Rossi Long Consulting

Flood Risk Assessment and Surface Water Drainage Strategy for:

Bicester Healthcare Hub

Graven Hill

Bicester

Oxfordshire

RLC Ref. 191607 [Rev 01]

March 2021

Prepared for

Bicester HC Development Ltd

Revision Schedule

RLC Ref. 191607

March 2021

Rev	Date	Details	Prepared by	Reviewed by
00	26 February 2021	Flood Risk Assessment & Drainage Strategy - Initial Issue	**Paul Cosford** CEng, MICE, MCIHT Technical Director	**Mike Lloyd** BEng(Hons), CEng, MIStructE Director
01	19 March 2021	Drainage strategy and calculations amended	Paul Cosford CEng, MICE, MCIHT Technical Director	Mike Lloyd BEng(Hons), CEng, MIStructE Director

[redacted]

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Table of Contents

1 Introduction and Client's Brief

1.1 This Flood Risk Assessment has been prepared by Rossi Long Consulting Ltd, on behalf of Bicester HC Projects Development Ltd, to support a planning application for the construction of a new Healthcare Hub at Graven Hill, Bicester, Oxfordshire.

1.2 The development is to comprise a new Healthcare Hub building of 3,350m² gross floor area with associated staff and visitors parking. A new entrance is to be formed on to the wider Graven Hill village infrastructure roads.

1.3 When determining planning applications, the Local Planning Authority should ensure flood risk is not increased as a result of the development. A site-specific Flood Risk Assessment is required for proposals of one hectare or greater in Flood Zone 1 and all proposals for new development in Flood Zones 2 and 3.

For major development greater than 0.5 hectares, the Lead Local Flood Authority is a statutory consultee and will comment on surface water flood risk and surface water drainage proposals.

1.4 The proposed site layout is shown on the Architect's drawing included at Appendix A.

1.5 This report is compiled with the benefit of our findings from desk study research, topographical survey, and with reference to site investigation undertaken by Geotechnical Engineering Ltd.

2 Site Description

2.1 The site is currently a vacant development plot within the Graven Hill village development adjacent to the A41. The majority of the site is open grassland, with a small area used as a site compound for construction activities on the wider Graven Hill site.

2.2 The site is located within an existing ongoing development area comprising residential housing and local amenities. The site has an area of 1.05 hectares (Ha) and is located at Ordnance Survey grid reference SP589212. A location plan is shown below:

Location Plan

2.3 Levels across the site are generally flat, with a slight fall from west to east. Levels fall from 68.0m down to 67.5m, with no discernible fall north/south. A site survey drawing is included as Appendix B.

3 Planning Policy and Flood Risk

3.1 The National Planning Policy Framework (NPPF) was published by the Department for Communities and Local Government in March 2012 and updated in February 2019. NPPF requires that flood risk is taken into account in the planning process, to avoid inappropriate development in areas at risk of flooding and to direct development away from areas at highest risk. The overall aim should be to steer new development towards Flood Zone 1.

3.2 Flood Zone 1 is a low probability flood zone defined as land having a less than 1 in 1000 annual probability of river or sea flooding (shown as 'clear' on the flood map – all land outside Flood Zones 2 & 3).

Flood Zone 2 is a medium probability flood zone defined as land having between a 1 in 100 and 1 in 1000 annual probability of river flooding; or land having between a 1 in 200 and 1 in 1000 annual probability of sea flooding (land shown 'light blue' on the flood map).

Flood Zone 3a is a high probability flood zone defined as land having a 1 in 100 or greater annual probability of river flooding; or land having a 1 in 200 or greater annual probability of sea flooding (land shown 'dark blue' on the flood map).

3.3 From Environment Agency flood zone mapping it is confirmed that the site is situated in Flood Zone 1 – a copy of the map is included in section 6.1.

3.4 There are no restrictions to the type of development permitted within Flood Zone 1.

The Government's Planning Practice Guidance permits certain types of developments within the other two higher probability zones, Zone 2 (medium) and Zone 3 (high), subject to the type of development and mitigation measures being put in place.

Table 2 "Flood Risk Vulnerability Classification" of Paragraph 066 (Reference ID: 7-066-20140306) of the above guidance sets out these development types and categorises them as follows:

a) Essential Infrastructure

b) High Vulnerability

c) More Vulnerable

d) Less Vulnerable

e) Water Compatible Development

The guidance defines "hospitals and healthcare service buildings" as 'more vulnerable' development.

Table 3: Flood risk vulnerability and flood zone 'compatibility' (Paragraph 067 Reference ID: 7-066-20140306)

Flood risk vulnerability classification (see table 2)		Essential infrastructure	Water compatible	Highly vulnerable	More vulnerable	Less vulnerable
Flood zone (see table 1)	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	✓	Exception Test required	✓	✓
	Zone 3a	Exception Test required	✓	x	Exception Test required	✓
	Zone 3b functional floodplain	Exception Test required	✓	x	x	x

Key: ✓ Development is appropriate x Development should not be permitted

'More vulnerable' development is appropriate in Flood Zone 1 and the Exception Test is not required.

Properly prepared assessments of flood risk will inform the decision-making process at all stages of development planning. A Strategic Flood Risk Assessment is a study carried out by one or more local planning authorities to assess the risk to an area from flooding from all sources, now and in the future, taking account of the impacts of climate change, and to assess the impact that changes or development in the area will have on flood risk. It may also identify, particularly at more local levels, how to manage those changes to ensure that flood risk is not increased. A site-specific Flood Risk Assessment is carried out by, or on behalf of, a developer to assess the risk to a development site and demonstrate how flood risk from all sources of flooding to the development itself and flood risk to others will be managed now, and taking climate change into account.

3.5 For site-specific Flood Risk Assessments, the main study requirement is to identify the flood zone and vulnerability classification relevant to the proposed development, based on an assessment of current and future conditions. A site-specific Flood Risk Assessment must demonstrate that the development will be safe for its lifetime, taking account of the vulnerability of its users without increasing flood risk elsewhere and, where possible, will reduce flood risk overall.

3.6 For sites in Flood Zone 1, the Flood Risk Assessment is principally required to consider the management of surface water run-off together with flood risk from sources other than rivers and the sea. Surface water arising from a developed site should, as far as practicable, be managed in a sustainable manner to mimic the surface water flows arising from the site prior to the proposed development, while reducing the flood risk to the site itself and elsewhere, taking climate change into account.

4 Ground Conditions

4.1 British Geological Survey (BGS) mapping shows that the regional geology comprises a bedrock of Peterborough Member – Mudstone. No superficial deposits are indicated to overlay the Mudstone.

4.2 A site investigation has been undertaken by Geotechnical Engineering Ltd to advise on ground conditions. Exploratory boreholes and trial holes were undertaken across the Graven Hill development area, with the results confirming the BGS data and revealing clay subsoil at depths of up to 8.0m below ground level (bgl). The borehole and trial pit records most relevant to the site are included at Appendix C.

4.3 BRE 365 infiltration testing was undertaken as part of the site investigation for the wider Graven Hill development, and none of the tests returned a positive result. Due to this, the site-wide surface water drainage strategy comprises positive drainage into strategic detention basins which discharge at restricted rates into an existing watercourse network which serves the area.

4.4 The infiltration test results are included in Appendix C, with those most relevant to the site being TP543 & TP548.

5 Existing Drainage

5.1 The Graven Hill development is served by a foul sewer network maintained by Anglian Water, and a private surface water system. The surface water system is designed to collect run-off from the individual development plots within Graven Hill and convey it to detention basins; from where, it is discharged at restricted rates into the local watercourse network. A plan showing the foul and surface water drainage in the vicinity of the site is included in Appendix D with an extract shown below:

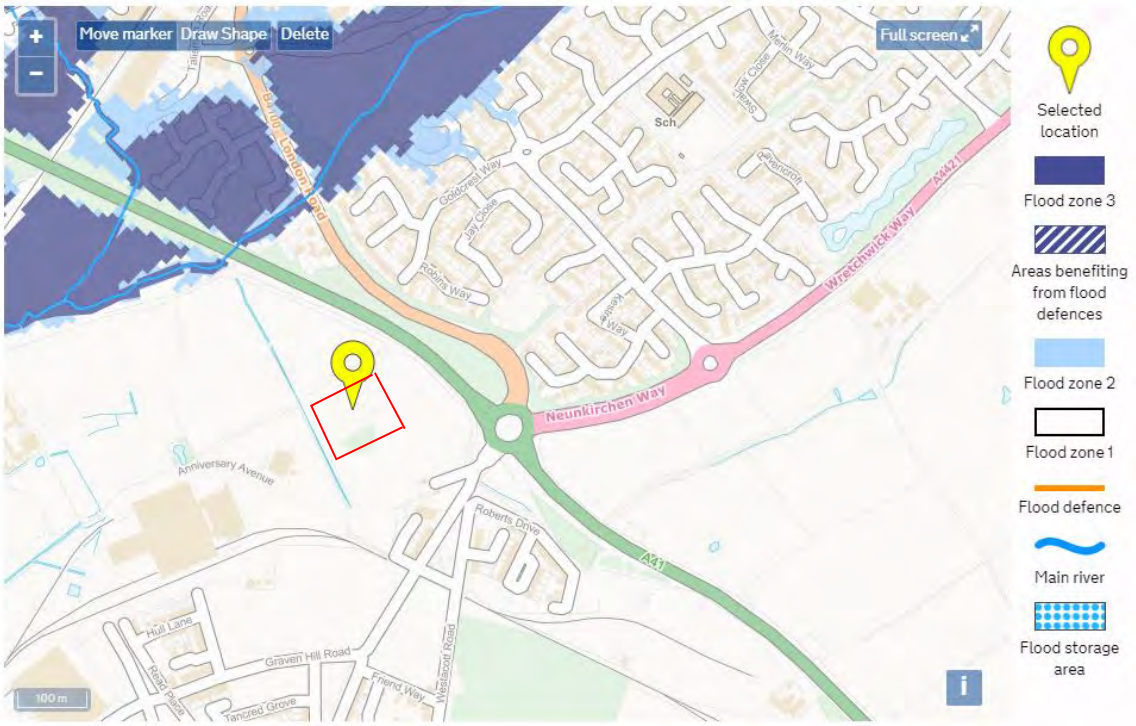
Extract from Development Infrastructure As-Built Records

5.2 The above plan shows that a foul sewer is located immediately adjacent to the western boundary of the site. The manhole allocated for connection is F2402b, which has a cover level of 67.390 and an invert level of 64.899.

