



EG/33/11

SOUTHCOTT HOMES LTD

**LAND TO THE REAR OF
GREENOAKS,
BARNHAM ROAD,
BARNHAM**

FLOOD RISK ASSESSMENT

PFA Consulting
Stratton Park House
Wanborough Road
Swindon
SN3 4HG

engineering the future

DOCUMENT CONTROL

Job No.	S424		
	Name	Date	Initials
Prepared by	M Skivington	26/05/2011	[REDACTED]
Checked by	M J Packer	26/05/2011	

Issue	Date	Comments	Approved
1	26/05/2011		[REDACTED]
			M J Packer BSc (Hons) CEng MICE

This document has been prepared for the exclusive use of the client in connection with the project and unless otherwise agreed in writing by PFA Consulting, no other party may copy, reproduce, make use of or rely upon the contents of this report other than for the purposes for which it was originally prepared and provided.

Opinions and information provided in this document have been provided using due care and diligence. It should be noted and is expressly stated that no independent verification of any information supplied to PFA Consulting has been made.

Warning: This document may contain coloured images which may not print satisfactorily in black and white. It may also contain images originally created at a size greater than A4 which may not print satisfactorily on small printers. If copying is authorised but difficulty is incurred in reproducing a paper copy of this document, or a scaled copy is required, please contact PFA Consulting. Authorisation for reproducing plans based upon Ordnance Survey information cannot be given.



May 2011

G:\Workfiles\S424\REPORTS\S424-Disc02 FRA.docx

CONTENTS

PAGE NO.

1. INTRODUCTION	1
2. THE SCOPE OF THE ASSESSMENT	2
3. FLOOD RISK ASSESSMENT	4
4. CONCLUSIONS	9

APPENDICES

Appendix 1	Local Context Plan – FRA Figure 1
Appendix 2	Copy of Environment Agency's Flood Map
Appendix 3	Proposed Site Plans (Vivid Design Studio Drg. Nos. 100063/02 and 100063/03)
Appendix 4	Topographical Survey – T.J.K. Land Surveyors Drawing Reference TJK1463
Appendix 5	Geo-Environmental's Infiltration Test Results and Groundwater Monitoring Report
Appendix 6	Drainage Layout – Rushby Brewster's Drawing Reference RBA895 - 50 Rev P6
Appendix 7	Drainage Report and Calculations – Rushby Brewster's design sheets RBA 895 S/A-1 and S/A-2
Appendix 8	Micro Drainage Calculations

1. INTRODUCTION

- 1.1. This Flood Risk Assessment (FRA) has been prepared by PFA Consulting on behalf of Southcott Homes Ltd in support of a planning application for a residential development of 13 dwellings on land to the rear of Greenoaks in Barnham Road, Barnham. The overall site comprises around 0.5 hectares and is shown on Figure 1 in Appendix 1.
- 1.2. The purpose of this FRA is to provide sufficient flood risk information in order to demonstrate that the future users of the development would remain safe throughout its lifetime, that the development would not increase flood risk elsewhere and, where practicable, that the development would reduce flood risk overall.

2. THE SCOPE OF THE ASSESSMENT

- 2.1. Planning Policy Statement 25: Development and Flood Risk (PPS25), Revised in March 2010, sets out the Government's policy on development and flood risk. It highlights the key role of the planning system in managing flood risk and planning's contribution to mitigating and adapting to climate change.
- 2.2. The need for an appropriate assessment of flood risk is set out in Paragraphs 8, 10-13, and 22 of PPS25. Guidance on the minimum requirements for Flood Risk Assessments is contained in Annex E of PPS25. Annex E3 of PPS25 advises that any assessment of flood risk should be proportionate to the risk and appropriate to the scale, nature, and location of the development.
- 2.3. Advice on the practical implementation of PPS25 is given in the Department for Communities and Local Government's publication entitled 'Planning Policy Statement 25: Development and Flood Risk Practice Guide' published in December 2009.
- 2.4. PPS25 requires that a sequential risk-based approach to determining the suitability of land for development in flood risk areas should be applied, and that flood risk assessment should be carried out to the appropriate degree, at all levels of the planning process.
- 2.5. PPS25 states that a Strategic Flood Risk Assessment (SFRA) should be carried out by the Local Planning Authority to inform the preparation of its Local Development Documents (LDDs). The Arun District SFRA was published in February 2008. One of the objectives of the SFRA is that it should be used by the Council to inform the application of the Sequential Test. The aim of the Sequential Test is to steer new development to areas at the lowest probability of flooding (Zone 1).
- 2.6. The Environment Agency's Flood Zones provide indications of the probability of flooding and the predicted extent of the natural floodplain and extreme flood events. A copy of the Environment Agency's Flood Map, which indicates the Flood Zones in the vicinity of the site is reproduced in **Appendix 2**.
- 2.7. The Environment Agency's Flood Map indicates those areas at risk of flooding from rivers, corresponding to Flood Zone 3 shown coloured dark blue, and the extent of the extreme flood, corresponding to Flood Zone 2 shown coloured light blue. The remaining land falls in Flood Zone 1. It can therefore be seen that the site lies within Flood Zone 1.
- 2.8. PPS25 defines Flood Zone 1 as a 'Low Probability' zone assessed as having a less than 1 in 1000 (0.1%) annual probability of river flooding in any year. PPS25 advises that all uses of land are appropriate in this zone.
- 2.9. Table D.1 in PPS25 also states that for development proposals in Flood Zone 1 comprising one hectare or above the vulnerability to flooding from other sources as well as from river and sea flooding, and the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water runoff, should be incorporated in a FRA.

- 2.10. The Environment Agency has produced updated standing advice in the light of PPS25 to assist Local Planning Authorities make decisions on low risk planning applications where, whilst flood risk is an issue, there is no need to consult the Environment Agency for a bespoke response. The standing advice also sets out those higher risk developments on which the Environment Agency are a statutory consultee on development and flood risk and so need to be consulted directly by a Local Planning Authority.
- 2.11. The standing advice contains a Consultation Matrix which sets out when the Environment Agency needs to be consulted by Local Planning Authorities, and gives guidance on what information is required, for different development scenarios. The proposed development falls into the category 'Operational Development of 1 hectare or less'. For this category of development falling within Flood Zone 1, the Consultation Matrix indicates that the Local Planning Authority does not need to consult the Environment Agency and refers to the Environment Agency's notes which set out good practice principles and standards to achieve sustainable surface water management.
- 2.12. The scope of this Flood Risk Assessment is therefore to provide sufficient information to satisfy the relevant requirements of PPS25 and the Environment Agency's good practice notes.

3. FLOOD RISK ASSESSMENT

Site Location

- 3.1. The site location plan, contained in Appendix 1, is based on the Ordnance Survey map and shows geographical features and identifies watercourses and other bodies of water in the vicinity of the site.

Development Description

- 3.2. The proposed development comprises the construction of 13 dwellings along with an associated access road and parking. The development proposals are shown on the Vivid Design Studio Drg. Nos. 100063/02 and 100063/03, copies of which are reproduced in Appendix 3.

Planning Context

- 3.3. The Local Development Framework for Arun District contains saved policies from the Arun District Local Plan 2003. Policy GEN9 deals with foul and surface water drainage, Policies GEN10 and GEN11 deal with tidal and inland flooding.
- 3.4. The proposed development area falls within Flood Zone 1. Therefore, it is unnecessary to apply the Sequential Test.
- 3.5. From Table D.2 of PPS25, the proposed development falls into the 'More Vulnerable' flood risk vulnerability classification. In relation to Flood Risk Vulnerability and Flood Zone 'Compatibility', Table D.3 of PPS25 indicates that this type of development is appropriate in Flood Zone 1.

Site Levels

- 3.6. A topographical survey of the site was undertaken by TJK Land Surveyors in July 2009. A copy of the topographical survey, TJK Drawing Reference TJK1463, is reproduced in Appendix 4.
- 3.7. The levels shown on the survey drawing relate to Ordnance Datum. The survey shows that the site is fairly flat with levels varying from around 11.2m AOD on the southern boundary to 11.8m AOD along the eastern boundary.

Definition of Existing Flood Hazard

- 3.8. The Flood Map, reproduced in Appendix 2, shows that the site lies within Flood Zone 1, which PPS25 defines as a 'Low Probability' flood risk zone.
- 3.9. Surface water drainage from adjacent fields to the north west currently drains to an open ditch system located to the rear of properties on Ewens Gardens and to the north of the site.
- 3.10. Localised flooding was experienced in 2000 and subsequent improvements were carried out to the Barnham Rife. Despite these improvements, residents have reported that localised flooding of gardens and driveways still occurs following heavy rainfall. The flooding associated with the Barnham Rife has since been included on the Environment Agency's Flood Map contained in Appendix 2.

- 3.11. The development site is located uphill of the ditch system, and the Flood Map does not show the site as being affected by Flood Zones 2 or 3. Therefore, the reported localised flooding problems do not affect the site.
- 3.12. In addition to fluvial flooding, it is also necessary to consider all other sources of potential flooding, which includes groundwater flooding and overland flow flooding, as well as sewer flooding and flooding from artificial sources such as canals, ponds and reservoirs. The SFRA provides an assessment of the impact of other sources of potential flooding. Based on the SFRA there are no historic flood incidents recorded on the site from other sources of potential flooding.
- 3.13. It is considered that the most likely cause of potential flooding would be excessive rainfall falling on the sub-catchment area leading to an increase in the volume and rate of runoff exceeding the capacity of the drainage system and resulting in overland flood flows.

Probability

- 3.14. The proposed development is not affected by any floodplain and lies within Flood Zone 1, which PPS25 defines as a 'Low Probability' Zone assessed as having a less than 1 in 1000 (0.1%) annual probability of river flooding in any year.
- 3.15. The Environment Agency's standing advice states that for developments of less than 1 hectare in Flood Zone 1, the main flood risk issue to consider is the management of surface water.

Climate Change

- 3.16. In terms of providing an acceptable standard of protection against flooding for new development, paragraph 5.51 in the PPS25 Practice Guide states: 'No flooding of property should occur as a result of a one in 100 year storm event (including an appropriate allowance for climate change).'
- 3.17. In terms of maintaining a natural flow regime in the receiving watercourse, paragraph 5.54 in the PPS25 Practice Guide states: 'For the range of annual flow rate probabilities up to and including the one per cent annual exceedance probability (1 in 100 years) event, including an appropriate allowance for climate change, the developed rate of runoff into a watercourse, or other receiving body of water, should be no greater than the existing rate of runoff for the same event.'
- 3.18. Annex B of PPS25 provides details of the allowances to be made for climate change effects when assessing flood risk. Table B.2 provides recommended precautionary sensitivity ranges for peak rainfall intensities and peak river flows.
- 3.19. The lifetime of a residential development is taken as 100 years. Therefore, in accordance with Table B.2 of PPS25, the appropriate allowance for climate change when designing flood risk management measures to serve the proposed development is to increase the peak rainfall intensity for the 1 in 100 year storm event by 30%.

Sustainable Drainage Systems (SUDS)

- 3.20. PPS25 requires local planning authorities to promote SUDS for the management of runoff in new development. Guidance on the use of SUDS is contained in Annex F of PPS25, and in the Practice Guide Companion to PPS25.
- 3.21. Paragraph F6 in Annex F of PPS25 states that surface water arising from a developed site should, as far as is 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.
- 3.22. Guidance on the design and construction of SUDS is provided in the 'Interim Code of Practice for Sustainable Drainage Systems' published by the National SUDS Working Group in July 2004, as well as other CIRIA documents including CIRIA C697 'The SUDS Manual'.
- 3.23. There are a number of potential SUDS techniques that might be used on any particular site. These include pervious pavements, rainwater harvesting systems and infiltration devices such as soakaways and infiltration trenches, as well as flow balancing methods which include ponds/detention basins and underground storage facilities.
- 3.24. The use of pervious pavements and infiltration devices to discharge surface water runoff to ground depends upon the underlying strata having a suitable permeability. Soakage Tests were carried out in accordance with BRE Digest 365 by Geo-Environmental in November 2009. Groundwater monitoring was carried out between January and March 2010. A copy of the infiltration test results and groundwater monitoring report is reproduced in **Appendix 5**.
- 3.25. The results of the infiltration tests indicate that infiltration drainage would be possible on the site. In accordance with BRE Digest 365 soakage tests should be undertaken at the locations of the proposed soakaways.
- 3.26. From an inspection of the Environment Agency's Groundwater Source Protection Zone Map on its website it can be seen that the site does not lie within a Groundwater Source Protection Zone.

Proposed surface water drainage arrangements

- 3.27. A sustainable drainage strategy, involving the implementation of Sustainable Drainage Systems (SUDS) is proposed for managing the disposal of surface water runoff from the proposed development on the site. A plan showing the indicative drainage arrangements, Rushby Brewster's Drawing Reference RBA895-50 Rev P6, is reproduced as **Appendix 6**.
- 3.28. The house plots would drain to suitably designed shallow soakaways and the access road would be constructed as a pervious pavement.

Preliminary Soakaway and Pervious Pavement Design

- 3.29. Preliminary calculations have been undertaken for the design of soakaways and pervious pavements to drain surface water runoff from the proposed built development on the site. The soakaway calculations are shown on Rushby Brewster's design sheets RBA 895 S/A-1 and S/A-2, copies of which are reproduced in **Appendix 7**.

