ARDENT CONSULTING ENGINEERS

COUNTRYSIDE PROPERTIES LTD.

LAND NORTH OF CUFFLEY HILL, GOFFS OAK, EN7 5EX

FLOOD RISK ASSESSMENT

REPORT REF. 162101-03
PROJECT NO. 162101
DECEMBER 2018

LAND NORTH OF CUFFLEY HILL, GOFFS OAK

FLOOD RISK ASSESSMENT

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APPENDICES

DOCUMENT CONTROL SHEET

REV	ISSUE PURPOSE	AUTHOR	CHECKED	APPROVED	DATE
-	DRAFT	FY	BB	DRAFT	SEP 18
-	FINAL	FY	FY	BB	OCT 18
A	FINAL	AW	FY	BB	DEC 18

FY B. BROOKS

1. INTRODUCTION

1.1. Ardent Consulting Engineers (ACE) has been commissioned by Countryside Properties PLC to carry out a Flood Risk Assessment (FRA) and Drainage Strategy for the proposed development of the Land North of Cuffley Hill, Goffs Oak, EN7 5EX, hereafter referred to as 'The Site'.

1.2. The planning submission will be on the basis of a full planning application for 58 dwellings, access, landscaping, open space and pedestrian routes.

1.3. The Local Planning Authority is the Borough of Broxbourne and the Lead Local Flood Authority is Hertfordshire County Council (HCC).

1.4. This FRA has been prepared in compliance with both the National Planning Policy Framework (NPPF) and the supporting Planning Practice Guidance (PPG). It has also been written with reference to the Borough of Broxbourne Strategic Flood Risk Assessment (SFRA) and HCC SuDS Guidance.

1.5. During the preparation of this FRA, consultation with Thames Water was undertaken.

Scope

1.6. In accordance with the assessment criteria found in NPPF, this FRA will ultimately seek to;

- Ensure that flood mitigation is provided within the development site to avoid detrimental impacts to third parties;
- Ensure that the impact of climate change is assessed;
- Ensure impermeable areas within the development are minimised where practicable; and
- Ensure the use of sustainable drainage systems (SuDS) is optimised in line with current best practice.

Sources of Information

1.7. Key reports/documents reviewed as part of this study are:

- Local Flood Risk Management Strategy for Hertfordshire;
- Hertfordshire County Council Preliminary Flood Risk Assessment (2011);
- Borough of Broxbourne Strategic Flood Risk Assessment (2016);
- HCC SuDS Design Guidance;
- Drainage Asset Plans;
- Flood Maps; and
- Borehole Records.

Existing Site

1.8. The Site is bound by C.G. Edward Landscape and Stone Suppliers to the west, residential dwellings to the east, north-east and south, with greenfield land to the north-west. There is an existing private access road off Cuffley Hill.

1.9. The Site is within Hertfordshire and is centred on grid reference 531725E; 203061N. A Site Location Plan is included in **Appendix A**.

Development Proposals

1.10. The proposals comprise the development of 58 residential units (C3 use), including landscaping and associated infrastructure works. The Site is to be served by an access road from Cuffley Hill.

1.11. A copy of the latest development layout is included in **Appendix A**.

2. POLICY CONTEXT

National Planning Policy Framework

2.1 The National Planning Policy Framework (NPPF) was introduced on 27 March 2012. This document was revised in July 2018, where paragraphs 155 to 169 inclusive, establish the Planning Policy relating to flood risk management. The Technical Guide to the NPPF has been superseded by the Planning Practice Guidance (PPG) in March 2014 and updated accordingly.

2.2 The main focus of the policy is to direct development towards areas of the lowest practicable flood risk and to ensure that all development is safe, without increasing flood risk elsewhere. The main considerations are:

- Applying the Sequential Test, and if necessary, applying the Exception Test;
- Safeguarding land from development that is required for current and future flood management;
- Using opportunities offered by new development to reduce the causes and impacts of flooding; and
- Where climate change is expected to increase flood risk so that some existing development may not be sustainable in the long-term, seeking opportunities to facilitate the relocation of development, including housing, to more sustainable locations.

Flood and Water Management Act (2010)

2.3 The Flood and Water Management Act 2010 defines clearer roles and responsibilities for the implementation of SuDS in developments, by requiring drainage systems to be approved against a set of draft national standards.

