circa 10,000 years BC. Another scatter was composed of two chronologically distinct remains. One of these comprised evidence of the long-blade stone industry and similar animal remains to those in the first scatter and is likely to be of similar Late Glacial (Upper Palaeolithic) date. The other consisted of a dense concentration of Early Mesolithic stone artefacts and animal remains, the latter mostly of red deer. Radiocarbon dates placed the Mesolithic activity on the site at circa 7,200 years BC.

6.3.15 Typically Mesolithic, Neolithic and Early Bronze Age activity is identified on upper slopes with well drained soils overlooking watercourses. From the Middle Bronze Age (circa 10,000 – 6,500 BC) settlement became more permanent, usually as single farmsteads only large enough to accommodate a single family unit.

6.3.16 A number of Early Mesolithic sites are known in the braided system of the lower Colne Valley, the most well-known of these are at "100 Acres" and Boyer's Pit, Denham and Sandstone, Iver. The River Colne is fed by the rivers Chess, Misbourne and

[40] The geological epoch that began at the end of the last glacial period c. 12,000 BC and has continued almost to the present day.

Alderbourne which cut through the Chalk of the Chilterns and at Sandstone, Iver, flint tools were found lying upon the basal floodplain gravels.

6.3.17 Mesolithic to Bronze Age flints have been found near Marsh Farm close to the border with CFA8. Mesolithic finds have also been recovered from Dew's Farm (CVA021) and Dew's Pit (CVA029) on the eastern side of the valley. At Dew's Farm the finds were made in association with organic sediments suggesting that a preserved land surface could be present in this area. The assemblage recovered from Dew's Pit indicated the presence of a stone working site, again suggestive of a preserved land surface being present in this area.

6.3.18 Numerous Bronze Age to Neolithic flints have been found near Mopes Farm and Warren Farm (CVA078) some in association with a prehistoric ground surface or within pits. Neolithic flints have also been recovered during fieldwalking to the east of Denham (CVA006). Flint scatters aside; there is no evidence of Bronze Age or Iron Age settlement or funerary activity within the study area.

6.3.19 There is evidence to point to continuity of settlement from the Late Iron Age into the centuries following the Roman invasion of Britain in AD 43 onwards into the post-Conquest (AD 43) period. The study area during this period formed part of the civitas of the Catuvellauni.

6.3.20 The pattern of Roman rural settlement in the Colne Valley was likely to have been one of dispersed agrarian villas and farmsteads. An example of such a settlement has been identified during archaeological investigations at Denham Park Farm and Chenies (CVA076) where a Late Iron Age settlement appears to have continued to develop in the Roman period.

6.3.21 Generally there appears to have been a re-location of settlement during the late 1st to 2nd centuries AD to focus on the line of newly established Roman roads and market centres.

6.3.22 At least one possible Roman road lies within the study area on the western side of the Colne Valley (CVA066). The alignment of this road is far from clearly defined within the study area although it is possible that it has become fossilised into the alignments of extant tracks such as Old Shire Lane (CVA094).

6.3.23 Understanding what was occurring in the 5th to 7th centuries AD is very challenging. Material culture is drastically reduced as handmade Anglo-Saxon pottery does not survive well in plough soils and coinage is only present reliably from c. AD 700 and even then is very rare. Much of the evidence for the 5th to 7th centuries comes from cemeteries, although place names can also be a very useful indicator of settlement activity of this period.

6.3.24 Documentary evidence suggests that early medieval settlement was becoming more extensive by the 8th century AD as there are references in Anglo-Saxon charters of the settlements at Iver and Denham (CVA013). Early medieval manorial centres may also be present at Pynesfield (CVA091) and at The Savay (CVA023).

6.3.25 Evidence of medieval (AD 1066-1539) settlement will probably be located in and adjacent to existing settlement in the area, although the possibility of there being

abandoned medieval settlements cannot be entirely discounted. A number of medieval manorial sites are located within the study area including a moated manor at The Savay (CVA023), manorial sites at Pynesfield (CVA091), South Harefield (CVA042), Le Troy (CVA079) and possibly Dew's Farm (CVA022).

6.3.26 It is likely that the pattern of settlement established in the medieval period forms the basis for the pattern that continued through the post-medieval period (AD 1539 – 1900) to the present day.

6.3.27 The widespread enclosure of the landscape to create the present arrangement of hedged fields and winding tracks may have begun with the dissolution of the monasteries in the 16th century and accelerated with the introduction of new farming techniques during the 17th century.

6.3.28 A number of large houses established by the gentry are present within the Colne Valley and are often associated with surrounding planned estates as at Denham Place (CVA001), Denham Court (CVA007), The Fishery (CVA034) and Harefield Place (CVA055 and CVA058).

6.3.29 Many of the extant farmhouses and associated agricultural buildings in the study area were built between the 17th and 19th centuries but were founded on the sites of older buildings, some dating back to the medieval period as at Pynchfield Farm (CVA092) and The Savay (CVA023). It is buildings of these types that make up the majority of the listed buildings in the study area.

6.3.30 The Colne Valley has a rich and diverse landscape character that was mainly formed during the rapid changes of the last two hundred years but still contains some elements of earlier features. Relatively early post-medieval enclosures can be identified on the eastern side of the Colne Valley and there is a good survival of ancient woodland with 12 parcels of designated ancient woodland being present within the study area.

6.3.31 From the later prehistoric period through to the 19th century the Colne Valley was primarily an agricultural landscape that began a slow transformation with the onset of the Industrial Revolution and construction of the Grand Union Canal (CVA102) in the latter half of the 18th century.

6.3.32 The scale and pace of transformation increased during the 19th century with the construction of the railways, including the Great Western and Great Central Joint Railway (CVA020) and Uxbridge High Street Junction Railway (CVA003). This development ran in parallel with the rapid expansion of London, with its associated increase in population pressure and demand for resources and raw materials. By the later 19th century the study area had a long tradition of dairy farming to supply the needs of the rapidly expanding capital.

6.3.33 Rapid changes occurred to the landscape character of the Colne Valley during the 20th century due to its proximity to central London attracting suburban settlement and its rich gravel resources attracting extensive aggregate extraction. The latter has removed much of the Terrace Gravels from the valley floor of the Colne. These excavations have since flooded to create the lakes that now characterise the area.

6.3.34 Alongside the gravel extraction suburban expansion occurred throughout the study area focused around the settlements that had developed in the medieval period. Some developments such as the now demolished Denham Garden Village were planned estates (CVA030). The Denham Film Studios (CVA036) were also established in the 1930s but became industrial units in the 1950s. Other industry includes the Harefield Rubber Company (CVA088).

6.3.35 In World War I the Royal Flying Corps (RFC) created an airfield near Denham Aerodrome (CVA040) which has continued in use as a landing ground through to the present day. During World War II two pill boxes (CVA012 and CVA017) may have been constructed near the junction of the Great Western and Great Central Junction Railway and the Uxbridge High Street Junction Railway. A searchlight battery was also established near Corner Hall (CVA084). The Australian Military Cemetery was established after World War I at Harefield.

6.3.36 Much of the agricultural land in the study area is characterised by 20th century prairie fields (especially to the west of the A412 Denham Way/North Orbital Road up to the M25) created by the amalgamation of smaller fields originally enclosed in the 18th and 19th centuries.

Future baseline

Construction (2017)

6.3.37 Volume 5: Appendix CT-004-000 provides details of the developments which are assumed to have been implemented by 2017.

6.3.38 A planning application has been granted for mineral extraction at Denham Park Farm. This site lies partially within the land required temporarily for construction of the Proposed Scheme. If development of the resource takes place, any surviving buried archaeological remains at this site will have been partially removed prior to construction of the Proposed Scheme.

Operation (2026)

6.3.39 No committed developments have been identified in this local area that will materially alter the baseline conditions in 2026.

6.3.40 None have been identified which will alter the condition of any cultural heritage assets in a manner which affects the assessment of the Proposed Scheme's likely impacts and effects.

6.4 Effects arising during construction

Avoidance and mitigation measures

6.4.1 The draft CoCP sets out the provisions that will be adopted to control effects on cultural heritage assets. The provisions include the following (see Volume 5: Appendix CT-003-000):

- management measures that will be implemented for assets that are to be retained within the land required for the construction of the Proposed Scheme (draft CoCP, Section 8);

- the preparation of project wide principles, standards and techniques for works affecting heritage assets (draft CoCP, Section 8);
- a programme of archaeological investigation and recording to be undertaken prior to/or during construction works affecting the assets (draft CoCP, Section 8); and
- a programme of historic building investigation and recording to be undertaken prior to modification or demolition of the assets (draft CoCP, Section 8).

6.4.2 The following design measures have been incorporated into the design of the Proposed Scheme to reduce impacts on assets:

- planting of vegetation between Juniper Wood and Little Halings Wood and north of Little Halings. These areas of planting will consolidate existing bands of woodland to provide a more continuous visual screen to the Proposed Scheme from the direction of Denham (CVA013); and
- planting around the National Grid feeder station south of South Harefield and existing copses in this area will be augmented to provide a more continuous band of screening from Harefield (CVA068).

6.4.3 Planting and implementation of landscaping will not detract from the historical landscape context of any assets.

Assessment of impacts and effects

Temporary effects

6.4.4 The construction works, comprising excavations and earthworks and including temporary works such as construction compounds, storage areas and diversion of existing roads and services have the potential to affect heritage assets during the construction period. Impacts will occur to assets both within the land required, temporarily or permanently, for the construction of the Proposed Scheme and assets in the wider study area due to the visibility of plant, cranes and equipment and other construction factors. For further information on construction durations see Section 2.

6.4.5 The following significant effects will occur as a result of impacts to the setting of heritage assets within the land required, temporarily or permanently, for construction of the Proposed Scheme.

6.4.6 The Proposed Scheme and associated construction will extend in a broadly south-east to north-west direction approximately 350m north-east of Savay Farm (CVA023) an asset grouping of high value. The historical coherence of this site lies almost entirely within the built fabric, character and appearance of the listed buildings that make up the grouping. Any legible historical context to its setting exists only to the south linking with the potential medieval earthwork (CVA024). The historic landscape context to the east has been removed by gravel extraction and formation of the Colne Valley lakes. The high visibility of construction activities associated with the Colne Valley viaduct and associated disturbance will, however, detract from the otherwise semi-rural setting immediately surrounding the buildings for a period of approximately five years. Construction activities will also form a backdrop for any

views from the west, which is the principal direction of access and the direction from which this asset can best be appreciated. This will result in a medium adverse impact and a major adverse effect.

6.4.7 The Proposed Scheme and associated construction work will extend in a broadly south-east to north-west direction approximately 350m north-east of the scheduled monument of a mound to the south of The Savay (CVA024) an asset of high value. The historic landscape context to the east has been removed by gravel extraction and formation of the Colne Valley lakes. The visibility of the Colne Valley viaduct and significant construction noise (identified in Section 11 of this report) will detract from the semi-rural setting immediately surrounding the buildings over a period of approximately five years. The construction of the viaduct will form a backdrop for any views from the west which is the principal direction of access and the direction from which this asset can best be appreciated. This will result in a medium adverse impact and a major adverse effect.

Cumulative effects

6.4.8 It is not considered that there will be any cumulative effects from temporary impacts on heritage assets within the study area.

Permanent effects

6.4.9 The following significant effects will occur as a result of physical impacts on heritage assets within the land required, temporarily or permanently, for construction of the Proposed Scheme.

6.4.10 Buried archaeological remains associated with the Mesolithic activity at Dew's Farm (CVA021) an asset of moderate value, will be entirely removed during construction. Construction activity will comprise construction of the Colne Valley viaduct with associated haul routes, temporary spoil storage, access routes and landscaping. This will constitute a high adverse impact resulting in a major adverse effect.

6.4.11 The historical significance of Dew's Farm (CVA022) lies predominantly in its probable 14th to 18th century construction and any buried archaeology that will be associated with the probable medieval occupation at the site. Some further value is lent to the building as the birth place of Cecil John Kinross V.C. Although unlisted, it is of moderate value and will be demolished and any buried archaeological remains removed during construction of the Colne Valley viaduct. This will constitute a high adverse impact resulting in a major adverse effect.

6.4.12 Thames Terrace deposits which will be removed near the two tunnel portals and the Colne Valley viaduct, Colne Valley viaduct south embankment satellite compound, Colne Valley viaduct satellite compound, Colne Valley roadhead, National Grid feeder station and Ickenham auto-transformer feeder station are known to contain Palaeolithic artefacts and deposits of moderate value (CVA044). Removal of any in-situ buried archaeological remains of Palaeolithic and Mesolithic date will constitute a medium adverse impact resulting in a moderate adverse effect.

6.4.13 Buried archaeological remains of prehistoric to Roman date, of moderate value, will be removed at Denham Park Farm and Chenies (CVA076) by the establishment of

temporary spoil storage, permanent engineered embankments, landscaping and planting. This will constitute a high adverse impact resulting in a major adverse effect.

6.4.14 Buried archaeological remains of the former post-medieval garden at The Fisheries (CVA034) an asset of low value, will be removed during the establishment of temporary stockpiling, a haul route and a balancing pond. This will constitute a high adverse impact resulting in a moderate adverse effect.

6.4.15 Approximately 1ha of the ancient woodland at Battlesford Wood (CVA045) an asset of high value will be removed during construction. Construction will comprise the establishment of a haul route, the Colne Valley viaduct and environmental mitigation. This will constitute a low adverse impact resulting in a moderate adverse effect.

6.4.16 Buried archaeological remains of the former 19th century garden at Denham Grove (De Vere Hotel) (CVA073) an asset of low value, will be removed during construction by the establishment of a haul route, the Colne Valley viaduct north launch satellite compound, the Colne Valley viaduct north approach embankment and landscaping. This will constitute a high adverse impact resulting in a moderate adverse effect.

6.4.17 Buried archaeological remains of potential prehistoric date and of low value off Tilehouse Lane (CVA080) will be removed by the establishment of a haul route, temporary spoil storage, construction of the Tilehouse Lane cutting, Tilehouse Lane overbridge, West Hyde auto-transformer station, Chiltern tunnel main construction compound, landscaping and plantings. This will constitute a high adverse impact resulting in a moderate adverse effect.

6.4.18 Buried remains of a World War II searchlight battery at Corner Hall (CVA084) an asset of low value, will be removed by the establishment of a haul route, temporary spoil storage the Tilehouse Lane Cutting, Tilehouse Lane overbridge, West Hyde auto-transformer station, Chiltern tunnel main construction compound, landscaping and planting. This will constitute a high adverse impact resulting in a moderate adverse effect.

6.4.19 No significant effects will occur as a result of permanent impacts on the setting of heritage assets.

Permanent cumulative effects

6.4.20 There are no inter-project effects on cultural heritage.

Other mitigation measures

6.4.21 Refinements to the mitigation measures incorporated into the design of the Proposed Scheme or included in the draft CoCP will be considered during detailed design to reduce further the significant effects described above. These refinements will include the identification of:

6.4.22 suitable locations for advanced planting to reduce impacts on the setting of assets; and

6.4.23 locations where the physical impact on below ground assets can be reduced through the design of earthworks.

Summary of likely residual significant effects

6.4.24 As no mitigation beyond that described has been identified, the residual effects are the same as those reported in the permanent effects section.

6.4.25 The temporary effects of construction activity on the setting of heritage assets are largely reversible in nature and last for the duration of the construction works. Residual effects will arise from the visibility of construction plant and in particular the loss of vegetation which forms part of the setting of assets.

6.4.26 The physical impacts of construction on heritage assets are permanent and not reversible, heritage assets will be removed.

Archaeology

6.4.27 A number of archaeological assets will be permanently lost due to the construction of the Proposed Scheme that will be significant. These assets include the remains associated with Mesolithic activity (CVA021) and medieval occupation (CVA022) at Dew's Farm, Palaeolithic and Mesolithic remains in the Thames Terrace deposits (CVA44), Roman remains at Denham Park Farm and Chenies (CVA076) and post-medieval archaeology associated with the 19th century garden at Denham Grove (De Vere Hotel). A programme of archaeological works will be prepared to investigate, analyse, report and archive these assets.

Listed and non-listed historic buildings

6.4.28 The Proposed Scheme will result in the demolition of Dew's Farm (a locally listed building, CVA022) that will be significant. A programme of built heritage works will be prepared to investigate, analyse, report and archive this asset.

Setting and historic landscape

6.4.29 The Proposed Scheme will sever elements of the historic landscape that will be significant, for example the ancient woodland at Battlesford Wood (CVA045). The introduction of the Colne Valley viaduct will change the setting of several heritage assets, including the Grade I listed Savay Farm (CVA023), and The Savay scheduled monument (CVA024). Further consideration will be given to the historic vegetation and landscapes as part of the planting and landscape design.

6.5 Effects arising from operation

Avoidance and mitigation measures

6.5.1 The following design measures have been incorporated into the design of the Proposed Scheme to reduce the impacts and effects on assets:

- noise mitigation measures have been included within the scheme design to reduce potential impacts on identified assets; and
- landscape planting to reduce the potential impacts derived from changes to the setting of identified assets.

Assessment of impacts and effects

6.5.2 The assessment considers the Proposed Scheme once operational and all effects are considered to be permanent. There will be no physical impacts on buried archaeological remains or other heritage assets arising from the operation of the Proposed Scheme. Impacts on the setting of heritage assets arising from the physical presence of the Proposed Scheme are described as permanent occurring within the construction phase and are not repeated in detail here, albeit that they will endure through the operation of the Proposed Scheme. Where there is a combined effect on the setting of an asset from the presence of the constructed Scheme and its operation, this is reported in the assessment of operation.

6.5.3 The following significant environmental effects will occur as a result of permanent changes to the setting of any assets arising from the impacts of railway operation:

6.5.4 Savay Farm (CVA023) an asset grouping of high value, lies in an area which will be subject to significant operational noise due to passing trains (see Section 11). The setting is presently semi-rural and this contributes to the appreciation of this asset and therefore its value. This will constitute a medium adverse impact resulting in a major adverse effect.

6.5.5 The scheduled monument of a mound to the south of The Savay (CVA024) an asset of high value, lies in an area which will be subject to significant operational noise due to the passage of trains (see Section 11). The setting is presently semi-rural and this contributes to the appreciation of this asset and therefore its value. This will constitute a medium adverse impact and therefore a major adverse effect.

Cumulative effects

6.5.6 Assessment of inter-project effects on cultural heritage assets arising from the interaction of the Proposed Scheme with cumulative development projects has been undertaken. These are listed in Section 2.1 and, Volume 5: Appendix CT-004-000. No significant cumulative effects have been identified in relation to cultural heritage.

Other mitigation measures

6.5.7 The Proposed Scheme includes a number of design measures to address potential impacts and significant effects. No additional operational mitigation measures beyond those included within the Proposed Scheme design have been identified.

Summary of likely residual significant effects

6.5.8 The setting of several assets will be significantly affected visually and by noise once the Proposed Scheme becomes operational. This includes Savay Farm (CVA023) and The Savay (CVA024). In due course visual effects will reduce as planting matures and the new railway assimilates into the landscape. Operational noise will remain a significant residual effect.

7 Ecology

7.1 Introduction

7.1.1 This section describes the ecological baseline and identifies likely impacts and significant ecological effects that will arise from the construction and operation of the Proposed Scheme. These include impacts on species, habitats and sites designated for their importance for nature conservation.

7.1.2 The principal ecological issues in this area are the loss of habitat used by and disturbance of breeding birds in the Mid Colne Valley Site of Special Scientific Interest (SSSI), the Mid Colne Valley Site of Metropolitan Importance (SMI) and the loss of woodland, of which some is ancient woodland and some supports coralroot, a notable plant species.

7.1.3 Volume 5 of the ES contains supporting information to the ecological assessment reported in this section, including:

- ecological baseline data (Appendix EC-001-002, EC-002-002, EC-003-002, and EC-004-002);
- register of local/parish level effects, which are not reported individually in Volume 2 (Appendix EC-005-002); and
- data obtained from bat trapping/radio tagging study (Appendix EC-007-002).

7.1.4 As well as survey data, the assessment draws on existing information gathered from national organisations and from regional and local sources including the Environment Agency; Hertfordshire and Middlesex Wildlife Trust; Berkshire, Buckinghamshire and Oxfordshire Wildlife Trust; Buckinghamshire and Milton Keynes Environmental Records Centre; Hertfordshire Biological Records Centre; Greenspace Information for Greater London; Hertfordshire Bird Club; London, Essex and Hertfordshire Amphibian and Reptile Trust and Hillingdon Natural History Society.

7.2 Scope, assumptions and limitations

7.2.1 The scope and methodology of the ecological assessment are introduced in the SMR (Volume 5: Appendix CT-001-000/1) and SMR Addendum (Volume 5: Appendix CT-001-000/2). Further detail, including the study area for individual surveys, is provided within the SMR Addendum (Volume 5: Appendix CT-001-000/2). The assessment methodology is summarised in Section 8.5 of Volume 1, along with route-wide assumptions and limitations. Limitations associated with particular surveys are reported, Volume 5: Appendices EC-001-002, EC-002-002, EC-003-002 and EC-004-002.

7.2.2 A Water Framework Directive assessment has been undertaken in conjunction with the environmental assessment. Details of this assessment are presented, Volume 5: Appendix WR-001-000.

7.2.3 A Habitats Regulations Appraisal (HRA) screening exercise was undertaken in consultation with Natural England during 2011 and 2012. The HRA concluded that the

South West London Waterbodies Special Protection Area (SPA), some 12km south of the Mid Colne Valley SSSI, will not be significantly affected by the Proposed Scheme. This conclusion has been agreed by Natural England. The HRA is presented, Volume 5: Appendix EC-006-007.

7.2.4 As well as the standard range of bat surveys described in the SMR, additional bat trapping and radio-tracking surveys of noctule bats were undertaken to provide information on the likelihood of collision risks with moving trains and the Colne Valley viaduct. A lake habitat survey was also undertaken to provide information on plant, fish and invertebrate assemblages in the Mid Colne Valley SSSI.

7.2.5 Access was not obtained to all of the land area where general habitat survey (Phase 1 habitat survey) was proposed. Locations with the potential to support key ecological receptors where access could not be gained for survey include Dew's Farm and the Newyears Green Bourne; Savay Lake; Harefield No.2 Lake and surrounding habitats (although some survey data were collected from public rights of way for these lakes); Uxbridge Golf Course; Buckinghamshire Golf Course; farmland between the A412 Denham Way/North Orbital Road and M25; farmland east of South Harefield and lakes and woodland south of the Chiltern Main Line. Further details are provided, Volume 5: Appendices EC-001-002, EC-002-002, EC-003-002 and EC-004-002.

7.2.6 Where data are limited, a precautionary baseline has been built up according to the guidance provided, Volume 5: Appendix CT-001-000/2. This constitutes a 'reasonable worst case' basis for the subsequent assessment.

7.2.7 The precautionary approach to the assessment has been adopted to identify the likely significant ecological effects of the Proposed Scheme.

7.3 Environmental baseline

Existing baseline

7.3.1 This section describes the ecological baseline relevant to the assessment at the designated sites, habitats and species recorded in this area. Further details are provided in the reports and maps presented, Volume 5 (Appendices EC-001-002, EC-002-002, EC-003-002 and EC-004-002 and Map Series EC-01 to EC-12, Volume 5, CFA7 Ecology Map Book). Statutory and non-statutory designated sites are shown on Map EC-01 (Volume 5, Ecology Map Book).

7.3.2 Land required for the construction of the Proposed Scheme and that adjacent to it includes the valley of the River Colne where past mineral extraction has created a series of large lakes. These lakes support important populations of breeding birds and waterfowl as well as wetland and wet woodland habitats. Many of the lakes are used for angling and Tilehouse Lake South, Harefield No. 2 Lake and the northern part of Broadwater Lake are all used for water sports. Lafarge Aggregates operates on the eastern side of Broadwater Lake and Harefield Moor Lake is a gravel washing lagoon. Large areas of arable farmland are present to the west of the A412 Denham Way/North Orbital Road and farmland is present between Harefield No. 2 Lake and Harvil Road; both areas are crossed by hedgerows. There are several ancient woodlands in the surrounding area.

Designated sites

7.3.3 There are four SSSI within 500m of the land required for construction of the Proposed Scheme. All are of national value:

- Mid Colne Valley SSSI (141ha) – is partly within the land required for the construction of the Proposed Scheme. It is designated for a diverse assemblage of breeding birds associated with woodland and wetland and for wintering wildfowl. The citation includes 70 species of breeding bird and 80 species of wintering bird, a large cormorant roost, counts of tufted duck that frequently reach levels of national importance and counts of pochard and shoveler that occasionally reach levels of the same importance. The site includes large areas of open water[41], semi-natural broadleaved woodland, including ancient woodland and an area of chalk grassland at Coppermill Down[42].
- Denham Lock Wood SSSI (6.8ha) – is located approximately 100m south of the Proposed Scheme where National Grid overhead power lines will be realigned, east of the Grand Union Canal (about 1km south of the proposed viaduct). It is designated for diverse wet woodland and swamp habitats;
- Fray's Farm Meadows SSSI (26.3ha) – adjoins the southern boundary of Denham Lock Wood SSSI and is adjacent to the realignment of the National Grid overhead power lines. It is designated for species-rich grassland, wetland plants and invertebrates; and
- Ruislip Woods SSSI (305ha) – is adjacent to land required for construction of the Proposed Scheme south of Breakspear Road North (where National Grid overhead power lines will be realigned). It is a large ancient woodland designated for woodland plants and invertebrates with small areas of acid heath vegetation. The site is within the adjacent area and is assessed in the CFA6 report.

7.3.4 There are four Local Nature Reserves (LNR) within 500m of the land required for construction of the Proposed Scheme. All are of district/borough value:

- Denham Country Park LNR (19ha) – is partly within the land required for construction of the Proposed Scheme, south of Moorhall Road, where National Grid overhead power lines will be realigned. This site is designated for woodland, grassland, scrub and wetland habitats. This LNR is in the larger Mid Colne Valley SMI;
- Fray's Valley LNR (71.8ha) – is partly within the land required for construction of the Proposed Scheme, south of the Chiltern Main Line, where National Grid overhead power lines will be realigned. It is designated for woodland, grassland, scrub and wetland habitats. This LNR is also in the larger Mid Colne Valley SMI;

[41] The Mid Colne Valley SSSI includes the following lakes: Broadwater Lake, Harefield Moor Lake, Korda Lake, Tilehouse Lake South and Long Pond.
[42] Coppermill Down is over 900m away from the land required for construction of the Proposed Scheme.

- Denham Quarry Park LNR (29ha) – is crossed by the land required for construction of the Proposed Scheme where National Grid overhead power lines will be realigned, at the location where Denham Court Drive passes over the River Misbourne. It is designated for wetland birds, invertebrates and grassland habitat. A small part of this site is in the Mid Colne Valley SMI; and
- Northmoor Hill Wood LNR (8.7ha) – is located approximately 45m from the land required for construction of the Proposed Scheme on the western side of the A412 Denham Way/North Orbital Road and is designated for ancient woodland.

7.3.5 There are eleven non-statutory SMI, Local Wildlife Sites (LWS), Biological Notification Sites (BNS) and Sites of Borough Importance grade 1 or grade 2 (SBI.I or SBI.II)[43] relevant to the assessment in this area. Each is of county/metropolitan value, except the SBI which are of district/borough value[44]. The eleven sites located in or adjacent to the Proposed Scheme are:

- Mid Colne Valley SMI (321ha) – a large site that is partly within the land required for construction of the Proposed Scheme. It overlaps most of the Mid Colne Valley SSSI[45]. It is designated for the Fray's River with a diverse assemblage of aquatic and wetland plants, species-rich grassland at Fray's Farm Meadows and wet woodland at Denham Lock Wood. It is also designated for wintering waders (birds that are associated with damp grassland), invertebrates including glow worm, Desmoulin's whorl snail, mammals such as water vole and harvest mouse, breeding and wintering waterfowl and passage migrants using the flooded gravel pits. The land required for the construction of the Proposed Scheme will cross Harefield No. 2 Lake, Savay Lake, Korda Lake, Harefield Moor Lake, the Long Pond and is adjacent to Broadwater Lake all of which are in the SMI[46];
- London's Canals SMI (178ha) – is designated for wetland plants and water birds. This site extends across the London canal system. It lies partly in the land required for construction of the Proposed Scheme at the Grand Union Canal, between Harefield No. 2 Lake and Savay Lake;
- Northmoor Hill Wood and Wyatt's Covert LWS (13.1ha) – one of a group of woodlands between Denham Green and Gerrards Cross that are designated for ancient woodland. It has oak, ash and birch woodland in the drier, more acidic areas and beech and alder woodland in the low-lying, wetter areas (some of which are spring-fed). The south-west of the site has more open,

[43] Non-statutory nature conservation sites in London are designated at four levels: SMI contain features, which are notable across Greater London scale; SBI.I (grade 1) and SBI.II (grade 2) contain features, which are notable at the London Borough scale (grade 1 sites are more important than grade 2 sites).
[44] Parts of the Colne Valley area are situated in Buckinghamshire, Greater London and Hertfordshire and thus there are five types of non-statutory nature conservation site: Local Wildlife Sites (LWS) and Biological Notification Sites (BNS) in Buckinghamshire, Sites of Metropolitan Importance (SMIs) and Sites of Borough Importance (SBI) in Greater London and LWS in Hertfordshire.
[45] The SMI overlaps the smaller Mid Colne Valley SSSI north of Moorhall Road. Korda Lake, Harefield Moor Lake, Broadwater Lake, Tilehouse Lake South and surrounding woodland and wetland habitats are both in the SSSI and the SMI. Broadleaved woodland at Ranston Covert and Battlesford Wood is in the SSSI but it is not in the SMI.
[46] The Mid Colne Valley SMI includes all of the lakes in the Mid Colne Valley SSSI and Harefield No. 2 Lake, Savay Lake, Denham Quarry Lake and other lakes (un-named) south of the Chiltern Mainline.

scrubby, birch dominated woodland. Alder woodland in the north-west of Northmoor Hill Wood is managed by rotational coppicing;

- Great Halings Wood LWS (9.5ha) – designated for ancient woodland that is relatively species-rich and dominated by mature beech and hazel coppice. It is adjacent to an area of land required for construction of the Proposed Scheme that will be used for ecological compensation;
- Colne Valley Gravel Pits Hertfordshire LWS (114ha) – is designated for wintering birds and wetland habitats. It includes several lakes north of the Mid Colne Valley SSSI. A small area of this site is in the land required for construction of the Proposed Scheme at the western edge of Pynesfield Lake;
- Tilehouse Gravel Pits BNS (26ha) – is within the Mid Colne Valley SSSI and is centred on Tilehouse Lake South. It is designated for standing water, wetland vegetation and water-birds, including breeding pochard. Woodland at the south-west corner of the site is within land required for the construction of the Proposed Scheme;
- Juniper Wood BNS (15.4ha) – designated for ancient woodland. It is adjacent to the land required for the construction of the Proposed Scheme (part of which will be used for ecological mitigation) between Tilehouse Lane and the M25 motorway;
- The River Colne east of Denham BNS (4.6ha) – designated for river habitat including aquatic plants and fauna. This site lies partly in land required for construction of the Proposed Scheme, south of the Chiltern Main Line where National Grid overhead power lines will be realigned;
- Dew's Dell SBI.I (8.9ha) – is designated for broadleaved woodland with small areas of species-rich grassland. It lies partly within land required for construction of the Proposed Scheme west of Harvil Road;
- Harefield Hall and The Lodge SBI.II (11.2ha) – is designated for broadleaved woodland and lies partly within land required for the realignment of the National Grid overhead power lines; and
- Breakspear House Woods SBI.II (5.5ha) – is designated for broadleaved woodland with several species of ancient woodland indicator plant (although it is not listed on the ancient woodland inventory). It is adjacent to the Proposed Scheme, east of South Harefield.

7.3.6 The statutory and non-statutory designation, part of the Mid Colne Valley SSSI (Korda Lake, Long Pond, Harefield Moor Lake and the western part of Broadwater Lake) is managed as a nature reserve by the Hertfordshire and Middlesex Wildlife Trust.

7.3.7 In addition to the ancient woodland within the designated sites, Pinnocks Wood, a broadleaved ancient semi-natural woodland is partly in land required for the construction of the Proposed Scheme (where electricity cables will be bored underground). This ancient woodland represents an irreplaceable resource.

Habitats

7.3.8 The following habitat types, which occur in this area are relevant to the assessment.

Watercourses

7.3.9 The River Misbourne will be crossed by land required for the realignment of the National Grid overhead power lines, east of Denham Court Drive. Being a chalk stream with vegetation associated with fast flowing streams (water starwort-water crowfoot vegetation) it qualifies under two criteria as a habitat of principal importance[47]. Owing to its size, geomorphological characteristics and the rarity and distinctive assemblages of chalk stream species, the River Misbourne is of regional value.

7.3.10 The River Colne is crossed by the Proposed Scheme in the Mid Colne Valley SSSI. The Joint Nature Conservation Committee (JNCC)[48] assessed the River Colne as also being a habitat of principal importance for the same reason as the River Misbourne. River Corridor Surveys (RCS) and River Habitat Surveys (RHS) [49] of the River Colne that were carried out between 1996 and 2013 by Affinity Water and field surveys in 2013 indicate it has been extensively modified. The river alterations are likely to have taken place during the excavation of the adjacent gravel pits and the construction of the Grand Union Canal. However, owing to its size, its distinctive assemblages of river species and the fact that it forms an integral part of several designated nature conservation sites (the Mid Colne Valley SSSI and the Mid Colne Valley SMI) it is of county/ metropolitan value.

7.3.11 A short section of the Newyears Green Bourne is within the land required for construction of the Proposed Scheme, west of Harvil Road, near Dew's Farm. Field surveys of the Newyears Green Bourne CFA6 indicate that it is generally small (1.5 m wide, 0.1m deep) and eutrophic with fenced banks. It has tall ruderal and scrub vegetation on its banks and occasional mature trees. The Newyears Green Bourne does not support distinctive river species or habitats and is of local/parish value.

Woodland

7.3.12 There is approximately 30ha of semi-natural broadleaved woodland in land required for construction of the Proposed Scheme in this area[50]. The majority is in either the Mid Colne Valley SSSI or Mid Colne Valley SMI, with small areas present in a number of other designated wildlife sites and in farmland:

- Ranston Covert and Battlesford Wood is an area of ancient woodland in the Mid Colne Valley SSSI. It is ash woodland with dog's mercury in the ground flora. National Vegetation Classification NVC[51] surveys indicated that parts of these woods could be classified as NVC type ash woodland W8 *Fraxinus*

[47] Habitat of principal importance includes 56 habitats that form priorities for conservation in the UK as identified in Section 41 of the Natural Environment and Rural Communities (NERC) Act 2006.
[48] JNCC (2011) *UK BAP Rivers – Qualifying Reaches*. Available online at: http://jncc.defra.gov.uk/page-4863 (accessed September, 2013).
[49] A RCS and RHS survey of the River Colne was undertaken from Moorhall Road north to Tilehouse Lake South.
[50] The Ecology section considers all woodland types, including immature re-growth. Therefore, there may be differences between the figures quoted in the Agriculture assessment (which are taken from the Forestry Commission's national woodland inventory).
[51] The National Vegetation Classification (NVC) a common standard developed with the purpose of producing a comprehensive classification and description of the plant communities of Britain.

excelsior-Acer campestre-Mercurialis perennis woodland. Two NVC sub-communities are present: W8d *Hedera helix* sub-community (ivy sub-community) and W8e *Geranium robertianum* sub-community (herb robert sub-community). The woodland is moderately species-rich and includes two populations of coralroot. It qualifies as lowland mixed deciduous woodland, a habitat of principal importance. It is of county/metropolitan value;

- the western bank of the River Colne consists of a mixture of alder woodland W6 *Alnus glutinosa – Urtica dioica* woodland with some hawthorn scrub W21 *Crataegus monogyna-Hedera helix* scrub. The ground flora includes abundant common nettle and frequent dog's mercury. Wet woodland is uncommon nationally and the example here qualifies as a habitat of principal importance. It is of county/metropolitan value;
- Great Halings Wood and Juniper Wood are both semi-natural broadleaved woodlands that are also ancient woodland. They are adjacent to the land required for ecological mitigation. They are likely to be fairly species-rich and to qualify as lowland mixed deciduous woodland and a habitat of principal importance. These woodlands are each of county/metropolitan value;
- Harefield Hall and The Lodge contains semi-natural broadleaved woodland that is partly in land required for construction of the Proposed Scheme. Parts are ancient woodland and it is likely to be a habitat of principal importance. It is of county/metropolitan value;
- Pinnocks Wood is a broadleaved ancient semi-natural woodland that lies partly within the land required for the construction of the Proposed Scheme, where electricity cables will be tunnelled underground. It is of county/metropolitan value;
- woodland around many of the lakes in the Mid Colne Valley SSSI is dominated by willow and alder with frequent sycamore and oak. The shrub layer has occasional elder, hawthorn and dogwood and the ground flora is dominated by common nettle and bramble. The majority of this woodland qualifies as wet woodland that is a habitat of principal importance. However, it is less species-rich than some of the wet woodland in the wider landscape and it includes a high cover of ruderal species. This type of woodland is also frequent in the River Colne valley and is of district/borough value;
- the woodland around Harefield No. 2 Lake and Savay Lake and the woodlands south of the Chilterns Main Line at Widows Cruise Covert and Flagmoor Covert are on similar soils to woodland found around the lakes in the Mid Colne Valley SSSI. Therefore, they are likely to be wet woodland dominated by alder and willows. These woodlands are all in the Mid Colne Valley SMI and may qualify as wet woodland, a habitat of principal importance. Individually, they are of up to district/borough value;
- woodland at Dew's Dell contains semi-natural broadleaved woodland that is in land required for construction of the Proposed Scheme. It is not on the ancient

woodland inventory but may qualify as a habitat of principal importance. It is of district/borough value; and

- woodland at Breakspear House Woods is semi-natural broadleaved woodland and adjacent to land required for the construction of the Proposed Scheme. It is dominated by ash with several ancient woodland indicator plant species (but it is not ancient woodland). It may qualify as lowland mixed deciduous woodland, a habitat of principal importance. It is of district/borough value.

7.3.13 Approximately 4ha of broadleaved plantation woodland, consisting of young trees is present in land that was not surveyed but required for construction of the Proposed Scheme at Denham Grove (De Vere Hotel) and approximately 2ha in smaller fragments in a number of other locations. This woodland is unlikely to be species-rich or a habitat of principal importance. It is of up to local/parish value.

Hedgerows

7.3.14 Approximately 7km of hedgerow habitat were recorded within land required for the construction of the Proposed Scheme, of which approximately 30% qualify as an important hedgerow under criteria set out in the Hedgerows Regulations 1997[52].

7.3.15 The double hedgerow along Old Shire Lane (between the M25 and A412 Denham Way/North Orbital Road) is species-rich, connects to several ancient woodlands and marks an ancient trackway. It qualifies as an important hedgerow and is of district/borough value.

7.3.16 Other hedgerows in land required for construction of the Proposed Scheme are mainly in two locations to the west of Harvil Road and east of South Harefield. Several of these may qualify as important hedgerows and most are likely to qualify as a habitat of principal important (hedgerow). However, given their limited extent, that they do not form a continuous network and the relative frequency in the wider landscape, hedgerows are of local/parish value.

Grassland

7.3.17 There is an area of grassland that was not surveyed to the south of the Chiltern Main Line, between the River Colne and Grand Union Canal. This habitat is in both the Mid Colne Valley SMI and Denham Country Park LNR but is not mentioned in the citation of either site. However, as part of the precautionary assessment, it is assumed the grassland is species-rich and thus a habitat of principal importance. It is considered to be of up to district/borough value.

7.3.18 Poor semi-improved grassland was recorded along the narrow causeway between Broadwater Lake and the River Colne. It is dominated by false oat-grass and includes a low frequency of herbs including birds-foot-trefoil, creeping buttercup and species indicative of soil disturbance such as pineapple weed and greater plantain. This habitat type is also likely to be present in two (un-surveyed) fields close to Moorhall

[52] The Hedgerows Regulations 1997 (1997 No. 1160). London. Her Majesty's Stationery Office. The Hedgerows Regulations 1997 comprise two criteria for determining whether a hedgerow is important or unimportant: Wildlife and Landscape, and Archaeology and History. The Ecology Chapter and the Technical Appendix for hedgerows refer to the Wildlife and Landscape criteria. Therefore it is likely that there will be differences between the total number of important hedgerows in the Ecology and the Cultural Heritage chapters of the ES.

Road, one adjacent to the east side of Korda Lake and the other adjacent to the north east part of Savay Lake. All of these areas are partly within the land required for the construction of the Proposed Scheme. This type of grassland does not qualify as a habitat of principal importance, nor does it support any notable species. It is common in the surrounding landscape and each area is of local/parish value.

Wetland

7.3.19 In the Mid Colne Valley SSSI, the majority of the lake shores have steep banks and are shaded by trees. However, small areas of swamp vegetation are present around Broadwater Lake, Korda Lake, Harefield Moor Lake, Tilehouse Lake South and Long Pond (no more than 3ha in total). This vegetation is dominated by either common reed or reedmace or a mixture of wetland plants such as greater willowherb, purple loosestrife, gypsywort and yellow iris. This habitat type is included on the SSSI citation but is not a primary reason for designation. It is species-poor and each area is of local/parish value.

7.3.20 Along the River Colne there are occasional stands of swamp dominated by reed sweetgrass, reed canary grass or lesser pond sedge. Shading from adjacent trees restricts the extent of swamp to no more than 0.5ha in total. This habitat type is species-poor and of local/parish value.

Water bodies

7.3.21 There are eight lakes (water bodies over 2ha in size) relevant to this assessment:

- Harefield No. 2 Lake, Savay Lake, Korda Lake, Harefield Moor Lake, Long Pond and Denham Quarry Lake south of the Chiltern Main Line are all within the land required for construction of the Proposed Scheme;
- a small area of Broadwater Lake is also within the land required for construction of the Proposed Scheme (for part of an ecological mitigation area); and
- Tilehouse Lake South is adjacent to the land required for construction of the Proposed Scheme.

7.3.22 Korda Lake, Harefield Moor Lake, Long Pond, Broadwater Lake and Tilehouse Lake South have poor plant diversity and support invertebrate communities associated with high nutrient levels. These lakes do not qualify as a habitat of principal importance and are of local/parish value.

7.3.23 Other lakes were not accessible for survey, they are likely to have a similar water chemistry and substrate to the lakes that were surveyed and are therefore considered to be of up to local/parish value.

7.3.24 There are 11 ponds (identified using aerial photography and OS maps) in or adjacent to land required for construction of the Proposed Scheme. Field surveys of a pond east of the M25 and another in Ranston Covert and Battlesford Wood found that they supported common aquatic plants and/or were heavily shaded by surrounding woodland and dried annually. They were not considered sufficiently species-diverse to qualify for a detailed pond survey and do not qualify as a habitat of principal importance. The surveyed ponds are of local/parish value.

7.3.25 Ponds that have not been accessed are considered to be of up to local/parish value. In this area, this includes ponds in the vicinity of Buckinghamshire Golf Course, Uxbridge Golf Course, east of South Harefield and land between the A412 Denham Way/North Orbital Road and Troy Lake.

7.3.26 There are at least four ditches in Uxbridge Golf Course or west of the Grand Union Canal, south of the Chiltern Main Line. They are unlikely to support notable plant or invertebrate assemblages as wetland vegetation appears to be scarce (assessed from aerial photography) and they are likely to be subject to nutrient-rich drainage from the adjacent golf courses. Ditch habitat is of up to local/parish value in this area.

Other habitats

7.3.27 A number of other habitats are present but none are of greater than local/parish value. They include large areas of arable habitat and improved grassland, which is abundant between the M25 and the A412 Denham Way/North Orbital Road and east and west of Harvil Road. These habitats are likely to be botanically poor due to intensive farming practices. Small areas of scrub are present in the vicinity of Dew's Farm and adjacent to farmland and woodland close to the M25. Typical species are likely to include hawthorn and blackthorn. There are also small areas of amenity grassland in the land required for construction of the Proposed Scheme.

