



SUDS DRAINAGE SYSTEM PROPOSALS

CONSTRUCTION OF A
NEW 3G ARTIFICIAL PITCH
AT

THE UNIVERSITY OF
READING

Job No. 2848

April 2019

For

The University of Reading

Sports Labs Ltd
1 Adam Square
Brucefield Industry Park,
Livingston
EH54 9DE

Contract Number: **2848**

Issued by: Sports Labs on behalf of
The University of Reading

For the development of

A new build synthetic turf 3G pitch construction accommodating primarily full-size rugby and football use. Pitch construction consisting of geo-grid, sub-base, asphalt base layer, performance shockpad and synthetic turf. The works inclusive of parallel pitch drainage system, 6 column floodlighting system and all ducting, perimeter weld mesh panel fencing of 3m high, rising to 6m height behind each goal, 1.2m high spectator fencing, 3m wide spectator hardstanding, spectator stand, 3m wide footpath connecting main access gate to existing footpath network, separate synthetic cricket square with 3no. bays incorporating steel cage and netting structures.

Date of Issue:
April 2019

Version	Issue Date	Details
Original (Planning)	April 2019	-
Approvals		Signatures
Author:	Fraser Gilbert	
Checked by:	David Dickinson	
Client approval:	For and on behalf of The University of Reading	
Issued by: Location:	Sports Labs Ltd, 1 Adam Square, Brucefield Industry Park, Livingston, EH54 9DE	Tel: +44(0)1506 444 755 E-mail: info@sportslabs.co.uk

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CONTENTS

1 INTRODUCTION.....4

2 PITCH DRAINAGE SYSTEM.....5

3 SUDS DRAINAGE PROPOSAL.....5

4 SITE TOPOGRAPHY5

APPENDIX A – DETAILED DESIGN SECTIONS6

APPENDIX B – INFILTRATION TEST RESULTS7

APPENDIX C – DESIGN CALCULATIONS8

1 INTRODUCTION

1.1 Sports Labs Ltd has been appointed on behalf of Bailey Partnership to develop an application for planning permission for a proposed new 3G artificial pitch within the grounds of The University of Reading.

1.2 In order to assist in the approval of planning permission and the development of the proposed project, this document shall outline the SUDS drainage system put forward for the new pitch.

1.3 Site Address

University of Reading
Whiteknights
Reading
RG6 6BW

1.4 Applicant Details

University of Reading
Whiteknights PO Box 217
Reading
RG6 6AH
United Kingdom

Project Lead - Elizabeth Jackson – e.jackson@reading.co.uk

1.5 Agent Details

Sports Labs Ltd
1 Adam Square
Brucefield Industry Park
Livingston
West Lothian
EH54 9DE

Consultancy Manager – David Dickinson - david@sportslabs.co.uk

Consulting Engineer – Fraser Gilbert - fraser@sportslabs.co.uk

2 PITCH DRAINAGE SYSTEM

- 2.1 The proposed primary drainage system for the new pitch is a parallel lateral drainage system across the width of the pitch. The lateral drainage shall be 80mm standard diameter falling down to the Eastern touchline, using the natural fall of existing ground conditions. This shall connect into a 150mm diameter carrier drain transporting all surface water run-off down to the proposed SUDS system.
- 2.2 The pitch itself is porous in nature down through the synthetic turf, shockpad, porous asphalt and sub-base. The sub-base of the pitch itself is 300mm in depth and so within it has a large volume storage capacity for surface water run-off, slowly dispersing this into the sub-soils beneath.
- 2.3 The pitch construction is to be controlled by Key Stage Inspections (KSI's) at each phase of construction. This will allow porosity testing to be carried out in line with BS EN standards to ensure that the pitch is draining correctly at key stage of construction.

