



British
Geological Survey

NATURAL ENVIRONMENT RESEARCH COUNCIL

Gateway to the Earth

Creating a step change in site investigations through the use of 3D models

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GROUND
ENGINEERING

GROUND INVESTIGATION
CONFERENCE
2015

22 April 2015

The Bloomsbury Hotel, London

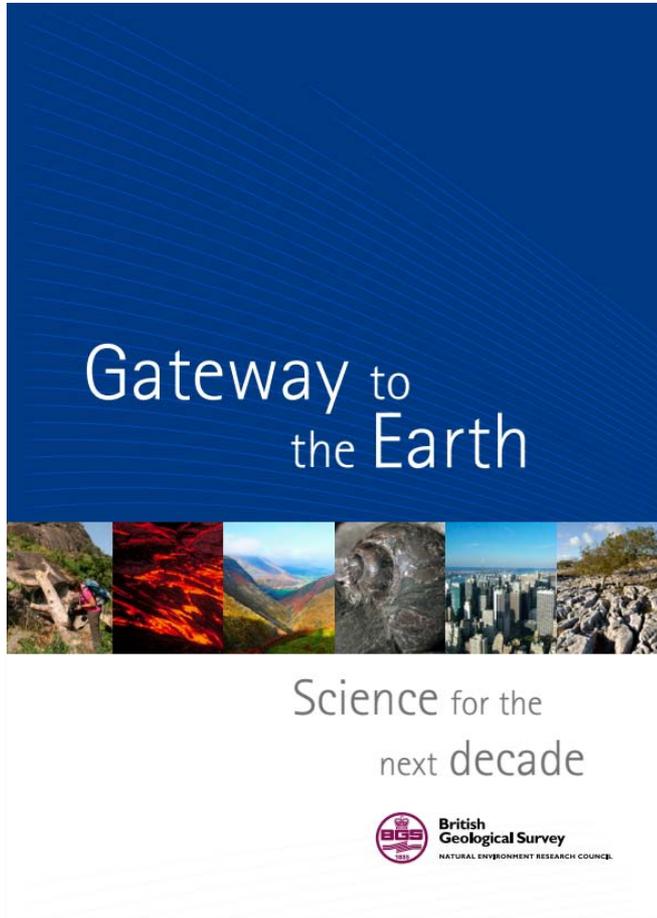


Introduction

- The role and strategy of the British Geological Survey
- The London and Thames Valley regional model
- The National Geological Model
- Working with others
- Future initiatives



The role and strategy of the British Geological Survey



BGS Strategy 2014-2019

- National geological survey founded in 1835
- UK custodian of geoscientific information
- Independent and impartial
- 630 staff (520 multi-disciplinary scientists)
- Part of NERC, a not-for-profit public sector research establishment
- Funded by Government & external income
- Offices at Keyworth, Wallingford, Edinburgh & Cardiff

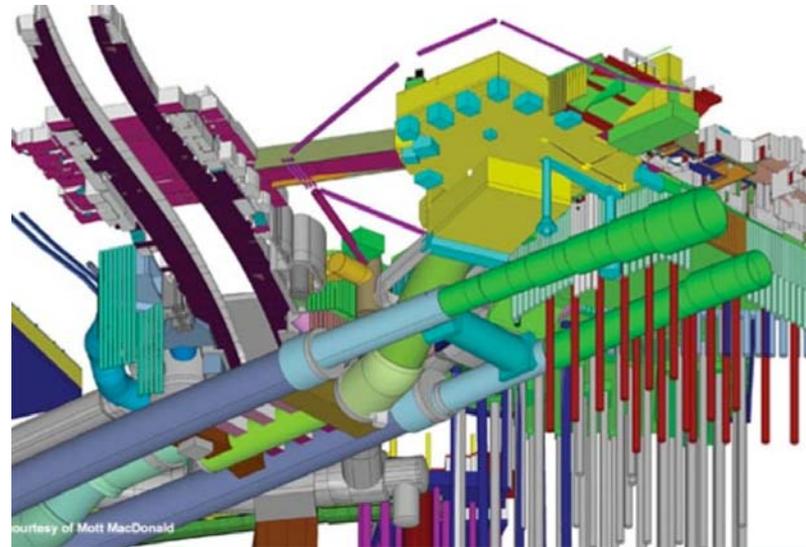
Sustainable Cities

“With urbanisation comes pressure on space and resources and, increasingly, the underground. So **understanding the subsurface beneath our cities is a key focus** for a modern geological survey”



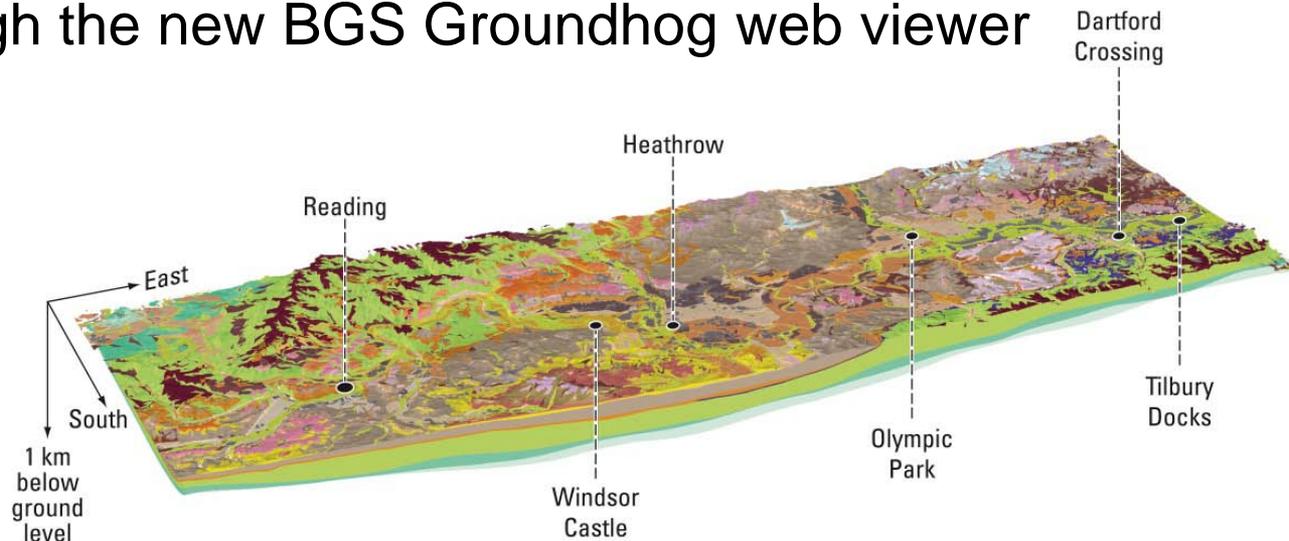
BIM

(but where is the Geology?!)

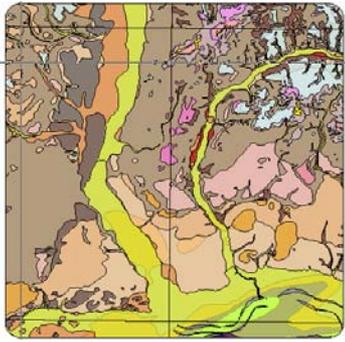


The London and Thames Valley model

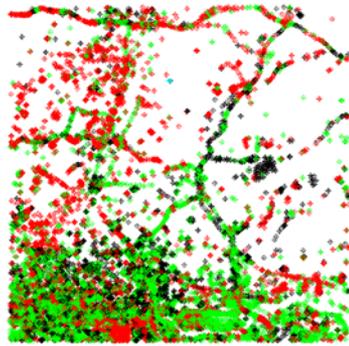
- Modelled area: 4,800km² (equivalent to 8 50K map sheets)
- Model extends the geological maps into 3D
- 70 bedrock and superficial geological units modelled, plus artificial ground and mass movement deposits
- Attributed with engineering and hydrogeological properties
- Modelled to c.500m depth
- Revised fault network
- Delivered as standard file types (vector, raster etc.) and also through the new BGS Groundhog web viewer



