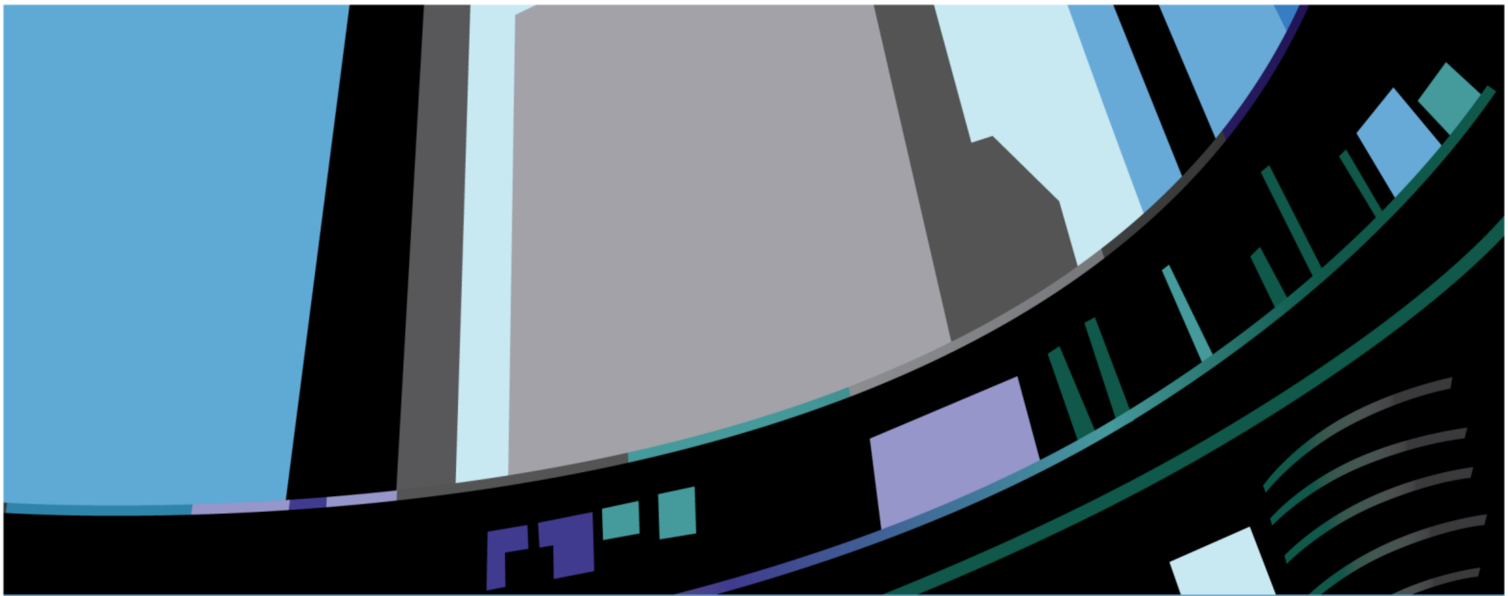

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Report

Flood Risk Assessment and Drainage Strategy

Project: Land West of Hook Norton Road, Sibford Ferris

Client: Land & Partners South East Limited

Reference: C85855

Date: September 2018

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DOCUMENT CONTROL SHEET

Flood Risk Assessment

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FOR AND ON BEHALF OF JNP GROUP

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Executive Summary

jnp**group** was commissioned by Land & Partners Limited to undertake a Flood Risk Assessment (FRA) for the proposed development of land west of Hook Norton Road, Sibford Ferris. Also included within this FRA is a chapter on the existing and proposed foul and surface water drainage of the site.

The application site is approximately 3.7ha in areas, however, the ‘study area’ covers the whole field (as shown in Figure 1) and is bounded by an existing residential estate to the north, Hook Norton Road to the east, Woodway Road to the west and open fields to the south. The land within the site is comprised entirely of agricultural fields, with protected hedgerows that run along the northern, eastern and western boundaries of the site.

The site is identified in Flood Zone 1 on the Environment Agency’s (EA) Flood Map for Planning, meaning the site passes the Sequential Test and Exception Test.

Groundwater has been identified as a possible risk to the site, specifically perched groundwater. This is due to the impermeable Whitby Mudstone being encountered at shallow depths in the southern end of the site. A single day of preliminary Site Investigation (SI) works was carried out during July 2018. The SI found no groundwater across the site; however, July is considered to be a seasonal low for groundwater levels. In order to fully understand the groundwater regime, it is recommended that ground water monitoring should be carried out throughout the year and the results used to inform the final drainage and excavation strategy. As a safeguard against the potential risk of perched groundwater, it is recommended that proposed Finished Floor Levels (FFLs) are set a minimum of 300mm above the existing ground level.

The site has been found to be at low risk from all of other sources of flooding.

Preliminary SI works were carried out by jnp**group** during July 2018 and included soakage testing in three locations. The testing was carried out over a single day only and was intended to provide an indication as to whether infiltration may be viable or not. Full site wide soakage testing will be required as part of the formal site investigation works.

The investigation works confirmed the strata to be Northampton Sand Formation (between 2m and 1m thick) over Whitby Mudstone Formation. The Northampton Sand was found to be of greater thickness in the north east of the site (approx. 2m) and became shallower in the south.

The days soakage testing has revealed that infiltration may be viable in the north-eastern area of the site, due to this area of the site having relatively thick layers of permeable Northampton Sands. However, until the depth of the Northampton Sands is confirmed across the whole of the developable area and its interaction with possible perched groundwater (taking into account the impermeable clay at depth), the assumption that infiltration is viable across the whole of the north east of the site must be used with caution.

Due to poorer infiltration rates, the soakage test carried out in the more southern area of the site did not drain sufficiently to establish a design soakage rate (bearing in mind that only a single days testing was carried out). In order to ascertain what soakage rate could be achieved within these areas, it is likely that the test will need to be carried out over a number of days (to allow the pit to drain to the required level). However, this result is a fairly strong indication that infiltration is unlikely to be considered viable in the southern part of the site. These results are consistent with the findings of the trial pits, where a thinner layer of the Northampton Sands was observed meaning the impermeable Whitby Mudstone was encountered at shallower depths.

Based on the initial findings (and subject to a full and detailed site investigation inc. ground water monitoring and BRE compliant soakage testing) the proposed surface water drainage strategy will be to discharge run-off to the ground via shallow soakaways located in the north eastern area of the site. As the north east of the site is where ground levels are at their highest, private pumping may need to be considered as part of the detailed design. For the purpose of this report, it will be assumed that the Northampton Sand is at least 2m thick over the developable area and that shallow soakaways can be utilised without the need for pumping. The assessment will also assume

that perched groundwater levels will not rise to within 1m of the base of the proposed soakaways. Both these assumptions will need to be verified at detailed design stage.

The local sewer authority in the area is Severn Trent and their asset location plans show that there is an existing 150mm dia. foul sewer (possibly combined) which runs beneath Hook Norton Road to the North East of the site. Due to the shallow nature of this sewer, it is envisaged that foul will need to be pumped to the nearest point of discharge (MH Ref 5001) via a new rising main. It is recommended that a formal capacity study is carried out with Severn Trent to establish whether the existing network has capacity for the additional flows from the proposed development. Should the study indicate that there is sufficient capacity for the proposed development within the existing infrastructure, further consultation will be required (with Severn Trent) in order to establish the timescale for implementation of these works or an alternative connection point will need to be established.

As of April 2018, developers are no longer responsible for the up-front cost of offsite upgrade works associated with new developments and instead these costs are claimed back through infrastructure charges per property.

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1 INTRODUCTION

1.1 Terms of Reference

1.1.1 **jnpgroup** was commissioned by Land & Partners Limited to undertake a Flood Risk Assessment (FRA) in support of an outline application for the proposed development of land west of Hook Norton Road, Sibford Ferris. Also included within this FRA is a chapter on the site's existing and proposed foul and surface water drainage regimes.

1.1.2 The total site area is approximately 3.7ha and the proposed development includes the construction of 25 new domestic dwellings in the northern area of the site, whilst the southern side of the site will be used as open space with woodland and associated landscaping. A copy of the proposed development layout is provided in Appendix A

1.1.3 The National Planning Policy Framework (NPPF) states that when determining planning applications, local planning authorities should ensure flood risk is not increased elsewhere and only consider development appropriate in areas at risk of flooding where informed by a site-specific flood risk assessment. This assessment is required for:

> *"Proposals of 1 hectare or greater in Flood Zone 1, all new development (including minor development and change of use) in Flood Zones 2 and 3 and an area within Flood Zone 1, which has critical drainage problems as notified to the local planning authority by the Environment Agency (EA)."*

1.1.4 In accordance with the March 2014 Planning Practice Guidance (PPG), which supports the NPPF, the objectives of this flood risk assessment are to establish:

- *"Whether a proposed development is likely to be affected by current or future flooding from any source.*
- *Whether it will increase flood risk elsewhere.*
- *Whether the measures proposed to deal with these effects and risks are appropriate."*

1.1.5 Consultation has been undertaken with the EA to obtain site-specific flood data, as well Oxfordshire County Council (OCC) who are the acting Lead Local Flood Authority (LLFA).