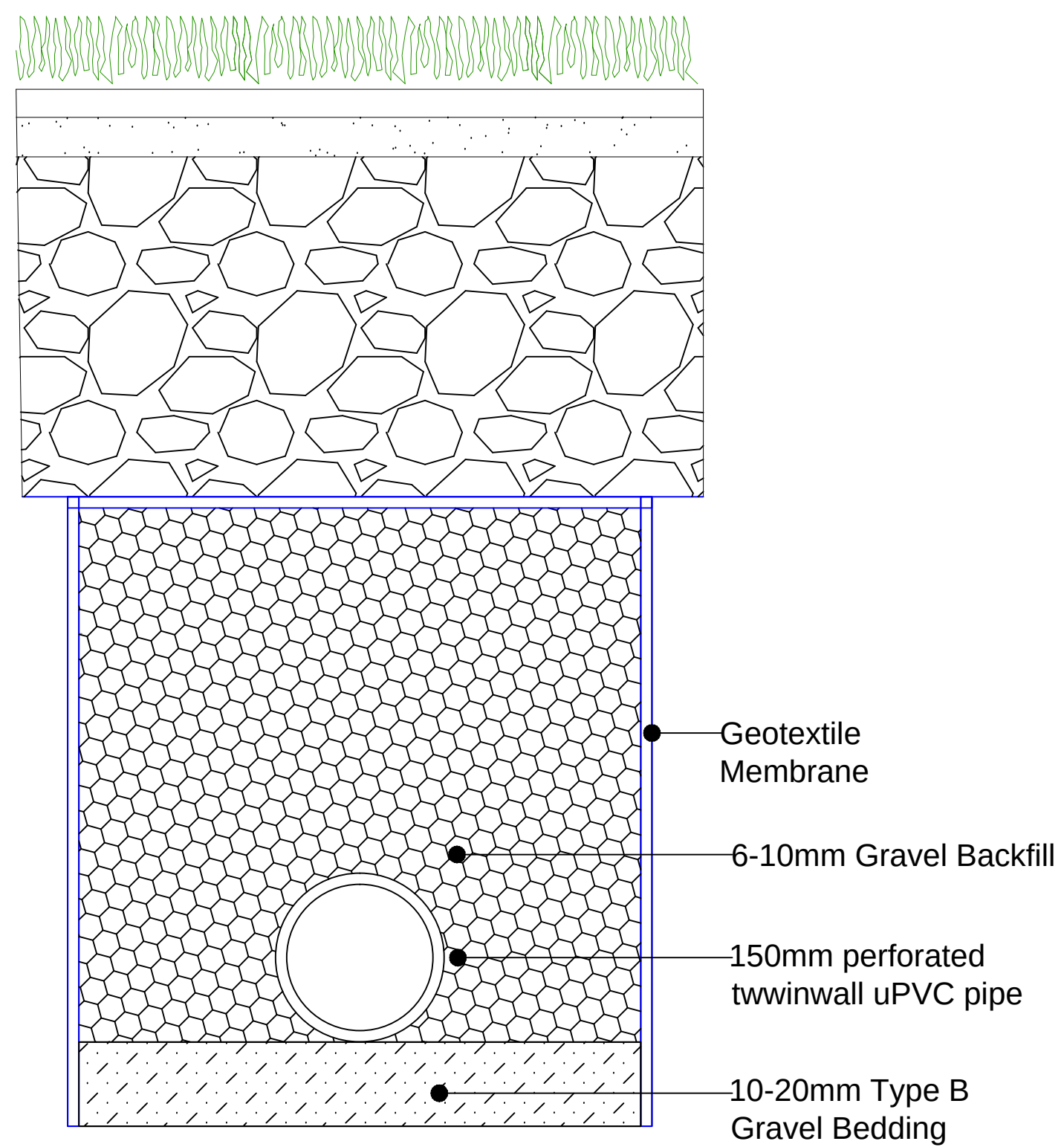
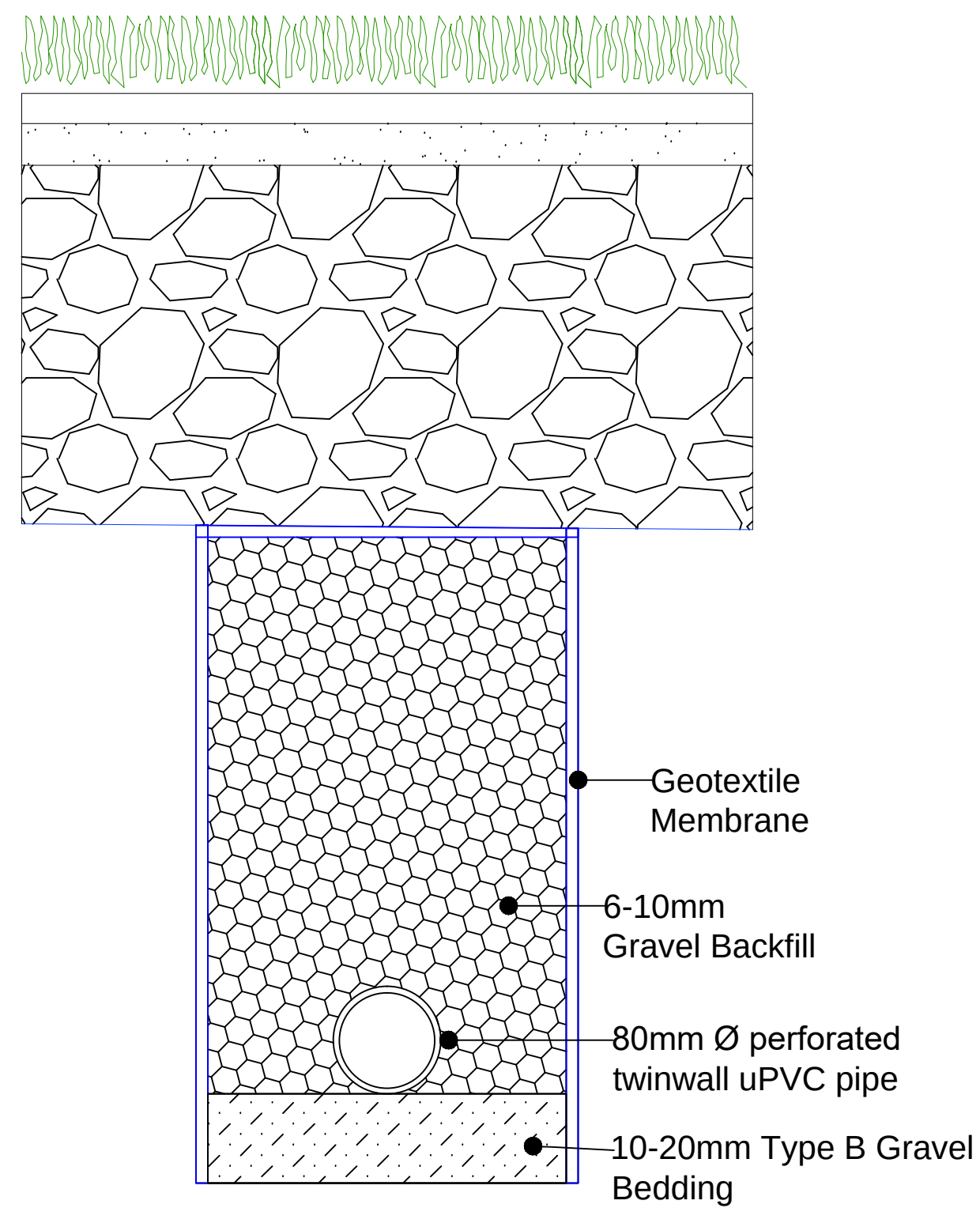
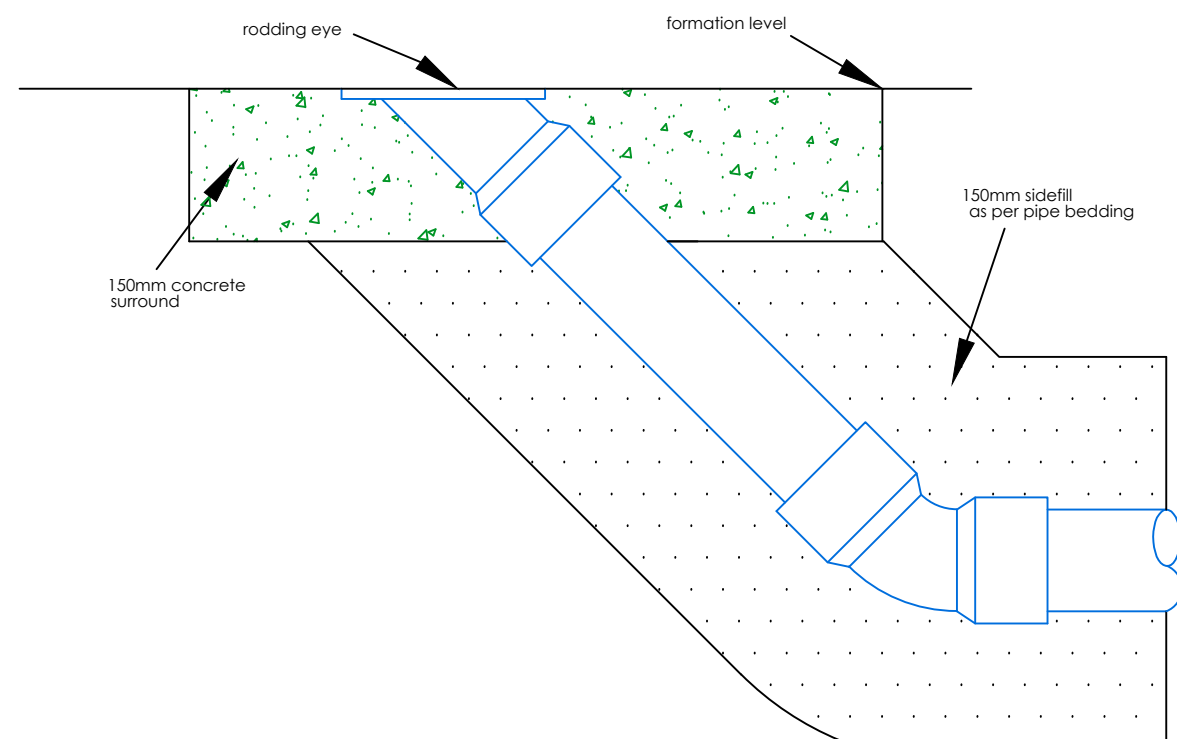
