The HR Wallingford document of September 2015 entitled:
"Grove Lodge, Admirals Walk
Review of First Steps BIA Response"
attached to and relied on in the Campbell Reith Report of October 2015
("the WR")

This response to the above document has been prepared by Mr. Gardiner and reviewed and edited by Dr. de Freitas and Mr. Eldred. Any technical views expressed herein are those of Dr. de Freitas and Mr. Eldred in relation to their own technical spheres.

1. The WR has been prepared by Mr. Briggs, a Chartered Civil Engineer and approved by Mr. McBride, who, whilst possessing an MSc in Hydrogeology and being a Fellow of the Geological Society is not a Chartered Geologist, and authorised by Mr. Tagg, a Chartered Civil Engineer who is also a member of the Chartered Institute of Water Managers but is not Chartered; i.e. not C.WEM. None of them have the qualification of either C.Geol or C.WEM as required by Camden.

   The only persons associated with the WR who are C.Geol are Mr. Flemming of Ground Engineering Ltd., and Mr. Race of Southern Testing Ltd., the contractors (and third parties) engaged to undertake the ground investigation at the instruction of either Mr. Briggs or Mr. Jordan, both of whom are Chartered Engineers.

   Whilst the experience of those involved is not questioned the competence, prudence and duty of care on matters geological and hydrogeological that should accompany the work of either a C.Geol or a C.WEM is missing from the WR document.

2. The WR was served as part of Appendix 3 to the Campbell Reith audit report of October 2015 ("the CR report") from whose terms it is plain that much reliance was placed on the WR. The WR is a long document but for the purposes of presentation we shall commence with its Executive Summary and what we consider to be the defects therein and then to consider how these have been transferred into the CR report. Finally we deal with remaining material from the WR and as to whether or not it supports the initial conclusions relied on. The headings quoted are taken from the WR in sections A and C or the CR report in section B.

A. THE "EXECUTIVE SUMMARY" IN THE WR

3. The points made under this heading need to be established in fact. They are probably written for the lazy reader in the hope that he or she will not go on to consider the evidential basis for making them. This necessitates, unfortunately, our considering later in some detail remaining statements in this report as to whether or not they justify these conclusions. As that examination demonstrates none of these conclusions are justified.

4. We do not believe that any fair reading of the First Steps Report of 3rd September 2015 would conclude that it is "very emotive". It does "repeatedly raise concerns" but that is only because the Wallingford BIA repeatedly asserts as fact matters that are not well founded in fact – the same matters time and again assumedly on the basis that by constant repetition it will be assumed that it must be correct, in particular the (unfounded) assertion that water levels will be at or below the level of the proposed

basement. That is why the First Steps Report has repeatedly to identify the same and enquire as to the factual basis for making them, concluding that there is none. That this is the exercise undertaken is plain from paragraphs 4 to 10 of the First Steps Report.

The significance of the water problem in this area must not be underestimated. It is understood that the contractors conducting the ground works for the old Fleet House (immediately opposite Grove Lodge) have hit serious flows of water; a situation that is in full accord with the observations made in the First Steps Report many months before, in paragraphs 21.1 to 21.2 inclusive. Further we now understand that substantial holes have appeared in the adjacent Windmill Hill.

"General Points"

5. None of the observations made here in the WR are justified by facts established in that document. The repetition is a criticism of Wallingford by themselves. It is manifest that Wallingford have not "used all available facts in assessing the basement impacts." They have relied solely on the corrupted data from the boreholes and dismissed all the other evidence because it doesn't suit the conclusion they want. That other evidence is summarised in paragraph 3.4 of the First Steps Report of 19th November 2015 and we need to repeat it herein:

   (1) the well in Admirals House has not been seen

   (2) the swimming pool in Admirals House has not been seen

   (3) the levels for either of these have not been measured

   (4) The evidence from the holes in the road has been dismissed

   (5) perfectly reliable methods of defining the direction of groundwater flow are ignored in favour of some notion from topography of where water is flowing

   (6) no means of determining hydraulic gradient exist on site, and

   (7) rainfall cannot be related to water level

6. Taking the above in turn:

   (1) <u>The well in Admirals House</u>

7. Paragraph 7.2 of the Wallingford Report in two places states that they were denied access to the well. That is false: they never asked for such access, it was never denied and had they asked permission would obviously have been given. They have been asked as to what evidential basis they had for making such a claim and have refused to respond passing the matter on to their client who has likewise refused to respond, leaving one with the only possible conclusion that they know and knew that they had no basis for doing so but made the statements regardless. They have left this false statement in their report (and others) and assumedly Campbell Reith have been influenced by the same.

8. The factually observed levels of the ingress of water over the years into the well, immediately adjacent to Grove Lodge, are real evidence of the various levels at which water has been observed and are significant particularly having regard to the alternatives relied on by Wallingford – the corrupted data from the boreholes. Wallingford seek to dismiss this on the basis that it is unclear/unreliable. There was nothing unclear about the measurements taken by Dr. de Freitas or those taken by him and Mr. Eldred or the water levels observed by the Gardiners over the years since these were related to the various stages/sections of the pump still extant in the well and measured by Dr. de Freitas.

9. The observed level of 124.51 metres AOD from the well gives a water level substantially above the level of the proposed basement for Grove Lodge disproving the assurance given in the BIA (based on the corrupted data from the boreholes) that the water level would be below the proposed basement. Wallingford attempt to dismiss this by reference to a hydraulic gradient between the well and a measurement from BIH but this is fallacious: they have not established any hydraulic gradient (which they could have done but have not by a system of triangulation for the boreholes) and the latter measurement is simply part of the corrupted data. In any event these are no reasons to assume that the water level would be any lower at the Grove Lodge basement site.

10. Dr. de Freitas and Mr. Eldred subsequently made measurements of the water ingress into the well. The first of these measurements were made available to the Applicants in the First Steps Report of 25th March 2015 and despite this no mention of these measurements is made in the relevant paragraph of the BIA (Appendices A.2.2) but instead the unmeasured (incorrect) visual observations of their clients (who are neither experienced nor qualified in these matters) are referred to apparently based on recollections made during a social occasion or occasions prior to any applications.

    Those figures given in paragraph A.2.2 of the BIA are completely at odds with Dr. de Freitas's measurements (which show water ingress at a much higher level) and yet no reference whatever is made to the latter in this paragraph which also seeks support from a "consultation response to the first planning application" which cannot have been the First Steps Report of 25th March 2015 because that is referred to as a "separate consultation response" and there was no such earlier consultation response as suggested. Again this statement is false.

    The whole paragraph is inaccurate and misleading; the Applicants have refused to answer these points or remove and rewrite the paragraph.

11. In accordance with the Arup Report adopted by Camden, Wallingford should have sought to establish whether any wells existed within one hundred metres of the site. They never did but despite the fact that their clients were fully aware of the existence of the well and its significance made a statement in relation to the first application that there was no well within one hundred metres of the site.