1.2 Site Description

1.2.1 The planning application site is approximately 3.7ha in area and forms the northern part of an agricultural field bounded by existing residential dwellings to the north, Hook Norton Road to the east, Woodway Road to the west and open fields to the south. The study area of this report covers the wider field to provide a broader context in terms of geology and flood risk assessment.

1.2.2 A site location plan is shown below in Figure 1, this location plan shows the site boundary.

Figure 1: Study Area Location Plan

1.2.3 The site is comprised entirely of agricultural fields. North-east of the site is the village of Sibford Ferris which is part of a group of villages known as Sibford, the other villages are Sibford Gower and Burdrop.

1.2.4 Cherwell District Council (CDC) identified the site as suitable for development in their February 2018 Housing and Economic Land Availability Assessment.

1.2.5 The site co-ordinates are:

- N23705 E435430
- Nearest postcode- OX15 5QW

1.2.6 Although, the site is located within the northern area of the field, the study area for this report covers the wider field. This will allow for a broader context in terms of geology, topography and how the proposed development may affect the wider area in terms of flood risk.

1.3 Topography

Site Topography

1.3.1 This section should be read in conjunction with the site-specific topography survey, which was carried out by greenhatch group on May 2017. A copy of this survey is provided in Appendix B.

1.3.2 The site has a fall of approximately 1:30 from east to west, with the high point of the site observed at 181.82m AOD located centrally along the sites eastern boundary. The lowest area onsite is located in the south-west corner of the site at 168.70m AOD. The overall fall from the high point to the low point of the site is 13.12m. Topographic survey information for the field located adjacent to the sites northern boundary shows levels continue to beyond the site boundary at a similar rate of approximately 1:33.

1.3.3 Levels fall at an approximate gradient of 1:50 to the north and the south from levels near the centre of the site that fall east-west.

1.3.4 The topographic survey suggests that the site forms part of the river valley for the surrounding watercourses. The high point of the site (the eastern boundary) is the furthest away from the watercourse and levels decline towards the River Stour and its tributaries. Section 1.4 below explores the hydrology of the site and the wider area the site is situated in.

1.4 Hydrology

1.4.1 The closest major watercourse to the site according to the EA's River and Major Watercourses Map is the River Stour which is located approximately 700m south of the site. There is also a small un-named tributary of the River Stour located approximately 370m north of the site that flows west and then southwards approximately 300m from the sites western boundary.

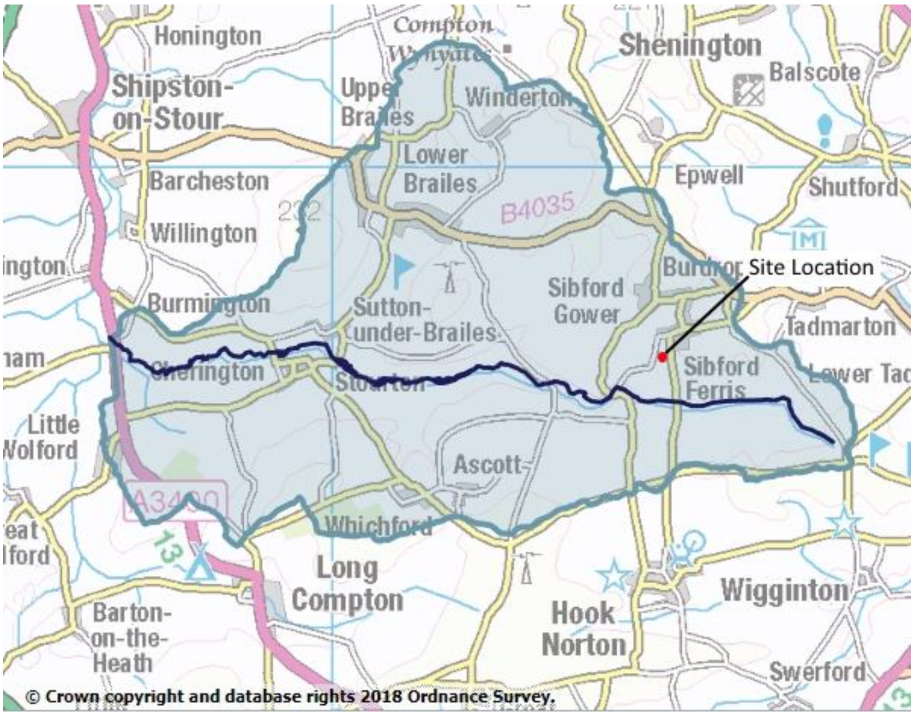

Figure 2: EA River Stour Catchment Plan

1.5 Existing Geology and Ground Conditions

1.5.1 British Geological Survey (BGS) 1:50,000 map shows that the bedrock geology of the site is comprised of Northampton Sand Formation, with no superficial geology shown. The Northampton Sand Formation that underlays the site is classified by the EA as a Secondary A aquifer, meaning the bedrock is capable of supporting water supplies at local levels. Secondary A aquifers are also known as minor aquifers.

1.5.2 A one-day Site Investigation (SI) was carried out by jnp**group** on 12/07/2018. 5 trial pits were dug to various depths (maximum 3m below ground level (m bgl)). A plan showing the locations of the trial pits is provided below in Figure 3.

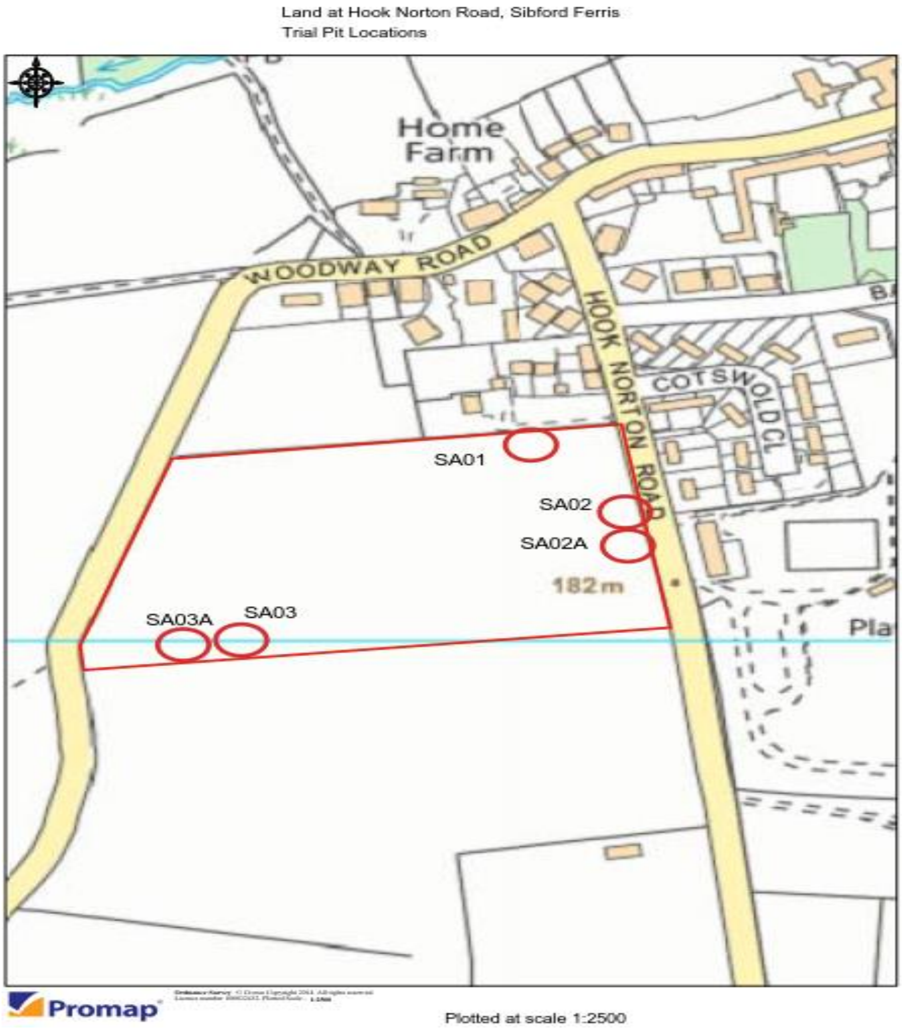

Figure 3: Trial Pit Location Plan

1.5.3 The logs from the trail pits have been summarised below in Table 1.

Table 1: Trial Pit Logs Data Summary

Trial Pit Reference	Trial Pit Depth (m)	Topsoil (m bgl)	Northampton Sands (m bgl)	Whitby Mudstone (m bgl)	Groundwater (m bgl)
SA01	2.10	0.10	2.10 (unproven)	N/A	Pit Dry
SA02	3.00	0.10	2.80	3.00 (unproven)	Pit Dry
SA02A	1.40	0.10	1.40 (unproven)	N/A	Pit Dry
SA03	1.30	0.10	1.10	1.30 (unproven)	Pit Dry
SA03A	1.10	0.10	1.10 (unproven)	N/A	Pit Dry

1.5.4 The site investigation indicates that the Northampton Sands are not the bedrock of the site as the BGS data suggested, this layer is in-fact the superficial geology that underlays the site. The bedrock geology has been identified as Whitby Mudstone which is an impermeable layer comprised of clay, silt and mudstones. Whitby Mudstone is classified by the EA as an unproductive strata and has little or no capacity for groundwater.