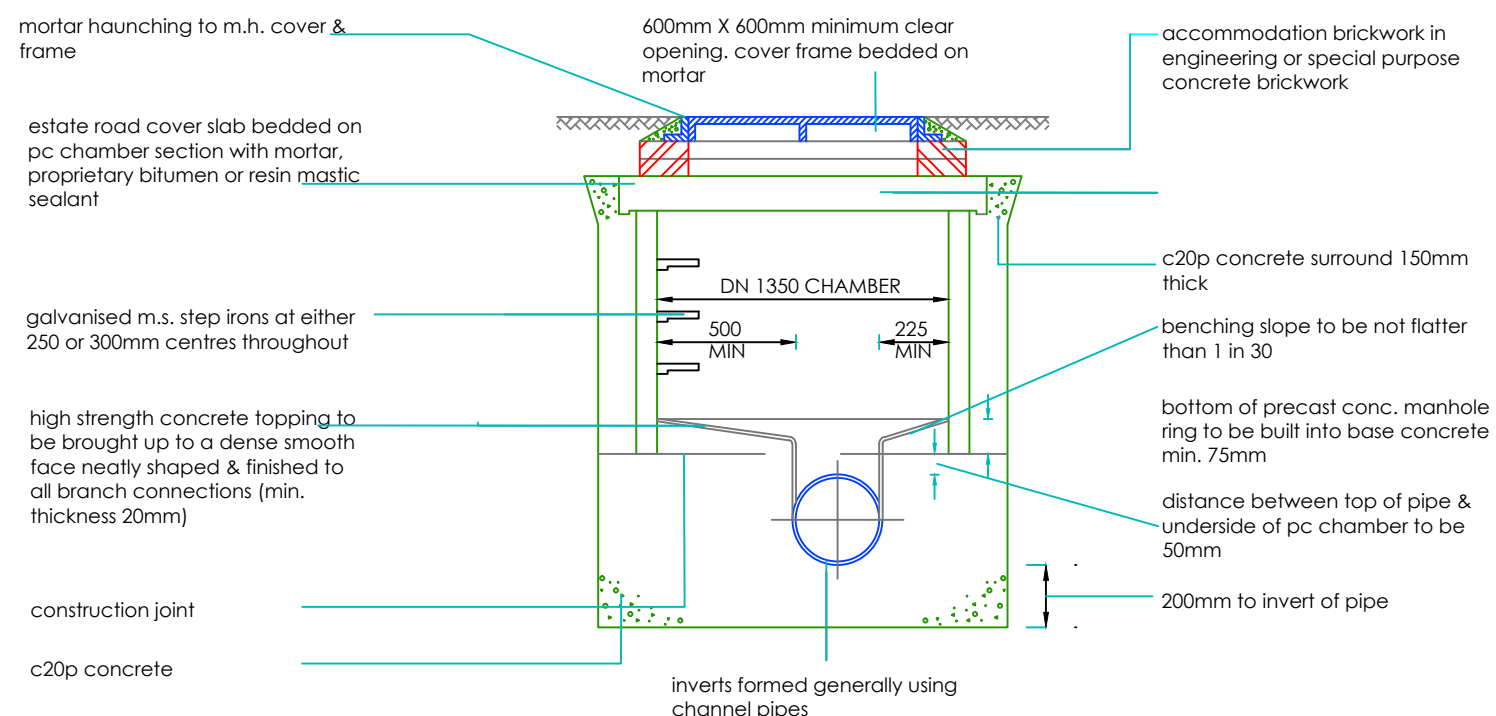
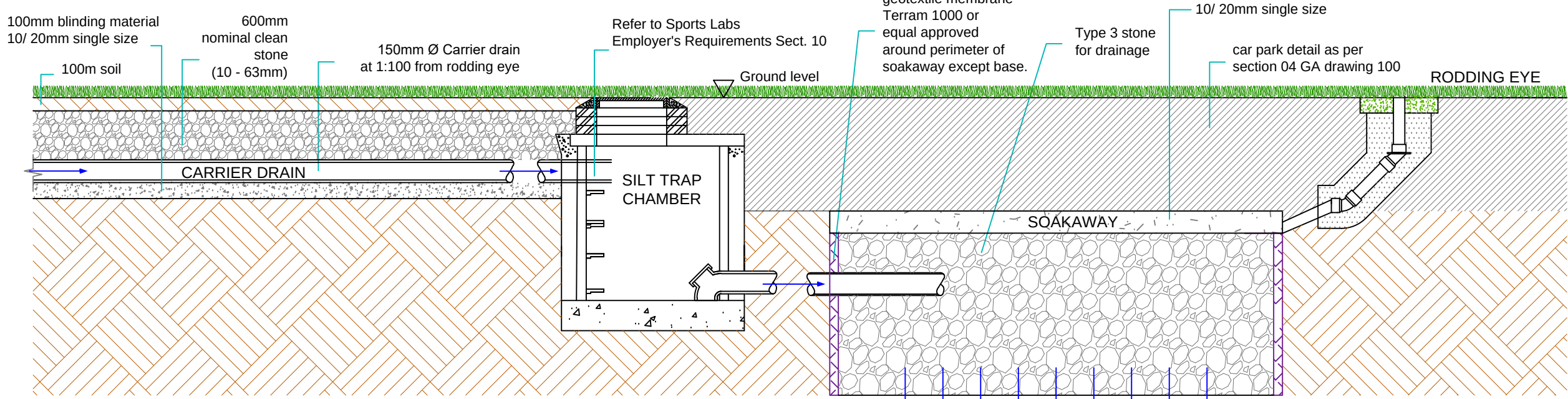
3 SUDS DRAINAGE PROPOSAL

