Land at Sandleford Park, Newbury

Flood Risk Assessment and Drainage Strategy

Bloor Homes Ltd & Sandleford Farm Partnership

Brookbanks

Document Control Sheet

Document Title: Flood Risk Assessment and Drainage Strategy

Document Ref: 10309 FRA04 Rv1

Project Name: Land at Sandleford Park, Newbury

Project Number: 10309

Client: Bloor Homes Ltd & Sandleford Farm Partnership

Document Status

Rev	Issue Status	Prepared / Date	Checked / Date	Approved / Date
0	Draft	KM 12.12.18	AA 12.12.18	LW 12.12.18
1	Final	KM 18.12.19	JK 18.12.19	JK 18.12.19

Issue Record

Name / Date & Revision	14.12.18	18.12.19				
Bloor Homes Ltd	0	1				
Sandleford Farm Partnership	0	1				

Contents

1 Introduction

1.1 Brookbanks Consulting Limited is appointed by Bloor Homes Ltd and Sandleford Farm Partnership to complete a Flood Risk Assessment for a proposed residential development on land at Sandleford Park in Newbury.

1.2 The objective of the study is to demonstrate the development proposals are acceptable from a flood risk and drainage viewpoint.

1.3 This report summarises the findings of the study and specifically addresses the following issues in the context of the current legislative regime:

- Flooding risk
- Surface water drainage
- Foul water drainage

2 Background Information

Location & Details

2.1 Sandleford Park is located south-west of Newbury and lies within the county of Berkshire. The Local Planning Authority is West Berkshire Council. The site is bounded to the north by Monks Lane with residential development beyond. Monks Lane connects the A339 Newtown Road in the east (from its junction with the access to Newbury Retail Park) with the A343 Andover Road in the west at Wash Common centre. Newbury College is located adjacent to the eastern corner of the site, with Newbury Retail Park located beyond (on the opposite side of the A339). Newbury Rugby Club and Park House School with their associated grounds are adjacent to the North-west of the site.

2.2 The site is currently undeveloped and is not thought to have been historically subject to any significant built development. The site comprises a mixture of agricultural land, grassed fields and woodland. An unnamed watercourse flows through the site, towards the River Enbourne to the south of the site, and there are a number of ponds situated in the south and north east of the site. The site location and proposed development boundary is outlined in red on Figure 2a.

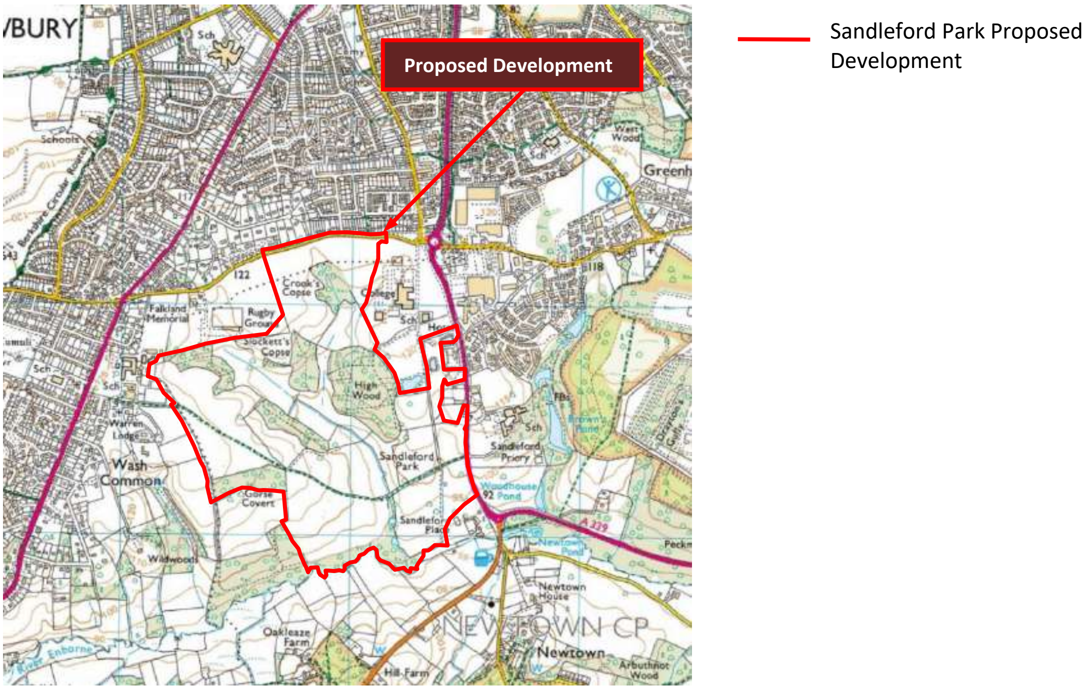


Figure 2a: Site Location

Development Criteria

2.3 Sandleford Park is a Strategic Site Allocation in Policy CS3 of West Berkshire Core Strategy (2006-2026) identified for a sustainable and high quality mixed use development for up to 2,000 dwellings with associated infrastructure. The site has been allocated to contribute towards meeting West Berkshire's future housing requirements. The development will also provide education, community uses, public open space and new highways infrastructure. The development proposals have been conceived in the context of this Policy.

2.4 In this instance, the planning application therefore seeks outline permission with all matters reserved (except for access) for the following development, which forms the majority of the allocation:

'Outline planning permission for up to 1,000 new homes; an extra care facility as part of the C3 provision; a new 2 form entry primary school (D1); a local centre to comprise flexible commercial floorspace (A1-A5 up to 2,150 sq m, B1a up to 200 sq m) and D1 use (up to 500m); the formation of new means of access onto Monks Lane; new open space including the laying out of a new country park; drainage infrastructure; walking and cycling infrastructure and other associated infrastructure works.'

Sources of Information

2.5 The following bodies have been consulted while completing the study:

- Thames Water - Storm & foul water drainage
- Environment Agency - Flood risk and storm drainage
- West Berkshire Council - Flood risk and storm drainage

2.6 The following additional information has been available while completing the study:

- Mastermap Data - Ordnance Survey
- Published Geology - British Geological Survey
- West Berks Council - Preliminary Flood Risk Assessment (June 2011)
- West Berks Council: *Level 1 Strategic Flood Risk Assessment 2008, 2015 Update*
- West Berks Council: *Level 2 Strategic Flood Risk Assessment 2009*

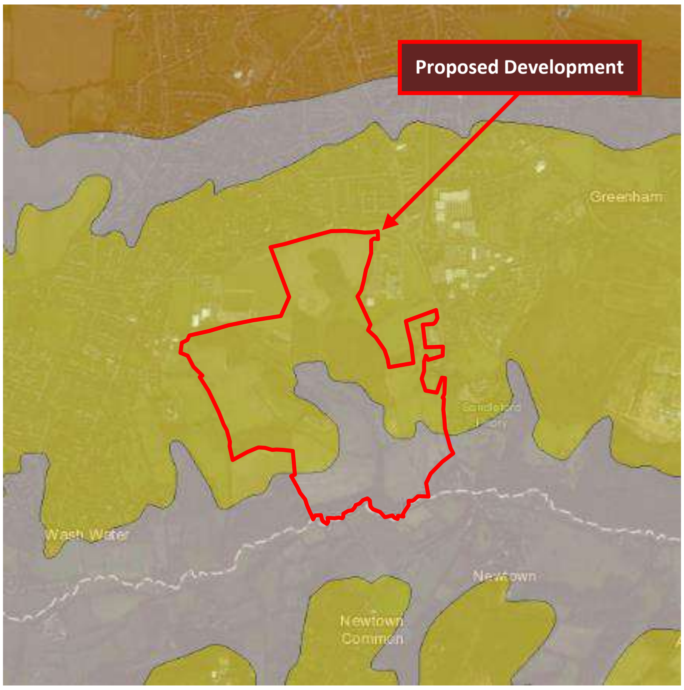
Topography & Site Survey

2.7 The site is characterised by relatively shallow falls from the sides to an ordinary watercourse flowing from north to south through the centre of the site, and generally from north towards the River Enborne to the south of the site.

Ground Conditions

Geology

2.8 With reference to the published British Geological Survey (BGS) digital mapping, the entire site is shown to be underlain by the London Clay Formation, as shown on Figure 2b. Most of the sedimentary bedrock comprises sand, however the southern and central areas of the site are shown to comprise clay, silt and sand.



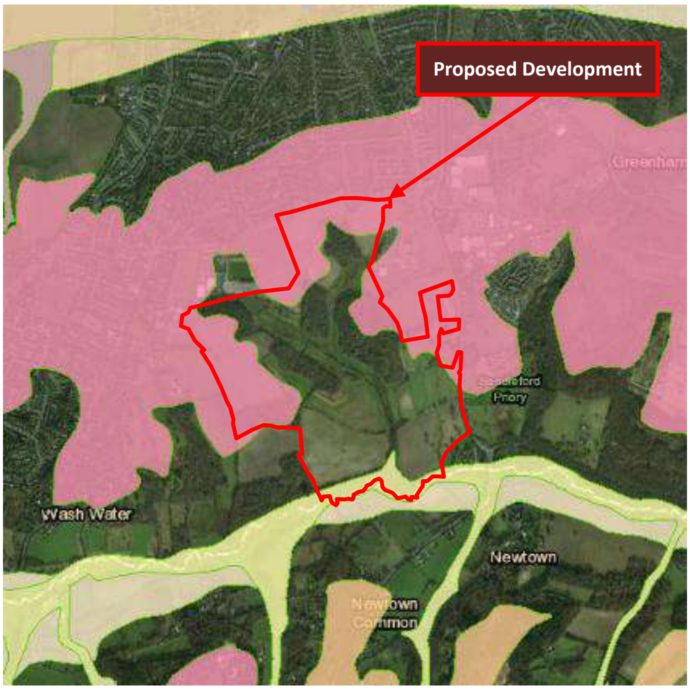
London Clay Formation - Sand

London Clay Formation – Clay, Silt & Sand

Lambeth Group – Clay, Silt & Sand

Figure 2b: BGS Bedrock Geology Map

2.9 There are two bands of superficial deposits shown to cross the site, as shown in Figure 2c. The north, north west and north east of the site is shown to comprise sand and gravel belonging to the Silchester Gravel Member whilst alluvium deposits comprising of clay, silt, sand and gravel are shown along the River Enbourne in the south of the site.



Silchester Gravel Member – Sand and Gravel

Alluvium – Clay, Silt, Sand and Gravel

Lower Thatcham Gravel – Sand and Gravel

Head – Clay, silt, sand and Gravel

Beenham Grange Gravel Member – Sand and Gravel

Figure 2c: BGS Superficial Deposits Geology Map

Hydrogeology

2.10 With reference to Magic Maps the underlying London Clay sand bedrock in the northern half of the site is shown to form a Secondary A Aquifer and the superficial Silchester sand and gravel deposits (in the north, north west and north east of the site) and the alluvium in the south are shown to form a Secondary A Aquifer.

2.11 The EA provides the following definitions for Secondary Aquifers:

> _Secondary Aquifers_ - *"These include a wide range of rock layers or drift deposits with an equally wide range of water permeability and storage. Secondary aquifers are subdivided into two types:*
>
> _Secondary A_ - *permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers;*

Groundwater

2.12 The EA estimates that there are around 2000 groundwater sources such as wells, boreholes and springs that are used for public drinking water supply in England and Wales. The majority of these have been assigned with Source Protection Zones (SPZs), which illustrate the risk of contamination from any activities that may cause pollution in the area, with the closest 'Inner Zone' being at a higher risk from a polluting activity.

2.13 The site lies within Zone 3 (the Total Catchment) of a groundwater SPZ, which is defined by the EA as, *"the area around a source within which all groundwater recharge is presumed to be discharged at the source. In confined aquifers, the source catchment area may extend for some distance from the source".*

2.14 Figure 2d is an extract of the EA's Simplified GVZ map, in which the indicative risks on site are shown to vary across the site from 'Unproductive/ Low/ Medium' in the southern half to 'High - Medium' in the east, west and northern half.

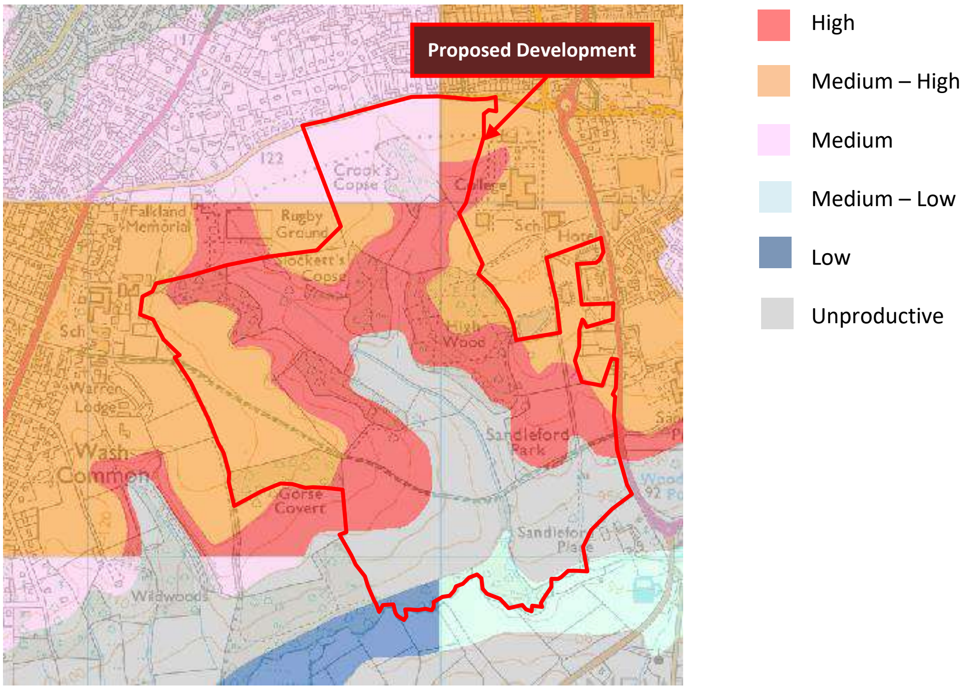


Figure 2d: The EA's Simplified Groundwater Vulnerability Zones Map (September 2017)

2.15 The EA provides the following definitions for the five GVZs:

"<u>High</u> – These are high priority groundwater resources that have very limited natural protection. This results in a high overall pollution risk to groundwater from surface activities. Operations or activities in these areas are likely to require additional measures over and above good practice pollution prevention requirements to ensure that groundwater isn't impacted.

<u>Medium-high</u> – These are high priority groundwater resources that have limited natural protection. This results in a medium-high overall pollution risk to groundwater from surface activities. Activities in these areas may require additional measures over and above good practice to ensure they do not cause groundwater pollution.

<u>Medium</u> – these are medium priority groundwater resources that have some natural protection resulting in a moderate overall groundwater risk. Activities in these areas should as a minimum follow good practice to ensure they do not cause groundwater pollution.

<u>Medium-low</u> - these are lower priority groundwater resources that have some natural protection resulting in a moderate to low overall groundwater pollution risk. Activities in these areas should follow good practice to ensure they do not cause groundwater pollution.

<u>Low</u> – these are low priority groundwater resources that have a high degree of natural protection. This reduces their overall risk of pollution from surface activities. However, activities in these areas may be a risk to surface water due to increased run-off from lower permeability soils and near-surface deposits. Activities in these areas should be adequately managed to ensure they do not cause either surface or groundwater pollution."

2.16 In terms of Groundwater Vulnerability the underlying geology is shown on DEFRA's MAGIC maps to form a Minor Aquifer with soils of a High leaching potential across the northern two thirds of the site.

Watercourse Systems & Drainage

2.17 The site includes an unnamed ordinary watercourse, a tributary to the River Enbourne, which runs in a southerly direction from the north west of the site through the centre. The River Enbourne is designated as a 'Main River' by the EA and is situated along the southern boundary of the site.

2.18 There are two existing detention/balancing ponds situated in the north east of the site (adjacent to the rear of West Berkshire Recycling Centre) and one outside of the redline boundary (to the south of Newbury College). The position of these ponds are shown below on Figure 2h.

2.19 The MAGIC map website indicates that the site includes an 'issues' in the north of the site which drains to the centre, where it traverses into the unnamed watercourse. There are also 2 'spreads' shown in the south of the site, these are shown on Figure 2e. The Ordnance Survey provides the following definitions for the above terms:

***Issues**: "The start of a flowing watercourse which is a natural emission from an agricultural drain, or where the stream re-emerges from underground".*

***Spreads**: "A place where a stream spreads into a marsh or onto a sand or shingle beach or an area of rough grass".*

2.20 With reference to the Flood Estimation Handbook (FEH) Web Service, the site is shown to comprise of 'rocks with essentially no groundwater'.

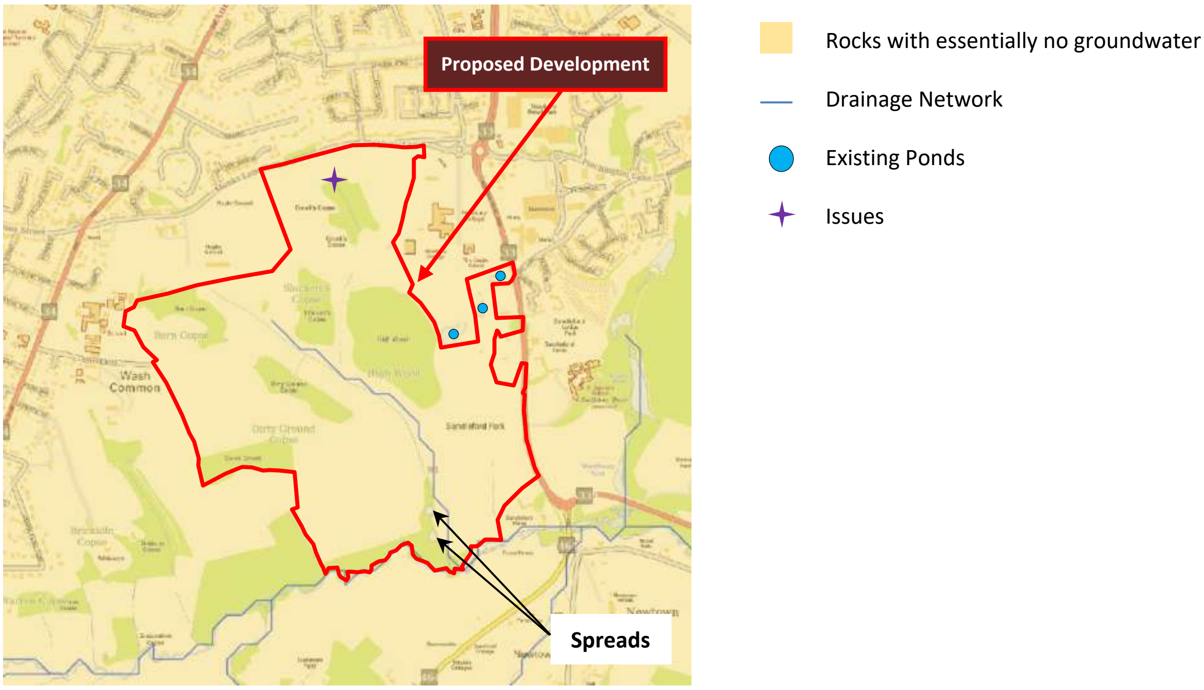


Figure 2e: BGS Hydrogeology and Drainage Network (Source: FEH Web Service)

2.21 With reference to the Flood Estimation Handbook CD dataset V3, the majority of the land is shown to lie within the catchment of an ordinary watercourse which forms a tributary of the River Enbourne. With an URBEXT2000 value of 0.06 the catchment can be described as *"moderately urban"*. The indicative FEH catchment for the site is shown in Figure 2f.

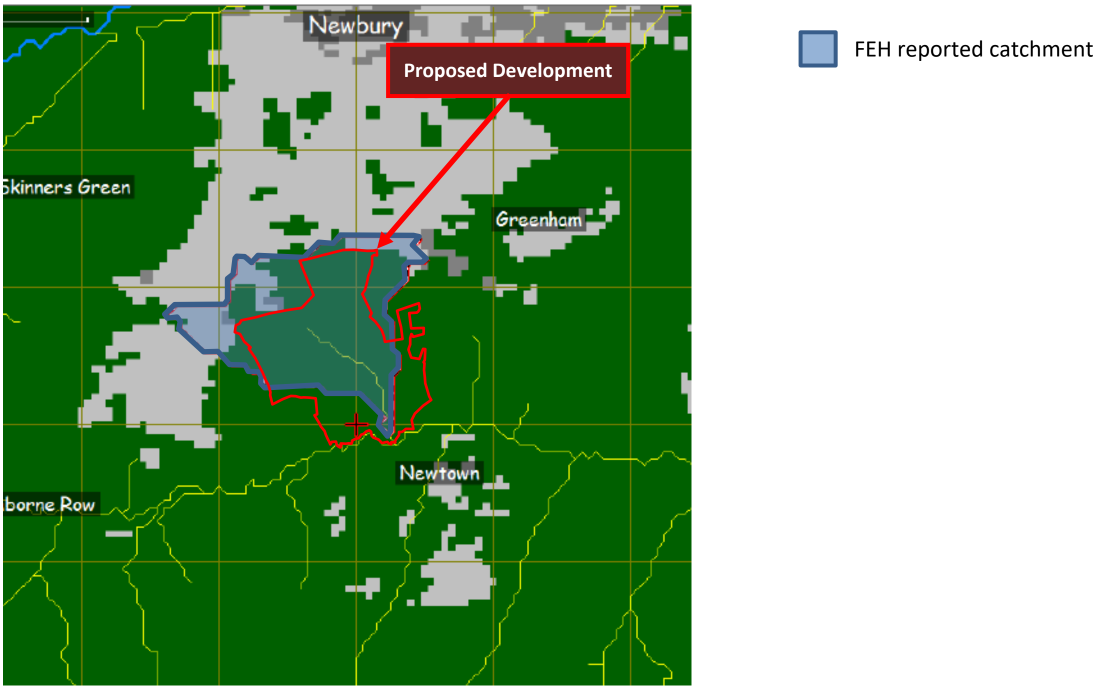


Figure 2f: FEH reported catchment

2.22 With the exception of the watercourse feature outlined above, a site inspection shows the presence of only minor field ditches that follow the existing hedge lines and field boundaries.

3 Flooding Risk

National Planning Context

3.1 The National Planning Policy Framework (NPPF) was introduced in March 2012 and updated in February 2019, with the aim at rationalising and simplifying planning guidance.

3.2 Allocation and planning of development must be considered against a risk based search sequence, as provided by the NPPF guidance. In terms of fluvial flooding, the guidance categorises flood zones in three principal levels of risk, as follows:

Flood Zone	Annual Probability of Flooding
Zone 1: Low probability	< 0.1 %
Zone 2: Medium probability	0.1 – 1.0 %
Zone 3a / 3b: High probability	> 1.0 %

Figure 3a: NPPF Flood Risk Parameters

3.3 The Guidance states that Planning Authorities should *"apply a sequential, risk-based approach to the location of development to avoid where possible flood risk to people and property and manage any residual risk, taking account of the impacts of climate change."*

3.4 According to the NPPF guidance, residential development at the proposed site being designated as a "More Vulnerable" classification, should lie outside the envelope of the predicted 1 in 100 year (1%) flood, with preference given to sites lying outside the 1 in 1,000 (0.1%) year event and within Flood Zone 1.

3.5 Sites with the potential to flood during a 1 in 100 (1%) year flood event (Flood Zone 3a) are not normally considered appropriate for proposed residential development unless on application of the "Sequential Test", the site is demonstrated to be the most appropriate for development and satisfactory flood mitigation can be provided. Additionally, proposed residential developments within Flood Zone 3a are required to pass the "Exception Test", the test being that:

- The development is to provide wider sustainability benefits
- The development will be safe, not increase flood risk and where possible reduce flood risk

Regional & Local Policy

3.6 Newbury lies within West Berkshire, in which West Berkshire Council (WBC) is the Lead Local Flood Authority (LLFA). A **Preliminary Flood Risk Assessment** (PFRA) was produced in 2011 by WBC according to the guidance and information provided by DEFRA. The PFRA identifies flood risk from local flood sources and extreme events occurrence.

3.7 Indicative Flood Risk Areas consist of an area where flood risk is most concentrated, and over 30,000 people are predicted to be at risk of flooding. The PFRA reports that "*no areas in West Berkshire have been identified as national Indicative Flood Risk Areas*".

3.8 **Regional Flood Risk Assessment:** The South East Regional Assembly published their Regional Flood Risk Assessment (RFRA) in October 2008. The document is a high level review of flood risk and strategy. In this document, concerns over the effects of flood risk and potential of climate change are identified across the wider West Midlands region

3.9 As with many RFRA's, this document outlines the broad understanding of flooding risk across areas of potential higher growth however makes no specific reference to the proposed site at Newbury.

3.10 **Strategic Flood Risk Assessment:** To support local planning policy, NPPF guidance recommends that local planning authorities produce a Strategic Flood Risk Assessment (SFRA). The SFRA should be used to help define the Local Development Framework and associated policies; considering potential development zones in the context of the sequential test defined in the guidance.

3.11 West Berkshire Council published a district-wide Level 1 Strategic Flood Risk Assessment (SFRA) in 2008 and a Level 2 SFRA for specific areas in 2009. These documents outline the results of a review of available flood risk related policy and data across the region and set out recommendations and guidance in terms of flood risk and drainage policy that generally underpin national guidance.

3.12 The SFRA document makes no specific reference to the proposed development site however the document assess the risk of flooding of the wider Newbury area from the following sources which will be discussed further in this document:

- Surface Water Flooding
- Sewer Flooding
- Overland flooding
- Groundwater Flooding

3.13 The SFRA provides recommendations to developers with regards to Sustainable Urban Design Systems (SUDS) which will be investigated further in Section 4.

3.14 **Catchment Flood Management Plans:** A Catchment Flood Management Plan (CFMP) is a high-level strategic plan through which the Environment Agency seeks to work with other key-decision makers within a river catchment to identify and agree long-term policies for sustainable flood risk management.

3.15 The Thames Catchment Flood Management Plan (December, 2009), outlines that the Thames River Basin District- South Essex catchment has been divided into 9 sub-catchments. The Site is shown to be covered by the following policy:

"**Policy 6: Areas of low to moderate flood risk where we will take action with others to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits.**

This policy will tend to be applied where there may be opportunities in some locations to reduce flood risk locally or more widely in a catchment by storing water or managing run-off. The policy has been applied to an area (where the potential to apply the policy exists), but would only be implemented in specific locations within the area, after more detailed appraisal and consultation."

3.16 **Development Flood Risk Assessment:** At a local, site by site level the NPPF guidance and supporting documents advocate the preparation of a Flood Risk Assessment (FRA). NPPF requires that developments covering an area of greater than one hectare prepare an FRA in accordance with the guidance. The FRA is required to be proportionate to the risk and appropriate to the scale, nature and location of the development.

3.17 This document forms a Flood Risk Assessment (FRA), to accord with current guidance and addresses national, regional and local policy requirements in demonstrating that the proposed development lies within the acceptable flood risk parameters.

Flood Mechanisms

3.18 Having completed a site hydrological desk study and walk over inspection, the possible flooding mechanisms at the site are identified in Figure 3b.

Mechanisms	Potential Risk	Comment
Fluvial	N	The EA flood map shows there to be no risk of flooding form the watercourse through the middle of the site, therefore situated within Flood Zone 1 (an area of low probability for fluvial flooding).
Coastal & tidal	N	There is no risk of tidal flooding.
Overland flow	N	The site is protected from overland flow from the north by Monks Lane, the east by the A339 Newtown Road and the west by open fields.
Groundwater	N	Geology underlying the site is London Clay formation and thus considered relatively impermeable.
Sewers	N	There is no reported sewer network within the site boundary.
Reservoirs, Canals etc	N	No reservoirs or artificial sources lie within an influencing distance of the proposed development.

Figure 3b: Flooding mechanisms

Fluvial Flooding

3.19 The Environment Agency's (EA) National Generalised Modelling (NGM) Flood Zones Plan indicates predicted flood envelopes of Main Rivers across the UK. In many circumstances, the NGM is based on basic catchment characteristic data and modelling techniques. Where appropriate, more accurate Section 105 / SFRM models are produced using more robust analysis techniques.

3.20 The mapping shows that apart from a narrow strip along the Enbourne, the proposed site lies within Flood Zone 1, an area of Low Probability of flooding, outside both the 1 in 100 (1% AEP) and 1 in 1,000 (0.1% AEP) year flood events. An extract of the EA Flood Zone plan is shown in Figure 3c.

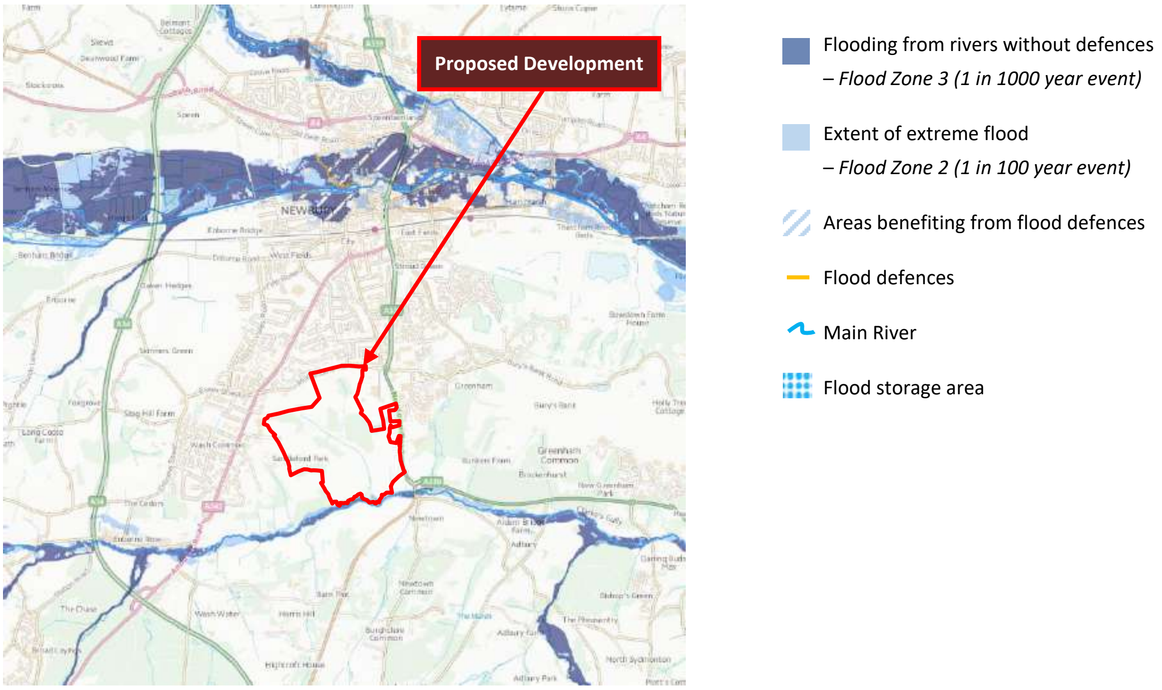


Figure 3c: Flooding mechanisms

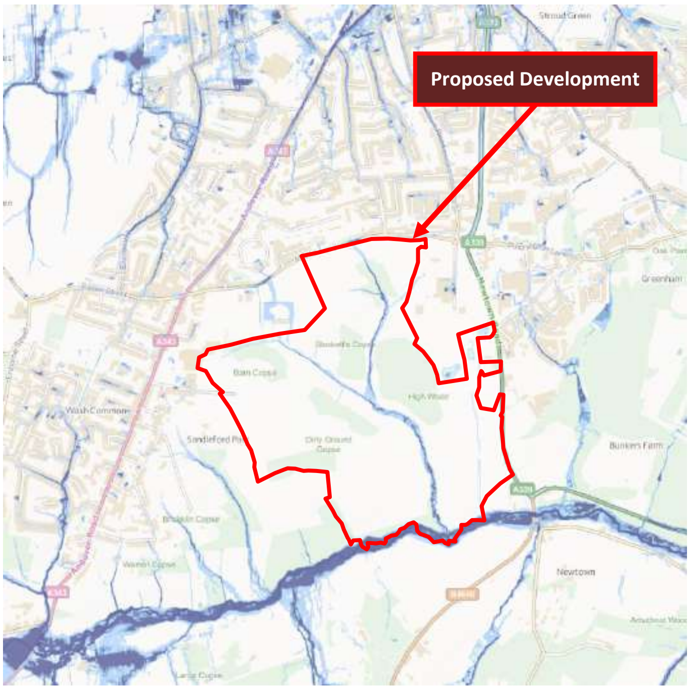
Coastal Flooding

3.21 The site lies a significant distance from the nearest tidal watercourse and the coast. As such there is no material risk of tidal or coastal flooding at this location.

Overland Flow

3.22 Overland flow mechanisms result from the inability of unpaved ground to infiltrate rainfall or due to inadequacies of drainage systems in paved areas to accommodate flow directed to gullies, drainage downpipes or similar. In minor cases, localised ponding may occur. In more extreme events, flows accumulate and may be conveyed across land following the topography.

3.23 The Environment Agency, in partnership with lead local flood authorities, produced a series of surface water flood maps for many parts of the UK, which were updated in 2013. These maps can be accessed via the Gov.Uk website, under 'Long term flood risk assessment for locations in England'.



Risk of Flooding from Surface

- **High** – Chance of flooding greater than 1 in 30 (3.3%)
- **Medium** – Chance of flooding between 1 in 100 (1%) and 1 in 30 (3.3%)
- **Low** – Chance of flooding between 1 in 1,000 (0.1%) and 1 in 100 (1%)
- **Very Low** – Chance of flooding less than 1 in 1,000 (0.1%)

Figure 3d: EA Long Term Flood Risk Maps – *Flood risk from Surface Water* (Gov.Uk website)

3.24 The mapping provided by the EA identifies potential risks of surface water flooding around the River Enborne to the south of the site, and along the ordinary watercourse that runs through the centre of the Site. However the majority of the site is not shown to be at risk from surface water flooding. In particular, there is no risk of flooding shown within any of the proposed development parcels.

3.25 The findings of the Brookbanks and EA assessments have been taken into account as part of the master planning proposals for the site and accordingly it is proposed to ensure all built development remains outside identified significant surface water flooding areas.

3.26 Recognising the risk of overland flow mechanisms, published guidance in the form of Sewers for Adoption 7th Edition and the Environment Agency document *Improving the Flood Performance of New Buildings: Flood Resilient Construction et al* (June 2007) advocate the design of developments that implement infrastructure routes through the development that will safely convey flood waters resulting from sewer flooding or overland flows away from buildings and along defined corridors. Further to protect the proposed development, current good practice measures defined by the guidance (such using materials with low permeability, raising finished floor levels above flood levels and raised thresholds), where appropriate will be incorporated at the proposed development.

3.27 Given the baseline site characteristics and further mitigating measures to be implemented residual flood risk from an overland flow mechanism is considered of a low probability.

Groundwater

3.28 Ground water related flooding is fortunately quite rare, although where flooding is present, persistent issues can arise that are problematic to resolve. Such mechanisms often develop due to construction activities that may have an unforeseen effect on the local geology or hydrogeology.

3.29 Positive drainage systems incorporated into the proposed development will further reduce the risk as a result of permeable pipe bedding materials and filter drains incorporated elements of the built development.

3.30 Given the baseline site characteristics and further mitigating measures to be implemented, residual flood risk from a ground water mechanism is considered of a low probability.

Sewerage Systems

3.31 No records of historical flooding have been located.

3.32 Positive drainage measures incorporated on site, coupled with sustainable drainage systems (SUDS) will ensure that no increase in surface water discharge to sewers will result from the site. Flood risk associated with sewer flooding is therefore considered to be of a low probability.

Artificial Water Bodies - Reservoirs & Canals

3.33 There are no reservoirs identified within an influencing distance of the site boundary.

3.34 Reservoir flooding is extremely unlikely to happen. However, in the unlikely event that a reservoir dam failed, a large volume of water would escape at once and flooding could happen with little or no warning. If living or working in an area that could be affected, it is recommended to plan in advance what to do in an emergency. It might be necessary to evacuate immediately.

