Applications of Digital Ground Models to support the maintenance and upgrading of rail infrastructure

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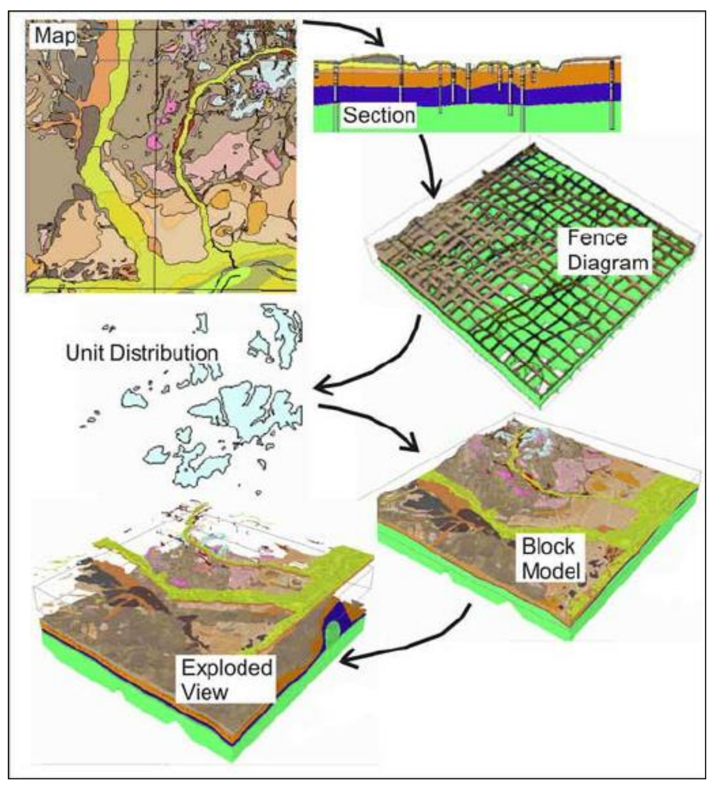
Summary

The development of digital conceptual and observational ground models has become more widespread over the last few years. This poster describes the construction and use of a 3D geological model for the Leeds-York North Trans Pennine Electrification project (TPE), which was created by the British Geological Survey (BGS) and commissioned by TSP Projects. The main purpose of the work was to assist in the selection for electrification mast foundation (deep or shallow) types for the route.
This poster describes future ambitions of both organisations regarding ground modelling, data integration and assurance. An important aspect of the assurance process is to communicate how the model can be used by different parties (client, contractor and designer). When these developments are communicated clearly, they can be used to reduce programme risks and project duration by increasing productivity in construction, as such they also form a part of the sub-surface BIM requirement.

