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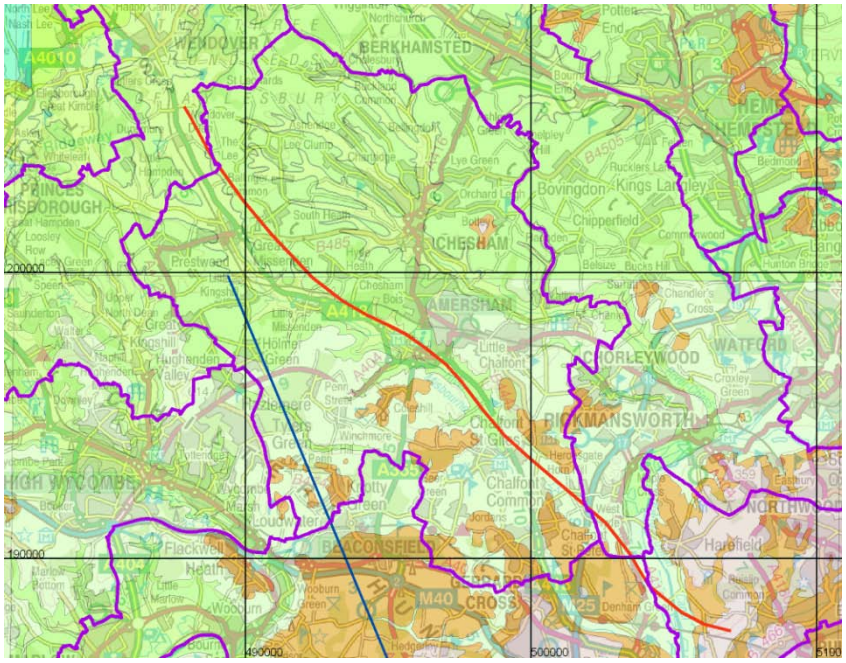
# Summary Report on the Geology of the Proposed HS2 Route (3) in the Chesham and Amersham Constituency

Open-file Report OR/11/040



BRITISH GEOLOGICAL SURVEY

OPEN-FILE REPORT OR/11/040

# Summary Report on the Geology of the Proposed HS2 Route (3) in the Chesham and Amersham Constituency

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*Keywords*

Geology, hydrogeology, geological hazards, Chesham and Amersham, High Speed Rail Link, HS2.

*Map*

Sheet 255, 1:50 000 scale Beaconsfield; Sheet 238, 1:63 360 scale Aylesbury

*Front cover*

Generalised geological map (bedrock) of the area.

*Bibliographical reference*

MORIGI, A N, POWELL, J H, WARD, R, LEWIS, M A AND SMITH, M. 2011. Summary Report on the Geology of the Proposed HS2 Route (3) in the Chesham and Amersham Constituency. *British Geological Survey Open-file Report*, OR/11/040. 15pp.



Keyworth, Nottingham British Geological Survey 2011

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# Contents



## FIGURES

# Summary

This brief open-file report summarises the information available from the British Geological Survey (BGS), a component body of the Natural Environment Research Council (NERC), on the geology, hydrogeology and potential geological hazards of the proposed HS2 Route 3 within the Chesham and Amersham Constituency, and surrounding areas.

The report summarises the geology and hydrogeology of the district and highlights geological and hydrogeological considerations that may need further investigation along the route.

Further review and analysis of existing data and possible field investigation would be required to confirm details of the local geology[1].

The report was requested by Mrs Cheryl Gillan MP following a meeting with Dr Martin Smith, Head of Geology & Landscapes programme, on Monday 16th May 2011 at the offices of the Secretary of State for Wales in Whitehall. The report is available to the public through the BGS NERC Open Research Archive (NORA) website at http://nora.nerc.ac.uk/ .