3.35 It may therefore be concluded that there is a low risk of flooding associated with artificial water bodies at the proposed development. It is, however, important to make sure local emergency plans are followed.

Summary

3.36 In terms of fluvial and tidal flood risk, the site lies almost entirely within Flood Zone 1 and hence has a low probability of flooding from this mechanism. All built development will lie within Flood Zone 1.

3.37 Assessment of other potential flooding mechanisms show the land to have a low probability of flooding from overland flow, ground water and sewer flooding.

3.38 Accordingly, the proposed development land is in a preferable location for residential development when appraised in accordance with the NPPF Sequential Test and local policy. These findings are consistent with the West Berkshire Council Level 1 Strategic Flood Risk Assessment.

Objectives

3.39 The key design outcomes that are recommended in relation to flooding are:

- Compliance with SFA 7th Edition and EA guidance in relation to flood routing through the proposed development in the event of sewer blockages.

4 Storm Drainage

Background

4.1 The land is presently not serviced by a positive storm water drainage network. Storm water currently discharges to the existing ordinary watercourse and drainage ditches within the site boundary.

Drainage Options

4.2 The following paragraphs in this section outline the proposed drainage strategy to meet national and local design requirements and guidance.

4.3 Current guidance[1] requires that new developments implement means of storm water control, known as SUDS (Sustainable Drainage Systems), to maintain flow rates discharged to the surface water receptor at the pre-development 'baseline conditions' and improve the quality of water discharged from the land.

4.4 It is proposed to implement a SUDS scheme consistent with local and national policy at the proposed development.

4.5 The West Berkshire SFRA underpins national guidance on the provision of storm water drainage, encouraging the use of sustainable means of drainage at new developments. This proposed development adheres to the guidance in offering a range of site appropriate SUDS.

4.6 When appraising suitable storm water discharge options for a development site, Part H of the Building Regulations 2002 (and associated guidance) provides the following search sequence for identification of the most appropriate drainage methodology.

"Rainwater from a system provided pursuant to sub-paragraphs (1) or (2) shall discharge to one of the following, listed in order of priority -

(a) an adequate soakaway or some other adequate infiltration system; or where that is not reasonably practicable,
(b) a watercourse; or where that is not reasonably practicable,
(c) a sewer. "

4.7 Dealing with the search order in sequence:

a) Source control systems treat water close to the point of collection, in features such as soakaways, porous pavements, infiltration trenches and basins. The use of these can have the benefit of discharging surface water back to ground rather than just temporarily attenuating peak flows before discharging it to a receiving watercourse or sewer.

As source control measures generally rely upon the infiltration of surface water to ground, it is a prerequisite that the ground conditions are appropriate for such.

The infiltration tests undertaken by GEG Ltd (Report GEG-14-352 included within the Appendix) indicate that the soils are of a relatively low permeability. In view of this, it is considered that the site is unsuitable for soakaway drainage. However, locally there is a possibility that limited soakaway drainage may be possible such as in the vicinity of TP07 in the north of the site, as shown below on Figure 4a. Therefore, further assessment may be prudent targeting the thicker granular areas once the detailed proposed residential layout is finalised. For the outline submission it has been assumed that infiltration is not a viable option.

[1] NPPF, CIRIA C522, C609, C697, C753et al.

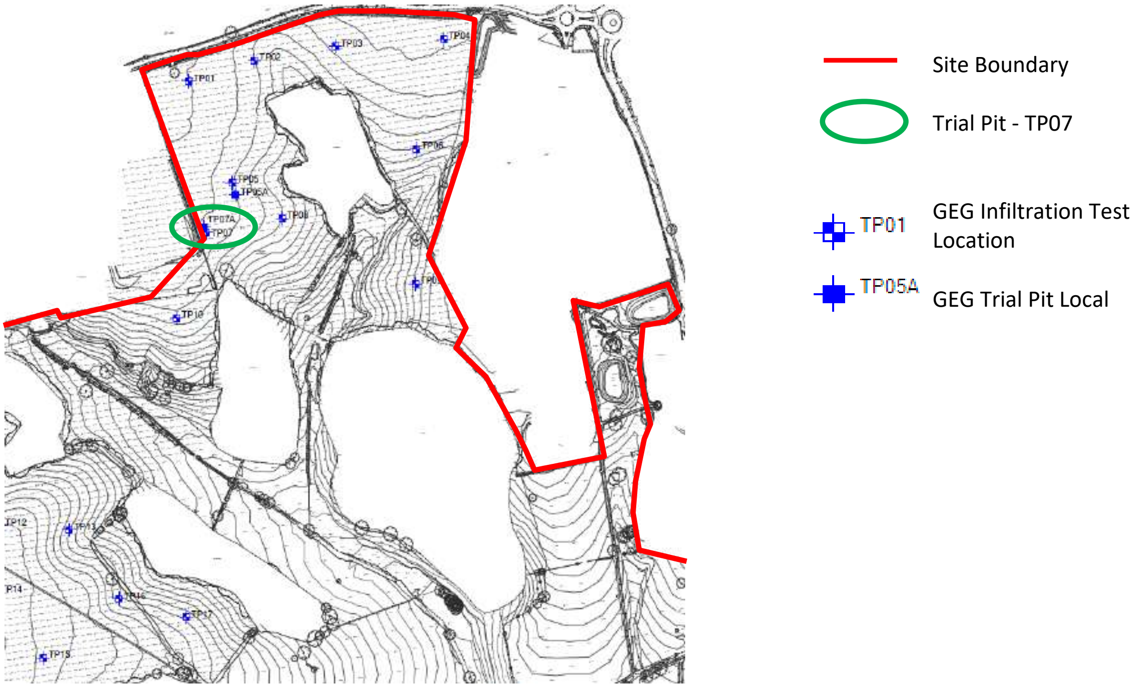


Figure 4a: GEG Infiltration Trial Pit Location Plan extract (Report *GEG-14-352)*

b) Next in the search sequence is discharge to a watercourse or suitable receiving water body. Coupled with appropriate upstream attenuation measures, this means of discharge can provide a sustainable drainage scheme that ensures that peak discharges and flood risk in the receiving water body are not increased.

The ordinary watercourse through the centre of the site currently receives stormwater from the existing land and as such, has the potential to receive flows from the proposed development once restricted to the pre-existing 'greenfield' rates of run-off.

c) Last in the search sequence is discharge to a sewer (surfacewater or combined). In the context of SuDS this is the least preferable scheme as it relies on 'engineered' methods to convey large volumes of water from development areas, has a higher likelihood of flooding due to blockage and provides less intrinsic treatment to the water.

4.8 Therefore, the search sequence outlined above indicates that the existing watercourse network is the most appropriate receptor of storm water from the proposed development, having the potential to employ source control measures and on-line SUDS to control peak discharges to no greater than the baseline conditions.

4.9 Proposals have been developed to inform the strategic drainage network across the development. It is proposed that the drainage system for the site utilise a SUDS system as the primary storm water management scheme.

4.10 Accordingly, a plan showing the conceptual drainage masterplan for the site is contained in the Appendix as drawings 10309-DR-02.

4.11 Coupled with the storm water control benefits, the use of SUDS can also provide betterment on water quality. National guidance in the form of CIRIA 753 outlines that by implementing SUDS*,* storm water from the site can be polished to an improved standard thus ensuring the development proposals have no adverse effects on the wider hydrology.

4.12 The following paragraphs outline the potential SUDS features appropriate for use on-site.

Primary Drainage Systems (source control)

4.13 At the head of the drainage network, across the site, source control measures could be implemented to reduce the amount of run-off being conveyed directly to piped drainage systems.

4.14 The common aims of a Primary Drainage System are:

- Reduction in peak discharges to the agreed site wide run-off rate from the development areas.
- Provide water quality treatment where appropriate

4.15 Through consultations at outline planning stage, it has been agreed that nature of source control measures to be implemented will need to remain flexible, providing each house builder with a 'toolkit' of options to reach an agreed target for peak discharge reduction and water treatment. Figure 4b is an extract of Table 1.1 from the CIRIA SuDS Manual C753 which outlines a number of options available.

Component Type	Description	Considered as part of the Development	
Rainwater Harvesting Systems	Rainwater is collected from the roof of a building or from other paved surfaces in an over-ground or underground tank for use on site. Depending on its intended use, the system may include treatment elements. The system should include specific storage provision if it is to be used to manage runoff to a design standard.	No	Not considered at outline stage. Developer to confirm suitability at Reserved Matters.
Green roofs	A planted soil layer is constructed on the roof of a building to create a living surface. Water is stored in the soil layer and absorbed by vegetation. Blue roofs store water at a roof level, without the use of vegetation.	No	Not considered at outline stage. Developer to confirm suitability at Reserved Matters.
Infiltration Systems	These systems collect and store runoff allowing it to infiltrate into the ground. Overlaying vegetation and underlying unsaturated soils can offer protection to groundwater from pollution risks.	No	Limitation for infiltration use due to underlying geology following initial infiltration testing. However further investigation may be carried out at Reserved Matters.
Proprietary treatment systems	These subsurface are surface structures are designed to provide treatment of water through the removal of contaminants.	Yes	Petrol interceptors will be provided for all estate roads as part of Section 278 approval/38 approval.
Filter strips /Ditches	Runoff from an impermeable area can flow across a grassed or otherwise densely planted area to promote sedimentation and filtration.	**Yes**	Suited to be implemented adjacent to large impervious areas. Easily integrated into landscaping and can be designed to provide aesthetic benefits.
Filter drains	Runoff is temporarily stored below the surface in a shallow trench willed with stone/gravel, providing attenuation, conveyance and treatment (via filtration).	yes	Proposed inclusion of both swales and conventional pipe system. Filter drains considered a non-requirement for water conveyance.
Swales	A vegetated channel is used to convey and treat runoff (via filtration). These can be 'wet' where water is designed to remain permanently at the base of the swale or 'dry' where water is only present in the channel after rainfall events, It can be lined, or unlined to allow infiltration.	**Yes**	Easily integrated into landscaping and maintenance can be incorporated into general landscaping management. Pollution and blockages are visible and easily dealt with.
Bio retention systems	A shallow landscaped depression allows for runoff to pond temporarily on the surface, before filtering through the vegetation and underlying soils prior to collection or infiltration. In the simplest form it is often referred to as a rain garden. Engineered soils (gravel and sand layers) and enhanced vegetation can be used to improve treatment performance.	**Yes**	Land availability and suitable ground conditions allow for small bio retention systems within the proposed built development.
Trees	Trees can be planted within a range of infiltration SuDS components to improve their performance, as root growth and decomposition increase soil infiltration capacity. Alternatively they can be used as standalone features within soil-filled tree pits, tree planters or structural soils collecting and storing runoff and providing treatment.	**Yes**	As part of the proposed master planning trees will be incorporated into the built development and SUDS area. He details of which will be confirmed at the detailed design stage.
Pervious pavements	Runoff is allowed to soak through structural paving. This can be paving blocks with gaps between solid blocks, or porous paving where water filters through the block	**Yes**	Can be used where infiltration is not desirable, or where soil integrity may be compromised.

	itself. Water can be stored in the sub-base and potentially allowed to infiltrate into the ground.		The use of pervious surfaces will allow for reduced peak flows to watercourses, reducing the risk of flooding downstream. In turn this reduces the effects of pollution in runoff on the environment. They can be used in high density developments with a range of surface finishes that accept surface waters over their area of use.
Attenuation storage tanks	Large, below ground voided spaces can be used to temporarily store runoff before infiltration, controlled release or use. The storage structure is often constructed using geocellular or other modular storage systems, concrete tanks or oversized pipes.	No	Due to the available space and ground conditions, these are not considered necessary. Therefore more viable SUDS have been selected.
Detention basins	During a rainfall event, runoff drains to a landscaped depression with an outlet that restricts flows, so that the basin fills and provides attenuation. Generally basins are dry, except during and immediately following the rainfall events. If vegetated, runoff will be treated as it is conveyed and filtered across the base of the basin.	**Yes**	These are able to cater for a wide range of rainfall events and if lined can also be used where groundwater is vulnerable.
Ponds and wetlands	Features with a permanent pool of water can be used to provide both attenuation and treatment runoff. Where outflows are controlled and water levels are allowed to increase following rainfall. They can support emergent and submerged vegetation along their shoreline and in shallow, marshy zones, which enhances treatment processes and biodiversity.	**Yes**	Permanent wet features can be designed into the SuDS features and will be further outlined within the Reserved Matters.

Figure 4b: Table 1.1 Types of SuDS components (CIRIA SuDS Manual C753)

4.16 Taking into consideration the existing underlying ground conditions on site and infiltration limitation the following two potential options are considered to be the most practical. However further detailed ground investigations may be undertaken to confirm the suitability of other measures, once at the detailed design stage.

Filter Strips

4.17 Filter strips have been used in the drainage of highways alike for many years. The absence of traditional pipe work in such a system frees the drainage design to employ shallow gradients on both channels and drains, which in turn also act as a means of passive treatment to improve water quality.

4.18 The detailed design of highways could potentially include filter drains, subject to approval by the Highways Authority. Alternatively, filter strips can be used to collect flows from areas such a group of house. Figure 4c shows an example of a filter strip in a road corridor.

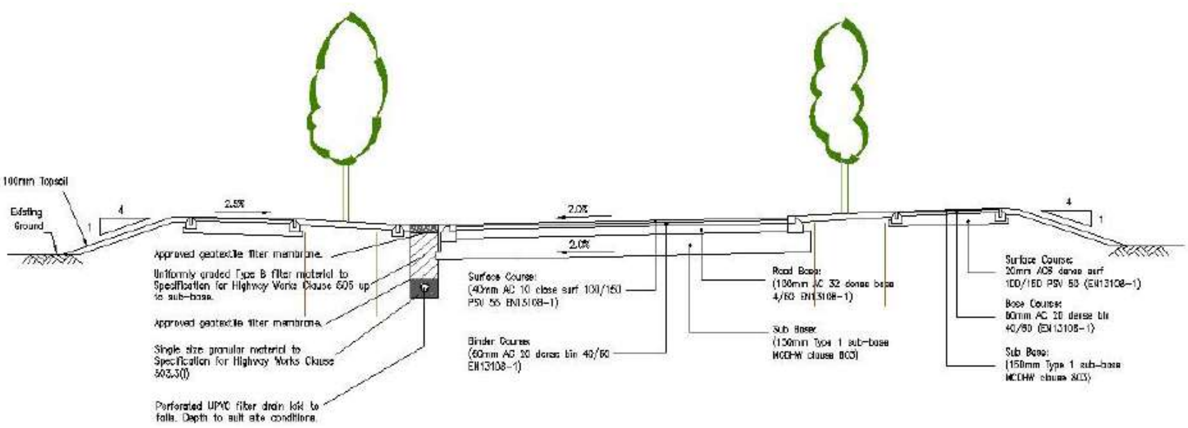


Figure 4c: Filter Strips

Ditches

4.19 Ditches may be used along highways and in common areas to infiltrate, attenuate and convey flows from hard surfaces across the development before being discharged in to the secondary system. Linear features, such as ditches and filter strips provide an efficient means of improving water quality.

Swales

4.20 While swales implemented at development parcel level can be very land hungry, costly to maintain and provide difficulties with frontage access, the opportunity potentially exists to implement a swale on the eastern boundary of the site, through the development. Green space being incorporated along the highways could be designed to allow 'over the edge' flows to be directed into the swale for infiltration, attenuation and conveyance. A typical highway swale is show in Figure 4d:

Figure 4d: Swale along road corridor

Permeable Paving

4.21 Permeable Paving can act as a receptor for surface water run-off from nearby commercial buildings and house roofs. However, the system is perhaps best suited to manage parking areas and shared surfaces where block paving is typically used as the surface treatment and ongoing maintenance can be ensured by way of a management company or the like.

4.22 There is little need for underground pipes or gullies, and the attenuation afforded within the sub-base layer helps to reduce the volume of storage required elsewhere.

Figure 4e: Filter Strip along highway

Attenuation Basins

4.23 Attenuation drainage systems collect partially treated excess water from the primary source control systems at a local level, thereafter providing both flow and water quality attenuation and flow conveyance through the Site towards the main outfall.

4.24 It is anticipated that two basins will be utilised and designed to primarily be dry with permanently wet low flow channels to convey run-off in periods of low rainfall, which will in turn provide the passive treatment benefits offered within the remainder of the surface water management network.

4.25 The primary aims of the basin will therefore be:

- Final flow and water quality conditioning
- Provide landscaping, amenity and ecological benefits

SuDS in the Built Development

4.26 A series of small linear basins (bio retention systems) are proposed within the build environment. These are very effective in removing urban pollutants and can reduce the volume and rate of runoff being conveyed to the overall site wide SUDS basin.

4.27 The SuDS for any given phase will be constructed prior to occupation of the same phase. This principal of SuDS delivery will be carried forward throughout all proposed development phases. The specific details of each phase will be managed through Reserved Matters applications and will be subject to the approval of the LLFA. The surety of appropriate delivery of drainage features per phase can be delivered through Planning Condition(s) linked to this Planning Application.

4.1 The following SuDS guidance is for West Berkshire is as followed:

"Developers and property owners deliver SuDS which

- *Are appropriate to the local area and its hydrology;*
- *Deliver social, environmental and financial benefits;*

- *Aim to meet a range of sustainability and place-making objectives;*
- *Are clearly presented at planning stage, enabling an efficient review and approval process; and*
- *Have clear responsibilities for future maintenance and management."*

4.28 It has been assumed that the functionality of the storm water management system would be ensured by ongoing maintenance, completed by West Berkshire Council, Thames Water, or a private maintenance company as appropriate. Through Reserved Matters, the Applicant shall determine the most sustainable and viable of these options.

4.29 It is commonplace, and recommended in this case, for the following maintenance regime to be implemented:

Frequency	Operation
Post major storm events	Inspection and removal of debris.
Every two months	Grass mowing (growing season) & litter removal.
Annual	Weeding & vegetation maintenance. Minor swale clearance. Sweeping of permeable pavements.
2 years	Tree pruning.
5-10 years	Desilting of channels. Remove silt around inlet and outlet structures.
15-20 years	Major vegetation maintenance and watercourse channel works.

Table 4f: Framework maintenance of detention / retention system

Proposed Drainage Strategy

4.30 Surface water from the new development will be managed by appropriate use of SUDs techniques, as previously discussed, minimising the use of externally sourced water and promoting biodiversity. The existing network of streams and ponds will be retained within the development.

4.31 The SUDS system features, which will be present in the verges along the main road, have been designed as an integrated network within the Country Park and the development area. They will be developed through each phase. The Conveyance features such as the swales will route stormwater to the detention basins for further attenuation and storage at the naturally occurring low areas of the site. In addition to this, open features may include water butts, grey water recycling and permeable paving to driveways, potential for green roofs in non-residential buildings.

Construction Phase – Water, Geology and Soil Management

4.32 The following outlines the high level strategy that will be adopted for the construction process. It is noted that the formal, detailed strategy for the construction phase will be addressed by the Construction and Environmental Management Plan, which will follow from consent of this outline Planning Application.

Management Plan

4.33 All work is to be carried out mindful of NPPF and current guidance.

4.34 Two potential construction phase environmental effects have been identified relating to hydrogeology and hydrology. These mechanisms are as follows:

- Direct and indirect contamination of surface water due to mobilisation of soils, contamination and spillage of oils and the like from construction plant.
- Direct and indirect flooding and changes to baseline drainage hydrology due to disturbance of the ground during construction works.

4.35 The discharge of suspended solids to watercourses and ground waters will be avoided by prohibiting any temporary construction discharge without the prior approval of the Environment Agency. Discharges of waters resulting from construction activities will generally be directed to foul sewers, subject to approval of the drainage authority.

4.36 There is the potential for fuel oil spillage from stored materials supplying site plant, this potential impact will be controlled by storing such materials within bunded tanks located within the site compounds. The works will be completed in a manner that is consistent with the need to protect the surface and ground water quality environment.

4.37 All hazardous liquids and chemicals are to be stored and utilised in accordance with COSHH regulations.

4.38 It will be incumbent on the Main Contractor to assess working practice related risks and effects before implementation and control such by employing industry good practice techniques.

Emergency Environmental Procedures

4.39 The Main Contractor will be required to develop emergency spillage, flood, fire and contamination control procedures such that any inadvertent incidents are immediately controlled to minimise the potential impact. All works will be completed in accordance with the Environment Agency documents, PPG 6 Working at Construction and Demolition Sites and PPG21 Pollution Incident Response Planning together with current best practice measures for the management of construction activities.

Monitoring Proposals

4.40 The Main Contractor's Environmental Manager will carry out an assessment of the Project's environmental performance, based on reports from the environmental specialists and site inspections. This will be carried out at a frequency at no greater than monthly intervals but could be held more regularly depending on the nature of the construction activity. An assessment of the performance over the month would be made and quantified.

4.41 A monthly report detailing performance for the period will be provided to the Project Manager and will include a summary of environmental inspections completed, audits undertaken, complaints and incidents.

4.42 The Environmental Manager will as necessary provide details to the project delivery team, and also to the relevant statutory environmental agencies or local authorities if required.

4.43 Monitoring of agreed environmental determinants will be carried out in accordance with the specialist environmental procedures and environmental commitments made. The Environmental Manager will maintain a register of all environmental monitoring, which is to be retained on site for review.

4.44 The Environmental Manager will inform the Main Contractor of any work areas that are to be covered by environmental monitoring.

Drainage Design Criteria

4.45 Preliminary assessment of the requirements for storm drainage has been based on the following criteria:

Application Site Area:	114.00 ha
Developed Area:	29.49 ha
Impermeability - Residential:	0.55
Impermeability - Commercial:	0.85
Impermeability - School:	0.45
Sewer design return period	1 in 1 year
Sewer flood protection	1 in 30 years

Fluvial / Development flood protection	1 in 100 years
M5-60[(2)]	19.4 mm
Ratio r [(2)]	0.35
Minimum cover to sewers	1.2 m
Minimum velocity	1.0 m/sec
Pipe ks value	0.6 mm
Allowance for climate change	40%

4.46 National policy[1] dictates that new developments control the peak discharge of storm water from a site to the baseline, undeveloped, site conditions. Over very large development areas, the baseline rate of run-off is normally estimated using the FEH methodologies. However, Paragraph 3.1.2 of the FEH guidance states:

"The frequency estimation procedures can be used on any catchment, gauged or ungauged, that drains an area of at least 0.5km^2. The flood estimation procedures can be applied on smaller catchments only where the catchment is gauged and offers simple flood peak or flood event data".

4.47 On undeveloped and ungauged catchments of less than 0.5km^2 in area, it is correct to complete baseline site discharge assessments using the nationally accepted IoH124 methodology for small rural catchments. Local policy is to employ IoH124 in a manner set out by CIRIA C697. This methodology requires that, for catchments of less than 50ha, the IoH assessment is completed for a 50ha area with the results linearly interpolated to determine the flow rate value based on the ratio of the development to 50ha.

4.48 The baseline IoH run-off rates are shown on Table 4g below.

Event	IoH 124 (50ha)	IoH 124 Scaled to 1ha
1 in 1 year (l/s)	218.3	4.37
Qbar (l/s)	256.8	5.14
1 in 100 year (l/s)	819.2	16.38

Table 4g: IoH124 baseline discharge rates

4.49 In order to determine the permitted rates of run-off from the development, the future impermeable catchment areas must be derived. This has been based on BCL measured ratios from previous projects. Calculations below show these ratios and areas and how these correlate to the rates of discharge.

4.50 However, the development proposals have the potential to provide betterment to the surrounding area by reducing the peak run-off from the proposed development. Coupled with the mitigation of increased volume of run-off associated with built development, by reducing peak flows in the 1 in 100 year event to the mean annual flow (Qbar) it is possible for the development to achieve circa 69% betterment in stormwater run-off. The calculations for this are shown in Figure 4h.

[2] Wallingford Report

Catchment	Land Use	Developable Area (ha)	Impermeable Area (ha)	Existing 100 Year Run-off (l/s)	Proposed 100 Year Run-off (l/s)	Betterment %
A	Residential /Commercial/ School	13.80	7.76	127.12	39.85	69%
B	Residential / School	8.85	4.65	76.26	23.91	69%
C	Residential	6.84	3.76	61.64	19.32	69%

Table 4h: Run-off calculation

4.51 In accordance with the SFRA document and NPPF guidance, it is proposed to implement a drainage strategy that provides attenuation of peak storm water discharges from the developed land to the baseline rate determined using IoH124 methodology.

4.52 In order to mitigate for the increased volume of run-off associated with built development, peak flows in the 1 in 100 year event must be attenuated to the mean annual flow (Qbar).

4.53 Using these methods, development at the site will comply with the requirements set out in paragraph 9 of the Technical Guide to the National Planning Policy Framework (NPPF), with the discharge of surface water from the proposed developments not exceeding that of the existing greenfield sites, thus ensuring that there is no material increase in the flood risk to surrounding areas.

4.54 Assessments have thereafter been completed to determine the characteristics of proposed SUDS features to be situated within the development. Best practice methods have been employed by performing detention routing calculations for the 1 in 100 year inlet and outlet return periods using the WinDES Source Control module. The summary calculations are contained in the Appendix.

Catchment A

4.55 Calculations demonstrate that storm water detention storage of 6,002m^3 will be required to attenuate storm water discharges from the site during the critical 1 in 100 year event storm. This will limit the peak discharges to 39.85 l/s, being equivalent to the mean annual storm (Qbar), estimated by the IoH124 calculations above, representing 69% reduction on peak Greenfield rates. Figure 4i, summarises the overall detention requirements. The summary calculations are contained within the Appendix.

Catchment Area (ha)	Impermeable Area (ha)	1 in 100 Year Run-off (l/s) Existing/Proposed		Detention Volume for 1 in 100 Year Event (m^3)	SUDS Type
13.80	7.76	127.12	39.85	6,002	Detention Basin

Table 4i: Summary run-off & detention assessment output

Catchment B

4.56 Calculations demonstrate that storm water detention storage of 3,578m^3 will be required to attenuate storm water discharges from the site during the critical 1 in 100 year event storm. This will limit the peak discharges to 23.91 l/s, being equivalent to the mean annual storm (Qbar), estimated by the IoH124 calculations above, representing 69% reduction on peak Greenfield rates. Figure 4j, summarises the overall detention requirements. The summary calculations are contained within the Appendix.

Catchment Area (ha)	Impermeable Area (ha)	1 in 100 Year Run-off (l/s) Existing/Proposed		Detention Volume for 1 in 100 Year Event (m^3)	SUDS Type
8.85	4.65	76.26	23.91	3,578	Detention Basin

Table 4j: Summary run-off & detention assessment output

Catchment C

4.57 Calculations demonstrate that storm water detention storage of 2,899m^3 will be required to attenuate storm water discharges from the site during the critical 1 in 100 year event storm. This will limit the peak discharges to 19.32 l/s, being equivalent to the mean annual storm (Qbar), estimated by the IoH124 calculations above, representing 69% reduction on peak Greenfield rates. Figure 4k, summarises the overall detention requirements. The summary calculations are contained within the Appendix.

Catchment Area (ha)	Impermeable Area (ha)	1 in 100 Year Run-off (l/s) Existing/Proposed		Detention Volume for 1 in 100 Year Event (m^3)	SUDS Type
6.84	3.76	61.64	19.32	2,899	Detention Basin

Table 4k: Summary run-off & detention assessment output

4.58 A side overflow weir will be provided on the detention features, at a level above the 1 in 100 year + 40% flood level to allow more extreme event flows to safely be conveyed away from properties, while at the same time not increasing flood risk to surrounding areas, in line with current good practice recommendations. The detailed design stage will provide further detail into the positioning of overflows and direction of flow.

4.59 A conceptual layout for the drainage system has been developed to accord with the design requirements. While this FRA informs the general principles of the proposed drainage system, at detailed design stage, each device will be individually designed for the site characteristics developed for this application.

4.60 Furthermore, based on Brookbanks FRA work undertaken to support other, similar development applications, it is recognised and accepted that in addition to the developments strategic attenuation basins, the implementation of source control measures can achieve a minimum 50% betterment in peak run-off from each development parcel, thus should this be a viable option, a further betterment may be achieved.

4.61 The proposed strategic drainage master plan is shown illustratively on drawing 10309-DR-02 contained in the Appendix.

Water Quality

4.62 Impermeable surfaces collect pollutants from a wide variety of sources including cleaning activities, wear from car tyres, vehicle oil and exhaust leaks and general atmospheric deposition (source: CIRIA C609). The implementation of SuDS in development drainage provides a significant benefit in removal of pollutant from development run-off.

4.63 The SuDS Manual C753 describes a 'Simple Index Approach' for assessing the pollution risk of surface run-off to the receiving environment using indices for likely pollution levels for different land uses and SuDS performance capabilities.

4.64 CIRIA document C753 Table 26.2, as shown in Figure 4n below, indicates the minimum treatment indices appropriate for contributing pollution hazards for different land use classifications. To deliver adequate treatment, the selected SuDS components should have a total pollution mitigation index (for each contaminant type) that equals or exceeds the pollution hazard index.

Land Use	Pollution Hazard Level	Total suspended solids (TSS)	Metals	Hydro-carbons
Residential roofs	Very Low	0.2	0.2	0.05
Individual property driveways, residential car parks, low traffic roads (e.g. cul-de-sacs, home zones and general access roads) and non-residential car parking with infrequent change (e.g. schools, offices) i.e. < 300 traffic movements/day	Low	0.5	0.4	0.4
Other roofs (typically commercial/ industrial roofs)	Low	0.3	0.2 (up to 0.8 where there is potential for metals to leach from the roof)	0.05
Commercial yard and delivery areas, non-residential car parking with frequent change (e.g. hospitals, retail) all roads except low traffic roads and trunk roads/motorways.	Medium	0.7	0.6	0.7
Sites with heavy pollution (haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites) sites where chemicals and fuels (other than domestic fuel oils) are to be delivered, handled, stored, used or manufactured, industrial sites, trunk roads and motorways.	High	0.8	0.8	0.9

Table 4l: CIRIA 753 Table 26.2 Pollution Hazard Indices

4.65 For a residential type development, roof water requires a very low treatment of 0.2 for total suspended solids, 0.2 for heavy metals and 0.05 for hydrocarbons, and run-off from low traffic roads such as cul-de-sacs and individual property driveways requires low treatment of 0.5 for total suspended solids, 0.4 for heavy metals and 0.4 for hydrocarbons.

4.66 To provide the correct level of treatment, an assessment needs to be made of the mitigation provided by each SuDS feature. Tables 26.3 and 26.4 of The SuDS Manual CIRIA document C753 (shown as Table 4m and Table 4n) is for discharges to surface waters and groundwater respectively. The tables indicate the treatment mitigation indices provided by each SuDS feature.

Type of SUDS component	Total suspended solids (TSS)	Metals	Hydro-carbons
Filter Strip	0.4	0.4	0.5
Filter Drain	0.4	0.4	0.4
Swale	0.5	0.6	0.6
Bio-retention system	0.8	0.8	0.8
Permeable pavement	0.7	0.6	0.7
Detention basin	0.5	0.5	0.6
Pond	0.7	0.7	0.5
Wetland	0.8	0.8	0.8
Proprietary treatment systems	These must demonstrate that they can address each of the contaminant types to acceptable levels for frequent events up to approximately the 1 in 1 year return period event, for inflow concentrations relevant to the contributing drainage area.		

Table 4m: CIRIA 753 Table 26.3 SuDS Mitigation Indices for discharges to surface waters.

Characteristics of the material overlying the proposed infiltration surface, through which the runoff percolates	Total suspended solids (TSS)	Metals	Hydro-carbons
A layer of dense vegetation underlain by a soil with good contaminant attenuation potential of at least 300 mm in depth	0.6	0.5	0.6
A soil with good contaminant attenuation potential of at least 300 mm in depth	0.4	0.3	0.3
Infiltration trench (where a suitable depth of filtration material is included that provides treatment, i.e. graded gravel with sufficient smaller particles but not single size coarse aggregate such as 20mm gravel) underlain by a soil with good contaminant attenuation potential of at least 300 mm in depth	0.4	0.4	0.4
Constructed permeable pavement (where a suitable filtration layer is included that provides treatment, and including a geotextile at the base separating the foundation from the subgrade) underlain by a soil with good contaminant attenuation potential of at least 300 mm in depth	0.7	0.6	0.7
Bioretention underlain by a soil with good contaminant attenuation potential of at least 300 mm in depth	0.8	0.8	0.8
Proprietary treatment systems	These must demonstrate that they can address each of the contaminant types to acceptable levels for frequent events up to approximately the 1 in 1 year return period event, for inflow concentrations relevant to the contributing drainage area.		

Table 4n: CIRIA 753 Table 26.4 SuDS Mitigation Indices for discharges to groundwater.

4.67 Where more than one mitigation feature is to be used, CIRIA guidance states that the total mitigation index shall be calculated as follows:

Total SUDS mitigation index = Mitigation Index 1 + 0.5 x Mitigation Index 2

4.68 Due to the need to provide wider sustainability benefits and view the development at a strategic level, SuDS will be implemented to passively treat run off from the development so as to have a positive impact on the surrounding natural environment.

4.69 The site will employ SuDS features, such as porous paving, and detention basins. These are widely accepted to be of high pollutant removal efficiency (CIRIA 609). This provides for one stage of treatment onsite. Coupled with this however, the unknown watercourse should also be seen as an additional stage of treatment as the sedimentation process is not limited to artificial drainage systems but is taken from the natural processes observed within the water cycle. This gives 2-3 stages of treatment, providing an extensive system by which to effectively decrease pollutant load within stormwater run-off.

4.70 As the site is not presently served by any means of storm water treatment mechanisms, by providing the afore mentioned SuDS within the proposed development it will be possible to maintain present water quality in the area and thus the development can be seen to be having no significant environmental impact in relation to water.

Implementation Proposals

4.71 The conceptual drainage proposals have been developed in a manner that will allow the site wide system to be designed to encourage passive treatment of discharged flows and to improve the water quality by removing the low-level silts, oils which could be attributed to track/parking area run off of this nature. Final design will provide for appropriate geometry and planting to maximise this benefit.

4.72 The storm water management features will be constructed and operational prior to the first use of the site, derived on a phase-by-phase requirement.

4.73 It has previously been the case that the functionality of the storm water management system would be ensured by ongoing maintenance, completed by the Local Authority, Drainage Authority, or a private maintenance company as appropriate. It is proposed that, for this development, a private maintenance company will be appointed to carry out the maintenance regime below in figure 4o.

4.74 It is usual for the following maintenance regime to be implemented:

Frequency	Operation
Post major storm events	Inspection and removal of debris.
Every two months	Grass mowing (growing season) & litter removal.
Annual	Weeding & vegetation maintenance. Minor swale clearance. Sweeping of permeable pavements.
2 years	Tree pruning.
5-10 years	Desilting of channels. Remove silt around inlet and outlet structures.
15-20 years	Major vegetation maintenance and watercourse channel works.

Table 4o: Framework maintenance of detention / retention system

4.75 The conceptual drainage masterplan proposals outlined in this report are indicative and will be subject to final drainage design and detailing. The storm water management system will be constructed before the start of any construction work and will be carried forward on a Phase by Phase basis. The specific details of each phase will be managed through Reserved Matters applications and will be subject to the approval of the LLFA. The surety of appropriate delivery of drainage features per phase can be delivered through Planning Condition(s) linked to this Planning Application.

Summary

4.76 A strategy for storm drainage at the site has been developed to meet both national and local policy. The above options outline the viability of the site to employ means of drainage to comply with NPPF guidance, together with the West Berkshire Council SFRA and other national and local guidance.

4.77 The development drainage system will manage storm water by way of a SUDS management train and ensure peak discharges from the developed land are reduced to circa 69% below the appraised baseline rates. The system will also provide improvements to the quality of water discharged from the development.

Objectives

4.78 The key objectives for the site drainage will be:

- Implementation of a sustainable drainage scheme in accordance with current national and local policy together with principals of good practice design.
- Control of peak discharges from the site to circa 69% below the baseline conditions.
- Development of storm water management proposals that improve water quality and biodiversity of the site.
- Implementation of the storm water management system prior to first occupation of dwellings.