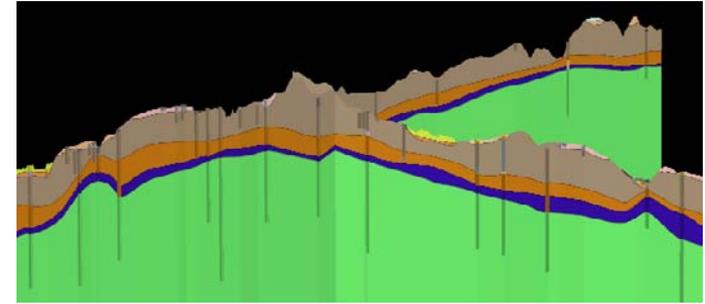
Building the model



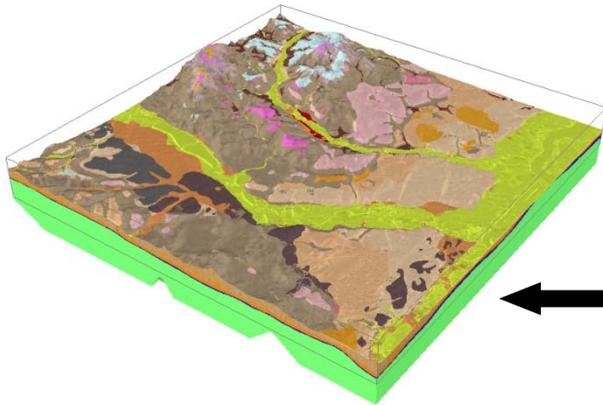
Map and DTM



Boreholes



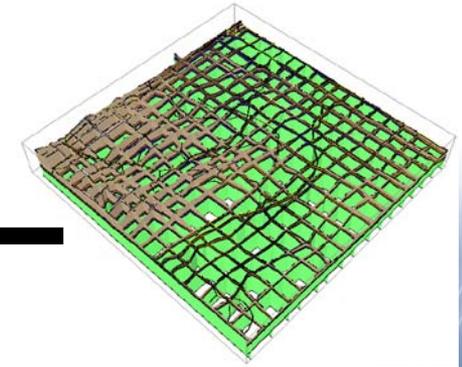
Cross-sections



Geological Block model



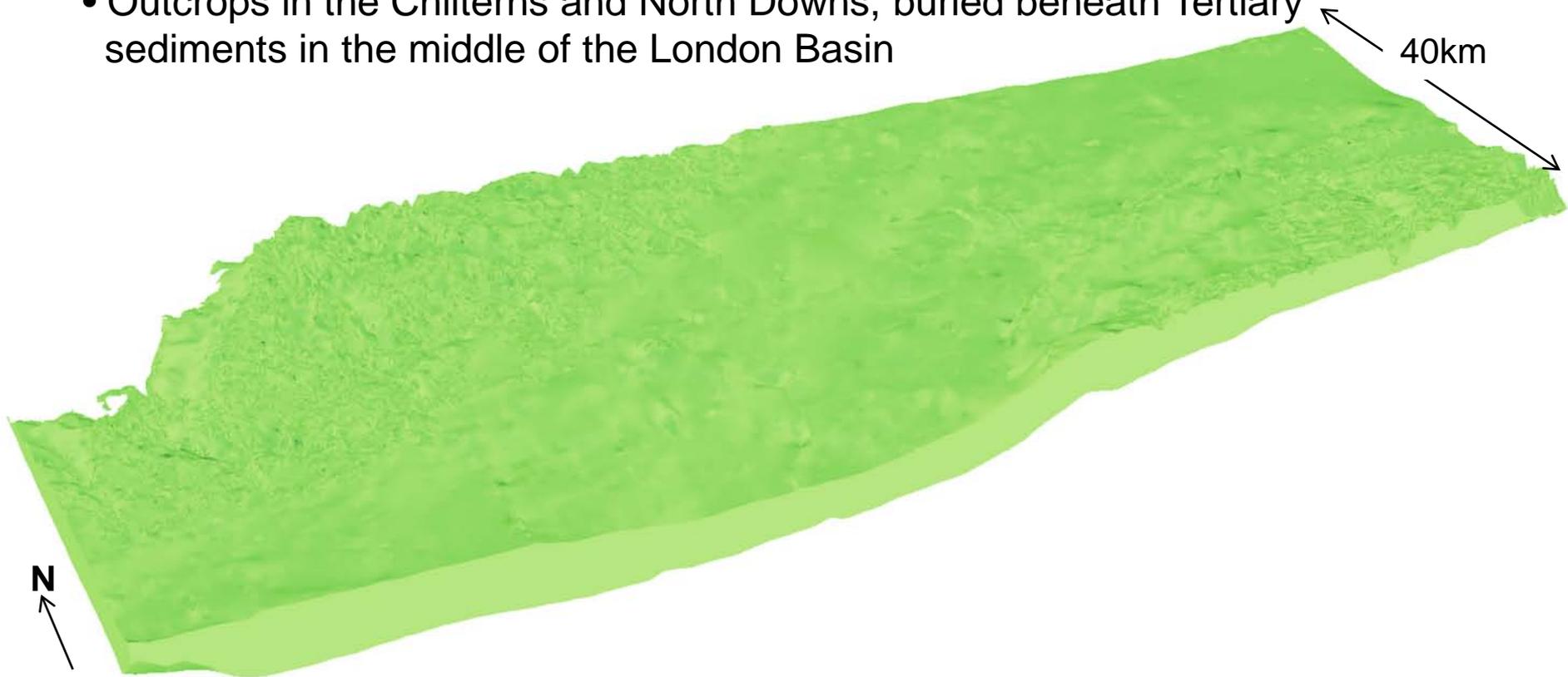
Unit distribution



Fence diagram

1 Chalk Group

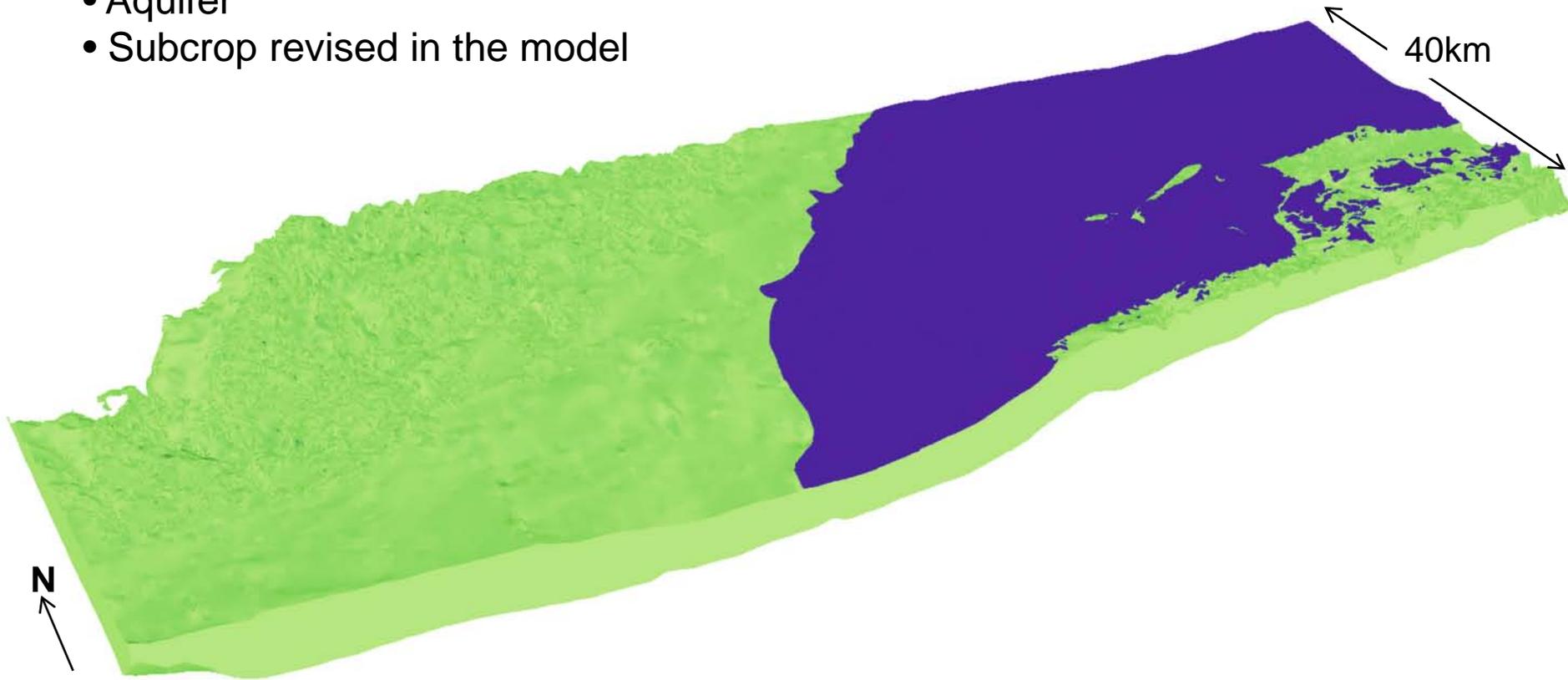
- Principal aquifer in SE England
- Outcrops in the Chilterns and North Downs, buried beneath Tertiary sediments in the middle of the London Basin



X10 vertical exaggeration

2 Thanet Formation subcrop (royal blue)

- Composed of v dense silty sand with green coated flints at base
- Aquifer
- Subcrop revised in the model

