



CPRE/9

Town and Country Planning Act 1990

**Appeal by Kent International Gateway Limited
APPU2235/A/09/2006565/NWF**

Kent International Gateway, Land West of Junction 8, M20, Maidstone, Kent

Statement by John Wale on behalf of Protect Kent (the Kent Branch of CPRE)

ENGINEERING FEASIBILITY/GEOLOGY



The Kent Branch of the Campaign to Protect Rural England exists to promote the beauty, tranquillity and diversity of rural England by encouraging the sustainable use of land and other natural resources in town and country.

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CONCERNS REGARDING GEOTECHNICAL STABILITY AND CONSTRUCTION ASPECTS AND THEIR IMPACT UPON THE LOCAL COMMUNITY

Summary – see page 7

1. I, John Hedley Wale, am a chartered civil engineer with more than 20 years' experience of geotechnical investigation, design, and performance on major construction projects in Kent. I have been asked by CPRE to comment on the geotechnical and construction aspects which are likely to be faced during and after the construction of the Kent International Gateway, should this go ahead.
2. I have an honours degree in Geology from the University of Sheffield, and a degree of Master of Science in Engineering Geology and Geotechnics from the University of Leeds. I was admitted as a Fellow of the Geological Society of London in 1971 and as a Chartered Engineer and Member of the Institution of Civil Engineers in 1973. I worked as Head of Geotechnics, later Assistant County Surveyor, Assistant Director and Head of Highway Management in Kent from November 1973 to 2001. I was Assistant to the Chief Executive in Kent County Council from 2001 until January 2008, when I retired from full-time employment.
3. I have worked for Kent County Council and the Department of Transport on geotechnical investigation and design for many highway and transport-related civil engineering projects in Kent including sections of the M20, M25 and M26 motorways.
4. This work included ground investigation, test sampling and analyses, site instrumentation, slope stability design, earthworks planning and design, foundation design, in-situ testing and pile design. Many of these projects involved work within the Folkestone Beds and Gault Clay formations which are widespread in this area of Mid-Kent. With private sector consultants and with Cambridge University, Kent CC's Geotechnical group pioneered instrumentation and monitoring and construction control mechanisms for embankments, trial piles and retaining walls.
5. At national level I represented Kent as a Member of the County Surveyors' Society (CSS), chairing the national Soils and Materials Group from 1995 to 2008. During this time I dealt regularly with the government, Members of Parliament, local authority representatives, the private sector, and national construction industry bodies on the development and performance of engineering soils, earthworks and materials.
6. I was involved in a number of multi-agency projects and trials to assist in the specification and performance of naturally occurring soils in earthworks, and also the performance of aggregates and stabilised soils; this work included lime stabilisation of clay soils.
7. I have been co-author, or contributor, to several technical papers and research reports, specifically relating to the performance of soils and materials in projects in Kent and the UK.
8. Having read the documents submitted by the Applicant, specifically Appendix 9 of the environmental statement accompanying the original application; and the additional Appendix 9 of the supplemental environmental statement dated June 2009, and comparing these with the description of the proposals in the full submission it is my professional opinion that the Applicant has not made allowance for the nature and complexity of ground

- conditions across the site as detailed by his consultants, and the soil/structure interaction and consequences that are likely to result if the KIG proposals are developed as described.
9. Further, it is my professional view that the consequences of potentially failing to understand fully, and respond to, the engineering complexity, short-term risks and longer term risks involved are:
- (i) matters of material concern which could prejudice the safe construction and operation of the proposed development
 - (ii) issues which could pose adverse short-term and longer term impact and risk to the local community and to surrounding infrastructure including roads and railways.
 - (iii) the scale of the above risks also has significant implications in relation to the Applicant's arguments that this development will help meet the government's climate change imperatives; it is my opinion that the additional construction work comprising import of quarried material, associated lorry movements, additional specialist plant for alternative ground treatment, piling for foundations and retaining walls and stabilisation measures will together generate a significant additional carbon footprint which will undermine arguments that modal shift of transport will cut carbon emissions.
10. My reasons for forming these opinions are based on the following:
- (i) examination of the Applicant's submissions and specifically Appendix 9 of the Environmental Statement (Ground Conditions)
 - (ii) consideration of the response from the Geotechnical Consulting Group (letter via Marrons Solicitors to CPRE dated July 2009);
 - (iii) technical and research papers published by the Institution of Civil Engineers, and the Engineering Group of the Geological Society on Gault Clay earthworks and Foundations (see references listed at conclusion of this statement)..
 - (iii) my own professional experience, over more than 20 years, of earthworks, structures, foundations and slope stability in Kent

Environmental Statement Appendix 9: Ground Conditions (dated June 2007).