    (2) <u>The swimming pool</u>

12. No-one from the Applicants or their advisers sought to see this for the purposes of the application. No such request therefore was refused nor would it have been. Mr. Gardiner was asked to give measurements for the pool which he did (width, length,

depth – at deep end and shallow end). The figure for the depth for the shallow end (which had to be constructed much shallower than intended because of the water inrush and was, therefore, the most relevant measurement) is not referred to in the BIA. The assumption made in the BIA that the pool depth was limited to that for the deep end by the water ingress is simply incorrect and the calculations therefore likewise wrong.

(3) The relevant levels of water ingress into the well and the swimming pool

13. These were measured jointly by Dr. de Freitas and Mr. Eldred and related to the positions of the three boreholes at Grove Lodge (figures 1 and 2 of the First Steps Report of 3rd September 2015). There is nothing unreliable as to these figures, nor, therefore the conclusions at paragraphs 13 and 14 of that Report demonstrating the range of water levels encountered with the consequence that no reliance can be made on the assumption that water levels will only be encountered below the level of the proposed basement. Yet Wallingford assert that "water levels at a nearby well and swimming pool are quoted but with no supporting information." Yet again this is simply and obviously incorrect.

(4) The evidence from the holes in the road

14. This was factually observed by the Gardiners and all those living in the immediate vicinity at the time and the substantial repairs to Admirals Walk can still be seen in the surface of the road. There are well over a dozen neighbours still living in the vicinity who can also speak to the same. The overwhelmingly likely cause of this is water erosion.

15. In their response to the First Steps Report in relation to the first application HR Wallingford (at paragraph 5.3) dismissed this evidence on the basis apparently that they found a Council employee who "if he had seen these holes had forgotten he had done so." That is a wholly unprofessional attitude for any professional person to adopt – Rejecting evidence of fact because you have found someone who can't recollect it. Campbell Reith are misled by the same token regarding this evidence as "anecdotal" – it is not, it is direct evidence of fact. Indeed from the context it would appear that Campbell Reith regarded all the evidence at (1) to (4) as anecdotal and have been misled by the false statements made.

(5) Perfectly reliable methods of defining the direction of groundwater flow are ignored (see in particular paragraph 15.1 of the First Steps Report of 3rd September 2015) in favour of some notion from topography of where water is flowing.

16. What was needed was a triangulation of boreholes not three more or less in a straight line.

(6) Consequently, no means of determining hydraulic gradient exist on site (see paragraph 15.6 of the First Steps Report of 3rd September 2015) and

(7) Rainfall cannot be related to water level (see paragraph 15.5 of the First Steps Report of 3rd September 2015).

17. Wallingford have to concede that a triangular arrangement would have achieved the data required and would be normal practice but they attempt to answer (5), (6) and (7) above by contending that an examination of the surface topography can determine groundwater flow i.e. the groundwater flows in the same direction as the surface slope of the land. As explained in the First Steps Report (21.4), with no adequate data a first attempt at defining ground water flow direction would use topography but as there is no firm geological basis for that and the hydrological basis for any such proposition relies on the homogeneity of the ground, not the least for the fact that it takes no account for differences in the underground geology and its hydrogeological characters, confirmation by BH measurements is the norm. This is simply an attempt by Wallingford to produce an alternative justification for the failure to carry out what was required properly (i.e. a triangulation system).

B. THE CR REPORT

18. Campbell Reith in their audit have chosen to disregard the points raised in the First Steps Report of 3rd September 2015 in favour of responses from Wallingford and the WR document of September 2015 that we are now considering (see the e-mail from Liz Brown of Campbell Reith to Mike Briggs of Wallingford of 1st October 2015). Clearly they were not made aware of the fact that statements in the BIA were undeniably false. Campbell Reith have, therefore, effectively disregarded all the shortcomings of the BIA identified by Dr. de Freitas in favour of (a) responses from Wallingford alone or (b) an implicit acceptance that these matters may (or might) be dealt with in the course of construction in the future, post planning permission.

    Campbell Reith have not, therefore, taken account of the shortcomings and misrepresentations in the WR as summarised above (and further considered later in this paper). That is not an audit in any commonly accepted form of the process – the observations or proposals on one side have not been tested by reference to the criticisms on the other.

    In consequence the process, at least so far, has been unfair to those relevantly objecting.

19. In its discussion Campbell Reith acknowledge the following:

    (1) Key construction issues will need to be covered in a Basement Construction Plan (see paragraph 4.2). If so that plan needs to be formulated pre permission otherwise the requirements of DP27 are not satisfied.

    (2) Because water was added during drilling the identification of water strikes from the boreholes was "difficult" (see paragraph 4.5). But the "evidence" from the boreholes is the totality relied on in the BIA and by Wallingfords for their assumption that the water may only possibly be slightly above the base of the proposed foundations.

    (3) Campbell Reith refer to the evidence from the well, the swimming pool and the holes in the road as "anecdotal". None of it is anecdotal, it is either measured or seen as a matter of fact. In this, Campbell Reith have been misled by Wallingfords dismissal of all this evidence on the completely unjustified grounds referred to earlier in this Report.

CR continue (4.5) with the comment "*However it is noted that there was no evidence of clay horizons in the upper sand and gravel/gravelly sand which would allow the formation of the shallower perched water bodies, in the four exploratory holes which were carried out by two separate ground investigation contractors*". Clearly CR had referred only to the borehole logs ignoring the descriptions of the samples submitted to the laboratories where the presence of clay is recorded (at 11.5m and 14m in BH1 (Southern Testing), at 4m and 6m in BH2, at 4m, 6m in BH3 (where occasional clay bands are actually mentioned in the log), and at 5.6m in WS1 (all sunk by Ground Engineering). So CR are wrong on two counts; clay is mentioned in the logs and appears in the samples from both site investigation contractors.

(4) They acknowledge that the "hydraulic gradient has not been definitively proven" (paragraph 4.5). It hasn't been proven at all.

(5) They state that Wallingford "anticipate that the basement will be above or very close to the perched water table" (paragraph 4.6). That is no doubt Wallingfords hope but for all the reasons given in the First Steps Report of 3rd September 2015 there is no reliable evidence to support such hope.

(6) It is suggested that a new Ground Movement Assessment (GMA) should be produced (4.12 and 4.13) but again to satisfy the requirements of DP27 that needs to be produced now before any permission.

(7) The proposed connections to soakaways (paragraph 4.15) should be part of a groundwater management plan, in the Basement Construction Plan.

Campbell Reith Conclusions

20. (1) Paragraph 5.3 – "It is accepted that the basement will be constructed close to and possibly below a perched groundwater table recorded at around 123.74 to 122.60 metres OD." However that is all based on the corrupted data from the boreholes (the defects of which they themselves have acknowledged in paragraph 4.5). No consideration is given to the evidence from the well and swimming pool at Admirals House in particular with a level at 124.5 (i.e. significantly above the base of the proposed basement). It may be that Campbell Reith have disregarded this in view of the false statements by Wallingfords to the effect that they were denied access to the well and there was no supporting information (see paragraphs 6 to 16 above).

