INNER LONDON GROUP

Flood Risk Assessment

For

STAR LANE PHASE 1

GREAT WAKERING, SOUTHEND-ON-SEA, ESSEX

No. 4242358

March 2012

BUREAU VERITAS

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Document Control Sheet

Issue/Revision	Issue 1	Issue 2	Issue 3	Revision 3
Remarks	Draft for comment	Final	Final (Revised for NPPF)	
Date		2/12/11	29/3/12	
Submitted to	Pegasus	Pegasus	Pegasus	
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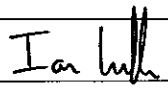
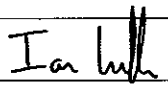
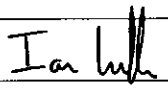
Signature				
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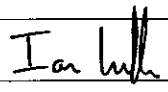
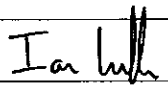
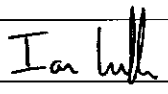
Signature				
Project number	4242358	4242358	4242358	
File reference				

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1.0 Introduction

1.1. Terms of reference

1.1.1. Bureau Veritas were retained by Inner London Group to prepare a Flood Risk Assessment (FRA) for the proposed redevelopment of land off Star Lane, Great Wakering, Southend-on-Sea, SS3 0HZ (the site). The location of the site is illustrated on Figure 1.

1.2. Background and aims

1.2.1. This report has been prepared to consider the risk of flooding to Phase 1 of the proposed development on the site of the former brickworks and to recommend appropriate mitigation measures. In addition the impact of the proposed development on the risk of flooding elsewhere has also been considered. The provisions of National Planning Policy Framework, (NPPF), (Department for Communities and Local Government, 2012) and the Technical Guidance to the National Planning Policy Framework (TG) (Department for Communities and Local Government, 2012) have been considered in preparing the Flood Risk Assessment.

1.2.2. The Flood Maps published on the Environment Agency's website indicate the site falls into a Zone 1 - low probability flood risk area (Flood Zone 1) as defined by TG Table 1: Flood zones. An extract of the Environment Agency's Flood Map is illustrated by Figure 2.

1.2.3. However, as the site area is greater than 1 hectare (ha), NPPF footnote 20 advises that a site-specific flood risk assessment is required by the local planning authority to determine the planning application.

1.3. Study limitations

1.3.1. The findings, recommendations and conclusions of this report are based on information obtained from a variety of external sources which are understood to be reputable. However, Bureau Veritas UK Limited cannot guarantee the authenticity or reliability of any data from third parties and no liability can be accepted for any erroneous information or the conclusions drawn from it.

2.0 Development Description and Location

2.1. Location and development proposals:

What type of development is proposed and where will it be located?

2.1.1. Phase 1 of the proposed development is located at National Grid Reference (NGR) TQ934872 in Great Wakering, Essex, as indicated in Figure 1.

2.1.2. The site extends to some 3.28ha and was a former brickworks that has now been demolished. It is bounded to the north an existing industrial estate, the west by Star Lane with agricultural and beyond, the south by agricultural land and to the asset by a series of lakes understood to be a remnant of former mineral extraction

2.1.3. A topographic survey of the Phase 1 site was completed by M.J. Rees & Company Limited in April 2007 and indicates that site is essentially flat at an elevation of approximately 11m above Ordnance Datum. A copy of the topographic survey is included at Appendix A.

2.1.4. The proposed development will provide 140 residential units. A detailed description of the proposed development is given at Section 6.0 and a copy of the proposed layout plan is enclosed at Appendix B.

2.1.5. The interactive map published on the British Geological Survey website indicates that the site is underlain by London Clay Formation (clay, silt and sand) with superficial river terrace deposits (clay and sand). Several site investigations have been completed and these are discussed in detail at Section 8.0

2.2. Vulnerability classification:

What is its vulnerability classification?

2.2.1. With reference to TG Table 2: Flood risk vulnerability classification, the residential development would be considered as a 'More Vulnerable' use.

2.3. Local Development Documents

Is the proposed development consistent with the Local Development Documents?

2.3.1. Rochford District Council is in the process of compiling the Rochford District Local Development Framework. The 'Core Strategy Submission Document' sets out the policies and aims for the district until 2025 and is the relevant document to consider.

2.3.2. To overcome development issues with regards to flooding, Policy ENV3 – Flood Risk states:

"The Council will direct development away from areas at risk of flooding by applying the sequential test and, where necessary, the exceptions test, as per PPS25. The vast majority of development will be accommodated within Flood Zone 1. However, considering the very limited supply of previously developed land in the District, proposed development on previously developed land within Flood Zone 3 will be permitted if it enables a contribution towards the District's housing requirement that would otherwise require the reallocation of Green Belt land, providing that it passes the exceptions tests and is able to accommodate the necessary flood defence infrastructure."

2.3.3. In addition, Policy ENV4 – Sustainable Drainage Systems (SuDS) highlights the requirement for a surface water management plan within the borough to map the areas most vulnerable to surface water flooding:

"All residential development over 10 units will be required to incorporate runoff control via SUDS to ensure runoff and infiltration rates do not increase the likelihood of flooding. The requirement for SUDs will only be relaxed where there is conclusive evidence demonstrating that the system is not viable on a particular site."

2.3.4. The flood risk management measures discussed at Sections 7.0, 8.0 and 9.0 will demonstrate that the proposed development will be consistent with Policy ENV3 – Flood Risk and Policy ENV4 – Sustainable Drainage Systems (SuDS) of the Core Strategy Submission Document.

2.4. Sequential Test and Exception Test

Please provide evidence that the Sequential Test or Exception Test has been applied in the selection of this site for this development type.

2.4.1. The NPPF requires that at all stages of planning a Sequential Test is completed, with the aim of steering new development to areas at the lowest probability of flooding. The Sequential Test would normally be completed by the Local Planning Authority (LPA) to inform the preparation of the Local Development Framework (LDF) where one exists.

2.4.2. As the proposed development is located within Flood Zone 1, the Sequential Test does not have to be applied.

2.4.3. With reference to TG Table 3 : Flood risk vulnerability and flood zone 'compatibility', the development is deemed to be 'appropriate' and as such the Exception Test does not have to

be applied. Nevertheless, it must be demonstrated that the development will be safe and will not increase the risk of flooding to others.

3.0 Definition of the Flood Hazard

3.1. Sources of flooding:

What sources of flooding could affect the site?

3.1.1. There are a number of potential sources of flooding and these include:

- Flooding from rivers or fluvial flooding;
- Flooding from the sea or tidal flooding;
- Flooding from land;
- Flooding from groundwater;
- Flooding from sewers; and
- Flooding from reservoirs, canals, and other artificial sources.

Flooding from rivers or fluvial flooding

3.1.2. With reference to the extract of the Environment Agency's flood map shown by Figure 2, the site is located outside of any flood risk area and considered to be within Flood Zone 1. This means the site has an annual probability of flooding of less than 0.1% (1 in 1,000).

3.1.3. The site is approximately 2km south of the Potton Creek and approximately 4km south of the Paglesham Reach of the River Roach. It is therefore considered that there is no significant fluvial flood risk to the site.

3.1.4. Flooding from fluvial sources has not therefore been considered further.

Flooding from the sea or tidal flooding

3.1.5. As noted above, the site is at an elevation of approximately 11m AOD and consequently is not at risk from tidal flooding.

3.1.6. Flooding from tidal sources has not therefore been considered further.

Flooding from land

3.1.7. With reference to the topographic survey enclosed at Appendix A, the site is essentially flat at an elevation of approximately 11m AOD. However, it was evident from a site visit that the adjoining land falls to the south and east and to the west beyond Star Lane.

3.1.8. It is therefore concluded that the there is no significant upslope catchment that could give rise to an overland flow onto the site, and further, no significant depth of water would accumulate on the site as it is locally higher than the surrounding ground.

3.1.9. Flooding from the land has not therefore been considered further.

Flooding from groundwater

3.1.10. As noted as 2.1.6 the underlying geology of the site comprises London Clay Formation (clay, silt and sand), with superficial river terrace deposits (clay and sand).

3.1.11. With reference to the Environment Agency's website, these superficial deposits are designated as 'Secondary A' aquifers. This is defined as 'permeable layers capable of supporting water supplies at local rather than strategic scale', or 'minor aquifers'.

3.1.12. As will be discussed in Section 8.0, the permeable strata underlying the site are in hydraulic continuity with the lakes. At the time of the site investigation the groundwater levels were some 3.5m to 4m below ground level.

3.1.13. In the unlikely event that groundwater levels were to rise significantly, they would be moderated by the existing land drainage system serving the adjacent agricultural land to the south and east of the site and in any event, as discussed in 3.1.6, groundwaters emerging at ground level would drain away from the site due to the local topography.

3.1.14. Flooding from groundwater has not therefore been considered further.

Flooding from sewers

3.1.15. The risk of flooding from sewers is likely to be very similar to that of flooding from the land discussed above. However, should a foul or surface water sewer surcharge in the vicinity of the proposed development, it is unlikely that significant flows would be generated across either site and the risk of significant inundation from this source is therefore considered to be low.

3.1.16. Flooding from sewers has not therefore been considered further.

Flooding from reservoirs, canals and other artificial sources

3.1.17. There are no reservoirs, canals and other artificial sources in the vicinity of the site that could give rise to a flood risk.

3.1.18. Flooding from reservoirs, canals and other artificial sources has not therefore been considered further.

3.2. Existing surface water drainage arrangements:

What are the existing surface water drainage arrangements for the site?

3.2.1. The site is a former brickworks that has now been demolished. It has been not possible to establish how the former brickworks was drained from the topographic survey enclosed at Appendix A and a site visit, however, it is noted that there was a formal consent in place for a discharge to the adjoining lake.

3.2.2. Whilst all the buildings that occupied the site have been demolished and the site cleared, the extensive area of hardstanding remains. This area of hardstanding covers virtually the entire site.

3.2.3. The sewer records in the vicinity of the sites are enclosed at Appendix C and suggest that the former brickworks was not connected to the public sewer.

3.2.4. It is therefore concluded that the site either drained to ground via formal or informal soakaways, or surface water runoff was discharged to the adjacent lake.

4.0 Probability

4.1. Flood Zone:

Which flood zone is the site within?

4.1.1. Reference to the extract of the Environment Agency's flood map illustrated by Figure 2 indicates that the site falls within Flood Zone 1.

4.1.2. This is defined by TG Table 1 as having an annual probability of flooding of 1 in 1,000 (0.1%) or less.

4.2. Strategic Flood Risk Assessment:

If there is a Strategic Flood Risk Assessment (SFRA) covering this site, what does it show?

4.2.1. A SFRA was produced by Scott Wilson in November 2006 for the Thames Gateway South Essex Partnership, which covers flood risk to the whole South Essex area including Rochford. In addition, Scott Wilson completed SFRA's for each local authority within the Thames Gateway to focus on the specific flood risk in the districts. As such, the report entitled 'Appendix D', published in November 2006, contains information regarding flood risk within the Rochford District.

4.2.2. The nearest water course to the site is the Potton Creek, approximately 2km to the north. Hazard maps were prepared to show the inundation from a tidal breach of the defences at the Potton Creek during a 1 in 200 year and 1 in 1,000 year tidal flooding event. The maps D4-6 and D5-6 from the Thames Gateway South Essex SFRA show that for both of these events, the sites remain outside of the flood envelope and within a Zone 1 'Low Probability' area.

4.2.3. A Level 1 and 2 SFRA was published in February 2011 by Scott Wilson for Rochford District that covering Great Wakering and the site. It is noted that the SFRA provides a revision to the Thames Gateway South Essex SFRA (published in November 2006) that was prepared under the previous Planning Policy Guidance 25 (PPG25), Development and Flood Risk.

4.2.4. The SFRA notes the potential for residential development of the site in Table 10-1: Core Strategy Development Locations due to the low probability of flooding in this area.

4.3. Run-off:

What are the existing rates and volumes of run-off generated by the site?

4.3.1. With reference to the topographic survey enclosed at Appendix A, the site comprises 100% hardstanding. Using the Modified Rationale Method detailed in Butler, D and Davies, J. (2006), Urban Drainage, 2nd ed., SPON, the surface water runoff for the existing site has been calculated as follows:-

Q = CiA where Q = maximum flow rate (l/s)
C= PR/PIMP=1
i= rainfall intensity (mm/hr),
A=area (ha)

4.3.2. It should be noted that a fixed rainfall intensity of 50mm/hr is used in this case, which has been recommended by Butler & Davies (2006) to avoid using inappropriately high intensities for very low concentration times, i.e. small sites.

4.3.3. Therefore, assuming a 100% impermeable area of 3.5 hectares, the total rate of runoff from the existing site is estimated to be $488ls^{-1}$.

5.0 Climate Change

5.1. Climate change:

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

5.1.1. The most recent advice on climate change is reported in TG Table 4: Recommended contingency allowances for net sea level rises and Table 5: Recommended national precautionary sensitivity ranges for peak rainfall intensities, peak river flows, offshore wind speeds and wave heights. This advice confirms that peak rainfall intensity, sea level, peak river flow, offshore wind speed and extreme wave heights are all expected to increase in the future. The TG recommends that considerations for future climate change are included in Flood Risk Assessments for proposed developments.

5.1.2. As such, in accordance with the advice contained within the TG, the site is likely to be subject to increases in rainfall intensity of 30% over the lifetime of the development assumed to be 100 years.

5.1.3. Increasing rainfall intensity will place additional pressure on the surface water drainage infrastructure over the lifetime of the development. It is therefore important that the proposed development has an effective surface water drainage system that will mitigate the predicted increase in rainfall intensity.

6.0 Detailed Development Proposals

6.1. Development layout:

Please provide details of the development layout, referring to the relevant drawings.

6.1.1. The proposal is for a residential development of 140 units, over an area of 3.28 hectares. Access roads, car parking spaces, amenity grassland and gardens will also be incorporated within the development. The proposed development will comprise:

- Two bedroom houses (35 no.)
- Three bedroom houses (26 no.)
- Four bedroom houses (60 no.)
- Two bedroom FOG apartment (4 no.)
- One bedroom apartment (6 no.)
- Two bedroom apartment (9 no.)

6.1.2. The proposed development plans are enclosed at Appendix B.

6.2. Sequential Test within site layout:

Where appropriate, demonstrate how land-uses most sensitive to flood damage have been placed in areas within the site that are at least risk of flooding.

6.2.1. It is inappropriate to sequentially test the layout of the proposed development given that the sites is essentially flat and lies lie wholly within Flood Zone 1.

7.0 Flood Risk Management Measures

7.1. Flood risk management measures:

How will the site be protected from flooding, including the potential impacts of climate change, over the development's lifetime?

7.1.1. Paragraph 9 of the TG requires that the flood risk assessment must demonstrate how the risks from all forms of flooding to and from the development will be managed so that the development remains safe throughout its lifetime, taking climate change into account.

7.1.2. As identified in Section 3.0, no significant sources of flood risk have been identified and therefore no specific measures are required to protect the proposed development from flooding other than to ensure adequate drainage provision is made.

7.1.3. The proposed means of managing surface water runoff from the proposed development is discussed in Section 8.0.

8.0 Off Site Impacts

8.1. Flood risk elsewhere:

How will you ensure that your proposed development and the measures to protect your site from flooding will not increase flood risk elsewhere?

8.1.1. As the proposed development lies entirely within Flood Zone 1, it will not have any adverse impact on the flood risk to others by virtue of obstruction to flood flows or the reduction of floodplain storage.

8.2. Surface water management:

How will you prevent run-off from the completed development causing an impact elsewhere?

8.2.1. The existing site is laid entirely to hardstanding, however, as illustrated by the proposed layout plan enclosed at Appendix B, redevelopment of the site will significantly reduce the impermeable surfacing. The area of hardstanding will be reduced from 3.5ha to 2ha (approximately 40%).

8.2.2. It is proposed to dispose of surface water runoff by means of chamber soakaways excavated into the underlying superficial river terrace deposits comprising sand and gravels. This is considered the most sustainable option as there are no public sewers in the vicinity of the site to which a connection could be readily made.

8.2.3. Several recent site investigations have been completed including DTS Raeburn Limited (DTS) (December 2006) and Ken Rush Associates (KRA) (June 2011). The purpose of these investigations was to confirm the underlying geology and establish the extent of contamination (if any) of the sub-soils resulting from the former use of the site.

DTS Raeburn Limited (December 2006)

8.2.4. Seven trial pits and four window sampling boreholes were excavated to depths of between 2.8m and 4.0m. The strata encountered is summarised in Table 1. A copy of the trial pit and borehole logs is enclosed at Appendix D.

8.2.5. Elevated levels of Extractable Petroleum Hydrocarbons (EPH) were noted at depth in one of the trial pits adjacent to a former diesel storage tank and high levels of arsenic, lead and nickel in the made ground in a further trial pit.

Thickness	General Description	Comments
0.0m to 1.0m	MADE GROUND	Made Ground
1.4m to 2.7m	Very sandy CLAY	River Terrace Deposits
Full thickness not established	Fine to coarse SAND	River Terrace Deposits

Table 1: Summary of DTS Site Investigation

Ken Rush Associates (June 2011)

8.2.6. Three boreholes were excavated to depths of between 4.0m and 5.5m. The strata encountered is summarised in Table 2. A copy of the site investigation report is enclosed at Appendix E.

Thickness	General Description	Comments
0.9m to 1.3m	MADE GROUND	Made Ground
1.5m to 1.7m	Sandy very silty CLAY laminated with silt and fine sand	River Terrace Deposits
Full thickness not established	Clayey silty fine SAND turning to gravelly silty coarse SAND with depth	River Terrace Deposits

Table 2: Summary of KRA Site Investigation

8.2.7. A percolation test was completed in Borehole 2 giving an infiltration rate of 2.6×10^{-3} ms^{-1} test. This is consistent with the description of the strata from the borehole logs.

Summary of site investigations.

8.2.8. The two site investigations confirm that that there is a persistent strata of permeable sands and gravels underling the site that comprise part of the superficial River Terrace Deposits.

8.2.9. This is consistent with the designation of these superficial deposits as 'Secondary A' aquifers. This is defined as 'permeable layers capable of supporting water supplies at local rather than strategic scale', or 'minor aquifers'. With reference to the Environment Agency's website it is of note that the sites lie outside of any designated groundwater protection zones.

8.2.10. The surveyed water level of the lake adjoining the site was recorded in September 11 as 6.87mAOD. It is therefore reasonable to conclude that the lake is in hydraulic continuity with the groundwater in the base of the River Terrace Deposits.