5 Hydrology Appraisal of Proposed Valley Crossing

5.1 The development team have designed a roadway and valley crossing which spans the Country Park open space situated to the west of the development. The valley crossing will span over an ordinary watercourse which serves as one of many existing and natural storm water conveyance systems within the development extents.

5.2 It is critical to note that the proposed valley crossing location is sited at a position of the ordinary watercourse upstream of any development outfall connection. Therefore, only the baseflow of storm water from the catchment upstream of the valley crossing needs to be assessed to determine if there is any impact on the valley crossing structure atop the watercourse.

5.3 In order to present a robust assessment, peak flows from the ordinary watercourse were determined for 1 in 100 year, 1 in 100 year + 40% climate change (cc) and 1 in 1000 year storm event using the REFH2 (Revitalised Flood Hydrograph) method with catchment data obtained from FEH online. The following results were generated:

- For the 1 in 100 year the catchment has a baseflow of BFO (m3/s) of 0.04 with a peak flow of 1.49 m3/s.
- For the 1 in 100 + 40% cc year the catchment has a baseflow of BFO (m3/s) of 0.04 with a peak flow of 2.09 m3/s.
- For the 1 in 1000 year the catchment has a baseflow of BFO (m3/s) of 0.04 with a peak flow of 2.47 m3/s.

5.4 The cross section of the watercourse at the location of the valley crossing has been assessed utilising survey data and OS digital mapping. The cross section of the watercourse is able to support a flow of 5.97 m3/s before the existing banks would overtop.

5.5 Furthermore, the area of the proposed culvert beneath the valley crossing has been measured using accurate digital mapping tools, and the cross section proposed would be able to accommodate a flow of 11.60 m3/s.

5.6 In addition, the proposed emergency access and cycleway route goes through Flood Zone 1; therefore there is no drainage or flood risk issues associated with the emergency access and cycleway route.

5.7 Therefore, the culvert has a significantly robust factor of safety which is able to comfortably accommodate a 1 in 1000 year storm flow without overtopping the culvert.

Summary

5.8 The proposed roadway, valley crossing and culvert can be supported from a hydraulic perspective.

5.9 Peak storm flow conditions were modelled, with all falling comfortably below the possible threshold of what can pass through the culvert without overtopping/flooding.

6 Foul Drainage

Background

6.1 A copy of the Thames Water sewerage network records has been obtained to confirm adopted foul sewers service the existing residential development areas to the east, north and west of the site.

Design Criteria / Network Requirements

6.2 Peak design discharges have been calculated based on the current development criteria as described in Section 2 of this report and for the following:

Domestic peak = 4,000 litres / dwelling / day (peak) [(3)]

6.3 Assessed in accordance with SFA 7th Edition requirements, the development will have a design peak discharge of approximately 44.1 l/s.

Network Requirements / Options

6.4 Thames Water have completed a detailed Sewer Impact Study (copy provided within the Appendix) for the development, which at the time of consultation was based on a larger site quantum (*2,000 new residential properties, 2,850m2 of commercial space, two schools with a total of 1,108 pupils and an 80 bed care home).* Thames water undertook the assessment using a pumped rate of 44.1l/s.

6.5 As outlined within Section 2, the Thames Water study represents a worst case impact onto the existing sewer from the combined Sandleford Park development and the Sandleford Park West development.

6.6 The hydraulic model indicates that the existing foul network does not have available capacity downstream of the proposed development. As such, Thames Water have developed a solution to mitigate the predicted detriment following the connection of the proposed developments.

6.7 One indicative option has been developed by Thames Water to prevent the detrimental impact on the existing system. This option has been developed during a preliminary desktop investigation, using the hydraulic model only. The solution identified is intended to indicate the likely extent and magnitude and the network enhancement required to mitigate the predicted detriment. Following the latest publication of Ofwat's new charging rules in August 2017, the following changes will apply from April 2018: "*all offsite network reinforcement costs will no longer be charged directly to a developer in their connection charges*".

6.8 Following a change in legislation and OFWAT's guidance, which becomes enforceable from 1st April 2018, Thames Water will be responsible for all sewer upgrade works required to enable development works to take place. This means the previously developer funded upgrades on the adopting Water Authority's network is removed and is placed on the Water Authority itself.

6.9 Due to the size of the proposed development Thames Water require 2 permanent depth loggers to be installed to monitor the flows at the downstream point of the development site and also at the proposed connection point.

6.10 Based on this Planning Application, plus the addition of Sandleford Park West, this Thames Water assessment provides a mitigation solution which is over and above that which will be required. Therefore the Thames Water assessment is considered sufficiently robust for the purposes of Outline validation.

6.11 The onsite strategy for foul water comprises a series of new sewers which will service each phase of development and link to one another via strategic Trunk sewers. As the offsite connection point is proposed as being on London Road, which is higher in level than the site, a series of pumping stations will be required to convey foul water from the site to the connection point.

6.12 Sandleford Park West can be serviced in the same manner via new onsite foul sewers plus pumping regime. It is to be confirmed by Thames Water whether the connection point offsite for Sandleford Park West will be via:

a) a connection to Sandleford Park foul network (to the east of NWF), or
b) an independent connection out to a manhole in Warren Road (to the north of NWF) which will subsequently connect to Andover Road (to the west of NWF).

[3] Sewers for Adoption 7th Edition

6.13 The Thames Water Sewer Impact Study, which takes into account a higher quantum than what is required for the Sandleford Park development alone, offers a solution which would therefore potentially accommodate the foul flows from the NWF development. However, the NWF development would be responsible for seeking approval from Thames Water for their choice of foul water drainage strategy.

6.14 Consultation with Thames Water is currently ongoing to establish and confirm the most feasible solution for Sandleford Park development.

Treatment Requirements

6.15 Discussions with Thames Water have confirmed that the proposed development will ultimately discharge to Newbury Sewerage Treatment Works.

6.16 Water companies have a statutory obligation through the Water Industry Act 1991, 2003 et al, to provide capital investment in strategic treatment infrastructure to meet development growth. This investment planning is managed and regulated by OFWAT through the Asset Management Plan (AMP) process. The five yearly cyclical process requires that water companies allocate finances to a range of strategic projects to meet their statutory obligations.

6.17 Where development programming requirements necessitate the reinforcement of facilities ahead of allocation in an AMP period, mechanisms are available to ensure the infrastructure can be delivered in a timely fashion, to meet the development programme.

Implementation Proposals

6.18 The proposed drainage network across the site will be designed to current Sewers for Adoption 7th Edition Standards, employing a point of connection agreed with Thames Water. The system will be offered for the adoption of Thames Water under S104 of the Water Industry Act 1991.

Summary

6.19 A site drainage strategy with offsite connection has been developed that will meet with current regulatory requirements by discharging drainage to a sewerage network with improved capacity to accommodate the flows. This will be confirmed following conclusion of the consultation with Thames Water.

6.20 Once development is complete, the network conveying flows from the site will be adopted by Thames Water and be maintained as part of their statutory duties.

Objectives

6.21 The key development objectives required for the site drainage scheme are:

- Implementation of a drainage scheme to convey water to the local Thames Water network which is designed and maintained to an appropriate standard.

7 Summary

7.1 This FRA has identified no prohibitive engineering constraints in developing the proposed site for the proposed residential usage.

7.2 Assessment of fluvial flood risk shows the land, post development, to lie in Flood Zone 1 and hence be a preferable location for residential development when considered in the context of the NPPF Sequential Test. Assessment of other potential flooding mechanisms shows the land to have a low probability of flooding from overland flow, ground water and sewer flooding.

7.3 Means to discharge storm and foul water drainage have been established that comply with current guidance and requirements of the Water Authority.

7.4 Storm water discharged from development will be disposed of by way of SUDS measures to the existing watercourses within the site. Foul water will discharge to the existing network offsite, following improvement works established by Thames Water.

7.5 The site is fully able to comply with NPPF guidance together with associated local and national policy guidance.

8 Limitations

8.1 The conclusions and recommendations contained herein are limited to those given the general availability of background information and the planned usage of the site.

8.2 Third party information has been used in the preparation of this report, which Brookbanks Consulting Ltd, by necessity assumes is correct at the time of writing. While all reasonable checks have been made on data sources and the accuracy of data, Brookbanks Consulting Ltd accepts no liability for same.

8.3 The benefits of this report are provided solely to Bloor Homes Ltd & Sandleford Farm Partnership for the proposed development land at Sandleford Park, Newbury only.

8.4 Brookbanks Consulting Ltd excludes third party rights for the information contained in the report.

Appendix A

Original Drawing Size A1

Construction Design and Management (CDM)
Key Residual Risks

Contractors entering the site should gain permission from the relevant land owners and/or principle contractor working on site at the time of entry. Contractors shall be responsible for carrying out their own risk assessments and for liaising with the relevant services companies and authorities. Listed below are Site Specific key risks associated with the project.

1) Overhead and underground services
2) Street Lighting Cables
3) Working adjacent to water courses and flood plain
4) Soft ground conditions
5) Working adjacent to live highways and railway line
6) Unchartered services
7) Existing buildings with potential asbestos hazards

NOTES:

1. Do not scale from this drawing
2. All dimensions are in metres unless otherwise stated.
3. Brookbanks Consulting Ltd has prepared this drawing for the sole use of the client. The drawing may not be relied upon by any other party without the express agreement of the client and Brookbanks Consulting Ltd. Where any data supplied by the client or from other sources has been used, it has been assumed that the information is correct. No responsibility can be accepted by Brookbanks Consulting Ltd for inaccuracies in the data supplied by any other party. The drawing has been produced based on the assumption that all relevant information has been supplied by those bodies from whom it was requested.
4. No part of this drawing may be copied or duplicated without the express permission of Brookbanks Consulting.

KEY:

- Site Boundary
- Catchment Areas
- Illustrative SuDS Location
- Proposed Conveyance Channel
- Illustrative Surface Water Flow Direction
- Existing Woodland
- Existing Watercourse
- Proposed outfall
- Spring

-	First Issue	KM	SO	LW	12.12.18

Brookbanks

6150 Knights Court Solihull Parkway Birmingham B37 7WY
Tel (0121) 329 4330 Fax (0121) 329 4331
www.brookbanks.com

Bloor homes Ltd
& Sandleford Farm Partnership

Land at Sandleford Park
Newbury

Illustrative Surface Water Drainage Strategy

Status		Status Date
DRAFT		DEC 2018
Drawn	**Checked**	**Date**
KM	LW	12.12.18
Scale	**Number**	**Rev**
1:2500	10309-DR-02	-

0 50 100 150 200 250
METRES

UNTIL TECHNICAL APPROVAL HAS BEEN OBTAINED FROM THE RELEVANT LOCAL AUTHORITIES, IT SHOULD BE UNDERSTOOD THAT ALL DRAWINGS ARE ISSUED AS PRELIMINARY AND NOT FOR CONSTRUCTION. SHOULD THE CONTRACTOR COMMENCE SITE WORK PRIOR TO APPROVAL BEING GIVEN, IT IS ENTIRELY AT HIS OWN RISK.

Appendix B

IH 124 Mean Annual Flood

Input

Return Period (years)	100	Soil	0.450
Area (ha)	50.000	Urban	0.000
SAAR (mm)	800	Region Number	Region 6

Results	**l/s**
QBAR Rural	256.8
QBAR Urban	256.8
Q100 years	819.2
Q1 year	218.3
Q2 years	226.2
Q5 years	328.7
Q10 years	416.0
Q20 years	514.4
Q25 years	551.6
Q30 years	582.0
Q50 years	672.8
Q100 years	819.2
Q200 years	963.0
Q250 years	1009.2
Q1000 years	1325.1

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.396	0.396	21.5	1837.1	O K
30 min Summer	0.523	0.523	25.3	2460.1	O K
60 min Summer	0.657	0.657	28.8	3130.9	O K
120 min Summer	0.791	0.791	31.9	3818.9	O K
180 min Summer	0.864	0.864	33.5	4199.5	O K
240 min Summer	0.910	0.910	34.4	4442.1	O K
360 min Summer	0.971	0.971	35.6	4768.5	O K
480 min Summer	1.008	1.008	36.4	4972.5	O K
600 min Summer	1.032	1.032	36.8	5103.4	O K
720 min Summer	1.048	1.048	37.1	5186.1	O K
960 min Summer	1.061	1.061	37.4	5258.3	O K
1440 min Summer	1.067	1.067	37.5	5290.7	O K
2160 min Summer	1.061	1.061	37.4	5257.7	O K
2880 min Summer	1.044	1.044	37.0	5165.7	O K
4320 min Summer	0.995	0.995	36.1	4901.1	O K
5760 min Summer	0.940	0.940	35.0	4607.0	O K
7200 min Summer	0.887	0.887	33.9	4323.5	O K
8640 min Summer	0.838	0.838	32.9	4065.4	O K
10080 min Summer	0.793	0.793	31.9	3827.7	O K
15 min Winter	0.441	0.441	22.9	2058.3	O K
30 min Winter	0.583	0.583	26.9	2757.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	127.517	0.0	1275.3	27
30 min Summer	85.701	0.0	1645.7	41
60 min Summer	54.957	0.0	2795.1	70
120 min Summer	34.010	0.0	3420.6	130
180 min Summer	25.295	0.0	3763.9	188
240 min Summer	20.351	0.0	3980.2	248
360 min Summer	14.971	0.0	4260.0	366
480 min Summer	12.028	0.0	4436.8	486
600 min Summer	10.141	0.0	4556.0	604
720 min Summer	8.817	0.0	4637.3	722
960 min Summer	7.063	0.0	4725.0	954
1440 min Summer	5.157	0.0	4718.3	1166
2160 min Summer	3.757	0.0	7444.2	1544
2880 min Summer	2.997	0.0	7768.0	1960
4320 min Summer	2.176	0.0	7785.6	2772
5760 min Summer	1.731	0.0	9546.2	3584
7200 min Summer	1.449	0.0	9966.8	4400
8640 min Summer	1.255	0.0	10312.3	5192
10080 min Summer	1.111	0.0	10560.2	5952
15 min Winter	127.517	0.0	1417.8	26
30 min Winter	85.701	0.0	1788.2	41

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	0.732	0.732	30.6	3511.0	O K
120 min Winter	0.880	0.880	33.8	4286.2	O K
180 min Winter	0.961	0.961	35.4	4718.3	O K
240 min Winter	1.013	1.013	36.4	4995.1	O K
360 min Winter	1.082	1.082	37.8	5372.4	O K
480 min Winter	1.125	1.125	38.6	5613.2	O K
600 min Winter	1.154	1.154	39.1	5772.7	O K
720 min Winter	1.173	1.173	39.4	5879.4	O K
960 min Winter	1.193	1.193	39.8	5992.2	O K
1440 min Winter	1.195	1.195	39.8	6001.6	O K
2160 min Winter	1.181	1.181	39.6	5923.0	O K
2880 min Winter	1.153	1.153	39.1	5766.8	O K
4320 min Winter	1.078	1.078	37.7	5351.1	O K
5760 min Winter	0.997	0.997	36.1	4912.6	O K
7200 min Winter	0.920	0.920	34.6	4499.3	O K
8640 min Winter	0.851	0.851	33.2	4130.5	O K
10080 min Winter	0.787	0.787	31.8	3798.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	54.957	0.0	3120.4	70
120 min Winter	34.010	0.0	3790.7	128
180 min Winter	25.295	0.0	4141.5	186
240 min Winter	20.351	0.0	4353.6	244
360 min Winter	14.971	0.0	4637.0	360
480 min Winter	12.028	0.0	4817.6	476
600 min Winter	10.141	0.0	4938.1	590
720 min Winter	8.817	0.0	5019.4	704
960 min Winter	7.063	0.0	5103.9	924
1440 min Winter	5.157	0.0	5085.0	1328
2160 min Winter	3.757	0.0	8287.8	1648
2880 min Winter	2.997	0.0	8587.2	2108
4320 min Winter	2.176	0.0	8505.8	2992
5760 min Winter	1.731	0.0	10697.8	3864
7200 min Winter	1.449	0.0	11167.9	4688
8640 min Winter	1.255	0.0	11552.1	5528
10080 min Winter	1.111	0.0	11819.8	6272

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.400	Shortest Storm (mins)	15
Ratio R	0.350	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 7.760

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	2.587	4	8	2.587	8	12	2.587

Model Details

Storage is Online Cover Level (m) 1.500

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	4460.0	0.400	4829.0	0.800	5212.8	1.200	5611.2
0.100	4550.9	0.500	4923.6	0.900	5311.0	1.300	5713.1
0.200	4642.7	0.600	5019.1	1.000	5410.2	1.400	5816.0
0.300	4735.4	0.700	5115.5	1.100	5510.3	1.500	5919.7

Orifice Outflow Control

Diameter (m) 0.134 Discharge Coefficient 0.600 Invert Level (m) 0.000

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.408	0.408	13.2	1100.2	O K
30 min Summer	0.537	0.537	15.4	1473.2	O K
60 min Summer	0.672	0.672	17.4	1874.6	O K
120 min Summer	0.805	0.805	19.2	2285.5	O K
180 min Summer	0.877	0.877	20.1	2512.3	O K
240 min Summer	0.922	0.922	20.7	2656.4	O K
360 min Summer	0.982	0.982	21.4	2849.9	O K
480 min Summer	1.019	1.019	21.8	2970.1	O K
600 min Summer	1.042	1.042	22.0	3046.8	O K
720 min Summer	1.057	1.057	22.2	3094.7	O K
960 min Summer	1.069	1.069	22.3	3134.9	O K
1440 min Summer	1.073	1.073	22.4	3148.1	O K
2160 min Summer	1.064	1.064	22.3	3120.5	O K
2880 min Summer	1.046	1.046	22.1	3059.1	O K
4320 min Summer	0.995	0.995	21.5	2891.5	O K
5760 min Summer	0.939	0.939	20.9	2709.6	O K
7200 min Summer	0.885	0.885	20.2	2536.7	O K
8640 min Summer	0.836	0.836	19.6	2380.5	O K
10080 min Summer	0.790	0.790	19.0	2237.3	O K
15 min Winter	0.454	0.454	14.1	1232.7	O K
30 min Winter	0.598	0.598	16.4	1651.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	127.517	0.0	807.7	27
30 min Summer	85.701	0.0	1011.8	41
60 min Summer	54.957	0.0	1726.5	70
120 min Summer	34.010	0.0	2101.3	130
180 min Summer	25.295	0.0	2300.4	188
240 min Summer	20.351	0.0	2421.8	248
360 min Summer	14.971	0.0	2584.1	366
480 min Summer	12.028	0.0	2688.1	486
600 min Summer	10.141	0.0	2758.2	604
720 min Summer	8.817	0.0	2805.9	722
960 min Summer	7.063	0.0	2857.0	954
1440 min Summer	5.157	0.0	2852.2	1168
2160 min Summer	3.757	0.0	4516.9	1544
2880 min Summer	2.997	0.0	4710.2	1964
4320 min Summer	2.176	0.0	4708.7	2772
5760 min Summer	1.731	0.0	5745.8	3584
7200 min Summer	1.449	0.0	6003.1	4400
8640 min Summer	1.255	0.0	6217.6	5192
10080 min Summer	1.111	0.0	6378.4	5952
15 min Winter	127.517	0.0	887.2	26
30 min Winter	85.701	0.0	1095.2	41

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	0.746	0.746	18.5	2102.4	O K
120 min Winter	0.894	0.894	20.3	2565.8	O K
180 min Winter	0.974	0.974	21.3	2823.6	O K
240 min Winter	1.025	1.025	21.8	2988.5	O K
360 min Winter	1.092	1.092	22.6	3212.8	O K
480 min Winter	1.135	1.135	23.0	3355.4	O K
600 min Winter	1.162	1.162	23.3	3449.5	O K
720 min Winter	1.181	1.181	23.5	3512.1	O K
960 min Winter	1.200	1.200	23.7	3577.1	O K
1440 min Winter	1.200	1.200	23.7	3578.2	Flood Risk
2160 min Winter	1.184	1.184	23.6	3523.4	O K
2880 min Winter	1.155	1.155	23.3	3424.4	O K
4320 min Winter	1.078	1.078	22.4	3167.0	O K
5760 min Winter	0.997	0.997	21.5	2898.6	O K
7200 min Winter	0.920	0.920	20.6	2647.4	O K
8640 min Winter	0.850	0.850	19.8	2424.4	O K
10080 min Winter	0.786	0.786	19.0	2224.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	54.957	0.0	1922.9	70
120 min Winter	34.010	0.0	2316.9	128
180 min Winter	25.295	0.0	2515.1	186
240 min Winter	20.351	0.0	2639.3	244
360 min Winter	14.971	0.0	2805.9	360
480 min Winter	12.028	0.0	2911.8	476
600 min Winter	10.141	0.0	2982.3	590
720 min Winter	8.817	0.0	3029.6	704
960 min Winter	7.063	0.0	3078.4	924
1440 min Winter	5.157	0.0	3065.8	1328
2160 min Winter	3.757	0.0	5021.9	1652
2880 min Winter	2.997	0.0	5187.6	2112
4320 min Winter	2.176	0.0	5134.5	3024
5760 min Winter	1.731	0.0	6437.4	3864
7200 min Winter	1.449	0.0	6724.9	4688
8640 min Winter	1.255	0.0	6963.6	5536
10080 min Winter	1.111	0.0	7136.8	6344

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.400	Shortest Storm (mins)	15
Ratio R	0.350	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 4.650

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	1.550	4	8	1.550	8	12	1.550

Model Details

Storage is Online Cover Level (m) 1.500

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	2558.4	0.400	2833.4	0.800	3122.5	1.200	3425.7
0.100	2625.8	0.500	2904.4	0.900	3197.0	1.300	3503.7
0.200	2694.1	0.600	2976.2	1.000	3272.4	1.400	3582.5
0.300	2763.3	0.700	3048.9	1.100	3348.6	1.500	3662.3

Orifice Outflow Control

Diameter (m) 0.103 Discharge Coefficient 0.600 Invert Level (m) 0.000

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.410	0.410	10.7	889.5	O K
30 min Summer	0.539	0.539	12.4	1191.2	O K
60 min Summer	0.672	0.672	14.0	1515.7	O K
120 min Summer	0.805	0.805	15.4	1848.0	O K
180 min Summer	0.876	0.876	16.1	2031.5	O K
240 min Summer	0.920	0.920	16.5	2148.2	O K
360 min Summer	0.980	0.980	17.1	2305.0	O K
480 min Summer	1.016	1.016	17.4	2402.6	O K
600 min Summer	1.039	1.039	17.6	2465.1	O K
720 min Summer	1.053	1.053	17.7	2504.3	O K
960 min Summer	1.066	1.066	17.8	2537.8	O K
1440 min Summer	1.069	1.069	17.9	2547.3	O K
2160 min Summer	1.061	1.061	17.8	2524.0	O K
2880 min Summer	1.042	1.042	17.6	2474.1	O K
4320 min Summer	0.992	0.992	17.2	2338.1	O K
5760 min Summer	0.937	0.937	16.7	2191.0	O K
7200 min Summer	0.883	0.883	16.2	2051.3	O K
8640 min Summer	0.835	0.835	15.7	1925.1	O K
10080 min Summer	0.790	0.790	15.2	1809.3	O K
15 min Winter	0.456	0.456	11.3	996.7	O K
30 min Winter	0.599	0.599	13.1	1335.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	127.517	0.0	659.4	27
30 min Summer	85.701	0.0	818.3	41
60 min Summer	54.957	0.0	1406.2	70
120 min Summer	34.010	0.0	1705.4	130
180 min Summer	25.295	0.0	1860.2	188
240 min Summer	20.351	0.0	1955.4	248
360 min Summer	14.971	0.0	2083.8	366
480 min Summer	12.028	0.0	2165.8	486
600 min Summer	10.141	0.0	2220.9	604
720 min Summer	8.817	0.0	2258.2	722
960 min Summer	7.063	0.0	2297.7	960
1440 min Summer	5.157	0.0	2292.1	1176
2160 min Summer	3.757	0.0	3660.3	1556
2880 min Summer	2.997	0.0	3808.7	1964
4320 min Summer	2.176	0.0	3795.8	2776
5760 min Summer	1.731	0.0	4651.6	3624
7200 min Summer	1.449	0.0	4860.6	4400
8640 min Summer	1.255	0.0	5035.5	5192
10080 min Summer	1.111	0.0	5167.5	5960
15 min Winter	127.517	0.0	720.0	26
30 min Winter	85.701	0.0	884.5	41

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	0.746	0.746	14.8	1700.0	O K
120 min Winter	0.892	0.892	16.3	2074.8	O K
180 min Winter	0.972	0.972	17.0	2283.5	O K
240 min Winter	1.021	1.021	17.4	2417.0	O K
360 min Winter	1.088	1.088	18.0	2598.9	O K
480 min Winter	1.130	1.130	18.4	2714.7	O K
600 min Winter	1.157	1.157	18.6	2791.4	O K
720 min Winter	1.176	1.176	18.8	2842.6	O K
960 min Winter	1.195	1.195	18.9	2896.3	O K
1440 min Winter	1.196	1.196	18.9	2898.9	O K
2160 min Winter	1.179	1.179	18.8	2853.1	O K
2880 min Winter	1.151	1.151	18.6	2773.6	O K
4320 min Winter	1.076	1.076	17.9	2566.6	O K
5760 min Winter	0.996	0.996	17.2	2349.6	O K
7200 min Winter	0.920	0.920	16.5	2146.3	O K
8640 min Winter	0.851	0.851	15.8	1966.2	O K
10080 min Winter	0.788	0.788	15.2	1804.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	54.957	0.0	1563.9	70
120 min Winter	34.010	0.0	1873.8	128
180 min Winter	25.295	0.0	2029.7	186
240 min Winter	20.351	0.0	2128.0	244
360 min Winter	14.971	0.0	2259.6	360
480 min Winter	12.028	0.0	2342.9	476
600 min Winter	10.141	0.0	2398.2	590
720 min Winter	8.817	0.0	2435.1	704
960 min Winter	7.063	0.0	2472.7	926
1440 min Winter	5.157	0.0	2460.7	1334
2160 min Winter	3.757	0.0	4063.5	1652
2880 min Winter	2.997	0.0	4185.4	2112
4320 min Winter	2.176	0.0	4134.1	3028
5760 min Winter	1.731	0.0	5211.0	3872
7200 min Winter	1.449	0.0	5444.6	4696
8640 min Winter	1.255	0.0	5639.0	5536
10080 min Winter	1.111	0.0	5779.9	6352

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.400	Shortest Storm (mins)	15
Ratio R	0.350	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 3.760

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	1.253	4	8	1.253	8	12	1.253

Model Details

Storage is Online Cover Level (m) 1.500

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	2047.2	0.400	2292.6	0.800	2551.9	1.200	2825.1
0.100	2107.2	0.500	2356.1	0.900	2618.9	1.300	2895.6
0.200	2168.1	0.600	2420.5	1.000	2686.8	1.400	2966.9
0.300	2229.9	0.700	2485.8	1.100	2755.5	1.500	3039.1

Orifice Outflow Control

Diameter (m) 0.092 Discharge Coefficient 0.600 Invert Level (m) 0.000

Appendix C

GEG | Geo Environmental Group

Geotechnical, Environmental & Ecological Consultants

GEG House, 17 Graham Road, Malvern, WR14 2HR
Tel. 01684 212526 Fax 01684 576917 www.g-eg.co.uk

INFILTRATION TESTING REPORT

SANDLEFORD PARK
LAND SOUTH OF MONKS LANE
NEWBURY, BERKSHIRE
RG14 7FN

NOVEMBER 2014

Prepared for:

Brookbanks Consulting
BLOOR HOMES

Registered Company - GEG Ltd
Registered in England No 6469985
Registered Office: Granta Lodge, 71 Graham Rd, Malvern, WR14 2JS

REPORT TITLE:	**INFILTRATION TESTING REPORT**
Site Address:	Sandleford Park Monks Lane Newbury Berkshire RG14 7FN
Performed By: Geo Environmental Group GEG House 17 Graham Road Malvern WR14 2HR	**On Behalf Of:** Bloor Homes Ltd c/o Brookbanks Consulting 6150 Knights Court Solihull Parkway Birmingham B37 7WY
Written by:	Matthew Perks *BSc(Hons) MSc FGS* *Senior Engineer*
Checked by:	Mark Rawlings *BSc(Hons) MSc FGS CGeol* *Associate Director*
Approved by:	Anthony Marriott *BSc(Hons) MRSC MIEnvSc FGS* *Managing Director*
Project Reference:	GEG-14-352
Report Reference:	GEG-14-352/IT
Issue Status:	FINAL
Date:	4th November 2014

TABLE OF CONTENTS *PAGE*

Title *Appendix*

EXECUTIVE SUMMARY

Current Site Status

The site lies to the south of Monks Lane at Sandleford Park on the southern edge of Newbury, Berkshire, at the approximate National Grid Reference 446916E, 164799N.

The site which is approximately 100 Ha in area, comprises a mixture of agricultural arable land, grassed fields and woodland over several fields with internal site boundaries.

Geology and Water Infiltration Properties

The solid geology of the London Clay Formation which varies between predominantly 'sand' over the majority of the site with a tongue of 'clay, silt and sand' exposed along the valley sides in the southern section of the site. The solid geology is overlain by superficial deposits of the Silchester Gravel Member over the majority of the northern and eastern central sections of the site, conjectured as being absent towards the valley bases.

Intrusive Investigation

The intrusive investigation was undertaken on the 9th to 12th and 15th September 2014 and comprised the excavation of 18 No. infiltration test pits to depths ranging from 1.25m to 4.00m bgl targeting the most permeable strata present in each case.

Ground Conditions

Natural topsoil was encountered across the site to depths of 0.30m to 0.40m.

Underlying the topsoil, the Silchester Sand & Gravel Member was encountered across the site to depths of 0.60m to 2.80m. It typically comprised loose to medium dense clayey occasionally gravelly SAND, clayey SAND & GRAVEL or sandy GRAVEL with occasional cobbles and soft to stiff slightly sandy slightly gravelly to gravelly CLAY.

The anticipated sand and limited gravel of the London Clay Formation (Sand) was in general not specifically identified on site probably due to the difficulty in differentiation from the Silchester Sand & Gravel Member. However, medium dense orange brown SAND with occasional grey silt pockets was encountered at 3 No. locations from depths of 0.90m to 1.50m and may comprise this stratum.

Cohesive soils of the weathered London Clay Formation were encountered underlying the superficial deposits in 6 No. of the trial pits from depths of 0.60m to 2.80m.

Potentially naturally re-worked London Clay was found in 3 No. locations from depths of 0.70m to 2.30m.

Infiltration Tests

A total of 18 No. infiltration tests were undertaken in the 18 No. trial pits.

Soakaway Calculations

The infiltration tests undertaken recorded little or no infiltration. Consequently, infiltration rates could not be calculated over the majority of the site with the exception of TP07 which, using extrapolated data, resulted in an infiltration rate of 2.71×10^{-6}.

Recommendations The infiltration tests undertaken indicated that the soils were of relatively low permeability.

Locally, an infiltration rate of 2.71×10^{-6} was obtained from TP07 within the Silchester Sand & Gravel Member based on extrapolated data.

In view of the above, at this stage it is considered that the site is unsuitable for soakaway drainage. However, locally there is a possibility that limited soakaway drainage may be possible such as in the vicinity of TP07. Therefore, further assessment may be prudent targeting the thicker granular areas once the detailed proposed residential layout is finalised.

This executive summary is intended to provide an outline of the site assessment in relation to ground infiltration rates. It does not provide a definitive analysis of the information obtained.

1. INTRODUCTION

1.1 General

Geo Environmental Group (GEG) were commissioned by Brookbanks Consulting Limited (Brookbanks) on behalf of Bloor Homes Ltd, to undertake infiltration testing at the site known as 'Sandleford Park, Newbury' for the purpose of determining infiltration rates of the strata and the suitability for soakaway drainage.

1.2 Available Information

The following drawing was supplied by Brookbanks:

- 'Site Investigation Location Plan' on behalf of Bloor Homes Ltd, Brookbanks Consulting Ltd, Drawing No. 10309-SI-01, dated 4th August 2014.
- Various utility company service drawings.

1.3 Proposed Site Usage

The site is currently being considered for residential development.

1.4 Scope

The works performed by GEG included:

- Trial pitting and infiltration testing.
- Recommendations for suitability of the site for soakaway drainage.
- Provision of a report documenting the above.

Limitations to the scope of the report are outlined in Section 7.

2. SITE SETTING

2.1 Site Location

The site lies to the south of Monks Lane at Sandleford Park on the southern edge of Newbury, Berkshire, at the approximate National Grid Reference 446916E, 164799N.

A section of the 1:25,000 Ordnance Survey (OS) map identifying the site location is shown in Figure 1 of Appendix A. The site layout plan is presented in Figure 2 (Appendix A) and a photographic record is provided in Appendix B.

2.2 Site Description

The site which is approximately 100 Ha in area, comprises a mixture of agricultural arable land, grassed fields and woodland (including Crook's Copse, High Wood, Slockett's Copse) over several fields with internal site boundaries. The eastern section of the site was not visited but contains two small ponds in the easternmost section adjacent to the A339. The site is intersected by two minor drains/watercourses, one of which flows southwards from Crook's Copse to converge with the second eastward flowing watercourse that traverses from the south of Slockett's Copse before turning southwards towards Sandleford Place south of the site. The topography is dictated by the watercourses which fall towards the base of two main valleys with slightly to moderately sloping sides.

3. GEOLOGY & HYDROGEOLOGY

3.1 Published Geology

British Geological Survey digital mapping indicates that the site is underlain by the solid geology of the London Clay Formation which varies between predominantly 'sand' over the majority of the site with a tongue of 'clay, silt and sand' exposed along the valley sides in the southern section of the site.

In the Newbury area the London Clay Formation includes relatively thick beds of sand and some gravels within the usual clays (described as blue grey or grey brown silty clay, clayey silt and sandy clay). The formation also includes a few thin beds of shells and fine sand partings or pockets of sand, which commonly increase towards the base and towards the top of the formation.

The solid geology is overlain by superficial deposits of the Silchester Gravel Member over the majority of the northern and eastern central sections of the site, conjectured as being absent towards the valley bases. The Silchester Gravel Member is described as gravel which is variably clayey and sandy.

3.2 Hydrogeology

Environment Agency data indicates that the solid geology of the London Clay Formation consisting of sand is regarded as a Secondary A Aquifer and the London Clay Formation consisting of clay silt and sand as Unproductive Strata.

The superficial deposits are also characterised as Secondary A Aquifer.

Unproductive Strata - are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.

Secondary A Aquifers are defined as permeable layers capable of supporting water supplies at a local rather than a strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.

3.3 Potential Water Infiltration Properties of the Strata

In terms of water infiltration, the strata of the Silchester Gravel Member are considered potentially relatively permeable. The extensive sand beds of the London Clay Formation, indicated over the majority of the site are potentially suitable for soakaway drainage subject to the depth of groundwater.

4. INTRUSIVE INVESTIGATION

The following section outlines the scope of the intrusive investigation undertaken by GEG and details the ground conditions encountered and the infiltration testing undertaken.

4.1 Scope of Works

The intrusive investigation was undertaken on the 9th to 12th and 15th September 2014 and comprised the excavation of 18 No. infiltration test pits (TP01 to TP17, TP05A) at the locations determined by Brookbanks (as shown on Figure 2) to depths ranging from 1.25m to 4.00m bgl targeting the most permeable strata present in each case.

A further trial pit (TP07A) was undertaken in order to confirm the ground conditions in relation to TP07.

All works were carried out in accordance with current British Standard guidance (BS: 5930 and BS: 10175) and infiltration testing in general accordance with BRE Digest 365 (Soakaway Design).

The ground conditions were logged by an experienced GEG geo-environmental engineer. The strata encountered, groundwater levels / seepages, stability of excavations and depths of sampling are recorded on the trial pit logs presented in Appendix C.

4.1.1 Limitations of Intrusive Investigation

There were no limitations to access across the site for the duration of the intrusive investigation. However, according to the Brookbanks Specification, only the northern and south western sections of the site were to be investigated.

4.2 Strata Encountered

The ground conditions encountered are described below and broadly confirmed the published geology.