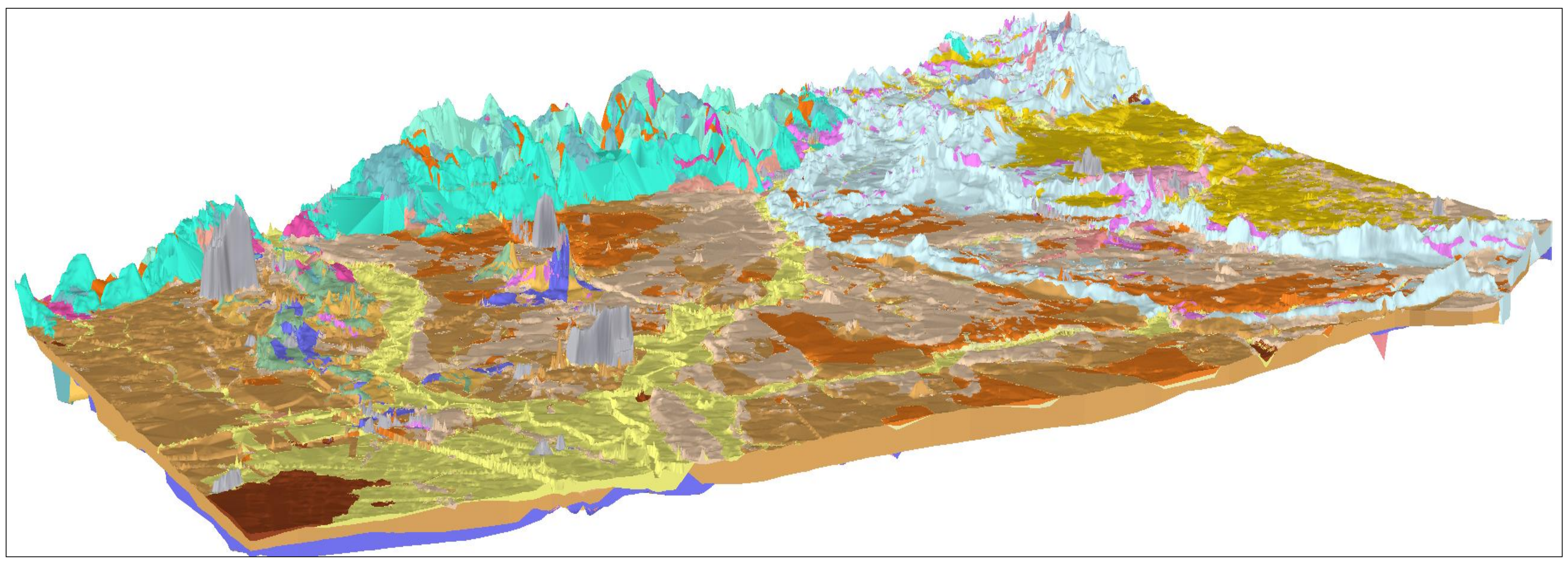
Conceptual Engineering Geological model
- Based largely on geological/ground information constituting the **Desk study**;
- Anticipates what might be encountered on site – ground hazards; ground/groundwater conditions, and uncertainties, also resources;
- Informs initial project risk register and is used to design the investigation on site.

Observational engineering/geotechnical ground model
- Based on data/information collected from the **Site Investigation**;
- Constrains and encapsulates the conceptual model in time and space;
- Identifies and to some degree quantifies ground hazards; ground/groundwater conditions and uncertainties, also resources and material management. Forms the Project risk register;
- Informs further investigation and can be further developed during construction.

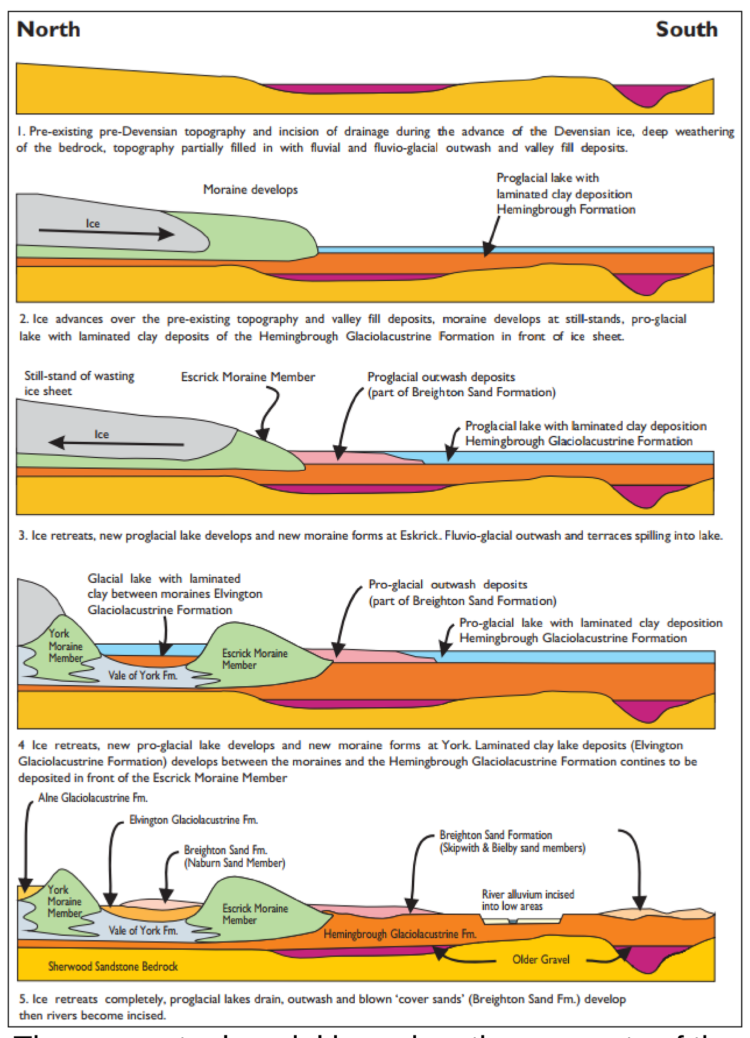
Conceptual and observational geological models (modified from Parry 2014)



