From Lord Berkeley
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Rt Hon Grant Shapps MP
Secretary of State for Transport
Department for Transport
London SW1

16 August 2022

Dear Grant,

HS2 Phases 2A AND 2b West - Geotechnical Risks

The UK's high-speed rail project has often been described as the largest engineering project in Europe. It was promoted for generations, has been under construction for decades, and, once completed, must operate for at least a century. It is regrettable, therefore, that it appears to have undergone remarkably little published independent technical scrutiny of geotechnical risks.

Sadly, UK history records all-too-numerous instances of bankruptcy, delay and disaster, as railway-mania succeeded canal-mania; those losses were *privately* funded. Those projects were designed to operate, respectively, at the speed of a walking, then of a galloping horse. By contrast, each HS2 train will be several hundred metres long, carrying thousands of passengers, at over 300 kilometres-per-hour.

Being taxpayer funded, there is an obligation on government as promoter to provide the necessary assurance that all risks have been investigated, and to publish in a full transparent manner the necessary independent reports to confirm that the project will deliver what it is designed to do within the allowed budget.

There is also an obligation on parliament to scrutinise this information and form its own view as to the viability of the project. It may be unrealistic to expect the members of either House to be familiar with the detailed superficial and solid geology of the UK north of Birmingham, but they should all appreciate the implications of the failure of HS2 to achieve, safely, its design-speeds throughout its lifetime. That risk must be assessed, objectively and independently, both at the start of the project and at regular intervals during its development.

HS2 Ltd.'s conflict of interest

HS2 Ltd. was set up, in 2009, for the sole purpose of promoting and constructing the project on behalf of government and taxpayer funding, and faces a fundamental conflict of interest, whenever it is tasked to review those risks.

HS2 Ltd.'s "Options for Phase 2…" report, 29th March 2012, arrived-at a "base proposition" for a route, which was NOT a "preferred scheme". Nevertheless, that base proposition now seems unalterable. That report confirms that HS2 must be a "safe and secure network", serving ONLY long-distance, city-to-city, high-speed trains; the design-speed is 400 kph; from Birmingham to Manchester, there will be 6 trains per hour. Their three Cost Estimate Tables are, all, "Excluding Risk". However, despite listing "engineering and construction feasibility" as one of the four sifting criteria, the authors "… did not engage externally on the development of line-of-route options", and the British Geological Survey [BGS] is not listed amongst the contributing specialist consultancies.

This letter therefore concentrates on the geological issues relating to the HS2 and, in particular, the ongoing risks associated with construction and operation in the areas of particular risk of long-term ground movements.

History

Any substantial civil-engineering project should be subject to continual review, through desk-study, phased site-exploration, design, construction, and operational monitoring. As technology advances, the available techniques will change, but the relevant data are augmented, *not* discarded. Some of the BGS Memoirs along the designated route-corridor may be over a century old, but they record progressive or catastrophic ground-movement before, during and subsequent to mining, particularly for salt and coal. They also describe the geomorphological processes induced, pre- and post-mining, which may occur kilometres away from the sites of salt-solution or extraction.

Such movement was, eventually, monitored, when it was acknowledged, through legislation, that compensation was payable - but only where damage was obvious, generally in built-up areas. Today, frequent monitoring can be performed, anywhere, remotely (by satellite), to accuracies of millimetres. HS2 Ltd. is aware of active subsidence along the route-corridor[1].

A selected list of references is set out at the end of this letter.

The geology of the HS2 route North of Birmingham

Scores of other documents, at BGS, and in various peer-reviewed academic journals, acknowledge the complexity of the superficial deposits in the glaciated areas north of Birmingham, and the difficulty in characterising them without detailed site survey. The behaviour of these deposits as the water-table fluctuates, and especially when salt-solution is also taking-place, is highly unpredictable.