1.5.5 The Northampton Sands layer varies in its composition across the site. The trial pit logs which are included in Appendix C, state that the Northampton Sands contain a higher amount of gravels, sands and cobbles in the north-eastern area of the site. Whilst the Northampton Sands in the south-western area of the site have a higher silt and clay content. The silt and clay content of the sands increased towards the base of the layer where there is most likely interaction with the Whitby Mudstone layer beneath.

1.5.6 As can be seen in Table 1 (above), the thinner layers of the permeable Northampton Sands are located in the south-western areas of the site. This area of the site was found to be set lower than the surrounding area. The thicker layers of Northampton Sands were found in the north-eastern area of the site, which the topographic survey identifies as one of the higher areas of the site. Therefore, areas of the site which are topographically higher are likely to have a thicker layer of Northampton Sands while in the lower areas the Whitby Mudstone will be encountered at a shallower depth. There is a risk that infiltration may cause groundwater levels to rise and lead to flooding of the lower areas of the site.

1.5.7 The illustrative site layout (see Appendix A), shows that a pond will be located in the open space within the lowest eastern area of the site. This pond will be able to contain any groundwater that could potentially emerge (and/or overland flow), whilst also providing aesthetic and biodiversity benefits.

1.5.8 There is also a risk that groundwater flows over the mudstone from areas where the Northampton Sands are thicker (such as the north-eastern area of the site), to where the sands are thinner, and the Whitby Mudstone is closer to the surface (such as in the southern area of the site).

1.5.9 The SI intrusive works were carried out during July which is a dry summer month and groundwater levels would be lower or non-existent. Thus, the accurate groundwater level for the site cannot be concluded from the one-day SI works and full year-round testing is recommended.

2 FLOOD RISK ASSESSMENT (FRA)

2.1 Flood Risk Guidance

2.1.1 The following resources have been reviewed to assist with the preparation of the FRA and assess the existing flood risk at the site:

- **Level 1 Strategic Flood Risk Assessment (SFRA)**: A review of the Level 1 SFRA was undertaken to gain a better understanding of known flood risks in the area. The Level 1 SFRA was prepared by AECOM in May 2017 for Cherwell District Council (CDC) and Oxfordshire County Council (OCC).
- **Preliminary Flood Risk Assessment (PFRA)**: A review of the PFRA was undertaken to gain a better understanding of the known flood risks in the area both current and historic. The PFRA was prepared for OCC in June 2011.

2.2 National Planning Policy

2.2.1 The PPG, which supports NPPF, defines three Flood Zones in relation to river flooding. These are defined as:

- Flood Zone 1 (Low Probability): This zone comprises land assessed as having less than a 1in1000 annual probability of river flooding;
- Flood Zone 2 (Medium Probability): This zone comprises land assessed as having between a 1in100 and 1in1000 annual probability of river flooding; and
- Flood Zone 3 (High Probability): This zone comprises land assessed as having greater than a 1in100 annual probability of river flooding.

2.2.2 The EA's Flood Map for Planning shows that the site is located in Flood Zone 1.

2.3 Climate Change

2.3.1 In accordance with the PPG, a site-specific flood risk assessment must consider the following question:

"How is flood risk at the site likely to be affected by climate change?"

2.3.2 The EA in February 2016 provided guidance on the predicted impacts of climate change on peak river flow and rainfall intensity over the next 100 years. The site is located in the Thames River Basin District, where peak river flow is predicted to increase by 35-70% by 2115. Peak rainfall intensity is predicted to increase by up to 40% by 2115.

2.3.3 Residential development has an expected minimum lifetime of 100 years, so to ensure that the development is safe from the effects of flood risk through this lifetime, climate change must be considered. The below assessment takes account of the forecasted effects of climate change on all possible sources of flood risk (fluvial, tidal and surface water drainage).

2.4 Sequential Test and Exception Test

2.4.1 In accordance with the NPPF:

"The aim of the sequential Test is to steer new developments to areas with the lowest probability of flooding. Development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with a lower probability of flooding."

2.4.2 Where areas of lower risk are not available, the Exception Test, as set out in paragraph 102 of the NPPF can be applied, to ensure flood risk management for people and property meets the required level of standard.

2.4.3 As the site is located in its entirety in Flood Zone 1, it passes the Sequential Test and Exception Test.

2.5 Flood Risk from Rivers (Fluvial)

2.5.1 The location of the proposed development is entirely within Flood Zone 1 of the EA's Flood Map for Planning an extract of which is provided below in Figure 4.

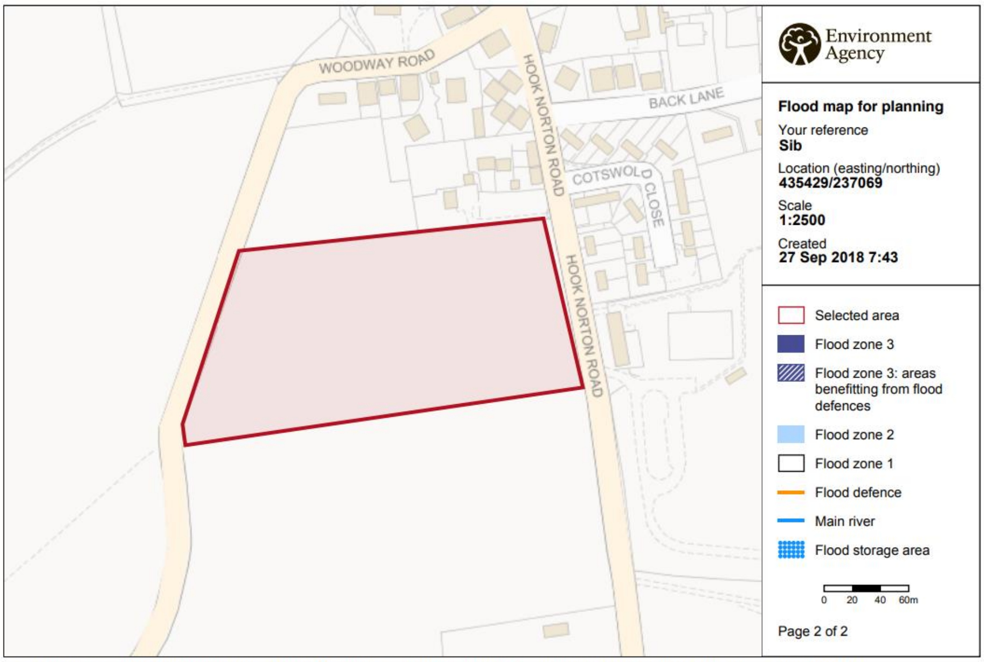

Figure 4: The EA's Flood Map for Planning

2.5.2 The Flood Zone 1 designation means that the site has a low risk of flooding from fluvial sources, with an annual probability of flooding of 0.1% (1in1000 year).

2.5.3 The 2007 SFRA for DBC shows no historic records of fluvial flooding at the site.

2.5.4 Given the sites distance from a watercourse and its allocation within Flood Zone 1, the risk of fluvial flooding is considered low.

2.6 Coastal and Tidal Flood Risk

2.6.1 The site is located inland and is not near any tidally influenced watercourses; therefore, there is a low risk of flooding from this source.

2.7 Groundwater Flood Risk

2.7.1 Groundwater flooding occurs when the water table rises and emerges onto the surface. This is most likely to occur in low-lying, areas underlain by a permeable strata.

2.7.2 The 2017 SFRA identifies the site as being between 25% to 50% susceptible to flooding from groundwater. This data is originally from the EA's Groundwater Flooding Susceptibility map which indicates the risk of flooding from groundwater on 1 km grid. The site is in the 25% to 50% bracket which indicates that the geology and hydrogeological conditions beneath the site are susceptible to groundwater flooding. This data does not indicate the risk of groundwater flooding to the site however, the ground conditions onsite will indicate if there is a risk to the proposed development.