2.4 In December 2014, the government set out changes to planning that apply for major development from 6 May 2015. This change confirmed that in considering planning applications, Local Planning Authorities should consult the relevant Lead Local Flood Authority on the management of surface water; satisfy themselves that the proposed

minimum standards of operation are appropriate and ensure through the use of planning conditions or planning obligations that there are clear arrangements in place for ongoing maintenance over the lifetime of the development.

2.5 This means that Schedule 3 of the Flood and Water Management Act (FWMA) will not be enacted at this point in time and that Lead Local Flood Authorities (established at the county or unitary local authority level) will not be required to establish SuDS Approving Bodies (SABs) as previously envisaged by the FWMA.

2.6 In March 2015, the Government confirmed that as of the 15 May 2015, Lead Local Flood Authorities will become a statutory consultee on all major planning applications.

Regional & Local Planning Policy Review

2.7 In the preparation of this report, the following regional and local planning policy documents have been referred to:

- Local Flood Risk Management Strategy for Hertfordshire;
- Hertfordshire County Council Preliminary Flood Risk Assessment;
- Borough of Broxbourne Strategic Flood Risk Assessment (2016); and
- LLFA SuDS Policy Statement.

2.8 Collectively the above documents provide a strategy for not only assessing flood risk at a regional level but also guidance on the management of surface water on a site-specific basis.

2.9 The Site is part of the GO5 site which has been identified for allocation of circa 26 homes within the Broxbourne Borough Council (BBC) emerging Local Plan (2016). A full planning application has been prepared for 58 dwellings, which this FRA relates to.

3. BASELINE CONDITIONS

Topography

3.1. A topographical survey was carried out by Countryside Properties in July 2018. A copy of the survey is included within **Appendix B** and shows that the fall across the Site varies between 1:20 and 1:5, which is steep in development terms. The north-west and south-west corners in particular are the steepest areas of the Site.

3.2. The existing Site is split into two catchments: i) a northern catchment which drains to a ditch in the north-west part of the Site and ii) a southern catchment which drains to a ditch south-east of the Site, outside the extents of land ownership.

3.3. The north-west part of the Site comprises a mixture of woodland and scrubland. A Tree Survey was carried out in 2018, included in **Appendix C**, which identified a number of Category-U (dead) and Category-C (low quality) trees. An Arboricultural Report has been prepared to support this application, which considers the impact of the development proposals, including the proposed drainage.

Hydrology

3.4. Based on the topographic survey, there are ditches within the northern site boundary and outside of the south-western site boundary, both watercourses are understood to drain to Cuffley Book, approximately 600m to the west of the Site.

Existing Sewer Infrastructure

3.5. The sewer records held by Thames Water indicate that there are no foul or surface water sewers within the Site boundary.

3.6. There is a 150mm diameter foul sewer in the rear gardens of the properties along Cuffley Hill, to the immediate southwest of the site. There is also a 150mm diameter foul sewer to the south of the site within Cuffley Hill and a 225mm diameter foul sewer within Robinson Avenue.

3.7. There is also a 225mm diameter surface water sewer to the east and south of the site, running within the carriageway of Robinson Avenue to Cuffley Hill.

3.8. A copy of the Thames Water Record Plans is included in **Appendix C**.

Ground conditions

3.9. According to the British Geological Survey (BGS) online datasets, the bedrock is made up of London Clay Formation. There are superficial deposits of Lowestoft Formation, which forms extensive sheets of chalky till, together with outwash sands and gravels, silts and clays.

3.10. A geotechnical investigation has been carried out by Rolton Group in August 2018. The investigation confirmed ground conditions consist of clayey gravelly sand topsoil overlying firm to stiff sandy gravelly clay. Groundwater was encountered at depths of circa 2.8m whilst elevated levels of Lead, PAH and glass were encountered during the investigation.

3.11. The report concluded that that the predominantly clay soil across the site are unlikely to be suitable for disposal of stormwater by infiltration. The contamination, steep topography and shallow water table is also likely to preclude the use of infiltration-based SuDS within this development.

3.12. The Site is not located within any Source Protection Zone and therefore has no issues with groundwater recharge.

3.13. Refer to **Appendix D** for a copy of the Geotechnical Investigation.

4. SOURCES OF FLOODING

4.1. The NPPF requires flood risk from the following sources to be assessed, each of which are assessed separately below:

- Fluvial sources (river flooding);
- Tidal sources (flooding from the sea);
- Groundwater sources;
- Pluvial sources (flooding resulting from overland flows);
- Drainage flooding;
- Artificial sources, canals, reservoirs etc.; and,
- It also requires the risk from increases in surface water discharge to be assessed (surface water management).