(2) Paragraph 5.4 states that "further assessment has shown that the cumulative effects on the groundwater are small even if the secant wall and basement were to form a barrier." However the only further assessment seems to have been a survey of the number and size of basements in the area. This does not deal with the consequences under and around the basement.

(3) Paragraph 5.7. To satisfy DP27 the GMA must be resubmitted prior to planning.

(4) 5.10 states that "The conclusions have been arrived at based on all necessary and reasonable evidence and considerations" when the author has positively stated that she is not going to consider the differences between Wallingfords and Dr. de Freitas and all the evidence at paragraphs 6 to 16 above is incorrectly dismissed as "anecdotal".

(5) It is then suggested that "further information required can be provided within a Basement Construction Plan." This is simply an attempt to shunt off into the "long grass" all the problems. But that is unacceptable and wholly contrary to the purpose of DP27.

21. Dr. de Freitas has summarised in short form the defects in the BIA and the audit by Campbell Reith. These are not repeated herein but in summary the position (with references to Dr. de Freitas' report dated 29th November 2015) is that:

(1) the BIA relies on water level investigations that were defective which consequently gave corrupted data (paragraph 2.3). The material relied upon were the investigations by Southern Testing Ltd. and Ground Engineering Ltd. and it is plain from their reports that their primary purpose was to test the constituents of the underlying soils. Because Southern Testing used water to assist their drilling the resultant data is simply unreliable for water measurement purposes (see paragraphs 15 and 15.1 to 15.8 and 19 to 20 of the First Steps Report of 3rd September 2015 – As Dr. de Freitas notes: "The ground investigation was designed by someone who did not know how to investigate ground water." Campbell Reith have acknowledged that this defect makes "the identification of water strikes [from the boreholes] difficult."

(2) The BIA disregards all the other objective facts summarised at headings (1) to (7) above (paragraphs 5 to 16) indicating that the assumptions and conclusions of the BIA are unreliable and unsafe (paragraph 3.4).

(3) No good professional reasons are given or exist for disregarding the evidence referred to at (2) above.

22. It follows from the above contrary to the WR that the proposed basement does not meet "the relevant requirements of DP27 and CS14 and should be approved with respect to CPG4" as suggested in the WR.

C. THE REMAINDER OF THE WR

Review of First Steps BIA Response

(2) "Facts, assumptions and judgments"

23. We don't know what dictionaries Mr. Briggs is using but Dr. de Freitas use is the commonplace (supported for example by the Oxford English Dictionary and the Shorter Oxford English Dictionary whose pre-eminence is recognised by their invariable use in courts). In any event Dr. de Freitas clearly identified in 15.6 and 15.7 of his report of 3rd September 2015 the meaning of the use of the term "assertion".

24. WR states that they "have not rejected material that might prove inconsistent with the conclusions desired." Paragraphs 6 to 16 above demonstrate that they have. They chose not to see and investigate the well and swimming pool at Admirals House and have not taken into their thinking the professional results of those who have as against the unreliable data from the boreholes and their clients own unmeasured transitory observations. Their reasons for rejecting the same are simply unprofessional and demonstrate at all stages a desire to reject anything likely to detract from the conclusion they and their clients desired.

25. The fundamental criticism is the unreliability of their water measurements. If they had been sound one could make worthwhile interpretations and judgments from them but they were not.

(3) "Layout of the site investigation boreholes"

26. The comments at 3.2 do not meet the point. What was required was a triangulation layout, not more boreholes. At 3.3 they acknowledge Dr. de Freitas' point and demonstrate that the true purpose of the boreholes was to determine soil conditions. They acknowledge that insufficient information is available but then conclude that it doesn't matter relying on the same insufficient information. It is, with respect, necessary to obtain the information required by Dr. de Freitas to be able to construct a reliable water management scheme (see paragraph 2.1 of his report of 19th November 2015).

(4) "Topography and groundwater flows"

27. Again the WR relies on "the relative depth of the basement and the groundwater" when they have no reliable figures of the latter and have discarded the evidence from the Admirals House well and swimming pool indicating that water levels may be much higher than they hope. To manage water flows you need to know their direction and variation in water levels with time and rainfall, and the investigations have not established it: topography being no determinant.

(5) "Rainfall and changes in groundwater levels"

28. There are two features here to note.

(i) Wallingford now correct an error in the original data submitted in the WR of the BIA where B.3 and B.4 were shown as plotting rainfall intensity with time against water levels in BH's 1, 2 and 3: apparently they were incorrectly labelled and the hydrographs are in fact plots rainfall with time. This however does not remove the criticism that rainfall cannot be properly linked to water levels.

(ii) Accepting the rainfall data as accurate, B.3 and B.4 both show there is a response in water level to rainfall, and that was acknowledged by Dr. de Freitas who did not say there was no evidence of response as claimed, but that the records fail to provide the quality of data needed to analyse the nature of that link. This is illustrated below.

The rainfall in B4 plots its relationship to water levels in BHs 2 and 3. On 2nd November 2014 a rainfall peak of about 7mm occurs; water levels in BH's 2 and 3 are both falling and continue to fall. On 4th November the water level in BH3 begins to rise but that in BH2 continues to fall. BH3's water level peaks around 6th November whereas that for BH2 peaks the next day. On 8th November approximately 26mm of rain is recorded and the water level in BH3 responds immediately whereas that for BH2 responds a day later. Now these holes are, for hydrological purposes, virtually next to each other. Much more can be said about the relationships between the peaks of water level and those of rainfall – the periods between them, peaks in water level that do not appear to be related to rainfall (around 22nd November) and more. The fact remains that WR's claim the relationship between rainfall and water levels can be established remains unproved.

The relevance of this is that the project is in gravels, close to the Heath which can be considered the major area for recharge from rainfall, and there are perched water levels in the vertical profile which the works will pierce, and to manage ground water some basic appreciation of how all these link is necessary. At present it remains absent. The problem lies with the water levels; they are not reflecting accurately what is happening in the ground in response to rainfall.

(6) "Monitored groundwater levels"

29. The Introduction to this section states that a statement by Dr. de Freitas is "conjecture and misleading" but gives no reasoning to support the same but refers the reader to Appendix B of the WR response where the question of clay layers is raised (again). This has been dealt with in 19(3) above. WR are wrong; Dr. de Freitas' claim is neither conjecture nor misleading, and is supported by the way water can be seen entering the well in Admirals House. No speculation or conjecture is needed here; water enters at many levels and cascades down the well to a standing water level that goes up and down with time.

The notion that sands and gravels above a clayey layer will carry sufficient water to fill a standpipe that connects the layer to lower layers of equal or possibly greater permeability (or thickness) disregards the relative hydraulic conductivities of the layers connected. Here again, what can be seen in the well explains all this.

