

## UD 1: HYDROGEOLOGY, GROUND AND GROUND WATER MOVEMENTS

### SCREENING

When applications for basement development are submitted, applicants generally possess only limited understanding of the geological, hydrological and hydrogeological complexity of the Redington Frogna! Area.

This has meant that complex engineering issues affecting neighbouring properties have been left to be settled by section 106 agreements and under the Party Wall Act 1996, leaving many unresolved issues and typically incurring high levels of expenditure by neighbours for the commission of reports by expert consultants <sup>1, 2, 3, 4, 5</sup>.

Basements are typically substantial engineering operations<sup>6</sup>. The need to submit engineering calculations prior to determination of a planning application was affirmed by the Planning Inspectorate, in appeal decision APP/X5210/W16/3164577 in relation to 28 Redington Road. In this case, the Inspector noted, “that basement development will only be permitted once it has been demonstrated that the proposal would not cause harm to neighbouring properties.” The Forum note, however, that the need for engineering calculations is application specific, although in almost all cases, structural engineering input and calculations will be required.

### GROUND MOVEMENTS

The ground beneath Redington Frogna! is a complex layering of Bagshot Sand, Claygate Member and band D of the London Clay Formation. The top two layers have a high silt and sandy component rendering them susceptible to high water conductivity, as well as being potentially less stable: even band D of the London Clay Formation, while less permeable, still has a variable but significant silt content with a degree of erodibility, and can contain water under pressure in sand partings.

Excavation of the earth creates stresses in the ground: vertical, horizontal and water stress. Prior to excavation all these stresses are perfectly balanced. Digging will cause the sides of the trench to cave in, the base to rise and the water to drain out of the soil, unless the ground is appropriately supported and its groundwater managed.

The excavation for a basement also causes change to the water pressures in the ground. Groundwater flow becomes diverted beneath neighbouring properties, requiring water drainage measures to be incorporated, if calculations indicate such drainage measures to be advisable. When the water pressure in the soil decreases, this causes the soil to consolidate. This can lead to brittle failure and plastic failure, if the water pressure in the soil is affected. If drainage is introduced, the water pressure decreases and soil particles move, creating soil consolidation. These changes in the ground, once started, are 99%

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- 1 The proposal to excavate a basement at 28 Redington Road (2016/2997/P) caused neighbours to incur expenditure of £13,300 on structural engineering and geological assessments and reports.
  - 2 Residents in Briardale Avenue incurred expenses of £55,000 to protect against predicted ‘severe’ structural damage (Nicole Sochor email chain, 23.3.18).
  - 3 Camden New Journal letter of 15.3.18
  - 4 Nicole Sochor evidence to DCLG inquiry, 6.1.17
  - 5 Nicole Sochor email to HHS, 26.3.18 and email evidence to Redington Frogna!, 25.3.18
  - 6 Eatherley v London Borough of Camden and another [2016] EWHC 3108 (Admin)

irreversible<sup>7</sup>.

Camden has compiled evidence of damage caused by basements to neighbouring properties in Hampstead, but little was collected for Redington Frogna, as home owners do not wish to affect the saleability of their properties. However, it has been demonstrated that soil consolidation can take ten years to complete and that this is the time lag between construction and cracks and distortions beginning to appear.

## GROUNDWATER MOVEMENTS

Redington Frogna is situated on the southern and western slopes of Hampstead, one of the largest and highest hills in London, with the highest rainfall of the Greater London area, and much of it located on the flank of this large hill. As a consequence, a significant number of Redington Frogna streets are downward sloping, where hard standing or building footprint enlargement produces additional surface run-off and drainage requirement, increasing flood risk in storm periods to vulnerable lower areas such as Frogna and West Hampstead.