[1] In addition to the data presented here, BGS is able to provide both regional and detailed 3D geological models along the line of the proposed HS2 route, and visualisation facilities to explain the sub-surface geology. We also provide customised products derived from our datasets targeted to specific users

# 1 Introduction

This report provides an overview of the geology, hydrogeology and potential geological hazards for the bedrock and overlying superficial deposits in the Chesham and Amersham district. It is based on existing data held by the British Geological Survey (BGS). Section 2 presents an overview of the geology and geological considerations in the district, and is accompanied by a summary of available data. Section 3 covers the general hydrogeology and surface-water hydrology, and includes groundwater considerations and a summary of available hydrogeological data. A list of the main references used to compile this report is provided; further information is available via the BGS web site www.bgs.ac.uk.

# 2 Geology

## 2.1 GENERAL GEOLOGY

The geology beneath the Chesham and Amersham district has been recently re-surveyed by the BGS. A detailed description of the geology of the district can be found in BGS (2005) and the accompanying booklet (Morigi et al., 2005). The bedrock and superficial deposits geology in the district (Figures 1, 2 and 3) is similar to that underlying much of the Thames Basin, and the reader is referred to *British Regional Geology: London and Thames Valley* (Sumbler, 1996) for background and further information.

Bedrock is at or near surface over much of the area and comprises a gently south-east dipping succession of chalk and chalk marl assigned to the Chalk Group (Figures, 1, 2 and 4). On the basis of hardness, fossil groups and physical attributes, including the presence or absence of marl beds and flints, the Chalk Group is divided into a number of units (sub-groups and formations) (Figure 2). The line of the HS2 Route 3, along some of its length, follows the Misbourne Valley which cuts down through these Chalk units (Figure1). The Chalk is, in turn, locally overlain by the Lambeth Group, a thin deposit of silty clay with beds of sand and gravel. The youngest, or superficial (Quaternary), deposits of the district (Figure 3) were formed prior to, during and following the Anglian Ice Age that ended about 430,000 years ago. These deposits include the Beaconsfield and Gerrards Cross gravels that were deposited by the ancestral River Thames, remnants of which underlie the higher land around Chalfont St Peter and Chalfont Common, and Clay-with-flints which underlies much of the high ground between Amersham and Wendover (Figure 3).

### 2.1.1 Geological Considerations

All the issues described below refer to features commonly seen in chalk rocks across the region. Further work would be required to confirm or deny their existence in the Chesham and Amersham district.

Chalk, although a highly porous rock (i.e. like a sponge), has low permeability (i.e. the interconnection of pores). Groundwater flow is mostly via joints and fractures within the chalk. The distribution and frequency of these joints and fractures, and hence their potential impact on any tunnelling, is difficult to predict without a detailed ground investigation.

The district has experienced a complex glacial history and this will have affected the physical weathering and dissolution of the chalk bedrock. Dissolution features (known collectively as ‘karst’) including collapse features, sink or swallow holes and sediment-filled pipes are present; their distribution and frequency within the Chesham and Amersham District are controlled by the

distribution of the most susceptible chalk units, by the presence or absence of the overlying Lambeth Group and Quaternary (superficial) deposits, and local geological structures (e.g. joints and fractures). These features have not been surveyed in detail over the whole district, but this could be accomplished by the application of modern LIDAR (Light Detection And Ranging) and radar scanning imagery, and follow-up ground surveys as employed in a recent BGS survey for the Environment Agency between the Misbourne and Colne valleys (Brayson and Woods, 2011).

In some areas the Chalk, as recorded in boreholes, is deeply weathered to “putty chalk”, a soft structureless chalk that can have an impact on engineering ground conditions and groundwater flow. Further investigation would be required to better understand the variation in physical properties of the Chalk in this area.

Clay within the Lambeth Group and Clay-with-flints deposit may be susceptible to ground movement (shrink and swell) especially during periods of enhanced rainfall or drought.