- 3.1 In addition to the porous formation of the pitch releasing surface water run-off into the sub-soils below, a SUDS drainage system is seen as a requirement to provide additional capacity for storm events as outlined in Microdrainage calculations. Calculations were undertaken with consideration of a 100 year return period (+30%). The proposed SUDS drainage system for the synthetic pitch is a soakaway. The volume of which shall be 30m³. The soakaway shall comprise a type 3 fill material, enclosed in a terram 1000 or similar geotextile layer. Microdrainage calculations have been undertaken in accordance with BRE Digest 365 for soakaway design, taking due consideration to soil infiltration rates from the Site Investigation undertaken attached to the back of this report. Calculations factor in the storage capacity already provided underlying the pitch as the sub-base holds a large capacity, which at 95% compaction will achieve 10% voids within a 300mm depth material over a synthetic area of 122.0m x 84.0m – this has been factored in to all calculations.
- 3.2 The soakaway will act as an overflow system for the pitch and function by slowly dispersing surface water run-off into the sub-soils and shall be designed as 30m³ in volume.

4 SITE TOPOGRAPHY

- 4.1 A topographical site survey was undertaken by Sports Labs Ltd on 19/02/2019. This captured information on ground levels and surrounding existing features such as footpath, utilities, street lighting, fencing etc. This information was aligned with ecology surveys provided by The University of Reading which outlined each tree located on site and root protection areas to be considered. Existing trees identified shall have protection measures in place and these shall be laid out within the Arboricultural Report undertaken by Challice.
- 4.2 The topographical survey indicates that levels for the new pitch are within the 1:100 maximum slope requirement for governing body certification of the pitch and therefore any cut & fill required to provide the formation level for the pitch is negligible. The playing fields currently fall naturally from North to South as a general pattern.

APPENDIX A – DETAILED DESIGN SECTIONS



Notes

It is the contractors responsibility to check design levels and sizes for compliance. Any discrepancies or errors to be identified to the design team.

Synthetic Area

Length	- 122.0m
Width	- 78.0m
Recesses	- 65.0m at 2.5m
Total Synthetic Area	- 9679m ²

Drainage

Lateral Drainage - 80mm diameter
Carrier Drainage - 150mm diameter

KEY

- | | |
|---|---|
|  | - Building |
|  | - Roads & Footways |
|  | - 3.0m high perimeter fence |
|  | - 1.2m high spectator fence |
|  | - 6.0m high perimeter fence |
|  | - 3.0m wide handstanding |
|  | - Spectator stand units
2no. (10.21 x 4.0 x 0.175m founds) |
|  | - Existing Vegetation & RPA |
|  | - Existing Utilities |
|  | - New soakaway Installation (30m³) |
|  | - New Floodlighting Column
(8 columns system, 15m height) |
|  | - Electric Cable |
|  | - Gas Pipe |
|  | - Water Pipe |
|  | - Telecomm |
|  | - Utility Mapping Boundary |
|  | - Radar Utility Trace |

	-	-
	-	-
	-	-
	Updated outfall as per infiltration results	04/19
	As per 190319 RIBA 2 - Orientation Review Rev1	03/19
v	Description	Date



Facilities Management Directorate
Whiteknights, PO Box 235, Reading, RG6 6BW
Tel. 0118 378 8958 Fax. 0118 975 3499



Building
University of Reading

Project
New 3G Pitch

Title
Drainage

rawn	Date	Scale
G	04/2019	1:500@A1

ject (WREN No.)-Originator-Volume-Level-Type-Role-Classification-Number	Suitability-Rev.
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APPENDIX B – INFILTRATION TEST RESULTS



Intrusive Site Investigation Report

LOCATION	Proposed Pitch, University of Reading, RG2 7BW
ISSUE DATE	25 th March 2019
FOR	Sports Labs Ltd.
CLIENT REF.	PO-11747
OUR REF.	G19090

Prepared by



Jack Harper BSc(Hons) MSc MEnvSc
Senior Geo-environmental Engineer

Checked by



Ross Nicolson BSc(Hons) MSc(Eng) CEng MIMM
Principal Geotechnical Engineer

Table of Contents

Section	Content	Page
1	Introduction	3
2	Scope of Ground Investigation	3
Appendix 1	Site Plan and Borehole Logs	
Appendix 2	Moisture Determination and Atterberg Limits Test Results (Table 1), Moisture / Shear Strength Profiles and Water Infiltration Test Results	
Appendix 3	Water Soluble Sulphate and pH Test Results	



Units 4 and 5 Terry Dicken Industrial Estate
Ellerbeck Way
Stokesley
North Yorkshire
TS9 7AE

Tel. 01642 713779
Fax 01642713923
Email enquiries@geoinvestigate.co.uk

1. Introduction

In accordance with your instruction Geoinvestigate Ltd. carried out a site investigation at the above site on 5 March 2019.