Protected and/or notable species

7.3.28 A summary of the species relevant to the assessment is provided in Table 10.

Table 10: Protected and/or notable species

Species/ species group	Value	Receptor	Baseline and rationale for valuation
Birds	National	Breeding birds associated with habitats in the Mid Colne Valley SSSI (includes Broadwater Lake, Korda Lake, Harefield Moor Lake, Tilehouse South Lake and a stretch of the River Colne)	Field surveys recorded 82 bird species during the breeding season. Broadwater Lake was the most important lake in terms of the abundance and diversity of breeding birds present: 69 species were recorded including seven species on the Birds of Conservation Concern[53] (BoCC) – red list and 24 on the BoCC – amber list. Other lakes mainly supported a subset of those birds recorded in and around Broadwater Lake. A number of notable[54] breeding species were recorded, including: four gadwall breeding territories in Broadwater Lake; two kingfisher territories, one to the east and one to the west of Broadwater Lake; one oystercatcher nest on the eastern side of Broadwater Lake; five common tern nests in the south-west corner of Broadwater Lake; one Cetti's warbler territory in the north-west of Broadwater Lake and 23 cormorant nests. There are no Hertfordshire breeding figures for these species but when using Buckinghamshire population estimates (the closest and

[53]Eaton M.A. *et al*. (2009) Birds of Conservation Concern 3: the population status of birds in the United Kingdom, Channel Islands and the Isle of Man. British Birds 102, pp296–341

[54] Assessed against Hertfordshire data as the majority of the SSSI is in this county – Hertfordshire Bird Club (undated) Hertfordshire Bird Atlas, available online http://www.hertsatlas.org.uk/ (accessed 2nd October 2013)

Species/ species group	Value	Receptor	Baseline and rationale for valuation
			most similar neighbouring county) all these species are greater than 1% of the county population[55]. The site has a high species-diversity and several species are present in county significant populations. The assemblage is also a component part of the SSSI.
	National	Wintering birds associated with habitats at the Mid Colne Valley SSSI (includes Broadwater Lake, Korda Lake, Harefield Moor Lake and Tilehouse South Lake)	Field surveys recorded 32 species of wintering waterfowl in the SSSI. Broadwater Lake is the most important lake in terms of abundance and diversity. Notable peak counts on Broadwater Lake were pochard (110), shoveler (84), wigeon (83), goldeneye (15) and a large cormorant roost. Species such as goosander were also present as were large flocks of siskin and redpoll on several occasions. White and Harris[56] concluded that Broadwater Lake is the joint most important lake for wintering birds in the Colne Valley[57]. Field data from 2012-2013 indicates that the abundance and species-richness of wintering birds was high. No nationally important populations were recorded. However, in recent times this site has supported wintering species counts, which exceed national thresholds. The assemblage is also a component part of the SSSI.
	County/ metropolitan	Lesser spotted woodpecker in the Mid Colne Valley SSSI	Recorded on two occasions in the breeding season in between the River Colne and Tilehouse Lake South. Considered to be a probable breeding species. It is rare in Hertfordshire (confirmed breeding or probable breeding in only 15 tetrads[58] in the county).
	County/ metropolitan	Pochard in the Mid Colne Valley SSSI	There are two areas used by Pochard for breeding. Five pairs were recorded breeding at the western edge of Broadwater Lake and four pairs at the north-western corner of Harefield Moor Lake. Pochard have not been recorded as a breeding bird in Buckinghamshire since 2006. It is a rare breeding species in Hertfordshire (confirmed breeding or probable breeding in 12 tetrads in the county).
	County/ metropolitan	Breeding birds associated with habitats in the Mid-Colne Valley SMI (excluding those in the SSSI, as previously described)	Bird species recorded in habitats where the SMI is not overlapped by the SSSI include 38 species at Savay Lake and Harefield No. 2 Lake. These include two BoCC – red list species (song thrush and sky lark) and eleven BoCC – amber list species. Other notable species recorded were one gadwall breeding territory in Savay Lake, one shoveler breeding territory in Savay Lake and part of a kingfisher territory in Savay Lake. There are no Hertfordshire or London breeding figures for these species but when using Buckinghamshire population estimates (the closest and most similar neighbouring

[55] Ferguson, D. (2012) *The Birds of Buckinghamshire*. Buckinghamshire Bird Club. Buckinghamshire
[56] White, G.J and Harris, A.J. (2008) *The wetland resource of the Colne Valley: an assessment of its importance to nature conservation, with special reference to waterbirds*. Natural England, Herts. and Middx. Wildlife Trust and Environment Agency
[57] Stockers Lake which is 3km away is the other lake considered by White and Harris (2008) to be of high importance to birds in the River Colne valley. It will not be affected by the Proposed Scheme.
[58] A tetrad is a 2km x 2km grid square.

Species/ species group	Value	Receptor	Baseline and rationale for valuation
			county) all these species are greater than 1% of the county population[59]. The SMI has a diverse assemblage of breeding birds with several species present in county important numbers. No bird counts exceeding national thresholds for importance were recorded during the 2012 or 2013 field season.
	County/ metropolitan	Wintering birds associated with habitats in the Mid Colne Valley SMI (excluding those in the SSSI, as previously described)	Bird species recorded in habitats where the SMI is not overlapped by the SSSI include 14 wintering species. Notable species recorded at Savay Lake include a large wintering pochard population with a peak count of 62 and a peak count of 41 gadwall. There are no London wintering population estimates but when using Buckinghamshire population estimates (the closest and most similar neighbouring county) pochard numbers are greater than 1% of the county population. No species count exceeded national importance thresholds in the 2012 or 2013 field season.
	County/ metropolitan	Breeding birds associated with habitats in the Colne Valley Gravel Pits LWS (including Pynesfield Lake, Lynsters Lake, Troy Lake and Blue Circle Lake)	Field surveys recorded 57 bird species during the breeding season. Notable species included two gadwall breeding territories, one shoveler territory and one kingfisher territory. There are no Hertfordshire breeding figures for these species but when using Buckinghamshire population estimates (the closest and most similar neighbouring county) all these species are greater than 1% of the county population. Garganey and pintail (examples of rarer waterfowl species) were recorded but were not breeding.
	County/ metropolitan	Breeding corn bunting between the A412 Denham Way/North Orbital Road and M25	Desk study records confirmed two corn bunting pairs were breeding in this area in 2013. This species is rare in Hertfordshire and is the only known breeding population in the south-east of the county. There are no Hertfordshire breeding figures for these species but when using Buckinghamshire population estimates (the closest and most similar neighbouring county) this population is approximately 35% of the county population.
	District/borough	Breeding barn owl in the south-east of this area	A barn owl nest is present in the Buckinghamshire part of this area. A single nesting pair represents 0.5% of the county population.
	Local/parish	Breeding birds associated with habitats between the A412 Denham Way/North Orbital Road and M25	Field surveys recorded 42 bird species, most of which are associated with the woodland adjacent to the Proposed Scheme. A single BoCC – red list species, lapwing, was confirmed as breeding. Other records were for common and widespread breeding bird species typical of open countryside and woodland.
Bats	Regional	Bat assemblage associated with the woodland, river habitat and standing water in	Static monitoring surveys recorded eleven species of bat, with high levels of activity for common pipistrelle, soprano pipistrelle in the south-western corner of the SSSI. Leisler's were recorded in moderate numbers.

[59]BMERC and TVERC (2009) *Criteria for the Selection of Local Wildlife Sites in Berkshire, Buckinghamshire and Oxfordshire*. BMERC and TVERC

Species/ species group	Value	Receptor	Baseline and rationale for valuation
		and adjacent to the Mid Colne Valley SSSI (roosting, foraging and commuting).	Serotine, brown long-eared bats, Natterer's bat, whiskered bat and unidentified whiskered/Brandts bats were recorded in low numbers. In addition, radio tracking studies recorded low to moderate levels of activity for Nathusius' pipistrelle bat and barbastelle bat, at woodland between the A412 Denham Way/North Orbital Road and the River Colne. Of these species five are less common and Nathusius' pipistrelle bat and barbastelle bat are rare[60]. Although both common species, the high levels of activity of common and soprano pipistrelle bats was notable. Three roosts were identified in the land required for the construction of the Proposed Scheme (peak emergence counts in brackets): one bat box roost of common pipistrelle bat and soprano pipistrelle bat (7); two soprano pipistrelle bat box roosts (droppings only). One other bat roosts was identified within 50m of the Proposed Scheme, a soprano pipistrelle bat box roost (1).
	Up to regional	Daubenton's bat population associated with the River Colne Valley (including commuting routes along the River Colne, foraging and roosts).	High levels of activity for Daubenton's bat were recorded along the River Colne that indicates that the river is an important foraging site and commuting route for this bat species. The high numbers and timing of the activity and direction of flight indicate there is likely to be a large maternity roost(s) close by, mostly likely to the south-east. Activity surveys identified two bat flight lines used by Daubenton's bats along the River Colne and along the vegetated causeway between Harefield Moor Lake and Korda Lake Three *Myotis* species (likely to be Daubenton's bat) roosts were identified in the land required for the construction of the Proposed Scheme (peak emergence counts in brackets): one bat box roost (12); one tree roost (10) and a bat roost in a building north of Tilehouse Lake South that may be a maternity roost. It was surveyed with an internal inspection only but the number of droppings suggested it was used by a small number of bats (less than 10). Outside the land required for the construction of the Proposed Scheme three roosts were recorded (also likely to be Daubenton's bat): *Myotis* sp. bat box roost (3) and two *Myotis* sp. bat box roosts, with droppings only. None of the bat box/tree roosts were maternity roosts. For the purposes of this impact assessment they are one of the rarer bats based on their national population size and restricted habitat preferences[61]. Therefore, roosts of any type are important for retaining wider populations of this species.

[60] Bat Conservation Trust (2012) *The state of the UK's bats: National Bat Monitoring Programme Population Trends 2012*. BCT. London
[61] Wray, S., Wells, D., Long, E. and Mitchell-Jones, T. (2010) *Valuing bats in ecological impact assessment*. In Practice: December issue. CIEEM

Species/ species group	Value	Receptor	Baseline and rationale for valuation
	Up to regional	Bat assemblage likely to be associated with open water, river habitat and woodland south of Moorhall Road (roosting, foraging and commuting)	A high abundance and a diverse assemblage of bats has been recorded immediately north of this area. Similar habitat of equal quality is present here and there are strong habitat connections between both areas of habitat. The network of lakes interspersed by woodland here is optimal for foraging bats and provides connectivity to potential roost sites[62]. As part of the precautionary assessment it is assumed that a large number of bats of a range of species are present.
	County/ metropolitan	Noctule population foraging at Korda Lake, Harefield Moor Lake and the woodland between the River Colne and the A412 Denham Way/North Orbital Road and moving between them	Static monitoring and transect surveys recorded moderate to high levels of noctule foraging and commuting activity at height over the woodland and around the lakes. Noctule numbers and range are restricted in Buckinghamshire and roosts of any size are uncommon and important to the survival of the population. The high activity levels recorded in and around the woodland indicate it is an important foraging resource.
	County/ metropolitan	Bat assemblage in and around Little Halings Wood (roosting, foraging and commuting)	Field surveys recorded a serotine and pipistrelle summer roosts at a building close to Little Halings Wood with 200-300 droppings recorded for each species. A brown long-eared bat transitionary roost with approximately 25 old droppings was also recorded at the same property. Field surveys recorded high numbers of soprano and common pipistrelles, moderate numbers of serotines, noctule bats and *Myotis* species, brown long-eared bats were also recorded in low-moderate numbers. Most activity was around woodland. All *Myotis* bats (including serotine and noctule bats) are classified as less common species; roosts of any size are considered important in maintaining the population of these species. The bat assemblage using this area indicates this site is important for foraging and likely to contribute to maintaining populations of these species.
	County/ metropolitan	Bat assemblage south-west of Tilehouse Lane (roosting, foraging and commuting)	Field surveys recorded a serotine and pipistrelle roost (with 200-300 droppings). A brown long-eared bat transitional roost with approximately 25 old droppings was also recorded. Field surveys recorded bats using the nearby woodlands in this area for foraging. Activity included high numbers of soprano and common pipistrelles, moderate numbers of serotines, noctule bats, and *Myotis* species and moderate numbers of brown long-eared bat. All *Myotis* bats, serotine and noctule are classified as uncommon, roosts of any size are considered important in maintaining the population of these species. The diversity of the bat assemblage is also notable.

[62] Potential bat roost – sites or features that may be used by bats to roost (for example mature trees or old buildings). Potential roosts are graded as being of low, moderate or high potential to support bats depending on the likely suitability of the feature concerned.

Species/ species group	Value	Receptor	Baseline and rationale for valuation
	Up to county/ metropolitan	Bat assemblage in farmland around Harvil Road	A high abundance of a diverse assemblage of bats has been recorded north-east of this area. There is a mature semi-natural woodland in this area (Dew's Dell) in which notable bat species may roost. Other mature woodlands are also present close by (Newyears Green Covert and Bayhurst Wood that are in CFA6). The hedgerow network may be used by bats to commute to the lake foraging sites. As part of the precautionary assessment it is assumed that a large number of bats of a range of species (including notable or rare species) are present.
Terrestrial invertebrates	Regional	Invertebrates associated with woodland in the Mid Colne Valley	Field surveys in Ranston Covert and Battlesford Wood recorded an assemblage of woodland species including two Red Data Book species (*Ctenophora flaveolata* and *Aulonothroscus brevicollis*) and two nationally scarce[63] species (*Ischnomera cyanea* and *Ischnomera sanguinicollis*). Desk study data indicates the presence of a further 13 notable species (9 nationally scarce; 3 red data book[64] and one species of principal importance) in ancient woodland adjacent to land required for the construction of the Proposed Scheme. Given the continuity and proximity of these woods, it is likely that these species also inhabit woodland within the land required for the construction of the Proposed Scheme. The assemblage meets the regional threshold[65] but does not meet the threshold for national importance due to its small size and limited range of dead wood habitats.
Plants	County/ metropolitan	Population of coralroot in the Mid Colne Valley	Two populations of coralroot (both of about 30 flowering plants) were recorded in woodland west of the River Colne, partly in the land required for the construction of the Proposed Scheme. This species is nationally scarce[66], although it is relatively frequent in south-west Hertfordshire[67] and Buckinghamshire.
	Local/parish	Populations of small teasel in Mid Colne Valley	A population of small teasel (about 50 flowering plants) was recorded either side of the path along the River Colne's eastern bank that is within land required for the construction of the Proposed Scheme. Small teasel is listed on the citation for the Mid Colne Valley SMI where it is described as 'very localised' in Greater London.

[63] Nationally scarce = invertebrates which are recorded in 16-100 hectads (10km squares) but not included in one of the Red List Categories.
[64] https://jupiter.erm.com/owa/redir.aspx?C=mqEyxnYYE0OJUc6sa-ZeOQgQvBFFmdAIjkctQ0T0slyQrxntBAfSNmfT8TBNfdX-DgBitdtQRn4.&URL=https%3a%2f%2fecl.webhop.net%2fowa%2f%3fae%3dPreFormAction%26a%3dForward%26t%3dIPM.Note%26id%3dRgAAAAC6bFclJ7tvQJ0vtxCsVN2RBwCwITyiUUhKTrvHymapjdcFAAAARZKcAACwITyiUUhKTrvHymapjdcFAAADDRiCAAAJ%26pspid%3d_1381399913462_641111363%23_ftn1
[65] Colin Plant Associates (2006) *Invertebrates and Ecological Assessment*. Unpublished Report to the Institute of Ecology and Environmental Management
[66] JNCC (2011). Taxon designations spreadsheet. Available online at:. http://jncc.defra.gov.uk/page-3408 (accessed 19th September 2013)
[67] James, T.J. (2009) *Flora of Hertfordshire*. Hertfordshire Natural History Society. Norwich

Species/ species group	Value	Receptor	Baseline and rationale for valuation
Otter	Up to county/ metropolitan	Otter population along the River Colne, surrounding lake and the Grand Union Canal	Fresh otter spraint was recorded on several occasions at two locations less than 300m from the Proposed Scheme: beside the River Colne and beside the Grand Union Canal. This indicates that otters use the watercourses for foraging and to commute. No otter holts were recorded. However, habitat in the SSSI and around (Savay Lake and Harefield No. 2 where access was limited) is likely to be highly suitable for breeding otter. As part of the precautionary assessment it is assumed that a breeding holt may be present within the Proposed Scheme that could be important within the county LWS criteria[68].
Amphibians	Up to county/ metropolitan	Great crested newt population associated with ponds and ditches in the vicinity Uxbridge Golf Course and Buckinghamshire Golf Course	A number of ponds are present close to suitable terrestrial habitat (hedgerow, grassland and scrub). There are no desk study records of great crested newt, however, as part of the precautionary assessment it is assumed all of the ponds that were not surveyed support a sustainable breeding population that could form a meta-population[69] and be important within the county LWS criteria.
	Up to county/ metropolitan	Great crested newt population associated with ponds and ditches in farmland east of South Harefield	Four ponds are present close to suitable terrestrial habitat. There are no desk study records of great crested newt, however, as part of the precautionary assessment it is assumed all of the ponds were not surveyed support a sustainable breeding population that could form a metapopulation and be important within the county LWS criteria.
	Up to county/ metropolitan	Great crested newt population associated with ponds in between Old Uxbridge Road and Pynesfield Lake	Four ponds are present close to suitable terrestrial habitat. There are no desk study records of great crested newt, however, as part of the precautionary assessment it is assumed all of the ponds that were not surveyed support a sustainable breeding population that could form a metapopulation and be important within the county LWS criteria.
	Up to county/ metropolitan	Great crested newt population associated with ponds in between Old Uxbridge Road and Pynesfield Lake	Four ponds are located within 200m of the Proposed Scheme. There are no desk study records of great crested newt, however, as part of the precautionary assessment it is be assumed all of these un-surveyed ponds support a sustainable breeding population that could form a metapopulation and be important within the county LWS criteria.
	Up to county/ metropolitan	Great crested newt population foraging habitat associated with a pond near Harefield Hall	One pond is located within 200m of the Proposed Scheme. There are no desk study records of great crested newt, however, as part of the precautionary assessment it is assumed this pond may a sustainable breeding population that could be important within the county LWS criteria.

[68] No Hertfordshire criteria were available for the significance of otter populations, therefore, Buckinghamshire criteria were used (part of this area is in Buckinghamshire): BMERC and TVERC (2009) *Criteria for the Selection of Local Wildlife Sites in Berkshire, Buckinghamshire and Oxfordshire*. BMERC and TVERC

[69] A set of local populations within some larger area, where typically migration from one local population to at least some other patches is possible.

Species/ species group	Value	Receptor	Baseline and rationale for valuation
Reptiles	Up to county/ metropolitan	Potential reptiles population associated with grassland near Moorhall Road	Two fields of semi-improved grassland close to Moorhall Road contained habitat suitable for reptiles. Both are within the land required for the construction of the Proposed Scheme but could not be accessed. A population of adder or a population containing high numbers of grass snake, common lizard or smooth snake is present, the site could be important within the county LWS criteria .
	Up to county/ metropolitan	Potential reptile population associated with woodland edge habitats between Harvil Road and Harefield No.2 Lake	Woodland edge habitats between Harvil Road and Harefield No.2 Lake may be suitable for reptiles but could not be accessed. A population of adder or a population containing high numbers of the other three common species could be important within the county LWS criteria.
	Up to county/ metropolitan	Potential reptile population associated with grassland in the Mid Colne Valley SMI (between the River Colne and the Grand Union Canal)	Rough grassland and scattered scrub may be suitable for reptiles but could not be accessed for survey. If a population of adder or a population containing high numbers of grass snake, common lizard or smooth snake is present, the site may be important within the county LWS criteria.
	Up to county/ metropolitan	Potential reptile population associated with grassland at Uxbridge Golf Course	Rough grassland and scattered scrub may be suitable for reptiles but could not be accessed for survey. If a population of adder or a population containing high numbers of grass snake, common lizard or smooth snake is present, the site may be important within the county LWS criteria.
	Local/parish	Potential reptile population associated with habitat at Northmoor Pumping Station (north of Tilehouse Lake South)	A population of grass snake (peak count of three individuals) was recorded along a small grass verge along the access drive to the pumping station.
Water vole	Up to county/ metropolitan value	Potential water vole population associated with in Savay Lake and Harefield No. 2 Lake, Denham Quarry Lake or the River Colne.	Habitat is generally poor for water vole as a result of heavy shading and a lack of swamp vegetation (assessed from aerial photography). There are water vole desk study records within 1km and so, although survey of the nearby River Pinn recorded American mink scat (a predator linked to water vole decline), the presence of water vole cannot be ruled out. A sustainable water vole breeding population could be important within the county LWS criteria.
Fish	Up to district/borough	Fish assemblage in the Grand Union Canal	Fish habitat was assessed as being 'moderate' although largely homogenous. No recent fisheries data was available for this reach of the Grand Union Canal. So this represents a precautionary valuation given in the absence of field data.
	Local/parish	Fish assemblage in the River Colne in the Mid Colne SSSI	Field surveys recorded good habitat quality to support a diverse and abundant fish population. However, low numbers of fish and juvenile fish were recorded. Large adult barbel dominated, with several year classes missing.

Species/ species group	Value	Receptor	Baseline and rationale for valuation
			Seven species (barbel, bullhead, chub, perch, eel, roach, three-spined stickleback) were found, although overall density was extremely low (0.06-0.56 fish/100m2). Fish populations here appear to be of lower quality than expected as a result of unknown factors. The desk study included records of eel and bullhead over seven different years but in low numbers only.
	Local/parish	Fish assemblage in the Mid Colne Valley SSSI lakes	Common roach, perch and roach/common bream hybrids were recorded. Anecdotal information from the angling club suggested that tench, European eel, non-native carp and the wels catfish are also present. Many of these lakes are managed for angling, principally as a commercial carp fishery.
Aquatic macro-invertebrates	Local/parish	Aquatic macro-invertebrate assemblage in the River Colne	Field surveys recorded a moderate diversity of macro-invertebrate taxa. The invertebrates present indicate 'Fair' water quality. Freshwater shrimp, riffle beetles, mayfly and a variety of caddis larvae were present. One sample included taxa that are highly sensitive to organic pollution (Ephemeridae and Leptoceridae).
	Local/parish	Aquatic macro-invertebrate assemblage of lakes in the Mid Colne Valley SSSI	Affinity Water's 2012 data show a macro-invertebrate community generally dominated by families such as Chironomidae (midges) and Crangonyctidae (amphipod crustaceans) which are tolerant to organic pollution and so indicative of high nutrient status and turbid, macrophyte-poor, algal-dominated states in the lakes.
Badger	Local/parish	Populations of badger throughout the area	Desk study records indicate that there are at least three main setts adjacent to the Proposed Scheme. At least three badger territories are likely to overlap the land required for construction of the Proposed Scheme as evidenced by several outlying setts within the Proposed Scheme. Badgers are frequent and widespread in the wider landscape.

7.3.29 Surveys in 2012 recorded the following invasive exotic species in the Mid Colne Valley SSSI in land required for construction of the Proposed Scheme; large stands of Japanese knotweed in woodland, mats of floating pennywort in the River Colne and two waterweed species of the genus *Elodea* in the lakes. All of these species are listed in Schedule 9 of the Wildlife and Countryside Act, 1981 (as amended)[70] and it is illegal to cause them to spread into the wild. During 2013 the Environment Agency undertook removal of floating pennywort in the River Colne.

[70] Wildlife and Countryside Act 1981 (1981 Chapter 69) Available online at: http://www.legislation.gov.uk/ukpga/1981/69 (accessed September 2013).

Future baseline

Construction (2017)

7.3.30 A summary of the known developments which are assumed to be mostly built and occupied prior to construction of the Proposed Scheme is provided in Section 2.1 of this report, with further details provided, Volume 5: Appendix CT-004-000.

7.3.31 In arable land required for construction of the Proposed Scheme between the M25 and the A412 Denham Way/North Orbital Road at Denham Park Farm a planning permission has been granted to extract minerals. The permission has been implemented and the quarrying has a lifetime of 20 years including 2 years restoration. This will have a neutral effect on ecological resources as both the operational quarrying site and the existing arable land, within which the quarrying will be sited, are of no greater than local/parish value. There are no further consented developments with potential to affect the character and value of the ecological baseline.

Operation (2026)

7.3.32 There are no known committed developments or changes to management in this area that will affect the operational baseline, beyond those described previously in relation to the construction baseline.

7.3.33 The otter population in England is expanding[71], therefore, it is possible that by the time of construction, a number of otter breeding holts may be created in land required for construction of the Proposed Scheme. It is unlikely this will increase the value of the otter population as stated in Table 10.

7.3.34 The Hertfordshire and Middlesex Wildlife Trust is likely to carry out a range of conservation measures in this area although none are likely to effect the ecological value of any of the receptors described in the baseline:

- creation of new reedbeds and shingle banks in Broadwater Lake which will provide additional habitat for birds; and
- control of feral American mink in the River Colne Valley which may permit water vole to colonise habitat along the River Colne.

7.3.35 Large colonies of the invasive plants including Japanese knotweed, floating pennywort and signal crayfish are present in the Mid Colne Valley SSSI. Further spread of these species could adversely affect the conservation value of the habitats in which they occur while conversely their effective control could increase conservation value. It is not currently certain how successful any management of these invasive species is likely to be.

[71] Tracking Mammals Partnership (2009) *UK Mammals Update 2009*. JNCC, Peterborough

7.4 Effects arising during construction

Avoidance and mitigation measures

7.4.1 The following measures have been included as part of the design of the Proposed Scheme and avoid or reduce impacts to features of ecological value:

- the viaduct will be built using a temporary construction jetty to limit permanent loss of standing water habitat;
- the design span of the viaduct prevents the need for a pier in the Grand Union Canal. This reduces the loss of standing water and will allow continued movement of species along the canal;
- the location of the proposed construction compound north of Moorhall Road reduces loss of woodland from the SSSI;
- Old Shire Lane will be retained within the Proposed Scheme boundary to protect two important hedgerows;
- the design of the Colne Valley viaduct ensures the River Colne will be diverted to flow between two viaduct piers avoiding the need for a long river diversion and associated loss of river habitat and ancient woodland; and
- modification of the river channel will be undertaken so as not to affect downstream flow characteristics or the frequency, duration or depth of flooding (as described in Section 13).

7.4.2 The assessment also assumes implementation of the measures set out within the draft CoCP (CT-003-000), which includes translocation of protected species where appropriate.

Assessment of impacts and effects

Designated sites

7.4.3 The Proposed Scheme crosses the west side of the Mid Colne Valley SSSI on a viaduct between Moorhall Road and the A412 Denham Way/North Orbital Road. Approximately 19ha (14%) of the SSSI lies within the land required for the construction of the Proposed Scheme; 5.4ha is open water (6% of the open water is the SSSI); 2.9ha is running water (50% of the length of the River Colne within the SSSI); approximately 10ha is woodland (33% of the total area of woodland within the SSSI), and 0.75ha is swamp vegetation (20% of the total area of swamp within the SSSI).

7.4.4 There will be loss of breeding bird habitat and disturbance of breeding birds in the Mid Colne Valley SSSI. Loss of habitat will lead to a reduction of suitable nesting sites and therefore, over the five year construction period, a reduction in the abundance of birds within the SSSI, such as BoCC – red or amber list species such as song thrush, bullfinch and reed bunting, and also reed warbler, sedge warbler and garden warbler. Breeding birds using woodland and wetland in the SSSI will also be disturbed during construction by an increase in noise, vibration, light, and the increased presence of people and movement within land required for construction of the Proposed Scheme. The viaduct will be parallel to the retained blocks of Ranston Covert and Battlesford

Wood for about 750m and thus a large area of woodland used by breeding birds will be subject to disturbance. Within the SSSI, habitat loss and disturbance will cause an overall decline in the numbers of breeding birds for a range of species.

7.4.5 Wintering water birds in the Mid Colne Valley SSSI will be disturbed by the same factors as the breeding bird assemblage and for the same length of time. However, the diversity and abundance of its wintering bird assemblage is likely to remain unaffected because:

- the main areas affected in the SSSI (Korda Lake, Harefield Moor Lake, the east of Tilehouse Lake South and Long Pond) support relatively low numbers of water birds and there are no species exclusively associated with these lakes. Broadwater Lake is by far the most important location for wintering birds in the SSSI (based on field data and desk study information) and is outside the land required for the construction of the Proposed Scheme;
- the south-western corner of Broadwater Lake is less than 100m from the viaduct construction site and will be disturbed. However, Broadwater Lake is of sufficient size to retain the bird assemblage if one location is subject to disturbance and, for most species, this particular location is not critical to their use of the lake;
- wintering birds, which are displaced from the south-western corner will find alternative roosting and foraging areas. There is already a refuge area in Broadwater Lake to protect birds from disturbance from recreational activities such as sailing and this will remain undisturbed;
- construction hours will be during daylight and thus bird night roosts and feeding areas are likely to remain undisturbed;
- lakes outside the SSSI (e.g. Troy Lake, Pynesfield Lake and Lynsters Lake) will be unaffected and there will be no impacts on wintering bird populations using them; and
- after construction standing water in Korda Lake, Harefield Moor Lake, Harefield No. 2 Lake and Savay Lake will be available again for wintering birds to use.

7.4.6 The combined effects of woodland and wetland loss and decrease in numbers of breeding birds will result in a permanent adverse impact on the integrity of the Mid Colne Valley SSSI that will be significant at the national level.

7.4.7 No significant effects are expected on the integrity of Fray's Farm Meadows SSSI. Construction traffic is expected to increase NO_x concentrations and nutrient nitrogen deposition on a small part of the SSSI as its southern extent is close to the A40. However, most of its southern boundary is set back from the roadside and any changes in air quality will be for the duration of the construction period only. Therefore there will be no long-term build up in deposition or a measurable change in the plant species-richness or abundance. The change in air quality will be small in comparison with background concentrations and any such change will have a negligible effect on the SSSI.

7.4.8 The Colne Valley viaduct will be constructed across the Mid Colne Valley SMI. The following assessment considers impacts on each of the SMI's designated features. Among other factors, the extent of species-rich grassland and wet woodland habitat, and the species-richness and abundance of its breeding bird assemblage are important to its integrity.

7.4.9 Construction will reduce the extent of habitats for which the SMI is designated. Approximately 25ha (8%) of terrestrial habitat in the SMI is in land required for construction of the Proposed Scheme. Of this approximately 4ha will be permanently lost during construction of the Colne Valley viaduct across Savay Lake and Harefield No. 2 Lake (2ha of semi-natural broadleaved woodland and 2ha of scrub and wetland habitat). A further approximately 15ha will be lost during the realignment of the National Grid overhead power lines (10ha of semi-natural broadleaved woodland from Widows Cruise Covert and Flagmoor Covert and 5ha of grassland with scrub). In addition, approximately 6ha of woodland and small areas of swamp vegetation will be lost where the SMI overlaps the SSSI (this has already described for the Mid Colne Valley SSSI). The vegetation clearance will result in a reduction of habitat available for breeding birds. In addition, there will be disturbance during construction.

7.4.10 The combined effect of woodland, wetland and grassland loss and disturbance of the breeding bird assemblage will result in a permanent adverse effect on the integrity of the SMI that will be significant at the county/metropolitan level.

7.4.11 Approximately 2.9ha (11%) of Tilehouse Gravel Pits BNS is within land required for construction of the Proposed Scheme, the majority of which is semi-natural broadleaved woodland. There will be disturbance to birds using the BNS during construction. These impacts will result in a permanent effect on the integrity of the site that is significant at the county/metropolitan level.

7.4.12 About 0.9ha (19%) of the River Colne east of Denham BNS is within land required for construction of the Proposed Scheme where National Grid overhead power lines will be realigned. This will result in a permanent adverse effect on the integrity of site that is significant at the county/metropolitan level.

7.4.13 Denham Country Park LNR will also be affected during construction. Approximately 10ha (52%) of this site is within land required for construction of the Proposed Scheme where National Grid overhead power lines will be realigned. This extent of habitat loss is a high proportion of the LNR and it will result in a permanent adverse effect on site integrity that is significant at the district/borough level.

7.4.14 In the Fray's Valley LNR, approximately 4.2ha (6% of the LNR) of woodland and grassland will be removed where National Grid power lines will be realigned. The extent of habitat loss is relatively small in relation to the site's size, however, as part of the precautionary assessment, it is assumed that the woodland and grassland lost is a habitat of principal importance. Vegetation clearance could therefore result in an adverse effect on site integrity that is significant at the district/borough level.

7.4.15 Dew's Dell SBI lies partly within land required for the construction of the Proposed Scheme. Construction will result in the loss of approximately 1ha (11%) of the site,

which will result in a permanent adverse effect on the integrity of site that is significant at the district/borough level.

7.4.16 Denham Quarry Park LNR; London's Canals SMI; the Colne Valley Gravel Pits Hertfordshire LWS; Harefield Hall and The Lodge SBI are all partly within land required for construction of the Proposed Scheme. The extent of habitat loss within these areas will be proportionally small and no significant effects on their integrity are expected.

7.4.17 It is considered unlikely that significant effects on site integrity will occur at the following designated sites: Ruislip Woods SSSI; Denham Lock Wood SSSI; Northmoor Hill Wood LNR; Northmoor Hill Wood and Wyatt's Covert LWS; Breakspear House Woods SBI; Great Halings Wood LWS and Juniper Wood BNS.

Habitats

7.4.18 Construction of the viaduct in the western part of the Mid Colne Valley SSSI will result in the clearance of approximately 1.0ha of ancient woodland from Ranston Covert and Battlesford Wood. As an important component of the landscape in this area the extent of this irreplaceable habitat is important to its conservation status. Therefore the loss will result in a permanent adverse effect on its conservation status that will be significant at the county/metropolitan level.

7.4.19 In this area, there is approximately 30ha of broadleaved woodland within land required for the construction of the Proposed Scheme. This includes approximately 24ha of semi-natural broadleaved woodland and approximately 6ha of plantation broadleaved woodland. The habitat losses relevant to the assessment comprise:

- approximately 10ha in the Mid Colne Valley SSSI, including areas of ash woodland and alder woodland, which are described in the baseline. This includes Ranston Covert and Battlesford Wood, 1.0ha of which is ancient semi-natural woodland;
- approximately 2ha woodland around Savay Lake and Harefield No. 2 Lake, within the Mid Colne Valley SMI;
- approximately 10ha in the area where National Grid overhead power lines will be realigned, including parts of Widows Cruise Covert and Flagmoor Covert, within the Mid Colne Valley SMI; and
- approximately 2ha distributed in a number of locations including the southern edge of Dew's Dell SBI.

7.4.20 As extent is important to the conservation status of this habitat, these losses will result in permanent adverse effects that are significant at the county/metropolitan level for woodlands in the SSSI, SMI and at the district/borough level for other areas of woodland.

7.4.21 No significant impacts are expected on the ancient woodland within Pinnocks Wood as the electricity cables that will pass through this site will be tunnelled underground. The depth of the utilities will be sufficient to avoid adverse effects on tree roots and will thus maintain the conservation status of the wood.

7.4.22 Approximately 5ha of grassland with scrub within the Mid Colne Valley SMI lies within land required for the realignment of the National Grid overhead power lines. As part of the precautionary assessment, it is assumed that this loss will result in a permanent adverse effect of the conservation status of the habitat that is significant at the district/borough level.

7.4.23 At the River Colne approximately 170m of the river will be modified in a location adjacent to the Long Pond resulting in the removal of riparian[72] vegetation and changes to river hydromorphology. This will be a permanent impact, as part of the river banks will be reinforced to maintain the new channel shape. However, the modified section of river will be engineered to prevent any upstream or downstream hydrological changes (see Section 13 for more information). Piling for the construction of viaduct piers could also adversely affect water quality and quantity. These changes are unlikely to have a significant effect on the conservation status of the River Colne as vegetation will re-colonise after construction and the majority of the river will remain unaffected.

7.4.24 It is considered unlikely that any other effects on habitat receptors significant at more than the local/parish level will occur. This includes hedgerow habitat and standing water, as relatively small areas are being affected given the abundance in the surrounding landscape. Effects significant at the local/parish level are listed, Volume 5: Appendix EC-005-002.

Species

7.4.25 Loss of breeding bird habitat and disturbance of breeding birds in the Mid Colne Valley SSSI and Mid Colne Valley SMI as previously described will reduce the numbers of several species of bird during the five year construction period. However, it is not expected that this will affect the conservation status of the overall breeding bird assemblage because woodland and wetland habitats are abundant in the wider landscape. Therefore bird populations will be relatively resilient against localised changes.

7.4.26 Loss of habitat and increased disturbance caused by the Proposed Scheme may have an adverse effect on less common breeding species and those that rely on more localised habitat within the land required for the construction of the Proposed Scheme, for example pochard. Viaduct construction along Harefield Moor Lake will temporarily disturb one of the two locations used by pochard for breeding in this area. This may result in an adverse effect on the conservation status of pochard that is significant at the county/metropolitan level.

7.4.27 Habitat used by at least two pairs of corn buntings will be removed from between the M25 and the A412 Denham Way/North Orbital Road. The conservation status of corn bunting populations is dependent on open arable farmland with mature hedges, field margins and winter stubbles. Hedges along Old Shire Lane will be retained close to where the birds are likely to nest. However, construction of Tilehouse Lane cutting and the Chiltern tunnel south approach embankment and associated compounds will

[72] The riparian area is the interface between a watercourse and land. It includes the bank profile and associated terrestrial and emergent vegetation.

remove the majority of foraging and nesting habitat for this species. It is unlikely that the birds will be able to maintain their existing range. The loss of a rare species from the area will result in a permanent adverse impact on conservation status that is significant at the county/metropolitan level.

7.4.28 Land required for construction of the Proposed Scheme will include a single population of coralroot. Among other factors, the conservation status of this species depends on ancient woodland soils. In Ranston Covert and Battlesford Wood, 1ha of ancient woodland habitat supporting coralroot will be removed. This will reduce the known population of this species to a single colony in the area leading to an increased risk of extinction. This will result in a permanent adverse effect on coralroot that will be significant at the county/metropolitan level.

7.4.29 The viaduct and overhead power line diversion will cross habitats known to be used by otters along the River Colne and at several of the lakes. It is not expected that there will be any fragmentation of otter movement routes, as extensive areas of open water, the Grand Union Canal and the majority of the River Colne will remain unaffected by the Proposed Scheme. As part of the precautionary assessment, it is assumed that a breeding holt may be present within land required for construction of the Proposed Scheme. Loss of an otter holt could result in an adverse effect on conservation status that would be significant at up to the county/metropolitan level.

7.4.30 The viaduct and overhead power line diversion will cross habitats that may be used by water vole. As part of the precautionary assessment, it is assumed that loss of these habitats could result in a permanent adverse effect on conservation status that is significant up to the county/metropolitan level.

7.4.31 If present, construction could remove habitat suitable for great crested newt from two locations:

- the realignment of the National Grid overhead power lines may remove ponds and ditches in the vicinity of Uxbridge Golf Course and Buckinghamshire Golf Course; and
- the proposed sustainable placement area will remove four ponds and surrounding grassland east of South Harefield.

7.4.32 The conservation status of great crested newt depends on the availability of breeding ponds, foraging habitat and features for hibernating in close proximity to each other. The loss of possible breeding ponds and surrounding terrestrial habitat could reduce the viability of the breeding population or fragment a metapopulation, if present, resulting in reduced genetic diversity. These impacts could result in a permanent adverse effect on the conservation status of each population that would be significant at up to the county/metropolitan level.

7.4.33 If present, common reptile species could be affected in three locations:

- the Colne valley viaduct satellite compounds may remove grassland with scrub in the vicinity of Moorhall Road;

- the realignment of the National Grid overhead power lines may remove grassland with scrub within Uxbridge Golf Course; and
- temporary material stockpiling along woodland edge habitats between Harvil Road and Harefield No. 2 Lake may remove grassland with scrub.

7.4.34 Habitat loss may reduce foraging and sheltering opportunities below that which is required to maintain viable populations in both locations. These impacts could, therefore, result in a permanent adverse effect on the conservation status of reptiles that is significant at up to the county/metropolitan level at each location.

7.4.35 The removal or disturbance of habitat features that are utilised by bats during breeding, hibernation or migrating between roosts is considered to have the potential to result in adverse effects on the bat populations or assemblages during construction. However, the point at which such impacts are considered likely to result in a significant adverse effect on the conservation status of the population concerned will differ dependent on the status of the species concerned.

7.4.36 Habitat used by an assemblage of 11 species of bat will be affected where the viaduct will be constructed in the Mid Colne Valley SSSI. Three known common and soprano pipistrelle roosts will be lost when the trees supporting the bat boxes are removed. The bat species recorded roosting in this area use several roosts within their range and readily use new or alternative roosts. With an abundance of alternative roosting opportunities within the surrounding woodland and farmland, the loss of these roosts is unlikely to significantly affect the bat assemblage.

7.4.37 The mosaic of woodland, wet woodland, flowing water and open water that will be lost is an optimal foraging resource and the River Colne is an important commuting feature. The loss of these habitats may result in the temporary disturbance of the bat assemblage, however, it is likely that all component species will disperse to, and forage within the abundant surrounding woodland and open water and are likely to use the nearby canal or lake edge as an alternative north-south commuting route. Therefore, it is unlikely that these impacts will have an adverse effect on the conservation status of the bat assemblage. For the same reasons, there is no expected adverse effect on the bat assemblage that is likely to be present in land south of Moorhall Road. Several Daubenton's bat roosts will be removed when woodland is cleared, although no maternity or hibernation roosts will be lost. Daubenton's bats will use several roosts within their range and will readily use new or alternative roosts . The Colne Valley viaduct laydown satellite compound will be within 20m of a Myotis sp. roost in a building, which may be a Daubenton's bat maternity colony. The compound will not, however, restrict the likely flight lines from the roost to the adjacent open water or woodland. The roost, which is within 30m of the A412 Denham Way/North Orbital Road, is also already subject to noise and vibration disturbance from passing traffic. The Daubenton's bat population associated with the River Colne may be affected by clearance of vegetation in this area. However, there is an abundance of optimum habitat (open and flowing water that is bounded by woodland) within the wider landscape and alternative commuting routes along the nearby canal and lake edges. Therefore, it is unlikely that these impacts will result in an adverse effect on the conservation status of Daubenton's bat.

7.4.38 Losses of other habitat within the land required for the construction of the Proposed Scheme may require some bats to travel further and expend more energy during day to day foraging and movement throughout their home range for the duration of construction. However, such effects alone are for all species considered unlikely to result in sufficient disturbance of the populations concerned to result in an adverse effect on their conservation status.

7.4.39 It is considered unlikely that any other effects on species receptors at more than the local/parish level will occur. Effects at the local/parish level are listed in Appendix EC-005-002, Volume 5.

Other mitigation measures

7.4.40 This section describes additional measures designed to reduce or compensate for significant ecological effects. These include habitat creation and habitat enhancement.

7.4.41 Ten ecological mitigation areas have been incorporated into the land required for construction of the Proposed Scheme, these are:

- Tilehouse Lane woodland creation area – approximately 17ha of new lowland mixed deciduous woodland;
- Broadwater Lake wetland creation area – approximately 0.5ha of wetland vegetation[73] will be created along the western shore approximately 400m north of where the viaduct will be constructed;
- Broadwater Lake tree planting area – approximately 0.5ha of willow and alder trees in the south-west corner of this lake;
- Broadwater Lake bird islands – several new gravel islands/rafts will be created in the south-eastern corner to provide nesting opportunities for water birds;
- Harefield Moor Lake wetland creation area – approximately 1ha of wetland vegetation will be created at the eastern end of the lake, about 450m from where the viaduct will be constructed;
- Harvil Road woodland creation area – approximately 2ha of new lowland mixed deciduous woodland will be created adjacent to Harvil Road;
- Battlesford Wood woodland creation area – approximately 0.5ha of semi-improved broadleaved woodland will be created east of A412 Denham Way/North Orbital Road;
- National Grid feeder station wet-grassland area – approximately 1ha of lowland meadow grassland will be created east of Harefield No. 2 Lake;
- Harefield No. 2 Lake wetland creation areas – approximately 1ha of wetland habitat will be created at the northern end of the lake and about 2ha of wetland habitat will be created at the southern end of this lake; and

[73] Wetland habitat will be a swamp and/or marshy grassland depending on local hydrological and soil conditions.

- Habitat reinstatement under the viaduct – after construction, woodland and scrub habitats will be allowed to re-colonise and/or they will be replanted in the land required for construction of the Proposed Scheme with the exclusion of areas that are directly beneath the viaduct or in the service road.

7.4.42 Opportunities for habitat creation are also possible within the green space between the M25 motorway, the A412 Denham Way/North Orbital Road and Chalfont Lane. Grassland, open water and scattered trees are likely to be created as part of the restoration of the construction area.

7.4.43 A number of other habitat areas will be created primarily for the purposes of flood compensation and landscape screening or compensation. It is likely that these measures will indirectly provide ecological benefits, such as foraging and nesting opportunities for birds.

7.4.44 As part of the precautionary assessment, it has been assumed that all land identified as being required for the realignment of the National Grid overhead power lines will be cleared of vegetation. Some of this land will be required for construction and during the detailed design stage opportunities to retain parts of this area will be considered.

7.4.45 The loss of woodland breeding bird habitat from the Mid Colne Valley SSSI will be compensated for by habitat creation in Tilehouse Lane and Battlesford Wood woodland creation areas as described previously. This new woodland will take at least 30 years to be of comparable value for most bird species, although it will be beneficial as a foraging resource sooner. The provision of nesting features will be provided in accordance with the principles of mitigation (Volume 5: Appendix CT-001-000/2).

7.4.46 To compensate for the loss of approximately 0.75ha wetland habitat used by breeding birds in the Mid Colne Valley SSSI and Mid Colne Valley SMI, about 4.5ha of new wetland habitat will be created within three of the ecological mitigation areas, as described previously.

7.4.47 In addition to the compensation for the loss of habitats from within the SSSI, compensatory habitats for additional loss of grassland, scrub and woodland within the Mid Colne Valley SMI will be created at the Harvil Road woodland creation area; the National Grid feeder station wet-grassland area; and the Ickenham auto-transformer feeder station woodland/grassland creation area.

7.4.48 Loss of breeding bird habitat from the Mid Colne Valley SMI will be compensated for by habitat creation measures already outlined above including the Tilehouse Lane woodland creation area; wetland creation areas at Harefield No. 2 Lake and Harefield Moor Lake; the Harvil Road woodland creation area; the National Grid feeder station wet-grassland area and Broadwater Lake. The new bird islands within Broadwater Lake will provide replacement nesting habitat for terns, gulls and waterfowl should small numbers be disturbed from the south-west corner of Broadwater Lake, Korda Lake and Harefield Moor Lake.

7.4.49 Measures outlined above to compensate for the loss of habitat from the Mid Colne Valley SSSI will also compensate for impacts on Tilehouse Gravel Pits BNS. The sites overlap and thus the habitat affected is the same.