Fluvial/Tidal Flooding

4.2. The Environment Agency's mapping indicates that the Site is located within Flood Zone 1 which means that the site has less than a 1 in 1,000 (0.1%) probability of river or sea flooding (low probability).

4.3. The Sequential and Exception Tests are therefore not required for this site, as it is located in Flood Zone 1.

4.4. The risk of flooding from rivers or sea is therefore extremely low.

Groundwater Flooding

4.5. According to the EA's mapping website, the site is located within the Total Catchment (Zone 1) Source Protection Zone, which is defined as the area around a source within which all groundwater recharge is presumed to be discharged at the source.

4.6. The geotechnical investigation confirmed the site is located in an area of clay and no groundwater was encountered within 2m of the existing ground levels.

4.7. Therefore, it is not anticipated that there will be a significant risk of groundwater flooding at the Site.

Pluvial Flooding

4.8. The EA flood maps for surface water indicate that the Site is located within an area of predominantly very low risk of surface water flooding, however, there are small areas of low risk to the north and south of the site and a medium risk of surface water flooding to the south. Refer to **Figure 4-1** below.

4.9. The SFRA sequential test identifies a small extent of surface water flooding for the 1 in 1000 year event, however this is understood to be related to the topography of the site.

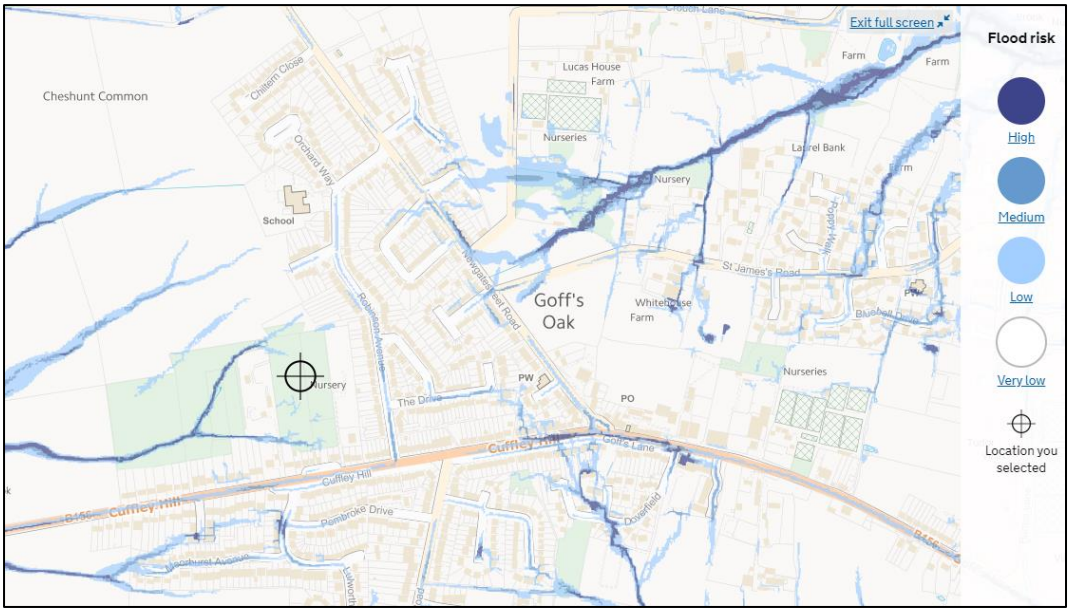

Figure 4-1: Extract of EA Surface Water Flood Mapping

Sewer Flooding

4.10. There have been no known sewer flooding events at the Site.

4.11. Thames Water has advised that there is sufficient capacity in the existing foul sewer network. Therefore, it is not anticipated that any upgrades to the sewer network will be required.

Artificial Sources

4.12. The Environment Agency's flood maps from reservoirs indicate that the site is not within an area as risk of flooding reservoirs, canals or other artificial water bodies.

4.13. The risk to the Site from reservoir flooding and other artificial sources is therefore considered very low.

5. FOUL AND SURFACE WATER MANAGEMENT

5.1. The Lead Local Flood Authority (LLFA) is HCC, who are responsible for reviewing the surface water drainage systems for major developments (ten dwellings or more), following changes to the planning process enacted in May 2015.