2. Scope of Investigation

Five (5) windowless sampling boreholes were sunk using a Dando Terrier mini drilling rig to depths of between 1.40m and 1.60m (ref. BH1-BH5).

Information on the ground conditions revealed by the investigation is presented on the borehole logs which are included in Appendix 1 of this report. The results of hand vane shear strength tests which were carried out in cohesive natural soils (where present) are shown on the logs as well as the results of Standard Penetration Test (SPTs) undertaken at a depth of 1.00m in each borehole.

California bearing ratio (CBR) testing was carried out in surface deposits at each borehole location using a handheld Mexeprobe to give indicative information regarding the competency of the near-surface soils for subbase/capping design. The results of these tests are presented on the borehole logs.

Water infiltration testing was carried out in BH3 according to the BS 5930 “Falling head tests in boreholes” method. Results are presented in Appendix 2 together with the calculation of the infiltration rate for these soils (test zone between 1.00m and 1.40m below ground level). Note that relatively shallow (perched) groundwater was encountered in some of the boreholes which may affect the functionality of any proposed soakaway features; the London Clay Formation is expected to be present at depth below the sands and gravels of the Boyn Hill Gravel Member which were encountered by the boreholes.

Results of Atterberg limits tests and moisture determinations are presented in Appendix 2 (Table 1) together with moisture and shear strength profiles of the boreholes. Results of water soluble sulphate and pH tests are presented in Appendix 3.

Minor roots were recorded to a depth of 1.00 in BH3.

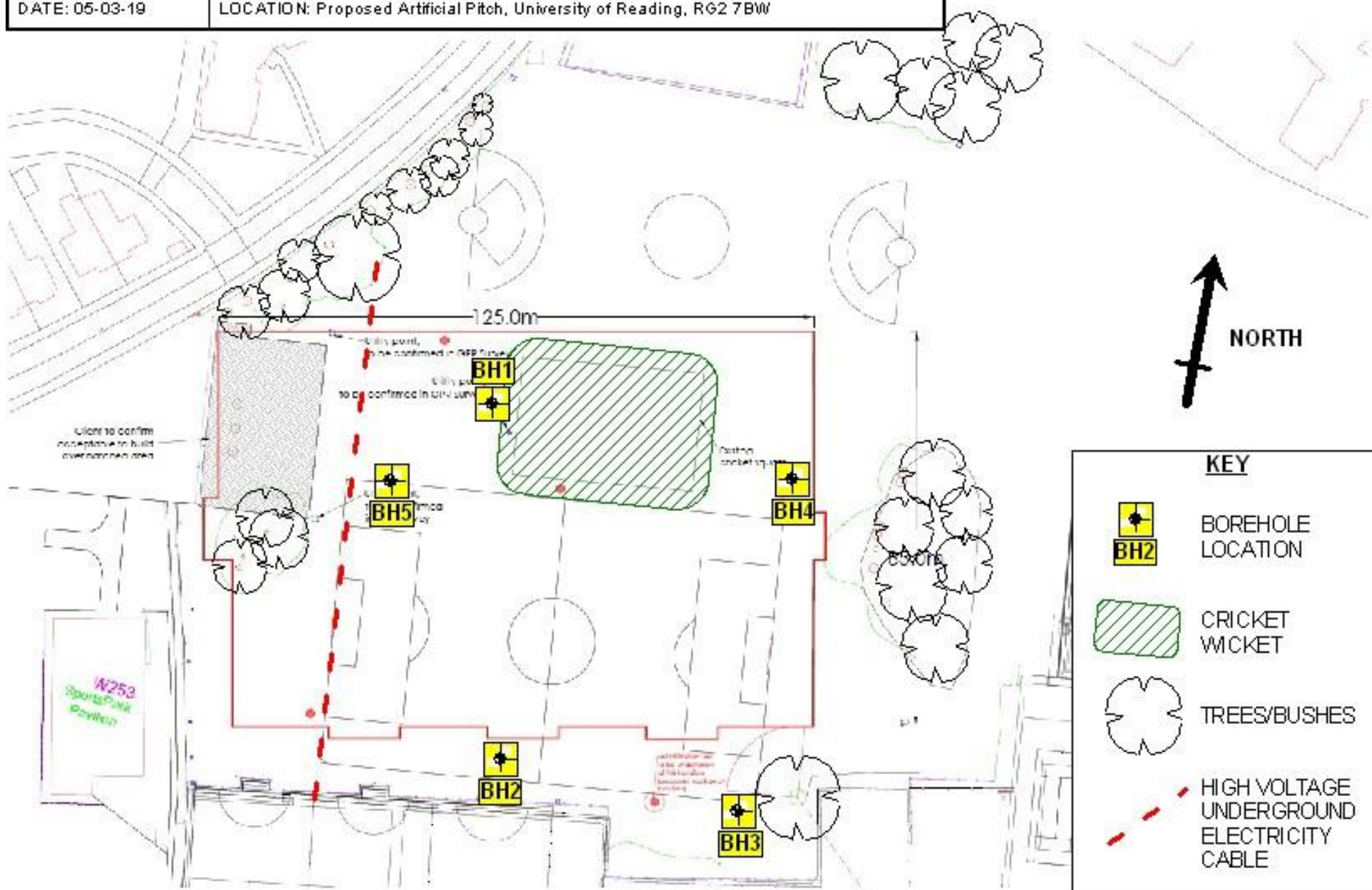
We trust that you will find the results of this investigation satisfactory and we would be pleased to provide any further assistance you may require with this matter.

END OF REPORT



APPENDIX 1
Site Plan
and
Borehole Logs

OUR REF: G19090	YOUR REF: PO 11474	SITE PLAN (NOT TO SCALE)
DATE: 05-03-19	LOCATION: Proposed Artificial Pitch, University of Reading, RG2 7BW	



GEOINVESTIGATE Ltd.

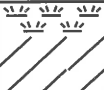
Your Ref. PO 11474

Our Ref. G19090

BH No.1 Sheet No. 1 of 1

Location: Proposed Artificial Pitch, University of Reading, RG2 7BW

DATE: 05/03/19

Depth (m)	Description of Strata	Thickness	Legend	Gas Well	Sample	Test Type Result	SPT N Value (Depth)	Depth to Water	Depth (m)
0.30	TURF and TOPSOIL. Loose brown slightly clayey gravelly sand. Gravel is fine to coarse of flint, brick and coal. Becoming very gravelly below 0.20m	300					Cv kN/m ² 1.00m-1.45m 8,10,13, 15,15,17 N = 60	SWL at 0.95m	0.25
0.80	"Medium dense" pale brown very clayey sandy GRAVEL. Gravel is fine to coarse of flint with occasional cobbles.	500			O				0.50
1.00	"Dense" orangish brown very sandy GRAVEL. Gravel is fine to coarse of flint.	200			O S				0.75
1.50	Very dense pale brown gravelly SAND. Gravel is fine to coarse of flint. Sand is medium to coarse. Wet.	500			O				1.00
									1.25
									1.50

Borehole Terminated at 1.50m due to refusal

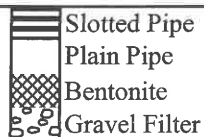
Mexeprobe CBR test results following removal of turf:

Depth (m)	1 st Test (%)	2 nd Test (%)	3 rd Test (%)
0.050	2.0	2.0	2.0
0.125	4.0	2.5	2.5
0.200	8.0	Refusal	Refusal
0.275	8.0		
0.350	Refusal		

Remarks:

Casing to 1.00m
Dynamic windowless sampling by Terrier Rig to 1.50m
Borehole closed below 1.30m on completion
Standing water level at 0.95m on completion

Key:



O Disturbed sample
Cv Shear vane
W Water sample
S Standard Penetration Test (with solid cone)

BH1

GEOINVESTIGATE Ltd.