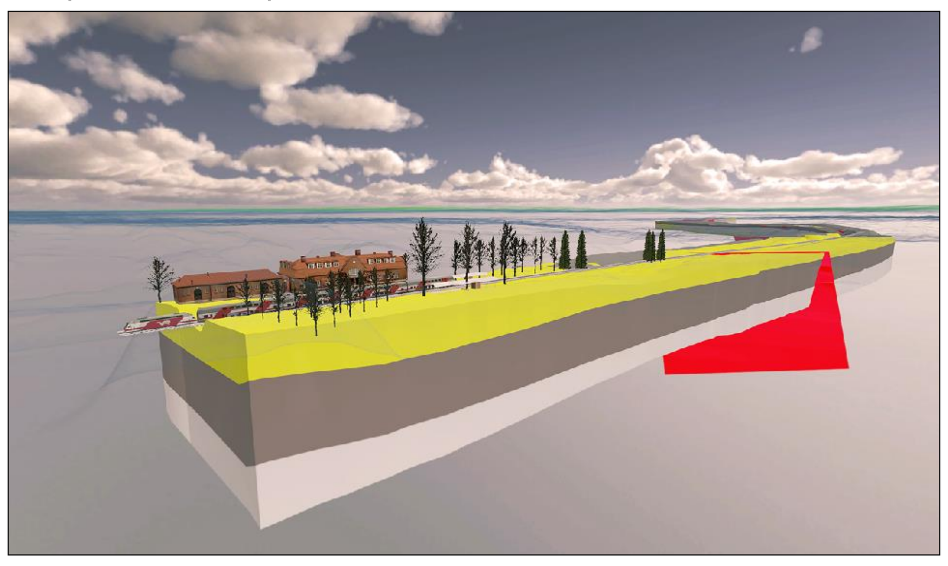
ABOVE - Constructing 3D 'preliminary' observational ground models (after Kessler 2009)



LEFT - The 'preliminary' observational ground model of the Vale of York expressed as a 3D geological model looking north west, with the Pennines in the background and showing the complex glacial and Holocene deposits in the foreground (from Burke et al 2017, supported by the Environment Agency)