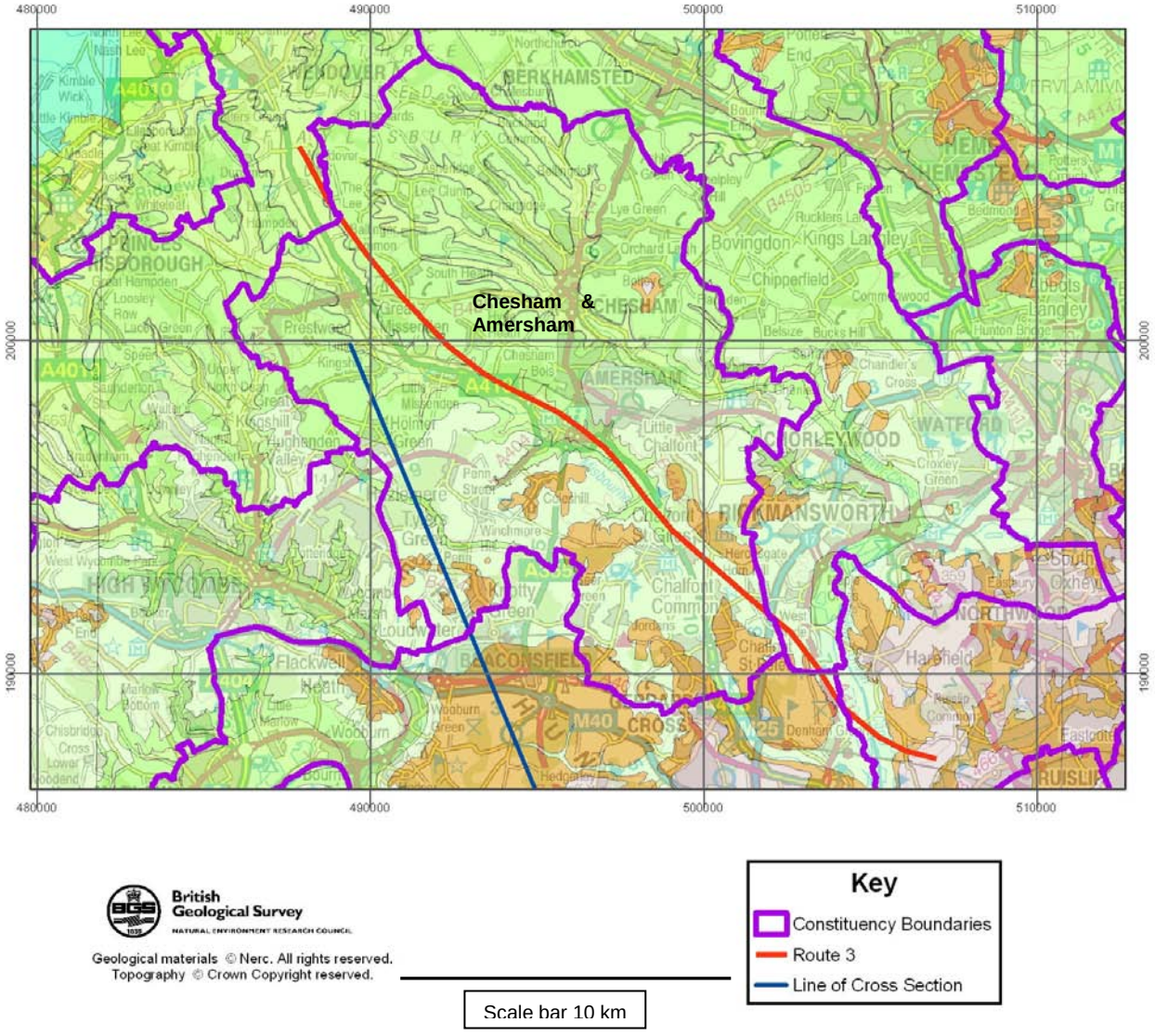


**Figure 1. Simplified bedrock geological map of the area showing the Chesham and Amersham Constituency boundary, and the proposed HS2 Route 3 (red). See Figure 2 for key to geological units and Figure 4 for the generalised cross-section (blue line). Geology based on BGS DigMapGB50.**