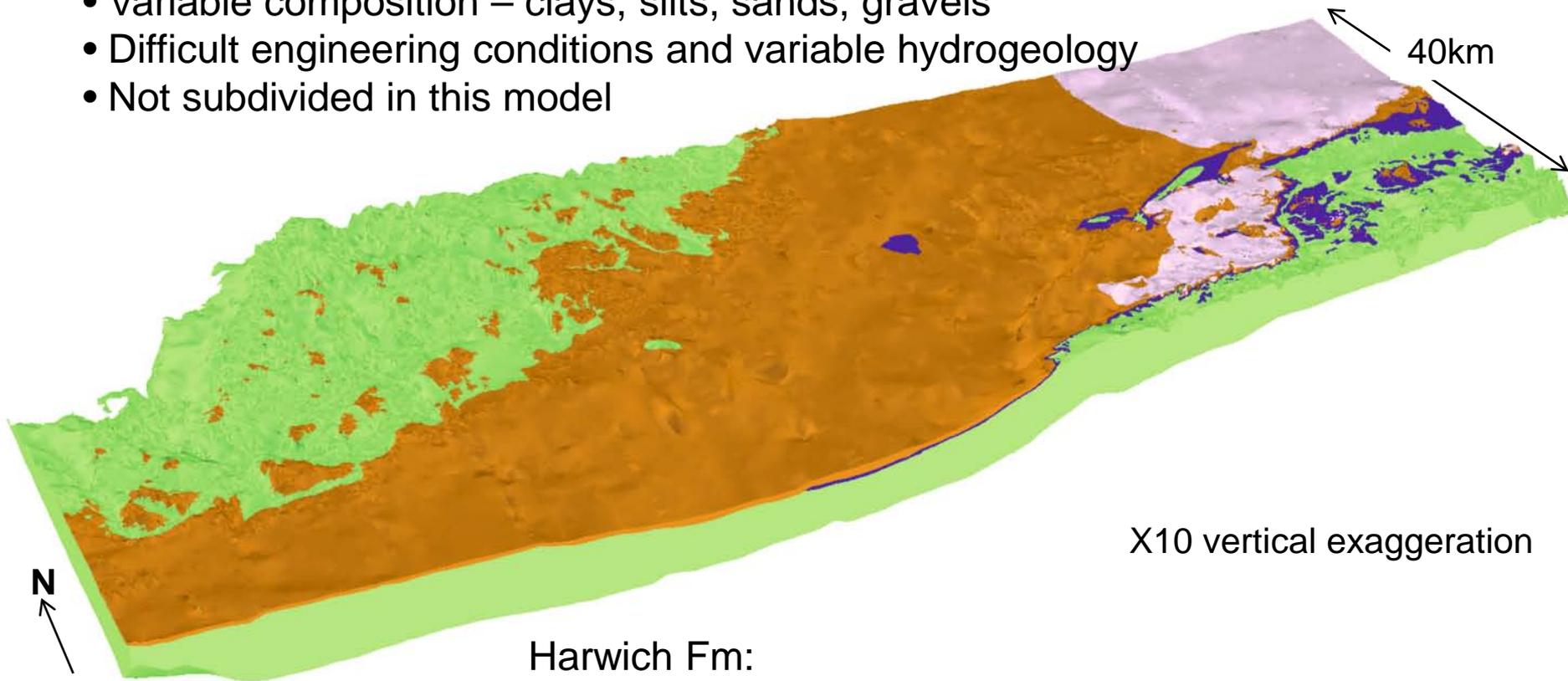


X10 vertical exaggeration

3 Harwich Formation (pink) and Lambeth Group (ochre)

Lambeth Group:

- Variable composition – clays, silts, sands, gravels
- Difficult engineering conditions and variable hydrogeology
- Not subdivided in this model



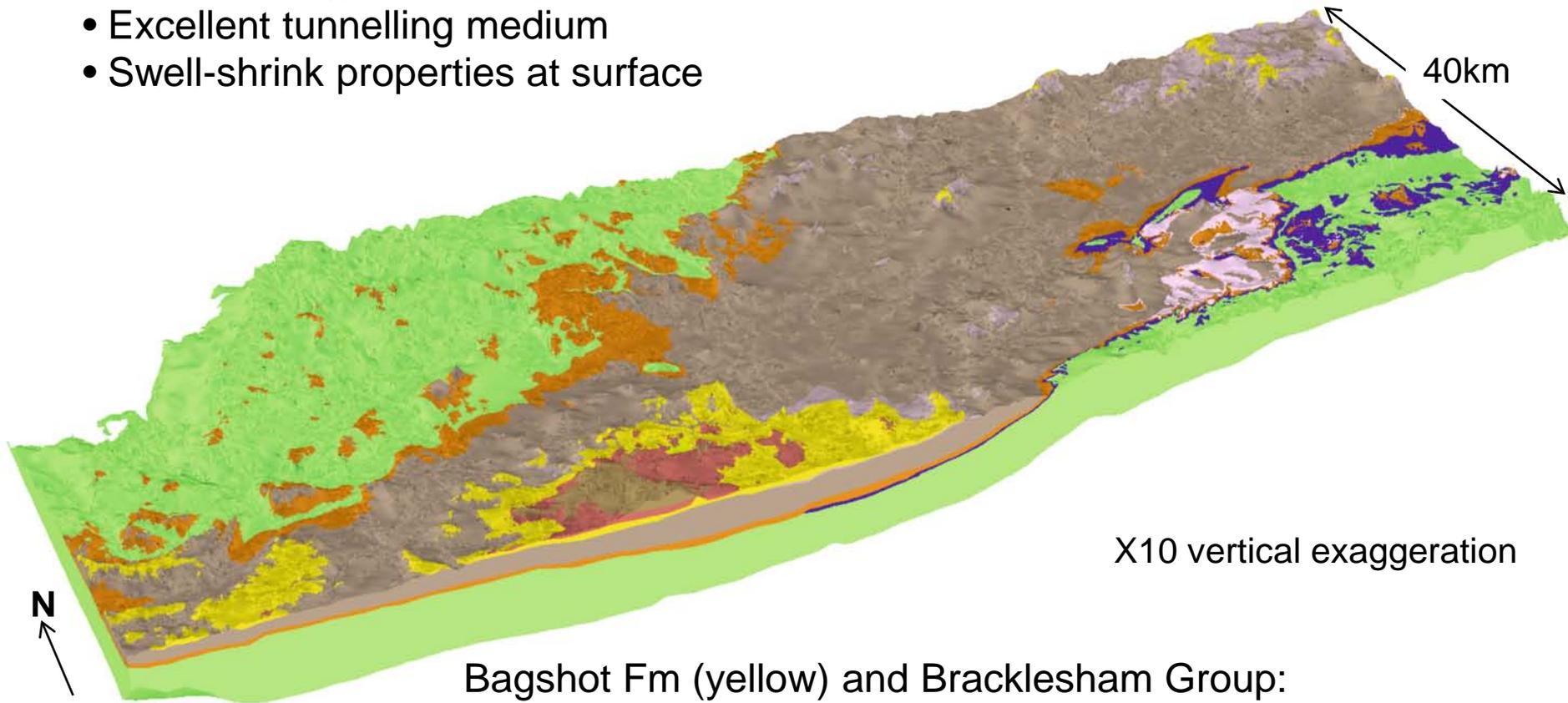
Harwich Fm:

- Composed of interbedded clays, sands and pebbles
- Subcrop revised in the model

5 Bedrock geology at rockhead (all Quaternary removed)

London Clay (grey-brown):

- Excellent tunnelling medium
- Swell-shrink properties at surface



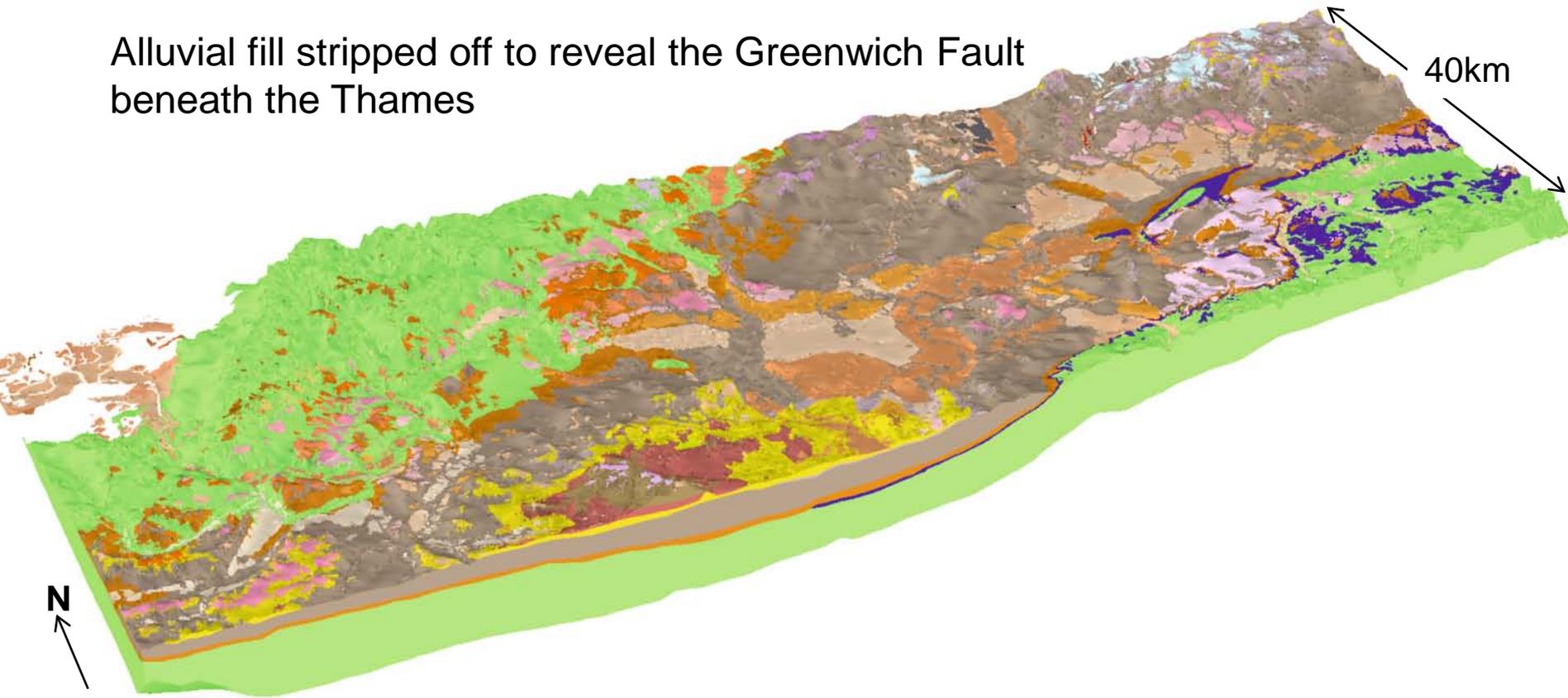
X10 vertical exaggeration

Bagshot Fm (yellow) and Bracklesham Group:

- Interbedded sands, silts and clays
- Variable engineering conditions and hydrogeology