WR conclude Appendix B with the comment that perched water levels may be present but they "*would be expected to be of limited volume and lateral persistence*". That expectation is not borne out by the evidence from the well.

30. With the greatest of respect Dr. de Freitas has a professional lifetime's experience with hydrology and observing water flows. To criticise his comments by reference to the momentary observations (for no more than a few seconds) of Mr. and Mrs Berendsen on a social occasion, yet again demonstrates the desire of Mr. Briggs of Wallingfords to refuse to recognise anything contrary to his desired result. Again why didn't Wallingfords come to see the well and indeed monitor the flows over a period of time?

31. The swimming pool shallow end was measured by Dr. de Freitas and Mr Eldred. The shallow end, closest to Grove Lodge was where the water entered and where the "anchor slab" had to be constructed. The resultant "shallow end" is in reality too shallow to swim in and at the base of the pool it is at least fifty centimetres above the level than originally intended.

WR takes issue with the analogy drawn by Dr. de Freitas between the piezometers installed and the well claiming there is not one piece of information that indicates this has occurred. Wallingford seem not to appreciate that the piezometer is the connection just like the side of the well; water above a clay layer enters the piezometer and flows down inside the piezometer to a lower level, whereas the water that does not enter the piezometer carries on flowing on the clay layer.

It should be noted that the instrumentation installed is described as piezometers whereas its manner of installation has converted them into standpipes. That is the term used, and correctly used, in the last paragraph of WR Appendix B.

(7) <u>"Levels at Admirals House well and swimming pool"</u>

32. The project team never asked to see the well or swimming pool and consequently were never refused. The statements to this effect are therefore false. Mr. Briggs of Wallingfords was asked to identify what material was relied on to make these false statements. He identified none but when challenged passed the matter on to Mr. Berendsen who likewise identified none. Mr Gardiner did not supply historical plans and cross sections as suggested since he had none or none legible. He was asked to attempt to state a relationship between the top of the pool and the steps at the front of the house which he attempted to do but he is not a surveyor and has no measuring equipment upon which he would rely. He is consequently not surprised that this exercise was not very accurate – the complexity of doing it was demonstrated by Dr. de Freitas and Mr. Eldred in producing the results in Dr. de Freitas's figure 2, results which are reliable.

33. The groundwater level of at least 124.51 was determined by Dr. de Freitas's and Mr. Eldreds measurements from the depth of the shallow end of the pool and as measured in relation to the first borehole on the Grove Lodge site.

34. Again reliance is placed on topographical gradient in determining underground water flows. There is no justification for this.

35. As stated the level of 124.47 was at the well. The level of the water coming in has varied from time to time and over the years. An old lead pipe remains in the middle of the well which has certain supporting struts at different depths. In consequence it is quite easy to identity the highs and lows that have occurred over the years and it was this "high" that was measured by Dr. de Freitas giving this figure.

36. There is no uncertainty as to the fact of the water levels and as measured by Dr. de Freitas. Again relevance is placed on a hydraulic gradient when none has been established.

37. New data has been provided by Wallingford, viz a water level from the Fleet House BH (Figure 7.1 of WR response); before that evidence can be used we need to know a lot more about where it came from, how it was measured, when it was measured and the instrumentation that provided the measurement. It is to be noted that those now proceeding with the excavations at the Fleet House site have encountered "a considerable amount of water" and if that is so it is unlikely that any water level measured now provides a picture of the natural environment.

Meanwhile the original objections remain. Indeed a puzzling statement is made in the WR response just above Figure 7.1; "*The perched groundwater levels at the basement site will be significantly less than the perched water levels at the well and at the swimming pool.*" This is geological nonsense; these levels are all within a stone's throw of each other and it is quite appropriate to compare them as has been done in Dr. de Freitas's Figure 2 (the section showing the water levels and the basement level).

38. Again reliance is placed on "the actual groundwater levels from the basement site" but this is reverting again to the corrupted data from the boreholes.

(8) Holes in Admirals Walk

39. Dr. de Freitas did not refer in his March 2015 report to these as being the result of "leaky drains", this is misinformation by WR. Their creation had simply been noted and taken as evidence that this ground may erode in flows of water.

The situation in Reddington Road has many geological and hydrogeological similarities with Admirals Walk – distance as the crow flies is irrelevant. This is a case history that should warn ground engineers and not be dismissed. There is now further evidence of such holes in the adjacent Windmill Hill.

If they were not caused by soil erosion what other explanation is there? Dr. de Freitas can think of none other likely and the use of the phrase "can be" was not intended to suggest that that was a mere possibility but a process whose probability should be assessed, and for this purpose Dr. de Freitas provided a reference to recent learned work on the subject, in which it is pointed out that our conventional ways of assessing erosion can be wrong.

40. The reasons that Wallingford gave for rejecting this evidence was that of "the Council employee who couldn't remember it."

(9) Previous planning application and BIA

41. Again the holes in Admirals Walk are regarded as not relevant, no doubt for the like reasons as before.

(10) Conclusion

42. Again the same criticisms are made as in the introduction. The First Steps Report was not emotive and Wallingfords criticism of repetition should be directed to themselves. They refer to the "best available information for the site" but rely on the acknowledged defective evidence from the boreholes and discard everything contrary to their desired

assumption. Points from their executive summary are repeated and are unmaintainable for the reasons already given.

The Appendices

The Appendices do not require major comment since they reflect Wallingfords general criticisms which have been dealt with in the text above. The following few instances are worth noting:

A8, Pages 9 to 10, Section 21.4

It is certainly not "incorrect or very misleading" to suggest that this substantial basement involving an excavation of some two hundred and eighty eight metre square that could find itself below layers of perched water will have a larger impact than the well with a dimension of one metre and depth of approximately eleven metres. They state that the proposed basement is located at/above the perched water table but that again relies on their unreliable evidence from the boreholes as this level is not that of the perched water.

If, as one must, one assumes that the water levels may be somewhat higher than the base of the basement (as would be indicated by the figures of measurement derived from the well) then plainly the basement will have a massive effect on water flows compared to the well. As stated in the First Steps Report Wallingfords here are attempting to defy all logic.

A9, Page 11, Section B.4.3

WR accept that the heads in the well and the swimming pool are up-gradient of the basement site, whatever that gradient is, yet do not connect that fact with the inevitable conclusion that it will be heads like these that are driving water to the basement excavation. As Wallingford will know, flow is from high to low total head.

A10, Page 12, Section B.5.2

No reason is given for stating that the 6.09 metre range is "incorrect and very misleading". That range is simply a product of the measured readings.

The issues with water levels and what can and cannot be deduced from them have been mentioned earlier; the water levels recorded and used in the design are unreliable, risks are associated with this, some acceptance of that is expected in the form of a ground water management plan but none is provided because the concept of there being groundwater problems on site has at first been ignored, and when brought to the attention of the applicant, dismissed, and now dismissed again. What more can be said?