Your Ref. PO 11474

Our Ref. G19090

BH No.2 Sheet No. 1 of 1

Location: Proposed Artificial Pitch, University of Reading, RG2 7BW

DATE: 05/03/19

Depth (m)	Description of Strata	Thick-ness	Legend	Gas Well			Sample	Test Type Result	SPT N Value (Depth)	Depth to Water	Depth (m)																				
0.40	TURF and TOPSOIL. Loose brown slightly clayey gravelly sand. Gravel is fine to coarse of flint. Becoming very gravelly below 0.20m	400						Cv kN/m ²			0.25																				
1.20	Medium dense pale brown very clayey sandy GRAVEL. Gravel is fine to coarse of flint with occasional cobbles.	800					O		1.00m-1.45m 4,4,9,10,15,15 N = 49		0.50																				
							O S	0.75																							
								1.00																							
								1.25																							
1.40	Dense orangish brown very sandy GRAVEL. Gravel is fine to coarse of flint.	200					O				1.40																				
Borehole Terminated at 1.40m due to refusal																															
Mexeprobe CBR test results following removal of turf:																															
<table><tr><th>Depth (m)</th><th>1st Test (%)</th><th>2nd Test (%)</th><th>3rd Test (%)</th></tr><tr><td>0.050</td><td>3.0</td><td>2.5</td><td>4.0</td></tr><tr><td>0.125</td><td>6.0</td><td>4.0</td><td>8.0</td></tr><tr><td>0.200</td><td>Refusal</td><td>8.0</td><td>Refusal</td></tr><tr><td>0.275</td><td></td><td>Refusal</td><td></td></tr></table>												Depth (m)	1 st Test (%)	2nd Test (%)	3rd Test (%)	0.050	3.0	2.5	4.0	0.125	6.0	4.0	8.0	0.200	Refusal	8.0	Refusal	0.275		Refusal	
Depth (m)	1 st Test (%)	2nd Test (%)	3rd Test (%)																												
0.050	3.0	2.5	4.0																												
0.125	6.0	4.0	8.0																												
0.200	Refusal	8.0	Refusal																												
0.275		Refusal																													

Remarks:

Casing to 1.00m
Dynamic windowless sampling by Terrier Rig to 1.40m
Borehole remained open and dry on completion

Key:

Slotted Pipe
 Plain Pipe
 Bentonite
 Gravel Filter

O Disturbed sample
Cv Shear vane
W Water sample
S Standard Penetration Test (with solid cone)

BH2

GEOINVESTIGATE Ltd.

Your Ref. PO 11474

Our Ref. G19090

BH No.3 Sheet No. 1 of 1

Location: Proposed Artificial Pitch, University of Reading, RG2 7BW

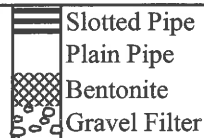
DATE: 05/03/19

Depth (m)	Description of Strata	Thickness	Legend	Gas Well			Sample	Test Type Result	SPT N Value (Depth)	Depth to Water	Depth (m)												
0.40	TURF and TOPSOIL. Loose brown slightly clayey gravelly sand. Gravel is fine to coarse of flint. Becoming very gravelly below 0.10m and clayey below 0.25m	400						Cv kN/m ²			0.25												
1.00	Soft to firm pale brown mottled grey very sandy gravelly CLAY. Gravel is fine to coarse of flint.	600					O	17	1.00m-1.45m 4,7,9,10,10,14 N = 43		0.50												
							O S	20		1.00													
								O		1.25													
1.30	Dense pale orangish brown very clayey gravelly SAND. Gravel is fine to coarse of flint. Sand is medium. Wet.	300								1.50													
1.60	Dense orangish brown sandy GRAVEL. Gravel is fine to coarse of flint. Wet.	300					O																
Borehole Terminated at 1.60m due to refusal Mexeprobe CBR test results following removal of turf: <table><tr><th>Depth (m)</th><th>1st Test (%)</th><th>2nd Test (%)</th><th>3rd Test (%)</th></tr><tr><td>0.050</td><td>2.0</td><td>2.0</td><td>2.0</td></tr><tr><td>0.075</td><td>Refusal</td><td>Refusal</td><td>Refusal</td></tr></table> Minor roots to 1.00m Water infiltration test carried out in borehole following drilling with 1.0m casing left in situ. Borehole collapsed below 1.40m on filling with water See Infiltration Test 1 results for details.												Depth (m)	1 st Test (%)	2nd Test (%)	3rd Test (%)	0.050	2.0	2.0	2.0	0.075	Refusal	Refusal	Refusal
Depth (m)	1 st Test (%)	2nd Test (%)	3rd Test (%)																				
0.050	2.0	2.0	2.0																				
0.075	Refusal	Refusal	Refusal																				

Remarks:

Casing to 1.00m
Dynamic windowless sampling by Terrier Rig to 1.60m
Borehole remained open on completion
Some water at base of borehole on completion

Key:



O Disturbed sample
Cv Shear vane
W Water sample
S Standard Penetration Test (with solid cone)

BH3

GEOINVESTIGATE Ltd.

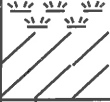
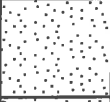
Your Ref. PO 11474

Our Ref. G19090

BH No.4 Sheet No. 1 of 1

Location: Proposed Artificial Pitch, University of Reading, RG2 7BW

DATE: 05/03/19

Depth (m)	Description of Strata	Thickness	Legend	Gas Well	Sample	Test Type Result	SPT N Value (Depth)	Depth to Water	Depth (m)
0.30	TURF and TOPSOIL. Loose brown slightly clayey gravelly sand. Gravel is fine to coarse of flint. Becoming very gravelly below 0.10m	300				Cv kN/m ²			0.25
0.60	Loose pale orangish brown fine SAND. Occasional fine to coarse gravel of flint. Moist.	300			O				0.50
0.90	Soft to firm pale brown mottled grey very sandy gravelly CLAY. Gravel is fine to coarse of flint.	300				24			0.75
1.50	Medium dense orangish brown very sandy slightly clayey GRAVEL. Gravel is fine to coarse of flint. Slightly Moist.	600			O S		1.00m-1.45m 3,4,5,7,7,9 N = 28		1.00
								SWL at 1.47m	1.25
					O				1.50
Borehole Terminated at 1.50m due to refusal									
Mexeprobe CBR test results following removal of turf:									
Depth (m)	1st Test (%)	2nd Test (%)	3rd Test (%)						
0.050	1.5	1.5	1.5						
0.075	Refusal	Refusal	Refusal						

Remarks:

Casing to 1.00m
Dynamic windowless sampling by Terrier Rig to 1.50m
Borehole remained open on completion
Standing water level at 1.47m on completion

Key:

	Slotted Pipe
	Plain Pipe
	Bentonite
	Gravel Filter

	Disturbed sample
	Shear vane
	Water sample
	Standard Penetration Test (with solid cone)

BH4

GEOINVESTIGATE Ltd.

Your Ref. PO 11474

Our Ref. G19090

BH No.5 Sheet No. 1 of 1

Location: Proposed Artificial Pitch, University of Reading, RG2 7BW

DATE: 05/03/19

Depth (m)	Description of Strata	Thickness	Legend	Gas Well	Sample	Test Type Result	SPT N Value (Depth)	Depth to Water	Depth (m)
0.10	TURF and TOPSOIL. Loose brown slightly clayey gravelly sand. Gravel is fine to coarse of flint.	100				Cv kN/m ²			
									0.25
	Loose pale brown silty gravelly SAND. Gravel is fine to coarse of flint.	500			O				0.50
0.60									
	Soft pale brown very sandy CLAY. Occasional fine to coarse gravel of flint.	150					1.00m-1.45m 7,10,14, 16,18,22 N = 70		0.75
0.85									
	Dense pale brown sandy GRAVEL. Gravel is fine to coarse of flint. Wet. Becoming very dense below 1.20m. Slightly clayey sand band at 1.00m.	550			O S			SWL at 1.20m	1.00
									1.25
1.40					O				1.40

Borehole Terminated at 1.40m due to refusal

Mexeprobe CBR test results from surface:

Depth (m)	1 st Test (%)	2nd Test (%)	3rd Test (%)
0.00	1.5	2.5	2.5
0.075	2.5	4.0	4.5
0.150	4.0	4.5	9.0
0.225	Refusal	8.0	8.0
0.300		6.0	8.0
0.375		6.0	Refusal
0.450		6.0	
0.525		6.0	

Remarks:

Casing to 1.00m
Dynamic windowless sampling by Terrier Rig to 1.40m
Borehole remained open on completion
Standing water level at 1.20m on completion

Key:

Slotted Pipe
 Plain Pipe
 Bentonite
 Gravel Filter

Disturbed sample
 Cv Shear vane
 W Water sample
 S Standard Penetration Test (with solid cone)

BH5

APPENDIX 2

Moisture Determination and Atterberg Limits Test Results (Table 1), Moisture / Shear Strength Profiles and Water Infiltration Test Results

GEOINVESTIGATE Ltd.