5.3 Surface water run-off from the site is to discharge directly into the section of existing watercourse located immediately to the west of the site. An agreed flow rate of 11.0 l/s/ha is to be used in the design of the proposed drainage system, this rate is confirmed in the Waterman Surface Water Strategy Document dated September 2015. The existing watercourse forms part of the overall site drainage strategy detailed in the Report, a copy of the Drainage Strategy drawing prepared by Waterman is included in Appendix D.

6 Flood Risk Sources

6.1 Fluvial Flooding: The site is not at risk of flooding from rivers or tidal sources, as indicated on the flood zone mapping below:

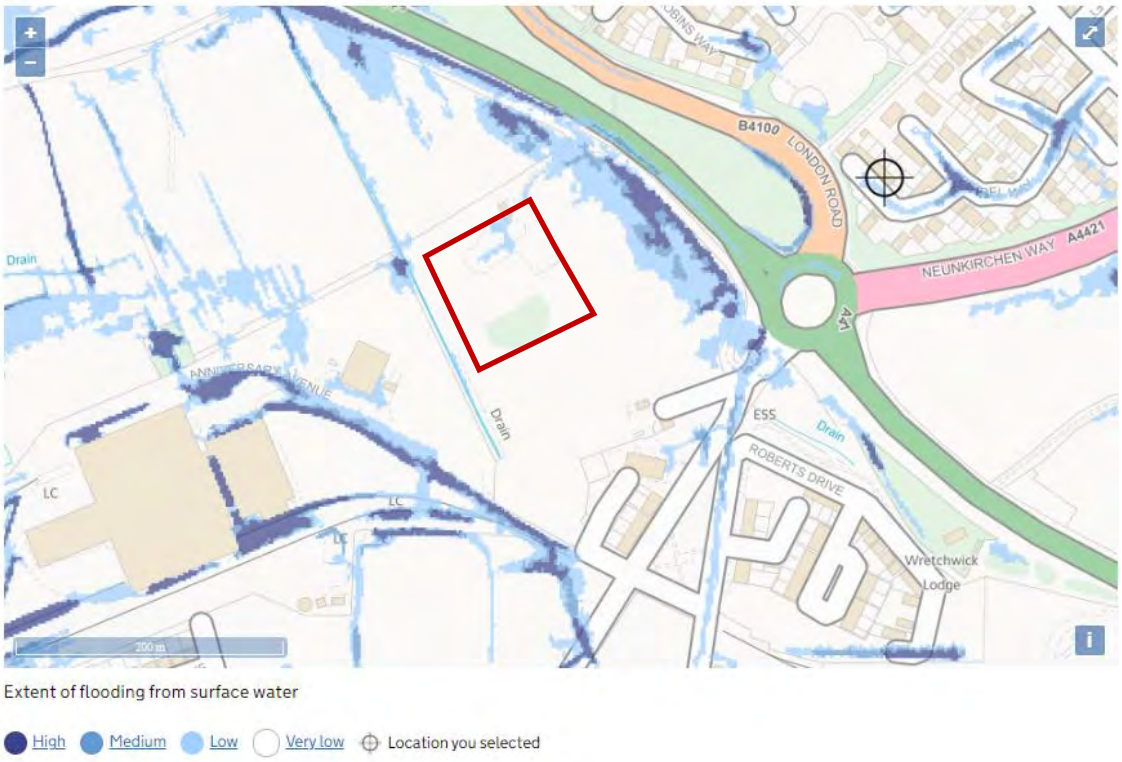


Flood Zone Map

The flood zone mapping shows that site is situated in Flood Zone 1. Flood Zone 1 is a low probability flood zone and comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (< 0.1%).

6.2 Groundwater flooding occurs when water levels in the ground rise above surface elevations. Groundwater was not encountered during site investigations and the underlying ground conditions of clay would indicate that the risk from groundwater flooding is 'low'.

6.3 Surface water flooding occurs when intense rainfall is unable to soak into the ground or enter drainage systems but lies on or flows over the ground instead. The Environment Agency publishes mapping showing the risk of flooding from surface water. An extract of this mapping is shown below and confirms that the site is generally at 'very low' risk of surface water flooding. 'Very low' risk means that each year this area has a chance of flooding of less than 0.1% (< 1 in 1000):



Extract from Surface Water Flood Map

A small area of 'low' risk flooding is indicated in the north of the site, this corresponds with the location of the existing area of hardstanding. This hardstanding will be removed prior to construction of the new development. The area of flooding is isolated and not linked to a wider issue, and is likely a result of the lack of gradient across the site.

6.4 From our review of Ordnance Survey mapping of the site and the surrounding area, our assessment is that there are no significant flood risks to the site from reservoirs, canals or other artificial sources. This is confirmed by reference to Environment Agency online mapping.

6.5 As far as we have been able to establish, there has been no history of flooding in the area of the site. All sources of flooding listed in the Government's online Planning Practice Guidance have been considered. The site is at 'low' risk of flooding from all sources.

7 Proposed Surface Water Drainage

7.1 The Building Regulations Approved Document H3 requires that rainwater from buildings and paved areas 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.

The Building Regulations therefore adopt a design philosophy that accords with sustainable drainage systems (SuDS).

7.2 The National Planning Policy also requires that, for planning applications relating to major development (development of 10 dwellings or more) or equivalent non-residential or mixed development, sustainable drainage systems for the management of run-off are put in place, unless demonstrated to be inappropriate. Sustainable drainage is an approach to managing surface water run-off which seeks to mimic natural drainage systems and retain water on or near the site, as opposed to traditional drainage approaches which involve piping water off-site as quickly as possible. SuDS involves a range of techniques including soakaways, infiltration trenches, permeable pavements, grassed swales, ponds and wetlands. SuDS offers significant advantages over conventional pipe drainage systems in reducing flood risk by attenuating the rate and quantity of surface water run-off from a site, promoting groundwater recharge and improving water quality and amenity.

Planning Practice Guidance considers what sort of sustainable drainage system should be considered. Generally, the aim should be to discharge surface run-off as high up the following hierarchy of drainage options as reasonably practicable:

1) Into the ground (infiltration);

2) To a surface water body;

3) To a surface water sewer, highway drain or another drainage system;

4) To a combined sewer.

Particular types of sustainable drainage systems may not be practicable in all locations.

This hierarchy follows the same order of priority of Approved Document H3 of the Building Regulations.

7.3 Oxfordshire County Council is the Lead Local Flood Authority (LLFA) for this area and the Local Planning Authority (LPA) should consult with the LLFA on surface water drainage. CIRIA has published guidance on the use of sustainable drainage systems, which is an approach to managing surface water run-off which seeks to mimic natural drainage systems and retain water on or near the site, as opposed to traditional drainage approaches which involve piping water off-site as quickly as possible. SuDS involves a range of techniques including soakaways, infiltration trenches, permeable pavements, grassed swales, ponds and wetlands. SuDS offers significant advantages over conventional pipe drainage systems in reducing flood risk by attenuating the rate and quantity of surface water run-off from a site, promoting groundwater recharge and improving water quality and amenity.

7.4 Site investigation has been completed, and ground conditions generally comprising clay have been confirmed on the site. The findings represent the bedrock deposits recorded on BGS mapping, which also indicate no superficial deposits. Infiltration testing was undertaken in numerous locations across the Graven Hill development, with all tests returning an infiltration rate of zero – all tests failed. This confirms that a drainage solution incorporating infiltration drainage is not suitable for the site.

7.5 Accordingly, surface water run-off from the development will be managed as follows:

- Surface water run-off from roof areas will be directed to an underground detention tank, prior to discharge to the existing watercourse to the west of the site. Discharge will be at a restricted rate to accord with the agreed site-wide strategy, with the tank designed to accommodate the volumes generated by all rainfall events up to and including the critical 1% AEP event +40% allowance for climate change;

- All new paved areas will comprise permeable paving systems for detention and water quality improvement purposes. Natural infiltration into the subsoil is not possible; therefore, the permeable paving will be a Type C system with no infiltration into the subsoil. All permeable paving will be designed to store the 1% AEP event +40% allowance for climate change;

- Finished floor levels will be set a minimum of 150mm above external ground levels to mitigate the risk of flooding from local sources;

- The drainage system as a whole will be designed with a restricted outflow rate of 11.0 l/s into the existing watercourse, in accordance with the Waterman Sitewide Drainage Strategy The proposed contributing area is 0.877ha, therefore the flow rate to the watercourse will be restricted to 9.6 l/s.

7.6 The use of permeable paving systems will provide SuDS techniques that reduce flood risk by attenuating the rate of surface water run-off from the site, whilst improving water quality and amenity.

7.7 A copy of surface water calculations is included in Appendix E, and a drainage strategy drawing is included in Appendix F.

7.8 Permeable paving and the detention tank will be maintained by the site operator. A preliminary copy of the SuDS Management and Maintenance Plan is included in Appendix G.

8 Conclusions and Recommendations

8.1 The proposal for the site is for the erection of a new Healthcare Hub and associated parking areas.

8.2 From examination of site levels and by reference to Environment Agency flood zone mapping, it is demonstrated that the site is situated in Flood Zone 1. This is a low probability flood zone with a less than 1 in 1000 annual probability of flooding.

8.3 The ground conditions are not suitable for infiltration; therefore, surface water management is proposed using a detention tank for roof drainage and Type C permeable paving for new access routes and parking areas. The use of permeable paving will provide water quality benefits to the receiving watercourse.

8.4 Sustainable drainage features will be maintained by the site operator in accordance with the SuDS Management and Maintenance Plan.

9 Appendices

Appendix A – Proposed Site Layout

Proposed application
site area = 2.61 acres
(10,552 m2)

boundary line - 1m wide soft landscape strip to back of parking spaces

RPA

EP

o/h elec pole & stay

Haul road access to site from North East

boundary line - 1m wide soft landscape strip to back of parking spaces

one way

staff only OUT

one way

80 staff parking spaces

IN staff only

amulance bay

143 visitor parking spaces

one way

urgent care access fire exit

landscaped therapy gardens

bus stop drop off pick up

one way

EX MID FOUL MH

existing sewer - 6m easement, 3m each side of sewer centre line

fire exit

main public entrance

pharmacy entrance

fire exit

staff cycle store

staff entrance fire exit

landscaped courtyard garden

visitor cycle store

Proposed 3 storey building
GFA = 3350 sq m

proposed bus turning head

service access

service bay

waste access

fire exit

service access

bin store

New elec sub sta 6m x 6m

T14

extg trees T13 & T14 retained

T13

Notes:
- This drawing is copyright.
- Do not scale dimensions from this drawing.
- All discrepancies on this drawing are to be reported to the architect.
- Do not modify any element of this drawing.
- Use drawing only for purpose(s) issued.