2.7.3 The one-day SI works carried out by jnp**group** in July 2018 revealed that the site is underlain by permeable Northampton Sands, which in turn is underlain by impermeable Whitby Mudstone. The SI works were carried out during the dryer season and groundwater was not struck in any of the 5 trial pits dug. However, during the wetter, winter months it is likely that run-off will infiltrate into the Northampton Sands and in areas where this layer is thinner such as the south-west and perched groundwater flooding may occur.

2.7.4 There is a risk that infiltration into the Northampton Sands may cause perched groundwater levels to rise and flood the lower areas of the site. It is possible that groundwater flows underground from areas where the Northampton Sands are thicker (such as the north-eastern area of the site), to where the sands are thinner, and the Whitby Mudstone is closer to the surface (such as in the southern area of the site). This may lead to infiltration in the higher end of the site causing flooding in the lower parts of the site. However, the lower areas of the site are not proposed to be developed and therefore no risk is posed to residents onsite.

2.7.5 Perched groundwater flooding is a possible risk in lower areas of the site where the Northampton Sands layer is thinner, and the Whitby Mudstone is encountered at shallower depths. To confirm this risk, year-round groundwater monitoring will be required across the site. Overall perched groundwater flooding is considered a risk to the site and appropriate mitigation methods will be stated in Section 3 of this report.

2.7.6 This pond will be able to contain any groundwater that could potentially emerge (and/or overland flow), whilst also providing aesthetic and biodiversity benefits.

2.8 Surface Water Flood Risk (Overland Flows)

2.8.1 Surface water flooding occurs when rainwater does not drain away through the normal drainage system or infiltrate into the ground, but instead lies on or flows over the ground.

2.8.2 The EA produced a Risk of Flooding from Surface Water Map in December 2013. The maps were produced using 'direct rainfall' modelling. Although they take into account local drainage capacity, non-surface water influences such as rivers, seas or groundwater are not considered. The map is based on LiDAR topographic data which is not suitable for site specific assessment and therefore, where available, site specific topographic survey data should be used to provide a more accurate understanding of potential flow paths.

2.8.3 The EA surface water flood risk map shows the entire country within four different risk categories, defined below in Table 2.

Table 2: EA Surface Water Flood Risk Categories

Risk Category	Definition
High	Each year, there is a chance of flooding of greater than 1in30 (3.3%)
Medium	Each year, there is a chance of flooding of between 1in30 (3.3%) and 1in100 (1%)
Low	Each year, there is a chance of flooding of between 1in100 (1%) and 1in1000 (0.1%)
Very Low	Each year, there is a chance of flooding of less than 1in1000 (0.1%)

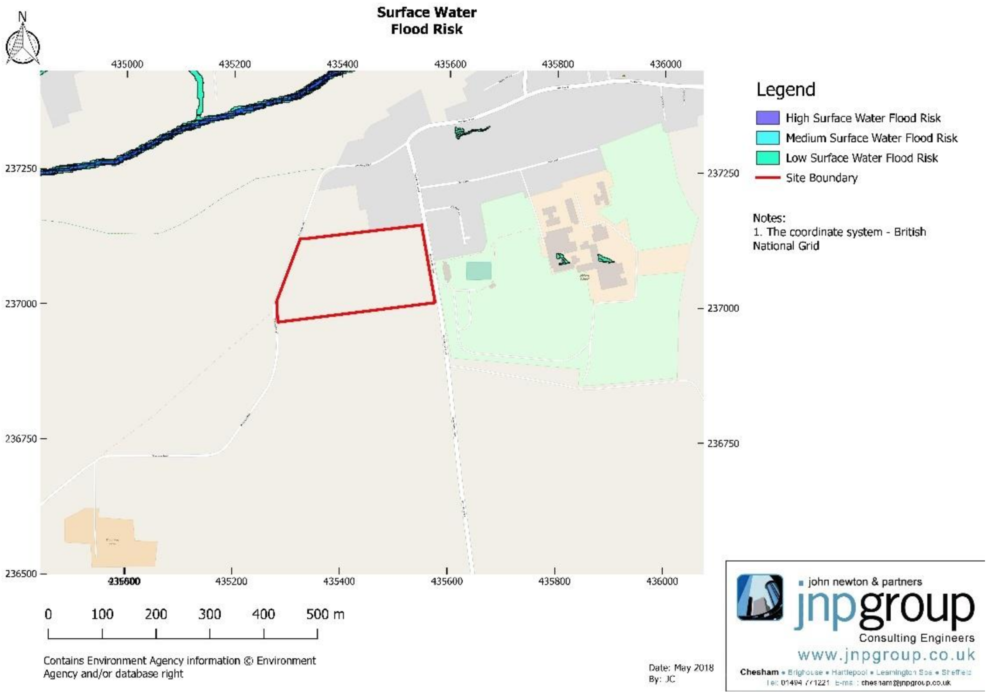

Figure 5: Surface Water Flood Risk Using EA Data

2.8.4 Figure 5 above shows the site to not be at risk of surface water flooding. The topographic survey information for the site shows that levels fall from the eastern boundary to the western boundary and continue to fall to the west. Therefore, surface water will flow across the site towards the eastern boundary and then offsite. The EA surface water flood risk data also shows very low risk to the area of land located east of the site boundary, meaning it is probable that levels continue to fall down towards the watercourses, which is the band of surface water flood risk seen in the north-western corner of Figure 5 above.

2.9 Sewer/Drainage Flood Risk

2.9.1 Sewer flooding occurs when excess surface water run-off enters the drainage network and the surface/foul water network is insufficient to deal with the influx of water. Sewer flooding can also occur due to 'one off' events such as blockages in the network.

2.9.2 The SFRA shows that there have been between 0 to 5 reported incidents of sewer related flooding over the past 10 years (from 2017) in the same post code as the site.

2.9.3 Thames Water and Severn Trent carried out an asset location searches for the site and surrounding are in February 2017. No Thames Water or Severn Trent sewers are located onsite, there are public combined gravity sewer which runs adjacent to the eastern side of Hook Norton Road. This sewer services the residential buildings located on Cotswold Close approximately 45m east of the sites north-eastern corner. A copy of the sewer asset location plans are provided in Appendix D.

2.9.4 As there are no sewers located onsite and the number of reported incidents in the area is low, (SFRA) the risk of sewer related flooding to the site is considered to be low.

2.10 Reservoir Flood Risk

2.10.1 The EA's Reservoir Flood Map shows no risk to the proposed development site. Therefore, the site is safe from flooding from reservoir failure.

2.11 Canal Flood Risk

2.11.1 The site is not located near to any canals. Consequently, there is no risk of flooding from this source.

3 FLOOD RISK MITIGATION

3.1 Introduction

3.1.1 Section 2 has identified that the site is at risk of groundwater flooding. This chapter will set out how this risk to the site will be mitigated.

3.1.2 Section 2 has demonstrated that the risk from all other sources of flooding is low.

3.2 Groundwater

3.2.1 Due to the varying thickness of the permeable Northampton Sands across the site and the unknown groundwater depth (the one-day SI works were carried out in July), there is a potential risk of perched groundwater flooding to the site. The risk perched groundwater poses to the site will need to be confirmed by further SI works on the site and annual ground water monitoring across the site.

3.2.2 However, in order to mitigate the risk groundwater poses to the site it is proposed to raise the Finished Floor Levels (FFLs) of all proposed residential dwellings onsite 300mm above the existing ground level as per the flood risk assessment: standing advice by the Department for Environment, Food & Rural Affairs and the EA.

3.2.3 The raising of FFLs will reasonably prevent water from entering properties in the event of groundwater emergence and flooding onsite.

4 FOUL AND SURFACE WATER DRAINAGE

4.1 Existing Drainage Regime

4.1.1 The site is currently greenfield with no impermeable area due to its exclusive usage as agricultural land. The one-day SI works revealed that the superficial geology of the site is permeable, meaning that surface water run-off currently infiltrates into the ground. The topographic survey for the site shows that levels generally fall from east to west and from the centre, northwards and southwards. Any surface water that does not infiltrate into the ground will therefore flow uncontrolled offsite towards the tributary of the River Stour.

4.2 Greenfield Run-Off Rates

4.2.1 The greenfield run-off rate for the site has been calculated using the Flood Estimation Handbook (FEH) Statistical method. The Qbar discharge rate is estimated to be 0.33 l/s/per ha. A copy of the greenfield run-off calculation parameters and results is provided in Appendix E.

4.3 General Principles for Proposed Site Run-Off

4.3.1 The National Standards for Sustainable Drainage Systems (Defra,2011) state that the following options must be considered for disposal of surface water run-off in order of preference:

- *Discharge to Ground*
- *Discharge to Surface Water Body*
- *Discharge to Surface Water Sewer*
- *Discharge to Combined Sewer*

Discharge to Ground

4.3.2 The underlying geology of the site is Northampton Sand Formation which is permeable, therefore, infiltrating to ground could be a viable option for the site.