A13, Page 13, Section 23.3a

Again they fail to recognise that the data from the boreholes is unreliable – continuous records continuously producing unreliable data. Further there is no reason to suppose that there are not multiple levels of perched water at the site, indeed that is what one

would expect. Superb measurements made at the wrong place and/or at the wrong time are not a substitute for the right measurements being made in the first place.

B Boreholes, perched water and level readings

This purports to summarise the views of some anonymous person but are dealt with nevertheless in 29 above.

Response to comments by Mr. Eldred

As with comments in relation to Dr de Freitas's report reliance is placed by Wallingford on their assumption "that the groundwater data that we have indicates that water is below the basement" but that data is defective and unreliable.

Mr. Eldred wishes to note that his only concern is that such applications and audits should evidence the full engineering regard for the public interest required by the Institutions of both Civil and Structural Engineers. This requirement is reflected to a large extent by Camden policy DP27.

In the present case he considers that the applicant's advisers have failed in that duty. They have counteracted concerns expressed in his report, concerns about issues which he believes to be fundamental and warranting further investigation before planning consent, by misleading interpretations and dismissal of them as matters for the Party Wall etc. Act. Those advisers have a commercial interest to pursue. The auditors do not but have followed suit, explicitly ignoring other opinion.

Wallingford Appendix C

Part C1 states that anything in Mr. Eldred's report that does not repeat Michael de Freitas' comments is typical of matters dealt with by the Party Wall etc. Act. As will be seen that is not true.

Part C2 refers to "*Long term effect of piling*". The Eldred report made no reference to long term effects. He was concerned more about what might occur during construction.

It is possible that ground between the basement and clay has the potential for internal instability during change of groundwater conditions. By that is meant that it has the propensity for fine grains to wash out leaving the ground weakened and able to subside. Holes in the road, international research and personal experience from the other areas cited give credence to the comment. What is the response of Wallingford? It is that *groundwater flows slowly and if fine silt particles do have the potential to wash out, they have nowhere to go.* But they do have somewhere to go during basement excavation and dewatering. And it is not just silt but fine sand that can become unstable and wash out.

Furthermore, when groundwater seeps through an internally unstable soil into an excavation, the pressure it needs to cause such an effect can be only as little as one fifth of that required for the same effect in an internally stable soil.

Wallingford then point out that Mr. Eldred should be aware "*that the primary piles would be founded in clay and not subject to erosion*". He was aware that the bottom 2m of the piles are expected to be in clay, just as he is aware that there would be 2m of sand and gravel below the basement, and that any erosion of that in gaps between the primary piles during construction would reduce lateral support of the wall, allow it to deflect more than the design estimates, increasing the probability of more ground movement and more damage to neighbouring property.

Wallingford go on to accuse him of "*scaremongering*" when he refers to personal experiences of such internal instability in South East London and mention the nationally reported closure of the A2, which despite their comment was in part due to internal instability of sand. They comment that geological differences make that experience inapplicable to Hampstead. They are quite wrong.

Apparently they are not aware that potential for internal stability depends only on material grading (proportions of different sized particles) and has little or nothing to do with names or ages of geological deposits.

Of course, instability can be prevented, but that requires engineering design to demonstrate stability. That has not been provided. What is worse, those responsible do not seem able to recognise that there is a risk to be considered. So a fundamental consideration; the means of ensuring stability of the piled wall around the basement has been swept aside with ignorant comment.

Part C3 completely ignores the substance of his concern, which is that flow of water towards the Admirals House well could have caused the distortion of the Admirals House west wall and that there is some risk that groundwater changes caused by the development could cause further disturbance.

Instead, Wallingford have misrepresented that concern as being that the proposed excavation 3m from the Admirals House wall could cause damage and have set the matter aside for attention under the Party Wall etc. Act.

Mr. Eldred cannot evaluate the risk to which he has actually referred and, since Wallingford ignore the need for adequate groundwater information, neither can the applicant's advisers. But to simply ignore the risk is potentially negligent.

Part C4 disputes the concern that the designed method shown by drawing 5954/306/P1 in the engineers' report could cause failure of the existing Terrace Lodge foundations. (Recap: they would be left exposed and resting on the ground surface during construction. At the east wall, the situation shown by the drawing as Stage 1 could not be achieved without first excavating very close to and deeper than the exposed foundation to clear obstructions before piling. At best, a situation requiring a slope stability check for DP27; at worst, a recipe for disaster.)

Wallingford respond by saying that exposed foundations would be protected by concrete blinding (a thin layer of concrete, about 50mm thick placed over other material to provide a surface for construction) and that the concern about the east wall is unfounded. How so? No explanation is given to support their statement. Blinding will

not aid stability, and potential for a slope failure below the east wall is either ignored or just not recognised.

Wallingford are right to note that piling is routinely carried out near existing foundations but those foundations are usually buried. The risk that constructing a secant piled wall will disturb sand below footings resting upon the ground surface is significantly greater but has been ignored.

Wallingford aver that Mr. Eldred was wrong to state that on completion the Terrace Lodge footings would be at or very near the ground surface. Yet that is exactly what the application drawings show. The footings would be at most, 0.35 metres below ground level. Wallingford's statement that the footings would finally be at the same depth as at present (about 1m below ground) is not true. The settlement risk referred to exists and has been ignored.

The final paragraph of Part C4 regards his comment on the ground movement assessment as emotive and states that Mr. Eldred has not offered any technical support for it.

That is quite wrong. Section 9 of his report explained the reasons for the comment quite clearly. The ground movement assessment models completely the wrong situation. He does not criticise its analytical quality, it is simply that the model takes no account of the ignored engineering risks and potential consequences embodied in other parts of the application. He has shown that his concerns are justified and that there is a need for them to be addressed.

Campbell Reith Audits

Mr. Eldred's concerns have all to do with matters that are at the heart of DP27. They are fundamental issues relating to the possibility of damage to Admirals House and Terrace Lodge. They are all valid; in truth, none of the sometimes ignorant, sometimes misleading comment by Wallingford serves to show otherwise.

The audit reports either repeat and accept the opinions of the applicant about these matters without considering other information or consigns them to be dealt with after planning consent.

In case of Terrace Lodge, the auditor refers to the existence of a basement and possible existence of piles. The conclusion is that this is something that should be investigated but that the matter can be left until after planning consent. Yet it is a matter of fundamental significance for both Terrace Lodge and the scheme proposed

Planning drawings recently submitted for retrospective planning consent for the basement give no indication of piled construction. It is not at all certain that the basement supports the eastern external wall and it does not extend to the north wall.

There is nothing to prevent the applicant making all necessary investigation of this and other outstanding matters now. Camden's recent changes to CPG4 provided for matters that truly could not be dealt with before a contractor was appointed to be the subject of a Basement Construction Plan after consent. Here, the auditor seems inclined to agree

that anything inconvenient to the applicant, including matters which are the essence of DP27 and capable of being resolved before planning may be consigned to a Basement Construction Plan.