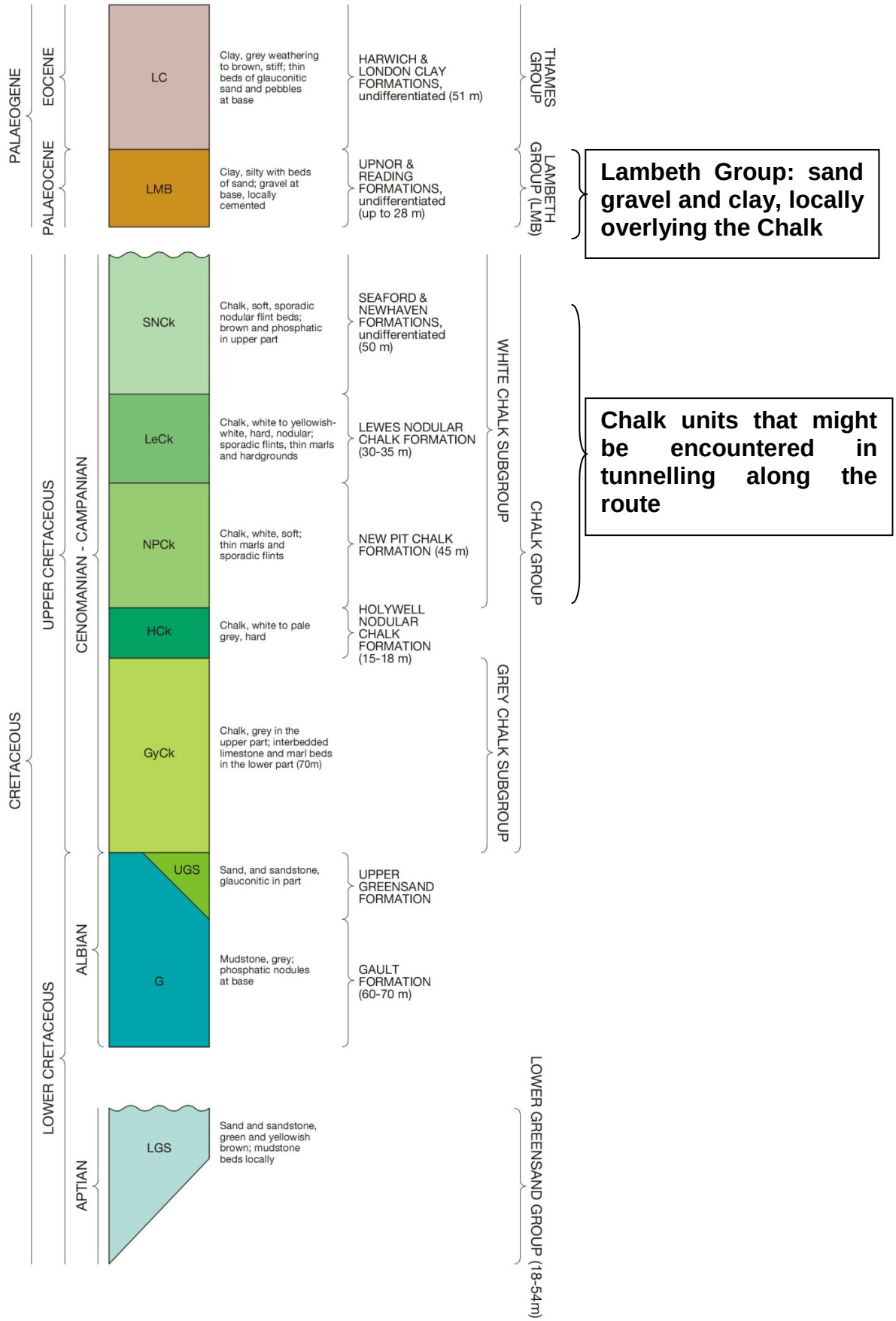


**Figure 2. Generalised vertical section (rock succession) of the bedrock in the area to the base of the Lower Greensand Group. The youngest rocks are at the top. Superficial deposits overlying bedrock are shown in Figure 3 and 4. Based on BGS (2005).**