4.3.3 One-day SI works were carried out by jnp**group** in July 2018. The aim of the SI works was to confirm if infiltration is viable and identify the geological strata's present onsite. To summarise the findings of the SI; the permeable Northampton Sands formation was found to be the underlying superficial strata. With impermeable Whitby Mudstone formation underlying the Northampton Sands as the bedrock geology of the site.

4.3.4 Three soakage tests were carried out in trial pit SA01 and one each was carried out in SA02A and SA03 (locations of which are shown in Figure 3). The results of the testing indicate that soakage is viable in the north-eastern area of the site (Calculated infiltration rate between 1.3E-3 to 2.2E-3 m/sec). Which is where the thicker layers of the more permeable Northampton Sands were found in the trial pits excavated. The other areas of the site tested, such as towards the south-west, showed poorer infiltrations rates and testing in these areas was not completed (bearing in mind that only a single days testing was carried out). In order to ascertain what soakage rates could be achieved within these areas, it is likely that testing will need to be carried out over a number of days (to allow the pit to drain to the required level). However, this result is a fairly strong indication that infiltration is unlikely to be considered viable in the southern part of the site. These results are consistent with the findings of the trial pits, where a thinner layer of the Northampton Sands was observed meaning the impermeable Whitby Mudstone was encountered at shallower depths.

4.3.5 A copy of the soakage testing calculations and results has been provided in Appendix F.

4.3.6 Due to the permeable Northampton Sands being underlain by impermeable Whitby Mudstone there is a risk that infiltration may cause groundwater levels to rise and lead to flooding of the area. This is especially a risk if groundwater flows underground from areas where the Northampton Sands are thicker (such as the north-eastern area of the site), to where the sands are thinner, and the Whitby Mudstone is closer to the surface (such as in the southern area of the site). This may lead to infiltration in the higher end of the site causing flooding in the lower parts of the site. However, the lower areas of the site are not proposed to be developed and therefore no risk is posed to residents onsite.

Discharge to Surface Water Body

4.3.7 There is no watercourse located onsite or within the immediate vicinity of the site. Therefore, discharging the site's post-development run-off to a surface water body is not a viable option.

Discharge to Surface Water Sewer/ Combined Sewer

4.3.8 Discharge to the public sewer network should only be considered once all other options for draining surface water from the site have been exhausted.

4.3.9 An asset location plan produced by Thames Water shows that there is a possible combined surface water and foul sewer located past the north-eastern boundary of the site. The sewer serves the residential estate located at Cotswold Close and at the uphill side of the site.

4.3.10 As infiltration has been identified as feasible (in certain areas of the site) from the one-day SI works carried out onsite, surface water will not be discharged to the local sewer network as this is the least desirable option for draining the site.

4.4 Sustainable Drainage Systems (SuDS)

4.4.1 To maximise the potential use of SuDS at the site, a review of each SuDS component has been undertaken and is shown below in Table 3 in accordance with the SuDS Hierarchy (refer to SuDS: A Practical Guide prepared by the Environment Agency). This review highlights the components referenced in the SuDS Hierarchy and provides recommendations on whether the components could be incorporated into the development. All recommendations are indicative only at this stage and will be assessed in further detail.

Table 3: SuDS Selection Based on the SuDS Hierarchy

Component	Recommendation
Green (living) roofs	Whilst the use of green roofs provides additional environmental benefits such as enhanced aesthetics and ecology, its exposure to wind and orientation must be considered. Access to undertake the construction and maintenance easily and safely is also a high priority. The proposed residential units will feature traditional pitched roofs, which are unsuitable for installation of a green roof.
Basins and Ponds	Ponds and attenuation basins can provide overland storage of surface water whilst also providing additional biodiversity and aesthetic/amenity value. If infiltration is found to be via in a suitable area (subject to the site layout) an infiltration basin or pond may be implemented onsite.
Filter Strips and Swales	Swales are linear vegetated drainage features, which provide overland conveyance and storage of surface water whilst trapping sediments and hydrocarbons within run-off. They also create biodiverse areas for planting and habitat. Where possible, swales will be used to formalise existing overland flow paths and provide effective conveyance across the site. Where swales are not feasible (due to site gradients), a traditional pipe network will be used. It is likely that due to the small nature of the site and fairly steep site levels, the opportunity to utilise a meaningful swale is minimal, although this will be considered as part of the detailed design.
Infiltration Devices	Infiltration devices, such as soakaways, can be utilised due to the permeable nature of the underlying geology in certain areas of the site. Infiltration devices will only be utilised in areas of the site where soakage testing has identified, a viable infiltration rate and perched groundwater levels are at a suitable depth to provide sufficient freeboard to the base of the devices.
Permeable Paving	Permeable paving will be used where possible to provide storage beneath private roads and parking areas, it is also considered as an option on adopted highways subject to confirmation from the adopting authority. This will provide additional attenuation of surface water run-off across the site. Permeable paving also provides treatment through filtration of silt (and attached pollutants), settlement and retention of solids, adsorption of pollutants and biodegradation of organic pollutants, including petrol and diesel.

Component	Recommendation
Tanked Systems	This is the least sustainable option in terms of the SuDS Hierarchy. However, the use of tanked systems would still be of benefit compared to traditional drainage systems as it does allow run-off to be slowed down to an acceptable discharge rate. A tanked system will only be used if it is not possible to use a more favourable form of storage/attenuation.

4.5 Proposed Surface Water Drainage Strategy

4.5.1 The following chapter should be read in conjunction with the surface water drainage schematic plan which has been prepared to provide an overview of the proposed site drainage strategy, see Appendix G.

4.5.2 The drainage strategy for the site shall consist of shallow soakaways in the north-eastern end of the site. Run-off from areas with poorer infiltration shall be conveyed to soakaways within the north-eastern area of the site. For the purposes of this initial strategy, it has been assumed that the geology is fairly consistent along the north of the site and that there is sufficient depth of Northampton Sand to allow shallow infiltration without the need for pumping. Should further SI work prove this not to be the case, private pumping of surface water may need to be considered.

4.5.3 Run off from roofs will be discharged directly to shallow private soakaways located within garden areas. Run off from driveways and shared parking will be drained via permeable paving, and road areas will be drained via a traditional piped system. The piped system will include suitable stages of treatment before discharge to a larger soakaway located within an area of public open space.

4.5.4 The proposed drainage strategy is subject to further SI works and BRE365 soakage testing across the site, to confirm that the indicative locations of proposed soakaways are viable.

5 FOUL DRAINAGE STRATEGY

5.1.1 Severn Trent is the local sewer authority for the area and will need to be consulted in order to connect the proposed development to the existing sewer network.

5.1.2 From a review of site levels, foul sewage from the site will be pumped to the existing 150mm combined gravity sewer that runs beneath Hook Norton Road (near past the sites north-eastern boundary). The proposed sewers will most likely connect to the exiting Severn Trent sewer at manhole 5001.

5.1.3 Consultation with Severn Trent was beyond the scope of this assessment, however, the need for upgrades to the existing sewer system will be subject to a capacity study by Severn Trent and should be established as early in the process as possible.

6 CONCLUSIONS AND RECOMMENDATIONS

6.1.1 This Flood Risk Assessment and Drainage Strategy has been prepared in accordance with the National Planning Policy Framework and the associated Planning Practice Guidance, which reviews aspects of flood risk to the site.

6.1.2 The existing site is comprised entirely of open fields used as agricultural land and hedgerows that bound the site along the northern, western and eastern boundaries. The southern boundary of the site is comprised of a continuation of the agricultural fields. There are currently no hardstanding structures onsite and therefore, the site has no impermeable area. The site is bounded by an existing residential estate to the north, Hook Norton Road to the east, Woodway Road to the west and open fields to the south.

6.1.3 The site is approximately 3.7ha in size and the proposed development includes the construction of 25 new residential dwellings in the northern end of the site, whilst the southern side of the site will be open green space.

6.1.4 In accordance with the EA's Flood Map for Planning, the site is located entirely within Flood Zone 1, meaning the site is at low risk from fluvial flooding.

6.1.5 The only potential flood risk to the site that has been identified is potential perched groundwater related flooding. This is due to the impermeable Whitby Mudstone being encountered at shallow depths in the southern end of the site.

6.1.6 The one-day SI works carried out onsite in July 2018 found no groundwater across the site, however, July is a seasonal low from groundwater levels. Therefore, ground water monitoring should be carried out onsite throughout the year to confirm groundwater levels across the site.

6.1.7 It is also proposed to raise FFLs of proposed residential dwellings at least 300mm above the existing ground level to protect against possible flooding from potential perched groundwater.

6.1.8 The one-day initial SI works were carried out by jnp**group** in July 2018 has indicated that discharging to ground via infiltration is the most viable method of surface water disposal. The one-day testing has shown that the ground in the north-eastern end of the site has viable soakage rates, due to this area of the site having the thickest layer of Northampton Sands. Whilst the other areas tested such as the south-western end of the site have very poor infiltration potential as a result of the Northampton Sands layer being thinner and more silty in nature along with the Whitby Mudstone bedrock at shallow depths.