8.2.11. The DTS site investigation indicated that some contamination of the sub-soils has resulted from the former use of the site as a brickworks. This will clearly have to be investigated further and may have an impact on the siting of individual soakaways.

Soakaway design

8.2.12. The preliminary design of the soakaways has been completed in accordance with BRE Digest 365, Soakaway Design (BRE, 2007). In considering the design of the chamber soakaways reference has been made to Estate Road Construction Manual (Essex County Council, 2010) in that:

- The base of the soakaway should remain above the groundwater table
- Depths in excess of 5m would not be acceptable for maintenance reasons; and
- No soakaway should be within 6m of an adopted highway.

8.2.13. A generic soakaway design has therefore been developed using the following parameters:

- Ring diameter varies to suit drained catchment area (see Table 4 below)
- An assumed depth to permeable strata of 3m
- An infiltration horizon of 0.5m (maximum depth of soakaway 3.5m to keep above groundwater table)
- Inlet pipe to soakaway 2m below ground level
- Storage depth taken to invert of inlet pipe (so surcharging of the drainage system)
- Infiltration rate obtained from the KRA report 2.6×10^{-3} ms^{-1}
- A very conservative design event of 1 in 100 years. Additional storage has been allowed for to cater for climate change and no allowance has been made for the storage capacity of the drainage system.

Diameter (m)	Catchment Area (m^2)
2.7	1000
2.4	800
2.1	700
1.8	600

Table 4: Soakaway diameters

8.2.14. The details of the soakaway design for each diameter are provided in Appendix F. It is noted that the limiting factor on the design of the soakaway is the storage requirement rather than the infiltration rate.

8.2.15. The enclosed Drawing No. 4242358C01 Rev P1 provides an indicative drainage layout based on the disposal of surface water via chamber soakaways. It has been assume that only the min access road would be adopted and that no soakaway would be permitted within 5m of a dwelling.

8.2.16. Soakaways will not be located in areas where contaminants have been identified in the near-surface deposits unless the ground has been fully remediated. It is therefore considered that the use of soakaways to dispose of surface water runoff would not pose any significant risk the groundwaters through the mobilisation of contaminants.

8.2.17. Road surfaces and parking areas will be drained by deep-trapped gullies.

9.0 Residual Risks

9.1. Residual flood risk

What flood-related risks will remain after you have implemented the measures to protect the site from flooding?

9.1.1. As reported at Sections 3.0 and 4.0, the site is not at significant risk of flooding.

9.1.2. However, whilst extreme rainfall events are generally predictable, by their nature predictions are based on probability and thus subject to uncertainty. Therefore an unquantifiable residual risk remains that events exceeding those predicted may occur.

9.1.3. If the drainage system where to be overwhelmed either by a storm event with a magnitude greater than that designed for, or due to a blockage, given the general topography of the site and that of the surrounding land , it is unlikely that significant flooding would develop across the site.

9.2. Management

How, and by whom, will these risks be managed over the lifetime of the development?

9.2.1. Where the highway and associated drainage system is to be offered for adoption, it will be managed and maintained by the Adopting Authority. The remainder of the drainage system will be maintained by a management company or other suitable body.

9.2.2. It is anticipated that a management regime will be established to ensure period inspection and maintenance of the system to ensure its continuing effectiveness.

10.0 Conclusions

10.1. Background

10.1.1. This report has been prepared to consider the risk of flooding to Phase 1 of the proposed residential development of the land off Star Lane, Great Wakering, Essex. The residential development is considered a 'More' vulnerable use by TG Table 2.

10.1.2. No source of flood risk to the site has been identified. In assessing the flood risk, the impacts of climate change have been considered for the lifetime of the development.

10.1.3. The site falls within Flood Zone 1 defined by TG Table 1. This indicates that the site has less than a 1 in 1,000 (<0.1%) annual probability of flooding from rivers or the sea.

10.1.4. The proposals comprise the redevelopment of the former brickworks site off Star Lane, Great Wakering. It is proposed to provide 140 residential units on the 3.28ha site. The existing site is almost entirely laid to hardstanding and therefore the proposed redevelopment of the site will reduce the impermeable area by approximately 40%.

10.2. Sequential and Exception tests

10.2.1. The development is considered as a 'More' vulnerable use and therefore, as it lies within Flood Zone 1, it is not subject to the Sequential or the Exception Tests.

10.3. Flood risk management

10.3.1. As the site lies wholly within Flood Zone 1 and no significant source of flood risk has been identified, no specific flood management measures are considered to be necessary.

10.4. Off site impacts

10.4.1. A sustainable surface water management system based on the disposal of run off to soakaways is proposed and therefore there will be no increase in the risk of flooding elsewhere arising from the proposed development.

10.5. Residual risks

10.5.1. A residual risk remains that an event with a magnitude greater than that adopted for the design of the surface water drainage system might occur, or a drain may become blocked. Given the topography of the site and that of the surrounding land, it is unlikely that significant depths of floodwaters would accumulate if the drainage system where to be overwhelmed.

10.5.2. It will be important that the drainage system is regularly maintained to ensure its effective long-term operation.

11.0 References

BRE, 2007, *BRE Digest 365, Soakaway Design,* BRE, Watford, Herts

Department for Communities and Local Government, 2012. *National Planning Policy Framework*, UK Government, London.

Department for Communities and Local Government, 2012. *Technical Guidance to the National Planning Policy Framework*, UK Government, London.

Essex County Council, 2010, *Estate Road Construction Manual*, Essex County Council, Chelmsford, Essex

FIGURES

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Star Lane Phase 1 Great Wakering, Southend-on-Sea, Essex			Job No. 4242358
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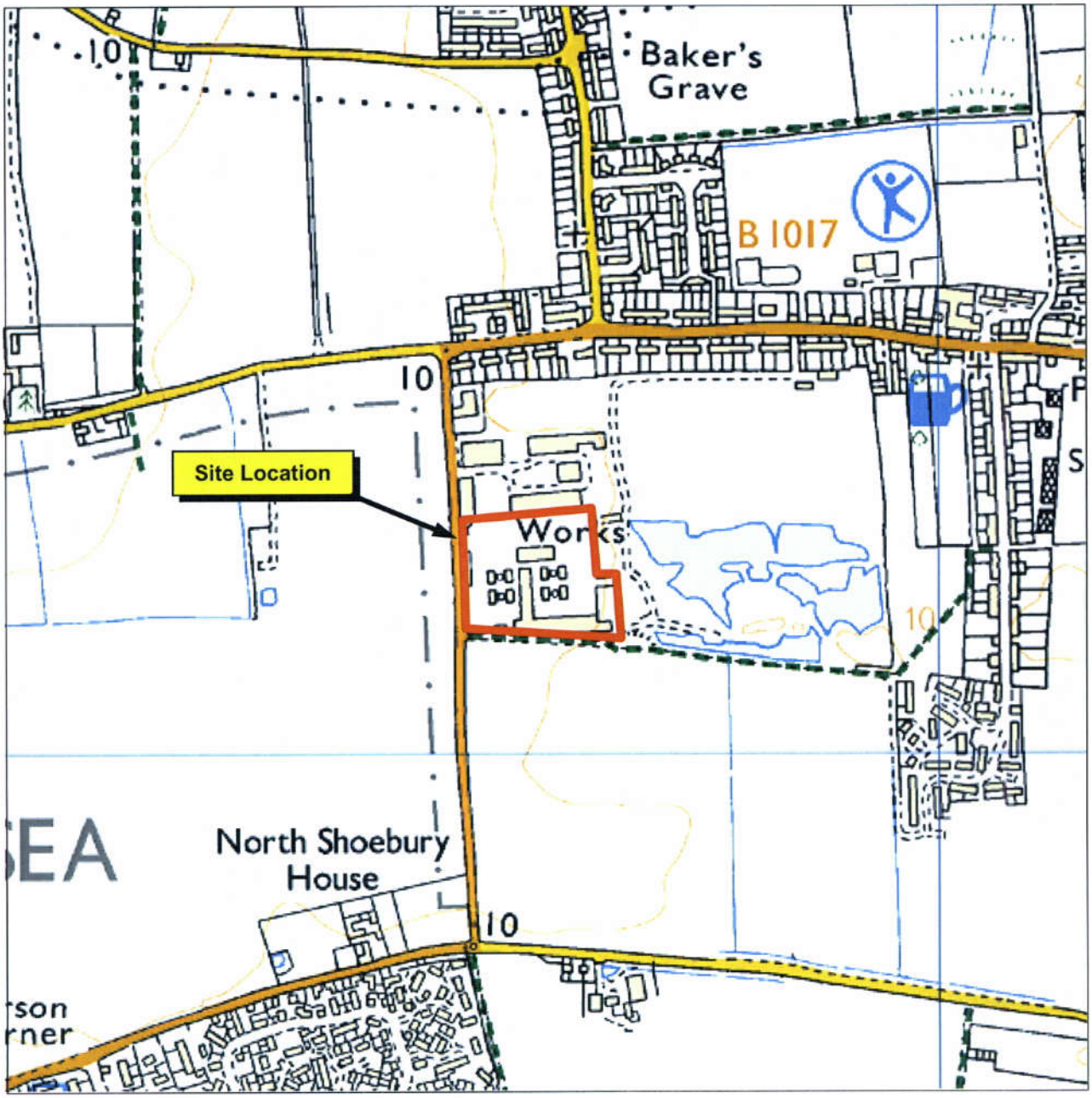

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Site Location Plan

Scale: NTS

FIGURE 1

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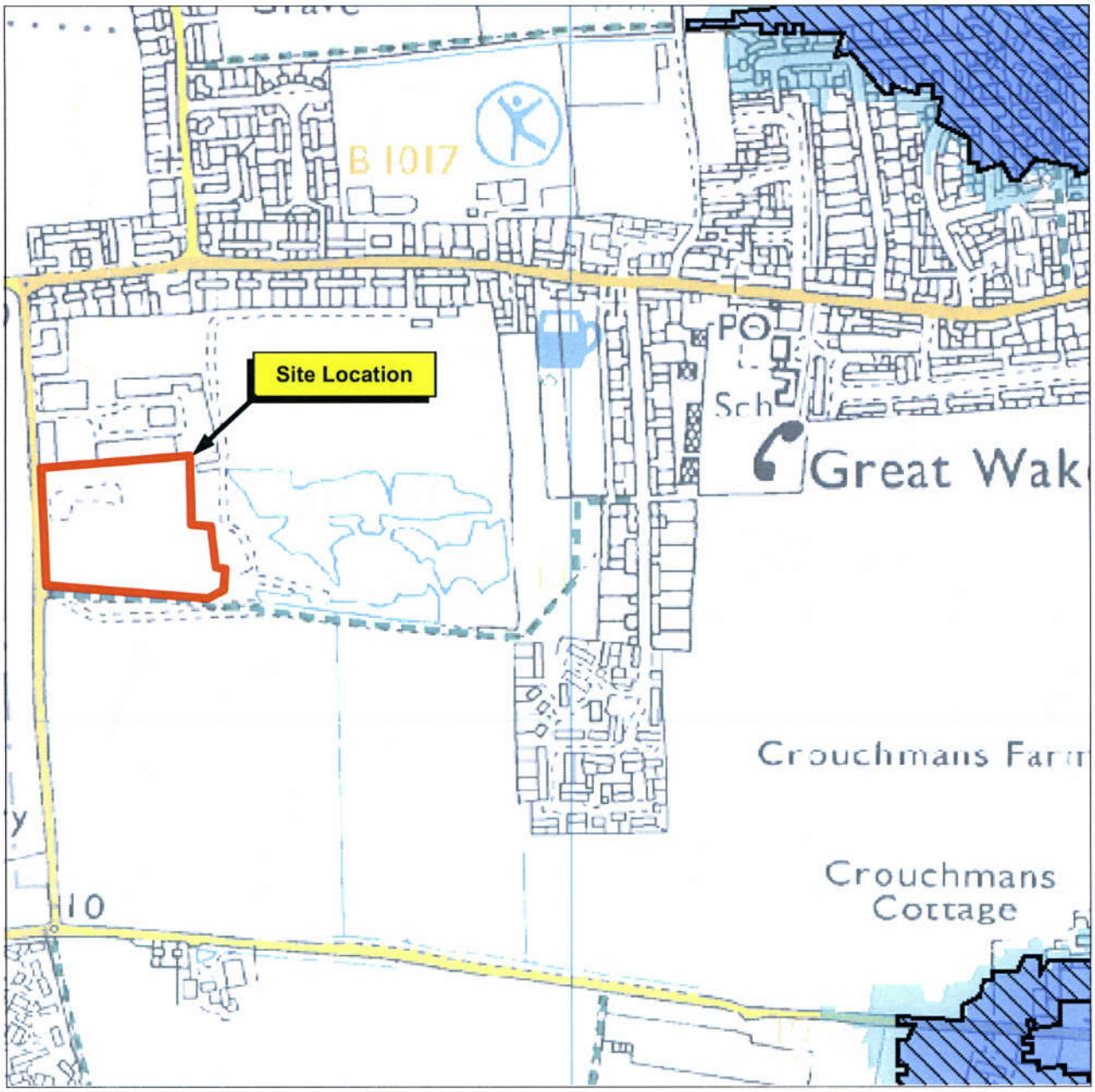
			Sheet 1 of 1
By: **LMW**	Checked:	Approved: **ILW**	Date: **Dec 2011**



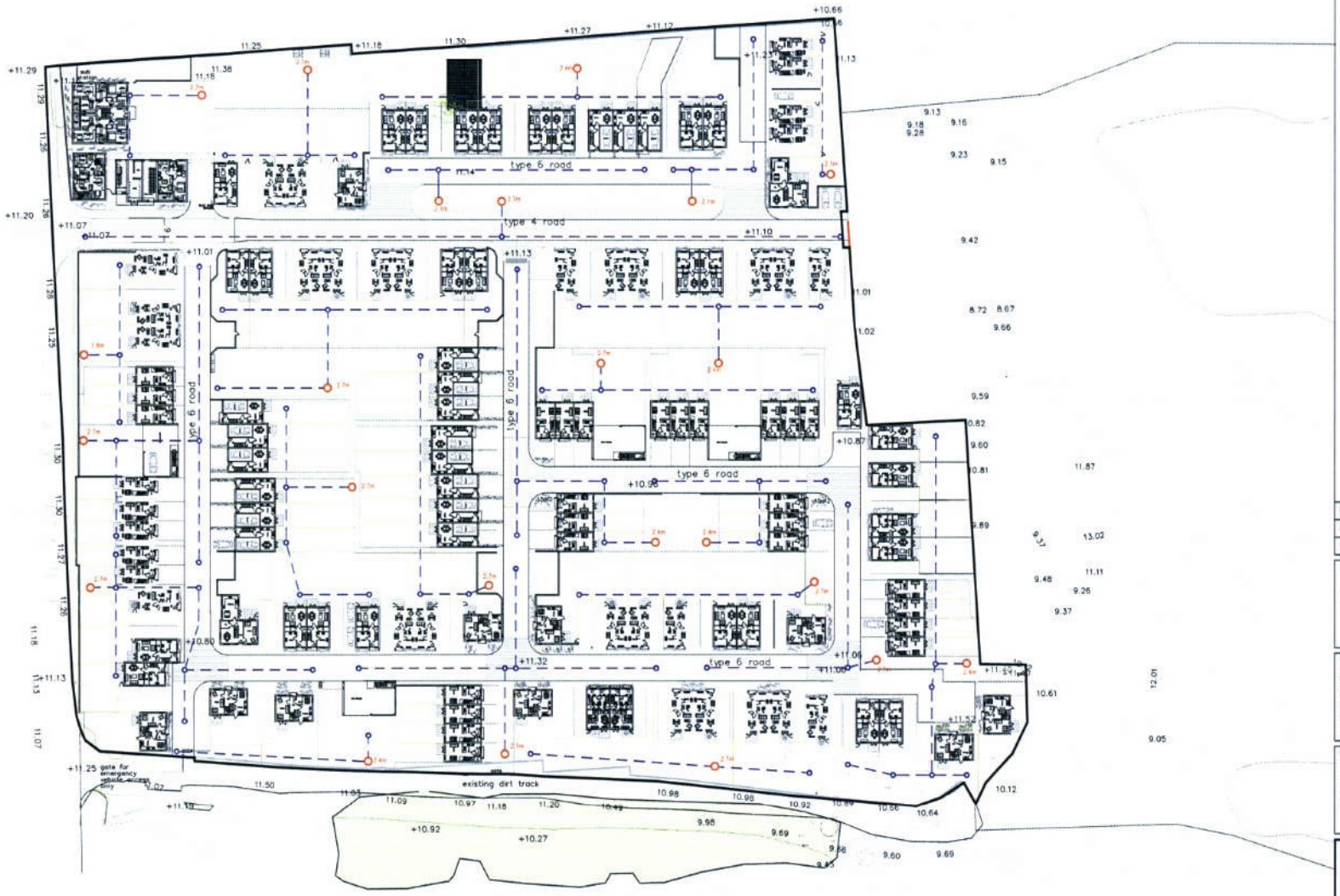
N

Extract of the Environment Agency's flood map
(*accessed 9 December 2011*)

Scale: NTS

FIGURE 2

DRAWINGS



Notes

1. DO NOT SCALE THIS DRAWING.
2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DRAWINGS AND SPECIFICATIONS.

KEY

INDICATIVE SURFACE WATER DRAINAGE LAYOUT

2.4m INDICATIVE SOAKAWAY LOCATION AND CHAMBER DIAMETER

Rev.	Description	App.	Chk.	Drn.	Date
P2	LAYOUT AMENDED			JC	28/3/12
P1	PRELIMINARY			JC	10/11/11

Client

INNER LONDON GROUP

Project

STAR LANE PHASE 1
GREAT WAKERING
SOUTHEND-ON-SEA
ESSEX

Drawing Title

PRELIMINARY
DRAINAGE STRATEGY

Telephone: 03976616700

Status: PRELIMINARY

File Path: C:\John Conyers Cons...r Lane\4242358C01.dwg

Scale: 1 : 500 @A1 Discipline: CIVIL

Drawing Number: 4242358C

Revision: P2

Appendix A

Topographic Survey

Appendix B

Proposed Development Plan

- NOTES:
- FOR HOUSE TYPE DETAILS REFER TO HOUSE TYPE FLOOR PLANS / ELEVS - PL220 - PL228
- FOR LANDSCAPING DETAILS REFER TO LANDSCAPE DESIGN STATEMENT
- FOR VARIATIONS ON ELEMENTS OF THE TYPICAL HOUSE TYPES REFER TO STREET SECTION ELEVATIONS PL230-PL237
- FOR APARTMENT DETAILS REFER TO DRAWINGS - PL210 - PL215
- BC - BRICK CLADDING TO DETACHED HOUSE TYPE C
- TC - TIMBER/FIBRE CEMENT WEATHERBOARDING TO HOUSE TYPE C
- TG - TIMBER/FIBRE CEMENT WEATHERBOARDING TO GABLE END

rev	date	description
A	21.03.12	Southern boundary & house types amended
	12.01.12	Issued for planning