North Sign / Key Plan

N

The following external model files are included within this drawing:

SIGN-OFF

DATE	PRINT NAME	SIGNATURE

Rev	Date	Revision Notes	Dn	Rv
15	09/02/21	Planning application site red line boundary updated to exclude proposed new access road link to include spine road junction Application site area = 2.61 acres		
14	09/01/21	Planning application site red line boundary updated to include existing hedge retained to Northern boundary and proposed new access road link to include spine road junction		
13	08/01/21	Site plan updated, new access road updated car parking numbers updated		
12	07/12/20	Red line site boundary updated, area = 1 ha car parking provision totals 223 spaces sewer easement 6m, 3m each side		
11	04/12/20	Red line site boundary updated to avoid extg hedge to Northern boundary two existing trees to be retained proposed new elec sub station relocated proposed access & car parking updated		
10	16/09/20	Waterman's Arboricultural Constraints Plan added as overlay upon proposed site plan		
9	08/09/20	Site plan updated, new access road indicated, potential new elec sub station indicated		
8	29/04/20	Site plan updated		
7	02/04/20	Site plan updated		
6	04/03/20	Site plan updated		
5	10/01/20	Site plan updated		
4	11/12/19	Site plan updated including Concept 4 plan		
3	26/11/19	Site plan updated including turning head		
2	20/11/19	Site plan updated		
1	29/10/19	Site plan updated, future expansion indicated		

Client / Contractor

Apollo

IBI Intelligence Buildings Infrastructure www.ibigroup.com

Project
Bicester Health & Wellbeing Hub

Drawing Title
Proposed Site Plan

Job Number	Date	Scale@A1
122447	23/10/2019	1:250

Status	Purpose
-	PLANNING APPLICATION

Drawing Number	Revision
IBI-XX-XX-PL-A-200-005	15

Appendix B – Site Survey Drawing

Proposed application
site area = 2.61 acres
(10,552 m2)

221300N

221200N

221100N

A41

B4100 LONDON ROAD

PRIVATE ROAD

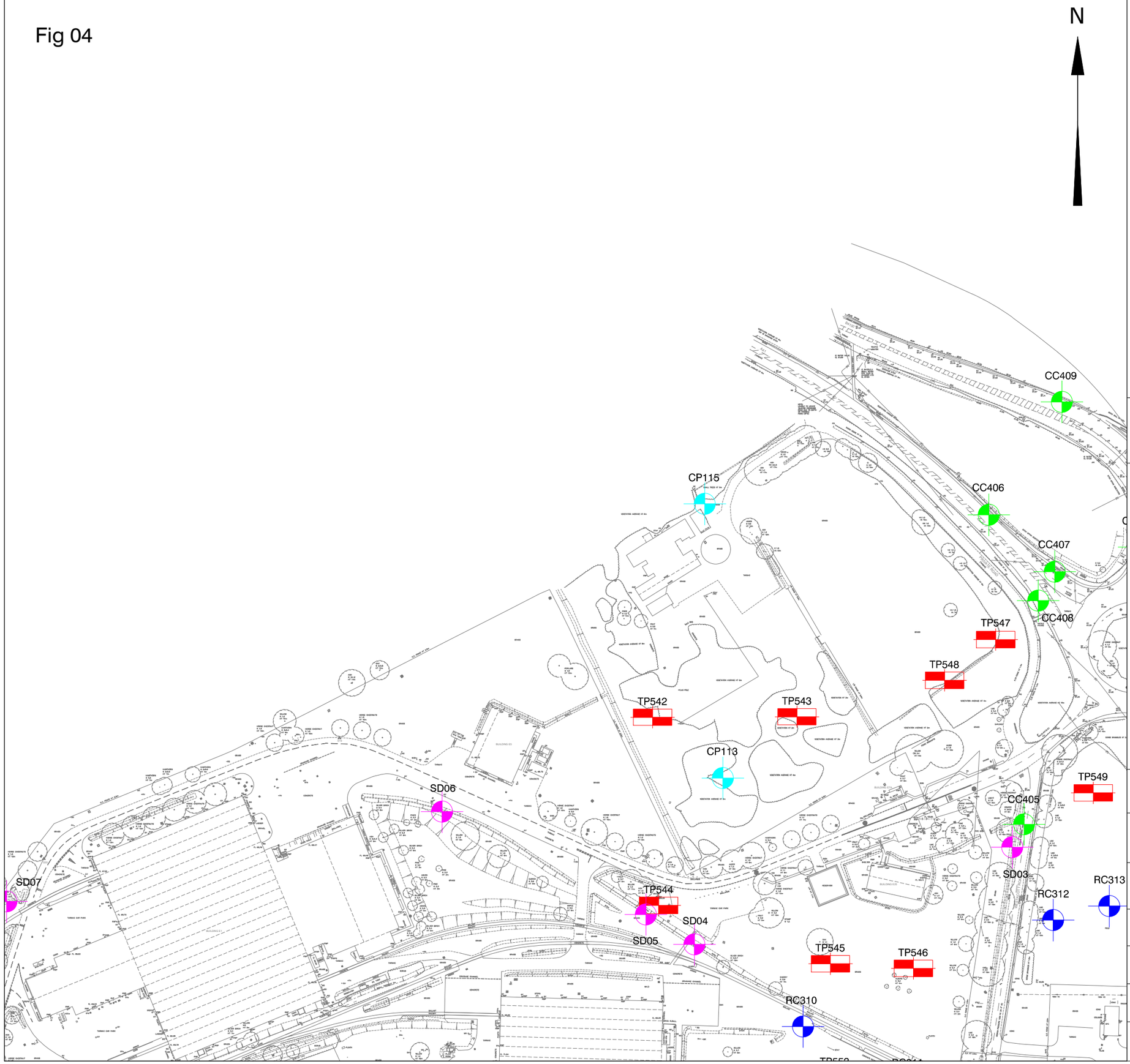
A41 AYLESBURY ROAD

A4421 NEUNKIRCHEN WAY

A4201 SEISSEN WAY

Appendix C – Site Investigation Report Extracts

Fig 04



Key.

- Rotary Core Location
- Cable Percussive Location
- Concrete Core/Dynamic Sample Location
- Surface Drain Sample Location
- Plate Load Location
- Trial Pit Location
- Trial Pit (Hand Dug) Location

Notes:

Drawing supplied by client.

geotechnical

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Client:	Graven Hill Village Development Company		
Consultant:	Waterman Infrastructure & Environment		
Site:	Graven Hill		
Title:	Exploratory Hole Location Plan		
Drawn By: MPE	Checked By: DO	Paper Size: A3	
Scale: 1:2000	Date: May 2015		
Contract: 30378	Figure: 04		

Geotechnical Engineering Limited

BOREHOLE LOG

CP113

CLIENT GRAVEN HILL VILLAGE DEVELOPMENT COMPANY

SITE GRAVEN HILL NEW URBAN COMMUNITY, BICESTER — Sheet 1 of 2

Start Date 25 March 2015 — Easting 458905.2 — Scale 1 : 50

End Date 25 March 2015 — Northing 221152.0 — Ground level 68.45mOD — Depth 8.20 m

progress date/time water depth	sample no & type	depth (m) from	depth (m) to	casing depth (m)	test type & value	samp. /core range	instru -ment	description	depth (m)	reduced level (m)	legend
25/03/15 0800hrs	D*	0.25						Grass over firm brown mottled orangish brown slightly sandy silty CLAY with frequent rootlets (up to 1mm diam). (MADE GROUND)	0.25	68.20	
	1B	0.25									
	2D*	0.50						Firm brown sandy silty CLAY with frequent rootlets (up to 1mm diam).			
	3B	0.50									
	4D*	1.00							1.00	67.45	
	5B	1.00						Firm fissured orangish brown and bluish grey slightly sandy silty CLAY with frequent black fine and medium gravel sized organic fragments.			
	6D	1.20	1.25								
	7UT	1.70	2.10	1.70							
	8D	2.10	2.20						2.20	66.25	
	9D	2.20	2.65	1.70	S 10			Firm fissured brownish grey slightly sandy silty CLAY with orangish brown and yellowish brown silt on fissure surfaces and rare fine and medium gravel sized gypsum crystals.			
	10UT	2.70	3.10	1.70							
	11D	3.10	3.20						3.20	65.25	
	12D	3.20	3.65	1.70	S 12			Firm brownish grey silty CLAY with rare fine and medium gravel sized pockets of orangish brown silt and frequent coarse gravel sized gypsum crystals.			
	13UT	3.70	4.10	1.70							
	14D	4.10	4.20						4.20	64.25	
	15D	4.20	4.65	1.70	S 18			Firm becoming stiff brownish grey silty CLAY with rare fine and medium gravel sized shell fragments.			
	16UT	4.70	5.10	1.70							
	17D	5.10	5.20								
	18D	5.20	5.65	1.70	S 24						
	19D	6.20	6.25								
	20UT	6.20	6.60	1.70							
	21D	6.60	6.70								
	22D	6.70	7.15	1.70	S 39			6.70m: Very stiff with frequent fine to coarse gravel sized shell fragments.			
	23D	7.70	7.75								
25/03/15 1100hrs	24UT	7.70	8.10	1.70							
								Continued Next Page	{8.00}		

EQUIPMENT: Light cable percussive (shell and auger) rig.

METHOD: Hand dug inspection pit 0.00-1.20m. Cable percussion (150mm) 1.20-8.20m.

CASING: 150mm diam to 1.70m.

BACKFILL: On completion, a slotted standpipe (50mm) was installed to 8.00m, granular response zone 8.20-0.40m, bentonite seal 0.40-0.10m, concrete and traffic rated cover 0.10-0.00m.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

water strike (m)	casing (m)	rose to (m)	time to rise (min)	remarks
				Groundwater not encountered.

AGS

CONTRACT	CHECKED
30378	EC

Geotechnical Engineering Limited

BOREHOLE LOG

CP113

CLIENT GRAVEN HILL VILLAGE DEVELOPMENT COMPANY

SITE GRAVEN HILL NEW URBAN COMMUNITY, BICESTER — Sheet 2 of 2

Start Date 25 March 2015 — Easting 458905.2 — Scale 1 : 50

End Date 25 March 2015 — Northing 221152.0 — Ground level 68.45mOD — Depth 8.20 m

progress date/time water depth	sample no & type	depth (m) from	depth (m) to	casing depth (m)	test type & value	samp. /core range		instru -ment	description	depth (m)	reduced level (m)	legend
Dry	25D	8.10	8.20						8.10 - 8.20m: Indistinctly laminated.	8.20	60.25	
									Borehole completed at 8.20m.			
										{18.00}		

water strike (m) casing (m) rose to (m) time to rise (m) remarks

Groundwater not encountered.