7.4.50 Measures outlined above to compensate for the loss of habitat from the Mid Colne Valley SMI will also compensate for impacts on Denham Country Park LNR and Fray's Valley LNR. The sites overlap and thus the habitat affected is the same.

7.4.51 The loss of woodland from Dew's Dell SBI will be compensated for by the Harvil Road woodland creation area, as well as the nearby landscape planting.

7.4.52 At the River Colne east of Denham BNS, if areas of habitat are temporarily lost, vegetation will quickly re-colonise or be planted after construction in accordance with the principles of mitigation (Volume 5: Appendix CT-001-000/2). If required, the reinstatement of the river habitat will be completed in consultation with the Environment Agency to seek to meet their objectives.

7.4.53 Following the successful implementation of these measures in accordance with the principles of mitigation (Volume 5: Appendix CT-001-000/2) and the maturation of the habitats, the effects relating to loss of habitat and the breeding bird assemblage within these designated sites is likely to be reduced to a level below that which is significant.

7.4.54 To compensate for the loss of up to approximately 30ha of woodland, of which 24ha is semi-natural broadleaved woodland and 1.0ha is ancient semi-natural woodland, a total of 19.5ha of lowland mixed deciduous woodland will be created in the Tilehouse Lane, Battlesford Wood and Harvil Road woodland creation areas. In addition, significant areas of woodland and scrub will be created as part of the landscaping. There are also likely to be scattered areas of tree planting within the environment open space area, between the M25 motorway, the A412 Denham Way/North Orbital Road and Chalfont Lane.

7.4.55 Ancient woodland is irreplaceable. However, the loss of woodland will be compensated for through a range of measures. Ancient woodland soil with its associated seed bank and associated species (including coralroot) will be translocated to the Tilehouse Lane woodland creation area. This will increase the connectivity between Juniper Wood, Little Halings Wood and Great Halings Wood, which are all ancient woodlands. Other measures such as planting native tree and shrub species of local provenance and translocation of coppice stools and dead wood will be used as appropriate.

7.4.56 Compensation for the possible loss of up to 5ha of unimproved grassland is described within the mitigation for the Mid Colne Valley SMI as the site includes all grassland that will be affected.If an otter holt were to be lost to the south of Moorhall Road, it will be replaced in one of the wetland compensation areas that was previously described and in accordance with the principles of mitigation (Volume 5: Appendix CT-001-000/2) and will therefore be sufficient to maintain the favourable conservation status of otter in the Colne Valley.

7.4.57 If water vole are present to the south of Moorhall Road, they will be moved to the wetland creation areas previously described, before construction starts. These areas will be designed in accordance with the principles of mitigation (Volume 5: Appendix CT-001-000/2) to provide alternative habitats, in advance of construction. New habitat will be sufficient to maintain the conservation status of water vole in the Colne Valley.

7.4.58 Compensatory habitat to address the possible impacts on great crested newt population at Uxbridge Golf Course, Buckinghamshire Golf Course and farmland east of South Harefield will be provided within the National Grid feeder station wet grassland area and the Harvil Road woodland creation area. The habitat creation will be in accordance with the principles of mitigation (Volume 5: Appendix CT-001-000/2). This will include the provision of ponds, terrestrial habitat and hibernation habitat sufficient to maintain the favourable conservation status of the populations affected.

7.4.59 Compensatory habitat to address the impacts on possible reptile populations from Harvil Road and Harefield No. 2 Lake, habitat adjacent to Moorhall Road, grassland within the Mid Colne Valley SMI and Uxbridge Golf Course will be created in the National Grid feeder station wet grassland creation area and the Tilehouse Lane woodland creation area. The habitat creation will be in accordance with the principles of mitigation (Volume 5: Appendix CT-001-000/2). This will include the provision of rough grassland, open water and habitat features for breeding and hibernating sufficient to maintain the conservation status of the populations affected.

7.4.60 Terrestrial invertebrates associated with dead-wood will not be significantly affected. However, the translocation of soils, plants and dead wood material from woodland that will be lost, to the Tilehouse Lane woodland and the Harvil Road woodland creation areas will encourage the establishment of new invertebrate populations within the compensation woodland.

7.4.61 Although no significant impacts on the conservation status of any bat species or assemblages are expected, the following measures will address any effects:

- woodland and wetland creation as previously described will compensate for loss of bat foraging habitat in the Mid Colne Valley SSSI, south of Moorhall Road;
- access between important foraging sites and roosts will be maintained in accordance with the principles of mitigation (Volume 5: Appendix CT-001-000/2);
- to mitigate for the removal of bat roosts in bat boxes and trees, new bat roosting will be created in the land required for construction of the Proposed Scheme as set out in the principles of mitigation (Volume 5: Appendix CT-001-000/2); and
- although no significant impact is expected for the bat assemblage around Little Halings Wood, the Tilehouse Lane linear planting area will provide a feature for bats to use as a safe flight line connecting to habitats on the other side of the A412 Denham Way/North Orbital Road.

7.4.62 Although there will be no significant impact on the conservation status of badger, mitigation measures to address the potential killing, injury and disturbance of badgers will be provided in accordance with the principles of mitigation (Volume 5: Appendix CT-001-000/2). This will include the provision of replacement setts for those lost.

Summary of likely residual significant effects

7.4.63 The mitigation, compensation and enhancement measures described reduce the effects to a level that is not significant except for the following receptors:

- in the Mid Colne Valley approximately 1ha of ancient woodland will be lost and cannot be replaced that will be significant;
- one of the two locations used by pochard for breeding in this area will be lost, resulting in a temporary adverse effect on the population; and
- corn bunting habitat will be lost from farmland between the M25 and the A412 Denham Way/North Orbital Road, resulting in a permanent adverse effect on the population.

7.5 Effects arising from operation

Avoidance and mitigation measures

7.5.1 The following measure has been included as part of the design of the Proposed Scheme and avoid or reduce impacts on features of ecological value. Noise fence barriers will be constructed along the Proposed Scheme where it is close to retained woodland in the Mid Colne Valley SSSI, reducing noise and visual disturbance to sensitive woodland and wetland birds.

Assessment of impacts and effects

7.5.2 Where the route of the Proposed Scheme bisects or is located in close proximity to existing features known to be utilised regularly by foraging or commuting bats, there is an increased risk that bats could be killed or injured as a result of collisions with passing trains or associated turbulence. The significance of any such effect will be dependent on both the flight habit of the species or species concerned and the vertical alignment of the Proposed Scheme.

7.5.3 The Colne Valley viaduct will cross habitats used by foraging and commuting bats, including noctule bat, a species which commonly flies above tree level. However, the height of the viaduct will not obstruct flight lines for most species and the risk to noctules is low. Noctules avoid cluttered environments as they are large bats with a poor ability to manoeuvre. They will therefore avoid the catenary infrastructure, rather than fly within or through it. The noise fence barriers along the majority of the viaduct, as it crosses the River Colne valley, will further reduce the risk of collision. Although it is possible that there may be infrequent incidental mortality, this is unlikely to result in a significant adverse effect on the conservation status of noctule.

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

7.5.5 The majority of bird species known to be present in the area are not considered to be particularly vulnerable to collision with trains. Large birds such as cormorants and geese are vulnerable to collision with overhead power lines and other aerial structures, however, vantage point surveys did not identify any important flight lines for any such species. Most birds will be able to see the structure given the height of the parapet and the noise fence barriers and avoid it. A small risk of infrequent collision will remain but this will not be significant to the conservation status of locally present bird species, particularly wintering waterfowl.

7.5.6 It is considered unlikely that any other effects on species receptors at more than the local/parish level will occur. Effects at the local/parish level are listed, Volume 5: Appendix EC-005-002.

Other mitigation measures

7.5.7 In the absence of any significant ecological impacts, no mitigation is required

Summary of likely residual significant effects

7.5.8 There are no likely significant residual ecological effects during operation.

8 Land quality

8.1 Introduction

8.1.1 This section presents the baseline conditions that exist along the Proposed Scheme in relation to land quality and reports the likely impacts and any significant effects resulting from construction and operation of the Proposed Scheme. Consideration is given to land that potentially contains contamination and land that has special geological significance, either from a scientific, mining or mineral resources point of view including geological sites of special scientific interest (SSSI), local geological sites (LGS), areas of current underground or opencast mining and areas of designated mineral resources. Mitigation measures are presented and any residual effects are summarised.

8.1.2 Potentially contaminated areas of land have been identified that could affect, or be affected by, the construction of the Proposed Scheme (for example contaminated soils may need to be removed or the construction may alter existing contamination pathways). Each of these areas has been studied to evaluate the scale of potential impacts caused by existing contamination (if present) and what needs to be done to avoid significant consequences to people and the wider environment. In addition, a review has been undertaken to establish whether the operation of the Proposed Scheme will lead to contamination of its surrounding environment and what needs to be done to prevent such contamination.

8.1.3 The main environmental features of this area include the River Colne, the Grand Union Canal, Broadwater Lake Nature Reserve, Mid Colne Valley SSSI, Northmoor Hill Wood Local Nature Reserve, Mid Colne Valley SMI, Brackenbury Railway Cutting SBI, Dew's Dell SBI and the underlying Chalk principal aquifer.

8.1.4 The main land quality issues in this area include:

- the existing Chiltern Main Line;
- Broadwater Park industrial estate;
- historical landfills along the route;
- potentially in-filled historical chalk, sand and gravel workings along the route;
- Mineral Safeguarding Areas for sand and gravel extraction; and
- an extant planning permission associated with the sand and gravel located at Denham Park Farm (Buckinghamshire County Council) and a former mineral extraction site on Moorhall Road (LBH).

8.1.5 Details of baseline information and the land quality assessment methodology are outlined in the following appendices (presented, Volume 5):

- Appendix CT-001-000/1: the SMR and Appendix CT-001-000/2 the SMR Addendum; and
- Appendix LQ-001-007: Land quality appendix.

8.1.6 Land contamination issues are closely linked with those involving water resources and waste. Issues regarding groundwater resources are addressed in Section 13 Water resources and flood risk assessment. Issues regarding the disposal of waste materials, including contaminated soils, are addressed in Volume 3: Section 16.

8.1.7 Engagement has been undertaken with the Three Rivers, South Bucks and Chiltern District Councils and the Environment Agency regarding land contamination and Hertfordshire and Buckinghamshire County Councils with regards to mineral policy. To date, information has been received on mineral extraction and Mineral Safeguarding Areas (June 2013) and contaminated land. Information provided is described in Section 2 Engagement (Volume 5).

8.2 Scope, assumptions and limitations

8.2.1 The assessment scope, key assumptions and limitations for the land quality assessment are set out in Volume 1 and in the SMR and its addendum presented, Volume 5 (Appendices CT-001-000/1 and 2). This section follows the standard assessment methodology.

8.2.2 Baseline data were reviewed for the area of land required to construct the Proposed Scheme together with a buffer extending out for a minimum of 250m, but in the case of groundwater data up to 1km. This is defined as the study area.

8.2.3 Familiarisation visits to the study area were made in July 2012 where the location of the Proposed Scheme was viewed from points of public access only. Due to access constraints not all sites considered to have the greatest potential for contamination were visited. However, the purpose of site visits is to verify desktop information and the lack of complete site walkovers is considered unlikely to have substantially affected the land quality assessment.

8.3 Environmental baseline

Existing baseline

8.3.1 Unless otherwise stated, all features described in this section are presented in Maps LQ-01-011 to LQ-001-013a (Volume 5, Land Quality Map Book).

Geology

8.3.2 This section describes the underlying ground conditions within the study area. It first describes any made ground present, followed by near surface superficial deposits and lastly describes the deeper bedrock geology. The geological mapping is illustrated on Map WR-02-007 (Volume 5, Water Resources and Flood Risk Assessment Map Book).

8.3.3 The Proposed Scheme in this study area mostly crosses agricultural land however, a cover of made ground may be present in built up areas of the study area as a result of previous cycles of development.

8.3.4 Historical mapping shows in-filled ground located at former gravel pits south of Moorhall Road, 200m north of the Proposed Scheme and to the east of Tilehouse Lane, 55m east of the Proposed Scheme in this area. A disused quarry is also known to be present north of Denham Green, 105m from the Proposed Scheme. This may

contain some reworked chalk or made ground. Flooded historical gravel pits are present in the Colne Valley, making up the Broadwater Lake Nature Reserve.

8.3.5 Across the majority of the southern and central areas of the Proposed Scheme, superficial deposits consist of River Alluvium, mainly clay, peat and silt, associated with the River Colne and its tributaries. In areas of worked ground, such as gravel pits to the north and south of the Proposed Scheme in the central section of the study area around the Broadwater Lake Nature Reserve, the older Shepperton Gravel, comprising sand and gravel with sparse lenses of silt and clay, has been exposed by the workings. There is also a thin exposure of Taplow Gravels near Battlesford Wood in the central area of the route section extending southwards. The Proposed Scheme crosses a small mapped area of Winter Hill Gravel at Tilehouse Lane which extends southwards, described as a sand and gravel with sparse lenses of silt and clay. Superficial deposits are absent along parts of the southern section of the study area where the bedrock is indicated as either Thames Group or Lambeth Group.

8.3.6 The bedrock geology of the first 150m at the southern end of this route section comprises the clay, silt and sand deposits of the Upnor and Reading Formations of the Lambeth Group. To the south of the Proposed Scheme the study area is underlain by London Clay from the Thames Group. This is typically stiff, grey weathering to brown clay with thin beds of sand and pebbles at the base and an expected thickness of up to 50m in this area. The remainder of the Proposed Scheme and study area is underlain by Seaford and Newhaven Formations of the Cretaceous White Chalk (a soft limestone with nodular flint beds) with a thickness of the order of 50m in this area.

Groundwater

8.3.7 The Chalk bedrock has been designated as a Principal Aquifer and the Lambeth Group has been designated as a Secondary A Aquifer by the Environment Agency. The Thames Group, including the London Clay, has been designated as unproductive strata. Where drift deposits are present at the surface these are designated as Secondary A Aquifers.

8.3.8 The entire route section will be within a Source Protection Zone (SPZ). The majority of the Proposed Scheme will cross a Zone 1 Inner Protection Zone (SPZ1), although there are three smaller sections that will cross through a Zone 2 Outer Protection Zone (SPZ2), as shown on Map WR-02-007 (Volume 5, Water Resources and Flood Risk Assessment Map Book).

8.3.9 A search for groundwater abstractions confirmed that there are three groundwater abstractions for Public Water Supply (PWS) within 1km of this section of the route.

8.3.10 Environment Agency information indicates that there are ten licensed groundwater abstractions (excluding PWS) and one unlicensed groundwater abstraction. One of these abstractions is located at Denham Laboratories and is for a pump and treat remediation system.

8.3.11 Further detail on the groundwater beneath the Proposed Scheme can be found in Section 13 Water resources and flood risk assessment.

Surface waters

8.3.12 The route will cross the Grand Union Canal and the River Colne between the Harvil Road and the A412 Denham Way/North Orbital Road.

8.3.13 There are also a number of lakes that have been formed in some of the disused gravel pits in this area that make up the Broadwater Lake Nature Reserve, part of the Mid Colne Valley SSSI.

8.3.14 There are no licensed surface water abstractions within 1km of the route in the Study Area.

8.3.15 Further information on surface waters is provided in Section 13.

Current and historical land use

8.3.16 Current potentially contaminative land uses include Broadwater Park Industrial Estate, comprising laboratories and photographic studios (see Map LQ-01-011, C7, Volume 5, Land Quality Map Book).

8.3.17 Historical potentially contaminative land uses include:

- areas of gravel workings around Denham;
- historical landfills (see Table 11);
- historical chalk pits also quarried for sands and gravel (see Map LQ-01-012, D5 and D6, Volume 5, Land Quality Map Book); and
- former sewage works at Denham Green (see Map LQ-01-011, A6, Volume 5, Land Quality Map Book).

8.3.18 Current and historical landfills are detailed in Table 11:

Table 11: Landfill sites located within the study area

Name	Location	Description
Land off Harvil Road	At the southern end of the study area to the south of the Proposed Scheme. Map LQ-01-011, G8	Historical landfill – last waste received in December 1973.
West Hyde House Landfill	West Hyde House in the central area of the study area, to the north of the Proposed Scheme. Map LQ-01-012, F5)	No further information available.
Dew's Farm Landfill	Southern end of the study area, north of the Proposed Scheme. Map LQ-01-011, F5	Historical landfill – no further information available.
Harefield Marina Landfill	Southern end of the study area, north of the Proposed Scheme. Map LQ-01-011, E5	Historical landfill – Inert, industrial, commercial and household waste received in 1947.
Disused chalk pit and historical landfill	At the northern end of the study area, to the north-east of the Proposed Scheme. Map LQ-01-012, B6	Historical landfill – inert, industrial and special waste last received in July 1975.

Name	Location	Description
Disused chalk pit and historical Pynesfield Landfill	To the north of Tilehouse Lane, to the south-west of the Proposed Scheme. Map LQ-01-012, E6	Historical landfill – inert and industrial waste last received in July 1972.
Pynesfield Farm/Maple Cross Landfill	To the north of Tilehouse Lane, to the south-west of the Proposed Scheme. Map LQ-01-012, E7	Historical landfill – inert and industrial waste last received in July 1975.
Pynesfield Farm Landfill	To the north of Tilehouse Lane, to the south-west of the Proposed Scheme Map LQ-01-012, E8	Historical landfill – no further information available.
New Years Green Landfill	Southern end of the study area, north of the Proposed Scheme. Map LQ-01-011, F3	Historical landfill – commercial and household waste, last received in 1974.

8.3.19 Contaminants commonly associated with these uses could include metals, semi-metals, asbestos, organic and inorganic compounds. In-filled pits could also give rise to landfill gases such as methane or carbon dioxide.

Other regulatory data

8.3.20 Regulatory data reviewed include pollution incidents, radioactive and hazardous substances consents and environmental permits (previously landfill, Integrated Pollution Control (IPC) and Integrated Pollution Prevention and Control (IPPC) licences). Notable data is as follows:

- five currently permitted or authorised Local Authority (LA) Pollution Prevention and Controls for mobile screening and crushing process, blending, packing, load and use of cement, petrol filling station, respraying of road vehicles and blending, packing, loading and use of bulk cement;
- two significant and one minor pollution incident to land; and
- one prosecution relating to authorised processes against the Harven Form Foundry (see Map LQ-01-012, F2, Volume 5, Land Quality Map Book).

Mining/mineral resources

8.3.21 A number of policies from LBH Local Plan: Part 1 (2001) and Hillingdon Local Plan: Part2 (formerly Saved Policies 2007) seek to preserve and enhance the boroughs/districts' land quality. Specifically the saved LBH UDP Policy MIN1 seeks to safeguard sand and gravel reserves from sterilisation by surface development. Core Strategy Policy EM9 affords similar policy protection to safeguarded mineral resources.

8.3.22 The Buckinghamshire Minerals and Waste Core Strategy Development Plan Document (DPD)[5], 2012 shows that the route passes through a Minerals Safeguarding Area. Policy CS1 states that development proposals in this area, other than those involving minerals extraction, will need to demonstrate that it will not sterilise the

mineral resource or that consideration has been given to prior extraction of the protected mineral or that the need for the proposed development outweighs the economic value of the mineral resource.

8.3.23 There are no recorded shallow mines or mineral resources currently being worked within this study area.

8.3.24 There are no preferred mineral sites designated by LBH or Hertfordshire County Council in the study area. However, Denham Park Farm, located between the M25 and the Buckinghamshire/Hertfordshire County Boundary currently has planning permission for the excavation of sand and gravel and eventual backfilling and has therefore been designated as a Preferred Mineral Site by Buckinghamshire County Council. The permission includes the construction of an access road from the A412 Denham Way/North Orbital Road.

8.3.25 The route passes through several Minerals Safeguarding Areas (MSA) and Minerals Consultation Areas (MCA) within this study area. (see Map Series LQ-01, Volume 5, Land Quality Map Book) The entire route section within the boundary of Buckinghamshire County Council is within the Mineral Consultation Area/Minerals Safeguarding Area designated by Buckinghamshire County Council for sand and gravel resources.

8.3.26 In LBH, in 2008, Boyer Pit (a sand and gravel pit to the east of Denham Green on Moorhall Road) was recorded as being a dormant mineral site. However it was noted that the operator had indicated that the bottom of the lake may be worked at some stage in the near future[74] (Map LQ-01-011, C6, Volume 5, Land Quality Map Book).

8.3.27 In Buckinghamshire, a historical quarry was located at Northmoor Hill that has exposures of the Chalk and the Reading Beds.

8.3.28 In Hertfordshire, there are a number of gravel pits in the Denham area that have been used for extracting gravel from the Shepperton Gravel formation. Many of these are now filled with water, creating lakes and forming part of the Broadwater Valley Nature Reserve/Mid Colne Valley SSSI. These are located on the alignment of the route and alongside the route from approximately Dew's Farm through to Tilehouse Lane. This section of the route is located within the sand and gravel belt and is therefore within a Minerals Consultation Area for the sand and gravel designated by Hertfordshire County Council.

8.3.29 Historical mapping shows four chalk pits located along the northern end of this study area that are also noted to have been quarried for sands and gravel. The Chalk in this area has also been identified by the BGS as a mineral resource.

Geo-conservation resources

8.3.30 There are no geological conservation resources identified within the study area.

[74] London Borough of Hillingdon (2008) *Local Development Framework, Minerals Background Report*

Receptors

8.3.31 The sensitive receptors that have been identified within this study area are summarised in Table 12.

Table 12: Summary of sensitive receptors

Issue	Receptor type	Receptor description	Receptor sensitivity
Land Contamination	People	Residents in existing properties	High
		Workers e.g. industrial facilities and existing railway	Medium
	Controlled Waters	Principal aquifer of the White Chalk	High
		Secondary A Aquifer of the Lambeth Group	Medium
		Secondary A Aquifer of the alluvium	Medium
	Mineral resources	Sand and gravel MSAs	Low
	Ecological	Mid Colne Valley SSSI	High
		Northmoor Hill Nature Reserve	Medium
	Built Environment	Buildings and property	Low to high
		Underground structures and services	Low
Impacts on mining/mineral sites (severance and sterilisation of mineral sites)	Mining/mineral sites	Sand and gravel MSAs	Low
		Mineral resource of chalk	Low

Future baseline

8.3.32 There is currently one identified committed development within the study area which is likely to change the land quality baseline during either construction or operation of the Proposed Scheme. The eastern side of the proposed quarry area at Denham Park Farm is located under an area designated as a temporary earthworks stockpile. Depending on the timescales this could temporarily sterilise the resource.

8.4 Effects arising during construction

Avoidance and mitigation measures

8.4.1 The construction assessment takes into account the mitigation measures contained within the draft CoCP (see Volume 5: Appendix CT-003-000). The draft CoCP sets out the measures and standards of work that will be applied to the construction of the Proposed Scheme. Its requirements in relation to work in contaminated areas will ensure the effective management and control of the work. Such requirements include:

- methods to control noise, waste, dust, odour, gasses and vapours (draft CoCP, Sections 5, 7, 13 and 15);
- methods to control spillage and prevent contamination of adjacent areas (draft CoCP, Section 5);
- the management of human exposure for both construction workers and people living and working nearby (draft CoCP, Section 11);
- methods for the storage and handling of excavated materials, both contaminated and uncontaminated (draft CoCP, Sections 7 and 15);
- management of any unexpected contamination found during construction (draft CoCP, Section 11);
- a post remediation permit to work system (draft CoCP, Section 11);
- storage requirements for hazardous substances such as oil (draft CoCP, Section 16);
- traffic management to ensure that there is a network of designated haul roads to minimise compaction/degradation of soils (draft CoCP, Section 7); and
- methods to monitor and manage flood risk and other extreme weather events which may affect land quality during construction (draft CoCP, Section 16).

8.4.2 The draft CoCP requires that prior to and during construction a programme of further investigations, which may include both desk based and site based work, will take place in order to confirm the full extent of areas of contamination and a risk assessment undertaken to determine what, if any, site specific remediation measures will be required to allow the Proposed Scheme to be constructed safely and to prevent harmful future migration of contaminants (draft CoCP, Section 11). The investigation and detailed assessment of potentially contaminated sites will be undertaken in accordance with:

- Environment Agency CLR11 Model Procedures for the Management of Land Contamination (2004)[75]; and
- British Standard BS10175 Investigation of Potentially Contaminated Sites (2011)[76].

8.4.3 Where significant contamination is encountered, a remedial options appraisal will be undertaken to define the most appropriate remediation techniques. This appraisal will be undertaken based on multi-criteria attribute analysis that considers environmental, resource, social and economic factors in line with Sustainable Remediation Forum UK's publication A Framework for Assessing the Sustainability of Soil and Groundwater Remediation (2010)[77]. The preferred option will then be developed into a remediation strategy, in consultation with regulatory authorities prior to implementation.

[75] Environment Agency (2004) *CLR11 Model Procedures for the Management of Land Contamination*
[76] *British Standards Institute (2011) British Standard BS10175Investigation of Potentially Contaminated Sites*
[77] Sustainable Remediation Forum UK (2010) *A Framework for Assessing the Sustainability of Soil and Groundwater Remediation*

8.4.4 Contaminated soils excavated from the site, wherever reasonably practicable, will be treated as necessary to remove or render any contamination inactive and reused within the Proposed Scheme where needed and suitable for use. Techniques are likely to include stabilisation methods, soil washing and bio-remediation to remove oil contaminants. Contaminated soil disposed of off-site will be taken to a soil treatment facility, another construction compound (for treatment, as necessary, and reuse) or to an appropriately permitted landfill.

8.4.5 In addition to the excavation and treatment of contaminated soils, ground (landfill) gas and leachate control systems within affected old backfilled sites, will be installed where necessary on a temporary or permanent basis, to ensure that ground (landfill) gas and leachate migration pathways are controlled.

Assessment of impacts and effects

8.4.6 This section of the route will start in cutting before passing on to a viaduct across the Colne Valley. The route will then pass into cutting, going below Tilehouse Lane and then run onto an embankment approaching the Chiltern tunnel south portal. From here the route will be run within a retained cutting before entering the Chiltern tunnel.

8.4.7 Construction works will include earthworks, utility diversions, deep foundations, temporary dewatering and other activities. In addition, road infrastructure works will also be required within this section of the Proposed Scheme.

8.4.8 There is a sustainable placement area located to the south-east of South Harefield. This is an area identified as a potential additional placement area for the disposal of surplus excavated material.

8.4.9 The Ickenham auto-transformer feeder station will be located at the eastern end of this route section south of the current HOAC site and an auto-transformer station located at West Hyde close to the Chiltern tunnel south portal. There will be a National Grid feeder station located north-east of the HOAC.

8.4.10 In the Colne Valley area there are two main compounds, used for activities including materials storage, precast works, concrete batching plant and a slurry plant and seven civil engineering satellite compounds and two railway installation satellite compounds (both of which will continue to use compounds previously established for the civil engineering works). (see Maps CT-05-019 to CT-05-023 in Volume 2, CFA7 Map Book)

Land contamination

8.4.11 In line with the assessment methodology, as set out in the SMR, SMR Addendum and its appendices, an initial screening process was undertaken (identified in the methodology as Stages A and B) to identify areas of current or historical contaminative use within the study area and to consider which of these areas might pose contaminative risks for the Proposed Scheme. In total, 33 areas were considered during this screening process; 15 of these areas were taken forward to more detailed risk assessments (Stages C and D) in which the potential risks were assessed more fully. The majority of the areas undergoing the more detailed risk assessments were historical landfills and potentially in-filled gravel or chalk pits. All areas assessed are shown on Maps LQ-01-011 to LQ-01-013a (Volume 5, Land Quality Map Book) and those considered as potentially posing a risk to the Proposed Scheme are labelled with a reference number.

8.4.12 Conceptual site models (CSM) have been produced for the fifteen areas taken to Stage C and D assessments. The detailed CSM are provided, Volume 5 (Appendix LQ 001-017, Section 3) and the results of the baseline risk assessments are summarised in this section. Potentially contaminated areas have been grouped and considered together, where appropriate. The following factors have determined the need for Stage C and D assessments:

- whether the area is on or off the Proposed Scheme or associated offline works, e.g. roads;
- the vertical alignment, i.e. whether the Proposed Scheme is in cut or on embankment;
- the presence of underlying Principal or Secondary A Aquifers or nearby watercourses; and
- the presence of adjacent residential properties or sensitive ecological receptors.

8.4.13 A summary of the baseline CSM is provided in Table 13. The impacts and baseline risks quoted are before any mitigation is applied. The assessed baseline risk is based on the information provided at the time of the assessment. Where limited information is available, it is based on precautionary, worst case assumptions and may therefore report a higher risk than that which actually exists.

Table 13: Summary of baseline CSM for sites which may pose a contaminative risk for the Proposed Scheme

Area ref [1][2]	Area name	Main potential impacts	Main baseline risk[3]
7-1	Existing Mainline Railway (Map LQ-01-011, G8)	Exposure of off-site human receptors (commercial) to contamination by direct contact, ingestion and inhalation of contaminants in windblown, soil-derived dusts.	Low
		Exposure of off-site human receptors (commercial) to contamination by direct contact, ingestion and inhalation of contaminants in windblown, soil-derived dusts.	Low
		Exposure of off-site human receptors (commercial) to contamination by inhalation of migrating ground-gas and volatile vapours from contaminated water.	Moderate/low
		Exposure of secondary A alluvium and Lambeth Group to leaching of contaminants from soil to groundwater and vertical and lateral migration in groundwater through culverts.	Moderate/low
		Exposure of Newyears Green Bourne to leaching of contaminants from soil to groundwater and vertical and lateral migration in groundwater, through culverts and surface run-off.	Moderate/low

Area ref [1][2]	Area name	Main potential impacts	Main baseline risk[3]
		Exposure of ecological receptors (Brackenbury Railway Cutting SBI and Mid Colne Valley SMI) to lateral migration of contaminants in groundwater.	Low
		Exposure of off-site ecological receptors (Brackenbury Railway Cutting SBI and Mid Colne Valley SMI) to contact with contaminants in windblown dusts.	Low
		Exposure of off-site properties to lateral migration and build up of asphyxiative or explosive gases.	Moderate/low
		Exposure of off-site properties to direct contact of property with contaminants in soil and surface water/groundwater.	Very low
7-2	Oil Depot (Map LQ-01-011, H8)	Exposure of on-site human receptors (commercial) to contamination by direct contact, ingestion and inhalation of contaminants in windblown, soil-derived dusts.	Moderate
		Exposure of on-site human receptors (commercial) to contamination by inhalation of migrating ground-gas and volatile vapours from contaminated water.	Moderate/low
		Exposure of on-site human receptors (commercial) to asphyxiative or explosive gases.	Moderate
		Exposure of off-site human receptors (residential and commercial) to contamination by direct contact, ingestion and inhalation of contaminants in windblown, soil-derived dusts.	Low
		Exposure of off-site human receptors (residential and commercial) to contamination by inhalation of migrating ground-gas and volatile vapours from contaminated water.	None
		Exposure of off-site human receptors (residential and commercial) to asphyxiative or explosive gases.	None
		Exposure of Secondary A Thames Valley Formation Gravel to leaching of contaminants from soil to groundwater and vertical and lateral migration in groundwater.	None
		Exposure of off-site ecological receptors (Brackenbury Railway Cutting SBI) to lateral migration of contaminants in	Very low

Area ref [1][2]	Area name	Main potential impacts	Main baseline risk[3]
		groundwater.	
		Exposure of off-site ecological receptors (Brackenbury Railway Cutting SBI) to contact with contaminants in windblown dusts.	Low
		Exposure of on-site properties to lateral migration and build up of asphyxiative or explosive gases.	Moderate
		Exposure of on-site properties to direct contact of property with contaminants in soil and surface water/groundwater.	Low
		Exposure of on-site properties to lateral migration and build up of asphyxiative or explosive gases.	Moderate
		Exposure of on-site properties to direct contact of property with contaminants in soil and surface water/groundwater.	Low
		Exposure of off-site properties to lateral migration and build up of asphyxiative or explosive gases.	None
		Exposure of off-site properties to direct contact of property with contaminants in soil and surface water/groundwater.	Very low
7-7	Historical in-filled gravel pit (Map LQ-01-011, G6, Volume 5)	Exposure of on and off-site human receptors (residential) to contamination by direct contact, ingestion and inhalation of contaminants in windblown, soil-derived dusts.	Moderate/low
		Exposure of on and off-site human receptors (residential) to contamination by inhalation of migrating ground-gas and volatile vapours from contaminated water.	Moderate/low
		Exposure of on and off-site human receptors (residential) to asphyxiative or explosive gases.	Moderate
		Exposure of secondary A Lambeth Group aquifer to leaching of contaminants from soil to groundwater and vertical and lateral migration in groundwater.	Low
		Exposure of off-site ecological receptors (Dew's Dell SBI) to lateral migration of contaminants in groundwater.	Moderate/low
		Exposure of off-site ecological receptors (Dew's Dell SBI) to contact with contaminants in windblown dusts.	Moderate/low
		Exposure of on and off-site properties to	Moderate

Area ref [1][2]	Area name	Main potential impacts	Main baseline risk[3]
		lateral migration and build up of asphyxiative or explosive gases.	
		Exposure of on and off-site properties to direct contact of property with contaminants in soil and surface water/groundwater.	Very low
7-9	Denham Media Park and Broadwater Park Industrial Estate (Map LQ-01-011, C7)	Exposure of on and off-site human receptors (residential and commercial) to contamination by direct contact, ingestion and inhalation of contaminants in windblown, soil-derived dusts.	Moderate/low
		Exposure of on and off-site human receptors (residential and commercial) to contamination by inhalation of migrating ground-gas and volatile vapours from contaminated water.	Moderate /low
		Exposure of on and off-site human receptors (residential and commercial) to asphyxiative or explosive gases.	Moderate/low
		Exposure of Principal Chalk and Secondary A Taplow Gravels Aquifer to leaching of contaminants from soil to groundwater and vertical and lateral migration in groundwater.	Very high
		Exposure of River Colne to leaching of contaminants from soil to groundwater and lateral migration in groundwater and surface run-off.	Low
		Exposure of off-site ecological receptors (Mid Colne Valley SSSI and SMI) to lateral migration of contaminants in groundwater.	Low
		Exposure of off-site ecological receptors (Mid Colne Valley SSSI and SMI) to contact with contaminants in windblown dusts.	Very low
		Exposure of on and off-site properties to lateral migration and build up of asphyxiative or explosive gases.	Moderate/low
		Exposure of on and off-site properties to direct contact of property with contaminants in soil and surface water/groundwater.	Low
7-11	Former Sewage Works (Map LQ-01-011 A6)	Exposure of principal Chalk aquifer to leaching of contaminants from soil to groundwater and vertical and lateral migration in groundwater.	Moderate
		Exposure of River Colne to leaching of contaminants from soil to groundwater	Low

Area ref [1][2]	Area name	Main potential impacts	Main baseline risk[3]
		and vertical and lateral migration in groundwater.	
		Exposure of off-site ecological receptors (Mid Colne Valley SSSI and SMI) to lateral migration of contaminants in groundwater.	Low
		Exposure of off-site ecological receptors (Mid Colne Valley SSSI and SMI) to contact with contaminants in windblown dusts.	Very low
7-16	Disused Sand and Gravel and Chalk Pit (Map LQ-01-012 D6)	Exposure of Principal Chalk Aquifer to leaching of contaminants from soil to groundwater and vertical and lateral migration in groundwater.	Moderate/low
7-17	Disused Sand and Gravel and Chalk Pit (Map LQ-01-012 D5)	Exposure of Principal Chalk Aquifer to leaching of contaminants from soil to groundwater and vertical and lateral migration in groundwater.	Moderate/low
7-18	Disused Chalk Pits and Historical Pynesfield Farm Landfill (Map LQ-01-12 E6)	Exposure of Principal Chalk Aquifer to leaching of contaminants from soil to groundwater and vertical and lateral migration in groundwater.	High
7-19	Disused Chalk Pits and Historical Landfill (Map LQ-01-012, B6)	Exposure of Principal Chalk Aquifer to leaching of contaminants from soil to groundwater and vertical and lateral migration in groundwater.	High
7-20	Pynesfield Farm/Maple Cross Landfill (Map LQ-01-12, E7)	Exposure of Principal Chalk and Secondary A Terrace Gravels Aquifer to leaching of contaminants from soil to groundwater and vertical and lateral migration in groundwater.	High
7-26	Historical West Hyde House Landfill – currently a water body (Map LQ-01-012, F5)	Exposure of off-site human receptors (residential and commercial) to contamination by inhalation of migrating ground-gas and volatile vapours from contaminated water.	Low
		Exposure of off-site human receptors (residential and commercial) to asphyxiative or explosive gases.	Moderate/low
		Exposure of Secondary A Alluvium and Shepperton Gravel Aquifer to leaching of contaminants from soil to groundwater and vertical and lateral migration in groundwater.	Moderate/low

Area ref [1][2]	Area name	Main potential impacts	Main baseline risk[3]
		Exposure of River Colne aquifer to leaching of contaminants from soil to groundwater and lateral migration in groundwater and surface run-off.	Low
		Exposure of off-site properties to lateral migration and build up of asphyxiative or explosive gases.	Moderate/low
		Exposure of off-site properties to direct contact of property with contaminants in soil and surface water/groundwater.	Very low
7-28	Dew's Farm Historical Landfill (Map reference LQ-01-011, F5)	Exposure of off-site human receptors (residential) to contamination by direct contact, ingestion and inhalation of contaminants in windblown, soil-derived dusts.	Moderate/low
		Exposure of off-site human receptors (residential) to contamination by inhalation of migrating ground-gas and volatile vapours from contaminated water.	Moderate/low
		Exposure of off-site human receptors (residential) to asphyxiative or explosive gases.	Moderate
		Exposure of secondary A Lambeth Group Aquifer to leaching of contaminants from soil to groundwater and vertical and lateral migration in groundwater.	Moderate/low
		Exposure of on-site ecological receptors (Dew's Dell SINC) to lateral migration of contaminants in groundwater.	Moderate/low
		Exposure of on-site ecological receptors (Dew's Dell SINC) to contact with contaminants in windblown dusts.	Moderate/low
		Exposure of off-site properties to lateral migration and build up of asphyxiative or explosive gases.	Moderate
		Exposure of off-site properties to direct contact of property with contaminants in soil and surface water/groundwater.	Very low
7-31	Harefield Marina Landfill (Map LQ-01-011,E5)	Exposure of off-site human receptors (residential and commercial) to contamination by direct contact, ingestion and inhalation of contaminants in windblown, soil-derived dusts.	Moderate/low

Area ref [1][2]	Area name	Main potential impacts	Main baseline risk[3]
		Exposure of off-site human receptors (residential and commercial) to contamination by inhalation of migrating ground-gas and volatile vapours from contaminated water.	Moderate/low
		Exposure of off-site human receptors (residential and commercial) to asphyxiative or explosive gases.	Moderate
		Exposure of Secondary A superficial gravel deposits Aquifer to leaching of contaminants from soil to groundwater and vertical and lateral migration in groundwater.	Moderate/low
		Exposure of on-site ecological receptors (Mid Colne Valley SMI) to lateral migration of contaminants in groundwater.	Moderate/low
		Exposure of on-site ecological receptors (Mid Colne Valley SMI) to contact with contaminants in windblown dusts.	Low
		Exposure of off-site properties to lateral migration and build up of asphyxiative or explosive gases.	Moderate
		Exposure of off-site properties to direct contact of property with contaminants in soil and surface water/groundwater.	Low
7-32	Pynesfield Farm Landfill (Map LQ-01-012, E8)	Exposure of Principal Chalk Aquifer to leaching of contaminants from soil to groundwater and vertical and lateral migration in groundwater.	High
7-33	New Years Green Landfill (Map LQ-01-011,F3)	Exposure of on and off-site human receptors (residential) to contamination by direct contact, ingestion and inhalation of contaminants in windblown, soil-derived dusts.	Moderate/Low
		Exposure of on and off-site human receptors (residential) to contamination by inhalation of migrating ground-gas and volatile vapours from contaminated water.	Moderate/Low
		Exposure of on and off-site human receptors (residential) to asphyxiative or explosive gases.	Moderate
		Exposure of Secondary A Lambeth Group Aquifer to leaching of contaminants from soil to groundwater and vertical and lateral migration in groundwater.	Moderate/low

Area ref [1][2]	Area name	Main potential impacts	Main baseline risk[3]
		Exposure of off-site ecological receptors (Dew's Dell SINC) to lateral migration of contaminants in groundwater.	Low
		Exposure of off-site ecological receptors (Dew's Dell SINC) to contact with contaminants in windblown dusts.	Low
		Exposure of off-site properties to lateral migration and build up of asphyxiative or explosive gases.	Moderate
		Exposure of on and off-site properties to lateral migration and build up of asphyxiative or explosive gases.	Moderate
		Exposure of on and off-site properties to direct contact of property with contaminants in soil and surface water/groundwater.	Very low

(1) Each area is assigned a unique identification number (See Volume 5, Appendix LQ-001-007).
(2) CSMs have been prepared as part of the detailed land contamination methodology (refer to Volume 5) for baseline, construction and post-construction
(3) The moderate or high risks identified reflect the uncertainty in existing baseline information. Whilst there are unlikely to be properties or receptors that experience the reported high or moderate existing baseline risk in the absence of site investigation a precautionary, worst case risk is reported in the table.

Temporary effects

8.4.14 An assessment of the effects of contamination has been undertaken by comparing the CSM developed for potential contaminated areas at baseline, construction and post construction stages. The baseline and construction CSM have been compared to assess effects at the construction stage.

8.4.15 Table 14 presents the summary of the construction effects obtained from a comparison of the baseline and construction impacts. The construction risk assessment takes into account the implementation of the mitigation measures set out within the draft CoCP. The details of these comparisons are presented, Volume 5 (Appendix LQ-001-007).

8.4.16 The baseline and construction CSM have been compared to determine the change in level of risk to receptors during the construction stage, and thus to define the level of effect at the construction stage. Where there is no change between the main baseline risk and the main construction risk, the temporary effect significance is deemed to be negligible even if the risk is assessed to remain as high. This will be the case where the construction of the Proposed Scheme does not alter the risks from an existing potentially contaminated site that is outside the construction boundary.

Table 14: Summary of temporary (construction) effects

Area ref	Area name	Main baseline risk	Main construction risk [1] [2]	Temporary effect and significance
7-1	Existing Mainline Railway	Very low to moderate/low	None to moderate/low	Negligible (not significant)

Area ref	Area name	Main baseline risk	Main construction risk (1) (2)	Temporary effect and significance
7-2	Oil Depot	None to moderate	None to moderate	Negligible (not significant)Negligible
7-7	Historical in-filled gravel pit	Very low to moderate	None to moderate	Negligible (not significant)Negligible
7-9	Denham Media Park and Broadwater Park Industrial Estate	Very low to very high	Very low to very high	Negligible (not significant)Negligible
7-11	Former Sewage Works	Very low to moderate	Low to high	Minor adverse effect (not significant))
7 -16	Disused Sand and Gravel and Chalk Pit	Moderate/low	Moderate	Minor adverse effect (not significant)
7-17	Disused Sand and Gravel and Chalk Pit	Moderate/low	Moderate/low	Negligible (not significant)
7-18	Disused Chalk Pits and Historical Pynesfield Farm Landfill	High	High	Negligible (not significant)
7-19	Disused Chalk Pits and Historical Landfill	High	High	Negligible (not significant)
7-20	Pynesfield Farm/Maple Cross Landfill	High	High	Negligible (not significant)
7-26	Historical West Hyde House Landfill – currently a water body	Very low to moderate/low	Very low to moderate	Negligible (not significant)
7-28	Dew's Farm Historical Landfill	Very low to moderate	Very low to moderate	Negligible (not significant)
7-31	Harefield Marina Landfill	Low to moderate	Low to moderate	Negligible (not significant)
7-32	Pynesfield Farm Landfill	High	Moderate	Minor beneficial effect (not significant)
7-33	New Years Green Landfill	Very low to moderate	Very low to moderate	Negligible (not significant)

(1) The low/moderate main construction risk identified in the above table does not necessarily imply an unacceptable risk. Application of the processes and measures within the CoCP will ensure that site risks during the construction stage are controlled.
(2) The high risks identified reflect the uncertainty in existing baseline information. Whilst there are unlikely to be properties or receptors that experience the reported high risk in the absence of site investigation a precautionary, worst case risk is reported in the table. Application of the processes and measures within the CoCP will ensure that site risks during the construction stage are controlled.

8.4.17 Table 14 indicates that based upon the assessment, the construction phase is expected to have a minor beneficial to minor adverse effect on the receptors overall. These effects are not considered to be significant in relation to potential land contamination.

8.4.18 Risks to receptors are considered to be potentially high during construction from 7-18, 7-19 and 7-20 as these are all sites that have been identified as recorded landfills and these sites are located within the footprint of the construction areas in advance of the Chiltern tunnel south portal. In accordance with the draft CoCP ground investigations

and risk assessments will be undertaken in advance of construction works commencing. The risks that have been identified (7-18, 7-19 and 7-20) are within land that will be used for construction activities associated with the compounds in this area and landscape mitigation at the portal. Therefore the level of disturbance to natural soils underlying the earthworks will in fact be limited. The disused sand and gravel and chalk pit (7-16) is partly located within an area of ground treatment and therefore any contamination encountered will be remediated. There will remain a potential risk that mobilisation of contamination could occur as contaminated soils are exposed and excavated at construction stage resulting in a minor adverse effect on controlled waters.