6 Quaternary deposits – most terrace gravel units and glacial deposits

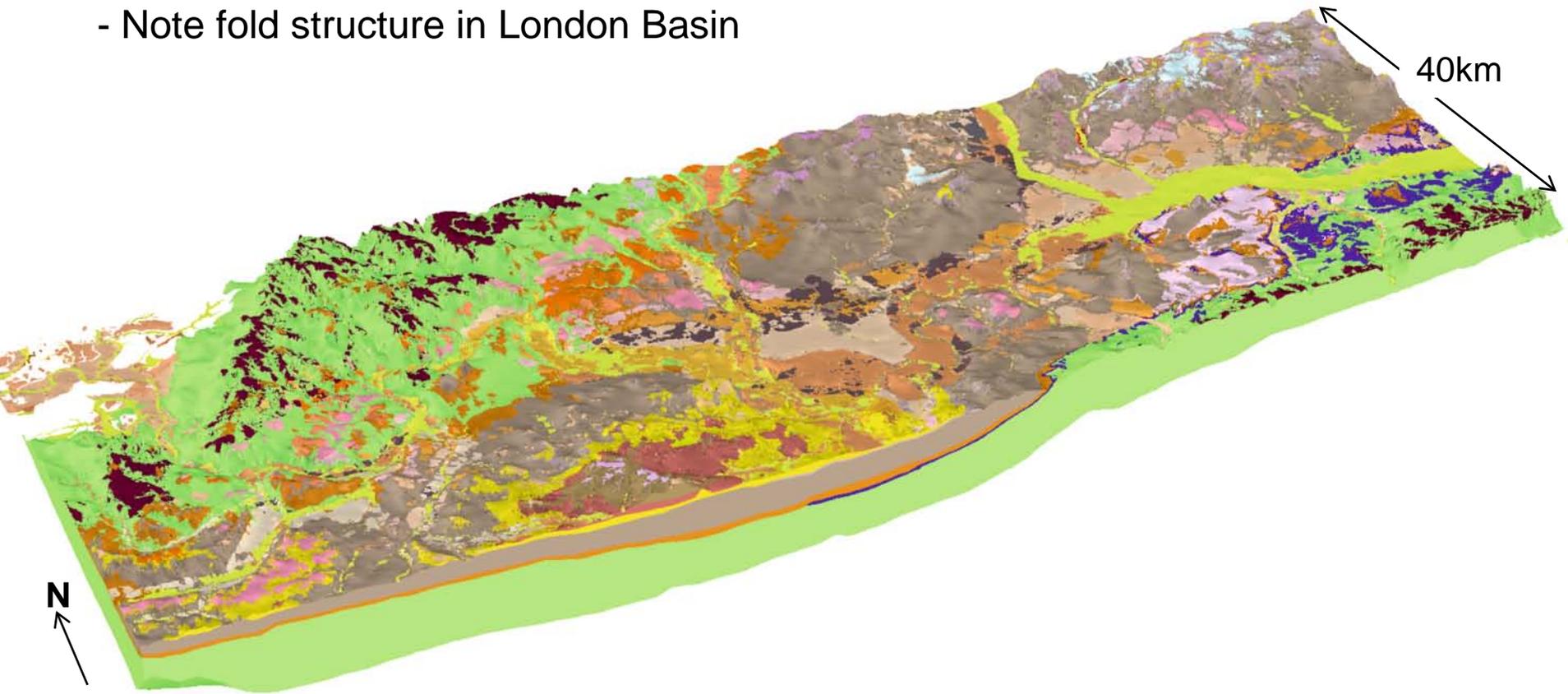
Alluvial fill stripped off to reveal the Greenwich Fault beneath the Thames



X10 vertical exaggeration

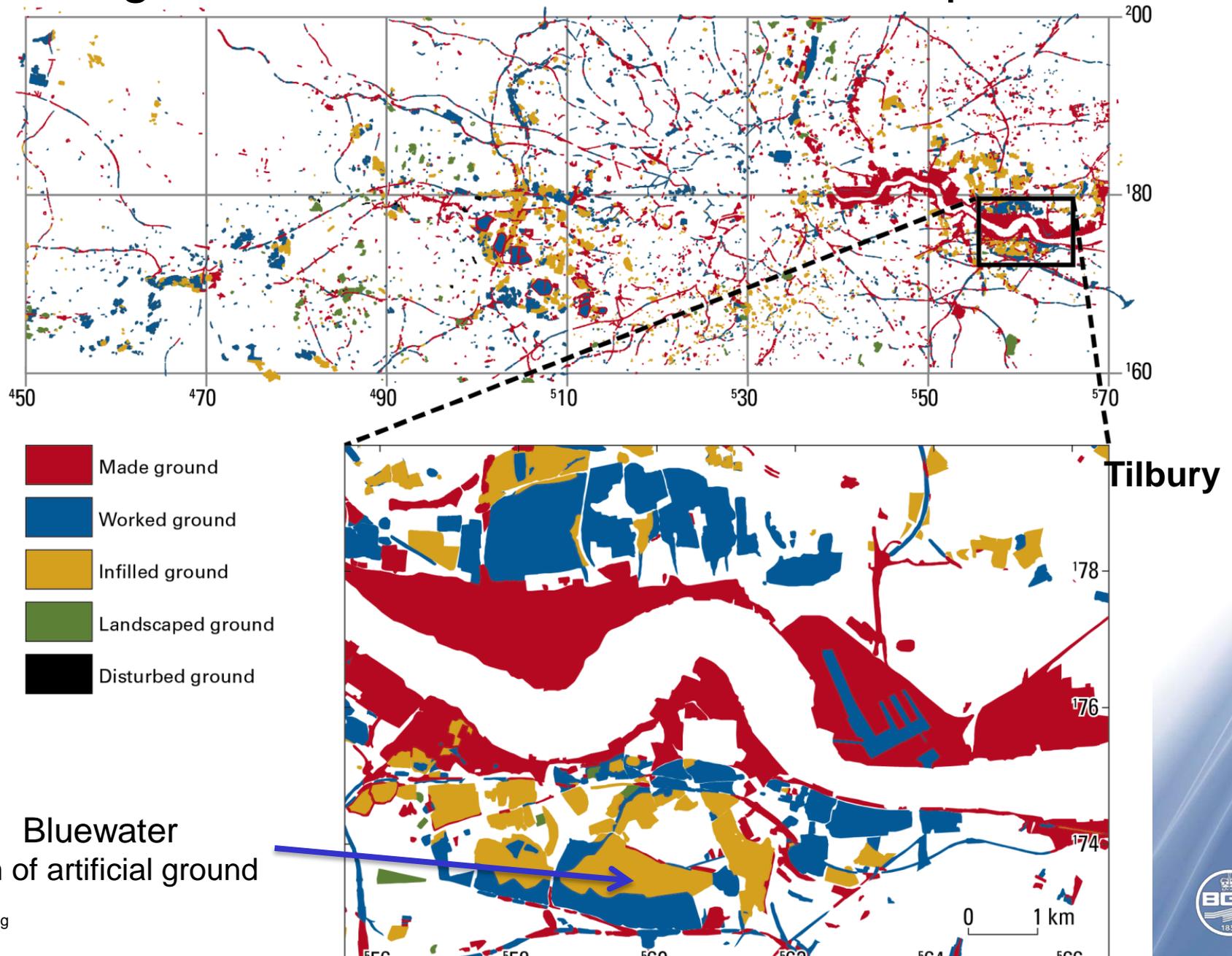
7 All geological units

All bedrock and Quaternary units shown to base Chalk
- Note fold structure in London Basin