AGS

CONTRACT 30378

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Geotechnical Engineering Ltd. Tel. 01452 527743 30378 MASTER.GPJ TRIALJH.GPJ GEOTECH.GLB 26/08/2015 16:43:22 ED CT

Geotechnical Engineering Limited

TRIAL PIT LOG

TP542

CLIENT	GRAVEN HILL VILLAGE DEVELOPMENT COMPANY						
SITE	GRAVEN HILL NEW URBAN COMMUNITY, BICESTER					Sheet	1 of 1
Start Date	2 March 2015	Easting	458867.6			Scale	1 : 25
End Date	2 March 2015	Northing	221184.6	Ground level	68.00mOD	Depth	3.00 m

water record	sample/test no/type	sample/test result	sample/test depth (m)	description	depth (m)	level (m)	legend
				Very soft dark brown slightly sandy gravelly CLAY with frequent roots and rootlets (up to 8mm diam). Gravel is subrounded and subangular fine and medium quartz with a low brick cobble content. (MADE GROUND)	0.20	67.80	
	1D*		0.30				
	2D		0.30	Soft and firm brown and orangish brown mottled slightly sandy slightly gravelly CLAY with frequent rootlets (up to 2mm diam). Gravel is subrounded fine to coarse limestone.	0.80	67.20	
	3D*		1.00	Firm mottled light brown, orangish brown and greyish brown silty CLAY with rare rootlets (up to 2mm diam) and rare cobble sized pockets of fine and medium gravel sized angular shell fragments.			
	4B	H 87	1.00				
	5B		1.50- 1.70	1.50 - 1.70m: Lens of soft light grey very sandy CLAY.			
		H 100	2.40				
	6B		2.60	Stiff fissured dark brown silty CLAY with partially decomposed roots (up to 3mm diam). Fissures are subhorizontal very closely spaced infilled with orangish brown fine sand.	2.60	65.40	
				2.60 - 2.80m: Fine and medium gravel sized angular gypsum crystals.	3.00	65.00	
Dry				Trial pit completed at 3.00m.			

Notes

Trial pit excavated by JCB 3CX mechanical excavator.
Groundwater not encountered.
Trial pit sides remained stable and vertical.
Trial pit dimensions 1.80x0.65x3.00m.
On completion, the trial pit was backfilled with materials arising.

Sketch of Foundation - Not to scale. All dimensions in metres.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

CONTRACT	CHECKED
30378	EC

Geotechnical Engineering Ltd. Tel. 01452 527743 30378 MASTER.GPJ TRIALJH.GPJ GEOTECH.GLB 26/08/2015 16:48:02 RD RE

Geotechnical Engineering Limited

TRIAL PIT LOG

TP543

CLIENT	GRAVEN HILL VILLAGE DEVELOPMENT COMPANY						
SITE	GRAVEN HILL NEW URBAN COMMUNITY, BICESTER					Sheet	1 of 1
Start Date	2 March 2015	Easting	458944.8			Scale	1 : 25
End Date	2 March 2015	Northing	221184.9	Ground level	68.20mOD	Depth	3.00 m

water record	sample/test no/type	sample/test result	sample/test depth (m)	description	depth (m)	level (m)	legend
				Very soft dark brown slightly sandy silty CLAY with frequent roots and rootlets (up to 3mm diam).	0.15	68.05	
	1D*		0.30	Firm reddish brown mottled orangish brown silty CLAY with frequent fine rootlets (up to 2mm diam).			
	2D	H 54	0.30				
					0.80	67.40	
	3D*		1.00	Firm light brown and orangish brown locally mottled light grey slightly gravelly sandy CLAY with rare rootlets (up to 2mm diam). Gravel is subrounded medium flint.			
	4B	H 58	1.00				
	5D		1.00				
				1.60m: Light grey locally orangish brown very sandy lenses.			
					2.40	65.80	
		H 74	2.40	Stiff fissured dark brown locally light brown CLAY with frequent fine and medium gravel sized angular gypsum crystals and rare coarse gravel pockets of orangish brown silty clay.			
	6B		2.40- 2.60				
				2.90 - 3.00m: Dark bluish grey.	3.00	65.20	
Dry				Trial pit completed at 3.00m.			

Notes

Trial pit excavated by JCB 3CX mechanical excavator.
Groundwater not encountered.
Trial pit sides remained stable and vertical.
Trial pit dimensions 1.70x0.60x3.00m.
On completion, the trial pit was backfilled with materials arising.

Sketch of Foundation - Not to scale. All dimensions in metres.

EXPLORATORY HOLE LOGS SHOULD BE READ IN CONJUNCTION WITH KEY SHEETS

CONTRACT	CHECKED
30378	EC

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Geotechnical Engineering Limited

SOAKAWAY TEST

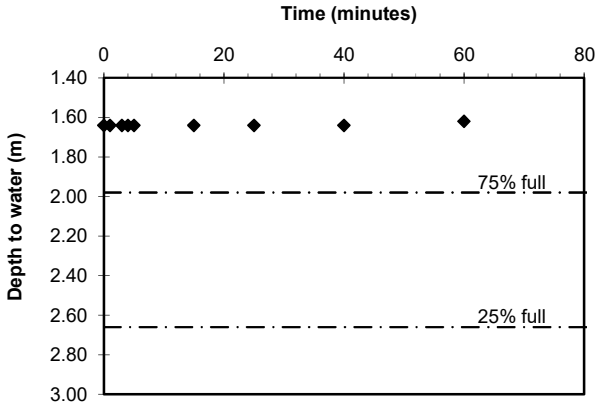
CLIENT	GRAVEN HILL VILLAGE DEVELOPMENT COMPANY		
SITE	GRAVEN HILL, BICESTER	TRIAL PIT	**TP501**
DATE	05/03/2015		

TEST 1

LENGTH	1.80	m
BREADTH	0.60	m
DEPTH	3.00	m
WATER LEVEL	Damp	
FILL LEVEL	1.64	m
v_{p75-25}	0.734	m^3
a_{p50}	4.344	m^2
t_{p75-25}		min

soil infiltration rate, *f* **ms^{-1}**

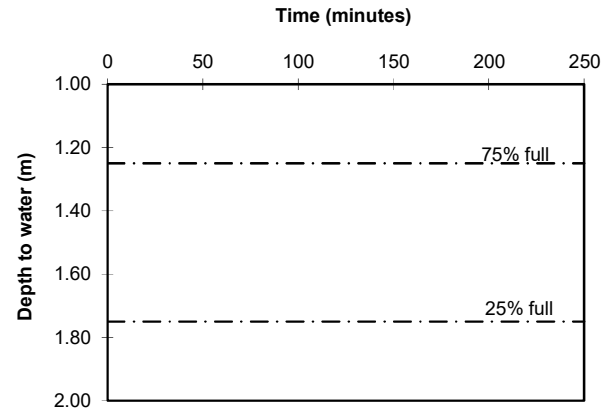
Insufficient fall in water level to calculate infiltration rate



TEST 2

LENGTH		m
BREADTH		m
DEPTH		m
WATER LEVEL		m
FILL LEVEL		m
v_{p75-25}		m^3
a_{p50}		m^2
t_{p75-25}		min

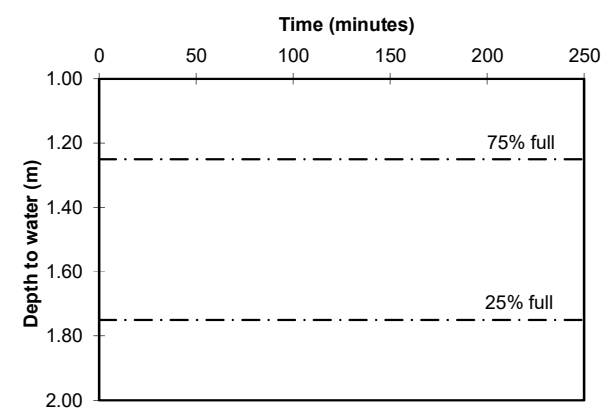
soil infiltration rate, *f* **ms^{-1}**



TEST 3

LENGTH		m
BREADTH		m
DEPTH		m
WATER LEVEL		m
FILL LEVEL		m
v_{p75-25}		m^3
a_{p50}		m^2
t_{p75-25}		min

soil infiltration rate, *f* **ms^{-1}**



Remarks	Test carried out in general accordance with BRE 365 (2007).	CONTRACT	CHECKED
	Seepage of groundwater encountered at 0.80m during excavation.	**30378**	**EC**

RD / DO

08/06/09 JH

Geotechnical Engineering Limited

SOAKAWAY TEST

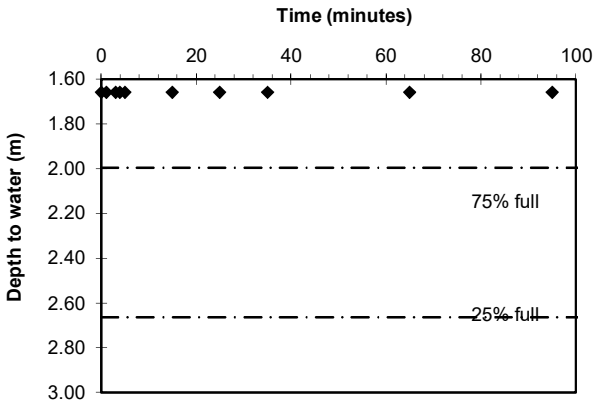
CLIENT GRAVEN HILL VILLAGE DEVELOPMENT COMPANY
SITE GRAVEN HILL, BICESTER TRIAL PIT **TP502**
DATE 04/03/2015

TEST 1

LENGTH	1.90	m
BREADTH	0.70	m
DEPTH	3.00	m
WATER LEVEL	Dry	
FILL LEVEL	1.66	m
v_{p75-25}	0.891	m^3
a_{p50}	4.814	m^2
t_{p75-25}		min

soil infiltration rate, *f* **ms^{-1}**

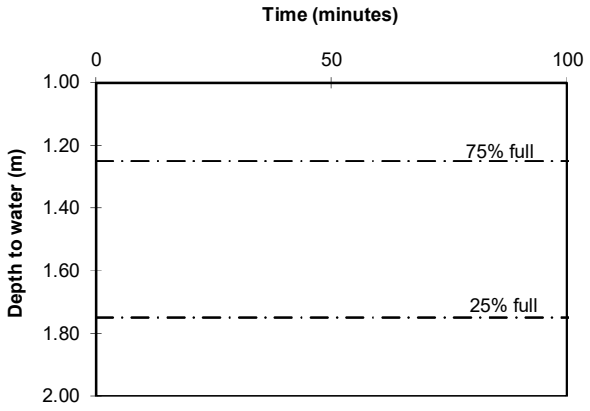
Insufficient fall in water level to calculate infiltration rate



TEST 2

LENGTH		m
BREADTH		m
DEPTH		m
WATER LEVEL		m
FILL LEVEL		m
v_{p75-25}		m^3
a_{p50}		m^2
t_{p75-25}		min

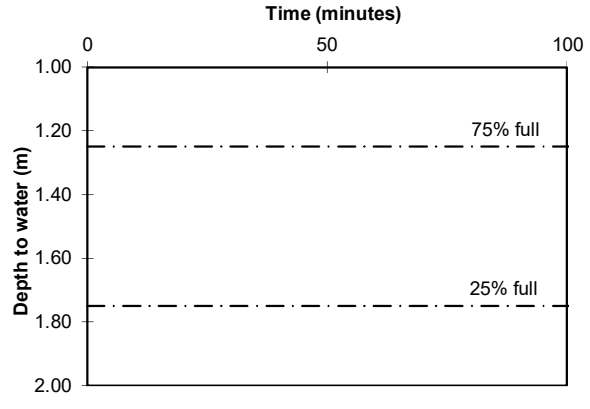
soil infiltration rate, *f* **ms^{-1}**



TEST 3

LENGTH		m
BREADTH		m
DEPTH		m
WATER LEVEL		m
FILL LEVEL		m
v_{p75-25}		m^3
a_{p50}		m^2
t_{p75-25}		min

soil infiltration rate, *f* **ms^{-1}**



Remarks Test carried out in general accordance with BRE 365 (2007).