8.4.19 Where sites are located beneath the viaduct there will also be relatively limited potential for disturbance of soils. However, there will be substantial piling associated with the viaduct piers that will have the potential to disturb contaminated soils and create new pathways. This is particularly likely at the former sewage works (7-11) at Denham Green, located directly beneath the viaduct where sewage sludge was historically deposited and associated organic and inorganic contamination may exist. Any contaminated land will be remediated in accordance with the draft CoCP including excavation, if appropriate. In addition, to manage the potential vertical migration of poorer quality surface water into the Chalk aquifer the piling method will be selected to provide an appropriate seal and to ensure that there are no significant effects to controlled waters. Sites located outside the footprint of the viaduct, such as the in-filled quarries but within landscape mitigation areas, are unlikely to be disturbed and impacts will be limited.

8.4.20 There will be a minor beneficial effect to 7-32 during construction as the landfill will be covered by a temporary stockpile which will reduce infiltration.

8.4.21 The Chiltern tunnel south portal will lie at the western end of this section of the area. Here the route will run below ground level as it passes into CFA8. This means it is unlikely that there will be any impact in the Colne Valley study area from the landfill lying at Warren Farm in the CFA8 area.

8.4.22 Construction compounds located in the area will include the storage of potentially hazardous substances, such as fuels and lubricating oils and may also be used for temporary storage of potentially contaminated soils. The measures outlined in the CoCP will manage risks from the storage of such materials.

Permanent effects

8.4.23 Baseline and post-construction CSM have been compared to assess the permanent (post-construction) effects. The post-construction CSM assumes that all the required remediation has been carried out and validated.

8.4.24 Table 15 includes the summary of the permanent (post-construction) effects obtained from a comparison of the baseline and post-construction impacts and whether these are significant. The details of these comparisons are presented, Volume 5 (Appendix LQ 002-007).

Table 15: Summary of permanent (post-construction) effects

Area ref	Area name	Main baseline risk	Main post-construction risk (1)	Post-Construction Effect – Significant? (Y/N)
7-1	Existing Mainline Railway	Very low to moderate/Low	None to Moderate/low	Negligible (not significant)
7-2	Oil Depot	None to moderate	None to moderate	Negligible (not significant) Negligible
7-7	Historical in-filled gravel pit	Very low to moderate	None to moderate	Negligible (not significant) Negligible
7-9	Denham Media Park and Broadwater Park Industrial Estate	Very low to very high	Very low to very high	Minor adverse effect (not significant)
7-11	Former Sewage Works	Very low to moderate	Very low to moderate	Minor adverse effect (not significant)
7-16	Disused Sand and Gravel and Chalk Pit	Moderate/Low	None	Moderate beneficial effect (significant)
7-17	Disused Sand and Gravel and Chalk Pit	Moderate/low	Moderate/low	Negligible (not significant)
7-18	Disused Chalk Pits and Historical Pynesfield Farm Landfill	High	Moderate	Minor beneficial effect (not significant)
7-19	Disused Chalk Pits and Historical Landfill	High	None	Major beneficial effect (significant)
7-20	Pynesfield Farm/Maple Cross Landfill	High	Moderate	Minor beneficial effect (not significant)
7-26	Historical West Hyde House Landfill – currently a water body	Very low to moderate/low	Very low to moderate/low	Negligible (not significant)
7-28	Dew's Farm Historical Landfill	Very low to moderate	Very low to moderate	Negligible (not significant)
7-31	Harefield Marina Landfill	Low to moderate	Low to moderate	Negligible (not significant)
7-32	Pynesfield Farm Landfill	High	High	Negligible (not significant)
7-33	New Years Green Landfill	Very low to moderate	Very low to moderate	Negligible (not significant)

(1) The high risks identified reflect the uncertainty in existing baseline information. Whilst there are unlikely to be properties or receptors that experience the reported high risk in the absence of site investigation a precautionary, worst case risk is reported in the table. Application of the processes and measures within the CoCP will ensure that site risks during the construction stage are controlled.

8.4.25 The magnitude of the permanent effects and their significance have been determined by calculating the change in risk between the main baseline risk and the main post-construction risk. Therefore, where there is no change between the main baseline risk and the main post-construction risk, the permanent effect significance is deemed to be negligible even if the risk is assessed to remain as high. This will be the case where

the construction of the Proposed Scheme does not alter the risks from an existing potentially contaminated site that is outside the construction boundary.

8.4.26 Table 15 shows that the Proposed Scheme results in either a reduction or no change in the level of risk already existing at each site for both on site and off site receptors.

8.4.27 Table 15 indicates that, following remediation, there will be an overall minor adverse to major beneficial effect. These effects may be significant at 7-16 and 7-19.

8.4.28 Beneficial effects will occur where the route will pass directly through sites such as disused chalk pits (landfills) resulting in removal or remediation of contaminated soils and therefore removing a contaminant linkage both to human receptors and to the sand and gravel secondary A aquifer and potentially to the Chalk principal aquifer.

8.4.29 A minor adverse effect will occur at 7-11 as the increase in hardstanding surrounding the site may increase surface water run-off into the site and potentially increase leaching of residual contamination to groundwater.

8.4.30 There are anticipated to be no significant cumulative permanent effects.

Mining/mineral resources

8.4.31 Construction of the Proposed Scheme has the potential to impact existing mineral resources and proposed areas of mineral exploitation. This could occur by sterilisation of the resource, direct excavation during construction of the Proposed Scheme or through temporary and/or permanent severance[78] that may occur during the construction phase of the Proposed Scheme, possibly continuing through to the operation.

8.4.32 Parts of the route within this study area will fall within a Mineral Consultation Area/ Mineral Safeguarding Area designated by Buckinghamshire County Council for sand and gravel extraction. These resources are not currently being worked in this area.

8.4.33 There are currently two mineral extraction sites within the study area at Denham Park Farm and Moorhall Road (not currently extracting).

Temporary effects

8.4.34 The eastern side of the proposed quarry area at Denham Park Farm is located under an area designated as a temporary earthworks stockpile. Depending on the timescales this could temporarily sterilise the resource which will be a temporary adverse effect, although not considered to be significant. A plan will be discussed and agreed in advance with the landowner, the mineral planning authority and any other interested parties to assist in achieving an effective management of minerals at this location.

Permanent effects

8.4.35 Construction of the Proposed Scheme will affect the designated Mineral Safeguarding Areas, resulting in a minor adverse impact. The effect is assessed as not significant

78 In this context, severance refers to the Proposed Scheme splitting an actual or proposed mining/mineral site into two or more areas, such that separate accesses would be required to work the whole site.

because the majority of the resource lies outside the land required to build the Proposed Scheme.

8.4.36 Table 16 presents a summary of the assessment of effects on the mining and mineral resources identified.

Table 16: Summary of effects for mining and mineral resources

Site name	Status	Description	Sensitivity/value	Magnitude of impact	Effect and significance
Study area within Buckinghamshire County Council (Map LQ-01-11 to 13a)	Mineral Safeguarding Area	Mineral Safeguarding Area for sand and gravel	Medium	Minor	Negligible (not significant)
Denham Park Farm	Preferred Mineral Site	Planning application granted for mineral extraction.	High	Minor	Minor adverse (not significant)
Moorhall Road	Mineral extraction site	Not currently extracting	Low	Minor	Minor adverse (not significant)
Pynesfield Farm	Mineral extraction site	Planning application pending for mineral extraction.	Medium	Moderate	Minor adverse (not significant)

8.4.37 There are anticipated to be no significant cumulative permanent effects from construction.

Geo-conservation sites

8.4.38 No geo-conservation areas such as SSSI or LGS are present in the study area.

Other mitigation measures

8.4.39 The CoCP details the approach to managing potential land contamination matters. No additional mitigation measures are considered necessary to mitigate risks from land contamination at construction phase beyond those set out in the draft CoCP and instigated as part of required remediation strategies.

8.4.40 Mitigation of the effects on mineral resources can include prior extraction of the resource for use within the project or elsewhere. Extraction may be limited to landscaped areas within the Proposed Scheme adjacent to, rather than beneath the trackbed which will require good founding conditions. A plan will be discussed and agreed in advance of the construction works with the landowner, the appropriate mineral planning department at and any other interested parties to assist in achieving an effective management of minerals within the affected location of the MSA.

Summary of likely significant residual effects

8.4.41 No likely significant adverse effects are anticipated with the application of the mitigation measures detailed above.

8.5 Effects arising from operation

8.5.1 Users of the Proposed Scheme (i.e. rail passengers) whilst within trains, are will at all routine times be within a controlled environment and have therefore been scoped out of the assessment.

Avoidance and mitigation measures

8.5.2 Maintenance and operation of the Proposed Scheme will be in accordance with environmental legislation and good practice whereby appropriate spillage and pollution response procedures will be established.

Assessment of impacts and effects

8.5.3 The Ickenham auto-transformer feeder station and the National Grid feeder station will be located at the eastern end of the study area close to the site currently used by HOAC and an auto-transformer station located at West Hyde. An auto-transformer station can, in principle, be a source of contamination through accidental discharge or leaks of coolant. However, the proposed auto-transformer stations, in common with other modern substations, will use secondary containment appropriate to the level of risk.

8.5.4 The operation of the trains may give rise to minor contamination through leakage of hydraulic or lubricating oils. However, such leakage or spillage is expected to be very small and unlikely to result in significant contamination.

8.5.5 It is unlikely that there will be any cumulative effects on land quality receptors due to the environmental controls that will be placed on operational procedures.

Other mitigation measures

8.5.6 No other land quality mitigation measures beyond those already outlined are considered necessary in the Colne Valley area.

8.5.7 There will be on-going monitoring requirements, as appropriate following remediation works carried out during construction. Such monitoring, including monitoring of groundwater quality or ground gas, could extend into the operational phase of the Proposed Scheme.

Summary of likely significant residual effects

8.5.8 No significant residual effects are anticipated associated with the operation of the Proposed Scheme.

9 Landscape and visual assessment

9.1 Introduction

9.1.1 This section reports the assessment of the likely significant landscape and visual effects. It starts by summarising the baseline and future conditions found within and around the route of the Proposed Scheme and goes on to describe the significant effects that will arise during construction and operation on landscape character areas (LCA) and visual receptors.

9.1.2 In this section, the operational assessment refers not just to the running of the trains but also the presence of the new permanent infrastructure associated with the Proposed Scheme.

9.1.3 Principal landscape and visual issues in the area include:

- temporary effects to LCA and visual receptors during construction arising from the presence of construction plant, construction compounds, demolition, temporary overhead power lines and pylon diversions, removal of existing vegetation, temporary access routes, earthworks and stockpiles and severance of agricultural land; and
- permanent landscape and visual effects during operation arising from the presence of new engineered landforms within the existing landscape. These will include a viaduct, embankments, Proposed Scheme in cutting, tunnel portal, highway infrastructure, noise fence barriers, overhead power line diversions, auto-transformer feeder stations, auto-transformer stations, a sustainable placement area and regular passing of high speed trains. The majority of permanent effects will reduce over time as planting established as part of the Proposed Scheme matures. This is with the exception of the diverted overhead power line, Colne Valley viaduct and associated passing high speed trains which will remain prominent in certain locations.

9.1.4 A separate but related assessment of effects on the setting of heritage assets is included in Section 6 Cultural Heritage. Further details on the landscape and visual assessment, including engagement, baseline information and assessment findings, are presented, Volume 5: Appendix LV-001-007 which comprises the following:

- Part 1 Engagement with technical stakeholders;
- Part 2 Environmental baseline report;
- Part 3 Assessment matrices; and
- Part 4 Schedule of non-significant effects.

9.1.5 The extent of the landscape and visual study area, the distribution of visual receptor viewpoints and the location of verifiable photomontages has been discussed with Three Rivers District Council, South Bucks District Council, Chiltern District Council, Natural England and LBH. Summer field surveys, including photographic studies of LCA and visual assessment of viewpoints, were undertaken from June to August 2012

and from May to June 2013. Winter surveys were undertaken from December 2012 to February 2013.

9.2 Scope, assumption and limitations

9.2.1 The assessment scope, key assumptions and limitations for the landscape and visual assessment are set out in Volume 1, the SMR (Volume 5: Appendix CT-0001-000/1) and the SMR Addendum (Volume 5: Appendix CT-0001-000/2). This report follows the standard assessment methodology.

9.2.2 The study area has been informed by the construction and operational phase zones of theoretical visibility (ZTV), which are shown on Maps LV-07-024b to LV-07-027a and LV-08-024b to LV-08-027a (Volume 5, Landscape and Visual Assessment Map Book). The ZTV has been produced in line with the methodology described in the SMR Addendum (Volume 5: Appendix CT-001-000/2) and is an indication of the theoretical visibility of the Proposed Scheme. In some locations, extensive vegetation cover will mean the actual visibility is substantially less than that shown in the ZTV. Tall construction plant (e.g. cranes and piling rigs) are excluded from the ZTV for the construction phase and overhead line equipment is excluded from the ZTV for the operational phase, but these are described and taken in to account in the assessment of effects on landscape character areas and visual receptors.

9.2.3 LCA and visual receptors within approximately 500m of the Proposed Scheme have been assessed. Long distance views of up to 1.5km have been considered at locations such as Mount Pleasant, west of Harefield and the nearby PRoW.

Limitations

9.2.4 During the baseline survey there were some areas which were inaccessible (such as private land, commercial premises and residential buildings). In several areas PRoW were also inaccessible due access being restricted by the owner/occupier. In these instances, professional judgement has been used to approximate the likely views from these locations.

9.3 Environmental baseline

Existing baseline

Landscape baseline

9.3.1 The settlement pattern in the Colne Valley is relatively sparse, although the valley is more densely developed to the south. On the valley sides mixed farmland is a dominant feature within the landscape. The corridors of open space that follow the River Colne, Grand Union Canal and the lakes that these waterways support are dominant landscape features in the valley bottom. There is concentrated residential and industrial development around Uxbridge. The Chiltern Main Line spans the Colne Valley and has a distinctive influence upon settlements along its route; either forming a perimeter boundary to urban development or travelling directly through the settled area, forming a green corridor due to adjacent line-side vegetation. The M25 corridor is a major urban feature within the landscape to the west of the area. A number of conservation areas, registered parks and gardens and listed buildings are located within the area. The vegetation patterns within the area comprise woodland, scrub

and meadow within open space, trees and shrubs within river corridors, hedgerows including Old Shires Way ancient hedgerow and small woodlands.

9.3.2 The LCA have been determined with reference to the Buckinghamshire Landscape Character Assessment and Hertfordshire Landscape Character Assessment.

9.3.3 Descriptions of all LCA are provided, Volume 5: Appendix LV-001-007 Part 2. For the purposes of this assessment the study area has been sub-divided into ten discrete LCA, six of which are most likely to be affected. A summary of these LCA is provided below. The LCA are shown on Maps LV-02-024b to LV-02-027a (Volume 5, Landscape and Visual Assessment Map Book).

Harefield Farmland Valley Slopes LCA

9.3.4 Land use is predominantly agricultural, with regular shaped, small to medium sized fields of pasture and some pockets of arable farmland. There are some areas of woodland, including Newyears Green Covert and Copthall Covert and many of the fields are bordered by hedgerows and hedgerow trees. Buildings comprise a mix of isolated two storey detached farmhouses and associated working buildings, such as barns and sheds. The existing Chiltern Main Line overhead power lines and other infrastructure detract from the overall quality of the area. However, the presence of hedgerows and woodland blocks help to integrate some of these elements. Managed and maintained elements within the wider landscape include golf courses, Bayhurst and Ruislip Woods National Nature Reserves and Harefield Place registered park and garden. Overall the landscape is relatively well maintained resulting in a fair condition. Extensive open space and widespread tree cover provides a sense of seclusion. Given the presence of the Chiltern Main Line embankment in the east of the LCA, tranquillity is considered to be medium. This LCA is located within green belt and is of regional value. Therefore, this area has a high sensitivity to change.

Colne River Valley LCA

9.3.5 The River Colne and the Grand Union Canal pass through the valley and are bordered by dense vegetation. The LCA also includes a series of lakes formed from past mineral extraction that are now predominantly used for leisure pursuits. The waterways and lakes are typically enclosed by vegetation and woodland areas creating a sense of isolation. The settlement pattern within the northern Colne Valley is relatively sparse, although there is a ribbon of villages along the Grand Union Canal. To the south the valley is more densely populated, with towns such as Uxbridge. The Chiltern Main line runs from east to west through a vegetated corridor across the valley basin to the south of the area. Due to the enclosed nature, low level of vehicular access and sense of isolation, the tranquillity has been assessed as medium. The various lakes that are used for a series of leisure pursuits are maintained to a fair condition.. This LCA is located within green belt and contains a number of conservation areas, namely South Harefield (Widewater Lock Conservation Area) and Denham Country Park LNR (Denham Lock Conservation Area). These factors contribute to make this a regionally valued LCA. Therefore, this area has a high sensitivity to change.

Colne Valley LCA

9.3.6 The shallow Colne Valley forms Buckinghamshire's eastern boundary, Hertfordshire's south western boundary and London's western edge. The landscape is defined by small arable fields and woodland blocks as well as urban fringe. The River Colne, Grand Union Canal and several lakes are important components of local landscape character, forming the eastern edge of the LCA bordering the Colne River Valley LCA. Managed and maintained elements within the wider agricultural landscape include Denham Place registered park and garden, ancient woodland and the Buckinghamshire Golf Course. There are also remnants of mineral extraction sites. The Colne Valley LCA is overall assessed as being in fair condition.

9.3.7 The two main settlements within this LCA are Denham Green and Denham which take up a large proportion of the landscape. Woodland cover is found between the urban fringe of Denham Green and the Colne Valley water bodies, creating a sense of localised seclusion. The Buckingham Golf Course is located to the south of the Chiltern Main Line. Roads and railway lines fragment the landscape in places decreasing both audible and visual tranquillity. Due to these factors, the overall level of tranquillity is considered to be medium. The LCA is located within green belt and includes part of Denham Country Park LNR and Conservation Area. These factors contribute to make this a regionally valued landscape character. Therefore, this area has a high sensitivity to change.

Colne Valley Gravel Pits LCA

9.3.8 The area follows the floodplain of the River Colne from Rickmansworth in the north-east to West Hyde and Harefield in the south. Native hedgerows and trees are generally confined to local roads. Several tracks and PRoW span the floodplain along the edge of the lakes. There are isolated industrial buildings within the floodplain with isolated traditional brick farmsteads on the edge. Within the landscape there are recreational land uses for a wide range of activities and areas of pasture with grazing. The landscape is relatively well maintained and so the condition of the LCA is assessed as being fair.

9.3.9 The area is dominated by water bodies created from flooded mineral workings, with recreational uses for a wide range of recreational activities. Tree cover forms linear belts which line lakesides, canals and local roads and combine to create a sense of enclosure. It is a relatively peaceful area, on the edge of extensive urbanisation. Due to these factors, the overall level of tranquillity is considered to be medium.

9.3.10 This LCA is located within green belt and includes key elements such as Colne Valley Regional Park resulting in a regionally valued LCA. Therefore, this area is considered to have a high sensitivity to change.

9.3.11 This LCA is located within green belt and includes key elements such as Colne Valley Regional Park resulting in a regionally valued LCA. Therefore, this area has a high sensitivity to change.

Maple Cross Slopes South LCA

9.3.12 The area is located to the west of the Colne Valley floodplain and comprises predominantly well maintained, large open arable fields with minimal hedgerows.

There are woodland areas concentrated on the slopes of narrow dry valleys to the west with prominent urban development on the lower slopes and along the A412 Denham Way/North Orbital Road. The M25 is a dominant feature on the skyline to the west and this, together with the strong urban influences of transport infrastructure and built form, results in a landscape of fair condition and a low level of tranquillity. The LCA is within green belt and as a result is considered to be of regional value. Therefore, this area has a medium sensitivity to change.

Chalfont St Peter South LCA

9.3.13 The predominant land use to the south comprises distinct woodland groups, including some ancient woodland, a golf course and the Denham Aerodrome, all of which are situated on a plateau at the edge of the Colne Valley. The area is bordered to the south by the Chiltern Main Line railway embankment. In the north, the M25 traverses the landscape, intersecting a series of dry tributary valleys extending across from the Colne Valley. The M25 also forms the western boundary, close to the urban edge of Chalfont St Peter. The presence of the M25, as well as prominent overhead power line, reduces levels of both audible and visual tranquillity resulting in an overall medium level of tranquillity within the LCA. The varying agricultural landscape is relatively well maintained and is therefore of fair condition. There is also a good network of PRoW across the area. Chalfont St Peter South LCA is within green belt and is of regional value. Therefore, this area has a medium sensitivity to change.

Visual baseline

9.3.14 Descriptions of the identified representative viewpoints are provided, Volume 5: Appendix LV-001-007 Part 2. A summary description of the distribution and types of receptors most likely to be affected is provided below. The viewpoints are shown on Maps LV-03-024b to LV-03-027a and Maps LV-04-024b to LV-04-027a (Volume 2, CFA7 Map Book). The viewpoints are numbered to identify their locations which are shown on Map Series LV-07 and LV-08 (Volume 5, Landscape and Visual Assessment Map Books). In each case, the middle number (xxx.x.xxx) identifies the type of receptor that is present in this area – 2: Residential, 3: Recreational, 4: Transport.

9.3.15 No protected views have been identified within the study area.

9.3.16 Residential receptors have a high sensitivity to change and are located around Maple Cross and along the perimeter of the settlements of South Harefield and Harefield. Views are typically rural across the Colne Valley. Residential receptors around Maple Cross also have views of the M25.

9.3.17 Recreational receptors, also with a high sensitivity to change, are located on PRoW throughout the study area, including the Grand Union Canal PRoW as well as users of the Canal, Denham Waterski Club and HOAC. Views from the Grand Union Canal are generally channelled views along the canal corridor. Views from Denham Waterski Club and the HOAC are typically of large expanses of water enclosed by lakeside vegetation.

9.3.18 People travelling on main roads, particularly those using Harvil Road and Moorhall Road, have a low sensitivity to change. Views are characterised by glimpsed views

across open countryside to the west and dense vegetation to the east within the Colne Valley.

Future baseline

9.3.19 A summary of the committed developments which are assumed to be built and occupied prior to either the construction or operation of the Proposed Scheme is provided below, along with the consequential effect on the character of LCA and nature of views. Developments which will introduce new visual receptors which may be significantly affected are also described. These developments are shown on Maps CT-13-011 to CT-13-013a (Volume 5, Cross Topic Appendix 1 Map Book).

Construction (2017)

9.3.20 A planning application has been granted for mineral extraction, infilling with waste and restoration to agriculture at Denham Park Farm, Denham Green, Buckinghamshire. The quarry will be most prominent from Old Shire Lane PRoW and Tilehouse Lane and will appear in more distant views from Harefield. The development will have a local influence within the agricultural landscape adjacent to the M25. A temporary road to Denham park farm quarry site will also be a prominent raised feature within the rural landscape. During construction therefore, there will be the potential for a combined visual influence of the Proposed Scheme and the quarry site, although the scale of the Proposed Scheme construction will be considerably larger.

Operation (2026)

9.3.21 The application at Denham Park Farm is for mineral extraction with a licence to operate for twenty years. Active extraction will still be underway by 2026. Proposed planting along the A412 Denham Way/North Orbital Road and Tilehouse Lane will help filter views from the east. The existing Nockhill, Juniper and Halings Woods and the proposed woodland planting will screen views from the south towards the quarry site. There will be potential views of the quarry from Old Shire Lane PRoW and Tilehouse Lane overbridge.

9.4 Temporary effects arising during construction

9.4.1 As is commonplace with major infrastructure works, the scale of the construction activities means that works will be visible in many locations and will have the potential to give rise to significant temporary effects which cannot be mitigated practicably. Such effects are temporary and vary over the construction period depending on the intensity and scale of the works at the time. The assessment of landscape and visual effects has been based on the activities occurring during the peak construction phase, which is defined as the period during which the main civil engineering works will take place, including establishment of compounds, main earthworks and structure works. The effects associated with the peak construction phase in this area will generally be considered to be long term given the construction programme (see Section 2.3). Overall, civil engineering works in this area will be undertaken between the start of 2017 and the end of 2025. The Colne Valley viaduct main compound will be in place for

approximately five years and three months[79] and the Chiltern tunnel main compound will be in place for approximately five years and three months. Satellite compounds will be in place for between approximately two and four years. The civil engineering works at most individual sites along the route in this area will occur for a period of between approximately six months and four years, with the exception of the construction of the Colne Valley viaduct which will take approximately four and a half years for the three sections. Effects during other phases of works are likely to be lesser due to less construction equipment being required at the time and a reduced intensity of construction activity.

9.4.2 The construction works that have been taken into account in determining the effects on landscape and visual receptors include:

- machinery and works associated with the demolition of the residential property at Dew's Farm and its associated outbuildings, an outbuilding opposite Dew's Farm Cottages, buildings at HOAC and outbuildings associated with Weybeards Cottages;
- machinery associated with the sustainable placement area;
- works to divert the Newyears Green Bourne and the River Colne;
- the realignment of Harvil Road and construction of Tilehouse Lane overbridge;
- construction of the temporary and permanent access road to Denham Park Farm quarry site;
- construction activity associated with the Colne Valley south embankment and Colne Valley north embankment;
- construction of the Colne Valley viaduct;
- construction of the Ickenham auto-transformer feeder station, the West Hyde auto-transformer station and the National Grid feeder station and associated overhead power line diversions;
- excavation and construction of the Tilehouse Lane cutting;
- construction of the passive provision for the Heathrow spur;
- excavation and construction of the Chiltern tunnel south portal and associated acoustic mitigation;
- construction of the new M25 slip road junction and local Chalfont Lane diversion;
- removal of lakeside vegetation within the Colne Valley, woodland vegetation along the River Colne, the A412 Denham Way/North Orbital Road and a section of mature vegetation along the Old Shire Lane PRoW (Footpath DEN/2/1) to accommodate the construction of the Proposed Scheme; construction of landform around the Chiltern tunnel south portal to integrate

[79] Durations quoted relate to engineering compounds only and do not include rail compounds durations.

this and the porous portal hood into the surrounding landscape and to provide noise and visual attenuation; and

- presence of construction compounds within this area as identified in Section 2.

Avoidance and mitigation measures

9.4.3 Measures that have been incorporated into the draft CoCP to avoid or reduce landscape and visual effects during construction include the following (see Volume 5: Appendix CT-003-000):

- maximising the retention and protection of existing trees and vegetation where possible (draft CoCP Section 12.2);
- use of well-maintained hoardings and fencing (draft CoCP Section 5.6);
- designing lighting to avoid unnecessary intrusion onto adjacent buildings and other land uses (draft CoCP Section 5.4);
- replacement of any trees intended to be retained which may be accidentally felled or die as a consequence of construction works (draft CoCP Section 12.2);
- appropriate maintenance of planting and seeding works and implementation of management measures, to continue through the construction period as landscape works are completed (draft CoCP Section 12.4); and
- temporary bunds will be positioned to screen views to the route construction.

9.4.4 These measures have been taken account of in the assessment of the construction effects below.

Assessment of impacts and effects

9.4.5 Prominent changes to landscape character and viewpoints during construction will relate to the temporary presence of construction plant and the removal of existing landscape elements, such as trees, hedges and agricultural land. Changes will be most notable within and around the Colne Valley where the Colne Valley viaduct will be constructed. Extensive earthwork profiling adjacent to the M25 and Chiltern tunnel southern portal will result in a notable change in the landscape. The height of the construction plant and viaducts and the close proximity of construction activities coupled with the absence of intervening screening (apart from the site hoardings and temporary earthwork bunds) will result in significant visual effects during construction. The topography in certain locations and the retention of intervening hedgerows and trees will partially screen low level construction activity.

Landscape assessment

9.4.6 The following section describes the likely significant effects on LCA during construction. All LCA within the study area considered to experience a non-significant effect (minor adverse or negligible) are described, Volume 5 Appendix LV-001-007 Part 4.

Harefield Farmlands Valley Slopes LCA

9.4.7 The Colne Valley viaduct will be 3.4 km in length and approached by a 190m long section of embankment. These elements will introduce large scale construction activity and substantially alter the character area, within an otherwise relatively secluded environment. The proposed Colne Valley viaduct and south embankment satellite compound, Ickenham auto-transformer feeder station satellite compound, roadhead and associated plant will be located on the southern side of this embankment and will introduce prominent elements that will impact the setting of the area. Three of the buildings of HOAC which will lie directly beneath the viaduct, will be demolished. The access road from Harvil Road to Dew's Farm will be used as a construction access road introducing higher frequencies of traffic. Dew's Farm and associated outbuildings will also be demolished. The removal of the existing overhead power line, pylons and the erection of new diversion route will result in the removal of areas of vegetation. The Colne Valley will be improved by a large section of overhead power line and pylons being removed. To the east of Harvil Road across to Breakspear Road South within CFA6, a large area of land will be used for segment casting and a sustainable placement area. This will introduce prominent elements into the urban fringe. To the south of South Harefield, a substantial area will be used by National Grid as the construction compound for the overhead power line diversion and feeder station.

9.4.8 To the northern side of the Chiltern Main Line embankment sections of hedgerows and woodland block will be removed to accommodate the Proposed Scheme, weakening the enclosed character of the immediate area. The large scale of construction and associated plant and frequency of construction traffic will reduce the tranquillity within this area.

9.4.9 Taking the above into account, the introduction of new elements will markedly alter the tranquillity of the LCA. There will be the addition of new features and components that substantially alter the character and setting. Therefore the magnitude of change is considered to be high.

9.4.10 The high magnitude of change, assessed alongside the high sensitivity of the character area, will result in a major adverse effect.

Colne River Valley LCA

9.4.11 During construction of the Colne Valley viaduct, lakeside vegetation will be removed opening up the land between individual water bodies. In addition a jetty will be positioned within the lakes to enable the piers of the viaduct to be constructed. This construction activity will be at odds with existing land use and adversely affect the character of the valley. The construction of the viaduct spanning the Colne Valley will reduce tranquillity. The two Colne Valley viaduct jetty storage satellite compounds on Moorhall Road will be present within this area and accessed from it. The Colne Valley viaduct and south embankment satellite compound will be accessed from Harvil Road. This will lead to an increase in construction traffic and plant activity within these areas. The overhead power line and pylons that currently traverse the Colne Valley will be temporarily diverted to the west of the existing alignment during construction. Overall, construction activity will introduce large scale construction elements within

the landscape, markedly altering the tranquillity of the area and will result in a high magnitude of change.

9.4.12 The high magnitude of change, assessed alongside the high sensitivity of the character area, will result in a major adverse effect.

Colne Valley LCA

9.4.13 A short section of the viaduct and a 290m long embankment will be constructed in the north of the LCA where the Colne Valley viaduct laydown satellite compound, the Colne Valley viaduct north launch satellite compound and associated plant will all be located. This will result in large areas of vegetation and agricultural fields being lost and the introduction of construction activity. An access route will be formed from the A412 Denham Way/North Orbital Road to the Colne Valley viaduct north launch satellite compound. Vegetation removal will be required alongside waterways within the Colne Valley to accommodate the Colne Valley viaduct and Colne Valley north embankment. There will be the addition of prominent features such as the viaduct within the setting. The River Colne diversion will involve the removal of an area of vegetation and the introduction of construction activity. These activities will alter the tranquillity of the character area.

9.4.14 As this construction activity will be confined to the northern edge of the LCA and will be largely screened by existing surrounding woodland, the overall magnitude of change is assessed as medium.

9.4.15 The medium magnitude of change, assessed alongside the high sensitivity of the character area, will result in a moderate adverse effect.

Colne Valley Gravel Pits LCA

9.4.16 This LCA setting will not be directly affected by the construction of the Proposed Scheme, with activities taking place within the adjoining Maple Cross, Colne River Valley and Colne Valley LCA. The addition of new features that will impact landscape character will include extensive earthworks in Maple Cross Slopes South LCA, the construction of the viaduct and removal of lakeside vegetation within Colne River Valley LCA and the removal of vegetation, earthworks and construction of the Heathrow spur within the Colne Valley LCA. Aspects of these construction works will be perceptible in neighbouring LCA from within the Colne Valley Gravel Pits LCA.

9.4.17 Construction activity in adjacent LCA will noticeably affect the existing tranquillity of this LCA. Taking this into account, the magnitude of change is considered to be medium.

9.4.18 The medium magnitude of change, assessed alongside the high sensitivity of the character area, will result in a moderate adverse effect.

Maple Cross Slopes South LCA

9.4.19 Construction activities within the southern part of this LCA will include the Colne Valley viaduct north embankment satellite compound and construction of the Tilehouse Lane overbridge and the temporary access road to Denham Park Farm quarry site. The Colne Valley viaduct north embankment satellite compound and associated plant will be a prominent feature to the north, close to the M25. The

compound will be accessed from the A412 Denham Way/North Orbital Road. The Colne Valley viaduct main compound will also be located in the LCA, with access from Chalfont Lane and via the temporary M25 slip roads for HGV traffic. The Chiltern tunnel main compound will also be accessed from Chalfont Lane. Lighting will be used throughout the night at these construction compounds, contributing to a reduction in the tranquillity of the LCA. Temporary overnight workers accommodation will be located within the Colne Valley viaduct main compound.

9.4.20 Removal of sections of hedgerow will result in a change to the character of the landscape as field boundaries will become more open, although the majority of Old Shire Lane mature hedgerows will be retained. The construction of the access track to Denham Park Farm quarry will reduce impacts to the mature Old Shire Lane hedgerow as far as practicable.

9.4.21 The Denham Park Farm quarry will have a cumulative effect on the LCA during construction.

9.4.22 The topography of agricultural fields will be substantially altered with the introduction of material associated with the tunnel excavation. Earthworks profiling will be prominent with material graded between 3m and 5m high.

9.4.23 Construction will cover a large part of the LCA reducing both visual and audible tranquillity. The addition of these construction elements will substantially alter landscape character through the introduction of elements that will markedly alter the tranquillity of Maple Cross Slopes South LCA. Therefore the magnitude of change is considered to be high.

9.4.24 The high magnitude of change, assessed alongside the medium sensitivity of the character area, will result in a major adverse effect.

Chalfont St Peter South LCA

9.4.25 Direct impacts upon the LCA will be confined to the distribution of excavated material adjacent to the M25. Elements of construction will be audible and visible from the northern edge of the LCA, introducing unfamiliar elements at odds with existing landscape character and decreasing levels of tranquillity.

9.4.26 Construction works within the LCA and the adjoining Maple Cross Slopes South LCA will be audible. Whilst woodland blocks in the south of the LCA will isolate much of the construction activity to the north, there will still be a notable reduction in tranquillity as a result of the works. The future development at Denham Park Farm quarry site and the associated temporary access road will further reduce tranquillity in the vicinity of the works. The Proposed Scheme will be set within the context of these mineral workings.

9.4.27 Given the presence of general construction activity, cranes and significant earth moving activities relating to the earthworks this will result in the introduction of elements which substantially alter the character of the setting. Therefore the magnitude of change is considered to be high.

9.4.28 The high magnitude of change, assessed alongside the medium sensitivity of the character area, will result in a major adverse effect.

Visual assessment

9.4.29 The following section describes the likely significant effects on visual receptors during construction. The construction assessment has been undertaken during winter, in line with best practice guidance, to ensure a robust assessment. However, in some cases, visibility of construction activities may be reduced during summer when vegetation, if present in a view, will be in leaf. Where residential receptors experience significant effects at night time arising from additional lighting, these are also presented in this section. Representative viewpoints within the study area considered to experience a non-significant effect (minor adverse or negligible) are described, Volume 5: Appendix LV-001-007 Part 4.

9.4.30 The number identifies the viewpoint locations which are shown on Maps LV-03-024b to LV-03-027a (Volume 2, CFA7 Map Book). In each case, the middle number (049.4.001) identifies the type of receptor that is present in this area – 2: Residential, 3: Recreational, 4: Transport, 6: Employment and 7: Active Sports.

9.4.31 Where a viewpoint may represent multiple types of receptor, the assessment is based on the most sensitive receptors. Effects on other receptor types with a lower sensitivity may be lower than those reported.

Viewpoint 049.2.002: View north from Harvil Road, Ickenham

9.4.32 There will be open and direct views of the topsoil storage area, offices and welfare, segment fabrication, sustainable placement areas and the treatment plant for excavated material in the foreground and middle ground of the view and over the Northolt tunnel and earthworks main compound located in the arable fields between Harvil Road and Breakspear Road South (approximately 770m from the viewpoint) within the adjacent CFA6. Oblique views of the removal of the existing vegetation within Newyears Green Covert on the skyline may be possible, together with the cranes and other plant associated with the construction of the cutting and track maintenance sidings to the east of Harvil Road and diversion of the overhead power lines. However, these will be filtered by intervening field boundary vegetation. The residential properties south of Harvil Farm to the Swakeleys Road junction will have oblique and partially filtered views of the southern extent of the construction compound area and sustainable placement areas. Construction activity will be screened from Harvil Farm by a temporary bund. There will be a substantial change partially filtered by intervening vegetation. Overall, there will be a medium magnitude of change.

9.4.33 The medium magnitude of change, assessed alongside the high sensitivity of the receptor, will result in a major adverse effect.

9.4.34 At night, lighting will be limited to an area to the south of the existing railway corridor and viewed within a predominantly dark landscape but filtered by Copthall Covert. Therefore, the magnitude of change to this receptor at night is considered to be medium, resulting in a moderate adverse effect.

Viewpoint 049.6.003: View west from Railway bridge on Harvil Road, representative of Uxbridge Skip Hire.

9.4.35 Views will be focussed on the construction of the Colne Valley viaduct (approximately 200m from the viewpoint) as it traverses the view, reducing in height to come to grade. Views may be afforded of the Colne Valley viaduct and south embankment satellite compound looking north-west over the Chiltern Main Line and the remaining area of Newyears Green Covert. Intervening vegetation will screen views at lower levels, however tall construction plant such as cranes will be visible. Due to the introduction of new construction elements that will be highly visible in close proximity from this viewpoint, the magnitude of change is therefore considered to be high.

9.4.36 The high magnitude of change, assessed alongside the low sensitivity of the receptor, will result in moderate adverse effects.

Viewpoint 049.3.005: View west from PRoW (Footpath U50)

9.4.37 Vegetation removal within the Uxbridge Golf Course will open up views of the diversion of overhead power line in the middle ground (approximately 500m from the viewpoint). In the northern extent of the view, cranes will be visible across the Chiltern Main Line in the background. There will be the addition of new features that are continuously visible and incongruous with the existing view. Therefore the magnitude of change is therefore considered to be high.

9.4.38 The high magnitude of change, assessed alongside the high sensitivity of the receptor, will result in major adverse effects.

Viewpoint 051.3.002: View north along the Grand Union Canal PRoW (Footpath U72) and the Colne Valley Trail PRoW (Footpath U75)

9.4.39 There will be views of the vegetation clearance in the middle ground either side of the canal to enable the construction of the proposed viaduct (approximately 250m from the viewpoint) that will open up views to the lakes either side of the canal. Associated construction plant in particular cranes will be prominent in the view. The corridor of vegetation will focus the view towards the construction activity in this location. The addition of the viaduct construction activity will be continuously highly visible. Therefore the magnitude of change is considered to be high.

9.4.40 The high magnitude of change, assessed alongside the high sensitivity of the receptor, will result in major adverse effects.

Viewpoint 051.4.003: View north from the Chiltern Main Line

9.4.41 There will be views of the construction of the proposed viaduct (approximately 600m from the viewpoint) and associated plant in the middle ground including the Colne Valley viaduct and south embankment satellite compound, bounded by hoarding and associated haul road. Open areas left by the removal of existing vegetation will also be visible from this elevated location. In addition, the demolition of Dew's Farm, the HOAC buildings and the removal of elements of the overhead power line will also be visible in the middle ground and beyond. Therefore, due to the addition of new features that will be continuously highly visible and out of keeping with the existing view, the magnitude of change is considered to be high.

9.4.42 The high magnitude of change, assessed alongside the medium sensitivity of the receptor, will result in a moderate adverse effect.

Viewpoint 052.4.001: View south from Harvil Road

9.4.43 There will be foreground views of the construction of the Colne Valley viaduct and its southern approach embankment (approximately 20m from the viewpoint) and associated satellite compound. Hoarding 2.4m in height (and possibly as high as 3.6m depending on acoustic requirements) will also be visible as it encloses the compound site. The excavation of a balancing pond and the demolition of three buildings within HOAC will be visible to the west. There will be filtered views of the Ickenham auto-transformer feeder station and roadhead in the background. There will also be views of overhead power line construction in the middle distance to the south-west and north. There will be substantial changes in close proximity to the visual receptor. The magnitude of change is therefore considered to be high.

9.4.44 The high magnitude of change, assessed alongside the medium sensitivity of the receptor, will result in a moderate adverse effect.

Viewpoint 052.3.002: View south from the northern edge of Harefield No.2 Lake from PRoW (Footpath U34)

9.4.45 There will be short to middle distance filtered or open views through lakeside vegetation towards the construction of the viaduct (approximately 200m from the viewpoint). Within the view, there will be a temporary jetty positioned across the water, piers constructed and the spans being launched into position or constructed in-situ. There will be filtered views of the proposed National Grid feeder station during construction in the middle ground. The addition of the viaduct and associated construction activity will be incongruous with the existing view. Taking all of the above construction activity into account, the magnitude of change is considered to be high.

9.4.46 The high magnitude of change, assessed alongside the high sensitivity of the receptor, will result in major adverse effects.

Viewpoint 052.2.004: View south-west from Harvil Road, Ickenham

9.4.47 Construction activity associated with the National Grid feeder station (approximately 250m from the viewpoint) and the removal of electricity pylon NG ZC046 associated with the overhead power line diversion will be visible in the middle ground. There will also be background filtered views of the viaduct construction activity, associated plant and Colne Valley viaduct satellite compound and haul route. The addition of new features will be continuously highly visible and incongruous with the existing valley view. Therefore the magnitude of change is therefore considered to be high.

9.4.48 The high magnitude of change, assessed alongside the high sensitivity of the receptor, will result in major adverse effects.

Viewpoints 053.4.002: View north-east from Moorhall Road, Denham Green and 054.4.001: View south-west from Moorhall Road

9.4.49 There will be views of the proposed viaduct construction and associated plant in the middle ground (approximately 150m from the viewpoint). The Colne Valley viaduct

jetty storage satellite compound, Colne Valley viaduct storage satellite compound and their accesses from Moorhall Road will also be visible. Areas of vegetation removal will also be visible either side of the road, along the route of the Proposed Scheme. Due to the existing roadside vegetation channelling the view along the road corridor, the magnitude of change is considered to be high.

9.4.50 The high magnitude of change, assessed alongside the medium sensitivity of the receptor, will result in a moderate adverse effect.

Viewpoint 054.3.003: View south from Colne Valley Trail PRoW (Footpath U75) along the Grand Union Canal

9.4.51 There will be narrow views of the viaduct (approximately 50m from the viewpoint) under construction in the middle ground. Cranes will be the most noticeable element along the Grand Union Canal corridor, visible above the tops of trees alongside PRoW U75. The temporary diversion of the Grand Union Canal tow path will also be evident. Taking the above into account, the magnitude of change is considered to be high.

9.4.52 The high magnitude of change, assessed alongside the high sensitivity of the receptor, will result in major adverse effects.

Viewpoint 054.2.004: View south from Hillside Road, South Harefield

9.4.53 There will be views to the south of the construction of the Colne Valley viaduct and associated works in the middle ground, including tall cranes and the removal of lakeside vegetation. There will be distant views over rising ground towards the National Grid feeder station (approximately 400m from the viewpoint) and overhead power line construction activity. The addition of new features will be highly visible and are incongruous with the existing view. Also taking into account the expansive view and extent of construction activities which will be visible, the magnitude of change is considered to be high.

9.4.54 The high magnitude of change, assessed alongside the high sensitivity of the receptor, will result in major adverse effects.

Viewpoint 054.2.005: View east from Harvil Road, South Harefield

9.4.55 There will be foreground filtered views through garden vegetation across Harvil Road towards agricultural fields where construction activity associated with the sustainable placement area (approximately 50m from the viewpoint) will be visible over the tops of hedgerows in the background of the view. As the excavated material is deposited during the construction process, the landform will rise resulting in increased plant visibility above the hedgelines. The view will be filtered, however taking into account the extensive scale of the construction activity, the magnitude of change is considered to be medium.

9.4.56 The medium magnitude of change, assessed alongside the high sensitivity of the receptor, will result in moderate adverse effects.

Viewpoint 054.3.006: View north east from PRoW (Footpath U31) near South Harefield

9.4.57 There will be foreground open views of construction activity at the sustainable placement area (approximately 170m from the viewpoint). Hedgerows within the foreground and middle ground of the view will be removed. The middle ground view will be altered by changes in topography, as land gradually rises and the background of the view becomes obscured as construction works progress. As the landform increases in height construction plant will form a moving feature on the skyline. Taking into account the expansive view and extent of construction activities which will be visible, the magnitude of change is considered to be high.

9.4.58 The high magnitude of change, assessed alongside the medium sensitivity of the receptor, will result in major adverse effects.

Viewpoint 054.3.007: View north west from PRoW (Footpath U31) near South Harefield

9.4.59 There will be foreground (approximately 20m from the viewpoint) and middle ground open views of construction plant and the re-profiling of the sustainable placement area. The raising of landform in the middle ground will obscure the view beyond, screening woodland in the background. As the land rises further, construction plant will form a moving feature on the skyline. Considering the expansive view and extent of construction activities which will be visible, the magnitude of change is considered to be high.