In parts of Redington Frogna the 'water table' ground water flow (across the top of both the Claygate beds and band D of the London Clay Formation) is constantly present and at times it can be rapid. Basement excavation can sometimes break into continuous flow of these water tables, but also will constrain and divert the ground water present throughout the area. Sometimes velocities of flow can be sufficient to cause erosion of the high silt and sand content of Redington Frogna's soil types leading to small but significant volume loss. This can result in the subsidence and cracking of neighbouring buildings, causing water ingress, and the formation of cavities under roadways and services.

A report by Alan Baxter for the Royal Borough of Kensington and Chelsea<sup>8</sup> notes that, where basements constructed in clay, they "effectively form a hole in the clay which can fill up with water and which is not able to drain away naturally. Although the hole appears to be completely filled in by the new basement structure which displaces water, the hydrostatic water pressures in the basement are present because of water at the interface between the clay and the basement construction up to the top of the clay or slightly higher than this depending on the ground conditions above the clay. This issue needs to be carefully considered in the design. The structure needs to be designed to resist the hydrostatic pressure, unless something is done to relieve it. Flotation can also be an issue, particularly for basements in clay subsoil beneath rear gardens or internal basements with little load on top of them." This problem is accentuated where swimming pools are constructed, as care must be taken to ensure their structure remains stable when they are emptied. This can be dealt with by designing in accordance with current standards and codes (e.g. BS8012 and BS EN 1997).

Sinkholes have appeared at a number of locations in Redington Road and these are attributed to underground development, with former Councillor Chris Knight photographed sitting in a sinkhole, which was reported in the Ham & High newspaper edition of 21 October 2011:

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<sup>7</sup> Dr. Michael de Freitas, Distinguished Research Fellow, Faculty of Engineering, Department of Civil and Environmental Engineering, Imperial College London.

<sup>8</sup> *Residential Basement Study Report, March 2013*, by Alan Baxter for the Royal Borough of Kensington and Chelsea [https://www.rbkc.gov.uk/wamdocs/0954-130\\_RBKC\\_Residential\\_Basement\\_Study\\_Report\\_2013-03\\_low.pdf](https://www.rbkc.gov.uk/wamdocs/0954-130_RBKC_Residential_Basement_Study_Report_2013-03_low.pdf)

*“Cllr Chris Knight discovered the apparent pothole in the middle of Redington Road on Saturday afternoon.*

*But it turned out to a small opening leading to a gaping cavern below – sparking renewed fears about the effects of basement developments on Hampstead’s foundations.*