6.1.9 Given the results of the one-day SI works carried out onsite, the proposed drainage strategy for the site is to implement shallow soakaways in the north-eastern area of the site. It is assumed that the depth of Northampton Sand is consistent across the North of the site and that onsite surface water pumping will not be required. This can only be confirmed through a more detailed site investigation and groundwater monitoring.

6.1.10 The proposed drainage strategy for the site is subject to further SI works and BRE365 soakage testing, to confirm all viable locations for soakaways across the site.

6.1.11 The comments stated above are based on information received from the EA and OCC (the LLFA). The flood risk classification of this site has been based on the above observations and the recommendations stated. This report is intended for the use of the developer of the site in support of their planning application for the site only

Appendix A: Proposed Development Details

NOTES:

DIMENSIONS ARE NOT TO BE SCALED FROM THIS DRAWING

ALL DIMENSIONS ARE TO BE CHECKED AGAINST ACTUAL SITE DIMENSIONS BEFORE ANY WORK IS FABRICATED

REVISIONS

Rev.	Date	Description

Client :
SIBFORD FERRIS
BANBURY

Job :
LAND AND PARTNERS LTD.

Drawing Title:
Concept Schematic

Scale:
1:1000 @ A1

Date:	Drawn By	Checked
July 2018	MPF	BDN

Drawing No:	Revision:
3361.101	-

PRELIMINARY

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Wiltshire, SN13 0RP
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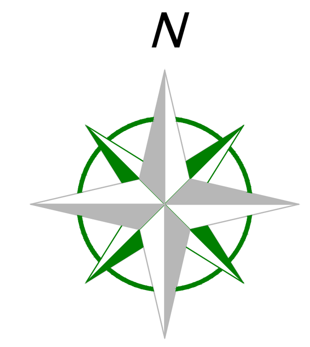
info@bhpharwood.co.uk - www.bhpharwood.co.uk

BHP HARWOOD
ARCHITECTS

Appendix B: Topographic Survey



Station Information:

Station	Easting (m)	Northing (m)	Level (m)
GH1	435603.555	236882.185	177.571
GH2	435581.669	237002.033	181.864
GH3	435557.561	237130.119	179.964

OS Note:

Some services may have been omitted due to parked vehicles. The Ordnance Survey tile is to be used as a guide only.

OS Buildings *Surveyed Buildings*

This survey has been orientated to the Ordnance Survey (O.S) National Grid OSGB36(15) via Global Navigational Satellite Systems (GNSS) and the O.S. Active Network (OS Net).

A true OSGB36 coordinate has been established near to the site centre via a transformation using the OSTN15GB & OSGM15GB transformation models.

The survey has been correlated to this point and a further one or more OSGB36 (15) points established to create a true O.S. bearing for angle orientation.

No scale factor has been applied to the survey therefore the coordinates shown are arbitrary & not true O.S. Coordinates which have a scale factor applied.

Please refer to Survey Station Table to enable establishment of the on-site grid and datum.

Legend:

Buildings, Wall, Kerb line, Line marking, Drop kerb, Centre line, Overhead Cable, Concrete edge, Tarmac edge, Grass verge, Canopy/Overhang, Verge

1 100.000 Station and Name, Station Level

Tree / Bush / Sapling

Area of Undergrowth

Woodland

R: Ridge Level

E: Eaves Level

F: Flat Roof Level

Gate

Fence types:

I\W	Interwoven
I\R	Iron Railings
W\M	Wire Mesh
P\R	Post & Rail
P\W	Post & Wire
C\L	Chain Link
W\P	Wooden Panels
C\P	Concrete Panels
S\P	Steel Palisade

IC	Inspection chamber	Bo	Bollard
PInv	Pipe invert	IB	Illuminated bollard
Gy	Gully	Bin	Rubbish bin
Bg	Back gully	Vp	Vent pipe
Dp	Down pipe	Grl	Ground light
Pipe	Pipe above ground	Lbox	Letter box
MH	Manhole	Ldr	Ladder
WL	Water level	Sty	Stile
Fl	Flood light	IFL	Internal floor level
Lp	Lamp post	THL	Threshold level
Tp	Telegraph post	Sp	Sign post
Ep	Electricity post	TH	Trialhole
Tl	Traffic light	BH	Borehole
Bus	Bus stop	ELC	Electric
Sv	Stop valve	BT	British Telecom
St	Stop tap	C'box	Control box
Er	Earth rod	TT	Tactile
Wm	Water meter	BP	Brick paved
Gas	Gas valve	CPS	Concrete paving slabs
Av	Air valve	CVR	Cover
ICU	Undentified inspection	IC	Inspection chamber
Wo	Wash out	R/wall	Retaining wall
Re	Rodding eye	UTL	Unable to lift
BB	Belisha beacon	TCL	Tree canopy level
CTV	Cable tv	G:	Girth
Mkr	Marker post	MG	Multi girth
Gmkr	Gas marker post	Stmp	Tree Stump
So	Soffit	CL:	Cover level
		IL:	Invert level

Rev	Date	Description	Drawn	Q. Ref

greenhatch group

Topographical Surveys, Site Engineering, Utility / CCTV Surveys, Measured Building Surveys, 3D Laser Scanning, Revit & BIM Models

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CLIENT
Mayer Brown Ltd

PROJECT
Hook Norton Road, Sibford Ferris, Banbury OX15 5QR

TITLE
Topographical Survey

SCALE: A1@ 1: 1000	DATE: 24.05.17
DRAWN: JS	QUALITY REF: GH0924
Level datum	See note
Grid orientation	See note
Job number	27085
Drawing No.: 27085_T	Rev.: 0

Comments
This plan should only be used for its original purpose. Greenhatch Group accepts no responsibility for this plan if supplied to any party other than the original client.

All dimensions should be checked on site prior to design and construction.

Drainage information (where applicable) has been visually inspected from the surface and therefore should be treated as approximate only.

Notes:
Tree girth = MG unless stated.

Appendix C: Trial Pit Logs

Trial Pit Log

jnpgroup Consulting Engineers

Project Name: Hook Norton Road, Sibford Ferris	Project No. C85855	Co-ords: - Level:	Trialpit No **SA01** Sheet 1 of 1 Date 12/07/2018
Location: Sibford Ferris, Banbury		Dimensions (m): 2 × 0.6 Depth 2.10	Scale 1:25
Client: Land & Partners South East Limited			Logged JP

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.10			Grass overlying light brown sandy TOPSOIL. TOPSOIL
				2.10			Orangey brown fine SAND with ocassional gravel and rare clayey pockets (5cm). Gravel is fine to medium subangular ironstone. Becoming very cobbley towards base. NORTHAMPTON SAND FORMATION
							End of pit at 2.10 m

Remarks: Terminated on refusal from hard ground. Pit dry.

Stability: Partial pit collase at 1.20m bgl.

AGS

Trial Pit Log

jnpgroup Consulting Engineers

Project Name: Hook Norton Road, Sibford Ferris	Project No. C85855	Co-ords: - Level:	Trialpit No **SA02** Sheet 1 of 1 Date 12/07/2018
Location: Sibford Ferris, Banbury		Dimensions (m): 2 × 0.6	Scale 1:25
Client: Land & Partners South East Limited		Depth 2.80	Logged JP

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.10			Grass overlying light brown sandy TOPSOIL with fine rootlets. TOPSOIL
				1.50			Orangey brown fine SAND with rare silty pockets (<5cm) and rare subangular ironstone cobbles. NORTHAMPTON SAND FORMATION
				2.30			Orangey brown silty, gravelly SAND. Gravel is fine to medium subangular ironstone and rare fissile siltstone. NORTHAMPTON SAND FORMATION
			HVP=65	2.80			Brown slightly clayey gravelly SAND. Gravel is fine to medium subangular ironstone. NORTHAMPTON SAND FORMATION
			HVP=68 HVP=68 HVP=72	3.00			Firm to stiff grey CLAY. WHITBY MUDSTONE FORMATION End of pit at 2.80 m

Remarks: Pit dry.

Stability: Stable

AGS

Trial Pit Log

jnpgroup Consulting Engineers

Project Name: Hook Norton Road, Sibford Ferris	Project No. C85855	Co-ords: - Level:	Trialpit No SA02A Sheet 1 of 1
Location: Sibford Ferris, Banbury		Dimensions (m): 2 × 0.6 Depth 1.40	Date 12/07/2018
Client: Land & Partners South East Limited			Scale 1:25 Logged JP

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.10			Grass overlying light brown sandy TOPSOIL with fine rootlets. TOPSOIL
				1.40			Orangey brown silty fine SAND with rare silty pockets (<5cm) and rare subangular ironstone cobbles. Becoming very silty towards base. NORTHAMPTON SAND FORMATION
							End of pit at 1.40 m

Scale: 1, 2, 3, 4, 5

Remarks: Pit dry.