### 2.1.2 Data Availability

BGS hold modern large-scale geological survey data (2002) that is available in printed and digital form for Route 3 between Chalfont St Peter and Little Missenden, covering the length of the proposed main twin-bore tunnel and the Little Missenden single-bore tunnel. This survey was carried out at 1:10 000-scale and is available as part of the Beaconsfield Geological Sheet 255 (BGS, 2005) and related maps, and accompanying publication (Morigi et al., 2005).

North of Little Missenden, to the north of the tunnel section, there has been no modern survey and the geological maps date from 1911 to 1922 (Aylesbury Sheet 238).

The following data are available:

- 1:50 000 scale sheets
    - Aylesbury Sheet 238 (published at 1:63 360) based on 1:10 560 surveys dated 1911 -12
    - Beaconsfield Sheet 255 based on 1:10 560 surveys and published in 1922, amended in 1964 and 1974. Substantially resurveyed and revised on 1:10 000-scale in 2002.
- Large scale maps
    - Aylesbury 1: 10 560 scale maps surveyed in 1911-12
    - Beaconsfield 1: 10 000 scale maps surveyed 2002
- Digital maps
    - DigMapGB50 for whole route, based on 1: 50 000 scale geological sheets, see above
    - DigmapGB10 for Beaconsfield sheet area, based on large scale maps, see above
- Cross-sections
    - Included in marginalia of printed 1:50 000 Beaconsfield Sheet – not along the exact route, but close enough to illustrate the geological succession (see Figure 4, herein), including subdivisions of the Chalk Group, Superficial Deposits (mostly sand and gravel) and the general structure.
- Boreholes
    - Borehole index level data entered in the Single Onshore Borehole Index (SOBI), captured along 1 km wide corridor centred along Route 3 (approx 200 boreholes)
    - Several hundred borehole logs for the district that could be used to produce a 3D geological model of Route 3.
- Memoirs and Sheet explanations
    - Aylesbury and Hemel Hempstead 1922 (Geological Survey Memoir: Sherlock, 1922)
    - Beaconsfield (Geological Survey Memoir: Sherlock and Noble, 1922)
    - Beaconsfield 2005 (Sheet Explanation: Morigi et al., 2005)
    - Geology of London (BGS Memoir: Ellison et al, 2004)
    - British Regional Geology: London and Thames Valley (Sumbler, 1996)