9.4.60 The high magnitude of change, assessed alongside the medium sensitivity of the receptor, will result in major adverse effects and therefore significant.

Viewpoint 055.6.003: View east from Denham Media Park

9.4.61 Views of construction will be heavily filtered by intervening buildings and individual tree planting within the grounds of the Media Park. An area of established vegetation between the vegetated boundary of the Media Park and the Colne Valley lakes will be removed. There will be filtered views towards the Colne Valley viaduct and associated construction activity (approximately 200m from the viewpoint). There will be filtered views of the construction of the Colne Valley viaduct and associated cranes in the background, particularly from upper storey windows above the tree line. The magnitude of change is therefore considered to be high.

9.4.62 The high magnitude of change, assessed alongside the low sensitivity of the receptor, will result in moderate adverse effects.

Viewpoint 056.2.002: View south from St Mary's Road, South Harefield

9.4.63 Construction activity will be visible (approximately 900m from the viewpoint) to the south from this elevated location. Filtered views will be afforded through foreground garden vegetation, across the Colne Valley towards the construction of the viaduct (approximately 850m from the view point) and associated high cranes in the background view. The addition of new features is incongruous with the existing view and will result in a medium magnitude of change.

9.4.64 The medium magnitude of change, assessed alongside the high sensitivity of the receptor, will result in moderate adverse effects.

Viewpoint 056.3.001: View south-west from Grand Union Canal, PRoW (Footpath U72)

9.4.65 There will be filtered views through lakeside vegetation and across the water towards construction works of the Colne Valley viaduct (approximately 1100m from the viewpoint) and embankment in the background. This view will also include areas of vegetation clearance, further opening up views across the lakes including views of viaduct construction activity in particular cranes However, the vegetated islands within the lake will partially interrupt views of the lower parts of the viaduct construction. Taking the above into account, the magnitude of change is considered to be medium.

9.4.66 The medium magnitude of change, assessed alongside the high sensitivity of the receptor, will result in moderate adverse effects.

Viewpoint 056.2.003: View south-west from Merle Avenue, South Harefield

9.4.67 There will be filtered views through intervening garden vegetation across the Colne Valley towards the viaduct and associated construction plant including tall cranes in the background of the view (approximately 1400m from the viewpoint). Views to the west will include the southern edge of the Chiltern tunnel main construction compound and Colne Valley viaduct main construction compound. Vegetation removed to enable construction will result in gaps which will be evident from this location. The addition of the viaduct construction activity will produce a substantial change partially filtered by intervening vegetation. Overall, the magnitude of change is considered to be medium.

9.4.68 The medium magnitude of change, assessed alongside the high sensitivity of the receptor, will result in moderate adverse effects.

Viewpoint 056.3.004: View north-west along A412 Denham Way/North Orbital Road near Denham Waterski Club

9.4.69 There will be open and filtered foreground views of vegetation clearance and construction activity associated with the Colne Valley viaduct (approximately 20m from the viewpoint). Vegetation removal will run parallel to the A412 Denham Way/North Orbital Road and will open up filtered views through to the Denham Waterski Club and associated lake. In the background, views will be available of construction activity associated with Colne Valley viaduct as it spans the A412 and the associated construction traffic. The close proximity and scale of the construction will result in high magnitude of change.

9.4.70 The high magnitude of change, assessed alongside the low sensitivity of the receptor, will result in moderate adverse effects.

Viewpoint 057.4.001: View east from Tilehouse Lane

9.4.71 The view looking east will include filtered and open foreground views of extensive earthworks profiling to accommodate excavated material across adjacent agricultural fields (approximately 5m from the viewpoint). In addition, foreground views will

include the construction of the Colne Valley viaduct north embankment which will be up to 10m high. In the middle ground of the view, the Colne Valley viaduct north launch satellite compound, Colne Valley viaduct north embankment satellite compound and associated plant will be visible. The substantial changes in close proximity to the visual receptor, within the direct view will result in a high magnitude of change.

9.4.72 The high magnitude of change, assessed alongside the medium sensitivity of the receptor, will result in a major adverse effect.

Viewpoint 057.3.002: View east from Old Shire Lane PRoW (Bridleway DEN/2)

9.4.73 There will be open views across agricultural fields towards construction works in the foreground (approximately 5m). The construction of the Colne Valley north embankment, the Chiltern tunnel main compound enclosed by hoarding will be evident from this location. Extensive areas of temporary and permanent earthworks will form the immediate view. There will also be views towards the construction of the footpath and the Tilehouse Lane overbridge (approximately 450m). Taking into account the open views of construction activities, the magnitude of change is considered to be high.

9.4.74 The high magnitude of change, assessed alongside the high sensitivity of the receptor, will result in major adverse effects.

Viewpoint 057.2.003: View north east from residential properties and Denham Grove (De Vere Hotel) off Tilehouse Lane

9.4.75 There will be filtered views through vegetation within the hotel grounds, over falling ground towards the construction of the viaduct in the background (approximately 350m from the viewpoint). The creation of a balancing pond may also be visible, as will the Colne Valley viaduct laydown satellite compound, north launch satellite compound and Colne Valley viaduct north approach embankment satellite compound enclosed by hoarding. Taking into account the extent of construction activities that will be visible in the background of the view only, the magnitude of change is considered to be medium.

9.4.76 The medium magnitude of change, assessed alongside the high sensitivity of the receptor, will result in moderate adverse effects.

Viewpoint 058.2.001: View south from Broadwater Sailing Club and associated residential properties

9.4.77 There will be filtered views through vegetation within the Colne Valley towards construction of the viaduct in the background (approximately 1200m from this viewpoint). The removal of lakeside vegetation will be visible, as will the tall cranes required for the works, above the tops of existing trees. There will be further views of construction activity associated with the viaduct where it decreases in height to return to grade on the opposite side of the Colne Valley. Taking into account the distance to the construction activity and the possible views of removed vegetation, the magnitude of change is considered to be medium.

9.4.78 The medium magnitude of change, assessed alongside the high sensitivity of the receptor, will result in moderate adverse effects.

Viewpoint 058.2.003: View south from residential properties on Park Lane

9.4.79 There will be filtered views through garden and field boundary vegetation towards the viaduct construction (approximately 1400m from the viewpoint) and associated plant including tall cranes. Vegetation removal required to accommodate the construction through the Colne Valley will be evident from this location. Panoramic views across to the opposite side of the Colne Valley will include extensive earthworks profiling and the excavation of a balancing pond to the east of the M25. Construction activity will also be set within the context of a proposed new mineral extraction site at Denham Park Farm. Taking into account the expansive view and extent of construction activities that will be visible, the magnitude of change is considered to be high.

9.4.80 The high magnitude of change, assessed alongside the high sensitivity of the receptor, will result in major adverse effects.

9.4.81 At night, continuous lighting of the Colne Valley viaduct main construction compound will be visible in the middle ground of the view, in a landscape, which at present, is predominantly dark with the exception of scattered individual properties and the M25 which is located in cutting and in the background of the view. Therefore the magnitude of change is considered to be medium.

9.4.82 The medium magnitude of change, assessed alongside the high sensitivity of the receptor, will result in moderate adverse effects.

Viewpoint 058.3.004: View south-west from public open space, Mount Pleasant

9.4.83 There will be filtered views through intervening field boundary vegetation towards construction of the viaduct. The removal of vegetation required to accommodate the Proposed Scheme will be visible in the middle ground of the view from this elevated location. Within the dense vegetation of the Colne Valley, plant machinery and tall cranes will be particularly noticeable. The construction works close to the M25 will also be visible across the valley in the background of the view (approximately 1300m from the viewpoint). The construction activity will be set within the context of a proposed new mineral extraction site at Denham Park Farm. The magnitude of change is therefore considered to be medium.

9.4.84 The medium magnitude of change, assessed alongside the medium sensitivity of the receptor, will result in moderate adverse effects.

Viewpoint 058.2.005: View south-west from The Old Orchard pub, Harefield

9.4.85 There will be filtered views over falling ground through intervening lakeside vegetation towards the viaduct construction and associated tall cranes (approximately 1150m from the viewpoint). The vegetation clearance required to accommodate construction through the Colne Valley will be visible from this location. There will also be more distant, panoramic views across the Colne Valley towards the extensive earthworks close to the M25. Taking into account the expansive view and extent of construction activities which will be visible, the magnitude of change is considered to

be high. The view of the Proposed Scheme from this location during construction is illustrated on the photomontage shown in Figure LV-01-184 (Volume 2, CFA7 Map Book).

9.4.86 The high magnitude of change, assessed alongside the high sensitivity of the receptor, will result in major adverse effects.

9.4.87 At night, continuous lighting of the Colne Valley viaduct main construction compound will be visible in the middle ground of the view, in a landscape which at present, is predominantly dark with the exception of the M25 and scattered individual properties on the opposite side of the valley. Therefore the magnitude of change is considered to be medium.

9.4.88 The medium magnitude of change, assessed alongside the high sensitivity of the receptor, will result in moderate adverse effects.

Viewpoint 058.2.006: View west from residential properties along Denham Way/North Orbital Road

9.4.89 Within the foreground there will be a 3m high material stockpile to the west side of the existing roadside vegetation (approximately 20m from the viewpoint). There will be filtered views through roadside vegetation in the middle ground over rising ground towards the M25 construction compound and in particular the permanent diversion of Tilehouse Lane overbridge. The construction activity will be set within the context of the proposed new mineral extraction sites at Denham Park Farm. This will be situated in the background of the view. Taking into account the close proximity of the view and the addition of an intervening temporary material stockpile, the magnitude of change is considered to be high.

9.4.90 The high magnitude of change, assessed alongside the high sensitivity of the receptor, will result in major adverse effects.

Viewpoint 059.3.002: View east and north from Old Shire Lane, Circular Walk and PRoW (Bridleway DEN/2)

9.4.91 Extensive temporary earthwork stockpiles will be seen in the immediate foreground of the view (approximately 5m from the viewpoint) with more permanent landscape earthwork profiling taking place beyond. There will be views across fields in the middle ground towards the construction of the northern approach embankment, Tilehouse Lane overbridge, Chiltern tunnel main construction compound and Colne Valley viaduct main construction compound with access from Chalfont Lane. The substantial changes in close proximity will result in high magnitude of change.

9.4.92 The high magnitude of change, assessed alongside the high sensitivity of the receptor, will result in major adverse effects.

Viewpoint 059.3.003: View north from Old Shire Lane, Circular Walk and PRoW (Bridleway DEN/2)

9.4.93 The view north across gently rising agricultural fields will include the portal construction compound and associated plant in the middle ground (approximately 5m from this viewpoint). There will also be views of extensive areas of temporary

earthwork stockpiles from the excavation of the tunnel in the foreground, stored to a height of 5m. More permanent earthwork profiling will also form the foreground of the view. The magnitude of change is therefore considered to be high.

9.4.94 The high magnitude of change, assessed alongside the high sensitivity of the receptor, will result in major adverse effects.

Viewpoint 060.2.001: View south from residential properties on Chalfont Lane

9.4.95 Views of the Chiltern tunnel main construction compound and the Colne Valley viaduct main construction compound enclosed by hoarding, plant traffic, construction access and car parking will be filtered through existing garden vegetation in the foreground (approximately 10m from the viewpoint). Temporary earthwork bunds will partially screen the works from this location during construction. Despite this screening, there will also be views of the Colne Valley viaduct north approach embankment and 1.4km long sections of cutting under construction. The majority of the middle ground will be altered through the earthwork re-profiling across the extensive site. Views of the Tilehouse Lane bridge construction will be set in the background. Taking the above into account, the magnitude of change is considered to be high.

9.4.96 The high magnitude of change, assessed alongside the high sensitivity of the receptor, will result in major adverse effects.

9.4.97 At night there will be foreground construction lighting from the M25 main construction compound and the Chiltern tunnel main construction compound. The lighting will be set within an otherwise predominantly dark landscape. The magnitude of change is therefore considered to be high.

9.4.98 The high magnitude of change, assessed alongside the high sensitivity of the receptor, will result in major adverse effects.

Viewpoint 060.3.002: View west from PRoW (Bridleway BR004), near the A412 Denham Way/North Orbital Road

9.4.99 There will be open views across agricultural fields over rising ground in the middle distance towards the Colne Valley viaduct north embankment satellite compound (approximately 350m from the viewpoint) and redistributed excavated material. Large, temporary balancing ponds will be constructed in the foreground, with views towards the construction of the diverted PRoW and Tilehouse Lane overbridge in the middle ground. If the mineral extraction application is successful, the construction of the Proposed Scheme will be set within the context of the proposed new mineral extraction sites at Denham Park Farm in the background of the view. The magnitude of change is therefore considered to be high.

9.4.100 The high magnitude of change, assessed alongside the medium sensitivity of the receptor, will result in major adverse effects and therefore significant.

Viewpoint 060.2.003: View south-west from residential properties on Old Uxbridge Road

9.4.101 The majority of the filtered middle ground view will be altered through the placement of excavated material across an extensive area. There will also be filtered views towards the Colne Valley viaduct main construction compound enclosed by hoarding from this location (approximately 200m from the viewpoint). Views will include the PRoW and Tilehouse Lane overbridge construction and associated large cranes required to place the structures into position in the background. The construction of the Proposed Scheme will be set within the context of the proposed new mineral extraction sites at Denham Park Farm in the background of the view. There will also be filtered views of the northern approach embankment and cutting under construction. Therefore, the magnitude of change is considered to be high.

9.4.102 The high magnitude of change, assessed alongside the high sensitivity of the receptor, will result in a major adverse effect.

9.4.103 Night time views will be adversely affected by lighting within the site compounds, set within the context of intervening street lighting in the foreground on Denham Way. Other than the lighting from Denham Way, the rural landscape appears dark. The magnitude of change is therefore medium.

9.4.104 The medium magnitude of change, assessed alongside the high sensitivity of the receptor, will result in a moderate adverse effect.

Viewpoint 062.2.001: View south-west from properties along Hornhill Road and PRoW (Footpath FP005) at western edge of Maple Cross

9.4.105 There will be open middle ground views of the construction of the temporary exit slip road from the M25 (approximately 300m from the viewpoint). The majority of the middle ground and background of the view will be altered through the re-profiling of excavated material across the extensive site. The construction compounds and associated plant and traffic will also be visible from this location (approximately 650 from the viewpoint). Therefore, the magnitude of change is considered to be high.

9.4.106 The high magnitude of change, assessed alongside the high sensitivity of the receptor, will result in a major adverse effect.

9.4.107 At night there will be middle ground construction lighting from the Colne Valley viaduct main construction compound and the Chiltern tunnel main construction compound. The lighting will be set within an otherwise predominantly dark landscape, with the exception of light spill from the M25 in the west of the view. The magnitude of change is therefore considered to be medium.

9.4.108 The medium magnitude of change, assessed alongside the high sensitivity of the receptor, will result in a moderate adverse effect.

Cumulative effects

9.4.109 Section 2.1 and Appendix CT-004-000 identify developments with planning permission or sites allocated in adopted development plans, on or close to the Proposed Scheme. These are termed 'committed developments' and will form part of

the baseline for the construction of the Proposed Scheme. The consequential cumulative effect of these developments on LCA and viewpoints is described below.

9.4.110 Due to the combined presence of construction activity and plant of the Proposed Scheme and consented Denham Park Farm quarry, effects on the following receptors, which are significant when considering the construction of the Proposed Scheme on its own, will be exacerbated:

- Maple Cross Slopes South LCA;
- viewpoints located along Old Shire Lane PRoW; and
- viewpoints on Tile House Lane.

9.4.111 In this area there are no known instances where receptors that will not be significantly affected by the construction of the Proposed Scheme on its own, will be significantly adversely affected by the combined presence of construction activity and plant from the surrounding developments.

Other mitigation measures

9.4.112 To further reduce the significant effects described above, consideration of where planting can be established early in the construction programme will be given during the detail design stage. This may include consideration of early planting in ecological mitigation sites which would have the additional benefit of providing some visual screening. However, not all landscape and visual effects can be practicably mitigated due to the visibility of construction activity and the sensitivity of surrounding receptors. Therefore, no other mitigation measures are considered practicable during construction.

Summary of likely residual significant effects

9.4.113 The temporary residual significant effects during construction remain as described above. These effects will be temporary and reversible in nature lasting only for the duration of the construction works. Any residual effects will generally arise from the widespread presence of construction activity and construction plant within the landscape and viewed from surrounding residential receptors, and users of PRoW and main roads within the study area.

9.5 Permanent effects arising during operation

9.5.1 The specific elements of the Proposed Scheme that have been taken into account in determining the effects on landscape and visual receptors includes:

- Harvil Road realignment and public bridleway bridges;
- Colne Valley viaduct;
- Ickenham auto-transformer feeder station and West Hyde auto-transformer station;
- the National Grid feeder station;
- Tilehouse Lane cutting;

- passive provision for the Heathrow spur and retaining wall, 400m long northbound and 200m southbound;
- Tilehouse Lane overbridge;
- West Hyde embankment;
- Chiltern tunnel south cutting and Chiltern tunnel south portal including a porous portal structure;
- fencing and lighting; and
- permanent access roads to Denham Park Farm quarry site.

Avoidance and mitigation measures

9.5.2 The operational assessment of impacts and effects is based on year 1 (2026), year 15 (2041) and year 60 (2086) of the Proposed Scheme. A process of iterative design and assessment has been employed to avoid or reduce adverse effects during the operation of the Proposed Scheme. Measures that have been incorporated into the design of the Proposed Scheme include:

- embankment and cuttings, both for the route and highway realignments, have been shaped so as to integrate the Proposed Scheme into the character of the surrounding landscape. Planting will reflect tree and shrub species native to the UK and characteristic of the local LCA;
- balancing ponds will be integrated into the landscape to alleviate flooding and also provide opportunities for biodiversity; and
- planting, including native broad-leaved woodland, shrub and hedgerows, will be implemented along various sections of the route to screen the Proposed Scheme from neighbouring residential properties and users of adjacent PRoW and to aid integration of the Proposed Scheme into the landscape. The selection of species will take into account possible climate change impacts associated with the quality and availability of water and the potential increase in pests and diseases.

9.5.3 These measures have been taken account of in the assessment of the operational effects below.

Assessment of impacts and effects

9.5.4 The likely significant effects on the LCA and viewpoints in operation will arise from new engineered landforms and structures cutting across the existing landscape including a new viaduct with associated infrastructure. There will also be permanent land severance, the introduction of noise fence barriers, of highway infrastructure into the semi-rural environment including road bridges, of overhead power lines and the introduction of regular high speed trains. At a number of locations, views of the Proposed Scheme will be filtered or screened by rising landform, retention of intervening hedgerows and trees and the route of the Proposed Scheme within a cutting. Furthermore, effects will reduce over time as planting established as part of the Proposed Scheme matures, notably at the landward ends of the Colne Valley

viaduct. In the vicinity of the viaduct, given its scale, the planting will not always be sufficient to provide screening, even in the long term.

Landscape assessment

9.5.5 This section describes the significant effects on LCA during year 1, year 15 and year 60 of operation. Non-significant effects on LCA are presented, Volume 5 Appendix LV-001-007 Part 4.

9.5.6 The assessment of effects by year 15 assume proposed planting has grown by approximately 450mm a year (i.e. trees will be 7-7.5m high). The assessment of effects by year 60 assumes all planting has reached its fully mature height.

Harefield Farmland Valley Slopes LCA

9.5.7 The Proposed Scheme will enter the Colne Valley on embankment, from the eastern boundary of the LCA. The introduction of the Colne Valley viaduct and associated overhead line equipment and trains will introduce elements that will noticeably alter the tranquillity although this is considered within the context of the current Chiltern Main Line which traverses this LCA. Harvil Road will be realigned and the Ickenham auto-transformer feeder station will be located adjacent to the road. There will also be a National Grid feeder station and an associated overhead power line which will be realigned further to the east. These large scale features will introduce prominent built elements into the landscape altering the character of the landscape. The overhead power line diversion will be partly in this area but also within CFA6 and will be subject to further design development in conjunction with National Grid. Mitigation planting adjacent to the Proposed Scheme in particular the Ickenham auto-transformer feeder station and National Grid feeder station, will not have matured sufficiently to integrate the Proposed Scheme into the surrounding landscape by year 1.

9.5.8 Tranquillity will be affected by the trains travelling frequently along the Proposed Scheme, although they will be set in the context of the existing Chiltern Main Line. Overall, the magnitude of change is therefore considered to be medium.

9.5.9 The medium magnitude of change, assessed alongside the high sensitivity of the LCA will result in a major adverse effect by year 1of operation.

9.5.10 By year 15 the proposed planting will have started to integrate and screen the National Grid feeder station. The overhead power line diversion will still be a prominent element within the landscape and the Colne Valley viaduct will still perceptible to the west of the LCA. This will result in a medium magnitude of change.

9.5.11 The medium magnitude of change, assessed alongside the high sensitivity of the LCA will result in a moderate adverse effect.

9.5.12 By year 60 of operation, the maturity of planting will help to integrate the Proposed Scheme into the landscape resulting in effects becoming non-significant. This is reported, Volume 5: Appendix LV-001-007 Part 4.

Colne River Valley LCA

9.5.13 The proposed 3.4km long viaduct will pass through the River Colne Valley LCA spanning the various water bodies along the valley floor. The viaduct will be

approximately 11-15m in height and with a noise fence barrier up to 3m high. The viaduct will also be noticeable as it spans the Grand Union Canal, including the tow path and Moorhall Road.

9.5.14 To accommodate the viaduct, the existing overhead power line will be removed and redirected within the Colne Valley and south of the Chiltern Main Line. This will improve a sense of isolation in those areas where it has been removed but reduce the sense of isolation where it has been introduced.

9.5.15 Planting to replace vegetation removed during construction along the lakeside and the River Colne will not have re-established in 2026 when operation commences.

9.5.16 Tranquillity will be most noticeably impacted by the trains travelling across the viaduct in this semi-rural and densely vegetated landscape. The existing lakeside vegetation will lessen the presence of the viaduct within the valley but ultimately the scheme will reduce the sense of isolation and tranquillity in the valley.

9.5.17 The introduction of the proposed viaduct and associated trains will introduce a large scale and dominant built feature to this previously isolated landscape and will be out of character with the surrounding LCA therefore resulting in a high magnitude of change.

9.5.18 The high magnitude of change, assessed alongside the high sensitivity of the LCA will result in a major adverse effect.

9.5.19 By year 15 and beyond to year 60, the large scale viaduct and associated trains will still be prominent, however replaced vegetation will have re-established and reformed the connectivity of the lakeside vegetation. Therefore, the magnitude of change is considered to be medium.

9.5.20 The medium magnitude of change, assessed alongside the high sensitivity of the LCA, will result in a moderate adverse effect by year 15 and year 60 of operation.

Colne Valley LCA

9.5.21 During operation the northern part of the LCA will be directly impacted by the presence of the Colne Valley north embankment and the passive provision for the Phase 2 Heathrow spur, together with the loss of areas of woodland. This will introduce uncharacteristic elements within the LCA. The proposed 3.4 km long viaduct will pass through Colne Valley LCA spanning the various water bodies within the floor of the valley. The viaduct will be approximately 11 to 15m in height, will span the water on piers located approximately every 40m and with noise fence barriers up to 3m in height. The scale of such a structure traversing the Colne Valley and the adjacent River Colne Valley LCA will adversely impact the landscape character within Colne Valley LCA. The reinstated vegetation will not have re-established by 2026 when operation commences.

9.5.22 Tranquillity will be affected by the trains travelling across the viaduct, in an otherwise quiet and enclosed landscape. The viaduct and associated trains will introduce large scale infrastructure into the adjacent LCA and the northern edge of this LCA. Therefore, the magnitude of change is considered to be medium.

9.5.23 The medium magnitude of change, assessed alongside the high sensitivity of the LCA, will result in a moderate adverse effect.

9.5.24 By year 15 and beyond to year 60 of operation, reinstatement planting will have matured helping integrate the Proposed Scheme into the landscape resulting in effects becoming non-significant. This is reported, Volume 5: Appendix LV-001-007 Part 4.

Maple Cross Slopes South LCA

9.5.25 Tilehouse Lane overbridge and the Tilehouse Lane cutting will be prominent within the landscape. The distributed excavated material will be re-profiled to reflect the gentle undulating landform which is largely characteristic of the existing setting. Due to the characteristic open views available across the valley, elements of the Chiltern tunnel south portal will be perceptible within the landscape.

9.5.26 Tranquillity will be most noticeably affected by the trains travelling in and out of the portal although this will be set in the context of considerable existing traffic noise and activity from the M25 road corridor.

9.5.27 During year 1 when operations commence the proposed mitigation planting will not have had time to establish. The additional new features will form prominent elements within the landscape. The introduction of the Proposed Scheme will noticeably alter the tranquillity of the character area. Therefore the magnitude of change is considered to be medium.

9.5.28 The medium magnitude of change, assessed alongside the medium sensitivity of the LCA, will result in a moderate adverse effect.

9.5.29 By year 15 and beyond to year 60 of operation, the maturity of proposed mitigation planting alongside the Proposed Scheme and Chiltern tunnel south portal will further integrate the Proposed Scheme into the landscape resulting in effects becoming non-significant. This is reported, Volume 5: Appendix LV-001-007 Part 4.

Chalfont St Peter South LCA

9.5.30 The Proposed Scheme will not directly pass through the Chalfont St Peter South LCA. However, the presence of the Proposed Scheme in the adjacent Maple Cross Slopes South LCA (approximately 400m away) will affect the setting and tranquillity of this LCA. However this will be set in the context of considerable existing traffic noise and activity from the M25 and the new mineral extraction sites at Denham Park Farm.

9.5.31 The proposed mitigation planting located in the adjacent LCA will not have had time to establish and integrate the Proposed Scheme into the receiving landscape by 2026. The magnitude of change is therefore considered to be medium within Chalfont St Peter South LCA.

9.5.32 The medium magnitude of change, assessed alongside the medium sensitivity will result in a moderate adverse effect.

9.5.33 By year 15 and beyond to year 60 of operation, the maturity of mitigation planting within the adjacent Maple Cross LCA will help to integrate the Proposed Scheme into

the landscape resulting in effects becoming non-significant within Chalfont St Peter South LCA. This is reported, Volume 5 Appendix LV-001-007 Part 4.

Visual assessment

9.5.34 This section describes the significant effects on visual receptors during year 1, year 15 and year 60 of operation. Non-significant effects on visual receptors are presented, Volume 5: Appendix LV-001-007 Part 4.

9.5.35 For each viewpoint the following assessments have been undertaken:

- effects during winter of year 1 of operation;
- effects during summer of year 1 of operation;
- effects during summer of year 15 of operation; and
- effects during summer of year 60 of operation.

9.5.36 Where significant effects have been identified, an assessment of effects at night time arising from additional lighting has also been undertaken.

9.5.37 The number identifies the viewpoint locations which are shown on Maps LV-04-024b to LV-04-027a (Volume 2, CFA7 Map Book). In each case, the middle number (xxx.x.xxx) identifies the type of receptor that is present in this area – 2: Residential, 3: Recreational, 4: Transport, 6: Employment and 7: Active Sport.

9.5.38 Where a viewpoint may represent multiple types of receptor, the assessment is based on the most sensitive receptors. Effects on other receptor types with a lower sensitivity may be lower than those reported.

Viewpoint 049.3.005: View west from PRoW (Footpath U50)

9.5.39 There will be filtered views of the overhead power line diversion crossing Uxbridge Golf Course in the middle ground (approximately 500m away). Planting reinstated within the golf course will not have established by year 1. The diversion of the overhead power line will give rise to notable changes to the golf course. Overall, there will be a medium magnitude of change.

9.5.40 The medium magnitude of change, assessed alongside the medium sensitivity of the receptor will result in a moderate adverse effect in the winter of year 1 of operation.

9.5.41 There will be no change to the assessment during summer of 2026 and the effect remains significant.

9.5.42 By year 15 and beyond to year 60 of operation, golf course reinstatement planting will have further established, filtering the view of the diverted overhead power line. Therefore reducing effects to non-significant. These are reported, Volume 5 Appendix LV-001-007 Part 4.

Viewpoint 051.3.002: View north along the Grand Union Canal PRoW (Footpath U72) and the Colne Valley Trail PRoW (Footpath U75)

9.5.43 There will be open views of the proposed viaduct as it crosses the canal in the middle ground (approximately 250m away). The viaduct will be approximately 11 -15m high

and will block views along the canal at a higher level within the narrow view. There will also be filtered views through adjacent vegetation to the viaduct as it passes across the lakes. The magnitude of change is considered to be medium.

9.5.44 The medium magnitude of change, assessed alongside the high sensitivity of the receptor will result in a moderate adverse effect in the winter of year 1.

9.5.45 The view of the Proposed Scheme in the winter of year 1 of operation is illustrated on the photomontage shown in Figure LV-01-026 (Volume 2, CFA7 Map Book).

9.5.46 During the summer of year 1, mature trees either side of the canal will narrow the view and further obscure views towards the Proposed Scheme. However, given the scale of the new viaduct structure in the view there will be no change to the assessment during summer and the effect remains significant.

9.5.47 By year 15 and beyond to year 60 of operation, vegetation reinstated along the Grand Union Canal will have matured, enclosing the vegetated corridor once again. Despite the vegetation, the viaduct will remain visible in the centre of the view as it passes from east to west. Therefore the magnitude of change will remain medium.

9.5.48 The medium magnitude of change, assessed alongside the high sensitivity of the receptor will result in a moderate adverse effect and remains significant.

Viewpoint 051.4.003: View from the Chiltern Main Line

9.5.49 There will be open views of the Colne Valley viaduct in the middle ground (approximately 600m away). . There will also be elevated views either side of the canal through adjacent vegetation towards the viaduct. Taking the above into account, the magnitude of change is considered to be medium.

9.5.50 The medium magnitude of change, assessed alongside the medium sensitivity of the receptor, will result in a moderate adverse effect in the winter of year 1.

9.5.51 During the summer of year 1 of operation, mature trees either side of the canal and the lakeside boundary vegetation will further filter views of the viaduct, although not sufficiently to alter the assessment.

9.5.52 By year 15 and beyond to year 60 of operation, reinstatement vegetation along the Grand Union Canal will have matured, enclosing the vegetated corridor once again. Despite the vegetation, the viaduct will remain visible in the centre of the view as it passes from south to north. Therefore the magnitude of change remains medium.

9.5.53 The medium magnitude of change, assessed alongside the high sensitivity of the receptor will result in a moderate adverse effect and remains significant.

Viewpoint 052.4.001: View south from Harvil Road

9.5.54 There will be filtered views through roadside hedgerows and field boundaries towards the southern approach embankment and the start of the viaduct in the foreground (approximately 20m from the receptor). There will be filtered views of the Ickenham auto-transformer feeder station in the background. The viaduct with associated train and overhead line equipment will also be visible. The relatively short distance from the

receptor and substantial change partially filtered will result in a medium magnitude of change.

9.5.55 The medium magnitude of change, assessed alongside the medium sensitivity of the receptor will result in a moderate adverse effect in the winter of year 1.

9.5.56 During the summer year 1, the intervening roadside vegetation will further filter views of the Proposed Scheme, although the assessment will remain unchanged.

9.5.57 By year 15 and beyond to year 60 of operation, mitigation planting adjacent to Harvil Road, as well as along the line of the Proposed Scheme will have established, partially screening the route from this location. This will reduce effects to non-significant. These are reported, Volume 5 Appendix LV-001-007 Part 4.

Viewpoint 052.3.002: View south from the northern edge of HOAC from PRoW (Footpath U34)

9.5.58 There will be filtered views through lakeside vegetation and occasional open views of the proposed viaduct in the middle ground (approximately 200m away). The proposed 3m high noise fence barrier on the west side of the viaduct, north of the Grand Union Canal, will form a substantial element in the view. The approximately 11 – 15m high viaduct will cross the lake in the view, gradually disappearing behind the lake's perimeter vegetation. Piers will be located approximately every 40m, partially obscuring views across the lake. There will also be filtered views through existing lakeside vegetation of the National Grid feeder station in the middle ground. The magnitude of change is considered to be high.

9.5.59 The high magnitude of change, assessed alongside the high sensitivity of the receptor will result in a major adverse effect in the winter of year 1 of operation.

9.5.60 The view of the Proposed Scheme in the winter of year 1 of operation is illustrated on the photomontage shown in Figure LV-01-028 (Volume 2, CFA7 Map Book).

9.5.61 During the summer of year 1 operation, the view to the viaduct will remain open and the assessment will be unchanged.

9.5.62 In year 15 and beyond into year 60 there will be filtered views through lakeside vegetation and occasional open views towards the viaduct in the middle ground. The view towards the National Grid feeder station will be further filtered by maturing mitigation planting. The magnitude of change is considered to be medium.

9.5.63 The medium magnitude of change, assessed alongside the high sensitivity of the receptor, will result in a major adverse effect by year 15 and beyond to year 60.

9.5.64 The view of the Proposed Scheme in the summer of year 15 of operation is illustrated on the photomontage shown in Figure LV-01-225 (Volume 2, CFA7 Map Book).

Viewpoint 052.2.004: View south-west from residential properties on Harvil Road, Ickenham

9.5.65 There will be open views along the National Grid feeder station access road. The top of the feeder station will be visible across the sloping agricultural fields in the background of the view. The pylon diversion will be visible in the background of the

view and will form a strong vertical presence in the landscape. The proposed planting during year 1 of operation will not have established to form an effective screen. The magnitude of change is considered to be high.

9.5.66 The high magnitude of change, assessed alongside the high sensitivity of the receptor will result in a major adverse effect in the winter of year 1.

9.5.67 During summer of year 1 operation, field and garden vegetation will further filter views of the Proposed Scheme, resulting in a medium magnitude of change and a reduction in the effect to moderate adverse.

9.5.68 The view of the Proposed Scheme in the summer of year 1 of operation is illustrated on the photomontage shown in Figure LV-01-027 (Volume 2, CFA7 Map Book).

9.5.69 In year 15 and beyond into year 60 there will be filtered views through field boundary vegetation towards the National Grid feeder station in the background. The proposed planting will have further established to screen views. This will result in a minor adverse effect by year 15 and year 60 and is therefore non-significant in both years. This is reported, Volume 5 Appendix LV-001-007 Part 4

Viewpoint 053.4.002: View north from Moorhall Road, Denham Green

9.5.70 Looking north along Moorhall Road there will be open views to the proposed viaduct crossing the road at approximately 12m above existing road level in the middle ground. Existing roadside vegetation will not screen views during winter. Passing trains will also be visible from this location. Taking the above into account, the magnitude of change is considered to be medium.

9.5.71 The medium magnitude of change, assessed alongside the low sensitivity of the receptor, will result in a moderate adverse effect in the winter of year 1 of operation.

9.5.72 During the summer of year 1 of operation existing roadside vegetation will enclose the highway corridor further screening views of the Proposed Scheme. However, as the viaduct and passing trains will be clearly visible in the centre of the view, there is no change to the assessment and remains significant.

9.5.73 The view will not have altered greatly by year 15 and beyond to year 60 due to the open nature of the view and central location of the viaduct within the view. As such, the magnitude of change is considered to be medium.

9.5.74 The medium magnitude of change, assessed alongside the low sensitivity of the receptor, will result in a moderate adverse effect.

Viewpoint 054.4.001: View south-west from Moorhall Road

9.5.75 There will be open views towards the viaduct in the middle ground. The viaduct will cross the road at approximately 12m above existing road level and high speed trains will also be visible. Therefore, the magnitude of change is considered to be medium.

9.5.76 The medium magnitude of change, assessed alongside the low sensitivity of the receptor, will result in a moderate adverse effect in the winter of year 1.

9.5.77 During the summer, adjacent established roadside vegetation will further screen views of the Proposed Scheme and associated trains. However, as the viaduct and

passing trains will be clearly visible in the centre of the view, there is no change to the assessment during summer months.

9.5.78 By year 15 and beyond to year 60, the view will not have greatly altered from that in year 1. Taking the above into account, the magnitude of change is considered to be medium.

9.5.79 The medium magnitude of change, assessed alongside the low sensitivity of the receptor, will result in a moderate adverse effect and remains significant.

Viewpoint 054.3.003: View south from Colne Valley Trail PRoW (Footpath U75) along the Grand Union Canal

9.5.80 There will be open views of the proposed viaduct as it crosses the canal in the middle ground. The viaduct will be approximately between m high at this point and will block views at height along the canal corridor. There will be filtered views of the viaduct from either side of the canal through adjacent vegetation as it crosses the lakes. Taking the above into account, the magnitude of change is considered to be medium.

9.5.81 The medium magnitude of change, assessed alongside the high sensitivity of the receptor will result in a moderate adverse effect in the winter of year 1.

9.5.82 The view of the Proposed Scheme in the winter of year 1 of operation is illustrated on the photomontage shown in Figure LV-01-030 (Volume 2, CFA7 Map Book).

9.5.83 During summer of year 1 existing mature trees either side of the canal will narrow the view and further filter views towards the Proposed Scheme. However, some areas of vegetation removal alongside the Grand Union Canal will open up filtered views. Therefore, there will be no change to the assessment during summer.

9.5.84 By year 15 and 60 there will be open focused views of the viaduct as it crosses the canal in the middle ground softened by canal side vegetation either side. This will result in a medium magnitude of change.

9.5.85 The medium magnitude of change, assessed alongside the high sensitivity of the receptor, will result in a moderate adverse effect by year 15 and year 60 and remains significant.

9.5.86 The view of the Proposed Scheme in the summer of year 15 of operation is illustrated on the photomontage shown in Figure LV-01-226 (Volume 2, CFA7 Map Book).

Viewpoint 054.2.004: View south from Hillside Road, South Harefield

9.5.87 There will be filtered foreground views through field hedgerows towards the National Grid feeder station in the background. The top of the feeder station will be visible over the hedgerows in the middle ground of the view. The proposed planting extending the existing copses within Harefield Moor in the middle ground will not have established. The scale of the magnitude of change is considered to be medium.

9.5.88 The medium magnitude of change, assessed alongside the high sensitivity of the receptor will result in a moderate adverse effect in the winter of year 1 operation.

9.5.89 During summer of year 1 the field and garden vegetation will further filter views of the Proposed Scheme in the background, resulting in a low magnitude of change and a consequent reduction in the effect to minor adverse effect that is non-significant.

9.5.90 In year 15 and beyond into year 60 the proposed planting extending the copses in the middle ground will screen views of the proposed National Grid feeder station. The magnitude of change is considered to be negligible.

9.5.91 The negligible magnitude of change, assessed alongside the high sensitivity of the receptor, will result in a negligible effect by year 15 and year 60 and is therefore non-significant in both years. These are reported, Volume 5: Appendix LV-001-007 Part 4.

Viewpoint 054.3.006: View north east from PRoW (Footpath U31) near South Harefield

9.5.92 There will be open foreground and middle ground views of the raised agricultural land which will form the new horizon and obscure the woodland view beyond. There will be views of the reinstated hedgerows which will not have established. The foreshortened view and immature hedgerows will contribute to a medium magnitude of change.

9.5.93 The medium magnitude of change, assessed alongside the medium sensitivity of the receptor will result in a moderate adverse effect in the winter of year 1 operation.

9.5.94 During the summer of year 1 the reinstated agricultural land will have re-established reducing the magnitude of change to minor adverse that is non-significant.

9.5.95 By year 15 and 60 whilst open views of the newly profiled landform will not have changed, the reinstated hedgerows will have established and will have integrated with the existing field hedgerow patterns. This will result in a non-significant effect. This is reported, Volume 5: Appendix LV-001-007 Part 4.

Viewpoint 054.3.007: View north-west from PRoW (Footpath U31) near South Harefield

9.5.96 There will be open foreground and middle ground views of re-profiled agricultural land which will form the new horizon and obscure the woodland view beyond. The foreshortened view and steep slopes will contribute to the medium magnitude of change.

9.5.97 The medium magnitude of change, assessed alongside the medium sensitivity of the receptor will result in a moderate adverse effect in the winter of year 1.

9.5.98 During the summer of year 1 the reinstated agricultural land will have re-established reducing the magnitude of change to minor adverse and therefore non-significant.

9.5.99 By year 15 and 60 the open views of the re-profiled landform will not have changed however, the land will have reverted back to its former agricultural land use and as such will result in a non-significant effect. This is reported, Volume 5: Appendix LV-001-007 Part 4.

Viewpoint 055.6.003: View east from Denham Media Park

9.5.100 There will be filtered middle ground views through adjacent River Colne vegetation to the proposed Colne Valley viaduct. The magnitude of change will be high.

9.5.101 The high magnitude of change, assessed alongside the low sensitivity of the receptor will result in a moderate adverse effect in the winter of year 1 operation.

9.5.102 During the summer of year 1 operation the view to the viaduct will not greatly differ and the magnitude of change will remain as high and result in a moderate adverse effect.

9.5.103 By year 15 and 60 the proposed mitigation planting along the River Colne will have further established, filtering and screening views of the viaduct. This will result in a minor adverse effect and non-significant effect in both years. This is reported, Volume 5: Appendix LV-001-007 Part 4.

Viewpoint 056.3.001: View south-west from Grand Union Canal PRoW (Footpath U72)

9.5.104 There will be open views of the viaduct as it crosses the lake in the middle ground to the west. The viaduct will be partially screened by vegetated islands within the lake. The change to the view will also be partially filtered by intervening vegetation which is characteristic of the Colne Valley. As such, the magnitude of change is considered to be medium.

9.5.105 The medium magnitude of change, assessed alongside the medium sensitivity of the receptor will result in a moderate adverse effect in the winter of year 1 operation.

9.5.106 During summer of year 1 operation, mature trees either side of the canal will narrow and further obscure the view towards the Proposed Scheme. Despite this, the overall impact will remain moderate adverse.

9.5.107 Given the open nature of the view, there will be little change by years 15 and 60 and as such the magnitude of change remains medium.

9.5.108 The medium magnitude of change, assessed alongside the high sensitivity of the receptor, will result in a moderate adverse effect by years 15 and 60.

Viewpoint 056.3.004: View north west along A412 Denham Way/North Orbital Road near Denham Waterski Club

9.5.109 There will be foreground open views along the line of the Colne Valley viaduct including views from below the viaduct looking up towards the underside of the deck and along the piers. There will be filtered views still available through to the lake beyond. The viaduct will span the A412denham Way/North Orbital Road in the background of the view. Taking the above into account, the magnitude of change is considered to be high.

9.5.110 The high magnitude of change, assessed alongside the low sensitivity of the receptor, will result in a moderate adverse effect in the winter of year 1 of operation.

9.5.111 During the summer of year 1 operation the view will not change greatly due to the large areas of cleared vegetation along the route of the proposed Colne Valley viaduct. The magnitude of change will remain as moderate.

9.5.112 By year 15 and beyond to year 60 of operation, the proposed woodland planting will have matured, providing further integration of the proposed viaduct. In locations

filtered views of the viaduct will remain and open views will still be afforded where the viaduct crosses the road in the background. The further growth of existing and proposed vegetation will result in a reduction in impact and effects will be non-significant. This is reported, Volume 5: Appendix LV-001-007 Part 4.

Viewpoint 057.4.001: View east from Tilehouse Lane

9.5.113 There will be middle ground open and filtered views of the Colne Valley north embankment (approximately 150m from the viewpoint). The train and overhead line equipment will be visible before it enters into cutting. Taking the above into account, the magnitude of change is considered to be medium.

9.5.114 The medium magnitude of change, assessed alongside the low sensitivity of the receptor, will result in a moderate adverse effect in the winter of year 1 of operation.

9.5.115 During the summer of year 1 the view will not change as mitigation planting will not have established.

9.5.116 By year 15 and beyond to year 60 of operation, the large swathes of proposed woodland planting will have matured, providing effective screening of the Proposed Scheme. This will reduce effects to being non-significant. These are reported, Volume 5: Appendix LV-001-007 Part 4.

Viewpoint 057.2.003: View north-east from residential properties and Denham Grove (De Vere Hotel) off Tilehouse Lane

9.5.117 There will be middle ground open and filtered views across the grounds of the Hotel to the Colne Valley north embankment and the Colne Valley viaduct including trains and associated overhead line equipment. Taking the above into account, the magnitude of change is considered to be medium.

9.5.118 The medium magnitude of change, assessed alongside the medium sensitivity of the receptor, will result in a moderate adverse effect in the winter of year 1.

9.5.119 During the summer of year 1 there will not be a noticeable change as mitigation planting will not have established, and therefore effects will remain.

9.5.120 By year 15 and beyond to year 60 of operation, the proposed planting will have further matured, filtering views of the viaduct. This will reduce effects to minor adverse and non-significant. This is reported, Volume 5 Appendix LV-001-007 Part 4.

Viewpoints 057.3.002: View east from Old Shire Lane PRoW (Bridleway DEN/2) and 059.3.002: View east and north from Old Shire Lane Circular Walk, PRoW (Bridleway DEN/2)

9.5.121 There will be open views across agricultural fields towards the northern approach embankment and large areas of immature woodland planting in the middle ground. The Proposed Scheme will be predominantly in cutting within these views, although there will be a short section where the train and associated overhead line equipment will be visible. The proposed Tilehouse Lane overbridge will be a prominent element in the landscape. Taking the above into account, the magnitude of change is considered to be medium.

9.5.122 The medium magnitude of change, assessed alongside the high sensitivity of the receptor, will result in a moderate adverse effect in the winter of year 1 operation.

9.5.123 During summer of year 1 the views will remain unchanged due to the lack of existing intervening vegetation and the immature proposed mitigation planting.