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ARCHITECTURE + URBANISM

client
Inner London Group

project
Star Lane, Great Wakering
The Brickworks Site

drawing
Roof Plan
as Proposed

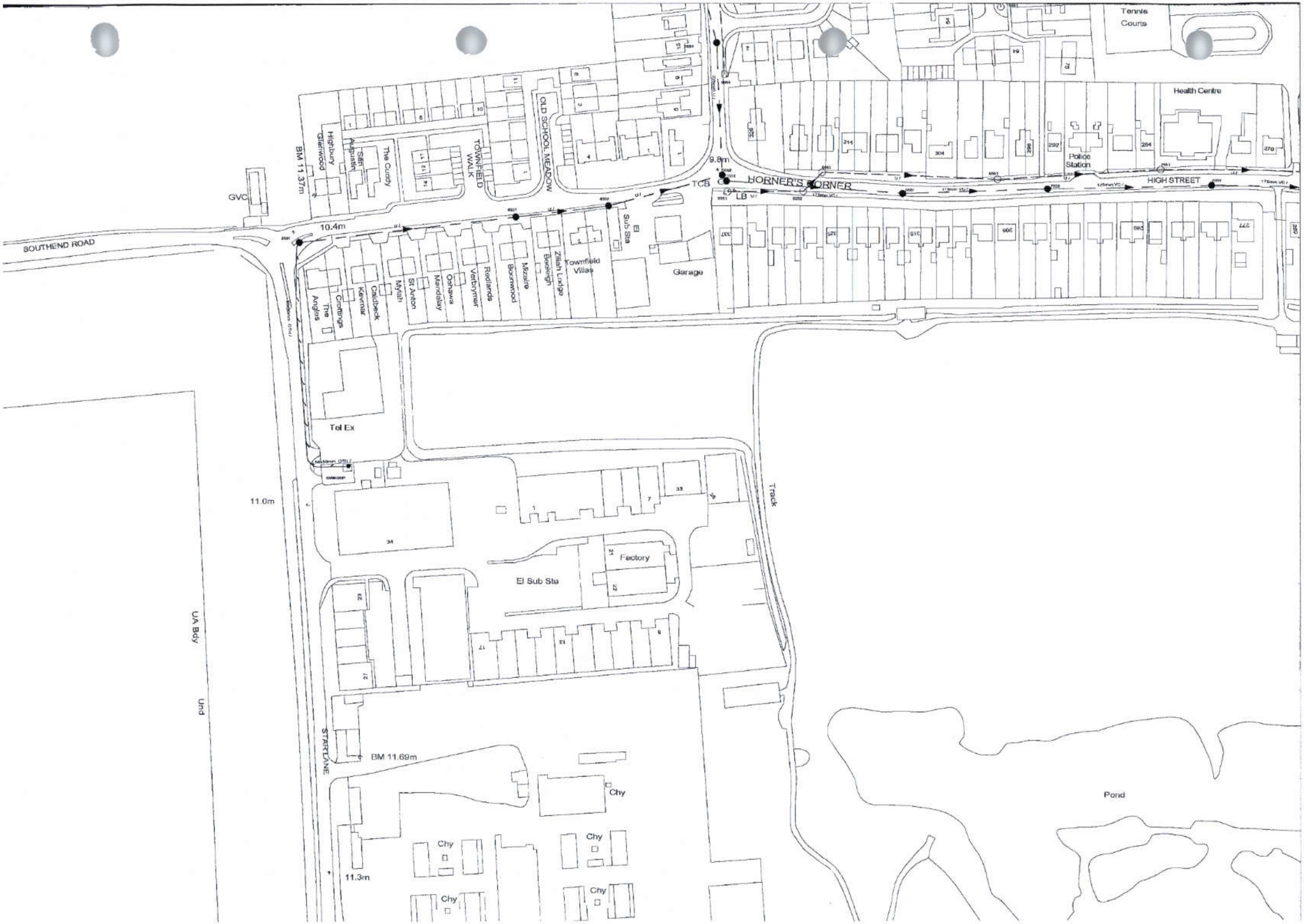
scale: 1:500 @ A1
cad file: 3201 ICAD\Master\Planning
date: November 2011
drawn:
checked:

project no	drawing no	revision
3201	PL113	A

0 10 20 30 40 50m
scale 1:500 @ A1

Appendix C

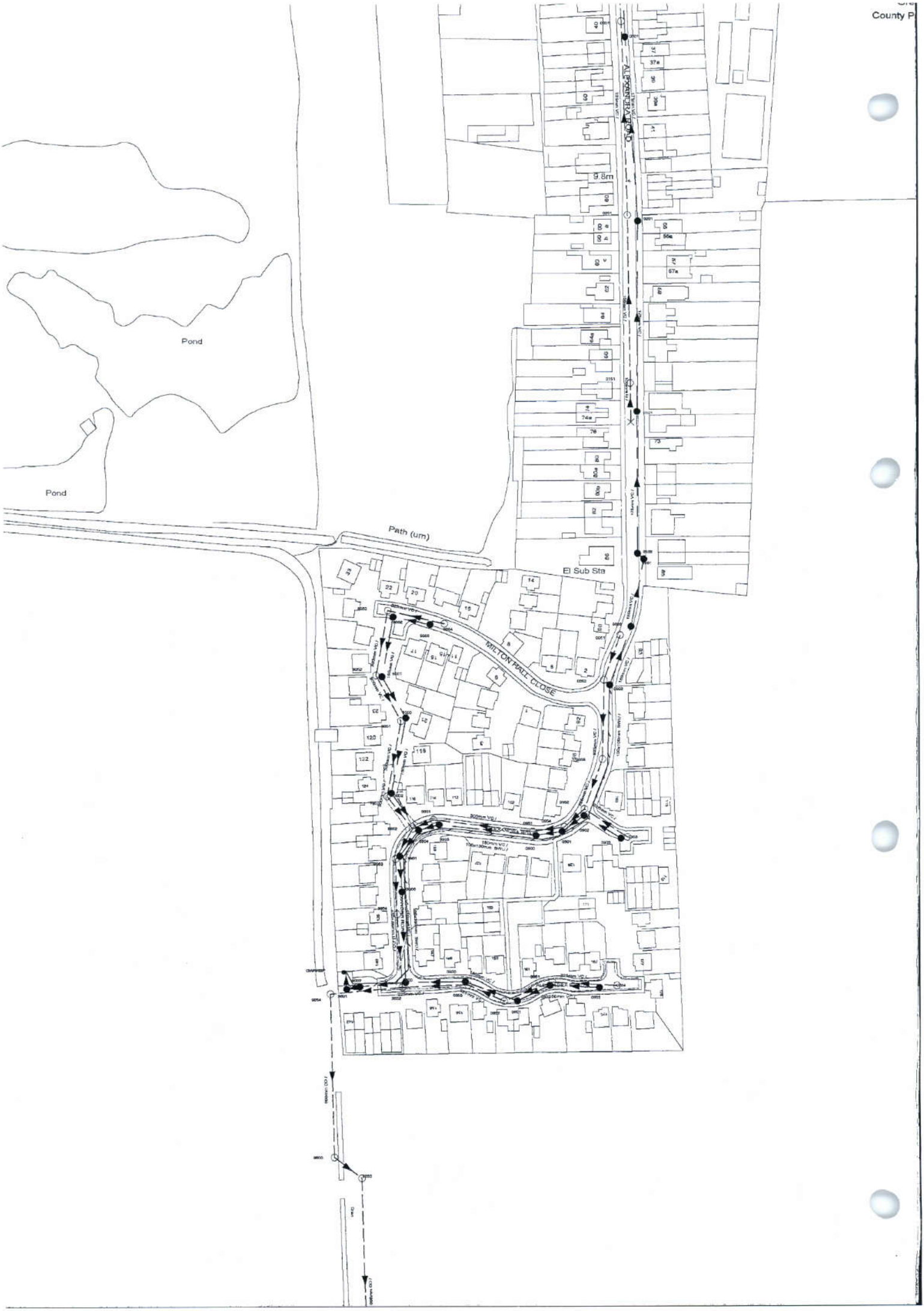
Sewer Records



SOUTHEND ROAD
GVC
BM 11.37m
Highbury
Glenwood
Sain Augustin
The Cuddy
TOWNFIELD WALK
OLD SCHOOL MEADOW
10.4m
9.8m
TCB
LB
HORNER'S CORNER
HIGH STREET
Police Station
Health Centre
Tennis Courts
The Angles
Croftings
Kevmar
Caldbeck
Myiah
St Anton
Mandalay
Oshawa
Verbrymar
Redlands
Boomwood
Mizaire
Beeleigh
Zillah Lodge
Townfield Villas
El Sub Sta
Garage
Tel Ex
11.0m
Track
Factory
El Sub Sta
UA Bdy
Und
STAR LANE
BM 11.69m
Chy
Chy
Chy
Chy
11.3m
Pond


Tennis Courts
Sports Centre
Pavilion
Health Centre
The Mallards
Hall
Warehouse
York Bungalow
Police Station
HIGH STREET
B 1017
BM 8.6m
Sub Sta
Peace Haven
Club
PW
PH
Great Wakering Methodist Church
BM 7.3m
Nursery
9.8m
Pond


Football Ground
Club
Allotment Gardens
LITTLE WAKERING HALL LANE
Playing Field
Allotment Gardens
Sports Centre
Pavilion
RUSHLEY CLOSE
The Mallards
Hall
Warehouse
El Sub Sta
BROUGHAM CLOSE
York Bungalow
Peace Haven
Club
PW
PH
B 1017
Great Wakering Methodist Church
EXMOUTH LANE
Nursery
ALEXANDRA ROAD
Pond


County P
ALDERNBURY ROAD
9.8m
Pond
Pond
Path (um)
El Sub Sta
MILTON HALE CLOSE

Appendix D

DTS Raeburn Limited Site Investigation, December 2006

CONTRACT NO. E11997/1

GEO-ENVIRONMENTAL DESK STUDY REPORT FOR A SITE AT STAR LANE, GREAT WAKERING, ESSEX

Prepared by
DTS Raeburn Limited

Client:
Anglo Irish Finance Plc &

JG Great Wakering LLP
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W1K 2RZ

Structural Engineer:
Stirling Maynard and Partners
Stirling House
Rightwell
Bretton
Peterborough
PE3 8DJ

LIST OF CONTENTS

LIST OF FIGURES AND PLATES

LIST OF ENCLOSURES

GEO-ENVIRONMENTAL DESK STUDY REPORT FOR A SITE AT STAR LANE, GREAT WAKERING, ESSEX

Executive Summary

DTS RAEBURN Limited were commissioned by Stirling Maynard and Partners on behalf of JG Great Wakering LLP and Anglo Irish Asset Finance Plc, to carry out a geo-environmental desk study at a site at Star Lane, Great Wakering, Essex. It is understood that the proposed development will comprise residential properties. The desk study is required to determine the past usage of the site and likely ground conditions, and also to highlight any associated ground contamination and geotechnical risks. The desk study has also been designed to fulfil the objectives of a 'preliminary investigation' as defined by British Standard BS10175:2001, the current standard for contaminated land investigation. The following principal findings have been established:

- The site is occupied by Hanson brickworks. Production at the site ceased in April 2005 and at the time of the site visit the remaining stockpiles of bricks were in the process of being removed. The site comprises a number of brick buildings, some of which have roofs constructed from corrugated asbestos cement sheeting. Five above ground waste oil and diesel storage tanks are also located within the site. Adjacent the site to the south is an area previously used to stockpile clay soils, but this has recently been restored to agricultural land. A detailed description is contained in Section 2.0 and a site plan is included as Figure 3.

- Published geological information (Section 3.0 and Figure 5) indicates the site to be underlain by River Brickearth, which has been worked over a fairly large area to the south and east of the site as well as a smaller area to the north. The Brickearth may be underlain by deposits of fluvial sand and gravel. The underlying solid geology is London Clay, which typically consists of stiff to hard bluish grey clay which weathers at outcrop to brown. Characteristics of the London Clay include selenite crystals (calcium sulphate).

- Site sensitivity data is presented in Enclosure A and discussed in Section 4.0. On the basis of this information the site should be considered potentially sensitive to controlled waters because of the proximity of surface water bodies. However, both the Brickearth and London Clay are classified as non-aquifers, suggesting that the site is of low sensitivity to groundwater. The data suggests that the site is not vulnerable to flooding.

- The environmental database indicates a moderate risk of compressible ground, which is probably associate with mineral extraction adjacent the site. However, further enquiries have revealed that the extraction closest to the site was restored to agricultural land on completion and has not been used for landfill. This suggests a low risk of subsidence occurring at the site as a result of mineral extraction (Section 5.0).

- Historical map information (Section 6.0 and Figures 6 to 19) along with additional information (Section 6.2) suggests that the brickworks was developed at the site from Greenfield in 1932. The site remained in use as a brickworks until its closure in 2005, but a number of structural alterations have taken place during this period. A map of 1939 suggests that clay extraction encroached onto the south eastern corner of the site at this time. Planning records and other enquiries have revealed that a narrow gauge railway was used to transport clay from nearby quarries to the brickworks, but this ceased to operate in 1991 and was later dismantled.

- Environmental database information supplied by Landmark Information Group Limited is presented in Enclosure B and reviewed in Section 7.0. The database information states that the site is located on an area of landfill which extends approximately 1.1km to the east and 300m to the south of the site. However, enquiries submitted to Essex County Council have revealed that this represents an

area for which a licence has been granted for clay extraction. The areas of extraction to the south and east of the site were restored to agricultural use on completion and have not been used for landfill. The database information also lists a number of manufacturing units and other industrial sites within Star Lane Industrial Estate, located adjacent the site to the north. These include three garage servicing firms, two engineering firms, two printing firms, a sheet metal works and a injection moulding plastics company.

An initial conceptual model for the site is introduced in Section 8.0. This has identified a relatively small number of potential contaminant sources at the site, including the existing oil and diesel storage tanks, an electricity substation and the former narrow gauge railway. A ground contamination risk prioritisation is presented in Section 9.2 and indicates that a moderate risk of significant harm may be presented to human receptors, the development end use and controlled water receptors (nearby surface water bodies) from soil contamination at the site. The risk of soil contamination from off-site sources (most significantly the adjacent industrial estate) is also considered moderate. An intrusive investigation is recommended to confirm the extent of ground contamination and to confirm the potential 'pollutant linkages' identified.

A preliminary geotechnical assessment is included in Section 9.1. Shallow pad or strip foundations may suffice for lightly loaded structures such as 2-3 storey dwellings, but piled foundations are likely to be the most appropriate solution for heavier structures such as multi-storey apartments. A physical investigation is recommended to provide quantitative information for foundation design. The presence of selenite crystals within the London Clay may generate increased concentrations of soluble sulphate, which could necessitate additional protective measures for buried concrete particularly if piled foundations are used.

The desk study information suggests a low risk of soil gas migration to the site, but it would be prudent to quantify this by means of a gas monitoring regime as part of any future site investigation works (Section 9.3).

Section 9.4 shows that the site has been designated as Employment Land under the current Local Plan, and hence business or industrial developments would normally be permitted. Six key sites have been allocated for residential development, but these are located some distance from the site under consideration. It is recommended that consultations with the relevant authorities be initiated at an early stage if these have not already been undertaken.

A summary of identified ground risks is tabulated in Section 9.5. This is not exhaustive and should be read in conjunction with the main text of the report.

Attention is drawn to the limitations and use of this report in Section 10.0.

GEO-ENVIRONMENTAL DESK STUDY REPORT FOR A SITE AT STAR LANE, GREAT WAKERING, ESSEX

1.0 INTRODUCTION

DTS RAEBURN Limited were commissioned by Stirling Maynard and Partners on behalf of JG Great Wakering LLP and Anglo Irish Asset Finance Plc, to carry out a geo-environmental desk study for a site at Star Lane, Great Wakering, Essex. It is understood that the site is to be redeveloped into residential houses. The desk study is required to provide information regarding the past usage of the site and likely ground conditions, and also to highlight any associated ground contamination and geotechnical risks.

The environmental aspects of the desk study have been prepared utilising a risk based approach and incorporating the accepted 'pollutant linkage' approach to contaminated land hazard identification (i.e. source – pathway – receptor linkage). This approach is consistent with methodologies contained in Part IIA of the Environmental Protection Act 1990 and introduced by Section 57 of the Environment Act 1995 which came into force in England and Wales in April 2000. The desk study has also been designed to fulfil the objectives of a 'preliminary investigation' as defined by British Standard BS10175:2001, 'Investigation of Potentially Contaminated Sites – Code of Practice'.

The following information has been used to formulate the geo-environmental desk study report:

- Site walk over survey carried out on 4th December 2006.
- Ordnance Survey maps obtained from Landmark Information Group Limited.
- Review of additional information held at Great Wakering Library and Southend Central Library
- Geological Survey of England and Wales Sheet 258/259 of Southend (1:50,000 Solid and Drift Edition).
- Environmental database information prepared by Landmark Information Group Limited.
- Correspondence with Local Authorities and other statutory agencies.
- SLR Consulting Limited Report Ref 4C-027-058-21 'Star Lane Brickworks, Great Wakering, Near Southend-on-Sea, Essex. Site Report for A(2) PPC Application', dated September 1998, supplied by Stirling Maynard and Partners, (hereinafter referred to as the 'SLR Report'). This report was commissioned by Hanson Brick Limited and prepared in support of an application for permit to operate under the Pollution Prevention and Control (PPC) Regulations 2000. The report includes a review of the site history and an Envirocheck database search.

2.0 THE SITE AND SURROUNDING AREA

2.1 Site Location

The site consists of an irregular parcel of land covering approximately 3.3 hectares located approximately 700m to the southwest of Great Wakering as shown in Figures 1 and 2. The site is centred on National Grid Reference 593470, 187230. A plan showing the site and the immediate surrounding area is included as Figure 3 and a satellite image of the site as Figure 4. Hereafter in this report 'the site' refers to the area within the boundary indicated in Figures 3 and 4.

2.2 Site Description

The site is occupied by Hanson brickworks. Production at the site ceased in April 2005 and at the time of the site visit the remaining stockpiles of bricks were in the process of being removed. Vehicular access to the site is gained via Star Lane which bounds the site to the west.