5.2. A non-statutory technical standard for sustainable drainage systems was published by the Department of Environment, Food and Rural Affairs in March 2015 to guide planning authorities, designers and developers on the use of SuDS. A Best Practice Guidance was published by the Local Authority SuDS Officer Organisation (LASOO) in July 2015 to accompany the aforementioned document.

5.3. The CIRIA guidance C753 (The SuDS manual) and The SuDS Guidance for Hertfordshire has been used to determine the appropriate SuDS strategy, which considers the spatial and environmental constraints of the site.

5.4. The Guidance to Support the NPPF (Climate Change Allowance for Planners) was updated in May 2016. The new guidance document considers 'Upper end' and 'Central' scenarios for peak rainfall intensity allowances in small urban catchments due to climate change, as shown in **Table 5-1** below.

Table 5-1: Peak Rainfall Intensity Allowance in Small Urban Catchments

Peak Rainfall Scenario	Total Potential Change for 2015 to 2039	Total Potential Change for 2040 to 2069	Total Potential Change for 2070 to 2115
Upper end	10%	20%	40%
Central	5%	10%	20%

5.5. Therefore, under this guidance, a conservative allowance of 40% for the effects of climate change would achieve the policy requirements for the proposed development.

Existing Surface Water Discharge

5.6. In line with CIRIA guidance C753 (The SuDS manual), Greenfield runoff rates have been calculated using the ICP SuDS method using WinDes MicroDrainage and are included in **Appendix E**:

- 1 year Greenfield runoff = 3.3 l/s; and
- 100 year Greenfield runoff = 12.4 l/s.

5.7. The existing Greenfield runoff rates are based on the development parcel within the northern catchment only, which is adjudged to be the contributing area to the existing ditch in the north-west corner of the Site. The runoff rates do not include the existing impermeable area or the southern catchment and therefore represent a conservative approach.

Proposed Surface Water Drainage and Options consideration

5.8. In line with CIRIA guidance C753 (The SuDS manual), the drainage hierarchy needs to be considered and is listed below in order of preference:

- Store rainwater for later use;
- Use infiltration techniques, such as porous surfaces in non-clay areas;
- Attenuate rainwater by storing in tanks or sealed water features for gradual release to a watercourse;
- Discharge rainwater direct to a watercourse;
- Discharge rainwater to a surface water drain; and
- Discharge rainwater to the combined sewer.

Store rainwater for later use

5.9. The potential to reuse a percentage of the rainwater from the site on the proposed development should be explored further during detail design, in particular through the use of water butts. This assessment considers the worst-case runoff rates and assumes this option is not viable.

Use infiltration techniques, such as porous surfaces in non-clay areas

5.10. Rolton Group has confirmed that infiltration is not suitable for the site due to the clay soils and therefore is not feasible as a means of surface water discharge.

Discharge to a watercourse at greenfield rates

5.11. There is an existing ditch in the north-west of the site, which the proposed drainage network will outfall to.

Proposed Sustainable Drainage Systems (SuDS)

5.12. **Table 5-2** below appraises the constraints and opportunities for the use of SuDS techniques within the Site and it adopts the management train approach outlined in CIRIA C753 'The SuDS Manual'.

Table 5-2: C753 SuDS Components - Management Train Approach

Type:	**Infiltration Devices** (Source Control)
Constraints:	The site is underlain by clay with poor infiltration capabilities.
Opportunities:	None.
Type:	**Permeable Paving** (Source Control)
Constraints:	Permeable paving potential is limited due to the presence of London clay.
Opportunities:	None.
Type:	**Swales/Filter Drains** (Permeable Conveyance)
Constraints:	Steep site will limit the potential for the use of above ground SuDS.
Opportunities:	Could be used for conveyance and to improve quality of surface water effluent.
Type:	**Attenuation Basin / Ponds** (end of pipe treatment)
Constraints:	Attenuation basin sizes will be restricted in size due to the number of trees onsite and steep site topography.
Opportunities:	Basins could be used to store water prior to discharging into the nearby ditch and to allow additional treatment of the surface water runoff.
Type:	**Buried Storage** (end of pipe treatment)
Constraints:	None.
Opportunities:	Geocellular storage could be used within the network to provide additional storage if required.