9.5.124 By year 15 and beyond to year 60 of operation, large areas of proposed woodland planting will have matured, effectively screening the Proposed Scheme. This will reduce effects to non-significant. These are reported, Volume 5: Appendix LV-001-007 Part 4.

Viewpoint 059.3.003: View north from Old Shire Lane, Circular Walk, PRoW (Bridleway DEN/2)

9.5.125 From the Circular Walk looking north, there will be open and filtered views towards the portal and associated infrastructure in the middle ground. There will also be a short section of the Proposed Scheme where the train and associated overhead line equipment will be visible before entering the tunnel. Therefore, the magnitude of change is considered to be medium.

9.5.126 The medium magnitude of change, assessed alongside the high sensitivity of the receptor, will result in a moderate adverse effect in the winter of year 1 operation.

9.5.127 The view during summer of year 1 will remain predominantly unchanged due to lack of intervening vegetation.

9.5.128 By year 15 and beyond to year 60 of operation, intervening mitigation planting will have established to aid screening of the Proposed Scheme from this viewpoint. This will reduce effects to being non-significant. These are reported, Volume 5: Appendix LV-001-007 Part 4.

Viewpoint 060.2.001: View south from residential properties on Chalfont Lane

9.5.129 There will be filtered foreground views across agricultural fields, through garden vegetation, to the Proposed Scheme in cutting. The most visible features from this location will be the elevated bridge at Tilehouse Lane that will span the route of the Proposed Scheme. By year 1, landscape mitigation planting will not have established an effective screen. Therefore the magnitude of change is considered to be medium.

9.5.130 The medium magnitude of change, assessed alongside the high sensitivity of the receptor, will result in a moderate adverse effect in the winter of year 1 operation.

9.5.131 During the summer of year 1 operation, existing intervening garden vegetation will further screen views to the Proposed Scheme. However, the effects will remain moderate adverse during summer.

9.5.132 By year 15 and beyond to year 60 of operation, linear swathes of woodland planting will have established to screen the Proposed Scheme from this location. This will reduce effects to being non-significant. This is reported, Volume 5 Appendix LV-001-007 Part 4.

Viewpoint 060.3.002: View west from PRoW (Bridleway BR004) near A412 Denham Way/North Orbital Road

9.5.133 There will be filtered foreground views through roadside vegetation across agricultural fields, to the Proposed Scheme in cutting. The most visible feature from this location will be the elevated overbridge at Tilehouse Lane that will span the route of the Proposed Scheme. By year 1, landscape mitigation planting will not have established an effective screen. Therefore the magnitude of change is considered to be medium.

9.5.134 The medium magnitude of change, assessed alongside the medium sensitivity of the receptor, will result in a moderate adverse effect in the winter of year 1 of operation.

9.5.135 During the summer of year 1, existing intervening roadside vegetation will further screen views to elements of the Proposed Scheme. The proposed planting along the Tilehouse Lane overbridge will not yet have established and there will be views of the bridge and associated embankments. The effects will remain moderate adverse during the summer.

9.5.136 By year 15 and beyond to year 60 of operation, linear swathes of woodland planting will have established to screen the Proposed Scheme from this location. In particular Tilehouse Lane overbridge embankment planting will have established filtering views of the overbridge. This will reduce effects to minor adverse and being non-significant. This is reported, Volume 5: Appendix LV-001-007 Part 4.

Viewpoint 062.2.001: View south-west from Hornhill Road and PRoW (Footpath FP005) at western edge of Maple Cross

9.5.137 During operation, there will be filtered views through garden vegetation, across undulating agricultural fields towards the Proposed Scheme in cutting, the Chiltern tunnel south portal and associated extensive earthworks in the back ground. Most visible from this location will be the elevated overbridge at Tilehouse Lane and the diverted pylons. As mitigation planting will not have established an effective visual screen in year 1, the magnitude of change is considered to be medium.

9.5.138 The medium magnitude of change, assessed alongside the high sensitivity of the receptor, will result in a moderate adverse effect in the winter of year 1 of operation.

9.5.139 During the summer of year 1, existing intervening garden vegetation will provide a degree of extra screening, although effects will remain moderate adverse.

9.5.140 By year 15 and beyond to year 60 of operation, linear belts of proposed planting will have matured, providing additional screening of the Proposed Scheme. This will reduce effects to non-significant. This is reported, Volume 5: Appendix LV-001-007 Part 4.

Cumulative effects

9.5.141 Section 2.1 and Appendix CT-004-000 identify developments with planning permission or sites allocated in adopted development plans, on or close to the Proposed Scheme. These are termed 'committed developments' and will form part of the baseline for the operation of the Proposed Scheme. The consequential cumulative

effect of these committed developments on LCA and viewpoints is described below. These developments are shown on Maps CT-13-011 to CT-13-013a (Volume 5, Cross Topic Appendix 1 Map Book).

9.5.142 There are no known instances where receptors that will be significantly affected by the operation of the Proposed Scheme on its own, will be significantly adversely affected by the combined operation of the Proposed Scheme and Denham Park Farm Quarry.

Other mitigation measures

9.5.143 The permanent effects of the Proposed Scheme on landscape and visual receptors have been substantially reduced through incorporation of the measures described previously. Effects in year 1 of operation may be further reduced by establishing planting early in the construction programme, which will be considered during the detail design stage. This will provide additional screening and greater integration of the Proposed Scheme into the landscape. However, no other mitigation measures are considered practicable due to the high visibility of elements of the Proposed Scheme and the sensitivity of the surrounding receptors.

Summary of likely residual significant effects

9.5.144 As no other mitigation measures are considered practicable, the permanent residual significant effects during operation remain as described above. In most cases, significant effects will reduce over time as the proposed mitigation planting matures and reaches its designed intention. However, the following residual effects will remain following year 15 of operation:

- effects on the character of Colne River Valley LCA due to the influence that engineered landforms and the Colne Valley viaduct will have on the otherwise isolated and enclosed landscape;
- effects on views from the PRoW adjacent to HOAC arising from the visibility of the Colne Valley viaduct which will form a notable feature in the immediate landscape given the open aspect of view (receptor 52.3.005);
- effects on users of PRoW along the Colne Valley Trail and Grand Union Canal where views of the Colne Valley viaduct will remain (receptors 51.3.002 and 54.3.003); and
- effects on people travelling along Moorhall Road arising from the direct view of the Colne Valley viaduct crossing over the road (receptors 53.4.002 and 54.4.001).

10 Socio-economics

10.1 Introduction

10.1.1 This section reports the likely significant economic and employment effects during the construction and operation of the Proposed Scheme.

10.1.2 The need for a socio-economic assessment results from the potential for the Proposed Scheme to affect:

- existing businesses and community organisations and thus the amount of local employment;
- local economies, including employment; and
- planned growth and development.

10.1.3 The beneficial and adverse socio-economic effects of the Proposed Scheme are reported at two different levels: route-wide and within the Colne Valley Area. Effects on levels of employment are reported at a route-wide level in Volume 3. Localised effects on businesses and observations on potential local economic effects are reported within each CFA report.

Construction

10.1.4 The proposed construction works will have the following relevance in terms of socio-economics in relation to:

- effects on amenity (e.g. air quality and construction dust, noise and vibration, construction traffic and visual impacts) which could affect business operations. Any resulting effects on employment are reported at a route-wide level; and
- potential employment opportunities arising from construction in the local area (including in adjacent areas).

Operation

10.1.5 The proposed operation of the route will have relevance in terms of socio-economics in relation to:

- train operation activities could result in effects on amenity (e.g. air quality, noise, and vibration, and visual impacts) which could affect a business's operations. Any resulting effects on employment are reported at a route-wide level; and
- potential employment opportunities created by new business opportunities.

10.2 Scope, assumptions and limitations

10.2.1 The assessment scope, key assumptions and limitations for the socio-economics assessment are set out in Volume 1, the SMR (see Volume 5: Appendix CT-001-000/1) and the SMR addendum (Volume 5: Appendix CT-001-000/2). This report follows the standard assessment methodology.

10.2.2 There have been no variations to the socio-economic assessment methodology arising from engagement with stakeholders and community organisations.

10.3 Environmental baseline

Existing baseline

Study area description

10.3.1 Section 2 of this report provides a general overview of the Colne Valley area which includes data of specific relevance to socio-economics notably demographic and employment data. The following provides a brief overview in terms of employment, economic structure and the labour market within the area[80].

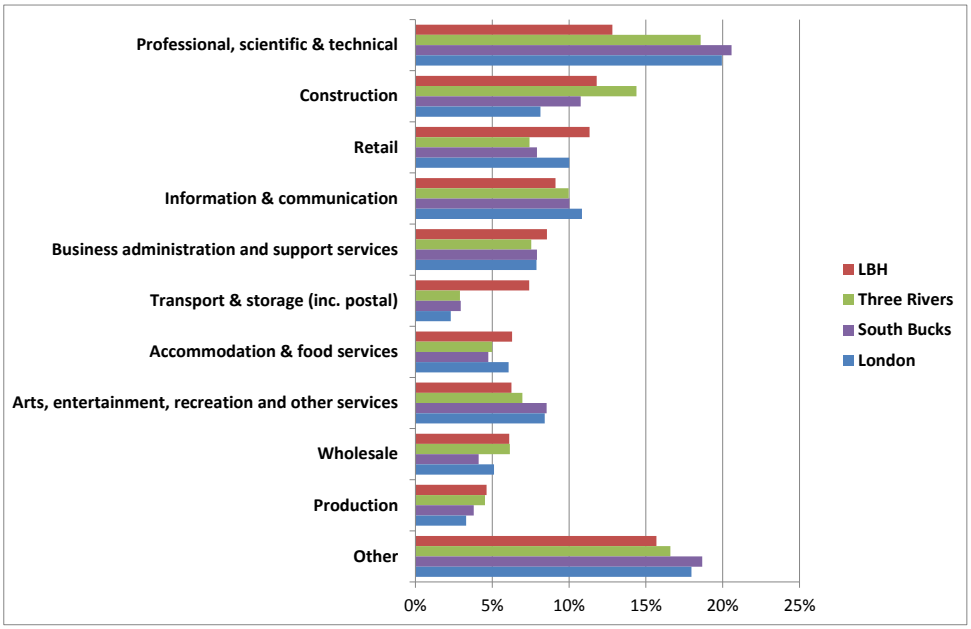
10.3.2 The Colne Valley area lies within the boundaries of the LBH, South Bucks District and Three Rivers District, with a small portion lying in the Chiltern District. Where possible, baseline data has been gathered on demographic character areas (DCA)[81] to provide a profile of local communities. Volume 5: Appendix SE-02-008 shows the location of these DCA. The area contains three DCA; Denham Green, Maple Cross and West Hyde, and South Harefield.

Business and labour market

10.3.3 Within the LBH, where most socio-economic impacts will arise, the professional, scientific and technical services sector accounts for the largest proportion of businesses (13%), with the construction (12%) and retail (11%) sectors also accounting for relatively large numbers of businesses within the borough. In Three Rivers District, the professional, scientific and technical services sector accounts for the largest proportion of businesses (19%), with the construction (14%) and the information and communication sector (10%) also accounting for relatively large proportions. The professional, scientific and technical services sector also accounts for the largest (21%) proportion of businesses within South Bucks, whilst construction (11%) and information and communication (10%) are also important sectors. This is shown below in Figure 7. For comparison, within the London region the professional, scientific and technical services sector accounts for the largest number of businesses (20%), with the information and communication (11%), retail (10%) and arts, entertainment, recreation and other services (8%) sectors also accounting for relatively large numbers of businesses.

[80] Further information on the socio-economics baseline, with regard to business and labour market profile within the area, is contained, Volume 5 (Appendix SE-001-000)
[81] DCA have been determined through an understanding of local context and aim to be aligned as closely as possible to groups of lower super output areas (LSOAs)

Figure 7: Business sector composition in the LBH, Three Rivers district, South Bucks and London [82, 83]

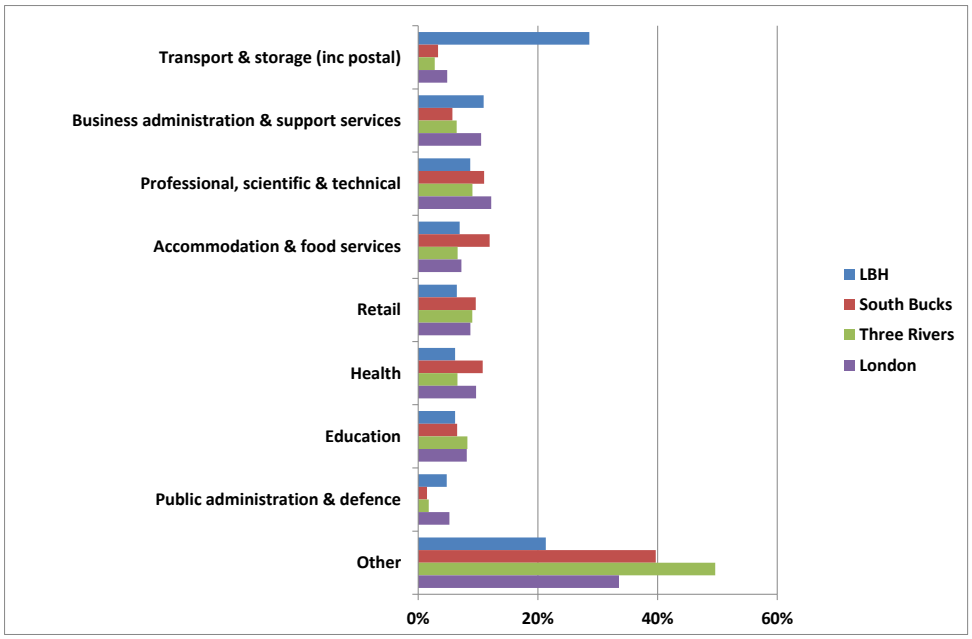


10.3.4 Approximately 180,000 people worked in LBH, 31,000 in South Bucks and 32,000 in Three Rivers District while 2,000 people worked within Denham Green DCA, 3,000 within Maple Cross and West Hyde DCA and 1,000 within South Harefield DCA[84].

10.3.5 According to the ONS Business Register and Employment Survey 2011, the sector accounting for the highest proportion of employment in the LBH is transport and storage accounting for 28% of jobs. This is compared to 5% recorded for both London and England. Employment in the business administration and support services sector accounts for 11%, which is greater than regional and national levels (10% and 8% respectively). The sector with the highest proportion of employment in South Buckinghamshire is accommodation and food services with 12% of jobs, compared to 7% in England. The sector with the highest proportion of employment in Three Rivers District is construction which accounts for 14% of jobs, compared to 5% in England. This is shown in Figure 8. Key sectors, in terms of employment for Denham Green DCA are accommodation and food services (34%) and wholesale (23%). For Maple Cross and West Hyde DCA key sectors are construction (58%) and motor trades (11%). The key sector in South Harefield DCA was professional, scientific and technical (68%).

[82] 'Other' includes agriculture, forestry and fishing, motor trades, finance and insurance, property, public administration and defence, health and education sectors.
[83] Office of National Statistics (ONS) (2011), *UK Business: Activity, Size and Location*, ONS, London. Please note 2011 data has been presented to provide an appropriate comparison with 2011 Census data.
[84] ONS (2012), *Business Register and Employment Survey 2011*, ONS, London.

Figure 8: Proportion of employment by industrial sector in the LBH, South Bucks, Three Rivers and London[85]



10.3.6 According to the 2011 Census[86], the employment rate[87] within the LBH was 65% (which represents 130,000 people), 69% for South Bucks (which represents 33,000 people) and 71% for Three Rivers District (which represents 44,000 people). This compares with an average rate of 65% for England. The employment rate in the Denham Green DCA was 64%, 72% in Maple Cross and West Hyde DCA and 69% in South Harefield DCA.

10.3.7 The unemployment rates for the LBH and the Three Rivers District stood at 8% and 5% respectively compared to the England average of 7%, whilst the unemployment rate for South Bucks stood at 4%. The unemployment rate was 5% in the Denham Green DCA, and 6% in both Maple Cross and West Hyde DCA and South Harefield DCA[88].

10.3.8 According to the 2011 Census, 28% of LBH residents aged 16 and over were qualified to National Vocational Qualification Level 4 (NVQ4) compared to 38% in London and 27% in England. Whilst 19% of LBH residents had no qualifications which was greater than that recorded for London (18%) but lower than the average for England (23%). In South Bucks, 37% were qualified to NVQ4, compared to 30% in the South East region and 17% had no qualifications, compared to 19% regionally. In Three Rivers, 34% were qualified to NVQ4, compared to 26% in the East of England region and 18% had no qualifications compared to 23% regionally.

10.3.9 In 2011 26% of Denham Green DCA residents aged 16 and over were qualified to NVQ4, compared to 22% in Maple Cross and West Hyde DCA and 21% in South

[85] 'Other' includes agriculture, forestry and fishing, production, construction, motor trades, wholesale, information and communication, finance and insurance, property and arts, entertainment, recreation and other services sectors.
[86] ONS (2012), *Census 2011*, ONS, London.
[87] The proportion of working age (16-74 years) of residents that are in employment. Employment comprises the proportion of the total resident population who are 'in employment' and includes full-time students who are employed.
[88] Unemployment figures have been rounded. DCA unemployment rates are presented for each DCA in this chapter while in Section 2 they are shown in aggregate.

Harefield DCA. The proportion of residents with no qualifications was 29% in Denham Green, 23% in Maple Cross and West Hyde DCA and 26% in South Harefield DCA.

10.3.10 The Denham Green, Maple Cross and West Hyde, and South Harefield DCA are predominantly residential areas, set within a mostly rural and agricultural district, recording high rates of employment and low unemployment. However, they are characterised by below average levels of higher qualification attainment compared to both regional and national averages.

Future baseline

Construction (2017)

10.3.11 Volume 5: Appendix CT-004-000 provides details of the developments which are assumed to have been implemented by 2017. There are no consents in this area which are expected to accommodate additional material employment by 2017.

Operation (2026)

10.3.12 Volume 5: Appendix CT-004-000 provides details of the developments which are assumed to have been implemented by 2026. There are no consents or allocations in this area which are expected to accommodate additional material employment between 2017 and 2026.

10.4 Effects arising during construction

Avoidance and mitigation measures

10.4.1 In order to avoid or minimise the environmental impacts during construction, the design of the Proposed Scheme includes provisions to maintain access to businesses during the construction phase.

10.4.2 The draft CoCP includes a range of provisions that will help mitigate the socio-economic effects associated with construction within this local area, including:

- consulting businesses located close to hoardings on the design, materials used and construction of the hoarding, to reduce impacts on access to and visibility of their premises (draft CoCP Section 5);
- reducing nuisance through sensitive layout of construction sites (draft CoCP Section 5);
- applying best practicable means (BPM) during construction works to reduce noise (including vibration) at sensitive receptors (including local businesses) (draft CoCP Section 13);
- contractors will be required to monitor and manage flood risk and other extreme weather events which may affect socio-economic resources during construction (draft CoCP Sections 5 and 16); and
- site specific traffic management measures including requirements relating to the movement of traffic from business and commercial operators of road vehicles, including goods vehicles (draft CoCP Section 14).

Assessment of impacts and effects

Temporary effects

Change in business amenity value

10.4.3 Businesses within the Colne Valley area may experience air quality, noise and vibration, visual or construction traffic impacts as a result of construction of the Proposed Scheme. Taken in combination, the residual effects from these other topic assessments may amount to a significant change in amenity which leads to a possible loss of trade for the affected businesses.

10.4.4 The Denham Grove (De Vere Hotel) on Tilehouse Lane may experience potentially significant noise and visual effects as a result of the proposed construction activities associated with the passive provision for the Heathrow spur, clearance of woodland vegetation and construction of the Colne Valley viaduct. The Hotel is set within parkland and is marketed as an environment of relaxation and tranquillity. The sensitivity of this establishment is deemed to be high as users are considered to be susceptible to changes in amenity and the construction works may discourage guests. These in-combination effects will occur over a period of 15 months and given the high level of sensitivity, the Proposed Scheme is assessed to have a significant amenity effect on this business.

10.4.5 The resulting effects on employment are reported in aggregate at a route-wide level (see Volume 3).

Isolation

10.4.6 No non-agricultural businesses[89] have been identified within the area, which are expected to experience significant isolation effects as a result of the Proposed Scheme.

Construction employment

10.4.7 There are plans to locate construction compounds for the Proposed Scheme at the following locations within the Colne Valley area:

- Colne Valley viaduct main compound;
- Colne Valley viaduct and south embankment satellite compound/Ickenham auto-transformer feeder station satellite compound;
- Colne Valley viaduct satellite compound;
- Colne Valley viaduct storage satellite compound;
- Colne Valley viaduct jetty storage satellite compound;
- Colne Valley viaduct laydown satellite compound;
- Colne Valley viaduct north launch satellite compound;
- Colne Valley viaduct north embankment satellite compound; and

[89] Possible employment loss in agricultural businesses as a result of the Proposed Scheme is being estimated at the route-wide level.

- Chiltern Tunnel main compound/Chiltern tunnel south portal satellite compound.

10.4.8 The use of these sites could result in the creation of 2900 person years of construction employment opportunities[90], equivalent to 290 full time equivalent permanent jobs[91], which, depending on skill levels required and the skills of local people, are potentially accessible to residents in the locality and to others living further afield. The impact of the direct construction employment creation has been assessed as part of the route wide assessment (see Volume 3).

10.4.9 Direct construction employment created by the Proposed Scheme could also lead to opportunities for local businesses to supply the project or to benefit from expenditure of construction workers. The impact of indirect construction employment creation has been assessed as part of the route-wide assessment (see Volume 3).

Cumulative effects

10.4.10 No committed developments have been identified that are considered to interact with the Proposed Scheme which are relevant to socio-economics.

10.4.11 Cumulative effects arise in relation to the accumulation of individual resource based job displacement/losses on a local labour market. These effects are assessed and reported as part of the route-wide assessment (see Volume 3).

10.4.12 Combined effects arise where business establishments are affected by other environmental effects (from noise, vibration, air quality, visual and construction traffic) such that their ability to trade is disadvantaged thereby potentially prejudicing jobs in business establishments affected. These effects are identified earlier in Section 1 and assessed in the route-wide assessment (see Volume 3).

Permanent effects

Businesses

10.4.13 Businesses directly affected, i.e. those that lie within land which will be acquired for the construction of the Proposed Scheme, are reported in groups where possible to form defined resources, based on their location and operational characteristics. A group could contain either one or a number of businesses reflecting the fact that a building may have more than one occupier or that similar businesses/resources are clustered together.

10.4.14 A business unit at Dew's Farm Cottages will be directly impacted upon by the Proposed Scheme.

10.4.15 Land required for the construction of the Proposed Scheme will also impact HOAC. This is a community resource (see Section 6 for further details) whose ability to operate will be compromised and unlikely to remain open during the construction period. However, from an employment perspective, no significant direct effects on non-agricultural employment have been identified within the Colne Valley area.

[90] Construction labour is reported in construction person years, where one construction person year represents the work done by one person in a year composed of a standard number of working days.
[91] Based on the convention that 10 employment years is equivalent to one full time equivalent job.

10.4.16 It is estimated that land required for the construction of the Proposed Scheme will result in the displacement or possible loss of approximately 10 jobs[92]. Taking into account the availability of alternative premises and the total employed within the district, the displacement or possible loss of jobs is considered to be modest compared to the scale of economic activity and opportunity in the area.

Cumulative effects

10.4.17 No committed developments have been identified that are considered to interact with the Proposed Scheme.

10.4.18 Cumulative effects arise in relation to the accumulation of individual resource based job displacement/losses on a local labour market. These effects are assessed and reported as part of the route-wide assessment (see Volume 3).

Other mitigation measures

10.4.19 The above assessment has concluded that there are significant adverse effects arising during construction in relation to amenity effects on businesses by the Proposed Scheme.

10.4.20 Businesses displaced by the Proposed Scheme will be fully compensated within the provisions of the National Compensation Code. HS2 Ltd recognises the importance of displaced businesses being able to relocate to new premises and will therefore provide additional support over and above statutory requirements to facilitate this process.

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

Summary of likely significant residual effects

10.4.22 The residual significant socio-economic effects that will arise during construction of the Proposed Scheme are the same as those reported above, as illustrated on Maps SE-01-020 to SE-01-022a (Volume 5, Socio-economics Map Book).

10.5 Effects arising during operation

Avoidance and mitigation measures

10.5.1 No mitigation measures are proposed during operation within this area.

Assessment of impacts and effects

Resources with direct effects

10.5.2 There are no resources considered likely to experience significant direct effects during the operational phase of the Proposed Scheme within this area.

[92] Employment within businesses has been estimated through a combination of sources, for example, surveys of businesses, the Experian employment dataset, employment floor space and the Homes and Communities Agency (HCA) (2010) *Employment Densities Guide 2nd Edition*. The estimate is calculated using standard employment density ratios and estimates of floor areas and may vary from actual employment at the sites.

Change in business amenity

10.5.3 Businesses within the Colne Valley area may experience air quality, noise and vibration and visual impacts as a result of operation of the Proposed Scheme. Taken in combination, the residual effects from these other topic assessments may amount to a significant change in amenity which leads to a possible loss of trade for the affected businesses. Any resulting effects on employment numbers are reported in aggregate at a route-wide level (see Volume 3).

10.5.4 The Denham Grove (De Vere Hotel) on Tilehouse Lane may experience potentially significant noise and visual effects as a result of the operation of the HS2 route and operational features such as the Colne Valley viaduct. The Hotel is set within parkland and is marketed as an environment of relaxation and tranquillity. The sensitivity of this establishment is deemed to be high as users are considered to be susceptible to changes in amenity and the operation of the route may discourage guests. Given these in combination effects and the high level of sensitivity, the Proposed Scheme is assessed to have a significant amenity effect on this business.

Operational employment

10.5.5 Operational employment will be created at locations along the route including stations, train crew facilities and infrastructure/maintenance depots which are considered unlikely to be accessed by residents within the area.

10.5.6 Direct operational employment created by the Proposed Scheme could also lead to indirect employment opportunities for local businesses in terms of supplying the project or benefiting from expenditure of directly employed workers on goods and services. Some of these employment opportunities will be accessible to residents in the locality.

10.5.7 The impact of operational employment creation has been assessed as part of the route-wide assessment (see Volume 3).

Cumulative effects

10.5.8 No committed developments have been identified that are considered to interact with the Proposed Scheme.

Other mitigation measures

10.5.9 The above assessment has concluded that there are significant adverse effects arising during operation in relation to amenity effects on businesses by the Proposed Scheme.

Summary of likely residual significant effects

10.5.10 The residual significant socio-economic effects that will arise during operation of the Proposed Scheme are the same as those reported above, as illustrated on Maps SE-01-020 to SE-01-022a (Volume 5, Socio-economics Map Book).

11 Sound, noise and vibration

11.1 Introduction

11.1.1 This section reports the assessment of the likely noise and vibration significant effects arising from the construction and operation of the Proposed Scheme for the Colne Valley area on:

- people, primarily where they live ('residential receptors') in terms of a) individual dwellings and b) on a wider community basis, including any shared community open areas[93]; and
- community facilities such as schools, hospitals, places of worship, and also commercial properties such as offices and hotels, collectively described as 'non-residential receptors' and 'quiet areas[94]'.

11.1.2 The assessment of likely significant effects from noise and vibration on agricultural, community, ecological or heritage receptors and the assessment of tranquillity are presented in Sections 3, 5, 6, 7 and 9 of this report respectively.

11.1.3 In this assessment 'sound' is used to describe the acoustic conditions that people experience as a part of their everyday lives. The assessment considers how those conditions may change through time and how sound levels and the acoustic character of community areas is likely to be modified through the introduction of the Proposed Scheme. Noise is taken as unwanted sound and hence adverse effects are noise effects and mitigation is, for example, by noise fence barriers.

11.1.4 Effects can either be temporary from construction or permanent from the operation of the Proposed Scheme. These effects may be direct, resulting from the construction or operation of the Proposed Scheme, and/or indirect e.g. resulting from changes in traffic patterns on existing roads or railways that result from the construction or operation of the Proposed Scheme.

11.1.5 This section sets out the means to avoid or reduce the adverse effects that may occur.

11.1.6 The approaches to assessing sound, noise and vibration and appropriate mitigation are outlined in Volume 1 and scope and methodology are defined in the following documents:

- Scope and Methodology Report (SMR) (Appendix CT-001-000/1); and
- SMR addendum (Appendix CT-001-000/2).

[93] 'shared community open areas' are those that the emerging National Planning Practice Guidance identifies may partially offset a noise effect experienced by residents at their dwellings and are either a) relatively quiet nearby external amenity spaces for sole use by a limited group of residents as part of the amenity of their dwellings or b) a relatively quiet external publicly accessible amenity space (e.g. park to local green space) that is nearby.

[94] Quiet areas are defined in the Scope and Methodology Report as either Quiet Areas as identified under the Environmental Noise Regulations or are resources which are prized for providing tranquillity (further information is provided in Section 9) .

11.1.7 More detailed information and mapping regarding the sound, noise and vibration assessment for Colne Valley is available in the relevant appendices, Volume 5:

- sound, noise and vibration, route-wide assumptions and methodology (Appendix SV-001-000);
- sound, noise and vibration baseline (Appendix SV-002-007);
- sound, noise and vibration construction assessment (Appendix SV-003-007);
- sound, noise and vibration operation assessment (Appendix SV-004-007); and
- Map Series SV-01, SV-02, SV-03 and SV-04 (Volume 5, Sound, Noise and Vibration Map Book).

11.2 Environmental baseline

Existing baseline

11.2.1 The composition of the sound environment in this area is typical for a mixture of settlements and isolated properties on the periphery of West London. The presence of the M25, A40 and M40 and the relatively busy A412 Denham Way/North Orbital Road leads to significant variation in the sound environment throughout the area.

11.2.2 In locations close to these busy main roads, the existing acoustic climate is dominated by road traffic, and daytime sound levels are typically 75 to 80dB[95] with levels in community locations further from these roads being considerably lower as described below.

11.2.3 Within Denham Green, traffic on local roads and the North Orbital Road dominates the soundscape, giving rise to daytime sound levels of typically around 60dB for properties located close to the North Orbital road reducing to around 45dB for properties set back into the village. The night time noise levels[96] within Denham Garden are typically 5 to 10dB lower than the daytime, with the greater reduction between the day and night seen at locations close to the North Orbital Road.

11.2.4 The soundscape at Savay Lake, located to the north of Denham Green is shaped by traffic noise from local roads and the more distant North Orbital Road as well as activity around the lake, giving rise to daytime noise levels which typically range between 45 – 55dB.. The night time noise levels are generally 6dB lower than daytime at this location.

11.2.5 Current sound levels on the west side of South Harefield, are dominated during the daytime by activities at the gravel works located by the River Colne. Typical daytime sound levels in the area are around 55dB. At other times the sound of aircraft is a regular feature. The night time noise levels within South Harefield are typically 5dB lower than the daytime.

[95] Quoted dB values at residential areas refer to the free-field 16 hour daytime (07:00 to 23:00) equivalent continuous sound pressure level, $L_{pAeq,16hr.}$
[96] Night-time sound levels refer to the free-field 16 hour night-time (23:00 to 07:00) equivalent continuous sound pressure level, $L_{pAeq,8hr.}$

11.2.6 At Wyatt's Covert, the current acoustic environment is shaped by road traffic from local roads and the more distant North Orbital Road. The daytime noise levels at this location are typically around 55dB during the day reducing by around 7dB at night.

11.2.7 At Denham Grove (De Vere Hotel), the sound levels are shaped by local road traffic and community activity and by the distant North Orbital Road. The daytime sound levels are typically 50dB reducing by around 7dB at night.

11.2.8 On Chalfont Lane towards West Hyde, there is a small residential settlement at Sunnyhill Road. Daytime sound levels here are around 60dB and the soundscape is comprised of distant road traffic from the M25 motorway and occasional local vehicles, occasional aircraft over flights and natural sounds. The night time noise levels along Chalfont Lane are typically 9dB lower than the daytime.

11.2.9 Further information on the existing baseline, including baseline sound levels and baseline monitoring results, is provided for this area, Volume 5: Appendix SV-002-007.

11.2.10 It is likely that the majority of receptors adjacent to the line of route are not currently subject to appreciable vibration[97]. Vibration at all receptors from the Proposed Scheme has therefore been assessed using specific thresholds, below which receptors will not be affected by vibration. Further information is provided in Volume 1, Section 8.

Future baseline

11.2.11 Without the Proposed Scheme, existing sound levels in this area are likely to increase slowly over time. This is primarily due to road traffic growth. Changes in car technology may offset some of the expected sound level increases due to traffic growth on low speed roads[98], tyre sound dominates and hence the expected growth in traffic is likely to continue to increase ambient sound levels.

Construction (2017)

11.2.12 The assessment of noise from construction activities assumes a baseline year of 2017 which represents the period immediately prior to the start of the construction period. As a reasonable worst case, it has been assumed that no change in baseline sound levels will occur between the existing baseline (2012/13) and the future baseline year of 2017. The assessment of noise from construction traffic assumes a baseline year of 2021, representative of the middle of the construction period when the construction traffic flows are expected to be at their peak. Further information can be found in the Traffic and Transport assessment.

Operation (2026)

11.2.13 The assessment is based upon the predicted change in sound levels that result from the Proposed Scheme. The assessment initially considered a worst case (that overestimates the change in levels) by assuming that sound levels will not change from the existing baseline year of 2012/2013. Where significant effects were identified on this basis, the effects have been assessed using a baseline year of 2026 to coincide

[97] Further information is available in the Volume 5: Appendix SV-001-000, the SMR and its Addendum.
[98] Tyre noise typically becomes the dominant sound source for steady road traffic at speeds above approximately 30mph

with the proposed start of passenger services. The future baseline is for the sound environment that would exist in 2026 without the Proposed Scheme.

11.3 Effects arising during construction

Local assumptions and limitations

Local assumptions

11.3.1 The construction arrangements that form the basis of the assessment are presented in Section 2.3 of this report.

11.3.2 Tunnelling support activities at Chiltern tunnel south portal will need to be undertaken during the evening and night-time for reasons of safety, engineering practicability or to reduce the impact on existing transport.

11.3.3 The assessment takes account of people's perception of noise throughout the day. More stringent criteria are applied during evening and night-time periods, when people are more sensitive to noise, compared to the busier and more active daytime period.

Local limitations

11.3.4 In this area, there are a number of locations where the land or property owners did not permit baseline sound level monitoring to be undertaken at their premises. However, sufficient information has been obtained to undertake the assessment. Further information is provided, Volume 5: Appendix SV-002-007.

Avoidance and mitigation measures

11.3.5 The assessment assumes the implementation of the principles and management processes set out in Section 13 of the draft CoCP which are:

- Best Practicable Means (BPM) as defined by the Control of Pollution Act 1974 (CoPA) and Environmental Protection Act 1990 (EPA) will be applied during construction activities to minimise noise (including vibration) at neighbouring residential properties;
- as part of BPM, mitigation measures are applied in the following order:
  - noise and vibration control at source: for example the selection of quiet and low vibration equipment, review of construction methodology to consider quieter methods, location of equipment on site, control of working hours, the provision of acoustic enclosures and the use of less intrusive alarms, such as broadband vehicle reversing warnings; and then
  - screening: for example local screening of equipment or perimeter hoarding;
- where, despite the implementation of BPM, the noise exposure exceeds the criteria defined in the draft CoCP, noise insulation or ultimately temporary re-housing will be offered in accordance with the draft CoCP Noise Insulation and Temporary Re-housing Policy;
- lead contractors will seek to obtain prior consent from the relevant local authority under Section 61 of CoPA for the proposed construction works. The

consent application will set out BPM measures to minimise construction noise, including control of working hours, and provide a further assessment of construction noise and vibration including confirmation of noise insulation/ temporary re-housing provision;

- contractors will undertake and report such monitoring as is necessary to assure and demonstrate compliance with all noise and vibration commitments. Monitoring data will be provided regularly to and be reviewed by the Nominated Undertaker and will be made available to the local authorities; and
- contractors will be required to comply with the terms of the draft CoCP and appropriate action will be taken by the Nominated Undertaker as required to ensure compliance.

11.3.6 In addition to this mitigation, taller screening as described in the draft CoCP[99] has been assumed along edge of the construction site boundary adjacent to the residential properties around and including Denham Grove (De Vere Hotel) on Tilehouse Lane.

11.4 Assessment of impacts and effects

Residential receptors: direct effects – individual dwellings

11.4.1 The avoidance and mitigation measures will reduce noise inside all dwellings from the construction activities such that it is does not reach a level where it would significantly affect[100] residents.

Residential receptors: direct effects –communities

11.4.2 The avoidance and mitigation measures in this area will avoid airborne construction noise adverse effects[100] on the majority of receptors and communities. Residual temporary noise or vibration effects are identified later in this section.With regard to noise outside dwellings, the assessment of temporary effects takes account of construction noise relative to existing sound levels.

11.4.3 In locations with lower existing sound levels[101], construction noise effects[100]are likely to be caused by changes to noise levels outside dwellings. These may be considered by the local community as an effect on the acoustic character of the area and hence be perceived as a change in the quality of life. These effects are considered to be significant when assessed on a community basis taking account of the local context[102].

11.4.4 Piling is likely to result in appreciable ground-borne vibration at a small number of dwellings, situated very closest to these activities. These receptors will also be exposed to appreciable noise from the construction of the Proposed Scheme. The significance of the identified vibration effects has been assessed in combination with the airborne noise also identified at these receptors.

[99] As described in the draft CoCP, provided as necessary by solid temporary hoarding, temporary earth stockpiles, screening close to the activities or other means to provide equivalent noise reduction.
[100] Information is provided in the emerging National Planning Practice Guidance – Noise http://planningguidance.planningportal.gov.uk,
[101] Further information is provided, Volume 5: Appendix SV-001-000.
[102] Further information is provided in SV-001-000 and SV-003-007.

11.4.5 In this area, the mitigation measures reduce the effects of outdoor construction noise on the acoustic character around the local residential communities such that the effects are not considered to be significant.

Residential receptors: indirect effects

11.4.6 Construction traffic is likely to cause adverse noise effects on residential receptors along the following local roads:

- Harvil Road and the between the junction of Harvil Road and Swakeleys Road and the proposed scheme (CSV07-C01) – approximately 25 dwellings located immediately adjacent to the road are forecast to experience an increase in outdoor noise levels of around 2 dB during the peak months (further information on traffic flows is provided in Section 12: Traffic and Transport); and
- B467 Swakeleys Road between the junction with Harvil Road and the A40 (CSV07-C02) – approximately 70 dwellings located immediately adjacent to the road are forecast to experience an increase in outdoor noise levels of around 3dB during the peak months (further information on traffic flows is provided in Section 12: Traffic and Transport).

11.4.7 This usually negligible increase in sound level is considered to be significant at these receptors as they are already exposed to high ambient noise levels.

Non-residential receptors: direct effects

11.4.8 On a reasonable worst case basis, significant construction noise or vibration effects[103] have been identified on the following non-residential receptors:

- Denham Grove (De Vere Hotel), Tilehouse Lane, Denham (CSV07-N01). A significant noise effect has been identified due to noise levels rising to 61dB[104] over a period of approximately 15 months between 2018 and 2020 during the construction of the Colne Valley Viaduct and the retaining wall that provides future provision for a Heathrow Spur;
- HOAC, Dew's Lane (CSV07-N02). A significant noise effect has been identified during the daytime over a period of approximately 8 months between 2018 and 2020 on the building at the centre due to the construction of the Colne Valley Viaduct and Harvil Road overbridge works; and
- Denham Waterski Club, (CSV07-N03). A significant noise effect has been identified at the club house during the daytime over a period of approximately 15 months between 2018 and 2020 during the construction of the Colne Valley Viaduct.

Non-residential receptors: indirect effects

11.4.9 Significant noise effects on non-residential receptors arising from construction traffic are unlikely to occur in this area.

[103] Activity disturbance, especially for activities that require good conditions for verbal communication
[104] Equivalent continuous sound level at the facade, $L_{pAeq,\ 0700\text{-}1900}$.

Summary of likely residual significant effects

11.4.10 The avoidance and mitigation measures reduce noise inside all dwellings from the construction activities such that it is does not reach a level where it would significantly affect residents.

11.4.11 The measures also reduce the effect[100] of outdoor construction noise on the acoustic character around the local residential communities such that the effects are not considered to be significant.

11.4.12 On a reasonable worst case basis, noise from specific construction activities have been identified as resulting in significant residual temporary effects on non-residential receptors Denham Grove (De Vere Hotel), HOAC and Denham Waterski Club.

11.4.13 Construction traffic on Harvil Road and B467 Swakeleys Road is likely to cause significant noise effects on adjacent residential and non-residential receptors.

11.4.14 HS2 Ltd will continue to seek reasonably practicable measures to further reduce or avoid these significant effects. In doing so the HS2 Ltd will continue to engage with stakeholders to fully understand the receptor, its use and the benefit of the measures. The outcome of these activities will be reflected in the Environmental Minimum Requirements.

11.5 Effects arising during operation

Local assumptions and limitations

Local assumptions – service pattern

11.5.1 The effects of noise and vibration from the operation of the Proposed Scheme have been assessed based on the highest likely train flows, including the Phase Two services. Trains are expected to be 400m long during peak hours and a mix of 200m and 400m long trains at other times.

11.5.2 The expected passenger service frequency for both Phase One, and Phase One with Phase Two services are described in Volume 1[105]. As a reasonable worst case, this assessment is based upon the service pattern for Monday to Saturday including Phase Two services. Passenger services will start at or after 05:00 from the terminal stations and in this area will progressively increase to the number of trains per hour in each direction on the main lines set out in Table 17. This number of services is assumed to operate every hour from 07:00 to 21:00. The number of services will progressively decrease after 21:00 and the last service will arrive at terminal stations by 24:00. Train speeds are shown in Table 17.

[105] The change in noise and vibration effects between the different passenger services is assessed in Volume 1

Table 17: Train flows and speeds

Description of line	Time period for peak daytime flows	Number of trains per hour in each direction with Phase Two services (Phase One only trains per hour in each direction is set out in brackets)	Speed
Main line between London and the north	07:00 – 21:00	18 (14)	330kph for 90% of timetabled services, 360 kph for 10% of services, with speeds reducing towards the Chiltern tunnel

Avoidance and mitigation measures

11.5.3 The development of the Proposed Scheme has, as far as reasonably practicable, kept the alignment away from main communities. This avoidance measure has protected communities from likely significant noise or vibration effects.

Airborne noise

11.5.4 HS2 trains will be quieter than the relevant current European Union specifications. This will include reduction of aerodynamic noise from the pantograph that otherwise would occur above 300kph (186mph) with current pantograph designs, drawing on proven technology in use in East Asia. The track will be specified to reduce noise, as will the maintenance regime. Overall these measures will reduce noise emissions by approximately 3dB at 360kph compared to a current European high speed train operating on the new track. Further information is provided, Volume 5: Appendix SV-001-000.

11.5.5 To avoid or reduce significant airborne noise effects, the Proposed Scheme incorporates noise barriers in the form of landscape earthworks, noise fence barriers and/or 'low-level' barriers on viaducts. Noise barrier locations are shown on Map Series SV-05 (Volume 2, CFA7 Map Book).

11.5.6 Generally, the assessment has been based on noise barriers having a noise reduction performance equivalent to a noise fence barrier with a top level 3m above the top of the rail, which is acoustically absorbent on the railway side, and which is located 5m to the side of the outer rail. In practice, barriers may differ from this description, but will provide the same acoustic performance. For example, where noise barriers are in the form of landscape earthworks they will need to be higher above rail level to achieve similar noise attenuation to a 3m barrier because the crest of the earthwork will be further than 5m from the outer rail.

11.5.7 The Proposed Scheme incorporates 'low-level' barriers into the design of viaducts. Where needed to avoid or reduce significant airborne noise effects, these barriers are designed to provide noise reduction that is equivalent to a 2m high absorptive noise fence barrier located on the parapet of the viaduct. Locating these 'low-level' barriers close to the rail also reduces visual impact and limits the mass of the viaduct itself.

11.5.8 Noise effects are reduced in other locations along the line by landscape earthworks provided to avoid or reduce significant visual effects and engineering structures such as cuttings and safety fences on viaducts (where noise fence barriers are not required).

The location of these barriers is shown on Map Series SV-05 (Volume 2, CFA7: Map Book).

11.5.9 The Proposed Scheme includes taller barriers on the viaduct over the Colne Valley to avoid or reduce significant noise effects on Denham Green, Denham Grove (De Vere Hotel) and Wyatt's Covert.

11.5.10 Significant noise effects from the operational static sources such as line-side equipment will be avoided through their design and the specification of noise emission requirements (for further information please see Volume 5: Appendix SV-001-000).

11.5.11 Noise insulation measures will be offered for qualifying buildings as defined in the Noise Insulation (Railways and Other Guided Transport Systems) Regulations 1996[106] (the Regulations). The assessment reported in this section provides an estimate of the buildings that are likely to qualify under the Regulations. Qualification for noise insulation under the Regulations will be identified and noise insulation offered at the time that the Proposed Scheme becomes operational.

11.5.12 Where required, as well as improvements to the noise insulation of windows facing the railway, ventilation will be provided so that windows can be kept closed to protect internal sound levels.