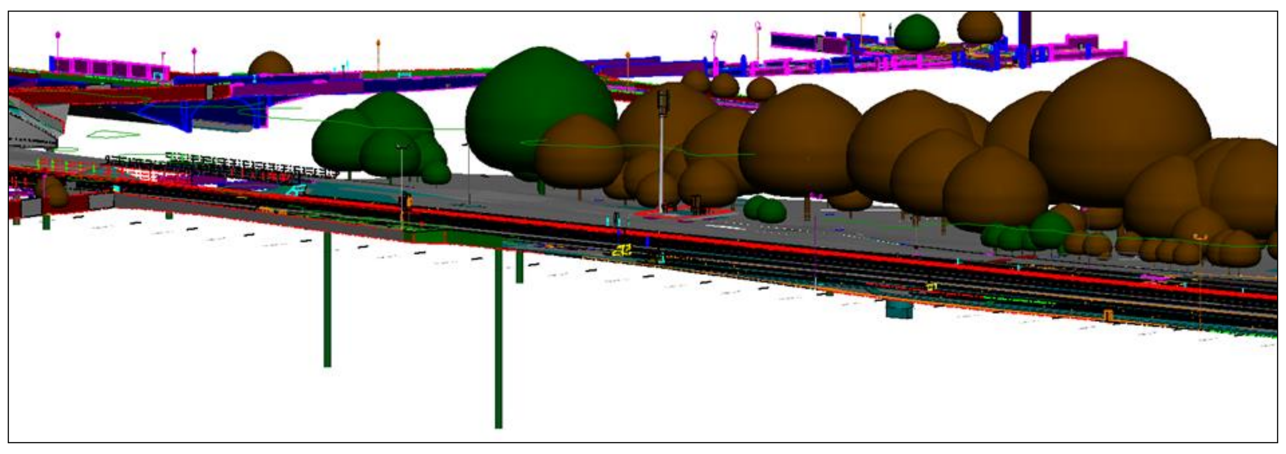


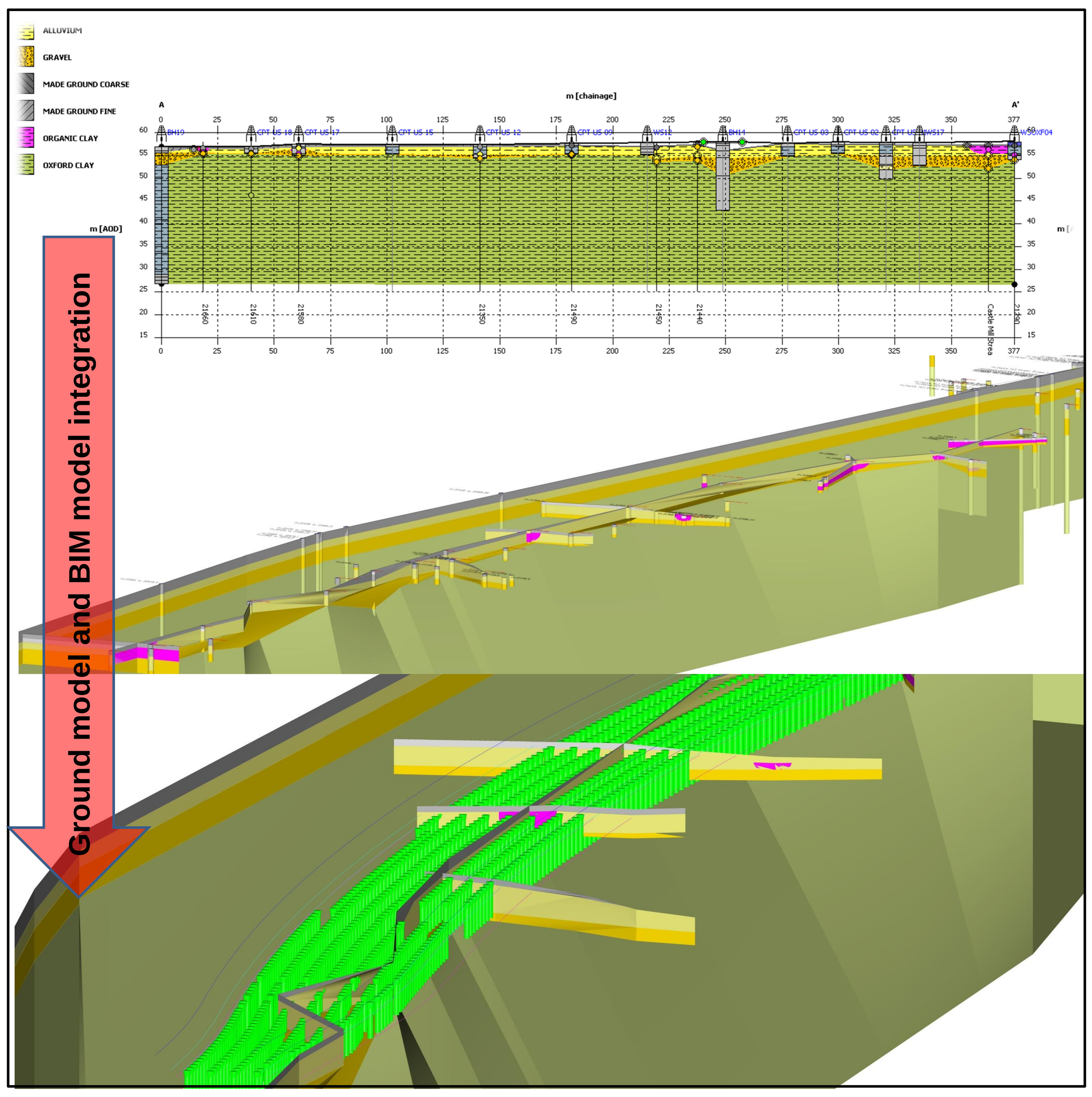
The conceptual model based on the concepts of the Quaternary evolution of the Vale of York as a schematic diagram (from Cooper et al. 2007)