- 3.30. The preliminary soakaway calculations have been undertaken using the lowest infiltration rate recorded on the site of 5.9×10^{-6} m/s.
- 3.31. Ciria Report 156 'Infiltration drainage – Manual of good practice' advises that for the 1 in 10 year design storm event soakaways should half-empty within 24 hours. In addition, soakaways should not flood during the 1 in 100 year return period event, including an appropriate allowance to take account of climate change.
- 3.32. From an inspection of the calculations contained in Appendix 7, it can be seen that suitably designed soakaways can accommodate the runoff from the impermeable areas. For the 1 in 10 year design events the time to half-empty is around 14 hours and for the 1 in 100 year design events, including an allowance of 30% for climate change, the required storage volume can be achieved.
- 3.33. The preliminary pervious pavement calculations have been undertaken using Micro Drainage's WinDes version W.12.5. The calculations have been based on the pavement area shown on the drainage layout contained in Appendix 3. A typical overall construction depth of 480 mm has been used, as indicated on the drainage layout contained in Appendix 6. Ciria C582 'Source Control using Constructed Pervious Surfaces' states, at paragraph 3.2.4, that pervious pavements should half-empty within 24-48 hours. Copies of the WinDes outputs are contained in Appendix 8.
- 3.34. From an inspection of the output in Appendix 7, it can be seen that pervious pavements provide a suitable means of discharging surface water runoff to ground within the site. For the worst infiltration rate the time to half-emptying, even for the 1 in 100 year event, is around 2 hours (106 mins) and the maximum depth of water is 187 mm with no flooding.

Off-Site Impacts

- 3.35. The preliminary calculations demonstrate that for the range of annual flow probabilities up to and including the 1% annual probability (1 in 100 year) event, including an appropriate allowance for climate change, the site can be drained using infiltration devices thereby removing all offsite runoff.
- 3.36. The proposed drainage measures would be designed in accordance with best practice guidance.
- 3.37. The proposed development would help mitigate offsite impacts by removing any existing uncontrolled overland flood flows that flow offsite for all events up to the 1 in 100 year return period, including an allowance for climate change, thereby helping to reduce flood risk overall.
- 3.38. As an additional measure a French Drain is proposed to run along the southern boundary of the site to intercept any overland flows that may flow offsite, towards adjacent properties, during extreme events.

Residual Risks

- 3.39. The proposed drainage measures would ensure that there is little or no residual risk of property flooding occurring during events well in excess of the minimum acceptable standard of protection for new property, which requires that no flooding of property should occur as a result of a one in 100 year storm event including an appropriate allowance for climate change.

- 3.40. For extreme events, the proposed development would convey exceedance flows overland towards the south where they would be intercepted by the proposed French Drain. It is therefore considered that the proposed development would have adequate flood protection for extreme events over the lifetime of the development. On this basis it is considered that the proposed drainage measures can safely manage any residual risks.

Foul Water Drainage Measures

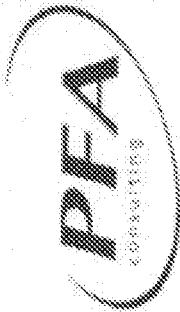
- 3.41. The proposed development would give rise to a foul design flow of around 0.6 litres per second. It is proposed that foul flows from the proposed development would discharge to the existing public foul water sewer located in Barnham Road. These foul drainage arrangements are shown on Rushby Brewsters's Drawing Number RBA895-50 Rev P6, a copy of which is reproduced in Appendix 6.

4. CONCLUSIONS

- 4.1. This Flood Risk Assessment has been prepared in support of a planning application for a residential development of 13 dwellings on land to the rear of Greenoaks in Barnham Road, Barnham.
- 4.2. The Environment Agency's Flood Map shows that the development site falls within Flood Zone 1. With reference to PPS25 residential development is appropriate in Flood Zone 1.
- 4.3. A sustainable drainage strategy, involving the implementation of SUDS, is proposed for managing the disposal of surface water runoff from the proposed development. It is proposed that the house plots would drain to suitably designed soakaways and the access road would be constructed as a pervious pavement.
- 4.4. Soakage Tests were carried out in accordance with BRE Digest 365 by Geo-Environmental in November 2009. The results of the infiltration tests indicate that infiltration drainage would be possible on the site.
- 4.5. Preliminary calculations demonstrate that it will be feasible to dispose of all surface water by infiltration for all events up to the 1 in 100 year event, including an appropriate allowance for climate change in accordance with PPS25.
- 4.6. The proposed development would help mitigate offsite impacts by removing any existing uncontrolled overland flood flows that flow offsite for all events up to the 1 in 100 year return period, including an allowance for climate change, thereby helping to reduce flood risk overall.
- 4.7. The proposed drainage measures would ensure that there is little or no residual risk of property flooding occurring during events well in excess of the minimum acceptable standard of protection for new property, which requires that no flooding of property should occur as a result of a one in 100 year storm event including an appropriate allowance for climate change.
- 4.8. In terms of foul water drainage, it is proposed that foul flows from the proposed development would discharge to the existing public foul water sewer located in Barnham Road.
- 4.9. The overall conclusions drawn from this Flood Risk Assessment are that future users of the development would remain safe throughout its lifetime, the development would not increase flood risk elsewhere, and the development would reduce flood risk overall.

Appendices

Appendix 1



Office: 1st Floor
 Barnham Road
 Bournemouth BH10 0DQ

Telephone: 01202 551111
 Fax: 01202 551112
 Email: info@pfaconsulting.co.uk

Site Boundary
 (indicative only)



Client:

Southcott Homes Ltd

Project:

Land to the Rear
 of Greenoaks,
 Barnham Road, Barnham

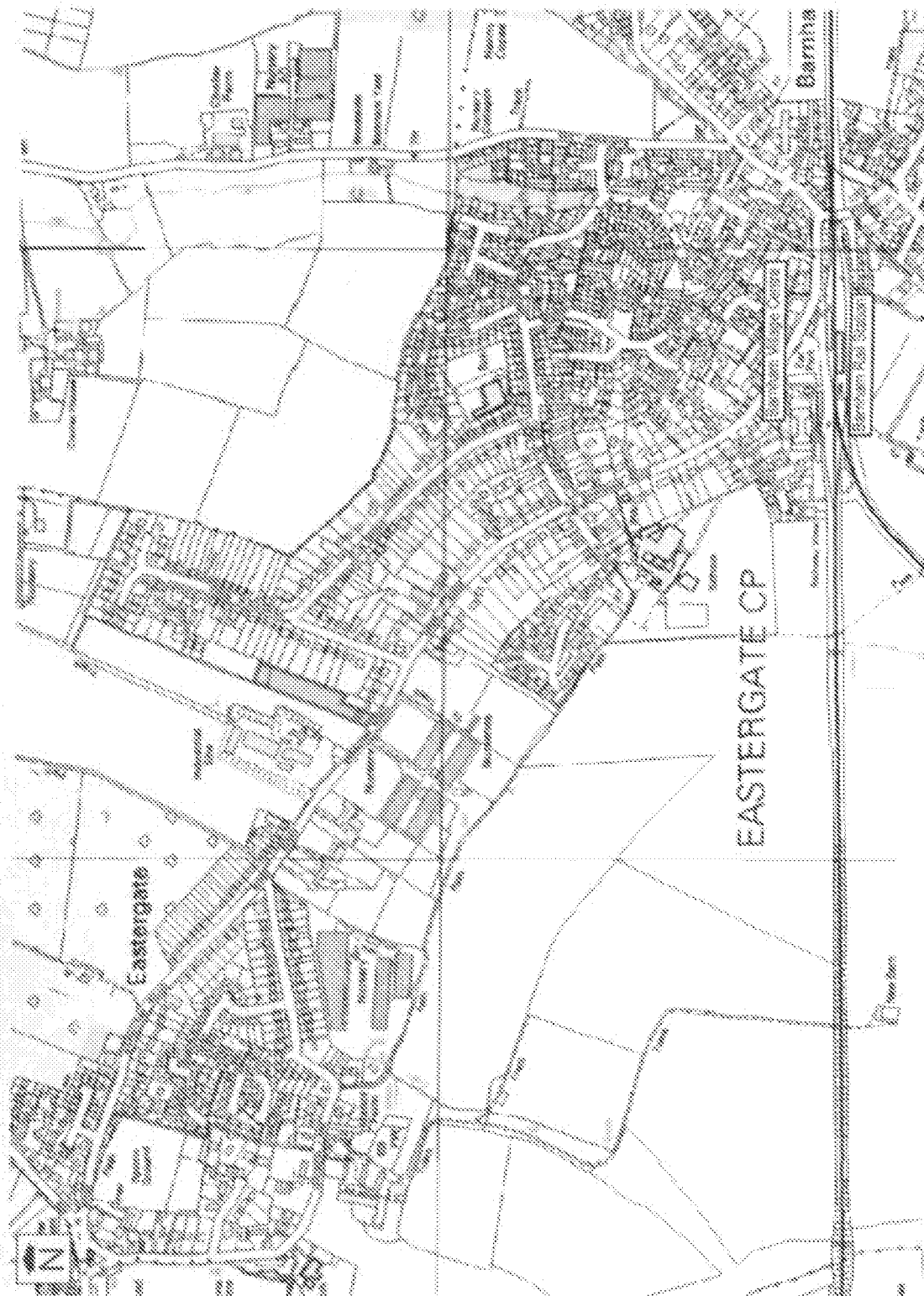
Report Title:

Local Context Plan

Figure No:

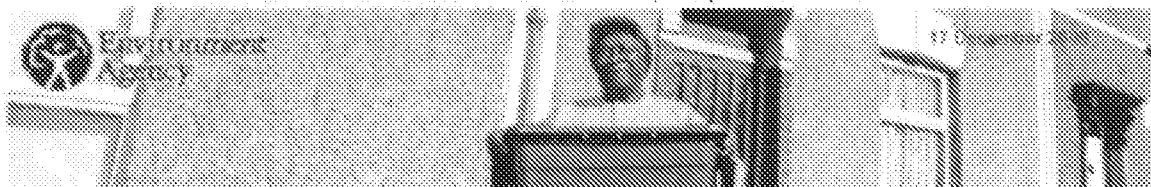
PFA Figure 1

Date: May 2011
 Drawn By: JH
 Checked By: JH
 Status: Final
 File No: Local Context Plan 1
 Date: May 2011



Based on Ordnance Survey data with the permission
 of the Controller of the Ordnance Survey Office
 Crown Copyright © 2011, Ordnance Survey
 Licence No. AL 100002054

Appendix 2



Flooding

Enter postcode or place name:

Barnham, West Sussex

Overview map:



Other topics for this area:

[Flood Risk](#)
[Flood Warning](#)
[Rivers](#)
[Bathing Water Quality](#)
[Groundwater Sources](#)
[Waste](#)
[Pollution](#)
[Air Pollution](#)

[Environment Agency Office](#)

[draft River Basin Management Plans - Rivers](#)

[draft River Basin Management Plans - Lakes](#)

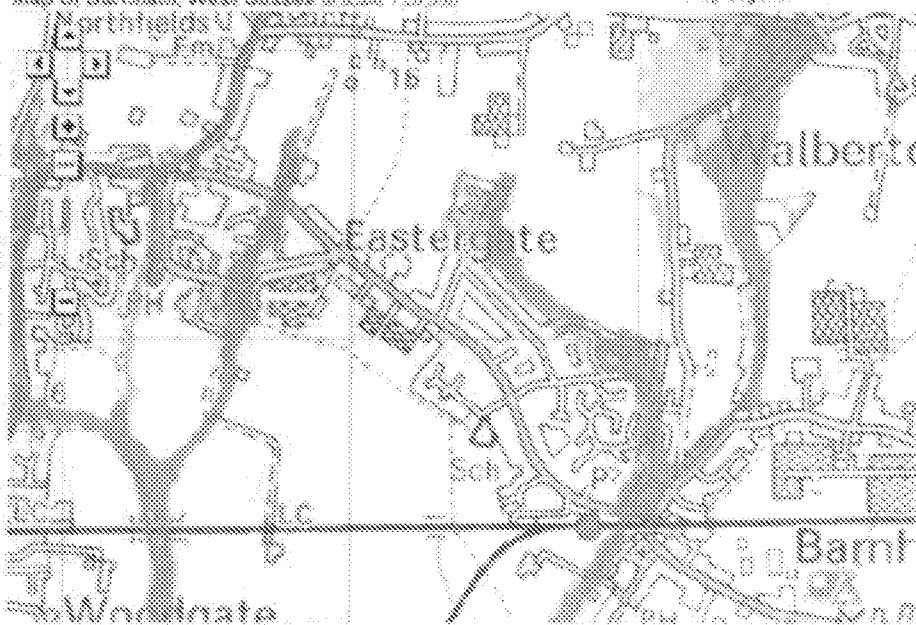
[draft River Basin Management Plans - Coastal Waters](#)

[draft River Basin Management Plans - Estuarine](#)

[draft River Basin Management Plans - Groundwater](#)

Map of Barnham, West Sussex at scale 1:20,000

Map Legend



© Crown copyright. All rights reserved. Environment Agency, 100036380, 2009

[view text version of all results](#)

[Problems viewing the map](#)

See also:

[Understanding the flood map](#)

A more detailed explanation to help you understand the flood map shown above.