A number of small single storey buildings are located adjacent the western site boundary near the main site entrance. These include a gas house, offices, a canteen and storage sheds. An above ground brick 40,000 litre diesel storage tank, surrounded by a brick bund, is also located adjacent the western site boundary. Site operatives stated that only a small amount of fuel remained in the tank and was used to fuel the fork lift trucks.

The former processing building occupies the central and southern parts of the site, and has been amalgamated from a number of smaller buildings and extensions. Discussions with the site operatives indicated that the building was used for brickmaking and drying processes. Parts of the building have roofs constructed from corrugated asbestos cement sheeting. The central part of the building also contains a number of drums containing engine and hydraulic oils, and three above ground heavy oil storage tanks which were formerly used to fire the nearby kilns. The site operatives stated that the tanks have been redundant for a number of years because the kilns are currently gas-fuelled. At the time of the site visit sections of the roof of the building had been removed to allow the removal of the oil drums from the building.

A small above ground waste oil tank, surrounded by a brick bund, is located adjacent the main building to the north and an electricity substation is situated adjacent the building to the south.

Eight brick-built kilns with four chimneys and two control houses are located in the central part of the site to the east and west of the main processing building. An above ground brick bunded 6,000 litre diesel tank is also located between two of the kilns to the east of the main building. In the northern section of the site is a large two-storey barn used for brick storage. The barn is of brick and steel construction with a corrugated asbestos cement sheet roof. A chimney is located adjacent the barn to the west and two small single storey buildings, most recently used as a cutting shed and a shrink wrap shed are located adjacent the barn to the west and north respectively.

A former transport building and a concrete loading bay occupy the south-eastern corner of the site. The building is two-storey and of brick construction with a corrugated asbestos cement sheet roof. The level of the building and loading bay is approximately 1m below the remainder of the site. Adjacent the building to the south are the concrete and tile floors of two previous buildings, and the partial remains of one of the brick walls.

The external areas within the site are almost entirely covered by concrete or tarmac hardstanding. No infestations of Japanese Knotweed or other notifiable weeds were observed within the site at the time of the visit, but it would be prudent to verify their absence by conducting a second inspection during the spring or summer months when the plants would be flowering.

2.3 Surrounding Area

The site is bounded to the north by Star Lane Industrial Estate which includes a telephone exchange, a waste transfer facility, several garages and a number of engineering firms. Opposite the site to the west is farmland and adjacent the site to the east are a number of fishing ponds. Discussions with the site occupiers revealed that these formerly formed part of an open cast quarry. A partially culverted ditch is located adjacent the site to the south, and has an outlet into a fish pond approximately 60m to the south east of the site. To the south of the ditch is an area that was previously used by the brickworks to stockpile clay but has recently been restored to farmland.

3.0 GENERAL GEOLOGY

Figure 5 shows extracts from the British Geological Survey Sheets 258/259 of Southend (1:50,000 Solid and Drift Edition). This shows the site to be underlain by the following strata:

Loam (River Brickearth) (of *Pleistocene* and *Recent* age). The map indicates that these deposits have been extracted over a fairly large area adjacent the site to the south and east, as well as a smaller area to the north. Deposits of fluvial sand and gravel are also shown in the vicinity, and these may underlie the Brickearth.

London Clay (of *Eocene* age). These deposits consist of stiff dark or bluish grey clay which weathers at outcrop to brown. Characteristics of the clay can include selenite crystals (calcium sulphate).

There are no faults indicated within 1km.

4.0 HYDROLOGY, HYDROGEOLOGY AND SITE SENSITIVITY

Enclosure A contains three maps indicating flood risk, groundwater vulnerability and environment quality in the vicinity of the site.

The Flood Map (Page 1 of Enclosure A) shows that the site is not at risk from fluvial or marine flooding. A number of water bodies are recorded within 1km of the site, the closest of

which is a lagoon located approximately 40m to the east of the site. These are likely to represent flooded clay pits associated with the former brickworks.

The Groundwater Vulnerability Map (Page 2 of Enclosure A) shows that the underlying geology is classified as a non-aquifer which is negligibly permeable. This classification would be applicable to both the Brickearth and the London Clay. However, the area adjacent the site to the north, south and east is identified as a minor aquifer. Correlation of this map to the Geological map suggests that the minor aquifer classification has been applied to the areas where Brickearth has been extracted.

Reference to environmental database information, presented in Enclosure B, has shown that there are four licensed abstractions of groundwater within 500m of the site. The information states that the strata from which groundwater is abstracted include fluvial sand and gravel and chalk. The latter exists at depth beneath the London Clay. The purpose of the abstractions is for agricultural use (spray irrigation). Further information from the Environment Agency has revealed that the site does not lie within a Groundwater Source Protection Zone associated with these abstractions.

The Land Sensitivity Map (Page 3 of Enclosure A) indicates that two areas located approximately 1.5km to the north east of the site and a section of coastline approximately 2km to the south east of the site are designated Ramsar Sites (wetlands of international importance), Sites of Special Scientific Interest (SSSI) and Special Protection Areas (SPA). These designations constitute major ecological receptors. In addition, The Royal Society for the Protection of Birds (RSPB) have identified the former clay pit adjacent the site as an ideal habitat for bird watching. The map also shows that the surrounding area to the west, east and south of the site has been adopted as a Green Belt, but this does not constitute an ecological receptor.

In view of the above information the site is likely to be of low sensitivity with respect to groundwater due to the non-aquifer status of the underlying Brickearth. However, the site should still be considered potentially sensitive to controlled waters, given the proximity of surface watercourses. At this stage the site should also be considered potentially sensitive to major ecological receptors. The data suggests that the site is not vulnerable to flooding.

5.0 MINERAL EXTRACTION

The geological map (Figure 5 and Section 3.0), historical information (Section 6.0 and Figures 6-22) and the environmental database information (Section 7.0 and Enclosure B) indicate that Brickearth has been extracted from the areas adjacent the site to the east and north for the purposes of brick manufacture on the site. The maps suggest that the extraction may have encroached onto the south eastern corner of the site. The environmental databases report a moderate risk of subsidence due to compressible ground, which probably reflects the clay extraction in the area. However, enquiries submitted to both Rochford District Council and Essex County Council have revealed that the excavations were either flooded or restored to agricultural land, and were not used for landfill. This information suggests a low risk of subsidence occurring at the site as a result of mineral extraction.

6.0 SITE HISTORY

The site history has been deduced primarily from historical Ordnance Survey maps and plans obtained from Landmark Information Group Limited. Copies of the relevant map extracts are included as Figures 6 to 22. Information on planning applications has also been obtained from Rochford District Council and is discussed in Section 6.2.

6.1 Historical Maps and Plans

In order to determine the historical development of the site the following maps and plans were studied.

Figure 6 Essex Sheet LXXIX .05 Published 1873 1:2,500	The map shows the site to have been undeveloped except for a small footpath or bridleway running east-just inside the southern boundary of the site. The surrounding area was also largely undeveloped, but Star Lane had been established along its present day route adjacent the western boundary of the site. Patron's Pit, possibly a very small clay pit, is shown at approximately 200m to the north of the site.
Figure 7 Essex Sheet LXXIX .00 Published 1880 1:10,000	The map shows the site and much of the surrounding area to have been undeveloped and occupied by agricultural land. The village of Great Wakering is identified at approximately 600m to the northeast of the site.
Figure 8 Essex Sheet LXXIX .05 Published 1897 1:2,500	Townfield Villas are shown approximately 200m to the north of the site, but there are no other significant changes to the site or surrounding area.
Figure 9 Essex Sheets LXXIX .NW & LXXIX .SW Published 1898 1:10,000	No changes are shown within the site. Two clay pits are shown to have been established approximately 1.1km and 1.6km to the southeast of the site. A brickworks had also been constructed approximately 1.4km to the northeast of the site.
Figure 10 Essex Sheets LXXXIII .16 & XCI .04 Published 1923 1:10,000	No changes are shown within the site. A pumping station had been constructed approximately 250m to the west of the site. To the east of the site, Great Wakering had expanded slightly and various farms, cottages and large houses are shown to have been constructed in the surrounding area. The map suggests that the clay pit about 1.1km to the southeast of the site was no longer operational but that it had vastly expanded in size and had included a brickworks prior to its closure. The clay pit 1.6km to the southeast and another clay pit approximately 850m to the north of the site are also indicated to have closed. In addition to this, the brickworks about 1.4km to the northeast of the site is no

	longer indicated, but a large pit is shown suggesting that substantial clay extraction had taken place at this location.
Figure 11 Essex Sheet XCI .NE Published 1923 1:2,500	No changes to the site are apparent.
Figure 12 Essex Sheets XCI .NE Published 1938 1:10,000	A track is shown in the southern part of the site, extending from the western boundary about half way into the site. Six small square shaped buildings are shown at about 80m to the north of the site.
Figure 13 Essex Sheet XCI .04 Published 1939 1:2,500	This map shows that the site had been designated as a brick works, although the buildings within the site were limited to a small rectangular structure adjacent the western boundary of the site and five small structures just inside the southern boundary. The latter appear to have been served by the track identified in the previous map. A brick field is identified adjacent the site to the south east, and this appears to have encroached onto the south eastern corner of the site. Outside the site boundary, a small number of residential houses are shown at about 200m to the north of the site.
Figure 14 Ordnance Survey Sheet TQ98NW Published 1961 1:10,000	This map shows the establishment of two rectangular buildings in the central part of the site and a further five smaller structures adjacent the western boundary. A further small building (not the transport building currently present) is shown in the south easern corner of the site. This map suggests that clay extraction within and adjacent the south eastern corner of the site had ceased, and the closest remaining pit was now approximately 100m to the east of the site. Outside the site boundary, the pumping station located at about 250m to the west is shown to have been demolished. Two further medium sized clay pits are also shown at distances of about 650m to the south and 900m to the north of the site; the former was served by a tramway. Great Wakering appears to have expanded westwards to within about 200m to the north east of the site.
Figure 15 Ordnance Survey Sheet TQ9387 Published 1966 1:2,500	This map indicates further development of the brickworks, including the establishment of the existing kilns and chimneys. Ponds are identified at approximately 80m of the site, and are likely to represent flooding of former clay pits. Further residential housing and a garage had developed approximately 200m to the north of the site. The map identifies the presence of sloping features between the site and the housing, and thus suggests that clay extraction had extended into this area.

Figure 16 Ordnance Survey Sheet TQ98NW Published 1971 1:10,000	No changes to the site are apparent at this scale. The clay pits shown in the vicinity of the site in previous maps are no longer identified.
Figure 17 Ordnance Survey Sheet TQ98NW Published 1976 1:10,000	This map shows that industrial units had been constructed adjacent the site to the north.
Figure 18 Ordnance Survey Sheet TQ9387 Published 1978 1:2,500	Two small buildings and a further chimney had been constructed in the north-eastern section of the site, and two small rectangular shaped buildings had been developed in the south-eastern corner of the site. The industrial units adjacent the site to the north formed part of Star Lane Industrial Estate, which is shown to have comprised seventeen small units, two plastics factories and a telephone exchange.
Figure 19 Ordnance Survey Sheet TQ9387 Published 1982 1:2,500	No significant changes are indicated within the site or surrounding area.
Figure 20 Ordnance Survey Sheet TQ98NW Published 1989 1:10,000	The map shows that the building located within the centre of the site had been significantly extended to the east. However, later map editions indicate this to be a separate building rather than an extension.
Figure 21 Ordnance Survey Sheet TQ9387 Published 1993 1:2,500	This map indicates the demolition of two small buildings located in the south-western section of the site.
Figure 22 Ordnance Survey Sheet TQ98NW Published 2005 1:10,000	No significant changes are indicated within the site boundary. The industrial estate to the north of the site had expanded. A path is shown to have been constructed running east-west adjacent the southern boundary of the site. A substantial amount of residential development had occurred in the vicinity of North Shoebury and extended to within about 400m to the south of the site.

6.2 Planning History

Records of planning applications submitted within the site boundary have been obtained from the Planning Department of Rochford District Council. The most significant of these are listed in Table 6.1 below. It should be noted that the approval of a planning application should not be taken as definitive proof that construction work actually took place.

Table 6.1 Records of Planning applications submitted at the site

Application Number	Date	Subject of Application	Decision
EEC/ROC/134 /48	07.12.48	Erection of open dryer shed (central part of site)	Approved
EEC/ROC/10/ 49	01.02.49	Erection of sand dryer and sand store (adjacent tunnel dryer)	Approved
EEC/ROC/315 /56	07.12.56	Erection of permanent office building to replace temporary office building (offices)	Approved
EEC/ROC/433 /57	20.12.57	Extension of machine shop (southern part of site adjacent tunnel dryer)	Approved
EEC/ROC/325 /58	08.09.58	Erection of works extension for processing clay (Main clay prep building)	Conditional Approval
EEC/ROC/209 /58	28.10.58	Extraction of Brickearth from 4.5 acres of land at Star Lane	Conditional Approval
EEC/ROC/210 /58	28.10.58	Use of 1.33 acres of land at Star Lane for the extraction of Brickearth	Conditional Approval
EEC/ROC/271 /58	08.05.59	Extraction of Brickearth from 32acres of land between Alexandra Road and Poynters Lane (south of brickworks)	Conditional Approval
EEC/ROC/457 /59	21.12.59	Additions and modifications to drying unit	Conditional Approval
EEC/ROC/42/ 63	26.02.63	Extension to offices	Approved
EEC/ROC/224 /63	14.10.63	Modernisation of brickworks including the erection of 8 kilns, 4 chimneys and 2 control rooms	Conditional Approval
T/ROC/312/65	06.07.65	Erection of 8 additional kilns, 2 control rooms and 4 chimneys (to north of existing kilns). Erection of fuel store and compressor house, extension to machine shop and mixing & milling shop, and re-siting of dutch barn.	Approved
T/ROC/235/66	27.09.66	Layout and construct roads and sewers	Conditional Approval
T/ROC/233/67	13.06.67	Erection of toilet block (adjacent stores) and construction of new drainage	Conditional Approval
ROC/413/71	21.10.71	Demolish existing canteen and erect new canteen next to existing toilet block	Conditional Approval

Table 6.1 ***continued***

ROC/625/76	01.12.76	Extend and enclose existing dutch barn and erect Drayton solid hearth gas fired kiln and chimney	Conditional Approval
ROC/772/78	27.09.78	Construction of additional Drayton solid hearth gas fired kiln and chimney in dutch barn	Conditional Approval
ROC/927/78	08.11.78	Permission to site porta-cabin as temporary office accommodation while an application is submitted to extend existing offices	Conditional Approval
ROC/11/79	07.03.79	Erect a maintenance workshop and convert existing workshop into offices and stores (both in south-east corner of site)	Conditional Approval
109/87	10.06.87	Erection of building for brick machine and dryer (southern part of site)	Conditional Approval
936/88	05.10.88	Erection of new gas fired, computer controlled kiln with blue pvc cladding and chimney (eastern part of site)	Conditional Approval
256/89	09.08.89	Extension to existing canteen and kitchen	Conditional Approval
1015/88	13.03.89	Restoration of former stockpile area, narrow gauge railway to Crouchman's Farm to be removed, landscaping, tree planting and temporary use of land for unloading and parking of earth moving machinery (land adjacent brickworks to south) – plans also indicate a fuel tank in this area	Conditional Approval
CM/0009/91/ROC	17.12.90	Winning, working and stockpiling of brickearth and ancillary matters including construction of conveyor, provision of access and restoration to agriculture of land on western side of Star Lane	No Decision
CM/00208/98	28.08.98	Relocation of brickearth stockpile area and Haul Road	Conditional Approval
CM/509/98	28.10.98	Lean-to extension to the clay preparation building	Conditional Approval
CM/00002/02	09.01.02	Continuation of brick imports from Cherry Orchard until 31.12.06 and modifications to CM/00208/98	No decision

6.3 Additional Information

A review of information held at Great Wakering Library and Southend Central Library has revealed that the brickworks opened in 1932 and production quickly rose to 13 million bricks per year. Information from the University of Essex has indicated that brick manufacture at Star Lane Brickworks was suspended in 1991, but that the works re-opened in 1994. The brickworks finally closed in April 2005. Information from the Industrial Narrow Gauge Railways Society's website has confirmed that Brickearth was previously transported to the

works from a nearby quarry by means of a narrow gauge railway. The railway ceased to operate in 1991 and was later dismantled.

6.4 Summary

The available historical information suggests that the site remained undeveloped until 1932 when a brickworks was constructed and a clay pit opened adjacent the site to the east. A map of 1939 indicates that the clay pit encroached onto the south eastern corner of the site at this time. By 1966 the brickworks had expanded to include the establishment of the existing kilns and chimneys. Planning records and other enquiries have revealed that a narrow guage railway was used to transport clay from nearby quarries to the brickworks, but that this was dismantled after 1991. The area adjacent the site to the south has remained undeveloped but was until recently used for the stockpiling of clay. Production at the brickworks ceased in 1991 but the site was re-opened in 1994 before finally closing again in 2005. The possibility of ground contamination having occurred as a result of the previous uses of the site and surrounding area is discussed further in Section 8.0 of this report.

7.0 ENVIRONMENTAL DATABASE INFORMATION

Enclosure B contains information derived from Environmental Databases for a radius of up to 2 kilometres from the site. The information contained therein covers data sets held by the following organisations:

British Geological Survey
Catalist Limited (Fuel Station Data)
Centre for Ecology and Hydrology
Health and Safety Executive
Health Protection Agency
English Nature
Environment Agency
Essex County Council
Ordanance Survey
Ove Arup and Partners
Peter Brett Associates
The Coal Authority
Thompson Directories

The results are presented in both summary and detailed form in Enclosure B. The main points of note within the database information are reviewed briefly below. The information has been categorised into the following data types:

Agency and Hydrological
Waste
Hazardous Substances
Geological
Industrial Land Use
Sensitive Land Uses

7.1 Agency and Hydrological

Discharge Consents: The databases show that the brickworks held a Discharge Consent for the release of surface water to a tributary of the River Thames approximately 150m to the northeast of the site. A further three consents are recorded within 1km of the site, the closest of which relate to the discharge of sewerage effluent into a soakaway approximately 500m to the southeast of the site. At about 850m to the west of the site, agricultural and surface effluents are discharged onto land, and at approximately 1km to the north of the site, surface water is discharged into Little Wakering Creek. None of these consents are likely to have affected the site.

Pollution Incidents to Controlled Waters: All of the four pollution incidents to controlled waters listed within 1km of the site have been categorised as Category 3 ('minor') incidents. The most proximal of these to the site occurred at a distance of approximately 266m to the north and involved the accidental spillage/leakage of waste oil. This is unlikely to have affected the site.