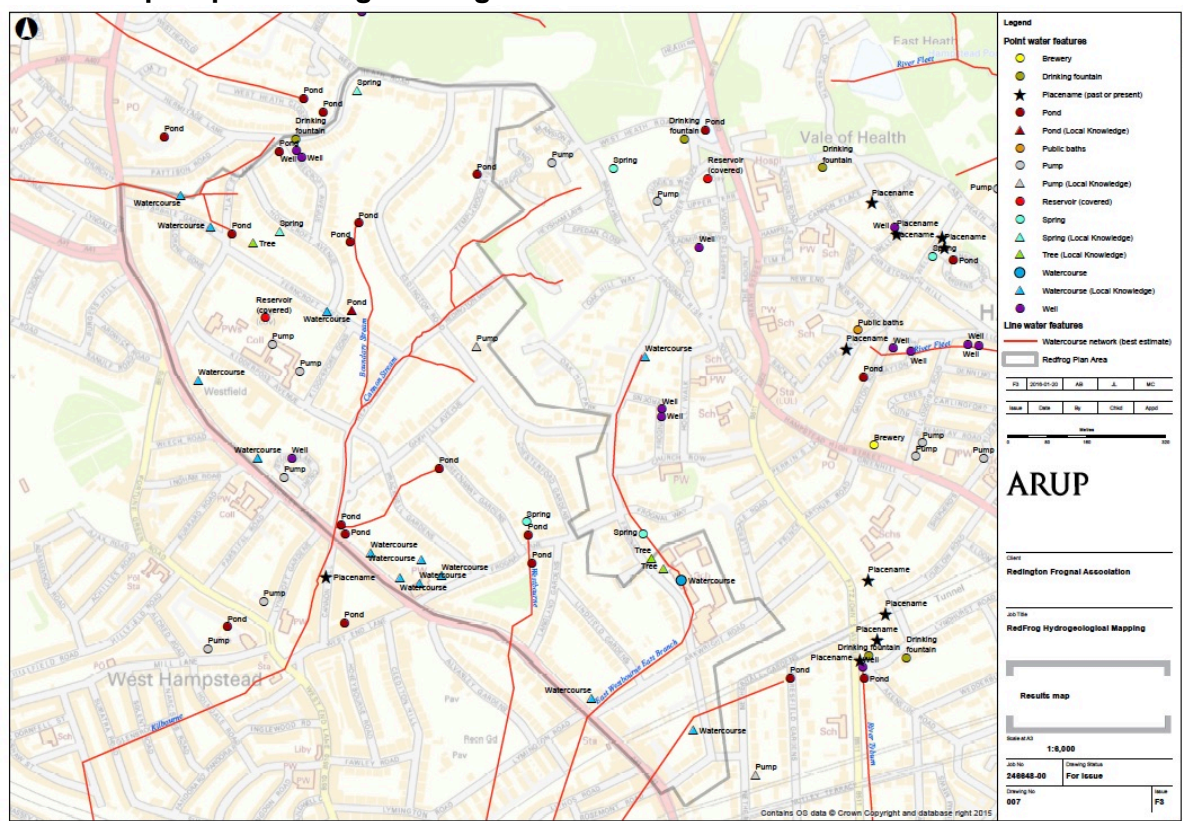
*The former cabinet member for environment said: “The hole is big enough to swallow a small car.*

*“This is precisely the sort of thing that’s very worrying for people. It does not bode well for basement construction in the area if one small water flow can do this.”*

*He believes the hole formed because of sand being eroded over a long period of time.”*

Groundwater is present throughout the neighbourhood Plan Area. To better understand the complexity of the area and its sub surface water features, Redington Frogna! Neighbourhood Forum commissioned a study by Arup of the area’s sub surface water features. This includes a detailed map which records the manifestation of water at or near ground level in the form of known spring lines, underground streams, ponds, wells, soggy gardens and pumps, showing that many streets lie above, or in very close proximity to, underground streams and spring lines.

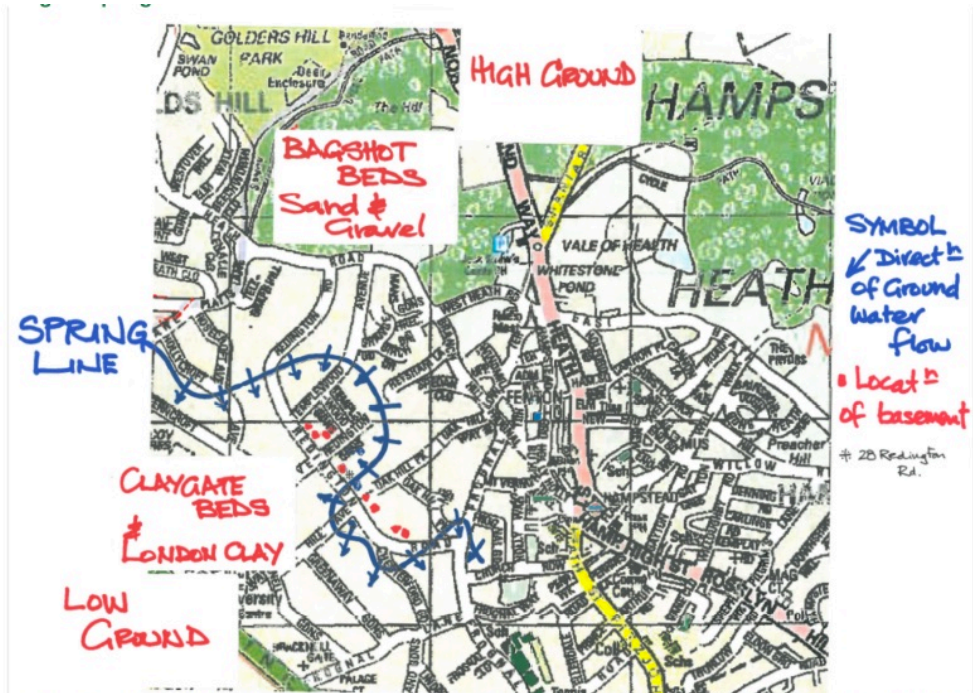
### Arup Map of Redington Frogna! Subterrenean Water Features