Atterberg Limit Test Results

Our ref. G19090

Table 1

Your ref. PO 11474

Location: Proposed Artificial Pitch, University of Reading, RG2 7BW

TP / BH No.	Sample Depth (m)	Insitu Moisture Content (%)	% Passing BS 425 Micron Sieve	Corrected Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Plasticity Index (%)	Soil Classification
1	0.50	13.6	46.0	29.6	17.5	31.4	13.9	CL
	1.00	7.7						
	1.50	11.3						
2	0.40	9.7						
	1.00	5.8						
	1.40	10.1						
3	0.50	17.9	82.8	25.8	*	*	*	*
	1.00	21.4						
	1.25	14.1						
	1.60	5.9						
4	0.50	16.2	29.9	33.7	18.0	36.5	18.5	CI
	1.00	10.1						
	1.50	13.5						
5	0.50	13.1						
	1.00	14.4						
	1.40	12.3						

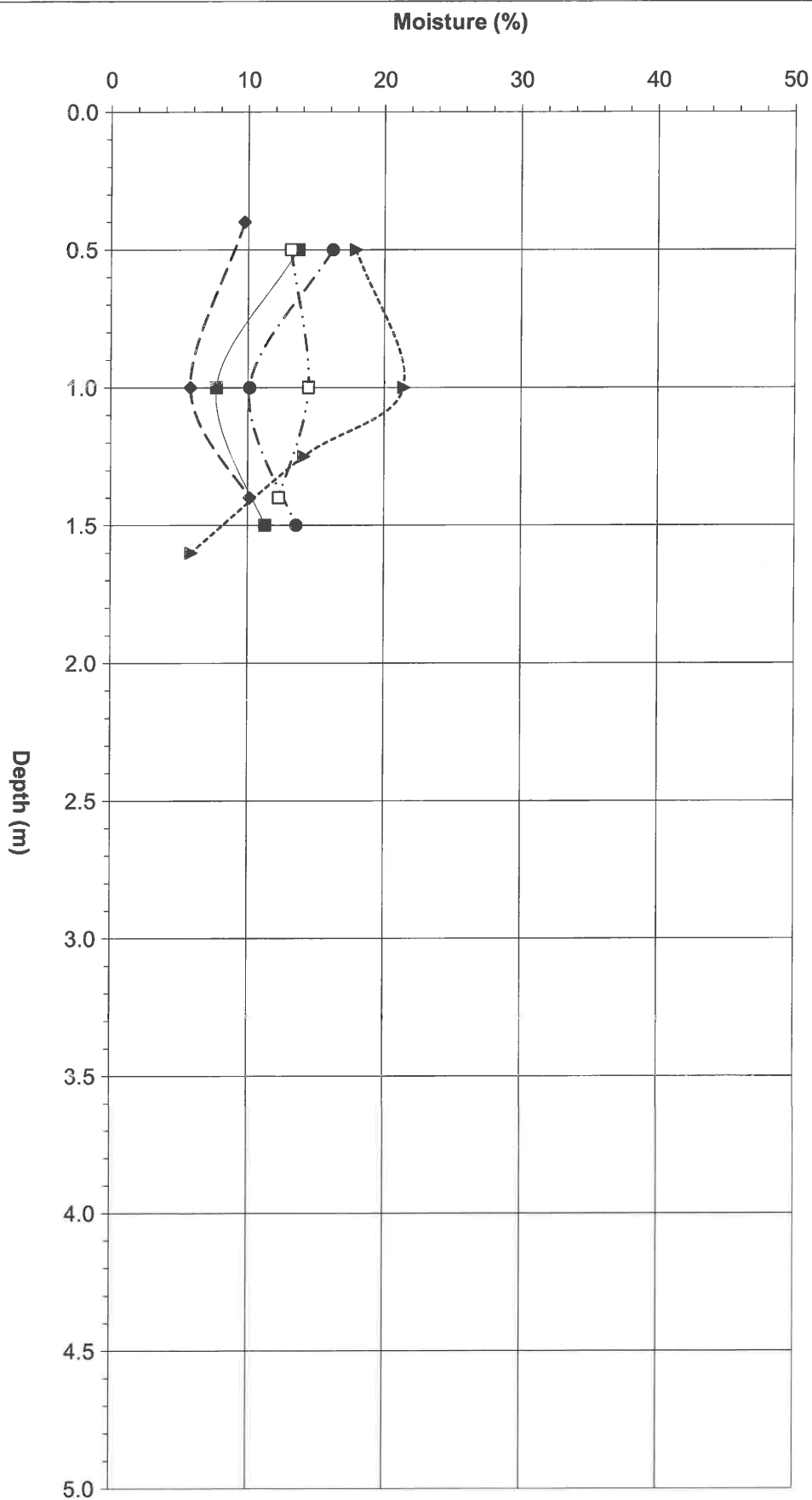
* Essentially non-plastic material

CL = Clay of Low Plasticity according to BS 5930

CI = Clay of Intermediate Plasticity according to BS 5930

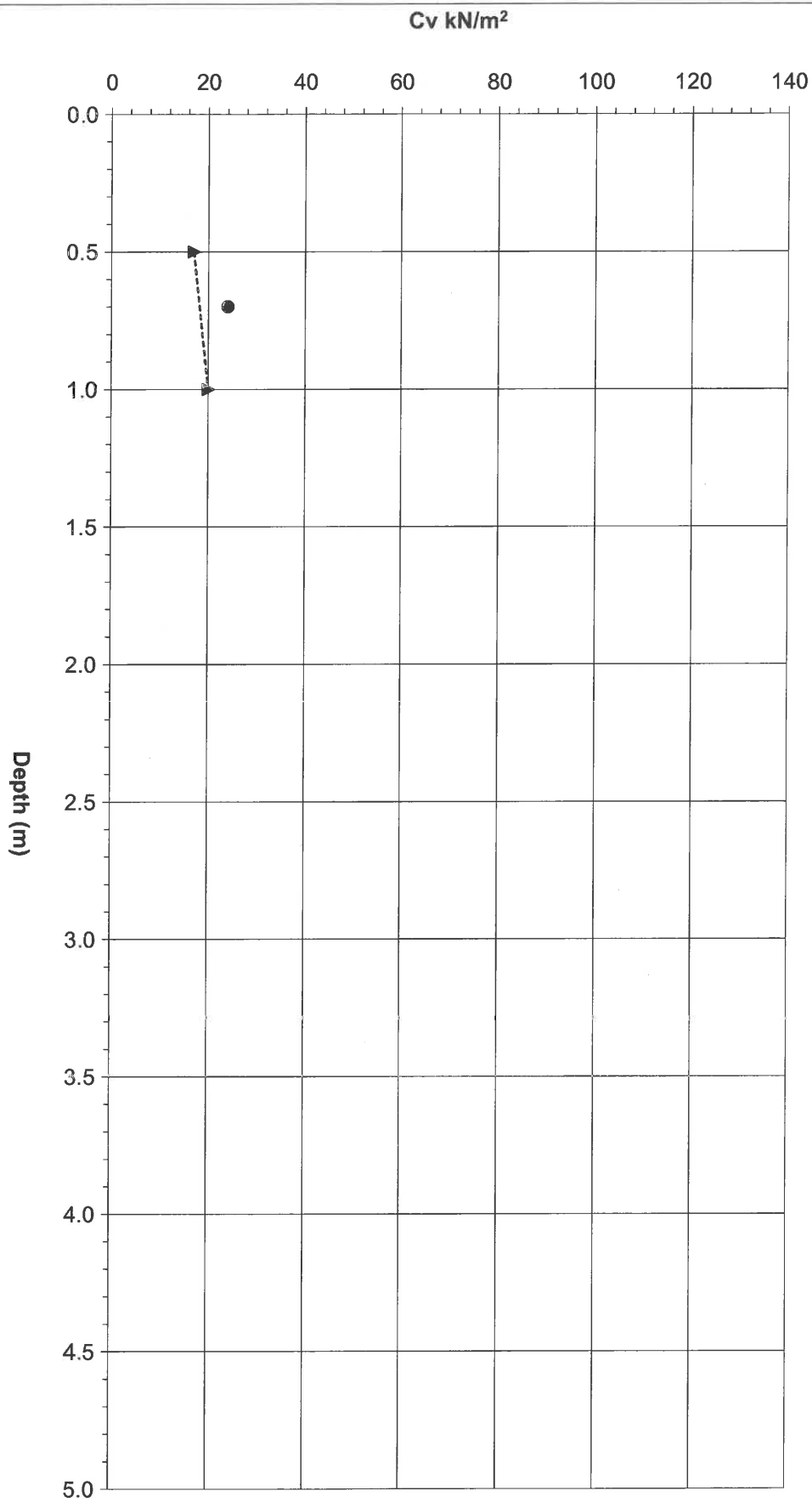
Moisture / depth profile

G19090



Shear strength / depth profile

G19090



Infiltration Test Result

G19090

Proposed Pitch, University of Reading,
Reading, RG2 7BW

05/03/19

Infiltration test 1

(BH3)

Time/s	Depth to water/m	Head/m (above base of borehole)
0	0.000	1.400
30	0.008	1.392
60	0.013	1.387
90	0.017	1.383
120	0.020	1.380
240	0.042	1.358
300	0.051	1.349
600	0.097	1.303
900	0.144	1.256
1200	0.175	1.225
1800	0.235	1.165
2700	0.310	1.090
3600	0.370	1.030

Borehole dimensions:

Depth of Casing, D = 1.00 m

Diameter of Casing, D = 0.125 m

Cross-sectional area, A = 0.012277 m²

Depth below Casing, L = 0.40 m

Ground Water Level = N/A m

Intake factor, F, using:

$$F = \frac{2\pi L}{\log_e \left[\left(\frac{L}{D} \right) + \sqrt{1 + \left(\frac{L}{D} \right)^2} \right]}$$

Source: BS 5930

Intake factor, F = 1.337 m

Choose start time t_1 to be: $t_1 = 0$ s

Choose end time t_2 to be: $t_2 = 3600$ s

Head at time t_1 , $H_1 = 1.400$ m

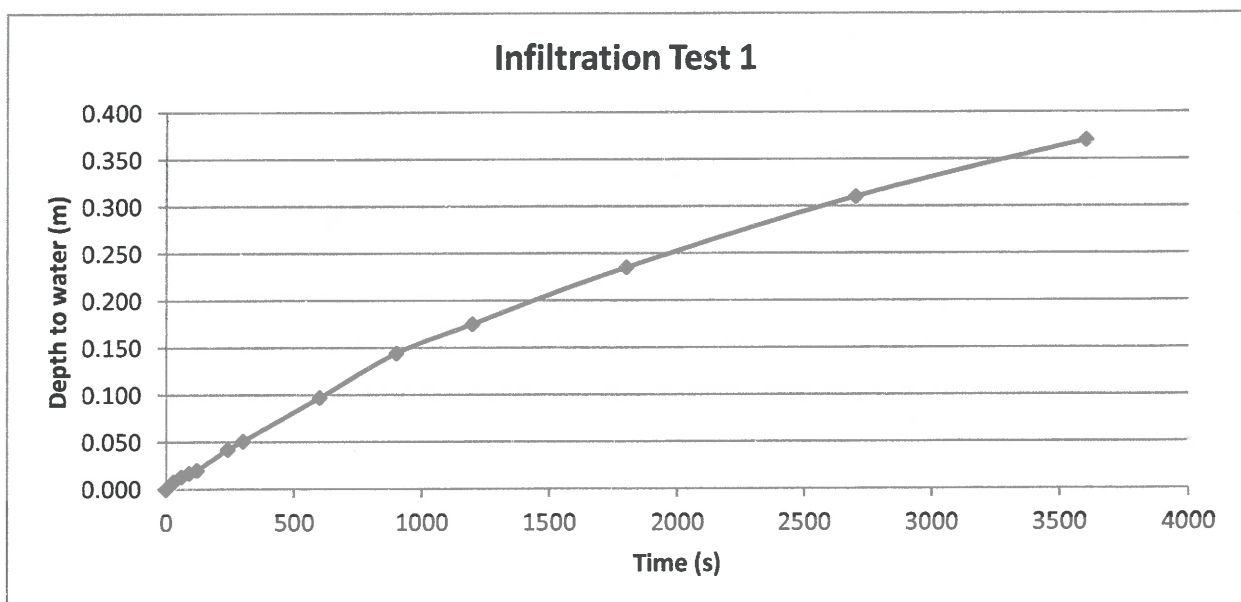
Head at time t_2 , $H_2 = 1.030$ m

Permeability, k, using:

$$k = \frac{A}{F(t_2 - t_1)} \log_e \frac{H_1}{H_2} \text{ (general approach)}$$

Source: BS 5930

Permeability, k = 7.83E-07 ms⁻¹



APPENDIX 3

Water Soluble Sulphate and pH Test Results



ANALYTICAL TEST REPORT

Contract no: 77367

Contract name: Proposed Artificial Pitch - Reading University, RG2 7BW

Client reference: G19090

Clients name: Geo Investigate

Clients address: Units 3a & 4 Terry Dicken Industrial Estate
Ellerbeck Way, Stokesley
North Yorkshire
TS9 7AE

Samples received: 12 March 2019

Analysis started: 12 March 2019

Analysis completed: 18 March 2019

Report issued: 19 March 2019

Notes: Opinions and interpretations expressed herein are outside the UKAS accreditation scope.
Unless otherwise stated, Chemtech Environmental Ltd was not responsible for sampling.
Methods, procedures and performance data are available on request.
Results reported herein relate only to the material supplied to the laboratory.
This report shall not be reproduced except in full, without prior written approval.
Samples will be disposed of 6 weeks from initial receipt unless otherwise instructed.

Key: U UKAS accredited test
M MCERTS & UKAS accredited test
\$ Test carried out by an approved subcontractor
I/S Insufficient sample to carry out test
N/S Sample not suitable for testing

Approved by:

K Campbell

Karan Campbell
Director

Chemtech Environmental Limited

SAMPLE INFORMATION

MCERTS (Soils):

Soil descriptions are only intended to provide a log of sample matrices with respect to MCERTS validation. They are not intended as full geological descriptions. MCERTS accreditation applies for sand, clay and loam/topsoil, or combinations of these whether these are derived from naturally occurring soils or from made ground, as long as these materials constitute the major part of the sample. Other materials such as concrete, gravel and brick are not accredited if they comprise the major part of the sample.

All results are reported on a dry basis. Samples dried at no more than 30°C in a drying cabinet.

Analytical results are inclusive of stones.