11. This document describes the local topography and solid/superficial geology, based on desk-top studies and ground investigations. It is my opinion that this document states the challenges that are likely to be faced by the Applicant, but the solutions proposed in later statements on behalf of the Applicant do not go far enough to satisfy concerns about the engineering and financial risks. Put simply, the message within the Application documentation is that detail and explanation of design and construction processes will need to follow. For a project of this size and complexity, and its proximity to the community infrastructure in the north eastern area of Bearsted, I do not believe this is acceptable or responsible in relation to possible effects upon the works themselves and especially upon the local community.
12. In paragraph 9.3 there are references to existing boreholes and data obtained, but no apparent reference is made to Kent County Council records (M20), those of the Department for Transport (DfT) (M20 Widening) or those for the Channel Tunnel Rail Link (CTRL). Given the extensive investigations carried out for these major works I would have expected some data to be evidenced. I would also have expected the Applicant to provide not only borehole logs and soil test results, but also earthworks appraisals and slope stability analyses. These are in my experience essential in the selection of parameters for safe design, construction, and long-term stability.
13. Paragraph 9.3.6 refers to the lithology of the Gault and Folkestone Beds, but in my view this is over-simplified. Gault Clay varies both vertically and horizontally throughout its succession, and additionally the junction of the two formations (base of the Gault) is

characterised by bands of coarse green glauconitic sands, in which ground water may percolate through. This can have an adverse effect upon major earthworks.

Gault Clay-Engineering properties, and behaviour in earthworks and foundations.

14. The major engineering features of Gault Clay are

- (i) its high plasticity and tendency to swell and soften when overburden is removed; this can cause a stiff unweathered clay to soften considerably over an earthmoving cycle, with a significant loss in undrained shear strength (which applies in earthworks operations).
- (ii) the effects of solifluction (surface soil flow during freeze-thaw cycles in periglacial periods) producing highly polished shear surfaces in some horizons; if water gains access to these, or high vertical loads are applied (e.g. from embankments, surface movement can be re-activated in the form of shallow or rotational landslips. This is a critical aspect of Gault Clay behaviour in embankments and cuttings. Although this is referred to in Appendix 9, there is no explanation of how it might affect stability in specific areas of major cuttings and embankments, or evidence of analyses carried out to provide confidence that the problems can be overcome.
- (iii) the loss in shear strength in major earthmoving operations from allowing water to be mixed with the clay; during construction of the M25 and M26 Motorways in Kent earthworks in Gault were only undertaken during spring and summer.
- (iv) the challenge of achieving long term (50-100 years) stable cutting slopes in shallow and deeper (>5 metres) cuttings and the need to control surface water as well as occasional springs; many cuttings on M25 were flatter than 1v (vertical) in 4h (horizontal); some were constructed as flat as 1v in 6h or 1v in 8h and returned to agricultural use. Within the past decade extensive and costly remedial works have had to be undertaken on the cutting slopes of M25 westbound near Flower Lane Bridge in Surrey.
- (v) the need to estimate progressive long term ground heave at the base of Gault cuttings; this will affect operational formation level in the longer term, a point recognised by the consultant. I can see no clear indication within the Application as to how this will be overcome in areas where large and highly sensitive structures and rail infrastructure are proposed.
- (vi) the occurrence of shear surfaces beneath embankments which on M25 and M26 was treated by embankment toe digout to depths of 4 metres or more, depending upon the local conditions; this is acknowledged in Appendix 9 but it is a costly and hazardous exercise (in terms of engineering risk) and has considerable implications for existing infrastructure alongside which KIG would be built, eg road and rail embankments.
- (vii) the long term consolidation behaviour which will occur beneath embankments and which generally necessitates the use of bored piles for structures and retaining walls
- (viii) the importance of understanding the soil's behaviour and choosing design parameters with great care where major retaining structures are proposed; this was the case with the retaining wall at M26 Dunton Green (ref).
- (ix) the variable and complex nature of the soils near the Folkestone/Gault interface. This applies not only to earthworks, but also to piling; piles driven through the Gault into the underlying Folkestone Beds will require a completely different design approach both individually and from the perspective of pile group behaviour.