4.2.1 Topsoil

Natural topsoil was encountered across the site to depths of 0.30m to 0.40m and typically comprised soft sandy slightly gravelly occasionally gravelly CLAY with occasional rootlets or locally loose slightly clayey gravelly SAND (TP03 and TP04).

4.2.2 Superficial Deposits

Underlying the topsoil, the Silchester Sand & Gravel Member was encountered across the site to depths of 0.60m to 2.80m. It typically comprised loose to medium dense clayey occasionally gravelly SAND, clayey SAND & GRAVEL or sandy GRAVEL with occasional cobbles and soft to stiff slightly sandy slightly gravelly to gravelly CLAY. The gravel was generally quartzite and chert.

4.2.3 *Solid Geology*

The anticipated sand and limited gravel of the London Clay Formation (Sand) was in general not specifically identified on site probably due to the difficulty in differentiation from the Silchester Sand & Gravel Member (although it was anticipated that a marked colour change would be present). However, the medium dense orange brown SAND with occasional grey silt pockets encountered in TP12, TP13 and TP14 from depths of 0.90m, 1.00m and 1.50m may comprise this stratum.

Cohesive soils of the weathered London Clay Formation were encountered underlying the superficial deposits in 6 No. of the trial pits from depths of 0.60m to 2.80m. The strata typically comprised firm occasionally stiff grey CLAY with occasional silty pockets.

Potentially naturally re-worked London Clay was found in TP06, TP07A and TP09 from depths of 2.30m, 1.80m and 0.70m respectively as firm orange brown CLAY with grey silt pockets.

4.2.4 *Groundwater*

Groundwater was not encountered in any of the trial pits during the intrusive investigation. It should be noted that groundwater levels may vary due to seasonal and other effects.

4.3 Infiltration Tests

A total of 18 No. infiltration tests were undertaken in the 18 No. trial pits (TP01-TP17, TP05A) which were excavated to depths ranging from 1.25m to 4.00m bgl. The tests were undertaken in accordance with BRE Digest 365.

Clean water was dispensed from a bowser at a rapid rate to fill each excavation as quickly as possible to the proposed depth of the invert levels and/or the most permeable strata. The excavations took less than 5 minutes to fill to their maximum capacity. Each test pit was filled to give a head of water of approximately 1.00m.

Measurements were then taken of the fall of water at suitable time increments to allow the infiltration rate to be calculated from the time taken for the water level to drop from 75% to 25% effective depth (where possible). If there was sufficient time, the tests were repeated a maximum of three times in accordance with BRE Digest 365.

On completion of the measurements, the infiltration pits were backfilled with arisings.

4.4 Soakaway Calculations

The water level measurements from the infiltration tests are tabulated and graphically depicted on Figures D-1 to D-18 in Appendix D.

The effective depths reached during the tests and associated times are summarised in Table 1 below.

Table 1. Infiltration Test Results

Location	Test No.	Strata*	Effective Depth Reached (%)	Time (mins)	Infiltration Rate (m/s)
TP01	1	SGM	60	426	N/A
TP02	1	LC	103	282	N/A
TP03	1	SGM	76	392	N/A
TP04	1	SGM	85	353	N/A
TP05	1	LC	101	245	N/A
TP05A	1	SGM	74	423	N/A
TP06	1	LC	97	293	N/A
TP07*	1	SGM	25	800	2.71×10^{-6}
TP08	1	SGM	85	340	N/A
TP09	1	LC	86	384	N/A
TP10	1	SGM	87	347	N/A
TP11	1	SGM	89	383	N/A
TP12	1	SGM	86	381	N/A
TP13	1	SGM	63	381	N/A
TP14	1	SGM	89	395	N/A
TP15	1	SGM	97	243	N/A
TP16	1	SGM	68	420	N/A
TP17	1	SGM	95	304	N/A

*Based on extrapolated data.
SGM=Silchester Sand & Gravel Member; LC=London Clay

The infiltration tests undertaken recorded little or no infiltration. Consequently, infiltration rates could not be calculated over the majority of the site with the exception of TP07 which, using extrapolated data, resulted in an infiltration rate of 2.71×10^{-6}.

The results therefore indicated that the soils were typically of low permeability.

Recommendations for soakaways are presented in Section 5.1.

5. CONCLUSIONS & RECOMMENDATIONS

5.1 Soakaway Recommendations

The infiltration tests undertaken indicated that the soils were of relatively low permeability.

Locally, an infiltration rate of 2.71×10^{-6} was obtained from TP07 within the Silchester Sand & Gravel Member based on extrapolated data.

In view of the above, at this stage it is considered that the site is unsuitable for soakaway drainage. However, locally there is a possibility that limited soakaway drainage may be possible such as in the vicinity of TP07. Therefore, further assessment may be prudent targeting the thicker granular areas once the detailed proposed residential layout is finalised.

6. REFERENCES

1. British Standard Institute (1990) BS: 1377 Parts 1-9. Methods of Tests for Soils for Civil Engineering Purposes.

2. British Standard Institute (1999) BS: 5930 Code of Practice for Site Investigations. BSI, London.

3. BRE Digest 365 (September 1991) Soakaway Design.

7. LIMITATIONS

As with all intrusive site investigations, there is a possibility that there are local variations in ground conditions not identified by the current investigation.

The conclusions and recommendations stated herein are based on information available at the time of production. These may not necessarily apply if the site is to be utilised for a more or less sensitive purpose in the future, or if operational procedures or management alter over time.

GEG maintain intellectual copyright of the contents of this report and grant exclusive use of the material contained herein to the client, the client's agents, the client's respective sub-contractors and the specific local authority. No unauthorised distribution shall be made to any third parties without the prior consent of both GEG and the Client.

GEG shall not be liable by reason of any representation (unless fraudulent), or any implied warranty, condition or other term, or any duty at common law for any loss of profit or any indirect, special or consequential loss, damage, costs, expenses or other claims (whether caused by the negligence of the Supplier, its servants, sub-contractors or agents or otherwise) which arise out of or in connection with the provision of the Specified Service or their use by the Client.

APPENDIX A

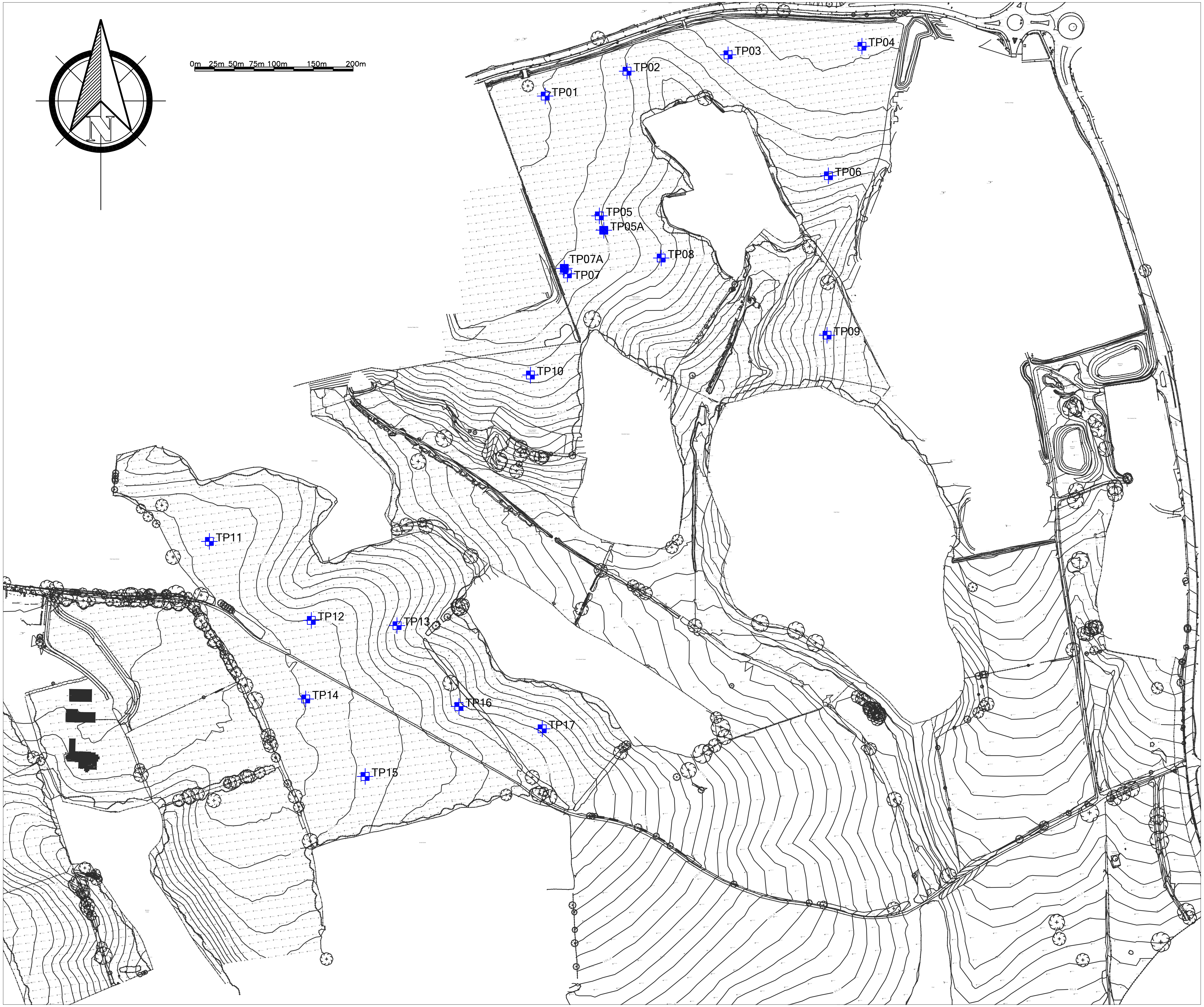
FIGURES AND PLANS

SITE LOCATION

TITLE: FIGURE 1 : SITE LOCATION PLAN	
SITE: SANDLEFORD PARK, NEWBURY	
CLIENT: BLOOR HOMES LTD/ BROOKBANKS CONSULTING LTD	
PROJECT No.: GEG-14-352	**DRAWN/CHECKED:** MP / MR
SCALE: NTS	**DATE:** 15/10/14

Geo Environmental Group

GEG House
17 Graham Road
Malvern, WR14 2HR
Tel. 01684 212526
Fax 01684 576917
admin@g-eg.co.uk
www.g-eg.co.uk



LEGEND

TP01 GEG INFILTRATION TEST LOCATION

TP05A GEG TRIAL PIT LOCATION

NOTES:

1. BASE IMAGE PROVIDED BY BROOKBANKS CONSULTING.

2. DRAWING TO BE USED IN CONJUCTION WITH GEG REPORT GEG-14-352/IT

JOB NUMBER				
GEG-14-352				
PROJECT TITLE: SANDLEFORD PARK, NEWBURY			Geo Environmental Group	
DRAWING TITLE: FIGURE 2: EXPLORATORY HOLE LOCATION PLAN			DRAWING NO.: GEG-14-352_001	
CLIENT: BROOKBANKS CONSULTING	REVISION NO.: A	ORIGINAL SIZE: A3	DIMENSIONS: METRES	SCALE: AS SHOWN
DRAWN BY: FT	CHECKED BY: MP	APPROVED BY: MR	ISSUE: FINAL ISSUE	DATE: 10-11-14

APPENDIX B

PHOTOGRAPHIC RECORD

		Geo Environmental Group Geotechnical, Environmental & Ecological Consultants **Geo Environmental Group** **GEG House** **17 Graham Road** **Malvern** **WR14 2HR**
Photo 1: Excavation of trial pit TP01.	**Photo 2:** Arisings from trial pit TP01.	**Client:** **Brookbanks Consulting Ltd /** **Bloor Homes Ltd**
		**Project:** **Sandleford Park, Newbury** **Project No.:** **GEG-14-352**
Photo 3: Excavation of trial pit TP02.	**Photo 4:** Arisings from trial pit TP02.	

		Geo Environmental Group Geotechnical, Environmental & Ecological Consultants **Geo Environmental Group** **GEG House** **17 Graham Road** **Malvern** **WR14 2HR**
Photo 5: Excavation of trial pit TP03.	**Photo 6:** Arisings from trial pit TP03.	**Client:**
	 	**Brookbanks Consulting Ltd / Bloor Homes Ltd** **Project:** **Sandleford Park, Newbury** **Project No.:** **GEG-14-352**
Photo 7: Excavation of trial pit TP04.	**Photo 8:** Arisings from trial pit TP04.	

	 	Geo Environmental Group Geotechnical, Environmental & Ecological Consultants **Geo Environmental Group** **GEG House** **17 Graham Road** **Malvern** **WR14 2HR**
Photo 9: Excavation of trial pit TP05.	**Photo 10:** Arisings from trial pit TP05.	**Client:**
		**Brookbanks Consulting Ltd /** **Bloor Homes Ltd** **Project:** **Sandleford Park, Newbury** **Project No.:** **GEG-14-352**
Photo 11: Excavation of trial pit TP05A.	**Photo 12:** Arisings from trial pit TP05A.	

Photo 13: Excavation of trial pit TP06.

Photo 14: Arisings from trial pit TP06.

Photo 15: Excavation of trial pit TP07.

Photo 16: Arisings from trial pit TP07.

Geo Environmental Group
Geotechnical, Environmental & Ecological Consultants

Geo Environmental Group
GEG House
17 Graham Road
Malvern
WR14 2HR

Client:

Brookbanks Consulting Ltd / Bloor Homes Ltd

Project:

Sandleford Park, Newbury

Project No.:

GEG-14-352

Photo 17: Excavation of trial pit TP07A.

Photo 18: Arisings from trial pit TP07A.

Photo 19: Excavation of trial pit TP08.

Photo 20: Arisings from trial pit TP08.

Geo Environmental Group
Geotechnical, Environmental &
Ecological Consultants

Geo Environmental Group
GEG House
17 Graham Road
Malvern
WR14 2HR

Client:

Brookbanks Consulting Ltd / Bloor Homes Ltd

Project:

Sandleford Park, Newbury

Project No.:

GEG-14-352

Photo 21: Excavation of trial pit TP09.

Photo 22: Arisings from trial pit TP09.

Photo 23: Excavation of trial pit TP10.

Photo 24: Arisings from trial pit TP10.

Geo Environmental Group
Geotechnical, Environmental &
Ecological Consultants

Geo Environmental Group
GEG House
17 Graham Road
Malvern
WR14 2HR

Client:

Brookbanks Consulting Ltd / Bloor Homes Ltd

Project:

Sandleford Park, Newbury

Project No.:

GEG-14-352

		Geo Environmental Group Geotechnical, Environmental & Ecological Consultants **Geo Environmental Group** **GEG House** **17 Graham Road** **Malvern** **WR14 2HR**
Photo 25: Excavation of trial pit TP11.	**Photo 26:** Arisings from trial pit TP11.	**Client:** **Brookbanks Consulting Ltd /** **Bloor Homes Ltd**
		**Project:** **Sandleford Park, Newbury** **Project No.:** **GEG-14-352**
Photo 27: Excavation of trial pit TP12.	**Photo 28:** Arisings from trial pit TP12.	

Photo 29: Excavation of trial pit TP13.

Photo 30: Arisings from trial pit TP13.

Photo 31: Excavation of trial pit TP14.

Photo 32: Arisings from trial pit TP14.

Geo Environmental Group
Geotechnical, Environmental & Ecological Consultants

Geo Environmental Group
GEG House
17 Graham Road
Malvern
WR14 2HR

Client:

Brookbanks Consulting Ltd / Bloor Homes Ltd

Project:

Sandleford Park, Newbury

Project No.:

GEG-14-352

Photo 33: Excavation of trial pit TP15.

Photo 34: Arisings from trial pit TP15.

Photo 35: Excavation of trial pit TP16.

Photo 36: Arisings from trial pit TP16.

Geo Environmental Group
Geotechnical, Environmental &
Ecological Consultants

Geo Environmental Group
GEG House
17 Graham Road
Malvern
WR14 2HR

Client:

Brookbanks Consulting Ltd / Bloor Homes Ltd

Project:

Sandleford Park, Newbury

Project No.:

GEG-14-352

		Geo Environmental Group Geotechnical, Environmental & Ecological Consultants **Geo Environmental Group** **GEG House** **17 Graham Road** **Malvern** **WR14 2HR**
Photo 37: Excavation of trial pit TP17.	**Photo 38:** Arisings from trial pit TP17.	**Client:**
		Brookbanks Consulting Ltd / **Bloor Homes Ltd** **Project:** **Sandleford Park, Newbury** **Project No.:** **GEG-14-352**

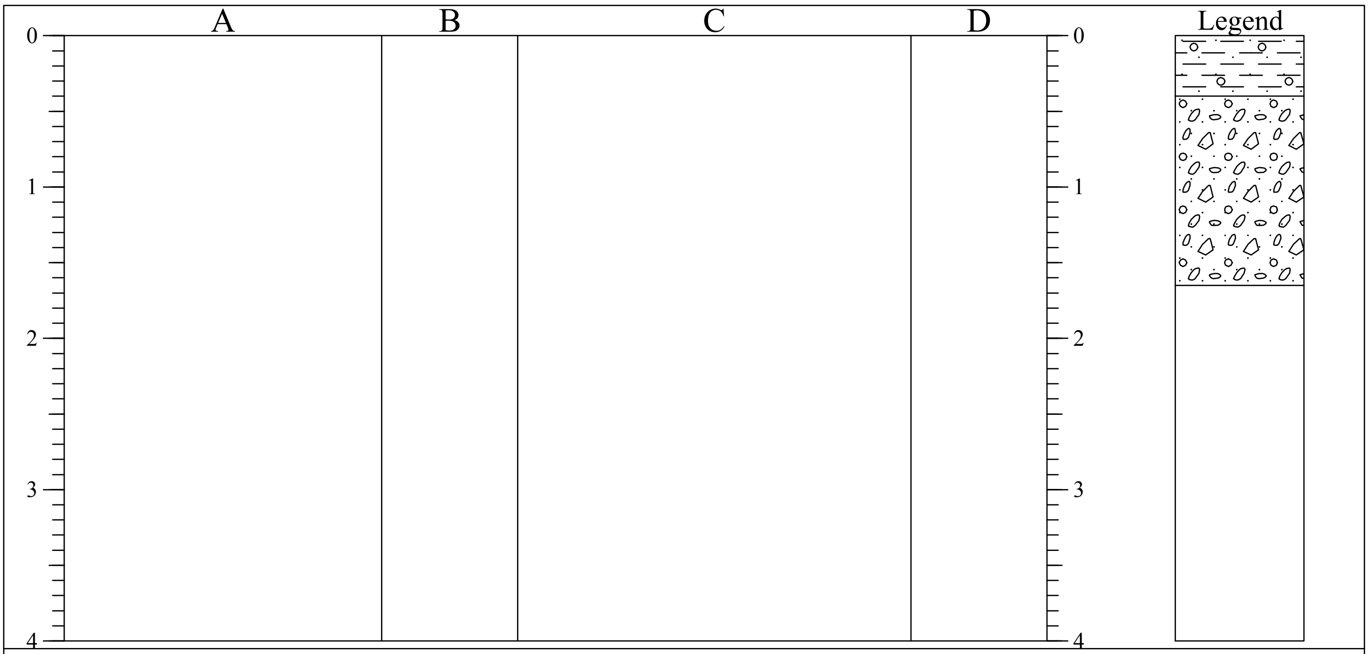
APPENDIX C

EXPLORATORY HOLE LOGS

Geo Environmental Group
GEG House, 17 Graham Road
Malvern, WR14 2HR
Telephone: 01684 212526
Fax: 01684 576917

TRIAL PIT LOG

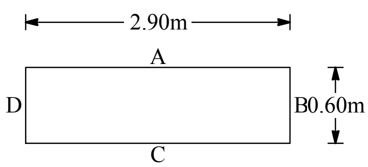
Project				TRIAL PIT No
Sandleford Park, Newbury				**TP01**
Job No: GEG-14-352	Date: 09-09-14	Ground Level (m):	Co-Ordinates (): E 446,694.3 N 165,184.1	
Contractor:				Sheet: 1 of 1



STRATA / SAMPLES & TESTS

Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.40		(Soft) dark brown sandy gravelly CLAY with occasional rootlets. Gravel is sub-rounded quartzite and sub-angular chert. (TOPSOIL)			
0.40-1.65		(Loose) yellow brown clayey SAND & GRAVEL of sub-angular chert with occasional silt pockets. (SILCHESTER SAND & GRAVEL MEMBER) 1.20 - 1.65 Becoming (medium dense) occasionally orange brown clay pockets 1.30 - 1.65 With occasional cobbles of sub-angular chert			

Shoring/Support: None
Stability: Sides stable



GENERAL REMARKS

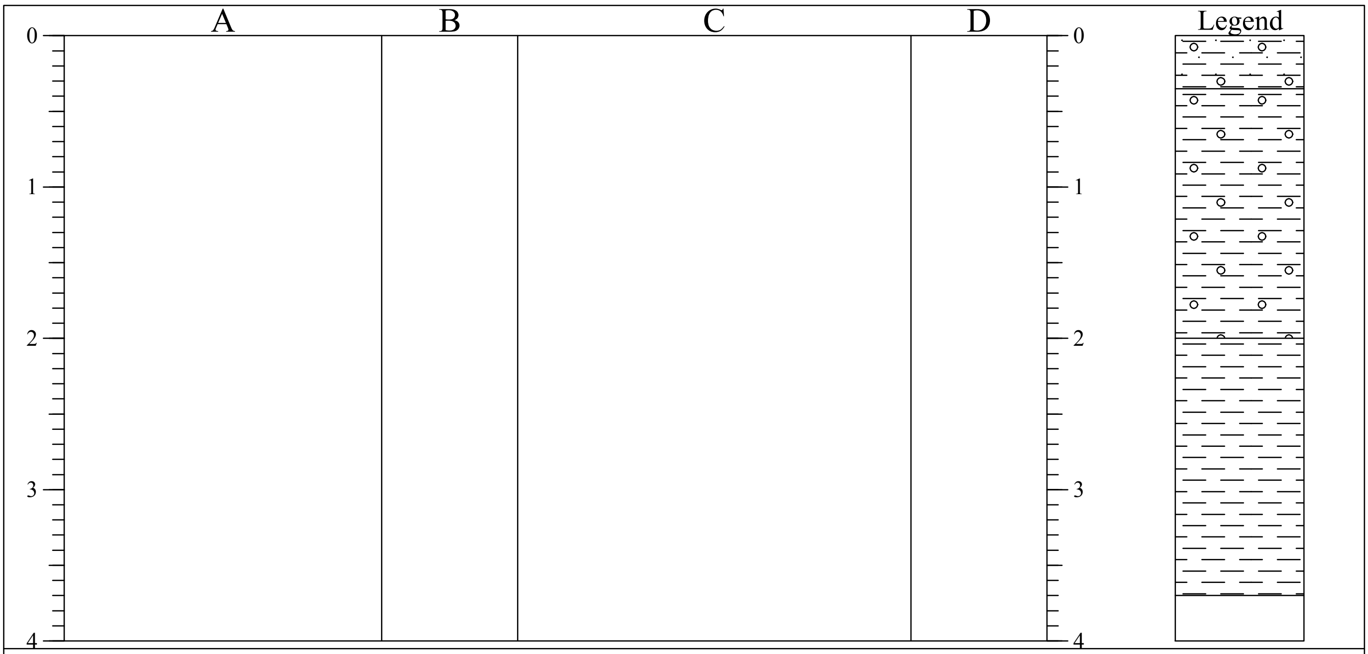
1. No groundwater encountered. 2. Infiltration test undertaken in trial pit. 3. Upon completion, trial pit backfilled with arisings.

All dimensions in metres Scale 1:50	Client: Brookbands Consulting/Bloor Homes	Method/ Plant Used: JCB-3CX	Logged By: FT

Geo Environmental Group
GEG House, 17 Graham Road
Malvern, WR14 2HR
Telephone: 01684 212526
Fax: 01684 576917

TRIAL PIT LOG

Project				TRIAL PIT No
Sandleford Park, Newbury				TP02
Job No: GEG-14-352	Date: 09-09-14	Ground Level (m):	Co-Ordinates (): E 446,797.6 N 165,215.5	
Contractor:				Sheet: 1 of 1



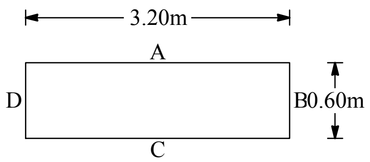
STRATA

Depth	No	DESCRIPTION
0.00-0.35		(Soft) dark brown sandy slightly gravelly CLAY with occasional rootlets. Gravel is sub-rounded quartzite and sub-angular chert. (TOPSOIL)
0.35-2.00		(Soft) orange brown slightly gravelly CLAY. Gravel is sub-angular chert. (SILCHESTER SAND & GRAVEL MEMBER) 0.70 - 2.00 Becoming (soft to firm) friable with occasional gravel-sized silty pockets 1.20 - 1.40 With occasional boulder-sized pockets of (medium dense) grey clayey slightly sandy GRAVEL pockets of sub-angular chert
2.00-3.70		(Firm) grey CLAY with occasional gravel to cobble-sized grey silty pockets. (LONDON CLAY)

SAMPLES & TESTS

Depth	No	Remarks/Tests

Shoring/Support: None
Stability: Sides stable



GENERAL REMARKS

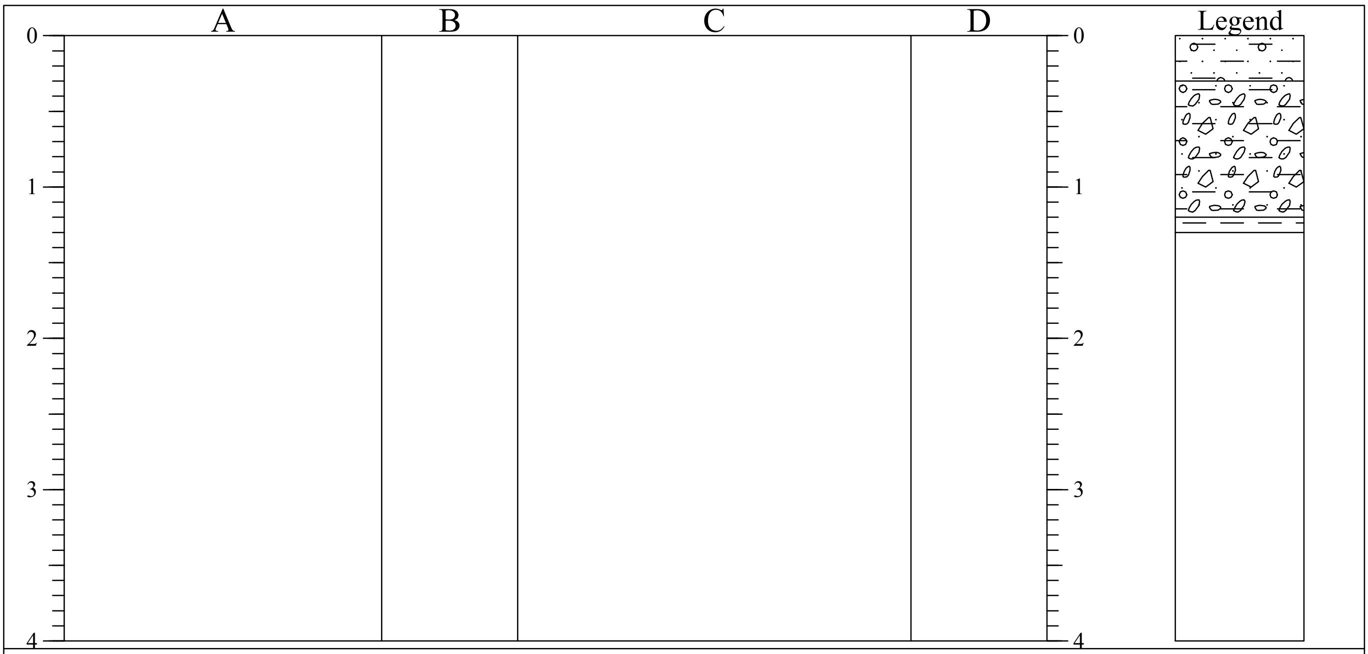
1. No groundwater encountered. 2. Infiltration test undertaken in trial pit. 3. Upon completion, trial pit backfilled with arisings.

All dimensions in metres Scale 1:50	Client: Brookbands Consulting/Bloor Homes	Method/Plant Used: JCB-3CX	Logged By: FT

Geo Environmental Group
GEG House, 17 Graham Road
Malvern, WR14 2HR
Telephone: 01684 212526
Fax: 01684 576917

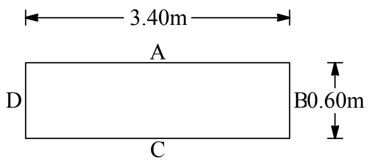
TRIAL PIT LOG

Project				TRIAL PIT No
Sandleford Park, Newbury				TP03
Job No: GEG-14-352	Date: 11-09-14	Ground Level (m)	Co-Ordinates (): E 446,925.2 N 165,236.3	
Contractor				Sheet: 1 of 1



STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.30		(Loose) dark brown slightly clayey gravelly SAND with occasional rootlets. Gravel is sub-rounded quartzite and sub-angular flint. (TOPSOIL)			
0.30-1.20		(Loose to medium dense) orange brown clayey fine sandy GRAVEL of sub-rounded chert with occasional pockets of orange brown gravel-sized pockets of clay. (SILCHESTER SAND & GRAVEL MEMBER) 0.70 - 1.30 Becoming (medium dense) 1.10 - 1.20 Becoming very clayey			
1.20-1.30		(Firm) grey CLAY. (LONDON CLAY)			

Shoring/Support: None
Stability: Sides stable



GENERAL REMARKS

1. No groundwater encountered. 2. Infiltration test undertaken in trial pit. 3. Upon completion, trial pit backfilled with arisings.

All dimensions in metres Scale 1:50	Client: Brookbands Consulting/Bloor Homes	Method/Plant Used: JCB-3CX	Logged By: FT

Geo Environmental Group
GEG House, 17 Graham Road
Malvern, WR14 2HR
Telephone: 01684 212526
Fax: 01684 576917

TRIAL PIT LOG

Project				TRIAL PIT No
Sandleford Park, Newbury				TP04
Job No: GEG-14-352	Date: 11-09-14	Ground Level (m)	Co-Ordinates (): E 447,094.0 N 165,247.0	
Contractor				Sheet: 1 of 1

A B C D

0 1 2 3 4

Legend

STRATA

Depth	No	DESCRIPTION
0.00-0.30		(Loose) dark brown slightly clayey slightly clayey gravelly SAND with occasional rootlets and boulders. Gravel is sub-rounded quartzite and sub-angular flint. Boulders are sub-angular flint. (TOPSOIL)
0.30-0.60		(Loose) yellow brown clayey slightly fine sandy GRAVEL and occasional boulders of sub-rounded chert. (SILCHESTER SAND & GRAVEL MEMBER) 0.55 - 0.60 Becoming orange brown
0.60-2.00		(Firm) friable orange brown slightly sandy gravelly CLAY. Gravel is sub-angular chert. (SILCHESTER SAND & GRAVEL MEMBER) 1.30 - 2.00 Becoming (firm to stiff) slightly gravelly with occasional grey pockets of silt 1.50 - 2.00 Becoming very friable

SAMPLES & TESTS

Depth	No	Remarks/Tests

Shoring/Support: None
Stability: Sides stable

3.00m

A

D B0.60m

C

GENERAL REMARKS

1. No groundwater encountered. 2. Infiltration test undertaken in trial pit. 3. Upon completion, trial pit backfilled with arisings.

All dimensions in metres Scale 1:50	Client: Brookbands Consulting/Bloor Homes	Method/ Plant Used: JCB-3CX	Logged By: FT

Geo Environmental Group
GEG House, 17 Graham Road
Malvern, WR14 2HR
Telephone: 01684 212526
Fax: 01684 576917

TRIAL PIT LOG

Project				TRIAL PIT No
Sandleford Park, Newbury				**TP05**
Job No	Date	Ground Level (m)	Co-Ordinates ()	
GEG-14-352	09-09-14		E 446,762.7 N 165,033.0	
Contractor				Sheet
				1 of 1

A B C D

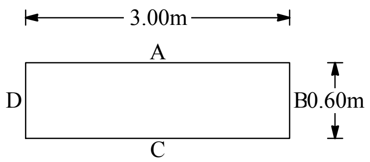
0 1 2 3 4

Legend

STRATA / SAMPLES & TESTS

Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.30		(Soft) dark brown sandy gravelly CLAY with occasional rootlets. Gravel is sub-rounded quartzite and sub-angular chert. (TOPSOIL)			
0.30-0.90		(Soft) friable yellow brown slightly sandy gravelly CLAY. Gravel is sub-angular chert. (SILCHESTER SAND & GRAVEL MEMBER)			
0.90-1.10		(Loose to medium dense) yellow brown very clayey GRAVEL of sub-angular chert with occasional gravel to cobble-sized grey silt pockets. (SILCHESTER SAND & GRAVEL MEMBER)			
1.10-2.80		(Firm) friable yellow brown very gravelly CLAY with occasional gravel to cobble-sized silt pockets. Gravel is sub-angular chert. (SILCESTER SAND & GRAVEL MEMBER)			
2.80-4.00		(Firm to stiff) grey CLAY with occasional gravel to cobble-sized grey silty pockets. (LONDON CLAY)			

Shoring/Support: None
Stability: Sides stable



GENERAL REMARKS

1. No groundwater encountered. 2. Infiltration test undertaken in trial pit. 3. Upon completion, trial pit backfilled with arisings.

All dimensions in metres Scale 1:50	Client Brookbands Consulting/Bloor Homes	Method/ Plant Used JCB-3CX	Logged By FT

Geo Environmental Group
GEG House, 17 Graham Road
Malvern, WR14 2HR
Telephone: 01684 212526
Fax: 01684 576917

TRIAL PIT LOG

Project				TRIAL PIT No
Sandleford Park, Newbury				**TP05A**
Job No: GEG-14-352	Date: 10-09-14	Ground Level (m):	Co-Ordinates (): E 446,768.2 N 165,014.8	
Contractor:				Sheet: 1 of 1

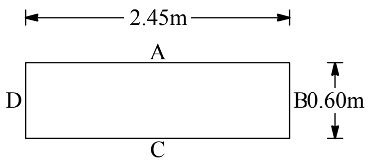
STRATA

Depth	No	DESCRIPTION
0.00-0.35		(Soft) brown slightly sandy gravelly CLAY with occasional rootlets. Gravel is sub-rounded quartzite and sub-angular chert. (TOPSOIL)
0.35-1.00		(Soft to firm) orange brown gravelly CLAY with occasional gravel-sized pockets of silt. Gravel is sub-angular chert. (SILCHESTER SAND & GRAVEL MEMBER)
1.00-1.40		(Loose to medium dense) orange brown clayey GRAVEL of sub-angular chert with occasional gravel to cobble-sized orange brown clay and grey silt pockets. (SILCHESTER SAND & GRAVEL MEMBER)

SAMPLES & TESTS

Depth	No	Remarks/Tests

Shoring/Support: None
Stability: Sides stable



GENERAL REMARKS

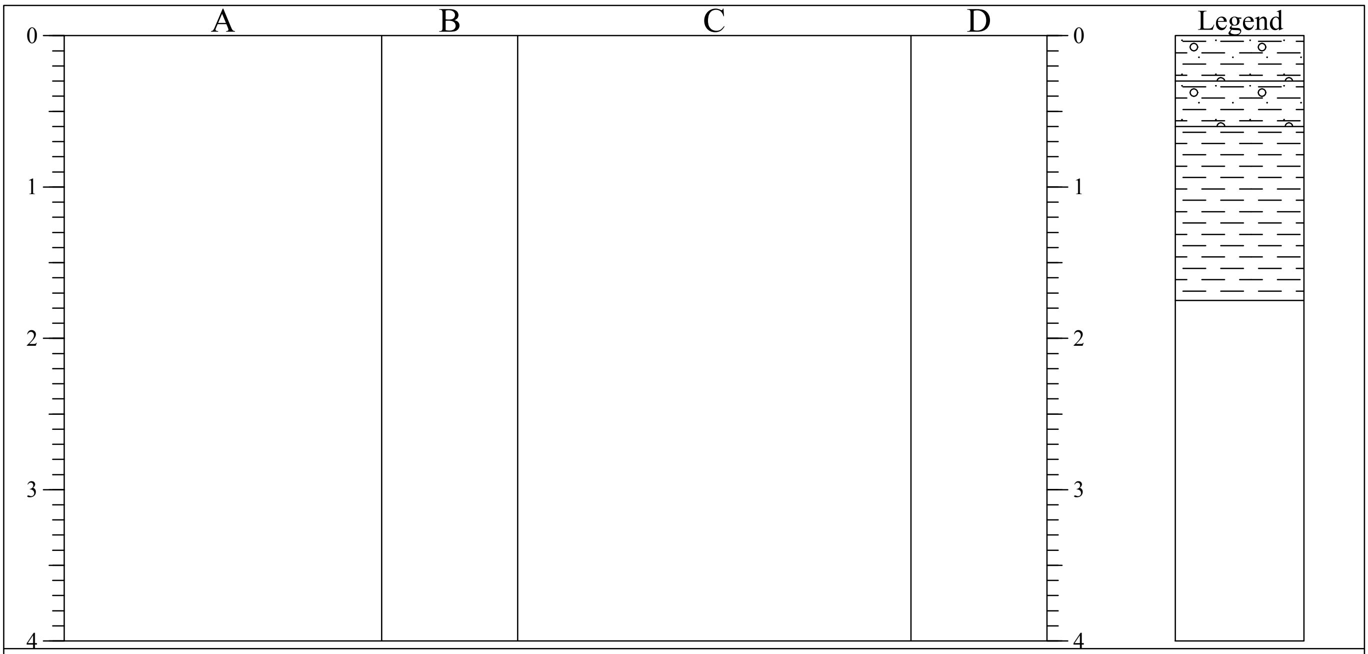
1. No groundwater encountered. 2. Infiltration test undertaken in trial pit. 3. Upon completion, trial pit backfilled with arisings.