Source: Dr. Adam Broadhead, Arup



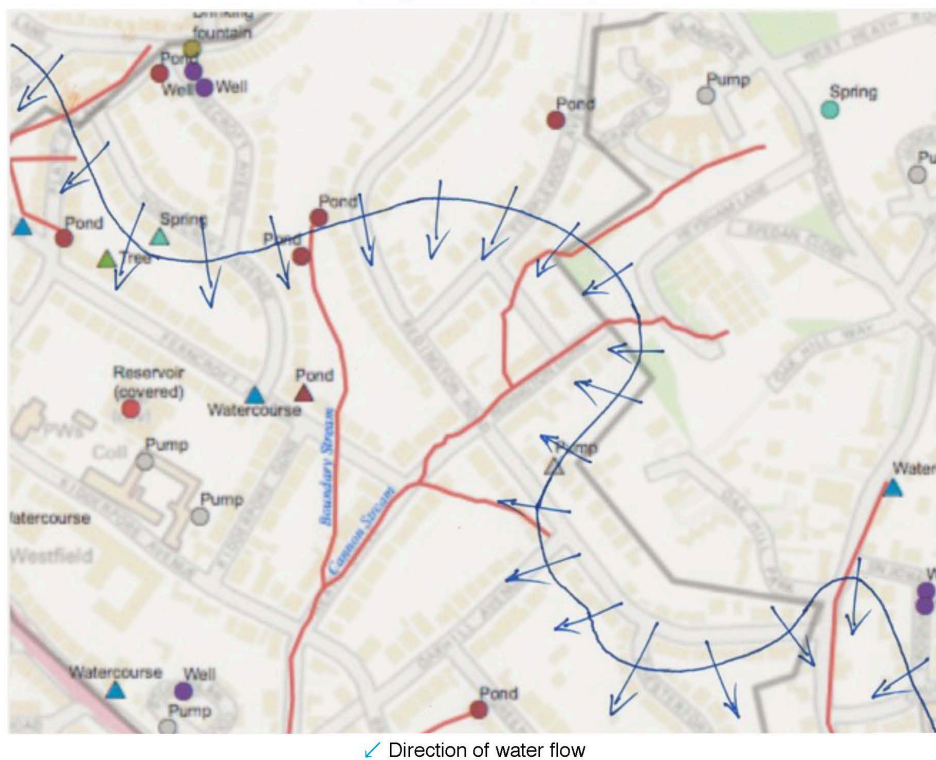
## Redington Frognal Spring Line



Source: Drawn for 28 Redington Road Planning Appeal APP/X5210/W/3164577, 12.19.17 by MH de Freitas PhD, DIC, C.Geol, C.WEM, Emeritus Reader in Engineering Geology, Imperial College London and Ground Engineering Adviser, UK Register of Ground Engineering Professionals (RoGEP) (68302453)