Licensed Water Abstractions: The databases record that a licensed groundwater abstraction was operated by Hanson Brick Limited at a location approximately 230m to the east of the site. The database states that the licence remains in perpetuity, but in practice it is unlikely that this has been used since closure of the brickworks in 2005. A further six abstractions, two of which are recorded to have been revoked, are listed within 1km of the site and are used for spray irrigation. The site does not lie within a Groundwater Source Protection Zone associated with any of these abstractions.

7.2 Waste

Registered Waste Transfer Sites: According to the database, a waste transfer site is located approximately 135m to the north-east of the site. The transfer site is licensed to accept household, commercial and industrial waste but as the activities undertaken comprise waste transfer rather than disposal this is unlikely to have affected the site.

Local Authority Recorded Landfill Sites: The databases suggest that the site is located on an area of landfill which extends approximately 1.1km to the east and 300m to the south of the site. In addition to this, landfill sites are also listed opposite the site to the west, approximately 490m to the south, approximately 740m to the northeast and approximately 770m to the north of the site.

Further enquires submitted to Rochford District Council have revealed that the landfill site recorded in the databases at 770m to the north of the site is in fact located at approximately 2km to the north-east. The landfill site was operational between 1970 and 1993 and was licensed to accept household, commercial and non-hazardous industrial waste.

Discussions with the Planning Department of Essex County Council have revealed that the remaining four landfill sites listed above, including the one shown to extend beneath the brickworks, represent areas where licences have been granted for mineral extraction. However, no mineral extraction has been undertaken to the south or west of the site. A small amount of excavation took place approximately 740m to the northeast of the site, but on completion the excavation was flooded to create a pond/lake. Brickearth has also been excavated to the east of the site, but the Council have stated that no landfill occurred in this

area, and that the land was restored to agricultural use on completion of the clay extraction. Essex County Council have also confirmed that the brickworks was developed from Greenfield.

7.3 Hazardous Substances

The databases list no companies within 1km of the site that are licensed to produce, handle or store hazardous substances.

7.4 Geological

BGS Recorded Mineral Sites: Five opencast mining operations are listed within 1km of the site, all of which have now ceased to be operational. Sand and gravel was extracted at a distance of about 200m to the east of the site and clay and shale were extracted from locations approximately 150m to the east, 800m to the north, 900m to the southeast and 1km to the northeast.

Ground Stability Hazards: The database indicates a moderate risk of subsidence due to collapsible ground and shrinking or swelling clay. However, this classification is likely to reflect the presence of clay beneath the site and clay extraction in the vicinity, and does not necessarily indicate that subsidence has occurred in the area. No risks of ground instability as a result of shallow mining, compressible ground, running sand or ground dissolution are reported.

Radon Gas: According to the database less than 1% of homes in the area are above the radon action level and consequently no radon protective measures are necessary in the construction of new dwellings.

7.5 Industrial Land Use

Trade Directories: The database lists 14 active commercial and industrial properties within 250m of the site, all of which are located within the adjacent Star Lane Industrial Estate. These include three garage services, two engineering firms, a sheet metal works, a screen printing firm, a car breakdown and recovery service, an injection moulding plastics company, two car body repair workshops, a printing works, a road haulage operator and an air conditioning firm 199m to the north. Between 251 and 1,000m from the site there are a further three commercial and industrial properties listed. These are a car dealership 301m to the north and garage services 790m and 916m to the northeast of the site.

Fuel Station Entries: One closed petrol filling station (PFS) is recorded in the database at a distance of 301m to the north of the site.

7.6 Sensitive Land Uses

The database shows that the site is surrounded by, but not included in, areas of Green Belt. No major ecological receptors or other sensitive land uses are recorded within 1km of the site.

8.0 INITIAL CONCEPTUAL MODEL

A qualitative risk assessment of the site was undertaken utilising the information obtained in the preceding desk study section of this report in order to facilitate the development of an initial conceptual site model (CSM).

The risk of contamination is assessed through the accepted Source-Pathway-Receptor linkage approach ('pollutant linkage'), where the **source** is defined as a function of the nature of the contaminants that may be present, and the harm that they may present. The **pathway** is the route in the environment by which the contaminants may be transferred, and the **receptor** is the point at which damage may occur if the contaminant is present at a level sufficient to cause harm. A pathway linking an identified contamination source and a receptor must first be established for a contaminated land hazard to exist and before any other secondary considerations to the effects and the need/requirement for remediation.

In the preparation of this assessment, four broad types of **receptors** are considered with respect to the development sites, an approach that is consistent with current industry best practice. These are

- Human Health (Site Workers, Occupiers and Off-Site Residents)
- Development End Use (Buildings, Hardstandings, Domestic Garden Areas etc)
- Controlled Waters (Groundwater and Surface Water Resources)
- Ecological Receptors (Nature Reserves, Environmentally Sensitive Areas, SSSIs, etc)

At this stage, the **sources** of ground contamination can only be considered as potential sources until proven and hence the assessment is qualitative. For the purpose of this assessment the potential sources have been split between **on-site** and **off-site**.

The desk study research has revealed that the site was developed from Greenfield into a brickworks in 1932. Alterations to the site layout have occurred during its operation until the closure of the site in 2005. In general, the use of the site for brick manufacture is likely to present a low risk of ground contamination. However, the presence of oil drums, fuel and oil storage tanks and associated pipework within the site could constitute a potential **on-site source** of hydrocarbons (diesel, engine oil and hydraulic oil) and heavy metals. Similar contaminants could have been generated by the narrow gauge railway previously used to transport clay soil onto the site. The electricity substation in the southern section of the site could also constitute a potential **on-site source** of polychlorinated biphenyls (PCBs) and other dielectric oils.

The SLR Report indicates that calcium chloride solution, used as an additive during the brick making process, has also been stored at the site. However, this is of low toxicity and is non-persistent, and is therefore considered to present a low risk of ground contamination. Discussions with Essex County Council and Rochford District Council have revealed that the site and surrounding area have not been used for landfill. The release of inorganic sulphur and nitrogen salts to the air is typically associated with brick kilns, but it is unlikely that significant quantities of these substances would have been deposited and accumulated in the soils beneath the site.

Star Lane Industrial Estate adjacent the site to the north contains a number of manufacturing units and other industrial works, which constitute of potential **off-site sources** of ground

contamination. Potential contaminants that could occur as a result of these activities could include heavy metals, hydrocarbons, sulphates, acids/alkalis (low/high soil pH) solvents and other volatile organic compounds (VOCs).

The geological map records the site to be underlain by Brickearth, which is classified as a non-aquifer and is typically of low permeability. However, the transfer of contaminants could still occur through pores or fissures within the subsoil to adjacent watercourses (controlled water **receptors**). Direct run-off into surface water drains could also take place. In addition, the development end use and human **receptors** have the potential to come into direct contact with contaminated materials.

The CSM thus suggests that the accepted contaminated land hazard identification convention (Source-Pathway-Receptor linkage) may be completed for this site with respect to human health, development end use and controlled water receptors and major ecological receptors. A ground contamination risk prioritisation is presented in Section 9.3.

As discussed in Section 4.0, the site is surrounded to the west, east and south by areas of Green Belt, but this does not constitute a major ecological receptor. The closest ecological receptors to the site are located some 1.5km to the northeast and 2km to the southeast of the site. In view of this distance together with the generally low risk of contamination from the site and the likely low permeability of the underlying Brickearth, in practice it is unlikely that contamination from the site could affect the ecological receptors identified. The accepted 'pollutant linkage' is therefore unlikely to be completed with respect to major ecological receptors.

9.0 PRLIMINARY RISK ASSESMENT

9.1 Geotechnical Assessment

At the present time there is little information available regarding the Engineering properties of the underlying Brickearth, largely due to the lack of previous development in the area. However, previous experience of similar soils suggests that the use of conventional pad or strip foundations may be feasible for lightly loaded structures such as 2-3 storey domestic dwellings. For larger or heavier structures such as multi-storey apartments, it is likely that piled foundations would be the most appropriate solution. A physical investigation is recommended to provide quantitative information for foundation and pavement design.

The presence of selenite crystals (calcium sulphate) within the London Clay could generate increased concentrations of soluble sulphate. This may necessitate the requirement for additional protective measures to buried concrete, particularly if piled foundations are required. This risk should be quantified by means of appropriate laboratory testing of soil and groundwater samples.

9.2 Ground Contamination Risk Prioritisation

Tables 9.1 and 9.2 illustrate a risk prioritisation of pollutant linkages that may be present as a result of **on-site sources** and **off-site sources** respectively. Details of the **pathway** and **receptor** considerations in the risk prioritisation are presented below.

Potential **receptors**: Humans (Site workers and end users, offsite residents)
Development end use (Buildings, hardstandings, services/utilities and limited landscaped areas)
Controlled Waters (Proximal surface water courses)

Potential **pathways**: Humans: Ingestion, skin contact, inhalation of indoor and outdoor air
Development End Use: Contact
Controlled Waters: Surface run-off and lateral migration within underlying soils

The significance of 'pollutant linkages' has been assessed as low, moderate or high based upon the following definitions:

- Low: No significant linkage exists and / or the potential for future impact is considered to be minimal.
- Moderate: The linkage exists however there is insufficient field or laboratory data to confirm the link.
- High: The linkage exists and the availability of data indicates remedial action may be required to address potential liability issues.

The assessment relates the relevance of these features to the site under consideration and assumes the redevelopment of the site into residential properties.

Table 9.1 Ground Contamination Assessment with respect to on-site sources

On-site sources	Potential contamination	Pathway	Receptor	Risk
Above ground oil and diesel storage tanks and associated pipework, and oil drums	Hydrocarbons Heavy metals	Contact Ingestion Inhalation	Humans (construction workers) Humans (site end users, off-site residents)	Moderate Moderate
		Contact	Development End Use	Moderate
Former narrow gauge railway	Residual hydrocarbons Heavy metals	None (underlying soils are classified as a non-aquifer)	Controlled Waters: Groundwater	Low
Electricity substation	PCBs			
		Surface run-off and lateral migration through soils	Surface waters	Moderate
Demolition of former buildings and materials in exisiting buildings	Asbestos	Contact Ingestion Inhalation	Humans (construction workers)	High
			Humans (site end users) and development end use	Low

The above assessment indicates that the risk of significant harm to human receptors and the development end use should be considered moderate, although the risk to site end users would decrease if the finished development did not include domestic gardens. The risk to surface water bodies is considered moderate because of their proximity to the site.

Asbestos containing materials were observed within a number of the existing buildings at the site, hence the 'high' risk classification adopted in the above table with regard to construction/demolition workers. It is recommended that a detailed 'Type 3' asbestos survey be undertaken prior to demolition of the existing structures. However, risks to the health of construction workers should be minimised by the use of appropriate working practices and personal protective equipment. There should be no significant risk to site end users, the proposed development end use or controlled water receptors from asbestos provided that safe working practices are adopted during the construction phase.

Table 9.2 Ground Contamination Assessment with respect to off-site sources

Off-site sources	Potential contamination	Pathway	Receptor	Risk
Garage services, printers, engineering firms, plastics factory and other industry adjacent the site to the north	Hydrocarbons Heavy metals Sulphates Acids/alkalis VOCs (including chlorinated solvents)	Contact Ingestion Inhalation	Humans (construction workers) Humans (site end users, off-site residents)	Moderate Moderate
		Contact	Development End Use	Moderate
		None	Controlled Waters: Groundwater	Low
		Surface run-off and lateral migration through made ground	Surface waters	Moderate

The assessment indicates the possibility of contamination at the site from the potential off-site sources identified above. The risk of significant harm to humans, the development end use and surface waters is considered to be moderate due to the proximity of the potential sources to the site. However, the responsibility for contamination from off-site sources would lie with the respective site owners/occupiers.

9.3 Soil Gas Hazard

Discussions with Essex County Council have revealed that no landfill has taken place beneath the site or in the immediate vicinity. Further discussions with Rochford District Council have revealed that the closest recorded landfill site is approximately 2km to the northeast of the site. In practice it is unlikely that the migration of landfill gases would occur over this distance. Therefore, on the basis of current information it is unlikely that soil gas protection measures would be required for new development on the site, but it would be prudent to confirm this by means of a gas monitoring regime as part of any future site investigation works.

9.4 Planning Considerations

Information from the Planning Department of Rochford District Council has revealed that the site has been designated as Employment Land under the Rochford District Replacement Local Plan, adopted in February 2006. Development end uses normally permitted on such sites are Class B1 (Business), Class B2 (General industrial) and Class B8 (Storage). Provision made for new housing developments until 2011 have identified six key development sites which are located some distance from the site under consideration. It is therefore recommended that consultations with the relevant authorities be initiated at an early stage if these have not already been undertaken to avoid delays during the Planning process.

9.5 Summary of Identified Ground Risks

Table 9.3 summarises the main risks to the proposed development by the desk study as perceived by DTS Raeburn. A risk classification has not been included, as this would need to include a likely cost-benefit analysis, which is outside the scope of this report. The list of hazard/risks tabulated is not exhaustive and should be read in conjunction with the main text of the report.

Table 9.3 Main risks to proposed development as identified by desk study

HAZARD/RISK	CAUSE	POSSIBLE IMPACT/ CONSEQUENCE	RECOMMENDATIONS
Need for piled foundations or ground improvement	Site shown to be underlain by Brickearth, but no Engineering data currently available. Previous experience suggests piled foundations are likely to be required for heavy structures, but shallow foundations may suffice for 2-3 storey dwellings	Higher costs and possible programming issues	Site investigation required
Naturally occurring soluble sulphates	Presence of selenite crystals (calcium sulphate) within London Clay	May necessitate additional protective measures for buried concrete, particularly for piled foundations	Appropriate laboratory tests to be included as part of site investigation works
Potential soil and groundwater contamination	Potential 'pollutant linkages' as identified in preceding sections	Need for consideration of all remedial options or soil removal. May affect cost of soil disposal, and buried concrete classification	Site investigation required

10.0 LIMITATIONS AND USE OF THIS REPORT

IMPORTANT: This section should be read before reliance is placed on any of the opinions, advice, recommendations and conclusions contained in this report.

a) This report has been prepared at the request of Stirling Maynard and Partners to provide advice to JG Great Wakering LLP and Anglo Irish Finance Plc ('the Client') pursuant to their appointment of DTS Raeburn Limited in connection with the desk study;

b) Except for JG Great Wakering LLP and Anglo Irish Finance Plc no duty is undertaken or warranty or representation made to any party in respect of the opinions, advice, recommendations or conclusions contained in this report;

c) All work carried out in preparing this report has used, and is based upon DTS Raeburn's professional knowledge and understanding of the current (November 2006) relevant English, Scottish and European Community standards and codes, technology and legislation. Changes in the above may cause the opinion, advice, recommendations or conclusions set out in this report to become inappropriate or incorrect. Following delivery of this report, DTS Raeburn will have no obligation to advise the Clients of any such changes or of their effects. It may therefore be necessary to review the opinions, advice, recommendations and conclusions of this report following future changes to legislation;

d) Some of the information referenced and included in the desk study has been provided by third parties and whilst DTS Raeburn has no reason to doubt the accuracy, these items have not been verified. DTS Raeburn accepts no responsibility for errors within third party materials referenced and presented in this report;

e) The content of this report represents the professional opinion of experienced geotechnical and environmental specialists. DTS Raeburn does not provide associated legal advice and the advice of lawyers will be required in this regard;

f) The lack of evidence of the presence of hazardous materials, voids or obstructive features at the subject property does not guarantee the absence of such materials/features rather it indicates only that none was found as a result of the services provided.

For DTS RAEBURN Ltd

.....	.....
J. Brown BSc	**A. B. C. Obinwa BEng MSc CEng MICE**
Geo-environmental Engineer	**Managing Director**

E11997/1 – December 2006

Appendix E

Ken Rush Associates Site Investigation, June 2011

KEN RUSH ASSOCIATES

STRUCTURAL & CIVIL ENGINEERS

Geotechnical Report

For

Star Lane
Great Wakering

11-4593 June 2011

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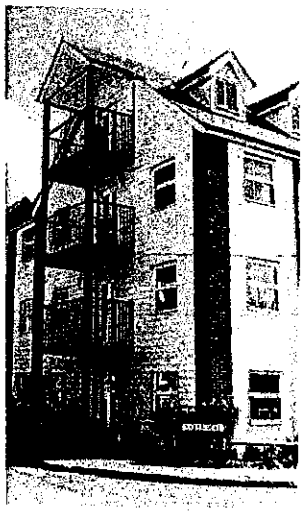
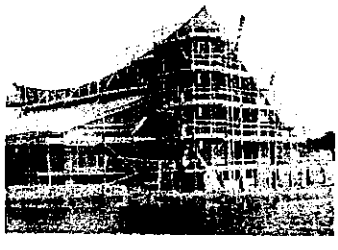


ace

consultancy engineering business environment



KEN RUSH ASSOCIATES

INDEX

1.0 INTRODUCTION

The site under investigation is an area of land adjacent Star Lane Industrial Estate. The site was previously a brickworks, all buildings had been demolished by the time of the investigation, some ground floor slabs remain. The depth of existing foundations are unknown.

Access to the site is gained by a gate from Star Lane at the Southern end of the site, this leads to a track which runs along the South of the site to fishing lakes which are located in the open land to the East boundary.

The Industrial Estate is to the North of the site and Star Lane is on the West boundary. There is a second access gate to the Western boundary however large concrete blocks have been placed in front of the gates to prevent access.

The site is reasonably level with the exception of the South East corner which is lower than the rest of the site.

There is vegetation to the East, South and West boundaries.

At the request of Taylor Wimpey East London Ltd Ken Rush Associates were appointed to carry out a geotechnical investigation in order to advise on foundation requirements for a proposed development of 141 houses and apartments.

We now report our findings.

It may be possible that exceptional conditions exist elsewhere on the site not revealed by this exploratory investigation.

2.0 FIELDWORK

A borehole investigation was carried out on Wednesday 25th May 2011 using an augered rig to construct two boreholes to 4.0m and one deeper borehole, which was terminated at 5.5m due to the depth of sand encountered.