All dimensions in metres Scale 1:50	Client: Brookbands Consulting/Bloor Homes	Method/Plant Used: JCB-3CX	Logged By: FT

Geo Environmental Group
GEG House, 17 Graham Road
Malvern, WR14 2HR
Telephone: 01684 212526
Fax: 01684 576917

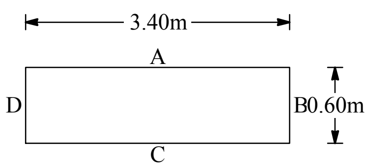
TRIAL PIT LOG

Project				TRIAL PIT No
Sandleford Park, Newbury				TP06
Job No: GEG-14-352	Date: 11-09-14	Ground Level (m)	Co-Ordinates (): E 447,051.7 N 165,083.6	
Contractor				Sheet 1 of 1



STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.30		(Soft) friable dark brown slightly sandy gravelly CLAY with occasional rootlets. Gravel is sub-rounded quartzite and sub-angular chert. (TOPSOIL)			
0.30-0.60		(Soft to firm) friable orange brown slightly fine sandy slightly gravelly CLAY with occasional grey gravel-sized silt pockets. Gravel is sub-angular chert. (SILCHESTER SAND & GRAVEL MEMBER)			
0.60-1.75		(Firm) orange brown CLAY with some grey pockets of silt. (POSSIBLE REWORKED LONDON CLAY)			

Shoring/Support: None
Stability: Sides stable



GENERAL REMARKS

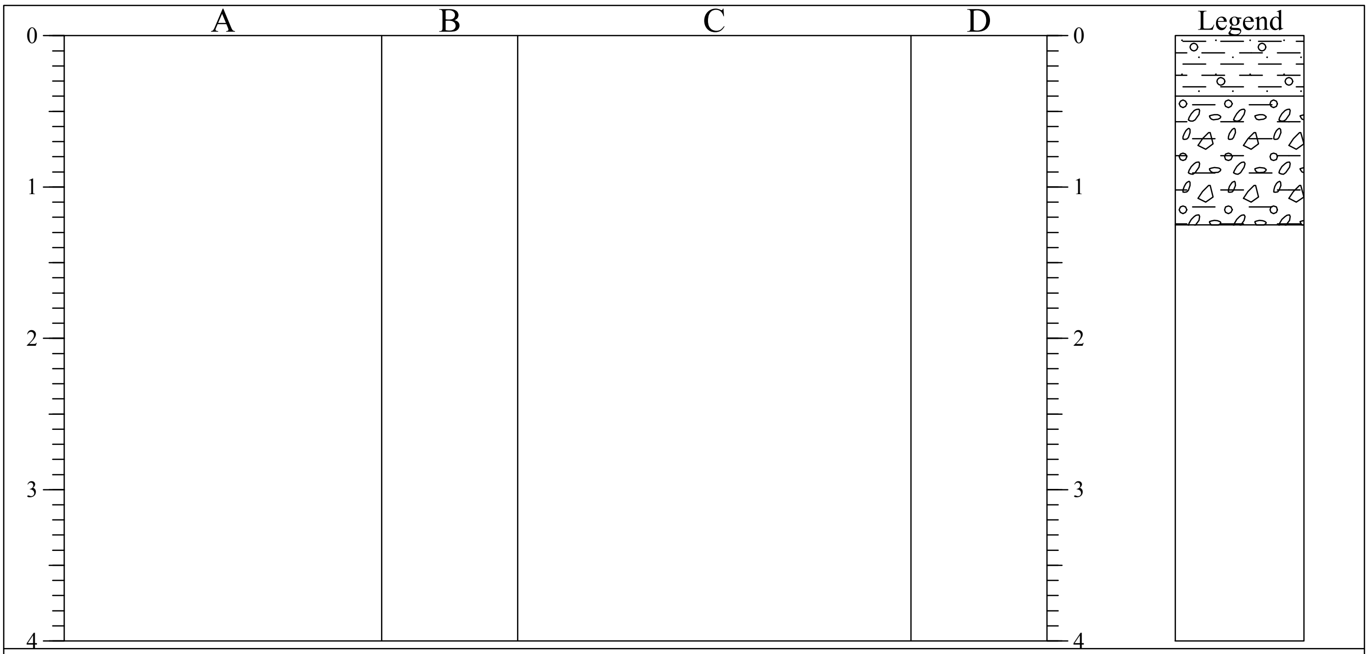
1. No groundwater encountered. 2. Infiltration test undertaken in trial pit. 3. Upon completion, trial pit backfilled with arisings.

All dimensions in metres Scale 1:50	Client: Brookbands Consulting/Bloor Homes	Method/Plant Used: JCB-3CX	Logged By: FT

Geo Environmental Group
GEG House, 17 Graham Road
Malvern, WR14 2HR
Telephone: 01684 212526
Fax: 01684 576917

TRIAL PIT LOG

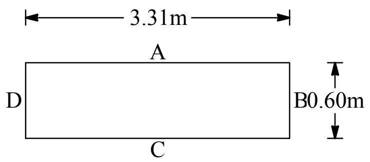
Project				TRIAL PIT No
Sandleford Park, Newbury				TP07
Job No: GEG-14-352	Date: 10-09-14	Ground Level (m):	Co-Ordinates (): E 446,722.3 N 164,959.8	
Contractor:				Sheet: 1 of 1



STRATA / SAMPLES & TESTS

Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.40		(Soft) brown slightly sandy gravelly CLAY with occasional rootlets. Gravel is sub-rounded quartzite and sub-angular chert and sub-rounded quartzite. (TOPSOIL)			
0.40-1.25		(Loose to medium dense) brown slightly clayey fine sandy GRAVEL of sub-angular to sub-rounded chert. (SILCHESTER SAND & GRAVEL MEMBER) 0.50 - 1.25 With occasional cobbles 1.10 - 1.25 Becoming (meduim dense) and sandy			

Shoring/Support: None
Stability: Sides stable



GENERAL REMARKS

1. No groundwater encountered. 2. Infiltration test undertaken in trial pit. 3. Upon completion, trial pit backfilled with arisings.

All dimensions in metres Scale 1:50	Client: Brookbands Consulting/Bloor Homes	Method/Plant Used: JCB-3CX	Logged By: FT

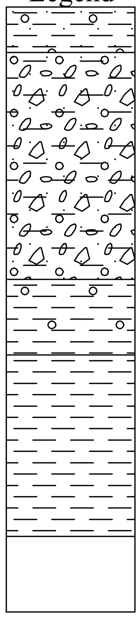
Geo Environmental Group
GEG House, 17 Graham Road
Malvern, WR14 2HR
Telephone: 01684 212526
Fax: 01684 576917

TRIAL PIT LOG

Project				TRIAL PIT No
Sandleford Park, Newbury				**TP07A**
Job No: GEG-14-352	Date: 10-09-14	Ground Level (m):	Co-Ordinates (): E 446,718.5 N 164,966.7	
Contractor:				Sheet: 1 of 1

A B C D (0–4 m)

Legend



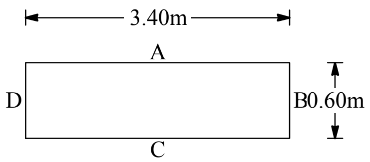
STRATA

Depth	No	DESCRIPTION
0.00-0.30		(Soft) brown slightly sandy gravelly CLAY with occasional rootlets. Gravel is sub-rounded quartzite and sub-angular chert and sub-rounded quartzite. (TOPSOIL)
0.30-1.80		(Loose to medium dense) orange brown clayey fine sandy GRAVEL of sub-rounded chert. (SILCHESTER SAND & GRAVEL MEMBER) 0.70 - 1.80 Becoming (medium dense) slightly clayey sandy 1.50 - 1.80 With occasional gravel-sized grey silt pockets 1.70 - 1.80 With occasional orange brown gravel to cobble-sized clay pockets
1.80-2.30		(Stiff) friable orange brown gravelly CLAY with some grey gravel to cobble-sized silt pockets. Gravel is sub-angular chert. (SILCHESTER SAND & GRAVEL MEMBER)
2.30-3.50		(Firm) light orange brown CLAY. (POSSIBLE REWORKED LONDON CLAY) 2.90 - 3.50 With many grey silt pockets

SAMPLES & TESTS

Depth	No	Remarks/Tests

Shoring/Support: None
Stability: Sides stable



GENERAL REMARKS

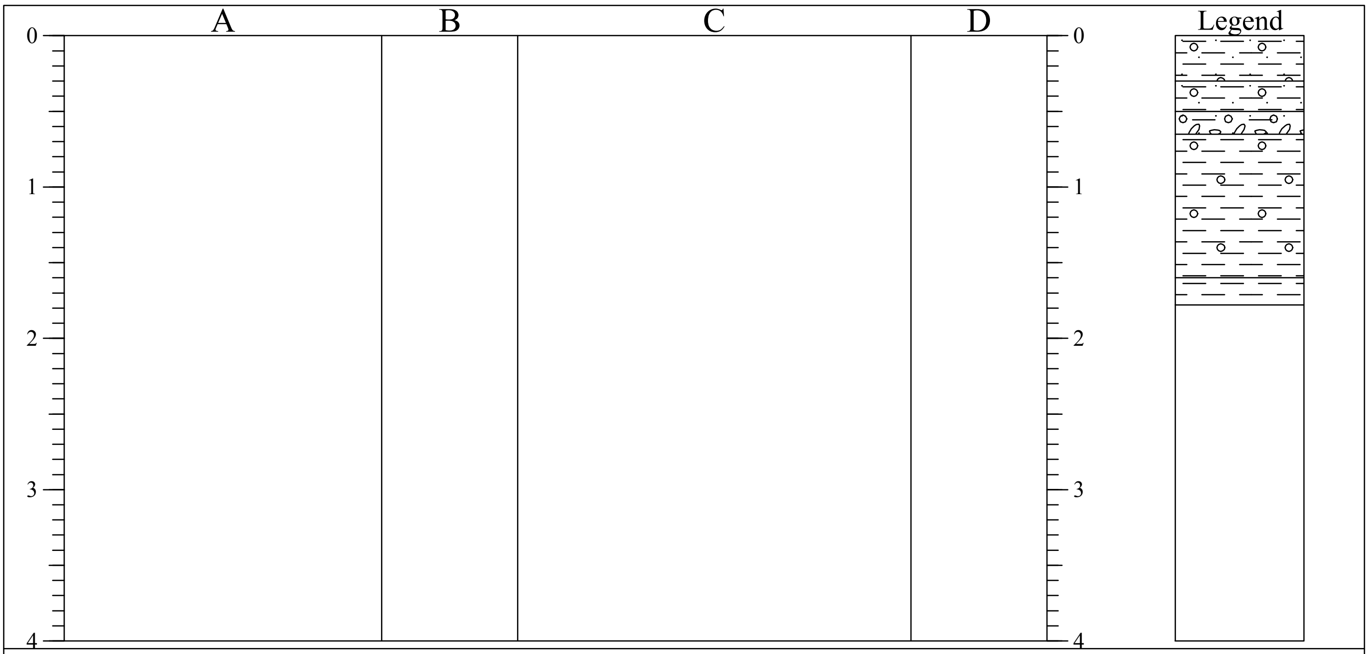
1. No groundwater encountered. 2. Upon completion, trial pit backfilled with arisings.

All dimensions in metres Scale 1:50	Client: Brookbands Consulting/Bloor Homes	Method/Plant Used: JCB-3CX	Logged By: FT

Geo Environmental Group
GEG House, 17 Graham Road
Malvern, WR14 2HR
Telephone: 01684 212526
Fax: 01684 576917

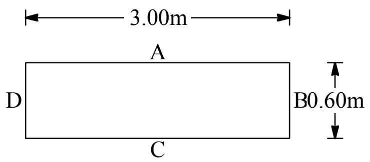
TRIAL PIT LOG

Project				TRIAL PIT No
Sandleford Park, Newbury				**TP08**
Job No: GEG-14-352	Date: 10-09-14	Ground Level (m):	Co-Ordinates (): E 446,840.8 N 164,979.8	
Contractor:				Sheet: 1 of 1



STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.30		(Soft) brown slightly sandy gravelly CLAY with occasional rootlets. Gravel is sub-rounded quartzite and sub-angular chert and sub-rounded quartzite. (TOPSOIL)			
0.30-0.50		(Firm) orange brown slightly fine sandy slightly gravelly CLAY. Gravel is sub-angular chert. (SILCHESTER SAND & GRAVEL MEMBER)			
0.50-0.65		(Loose to medium dense) orange brown clayey slightly sandy GRAVEL of sub-angular to sub-rounded chert. (SILCHESTER SAND & GRAVEL MEMBER)			
0.65-1.60		(Firm) orange brown slightly gravelly CLAY with occasional grey silt pockets. Gravel is sub-angular chert. (SILCHESTER SAND & GRAVEL MEMBER)			
1.60-1.78		(Firm) orange brown CLAY with occasional grey silt pockets. (POSSIBLE REWORKED LONDON CLAY)			

Shoring/Support: None
Stability: Sides stable



GENERAL REMARKS

1. No groundwater encountered. 2. Infiltration test undertaken in trial pit. 3. Upon completion, trial pit backfilled with arisings.

All dimensions in metres Scale 1:50	Client: Brookbands Consulting/Bloor Homes	Method/ Plant Used: JCB-3CX	Logged By: FT

Geo Environmental Group
GEG House, 17 Graham Road
Malvern, WR14 2HR
Telephone: 01684 212526
Fax: 01684 576917

TRIAL PIT LOG

Project				TRIAL PIT No
Sandleford Park, Newbury				TP09
Job No: GEG-14-352	Date: 11-09-14	Ground Level (m):	Co-Ordinates (): E 447,050.0 N 164,882.4	
Contractor:				Sheet: 1 of 1

STRATA

Depth	No	DESCRIPTION
0.00-0.40		(Firm) friable red brown sandy slightly gravelly CLAY with occasional rootlets. Gravel is sub-rounded quartzite and sub-angular chert. (TOPSOIL)
0.40-0.70		(Loose) orange brown clayey slightly slightly fine sandy GRAVEL of sub-angular chert. (SILCHESTER SAND & GRAVEL MEMBER)
0.70-1.80		(Firm) friable orange brown CLAY with occasional grey pockets of silt. (POSSIBLE REWORKED LONDON CLAY)

SAMPLES & TESTS

Depth	No	Remarks/Tests

Shoring/Support: None
Stability: Sides stable

3.00m
A
D B 0.60m
C

GENERAL REMARKS

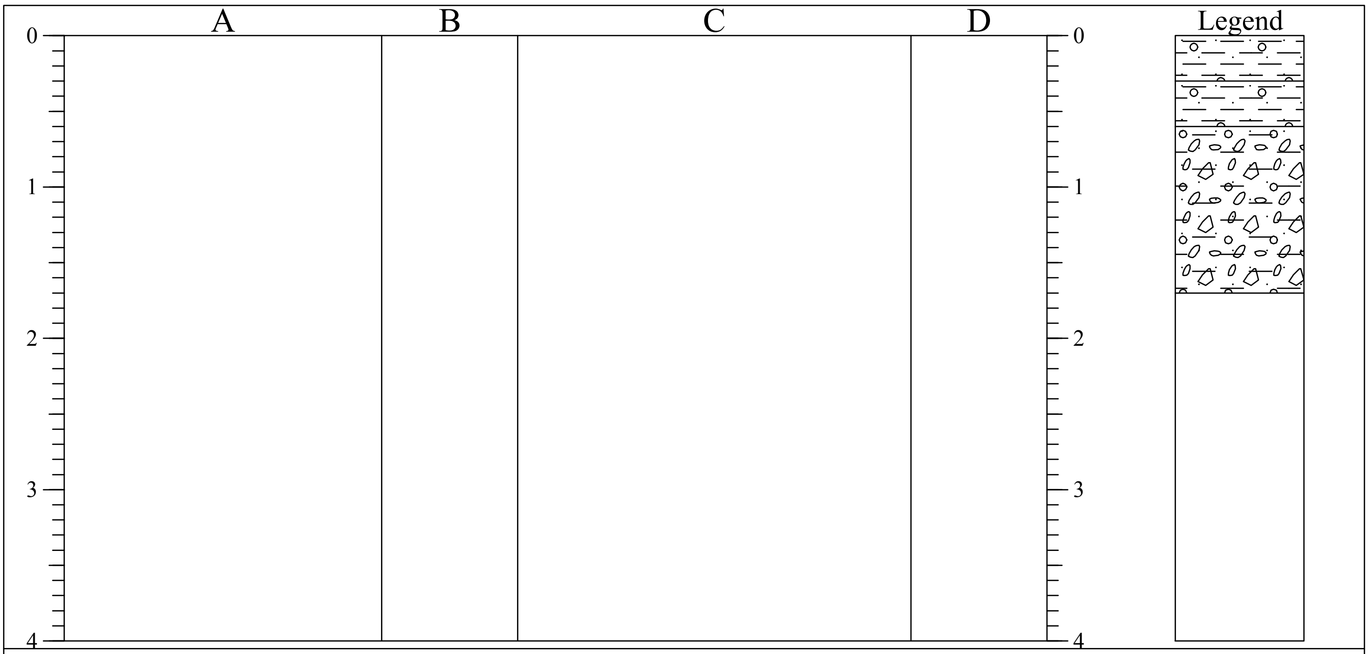
1. No groundwater encountered. 2. Infiltration test undertaken in trial pit. 3. Upon completion, trial pit backfilled with arisings.

All dimensions in metres Scale 1:50	Client: Brookbands Consulting/Bloor Homes	Method/Plant Used: JCB-3CX	Logged By: FT

Geo Environmental Group
GEG House, 17 Graham Road
Malvern, WR14 2HR
Telephone: 01684 212526
Fax: 01684 576917

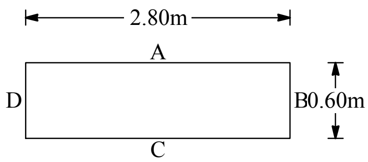
TRIAL PIT LOG

Project				TRIAL PIT No
Sandleford Park, Newbury				**TP10**
Job No: GEG-14-352	Date: 10-09-14	Ground Level (m)	Co-Ordinates (): E 446,675.7 N 164,832.0	
Contractor				Sheet: 1 of 1



STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.30		(Soft) brown slightly sandy gravelly CLAY with occasional rootlets. Gravel is sub-rounded quartzite and sub-angular chert and sub-rounded quartzite. (TOPSOIL)			
0.30-0.60		(Firm) yellow brown slightly fine sandy gravelly CLAY. Gravel is sub-angular chert. (SILCHESTER SAND & GRAVEL MEMBER)			
0.60-1.70		(Loose to medium dense) yellow brown slightly clayey slightly fine sandy GRAVEL of sub-angular to sub-rounded chert with occasional cobble-sized pockets of orange brown clay. (SILCHESTER SAND & GRAVEL MEMBER) 1.20 - 1.70 With occasional boulder-sized pockets of orange brown clay			

Shoring/Support: None
Stability: Sides stable



GENERAL REMARKS

1. No groundwater encountered. 2. Infiltration test undertaken in trial pit. 3. Upon completion, trial pit backfilled with arisings.

All dimensions in metres Scale 1:50	Client: Brookbands Consulting/Bloor Homes	Method/ Plant Used: JCB-3CX	Logged By: FT

Geo Environmental Group
GEG House, 17 Graham Road
Malvern, WR14 2HR
Telephone: 01684 212526
Fax: 01684 576917

TRIAL PIT LOG

Project				TRIAL PIT No
Sandleford Park, Newbury				TP11
Job No: GEG-14-352	Date: 12-09-14	Ground Level (m):	Co-Ordinates (): E 446,270.5 N 164,622.1	
Contractor:				Sheet: 1 of 1

A B C D

Legend

0 1 2 3 4

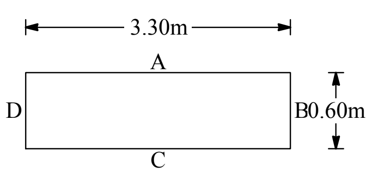
STRATA

Depth	No	DESCRIPTION
0.00-0.30		(Soft) friable dark brown slightly sandy gravelly CLAY with occasional rootlets. Gravel is sub-rounded quartzite and sub-angular chert. (TOPSOIL)
0.30-1.30		(Loose to medium dense) brown clayey gravelly SAND. Gravel is sub-angular chert. (SILCHESTER SAND & GRAVEL MEMBER) 1.20 - 1.30 Becoming (medium dense)
1.30-1.92		(Medium dense) brown slightly clayey slightly slightly sandy GRAVEL of sub-angular chert. (SILCHESTER SAND & GRAVEL MEMBER)

SAMPLES & TESTS

Depth	No	Remarks/Tests

Shoring/Support: None
Stability: Sides stable



GENERAL REMARKS

1. No groundwater encountered. 2. Infiltration test undertaken in trial pit. 3. Upon completion, trial pit backfilled with arisings.

All dimensions in metres Scale 1:50	Client: Brookbands Consulting/Bloor Homes	Method/Plant Used: JCB-3CX	Logged By: FT

Geo Environmental Group
GEG House, 17 Graham Road
Malvern, WR14 2HR
Telephone: 01684 212526
Fax: 01684 576917

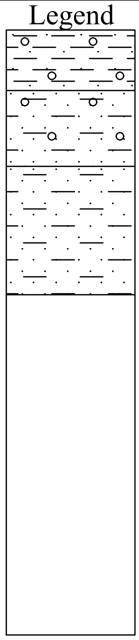
TRIAL PIT LOG

Project				TRIAL PIT No
Sandleford Park, Newbury				**TP12**
Job No: GEG-14-352	Date: 12-09-14	Ground Level (m):	Co-Ordinates (): E 446,399.1 N 164,522.4	
Contractor:				Sheet: 1 of 1

A B C D

0 1 2 3 4

Legend



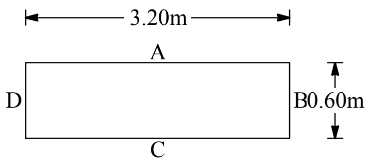
STRATA

Depth	No	DESCRIPTION
0.00-0.40		(Soft) friable dark brown slightly sandy gravelly CLAY with occasional rootlets. Gravel is sub-rounded quartzite and sub-angular chert. (TOPSOIL)
0.40-0.90		(Loose) orange brown slightly clayey gravelly fine SAND. Gravel is sub-angular to sub-rounded chert. (SILCHESTER SAND & GRAVEL MEMBER)
0.90-1.75		(Medium dense) orange brown clayey fine SAND with occasional grey silt pockets. (POSSIBLE SILCHESTER SAND & GRAVEL MEMBER/LONDON CLAY FORMATION)

SAMPLES & TESTS

Depth	No	Remarks/Tests

Shoring/Support: None
Stability: Sides stable



GENERAL REMARKS

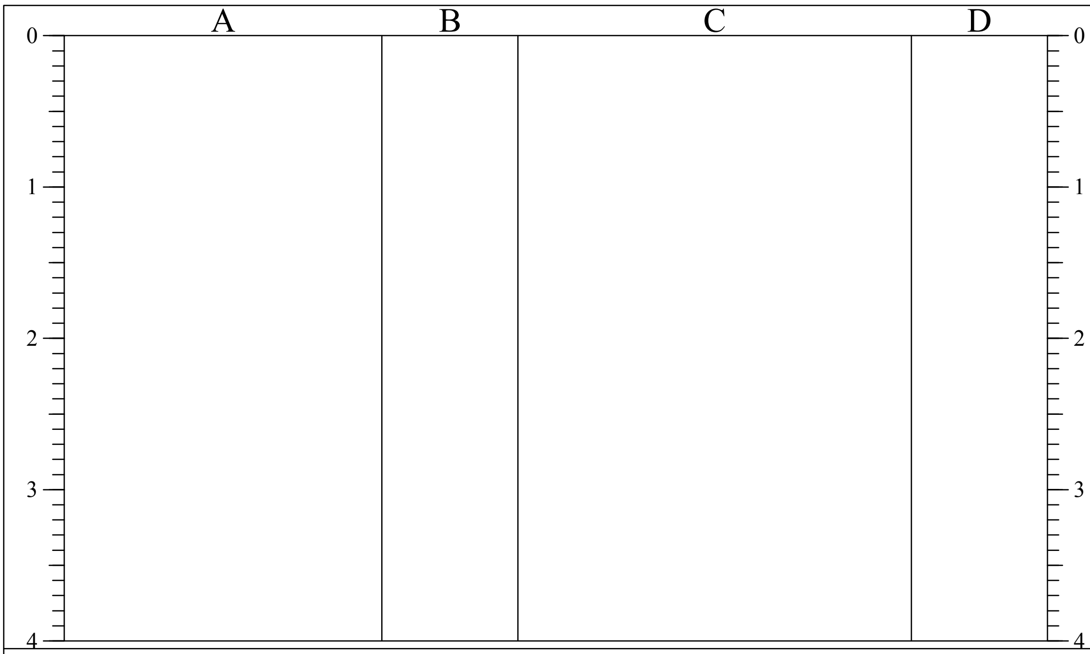
1. No groundwater encountered. 2. Infiltration test undertaken in trial pit. 3. Upon completion, trial pit backfilled with arisings.

All dimensions in metres Scale 1:50	Client: Brookbands Consulting/Bloor Homes	Method/ Plant Used: JCB-3CX	Logged By: FT

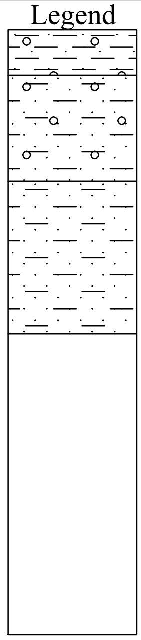
Geo Environmental Group
GEG House, 17 Graham Road
Malvern, WR14 2HR
Telephone: 01684 212526
Fax: 01684 576917

TRIAL PIT LOG

Project				TRIAL PIT No
Sandleford Park, Newbury				**TP13**
Job No GEG-14-352	Date 15-09-14	Ground Level (m)	Co-Ordinates () E 446,507.4 N 164,515.8	
Contractor				Sheet 1 of 1

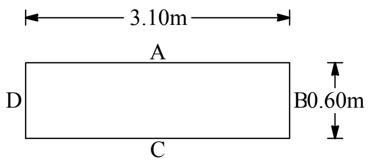


Legend



STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.30		(Soft) friable brown slightly sandy gravelly CLAY with occasional rootlets. Gravel is sub-angular to sub-rounded chert. (TOPSOIL)			
0.30-1.00		(Loose) yellow brown clayey slightly gravelly medium SAND. Gravel is sub-angular to sub-rounded chert. (SILCHESTER SAND & GRAVEL MEMBER) 0.80 - 1.00 Becoming very gravelly			
1.00-2.01		(Medium dense) orange brown clayey fine SAND with occasional grey gravel-sized silt pockets. (POSSIBLE SILCHESTER SAND & GRAVEL MEMBER/LONDON CLAY FORMATION)			

Shoring/Support: None
Stability: Sides stable



GENERAL REMARKS

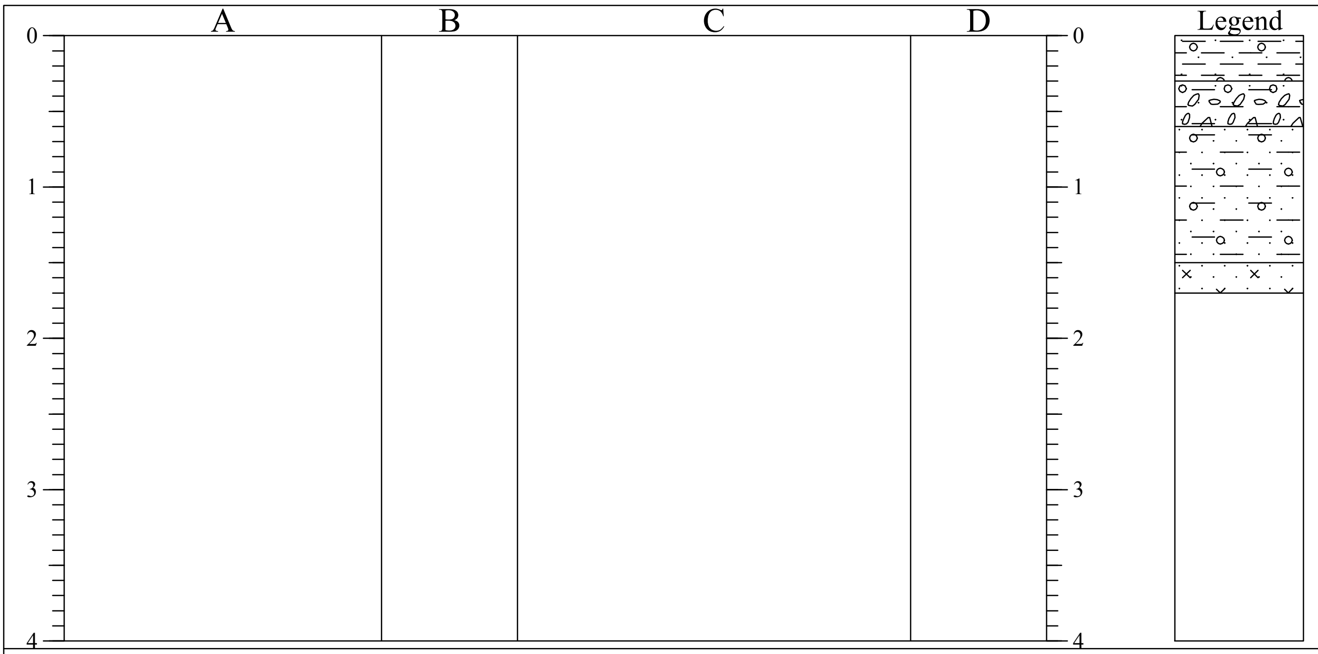
1. No groundwater encountered. 2. Infiltration test undertaken in trial pit. 3. Upon completion, trial pit backfilled with arisings.

All dimensions in metres Scale 1:50	Client: Brookbands Consulting/Bloor Homes	Method/ Plant Used: JCB-3CX	Logged By: FT

Geo Environmental Group
GEG House, 17 Graham Road
Malvern, WR14 2HR
Telephone: 01684 212526
Fax: 01684 576917

TRIAL PIT LOG

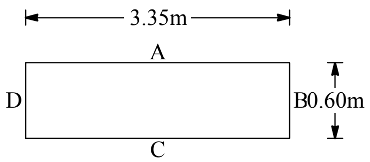
Project				TRIAL PIT No
Sandleford Park, Newbury				TP14
Job No: GEG-14-352	Date: 12-09-14	Ground Level (m):	Co-Ordinates (): E 446,392.2 N 164,423.2	
Contractor:				Sheet: 1 of 1



STRATA / SAMPLES & TESTS

Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.30		(Soft) friable dark brown slightly sandy gravelly CLAY with occasional rootlets. Gravel is sub-rounded quartzite and sub-angular chert. (TOPSOIL)			
0.30-0.60		(Loose) brown slightly clayey sandy GRAVEL of sub-angular chert. (SILCHESTER SAND & GRAVEL MEMBER)			
0.60-1.50		(Loose to medium dense) yellow brown slightly clayey slightly gravelly SAND with occasional grey silt pockets. (SILCHESTER SAND & GRAVEL MEMBER) 1.20 - 1.30 With grey silt boulder-sized pocket 1.20 - 1.50 Becoming (medium dense) gravelly			
1.50-1.70		(Medium dense) orange brown slightly silty fine to medium SAND with occasional grey silt pockets. (POSSIBLE SILCHESTER SAND & GRAVEL MEMBER/LONDON CLAY FORMATION)			

Shoring/Support: None
Stability: Sides stable



GENERAL REMARKS

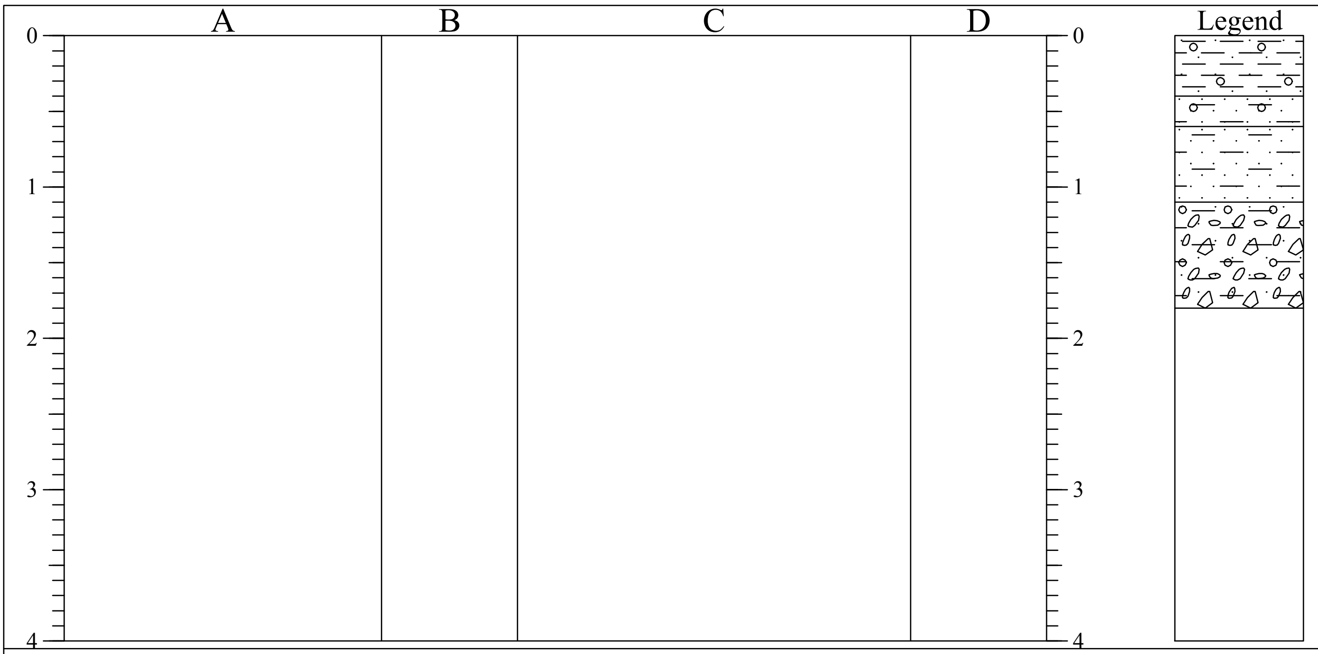
1. No groundwater encountered. 2. Infiltration test undertaken in trial pit. 3. Upon completion, trial pit backfilled with arisings.