Stability: Stable

AGS

Trial Pit Log

jnpgroup Consulting Engineers

Trialpit No	SA03
Sheet	1 of 1
Project Name:	Hook Norton Road, Sibford Ferris
Project No.	C85855
Co-ords:	-
Level:	
Date	12/07/2018
Location:	Sibford Ferris, Banbury
Dimensions (m):	2 x 0.6
Depth	1.30
Scale	1:25
Client:	Land & Partners South East Limited
Logged	JP

Water Strike	Samples and In Situ Testing Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.10			Grass overlying light brown sandy TOPSOIL with fine rootlets. TOPSOIL
				1.10			Orangey brown silty fine SAND with ocassional silt pockets (<5cm) and rare fine to medium subangular ironstone gravel. NORTHAMPTON SAND FORMATION
				1.30			Firm to stiff grey CLAY. WHITBY MUDSTONE FORMATION
							End of pit at 1.30 m

Remarks: Pit dry.

Stability: Stable

AGS

Trial Pit Log

jnpgroup Consulting Engineers

Trialpit No **SA03A**

Sheet 1 of 1

Project Name: Hook Norton Road, Sibford Ferris	Project No. C85855	Co-ords: - Level:	Date 12/07/2018
Location: Sibford Ferris, Banbury		Dimensions (m): 2 x 0.6, Depth 1.10	Scale 1:25
Client: Land & Partners South East Limited			Logged JP

Water Strike	Samples and In Situ Testing Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.10			Grass overlying light brown sandy TOPSOIL. TOPSOIL
				1.10			Orangey brown silty fine SAND with ocassional silt pockets (<5cm) and rare fine to medium subangular ironstone gravel. Becoming slightly clayey towards base. NORTHAMPTON SAND FORMATION
							End of pit at 1.10 m

Remarks: Pit dry.

Stability: Stable

AGS

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geoenvironmental@jnpgroup.co.uk

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SOIL INFILTRATION TEST

Project:
Hook Norton Road, Sibford Ferris

Project No: C85855

Test Location: SA01 Test No: 1 Date: 12 Jul 2018

Water level during test

Time mins	Depth m bgl
0	1.700
1.5	1.850
2	2.100

Trial pit dimensions

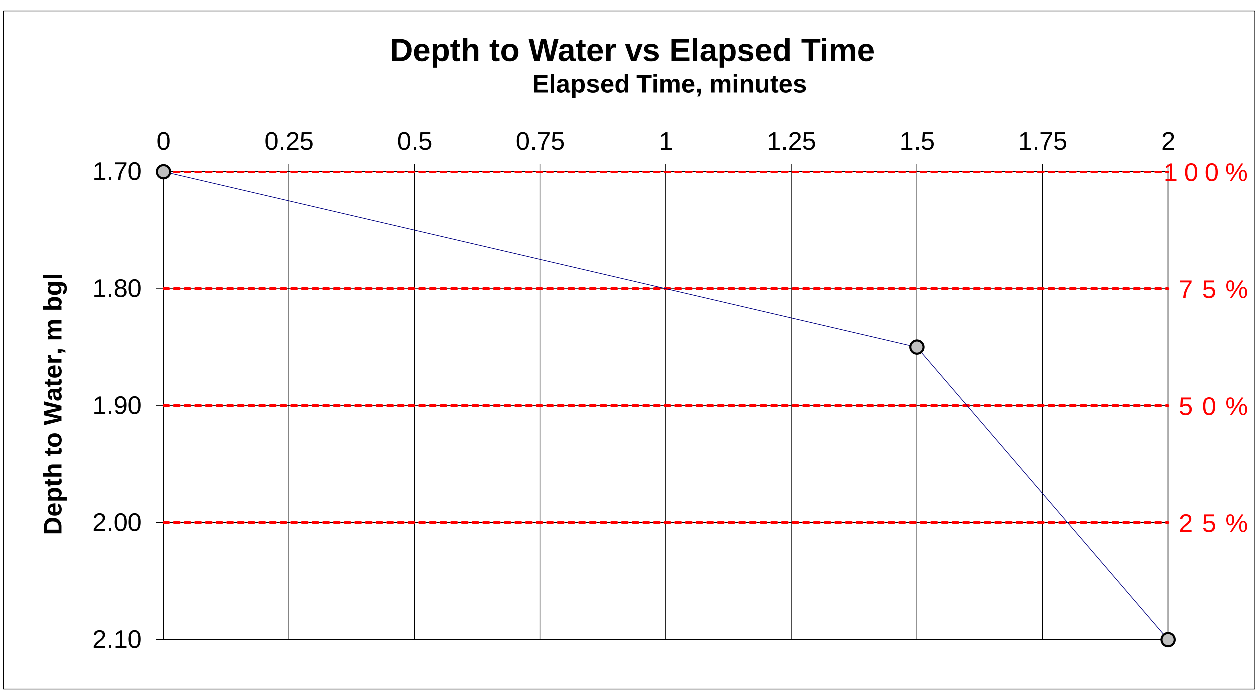
depth (m)	2.10
length (m)	2.00
width (m)	0.60

$$f = \frac{V_{p75-25}}{a_{s50} \times t_{p75-25}}$$

f = soil infiltration rate
V_{p75-25} = volume of water from 75% to 25% effective depth
a_{s50} = internal surface area at 50% effective depth
t_{p75-25} = time for the water level to fall from 75% to 25% effective depth

time at 75% effective depth (mins) 1
time at 25% effective depth (mins) 1.8
(from graph)

Calculated Soil Infiltration Rate = 2.2E-03 m/sec



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SOIL INFILTRATION TEST

Project:
Hook Norton Road, Sibford Ferris

Project No: C85855

Test Location: SA01 | Test No: 2 | Date: 12 Jul 2018

Water level during test

Time mins	Depth m bgl
0	1.600
1.5	1.850
2	2.100

Trial pit dimensions

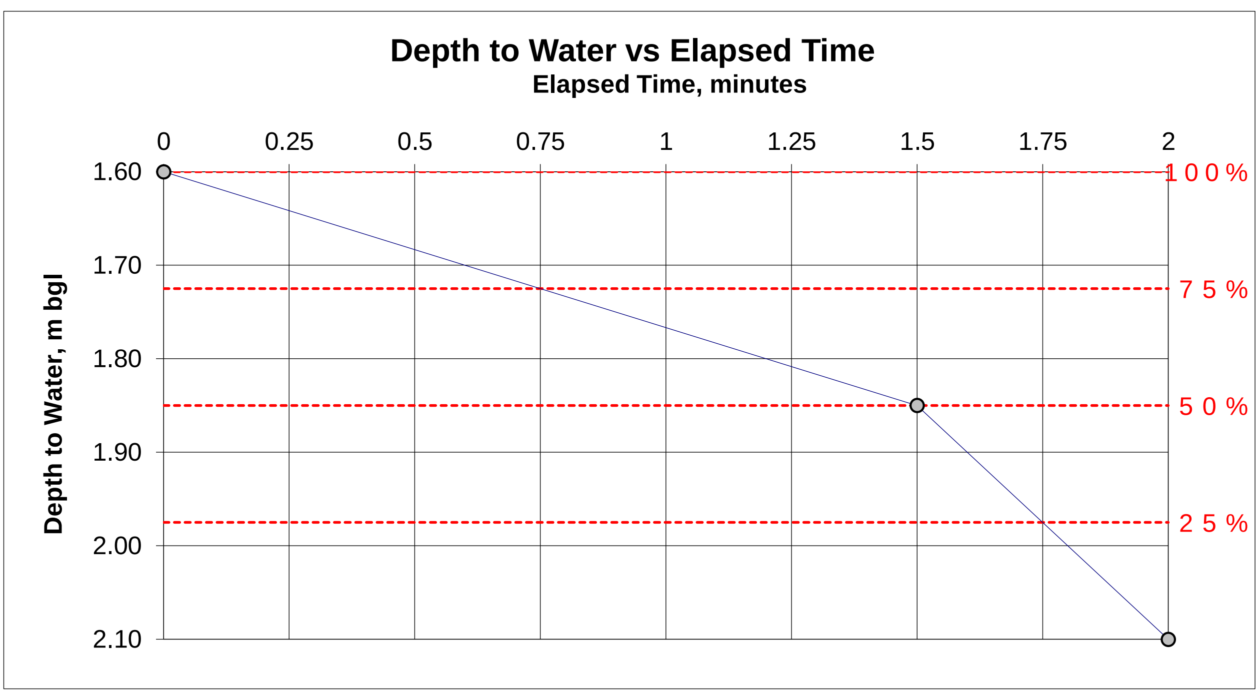
depth (m)	2.10
length (m)	2.00
width (m)	0.60

$$f = \frac{V_{p75-25}}{a_{s50} \times t_{p75-25}}$$

f = soil infiltration rate
V_{p75-25} = volume of water from 75% to 25% effective depth
a_{s50} = internal surface area at 50% effective depth
t_{p75-25} = time for the water level to fall from 75% to 25% effective depth

time at 75% effective depth (mins) 0.75
time at 25% effective depth (mins) 1.75
(from graph)