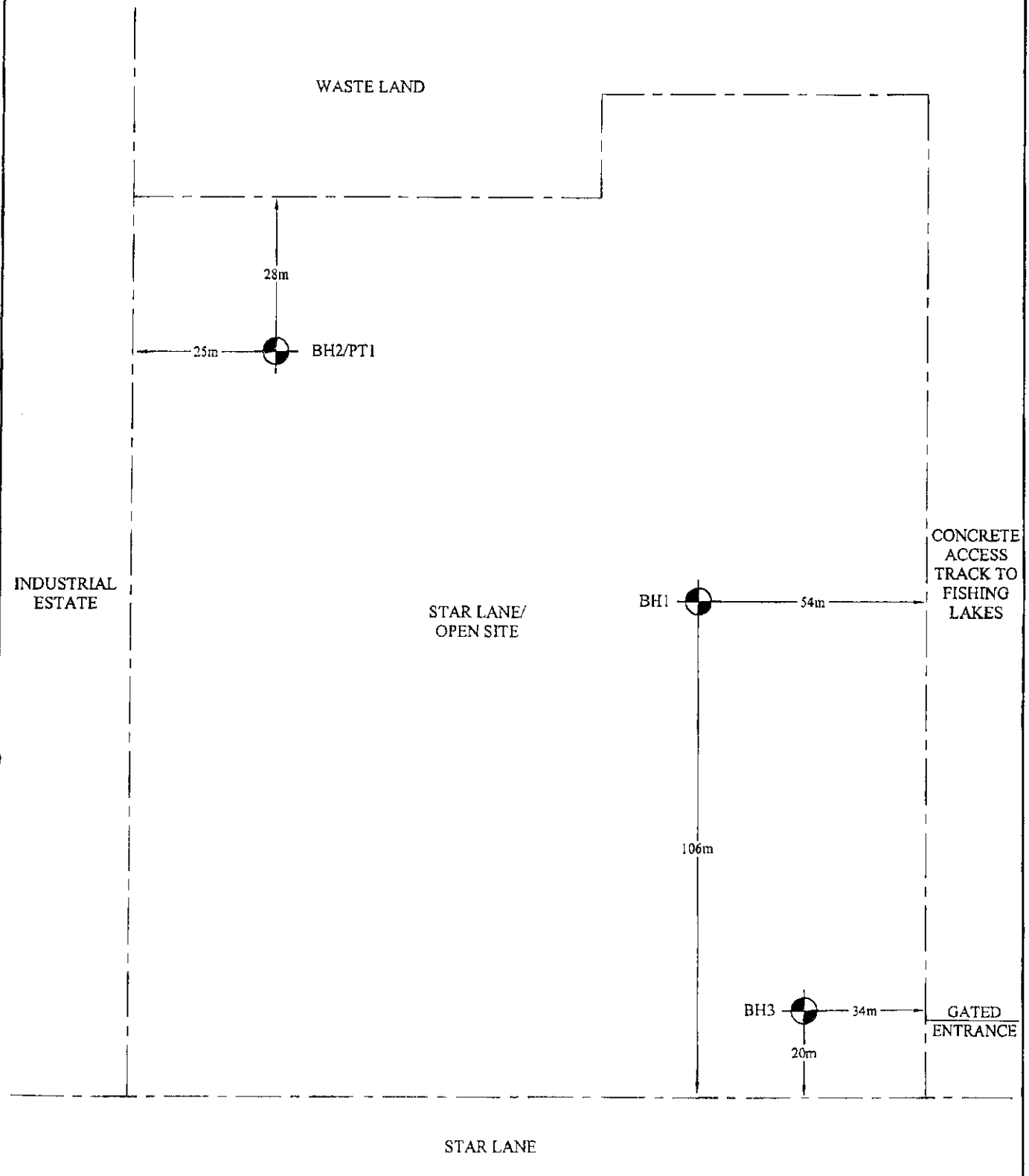
Percolation testing was carried out in one of the boreholes to determine if soakaways will be suitable for the development.

The depth, thickness and engineering description of the strata encountered were logged. Section 3.0 provides the site location plan and log for each borehole, Section 4.0 provides the geotechnical test results.

SITE LOCATION PLAN & BOREHOLE LOGS

Chelmer Site Investigations
Unit 15 East Hanningfield Industrial Estate
Old Church Road, East Hanningfield, Essex CM3 8AB
Telephone: 01245 400930 Fax: 01245 400933
Email: info@siteinvestigations.co.uk Website: www.siteinvestigations.co.uk

Client: Ken Rush Associates	Scale: N.T.S.	Sheet: 1 of 1	Date: 25.5.11	
Location: Star Lane, Great Wakering, Essex	Job No: 2640	Weather: Fine	Drawn by: MM	Checked by: ME



Notes:

On site tree identification for guidance only. Not authenticated.

Key:

Tree/Shrub | Borehole | Trial Pit | Gully | Tree Stump | Rain Water/ Soil Pipe | Manhole

Chelmer Site Investigations
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Old Church Road, East Hanningfield, Essex CM3 8AB
Telephone: 01245 400930 Fax: 01245 400933
Email: info@siteinvestigations.co.uk Website: www.siteinvestigations.co.uk

Client: Ken Rush Associates	Scale: N.T.S.	Sheet No: 1 of 1	Weather: Fine	Date: 25.5.11
Site: Star Lane, Great Wakering, Essex	Job No: 2640	Borehole No: 1	Boring method: GEO 205 (150mmØ) C.F.A.	

Depth Mtrs.	Description of Strata	Thick-ness	Legend	Sample	Test Type Result	Root Information	Depth to Water	Depth Mtrs
G.L.	MADE GROUND: medium compact mid brown silty clay with numerous brick fragments and gravel. (Tar/fluid present in samples).	1.2		D		Hair and fibrous roots to 0.9m.		0.5
				D		No roots observed below 0.9m.		1.0
1.2	Stiff moist mid brown sandy very silty CLAY thickly laminated with brown silt and fine sand.	1.6		D	150 SPT 05, 03, 04, 04, 05 N = 16			1.5
				D				2.0
				D				2.5
2.8	Medium dense moist mid brown clayey silty fine SAND.	1.0		D	150 CPT 11, 05, 05, 05, 05 N = 20			3.0
				D				3.5
3.8	Medium dense wet mid brown silty fine and medium SAND with numerous fine gravel.	1.0		D			3.7	4.0
				D				4.5
4.8	Medium dense wet mid brown/orange gravelly silty coarse SAND.	0.7		D				5.0
5.5	Borehole ends at 5.5m As instructed on site by Engineer.			D				5.5

Drawn by: MM | Approved by: ME

Remarks: *Water seepage at 3.7m.*
Unable to carry out CPT at 4.5m due to collapsing sand - Engineer on site and aware.
Borehole wet and collapsed at 4.0m on completion.

Key: T.D.T.D. Too Dense to Drive
D Small Disturbed Sample J Jar Sample
B Bulk Disturbed Sample V Pilcon Van (kPa)
U Undisturbed Sample (U100) M Mackintosh Probe
W Water Sample N Standard Penetration Test Blow Count

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Client:	Ken Rush Associates	Scale: N.T.S.	Sheet No: 1 of 1	Weather: Fine	Date: 25.5.11
Site:	Star Lane, Great Wakering, Essex	Job No: 2640	Borehole No: 2	Boring method:	GEO 205 (150mmØ) C.F.A.

Depth Mtrs.	Description of Strata	Thick-ness	Legend	Sample	Test Type Result	Root Information	Depth to Water	Depth Mtrs
G.L.	Turf/weeds over MADE GROUND: medium compact reddish brown silty fine sand with numerous brick fragments and occasional gravel.	0.7		D		Hair and fibrous roots observed to 0.8m.		0.5
0.7	MADE GROUND: medium compact mid to dark brown clayey silty fine sand with numerous brick fragments and occasional gravel.	0.6		D		No roots observed below 0.8m.		1.0
1.3	Stiff moist mid brown sandy very silty CLAY thickly laminated with brown silt and fine sand.	1.5		D	150 SPT 06, 04, 04, 04, 05 N = 17			1.5
				D				2.0
				D				2.5
2.8	Medium dense wet mid brown/orange silty gravelly coarse SAND.	1.2		D	150 CPT 11, 06, 05, 05, 06 N = 22		*2.8*	3.0
				D				3.5
4.0	Borehole ends at 4.0m			D				4.0

Drawn by: MM **Approved by:** ME

Remarks: *Water seepage at 2.8m.*
Borehole wet at base and open on completion.

Key: T.D.T.D. Too Dense to Drive
D Small Disturbed Sample J Jar Sample
B Bulk Disturbed Sample V Pilcon Van (kPa)
U Undisturbed Sample (U100) M Mackintosh Probe
W Water Sample N Standard Penetration Test Blow Count

Chelmer Site Investigations
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Telephone: 01245 400930 Fax: 01245 400933
Email: info@siteinvestigations.co.uk Website: www.siteinvestigations.co.uk

Client:	Ken Rush Associates	Scale: N.T.S.	Sheet No: 1 of 1	Weather: Fine	Date: 25.5
Site:	Star Lane, Great Wakering, Essex	Job No: 2640	Borehole No: 3	Boring method:	GEO 205 (150mmØ) C.F.A.

Depth Mtrs.	Description of Strata	Thick-ness	Legend	Sample	Test Type	Test Result	Root Information	Depth to Water	Depth Mtrs
G.L.	Turf/moss over MADE GROUND: medium compact reddish brown gravelly silt with numerous brick fragments.	0.4					Hair and fibrous roots observed to 0.5m.		
0.4	Stiff mid brown very silty CLAY thinly laminated with red and brown silt and fine sand and occasional carbon flecks.	0.5		D			No roots observed below 0.5m.		0.5
0.9	Stiff moist mid brown very silty CLAY thickly laminated with brown silt and fine sand.			D					1.0
				D	SPT	150 07, 04, 04, 05, 05 N = 18			1.5
				D					2.0
				D					2.5
2.8	Medium dense moist light brown silty gravelly fine and medium SAND.	1.2		D	CPT	150 14, 07, 06, 07, 08 N = 28			3.0
				D					3.5
4.0	Borehole ends at 4.0m			D					4.0

Drawn by: MM | Approved by: ME

Remarks: Borehole wet at base and open on completion.

Key: T.D.T.D. Too Dense to Drive
D Small Disturbed Sample J Jar Sample
B Bulk Disturbed Sample V Pilcon Van (kPa)
U Undisturbed Sample (U100) M Mackintosh Probe
W Water Sample N Standard Penetration Test Blow Count

Chelmer Site Investigations,
Unit 15, East Henningfield Industrial Estate, Old Church Road.
East Henningfield, Essex CM3 8AB
Telephone: 01245 400930 Fax: 01245 400933
Email: info@siteinvestigations.co.uk Website: www.siteinvestigations.co.uk

Client:	Ken Rush Associates	**Sheet No: 1 of 1**	**Date:**	25.5.11
Site:	Star Lane, Great Wakering, Essex		**C S I Ref:**	2640
Borehole No:	**2 (150mm)**			
Depth of Trial pit:	4.0m			

PERCOLATION TEST RESULTS

Time Taken (Minutes)	Test 1 (Depth mm)	Test 2 (Depth mm)	Test 3 (Depth mm)
0	4000		
1	3700		
2	3600		
3	3525		
4	3475		
5	3400		
6	3375		
7	3350		
8	3325		
9	3300		
10	3275		
15	3200		
20	3125		
25	3050		
30	3025		
35	3000		
40	2975		
45	2975		
50	2975		
55	2965		
60	2950		
70	2950		
80	2925		
90	2900		
100	2900		
120	2850		
150	2800		
180	2750		

Comments:

LABORATORY TESTS

Chelmer Geotechnical Laboratories

Unit 15 East Hanningfield Industrial Estate Old Church Road East Hanningfield Essex CM3 8AB Tel: 01245 401393 Fax: 01245 400933 Email: info@soillabs.co.uk

Laboratory Testing Results

Job No: CGL02186
Client: Ken Rush Associates CSI Ref: 2640
Site: Star Lane Great Wakering

Received: 25.05.11
Tested: 31.05.11
Complete: 02.06.11

Sample Ref		Type	Moisture Content	Soil Fraction	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Modified Plasticity Index	Soil Class	Filter Paper Contact Time	Soil Sample Suction	In situ Shear Vane Strength	Organic Content	pH Value	Sulphate Content (g/l)		Class
BH / Sample No	Depth (m)		(%) [1]	>0.425mm (%) [2]	(%) [3]	(%) [4]	(%) [5]	[5]	(%) [6]	[7]	(h) [8]	(kPa)	(kPa) [9]	(%) [10]	[11]	SO_3 [12]	SO_4 [13]	[14]
1/018206	1.0	D	19	<5	43	18	25	0.04	25	CI								
1/018207	1.5	D													8.0	0.00	0.00	DS-1

Test Methods / Notes

[1] BS 1377 : Part 2 : 1990, Test No 3.2
[2] Estimated if <5%, otherwise measured
[3] BS 1377 : Part 2 : 1990, Test No 4.4
[4] BS 1377 : Part 2 : 1990, Test No 5.3
[5] BS 1377 : Part 2 : 1990, Test No 5.4
[6] BRE Digest 240 : 1993
[7] BS 5930 : 1981 : Figure 31 - Plasticity Chart for the classification of fine soils
[8] In-house method S9a adapted from BRE IP 4/93
[9] Values of shear strength were determined in situ by Chelmer Site Investigations using a Pilcon hand vane or Geonor vane (GV).
[10] BS 1377 : Part 3 : 1990, Test No 4
[11] BS 1377 : Part 2 : 1990, Test No 9
[12] BS 1377 : Part 3 : 1990, Test No 5.6
[13] $SO_4 = 1.2 \times SO_3$
[14] BRE Special Digest One (Concrete in Aggressive Ground) 2005
Note that if the SO_4 content falls into the DS-4 or DS-5 class, it would be prudent to consider the sample as falling into the DS-4m or DS-5m class respectively unless water soluble magnesium testing is undertaken to prove otherwise

Key

D	Disturbed sample
B	Bulk sample
U	U100 (undisturbed sample)
W	Water sample
ENP	Essentially Non-Plastic by inspection
U/S	Underside Foundation

Chelmer Geotechnical Laboratories

Unit 15 East Hanningfield Industrial Estate Old Church Road East Hanningfield Essex CM3 8AB Tel: 01245 401393 Fax: 01245 400933 Email: info@soillabs.co.uk

Laboratory Testing Results

Job No: CGL02186

Client: Ken Rush Associates CSI Ref: 2640

Site: Star Lane Great Wakering

Received: 25.05.11

Tested: 31.05.11

Complete: 02.06.11

Sample Ref.		Type	Moisture Content	Soil Fraction	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Modified Plasticity Index	Soil Class	Filter Paper Contact Time	Soil Sample Suction	In situ Shear Vane Strength	Organic Content	pH Value	Sulphate Content (g/l)		Class
BH / Sample No	Depth (m)		(%) *[1]*	>0.425mm (%) *[2]*	(%) *[3]*	(%) *[4]*	(%) *[5]*	*[5]*	(%) *[6]*	*[7]*	(h) *[8]*	(kPa)	(kPa) *[9]*	(%) *[10]*	*[11]*	SO_3 *[12]*	SO_4 *[13]*	*[14]*
2/018208	2.0	D	20	<5	34	19	15	0.09	15	CL								

Test Methods / Notes

[1] BS 1377 : Part 2 : 1990, Test No 3.2
[2] Estimated if <5%, otherwise measured
[3] BS 1377 : Part 2 : 1990, Test No 4.4
[4] BS 1377 : Part 2 : 1990, Test No 5.3
[5] BS 1377 : Part 2 : 1990, Test No 5.4
[6] BRE Digest 240 : 1993
[7] BS 5930 : 1981 : Figure 31 - Plasticity Chart for the classification of fine soils
In-house method S9a adapted from BRE IP 4/93
[9] Values of shear strength were determined in situ by Chelmer Site Investigations using a Pilcon hand vane or Geonor vane (GV).
[10] BS 1377 : Part 3 : 1990, Test No 4
[11] BS 1377 : Part 2 : 1990, Test No 9
[12] BS 1377 : Part 3 : 1990, Test No 5.6
[13] $SO_4 = 1.2 \times SO_3$
[14] BRE Special Digest One (Concrete in Aggressive Ground) 2005
Note that if the SO_4 content falls into the DS-4 or DS-5 class, it would be prudent to consider the sample as falling into the DS-4m or DS-5m class respectively unless water soluble magnesium testing is undertaken to prove otherwise

Key

D	Disturbed sample
B	Bulk sample
U	U100 (undisturbed sample)
W	Water sample
ENP	Essentially Non-Plastic by inspection
U/S	Underside Foundation

[redacted]

Chelmer Geotechnical Laboratories

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Laboratory Testing Results

Job No: CGL02186
Client: Ken Rush Associates CSI Ref: 2640
Site: Star Lane Great Wakering

Received: 25.05.11
Tested: 31.05.11
Complete: 02.06.11

Sample Ref. BH / Sample No	Depth (m)	Type	Moisture Content (%) [1]	Soil Fraction > 0.425mm (%) [2]	Liquid Limit (%) [3]	Plastic Limit (%) [4]	Plasticity Index (%) [5]	Liquidity Index [5]	Modified Plasticity Index (%) [6	Soil Class [7]	Filter Paper Contact Time (h) [8]	Soil Sample Suction (kPa)	In situ Shear Vane Strength (kPa) [9]	Organic Content (%) [10]	pH Value [11]	Sulphate Content (g/l) SO_3 [12]	Sulphate Content (g/l) SO_4 [13]	Class [14]
3/018209	0.5	D	18	<5	39	20	19	-0.11	19	CI								
3/018210	2.5	D													7.9	0.00	0.00	DS-1

Test Methods / Notes

[1] BS 1377 : Part 2 : 1990, Test No 3.2
[2] Estimated if <5%, otherwise measured
[3] BS 1377 : Part 2 : 1990, Test No 4.4
[4] BS 1377 : Part 2 : 1990, Test No 5.3
[5] BS 1377 : Part 2 : 1990, Test No 5.4
[6] BRE Digest 240 : 1993
[7] BS 5930 : 1981 : Figure 31 - Plasticity Chart for the classification of fine soils
[8] In-house method S9a adapted from BRE IP 4/93
[9] Values of shear strength were determined in situ by Chelmer Site Investigations using a Pilcon hand vane or Geonor vane (GV).
[10] BS 1377 : Part 3 : 1990, Test No 4
[11] BS 1377 : Part 2 : 1990, Test No 9
[12] BS 1377 : Part 3 : 1990, Test No 5.6
[13] $SO_4 = 1.2 \times SO_3$
[14] BRE Special Digest One (Concrete in Aggressive Ground) 2005
Note that if the SO_4 content falls into the DS-4 or DS-5 class, it would be prudent to consider the sample as falling into the DS-4m or DS-5m class respectively unless water soluble magnesium testing is undertaken to prove otherwise

Key

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B	Bulk sample
U	U100 (undisturbed sample)
W	Water sample
ENP	Essentially Non-Plastic by inspection
U/S	Underside Foundation