All dimensions in metres Scale 1:50	Client: Brookbands Consulting/Bloor Homes	Method/Plant Used: JCB-3CX	Logged By: FT

Geo Environmental Group
GEG House, 17 Graham Road
Malvern, WR14 2HR
Telephone: 01684 212526
Fax: 01684 576917

TRIAL PIT LOG

Project				TRIAL PIT No
Sandleford Park, Newbury				**TP15**
Job No: GEG-14-352	Date: 12-09-14	Ground Level (m):	Co-Ordinates (): E 446,467.1 N 164,325.4	
Contractor:				Sheet: 1 of 1



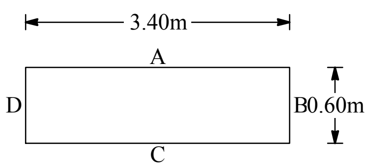
STRATA

Depth	No	DESCRIPTION
0.00-0.40		(Soft) friable dark brown slightly sandy gravelly CLAY with occasional rootlets. Gravel is sub-rounded quartzite and sub-angular chert. (TOPSOIL)
0.40-0.60		(Loose) orange brown very clayey slightly gravelly fine SAND. Gravel is sub-angular chert. (SILCHESTER SAND & GRAVEL MEMBER)
0.60-1.10		(Loose to medium dense) orange brown clayey fine to medium SAND with occasionl grey silt pockets. (SILCHESTER SAND & GRAVEL MEMBER) 0.90 - 1.00 With occasional boulder-sized grey silt pockets
1.10-1.80		(Medium dense) orange brown slightly clayey sandy GRAVEL of sub-angular chert with occasional gravel-sized grey silt pockets. (SILCHESTER SAND & GRAVEL MEMBER) 1.40 - 1.80 Becoming clayey with occasional cobbles

SAMPLES & TESTS

Depth	No	Remarks/Tests

Shoring/Support: None
Stability: Sides stable



GENERAL REMARKS

1. No groundwater encountered. 2. Infiltration test undertaken in trial pit. 3. Upon completion, trial pit backfilled with arisings.

All dimensions in metres Scale 1:50	Client: Brookbands Consulting/Bloor Homes	Method/Plant Used: JCB-3CX	Logged By: FT

Geo Environmental Group
GEG House, 17 Graham Road
Malvern, WR14 2HR
Telephone: 01684 212526
Fax: 01684 576917

TRIAL PIT LOG

Project				TRIAL PIT No
Sandleford Park, Newbury				TP16
Job No: GEG-14-352	Date: 15-09-14	Ground Level (m):	Co-Ordinates (): E 446,585.4 N 164,413.7	
Contractor:				Sheet: 1 of 1

A B C D

Legend

0 1 2 3 4

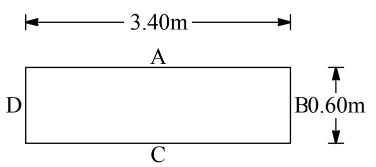
STRATA

Depth	No	DESCRIPTION
0.00-0.40		(Soft) friable brown slightly sandy gravelly CLAY with occasional rootlets. Gravel is sub-angular to sub-rounded chert and quartzite. (TOPSOIL)
0.40-1.50		(Loose to medium dense) brown clayey slightly gravelly fine SAND. Gravel is sub-angular to sub-rounded chert. (SILCHESTER SAND & GRAVEL MEMBER) 0.80 - 1.00 With occasional gravel-sized grey SILT pockets
1.50-1.90		(Medium dense) orange brown very clayey gravelly fine to medium SAND with occasional to some grey gravel-sized silt pockets. Gravel is sub-angular to sub-rounded chert. (SILCHESTER SAND & GRAVEL MEMBER)

SAMPLES & TESTS

Depth	No	Remarks/Tests

Shoring/Support: None
Stability: Sides stable



GENERAL REMARKS

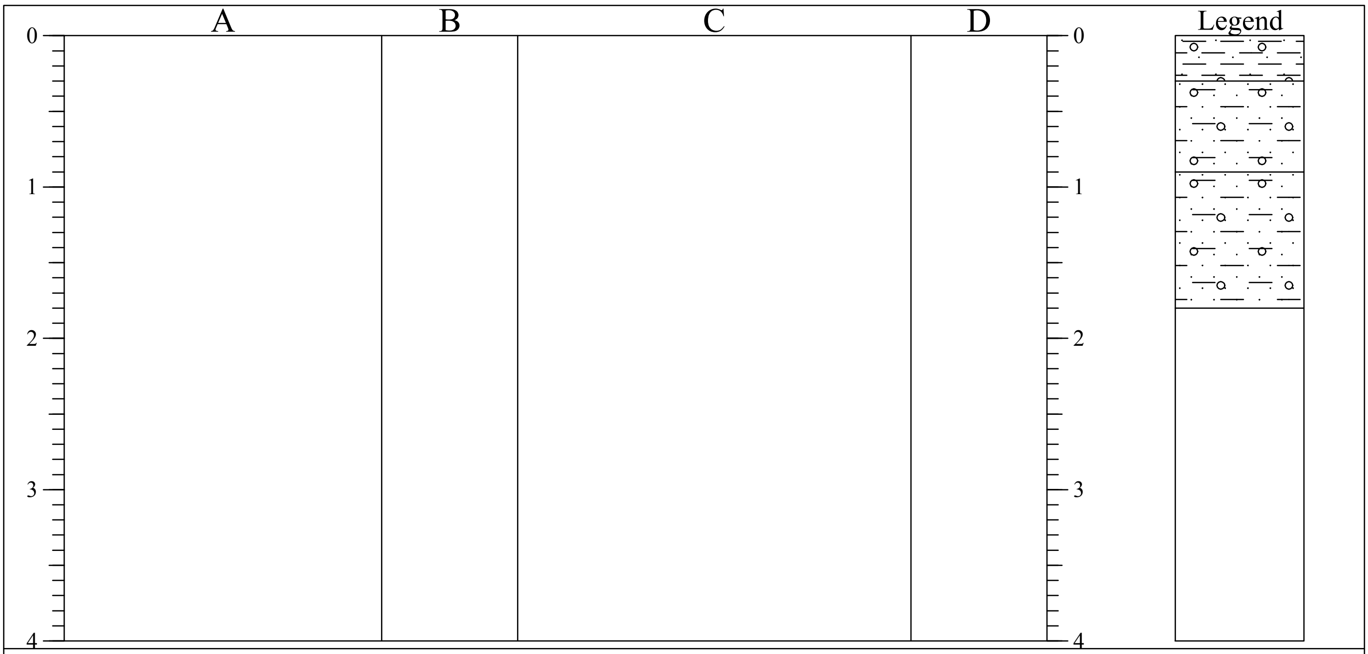
1. No groundwater encountered. 2. Infiltration test undertaken in trial pit. 3. Upon completion, trial pit backfilled with arisings.

All dimensions in metres Scale 1:50	Client: Brookbands Consulting/Bloor Homes	Method/Plant Used: JCB-3CX	Logged By: FT

Geo Environmental Group
GEG House, 17 Graham Road
Malvern, WR14 2HR
Telephone: 01684 212526
Fax: 01684 576917

TRIAL PIT LOG

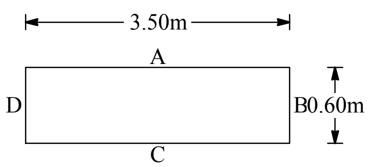
Project				TRIAL PIT No
Sandleford Park, Newbury				**TP17**
Job No: GEG-14-352	Date: 15-09-14	Ground Level (m):	Co-Ordinates (): E 446,690.5 N 164,385.6	
Contractor:				Sheet: 1 of 1



STRATA / SAMPLES & TESTS

Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.30		(Soft) friable brown slightly sandy gravelly CLAY with occasional rootlets. Gravel is sub-angular to sub-rounded chert. (TOPSOIL)			
0.30-0.90		(Loose to medium dense) yellow brown clayey slightly gravelly fine to medium SAND with occasional gravel-sized grey SILT pockets. Gravel is sub-angular to sub-rounded chert. (SILCHESTER SAND & GRAVEL MEMBER)			
0.90-1.80		(Medium dense) orange brown slightly clayey fine SAND with some gravel-sized grey silt pockets. (POSSIBLE SILCHESTER SAND & GRAVEL MEMBER)			

Shoring/Support: None
Stability: Sides stable



GENERAL REMARKS

1. No groundwater encountered. 2. Infiltration test undertaken in trial pit. 3. Upon completion, trial pit backfilled with arisings.

All dimensions in metres Scale 1:50	Client: Brookbands Consulting/Bloor Homes	Method/Plant Used: JCB-3CX	Logged By: FT

APPENDIX D

INFILTRATION TEST DATA

Appendix D
Infiltration Tests
Sandleford Park, Newbury
TP01 Test 1

Time (min)	Depth from Surface (cm)	% Effective Depth
0	65	100%
1	65	100%
2	66	99%
75	78	87%
93	80	85%
115	82	83%
136	83	82%
177	89	76%
201	91	74%
288	97	68%
323	100	65%
366	103	62%
406	105	60%
426	105	60%
End of Test		

Appendix D
Infiltration Tests
Sandleford Park, Newbury
TP02 Test 1

Time (min)	Depth from Surface (cm)	% Effective Depth
0	270	100%
1	269	101%
2	268	102%
43	268	102%
63	267	103%
106	267	103%
171	267	103%
219	267	103%
257	267	103%
282	267	103%
End of Test		

Appendix D
Infiltration Tests
Sandleford Park, Newbury
TP03 Test 1

Time (min)	Depth from Surface (cm)	% Effective Depth
0	30	100%
1	31	99%
2	31	99%
4	31	99%
77	39	91%
87	40	90%
137	43	87%
161	44	86%
220	47	83%
289	50	80%
331	52	78%
362	53	77%
392	54	76%
End of Test		

Appendix D
Infiltration Tests
Sandleford Park, Newbury
TP04 Test 1

Time (min)	Depth from Surface (cm)	% Effective Depth
0	98	100%
1	99	99%
2	99	99%
63	104	94%
79	105	93%
122	108	90%
148	108	90%
212	110	88%
280	113	85%
315	113	85%
337	113	85%
353	113	85%
End of Test		

Appendix D
Infiltration Tests
Sandleford Park, Newbury
TP05 Test 1

Time (min)	Depth from Surface (cm)	% Effective Depth
0	293	100%
1	292	101%
2	291	102%
17	292	101%
58	292	101%
126	292	101%
200	292	101%
245	292	101%
End of Test		

Appendix D
Infiltration Tests
Sandleford Park, Newbury
TP05A Test 1

Time (min)	Depth from Surface (cm)	% Effective Depth
0	40	100%
1	41	99%
3	41	99%
29	44	96%
57	47	93%
79	49	91%
112	52	88%
161	54	86%
225	58	82%
282	62	78%
336	64	76%
361	65	75%
386	66	74%
423	66	74%
End of Test		

Appendix D
Infiltration Tests
Sandleford Park, Newbury
TP06 Test 1

Time (min)	Depth from Surface (cm)	% Effective Depth
0	71	100%
1	70	101%
3	70	101%
4	70	101%
42	72	99%
65	72	99%
99	73	98%
127	73	98%
201	74	97%
265	74	97%
293	74.5	97%
End of Test		

Appendix D
Infiltration Tests
Sandleford Park, Newbury
TP07 Test 1*

Time (min)	Depth from Surface (cm)	% Effective Depth
0	25	100%
1	26	99%
3	28	97%
15	36	89%
46	46	79%
68	51	74%
100	58	67%
153	66	59%
216	72	53%
275	77	48%
326	80	45%
354	83	42%
375	84	41%
408	85	40%
428	86	39%
448	87	38%
700	93	32%
900	97	28%
1100	100	25%
End of Test		

*Last Data Point is Extrapolated

Appendix D
Infiltration Tests
Sandleford Park, Newbury
TP08 Test 1

Time (min)	Depth from Surface (cm)	% Effective Depth
0	76	100%
1	76	100%
2	76	100%
22	77	99%
75	82	94%
113	84	92%
176	87	89%
232	89	87%
286	90	86%
312	91	85%
340	91	85%
End of Test		

Appendix D

Infiltration Tests

Sandleford Park, Newbury

TP09 Test 1

Time (min)	Depth from Surface (cm)	% Effective Depth
0	78	100%
1	78	100%
9	80	98%
44	82	96%
69	84	94%
85	84	94%
180	87	91%
243	89	89%
280	90	88%
318	91	87%
355	92	86%
384	92	86%
End of Test		

Appendix D
Infiltration Tests
Sandleford Park, Newbury
TP10 Test 1

Time (min)	Depth from Surface (cm)	% Effective Depth
0	68	100%
1	69	99%
2	69	99%
37	72	96%
62	73	95%
93	75	93%
145	77	91%
210	77	91%
267	80	88%
317	81	87%
347	81	87%
End of Test		

Appendix D
Infiltration Tests
Sandleford Park, Newbury
TP11 Test 1

Time (min)	Depth from Surface (cm)	% Effective Depth
0	92	100%
1	93	99%
2	94	98%
95	99	93%
123	99	93%
146	99	93%
208	101	91%
263	102	90%
333	103	89%
368	103	89%
383	103.5	89%
End of Test		

Appendix D
Infiltration Tests
Sandleford Park, Newbury
TP12 Test 1

Time (min)	Depth from Surface (cm)	% Effective Depth
0	77	100%
1	78	99%
2	78	99%
3	78	99%
71	84	93%
105	85	92%
122	86	91%
183	88	89%
243	89	88%
309	90	87%
331	90.5	87%
356	90.5	87%
381	91	86%
End of Test		

Appendix D
Infiltration Tests
Sandleford Park, Newbury
TP13 Test 1

Time (min)	Depth from Surface (cm)	% Effective Depth
0	99	100%
1	99	100%
3	101	98%
30	106	93%
63	109	90%
91	113	86%
135	121	78%
180	122	77%
219	126	74%
276	131	69%
326	136	64%
358	136.5	63%
381	136.5	63%
End of Test		

Appendix D
Infiltration Tests
Sandleford Park, Newbury
TP14 Test 1

Time (min)	Depth from Surface (cm)	% Effective Depth
0	69	100%
1	69	100%
2	70	99%
42	74	95%
81	76	93%
155	77	92%
220	78	91%
281	79	90%
370	80	89%
395	80	89%
End of Test		

Appendix D
Infiltration Tests
Sandleford Park, Newbury
TP15 Test 1

Time (min)	Depth from Surface (cm)	% Effective Depth
0	80	100%
1	80	100%
2	81	99%
51	82	98%
121	83	97%
191	83	97%
243	83	97%
End of Test		

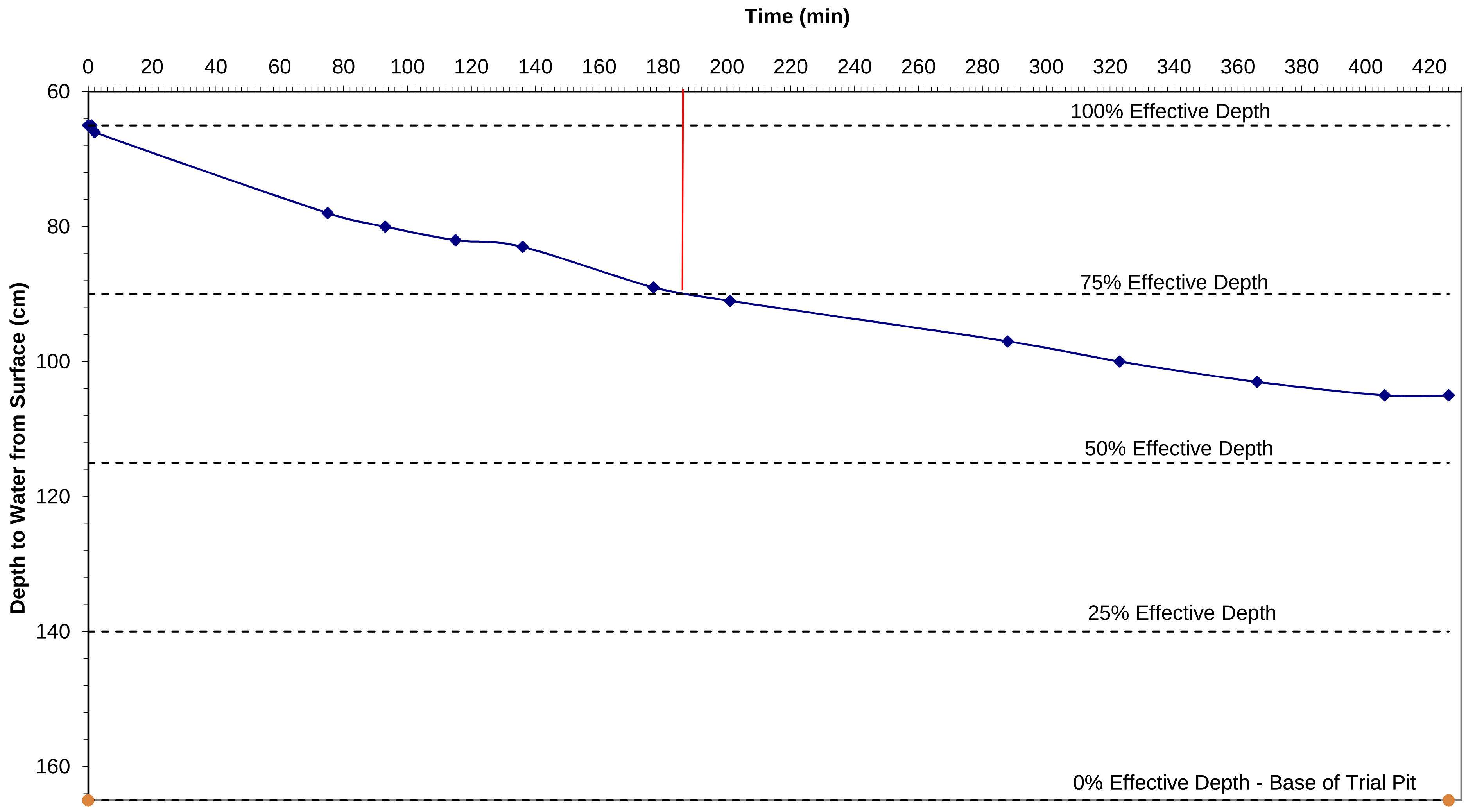
Appendix D
Infiltration Tests
Sandleford Park, Newbury
TP16 Test 1

Time (min)	Depth from Surface (cm)	% Effective Depth
0	85	100%
1	86	99%
2	86	99%
4	87	98%
50	95	90%
77	97	88%
105	100	85%
149	103	83%
194	107	79%
233	109	77%
291	112	74%
345	115	71%
375	117	69%
420	118	68%
End of Test		

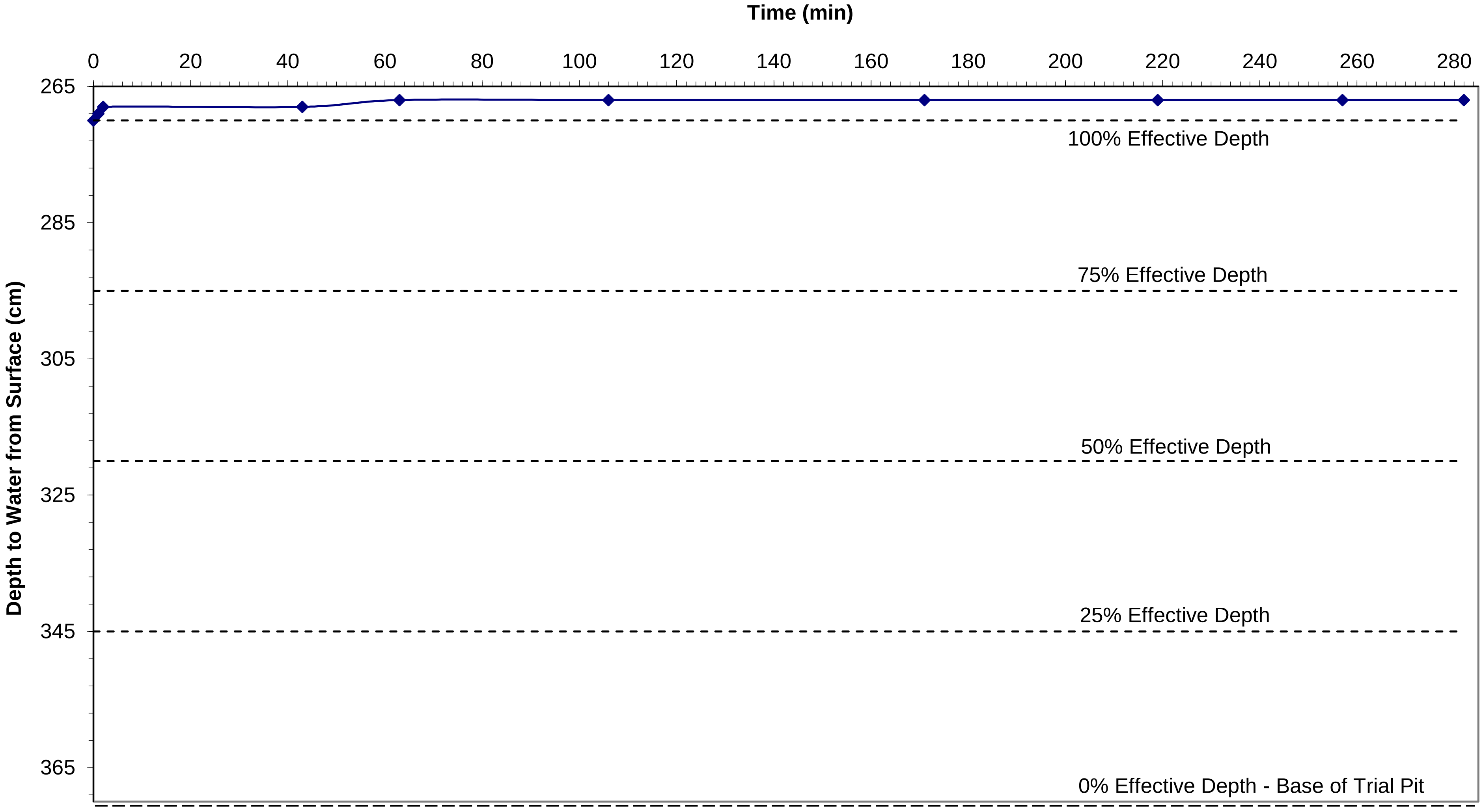
Appendix D
Infiltration Tests
Sandleford Park, Newbury
TP17 Test 1

Time (min)	Depth from Surface (cm)	% Effective Depth
0	76	100%
2	76	100%
4	77	99%
9	77	99%
24	77	99%
41	78	98%
79	78	98%
105	79	97%
167	80	96%
194	81	95%
264	81	95%
304	81	95%
End of Test		

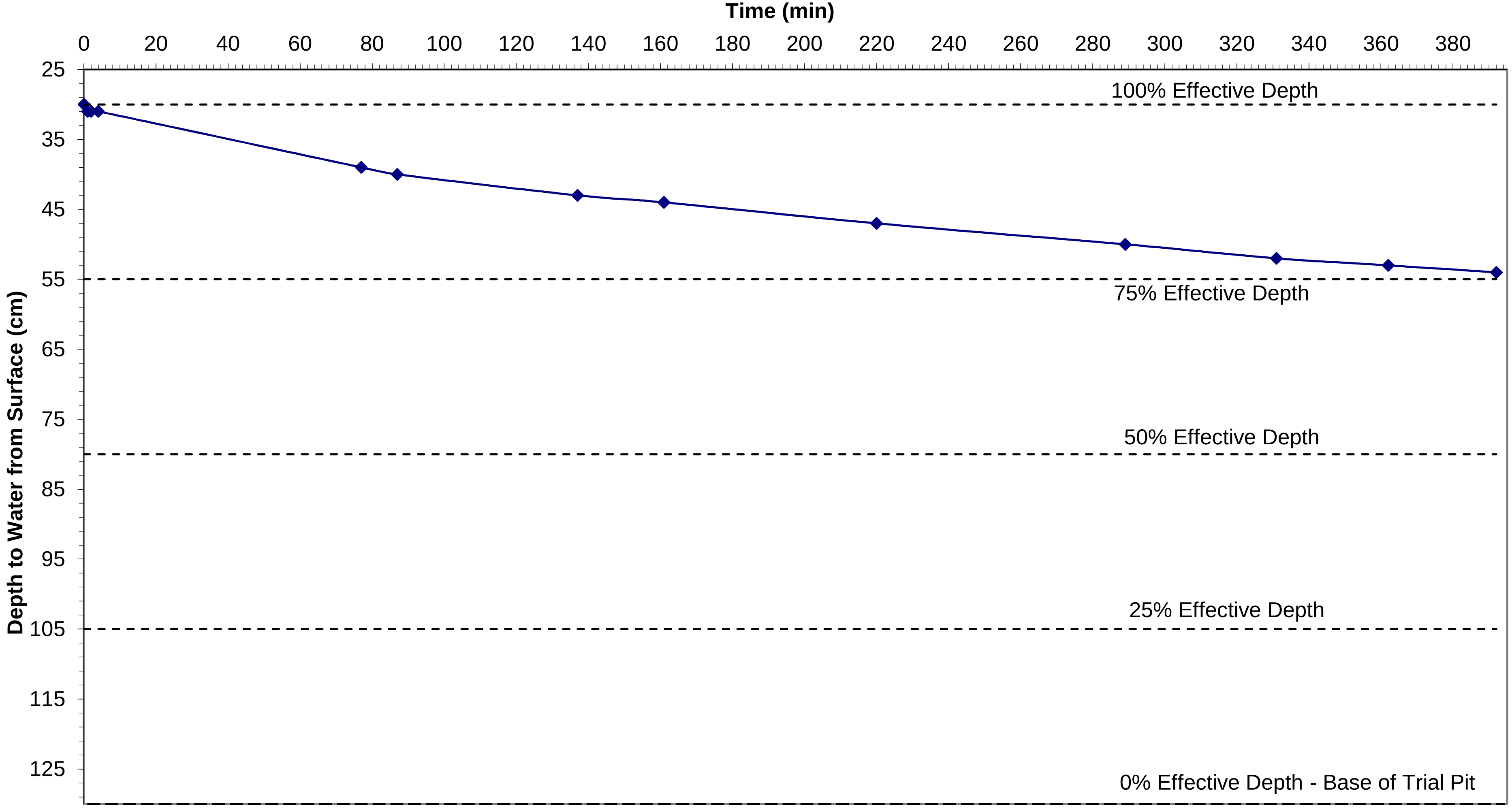
GEG-14-352 Sandleford Park, Newbury. Figure D-1. Infiltration Test Results - TP01 Test 1



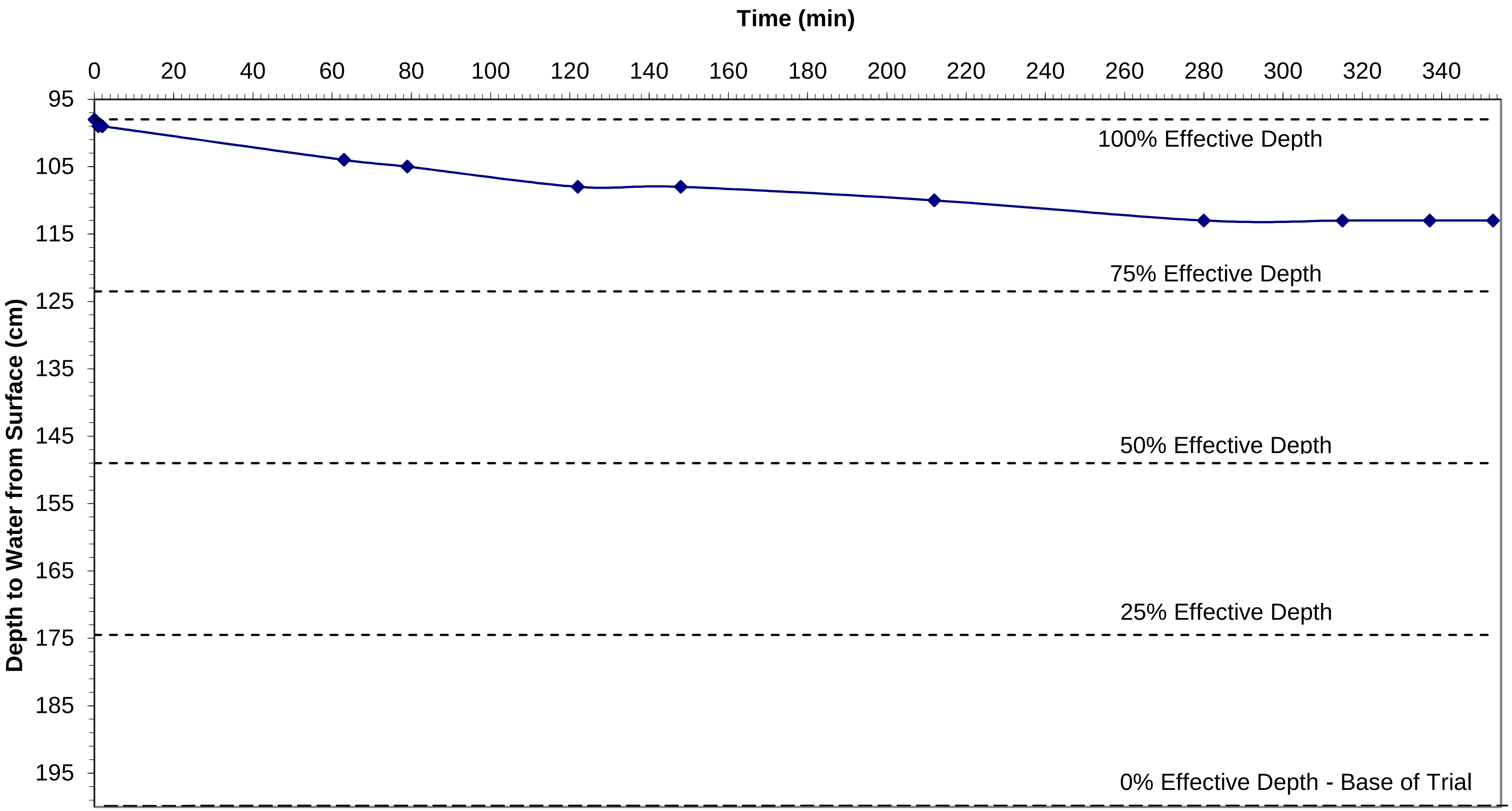
GEG-14-352 Sandleford Park, Newbury. Figure D-2. Infiltration Test Results - TP02 Test 1



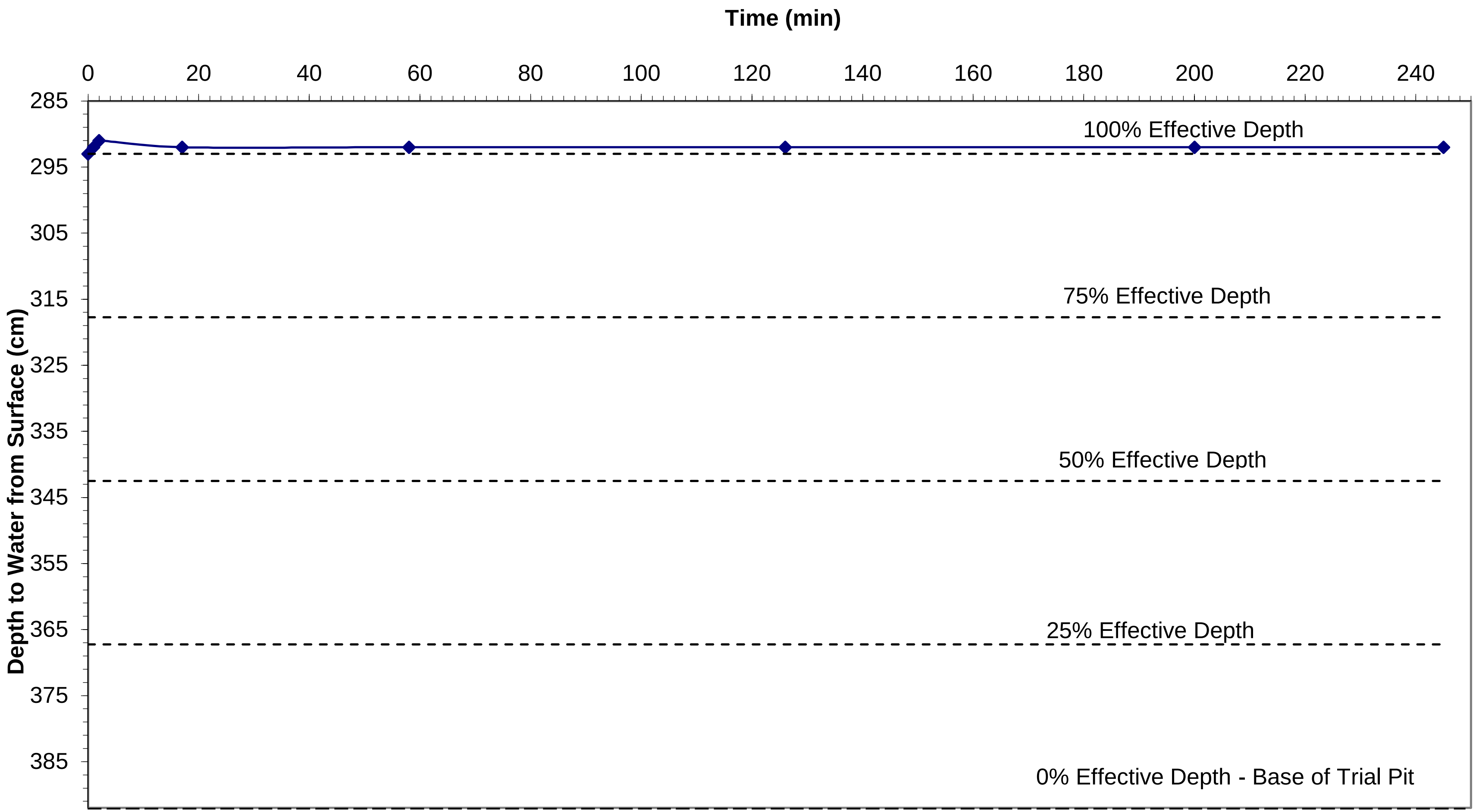
GEG-14-352 Sandleford Park, Newbury. Figure D-3. Infiltration Test Results - TP03 Test 1