Calculated Soil Infiltration Rate = 2.0E-03 m/sec



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SOIL INFILTRATION TEST

Project:
Hook Norton Road, Sibford Ferris

Project No: C85855

Test Location: SA01 Test No: 3 Date: 12 Jul 2018

Water level during test

Time mins	Depth m bgl
0	1.600
1.5	1.850
3	2.100

Trial pit dimensions

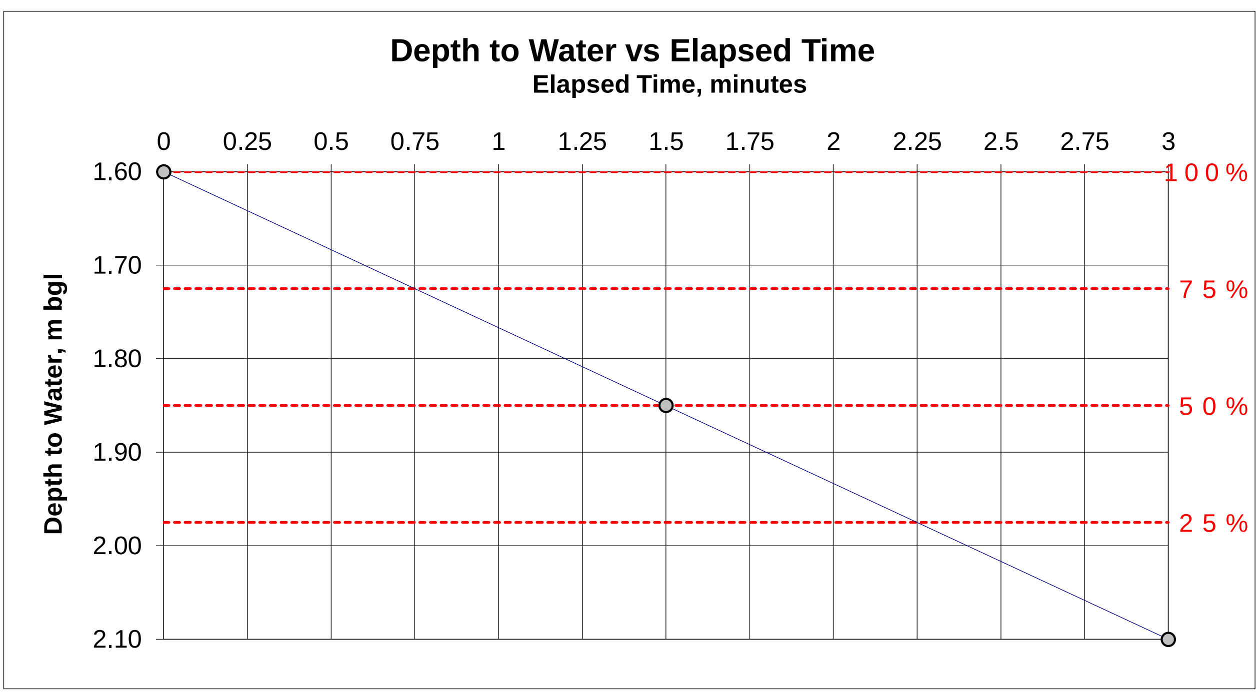
depth (m)	2.10
length (m)	2.00
width (m)	0.60

$$f = \frac{V_{p75-25}}{a_{s50} \times t_{p75-25}}$$

f = soil infiltration rate
V_{p75-25} = volume of water from 75% to 25% effective depth
a_{s50} = internal surface area at 50% effective depth
t_{p75-25} = time for the water level to fall from 75% to 25% effective depth

time at 75% effective depth (mins) 0.75
time at 25% effective depth (mins) 2.25
(from graph)

Calculated Soil Infiltration Rate = 1.3E-03 m/sec



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SOIL INFILTRATION TEST

Project:
Hook Norton Road, Sibford Ferris

Project No: C85855

Test Location: SA02A　　Test No: 1　　Date: 12 Jul 2018

Water level during test

Time mins	Depth m bgl
0	0.400
5	0.420
14	0.440
59	0.530
89	0.560
109	0.560
144	0.580
164	0.585

Trial pit dimensions

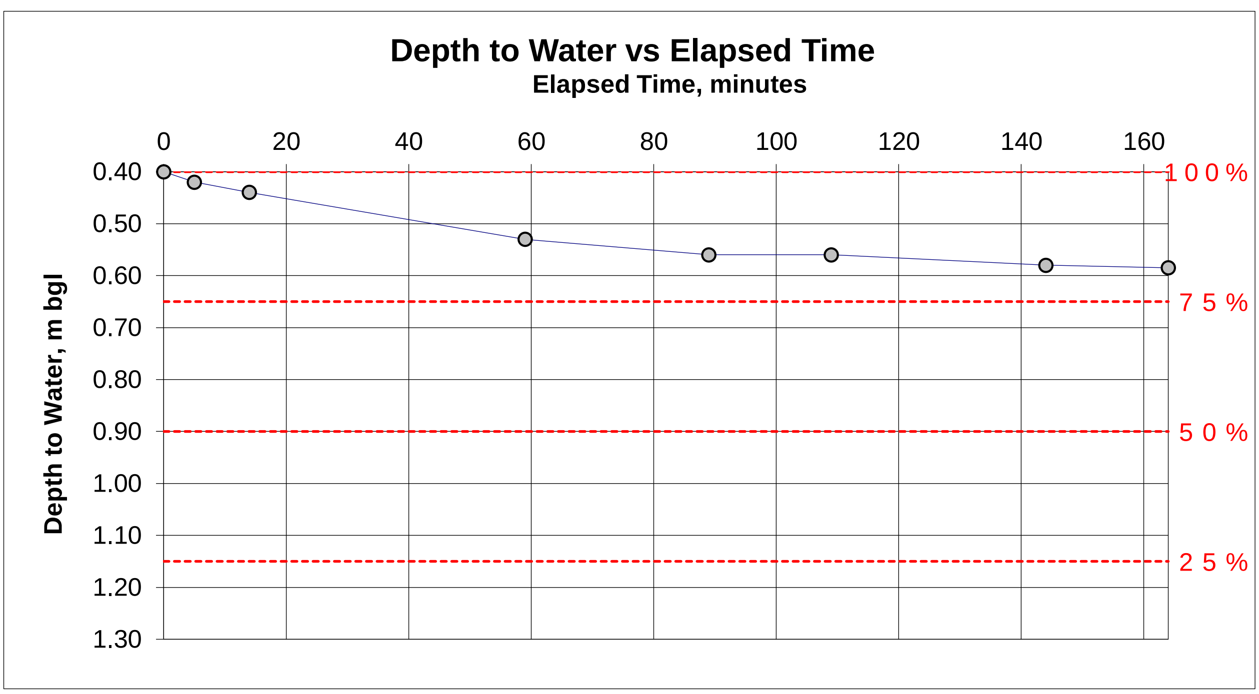
depth (m)	1.40
length (m)	2.00
width (m)	0.60

$$f = \frac{V_{p75-25}}{a_{s50} \times t_{p75-25}}$$

f = soil infiltration rate
V_{p75-25} = volume of water from 75% to 25% effective depth
a_{s50} = internal surface area at 50% effective depth
t_{p75-25} = time for the water level to fall from 75% to 25% effective depth

time at 75% effective depth (mins)　N/A
time at 25% effective depth (mins)　N/A

Test incomplete - Infiltration rate could not be determined
Calculated Soil Infiltration Rate = N/A



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SOIL INFILTRATION TEST

Project:
Hook Norton Road, Sibford Ferris

Project No: C85855

Test Location: SA03A   Test No: 1   Date: 12 Jul 2018

Water level during test

Time mins	Depth m bgl
0	0.100
5	0.120
27	0.270
57	0.350
87	0.430
142	0.480
162	0.490
192	0.520

Trial pit dimensions

depth (m)	1.10
length (m)	2.00
width (m)	0.60

$$f = \frac{V_{p75-25}}{a_{s50} \times t_{p75-25}}$$

f = soil infiltration rate
V_{p75-25} = volume of water from 75% to 25% effective depth
a_{s50} = internal surface area at 50% effective depth
t_{p75-25} = time for the water level to fall from 75% to 25% effective depth

time at 75% effective depth (mins) N/A
time at 25% effective depth (mins) N/A

Test incomplete - Infiltration rate could not be determined
Calculated Soil Infiltration Rate = N/A