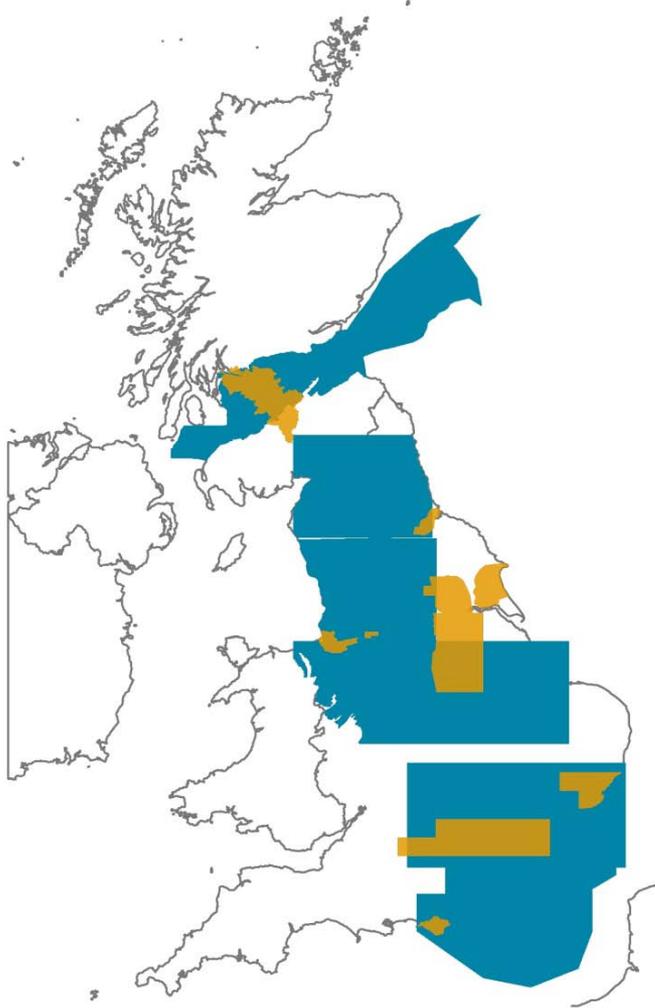


X10 vertical exaggeration

Significant revision of man-made deposits



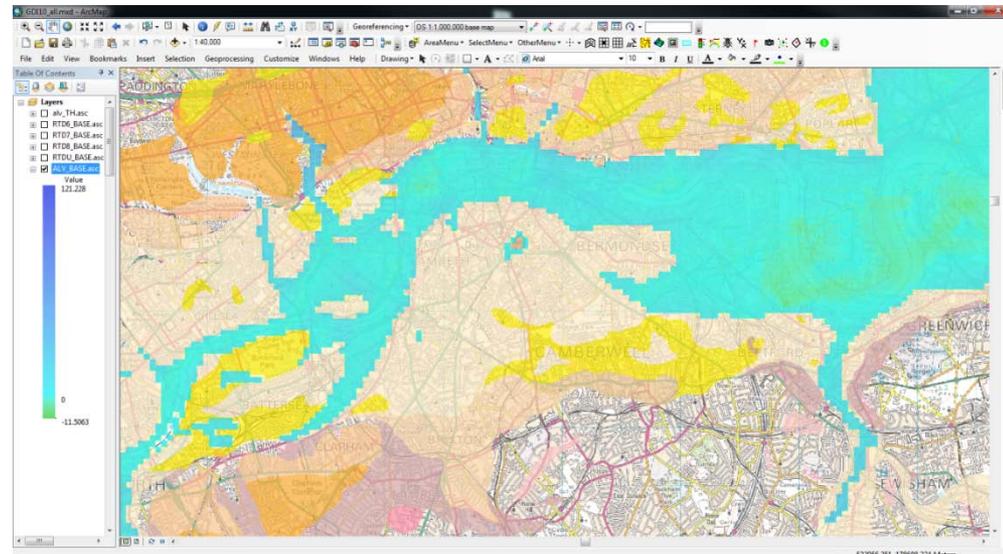
Model coverage and delivery



 Higher resolution models

 Lower resolution models

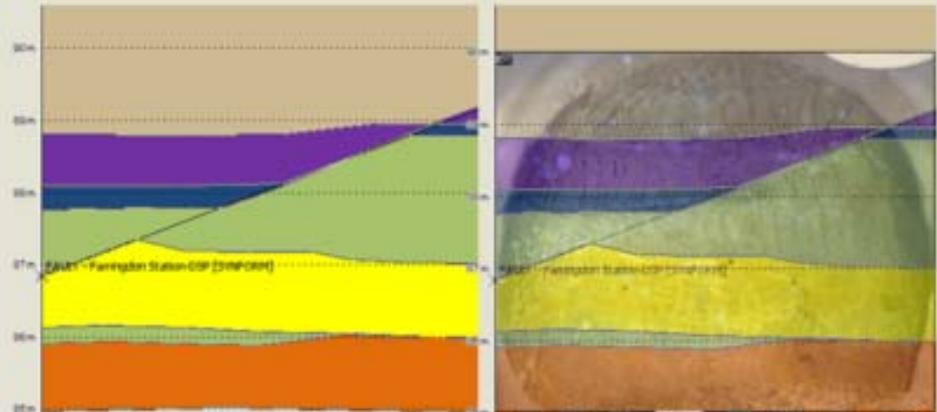
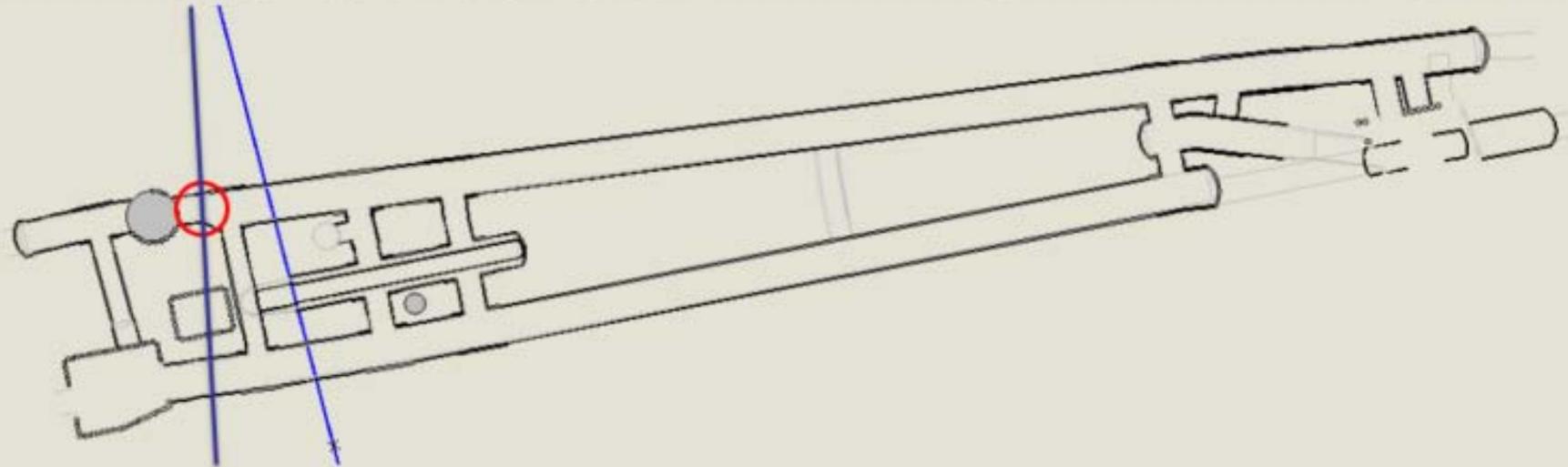
- 3D PDFs
- GIS (shapes and grids)
- CAD (BIM)
- Modelling software
- Visualisation packages
- Web-based delivery



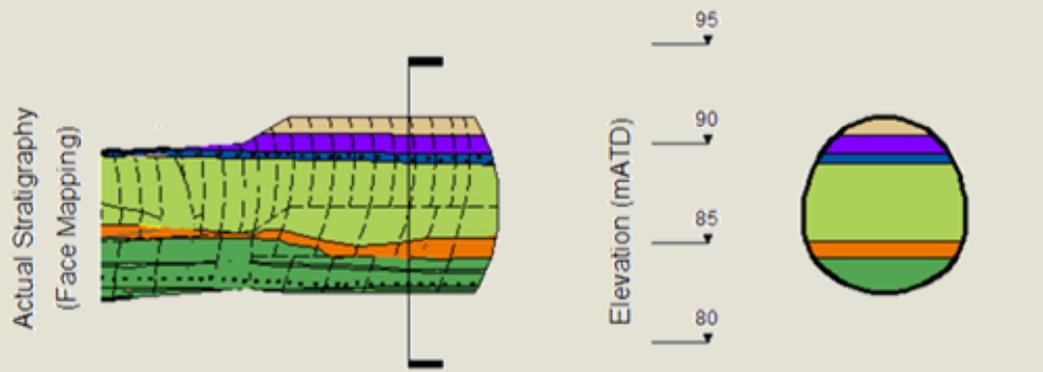
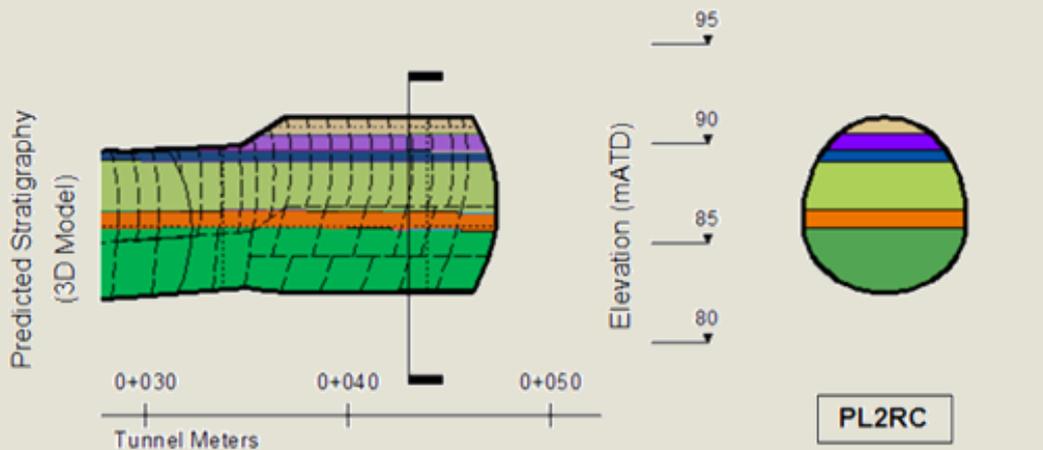
Working with others



Integrating tunnel excavation data

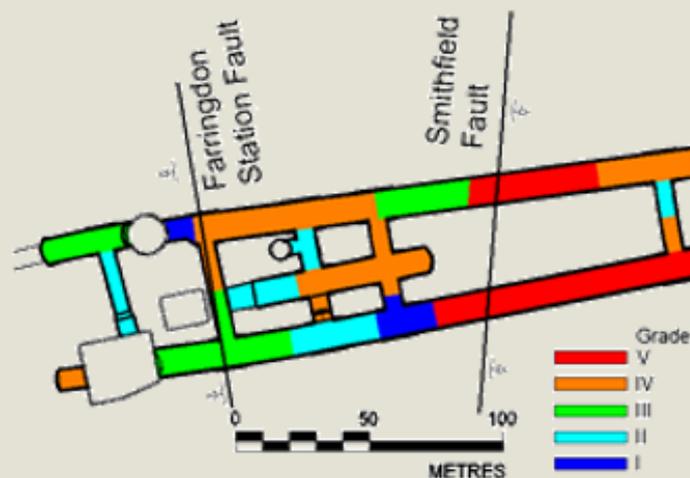


Case Study: Wraparound PL2RC

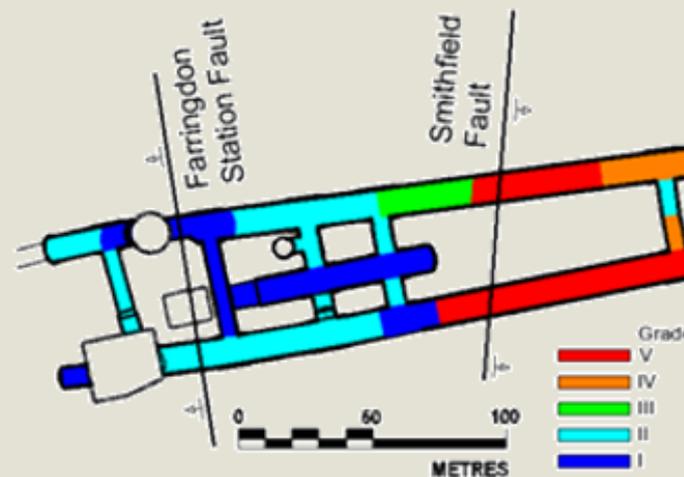


	Upper Mottled Beds [UMB]		Laminated Beds [LTB]		Lower Shelly Beds [LSB]
	Lower Mottled Beds Clay and Sandy Clay [LMB]		Sandy GRAVEL/GRAVEL		Upnor Formation [UF]