The audit has been prepared by a Chartered Geologist and makes no reference to involvement of other professional disciplines. Is it right that audit decisions about engineering matters should be made by a geologist?

Michael de Freitas Michael Eldred John Gardiner

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With reference to London Borough Camden Applications 2015/4485/P and 2015/4555/L and the RESPONSE to Campbell Reith's audit of the Wallingford BIA.

The following Appendices (**A** and **B**) have been permitted to compensate for the brevity with which technical submissions entitled *The HR Wallingford document of September 2015 entitled: "Grove Lodge, Admirals Walk Review of First Steps BIA Response" attached to and relied on in the Campbell Reith Report of October 2015 ("the WR")* were required in response to the audit conducted by Campbell Reith.

They address more fully two areas of error in the audit, viz. Campbell Reith's conclusions regarding perched water (Campbell Reith para 5.3 and its reliance of HR Wallingford's Response para 6.2 and Appendix 6) and Campbell Reith's conclusions regarding potential erodibility of sediments in the Bagshot Formation (Campbell Reith para 5.4 and its reliance of HR Wallingford's Response in Section 8).

Appendix A

A: Clay layers for perched water in the Bagshot sediments

A1. Attention has been directed to whether or not there are clay layers in the upper levels of the Bagshot sands and gravels, near ground level, on which groundwater may be perched. The borehole logs record none but samples sent to the laboratory are described as having clay and have a fine fraction that has not been analysed. The gradation of the samples show that samples from above the elevation of the basement contain 5% or more of particle sizes smaller than Coarse Silt (0.06mm). The well at Admiral's House shows water is perched at these high levels and so perching is present. Should it be expected?

A2. The London memoir of the British Geological Survey (BGS) Geology of London includes the following description for the Bagshot Beds (or more correctly Bagshot Formation);

Laminae of pale grey clay, less than 10mm thick, are common and there are sporadic units, generally up to 1m thick, of thinly interbedded, flaser laminated, pale grey to greenish grey silty clay, clayey silt and fine sand.

The Lexicon of the British Geological Survey (BGS) adds;

The sands are commonly cross-bedded but some are laminated. Thin beds and lenses of laminated pale grey to white sandy or silty clay or clay ('pipe-clay') occur sporadically, becoming thicker towards the top of the formation…… The facies (carefully mapped in exposures in Surrey) *showed rapid lateral and vertical changes in grain size and bed form.*

A3. That mapping revealed the Bagshot sediments to be estuarine in origin deposited under sub-tidal conditions where tidal, wave and river conditions dominated at different times. Overall, a sequence of interlayered sands, muds and fine sands accumulated, cut by sand filled channels with their accompanying contemporaneous erosion and re-deposition; a sequence that typically shows rapid lateral and vertical changes in grain size and bed form making lateral correlation of beds very difficult.

A4. Four illustrations are attached to show what all this means and to help explain a further feature found in these sediments; bioturbation i.e. the mixing of sediment by animals looking for food. This would disturb laminations and bioturbated sediment is recorded from the Bagshot sediments by the BGS and others. It tends to be sporadic as can be seen from the top picture which photographs a typical example of conditions under which these sorts of sediments would accumulate. Bottom feeders (birds, worms etc) would graze in their particular environment avoiding areas above water, or below water, or in a channel and so forth.

A5. This is a picture of ground that would be recognized in the Bagshot sediments of Hampstead.

A6. For groundwater to be perched only one criterion has to be satisfied, viz. that a difference in vertical permeability exists that is sufficient to cause water to pond under the vertical hydraulic gradients operating (in other words, sufficient to prevent what is technically described as *"steady flow"*). Clay alone is not needed for this; silt under sand or gravel will provide the change in permeability that is needed; all the more so if some small percentage of clay is caught up in the silt.

A7. The wide range of grain sizes that are typical of the Bagshot Beds and recorded in the samples recovered from Grove Lodge demonstrate that there is ample potential for this to happen here and that would explain the distribution of water that can be seen in the well at Admiral's House.

A8. Clay forming layers was mentioned originally in my report because it is a simple situation to imagine (clay layers holding up water and perching it at various levels within the sands and gravels) and clay is known to be present within the Bagshot Formation. However it is not the only cause of perching, as described above.

A9. Thus the search for clay at the expense of considering what other grain sizes could do is rather a distraction; clay is present and is known to form layers however clay layers are not the only cause for perching, clayey silts and fine silts and mixtures of fine sand and silt could all act as low permeability layers to an overlying coarse sand and gravel, so perching water within the sands and gravels.

A10. Thus there should be no doubt about the need to incorporate perched water levels and the heads they represent into the design for the management of groundwater.

Appendix B

B: Internal erosion in flowing water

B1. The holes in the road in Admiral's Walk, adjacent to the southern boundary of the site, raised the prospect of whether these sediments can erode in flows of water; this idea was dismissed as unproven and alarmist although many residents witnessed the holes and no alternative explanation for the occurrence of these holes has been provided.

B2. Interestingly all but 3 samples out of 14 recovered from clearly Bagshot sands and gravels in the ground investigation (not including 2 from BH3, one of which is Made Ground and the other possibly containing Made Ground) contained particles smaller than Coarse Silt. Two of the 3 that contained no particles smaller than Coarse Silt came from BH 1 where water had been used to assist drilling. This water could have eroded the fine fraction from the samples recovered.
B3. Even more interestingly, the third sample that contained nothing finer than Coarse Silt (from BH 2) came from 3.1m to 3.6m where the BH log records that water was added to assist drilling from 2.0m to 5.0m.

B4. If such particle erosion was occurring as a result of water added for drilling it could also explain the unnatural shape of the grading curves for other samples recovered from BH2 and BH3.

B5. So there is a body of evidence that points a finger of suspicion at this material being susceptible to erosion under normal conditions of its presence beneath a road and during its recovery from a borehole.

B6. For a sediment to erode in a flow of water it has to possess the following characters;

- It must have a primary fabric of stable grains that are not going to move under the disturbing forces that can act upon them. This is the fabric that transmits load.
- It must have an unstable grains that can move through the porous network created by the primary fabric. They carry no load until they collide with a pore size that will not allow them to pass, where upon they can contribute to whatever particle loading is operating.
- These two requirements generally mean that a wide grain size distribution (e.g. from gravels to clay) has the potential provided by its grain sizes to generate a stable fabric within which there are moveable grains. Note this means that density by itself is no measure of potential

erodibility – the issue is the stability of the material per unit volume not the amount of material per unit volume.

- The migrating particles will continue to travel through the primary fabric until they collide with a pore size that will not allow them to pass, where upon their migration is halted. Thus the length of the flow path is significant. If erosion is going to occur it will start where the flow path that carries the migrating particle out of the system is shortest. Erosion this works backwards from a “free face” into the body of the material so making it more porous.