CONTRACT	CHECKED
30378	**EC**

RD / DO

Geotechnical Engineering Limited

SOAKAWAY TEST

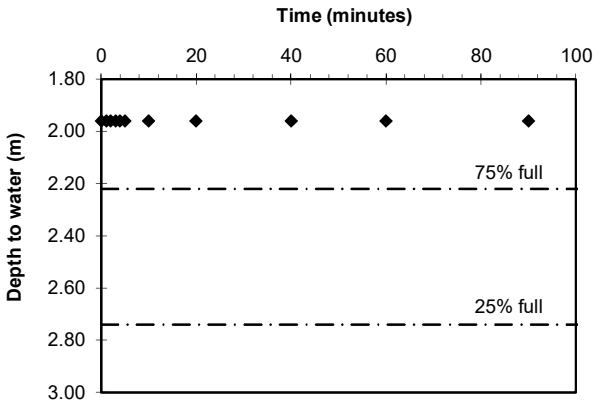
CLIENT GRAVEN HILL VILLAGE DEVELOPMENT COMPANY
SITE GRAVEN HILL, BICESTER TRIAL PIT **TP543**
DATE 02/03/2015

TEST 1

LENGTH	1.70	m
BREADTH	0.60	m
DEPTH	3.00	m
WATER LEVEL	Dry	
FILL LEVEL	1.96	m
v_{p75-25}	0.530	m^3
a_{p50}	3.412	m^2
t_{p75-25}		min

soil infiltration rate, *f* **ms^{-1}**

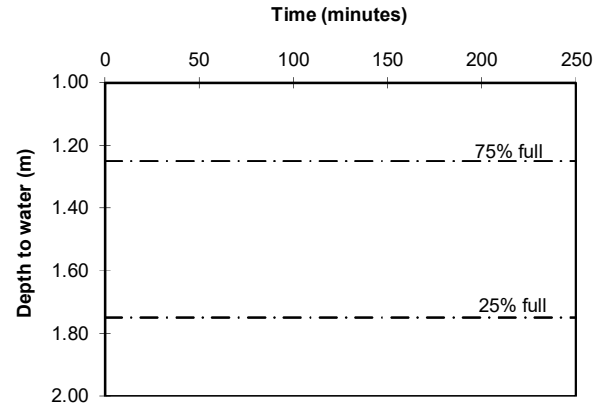
Insufficient fall in water level to calculate infiltration rate



TEST 2

LENGTH		m
BREADTH		m
DEPTH		m
WATER LEVEL		m
FILL LEVEL		m
v_{p75-25}		m^3
a_{p50}		m^2
t_{p75-25}		min

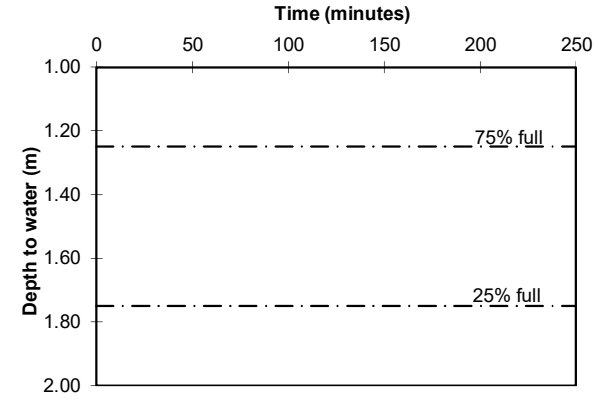
soil infiltration rate, *f* **ms^{-1}**



TEST 3

LENGTH		m
BREADTH		m
DEPTH		m
WATER LEVEL		m
FILL LEVEL		m
v_{p75-25}		m^3
a_{p50}		m^2
t_{p75-25}		min

soil infiltration rate, *f* **ms^{-1}**



Remarks Test carried out in general accordance with BRE 365 (2007).

CONTRACT	CHECKED
30378	**EC**

RD / DO

)8/06/09 JH

Geotechnical Engineering Limited

SOAKAWAY TEST

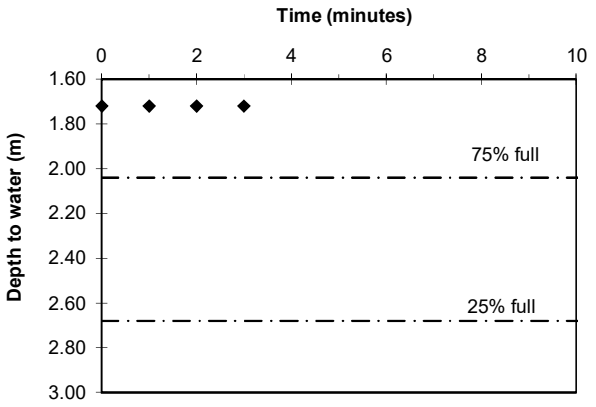
CLIENT GRAVEN HILL VILLAGE DEVELOPMENT COMPANY
SITE GRAVEN HILL, BICESTER TRIAL PIT **TP548**
DATE 03/03/2015

TEST 1

LENGTH	1.90	m
BREADTH	0.65	m
DEPTH	3.00	m
WATER LEVEL	Dry	
FILL LEVEL	1.72	m
v_{p75-25}	0.790	m^3
a_{p50}	4.499	m^2
t_{p75-25}		min

soil infiltration rate, *f* **ms^{-1}**

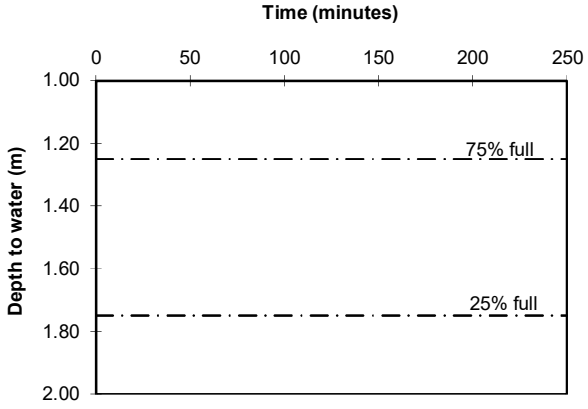
Test abandoned due to sidewall collapse



TEST 2

LENGTH		m
BREADTH		m
DEPTH		m
WATER LEVEL		m
FILL LEVEL		m
v_{p75-25}		m^3
a_{p50}		m^2
t_{p75-25}		min

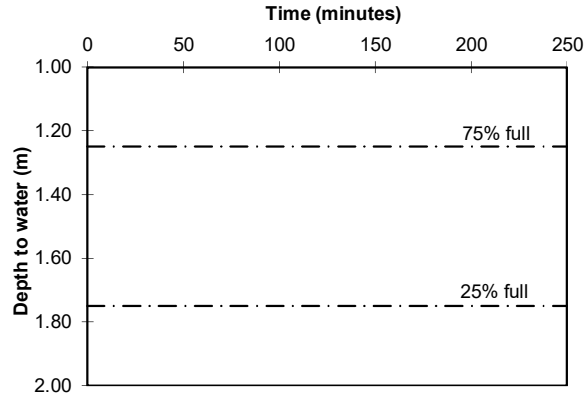
soil infiltration rate, *f* **ms^{-1}**



TEST 3

LENGTH		m
BREADTH		m
DEPTH		m
WATER LEVEL		m
FILL LEVEL		m
v_{p75-25}		m^3
a_{p50}		m^2
t_{p75-25}		min

soil infiltration rate, *f* **ms^{-1}**



Remarks Test carried out in general accordance with BRE 365 (2007).

CONTRACT	CHECKED
30378	**EC**

RD / DO

08/06/09 JH

Geotechnical Engineering Limited

SOAKAWAY TEST

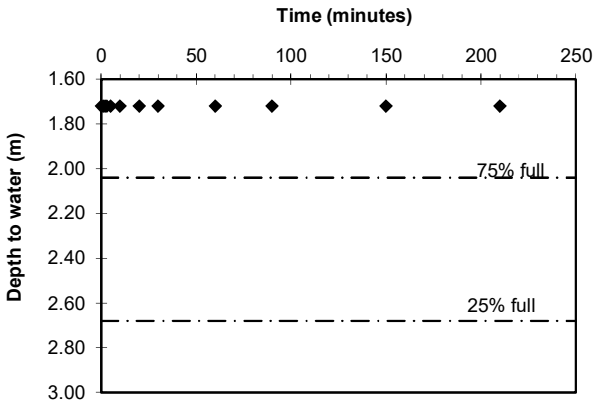
CLIENT GRAVEN HILL VILLAGE DEVELOPMENT COMPANY
SITE GRAVEN HILL, BICESTER TRIAL PIT **TP548A**
DATE 04/03/2015

TEST 1

LENGTH	1.80	m
BREADTH	0.60	m
DEPTH	3.00	m
WATER LEVEL	Dry	
FILL LEVEL	1.72	m
v_{p75-25}	0.691	m^3
a_{p50}	4.152	m^2
t_{p75-25}		min

soil infiltration rate, *f* **ms^{-1}**

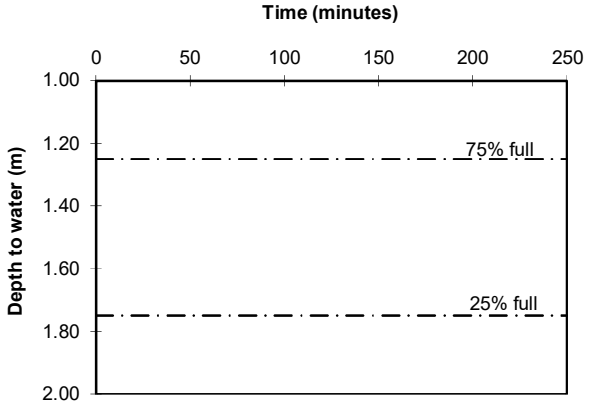
Insufficient fall in water level to calculate infiltration rate