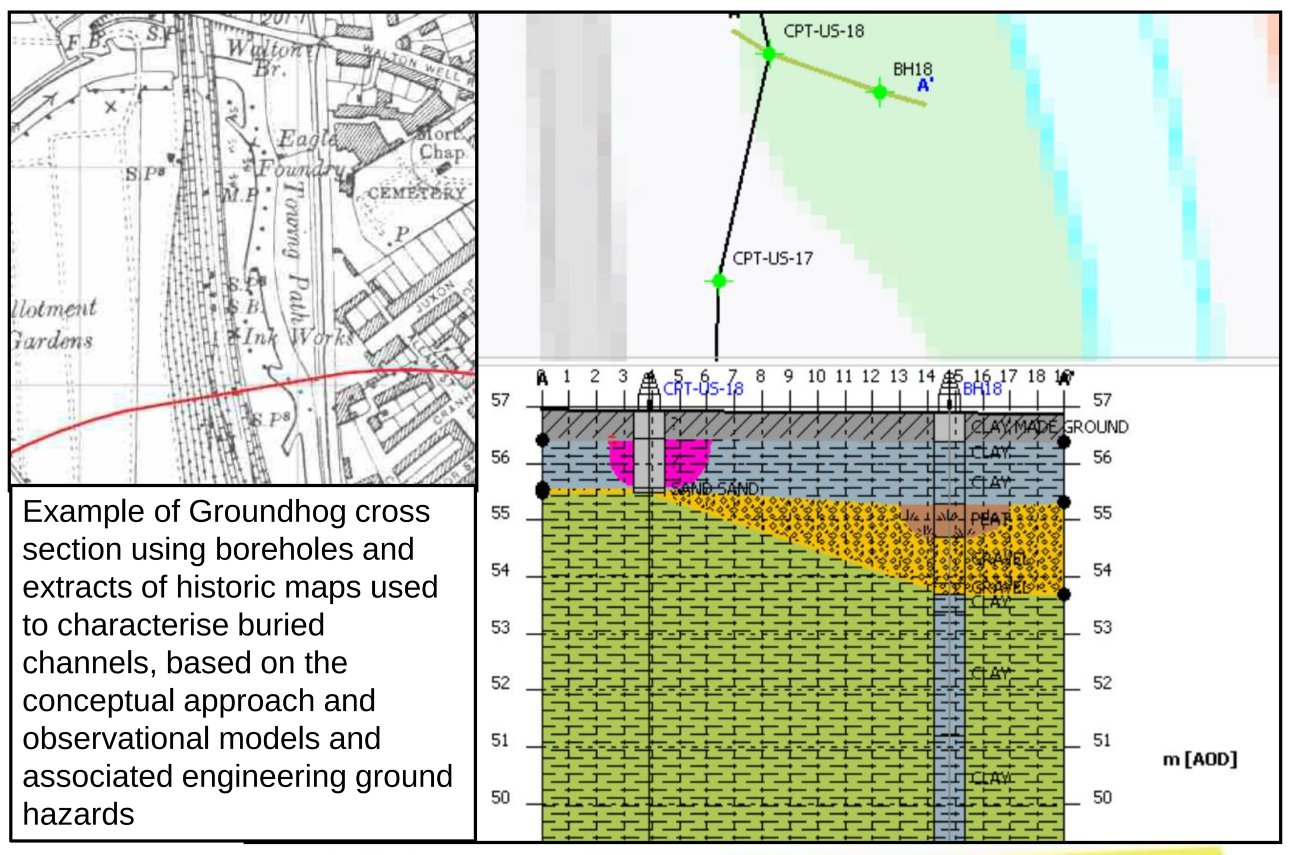
A mock-up of an integrated geological and infrastructure model including faults (from Burke et al 2015)

BELOW - Coordination Model (MOC) showing the design of the railway infrastructure including the factual borehole data