[Current flood warnings](#)

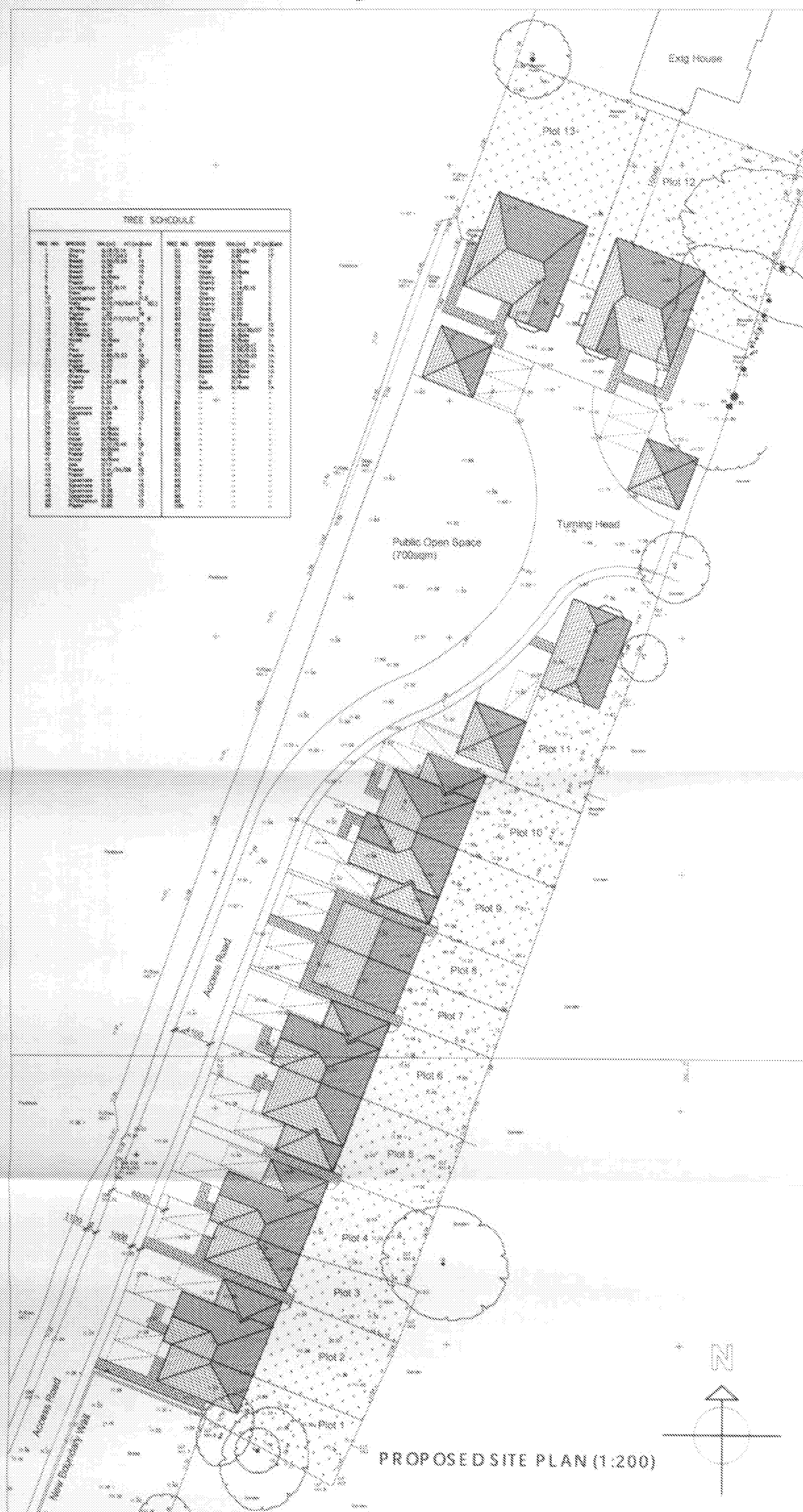
We provide flood warnings online 24 hours a day. Find out the current flood warning status in your local area.

[Flood map - your questions answered](#)

Answers to commonly asked questions about the flood map.

creating a better place

Appendix 3



Sixty

THIS DOCUMENT IS THE PROPERTY OF THE GOVERNMENT OF THE UNITED STATES AND IS NOT TO BE DISTRIBUTED OUTSIDE THE GOVERNMENT OF THE UNITED STATES WITHOUT THE EXPRESS WRITTEN PERMISSION OF THE GOVERNMENT OF THE UNITED STATES.

1. The first step is to identify the problem. This involves understanding the current situation and what needs to be changed.

[illegible]

Schedule of Assessments

Total Site Area
= 5230sqm/0.823Hectares/1.94Acres

Substrate of Accumulation

Plot 1 - 2 Bed Semi Detached House
NFA 73sqm/786sqft
2 Car Parking Spaces

Plot 2 - 3 Bed Semi Detached House:
NFA 93sqm/1023sqft
Single Integral Garage + 2 Car Parking
Spaces

Plot 3 - 2 Bed Semi Detached House
NFA 750sqm/786sqft
2 Car Parking Spaces

Plot 4 - 3 Bed Semi Detached House
NFA 95sqm/1023sqft
Single Integral Garage - 2 Car Parking
Spaces

Plot 5 - 3 Bed Semi Detached House
N/A 90sqm/96sqft
Single Integral Garage + 2 Car Parking
Spaces

Plot 6 - 3 Bed Semi Detached House:
NFA 95sqm/1023sqft
Single Integral Garage + 2 Car Parking
Spaces

Plot 7 - 2 Bed Semi Detached House
NPA 73sqm/786sqft
2 Car Parking Spaces

Plot 8 - 2 Bed Semi Detached House
 115sqm/1230sqft
 2 Car Parking Spaces

Plot 9 - 3 Bed Semi Detached House
NFA 93596/1023598
Single Integral Garage + 2 Car Parking
Spaces

Plot 10 - 3 Bed Semi Detached House
N/A 90sqm/90sqft
Single Integral Garage + 2 Car Parking
Spaces

Plot 11 - 4 Bed Detached House:
NEA 113sqm/1218sqft
Double Detached Garage + 2 Car Parking
Spaces

Plot 12 - 5 Bed Detached House
NFA 504sqm/219sqft
Double Detached Garage - 2 Car Parking
Spaces

Plot 13 - 3 Bed Detached House
NFA 20sqm/219sqft
Double Detached Garage - 2 Car Parking
Spaces



VIVID
design studio

40 Shipman Street, Chester, West Sussex, PO16 1JZ
Tel: 01243 899999
Fax: 01243 899999
Email: info@redesignstudio.co.uk
Website: www.redesignstudio.co.uk

Land to the Rear of
Greenoaks
Burnham Road
Burnham
West Sussex

¹ marco@math.uniroma2.it
² marco@math.uniroma2.it

Received 15 May 2006

[illegible]

Southeast Homeco Ltd

• • • • •

2008

Abstract

◆ ◆ ◆ ◆ ◆

Abstract

1000

100000

[illegible][illegible]

[illegible][illegible]

VIVID
design studio

to: stephen@stephenleung.com, stephenleung@gmail.com, stephenleung@yahoo.com
 or: <http://stephenleung.com>
 or: www.stephenleung.com
 or: www.stephenleung.net
 or: www.stephenleung.org
 or: www.stephenleung.info
 or: www.stephenleung.biz
 or: www.stephenleung.me
 or: www.stephenleung.co
 or: www.stephenleung.ac
 or: www.stephenleung.gov
 or: www.stephenleung.mil
 or: www.stephenleung.edu
 or: www.stephenleung.int
 or: www.stephenleung.mobi
 or: www.stephenleung.tel
 or: www.stephenleung.name
 or: www.stephenleung.pro
 or: www.stephenleung.art
 or: www.stephenleung.sch
 or: www.stephenleung.museum
 or: www.stephenleung.gallery
 or: www.stephenleung.press
 or: www.stephenleung.media
 or: www.stephenleung.film
 or: www.stephenleung.music
 or: www.stephenleung.sports
 or: www.stephenleung.travel
 or: www.stephenleung.health
 or: www.stephenleung.fitness
 or: www.stephenleung.beauty
 or: www.stephenleung.fashion
 or: www.stephenleung.hair
 or: www.stephenleung.skin
 or: www.stephenleung.nails
 or: www.stephenleung.cosmetics
 or: www.stephenleung.perfume
 or: www.stephenleung.jewelry
 or: www.stephenleung.watches
 or: www.stephenleung.shoes
 or: www.stephenleung.clothing
 or: www.stephenleung.accessories
 or: www.stephenleung.bags
 or: www.stephenleung.shirts
 or: www.stephenleung.tshirts
 or: www.stephenleung.tees
 or: www.stephenleung.hoodies
 or: www.stephenleung.jackets
 or: www.stephenleung.coats
 or: www.stephenleung.suits
 or: www.stephenleung.dresses
 or: www.stephenleung.skirts
 or: www.stephenleung.pants
 or: www.stephenleung.leggings
 or: www.stephenleung.underwear
 or: www.stephenleung.sleepwear
 or: www.stephenleung.eyewear
 or: www.stephenleung.glasses
 or: www.stephenleung.hats
 or: www.stephenleung.caps
 or: www.stephenleung.gloves
 or: www.stephenleung.socks
 or: www.stephenleung.shoes
 or: www.stephenleung.boots
 or: www.stephenleung.sneakers
 or: www.stephenleung.sandals
 or: www.stephenleung.slippers
 or: www.stephenleung.footwear
 or: www.stephenleung.bags
 or: www.stephenleung.backpacks
 or: www.stephenleung.valises
 or: www.stephenleung.suitcases
 or: www.stephenleung.trunks
 or: www.stephenleung.briefcases
 or: www.stephenleung.wallets
 or: www.stephenleung.purses
 or: www.stephenleung.clutches
 or: www.stephenleung.totebags
 or: www.stephenleung.handbags
 or: www.stephenleung.shoulderbags
 or: www.stephenleung.backpacks
 or: www.stephenleung.valises
 or: www.stephenleung.suitcases
 or: www.stephenleung.trunks
 or: www.stephenleung.briefcases
 or: www.stephenleung.wallets
 or: www.stephenleung.purses
 or: www.stephenleung.clutches
 or: www.stephenleung.totebags
 or: www.stephenleung.handbags
 or: www.stephenleung.shoulderbags
 or: www.stephenleung.backpacks
 or: www.stephenleung.valises
 or: www.stephenleung.suitcases
 or: www.stephenleung.trunks
 or: www.stephenleung.briefcases
 or: www.stephenleung.wallets
 or: www.stephenleung.purses
 or: www.stephenleung.clutches
 or: www.stephenleung.totebags
 or: www.stephenleung.handbags
 or: www.stephenleung.shoulderbags
 or: www.stephenleung.backpacks
 or: www.stephenleung.valises
 or: www.stephenleung.suitcases
 or: www.stephenleung.trunks
 or: www.stephenleung.briefcases
 or: www.stephenleung.wallets
 or: www.stephenleung.purses
 or: www.stephenleung.clutches
 or: www.stephenleung.totebags
 or: www.stephenleung.handbags
 or: www.stephenleung.shoulderbags
 or: www.stephenleung.backpacks
 or: www.stephenleung.valises
 or: www.stephenleung.suitcases
 or: www.stephenleung.trunks
 or: www.stephenleung.briefcases
 or: www.stephenleung.wallets
 or: www.stephenleung.purses
 or: www.stephenleung.clutches
 or: www.stephenleung.totebags
 or: www.stephenleung.handbags
 or: www.stephenleung.shoulderbags
 or: www.stephenleung.backpacks
 or: www.stephenleung.valises
 or: www.stephenleung.suitcases
 or: www.stephenleung.trunks
 or: www.stephenleung.briefcases
 or: www.stephenleung.wallets
 or: www.stephenleung.purses
 or: www.stephenleung.clutches
 or: www.stephenleung.totebags
 or:

11/11/2011 11:11 AM

Southworth, Thomas, 1835



100

60

PROPOSED SITE PLAN (1:200)

Appendix 4

Appendix 5

18 November 2009

Our ref: GE7217

Southcott Homes
Bramble House
Furzehall Farm
112 Wickham Road
Fareham
PO16 7JH



Geo-Environmental

For the Attention of: Mr. Darren Harman

Dear Sirs,

RE: 'GREENOAKS' BARNHAM ROAD, BARNHAM – SOAKAGE TESTS

Further to our investigative works at the above site, please find enclosed the results of the soakage tests, together with a test location plan and trial pit logs.

The trial pits were prematurely terminated in the range of 1.60m – 1.90m bgl as groundwater was encountered at these depths.

The result of the soakage tests are presented as BRE365 printouts for a wetted area of 200m². The infiltration rates were moderate but the results for each of the trial pits required extrapolation to calculate the soakage rate. Designs are given for trench and ring soakaways for SA1 (5.9×10^{-6} m/s), SA2 (6.3×10^{-6} m/s) and TP3 (3.5×10^{-6} m/s).

Please note these are preliminary designs for guidance only and final designs should be made by your drainage Engineers.

We trust that we have interpreted your instructions correctly, and please do not hesitate to contact us should you have any queries.

May we take this opportunity to thank you for your instruction, and we look forward to working with you again on further projects.

