

Proposed Development at Symondshyde Farm
Supplementary Report on the Potential Formation of Sink Holes

1. Introduction

1.1 This report has been prepared by John Boscawen Burland, Emeritus Professor of Soil Mechanics at Imperial College London. From 1966 to 1980 he worked at the Building Research Establishment, Watford becoming Head of the Geotechnics Division and then Deputy Director and Head of the Materials and Structures Department. In 1980 he was appointed Professor of Soil Mechanics at Imperial College, and on his retirement in 2005 he was appointed Emeritus Professor and Senior Research Investigator at Imperial College. Throughout his career he has been engaged in advising on numerous geotechnical problems both in the UK and overseas. Notably in the late 1960s, he led a major study into the mechanical properties of the Middle Chalk at Mundford in connection with a proposed nuclear accelerator for CERN. The work he did has since become seminal, transforming our understanding of the mechanical properties of chalk. More recently, he was responsible for devising and implementing the work of stabilising the Leaning Tower of Pisa, and he advised on the stabilisation of the Big Ben Clock Tower during the construction of the Jubilee Line Extension underground railway. He is a Fellow of the Royal Society and of the Royal Academy of Engineering. He is also a Foreign Member of the US National Academy of Engineering.

1.2 The purpose of this Supplementary Report is to describe briefly the mechanics of sinkhole formation and the potential for sinkhole formation in and around the Symondshyde Farm site that is proposed as a strategic development site in the Draft Welwyn Hatfield Local Plan. It supplements a report dated 13 March 2017 titled *Development at Symondshyde Farm: Geological Considerations* that was prepared by two of Professor Burland's colleagues at Imperial College, expert geologists Dr Richard Ghail and Dr Philippa Mason. That report describes the geology of the proposed development site at Symondshyde and the results of a walkover survey in which two probable chalk sinkholes were identified.

2. Sinkholes in Chalk

2.1 As described in the March 2017 report, the Symondshyde site is underlain by Chalk. In this area, the Chalk is overlain by a cover of glacial till of variable thickness which consists mainly of clay.

2.2 Due to its soluble constituents, Chalk frequently contains cavities and caves formed over many years by the infiltration of rainwater seeping down joints and cracks in the Chalk and causing its gradual dissolution. The collapse of the roof of such a cavity may propagate to the ground surface through the covering soil layer causing what has been termed a 'Sink Hole'.

2.3 Sinkholes fall into two categories:

- i) A cover-subsidence sinkhole which consists of a surface dish-shaped depression which develops gradually.

ii) A cover-collapse sinkhole that develops suddenly, often leaving a hole with steep sides.

2.4 The collapse of the roof of a pre-existing cavity in the Chalk can be triggered by a variety of processes both natural and man-made. Most frequently a collapse is triggered by a change in the groundwater conditions – either a rise in the groundwater table or a local increase in surface water infiltration.

3. Assessing the potential for sinkhole formation at Symondshyde

3.1 A key question is whether the formation of sinkholes at a given site can be predicted. Dr Helen Reeves, an expert in sinkholes from the Geological Survey of the UK, states:

‘We know the areas they are likely to occur but these events are impossible to predict. There are so many different processes that can cause them, natural and man-made, that have an influence. On the slower forming sinkholes, you sometimes can see evidence of the feature starting to collapse and you get cracks and voids starting to appear. But, sadly, sometimes these are catastrophic events that don’t give any warning’.

3.2 The most reliable preliminary guide to assessing the potential for sinkhole formation is expert local experience based on a walkover survey. The preliminary report in March 2017 described such a walkover survey which revealed a significant textbook example of a cover-subsidence sinkhole on the site. A further probable sinkhole was identified in the form of a pond-filled hollow.

3.3 A recent walkover survey has been carried out in the wider Symondshyde area surrounding the proposed development site by a professional geologist Mr Patrick Bird. In addition to the textbook example described above, ten other features were identified as possible sinkholes at the locations marked on the map in Figure 1 in the Annex to this report. Photographs of these features have been examined by Dr Richard Ghail of Imperial College, who concluded that features 1, 2, 3 and 10 in Figure 1 are most likely to be sinkholes. These photographs, together with that of the feature to the west of the Symondshyde Farm buildings identified in the March 2017 survey (Location 11 in Figure 1), are reproduced in the Annex.

4. Conclusions

1. The proposed development site at Symondshyde is underlain by Chalk which is well known to frequently contain cavities and caves, the roofs of which may collapse for a variety of reasons causing the formation of sinkholes.
2. It has been demonstrated through expert walkover survey that sink holes are present both on and around the proposed development site. This is important factual evidence that must not be ignored or brushed aside.
3. What we do not know is what latent cavities are present beneath the ground surface. However the fact that a number of sinkholes have been identified both on and around the site shows that there is a likelihood of the existence of undetected cavities beneath

the ground surface that could trigger the formation of sinkholes as a result of the development.

4. The only reliable way of detecting such cavities is by a large amount of expensive drilling through the footprints of the proposed buildings and sufficient in number to establish a quantitative risk assessment of potential sinkhole formation for the site. It is well known that geophysical methods are not reliable for the detection of cavities at the depths that are relevant here.

5. Responses to possible questions

- Q1. Why is it that site developments and building takes place all over Hertfordshire over the Chalk with few instances of sinkhole formation and consequent damage? Isn't the issue of potential sinkhole formation at Symondshyde simply 'project fear'?
- A1. Both the formation of a cavity in the chalk and the subsequent collapse of a cavity roof depends on a wide variety of processes and local groundwater conditions. It is true that the majority of urban and village developments in Hertfordshire do not experience significant problems from sinkholes. However, the proposed development at Symondshyde is a greenfield site development on chalk with little previous local experience on which to draw. The facts from the expert walkover survey are unarguable – a number of sink holes have been found on and around the site. In the light of the above conclusions, far from 'project fear' it would be project 'blind optimism' to build this development without very extensive and expensive drilling.
- Q2. What is the concern when most of the identified sinkholes are away from the proposed building footprints?
- A2. The fact that sinkholes have been identified both on and around the site means that there is a likelihood of cavities existing anywhere in the underlying chalk, the collapse of which could be triggered by changes in stress or groundwater conditions brought about by the proposed development.
- Q3. If a sinkhole is found on the allocation site then surely the master plan can be adjusted to ensure that this area is left as Public Open Space rather than being built on?
- A3. Without doing very expensive extensive drilling it is impossible to say whether there is one or more potential sink holes on the allocation site – see Conclusion 4 above. Therefore this suggestion in no way eliminates the risk of sinkhole formation beneath the proposed development.
- Q4. It may be questioned whether there are more sinkholes in the Symondshyde area than anywhere else on the Chalk proposed for development.

- A4. No development on a greenfield site of similar geology should take place without a professional study of the terrain to identify whether there is potential for sinkhole formation. To do so would be professionally negligent. The walkover survey described here and in the March 2017 Imperial College Report has clearly shown the potential for sinkhole formation on this site.
- Q5. What is the chance of the sinkholes already identified on the site suddenly caving in?
- A5. Without carrying out drilling within the sinkhole it is not possible to quantify the risk. However the consequences of such a collapse could result in loss of life so the risk is not negligible. It would be professionally negligent to go ahead with the development without carrying out sufficient expert ground investigation by means of drilling to quantify the risk.

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