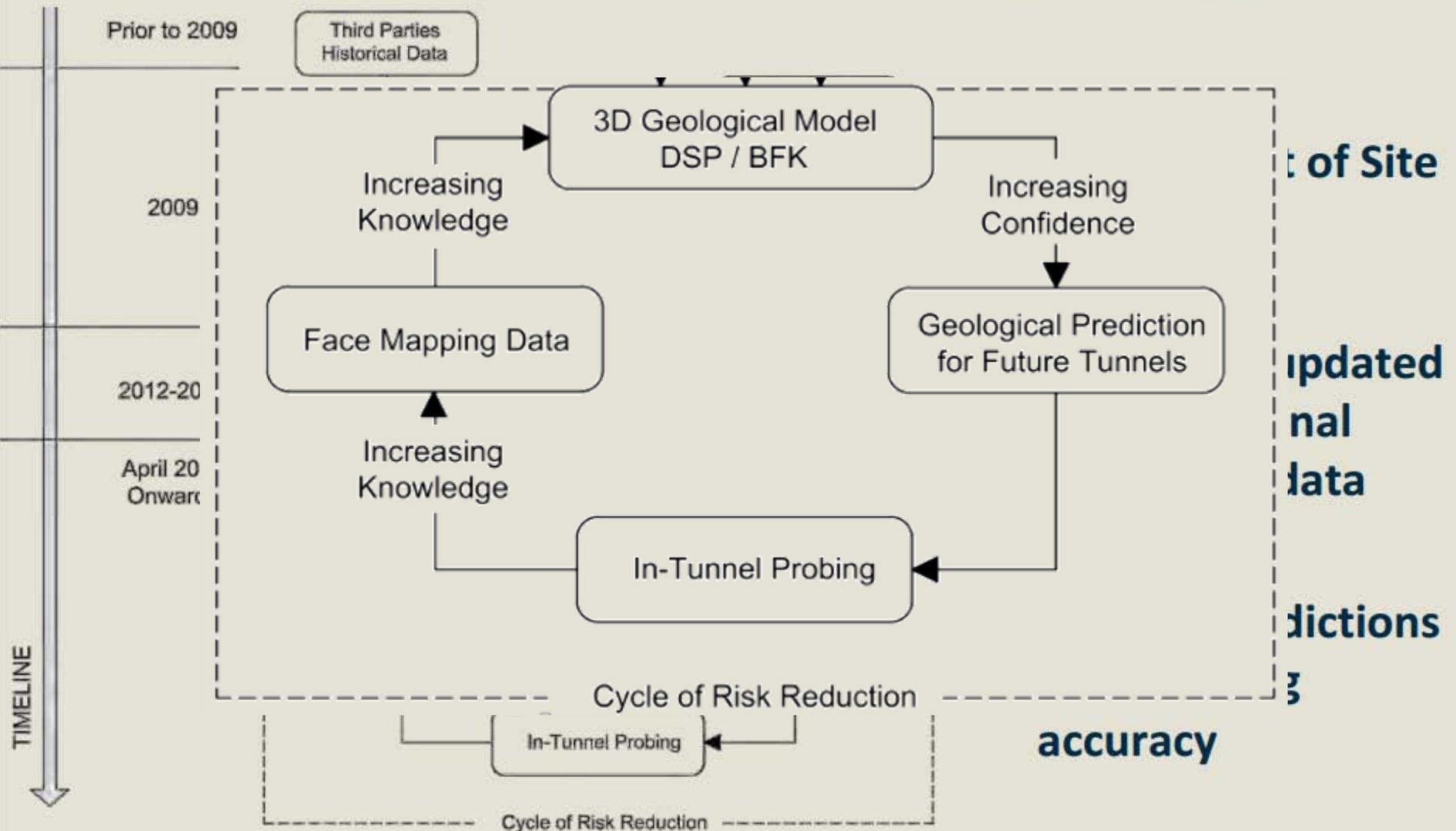
Design phase



Construction Phase



Case Study: Wraparound PL2RC



Future initiatives



BIM for the subsurface

2 year project funded by InnovateUK

- **Unforeseen ground conditions - major causes of project delay contributing to ~ 1/3 of construction programme over-runs**
- **Partly due to limited availability of high quality geotechnical data & interpretation**
- **Project to apply BIM process to ground investigation & subsurface infrastructure design.**
- **Integrate with BGS' national databases and implement BGS methodologies & standards for 3D geological modelling.**

Direct access to geological maps and boreholes

(TestProject) Quinley I - HoleBASE SI Professional

Project | Data | Scheduling | Mapping | Preferences | Configuration | Help | Grid Tools

Manage Columns | Reload Data | Add/Edit Data | Delete Selected | Audit Log | Clear Sorts | Clear Filters | Clear Groups | Bulk Update | CSV Export | Export XYZ | Location Group | Saved Search | Zoom on Map | Set Location | Quick Log | Log Report | View All | View Selected | Upload

Actions | Transfer | Data | Mapping | Log Production | Documents

All Data

- Summary
 - Location Details (32)
 - Samples and Lab Tests (4522)
 - Monitoring (21)
 - Hole Construction (152)
 - Insitu Tests (797)
 - Geological Information (140)
 - Discontinuity Data (0)
 - Field Geological Descriptions (132)
 - Fracture Spacing (5)
 - Stratum Detail Descriptions (3)
 - Weathering (0)
- Reports
 - Geology
 - Statistics
 - Summary
 - Validation
- Saved Searches
 - AS (38)
 - GM test (5)
 - CP holes (14)
 - High Aresnic (14)
 - Low blow counts (3)
 - Peat Undisturbed samples (5)
 - Peat U example (5)
 - Peat U samples (5)
 - Peat Samples U (5)
 - SPT > 3m (68)

Location Details | Field Geological Descriptions

Location ID	Depth Top (m)	Depth Base (m)	Description	Legend Code	Geology Code
BH136		0.00	1.10 TOPSOIL	101	FILL
BH136		1.10	2.70 Dense grey-brown SAND with medi...	404	GLACIAL TILL
BH136		2.70	3.30 Firm brown very sandy CLAY with a...	220	BOULDER CLAY
BH136		3.30	5.30 Brown CLAY with a little well rounde...	205	BOULDER CLAY
BH136		5.30	10.05 Brown CLAY with a little well rounde...	206	BOULDER CLAY
BH137	0.00	0.40	0.40 TOPSOIL	101	FILL
BH137	0.40	0.80	0.80 Spongy brown fibrous PEAT with so...	605	PEAT
BH137	0.80	3.50	3.50 Firm brown very sandy CLAY with a...	220	BOULDER CLAY
BH137	3.50	10.05	10.05 Brown CLAY with a little well rounde...	205	BOULDER CLAY
BH138	0.00	0.50	0.50 TOPSOIL	101	FILL
BH138	0.50	1.20	1.20 Dense grey-brown SAND with medi...	404	GLACIAL TILL
BH138	1.20	2.30	2.30 Firm brown very sandy CLAY with a...	220	BOULDER CLAY

Page 1 of 3 (132 of 132)

Quick Log (BH137)

Borehole Log				Borehole No. BH137				
Project Name: Quinley I		Project No. TestProject		Co-ords: 399671.18 - 301433.00				
Location: Peisatt		Level: 6.40		Scale: 1:50				
Client: Test Client		Dates: 29/09/1991 - 29/09/1991		Logged By: GJS				
Well	Water Strikes	Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
		0.00	J	Urbow=C	0.40	6.00		TOPSOIL FILL
		0.00 - 0.90	B	Urbow=C				Spongy brown fibrous PEAT with some wood fragments (<20mm) and a little medium grav. PEAT
		0.90 - 0.98	U	Urbow=C	0.80	6.60		Firm brown very sandy CLAY with a little subangular to subrounded medium grav. BOULDER CLAY
		1.10	D	Urbow=C				
		1.30	D	Urbow=C				
		1.50 - 1.95	U	Urbow=C				
		2.10	D	Urbow=C				
		2.30	D	Urbow=C				
		2.80 - 2.98	N=27 (4.6 S.E.S.E.B)	Urbow=C				
		2.90 - 3.00	B	Urbow=C				