B7. The consequence of this mixture of characters is that although guidelines based on experience and empiricism have provided safe guides to design for filters for over 60 years, as demonstrated by their use in the design and construction of earth embankments, there is as yet no theoretical basis for predicting internal erodibility; for that tests are required.

B8. Two other features of erodible sediments are of note both associated with the disturbing forces that cause particle migration and result in erosion; they are vibration and seepage forces.

- Vibration can have a profound affect upon the relative stability of primary fabrics, rendering what is stable under static conditions, unstable under dynamic conditions. Most vibrations are short lived but by themselves will not cause erosion.
- Seepage forces are long lived and generally less dramatic but ever present and over time are by themselves capable of causing erosion.

B9. Note here that seepage forces that initiate internal erosion can be below those that initiate “piping” or “quicksand” conditions, where the primary fabric itself is disrupted and everything it encloses; so simple reference to hydraulic gradients is not sufficient to dismiss the possibility of internal erosion.

B10. That holes attributed to internal erosion in Admiral’s Walk and Redington Road should have occurred on roads, where vibration and pipes are found together, can now be appreciated; the free surface would be between the ground and a pipe acting as a drain with a short flow path that would reduce the probability of particles encountering a pore that will not let them pass. In Redington Road, the hole developed adjacent to a manhole access to drains where vibrations would have been readily transmitted from the manhole cover to the rings and pipe network with which it connects. The newspaper pictures of the hole at Redington Road shows good quality tarmac that could not have been rolled had there been a void below. The ground at that time had been firm and solid.

B11. The question then turns to what effects erosion may have on the proposals for Grove Lodge. There are a number of scenarios that ought to be considered especially downstream of the basement in the region of Admiral’s walk where erosion has already occurred. However, concern here must be

directed to the continuous flight auger piling that is proposed to form the perimeter of the basement. This piling has three functions;

- It has to retain the ground outside the excavation so as to prevent excessive ground movement causing damage to neighbouring structures including that of Grove House.
- It has to control ground water, including that perched at levels higher than the “standing” water level.
- It has to permit a diverted but otherwise uninterrupted flow of groundwater beneath them so it may cross the site.

Each of these functions will be impaired by erosion occurring in the ground around the auger. Erosion affecting the first two will create voids that can be filled by the concrete later used to fill the pile shaft; rather irregular piles may result but in theory they should be able to fulfil their primary function. Whether the concrete would permeate ground loosened by erosion which has been weakened by the removal of mass from within it, is another matter. If it cannot, weak patches against the piled wall will remain.

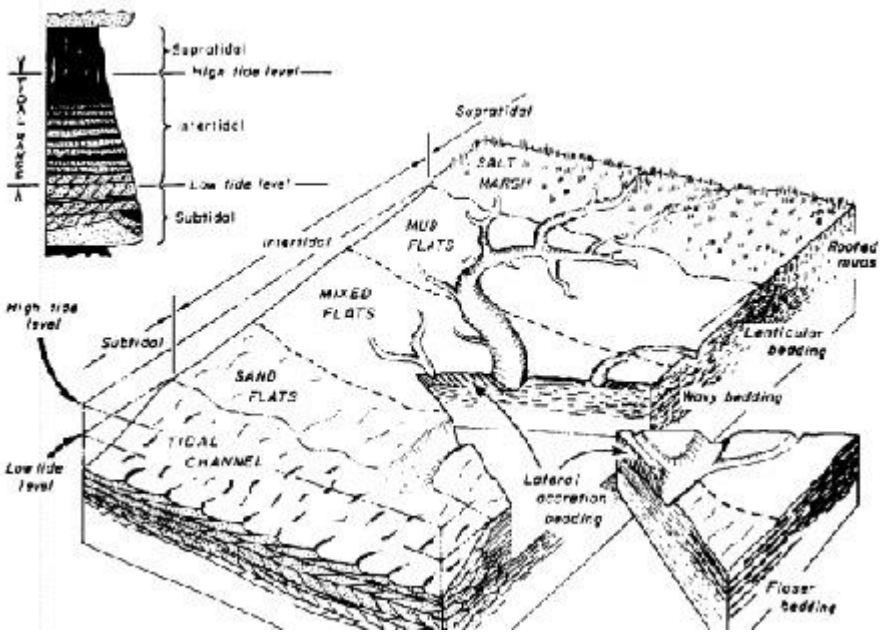
B12. The third function of the piles may not be fulfilled if erosion damages the augered void in the lower parts of the shaft. The management of groundwater in this proposal relies on there being long and short piles so that water can pass beneath the shorter piles. Erosion at the bae of the shaft, where the differential heads are at their greatest, could produce cavities at the base of the pile that are larger than planned and once filled with concrete would no longer provide the gaps for flow paths.

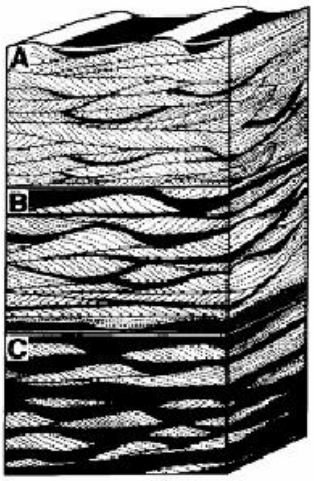
B13. In other words the design upon which this aspect of planning permission is sought is vulnerable to erosion and until the prospect of that can be eliminated the design as proposed cannot be guaranteed.

B14. Resolving these uncertainties relies on understanding the ground and how to work with it. That is lacking in sufficient detail for approval to be given with confidence.

MH de Freitas PhD, DIC, C.Geol, C.WEM
Director First Steps Ltd, and
Emeritus Reader in Engineering Geology
Imperial College London.
Ground Engineering Advisor,
UK Register of Ground Engineering Professionals (RoGEP) (68302453)

Attachments. Four Figures depicting (top) an example of the environment of sedimentation encountered in the Bagshot Formation; (below) an illustration of environments; (below) a typical vertical succession as might be encountered in a BH core through the Bagshot Formation; (last) typical deposit seen in 3D.