TEST 2

LENGTH		m
BREADTH		m
DEPTH		m
WATER LEVEL		m
FILL LEVEL		m
v_{p75-25}		m^3
a_{p50}		m^2
t_{p75-25}		min

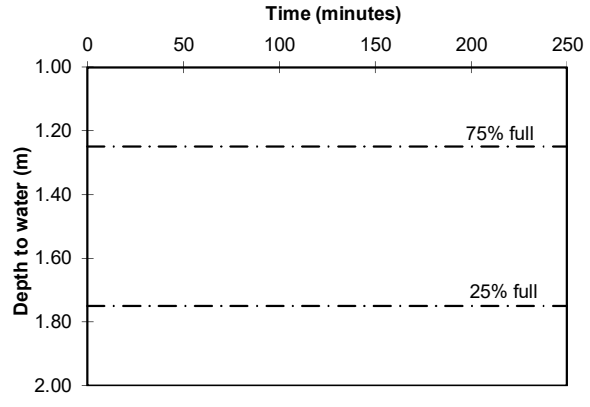
soil infiltration rate, *f* **ms^{-1}**



TEST 3

LENGTH		m
BREADTH		m
DEPTH		m
WATER LEVEL		m
FILL LEVEL		m
v_{p75-25}		m^3
a_{p50}		m^2
t_{p75-25}		min

soil infiltration rate, *f* **ms^{-1}**



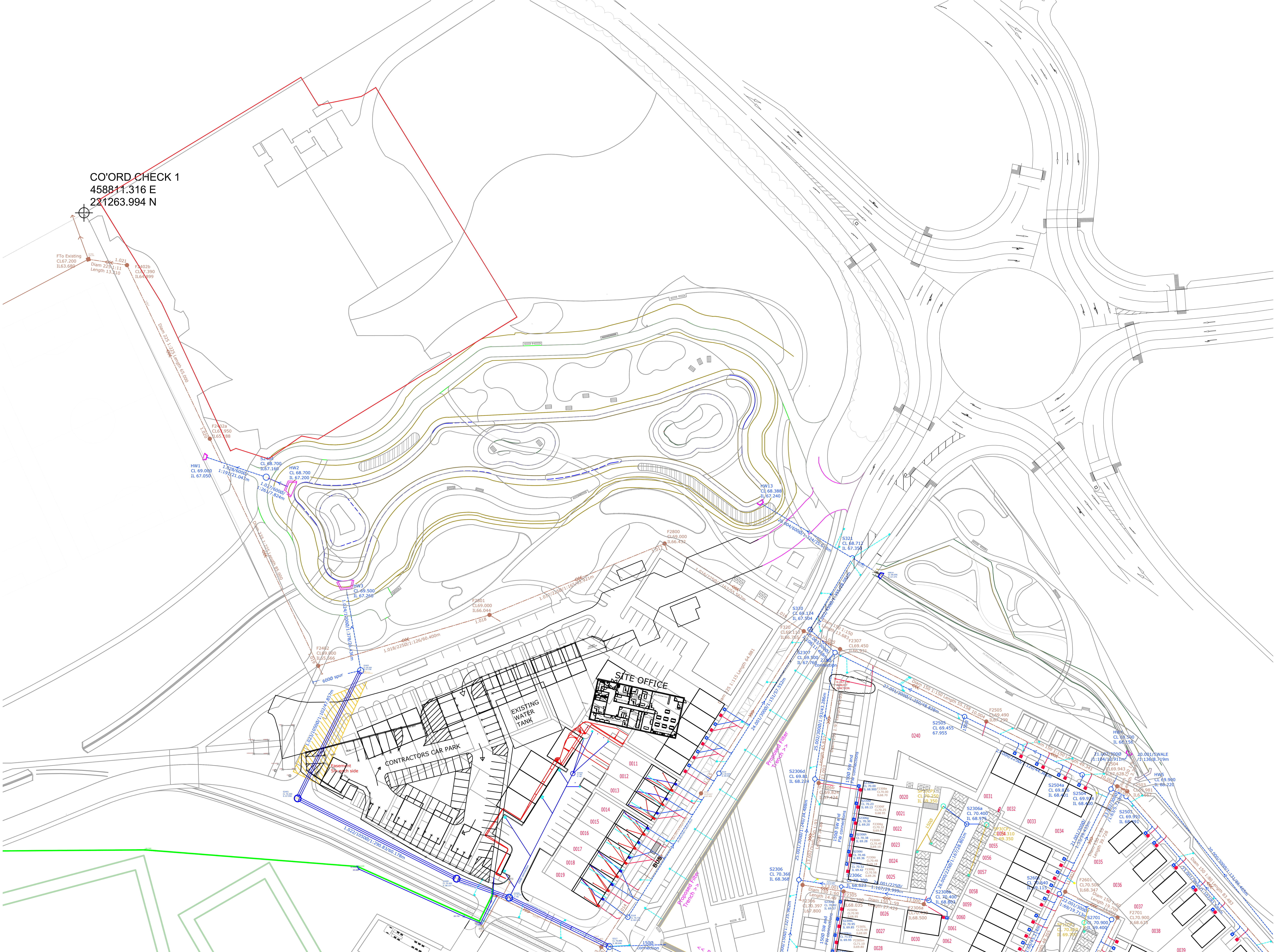
Remarks Test carried out in general accordance with BRE 365 (2007).

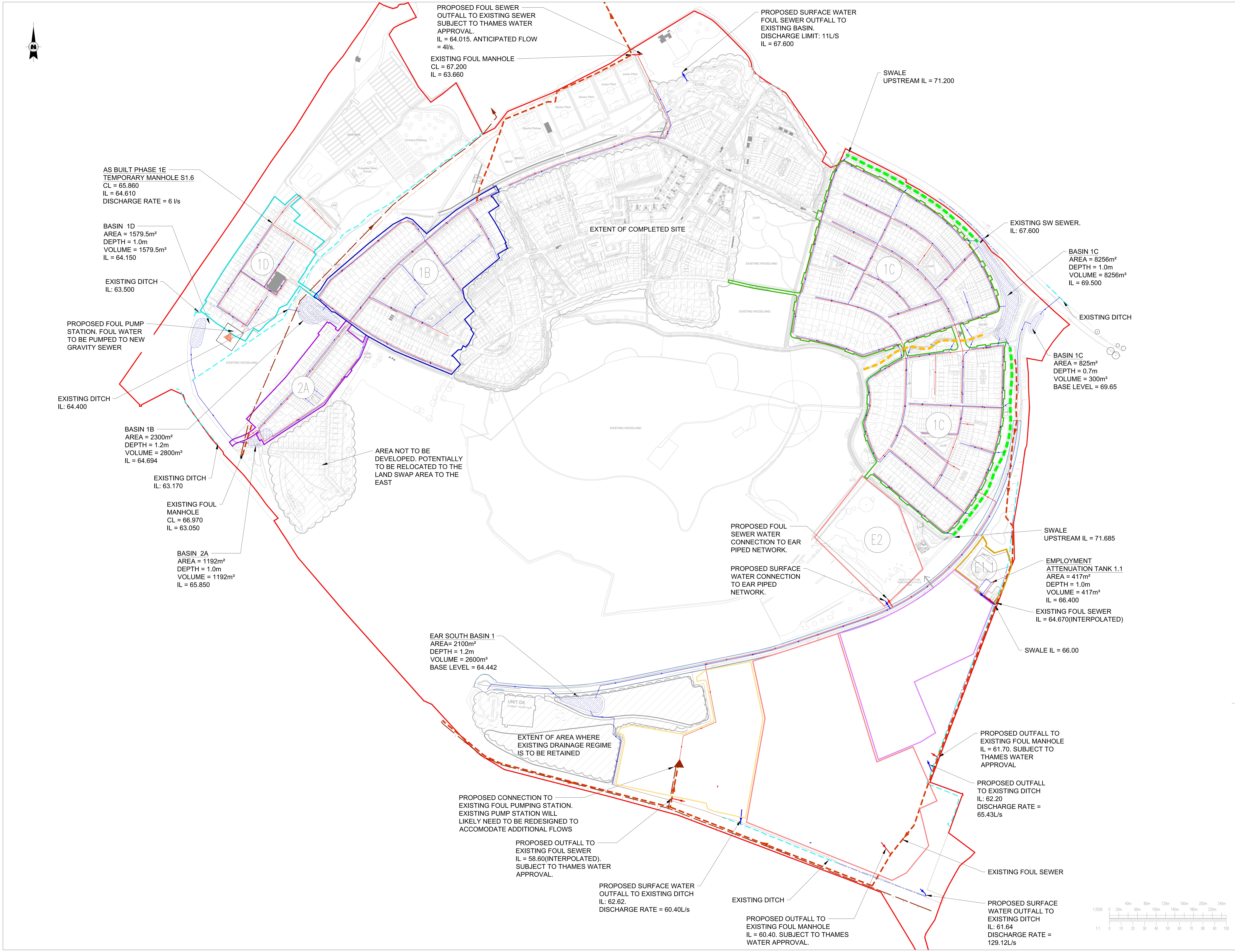
CONTRACT	CHECKED
30378	**EC**

RD / DO

)8/06/09 JH

Appendix D – Existing Drainage Plans


CO'ORD CHECK 1
458811.316 E
221263.994 N
SITE OFFICE
EXISTING WATER TANK
CONTRACTORS CAR PARK
HW1
CL 69.000
IL 67.050
HW2
CL 68.700
IL 67.200
HW3
CL 69.500
IL 67.260
HW13
CL 68.388
IL 67.240
F2800
CL69.000
F2801
CL69.000
IL66.044
F2402
CL69.000
F2307
CL69.450
S2306
CL 70.366
IL 68.368
Proposed Filter Trench



This drawing should not be scaled. Dimensions to be verified on site.
Any discrepancies should be referred to the Engineer prior to work being put in hand.