Yours sincerely
For and on Behalf of GESL

JASON KANELIS B.Sc. (Hons)
Geo-Environmental Engineer
Email: jason@gesl.net

SAMPLING & TESTING	STRATA DESCRIPTION	STRATA			
		Legend	mSCL	mSCL	Water
	Vegetation cover dark brown slightly clayey sandy silt with occasional fine to medium sub-angular fine gravel and nodules (TOPSOIL)		0.00		
	Orange brown slightly clayey SILT with occasional nodules (10-20mm) (BRICKPARTS)		0.10		
			1.20		
	Change to light brown sandy clayey SILT with frequent calcareous inclusions and fine to coarse sub-angular to sub-rounded fine gravel (BRICKS&RUB)		2.00		
	End of Trial Pit at 2.00 m				

SAMPLES: D=Disturbed S=Soil Undisturbed TESTS: SAC=macrotest D/D=di-vane HPH=hand penetrometer SPT=split spoon CPT=cone WATER: m=moisture %=percent OTHERS: L=liquid limit

Soilability No instability encountered	Type Machine Excavated Trial Pit	Ref GE7217	Position SA1A
Georeferencer Stake at 2.00m, 1.90 after 20mm	Method JCB 3CX	Start 12/11/2009	Scale 1:25
Plan JCB 3CX	Project Greenoaks, Barnham Road	Finish 12/11/2009	Box .
Remarks Groundwater Works - Back filled with sealings	Client Southcott Homes	Drawn JL	Depth 2.00mSCL
		Level .	Figure n/a
		Drawn JL	Sheet 1 of 1

SAMPLING & TESTING	STRATA DESCRIPTION	SOIL DATA			
		Legend	MO	MOG	Notes
	Vegetation over dark brown slightly clayey sandy silt with occasional fine to medium sub-angular to sub-rounded fine gravel and cobbles (TOPSOIL)			0.10	
	Brown clayey silt with occasional cobbles, fine fine sub-angular fine gravel and charcoal fragments (SHALE, GRAY, RED)			0.06	
	Change to brown clayey SILT with occasional cobbles and roots (2-5mm) (BROWN CLAY)			0.40	
				0.06	
				1.80	
	Light brown to off-white sandy clayey SILT with frequent calcareous nodules and fine to coarse sub-angular to sub-rounded fine gravel (BROWN CLAY)			4.00	
				1.00	
	End of Trial Pit at 1.80 m				

SAMPLED: Undisturbed Shale Undisturbed TOPSOIL Machine Excavated Trial Pit Method: JCB 3CX

Locality No locality encountered	Type Machine Excavated Trial Pit	Ref. GE7217	Position SA2
Groundwater No Groundwater Encountered	Method JCB 3CX	Start 17th 12/2004	Stop 17th 12/2004
Point JCB 3CX	Project Greenoaks, Barnham Road	File 17th 12/2004	Depth 1.80m (6ft)
Remarks Back filled with shingles on completion of leakage test	Client Southcott Homes	Drawn JC	Plotted JC
		Field JC	Sheet Sheet 1 of 1

SAMPLING & TESTING	STRATA DESCRIPTION	STRATA				
		Legend	mCO	mBG	Water	SP/pe
	Gravel over dark brown slightly clayey sandy silty with occasional fine to medium sub-angular silty gravel and cobbles (TOPSOIL)			0.10		
	Orange brown slightly clayey SILT with occasional nodules and roots (2-5cm) (BROWN EARTH)			0.70		
				0.80		
				0.90		
				1.20		
End of Trial Pit at 1.20 m						

SAMPLES: Unstabilised S&L&K Undisturbed TESTS: BAC:maximum Swellmax HPT:penetration SPT:soil strength CP:cone No. TEST: index ☒ mass OTHERS: (200) vibrator

Stability No instability encountered	Type Machine Excavated Trial Pit	Ref GE7217	Position SA3
Groundwater Spoke at 1.70m, 1.80 after 20mins	Method JCB 3CX	Date 17/11/2009	Scale 1:20
Plan JCB 3CX	Project Greenoaks, Barnham Road	From 17/11/2009	Size -
Remarks Bank filled with shingle on completion of exchange test	Client Southcott Homes	Filed 17/11/2009	Depth 1.70m@1.70
		Eng JK	Level -
		Drawn JK	Figure 1/1
		Cdd JK	Sheet Sheet 1 of 1

Site Ref.No.: SA1

Site Address: GE7217 - Barnham

Total depth of soakaway 1.60 m

Ground level to invert of inflow pipe 0.45 m

Impermeable surface area (A) 200.00 m²

Soil infiltration rate (f) 5.9E-06 m/s Rainfall ratio 0.35

.....

TRIAL OBSERVATIONS

Trial No.1

Interval (mins)	Depth (m)
0	0.45
2	0.45
3	0.46
5	0.48
10	0.51
20	0.54
40	0.61
60	0.65
120	0.78
180	0.85
300	0.97
420	1.04
660	1.32
900	1.46

Soil Infiltration Rate (f) 5.9E-06 m/s

NOTE: Depth is from ground level to level of water

RESULTS FROM DESIGN CALCULATIONS FOR TRENCH SOAKAWAYS

Site Ref.No.: SAI

Site Address: GE7217 - Barnham

Total depth of soakaway 1.60 m

Ground level to invert of inflow pipe 0.45 m

Impermeable surface area (A) 200.00 m²

Soil infiltration rate (f) 5.9E-06 m/s Rainfall ratio 0.35

Soakaway Width 0.3m		Soakaway Width 0.6m		Soakaway Width 1.00m	
Storm Duration (min)	Soakaway Length (m)	Storm Duration (min)	Soakaway Length (m)	Storm Duration (min)	Soakaway Length (m)
5	16.20	5	8.20	5	4.95
10	23.15	10	11.80	10	7.15
15	27.80	15	14.30	15	8.70
30	33.75	30	17.80	30	10.90
60	38.75	60	21.40	60	13.40
120 *	39.85 *	120	23.65	120	15.35
240	36.45	240 *	23.95 *	240 *	16.40 *
360	32.60	360	22.95	360	16.40
600	26.50	600	20.30	600	15.35
1440	16.85	1440	14.45	1440	12.05

NOTE: Critical Storm Durations are marked with an *

Soakaway Width (m)	Critical Storm Duration (min)	Trench Excavated Volume (m ³)	Granular Fill Required (m ³)	Emptying Time to 50% Storage (h)
0.3	120	19.13	13.75	2.10
0.6	240	22.99	16.53	4.13
1.0	240	26.24	18.86	6.66

Aggregate percentage void 30

Calculations are in accordance with BRE Digest 365

RESULTS FROM DESIGN CALCULATIONS FOR PERFORATED RING SOAKAWAYS

Site Ref.No.: SA1

Site Address: GE7217 - Barnham

Total depth of soakaway 1.60 m

Ground level to invert of inflow pipe 0.45 m

Impermeable surface area (A) 200.00 m²

Soil infiltration rate (f) 5.9E-06 m/s Rainfall ratio 0.35

Ring Unit Internal Diameter 2100 mm

Storm Duration (min)	Pit Sides (m)
5	*****
10	*****
15	*****
30	*****
60	*****
120	*****
240	3.45
360	3.65
600	3.75
1440 *	3.75 *

NOTE: Critical Storm Durations are marked with an *

Values marked ***** are $< 1.5 \times \text{Ring Dia.}$ or $> 2.4 \times \text{Ring Dia.}$

CALCULATED VALUES FOR CRITICAL STORM DURATION ARE AS FOLLOWS:-

Total Excavated volume 22.52 m³

Volume of Granular fill required 11.61 m³

Aggregate percentage void 30

Emptying time to 50% storage 20.4 hours

Calculations are in accordance with BRE Digest 365

Site Ref.No.: SA2

Site Address: GE7217 - Barnham

Total depth of soakaway 1.90 m

Ground level to invert of inflow pipe 0.50 m

Impermeable surface area (A) 200.00 m²

Soil infiltration rate (f) 6.2E-06 m/s Rainfall ratio 0.35

TRIAL OBSERVATIONS

Trial No.1

Interval (mins)	Depth (m)
0	0.80
3	0.81
6	0.83
10	0.85
20	0.89
30	0.92
60	1.02
120	1.12
180	1.20
300	1.34
420	1.41
660	1.64
900	1.81

Soil Infiltration Rate (f) 6.2E-06 m/s

NOTE: Depth is from ground level to level of water

RESULTS FROM DESIGN CALCULATIONS FOR TRENCH SOAKAWAYS

Site Ref.No.: SA2

Site Address: GE7217 - Barnham

Total depth of soakaway 1.90 m

Ground level to invert of inflow pipe 0.50 m

Impermeable surface area (A) 200.00 m²

Soil infiltration rate (f) 6.2E-06 m/s Rainfall ratio 0.35

Soakaway Width 0.3m		Soakaway Width 0.6m		Soakaway Width 1.00m	
Storm Duration (min)	Soakaway Length (m)	Storm Duration (min)	Soakaway Length (m)	Storm Duration (min)	Soakaway Length (m)
5	13.30	5	6.75	5	4.05
10	18.95	10	9.70	10	5.85
15	22.80	15	11.75	15	7.15
30	27.55	30	14.60	30	8.95
60	31.50	60	17.45	60	10.95
120 *	32.15 *	120	19.20	120	12.50
240	29.15	240 *	19.30 *	240 *	13.30 *
360	25.95	360	18.40	360	13.20
600	20.95	600	16.10	600	12.25
1440	13.20	1440	11.30	1440	9.45

NOTE: Critical Storm Durations are marked with an *

Soakaway Width (m)	Critical Storm Duration (min)	Trench Excavated Volume (m ³)	Granular Fill Required (m ³)	Emptying Time to 50% Storage (h)
0.3	120	18.33	13.50	1.99
0.6	240	22.00	16.21	3.90
1.0	240	25.27	18.62	6.23

Aggregate percentage void 30

Calculations are in accordance with BRE Digest 365

RESULTS FROM DESIGN CALCULATIONS FOR PERFORATED RING SOAKAWAYS

Site Ref.No.: SA2

Site Address: GE7217 - Barnham

Total depth of soakaway 1.90 m

Ground level to invert of inflow pipe 0.90 m

Impermeable surface area (A) 200.00 m²

Soil infiltration rate (f) 6.2E-06 m/s Rainfall ratio 0.35

Ring Unit Internal Diameter 1500 mm

Storm Duration (min)	Pit Sides (m)
5	*****
10	*****
15	*****
30	*****
60	2.80
120	3.15
240	3.45
360	3.55
600 *	3.65 *
1440	3.50

NOTE: Critical Storm Durations are marked with an *

Values marked ***** are $< 1.9 \times \text{Ring Dia.}$ or $> 2.4 \times \text{Ring Dia.}$

CALCULATED VALUES FOR CRITICAL STORM DURATION ARE AS FOLLOWS:-

Total Excavated volume 25.34 m³

Volume of Granular fill required 15.67 m³

Aggregate percentage void 30

Emptying time to 90% storage 15.7 hours

Calculations are in accordance with BRE Digest 365

Site Ref.No.: SA3

Site Address: GE7217 - Barnham Road

Total depth of soakaway 1.50 m

Ground level to invert of inflow pipe 0.50 m

Impermeable surface area (A) 200.00 m²

Soil infiltration rate (f) 3.5E-05 m/s Rainfall ratio 0.35

TRIAL OBSERVATIONS

Trial No.1

Interval (mins)	Depth (m)
0	0.60
1	0.62
2	0.64
7	0.72
12	0.79
20	0.87
40	1.03
60	1.15
120	1.34
180	1.50

Soil Infiltration Rate (f) 3.5E-05 m/s

NOTE: Depth is from ground level to level of water

RESULTS FROM DESIGN CALCULATIONS FOR TRENCH SOAKAWAYS

Site Ref.No.: SA3

Site Address: GE7217 - Barnham Road

Total depth of soakaway 1.50 m

Ground level to invert of inflow pipe 0.50 m

Impermeable surface area (A) 200.00 m²

Soil infiltration rate (f) 3.5E-05 m/s Rainfall ratio 0.35

Soakaway Width 0.3m		Soakaway Width 0.6m		Soakaway Width 1.00m	
Storm Duration (min)	Soakaway Length (m)	Storm Duration (min)	Soakaway Length (m)	Storm Duration (min)	Soakaway Length (m)
5	17.00	5	8.95	5	5.50
10	22.45	10	12.35	10	7.70
15	25.10	15	14.40	15	9.15
30 *	25.55 *	30	16.00	30	10.65
60	23.00	60 *	16.05 *	60 *	11.40 *
120	17.75	120	13.85	120	10.65
240	12.30	240	10.45	240	8.60
360	9.55	360	8.40	360	7.15
600	6.70	600	6.00	600	5.25
1440	3.55	1440	3.20	1440	2.70

NOTE: Critical Storm Durations are marked with an *

Soakaway Width (m)	Critical Storm Duration (min)	Trench Excavated Volume (m ³)	Granular Fill Required (m ³)	Emptying Time to 50% Storage (h)
0.3	30	11.50	7.66	0.36
0.6	60	14.45	9.63	0.70
1.0	60	17.10	11.40	1.11

Aggregate percentage void 30

Calculations are in accordance with BRE Digest 365

RESULTS FROM DESIGN CALCULATIONS FOR PERFORATED RING SOAKAWAYS

Site Ref.No.: SA3

Site Address: GE7217 - Barnham Road

Total depth of soakaway 1.50 m

Ground level to invert of inflow pipe 0.50 m

Impermeable surface area (A) 200.00 m²

Soil infiltration rate (f) 3.5E-08 m/s Rainfall ratio 0.35

Ring Unit Internal Diameter 1500 mm

Storm Duration (min)	Pit Sides (m)
5	*****
10	*****
15	*****
30	2.85
60	3.20
120 *	3.35 *
240	3.20
360	3.00
600	2.55
1440	*****

NOTE: Critical Storm Durations are marked with an *

Values marked ***** are < 1.5*Ring Dia. or >2.4*Ring Dia.