11.5.13 Following Government's emerging National Planning Practice Guidance, where the noise from the use of the Proposed Scheme measured outside a dwelling exceeds the Interim Target defined by the WHO Night Noise Guidelines for Europe[107], residents are considered to be significantly affected by the resulting noise inside their dwelling. The effect on people at night due to the maximum sound level as each train passes has also been assessed[108]. The Interim Target is a lower level of noise exposure than the Regulations trigger threshold for night noise. In these particular circumstances, where night-time noise levels for the use of new or additional railways authorised by the Bill are predicted following the methodology set out in the Regulations to exceed 55dB[109], or the maximum noise level (dependent on the number of train passes) as a train passes exceeds the criterion [108], noise insulation will be offered for these additional buildings.

Ground-borne noise and vibration

11.5.14 Significant ground-borne noise or vibration effects will be avoided or reduced through the design of the track and track-bed.

[106] *The Noise Insulation (Railways and Other Guided Transport Systems) Regulations* (1996). Her Majesty's Stationery Office, London.
[107] World Health Organization (2010) *Night-time Noise Guidelines for Europe*.
[108] During the night (2300-0700) a significant effect is identified where the Proposed Scheme results in a maximum sound level at the façade of a building at or above: 85 dB L_{pAFmax} (where the number of train pass-bys exceeding this value is less than or equal to 20); or 80 dB L_{pAFmax} (where the number of train pass-bys exceeding this value is greater than 20).
[109] Equivalent continuous level, LpAeq,23:00-07:00 measured without reflection from the front of buildings.

Assessment of impacts and effects

Residential receptors: direct effects –individual dwellings

Surface sections of route; airborne noise and ground-borne vibration

11.5.15 The assessment has identified two residential buildings, 1 – 2 Weybeards Cottages on Old Uxbridge Road, close to the Proposed Scheme where the daytime forecast noise level does not exceed the threshold set in the Regulations but the forecast night-time noise level will exceed the World Health Organization's Interim Target of 55dB [109] or the maximum noise level (dependent on the number of train passes) as a train passes exceeds the criterion [108]. It is estimated that these buildings will also be offered noise insulation as described previously in the Avoidance and mitigation measures section. These buildings are indicated on Map Series SV-05 (Volume 2, CFA7 Map Book).

11.5.16 The mitigation measures including noise insulation will reduce noise inside all dwellings, including those at Weybeards Cottages, such that it will not reach a level where it would significantly affect residents.

Residential receptors: direct effects – communities

11.5.17 The mitigation measures in this area will avoid airborne noise adverse effects on the majority of receptors, and at the majority of the following communities:

- Denham Green; and
- South Harefield

11.5.18 Taking account of the envisaged mitigation, Map Series SV-05 (Volume 2, CFA7 Map Book) shows the long term 40dB[110] night-time sound level contour from the operation of the new railway within the Proposed Scheme. The extent of the 40dB night-time sound level contour is equivalent to, or slightly larger than, the 50dB daytime contour[111]. In general, below these levels adverse effects are not expected.

11.5.19 Above 40dB during the night and 50dB during the day the effect of noise is dependent on the baseline sound levels in that area and the change in sound level (magnitude of effect) brought about by the Proposed Scheme. The airborne noise impacts and effects forecast for the operation of the scheme are presented on Map Series SV-05 (Volume 2, CFA7 Map Book).

11.5.20 The changes in noise levels are likely to affect the acoustic character of the area such that there is a perceived change in the quality of life and are considered to be significant when assessed on a community basis taking account of the local context[112].

11.5.21 The direct adverse effects[100] on the areas of the residential communities identified in Table 18 are considered to be significant.

[110] Defined as the equivalent continuous sound level from 23:00 to 07:00 (or LpAeq,night)
[111] With the train flows described in the assumptions section of this CFA Report, the daytime sound level (defined as the equivalent continuous sound level from 07:00 to 23:00 or LpAeq,day) from the Proposed Scheme would be approximately 10dB higher than the night-time sound level. The 40dB contour therefore indicates the distance from the Proposed Scheme at which the daytime sound level would be 50dB.
[112] Further information is provided in SV-001-000 and SV-004-007.

Table 18: Direct adverse effects on residential communities and shared open areas that are considered significant on a community basis

Significant effect number (see Map series SV-05)	Source of significant effect	Time of day	Location and details
OSV07-C01	Airborne noise increase from new train services	Daytime and night-time	Approximately 15 dwellings in the vicinity of Savay Lane, Denham Green, closest to the Proposed Route. Forecast increases in sound from the railway are likely to cause a moderate adverse effect on the acoustic character of the area around the closest properties and a minor adverse effect on the acoustic character of the area around of residential areas that are located further from the railway. The nearby external amenity space that is available to residents will also be adversely affected.
OSV07-C02	Airborne noise increase from new train services	Daytime and night-time	Approximately 85 dwellings (caravans and park houses) in the vicinity of Wyatt's Covert. Forecast increases in sound from the railway are likely to cause a moderate adverse effect on the acoustic character of the area around the closest park houses and a minor effect at the caravans further away, that over the community may be perceived as an adverse effect on quality of life. The nearby external amenity space that is available to residents will also be adversely affected.
OSV07-C03	Airborne noise increase from new train services	Daytime and night-time	Approximately 5 dwellings in the vicinity of Denham Grove (De Vere Hotel). Forecast increases in sound from the railway are likely to cause a moderate adverse effect on the acoustic character of the area around the dwellings nearest to the route and minor effect on those on the other side of Tilehouse Lane.

Residential receptors: indirect effects

11.5.22 The assessment of operational noise and vibration indicates that significant indirect effects on residential receptors are unlikely to occur in this area.

Non-residential receptors: direct effects

11.5.23 The assessment of operational noise and vibration indicates that significant effects are likely on the non-residential receptors identified in Table 19.

11.5.24 The assessment of effects on non-residential receptors has been undertaken on a reasonable worst case basis taking account of all the public information about each receptor. Further information can be found, Volume 5: Appendix SV-004-007.

Table 19: Likely significant noise or vibration effects on non-residential receptors arising from operation of the Proposed Scheme

Significant effect number (see Map series SV-05)	Type of effect and source	Time of day	Location and details
OSV07-N01	Minor risk of disturbance of hotel activities[113] inside due to the operation of train services and adverse effects on the acoustic character of the area around the hotel.	Daytime and night-time	Denham Grove (De Vere Hotel), Tilehouse Lane
OSV07-N02	Minor risk disturbance of activities [113] inside office buildings.	Daytime and night-time	HOAC, Dew's Lane.

Non-residential receptors: indirect effects

11.5.25 The assessment of operational noise and vibration indicates that significant indirect effects are unlikely to occur on non-residential receptors in this area.

Summary of likely significant residual effects

11.5.26 The mitigation measures reduce noise inside all dwellings such that it does not reach a level where it would significantly affect[100] residents.

11.5.27 The avoidance and mitigation measures in this area will avoid noise and vibration adverse effects on the majority of receptors and communities including shared open areas.

11.5.28 Taking account of the avoidance and mitigation measures and the local context, the residual permanent noise adverse effects on the acoustic character of the residential communities at Wyatt's Covert, in the vicinity of Denham Grove (De Vere Hotel) and the area of Denham Green closest to the route (Savay Lane) and are considered significant.

11.5.29 On a worst case basis, significant noise effects have been identified on two non-residential receptors: Denham Grove (De Vere Hotel) and HOAC.

11.5.30 HS2 Ltd will continue to seek reasonably practicable measures to further reduce or avoid these significant effects. In doing so HS2 Ltd will continue to engage with stakeholders to fully understand the receptors, their use and the benefit of any measures. The outcome of these activities will be reflected in the Environmental Minimum Requirements.

[113] Activity disturbance, especially for activities that require good conditions for verbal communication

12 Traffic and transport

12.1 Introduction

12.1.1 This traffic and transport section describes the likely impacts on all forms of transport and the consequential effects on transport users arising from the construction and operation of the Proposed Scheme through the Colne Valley area.

12.1.2 With regards to traffic and transport, the main issues as a result of the Proposed Scheme are traffic generated during construction and the closures of PRoW and roads, either temporarily or in some cases permanently, with associated diversions or realignments.

12.1.3 The effects on traffic and transport have been assessed quantitatively, based on baseline conditions and future projection scenarios.

12.1.4 A detailed report on traffic and transport and surveys undertaken within the area is contained, Volume 5: Appendix TA-001-000, Transport Assessment.

12.1.5 Figure 2 shows the location of the key transport infrastructure in this area.

12.1.6 Engagement has been undertaken with the relevant highway authorities including the Highways Agency (HA), Buckinghamshire County Council (BCC) and Hertfordshire County Council (HCC).

12.2 Scope, assumptions and limitations

12.2.1 The assessment scope, key assumptions and limitations for the traffic and transport assessment are set out in Volume 1, and in the SMR (see Volume 5: Appendix CT-001-000/1) and the SMR Addendum (see Volume 5: Appendix CT-001-000/2). This report follows the standard assessment methodology.

12.2.2 The study area includes the M25, M40, A40 Western Avenue, A413 Amersham Road, A405 Kingsway (North Orbital Road), A412 Denham Way/North Orbital Road, B467 Swakeleys Road and local roads that are affected by the Proposed Scheme.

12.2.3 The baseline forecast traffic flows for future years of assessment have been derived using the Department for Transport's traffic forecasting tool, Trip End Model Presentation Program (TEMPRO). The assessment covers the morning (08:00-09:00) and evening (17:00-18:00) peak periods for an average weekday.

12.2.4 It has been assumed that bus services for the future years of assessment will be the same as those currently operating, since it is not possible to forecast how the services may change in the future.

12.2.5 Forecast future year traffic flows with and without the Proposed Scheme have been based on an approach that does not take account of wider effects, such as redistribution and reassignment of traffic, modal shift and peak spreading, except where traffic flows have been obtained from a strategic traffic model (e.g. the West London Highways Assessment Model (WeLHAM) transport model). As a consequence, local transport effects may be over-estimated.

12.3 Environmental baseline

Existing baseline

12.3.1 Existing conditions in the Colne Valley area have been determined through site visits, specially commissioned transport surveys and liaison with relevant transport authorities and stakeholders to source traffic data, information on public transport, PRoW and accident data.

12.3.2 Traffic surveys were undertaken, to establish current traffic flows on the road network subject to assessment, during June and September 2012 and February 2013. The surveys comprised of automatic traffic counts, junction turning counts and queue surveys. This was supplemented by traffic and transport data obtained from other sources where available, including from the HA, BCC and HCC.

12.3.3 PRoW surveys were undertaken in August and September 2012, to establish the nature of the PRoW and their usage by pedestrians, cyclists and equestrians (non-motorised users). The surveys included all PRoW and roads that will cross the Proposed Scheme and any additional PRoW that will be affected by the Proposed Scheme. The surveys indicated that the majority of PRoW are used by no more than 30 people per day aside from one off-road cycle route (ref: ROW/5005/0268) which is used by no more than 60 people per day. The Proposed Scheme affects eight PRoW within the Colne Valley area and crosses five of these. In addition to the five PRoW, the Proposed Scheme also crosses four roads with potential for use by non-motorised users.

12.3.4 There are several strategic routes that pass through the area. The M25 runs in a north/south direction and forms the western boundary of the area. It is accessible from Junction 17 at Rickmansworth and intercepts the M40 at Junction 16. The M40 crosses the south of the area and merges with the A40 at Junction 1. A short stretch of the A413 Amersham Road passes to the south-west of the area and connects to the A40 west of Denham. The A405 and A412 Denham Way/North Orbital Road connects to the M25 at Junction 17 and travels in a north/south direction through the Colne Valley before merging with the A40 at Denham.

12.3.5 The main local roads affected by the Proposed Scheme are the B467 Swakeleys Road, Harvil Road, Tilehouse Lane, Denham Green Lane, Chalfont Lane, Hornhill Road, Woodland Road, Moorhall Road/Moorfield Road and Chalfont Road.

12.3.6 Relevant accident data for the roads subject to assessment has been obtained from the HA for the five year period of 2007 to2011 and from BCC and HCC for the three year period of 2009 to 2011. This has been assessed and any identified accident clusters have been examined. No significant accident clusters have been identified in the area.

12.3.7 The following eight public bus services operate along roads that were subject to assessment:

- Route 331- connecting Uxbridge to Ruislip and serving Denham, Harefield in this area;

- Route 581 – connecting Beaconsfield to Uxbridge and serving Gerrards Cross and Denham;
- Route 582 – Saturday only service connecting Higher Denham to Windsor and serving Iver and George Green;
- Route 724 – connecting Harlow to Heathrow and serving Maple Cross, and Denham;
- Route 951 – Saturday only service connecting Thorpe Park to Boreham Wood and serving Denham and Maple Cross;
- Route R21 – connecting Mount Vernon Hospital to Uxbridge and serving Mill End, Maple Cross and Denham;
- Route A30 – connecting Chesham to Heathrow and serving Amersham, Chalfont St Giles, Chalfont St Peter, Gerrards Cross and Denham; and
- Route A40/640 – connecting High Wycombe to Heathrow Airport and serving Gerrards Cross and Denham.

12.3.8 These bus routes all operate along the A40 Oxford Road with a combined peak frequency of 10 buses per hour. Six of these routes operate along the A412 Denham Way/North Orbital Road with a combined peak frequency of six buses per hour. Two services operate along Tilehouse Lane south of Wyatt's Caravan Site with route 581 providing the weekday service at up to one bus per hour. Route 331 operates along Moorhall Road/Moorfield Road and Harvil Road with a maximum frequency of three buses per hour. Route R21 operates along Hornhill Road at up to one bus per hour.

12.3.9 Frequent passenger rail services operate along the Chiltern Main Line serving stations within the area, including Denham and Denham Golf Club.

12.3.10 The Proposed Scheme also crosses the Grand Union Canal. There are no other navigable waterways that cross the Proposed Scheme, in this area.

Future baseline

12.3.11 The future baseline traffic volumes for the M25 and M25 slip roads have been derived from the Highways Agency's M25 transport model, for the future years 2021, 2026 and 2041.

12.3.12 Future baseline traffic volumes have been obtained from Transport for London's WeLHAM highway model for 2021, 2026 and 2041 for the following roads:

- Harvil Road;
- B467 Swakeleys Road; and
- A40 Western Avenue.

12.3.13 The future baseline traffic volumes for all other roads have been calculated by applying growth factors derived from TEMPRO for 2021, 2026 and extrapolation to 2041. The factors have been derived for the individual road types and relevant wards. No other changes to the traffic and transport baseline are anticipated in this area.

Construction (2017 to 2025)

12.3.14 Construction activities have been assessed against 2021 baseline traffic flows, irrespective of when they occur during the construction period. Future baseline traffic volumes in the peak hours are forecast to grow by 10% to 11% by 2021 compared to 2012, depending on road type.

Operation (2026)

12.3.15 Future baseline traffic volumes in the peak hours in this area are forecast to grow by 16% to 17% by 2026 compared to 2012, depending on road type.

Operation (2041)

12.3.16 Future baseline traffic volumes in the peak hours in this area are forecast to grow by 27% to 33% by 2041 compared to 2012, depending on road type.

12.4 Effects arising during construction

Avoidance and mitigation measures

12.4.1 The following measures (as detailed in Section 2) have been included as part of the engineering design of the Proposed Scheme that will avoid or reduce impacts on transport users:

- provision of one sustainable placement area used for excavated materials in the Colne Valley area (three others are located in CFA6) which reduces HGV movements on public roads within the area and in CFA6;
- construction materials and equipment will be transported along a haul road within the land required for construction where reasonably practicable, to reduce lorry movements on the public highway;
- the majority of roads crossing the Proposed Scheme will be kept open during construction resulting in reduced diversions of traffic onto alternative routes. Alternatives will be provided prior to any closures;
- providing temporary alternative routes or building structures early to maintain connectivity for PRoW closed during construction to reduce loss of amenity. Alternatives will be provided prior to any closures;
- providing on-site accommodation and welfare facilities to reduce daily travel by site workers; and
- HGV routeing as far as reasonably practicable along the strategic road network and using designated routes for access, as shown on Map TR-03-051 (Volume 5, Traffic and Transport Map Book).

12.4.2 The draft CoCP (see Volume 5: Appendix CT-003-000/1) includes measures which seek to reduce the impacts and effects of deliveries of construction materials and equipment, including reducing construction lorry trips during peak background traffic periods. The draft CoCP includes HGV management and control measures.

12.4.3 Where reasonably practicable, the number of private car trips to and from the site (both workforce and visitors) will be reduced by encouraging alternative modes of

transport or vehicle sharing. This will be supported through an over-arching framework travel plan[114] that will require travel plans to be used, along with a range of potential measures, to mitigate the impacts of traffic and transport movements associated with construction of the Proposed Scheme. As part of this, a construction workforce travel plan will be put into operation with the aim of reducing workforce commuting by private car, especially sole occupancy car travel. Where practical this will encourage the use of sustainable modes of transport or vehicle sharing.

12.4.4 The measures in the draft CoCP (Section 14.2) will include clear controls on vehicle types, hours of site operation and routes for heavy goods vehicles, to reduce the impact of road based construction traffic. In order to achieve this, generic and site specific traffic management measures will be implemented during the construction of the Proposed Scheme on or adjacent to public roads, bridleways, footpaths and other PRoW affected by the Proposed Scheme as necessary.

12.4.5 Specific measures will include:

- core site operating hours will generally be 08:00-18:00 on weekdays and 08:00 to 13:00 on Saturdays and site staff and workers will therefore generally arrive before the morning peak hour and depart after the evening peak hour (although the assessment has assumed that some work journeys to the construction sites take place within the morning and evening peak hours to reflect a reasonable worst case scenario). Tunnelling and directly associated activities (such as removal of excavated material, supply of materials and maintenance of tunnelling equipment) will be operational 24 hours a day. It is expected that shift changeover times would not coincide with the highway peak hours (draft CoCP, Section 5); and
- excavated material will be reused where reasonably practicable along the alignment of the Proposed Scheme which will reduce the effects of construction vehicles on the public highway (draft CoCP, Section 15).

Assessment of impacts and effects

Temporary effects

12.4.6 The following section considers the impacts on traffic and transport and the consequential effects resulting from construction of the Proposed Scheme.

12.4.7 The temporary traffic and transport impacts within this area will be:

- construction vehicle movements to and from the construction compounds;
- road closures and associated diversions; and
- PRoW closures and associated diversions.

[114] Construction and operational travel plans will promote the use of sustainable transport modes as appropriate to the location and types of trip. They will include measures such as: provision of information on and promotion of public transport services; provision of good cycle and pedestrian facilities; liaison with public transport operators; promotion of car sharing; and the appointment of a travel plan coordinator to ensure suitable measures are in place and are effective.

12.4.8 Construction vehicle movements required to construct the Proposed Scheme include the delivery of plant and materials, movement of excavated materials and site worker trips.

12.4.9 Details of construction compounds are provided in Section 2. The duration of when there will be busy transport activity at each site is shown in Table 20. This represents the periods when the construction traffic flows will be greater than 50% of the peak flows. Also shown is the estimated number of daily vehicle trips during the peak month of activity. The lower end of the range shows the average number of trips in the busy period and the upper end shows the average during the peak month.

Table 20: Typical vehicle trip generation for construction-site compounds in this area

Compound Type	**Location**	**Access to/from compound**	**Indicative start/set up date**	**Estimated duration of use (Years)**	**Estimated duration with busy vehicle movements (Months)**	**Average daily combined two-way vehicle trips during busy period and within peak month of activity**	
						Cars/ LGV	**HGV**
Main	Colne Valley viaduct	M25, A412 Denham Way/North Orbital Road and Chalfont Lane and temporary M25 slip roads from the east and the M40, A40, A412 and Chalfont Lane from the west	2017	Five years three months	51 months	80-120	10-20
Satellite	Colne Valley viaduct and south embankment	A40, B467 Swakeleys Road and Harvil Road and/or via the M40, A40, A412 Denham Way/North Orbital Road, Moorhall Road and Harvil Road from the west	2018	Six years and six months	11 months	90-140	40-60
Satellite	Ickenham auto-transformer feeder station						

Compound Type	Location	Access to/from compound	Indicative start/set up date	Estimated duration of use (Years)	Estimated duration with busy vehicle movements (Months)	Average daily combined two-way vehicle trips during busy period and within peak month of activity	
						Cars/ LGV	HGV
Satellite	Colne Valley viaduct	A40, B467 Swakeleys Road and Harvil Road and/or via the M40, A40, A412 Denham Way/North Orbital Road, Moorhall Road and Harvil Road from the west	2018	Three years and nine months	40 months	10-20	10-20
Satellite	Colne Valley viaduct storage	M40, A40, A412 Denham Way/North Orbital Road and Moorhall Road	2017	Three years and nine months	41 months	50-60	20-30
Satellite	Colne Valley viaduct jetty storage	M40, A40, A412 Denham Way/North Orbital Road and Moorhall Road	2018	Two years and nine months	29 months	10-20	10-20
Satellite	Colne Valley viaduct laydown	A412 Denham Way/North Orbital Road northwards to the M25 Junction 17 or via the A412, Chalfont Lane and temporary M25 slip roads	2019	Two years and three months	26 months	10-20	10-20

Compound Type	Location	Access to/from compound	Indicative start/set up date	Estimated duration of use (Years)	Estimated duration with busy vehicle movements (Months)	Average daily combined two-way vehicle trips during busy period and within peak month of activity	
						Cars/ LGV	HGV
Satellite	Colne Valley viaduct north launch	A412 Denham Way/North Orbital Road, A40 and M40 to the west and/or Chalfont Lane from the M25 via the M25 temporary slip roads and, A412 from the east	2017	Two years and nine months	14 months	230-280	10-20
Satellite	Colne Valley north embankment	A412 Denham Way/North Orbital Road, A40 and the M40 to the west and/or Chalfont Lane from the M25 via the M25 temporary slip roads and A412 from the east	2017	Four years	23 months	50-60	50-60
Main	Chiltern tunnel	A412 Denham Way/North Orbital Road, A40 and M40 to the west and/or Chalfont Lane from the M25 via the M25 temporary slip roads and A412 from the east	2017	Eight years	Five months	400-440	860-920
Satellite	Chiltern tunnel south portal (rail systems)						

12.4.10 Information on the indicative construction programme and methodology is provided in Section 2 which illustrates how the phasing of activities at different compounds will generally be staggered and that construction activities at individual compounds may

not occur over the whole duration presented in Table 20. Consequently the peak traffic movements will not generally occur at the same time, although in some instances there may be some overlap.

12.4.11 Where construction routes serve more than one construction compound, the combined vehicle movements have been assessed.

12.4.12 Construction of the Proposed Scheme is forecast to result in changes in daily traffic flows due to works and construction vehicles accessing worksites and also temporary road closures and diversions.

12.4.13 These changes in traffic flows will lead to significant increases in delays to vehicle users and congestion[115] at the following junctions:

- A412 Denham Way with Chalfont Lane (minor adverse effect);
- A412 North Orbital Road with Woodlands Road (minor adverse effect);
- A412 North Orbital Road with Chalfont Road (minor adverse effect);
- A412 Denham Way with A404 North Orbital Road (minor adverse effect);
- A412 North Orbital Road with Denham Green Lane (major adverse effect);
- Harvil Road with Woodstock Drive (minor adverse effect);
- B467 Swakeleys Road with Harvil Road (moderate adverse effect); and
- A40 Western Avenue with B467 Swakeleys Road (moderate adverse effect).

12.4.14 Road closures and associated diversions will result in the following effects for traffic due to increased travel distance:

- temporary short term closure (up to approximately six months) of Chalfont Lane requiring a temporary traffic diversion of approximately 6.1km via A412 Denham Way/North Orbital Road, Woodland Road, Hornhill Road, Shire Lane, Rickmansworth Lane, Denham Lane and West Hyde Lane, resulting in a major adverse effect on vehicle occupants;
- followed by a temporary long term closure (up to approximately five years and six months) of Chalfont Lane requiring a temporary diversion of approximately 1.6km via A412 Denham Way/North Orbital Road, Woodland Road, Hornhill Road and the new temporary link road between Hornhill Road and Shire Lane/Chalfont Lane, resulting in a moderate adverse effect on vehicle occupants; and

[115] In assessing significant effects of traffic changes on congestion and delays, a major adverse effect occurs where traffic flows at a junction will be beyond or very close to capacity with the Proposed Scheme and the increases in traffic due to the Proposed Scheme will be such as to substantially increase queues and delays on a routine basis at peak times. A moderate adverse effect will occur when traffic flows at a junction will be approaching or at capacity with the Proposed Scheme and modest increases in traffic will increase the frequency of queues and more substantial delays. A minor adverse effect occurs when traffic flows at a junction are not generally exceeding capacity with the Proposed Scheme but the increase in flows will result in occasional queues and delays or small increases in existing delays.

- temporary closure of Tilehouse Lane (up to one year six months) requiring a temporary traffic diversion of approximately 5.2km via A412 Denham Way/North Orbital Road and Denham Green Lane, resulting in a moderate adverse effect on vehicle occupants.

12.4.15 Construction of the Proposed Scheme will result in substantial increases in traffic flows (i.e. more than 30% for HGV or for all vehicles) and these will cause a significant increase in traffic related severance[116] for non-motorised users in the following locations:

- Hornhill Road, west of Woodland Road (major adverse effect) due to an increase in HGV flow as well as all traffic flow;
- Woodland Road (major adverse effect) due to an increase in HGV flow;
- Hornhill Road, east of Woodland Road (major adverse effect) due to an increase in HGV flow as well as all traffic flow;
- Chalfont Road, between Hornhill Road and A412 Denham Way (moderate adverse effect) due to an increase in HGV flow;
- Denham Green Lane (moderate adverse effect) – an increase in HGV flow as well as all traffic flow; Slip road on to A40 westbound from Swakeleys roundabout (major adverse effect) due to an increase in HGV flow;
- Slip road from A40 eastbound to Swakeleys roundabout (major adverse effect) due to an increase in HGV flow;
- Swakeleys Road, between A40 and Harvil Road (major adverse effect) due to an increase in HGV flow; and
- Harvil Road, south of Moorhall Road (major adverse effect) due to an increase in HGV flow.

12.4.16 There is, in addition, an increase in HGV flow on the A40, between M40 and Swakeleys roundabout but since this is not a pedestrian route it is not considered significant.

12.4.17 These traffic flow increases will not result in increases in congestion and significant delays except for those locations identified above.

12.4.18 Utilities works, including diversions, have been assessed in detail where they are major and where the traffic and transport impacts from the works separately, or in combination with other works, is greater than other construction activities arising within the area. More minor utility works are expected to result in only localised traffic and pedestrian diversions, which will be of short term duration. No additional significant effects are expected due to utilities works.

[116] In the context of this traffic and transport section, Severance is used to relate to a change in ease of access for non-motorised users due to, for example, a change in travel distance of travel time or a change in traffic levels on a route that makes it harder for non-motorised users to cross. A reference to severance does not imply a route is closed to access.

12.4.19 No significant effects on parking or loading have been identified during construction in this area.

12.4.20 The effect on accident and safety risks will not be significant as there are no locations where there are both accident clusters and substantial increases in traffic during construction.

12.4.21 Temporary PRoW diversions in this area during construction will have minor adverse effects on severance for non-motorised users due to temporary PRoW realignments of bridleway DEN/2 -Shire Lane and footpath U75 – Colne Valley Trail (footpath, bridleway, cycleway) with the length of diversions being between 600m and 1.2km. Additionally there will be temporary closures of bridleway DEN/3, bridleway Rickmansworth 004 and footpath U75 (Grand Union Canal tow path).There will be moderate adverse effects due to the temporary PRoW diversion at Chalfont Lane, with the length of diversion being approximately 2km, CSP/44 with a diversion of approximately4.8km, and Shire Lane (bridleway CSP/43/2) with a diversion of 1.2km.

12.4.22 There will be no traffic and transport effects on navigable waterways within this area.

Cumulative effects

12.4.23 The assessment includes the cumulative effects of planned development during construction by taking this into account within the background traffic growth.

12.4.24 The assessment also includes in combination effects by taking into account construction traffic and transport impacts of works being undertaken in neighbouring areas. From the adjacent areas to the north including the Chalfonts and Amersham area (CFA8), the Central Chilterns area (CFA9) and the Dunsmore, Wendover and Halton area (CFA10) the combined construction traffic flows of approximately 102 cars/LGVs per day (two-way) and 9 HGVs per day (two-way) have been included in the assessment for this area.

12.4.25 From neighbouring areas to the south-east the combined construction traffic flows of up to 460 HGVs per day (two-way) have been included in the assessment for this area.

Permanent effects

12.4.26 Any permanent effects of construction have been considered in the operations phase assessments for traffic and transport in Section 12.5. This is because the impacts and effects of the on-going increases in travel demand and the wider impacts and effects of the operations phase need to be considered together.

Other mitigation measures

12.4.27 The implementation of the draft CoCP (see Volume 5: Appendix CT-003-000) in combination with the framework travel plan and the construction workforce travel plan will, to some degree, mitigate the transport related effects during construction of the Proposed Scheme. The reductions in effects arising from these travel plan measures have not been included in the assessment, which will mean that the adverse effects may be over-stated.

12.4.28 No further traffic and transport mitigation measures during construction of the Proposed Scheme are considered necessary, based on the outcome of this assessment.

Summary of likely significant residual effects

12.4.29 Increased traffic during the most intensive periods of construction, particularly HGV traffic, will affect non-motorised users crossing and using; Hornhill Road through Maple Cross; Woodland Road; Chalfont Road, between Hornhill Road and A412 Denham Way; Denham Green Lane; Slip roads onto A40 from Swakeleys roundabout; Swakeleys Road, between A40 and Harvil Road; and Harvil Road, south of Moorhall Road.

12.4.30 Increased traffic during the most intensive periods of construction will also potentially cause additional intermittent traffic congestion and delay at a number of junctions in the area, including the A412 Denham Way with Chalfont Lane, A412 North Orbital Road with Woodlands Road, A412 North Orbital Road with Chalfont Road; A412 Denham Way with A404 North Orbital Road; A412 North Orbital Road with Denham Green Lane; Harvil Road with Woodstock Drive; B467 Swakeleys Road with Harvil Road and A40 Western Avenue with B467 Swakeleys Road.

12.4.31 Temporary closure of Chalfont Lane and Tilehouse Lane during construction will cause some additional delay for users of these roads due to the additional travel distance required by the associated diversions whilst in operation.

12.4.32 Temporary closure of five PRoW, including roads, during construction will affect the relatively few non-motorised users due to the increased travel distances required by associated diversions.

12.4.33 The significant effects that result from the construction of the Proposed Scheme are shown on Map TR-03-051 (Volume 5, Traffic and Transport Map Book).

12.5 Effects arising from operation

Avoidance and mitigation measures

12.5.1 The following measures have been included as part of the design of the Proposed Scheme and will avoid or reduce impacts on transport users:

- retaining all roads crossing the Proposed Scheme in, or very close to, their current location resulting in no diversions of traffic onto alternative routes; and
- retaining all PRoW crossing the Proposed Scheme, with localised realignments or diversions.

Assessment of impacts and effects

12.5.2 The following section considers the impacts on traffic and transport and the consequential effects resulting from the operational phase of the Proposed Scheme (as described in Section 2.4 of this report).

12.5.3 The operational traffic and transport impacts within this area will arise from the realignment of PRoW.

12.5.4 Occasional traffic may access areas of the Proposed Scheme for maintenance purposes. However, these infrequent vehicle movements will be very low and will not have a significant effect.

12.5.5 No significant effects on parking or loading will result from the operation of the Proposed Scheme in this area.

12.5.6 The effects on accident and safety risks will not be significant as there are no increases in traffic during operation.

12.5.7 It is not expected that the operation of the Proposed Scheme will require any bus route diversions and there will be no impacts on rail services in the area. Consequently, there will be no effects on public transport users during operation of the Proposed Scheme.

12.5.8 There will be minor adverse effects on the relatively few non-motorised users as a result of increased travel distance due to permanent PRoW and road realignments at Rickmansworth 004 (bridleway and dry valley); Tilehouse Lane, DEN/3 – Shire Lane (bridleway); Old Shire Lane Circular Walk; and U34 (footpath). The length of realignments will be between 250 metres and 400 metres.

12.5.9 There will be no effects on navigable waterways within this area due to the operation of the Proposed Scheme.

12.5.10 The impacts and consequential effects of the operation of the Proposed Scheme in 2041 will be the same as described for 2026, having taken account of increased background traffic growth.

Cumulative effects

12.5.11 The assessment includes cumulative effects of planned development during operation by taking this into account within background traffic growth.

12.5.12 The assessment includes cumulative effects by taking into account transport impacts as a result of the Proposed Scheme in neighbouring areas. There will, however, be no additional traffic in this area resulting from the operation of the Proposed Scheme in neighbouring areas.

Other mitigation measures

12.5.13 No other mitigation measures during operation of the Proposed Scheme are considered necessary based on the outcome of this assessment.

Summary of likely significant residual effects

12.5.14 Permanent realignment of five PRoW, including roads, to accommodate the Proposed Scheme will result in increased travel distances, but affect relatively few non-motorised users.

12.5.15 The significant effects that result from the Proposed Scheme in 2026 and 2041 are shown on Map TR-04-062 (Volume 5, Traffic and Transport Map Book).

13 Water resources and flood risk assessment

13.1 Introduction

13.1.1 This section provides a description of the current baseline for water resources including surface water, groundwater and the baseline conditions for flood risk. It then reports on the likely impacts and significant effects on these aspects as a result of the construction and operation of the Proposed Scheme.

13.1.2 The main environmental features of relevance to water resources and flood risk include:

- the wide floodplain valley of the River Colne and a tributary, the Newyears Green Bourne;
- the Mid Colne Valley SSSI (see Map EC-01-011 and EC-01-012 (Volume 5, CFA7 Ecology Map Book). This SSSI consists of several lakes between the River Colne and Grand Union Canal and part of the River Colne;
- flooded gravel pits and the Grand Union Canal which both occupy parts of the valley floor;
- the Cretaceous Chalk, a Principal aquifer (see Map WR-02-007, Volume 5, Water Resources and flood risk assessment Map Book); and
- licensed private and public water supply groundwater abstractions and associated source protection zones (SPZ).

13.1.3 Key environmental issues relating to water resources and flood risk include:

- permanent realignment of the River Colne and Newyears Green Bourne;
- construction of a viaduct pier in the existing River Colne and a number of piers through some of the lakes within the Mid Colne Valley, including Harefield No. 2 Lake, Savay Lake, Korda Lake and Long Pond;
- potential impacts on groundwater quality as a result of construction activities associated with tunnelling, piling and retaining walls;
- potential impacts on groundwater flow towards public water supplies (PWS) located close to the route due to the piles to be constructed in the aquifer to support the viaduct;
- potential impacts on the risk of river flooding at the crossings of the floodplain of the River Colne and Newyears Green Bourne; and
- potential impacts on the risk of surface water flooding at the dry valley close to Old Shire Lane.

13.1.4 Volume 5: Appendix WR-001-000 contains a report on the route-wide effects including:

- generic assessments on a route-wide basis;
- stakeholder engagement;
- in combination effects;
- a draft operation and maintenance plan for water resources and flood risk;
- a Water Framework Directive[117] (WFD) compliance assessment; and
- a route-wide Flood Risk Assessment (FRA).

13.1.5 Detailed reports on water resources and flood risk within this area are also contained in the Volume 5 appendices. These include:

- Appendix WR-002-007: Water Resources Assessment report; and
- Appendix WR-003-007: Flood Risk Assessment.

13.1.6 Map series WR-01 to WR-03 (Volume 5, Water Resources and Flood Risk Assessment Map Book) show some of the details, environmental baseline and design features referred to in this report.

13.1.7 Discussions have been held with the Environment Agency, Natural England, Buckinghamshire County Council, private borehole owners and the Canal & River Trust (formerly British Waterways).

13.1.8 Discussions have been undertaken and will continue, with the Environment Agency and Affinity Water[118], with regard to the PWS abstractions and the water resources management plan within this and the adjacent areas (CFA6 and CFA8).

13.2 Scope, assumptions and limitations

13.2.1 The assessment scope, key assumptions and limitations for the water resources and flood risk assessment are set out in Volume 1, and in the SMR and its addendum (see Volume 5: Appendix CT-001-000/1 and Appendix CT-001-000/2). This report follows the standard assessment methodology.

13.2.2 The spatial scope of the assessment was based upon the identification of surface water and groundwater features within 1km of the centre line of the route, except where there is clearly no hydraulic connectivity. For surface water features in urban areas, the extent was reduced to 500m. Outside of these distances it is unlikely that direct impacts upon the water environment will be attributable to the Proposed Scheme. Where works extend more than 200m from the centre line, for example at stations and depots, professional judgement has been used in selecting the appropriate limit to the extension in spatial scope required. For the purposes of this assessment this spatial scope is defined as the study area.

[117] *Water Framework Directive – Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy*, Strasbourg, European Parliament and European Council
[118] Affinity Water Limited

13.2.3 Site visits have included a visit in January 2013 of the Colne Valley area and in September 2012 and August 2013 to the River Colne and lakes within the Colne Valley.

13.2.4 WFD classification data has been made available by the Environment Agency. For water bodies that do not have a WFD status class shown in the relevant River Basin Management Plan (RBMP) the status class for those watercourses has been taken as the status class for the first downstream water body for which a status class is reported. Where groundwater does not have a WFD status class shown in the relevant RBMP, these are referred to as 'not assessed by the Environment Agency'.

13.2.5 The assessment uses existing data with regard to groundwater levels. No monitoring of groundwater levels has been undertaken as part of this assessment. Groundwater level data includes information received from the Environment Agency and Affinity Water. Maximum groundwater levels have been used, where appropriate, to provide an indication of the potential impact from the Proposed Scheme. In general, maximum groundwater levels were observed in early 2001, as stated in the baseline discussion.

13.2.6 The exact tunnelling method has not been selected, however, it is assumed for the purpose of assessment that the tunnel boring machine will be operated in a closed face mode when tunnelling within water bearing strata and the tunnel lining will be designed to reduce leakage rates to a minimum, thereby minimising the requirements for dewatering and drainage.

13.2.7 Piles for the temporary jetty have been assumed to penetrate the top of the productive Chalk aquifer which will be the founding substrate. This reflects the scale of support required for this temporary structure. As such, the piles associated with the temporary jetty will not hinder groundwater flow in the Chalk aquifer to the same degree as the permanent piles associated with the viaduct, which will be installed to deeper substrate.

13.2.8 Existing hydraulic modelling made available from the Environment Agency or others has been used for the assessment of flood risk. The limitations associated with flood risk within this study area are described in detail in the flood risk assessment, Volume 5: Appendix WR-003-007.

13.3 Environmental baseline

Existing baseline – Surface water resources

Surface water features

13.3.1 All water bodies within the study area, with the exception of the Grand Union Canal, fall entirely within the Colne catchment which itself falls within the Thames River Basin District (RBD) as set out in the Thames RBMP[119].

13.3.2 Map WR-01-008 (Volume 5, Water resources and flood risk assessment Map Book) shows the current surface water baseline and all surface water features within the

[119] Environment Agency (2009) *River Basin Management Plan, Thames River Basin District*

study area are assessed within Volume 5: Appendix WR-002-007. Table 21 includes features potentially affected by the Proposed Scheme.

13.3.3 The route will cross the Mid Colne Valley SSSI (see Map EC-01-011 and Map EC-01-012 (Volume 5, CFA7 Ecology Map Book). This is a 'very high' value receptor due to its national SSSI status, the water related aspects of which includes the River Colne, local wetlands and wildlife dependent on the water environment.

Table 21: Surface water features potentially affected by the Proposed Scheme

Water feature	**Location description (Volume 5, Water Resources and Flood Risk Assessment Map Book map reference)**	**Watercourse classification[120]**	**WFD water body and current overall status**	**WFD status objective (by 2027 as in RBMP)**	**Receptor value[121]**
Newyears Green Bourne	Crossed by the route near Dew's Farm, just before it flows into Harefield No 2 Lake (SWC-CFA7-02).	Main river	No status class in RBMP – assumed status Poor	No status class in RBMP – assumed status Good potential	High
Harefield No.2 Lake	Between the Alders woodland and the Grand Union Canal. There will be a 390m long crossing over this lake. (SWC-CFA7-05)	Ordinary watercourse (online)	No status class in RBMP – assumed status. Poor	No status class in RBMP – assumed status. Good potential	Moderate
Grand Union Canal	Eastern flank of the Colne Valley. (SWC-CFA7-01)	Artificial	Grand Union Canal, Maple Lodge to Uxbridge (Rivers Colne and Chess plus canal sections) GB70610252 Moderate	Good potential (by 2015)	Very High

[120] Water-feature classifications: Section 113 of the Water Resources Act 1991 defines a main river as a watercourse that is shown as such on a main river map. Section 72 of the Land Drainage Act 1991 defines an ordinary watercourse as 'a watercourse that is not part of a main river'. Section 221 of the Water Resources Act 1991 defines a watercourse as including 'all rivers and streams, ditches, drains, cuts, culverts, dikes, sluices, sewers (other than public sewers) and passages through which water flows'. Main rivers are larger rivers and streams designated by Defra on the main river map and are regulated by the Environment Agency.

[121] For examples of receptor value see Table 43 in the SMR addendum (Volume 5: Appendix CT-0001-000/2).

Water feature	Location description (Volume 5, Water Resources and Flood Risk Assessment Map Book map reference)	Watercourse classification[120]	WFD water body and current overall status	WFD status objective (by 2027 as in RBMP)	Receptor value[121]
Savay Lake and unnamed pond adjacent to Savay Lake	Between the River Colne and the Grand Union Canal. There will be three separate crossings, approximately 300m overall. (SWC-CFA7-06, SWC-CFA7-07 and SWC-CFA7-08)	Not applicable	Not applicable	Not applicable	High
Korda Lake	Part of the Mid Colne Valley SSSI. There will be a 325m long crossing over this lake. (SWC-CFA7-09)	Not applicable	Not applicable	Not applicable	Very High
Harefield Moor Lake	Part of the Mid Colne Valley SSSI. There will be a 50m long crossing over this lake. (SWC-CFA7-10)	Not applicable	Not applicable	Not applicable	Very High
Long Pond	Part of the Mid Colne Valley SSSI. There will be a 230m long crossing over this lake. (SWC-CFA7-11)	Not applicable	Not applicable	Not applicable	Very High
River Colne	Generally on western side of the Colne Valley bottom. (SWC-CFA7-03)	Main river	Colne and Grand Union Canal (from confluence with Chess to Ash) GB106039023090 Poor	Good Potential	Very High
Unnamed lake between the River Colne and Battlesford Wood	Unnamed lake approximately will be approximately 50m south of the route, part of the SSSI and west of Long Pond.	Not applicable	Not applicable	Not applicable	Very High

Water feature	Location description (Volume 5, Water Resources and Flood Risk Assessment Map Book map reference)	Watercourse classification[120]	WFD water body and current overall status	WFD status objective (by 2027 as in RBMP)	Receptor value[121]
Broadwater Lake Nature Reserve	Will be adjacent to the route and part of the SSSI.	Not applicable	Mid Colne Valley GB30641907 Good	Good Potential (by 2015)	Very High
Unnamed braided watercourse	Braided channel connected to the River Colne will be approximately 350m north of the route.	Ordinary watercourse	No status class in RBMP – assumed status Poor	No status class in RBMP – assumed status Good Potential	High
Tributary of the River Colne (The Marish)	Chalk stream near Denham Park Farm which disappears at a sink (SWC-CFA7-04)	Ordinary watercourse	No status class in RBMP – assumed status Poor	No status class in RBMP – assumed status Good Potential	High
Pynesfield Lake	Approximately 600m east of the route	Ordinary watercourse	No status class in RBMP – assumed status Poor	No status class in RBMP – assumed status Good Potential	High

Water Framework Directive status

13.3.4 The current overall status of the Grand Union Canal and the River Colne under the WFD are Moderate and Poor respectively. The Environment Agency predicts that by 2015 that the Grand Union Canal will be at Good Potential and by 2027 the River Colne will also be at Good Potential.

Abstractions and permitted discharges

13.3.5 There are no licensed surface water abstractions within 1km of the route in the study area. There is the potential for further unlicensed abstractions to exist, as a licence is not required for abstraction volumes below 20m³ per day.

13.3.6 The Environment Agency reports that there are 13 current consented surface water discharges within 1km of the route in the study area (see Volume 5, Appendix WR-002-007).

Existing baseline – groundwater resources

Geology and hydrogeology

13.3.7 The geological formations within this area are described further, with a schematic geological cross-section, Volume 5: Appendix WR-002-007.

13.3.8 The location of private abstractions, geological formations and indicative groundwater levels are shown on Map WR-02-007 (Volume 5, Water resources and flood risk assessment Map Book).

13.3.9 A summary of the superficial and bedrock geology and hydrogeology is presented in Table 22. Unless otherwise stated, the geological groups listed are all crossed by the route.