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Pickfords Wharf, Clink Street, London SE1 9DG t 020 7928 7888 f 03333 444 501

GENERAL NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL ENGINEER'S, ARCHITECT'S OR OTHER RELEVANT DRAWINGS AND SPECIFICATIONS.
2. ALL DIMENSIONS AND LEVELS ARE TO BE CHECKED ON SITE BY THE CONTRACTOR PRIOR TO PREPARING ANY WORKING DRAWINGS OR COMMENCING ON SITE.
3. THE CONTRACTOR MUST ENSURE AND WILL BE HELD RESPONSIBLE FOR THE OVERALL STABILITY OF THE BUILDING/STRUCTURE/EXCAVATION AT ALL STAGES OF THE WORK.
4. ALL WORK BY THE CONTRACTOR MUST BE CARRIED OUT IN SUCH A WAY THAT ALL REQUIREMENTS UNDER THE HEALTH AND SAFETY AT WORK ACT ARE SATISFIED.
5. ALL WORK IS TO BE CARRIED OUT IN COMPLIANCE WITH THE REQUIREMENTS OF THE RELEVANT STATUTORY AUTHORITIES AND REGULATIONS.
6. OS DATA, TOPOGRAPHICAL SURVEY AND LIDAR DATA PROVIDED BY GLENN HOWELLS ARCHITECTS ON 3RD OCTOBER 2013
7. ADDITIONAL DRAINAGE SURVEY INFORMATION PROVIDED BY MK SURVEYS ON 18TH DECEMBER 2014
8. LAND TRANSFER AREA 1&2 BOUNDARY BASED ON GLENN HOWELLS ARCHITECTS DRAWING NO: 1982-A-L-573 REV V
9. UPGRADES REQUIRED TO THE ONSITE & OFFSITE PUBLIC SEWERS, RISING MAINS AND SEWAGE TREATMENT WORKS TO BE CONFIRMED BY THAMES WATER.
10. NORTHERN AREA MASTERPLAN PROVIDED BY GLENN HOWELLS, DRAWING NO: 1982-A-L-011-AA
11. EMPLOYMENT AREA MASTERPLAN PROVIDED BY INC DESIGN, DRAWING NO: INC-SA[20]0020 REV. P08

KEY:

LAND TRANSFER AREA 2 BOUNDARY
CATCHMENT 1B
CATCHMENT 1C
CATCHMENT 1D
CATCHMENT 2A
CATCHMENT E1
CATCHMENT E1.1
CATCHMENT E2
CATCHMENT E3
CATCHMENT EAR1
ATTENUATION BASIN
EXISTING DITCH
EXISTING SURFACE WATER SEWER
PROPOSED DITCH
PROPOSED SURFACE WATER DRAIN
PROPOSED SWALES
PROPOSED STEEP SWALES
EXISTING PUBLIC FOUL SEWER
EXISTING PUBLIC RISING MAIN
EXISTING FW PUMPING STATION
PROPOSED FOUL DRAIN
EXISTING SEWER TO BE ABANDONED
PROPOSED FW RISING MAIN
PROPOSED FW PUMPING STATION
AREA OF POTENTIAL LAND RAISING REQUIRED

Rev	Date	Description	By
A05	18.08.20	BASIN 1D&2A OUTFALL AMENDED	KP
A04	11.06.20	CATCHMENT E1.1 ADDED	KP
A03	26.05.20	STRATEGY REVIEW	CT
A02	05.03.20	MINOR AMENDMENTS TO PIONEERS SITE SURFACE WATER	KP
A01	20.02.20	PRELIMINARY ISSUE	KP

Amendments

Project: GRAVEN HILL, BICESTER

Title: OVERALL SITE DRAINAGE STRATEGY

Client: Graven Hill Village Development Company Limited

Waterman
5th Floor, One Cornwall Street, Birmingham, B3 2DX
T: 0121 212 7700
mail@watermangroup.com www.watermangroup.com

Drawing Status: PRELIMINARY

Designed by KP	Checked by DB	Project No WIE11386		
Drawn by KP	Date FEBRUARY 2020			
Scales @ A0 work to figured dimensions only	1:2500	Computer File No WIE11386-148-92-501-A05_1.dwg		
Publisher	Zone	Category	Number	Revision
WIE	148	92	501	A05

File Path \\s-bm\WIEL\Projects\WIE11386_GH0_LTA 2\#WO148_DRAINAGE_OUTLINE_LTA2_Got PO7_CAD\92_Drainage\

A1-Wat-S-GHVDC, A1-Wat-S-GHVDC, R15 1106 MK Survey - Employment Area Ex Drainage, SITE WIDE OUTLINE DRAINGE STRATEGY

Appendix E – Surface Water Calculations

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	1	PIMP (%)	100
M5-60 (mm)	20.000	Add Flow / Climate Change (%)	0
Ratio R	0.400	Minimum Backdrop Height (m)	0.000
Maximum Rainfall (mm/hr)	200	Maximum Backdrop Height (m)	3.000
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.070	4-8	0.100

Total Area Contributing (ha) = 0.170

Total Pipe Volume (m³) = 11.143

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	54.600	0.364	150.0	0.085	4.00	0.0	0.600	o	225	Pipe/Conduit	
1.001	18.450	0.123	150.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
2.000	51.800	0.345	150.1	0.085	4.00	0.0	0.600	o	225	Pipe/Conduit	
2.001	25.700	0.142	181.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.002	17.200	0.078	220.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	55.42	4.85	68.445	0.085	0.0	0.0	0.0	1.07	42.4	12.8
1.001	54.04	5.14	68.081	0.085	0.0	0.0	0.0	1.07	42.4	12.8
2.000	55.63	4.81	68.445	0.085	0.0	0.0	0.0	1.06	42.3	12.8
2.001	53.53	5.25	68.100	0.085	0.0	0.0	0.0	0.97	38.5	12.8
1.002	52.33	5.52	67.883	0.170	0.0	0.0	0.0	1.06	74.6	24.1

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Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.003	33.850	0.154	220.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.004	21.900	0.100	220.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.003	50.13	6.06	67.805	0.170	0.0	0.0	0.0	1.06	74.6	24.1
1.004	48.82	6.40	67.651	0.170	0.0	0.0	0.0	1.06	74.6	24.1

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.004		69.000	67.551	67.550	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	4
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Storm Duration (mins)	30
Ratio R	0.400		

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Online Controls for Storm

Hydro-Brake® Optimum Manhole: 7, DS/PN: 1.004, Volume (m³): 3.8

Unit Reference	MD-SHE-0154-1100-0900-1100
Design Head (m)	0.900
Design Flow (l/s)	11.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	154
Invert Level (m)	67.651
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.900	11.0
Flush-Flo™	0.286	11.0
Kick-Flo®	0.629	9.3
Mean Flow over Head Range	-	9.3

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.5	1.200	12.6	3.000	19.5	7.000	29.2
0.200	10.7	1.400	13.5	3.500	20.9	7.500	30.2
0.300	11.0	1.600	14.4	4.000	22.3	8.000	31.2
0.400	10.8	1.800	15.2	4.500	23.6	8.500	32.1
0.500	10.5	2.000	16.0	5.000	24.9	9.000	33.0
0.600	9.7	2.200	16.8	5.500	26.0	9.500	33.8
0.800	10.4	2.400	17.5	6.000	27.1		
1.000	11.5	2.600	18.2	6.500	28.2		

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Storage Structures for Storm

Complex Manhole: 2, DS/PN: 1.001

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	31.4
Membrane Percolation (mm/hr)	1000	Length (m)	56.5
Max Percolation (l/s)	492.8	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	68.650	Cap Volume Depth (m)	0.350

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	30.1
Membrane Percolation (mm/hr)	1000	Length (m)	41.3
Max Percolation (l/s)	345.3	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	68.650	Cap Volume Depth (m)	0.350

Porous Car Park Manhole: 4, DS/PN: 2.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	19.7
Membrane Percolation (mm/hr)	1000	Length (m)	60.0
Max Percolation (l/s)	328.3	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	68.650	Cap Volume Depth (m)	0.350

Complex Manhole: 6, DS/PN: 1.003

Tank or Pond

Invert Level (m) 67.805

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	80.0	0.400	80.0	0.401	0.0

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	33.0
Membrane Percolation (mm/hr)	1000	Length (m)	31.2
Max Percolation (l/s)	286.0	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	68.550	Cap Volume Depth (m)	0.350

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Complex Manhole: 7, DS/PN: 1.004

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	36.5
Membrane Percolation (mm/hr)	1000	Length (m)	38.6
Max Percolation (l/s)	391.4	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	68.550	Cap Volume Depth (m)	0.350

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	12.7
Membrane Percolation (mm/hr)	1000	Length (m)	55.8
Max Percolation (l/s)	196.9	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	68.550	Cap Volume Depth (m)	0.350

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Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	4
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model		FSR	Ratio R 0.400
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	20.000	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	150.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	1	15 Winter	100	+40%	100/15 Summer				68.920
1.001	2	60 Winter	100	+40%	100/15 Summer				68.650
2.000	3	15 Winter	100	+40%	100/15 Summer				68.928
2.001	4	60 Winter	100	+40%	100/15 Summer				68.651
1.002	5	60 Winter	100	+40%	100/15 Summer				68.626
1.003	6	60 Winter	100	+40%	100/15 Summer				68.567
1.004	7	60 Winter	100	+40%	30/15 Summer				68.551

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	0.250	0.000	1.21			49.2	SURCHARGED	
1.001	2	0.344	0.000	0.72		34	27.6	SURCHARGED	
2.000	3	0.258	0.000	1.20			48.9	SURCHARGED	
2.001	4	0.326	0.000	0.78		33	27.6	SURCHARGED	
1.002	5	0.443	0.000	0.80			51.0	SURCHARGED	

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Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.003	6	0.462	0.000	0.28		58	19.1	SURCHARGED	
1.004	7	0.600	0.000	0.17		63	11.0	SURCHARGED	