## Redington Frognal Spring Line Superimposed onto Arup Underground Water Features Map

Spring Line+ Arup map

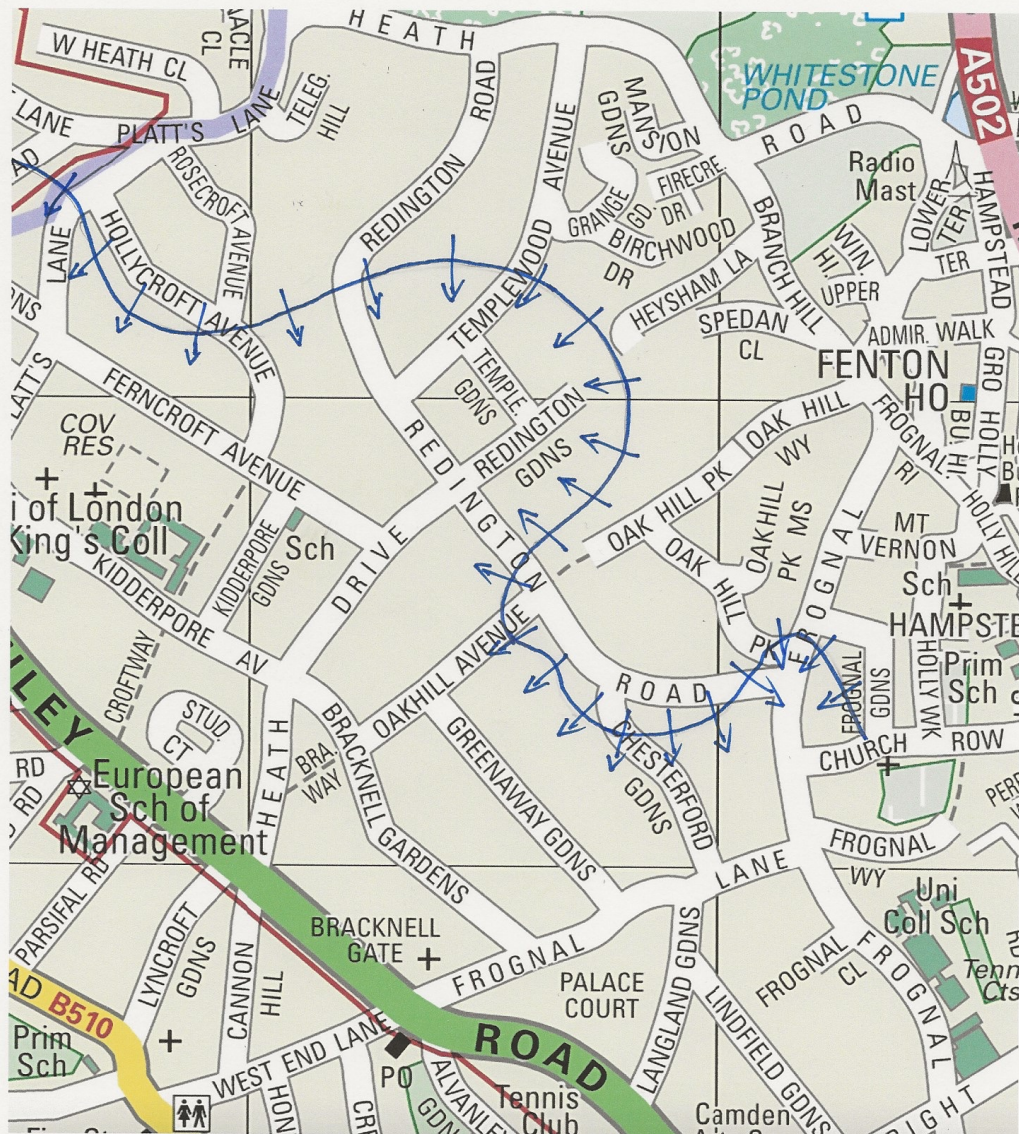


Source: Robin Lacey based on Arup and Dr. Michael de Freitas



## Redington Frognal Spring Line Superimposed onto A-Z Map

Spring line



↙ Direction of Ground Water flow

Source: Robin Lacey based on Dr. Michael de Freitas