Chelmer Geotechnical Laboratories

Unit 15 East Hanningfield Industrial Estate Old Church Road East Hanningfield Essex CM3 8AB Tel: 01245 401393 Fax: 01245 400933 Email: info@soillabs.co.uk

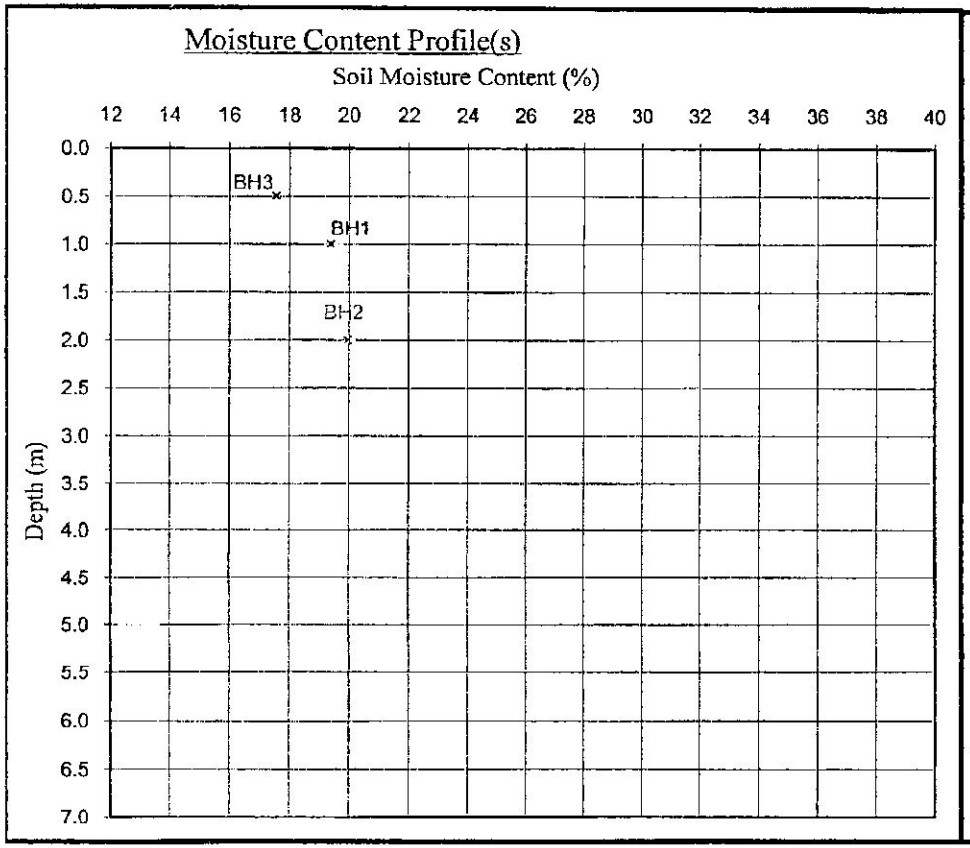
Moisture Content and Shear Strength Profiles

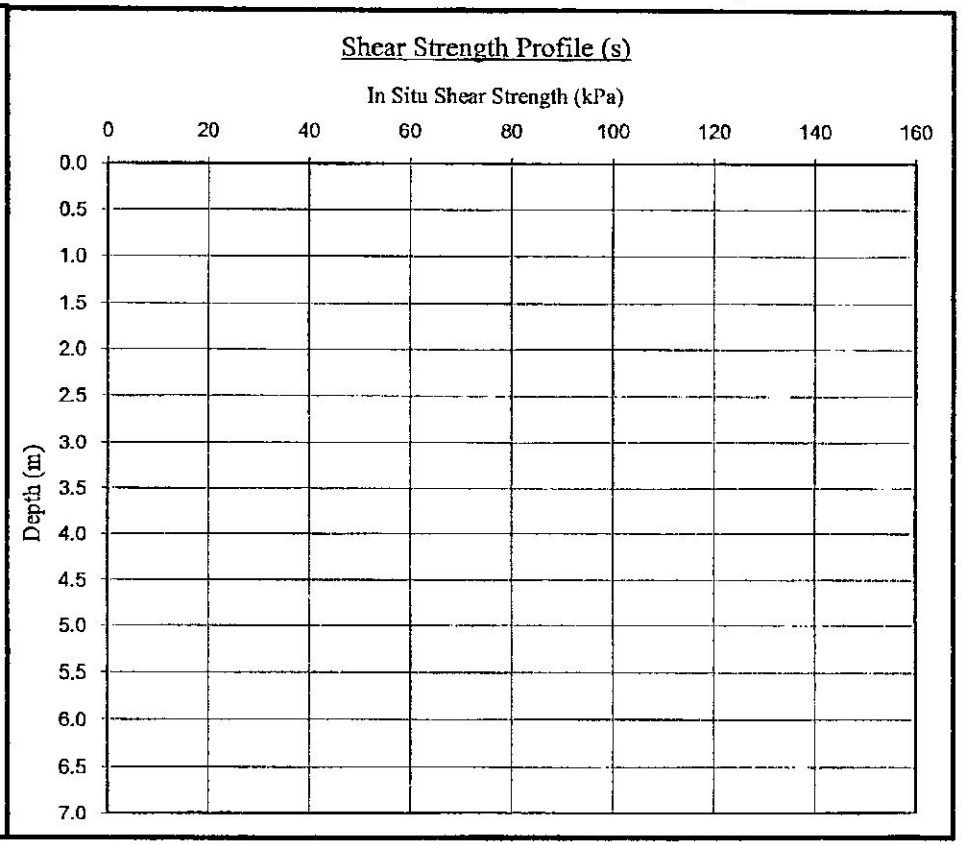
Client: Ken Rush Associates CSI Ref: 2640

Site: Star Lane Great Wakering

Note : Unless specifically noted the profiles have not been related to a site datum.

Job No: CGL02186
Received: 25.05.11
Tested: 31.05.11
Complete: 02.06.11





Notes

1. If the Soil Fraction > 0.425mm exceeds 5% the Equivalent Moisture Content of the remainder (calculated in accordance with BS 1377: Part 2 : 1990, cl3.2.4 note 1) is also plotted and the alternative profile additionally shown as an appropriately coloured broken line.
2. If plotted, 0.4 LL and PL+2 (after Driscoll, 1983) should only be applied to London Clay (and similarly overconsolidated clays) at shallow depths.

Note

Unless otherwise stated, values of Shear Strength were determined in situ by Chelmer Site Investigations using a Pilcon Hand Vane the calibration of which is limited to a maximum reading of 140 kPa.

Chelmer Geotechnical Laboratories

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Job No: CGL02186
Client: Ken Rush Associates CSI Ref: 2640
Site: Star Lane Great Wakering

Received: 25.05.11
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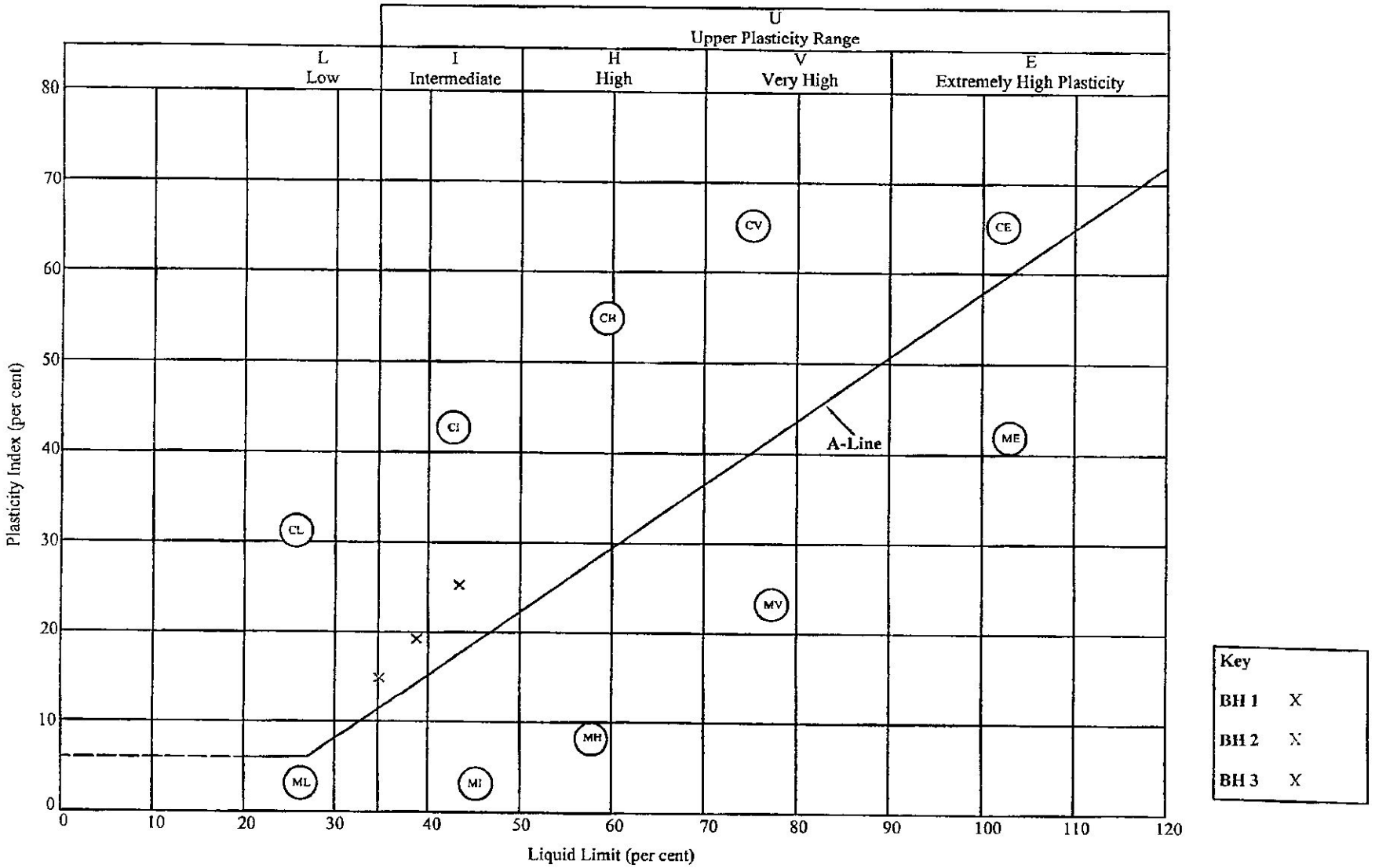


Plasticity Chart for the classification of fine soils and the finer part of coarse soils.

In Compliance with BS 5930 : 1981

SILT (M-SOIL), M, plots below A-Line
CLAY, C, plots above A-Line
} M and C may be combined as FINE SOIL, F.

5.0 DISCUSSION & RECOMMENDATIONS

The findings in the boreholes were made ground over Clay over Sand. The depth of made ground varied from 0.4m – 1.3m, and the Sand was encountered at 2.8m in all three boreholes. This is consistent with the Geological Data Sheet (258/259) Southend and Foulness.

In-situ testing carried out using standard penetration test equipment gave N-values at 1.5m in the Clay of N = 16, 17 and 18 in each borehole respectively. Atterberg limit tests carried out in the laboratory show the Clay to be of medium shrinkability with plasticity indices of 25, 15 and 19.

With these findings we would recommend a deepstrip foundation taken through any made ground to bear a minimum of 150mm into Virgin Clay, with a minimum depth of 1.0m. Where vegetation exists around the perimeter of the site foundations will need to be deepened in accordance with NHBC Chapter 4.2 "*Building Near Trees*". A detailed survey will be required to identify tree type and accurate location.

Where foundation depths exceed 1.5m anti heave precautions will be required. Due to the made ground encountered and the shrinkable soils a pre cast beam and block suspended ground floor will be required with a 250mm ventilated void. An allowable ground bearing pressure of 150 kN/m² should be adopted for design of foundations bearing into stiff Clays.

The results of the percolation testing showed reasonably good soakage, 1.25m of water soaked away in 180 minutes, giving an infiltration rate of 9.38 lts/m²/hr. This equates to 2.6×10^{-3}m/s, which is a good infiltration rate, and calculations under BRE 365 will determine size and technical details of the soakaways to be used.

We trust that the comments and recommendations within this report are clear, should further advice be required please contact the undersigned.

A.J.Rush BSc
KEN RUSH ASSOCIATES

Appendix F

Preliminary Soakaway Design

Soakaway Design to BRE 365 - Chamber Soakaways

Project	Star Lane Phase 1
Job No.	4242358

Catchment

Drained Area	600 sqm

Soil Data

Infiltration Rate	2.60E-03 m/s
Depth of infiltration horizon	0.5 m

Rainfall Data

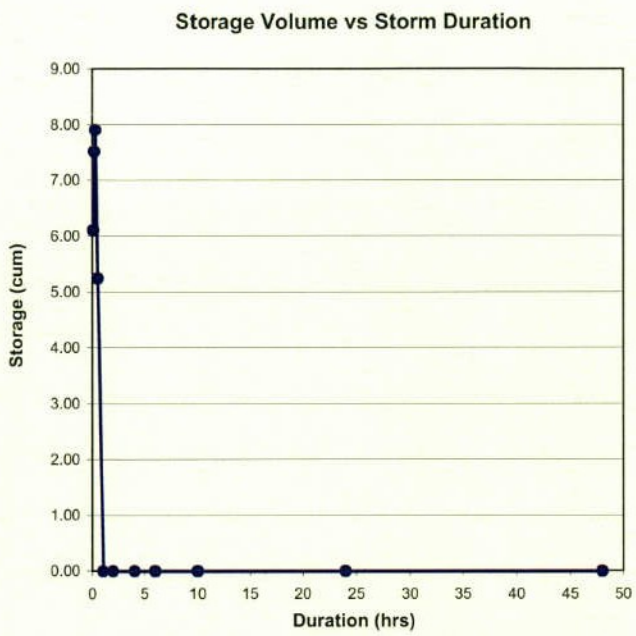
M5-60	20 mm/hr
Ratio r	0.42 (0.27 to 0.45)
Design Return Period	100 Years

Soakaway Details

Soakaway Diameter	1.8 m
Storage Depth	2 m
Void Ratio of fill	0.3
Ring Clearance	0.5 m

Results

Length of Pit Side	3 m
as50	3 sqm
Storage Volume (Chamber)	5.09 cum
Storage Volume (Backfill)	3.32 cum
Total Storage Volume	8.41 cum
Required Storage Volume	7.91 cum
Maximum time to Half Empty	0.14 hrs



Duration hrs	Z1 Factor r = 0.42	Rainfall M5-D	Z2 Factor	Rainfall M100-D	Inflow l/s	Outflow l/s	Net Inflow l/s	Storage cum	Time to half empty (hrs)
0.08	0.38	7.60	1.85	14.08	28.17	7.80	20.37	6.11	0.11
0.17	0.53	10.60	1.92	20.32	20.33	7.80	12.53	7.52	0.13
0.25	0.64	12.80	1.94	24.88	16.59	7.80	8.79	7.91	0.14
0.50	0.81	16.20	1.98	32.15	10.72	7.80	2.92	5.25	0.09
1	1.00	20.00	2.03	40.60	6.77	7.80	-1.03	0.00	0.00
2	1.20	24.00	2.05	49.30	4.11	7.80	-3.69	0.00	0.00
4	1.42	28.40	2.08	59.08	2.46	7.80	-5.34	0.00	0.00
6	1.57	31.40	1.96	61.51	1.71	7.80	-6.09	0.00	0.00
10	1.74	34.80	1.93	67.22	1.12	7.80	-6.68	0.00	0.00
24	2.16	43.20	1.86	80.54	0.56	7.80	-7.24	0.00	0.00
48	2.50	50.00	1.81	90.50	0.31	7.80	-7.49	0.00	0.00

Factor Z1

Ratio r / Duration	5 mins	10 mins	15 mins	30 mins	1 hour	2 hour	4 hours	6 hours	10 hours	24 hours	48 hours
0.27	0.33	0.48	0.58	0.76	1.00	1.27	1.64	1.88	2.24	3.10	4.00
0.30	0.34	0.49	0.59	0.77	1.00	1.25	1.57	1.78	2.12	2.84	3.50
0.33	0.35	0.50	0.61	0.78	1.00	1.23	1.53	1.73	2.04	2.60	3.25
0.36	0.36	0.51	0.62	0.79	1.00	1.22	1.48	1.67	1.00	2.42	2.90
0.39	0.37	0.52	0.63	0.80	1.00	1.21	1.46	1.62	1.82	2.28	2.70
0.42	0.38	0.53	0.64	0.81	1.00	1.20	1.42	1.57	1.74	2.16	2.50
0.45	0.39	0.54	0.65	0.82	1.00	1.19	1.38	1.51	1.68	2.03	2.30

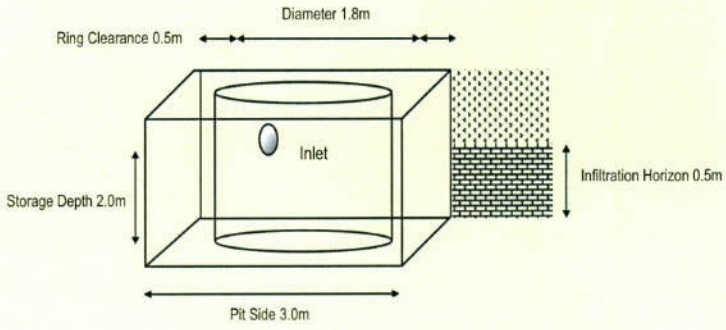
Factor Z2(100)

	100
5	1.79
10	1.91
20	2.03
30	1.97
40	1.89
50	1.81
100	1.54

Factor Z2

M5/MD	1	2	5	10	30	50	100
5	0.62	0.72	1.00	1.18	1.48	1.56	1.79
10	0.61	0.70	1.00	1.21	1.53	1.65	1.91
20	0.64	0.72	1.00	1.23	1.60	1.73	2.03
30	0.68	0.75	1.00	1.21	1.57	1.70	1.97
40	0.70	0.77	1.00	1.18	1.51	1.64	1.89
50	0.72	0.79	1.00	1.16	1.45	1.58	1.81
100	0.78	0.83	1.00	1.12	1.31	1.40	1.54