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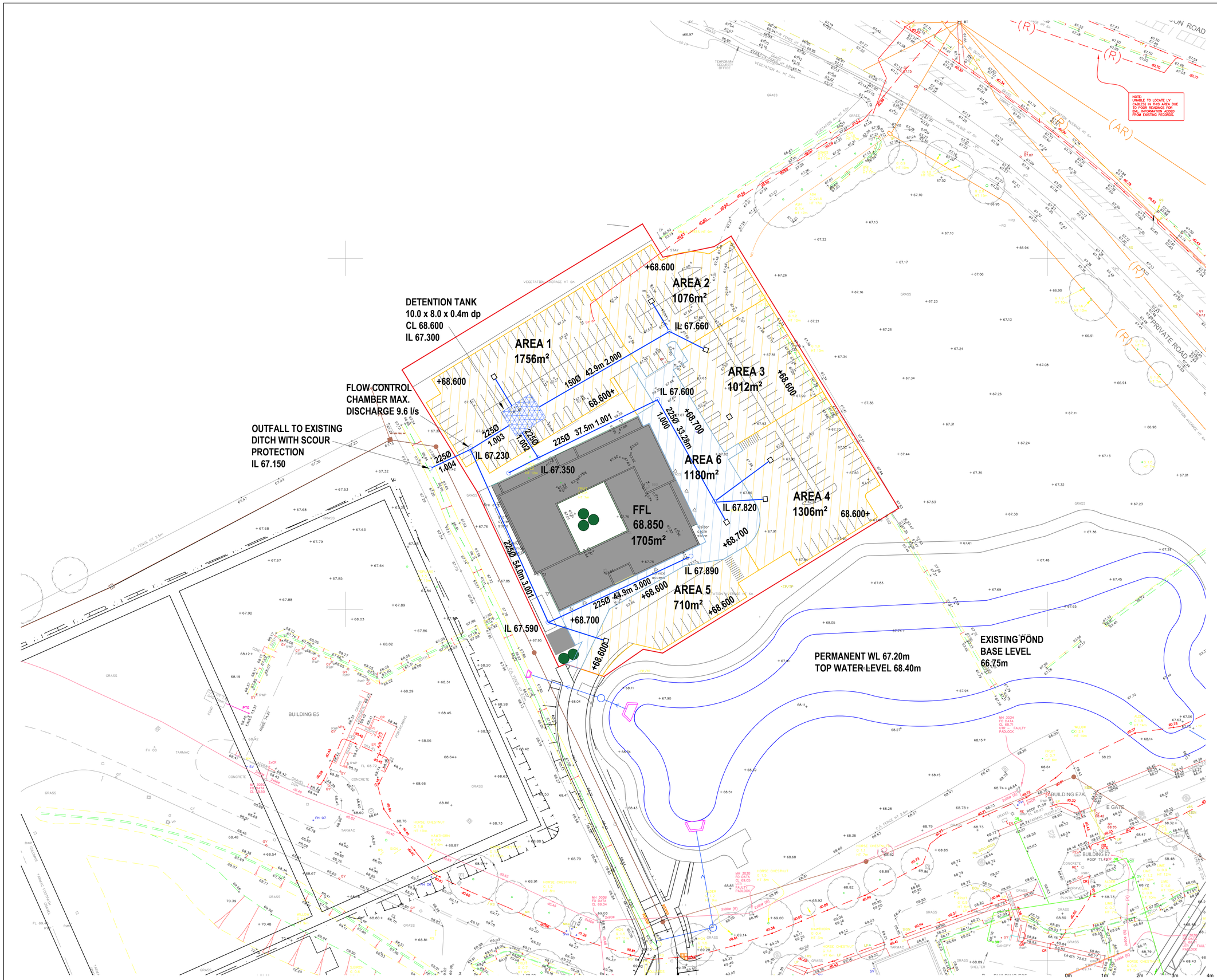
Appendix F – Drainage Strategy Drawing



SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION BOX

NOTES: THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE RISK REGISTER PRODUCED FOR INCLUSION IN THE HEALTH AND SAFETY PLAN. THE HAZARDS NOTED ARE IN ADDITION TO THE NORMAL HAZARDS AND RISKS FACED BY A COMPETENT CONTRACTOR WHEN DEALING WITH THE TYPE OF WORKS DETAILED ON THIS DRAWING.

CONSTRUCTION RISKS:

- WORKING ADJACENT TO WATER FEATURES.

MAINTENANCE/CLEANING/IN USE RISKS:

- NO SIGNIFICANT RISKS.

DEMOLITION RISKS:

- NO SIGNIFICANT RISKS.

NOTE:

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2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT STRUCTURAL ENGINEER'S DRAWINGS AND DETAILS, THE SPECIFICATION FOR THE WORKS, THE RELEVANT ARCHITECT'S DRAWINGS AND ANY OTHER SPECIALIST'S DRAWINGS.
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PROPOSED PERMEABLE PAVING TO VEHICULAR AREAS - 350thk SUB-BASE

PROPOSED PERMEABLE PAVING TO PEDESTRIAN AREAS - 250thk SUB-BASE

PROPOSED SURFACE WATER DRAINAGE

PRELIMINARY DRAWING:
THIS DRAWING IS FOR PRELIMINARY PURPOSES ONLY AND MUST NOT BE READ AS A CONSTRUCTION ISSUE. IT INDICATES DESIGN INTENT ONLY AND IS SUBJECT TO AMENDMENT DURING FINAL DESIGN DEVELOPMENT.

REV	DESCRIPTION	DATE	BY	AUTH
P02	SYSTEM AMENDED TO OUTFALL TO DITCH	22.03.21	PC	-
P01	INITIAL ISSUE	25.02.21	PC	-

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CLIENT

APOLLO

PROJECT

BICESTER HEALTH AND WELLBEING HUB

TITLE

SURFACE WATER DRAINAGE STRATEGY OPTIONS

DRAWN	AUTHORISED	DATE	SCALE AT A1
PDC	-	FEB 21	1:500

SUITABILITY
S2 -INFORMATION

PROJECT NO.	DRAWING FIELDS.	DRAWING NO.	REV
191607	RLC-00-XX-DR	C-001	P02

Appendix G – SuDS Management and Maintenance Plan

Rossi Long Consulting

SuDS Management and Maintenance Plan

Bicester Healthcare Hub

Graven Hill

Bicester

Oxfordshire

RLC Ref: 191607

February 2021

Prepared for

Bicester HC Development Ltd

1.0 General Description

1.1 The development is to comprise a new Healthcare Hub building of 3,350m² gross floor area with associated staff and visitors parking. A new entrance is to be formed on to the wider Graven Hill village infrastructure roads.

1.2 The site operator will be responsible for SuDS features within the curtilage of the site. Shared facilities such as the off-site detention basin will be maintained by a Management Company for the Graven Hill development.

1.3 For the purposes of this manual, maintenance refers to:

1) Inspections required to identify performance issues and plan appropriate maintenance needs.

2) Operation and maintenance of the drainage system.

1.4 The SuDS features comprise:

1) Inlets, Outlets and Inspection Chambers

2) Pervious Block Paving

2.0 Operation and Maintenance Requirements

2.1 Detention Basin

Detention Tanks – Table 21.3 CIRIA C753

TABLE 21.3 Operation and maintenance requirements for attenuation storage tanks

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action	Monthly for 3 months, then annually
	Remove debris from the catchment surface (where it may cause risks to performance)	Monthly
	For systems where rainfall infiltrates into the tank from above, check surface of filter for blockage by sediment, algae or other matter; remove and replace surface infiltration medium as necessary.	Annually
	Remove sediment from pre-treatment structures and/ or internal forebays	Annually, or as required
Remedial actions	Repair/rehabilitate inlets, outlet, overflows and vents	As required
Monitoring	Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed	Annually
	Survey inside of tank for sediment build-up and remove if necessary	Every 5 years or as required

2.2 Pervious Paving – Table 20.15 CIRIA C753

TABLE 20.15 Operation and maintenance requirements for pervious pavements

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Brushing and vacuuming (standard cosmetic sweep over whole surface)	Once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations – pay particular attention to areas where water runs onto pervious surface from adjacent impermeable areas as this area is most likely to collect the most sediment
Occasional maintenance	Stabilise and mow contributing and adjacent areas	As required
	Removal of weeds or management using glyphospate applied directly into the weeds by an applicator rather than spraying	As required – once per year on less frequently used pavements
Remedial Actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50 mm of the level of the paving	As required
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users, and replace lost jointing material	As required
	Rehabilitation of surface and upper substructure by remedial sweeping	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging)
Monitoring	Initial inspection	Monthly for three months after installation
	Inspect for evidence of poor operation and/or weed growth – if required, take remedial action	Three-monthly, 48 h after large storms in first six months
	Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually
	Monitor inspection chambers	Annually

Many of the specific maintenance activities for pervious pavements can be undertaken as part of a general site cleaning contract (many car parks or roads are swept to remove litter and for visual reasons to keep them tidy) and therefore, if litter management is already required at site, this should have marginal cost implications.

Generally, pervious pavements require less frequent gritting in winter to prevent ice formation. There is also less risk of ice formation after snow melt, as the melt water drains directly into the underlying sub-base and does not have chance to refreeze. A slight frost may occur more frequently on the surface of pervious pavements compared to adjacent impermeable surfaces, but this is only likely to last for a few hours. It does not happen in all installations and, if necessary, this can be dealt with by application of salt. It is not likely to pose a hazard to vehicle movements.

3.0 Operation and Maintenance Activities

3.1 Operation and Maintenance Activity Categories

Maintenance activities can be broadly defined as:

1) regular maintenance (including inspections);

2) occasional maintenance; and

3) remedial maintenance.

There may also be initial one-off requirements sometimes referred to as “establishment maintenance”, particularly for planting (e.g. weeding and watering). Regular maintenance consists of basic tasks carried out to a frequent and predictable schedule, including inspections / monitoring, silt or oil removal if required more frequently than once per year, vegetation management, sweeping of surfaces and litter and debris removal.

Occasional maintenance comprises tasks that are likely to be required periodically, but on a much less frequent and predictable basis than the regular tasks (e.g. sediment removal or filter replacement). The table overleaf summarises the likely maintenance activities required for each SuDS component.

Remedial maintenance describes the intermittent tasks that may be required to rectify faults associated with the system, although the likelihood of faults can be minimised by good design, construction and regular maintenance activities. Where remedial work is found to be necessary, it is likely to be due to site-specific characteristics or unforeseen events, and so timings are difficult to predict. Remedial maintenance can comprise activities such as:

- inlet and outlet repairs;
- erosion repairs;
- infiltration surface rehabilitation;
- replacement of blocked filter materials / fabrics;
- construction stage sediment removal (although this activity should have been undertaken before the start of the maintenance contract);
- system rehabilitation immediately following a pollution event.

3.2 Operation and Maintenance Activity Schedule

Operation and maintenance activity	SuDS component			
	Inspection chambers	Conveyance pipes	Detention tanks	Pervious paving
Regular maintenance (Monthly or as Required)				
Inspection	■	■	■	■
Inspect after leaf fall in the Autumn	■	☐	■	☐
Litter and debris removal	■	■	■	■
Grass cutting	■	■		
Weed and invasive plant control	☐	☐	☐	☐
Shrub management (including pruning)	☐			
Brush regularly and remove sweepings			☐	■
Occasional maintenance (Annually)				
Sediment management	■	■	■	■
Vegetation replacement			☐	
Vacuum sweeping and brushing				
Check topsoil levels are 20mm above chambers to avoid mower damage	■			
Remove covers and inspect ensuring water is free flowing and that any inlet / outlet is unobstructed	■	☐		
Remedial maintenance (As Required)				
Jet wash and suction cleaning				☐
Structure rehabilitation / repair	☐	☐	☐	☐
Infiltration surface reconditioning				

Key
■ will be required
☐ may be required

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