Much of the corridor traverses "made ground", where landfill has succeeded mineral-extraction, and/or demolition. Records of these sites are patchy, at best. Differential compaction will occur across the lateral boundaries of these sites - as exemplified on the M42, where

[1] Geological Society of London, paper, 3rd April 2022

“stepping” was observed across the boundary of an earlier opencast-coal site. Mine water “rebound” is happening, wherever pumping operations have ceased, post-mining, throughout the exposed and concealed coalfields, where multi-seam extraction, and underground connections between former collieries, compound the difficulties in predicting active surface-movement (both subsidence and “heave”). Faults at the surface have been, and are being re-activated, over abandoned coalfields; many of these faults are inadequately mapped. The quotation below is the last paragraph of the Conclusions of a paper, "A review of coal mining induced fault reactivation in Great Britain", by Donnelly, L.J.:

It would be prudent on all sites containing geological faults in active and former mining areas, to investigate their potential effects on ground stability, before development and construction is carried out. It is recommended that this be undertaken at the desk study and site investigation stage of a project to reduce the risks for unforeseen ground conditions.

Moore *et al*. recently published an online paper in the QJEGH. The entire text of its **Geohazard risk management** section reads:

The management of actual and potential geohazards identified by this EGA will help to mitigate potential adverse impacts such as construction delays and re-design, slope failures and differential ground settlement, reduced performance of earthworks over the life of the scheme, and the impact on operations such as service disruptions, reduced line speed and temporary line closures. This EGA supports geotechnical risk management; adopting a continuous geohazard risk-reduction approach through site investigation, design and construction will ensure that the stability and resilience of the infrastructure assets are optimized during construction and over the lifetime operation of HS2.

All these complexities were known, since long-before HS2 was initiated; it is understood that there is a temporary speed restriction on the adjacent West Coast Main Line dating from before 1926 and still in force today. Some of these complexities have even been acknowledged, by route-alterations in Cheshire, where salt-extraction leases, long-term document-storage, and precise, induced cavern-solution, for the storage of high-pressure gas, have already necessitated route alterations. However, where is the data in respect of HS2 as recommended in the above quotes?

The Challenge

The excavation of tunnels and cuttings, the construction of embankments, and the transient, dynamic loads of HS2 trains, will alter existing stresses at and near surface, with unpredictable impacts on joints and hydrology, including “feedback” effects, on salt-solution at depth.

Although it *may* be possible to design, construct, and monitor (continuously, and indefinitely) the entire route-corridor of HS2, in order to guarantee its safe lifetime performance at the design-speed that, ostensibly justified its initiation, no current estimate of those costs is available.

It is therefore essential that HS2 Ltd publish all the documentation relating to its desk, field and other studies, including independent ones, to demonstrate that it has considered all the

above risks and has chosen a route and engineering mitigation measures at the design stage and continuing into long term operations, that will enable the project to provide the services planned and at an agreed budget.

I therefore request you to provide me with the following documentation and place copies in the Library:

a) Comprehensive details of HS2 Ltd.'s monitoring of ground-movement along the entire route-corridor, before and since route-selection.
b) A full set of documentation of independent reports on geology issues.
c) A best, current estimate of the final construction-costs for HS2 Phases 2A and 2B west to include all associated geological risks.
d) A justification for the perceived conflict of interest of HS2 Ltd., as both assessor of the viability of the project, and objective provider of geotechnical data and analysis.
e) A table of the maximum design-speeds for sections North of Birmingham of the designated routes of HS2.
f) A railway-engineer's professional assessment of the acceptable tolerances of each section of the route, to those potential post-construction changes in elevation of the track bed, and its overhead power-supply cables, compatible with its design-speeds.

I look forward to your response.

Yours Tony Tony Berkeley

Other Selected References

1. Eccles C., and Ferley S., "Geology and HS2", Geoscientist, Volume 28, No. 01, February 2018, pp 10-13, Geological Society of London.

2. Moore R. *et al*., "Engineering geomorphology of HS2: management of geohazards", Quarterly Journal of Engineering Geology and Hydrology, May 2022, Online First, 15pp, Geological Society of London.

3. L.J. Donnelly, "A review of coal mining induced fault reactivation in Great Britain", Quarterly Journal of Engineering Geology and Hydrogeology, Vol. 39, pp 5-50, Review Article, 7 June 2022, Geological Society of London.

4. Gee D. *et al*., "Modelling groundwater rebound in recently abandoned coalfields using DInSAR", [from Remote Sensing Environment] 54pp.

5. Poole E.G., and Williams B.J., "The Keuper Saliferous Beds of the Droitwich Area", Report 81/2 of the Institute of Geological Sciences, 19pp.

6. Starkey R.E., "Minerals of the English Midlands", British Mineralogy Publications, 2018.

   [Chapters: Cheshire, Staffordshire, Worcestershire].

   [and references therein].