Folkestone Beds-Engineering Considerations.

15. I am in agreement with the general description and assessment of the lithologies and properties of the Folkestone Beds. The material has been worked extensively in Kent as a foundry sand and as an aggregate component in road surfacing materials. It was also encountered extensively in highway earthworks (M20, west of Maidstone to Wrotham, and M20 east of Ashford). Its uniformly graded and generally fine nature make it suitable for embankments, if compacted at the appropriate moisture content, and as a stable cutting

slope material (1v to 2h; 2.5h; or 3h), depending upon cutting depth and soil lithology, provided slopes are protected from surface water run-off.

16. The risks with Folkestone Beds in earthworks arise from excess water, which on this site will be in abundance during earthworks in the overlying Gault Clay, and in water seepages around the Gault/Folkestone interface. Saturation can make the Sand unworkable with substantial heave as pore water pressures rise and fall under construction traffic. There is also the risk of gully erosion during high intensity rainfall.
17. Folkestone Beds are normally suitable for spread footings in foundations and will behave elastically, with no major concerns likely on longer term settlement.
18. Piled foundations in Folkestone Beds are more complex. It is likely that they would encounter significant resistance in the dense Sand, which would result in large scale and highly intrusive vibration in any surrounding area on which foundations are already constructed on Folkestone Sand. This could therefore apply across extensive areas of the southern sections of the KIG site between Thurnham Lane and Roundwell/Ashford Road, and to the built up area south of the railway.

Earthworks: Logistics, Suitability, Stability and Use

19. The construction record and challenges to be expected in Gault Clay have been reported over many years in professional journals, including those of the Institution of Civil Engineers, and the Engineering Group of the Geological Society of London. Several conferences and seminars in the 1980s highlighted the difficulties which could be encountered and emphasised the need for thorough investigation at the outset.
20. The KIG project relies fundamentally on the safe construction and long-term performance of earth platforms constructed in cuttings and embankments. It is therefore crucial that the interface of the Gault/Folkestone Beds is well understood in both areal extent and in soil type. It is also important to understand natural groundwater levels and how these will influence the earthworks and be influenced by the changes in soil profile across the site.
21. Borehole data has been used by the Applicants to determine an approximate interface and dip of the Gault on the KIG site. However I believe that this data is insufficient to make accurate detailed estimates of material volumes, depth of weathering, (solifluction, cryoturbation), and suitability for use in structural fill; this brings an increased risk of imprecise estimation of quantities of suitable structural fill from the materials to be excavated. The consequences of this would be as follows:
 - a higher proportion of Gault Clay would be unsuitable for structural use and would therefore have to be removed from site; this would bring a need for importation of suitable material which would be costly bring about large numbers of additional vehicle movements as a consequence of removal of unsuitable material and import of replacement fill.
 - The original export figure for unsuitable material is stated in paragraph 9.4.21 of Appendix 9 as 8,000 cubic metres, out of a total excavation of 1,835,000 cubic metres. This is only 0.43% of the total. It is my opinion that this figure is very low. It implies that either all the other materials to be excavated and re-used as fill will either be naturally suitable when excavated, or that extensive use of soil improvement techniques will be needed.
 - The amended application indicates that 12,000 cubic metres of unsuitable material will be exported, out of a total excavation of 1,560,000 cubic metres. This represents 0.77%, still a very low figure.

- If soil improvement by Lime Stabilisation is necessary, there will be further impact upon the local community as a result of transport movements from import of lime or other chemicals, and the need for stockpiling, mixing, placement and compaction. Experience of lime stabilisation of M20 earthworks during the 1980s (and on a much smaller scale) suggests that there could be additional adverse environmental impact from noise and dust. If Lime Stabilisation has to be carried out on a major scale over a long period, the effects when winds are blowing towards the village could be significant and potentially very unpleasant.
- The long-term stability of embankments formed in a highly plastic clay such as Gault will be influenced directly by the condition of the material when excavated, and the manner in which it is placed and compacted. Experiences from the Otford Trial Embankment (Kent County Council, c 1970-72) and from construction of M25 and M26 in Kent post-1975 illustrate the need for careful investigation, design and construction. At present there are indicative slopes of 1v in 4h up to a height of 5 metres (Appendix 9 paragraph 9.4.34). For higher embankments, which, according to cross-sections provided will be the case, additional reinforcement is suggested, in the form of soil nails or reinforced earth. These measures are in effect statements that above 5m height, Gault Clay embankments will require additional strengthening. In my experience this will be needed to avoid both the surface slips from softening over two or three years, and also toe heave where the bank is itself sitting on a clay foundation. Reinforcement by geogrids, reinforced earth, soil nails or use of a composite embankment involving different materials in specific layers would require a very careful design assessment, including consideration of outer slope protection.
- Retaining walls offer a more permanent but costly structural solution for retained heights above 5 metres. With such heights and materials it is possible that a bored pile solution would be needed. Selection of at-rest parameters (K_0) is a crucial aspect of such designs (cf M26 Dunton Green retaining Wall.)