CALCULATED VALUES FOR CRITICAL STORM DURATION ARE AS FOLLOWS:-

Total Excavated volume 16.85 m³

Volume of Granular fill required 9.09 m³

Aggregate percentage void 30

Emptying time to 80% storage 2.7 hours

Calculations are in accordance with BRE Digest 365

Order ref: GET2004R1UK1010710

Steve Brewster
Rushby Brewster
The Town House
St. George's Square
Bishops Waltham
Southampton
SO32 1AF



Geo-Environmental

~~Chen, Sen~~

'GREENOAKS', BARNHAM - GROUNDWATER MONITORING

Further to our recent works at the above site, please find enclosed the results of the groundwater monitoring, together with a standpipe location plan.

Geo-Environmental were instructed to attend site in order to install three 35mm diameter groundwater monitoring standpipes (ref SP1 - SP3) to a depth of 4.0m. Subsequent monitoring of the standpipes was undertaken on six occasions.

The observed standing groundwater levels are displayed on the following table:

Date	SP1	SP2	SP3
19/01/2010	0.70m	0.58m	0.45m
03/02/2010	0.94m	0.94m	0.97m
17/02/2010	1.10m	0.90m	0.84m
03/03/2010	0.66m	0.53m	0.39m
16/03/2010	1.18m	1.33m	1.42m
29/03/2010	0.00m	1.21m	1.36m

It should be noted that changes in groundwater levels do occur for a number of reasons including seasonal effects and variations in drainage. Such fluctuations may only be recorded by the measurement of the groundwater level within a standpipe or piezometer installed within appropriate response zones.

We trust that we have interpreted your instructions correctly, and please do not hesitate to contact us should you have any queries.

Yours sincerely
For and on Behalf of GES:

Johnnie

JASON KANELIS B.Sc (Hons)

Geo-Environmental Engineer

Email: jason@gesl.net

2021 10 16 10:21 AM

[illegible]

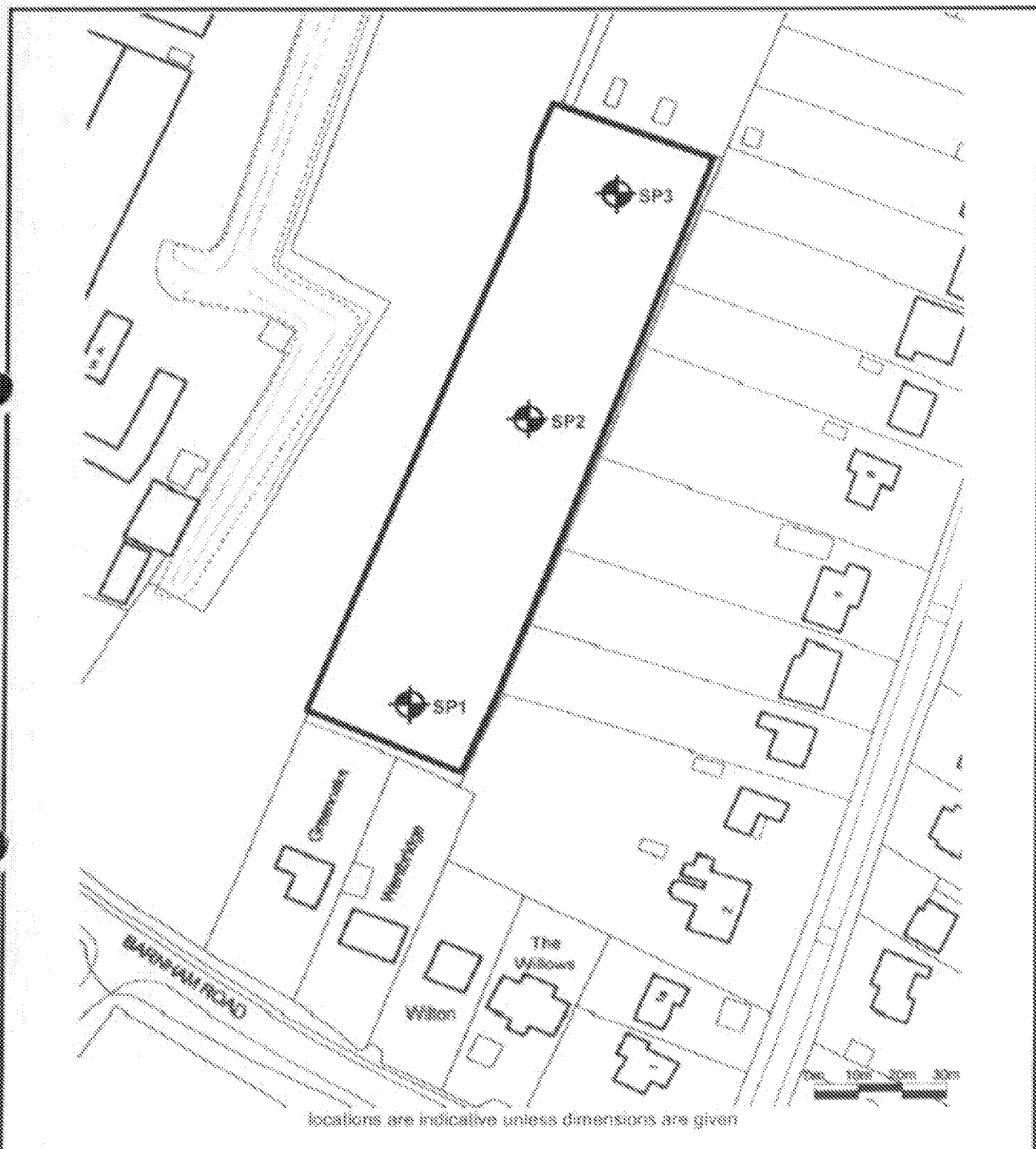
10

Downloaded from <http://ajphaphysocpharm.sagepub.com> at 11:04 11 September 2014

Order Department, 10000 Wilshire Boulevard, Los Angeles, CA 90024



Geo-Environmental



Project:	Greenoaks' Barnham Road, Barnham, West Sussex			Title	Standpipe Location Plan
Client:	Southcott Homes			Geo-Environmental Services Ltd	
Ref No:	GE7298	Revision:	v1	28 Crescent Road, Brighton, BN2 3RP	
Drawn:	EGMN	Date:	March 2010	T: 01273 699 399 F: 01273 699 388	
Figure:	1	Scale:	Not To Scale	E: mail@gesl.net W: www.gesl.net	

SAMPLING & TESTING		STRATA DESCRIPTION	STRATA				
			Legend	mOD	mBGL	Water	Sp/Sec
0.00	HP030v1.1 Region 2	Shells over dark brown, stringy AMORPHOUS silt with rare angular fine gravel (TOPSOIL) ... fine rootlets 1-2mm			0.00		
		Soft to firm light brown silty CLAY with occasional sub rounded fine to medium gravel (BRICKS/ARTHS) ... fine rootlets 1-2mm			0.25		
		Soft to firm light brown stringy silty CLAY with rare sub angular fine gravel and coarse sand (BRICKS/ARTHS) ... rare fine rootlets 2-4mm			0.40		
		Soft light brown slightly silty CLAY with abundant sub angular to angular medium to coarse fine gravel (BRICKS/ARTHS)			0.60		
1.00	HP030v1.1 Region 2	Soft light brown slightly silty CLAY with abundant sub angular to angular medium to coarse fine gravel (BRICKS/ARTHS)			1.00		
		Soft brownish yellow slightly sandy CLAY with frequent coarse sand and rare coarse gravel (BRICKS/ARTHS)			1.50		
		Soft light brown grey slightly silty sandy CLAY with abundant sub angular to angular clay bound coarse fine gravel (BRICKS/ARTHS)			2.00		
		Soft very light grey slightly clayey sandy SILT matrix with frequent sub angular fine to coarse fine gravel and abundant coarse sand (BRICKS/ARTHS)			2.70		
		Light brown fine SAND (BRICKS/ARTHS)			3.00		
		End of Borehole at 4.00 m			4.00		

SAMPLED: ☒ Drilled/rod Borehole ☐ Groundwater TESTS: SAC/microlog ☐ NMR ☐ HPEN/penetration ☐ SPT/Tip/Spcon ☐ OPT/moisture ☐ WATER ☐ marks ☒ none OTHERS: ☐ 2D/3D/strata

Ability: No instability encountered	Type: Hydraulic Window Sampler Geoprobe	Ref: GE7296	Position: SP1
Groundwater: No Groundwater Encountered	Method: Archway Competitor Dart	Start: 06/01/2010 Finish: 06/01/2010	Scale: 1:30 Size:
Plant: Archway Competitor Dart	Project: Greenoaks	Filed: 06/01/2010 Eng: EN	Depth: 4.00m (OD) Level:
Remarks: None	Client: Southcott Homes Ltd	Drawn: SB Cke: EN	Figure: no sp-1 Sheet: Sheet 1 of 1

ARUN DISTRICT COUNCIL EG/33/11/

SAMPLING & TESTING		STRATA DESCRIPTION	STRATA				
			Legend	MSL	MSGL	Water	SP/pt
0.00	10P20w-1.0g/cm ³	Dark olive dark brown, spongy ABSORPTIVE silt with rare sub rounded coarse gravel (TOPSOIL) ... fine rounded 1-3mm and rare small rounded 8mm			0.00		
		Soft light brown silty CLAY with occasional medium to coarse sub angular flint gravel (BRICKDARTHS) ... occasional fine rounded 1-2mm			0.30		
1.00	10P20w-1.0g/cm ³	Soft light brown yellowish silty CLAY with occasional coarse sand and rare sub angular medium gravel (BRICKDARTHS)			0.60		
1.50	10P20w-1.0g/cm ³	Soft light brown yellowish silty CLAY with occasional coarse sand and rare sub angular medium gravel (BRICKDARTHS)			0.90		
		Soft light greyish brown sandy CLAY with abundant clay round sub angular medium to coarse gravel and rare flint cobble (BRICKDARTHS)			1.20		
		Soft light grey brown silty clayey sandy CLAY with frequent clayround sub rounded to sub angular medium to coarse flint gravel and abundant coarse sand (BRICKDARTHS)			1.50		
		End of borehole at 4.00 m			4.00		

SAMPLES: Undisturbed Bulk Undisturbed TESTS: N/A-maintain 10min 10P20w-1.0g/cm³ SP-Triple grain CP-Triple WATER ☒ none ☐ wet G-THREE (G-THREE)

Stability: Unstable after 2.00m	Type: Hydraulic Window Sampler Geoprobe	Ref: GE7296	Reason: SP3
Groundwater: No Groundwater Encountered	Method: Archway Competitor Dart	Start: 06/01/2010	Stop: 1/06
Plant: Archway Competitor Dart	Project: Greenoaks	Finish: 06/01/2010	Site:
Remarks: None	Client: Southcott Homes Ltd	Plot: 06/01/2010	Depth: 4.00mBSL
		Eng: GS	Level:
		Drawn: AS	Figure: ENG 4070
		Out: GS	Sheet: Sheet 1 of 1

MONITORING DATA SHEET

SITE Greenoaks, Barnham	DATE 19 January 2010	REF GE7296	TECH Nick Bushby	VISIT 1 of 6
--------------------------------	-----------------------------	-------------------	-------------------------	---------------------

Position: SP1	Time of Reading:		Seconds	10s	20s	30s	60s	120s		
	Methane		CH ₄ (%)	-	-	-	-	-		
	Carbon Dioxide		CO ₂ (%)	-	-	-	-	-		
	Oxygen		O ₂ (%)	-	-	-	-	-		
VOC's	(ppm)	-								
Atmospheric Pressure	mBar	1019	Atmospheric readings				CO ₂	CH ₄	O ₂	VOC's
Hydrogen Sulphide	H ₂ S (%)	-					-	-	-	-
Maximum flow rate	Max (l/hr)	-	Weather Conditions						Volume Purged	
Minimum flow rate	Min (l/hr)	-								
LNAPL	(mbgl)	-	Remarks						Sample Volume	
Water Level	(mbgl)	0.70								
DNAPL	(mbgl)	-								
Standpipe depth	(mbgl)	-								

Position: SP2	Time of Reading:		Seconds	10s	20s	30s	60s	120s		
	Methane		CH ₄ (%)	-	-	-	-	-		
	Carbon Dioxide		CO ₂ (%)	-	-	-	-	-		
	Oxygen		O ₂ (%)	-	-	-	-	-		
VOC's	(ppm)	-								
Atmospheric Pressure	mBar	1019	Atmospheric readings				CO ₂	CH ₄	O ₂	VOC's
Hydrogen Sulphide	H ₂ S (%)	-					-	-	-	-
Maximum flow rate	Max (l/hr)	-	Weather Conditions						Volume Purged	
Minimum flow rate	Min (l/hr)	-								
LNAPL	(mbgl)	-	Remarks						Sample Volume	
Water Level	(mbgl)	0.58								
DNAPL	(mbgl)	-								
Standpipe depth	(mbgl)	-								