Table 22: Summary of geology and hydrogeology in the study area

Geology	Distribution	Formation description	Aquifer classification	WFD water body and current overall status	WFD status objective (by 2027 as in RBMP)	Receptor value
Superficial deposits						
Alluvium	Along the valley of the River Colne	Mainly clay, peat, silt, sand and gravel	Secondary A	Not assessed by Environment Agency	Not assessed by Environment Agency	Moderate
River Terrace Deposits - Shepperton Gravel	Within the valley of the River Colne, particularly underlying some of the lakes and in the western part of the study area	Permeable gravel, sandy and clayey in part	Secondary A	Not assessed by Environment Agency	Not assessed by Environment Agency	Moderate
Taplow Gravel	Outcrops to the south west of the Colne Valley lakes. Partially crossed to the west of the lakes.	Permeable gravel, sandy and clayey in part	Secondary A	Not assessed by Environment Agency	Not assessed by Environment Agency	Moderate
Winter Hill Gravel	Outcrops to the west of the lakes and largely south of the route. Partially crossed at Tilehouse Lane	Permeable gravel, sandy and clayey in part	Secondary A	Not assessed by Environment Agency	Not assessed by Environment Agency	Moderate
Gerrards Cross Gravel	Outcrops close to the boundary with CFA8. Partially crossed in CFA7	Permeable gravel, sandy and clayey in part	Secondary A	Not assessed by Environment Agency	Not assessed by Environment Agency	Moderate

Geology	Distribution	Formation description	Aquifer classification	WFD water body and current overall status	WFD status objective (by 2027 as in RBMP)	Receptor value
Bedrock						
London Clay Formation	Overlying the Lambeth Group. Only present in the north east of the study area (not crossed by the route)	Stiff grey, brown heterogeneous clay with closely spaced fissures	Unproductive	Not assessed by Environment Agency	Not assessed by Environment Agency	Low
Lambeth Group (Reading and Woolwich Formations)	Partially crossed along the eastern and western flanks of the Colne valley (150m and 207m respectively)	Silty clay with sand towards the top. Silty clay with occasional calcareous nodules towards the base, and limestone bands	Secondary A	Not assessed by Environment Agency	Not assessed by Environment Agency	Moderate
Newhaven Chalk	Small outcrop in the north of the study area (not crossed by the route)	Soft to medium hard chalk with marl seams and flint bands	Principal	Mid Chilterns Chalk – Poor	Good	High
Seaford Chalk	Underlying the whole study area, mostly in outcrop	Firm white chalk with nodular and tabular flint seams	Principal	Mid Chilterns Chalk – Poor	Good	High
Lewes Nodular Chalk	Small area in the north of the study area (not crossed by route)	Hard nodular chalks and hard grounds	Principal	Mid Chilterns Chalk – Poor	Good	High

Superficial deposits

13.3.10 Superficial deposits are present over the majority of the study area (as illustrated in Map WR-02-007, Volume 5, Water Resources and Flood Risk Assessment Map Book). These consist of River Alluvium, mainly clay, peat, silt, sand and gravel associated with the River Colne and Shepperton Gravel exposed by workings to the north and south of the Proposed Scheme and in the central section of the study area around Broadwater Lake. Other gravel deposits in the area include:

- the Winter Hill Gravel on an elevated ridge above Tilehouse Lane and which are not expected to contain any significant groundwater;

- the Taplow Gravel in a very limited extent but likely to be hydraulic continuity with underlying Chalk or the Alluvium along the River Colne; and
- the Shepperton Gravels which are exposed where Alluvium has been removed and are now largely covered by the lakes in the valley.

Bedrock aquifers

13.3.11 The first 150m at the southern end of the route in the study area is underlain by the clay, silt and sand deposits of the Lambeth Group.

13.3.12 The majority of the Proposed Scheme in this study area is underlain by the Cretaceous White Chalk Subgroup. The White Chalk Subgroup is classified as a Principal aquifer. The uppermost formation within the White Chalk Subgroup in this study area is the Seaford Chalk Formation.

13.3.13 The regional hydrogeological map data and available Environment Agency borehole monitoring data indicate that Chalk groundwater levels close to the Colne valley are from 30-37m AOD in the south-east, rising to 40-60m AOD to the north-west. The map indicates the regional direction of groundwater flow in the vicinity of the route to be towards the southeast (i.e. crossing the valley floor in this area). Peak groundwater levels are below the lowest elevation of tunnels and cuttings in the study area but are above the foundations of the viaduct. Other groundwater level data, such as the groundwater levels from South West Chilterns Groundwater Model[122] and data provided by Affinity Water support this conclusion.

13.3.14 Groundwater level data show that the superficial deposits, where present, are generally in a degree of hydraulic connection with the underlying Chalk.

13.3.15 Groundwater flow in the Chalk is usually dominated by flow in fissures. Desk studies suggest that the depths of major fissures bands under the floor of the valley include a zone around 20 to 30m below ground level (m bgl) and another zone around 45m bgl. Further details are given, Volume 5: Appendix WR-002-007.

13.3.16 LBH report[123] that there is an area of groundwater contamination in the Chalk aquifer associated with a closed landfill north of the route near Ickenham (see Map LQ-01-011, F1 to F4, Volume 5, Land Quality Map Book). Monitoring data for this site will be taken into account in the detailed design of the Proposed Scheme. There is another area of historic groundwater contamination known to exist in the area of Denham Studios (see Map LQ-01-011, B7 to C8, Volume 5, Land Quality Map Book).

13.3.17 There is a former sewage works at Denham Green adjacent to the River Colne (Map LQ-001-011 area 7-11, Volume 5, Land Quality Map Book). Sewage sludge was previously deposited in this area and there is potential for organic and inorganic contamination to exist in soils overlying the Chalk bedrock. Further information is provided in Section 8, Land quality, of this report.

[122] Atkins (2007) South West Chilterns Phase 1 Conceptual Model Final Report. February 2007.
[123] London Borough of Hillingdon (2011) Environmental Protection Act 1990, Part 2A – Section 78B,Record of Determination of the Land at the Former Landfill Site at Newyears Green Lane, Harefield, Middlesex.

Water Framework Directive status

13.3.18 No WFD classification has been given by the Environment Agency to the superficial deposits or the Lambeth Group.

13.3.19 The Environment Agency has classified the overall WFD status of the Mid Chilterns Chalk groundwater body as Poor Status with an objective to achieve Good Status by 2027.

Abstractions and permitted discharges

13.3.20 There are three groundwater abstractions for PWS protected by SPZ in the study area. Further details of the SPZ protecting these PWS are provided, Volume 5: Appendix WR-002-007 and shown on Map WR-02-007 (Volume 5, Water Resources and Flood Risk Assessment Map Book). All the SPZ protecting the PWS are located to the north of the route, with their designated SPZ1 and SPZ2 catchments crossed by the route. The location of the PWS sources ranges from less than 50m up to almost 1km from the route. The route also passes through the SPZ for a source in the adjacent study area (CFA6) and one source in the CFA8 study area. These are discussed in more detail, Volume 5: Appendix WR-002-007.

13.3.21 The Environment Agency reports that there are ten private licensed abstractions and one unlicensed private abstraction within the study area as set out, Volume 5: Appendix WR-002-007. There is the potential for further unlicensed abstractions to exist, as a licence is not required for abstraction volumes below 20m³ per day.

13.3.22 The Environment Agency reports that there are five consented discharges to ground/groundwater within 1km of the Proposed Scheme in the study area (details in Map WR-02-007, Volume 5, Water Resources and Flood Risk Assessment Map Book).

Surface water/groundwater interaction

13.3.23 Gravel deposits form a shallow aquifer across the valley floor and the lakes occur where these gravels have been excavated. Groundwater levels in the gravels mirror those in the lakes. Any potential wide scale changes to the groundwater levels and quality in the gravels may therefore impact surface water quality and levels and vice versa.

13.3.24 Vertical groundwater flow is generally restricted by a layer of weathered Chalk at the surface of the Chalk and some thin layers of finer material in the superficial deposits. However, the lower permeability layers are not consistent across the valley either in thickness or presence. Therefore in places the Chalk aquifer is vulnerable to contamination from the gravels and lakes due to the potential hydraulic continuity that is present.

Water dependent habitats

13.3.25 The River Colne, adjacent flooded gravel pits (including Savay Lake which is an important fishery) and the Grand Union Canal each occupy parts of the valley floor.

13.3.26 The Mid Colne Valley SSSI (see Map Series CT-10, Volume 2, CFA7 Map Book) consists of four large lakes between the River Colne and Grand Union Canal and part of the River Colne itself (refer to Volume 5: Appendix WR-002-007 for details). The water

related aspects contributing to the SSSI status include the River Colne, local wetlands and associated bird life as discussed in Section 7 of this report.

Existing baseline – flood risk

River flooding

13.3.27 The agreed data set for river flooding is the Environment Agency Flood Zone Mapping, as shown on Map WR-01-008 (Volume 5, Water resources and flood risk assessment Map Book).

13.3.28 The route will be on viaduct starting near to the Newyears Green Bourne close to HOAC before it crosses five lakes on the valley floor, the Grand Union Canal, and then the River Colne to the north of Denham Green (see Map WR-01-008, reference SWC-CFA7-02).

13.3.29 The Newyears Green Bourne has an upstream catchment size of approximately 5km² at this crossing (see Map WR-01-008, reference SWC-CFA7-02). According to Environment Agency mapping, the route will cross approximately 250m of Flood Zone 3 on viaduct. No records of historical flooding have been found for the Newyears Green Bourne. The land use within the floodplain in the vicinity of the Proposed Scheme is largely made up of arable farm land and pasture (moderate value receptor), with the exception of the residential dwelling at Dew's Farm (this would be a high value receptor however under the Proposed Scheme it will be demolished and thus will not be assessed further) and leisure uses associated with HOAC (moderate value receptor).

13.3.30 The Environment Agency flood zone mapping shows an area of fluvial floodplain along a natural valley to the north of Dew's Farm. The flood zone maps show the area of flooding ending 500m downstream of Harvil Road, however LiDAR information suggests that any flooding will continue to flow overland and discharge to Harefield No.2 Lake, a further 200m downstream and outside the study area (see Map WR-01-008, G5).

13.3.31 The River Colne has a much larger upstream catchment of approximately 725km² at the crossing (see Map WR-01-008, Water resources and flood risk assessment Map Book, reference SWC-CFA7-03). The floodplain of the River Colne is dominated by the presence of historical gravel pit workings that are now flooded and form the lakes in the area. The route will cross approximately 1.1km of Flood Zone 3.

13.3.32 There are a number of receptors that will have the potential to be affected by the Proposed Scheme across the Colne valley including residential properties at Savay Lane, Savay Farm, Widewater Lock and Weybeards Cottages, the Horse and Barge Public House (all high value receptors), electricity substations (very high value receptors), leisure facilities (moderate value receptors) and pumping stations (low value receptors).

Surface water flooding

13.3.33 As stated in the Hertfordshire County Council[124] and Buckinghamshire County Council Preliminary Flood Risk Assessment[125] (PFRA) reports, the locally agreed surface water information dataset is the Environment Agency Flood Map for Surface Water (FMfSW), which is shown on Map WR-01-008 (Volume 5, Water resources and flood risk assessment Map Book).

13.3.34 The locally agreed surface water information dataset for the LBH is from the modelling activities undertaken as part of the Drain London project for the production of the LBH PFRA[126]. Digital versions of the PFRA mapping outputs have not been made available from LBH and therefore the assessment relies on the maps in published documents rather than digital versions supplied elsewhere along the route.

13.3.35 According to the Buckinghamshire PFRA there are historical records of surface water flooding in Denham Green in 2001 and 2003.

13.3.36 There are areas on the FMfSW within the study area that have a high risk of surface water flooding outside of the floodplain of the River Colne and Newyears Green Bourne for rainfall events up to and including the 1 in 200 years return period (0.5% annual probability) event. The most notable area is where the route will cross the confluence of three dry valleys close to Old Shire Lane, as shown on Map WR-01-008 (Volume 5, Water resources and flood risk assessment Map Book) where flood to depths of over 0.3m are predicted for flooding for the 1 in 200-year return period (0.5% annual probability) event.

Sewer flooding

13.3.37 The agreed datasets for sewer flooding are Thames Water records in the Buckinghamshire, Hertfordshire[127] and LBH PFRA reports.

13.3.38 The LBH PFRA reports that there have been five historical records of sewer flooding within the study area (as at June 2010). The Buckinghamshire PFRA reports that there have been no recorded incidents of sewer flooding within the study area. There is not sufficient localised information for sewer flooding in the Hertfordshire PFRA to be able to identify historical records within the study area.

13.3.39 The route will not pass through any significantly urbanised areas within the study area. Consequently, there is currently a low risk of flooding from sewers.

Artificial water bodies

13.3.40 Flooding from artificial water bodies, such as canals and reservoirs, may occur as a result of failure of a retaining structure that impounds water. The agreed dataset for flooding due to reservoir failure is the Environment Agency Reservoir Inundation Map, as shown on Map WR-01-008 (Volume 5, Water resources and flood risk assessment Map Book).

[124] Hertfordshire County Council (2011), *Hertfordshire County Council Preliminary Flood Risk Assessment.*
[125] Buckinghamshire County Council (2011) *Buckinghamshire Preliminary Flood Risk Assessment*. Jacobs
[126] London Borough of Hillingdon (2011) *London Borough of Hillingdon Preliminary Flood Risk Assessment*
[127] Hertfordshire County Council (2011) *Hertfordshire Preliminary Flood Risk Assessment*

13.3.41 The LBH Strategic Flood Risk Assessment[128] (SFRA) identifies a potential flood risk from overtopping of the Grand Union Canal (see Map WR-01-008, Volume 5, Water resources and flood risk assessment Map Book, reference SWC-CFA7-03) during flood conditions within the River Colne. However, floodplain mapping suggests that the land adjacent to the Grand Union Canal does not become inundated until the 1 in 1,000 years return period (0.1% annual probability) flood event and it is not included in the Environment Agency hydraulic model of the River Colne.

13.3.42 To the north of HOAC, the route will cross an area shown on the Environment Agency Reservoir Inundation Maps to have a residual risk of flooding associated with a failure of the Harefield No. 3 covered reservoir. The modelled flow paths from this water body follow the course of the topographic depression to the north of Dew's Farm and end in Harefield No.2 Lake (see Map WR-01-018, G5, Volume 5, Water resources and flood risk assessment Map Book). The Proposed Scheme will also cross an area shown to be at risk in the event of breach of the Hilfield Park reservoir embankment, with flooding occurring via the Hilfield Brook and River Colne.

13.3.43 The gravel pit lakes situated along the Colne Valley are all at or below existing ground levels and consequently there is no existing risk of flooding associated with them except in combination with flooding from the River Colne.

Groundwater flooding

13.3.44 The agreed dataset for groundwater flooding is the Buckinghamshire PFRA.

13.3.45 The Buckinghamshire PFRA and the Hertfordshire PFRA show that there are areas that have a susceptibility to groundwater flooding within the study area. The most notable areas are:

- within the valley of the River Colne where more than 75% of the area is shown to be susceptible to groundwater flooding; and
- within the dry valleys close to Old Shire Lane, where the Chalk aquifer is unconfined and approximately 50% of the area is susceptible to groundwater flooding.

13.3.46 The LBH PFRA confirms that there is an increased potential for elevated groundwater within the valley of the River Colne within the LBH.

Future baseline

13.3.47 Appendix CT-004-000 identifies developments with planning permission or sites allocated in adopted development plans, on or close to the Proposed Scheme. These are termed 'committed developments' and will form part of the baseline for the operation of the Proposed Scheme. The potential cumulative effects arising from committed developments in relation to water resources and flood risk have been considered as part of this assessment of the construction and operation of the Proposed Scheme.

[128] London Borough of Hillingdon (2008) *London Borough of Hillingdon Strategic Flood Risk Assessment.*

13.3.48 The proposed mineral workings at Denham Park Farm (see Map WR-01-008, D6, Volume 5, Water resources and flood risk assessment Map Book) have approval for quarrying for 20 years (including two years of restoration to farmland). The planning consent takes account of the Environment Agency's requirements for this type of activity to ensure the protection of the Chalk aquifer and surface water features.

13.3.49 All developments are required to comply with the National Planning Policy Framework (NPPF)[129], development plans and other legislation and guidance. As such committed developments should have a neutral effect on the water resources and flood risk baseline.

13.3.50 WFD future status objectives are set out in Table 21 and Table 22. This potential change in baseline is not considered to result in the reported effects from the Proposed Scheme changing in significance.

Climate change

13.3.51 Current projections to the 2080s indicate that climate change may affect the future baseline against which the impacts of the Proposed Scheme on surface water and groundwater resources have been assessed. There may be changes in the flow and water quality characteristics of surface water and groundwater bodies as a result of changes in climate. However, except for flood flows described below, these changes are not considered to result in significant changes to the reported effects from the Proposed Scheme.

13.3.52 Current projections indicate that there will be more frequent, higher intensity rainfall events in the future. The probability and severity of surface water flooding could therefore increase as surface water drainage systems fail to cope with more frequent, higher intensity storms. Peak river flows during flood events are expected to increase, potentially causing greater depths and extents of flooding.

13.3.53 When considering the influence that climate change may have on the future baseline, against which the impacts from the Proposed Scheme on flood risk during have been evaluated, the assessment has used the recommended precautionary sensitivity ranges of key parameters, as given in Table 5 in the technical guidance to the NPPF. The sensitivity testing undertaken allows for variations in climate change factors included in other national guidance.

13.3.54 Further information on the potential additional impacts of climate change for water resources and flood risk is provided in Sections 7 and 8 of Volume 1 and Table 13 of Volume 5: Appendix CT-009-000.

13.4 Effects arising during construction

Avoidance and mitigation measures

13.4.1 The general approach to mitigation is set out in Volume 1.

[129] Department for Communities and Local Government (2012) *National Planning Policy Framework Technical Guidance*

13.4.2 The following are examples of avoidance and mitigation measures that will reduce potential adverse effects on surface water and flood risk. Further details are given, Volume 5, WR-002-007 and WR-003-007.

13.4.3 With regards to surface water features, the Proposed Scheme will cross the River Colne and Newyears Green Bourne on a long viaduct, these two watercourses are considered very high and high value receptors respectively. To ensure that flow in the rivers is unobstructed as far as reasonably practicable, the watercourses will be realigned and the new channels will be provided in advance of the main construction work within the existing channel.

13.4.4 The detailed design of the realignments will be completed in consultation with the Environment Agency to meet their objectives with respect to hydraulic capacity, flood risk, ecology and hydromorphology. Where reasonably practicable, the permanent channel realignments will be constructed in advance of other activities associated with the viaduct construction. The consideration of design features aligned with WFD objectives (for example use of soft engineering, aquatic marginal planting and inclusion of natural forms). This design mitigation will ensure that the channel is sufficiently sized to avoid a permanent impact on flow. Further detailed assessment is provided, Volume 5: Appendix WR-002-007.

13.4.5 Drainage, including that from access roads and hard standings, will discharge, where reasonably practicable, to sustainable drainage systems (SuDS) balancing ponds, prior to subsequent discharge to watercourses or if necessary to sewer. The SuDS balancing ponds provided in the current design are shown on Maps CT-06-019 to CT-06-023 (Volume 2, CFA7 Map Book). All discharges to watercourses will be conducted in accordance with consent conditions as appropriate.

13.4.6 Realignments of two minor roads (Harvil Road and Tilehouse Lane) and slip roads onto the M25, are required as part of the Proposed Scheme. Appropriate mitigation will be provided to address the risks to the receiving water body for both flow and water quality during the detailed design of the Proposed Scheme using the Design Manual for Roads and Bridges[130] and CIRIA[131] guidance to control the runoff rates and water quality in accordance with the necessary approvals.

13.4.7 The following measures will reduce potential impacts to groundwater that could arise from construction.

13.4.8 The tunnel boring machine will be operated in a closed face mode when tunnelling within water bearing strata and the tunnel lining will be designed to reduce leakage rates to a minimum, thereby reducing the requirements for dewatering and drainage.

13.4.9 The method of piling will be selected to avoid creating hydraulic pathways, such as cracks and cavities between the construction and the natural rock and will be selected to avoid creating pathways between the aquifer and shallower surface water and groundwater. This is particularly important for deep piles penetrating the Chalk and areas where contamination may exist, see Section 8, Land Quality.

[130] Department for Transport (2013) *Design Manual for Roads and Bridges*: Volume 4, Geotechnics and drainage, Section 2.
[131] Murname, E., Heap, A. and Swain, A. (2006) C648 Control of Water Pollution from Linear Construction Sites, CIRIA, London, UK.

13.4.10 The following measures will reduce potential impacts to flood risk that could arise from construction.

13.4.11 The Proposed Scheme will be raised on viaduct over the Newyears Green Bourne and the River Colne, along with their associated floodplains. This will reduce the footprint of the Proposed Scheme in the floodplain and the potential to increase flood risk elsewhere. At the Newyears Green Bourne crossing, mitigation will include the addition of two meandering bends (approximately 10m either side from the current channel) over a distance of approximately 140m.

13.4.12 At the River Colne crossing the length of the realignment has been limited to approximately 170m to maximise the retention of the existing channel. The realignment enables the channel to pass between two of the piers within the viaduct. This avoids an increase in flood risk which would have arisen had a pier been placed in the channel. Due to the angle of the river as it passes under the viaduct there may be a short section of narrowed channel. To address any potential increase in flood risk the Proposed Scheme includes replacement floodplain storage and channel improvement works to offset this impact.

13.4.13 Replacement floodplain storage areas will be provided at the edge of the modelled floodplain of the Newyears Green Bourne and the River Colne to mitigate loss of floodplain storage resulting from permanent structures in the floodplain such as piers for the Newyears Green Bourne and Colne Valley viaducts and the Ickenham National Grid feeder station, as shown on Map CT-06-019 to CT-06-020 (Volume 2, CFA7 Map Book). The replacement floodplain storage will mitigate for temporary loss of floodplain storage resulting from the construction works in the floodplain.

13.4.14 Culverts for minor watercourses and land drains, such as at Old Shire Lane, have been designed to convey the 1 in 100 years return period (1% annual probability) flood flows including an allowance for climate change. This has ensured continued conveyance (flow) and no increase in downstream flood risk.

13.4.15 The draft CoCP sets out the measures and standards of work that will be applied to the construction of the Proposed Scheme (see Volume 5: Appendix CT-003-000/1). These will provide effective management and control of the impacts during the construction period.

13.4.16 The following examples illustrate how measures in the draft CoCP will reduce potentially adverse effects arising during construction on water resources and flood risk.

13.4.17 With regard to surface water, Section 16 of the draft CoCP stipulates that works in or near the watercourses at the crossings and realignments of the River Colne and Newyears Green Bourne will be designed in consultation with the Environment Agency, so that sediment mobilisation is managed, the potential for contamination from fuel spills is minimised and the works are timed to minimise the impact on water quality and water dependent habitats and species.

13.4.18 Pro-active management practices will ensure that, should a pollution incident occur, the impact is minimised, controlled and reported to relevant parties and remediated in accordance with Section 5 of the draft CoCP.

13.4.19 With regard to groundwater, the Chiltern tunnel southern portal area will be associated with a major construction compound and there will be extensive handling and temporary stockpiling of material excavated from the tunnel and from cuttings. An area of sustainable placement will be to the east of Harvil Road and south-east of Harefield. The solid material placed at areas and temporary material stockpiles will be tested and the handling and storage adapted to the conditions required over an SPZ1. Fluids will be reused or disposed of appropriately to avoid risks to surface water or groundwater.

13.4.20 Section 11 of the draft CoCP states that the CL:AIRE Definition of Waste: Development Industry Code of Practice[132] will be followed which states that the material must be suitable for use and will not create an unacceptable risk of pollution to the water environment. The CL:AIRE Code of Practice also states that an appropriate Materials Management Plan, that must be reviewed by a 'Qualified Person', must be prepared for the project that describes how the material will be used and verifies that it is suitable for reuse

13.4.21 The Tilehouse Lane cutting will be excavated through unsaturated Chalk and will not affect groundwater levels. Despite this, the naturally fractured nature of the Chalk may provide preferential pathways to the groundwater table for any spillages. There may, therefore be issues relating to groundwater quality resulting from turbidity or release of fluids from construction equipment. The draft CoCP Section 16 requires selection, management and monitoring of material and construction practices to follow best practice, including spillage management. Further detailed discussion is provided, Volume 5: Appendix WR-002-007.

13.4.22 Specific monitoring to determine the potential impact to PWS (Affinity Water) and private abstractions will be undertaken. The monitoring schedule (to be agreed with the Environment Agency and in consultation with Affinity Water) will include monitoring before, during and after construction until the groundwater quality has stabilised within acceptable limits. The monitoring data will be assessed and used to define appropriate mitigation, should it be required.

13.4.23 Vertical migration of poorer quality surface water or poor quality porewater[133] in soils into the Chalk aquifer will be minimised by selection of piling methods which will provide an appropriate seal in the superficial deposits or surface soil layers. If contamination is encountered this will be remediated before piling is undertaken in that location. Application of measures within the draft CoCP (see section 16) will ensure suitable installation techniques for the foundations are applied. The risk assessment and design measures will be included with the method statement for the temporary works. Options include minimising the penetration into the gravels or cutting off the piles above the lake bed and leaving them in situ after construction

13.4.24 Section 16 of the draft CoCP sets out the requirements for dewatering of shallow groundwater for excavation works to ensure that and changes to local groundwater

[132] Contaminated Land: Applications in Real Environments (2011) *The Definition of Waste: Development Industry Code of Practice* (Version 2, March 2011).

[133] Porewater is the water within the soil or rock matrix above the water table. It represents a small volume of water that does not drain under gravity as the water is held in place by surface tension or adsorption by other forces onto soil particles.

levels and the hydrogeological regime are minimised, particularly within the immediate area surrounding the construction of pile caps and any deep utility diversions in the area of the valley floor. This would include the use of cut-offs and applying relatively short time-scales for the dewatering involved.

13.4.25 In accordance with Section 16 of the draft CoCP, excavated material storage, construction compounds and site offices will be located outside of areas at risk of flooding, where practicable, including the floodplain of the River Colne and Newyears Green Bourne, to avoid having an impact on the risk of flooding elsewhere. Where construction compounds cannot be located outside flood risk areas, there will be a site specific flood risk management plan prepared prior to construction to manage the potential risks.

Assessment of impacts and effects

13.4.26 This section describes the significant effects following the implementation of avoidance and mitigation measures.

13.4.27 Further details of the potential impacts that will not have significant effects are provided in the Water Resources Assessment report, Volume 5: Appendix WR-002-007 and Flood Risk Assessment in Appendix WR-003-007.

13.4.28 An assessment of the impact on the WFD status is detailed within the WFD Compliance Assessment, contained within the Route-Wide Water Resources appendix (Volume 5: Appendix WR-001-000).

13.4.29 It is not considered that projected climate change effects, combined with the effects from the construction of the Proposed Scheme, will alter the significance of any of the reported effects on surface water and groundwater resources (see Volume 3: Route-wide Effects Assessment for further information).

Temporary effects

Surface water

13.4.30 The Proposed Scheme includes 35[134] pier footings to be constructed within different sections of the Mid Colne Valley lakes including Savay Lake and, within the SSSI at Long Pond. A temporary jetty will be provided along the route and coffer dams will be constructed around each pier footing. These structures will not affect the hydrology of the lakes since the overall surface areas affected by the Proposed Scheme are small in relation to the area of each lake. The potential impacts on water quality in some individual lakes could lead to a risk of a significant adverse effect.

Groundwater

13.4.31 Tunnelling, piling and retaining wall construction could have the potential to impact on groundwater quality due to the migration of fluids or suspended bedrock particles giving rise to raised turbidity. At the scale of the classified Mid Chilterns Chalk groundwater body any turbid groundwater will be attenuated within the Chalk and diluted in regional flow and the overall impact on the groundwater body as a whole is

[134] This number includes some piers where the foundations are only partially in one of the lakes.

deemed to be negligible which for this high value receptor would be a neutral effect and therefore not significant.

13.4.32 Any migration of turbid groundwater to surface water is likely to be a slow process allowing natural attenuation within the chalk and dilution, to reduce turbidity to levels that are unlikely to significantly affect surface water quality. Therefore, the impact of any change in groundwater quality in the wider groundwater body on surface water and water dependent habitats will be negligible. Surface water features and associated water dependent habitats in the area are of high value leading to a neutral effect.

13.4.33 Although effects on wider water body receptors are considered to be neutral, if fissures connect the working area of the Proposed Scheme directly to very high value receptors such as PWS, the impact of even low levels of turbidity could cause the closure of a source due to the high quality required to be met for potable use. This risk is especially the case where the Colne Valley viaduct piers are sited within the areas designated SPZ1 TH177 and SPZ1 TH174 and where the SPZ1 TH027 (see Map WR-02-007, Volume 5, Water resources and flood risk assessment Map Book) will be intercepted by the retaining walls for the Tilehouse Lane cutting. If a PWS was forced to shut down this would be a major impact and will therefore result in a significant adverse effect.

13.4.34 In addition, there is potential to impact groundwater quality at high value receptors such as PWS in this study area that may result from construction of the Proposed Scheme in the neighbouring CFA8, such as the Chiltern tunnel. This is because the direction of groundwater flow is from west to east and south-east from CFA8 into this area. As such, there is a risk that there could be an adverse effect on the PWS in this study area resulting from tunnelling activities in CFA8.

13.4.35 The sources protected by SPZ TH027 and SPZ TH177 (see Map WR-02-007, Volume 5, Water resources and flood risk assessment Map Book) will be a substantial distance down hydraulic gradient from the Proposed Scheme (Chiltern tunnel) in the neighbouring CFA8. As a result, natural attenuation is likely to make any impact from the tunnelling on these SPZ negligible, resulting in a neutral and not significant effect on these PWS.

13.4.36 The source protected by SPZ TH171 (see Map WR-02-007, Volume 5, Water resources and flood risk assessment Map Book) is much closer to and directly down gradient of the Proposed Scheme (Chiltern tunnel) in CFA8 than TH027 and TH177. As a result of this proximity the risk of turbid water entering this abstraction point is greater than for those protected by SPZ TH027 and TH177 and hence would result in a major impact that would be a significant effect.

Flood risk

13.4.37 A temporary jetty will be constructed across the River Colne and floodplain for construction of the viaduct. In the vicinity of these works, the 1 in 100 years return period (1% annual probability) flood water level including an allowance for climate change varies between 37.73m AOD and 37.49m AOD. The top of the bank and adjacent towpath is at approximately 37m AOD along this reach of the watercourse,

which equates to a flood depth of approximately 500mm – 750mm above the towpath level. The deck and supporting structure of the jetty will be designed to take account of the potential for increased flood risk through measures to be incorporated within a site-specific flood risk management plan, as described in 'Other mitigation'. There remains the potential for the jetty to obstruct some flood flows temporarily during the construction works resulting in moderate impacts on flood risk to very high value receptors with a resulting large and significant adverse effect.

13.4.38 The assessment has identified no significant increase in flood risks from all other sources during the construction process and therefore no other significant temporary effects.

13.4.39 More detailed information is contained in the Flood Risk Assessment (Volume 5: Appendix WR-003-007).

Cumulative effects

13.4.40 There are no committed developments that have been identified which will result in significant cumulative effects.

Permanent effects

Surface water

13.4.41 No significant effects to surface water resources have been identified during the assessment.

Groundwater

13.4.42 One private licensed borehole used for groundwater abstraction at Tilehouse Lane lies within the land required for the construction of the Proposed Scheme The borehole will be decommissioned and backfilled. An alternative supply or compensation will be provided. The impact on overall water resources will be negligible and not significant.

13.4.43 The Colne Valley viaduct will be built on foundation piling that will penetrate the Newhaven and Seaford Chalk Principal aquifer, with some shallower footings for temporary supports. The groundwater table at this location is close to surface. The foundation piling is likely to disrupt groundwater flow. If significant flow horizons within the Chalk are obstructed this could lead to a reduction in flow to PWS abstractions that are particularly close to the route. The source protected by TH177 (see Map WR-02-007, Volume 5, Water resources and flood risk assessment Map Book) is located approximately 25m north-east of the route. It is predicted that the drawdown of groundwater levels at the source is likely to increase or there could be a reduction in yield by the same proportion. This potential additional drawdown or decline in yield could give rise to a major impact on the operation of this very high value receptor, particularly during times of drought. This would then be a very large and significant effect. Further details are provided, Volume 5: Appendix WR-002-007.

Flood risk

13.4.44 The assessment shows there will be no significant permanent adverse effects on flood risk.

Cumulative effects

13.4.45 There are no committed developments that have been identified which will result in significant cumulative effects.

Other mitigation measures

13.4.46 Due to the potential impacts on water quality in the lakes during construction, mitigation will be required where the temporary jetty and coffer dams are constructed around each pier footing. This is likely to include the use of floating booms to trap any hydrocarbons and floating detritus. Silt fences will be installed if there is a risk of construction giving rise to suspended solids due to disturbance of the silts in the lake bed or other causes. With these measures in place no significant residual effects will occur.

13.4.47 The Proposed Scheme could give rise to a significant adverse effect to groundwater quality and flow and thereby on water supplies that depend on the groundwater. As a result, the programme of monitoring to be undertaken in the study area, prior to, during and following completion of the construction works, will be integrated with monitoring undertaken by the owners to address these receptors. The programme will be structured taking into account all the construction processes that could have an impact on the quantity and quality of surface water and groundwater resources, and the interaction between the water resources and water supplies. The monitoring programme scope and duration will be developed and agreed with the Environment Agency in consultation with Affinity Water.

13.4.48 In respect of PWS, HS2 Ltd will agree a management strategy with the Environment Agency in consultation with Affinity Water that will cover timing of any physical mitigation, the scale and nature of monitoring and the thresholds at which actions are invoked (in terms of both quality and flow) the nature of other intervention measures and the responsibilities for ensuring agreed actions occur. These mitigation options could include:

- minimising construction durations in areas of risk for ground water impacts from turbidity;
- treatment of water at abstractions affected by turbidity; reduced amounts, or suspension, of abstraction at specific periods of construction. Reduction or suspension of abstraction will result in groundwater rebound occurring around the source in question but since this is permitted under the existing abstraction licence, the rebound will have negligible impact;
- temporarily importing water from another source such as those in the Colne Valley that are not affected by the Proposed Scheme and those in neighbouring areas for example, CFA8. Since these other sources would operate within their abstraction licence limits, there would be negligible impacts to groundwater at these other sources;
- use of scavenger wells to intercept poor quality groundwater between the works and the PWS abstraction points. This would require discharge of water arising from the scavenger wells, however, since higher levels of turbidity are

acceptable in most watercourses compared to the standard required by the Drinking Water Inspectorate, the discharge from scavenger wells will usually be suitable for discharge to the appropriate with minimal additional treatment; and

- regulatory and management initiatives such as demand reduction, leakage control or, less desirably, variations to conditions for licence abstractions in the area. In the event of adverse impacts arising from the activities of HS2 Ltd these initiatives could provide Affinity Water with enhanced flexibility of operations across its sources and additional supplies (in the event of an extreme drought or outage[135]) to manage the impacts from the Proposed Scheme.

13.4.49 The private abstraction at Tilehouse Lane may be used for drinking water and further mitigation is likely to comprise the provision of an alternative water supply or other appropriate compensation for loss of the borehole.

13.4.50 Construction of the jetty across the River Colne will require other mitigation to ensure a negligible impact on the temporary risk of flooding. Measures could include:

- the sequencing of construction;
- the pile spacing and location;
- setting the height of the jetty to take into consideration the risk of flooding from the River Colne;
- temporarily widening the River Colne channel whilst the jetty is in place over the watercourse; and
- use of a temporary by-pass.

13.4.51 The above mitigation measures will be discussed and agreed with the Environment Agency and incorporated in appropriate method statements and in the flood risk management plan as required by section 16 of the draft CoCP and will ensure no significant adverse effect on flood risk.

Summary of likely significant residual effects

13.4.52 No significant residual effects on surface water and the Mid-Chilterns Chalk groundwater body have been identified within the assessment.

13.4.53 Tunnelling and other construction below the water table has the potential to impact on groundwater quality. If fissures connect the working area of the Proposed Scheme directly to the Affinity Water groundwater abstraction which is protected by SPZ TH171, the impact of low levels of turbidity will be major due to the high quality required to be met for potable use, resulting in a large and significant temporary adverse effect during the construction works.

[135] Outage refers to periods where there is an unavailability or decrease in the level of service or abstraction.

13.4.54 Piling for the viaduct piers could disturb the groundwater flow regime to the Affinity Water groundwater abstraction protected by source protections zones referenced as TH177. Flow horizons to the abstraction are likely to be penetrated and obstructed and as a result there could be a permanent reduction in yield at the source, resulting in a very large and significant effect which could occur during construction works.

13.4.55 Until a management strategy is agreed with the Environment Agency in consultation with Affinity Water, one potentially significant temporary residual effect and one potentially permanent adverse effect on the Affinity Water groundwater abstractions remain.

13.4.56 Until design of the temporary jetty is complete and the site specific flood risk management plan is agreed with the Environment Agency, a potentially significant temporary residual effect on the risk of fluvial flooding remains. During construction works flood conveyance capacity will be reduced by the presence of a temporary jetty across the River Colne resulting in a moderate impact on very high value receptors and a large and significant effect.

13.5 Effects arising from operation

Avoidance and mitigation measures

13.5.1 Generic examples of design measures that will mitigate impacts so that there will be no significant adverse effects on the quality and flow characteristics of surface water courses and groundwater bodies during operation and management of the Proposed Scheme are described in Volume 1, Section 8.

13.5.2 Site specific examples of design measures that will mitigate impact include the drainage arrangements for the Proposed Scheme in the study area. This comprises a number of balancing ponds for either railway or highway drainage and land drainage areas. These ponds and their associated access tracks are shown on Maps CT-06-019 to CT-06-023 (Volume 2, CFA7 Map Book).

13.5.3 Generic examples of management measures during operation and management of the Proposed Scheme that will mitigate impacts so that there are no significant adverse effects on the quality and flow characteristics of surface water courses and groundwater bodies are described in Volume 1, Section 9 and in the draft operation and maintenance plan for water resources and flood risk included, Volume 5 Appendix WR-001-000.

13.5.4 For protection of sensitive areas such as the Mid Colne Valley SSSI and the SPZ associated with PWS measures will be developed to reduce impacts from track runoff draining directly to the surface water receptors. These will include measures such as controls on painting, track maintenance and the application of de-icing fluids and track grease.

13.5.5 As noted in the generic assessment in Volume 3, the risk of pollution from accidental spillage is considered to be extremely low. Incorporation of appropriate spillage control measures within the drainage of the viaduct will reduce this risk further.

13.5.6 Operation and management of the Proposed Scheme is not likely to have a significant adverse effect on flood risk anywhere in the catchments through which it passes.

Generic examples of management measures that may mitigate flood risk are described in Volume 1.

Assessment of impacts and effects

13.5.7 There are considered to be no significant adverse effects to surface water, groundwater or flood risk arising from operation of the Proposed Scheme.

Other mitigation measures

13.5.8 There are considered to be no further measures required to mitigate adverse effects on surface water resources or groundwater resources or flood risk.

14 References

Atkins (2007) *South West Chilterns Phase 1 Conceptual Model Final Report*. February 2007.

Bat Conservation Trust (2012) *The state of the UK's bats: National Bat Monitoring Programme Population Trends 2012*. BCT. London

BMERC and TVERC (2009) *Criteria for the Selection of Local Wildlife Sites in Berkshire, Buckinghamshire and Oxfordshire*

British Geological Survey (2013) Available online at: http://bgs.ac.uk/geologyofbritain/home/html

British Standards Institute (2011) *British Standard BS10175: Investigation of Potentially Contaminated Sites*

Buckinghamshire County Council (1991) *Buckinghamshire Structure Plan 1991-2011: Saved Policies*

Buckinghamshire County Council (2011) *Buckinghamshire Preliminary Flood Risk Assessment*. Jacobs

Buckinghamshire County Council (2012) *Minerals and Waste Core Strategy Development Plan Document*

Chiltern District Council (2011) *Chiltern District Local Plan, Adopted September 1997*. Consolidated September 2007 and November 2011

Chiltern District Council (2011) *Core Strategy for Chiltern District*

Colin Plant Associates (2006) *Invertebrates and Ecological Assessment*. Unpublished Report to the Institute of Ecology and Environmental Management

Contaminated Land: Applications in Real Environments (2011) *The Definition of Waste: Development Industry Code of Practice* (Version 2, March 2011).

Cranfield University (2001) *The National Soil Map of England and Wales* 1:250,000 scale

Department for Communities and Local Government (2012) *National Planning Policy Framework Technical Guidance*

Department for Transport *(2013) Design Manual for Roads and Bridges:* Volume 4, Geotechnics and drainage, Section 2.

Defra (2005) *Likelihood of Best and Most Versatile Agricultural Land*

Defra (2009) *Construction Code of Practice for the Sustainable Use of Soils on Construction Sites*

Defra (2009) *Soil Strategy for England*

Defra (2011) *2010 Based Background Maps for NO_x, NO_2, PM10 and PM2.5*. Available online at: http://laqm.defra.gov.uk/maps/maps2010.html; Accessed July 2013

Defra (2011) *The Natural Choice: securing the value of nature*

Directive 200/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, Strasbourg, European Parliament and European Council

Eaton M.A. et al. (2009) *Birds of Conservation Concern 3: the population status of birds in the United Kingdom, Channel Islands and the Isle of Man*. British Birds 102,pp296–341

Environment Agency (2004) *CLR11 Model Procedures for the Management of Land Contamination*

Environment Agency (2009) *River Basin Management Plan, Thames River Basin District*

Ferguson, D. (2012) *The Birds of Buckinghamshire*. Buckinghamshire Bird Club. Buckinghamshire

Forestry Commission (2001) *National Forest Inventory, Woodland and Ancient Woodland* (as updated)

Greater London Authority (2011) *The London Plan: Spatial Development Strategy for Greater London*

Hertfordshire Bird Club (undated). Hertfordshire Bird Atlas [on-line] http://www.hertsatlas.org.uk/ (accessed 2nd October 2013)

Hertfordshire County Council (2007) *Hertfordshire Minerals Local Plan Review 2002-2016*. Adopted march 2007

Hertfordshire County Council (2007) *Supplementary Planning Document, Mineral Consultation Areas in Hertfordshire*

Hertfordshire County Council (2011) *Hertfordshire Preliminary Flood Risk Assessment*

Hertfordshire County Council (2012) *Waste Core Strategy*

Homes and Communities Agency (HCA) (2010) *Employment Densities Guide.* 2nd Edition

IAQM (2012) *Guidance on the assessment of the impacts of construction on air quality and the determination of their significance*

James, T.J. (2009) *Flora of Hertfordshire*. Hertfordshire Natural History Society. Norwich

JNCC (2011) *Taxon designations spreadsheet*. Available online at:. http://jncc.defra.gov.uk/page-3408 (accessed 19th September 2013)

JNCC (2011) *UK BAP Rivers – Qualifying Reaches*. [on-line] http://jncc.defra.gov.uk/page-4863 (accessed September, 2013).

London Borough of Hillingdon (1998) *Adopted Unitary Development Plan*, Saved Policies

London Borough of Hillingdon (2008) Local Development Framework, Minerals Background Report

London Borough of Hillingdon (2008) *London Borough of Hillingdon Strategic Flood Risk Assessment*

London Borough of Hillingdon (2011) *Environmental Protection Act 1990, Part 2A – Section 78B, Record of Determination of the Land at the Former Landfill Site at Newyears Green Lane, Harefield, Middlesex*

London Borough of Hillingdon (2011) *Hillingdon Core Strategy*, Submission Draft

London Borough of Hillingdon (2011) *London Borough of Hillingdon Preliminary Flood Risk Assessment*

Murname, E., Heap, A. and Swain, A. (2006) *C648 Control of Water Pollution from Linear Construction Sites*, CIRIA, London, UK

Natural Environment and Rural Communities (NERC) Act 2006. Her Majesty's Stationery Office. London

National Planning Practice Guidance – Noise. Available online at: http://planningguidance.planningportal.gov.uk

Office for National Statistics (2011) *Population Census*

Office of National Statistics (2011) *UK Business: Activity, Size and Location*

Office of National Statistics (2012) *Business Register and Employment Survey 2011*

Soil Survey of England and Wales (1984) *Soils and their Use in South East England*

South Bucks District Council (1999) South Bucks District Local Plan, Adopted March 1999, Consolidated September 2007 and February 2011

South Bucks District Council (2011) *Core Strategy Development Plan Document*

South East Regional Assembly (2009) *The South East Plan, Regional Spatial Strategy for the South East*

Sustainable Remediation Forum UK (2010) *A Framework for Assessing the Sustainability of Soil and Groundwater Remediation*

The Hedgerows Regulations 1997 (1997 No. 1160). Her Majesty's Stationery Office. London

The Regional Strategy for the East of England (Revocation) Order 2012

The Regional Strategy for the South East (Partial Revocation) Order 2013

Three Rivers District Council (2011) *Core Strategy*

Three Rivers District Council (2013) *Development Management Policies Local Development Document Proposed Submission*, July 2012, Track changes Version Main and Additional Modifications.

Three Rivers District Council (2011) *Three Rivers Local Plan 1996-2011*, Word Version following the adoption of the Core Strategy in October 2011

The Noise Insulation (Railways and Other Guided Transport Systems) Regulations. Her Majesty's Stationery Office, London

Tracking Mammals Partnership (2009) *UK Mammals Update 2009*. JNCC, Peterborough

Water Resources Act, 1991. Her Majesty's Stationery Office, London

Wildlife and Countryside Act 1981 (1981 Chapter 69). Her Majesty's Stationery Office, London. Available online at: http://www.legislation.gov.uk/ukpga/1981/69 (accessed September 2013)

White, G.J and Harris, A.J. (2008) *The wetland resource of the Colne Valley: an assessment of its importance to nature conservation, with special reference to waterbirds*. Natural England, Herts and Middx. Wildlife Trust and Environment Agency

Wray, S., Wells, D., Long, E. and Mitchell-Jones, T. (2010) *Valuing bats in ecological impact assessment*. In Practice: December issue. CIEEM

World Health Organization (2010) *Night-time Noise Guidelines for Europ*e