Summary



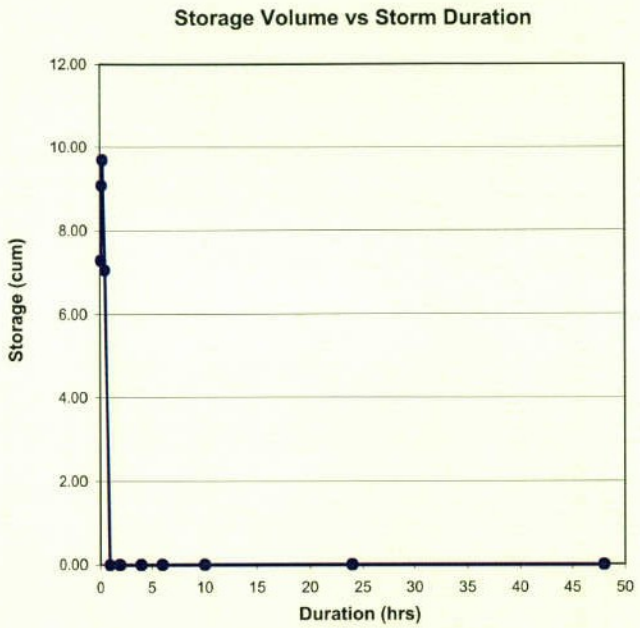
Required Storage Volume = 7.91 cum
Design Storage Volume = 8.41 cum
Maximum time to half empty = 0.1 hrs < 24 hrs

M5-60 Design Rainfall = 20 mm/hr
Ratio r = 0.42
Design Return Period = 100 years

Rev C ILW 25-01-02

Soakaway Design to BRE 365 - Chamber Soakaways

Project	Star Lane Phase 1	
Job No.	4242358	
Catchment		
Drained Area	700	sqm
Soil Data		
Infiltration Rate	2.60E-03	m/s
Depth of infiltration horizon	0.5	m
Rainfall Data		
M5-60	20	mm/hr
Ratio r	0.42	(0.27 to 0.45)
Design Return Period	100	Years
Soakaway Details		
Soakaway Diameter	2.1	m
Storage Depth	2	m
Void Ratio of fill	0.3	
Ring Clearance	0.5	m
Results		
Length of Pit Side	3.3	m
as50	3.3	sqm
Storage Volume (Chamber)	6.92	cum
Storage Volume (Backfill)	3.82	cum
Total Storage Volume	10.74	cum
Required Storage Volume	9.69	cum
Maximum time to Half Empty	0.16	hrs



Duration hrs	Z1 Factor r = 0.42	Rainfall M5-D	Z2 Factor	Rainfall M100-D	Inflow l/s	Outflow l/s	Net Inflow l/s	Storage cum	Time to half empty (hrs)
0.08	0.38	7.60	1.85	14.08	32.86	8.58	24.28	7.28	0.12
0.17	0.53	10.60	1.92	20.32	23.72	8.58	15.14	9.08	0.15
0.25	0.64	12.80	1.94	24.88	19.35	8.58	10.77	9.69	0.16
0.50	0.81	16.20	1.98	32.15	12.50	8.58	3.92	7.06	0.11
1	1.00	20.00	2.03	40.60	7.89	8.58	-0.69	0.00	0.00
2	1.20	24.00	2.05	49.30	4.79	8.58	-3.79	0.00	0.00
4	1.42	28.40	2.08	59.08	2.87	8.58	-5.71	0.00	0.00
6	1.57	31.40	1.96	61.51	1.99	8.58	-6.59	0.00	0.00
10	1.74	34.80	1.93	67.22	1.31	8.58	-7.27	0.00	0.00
24	2.16	43.20	1.86	80.54	0.65	8.58	-7.93	0.00	0.00
48	2.50	50.00	1.81	90.50	0.37	8.58	-8.21	0.00	0.00

Factor Z1

Ratio r / Duration	5 mins	10 mins	15 mins	30 mins	1 hour	2 hour	4 hours	6 hours	10 hours	24 hours	48 hours
0.27	0.33	0.48	0.58	0.76	1.00	1.27	1.64	1.88	2.24	3.10	4.00
0.30	0.34	0.49	0.59	0.77	1.00	1.25	1.57	1.78	2.12	2.84	3.50
0.33	0.35	0.50	0.61	0.78	1.00	1.23	1.53	1.73	2.04	2.60	3.25
0.36	0.36	0.51	0.62	0.79	1.00	1.22	1.48	1.67	1.00	2.42	2.90
0.39	0.37	0.52	0.63	0.80	1.00	1.21	1.46	1.62	1.82	2.28	2.70
0.42	0.38	0.53	0.64	0.81	1.00	1.20	1.42	1.57	1.74	2.16	2.50
0.45	0.39	0.54	0.65	0.82	1.00	1.19	1.38	1.51	1.68	2.03	2.30

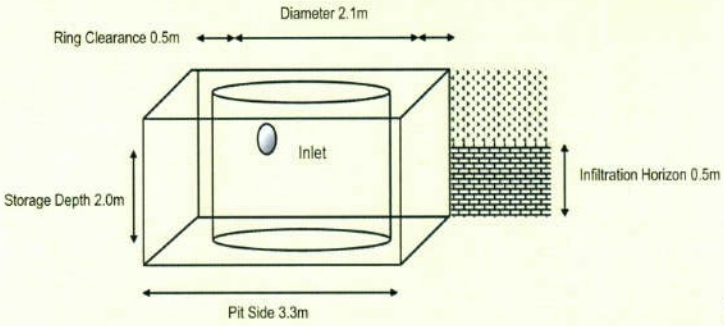
Factor Z2(100)

	100
5	1.79
10	1.91
20	2.03
30	1.97
40	1.89
50	1.81
100	1.54

Factor Z2

M5/MD	1	2	5	10	30	50	100
5	0.62	0.72	1.00	1.18	1.48	1.56	1.79
10	0.61	0.70	1.00	1.21	1.53	1.65	1.91
20	0.64	0.72	1.00	1.23	1.60	1.73	2.03
30	0.68	0.75	1.00	1.21	1.57	1.70	1.97
40	0.70	0.77	1.00	1.18	1.51	1.64	1.89
50	0.72	0.79	1.00	1.16	1.45	1.58	1.81
100	0.78	0.83	1.00	1.12	1.31	1.40	1.54

Summary



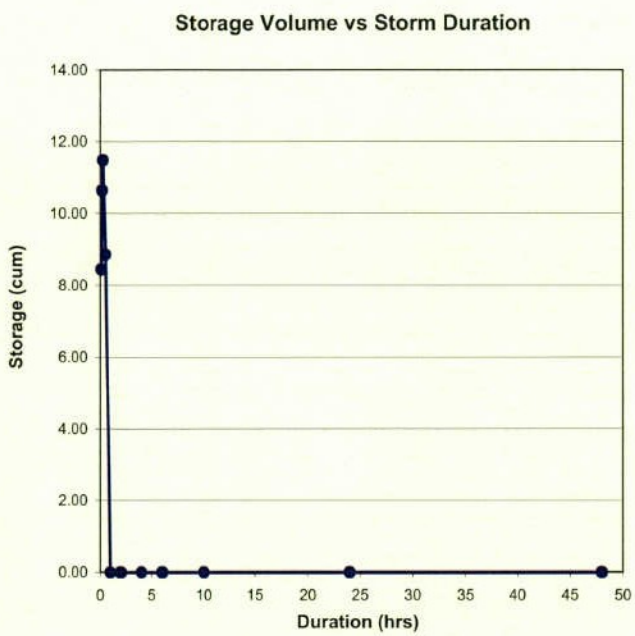
Required Storage Volume = 9.69 cum
Design Storage Volume = 10.74 cum
Maximum time to half empty = 0.2 hrs < 24 hrs

M5-60 Design Rainfall = 20 mm/hr
Ratio r = 0.42
Design Return Period = 100 years

Rev C ILW 25-01-02

Soakaway Design to BRE 365 - Chamber Soakaways

Project	Star Lane Phase 1
Job No.	4242358
Catchment	
Drained Area	800 sqm
Soil Data	
Infiltration Rate	2.60E-03 m/s
Depth of infiltration horizon	0.5 m
Rainfall Data	
M5-60	20 mm/hr
Ratio r	0.42 (0.27 to 0.45)
Design Return Period	100 Years
Soakaway Details	
Soakaway Diameter	2.4 m
Storage Depth	2 m
Void Ratio of fill	0.3
Ring Clearance	0.5 m
Results	
Length of Pit Side	3.6 m
as50	3.6 sqm
Storage Volume (Chamber)	9.04 cum
Storage Volume (Backfill)	4.34 cum
Total Storage Volume	13.39 cum
Required Storage Volume	11.48 cum
Maximum time to Half Empty	0.17 hrs



Duration hrs	Z1 Factor r = 0.42	Rainfall M5-D	Z2 Factor	Rainfall M100-D	Inflow l/s	Outflow l/s	Net Inflow l/s	Storage cum	Time to half empty (hrs)
0.08	0.38	7.60	1.85	14.08	37.56	9.36	28.20	8.46	0.13
0.17	0.53	10.60	1.92	20.32	27.11	9.36	17.75	10.64	0.16
0.25	0.64	12.80	1.94	24.88	22.11	9.36	12.75	11.48	0.17
0.50	0.81	16.20	1.98	32.15	14.29	9.36	4.93	8.87	0.13
1	1.00	20.00	2.03	40.60	9.02	9.36	-0.34	0.00	0.00
2	1.20	24.00	2.05	49.30	5.48	9.36	-3.88	0.00	0.00
4	1.42	28.40	2.08	59.08	3.28	9.36	-6.08	0.00	0.00
6	1.57	31.40	1.96	61.51	2.28	9.36	-7.08	0.00	0.00
10	1.74	34.80	1.93	67.22	1.49	9.36	-7.87	0.00	0.00
24	2.16	43.20	1.86	80.54	0.75	9.36	-8.61	0.00	0.00
48	2.50	50.00	1.81	90.50	0.42	9.36	-8.94	0.00	0.00

Factor Z1

Ratio r / Duration	5 mins	10 mins	15 mins	30 mins	1 hour	2 hour	4 hours	6 hours	10 hours	24 hours	48 hours
0.27	0.33	0.48	0.58	0.76	1.00	1.27	1.64	1.88	2.24	3.10	4.00
0.30	0.34	0.49	0.59	0.77	1.00	1.25	1.57	1.78	2.12	2.84	3.50
0.33	0.35	0.50	0.61	0.78	1.00	1.23	1.53	1.73	2.04	2.60	3.25
0.36	0.36	0.51	0.62	0.79	1.00	1.22	1.48	1.67	1.00	2.42	2.90
0.39	0.37	0.52	0.63	0.80	1.00	1.21	1.46	1.62	1.82	2.28	2.70
0.42	0.38	0.53	0.64	0.81	1.00	1.20	1.42	1.57	1.74	2.16	2.50
0.45	0.39	0.54	0.65	0.82	1.00	1.19	1.38	1.51	1.68	2.03	2.30

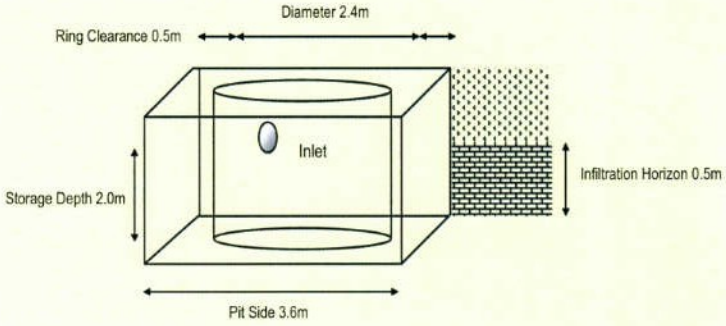
Factor Z2(100)

	100
5	1.79
10	1.91
20	2.03
30	1.97
40	1.89
50	1.81
100	1.54

Factor Z2

M5/MD	1	2	5	10	30	50	100
5	0.62	0.72	1.00	1.18	1.48	1.56	1.79
10	0.61	0.70	1.00	1.21	1.53	1.65	1.91
20	0.64	0.72	1.00	1.23	1.60	1.73	2.03
30	0.68	0.75	1.00	1.21	1.57	1.70	1.97
40	0.70	0.77	1.00	1.18	1.51	1.64	1.89
50	0.72	0.79	1.00	1.16	1.45	1.58	1.81
100	0.78	0.83	1.00	1.12	1.31	1.40	1.54

Summary



Required Storage Volume = 11.48 cum
Design Storage Volume = 13.39 cum
Maximum time to half empty = 0.2 hrs < 24 hrs

M5-60 Design Rainfall = 20 mm/hr
Ratio r = 0.42
Design Return Period = 100 years

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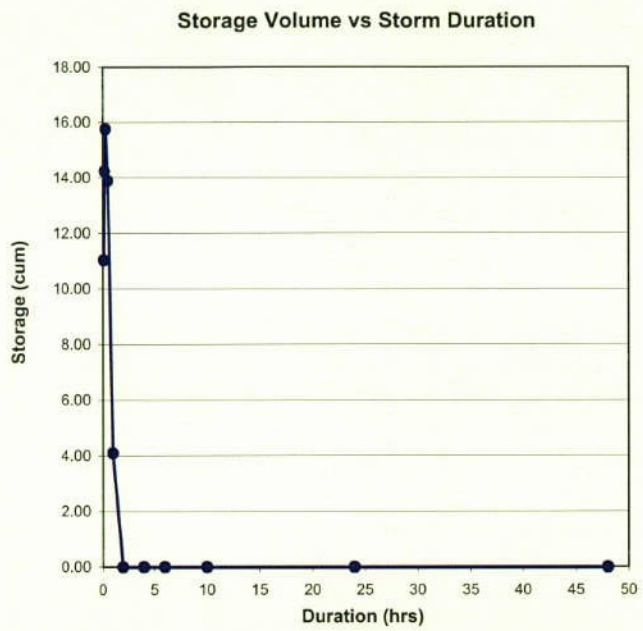
Soakaway Design to BRE 365 - Chamber Soakaways

Project	Star Lane Phase 1	
Job No.	4242358	
Catchment		
Drained Area	1000	sqm
Soil Data		
Infiltration Rate	2.60E-03	m/s
Depth of infiltration horizon	0.5	m
Rainfall Data		
M5-60	20	mm/hr
Ratio r	0.42	(0.27 to 0.45)
Design Return Period	100	Years
Soakaway Details		
Soakaway Diameter	2.7	m
Storage Depth	2	m
Void Ratio of fill	0.3	
Ring Clearance	0.5	m
Results		
Length of Pit Side	3.9	m
as50	3.9	sqm
Storage Volume (Chamber)	11.45	cum
Storage Volume (Backfill)	4.89	cum
Total Storage Volume	16.33	cum
Required Storage Volume	15.75	cum
Maximum time to Half Empty	0.22	hrs



Factor Z1

Ratio r / Duration	5 mins	10 mins	15 mins	30 mins	1 hour	2 hour	4 hours	6 hours	10 hours	24 hours	48 hours
0.27	0.33	0.48	0.58	0.76	1.00	1.27	1.64	1.88	2.24	3.10	4.00
0.30	0.34	0.49	0.59	0.77	1.00	1.25	1.57	1.78	2.12	2.84	3.50
0.33	0.35	0.50	0.61	0.78	1.00	1.23	1.53	1.73	2.04	2.60	3.25
0.36	0.36	0.51	0.62	0.79	1.00	1.22	1.48	1.67	1.00	2.42	2.90
0.39	0.37	0.52	0.63	0.80	1.00	1.21	1.46	1.62	1.82	2.28	2.70
0.42	0.38	0.53	0.64	0.81	1.00	1.20	1.42	1.57	1.74	2.16	2.50
0.45	0.39	0.54	0.65	0.82	1.00	1.19	1.38	1.51	1.68	2.03	2.30

Factor Z2(100)

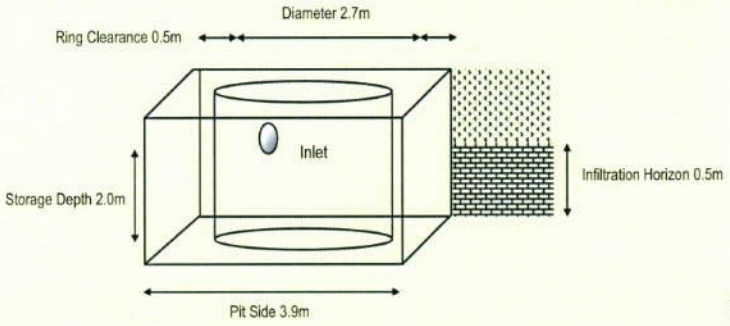
	100
5	1.79
10	1.91
20	2.03
30	1.97
40	1.89
50	1.81
100	1.54

Factor Z2

M5/MD	1	2	5	10	30	50	100
5	0.62	0.72	1.00	1.18	1.48	1.56	1.79
10	0.61	0.70	1.00	1.21	1.53	1.65	1.91
20	0.64	0.72	1.00	1.23	1.60	1.73	2.03
30	0.68	0.75	1.00	1.21	1.57	1.70	1.97
40	0.70	0.77	1.00	1.18	1.51	1.64	1.89
50	0.72	0.79	1.00	1.16	1.45	1.58	1.81
100	0.78	0.83	1.00	1.12	1.31	1.40	1.54

Duration hrs	Z1 Factor r = 0.42	Rainfall M5-D	Z2 Factor	Rainfall M100-D	Inflow l/s	Outflow l/s	Net Inflow l/s	Storage cum	Time to half empty (hrs)
0.08	0.38	7.60	1.85	14.08	46.95	10.14	36.81	11.04	0.15
0.17	0.53	10.60	1.92	20.32	33.88	10.14	23.74	14.24	0.20
0.25	0.64	12.80	1.94	24.88	27.64	10.14	17.50	15.75	0.22
0.50	0.81	16.20	1.98	32.15	17.86	10.14	7.72	13.90	0.19
1	1.00	20.00	2.03	40.60	11.28	10.14	1.14	4.10	0.06
2	1.20	24.00	2.05	49.30	6.85	10.14	-3.29	0.00	0.00
4	1.42	28.40	2.08	59.08	4.10	10.14	-6.04	0.00	0.00
6	1.57	31.40	1.96	61.51	2.85	10.14	-7.29	0.00	0.00
10	1.74	34.80	1.93	67.22	1.87	10.14	-8.27	0.00	0.00
24	2.16	43.20	1.86	80.54	0.93	10.14	-9.21	0.00	0.00
48	2.50	50.00	1.81	90.50	0.52	10.14	-9.62	0.00	0.00

Summary



Required Storage Volume = 15.75 cum
Design Storage Volume = 16.33 cum
Maximum time to half empty = 0.2 hrs < 24 hrs

M5-60 Design Rainfall = 20 mm/hr
Ratio r = 0.42
Design Return Period = 100 years

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