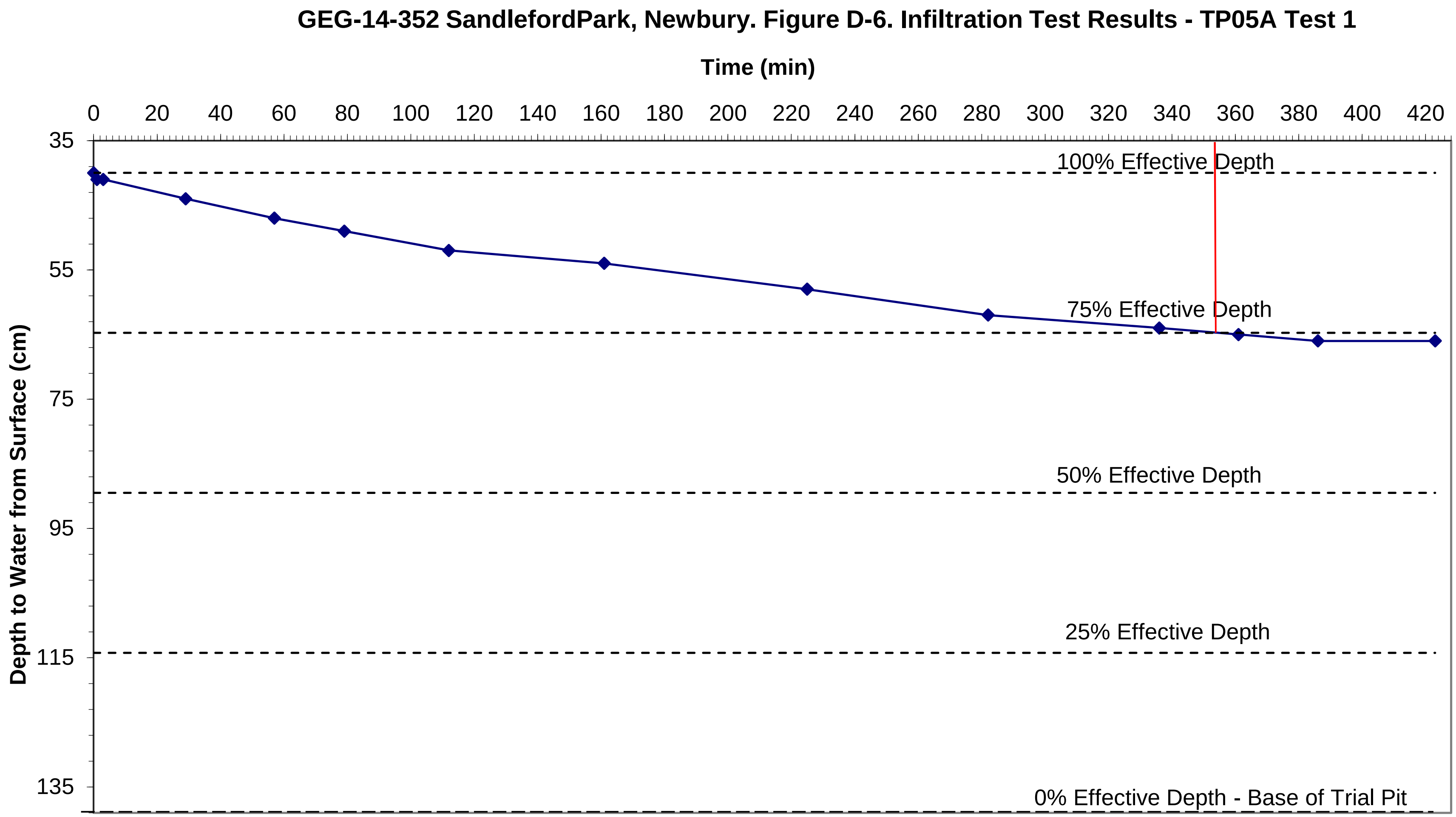


GEG-14-352 Sandleford Park, Newbury. Figure D-4. Infiltration Test Results - TP04 Test 1

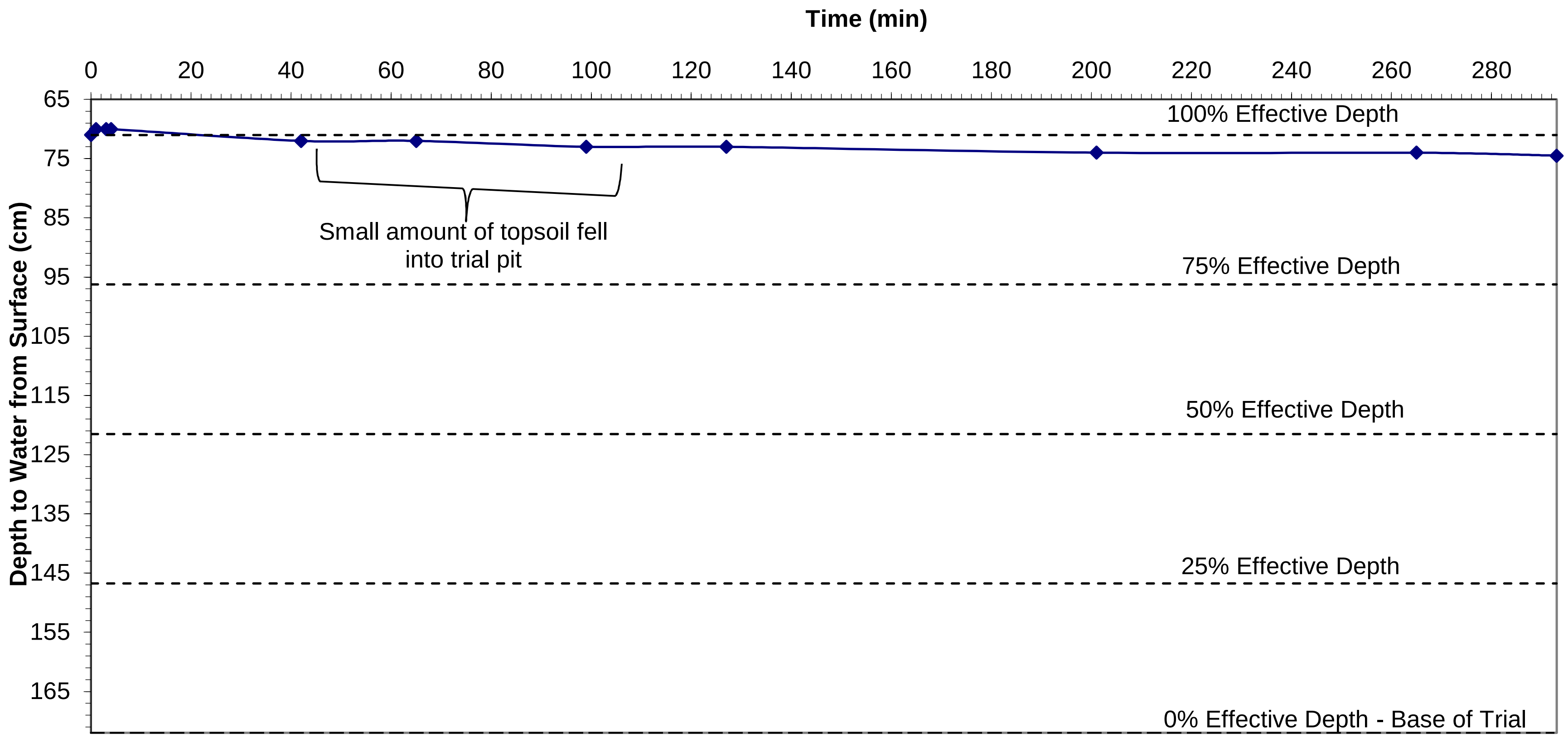


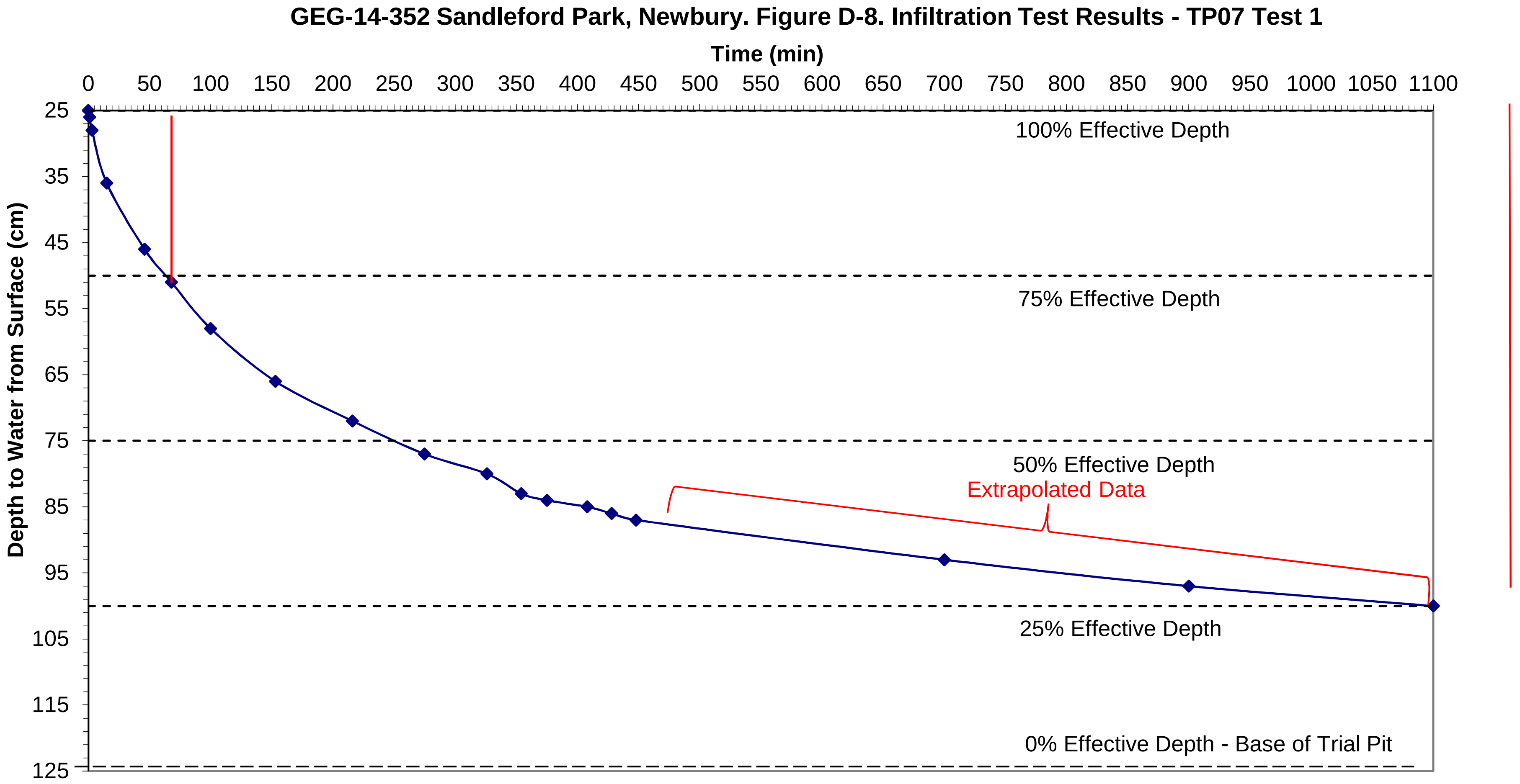
GEG-14-352 Sandleford Park, Newbury. Figure D-5. Infiltration Test Results - TP05 Test 1




GEG-14-352 SandlefordPark, Newbury. Figure D-6. Infiltration Test Results - TP05A Test 1
Time (min)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
Depth to Water from Surface (cm)
35
55
75
95
115
135
100% Effective Depth
75% Effective Depth
50% Effective Depth
25% Effective Depth
0% Effective Depth - Base of Trial Pit

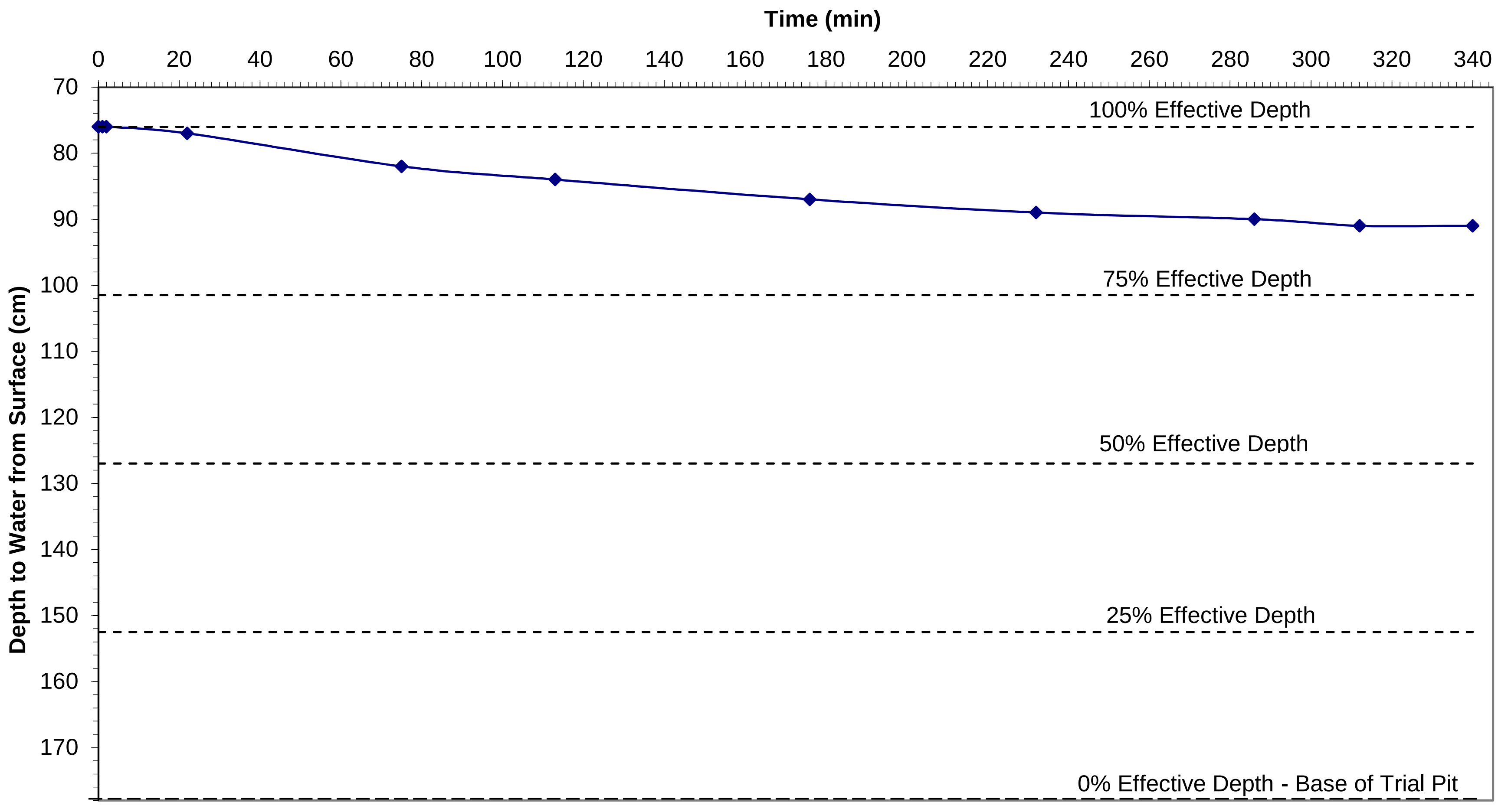
GEG-14-352 Sandleford Park, Newbury. Figure D-7. Infiltration Test Results - TP06 Test 1

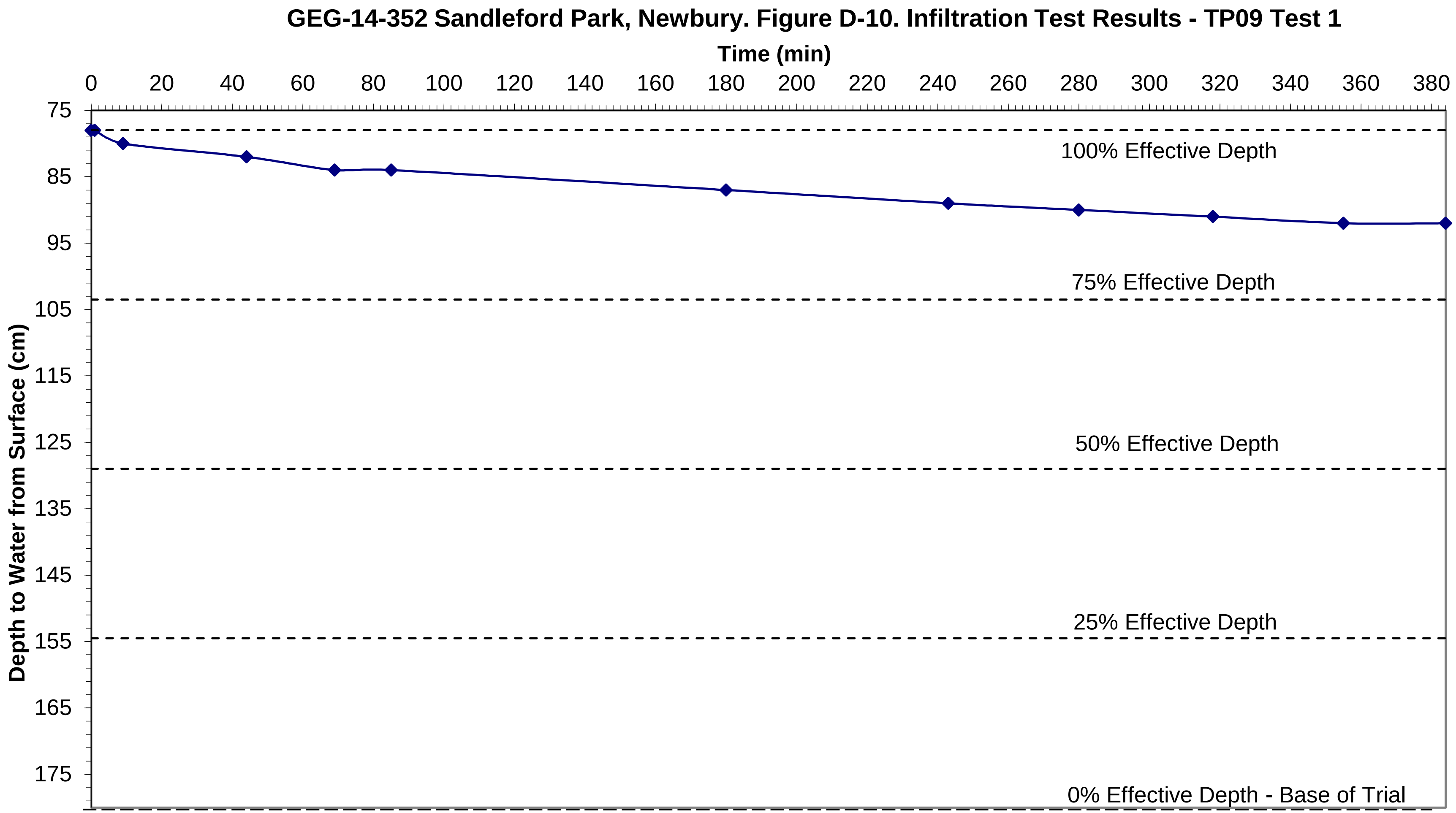




GEG-14-352 Sandleford Park, Newbury. Figure D-8. Infiltration Test Results - TP07 Test 1
Time (min)
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1000
1050
1100
Depth to Water from Surface (cm)
25
35
45
55
65
75
85
95
105
115
125
100% Effective Depth
75% Effective Depth
50% Effective Depth
Extrapolated Data
25% Effective Depth
0% Effective Depth - Base of Trial Pit

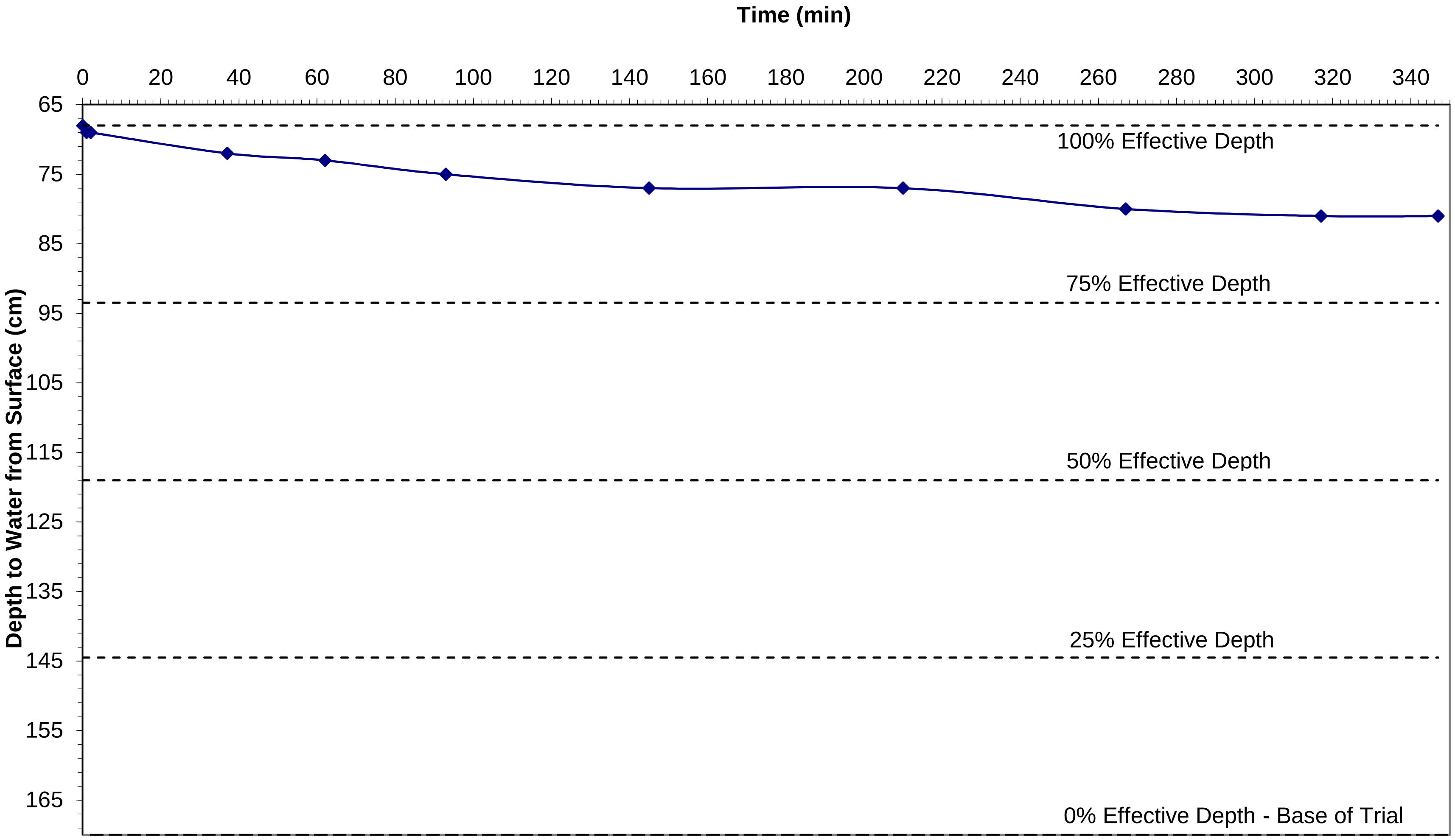
GEG-14-352 Sandleford Park, Newbury. Figure D-9. Infiltration Test Results - TP08 Test 1



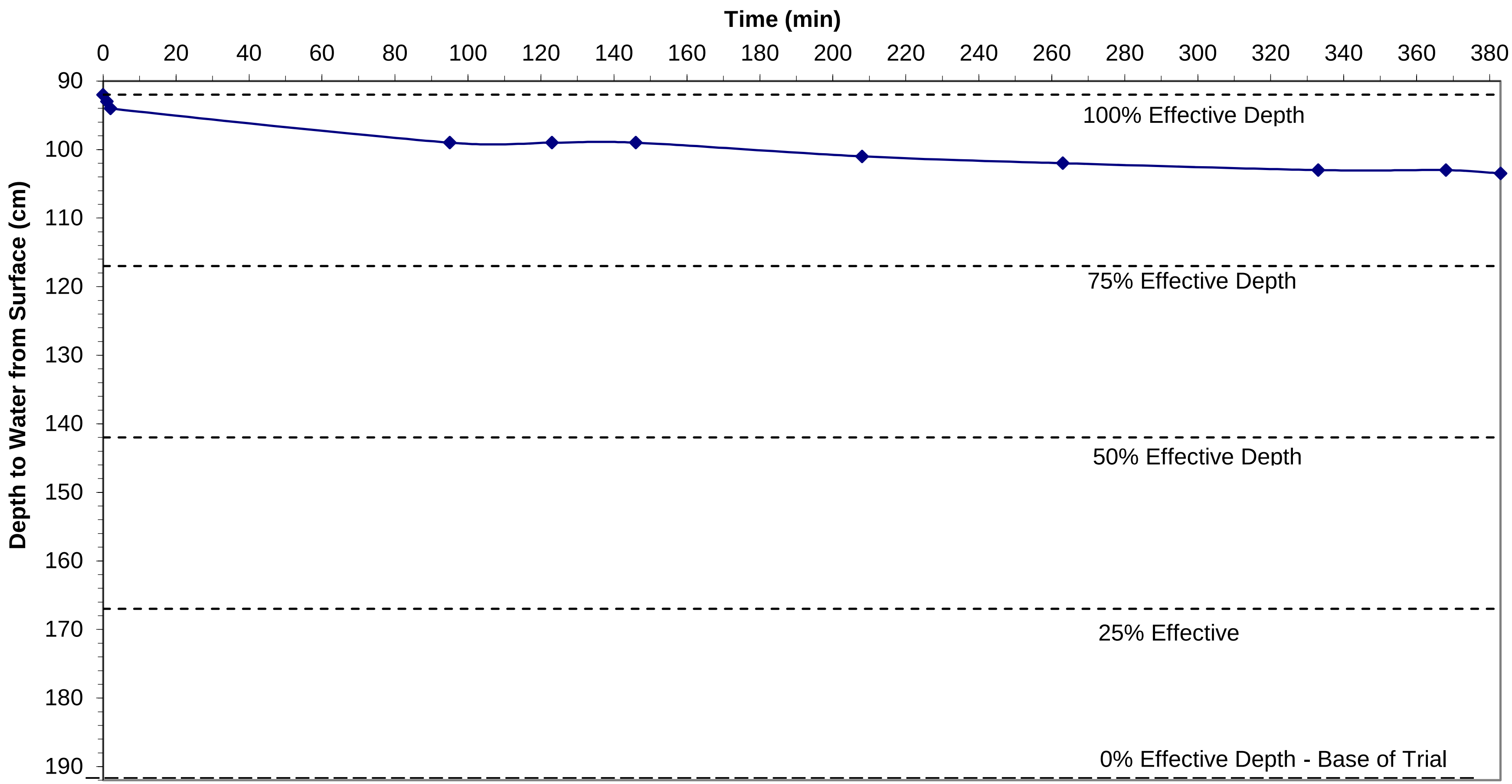


GEG-14-352 Sandleford Park, Newbury. Figure D-10. Infiltration Test Results - TP09 Test 1
Time (min)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
Depth to Water from Surface (cm)
75
85
95
105
115
125
135
145
155
165
175
100% Effective Depth
75% Effective Depth
50% Effective Depth
25% Effective Depth
0% Effective Depth - Base of Trial

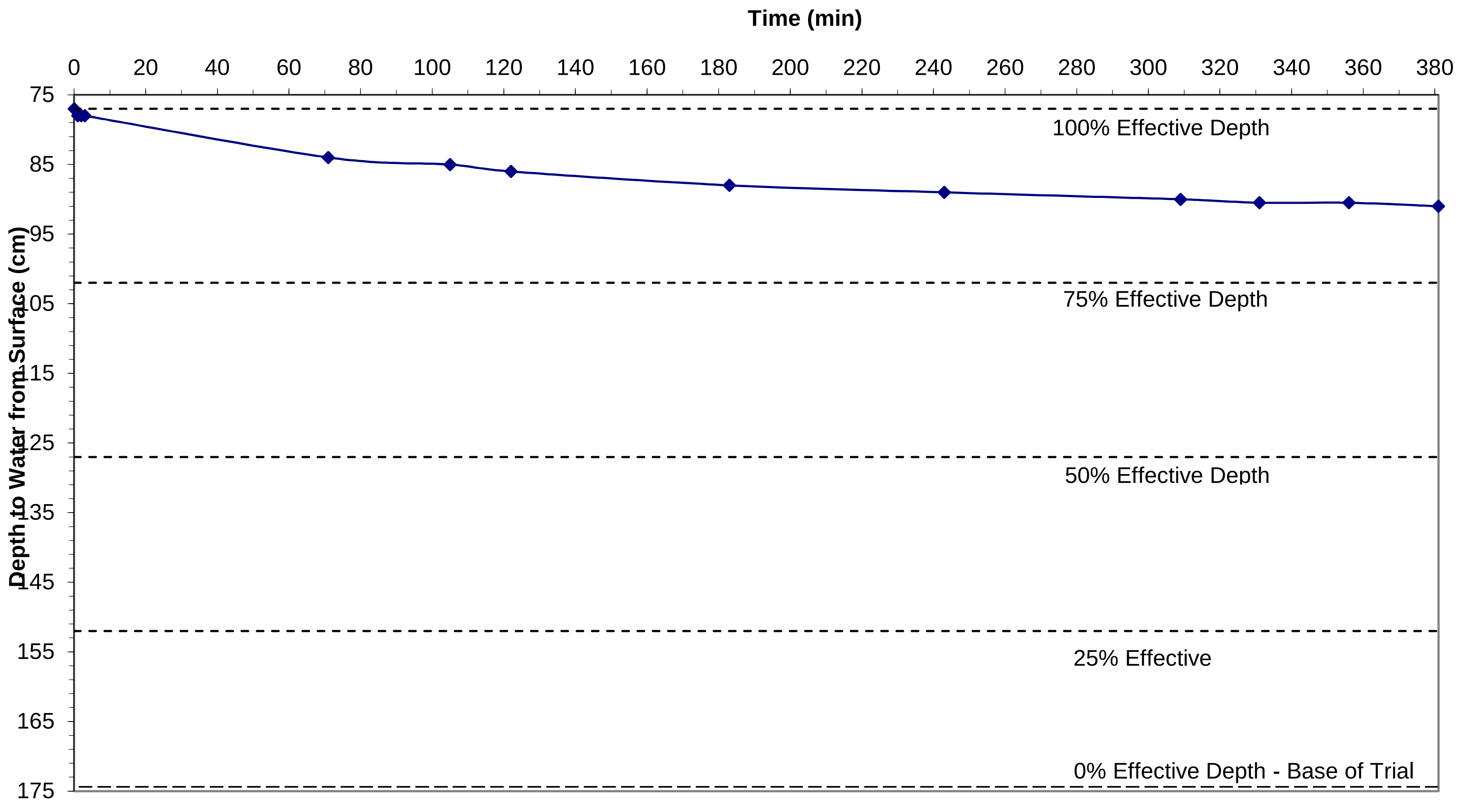
GEG-14-352 Sandleford Park, Newbury. Figure D-11. Infiltration Test Results - TP10 Test 1

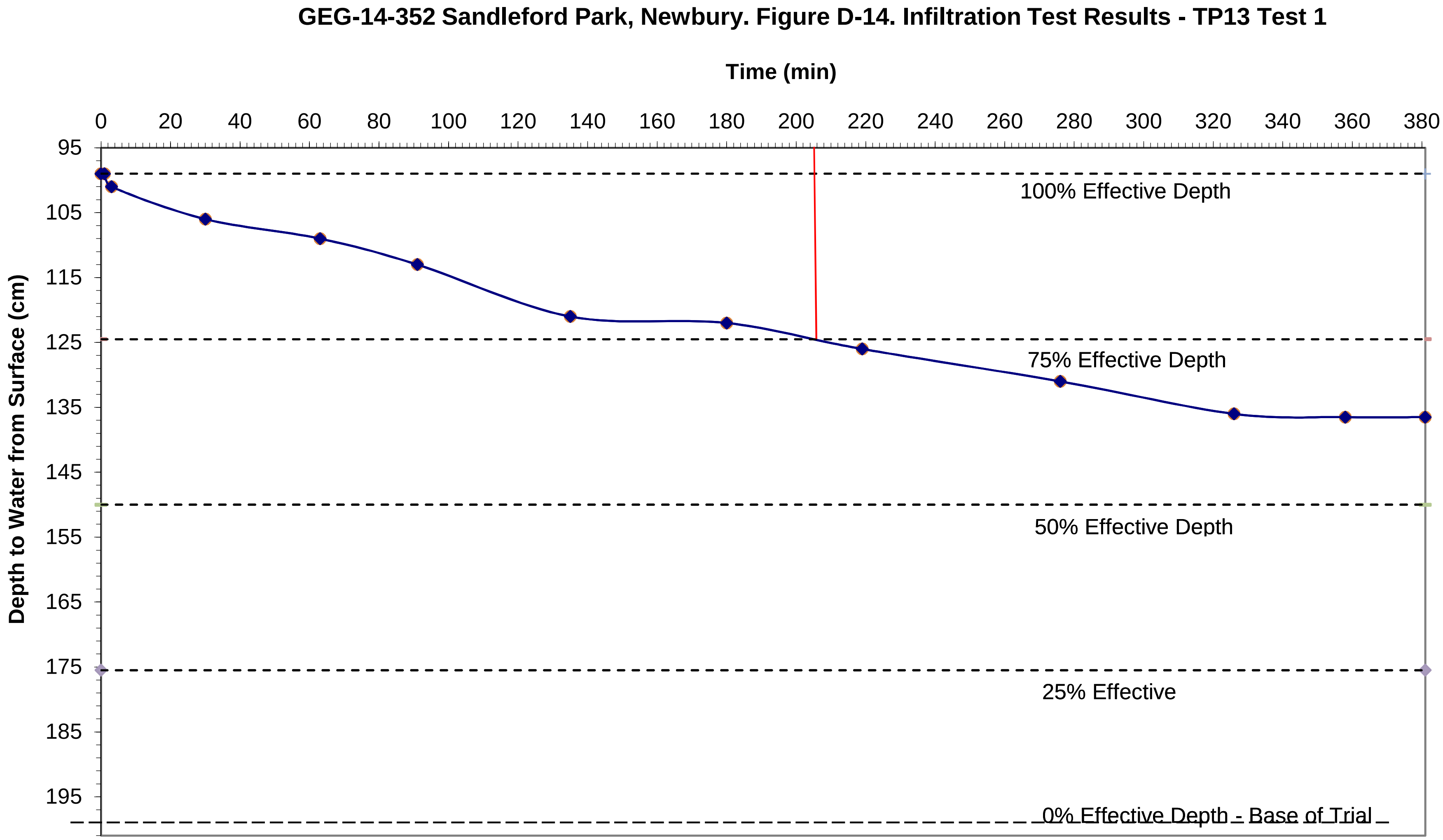


GEG-14-352 Sandleford Park, Newbury. Figure D-12. Infiltration Test Results - TP11 Test 1

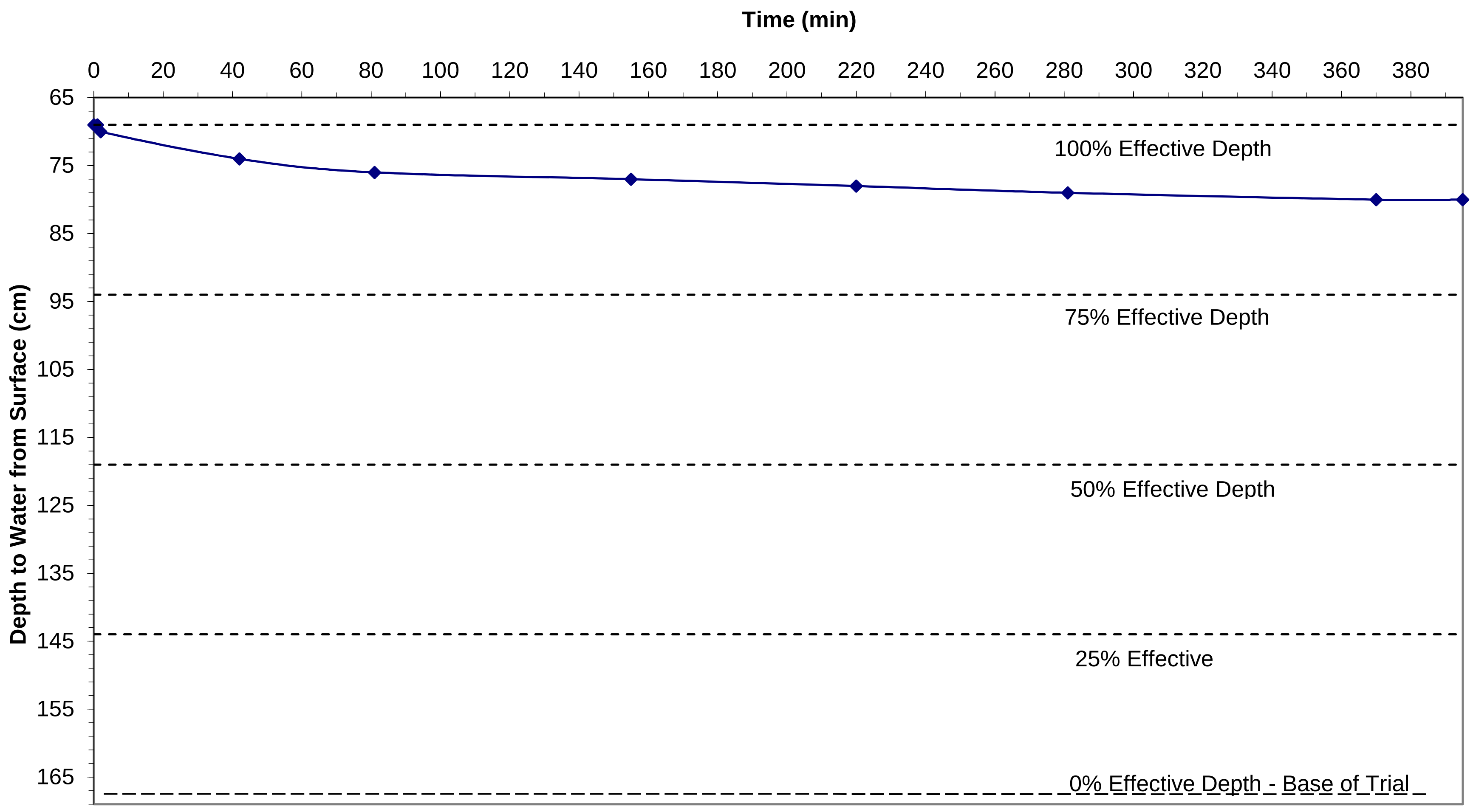


GEG-14-352 Sandleford Park, Newbury. Figure D-13. Infiltration Test Results - TP12 Test 1