Position: SP3	Time of Reading:		Seconds	10s	20s	30s	60s	120s		
	Methane		CH ₄ (%)	-	-	-	-	-		
	Carbon Dioxide		CO ₂ (%)	-	-	-	-	-		
	Oxygen		O ₂ (%)	-	-	-	-	-		
VOC's	(ppm)	-								
Atmospheric Pressure	mBar	1019	Atmospheric readings				CO ₂	CH ₄	O ₂	VOC's
Hydrogen Sulphide	H ₂ S (%)	-					-	-	-	-
Maximum flow rate	Max (l/hr)	-	Weather Conditions						Volume Purged	
Minimum flow rate	Min (l/hr)	-								
LNAPL	(mbgl)	-	Remarks						Sample Volume	
Water Level	(mbgl)	0.45								
DNAPL	(mbgl)	-								
Standpipe depth	(mbgl)	-								

Y:\PROFORMA\EXCEL\GASDATA v7

MONITORING DATA SHEET

SITE Greencaks, Barnham	DATE 03 February 2010	REF GE7296	TECH Nick Bushby	VISIT 2 of 6
--------------------------------	------------------------------	-------------------	-------------------------	---------------------

SP1	Position:		Time of Reading:		Seconds	10s	20s	30s	60s	120s	
	Methane		CH ₄ (%)		-	-	-	-	-	-	
	Carbon Dioxide		CO ₂ (%)		-	-	-	-	-	-	
	Oxygen		O ₂ (%)		-	-	-	-	-	-	
VOC's (ppm)		-									
Atmospheric Pressure	mBar	1009	Atmospheric readings					CO ₂	CH ₄	O ₂	VOC's
Hydrogen Sulphide	H ₂ S (%)	-						-	-	-	-
Maximum flow rate	Max (l/hr)	-	Weather Conditions							Volume Purged	
Minimum flow rate	Min (l/hr)	-									
LNAPL	(mbgl)	-	Remarks							Sample Volume	
Water Level	(mbgl)	0.94									
DNAPL	(mbgl)	-									
Standpipe depth	(mbgl)	-									

SP2	Position:		Time of Reading:		Seconds	10s	20s	30s	60s	120s	
	Methane		CH ₄ (%)		-	-	-	-	-	-	
	Carbon Dioxide		CO ₂ (%)		-	-	-	-	-	-	
	Oxygen		O ₂ (%)		-	-	-	-	-	-	
VOC's (ppm)		-									
Atmospheric Pressure	mBar	1009	Atmospheric readings					CO ₂	CH ₄	O ₂	VOC's
Hydrogen Sulphide	H ₂ S (%)	-						-	-	-	-
Maximum flow rate	Max (l/hr)	-	Weather Conditions							Volume Purged	
Minimum flow rate	Min (l/hr)	-									
LNAPL	(mbgl)	-	Remarks							Sample Volume	
Water Level	(mbgl)	0.94									
DNAPL	(mbgl)	-									
Standpipe depth	(mbgl)	-									

SP3	Position:		Time of Reading:		Seconds	10s	20s	30s	60s	120s	
	Methane		CH ₄ (%)		-	-	-	-	-	-	
	Carbon Dioxide		CO ₂ (%)		-	-	-	-	-	-	
	Oxygen		O ₂ (%)		-	-	-	-	-	-	
VOC's (ppm)		-									
Atmospheric Pressure	mBar	1009	Atmospheric readings					CO ₂	CH ₄	O ₂	VOC's
Hydrogen Sulphide	H ₂ S (%)	-						-	-	-	-
Maximum flow rate	Max (l/hr)	-	Weather Conditions							Volume Purged	
Minimum flow rate	Min (l/hr)	-									
LNAPL	(mbgl)	-	Remarks							Sample Volume	
Water Level	(mbgl)	0.97									
DNAPL	(mbgl)	-									
Standpipe depth	(mbgl)	-									

Y:\PROFORMA\EXCEL\GASDATA v7

MONITORING DATA SHEET

SITE	Greenrooks, Barnham	DATE	17 February 2010	REF	GE7296	TECH	Nick Bushby	VISIT	3 of 6
-------------	---------------------	-------------	------------------	------------	--------	-------------	-------------	--------------	--------

SP1	Position:		Time of Reading:		Seconds	10s	20s	30s	60s	120s	
	Methane		CH ₄ (%)		-	-	-	-	-	-	
	Carbon Dioxide		CO ₂ (%)		-	-	-	-	-	-	
	Oxygen		O ₂ (%)		-	-	-	-	-	-	
VOC's		(ppm)	-								
Atmospheric Pressure	mBar	991	Atmospheric readings					CO ₂	CH ₄	O ₂	VOC's
Hydrogen Sulphide	H ₂ S (%)	-						-	-	-	-
Maximum flow rate	Max (l/hr)	-	Weather Conditions							Volume Purged	
Minimum flow rate	Min (l/hr)	-									
LNAPL	(mbgl)	-	Remarks							Sample Volume	
Water Level	(mbgl)	1.10									
DNAPL	(mbgl)	-									
Standpipe depth	(mbgl)	-									

SP2	Position:		Time of Reading:		Seconds	10s	20s	30s	60s	120s	
	Methane		CH ₄ (%)		-	-	-	-	-	-	
	Carbon Dioxide		CO ₂ (%)		-	-	-	-	-	-	
	Oxygen		O ₂ (%)		-	-	-	-	-	-	
VOC's		(ppm)	-								
Atmospheric Pressure	mBar	991	Atmospheric readings					CO ₂	CH ₄	O ₂	VOC's
Hydrogen Sulphide	H ₂ S (%)	-						-	-	-	-
Maximum flow rate	Max (l/hr)	-	Weather Conditions							Volume Purged	
Minimum flow rate	Min (l/hr)	-									
LNAPL	(mbgl)	-	Remarks							Sample Volume	
Water Level	(mbgl)	0.89									
DNAPL	(mbgl)	-									
Standpipe depth	(mbgl)	-									

SP3	Position:		Time of Reading:		Seconds	10s	20s	30s	60s	120s	
	Methane		CH ₄ (%)		-	-	-	-	-	-	
	Carbon Dioxide		CO ₂ (%)		-	-	-	-	-	-	
	Oxygen		O ₂ (%)		-	-	-	-	-	-	
VOC's		(ppm)	-								
Atmospheric Pressure	mBar	991	Atmospheric readings					CO ₂	CH ₄	O ₂	VOC's
Hydrogen Sulphide	H ₂ S (%)	-						-	-	-	-
Maximum flow rate	Max (l/hr)	-	Weather Conditions							Volume Purged	
Minimum flow rate	Min (l/hr)	-									
LNAPL	(mbgl)	-	Remarks							Sample Volume	
Water Level	(mbgl)	0.84									
DNAPL	(mbgl)	-									
Standpipe depth	(mbgl)	-									

Y:\PROFORMA\EXCEL\GASDATA v7

MONITORING DATA SHEET

SITE	Greencrooks, Barnham	DATE	03 March 2010	REF	GE7296	TECH	Nick Bushby	VISIT	4 of 6
-------------	----------------------	-------------	---------------	------------	--------	-------------	-------------	--------------	--------

Position: SP1	Time of Reading:		Seconds	10s	20s	30s	60s	120s	
	Methane		CH ₄ (%)	-	-	-	-	-	
	Carbon Dioxide		CO ₂ (%)	-	-	-	-	-	
	Oxygen		O ₂ (%)	-	-	-	-	-	
VOC's	(ppm)	-							
Atmospheric Pressure	mBar	1018	Atmospheric readings			CO ₂	CH ₄	O ₂	VOC's
Hydrogen Sulphide	H ₂ S (%)	-				-	-	-	-
Maximum flow rate	Max (l/hr)	-	Weather Conditions					Volume Purged	
Minimum flow rate	Min (l/hr)	-							
LNAPL	(mbgl)	-	Remarks					Sample Volume	
Water Level	(mbgl)	0.66							
DNAPL	(mbgl)	-							
Standpipe depth	(mbgl)	3.40							

Position: SP2	Time of Reading:		Seconds	10s	20s	30s	60s	120s	
	Methane		CH ₄ (%)	-	-	-	-	-	
	Carbon Dioxide		CO ₂ (%)	-	-	-	-	-	
	Oxygen		O ₂ (%)	-	-	-	-	-	
VOC's	(ppm)	-							
Atmospheric Pressure	mBar	1018	Atmospheric readings			CO ₂	CH ₄	O ₂	VOC's
Hydrogen Sulphide	H ₂ S (%)	-				-	-	-	-
Maximum flow rate	Max (l/hr)	-	Weather Conditions					Volume Purged	
Minimum flow rate	Min (l/hr)	-							
LNAPL	(mbgl)	-	Remarks					Sample Volume	
Water Level	(mbgl)	0.53							
DNAPL	(mbgl)	-							
Standpipe depth	(mbgl)	3.25							

Position: SP3	Time of Reading:		Seconds	10s	20s	30s	60s	120s	
	Methane		CH ₄ (%)	-	-	-	-	-	
	Carbon Dioxide		CO ₂ (%)	-	-	-	-	-	
	Oxygen		O ₂ (%)	-	-	-	-	-	
VOC's	(ppm)	-							
Atmospheric Pressure	mBar	1018	Atmospheric readings			CO ₂	CH ₄	O ₂	VOC's
Hydrogen Sulphide	H ₂ S (%)	-				-	-	-	-
Maximum flow rate	Max (l/hr)	-	Weather Conditions					Volume Purged	
Minimum flow rate	Min (l/hr)	-							
LNAPL	(mbgl)	-	Remarks					Sample Volume	
Water Level	(mbgl)	0.39							
DNAPL	(mbgl)	-							
Standpipe depth	(mbgl)	2.76							

Y:\PROFORMA\EXCEL\GASDATA v7

MONITORING DATA SHEET

SITE	Greenoaks, Barnham	DATE	16 March 2010	REF	GE7296	TECH	Nick Bushty	VISIT	5 of 6
------	--------------------	------	---------------	-----	--------	------	-------------	-------	--------

SP1	Position:	Time of Reading:	Seconds	10s	20s	30s	60s	120s		
		Methane	CH ₄ (%)	-	-	-	-	-		
		Carbon Dioxide	CO ₂ (%)	-	-	-	-	-		
		Oxygen	O ₂ (%)	-	-	-	-	-		
VOC's	(ppm)	-								
Atmospheric Pressu	mBar	1026	Atmospheric readings				CO ₂	CH ₄	O ₂	VOC's
Hydrogen Sulphide	H ₂ S (%)	-					-	-	-	-
Maximum flow rate	Max (l/hr)	-	Weather Conditions						Volume Purged	
Minimum flow rate	Min (l/hr)	-								
LNAPL	(mbgl)	-								
Water Level	(mbgl)	1.16	Remarks						Sample Volume	
DNAPL	(mbgl)	-								
Standpipe depth	(mbgl)	2.79								

SP2	Position:	Time of Reading:	Seconds	10s	20s	30s	60s	120s		
		Methane	CH ₄ (%)	-	-	-	-	-		
		Carbon Dioxide	CO ₂ (%)	-	-	-	-	-		
		Oxygen	O ₂ (%)	-	-	-	-	-		
VOC's	(ppm)	-								
Atmospheric Pressu	mBar	1026	Atmospheric readings				CO ₂	CH ₄	O ₂	VOC's
Hydrogen Sulphide	H ₂ S (%)	-					-	-	-	-
Maximum flow rate	Max (l/hr)	-	Weather Conditions						Volume Purged	
Minimum flow rate	Min (l/hr)	-								
LNAPL	(mbgl)	-								
Water Level	(mbgl)	1.33	Remarks						Sample Volume	
DNAPL	(mbgl)	-								
Standpipe depth	(mbgl)	3.20								

SP3	Position:	Time of Reading:	Seconds	10s	20s	30s	60s	120s		
		Methane	CH ₄ (%)	-	-	-	-	-		
		Carbon Dioxide	CO ₂ (%)	-	-	-	-	-		
		Oxygen	O ₂ (%)	-	-	-	-	-		
VOC's	(ppm)	-								
Atmospheric Pressu	mBar	1026	Atmospheric readings				CO ₂	CH ₄	O ₂	VOC's
Hydrogen Sulphide	H ₂ S (%)	-					-	-	-	-
Maximum flow rate	Max (l/hr)	-	Weather Conditions						Volume Purged	
Minimum flow rate	Min (l/hr)	-								
LNAPL	(mbgl)	-								
Water Level	(mbgl)	1.42	Remarks						Sample Volume	
DNAPL	(mbgl)	-								
Standpipe depth	(mbgl)	3.31								

Y:\PROFORMA\EXCEL\GASDATA v7

MONITORING DATA SHEET

SITE	Greencaks, Barnham	DATE	29 March 2010	REF	GE7296	TECH	Nick Bushby	VISIT	6 of 6
-------------	--------------------	-------------	---------------	------------	--------	-------------	-------------	--------------	--------