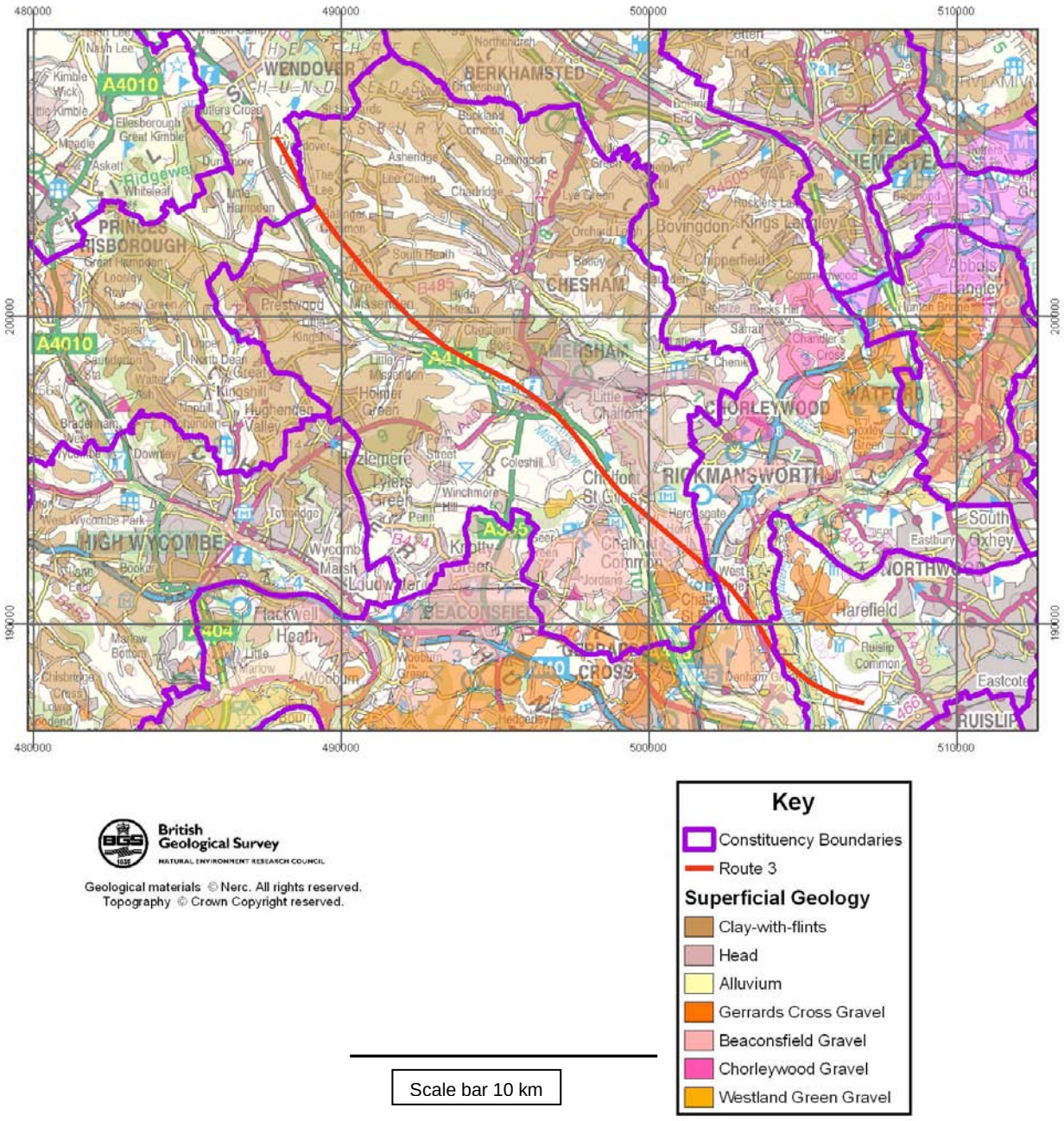


**Figure 3. Simplified geological map of the superficial deposits (overlying bedrock) for the area showing the Chesham and Amersham Constituency, and the proposed HS2 Route 3. Geology based on BGS DigMapGB50.**