Lab ref	Sample id	Depth (m)	Sample description	Material removed	% Removed	% Moisture
77367-1	BH3	0.50	Sandy Clay with Gravel	-	-	5.9
77367-2	BH4	0.50	Sandy Clay with Gravel	-	-	0.2
77367-3	BH5	0.50	Sandy Clay with Gravel	-	-	15.2

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SOILS

Lab number			77367-1	77367-2	77367-3
Sample id			BH3	BH4	BH5
Depth (m)			0.50	0.50	0.50
Date sampled			05/03/2019	05/03/2019	05/03/2019
Test	Method	Units			
pH	CE004 ^M	units	8.3	8.0	8.0
Sulphate (2:1 water soluble)	CE061 ^M	mg/l SO ₄	15	33	15

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METHOD DETAILS

METHOD	SOILS	METHOD SUMMARY	SAMPLE	STATUS	LOD	UNITS
CE004	pH	Based on BS 1377, pH Meter	As received	M	-	units
CE061	Sulphate (2:1 water soluble)	Aqueous extraction, ICP-OES	Dry	M	10	mg/l SO ₄

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DEVIATING SAMPLE INFORMATION

Comments

Sample deviation is determined in accordance with the UKAS note "Guidance on Deviating Samples" and based on reference standards and laboratory trials.

For samples identified as deviating, test result(s) may be compromised and may not be representative of the sample at the time of sampling.

Chemtech Environmental Ltd cannot be held responsible for the integrity of sample(s) received if Chemtech Environmental Ltd did not undertake the sampling. Such samples may be deviating.

Key

N	No (not deviating sample)
Y	Yes (deviating sample)
NSD	Sampling date not provided
NST	Sampling time not provided (waters only)
EHT	Sample exceeded holding time(s)
IC	Sample not received in appropriate containers
HP	Headspace present in sample container
NCF	Sample not chemically fixed (where appropriate)
OR	Other (specify)

Lab ref	Sample id	Depth (m)	Deviating	Tests (Reason for deviation)
77367-1	BH3	0.50	N	
77367-2	BH4	0.50	N	
77367-3	BH5	0.50	N	

APPENDIX C – DESIGN CALCULATIONS

UNIVERSITY OF READING				Page 1	
STORM EVENT					
Causeway		Source Control 2018.1.1			
Summary of Results for 100 year Return Period (+30%)					
Half Drain Time : 6 minutes.					
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	99.580	0.580	163.3	73.0	O K
30 min Summer	99.667	0.667	163.3	84.1	O K
60 min Summer	99.533	0.533	163.3	67.1	O K
120 min Summer	99.215	0.215	163.3	27.0	O K
180 min Summer	99.050	0.050	162.5	6.3	O K
240 min Summer	99.041	0.041	134.8	5.2	O K
360 min Summer	99.031	0.031	102.1	3.9	O K
480 min Summer	99.025	0.025	82.5	3.1	O K
600 min Summer	99.021	0.021	69.4	2.7	O K
720 min Summer	99.019	0.019	61.2	2.4	O K
960 min Summer	99.015	0.015	48.2	1.9	O K
1440 min Summer	99.011	0.011	35.1	1.4	O K
2160 min Summer	99.008	0.008	27.0	1.1	O K
2880 min Summer	99.006	0.006	20.4	0.8	O K
4320 min Summer	99.005	0.005	15.5	0.7	O K
5760 min Summer	99.004	0.004	13.9	0.6	O K
7200 min Summer	99.004	0.004	12.2	0.6	O K
8640 min Summer	99.003	0.003	9.0	0.5	O K
10080 min Summer	99.003	0.003	9.0	0.4	O K
15 min Winter	99.728	0.728	163.3	91.7	Flood Risk
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)		
15 min Summer	119.169	0.0	19		
30 min Summer	78.334	0.0	27		
60 min Summer	49.114	0.0	42		
120 min Summer	29.799	0.0	72		
180 min Summer	21.972	0.0	96		
240 min Summer	17.604	0.0	126		
360 min Summer	12.777	0.0	186		
480 min Summer	10.190	0.0	246		
600 min Summer	8.542	0.0	308		
720 min Summer	7.392	0.0	368		
960 min Summer	5.880	0.0	482		
1440 min Summer	4.253	0.0	728		
2160 min Summer	3.071	0.0	1104		
2880 min Summer	2.435	0.0	1420		
4320 min Summer	1.753	0.0	2176		
5760 min Summer	1.387	0.0	2816		
7200 min Summer	1.156	0.0	3640		
8640 min Summer	0.996	0.0	4264		
10080 min Summer	0.878	0.0	5456		
15 min Winter	119.169	0.0	19		
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Causeway

Source Control 2018.1.1

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
30 min Winter	99.804	0.804	163.3	101.3	Flood Risk
60 min Winter	99.540	0.540	163.3	68.0	O K
120 min Winter	99.064	0.064	163.3	8.1	O K
180 min Winter	99.039	0.039	128.2	5.0	O K
240 min Winter	99.032	0.032	103.7	4.0	O K
360 min Winter	99.023	0.023	76.0	2.9	O K
480 min Winter	99.019	0.019	61.2	2.4	O K
600 min Winter	99.016	0.016	51.4	2.0	O K
720 min Winter	99.014	0.014	44.9	1.7	O K
960 min Winter	99.011	0.011	35.1	1.4	O K
1440 min Winter	99.008	0.008	25.3	1.0	O K
2160 min Winter	99.006	0.006	18.8	0.8	O K
2880 min Winter	99.005	0.005	15.5	0.7	O K
4320 min Winter	99.004	0.004	12.2	0.5	O K
5760 min Winter	99.003	0.003	10.6	0.6	O K
7200 min Winter	99.003	0.003	9.0	0.5	O K
8640 min Winter	99.002	0.002	7.4	0.4	O K
10080 min Winter	99.002	0.002	7.4	0.4	O K

Storm Event	Rain (mm/hr)	Flooded Time-Peak Volume (m³)	(mins)
30 min Winter	78.334	0.0	28
60 min Winter	49.114	0.0	44
120 min Winter	29.799	0.0	70
180 min Winter	21.972	0.0	96
240 min Winter	17.604	0.0	126
360 min Winter	12.777	0.0	184
480 min Winter	10.190	0.0	246
600 min Winter	8.542	0.0	314
720 min Winter	7.392	0.0	368
960 min Winter	5.880	0.0	494
1440 min Winter	4.253	0.0	732
2160 min Winter	3.071	0.0	1100
2880 min Winter	2.435	0.0	1444
4320 min Winter	1.753	0.0	2368
5760 min Winter	1.387	0.0	3112
7200 min Winter	1.156	0.0	4216
8640 min Winter	0.996	0.0	4224
10080 min Winter	0.878	0.0	5192



Causeway

Source Control 2018.1.1

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)	18.700	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 1.000

Time (mins)	Area	Time (mins)	Area	Time (mins)	Area
From:	To:	From:	To:	From:	To:
0	4	0.350	4	8	0.350
				8	12
					0.300

		Page 4																				
																						
Causeway	Source Control 2018.1.1																					
<u>Model Details</u> Storage is Online Cover Level (m) 100.000 <u>Infiltration Trench Structure</u> <table> <tr> <td>Infiltration Coefficient Base (m/hr)</td> <td>2.80000</td> <td>Trench Width (m)</td> <td>3.5</td> </tr> <tr> <td>Infiltration Coefficient Side (m/hr)</td> <td>0.00000</td> <td>Trench Length (m)</td> <td>120.0</td> </tr> <tr> <td>Safety Factor</td> <td>2.0</td> <td>Slope (1:X)</td> <td>0.0</td> </tr> <tr> <td>Porosity</td> <td>0.30</td> <td>Cap Volume Depth (m)</td> <td>0.000</td> </tr> <tr> <td>Invert Level (m)</td> <td>99.000</td> <td>Cap Infiltration Depth (m)</td> <td>0.000</td> </tr> </table>			Infiltration Coefficient Base (m/hr)	2.80000	Trench Width (m)	3.5	Infiltration Coefficient Side (m/hr)	0.00000	Trench Length (m)	120.0	Safety Factor	2.0	Slope (1:X)	0.0	Porosity	0.30	Cap Volume Depth (m)	0.000	Invert Level (m)	99.000	Cap Infiltration Depth (m)	0.000
Infiltration Coefficient Base (m/hr)	2.80000	Trench Width (m)	3.5																			
Infiltration Coefficient Side (m/hr)	0.00000	Trench Length (m)	120.0																			
Safety Factor	2.0	Slope (1:X)	0.0																			
Porosity	0.30	Cap Volume Depth (m)	0.000																			
Invert Level (m)	99.000	Cap Infiltration Depth (m)	0.000																			
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