Temporary Drainage and Risk

22. Given the very large surface area which would be generated by the platform building process, and the use of compacted impermeable soil (Gault) on that surface, there is likely to be huge surface run-off from the site during periods of heavy rain. Since 2000 the UK has experienced several extreme weather events, including high intensity rainfall in very short periods, and it is therefore vital that adequate drainage collection and outfall systems are provided and kept in working order. The impact of a storm of 50mm rainfall over 24-36 hours (as experienced in Herne Bay in 2001 and which contributed to severe local flooding) would create huge volumes of water across the site on a completely impervious surface created by the removal of existing topsoil and large scale earthmoving. This aspect of the Application is in my view a matter of significant risk, particularly given the scale and likely duration of the earthworks over several seasons.

Slope Stability (based on interpolation of cross-sections provided)

23. In Appendix 9 there are generalised recommendations for slope stability in earthworks; I am not aware of stability analyses or discussion of chosen soil strength parameters and pore water conditions to convince the reader that a full analysis has been carried out. This is particularly relevant in the consideration of how the proposed earthworks abut existing transport infrastructure (roads and rail)

(i) the "North West Section of the Site" [sic] where the development is close to the M20. It would be expected that the Department for Transport would have a view on these major earthworks so close to a major transport corridor. There is minimal reference in Appendix 9 to the manner in which KIG's earthworks and structures will interact with M20.

(ii) the London-Dover Railway east of Thurnham Lane is on an embankment which has been in place for more than 100 years. Settlement of this embankment will now be

complete, but no mention is made in the Application of the impact on this rail embankment of the major engineering platforms on which KIG would be built. No mention is made of stability analyses and drainage, or assessment of KIG's impact along this section of the railway. Network Rail must presumably have a view on stability aspects involving their property and infrastructure, but again no mention appears to be made in Appendix 9 or in subsequent correspondence.

Conclusions

24. Normally the engineering and technical issues surrounding a planning application are deemed to be capable of resolution through discussion, negotiation, or assurance, albeit with cost implications for the developer. Such issues are normally a matter for building regulations.
25. It is my professional opinion that the proposals for earthworks and structures put forward within KIG are of such a huge scale and are proposed to be built on such complex and challenging geological materials that the construction risks and longer term risks are considerable, and of a magnitude beyond those that can be dealt with via normal building regulations.
26. This is especially true given the close proximity of most of the site to the M20, to the London-Dover Railway, and to local housing areas. Given these risks and the extreme measures that may have to be adopted to overcome them, with attendant additional impact from noise, dust from earthworks, dust from chemical stabilisation of the engineering soils, vibration from piling and ground treatment, and substantial additional traffic movements, all generating additional environmental impact and carbon footprint, it is in my view reasonable to conclude that the issues of ground conditions, geology and drainage are of material importance in the overall consideration of the Application.

Appendix 1: Selected Technical References

Garrett, C and Barnes SJ - The Design and Performance of the Dunton Green Retaining Wall; published in "Geotechnique", Volume 34 December 1984 (Thomas Telford, Institution of Civil Engineers, London)

Clarke, B G and Wroth, C P – Analysis of Dunton Green Retaining Wall based on the results of Pressuremeter Tests; Geotechnique, Volume 34 December 1984 (Thomas Telford, Institution of Civil Engineers, London)

Garrett C and Wale, J H; Performance of Embankments and Cuttings in Gault Clay Earthworks in Kent; Failures in Earthworks Symposium, Paper 7, 1985, Thomas Telford, London.