Position: SP1	Time of Reading:		Seconds	10s	20s	30s	60s	120s	
	Methane		CH ₄ (%)	-	-	-	-	-	
	Carbon Dioxide		CO ₂ (%)	-	-	-	-	-	
	Oxygen		O ₂ (%)	-	-	-	-	-	
VOC's (ppm)		-							
Atmospheric Pressure	mBar	1000	Atmospheric readings			CO ₂	CH ₄	O ₂	VOC's
Hydrogen Sulphide	H ₂ S (%)	-				-	-	-	-
Maximum flow rate	Max (l/hr)	-	Weather Conditions					Volume Purged -	
Minimum flow rate	Min (l/hr)	-							
LNAPL	(mbgl)	-							
Water Level	(mbgl)	0.00	Remarks					Sample Volume -	
DNAPL	(mbgl)	-							
Standpipe depth	(mbgl)	2.85							

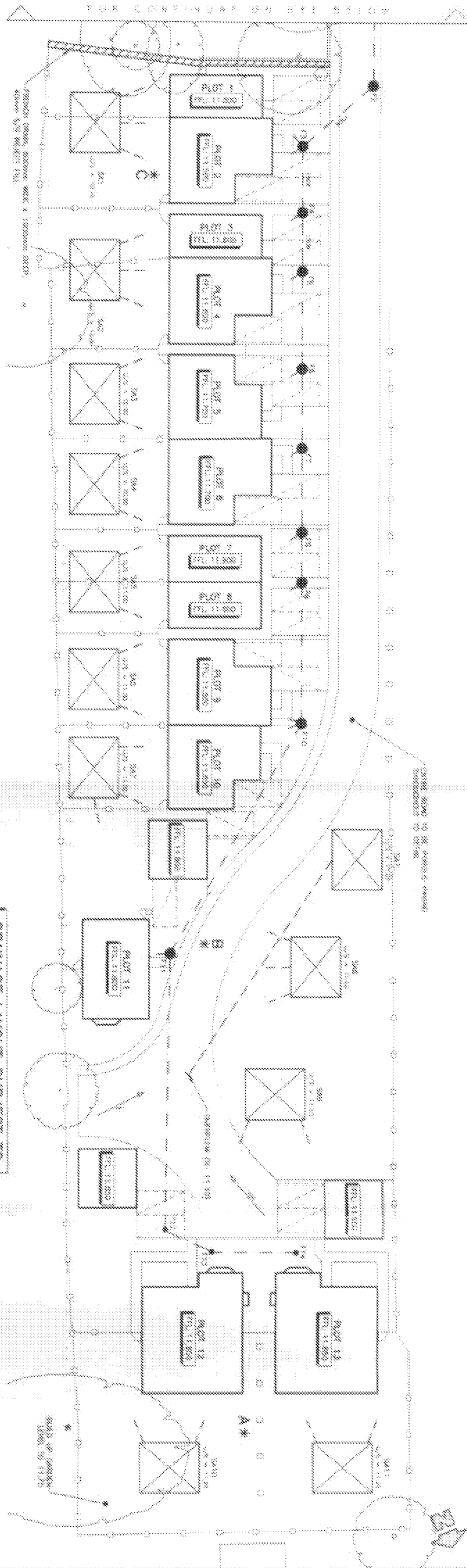
Position: SP2	Time of Reading:		Seconds	10s	20s	30s	60s	120s	
	Methane		CH ₄ (%)	-	-	-	-	-	
	Carbon Dioxide		CO ₂ (%)	-	-	-	-	-	
	Oxygen		O ₂ (%)	-	-	-	-	-	
VOC's	(ppm)	-							
Atmospheric Pressure	mBar	1000	Atmospheric readings			CO ₂	CH ₄	O ₂	VOC's
Hydrogen Sulphide	H ₂ S (%)	-				-	-	-	-
Maximum flow rate	Max (l/hr)	-	Weather Conditions					Volume Purged	
Minimum flow rate	Min (l/hr)	-							
LNAPL	(mbgl)	-							
Water Level	(mbgl)	1.21	Remarks					Sample Volume	
DNAPL	(mbgl)	-							
Standpipe depth	(mbgl)	3.22							

Position: SP3	Time of Reading:		Seconds	10s	20s	30s	60s	120s	
	Methane		CH ₄ (%)	-	-	-	-	-	
	Carbon Dioxide		CO ₂ (%)	-	-	-	-	-	
	Oxygen		O ₂ (%)	-	-	-	-	-	
VOC's	(ppm)	-							
Atmospheric Pressure	mBar	1000	Atmospheric readings			CO ₂	CH ₄	O ₂	VOC's
Hydrogen Sulphide	H ₂ S (%)	-				-	-	-	-
Maximum flow rate	Max (l/hr)	-	Weather Conditions					Volume Purged	
Minimum flow rate	Min (l/hr)	-							
LNAPL	(mbgl)	-	Remarks						
Water Level	(mbgl)	1.36							
DNAPL	(mbgl)	-							
Standpipe depth	(mbgl)	3.33							
								Sample Volume	

Y:\PROFORMA\EXCEL\GASDATA v7

Appendix 6

F.F.L.'s SHOWN ARE APPROXIMATE



DRAINAGE LAYOUT SUBJECT TO AGRICULTURAL REVIEW

STATION 1+00 TO 2+00

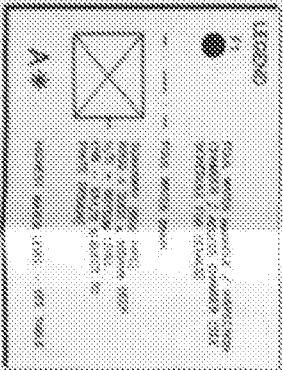
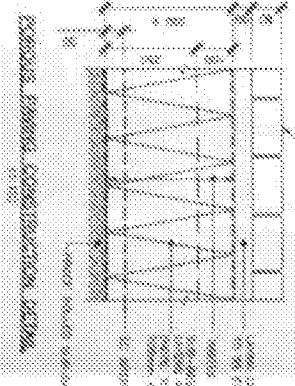
SCHEMATIC F.F.L. WITHOUT SCHEDULE

NO.	CD	5	CONNECTION
1	11.10	11.10	11.10
2	11.10	11.10	11.10
3	11.10	11.10	11.10
4	11.10	11.10	11.10
5	11.10	11.10	11.10
6	11.10	11.10	11.10
7	11.10	11.10	11.10
8	11.10	11.10	11.10
9	11.10	11.10	11.10
10	11.10	11.10	11.10
11	11.10	11.10	11.10
12	11.10	11.10	11.10
13	11.10	11.10	11.10
14	11.10	11.10	11.10
15	11.10	11.10	11.10
16	11.10	11.10	11.10
17	11.10	11.10	11.10
18	11.10	11.10	11.10
19	11.10	11.10	11.10
20	11.10	11.10	11.10

STATION 1+00 TO 2+00

SCHEMATIC F.F.L. WITH SCHEDULE

NO.	CD	5	CONNECTION
1	11.10	11.10	11.10
2	11.10	11.10	11.10
3	11.10	11.10	11.10
4	11.10	11.10	11.10
5	11.10	11.10	11.10
6	11.10	11.10	11.10
7	11.10	11.10	11.10
8	11.10	11.10	11.10
9	11.10	11.10	11.10
10	11.10	11.10	11.10
11	11.10	11.10	11.10
12	11.10	11.10	11.10
13	11.10	11.10	11.10
14	11.10	11.10	11.10
15	11.10	11.10	11.10
16	11.10	11.10	11.10
17	11.10	11.10	11.10
18	11.10	11.10	11.10
19	11.10	11.10	11.10
20	11.10	11.10	11.10



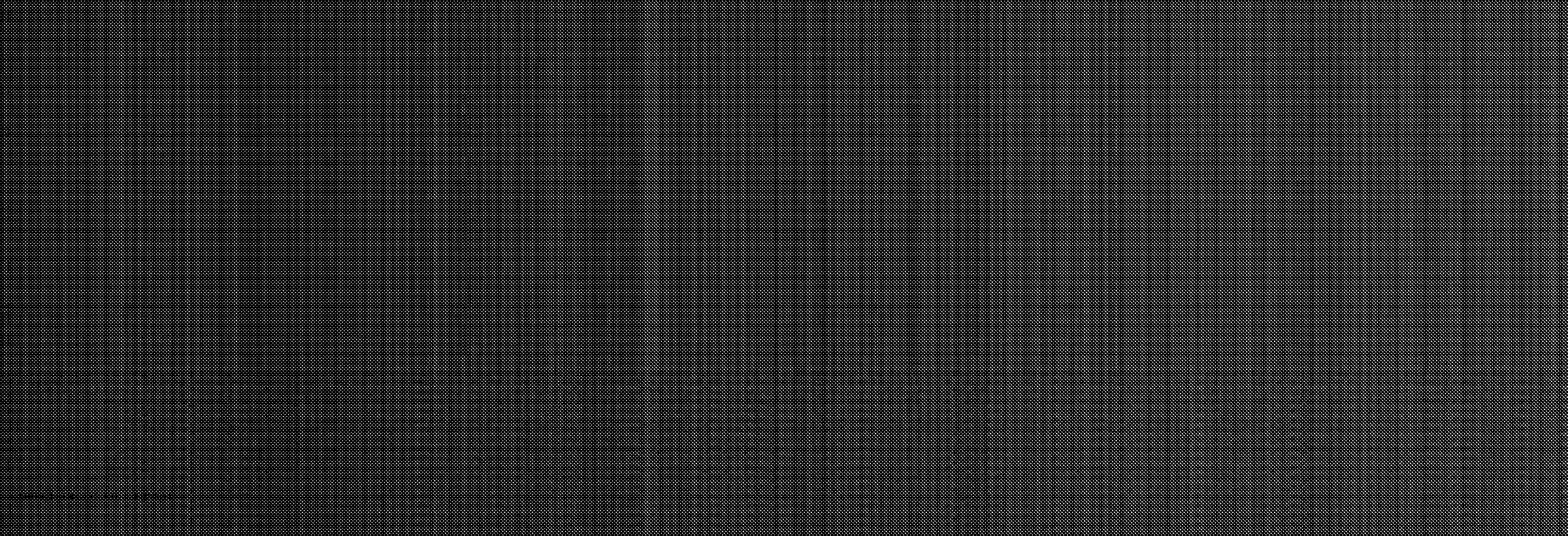
THE RUSBY BREWSTER

1000 RUSBY BREWSTER DRIVE
SUITE 100
DALLAS, TEXAS 75243
TEL: 214-343-1234
FAX: 214-343-1235
WWW.RUSBYBREWSTER.COM

SCHEMATIC

F.F.L. AND STORM WATER

REVISIONS: 50, 100, 150



Appendix 7



RUSHBY BREWSTER

CONSULTING CIVIL AND STRUCTURAL ENGINEERS

GREENOAKS, DARNHAM - SOUTHCOTT HOMES

Storm Drainage - Strategy & Design - Revised Scheme/May 2011

Technical

1. Attached revised drawing RBA 895-50/P6. This shows larger, shallower soakaways (as per the design sheet S/A-1 (20/01/11). The design for these has used the worst-case porosity figure of 5.8×10^{-6} throughout and is therefore 'safe' and gives a small margin of safety against the maximum water table level.
2. The roadway is, as before, porous paving throughout with an overflow for surge conditions such as 1/100 year storm event. An extract from porous pavement design Manual is also attached to confirm suitability of the granular sump.
3. Also attached are the monitoring results from the groundwater regime. These indicate a general improvement once wetter periods have passed.
4. Storage figures for the 100 yr + 30% climate change are enclosed (RBA 895 S/A-2) and confirm that the soakaways provided are adequate to cover this extreme condition.

Supporting Comments

1. The land slope is such that no surface water from adjacent land is positively encouraged to increase the on-site rainfall and, further, the adjacent site will utilise the LPA approved system to mitigate any migration on to this site. As such, the site under consideration may be treated 'independently'.
2. To offer a long-stop to potential overflows, a french drain has been introduced at the low end of the site (see drawing RBA 895-50/P6). This will effectively remove potential overflow to neighbouring gardens.
3. Raising ground levels could be considered to improve the actual site drainage but it is considered imprudent to potentially increase flood risk to any adjoining land and property, and the current scheme retains existing ground levels.

ace



The Town House, St George's Square, Bishop's Waltham, Southampton, Hampshire, SO12 1LR

E: arun@rushbybrewster.co.uk W: www.rushbybrewster.co.uk

T: 01487 890004 F: 01487 890005

Directors: Alan Rushby (Eng. 411819), Stephen Brewster (Str. 31402), Geoff NEE
Rushby Brewster Associates Limited. Registered in England. 2632795



4. The soakaways are set to maximise the distance between their invert and the water table. In general circumstances this distance is in the order of a minimum of 600-800mm which does, under extreme conditions reduce to zero. The roadway itself is porous with its own inherent storage/dispersal system.
5. In order to reduce water inundation, rainwater harvesting could be employed but this will be subject to acceptance of usage as, often, such systems can involve maintenance issues, and affect flushing systems within drainage apparatus.