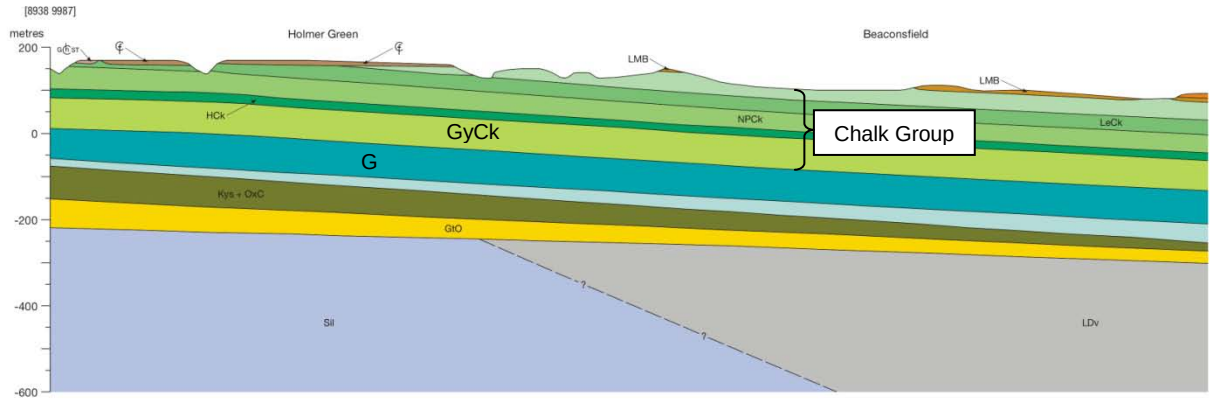


**Figure 4. Generalised cross-section (vertical slice) of the geology of the area from the north-north-west to south-south-east, showing the gently dipping Chalk units (green colours), the Lambeth Group (LMB) and Clay-with-flints deposits (see Figure 2 for an explanation of the bedrock symbols). The line of the cross-section is shown as a blue line in Figure 1. Vertical exaggeration is about x 5. Based on BGS (2005).**

# 3 Hydrogeology

## 3.1 GENERAL HYDROGEOLOGY AND HYDROLOGY

The Chesham and Amersham constituency and the proposed HS2 route area are principally underlain by the Chalk, the most important water supply aquifer in southern and eastern England. The Chalk yields and transmits water mainly by fracture flow. The Chalk transmits water less readily at interfluve locations (i.e. higher ground between two rivers) than it does in valley localities due to the presence of fewer fractures. The Chalk generally transmits water less readily with depth as fractures become smaller and less common, although occasional hard bands such as the Chalk Rock can have well-developed fracture systems and form productive (high yielding) horizons. In this area, the Chalk can be highly transmissive in the valleys.

The constituency area is primarily drained by the River Misbourne, a tributary of the River Colne (Figure 1). The river flows south-eastwards. To the north-west of Little Missenden the river is intermittent and only flows for part of the year. Downstream between Chalfont St Giles and Chalfont St Peter it is again intermittent. The south-eastern part of the proposed route crosses into the valley of the River Colne (Figure 1). The rivers are in hydraulic continuity with the Chalk aquifer. Water levels in the Chalk fluctuate seasonally in response to recharge from rainfall. Seasonal variations vary from less than a metre in the valleys to over 20 metres beneath the interfluves. The intermittent (bourne) nature of the rivers reflects the seasonal rise and fall in water levels in the aquifer. Groundwater levels decline south-eastwards away from the Chilterns.

The natural groundwater quality of the Chalk is generally good and of calcium bicarbonate type with a chloride ion concentration of less than 35 mg/l. Nitrate concentrations are elevated locally due to impacts from agricultural practices.

### 3.1.1 Groundwater considerations

The HS2 Route 3 is generally along valleys but on the higher ground the Chalk is overlain by younger deposits. The Chalk is prone to exhibit karstic features either side of its boundary with the overlying Lambeth Group or Clay-with-flints deposit. This means that the Chalk can have well-developed solution features such as sink holes, lost drainage and solution-enhanced fractures, resulting from infiltration of weakly acidic rainwater run-off, which often enhance permeability. Karst features make the aquifer more prone to contamination from polluted surface water, most commonly after prolonged or heavy rain.

The whole of HS2 route in this area lies within, or very close to, Groundwater Source Protection Zones for several public water supplies sources (Hampden, Amersham, Chalfont St Giles, Great Missenden, Wendover, Northmoor and West Hyde).