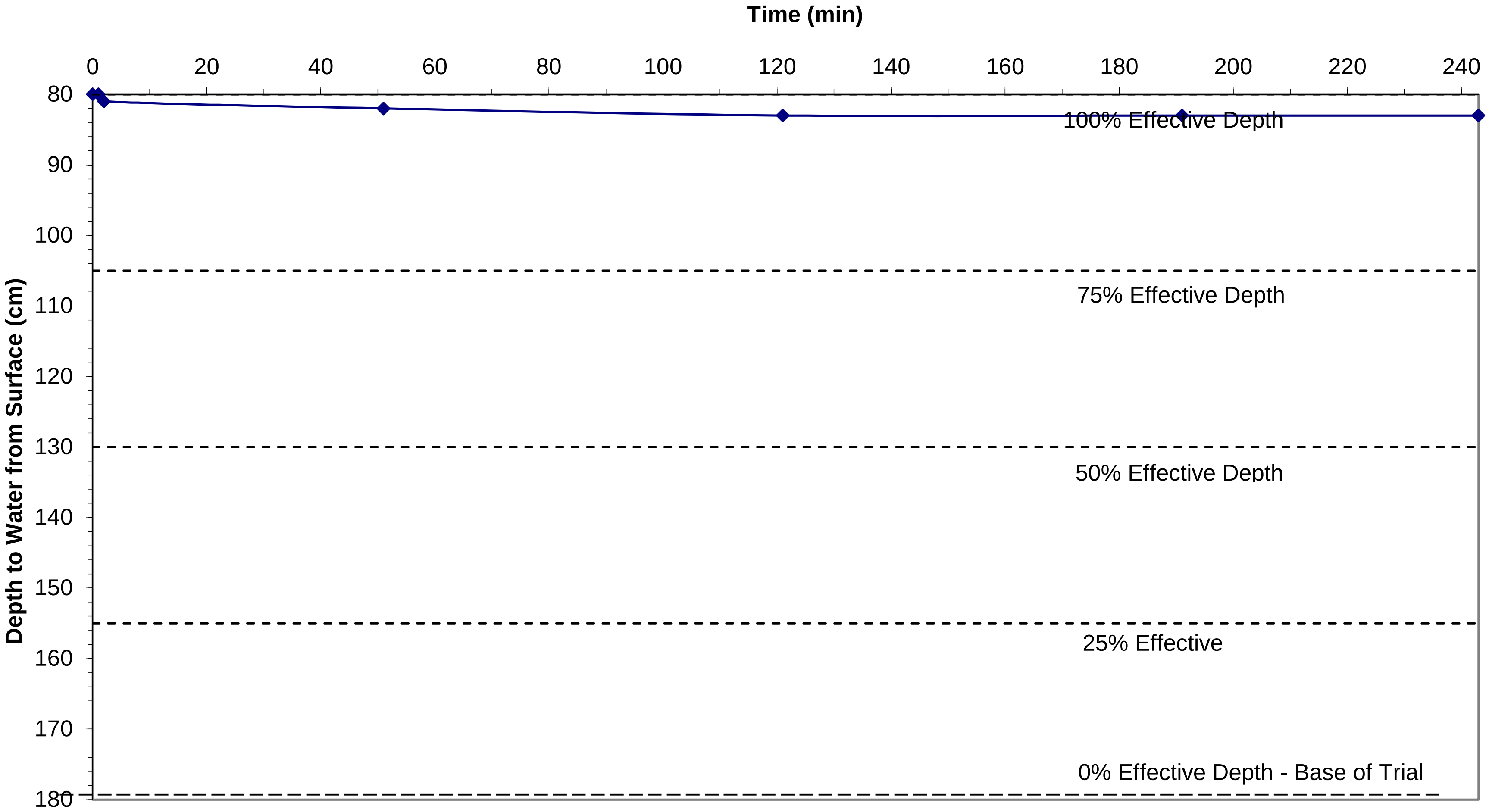



GEG-14-352 Sandleford Park, Newbury. Figure D-14. Infiltration Test Results - TP13 Test 1
Time (min)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
Depth to Water from Surface (cm)
95
105
115
125
135
145
155
165
175
185
195
100% Effective Depth
75% Effective Depth
50% Effective Depth
25% Effective
0% Effective Depth - Base of Trial

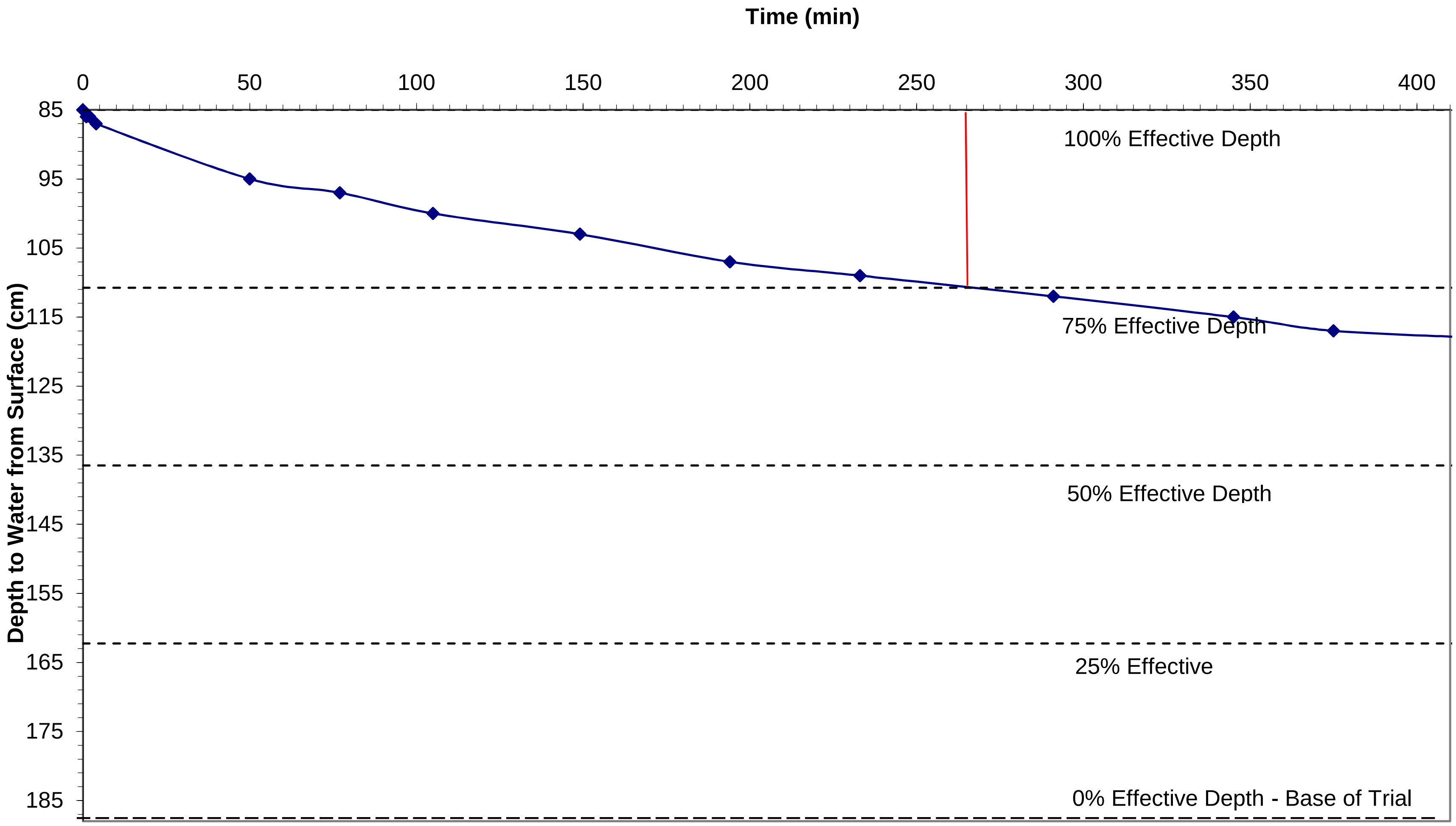
GEG-14-352 Sandleford Park, Newbury. Figure D-15. Infiltration Test Results - TP14 Test 1



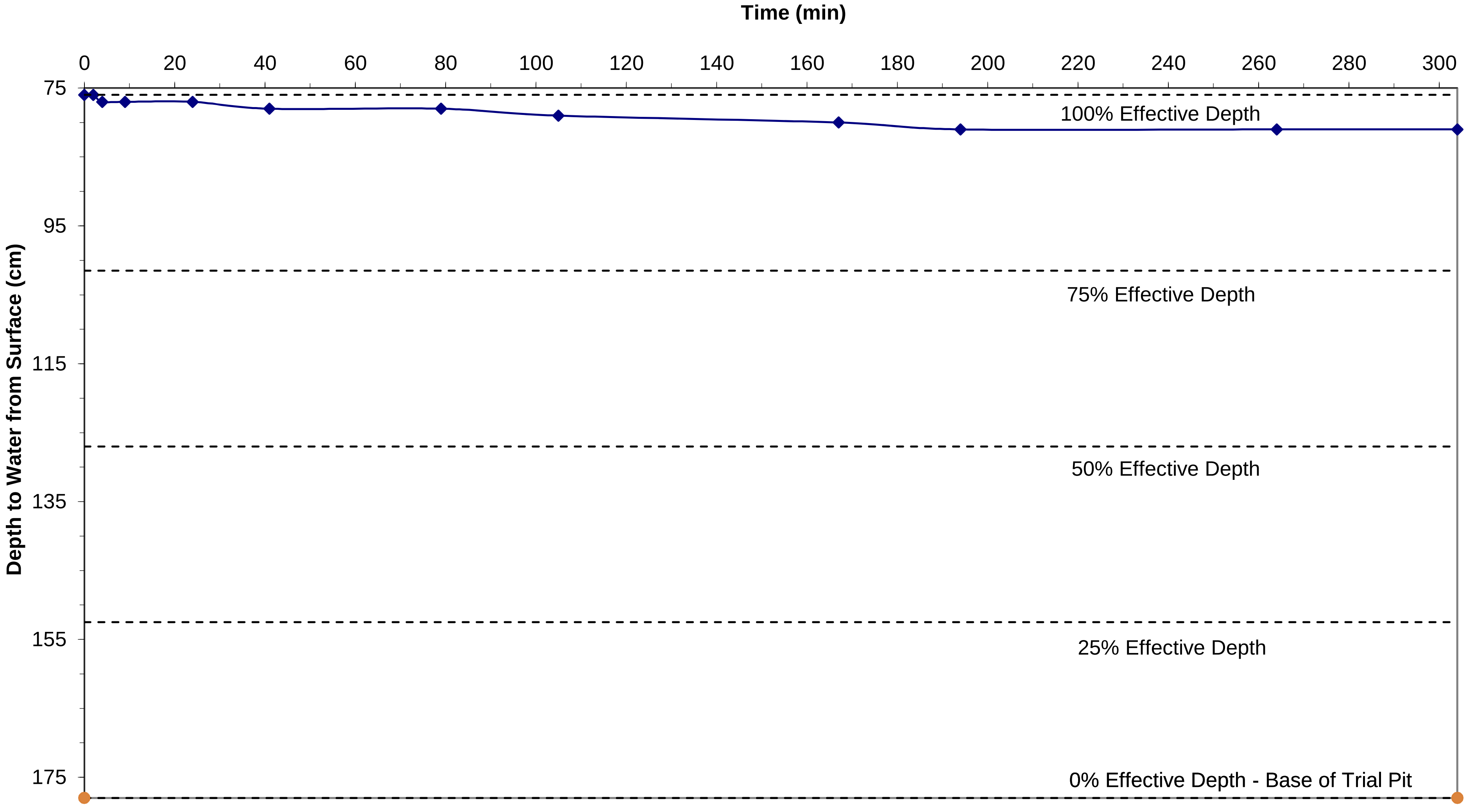
GEG-14-352 Sandleford Park, Newbury. Figure D-16. Infiltration Test Results - TP15 Test 1



GEG-14-352 Sandleford Park, Newbury. Figure D-17. Infiltration Test Results - TP16 Test 1



GEG-14-352 Sandleford Park, Newbury. Figure D-18. Infiltration Test Results - TP17 Test 1



Appendix D
Infiltration Rate Calculations
Sandleford Park, Newbury

Parameter	Symbol	Calculation	Units	TP01 Test 1	TP02 Test 1	TP03 Test 1	TP04 Test 1	TP05 Test 1	TP05A Test 1	TP06 Test 1	TP07 Test 1*	TP08 Test 1	TP09 Test 1
Effective Depth of Trial Pit	d_p		m	1.00	1.00	1.00	1.02	0.99	0.99	1.01	1.00	1.02	1.02
Width of Trial Pit	w		m	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.6
Length of Trial Pit	l		m	2.90	3.20	3.40	3.00	3.00	2.45	3.40	3.31	3.00	3
Volume of Trial Pit	V	$= d_p \times w \times l$	m^3	1.74	1.92	2.04	1.84	1.78	1.46	2.06	1.99	1.84	1.84
Volume of Trial Pit at 50% Effective Depth	$V_{50\%}$	$= V \times 0.5$	m^3	0.87	0.96	1.02	0.918	0.891	0.72765	1.0302	0.993	0.918	0.918
Internal Surface Area of Trial Pit to 50% Effective Depth (including base)	$a_{p50\%}$	$= l \times w + d_p \times (w + l)$	m^2	5.24	5.72	6.04	5.472	5.36	4.4895	6.08	5.896	5.47	5.47
Time to reach 75% Effective Depth	$T_{p75\%}$		min	184	-	-	-	-	353	-	64	-	-
Time to reach 25% Effective Depth	$T_{p25\%}$		min	-	-	-	-	-	-	-	1100	-	-
Time 75% - 25%	$T_{p75\%-25\%}$	$= T_{p25\%} - T_{p75\%}$	min	-	-	-	-	-	-	-	1036	-	-
Infiltration Rate	f	$= V_{50\%} / a_{p50\%} \times (T_{p75\%-25\%})$	m/s	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**2.71E-06**	**N/A**	**N/A**

*Based on extrapolated data

Parameter	Symbol	Calculation	Units	TP10 Test 1	TP11 Test 1	TP12 Test 1	TP13 Test 1	TP14 Test 1	TP15 Test 1	TP16 Test 1	TP17 Test 1
Effective Depth of Trial Pit	d_p		m	1.02	1.00	1.00	1.02	1.00	1.00	1.03	1.02
Width of Trial Pit	w		m	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Length of Trial Pit	l		m	2.80	3.30	3.20	3.10	3.35	3.40	3.40	3.50
Volume of Trial Pit	V	$= d_p \times w \times l$	m^3	1.71	1.98	1.92	1.90	2.01	2.04	2.10	2.14
Volume of Trial Pit at 50% Effective Depth	$V_{50\%}$	$= V \times 0.5$	m^3	0.8568	0.99	0.96	0.9486	1.005	1.02	1.0506	1.071
Internal Surface Area of Trial Pit to 50% Effective Depth (including base)	$a_{p50\%}$	$= l \times w + d_p \times (w + l)$	m^2	5.15	5.88	5.72	5.634	5.96	6.04	6.16	6.282
Time to reach 75% Effective Depth	$T_{p75\%}$		min	-	-	-	205	-	-	265	-
Time to reach 25% Effective Depth	$T_{p25\%}$		min	-	-	-	-	-	-	-	-
Time 75% - 25%	$T_{p75\%-25\%}$	$= T_{p25\%} - T_{p75\%}$	min	-	-	-	-	-	-	-	-
Infiltration Rate	f	$= V_{50\%} / a_{p50\%} \times (T_{p75\%-25\%})$	m/s	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**

SEWER IMPACT STUDY

X4503 – 1162

SMG 841

PROPOSED CONNECTION AT LAND SOUTH OF MONKS LANE, NEWBURY PHASE 2

FOUL SYSTEM

V1.0 August 2016

Prepared by:	Kishor Patil
Checked by:	Pugazh Thayumanavan
Reviewed by:	Graham Moralee
Amended and Approved by:	TWUTIL

Asset Modelling and Strategy Team
Wastewater SPA
Thames Water Utilities Ltd, Reading STW,
Island Road, Reading, Berks. RG2 ORP

Contents

Appendices

1.0 Introduction

The following report was commissioned by Thames Water's Developer Services to investigate the capacity within the existing foul network and to ascertain the impact of a proposed new connection on the foul network at Land South of Monks Lane, Sandleford Park, Newbury. A study was previously completed in 2010 and this study is to update the previous findings.

The scope of the study is to undertake a preliminary desktop study based upon an existing hydraulic model.

The scope of the study includes:

- Check the current performance of the existing network during both dry and wet weather events.

- Add development flows to the model and check the impact of additional flow to the sewer network during both dry and wet weather events.

- Suggest possible options to allow flows to be accepted into the existing network with no detriment to existing levels of service. It should be noted that these options are indicative and are likely to be subject to change based on site conditions, other utilities and requirements of third parties. However, the options indicate the feasibility of connecting the site to the sewerage system and the ability of the sewerage system to accept the development.

2.0 Background

The proposed new development is on a Greenfield site and the Developer proposes to accommodate 2,000 new residential properties, 2,850m^2 of commercial space, two schools with a total of 1,108 pupils and an 80 bed care home. The development area is situated in the town of Newbury, West Berkshire.

The development area is bounded by Monks Lane to the north, Newtown Road (A339) to the east and the River Enborne to the south.

The foul flow from the residential and non-residential properties in the development area has been calculated, using the latest Thames Water guidelines, as a pumped flow of 44.1l/s. The average inflow including peak infiltration from residential properties has been calculated as 12.2l/s with a peak inflow of 20.0l/s. The average inflow including peak infiltration from the non-residential properties has been calculated as 3.4l/s.

The preferred connection point was determined by the Developer as manhole SU47653301, located to the north-east of the development site.

A plan showing the location of the development and connection point is provided in Appendix A.

3.0 Existing Sewerage System and Treatment Works

The area in the vicinity of the development site is served by a separate foul and surface water sewer network.

From the development site, flows would be pumped to the connection manhole. From here, flows would gravitate in a northerly direction towards London Road (Newbury) Sewage Pumping Station (SPS).

Flows ultimately arrive at Newbury Sewage Treatment Works (STW), which is located approximately 5.6km to the north-east of the development site.

Flows would travel through sewers ranging from 225mm diameter to 525mm diameter from the development area towards Newbury STW.

The local foul sewers are shown in the plan provided in Appendix B.

4.0 Thames Water Drainage Requirements

It is necessary to provide separate foul and surface water drainage systems and to ensure that each system is connected to an appropriate drainage system.

This study considers the impact of foul flows discharging from the new development.

As the Developer proposes to connect only foul flows into the existing network, this report only covers the impact of the foul sewage flows from the proposed development on the existing foul sewer networks adjacent to and downstream of the proposed development. Surface water flows from the proposed development are not considered in this report and should not be connected to the foul sewer network.

The Developer is expected to follow the Local Authority's drainage hierarchy and be able to demonstrate how the proposed discharge rate of any surface water flows has been calculated.

Additional development flows should not cause new or additional flood risk to the existing system in either dry or wet weather.

5.0 Sewer Impact Assessment

Assessment of the hydraulic loading of the foul network was carried out by means of an existing hydraulic model.

The proposed new development area and connection point details were added to the model and the assessment completed to identify the impact of the proposed new development.

The analysis of the catchment indicates that the foul network is responsive to rainfall, with flooding being a risk in the catchment.

The impact of the proposed foul connection was assessed based on the design flows detailed in Section 2.0.

5.1 Foul Sewers

5.1.1 Assessment of Existing Catchment

The hydraulic model indicates that the existing foul network does not have available capacity in the network downstream of the proposed connection manhole. The hydraulic model has been used to assess wet weather scenarios of various durations. During these wet weather events, the hydraulic model predicts network surcharge and flooding to occur.

5.1.2 Assessment of Development Catchment

An analysis has been completed to assess the impact of connecting the flows from the development into the public sewer.

Table 1: Proposed Development Connection Details

Connection	Manhole	Diameter of Outgoing Sewer
Development Site	SU47653301	225mm

5.1.3 Foul System Improvement Works

The hydraulic model indicates that the foul network does not have available capacity in the network downstream of the proposed connection manhole to accept the proposed development flows. On inclusion of the additional flows from the development site, a decrease in the levels of service at multiple locations is predicted to occur.

One indicative option has been developed to prevent the detrimental impact on the existing system. This option has been developed during a preliminary desktop investigation, using the hydraulic model only. The solution identified is intended to indicate the likely extent and magnitude and the network enhancement required to mitigate the predicted detriment and thus inform negotiations between the Developer and Thames Water over the feasibility and likely cost of the connection. A detailed design is required to confirm the size, location and performance of the indicative option before proceeding with any construction. Detailed design may also indicate alternative options.

Option – Off-line Storage and local online upsizing (See Appendix C for Plan)

- Connect development flows to manhole SU47653301 at a pumped rate of 44.1l/s.
- Offline Storage at London Road SPS:
  - Provide approximately 1,671m^3 off-line storage in the green area adjacent to London Road (Newbury) SPS, located at Faraday Road. Flows would enter the storage via a low level weir constructed within manhole SU47676411, set at a spill level of 71.25m AOD. Flows would need to be pumped back to the existing sewer network at manhole SU47676411
- Local sewer upsize outside of the development at Newtown Road
  - Upsize foul sewer to a diameter of 375mm between manholes SU47653202 and SU47652301 for a length of 163m
- Local sewer upsize at Newbury Train Station at Station Road
  - Upsize foul sewer to a diameter of 375mm between manholes SU 47662601 and SU 47663707 for a length of 83m
  - Upsize foul sewer to a diameter of 300mm between manholes SU47661601 and SU47663708 for a length of 149m

Due to the size of the proposed development Thames Water require 2 permanent depth loggers to be installed to monitor the flows at the downstream point of the development site and also at the proposed connection point. The depth loggers need to feed into the Thames Water telemetry systems and need to fulfil Thames Water specifications.

[Note: As part of the optioneering process Thames Water have also considered alternative and linked up solutions which we wish to discuss further with the developer.]

6.0 Risks and Issues

The proposed development site is located within the Environment Agency's Risk of Flooding from Surface Water and Risk of Flooding from Rivers areas and the drainage of the site is therefore at risk of surface water ingress. The Developer should undertake necessary measures to ensure that the foul sewers are adequately protected against surface water ingress.

7.0 Pre-Construction Information

It should be noted that this is a hydraulic modelling desktop study. CDM Regulations do not apply at this high level design stage. The hydraulic modelling team has not undertaken site visits to identify H&S issues related to the proposed high level solution.

H&S issues to be considered in the outline and detailed design of the project as per the current CDM Regulations.

8.0 Conclusions

The desktop study has investigated and identified the implications of the proposed new development on a Greenfield site at Land South of Monks Lane, Sandleford Park, Newbury to the existing foul network.

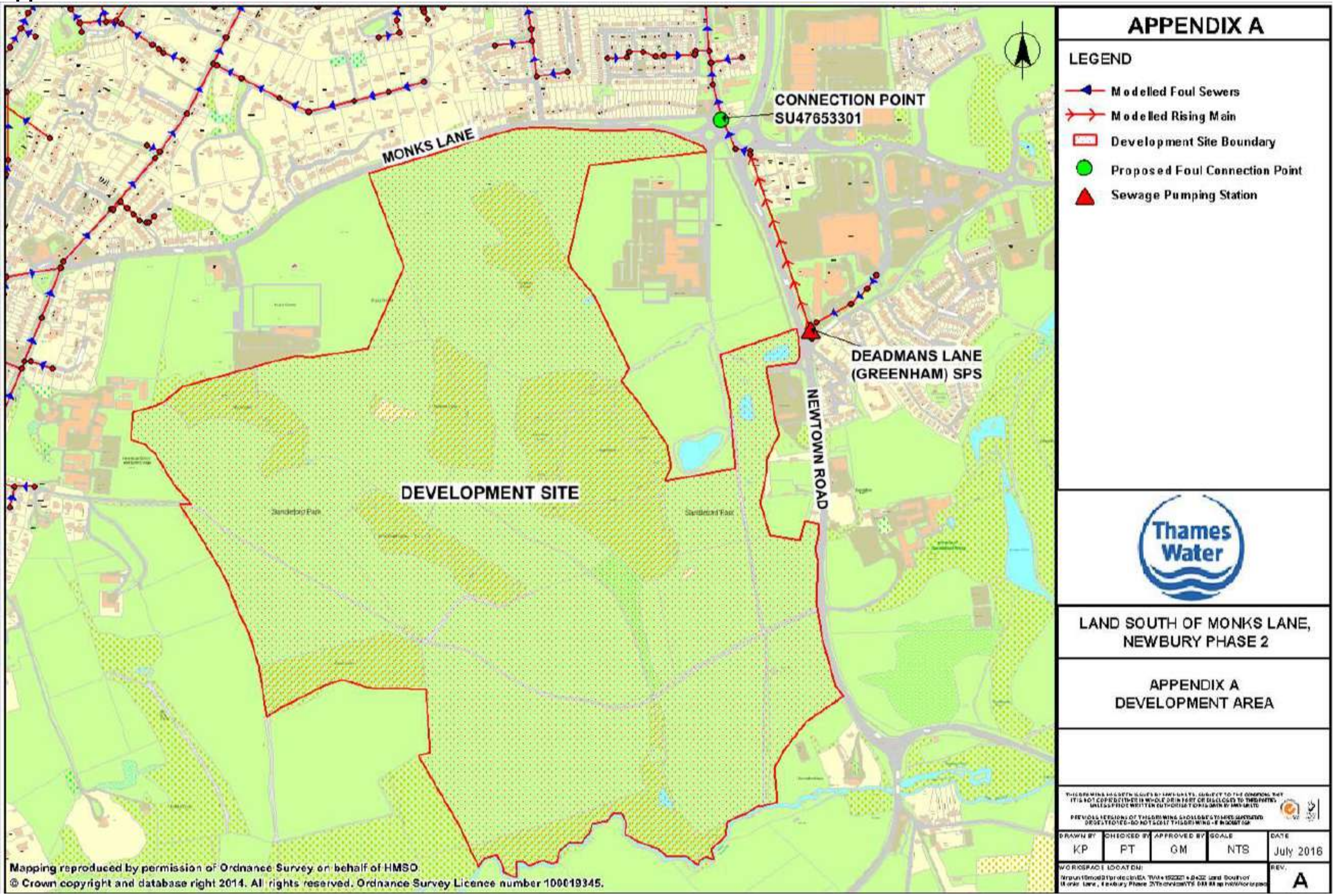
The hydraulic model indicates that the foul network does not have available capacity in the network downstream of the proposed connection manhole to accept the proposed development flows.

Improvements to the existing foul network are required to enable the proposed connection to the sewer network, without causing any detriment to the level of service provided. The proposed indicative option resolves the modelled increase in flooding and surcharge on the sewer network.

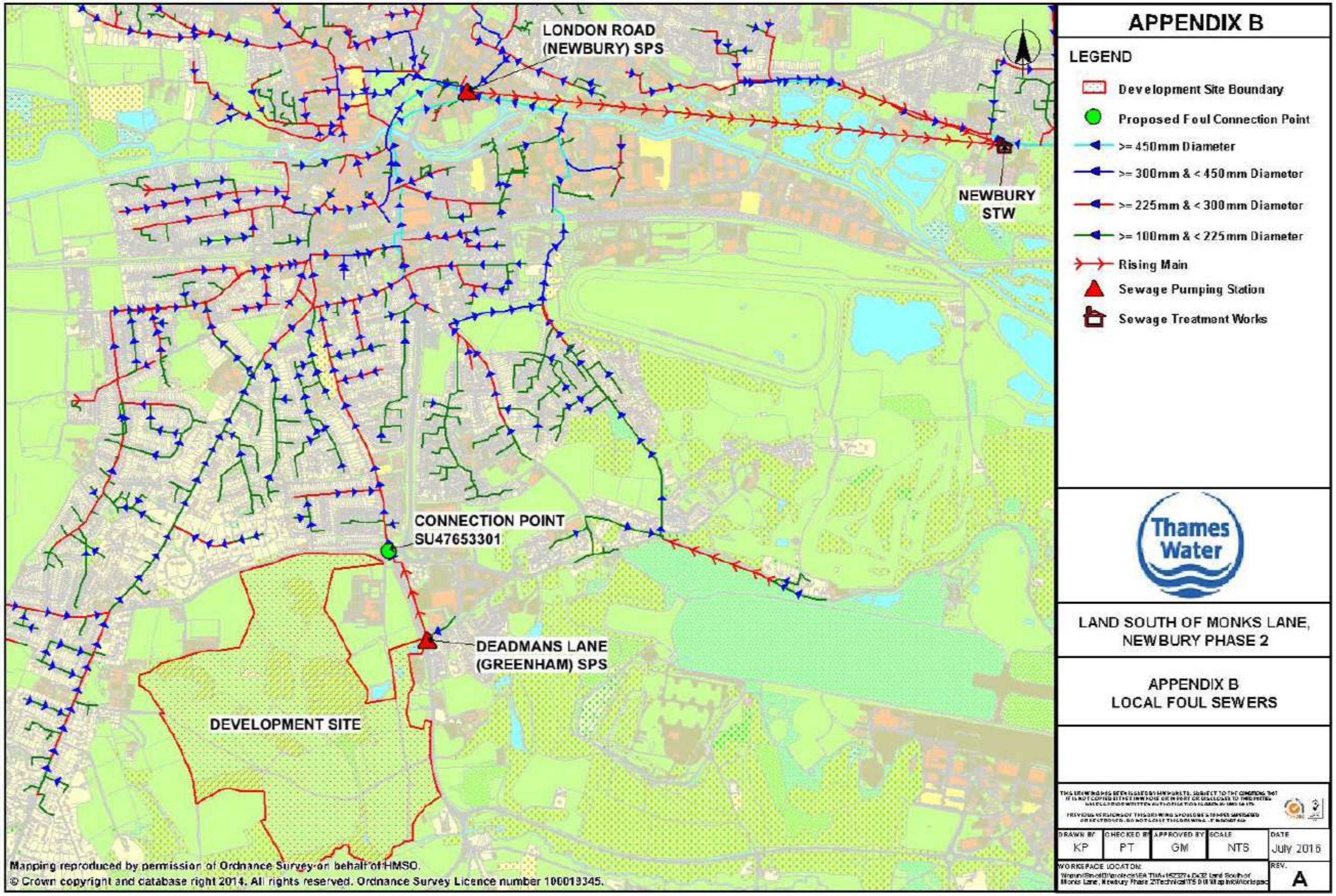
Due to the size of the proposed development Thames Water require 2 permanent depth loggers to be installed to monitor the flows at the downstream point of the development site and also at the proposed connection point. The depth loggers need to feed into the Thames Water telemetry systems and need to fulfil Thames Water specifications.

The issues highlighted and discussed throughout this report are recommendations to Thames Water Utilities and may be altered/added to based upon local operational knowledge of the system.

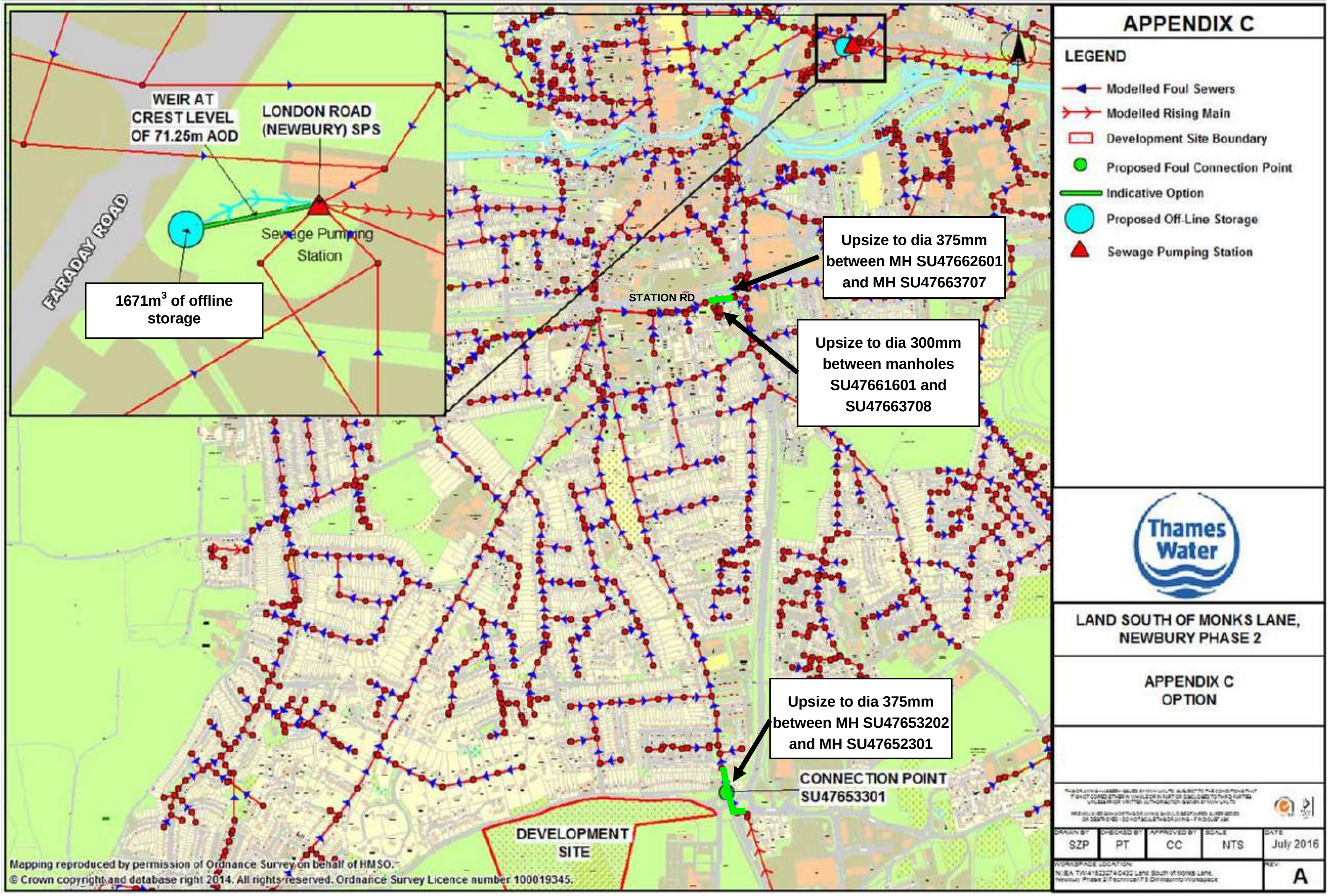
Appendix A – Site Plan



Appendix B – Local Sewers



Appendix C – Connections and Improvements – Option



Appendix D – Project Inputs Provided by the Developer