Map

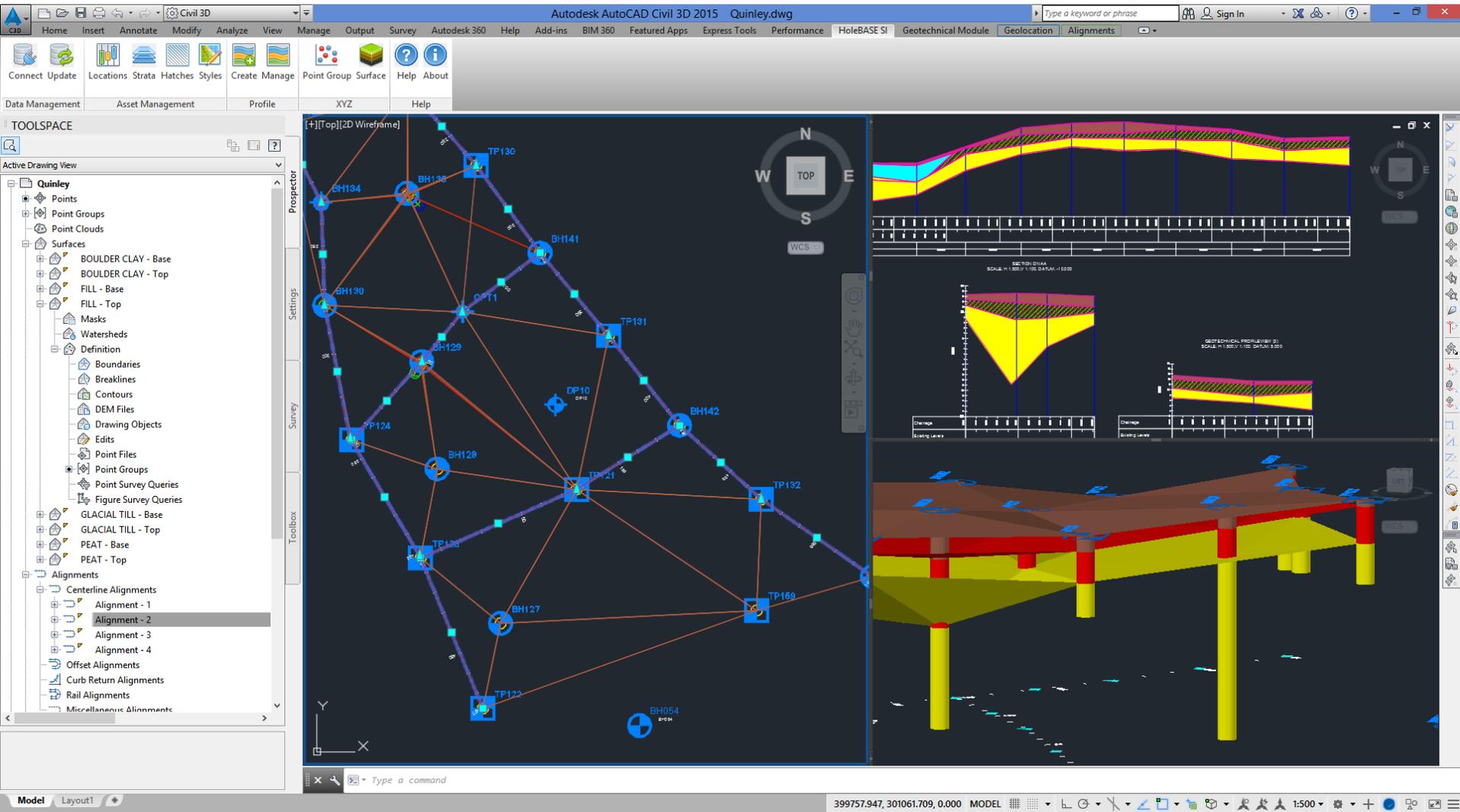
- Information Layers
 - AS (38)
 - GM test (5)
 - CP holes (14)
 - High Aresnic (14)
 - Low blow counts (3)
 - Peat Undisturbed samples (5)
 - Peat U example (5)
 - Peat U samples (5)
 - Peat Samples U (5)
 - SPT > 3m (68)
- Measures
 - Long Section AA
 - Long Section BB
 - Section CC
 - Section DD
- Locations
 - Saved Searches
 - Location Groups
 - Project
 - Imported Datasets
 - WMS Datasets
 - British Geological Survey (BGS) GeolIndex
 - BGS 50000 scale digital geology

Level 3

Search Project Explorer...

m E m N

In the future - direct access to geological sections and models



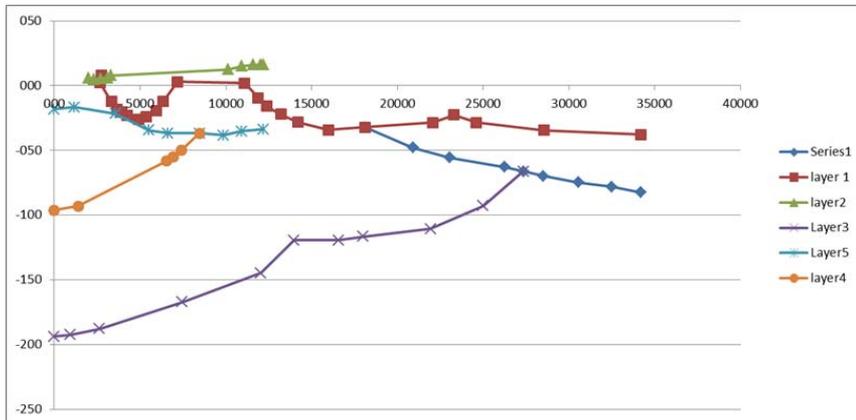
Software independent (via xml files and APIs)

AGSi



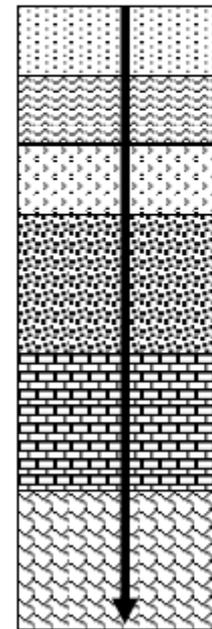
A new initiative to include interpreted data and the concept of layers in the next phase of the AGS data transfer format

Part of this is to introduce the concept of cross-sections where the unit is defined by its base