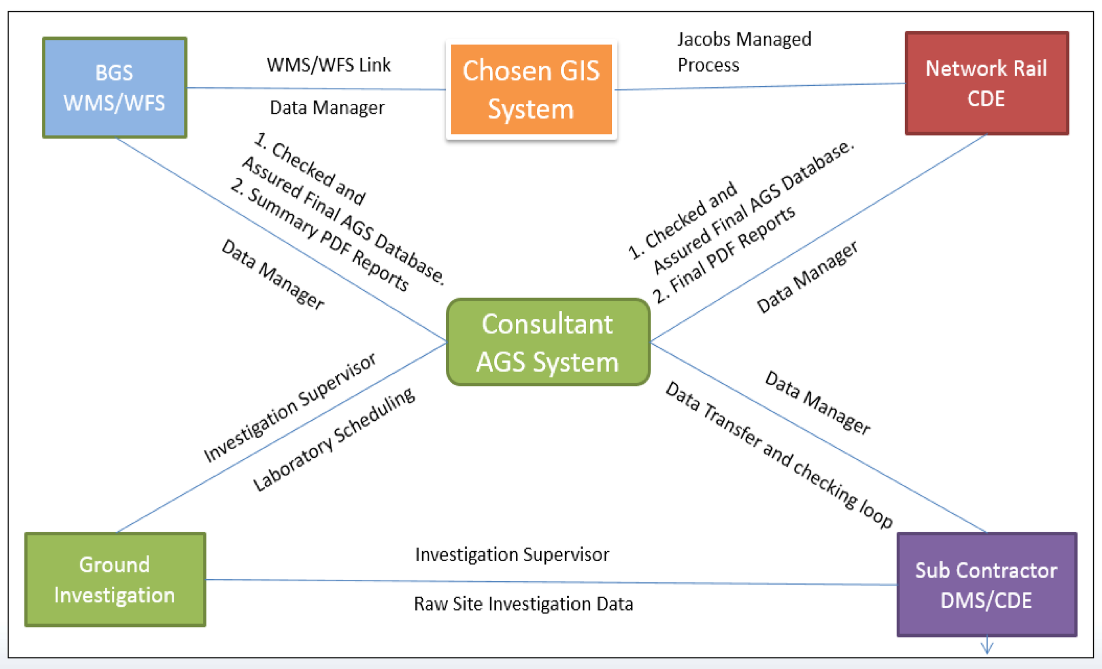




RIGHT - Example of Groundhog cross section and CAD models developed from the Groundhog modelling of a rail alignment.
- Upper image – Groundhog long section showing variable thicknesses of superficial deposits. Purple represents organic clay which was an engineering ground hazard.
- Middle image – CAD model of main alignment and the rail sidings alignment. Cross sections were created to identify infilled historic water courses.
- Lower image – Green cylinders represent ground improvement vibro concrete columns beneath the new embankment area to carry the sidings rail alignment



Example of Groundhog cross section using boreholes and extracts of historic maps used to characterise buried channels, based on the conceptual approach and observational models and associated engineering ground hazards



Complex interactions between data suppliers and clients.

Challenges and future plans

- Previous delivery mechanisms for the outputs (e.g. drawings) do not lend themselves to digital and dynamic outputs.
- Following the development of free ground modelling software and engineering assurance processes, a level of integration of the geological model with in the multidisciplinary engineering BIM models has been achieved.
- BGS and TSP Projects are working on this closer integration of conceptual models, factual BIM models and outputs.
- There is a compromise between levels of detail and model production time.
- Communicating what the level of detail is and the level of uncertainty within the model is essential.
- Maintaining the digital links between models and assurance documents is a challenge that is a high priority.
- Complex supply chains and processes between clients, consultants and contractor pose a challenge to frictionless and lossless transfer of models and associated metadata.

Leave your thoughts here:

The BIM process requires well managed data

We mustn't get blinded by complexity "a Spade is a Spade". There is a correct level of modelling for specific projects and/or assets.

Basic information needs to be defined and collected on all projects.

Information in smaller projects will inevitably affect larger projects and therefore reduce costs and risk to the client.

Data visualisation and ease of understanding is the goal, the cost of 3D modelling must be offset by the benefits in management, maintenance, decision making and reduce cost at construction.

Crucially models must inform risk management and provide confidence in the design.

References

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