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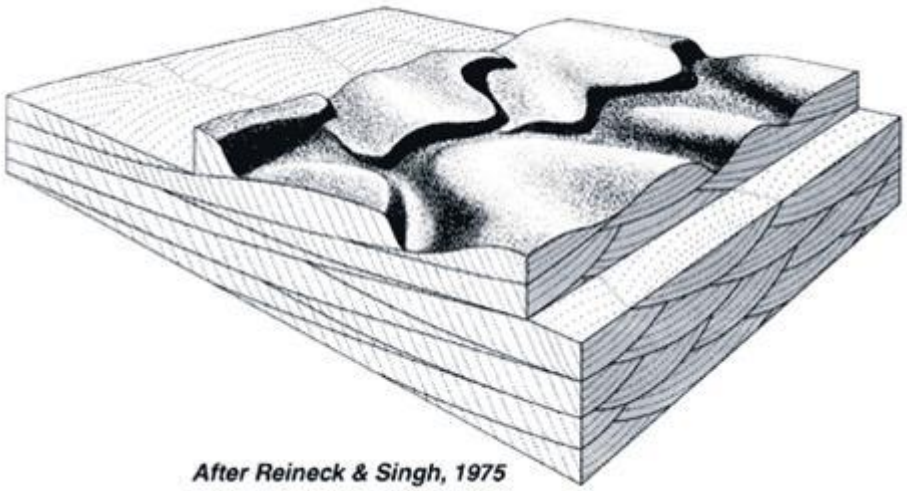
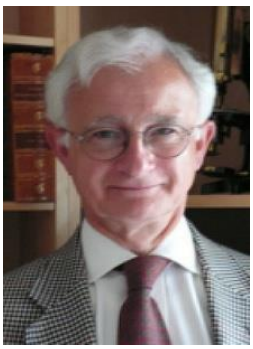


SHORT BIOGRAPHY (2015)
Dr Michael Henry de FREITAS C.Geol., C.WEM
UK Registered Ground Engineering Adviser (RoGEP)



Present position: Emeritus Reader in Engineering Geology,
Imperial College London and Director of First Steps Ltd.,

Higher Education: BSc (Hons) 1st Class. Geology. London 1964
PhD. Engineering Geology. London 1982 DIC 1982

Chartership: Chartered Geologist. 1990
Chartered Water & Environmental Manager 2009

Awards: Sir Henry Miers Prize of the Mineralogical Society; 1964.
Safety in Construction medal of the Institution of Civil Engineers; 1997.
Chevalier L'Ordre des Palmes Academiques; 2001
Rudolph Glossop medal of the Geological Society; 2008

Publications: The authorship of two text books, contributor to four books, editor of seven books, author of 49 refereed papers in geotechnical journals, and of 24 un-refereed publications in conferences.

Membership of Professional Bodies, Learned Societies, etc.:

Geological Society of London (F) 1960 – onwards
International Soc. Rock Mechanics 1967 – onwards
Institution of Water & Environmental Management (M) 1969 – onwards
Royal Geographical Society (F) 1974 – onwards
International Assoc. Engineering Geologists (M) 1979 – onwards
International Assoc. Hydrogeologists 1983 – onwards
British Geotechnical Society (M) 1985 – onwards
Geologists' Association (M) 1989 - onwards

Learned Society (Geological Society) & Professional service

2012 – onwards	Lead Author; Geol Soc Working Party Report (Glacial & Periglacial EG)
2012	Panel Member for the 2012 audit for C.Geol
2011 – onwards	Panel Member for the Register of Ground Engineering Professionals
2010	Panel Member for the 2010 audit for C.Geol
2009 – onwards	Chairman London Basin Forum Working Gp. of the Geol. Soc. London
2008	Glossop Lecturer
2005 – 2007	Chairman of the Fellowship and Validation Committee
2004 – 2005	Member of the Fellowship and Validation Committee.
1998 – onwards	Provider of Continuing Professional Development courses
1993 – onwards	Scrutineer for status of Chartered Geologist
1990 – 1994	Member of the Geological Society Awards Committee.
1990 – 19922	Chairman Engineering Group, Geological Society
1988 – 1990	Vice Chairman. Engineering Group of the Geological Society,
1981 – 1984	Editor Quart. Jour. Engineering Geology for the Geological Society.
1978 – 1979	Vice-President of the Geological Society.
1971 – 1984	Editor Geological Society Handbooks.
1976 – 1979	Member of Council of Geological Society and Chairman for the Promotion Co-ordinating Committee

International Society (Int. Assoc. Engineering Geologists) service

1996 – 2003	Chairman for International Assoc. Engineering Geologists Commission on Teaching and Training.
1994 – 1996	Secretary for International Assoc. Engineering Geologists

Research Council and national bodies

1996 – 1997	Chairman of the CIRIA working party report for British Stratigraphical Nomenclature
1991 – 1994	Member of ICE (Ground Board Committee) on Inadequate Site Investigation
1991 – 1993	Member BSI Committee: Ground Investigation, for the revision of BS 5930
1986 – 1988	Panel Member Natural Environment Research Council Research Grants Committee for Geology.

International invitations

1984 – onwards	External Examiner for the Technical University of Delft & Hong Kong, and many universities in the UK.
1974 - onwards	Visiting lecturer to Technical University of Athens; University of Complutense. Madrid; University of Stockholm (KTB); Guest touring lecturer, Beijing and Wuhan. University of Wuhan & University of Seoul.
1997	Commission 4 Rapporteur for Int. Assoc. Eng. Geol. (Athens)
1994	Rapporteur. 7th Int. Congr. Int. Assoc. Eng. Geol. (Lisbon)

Personal consulting

1974 – onwards	Widely on practical matters of engineering geology to contractors, designers and regulators both in the private and the public sector, in the UK and overseas. Work involving the practical solutions of problems arising from groundwater, stability and materials at surface and below ground. Recent contracts include:-Brighton Outfall tunnel; Dublin City Corporation (Dublin Port Tunnel); Railway Procurement Agency (Ireland) (Metro North Tunnel & surface works); ARUP Geotechnics (Havant Thicket reservoir); South African Council of Geoscience (Nuclear power sites), United Utilities Penrith UID scheme (for consortium Kier Murphy Interserve), London Borough of Camden, Donaldson Associates (various tunnels and pipelines).

Of particular relevance to Basements;

Advice to and involvement with ARUP, the Heath and Hampstead Soc and London Borough of Camden with the drafting and implementation of CPG4

Advisor on hydrology to Heath and Hampstead Soc

Consultant for 21 basements to date within the London Borough of Camden, and others within the Royal Borough of Kensington & Chelsea, with particular reference to the practical assessment of ground water management and ground response both on site and below surrounding properties.

Expert witness for the basement at 9 Downshire Hill, 2 Green Close & 9 Pilgrim's Lane

Research experience

Over 40 years experience with rock and soil slopes, the shear strength of clean and infilled rock surfaces, comminution in shear zones, rock and mineral reaction to water, weak rocks and the nature of boundary layers. Also the influence of basement tectonics and their reactivation on the sedimentation and geotechnical characters of cover rock sequences.

Present employment

My time is divided between teaching on the MSc in Engineering Geology in the Dept. Civil Engineering at Imperial College London, working at First Steps, the company I founded with a colleague in 2000, consulting as outlined above and continuing research with colleagues at Imperial and elsewhere. All major consultants and many contractors have sent staff to our courses at First Steps; in-house courses are also provided, the largest being to the Royal Engineers at Chatham. Web-based learning systems have also been developed to train those involved with creating Ground Models, the latest being Lapworth's Logs. All courses are endorsed by the Geological Society of London.