AGS data

Data transfer



Desk study

3D models

Site Exploration

Laboratory Testing

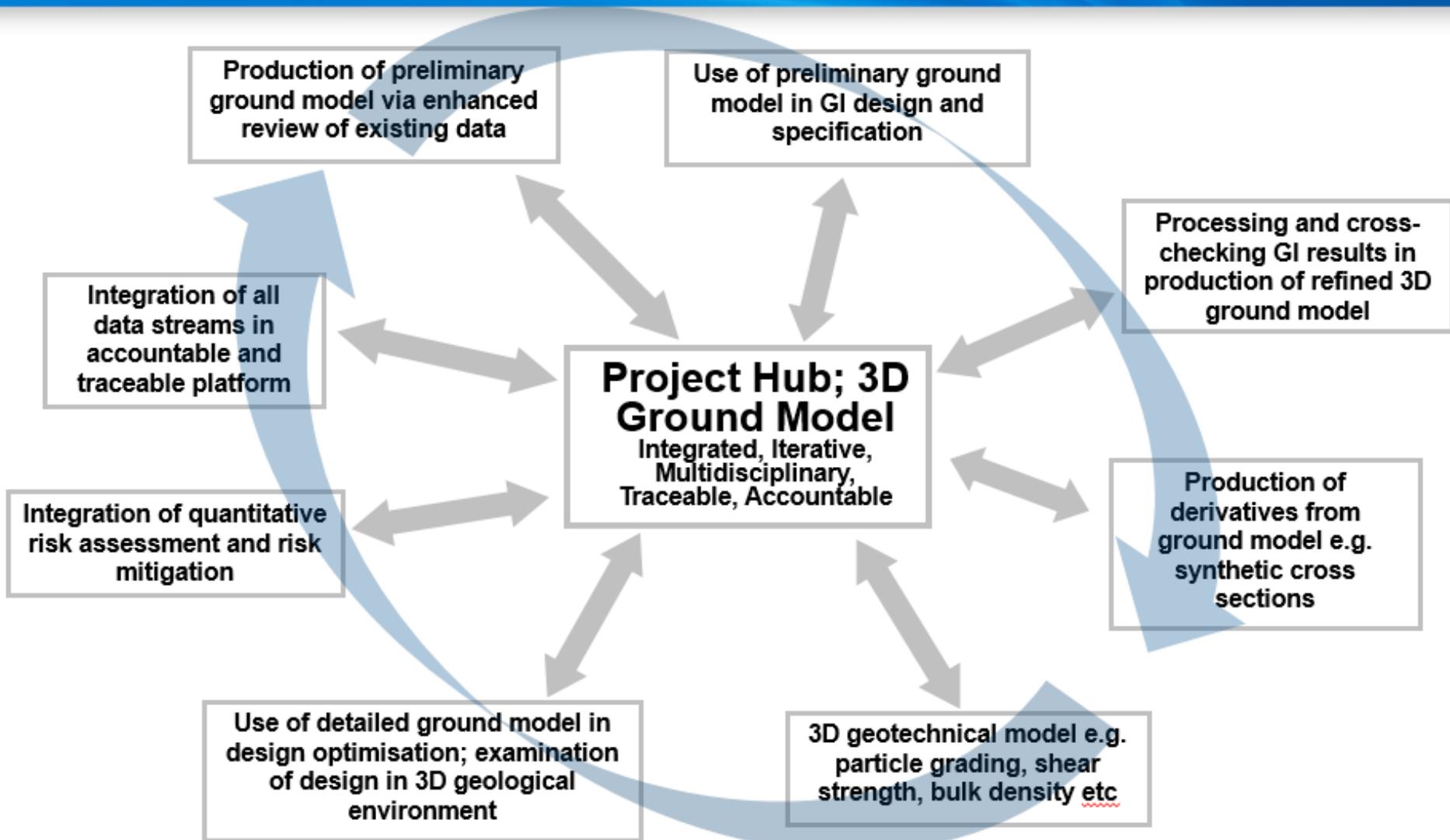
SI Presentation

Engineering Analysis

CAD Presentation, 3D modelling and GIS

National Geotechnical Properties Database

Potential BIM workflow

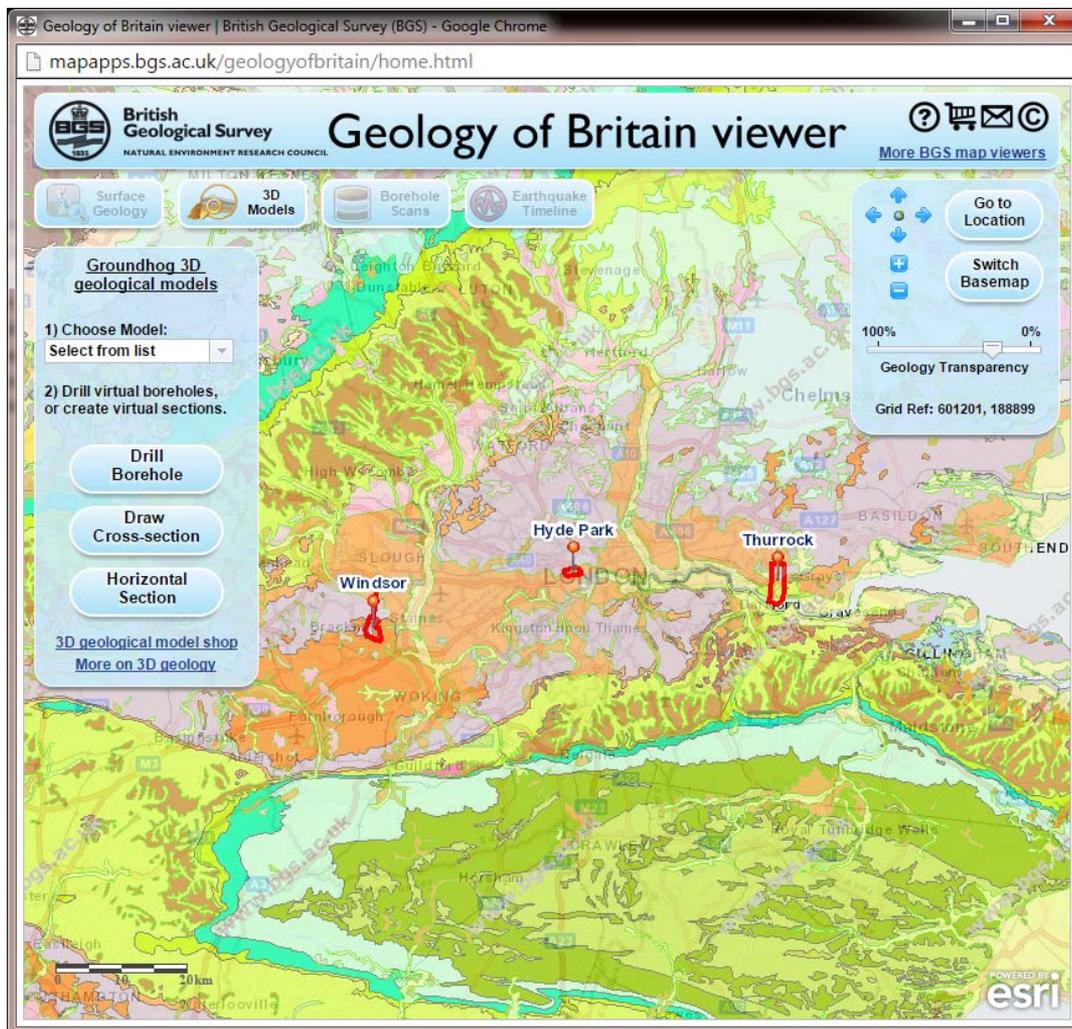


Questions?



Helen Burke hbu@bgs.ac.uk and Holger Kessler hke@bgs.ac.uk

Geology of Britain Viewer – free and open data



BGS Groundhog – professional reports

Geological models

A geological model is a virtual representation of the geology in three dimensions. Geological models can provide information on geological unit surface elevations or thicknesses and can be queried to generate synthetic boreholes and vertical and horizontal cross-sections.

Geological models are created by geologists using geological data and expert knowledge. Data such as borehole records, geophysics, field observations and digital terrain models are interpreted and the conceptual geological understanding is captured via geological cross sections, geological maps and/or point interpretations that describe a surface. The 3D geological model is created by interpolation between all interpreted points.

The accuracy of the geological model is dependent on, for example, the data density, the prevailing understanding of the geology at the time of modelling and the geological complexity. The geological map herein indicates the sites of borehole records considered by the geologist and also the locations of interpreted cross sections; the density of these around the area of interest provides an indication of uncertainty.

Limitations

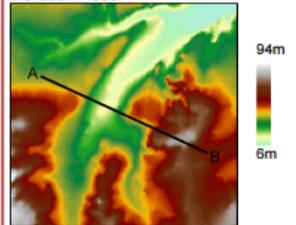
The quality of observations and interpretations may be affected by the availability of new data, by subsequent advances in knowledge, improved methods of interpretation, improved databases and modelling software, and better access to sampling locations. The top surface of the geological model is constrained by the digital terrain model; this may contain artefacts and may have been sub-sampled at a lower resolution and thus minor mismatches between geomorphological features and modelled units may occur.

The information herein should not be used as a replacement for site investigation. For further information on the limitations of modelling in this area, see the relevant metadata report available from enquiries@bgs.ac.uk and view the current terms and conditions at <http://shop.bgs.ac.uk/Groundhog>. For comprehensive information of the geology at this point, please use our BGS GeoReports Service at <http://shop.bgs.ac.uk/GeoReports/>.

Feedback

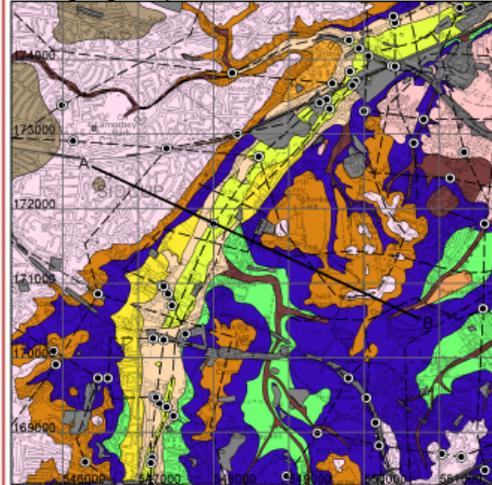
To improve geological models your feedback is essential. Please contact enquiries@bgs.ac.uk if your site investigations yield data that could improve our interpretations.

Elevation model



© NEXTMap Britain elevation data from Intermap Technologies

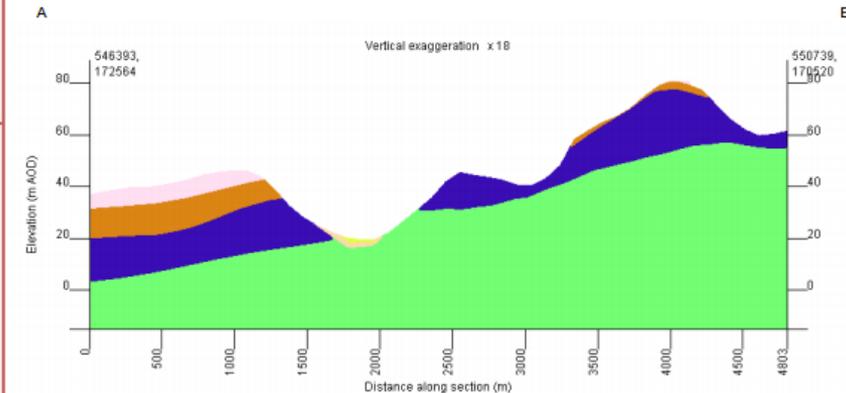
Surface geological map



Legend

- Worked Ground (Void)
 - Made Ground (Variable composition)
 - Infilled Ground (Variable composition)
 - Landscaped Ground (Variable composition)
 - Alluvium (Clay, Silty, Sandy, Gravelly)
 - River Terrace Deposits (Gravel, Sandy)
 - Head (Clay, Silty, Sandy, Gravelly)
 - Crayford Silt Formation (Silt, Sandy)
 - Taplow Gravel Formation (Gravel, Sandy)
 - Lynch Hill Gravel Formation (Gravel, Sandy)
 - Boyn Hill Gravel Formation (Gravel, Sandy)
 - London Clay (Clay, Silty, Sandy)
 - Harwich Formation (Sand, Gravelly)
 - Lambeth Group (Clay, Silty, Sandy, Gravelly)
 - Thanet Sand Formation (Sand)
 - Chalk Formation, undifferentiated (Chalk)
 - Gault and Upper Greensand Formations (Mudstone, Sandstone and Limestone)
 - Lower Greensand Formation (Sandstone and Mudstone)
 - Wealden and Jurassic strata, undifferentiated (Mudstone, sandstone and limestone)
- Borehole record
 Interpreted cross section
 Synthetic cross section

Geological cross section



British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

NERC
NATURAL ENVIRONMENT RESEARCH COUNCIL

Sidcup to Hextable

Report ID: GH_100074/H34
 Model: London and Thames Valley geological model
 Regional geological model originally created by H Burke, S Mathers, J Ford, R Terlington, S Thorpe, P Williamson. Model released: 2014.

The information on this map sheet, including the surface geological map and the synthetic cross section, is derived from the National Geological Model. Geological models provide an indication of reality; alternative interpretations of the same data are possible. The surface geological map is based on the published geological map, with revisions based on new interpretations and may therefore differ from published geological maps and products. Truncation of the lowest unit in the cross section does not necessarily denote its basal depth. Heights are in metres.

Deposits of artificial ground, head and clay with flints typically form thin veneers and whilst they are present on the surface map, they may be absent in the synthetic borehole or section.

Boreholes shown on the map were considered during the construction of the geological model. The original borehole records can be viewed at <http://shop.bgs.ac.uk/Groundhog>.

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<https://shop.bgs.ac.uk/Groundhog/>