### 3.1.2 Data availability

The following hydrogeological data are available:

- Hydrogeological maps
    - A hydrogeological map of the area (British Geological Survey, 1984) portrays and describes the hydrogeology of the area. This includes water levels (minimum, autumn 1976) as well as structural contours (on the base of the Lewes Nodular Chalk, base of the Chalk Group and top of the Lower Greensand) and thickness of Lower Greensand.
- Groundwater quality
    - Two reports are available on the groundwater quality of the area (Shand et al., 2003; Environment Agency, 2005)
- Boreholes with groundwater information
    - There are about 70 records in the BGS National Well Record Archive with water information within 1 km of the route; of these 2 have time-series water level data. There are few aquifer properties values available within 1 km of the route.
- Environment Agency data
    - The Environment Agency routinely monitors both groundwater quality and level within the area; data are available from the Agency. The groundwater quality data are summarised in the reports identified above and the groundwater level data used to inform the Catchment Abstraction Management Strategy (CAMS) for the Colne Valley, published on the Agency's website www.environment-agency.gov.uk. With respect to the River Misbourne there are spot flow measurements of surface flow taken by the Environment Agency; approximately 224 datasets are available for the period from 1993-2008.

# References and data access

British Geological Survey holds most of the references listed below, and copies may be obtained via the library service subject to copyright legislation (contact libuser@bgs.ac.uk for details). The library catalogue is available at: http://geolib.bgs.ac.uk.

In addition to the reference materials listed below, the public can access the geological data such as digital geological maps and borehole information via the BGS website http://www.bgs.ac.uk/services/home.html. and through BGS Open Geoscience at http://www.bgs.ac.uk/opengeoscience/.

BRAYSON, J and WOODS, M A. 2011. The Geology of part of the Misbourne Valley, Buckinghamshire. British Geological Survey Commissioned Report, CR/11/052. 28pp.

BRITISH GEOLOGICAL SURVEY, 1984, Hydrogeological map of the area between Cambridge and Maidenhead, 1: 100 000.

BRITISH GEOLOGICAL SURVEY, 2005. Beaconsfield. England and Wales Sheet 255. Solid* and Drift*Geology. 1:50 000. (Keyworth, Nottingham: British Geological Survey).

[* Solid, here, refers to Bedrock geology, (e.g. Chalk): Drift refers to Superficial Deposits (e.g. poorly consolidated Sand and Gravel)]

ELLISON, R A, WOODS, M A, ALLEN, D J, FORSTER, A, PHARAOH, T C, and KING, C. 2004. Geology of London. *Memoir of the British Geological Survey*, Sheets 256 (North London), 257 (Romford), 270 (South London) and 271 (Dartford) (England and Wales)

ENVIRONMENT AGENCY, 2005, Groundwater Quality Review: The Chalk of the Mid-Chilterns and Colne Valley, Thames Region, Environmental Simulations International Ltd.

MORIGI, A N, WOODS M A, REEVES, H J, SMITH, N J P and MARKS, R J. 2005. Geology of the Beaconsfield district – a brief explanation of the geological map. *Sheet Explanation of the British Geological Survey*. 1:50 000 Sheet 255 Beaconsfield (England and Wales). Keyworth, Nottingham: British Geological Survey.

SHAND P, TYLER-WHITTLE R, BESIAN T, PEACH DW, LAWRENCE AR AND LEWIS HO, 2003, Baseline Report Series 6: The Chalk of the Colne and Lee River Catchments, British Geological Survey Report CR/03/69N; Environment Agency Technical Report NC/99/74/6.

SHERLOCK, R L. 1922. The geology of the country around Aylesbury and Hemel Hempstead. *Memoir of the Geological Survey of Great Britain* (England and Wales, Sheet 238).

SHERLOCK, R L and NOBLE, A H. 1922. The geology of the country around Beaconsfield. *Memoir of the Geological Survey of Great Britain* (England and Wales, Sheet 255).

SUMBLER, M G. 1996. *British regional geology: London and the Thames Valley* (4th edition). (London: HMSO for the British Geological Survey)