Enclosures

Drawings: RBA 895 - 50 P6

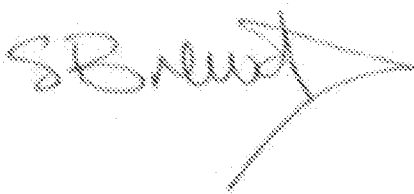
Calculations: RBA 895 - S/A 1 (1/10yr soakaway)

- S/A 2 (1/100yr soakaway, + 30% climate change)

Porosity Values: GESL letter 18.11.2009

Water Monitoring: GESL Layout and summary sheet

Porous Paving: Extracts from paving Manual (UK map & Table 5)



RBA 895/17.05.11

DRAWINGS

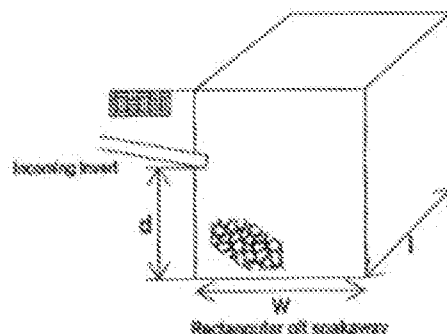
RDA 895 - 50 P5

RBA 895/17.05.11

	Project		Greenoaks Barnham		Job Ref.		RBA805	
	Section		Soakaways 1/10 year		Sheet no./rev.		S/A - 1	
	Calc. by	Date	Chk'd by	Date	App'd by	Date		
	SB	20/01/2011						

SOAKAWAY DESIGN - BRE DIGEST 365

TEDOS calculation version 1.0.01



Rectangular Pit Design

Pit length	$l = 8000 \text{ mm}$	Pit width	$w = 5000 \text{ mm}$
Pit depth below invert	$d = 400 \text{ mm}$	Free volume	$V_{\text{free}} = 100.0 \%$
Location of soakaway	England and Wales	Return period	10 years
Ratio of 60 minute to 2 day rainfalls of 5 year return period (BRE digest 365 - fig 1)		$r = 0.35$	
Impermeable area	$A = 78.0 \text{ m}^2$	Soil infiltration rate	$f = 0.0000059 \text{ m/s}$
Surface area of soakaway to 50% storage depth			

$$A_{50\%} = 2 \times (l + w) \times d / 2 = 4.400 \text{ m}^2$$

Outflow factor $AF = A_{50\%} \times f = 28.6 \times 10^{-6} \text{ m}^3/\text{s}$

M5 rainfalls are calculated from table 1 BRE digest 365 using Factor Z1

Duration	M5 rainfalls	Growth factor Z2	10 year rainfall	Inflow	Outflow	Storage required
5 mins	7.1 mm	1.20	8.8 mm	0.6 m ³	0.0 m ³	0.6 m ³
10 mins	10.1 mm	1.22	12.4 mm	0.9 m ³	0.0 m ³	0.9 m ³
15 mins	12.3 mm	1.23	15.2 mm	1.1 m ³	0.0 m ³	1.1 m ³
30 mins	15.7 mm	1.24	19.5 mm	1.5 m ³	0.0 m ³	1.4 m ³
1 hour	20.0 mm	1.24	24.8 mm	1.9 m ³	0.1 m ³	1.8 m ³
2 hours	24.5 mm	1.24	30.3 mm	2.3 m ³	0.2 m ³	2.1 m ³
4 hours	29.9 mm	1.22	36.5 mm	2.7 m ³	0.4 m ³	2.4 m ³
6 hours	33.8 mm	1.21	40.9 mm	3.1 m ³	0.6 m ³	2.5 m ³
10 hours	38.9 mm	1.19	46.5 mm	3.5 m ³	0.9 m ³	2.6 m ³
24 hours	49.6 mm	1.17	58.1 mm	4.4 m ³	2.2 m ³	2.1 m ³

Required storage volume $S_{\text{reqd}} = 2.5 \text{ m}^3$

Soakaway storage volume $S_{\text{sw}} = l \times d \times w \times V_{\text{free}} = 12.0 \text{ m}^3$

Soakaway storage volume - OK

Time for emptying soakaway to half volume

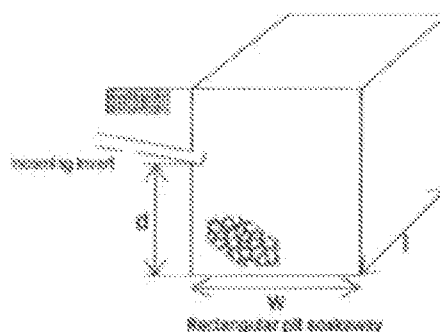
$$T_{50\%} = S_{\text{reqd}} \times 0.5 / (A_{50\%} \times f) = 13 \text{ hr } 38 \text{ min } 26 \text{ s}$$

Soakaway discharge time - OK

RUSHBY Consultants and Engineers Ltd	Project Greenoaks Barnham				Job Ref RBA005	
	Section Soakaways 1/100 year				Sheet no./rev S/A - 2	
	Date by SB	Date 20/01/2011	Checked by	Date	Approved by	Date

SOAKAWAY DESIGN - BRE DIGEST 365

TF050 calculation version 1.0.01



Rectangular Pit Design

Pit length	$l = 6000 \text{ mm}$	Pit width	$w = 5000 \text{ mm}$
Pit depth below invert	$d = 400 \text{ mm}$	Free volume	$V_{\text{free}} = 100.0 \%$
Location of soakaway	England and Wales	Return period	100 years
Ratio of 60 minute to 2 day rainfalls of 5 year return period (BRE digest 365 - fig 1)		$r = 0.35$	
Impermeable area	$A = 75.0 \text{ m}^2$	Soil infiltration rate	$f = 0.0000066 \text{ m/s}$
Surface area of soakaway to 50% storage depth			

$$A_{\text{so}} = 2 \times (l + w) \times d / 2 = 4.400 \text{ m}^2$$

Outflow factor $AF = A_{\text{so}} \times f = 28.6 \times 10^{-4} \text{ m}^3/\text{s}$

MS rainfalls are calculated from table 1 BRE digest 365 using Factor Z1

Duration	MS rainfalls	Growth factor Z2	100 year rainfall	Inflow	Outflow	Storage required
5 mins	7.1 mm	1.84	13.1 mm	1.0 m ³	0.0 m ³	1.0 m ³
10 mins	10.1 mm	1.91	19.4 mm	1.5 m ³	0.6 m ³	1.4 m ³
15 mins	12.3 mm	1.95	24.0 mm	1.8 m ³	0.6 m ³	1.8 m ³
30 mins	16.7 mm	2.00	31.4 mm	2.4 m ³	0.6 m ³	2.3 m ³
1 hour	20.0 mm	2.03	40.6 mm	3.0 m ³	0.1 m ³	3.0 m ³
2 hours	24.5 mm	2.01	49.2 mm	3.7 m ³	0.2 m ³	3.5 m ³
4 hours	29.9 mm	1.97	59.0 mm	4.4 m ³	0.4 m ³	4.1 m ³
6 hours	33.8 mm	1.94	66.6 mm	4.9 m ³	0.6 m ³	4.4 m ³
10 hours	38.9 mm	1.90	73.9 mm	5.5 m ³	0.9 m ³	4.6 m ³
24 hours	49.6 mm	1.81	89.9 mm	6.7 m ³	2.2 m ³	4.5 m ³

Required storage volume $S_{\text{req}} = 4.6 \text{ m}^3$

Soakaway storage volume $S_{\text{sw}} = l \times d \times w \times V_{\text{free}} = 12.0 \text{ m}^3$

LOW 30% CLIMATE CHANGE
VAL = $6.6 \times 1.3 = 8.6 < 12.0$

Soakaway storage volume - OK

Time for emptying soakaway to half volume

$$T_{\text{0.5}} = S_{\text{req}} \times 0.5 / (A_{\text{so}} \times f) = 24 \text{ hr } 39 \text{ min } 34 \text{ s}$$

Soakaway discharge time inadequate

Appendix 8

PFA Consulting		Page 1
Stratton Park House	B424 - Greenoaks	
Wasborough Road	Barnham Road	
Swindon SN3 4HG	Pervious Paving	
Date May 2011	Designed By MD	
File Perm Pave.srx	Checked By	
Mistree Computing Ltd	Source Control W.12.3	

Rainfall Details

Rainfall Model	PSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
MS-60 mm	19,000	Shortest Storm (mins)	15
Ratio R	0.350	Longest Storm (mins)	10000
Summer Storms	Yes	Climate Change %	+30

Time / Area Diagram

Total Area (ha) 0.081

Time	Area
(mins)	(ha)

0-4 0.081

PFA Consulting		Page 7
Stratton Park House	2424 - Greenoaks	
Wanborough Road	Barnham Road	
Swindon SN3 4NG	Previous Paving	
Date May 2011	Designed By MB	
File Perm Pave.srx	Checked By	
Kistree Computing Ltd	Source Control W.12.5	

Model Details

Storage is Online Cover Level (m) 100.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.02174	Width (m)	5.6
Membrane Percolation (mm/hr)	1000	Length (m)	145.0
Max Percolation (l/s)	902.7	Slope (1:X)	1000.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invest Level (m)	99.500	Cap Volume Depth (m)	0.350

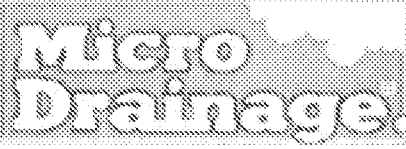
PFA Consulting		Page 3
Stratton Park House	5474 - Greenoaks	
Wanborough Road	Barnham Road	
Swindon SN3 4RG	Pervious Paving	
Date May 2011	Designed By MS	
File Perm Pave.srck	Checked By	
Elstree Computing Ltd	Source Control W.12.5	

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

Self Drain Time : 100 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	99.642	0.122	2.0	12.4	O.K.
30 min Summer	99.683	0.143	2.4	17.2	O.K.
60 min Summer	99.690	0.160	2.4	23.2	O.K.
120 min Summer	99.690	0.170	2.4	33.7	O.K.
180 min Summer	99.693	0.173	2.4	34.4	O.K.
240 min Summer	99.693	0.173	2.4	38.2	O.K.
360 min Summer	99.687	0.167	2.4	23.3	O.K.
480 min Summer	99.681	0.161	2.4	21.6	O.K.
600 min Summer	99.675	0.155	2.4	20.0	O.K.
720 min Summer	99.668	0.148	2.4	18.5	O.K.
960 min Summer	99.658	0.138	2.3	16.1	O.K.
1440 min Summer	99.642	0.122	2.0	15.5	O.K.
2160 min Summer	99.623	0.103	1.7	8.9	O.K.
2880 min Summer	99.610	0.090	1.5	6.9	O.K.
4320 min Summer	99.591	0.071	1.2	4.2	O.K.
5760 min Summer	99.579	0.059	1.0	2.9	O.K.
7200 min Summer	99.571	0.051	0.8	2.2	O.K.
8640 min Summer	99.567	0.047	0.7	1.9	O.K.
10080 min Summer	99.564	0.044	0.6	1.6	O.K.
15 min Winter	99.451	0.131	2.0	12.4	O.K.
30 min Winter	99.674	0.154	2.4	12.9	O.K.

Storm Event	Rain (mm/hr)	Time-to-Peak (mins)
15 min Summer	115.731	18
30 min Summer	77.804	32
60 min Summer	49.937	60
120 min Summer	30.934	98
180 min Summer	23.938	130
240 min Summer	18.577	164
360 min Summer	13.656	232
480 min Summer	10.974	300
600 min Summer	9.254	364
720 min Summer	8.046	426
960 min Summer	6.447	560
1440 min Summer	4.709	794
2160 min Summer	3.432	1164
2880 min Summer	2.739	1524
4320 min Summer	1.989	2244
5760 min Summer	1.587	2944
7200 min Summer	1.325	3672
8640 min Summer	1.147	4408
10080 min Summer	1.015	5136
15 min Winter	115.731	18
30 min Winter	77.804	32

PFA Consulting		Page 4
Stratton Park House	S424 - Greensaks	
Wanborough Road	Barnham Road	
Swindon SN3 4HS	Pervious Paving	
Date May 2011	Designed By MS	
File Perm Pave.srck	Checked By	
Elstree Computing Ltd	Source Control W.12.5	

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m ³)	Status
60 min Winter	99.694	0.174	2.4	24.7	O K
120 min Winter	99.705	0.185	2.4	27.5	O K
180 min Winter	99.707	0.187	2.4	37.9	O K
240 min Winter	99.708	0.188	2.4	27.4	O K
300 min Winter	99.697	0.177	2.4	29.4	O K
400 min Winter	99.687	0.167	2.4	22.9	O K
600 min Winter	99.676	0.156	2.4	20.4	O K
720 min Winter	99.667	0.147	2.4	18.2	O K
960 min Winter	99.654	0.134	2.2	15.0	O K
1440 min Winter	99.632	0.112	1.8	10.5	O K
2160 min Winter	99.609	0.089	1.5	8.0	O K
3880 min Winter	99.594	0.074	1.2	4.4	O K
4320 min Winter	99.575	0.055	0.9	2.5	O K
5760 min Winter	99.567	0.047	0.7	1.9	O K
7200 min Winter	99.563	0.043	0.6	1.5	O K
8640 min Winter	99.560	0.040	0.5	1.3	O K
10080 min Winter	99.557	0.037	0.5	1.2	O K

Storm Event	Rain (mm/hr)	Time-to-Peak (mins)
60 min Winter	49.997	60
120 min Winter	30.916	112
180 min Winter	21.058	180
240 min Winter	18.577	178
360 min Winter	13.604	254
480 min Winter	10.974	324
600 min Winter	9.354	388
720 min Winter	8.046	450
960 min Winter	6.447	578
1440 min Winter	4.709	874
2160 min Winter	3.432	1188
3880 min Winter	2.718	1928
4320 min Winter	1.949	2248
5760 min Winter	1.583	2934
7200 min Winter	1.323	3672
8640 min Winter	1.147	4312
10080 min Winter	1.015	5068