5.13. After consideration of the CIRIA C753 management train approach, the most viable SuDS options for the Site is an attenuation basin discharging to the nearby ditch to the northwest of the site.

5.14. The proposed surface water drainage has been split into two catchments, serving the eastern and western parts of the site. The eastern catchment discharges off-site via both the east and west basins. The western catchment is at the lower part of the site and discharges off-site via the western basin only. The total discharge rates off-site (i.e. from the west catchment into the receiving watercourse) are in line with existing greenfield runoff which are outlined in **Section 6.6**.

5.15. The use of cascading basins will provide appropriate water quality treatment and will remove sediment prior to discharging into the ditch.

5.16. The two basins will provide a total storage volume of 870m^3 for the entire site for the 1 in 100 year 40% climate change event, providing a minimum freeboard of 0.3m. Storage Calculations are included within **Appendix E**.

5.17. The surface water calculations are based on an assumed impermeable area of 60% of the site area. This is considered conservative for the density of development.

5.18. The design of the basins takes account of the existing site topography - refer to the levels shown on 162101-004 Drainage Strategy, included in **Appendix F**.

Long Term Storage

5.19. Long Term Storage (LTS) will be required as the impermeable area on site is increasing. The LTS volume required is 386m^3, which has been calculated using the method outlined in CIRIA C753 SuDS Manual. The LTS will be provided within the eastern basin, which has a maximum discharge rate of 2.2l/s (i.e. less than 2/ls/ha).

5.20. Hertfordshire County Council has confirmed that new planning applications do not need to make allowance for future urban creep.

Stages of Treatment

5.21. In terms of surface water treatment, the integration of the SuDS features outlined above allow for a SuDS management train approach to be applied to ensure that surface water runoff is of sufficient quality, so as not to cause pollutant-based detriment to the receiving ditch.

5.22. In determining the necessary SuDS treatment methods, reference is made to Table 26.2, Table 26.3 and Table 26.4 of the SuDS Manual (CIRIA C753), which have been duplicated in **Appendix G**. The tables outline the 'Simple Index Approach' which sets out the water treatment criteria in relation to land use and SuDS performance evidence. To ensure sufficient treatment is proposed for surface waters, the total pollution mitigation index of the selected SuDS methods must equal or exceed the pollution hazard index for the site.

5.23. The assessment has been carried out based on the use of a system of cascading basins. A swale is also proposed upstream of the discharge to the existing watercourse which will aid in pollution control, however the has not been considered due to the short overall length of the swale.

Exceedance Routes

5.24. As a result of heavy or extreme storm events it is sometimes unavoidable for the capacities of sewers and other drainage systems to be exceeded. Drainage exceedance will occur when the rate of surface water runoff exceeds the inlet capacity of the drainage system, when the receiving water or pipe system becomes overloaded, blocked or when the outfall becomes restricted due to flood levels in the receiving water.

5.25. The routes will ultimately mimic the current flow routes associated with the existing site as a result of the topography. Flow arrows have been added to the Drainage Strategy Plan within **Appendix F** to indicate the exceedance routes through the development.

Future Maintenance

5.26. It is the intention that the piped elements of the surface water network (up to the outfall into the two proposed basins) will be adopted by Thames Water under a S104 agreement. The extent of the network proposed for adoption will be addressed at detailed design stage and agreed with Thames Water.

5.27. A management company will be appointed to maintain the SuDS elements of the surface water drainage strategy. Funding of the maintenance regime will be via the yearly maintenance fees from the development. All maintenance should be in accord with the best practices and the CIRIA Manual C753.

5.28. A maintenance and management plan for the SuDS features is included in **Appendix H**.

Proposed Foul Water Drainage

5.29. Under the new charging arrangements introduced in April 2018, it is the responsibility of Thames Water to provide capacity within the sewer network to facilitate the proposed development. However, Thames Water has confirmed in their Pre-Planning Response dated July 2018 that there is sufficient capacity within the adjacent foul sewer network to serve the development.

5.30. The proposed foul drainage can connect by gravity to the existing foul network to the south-west of the site. A Section 98 application has been submitted to Thames Water for the off-site gravity sewer.

5.31. A copy of the Thames Water sewer record plans and correspondence is included in **Appendix D**.

6. FLOOD RISK MANAGEMENT

6.1. This site-specific FRA aims to demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, reduce flood risk overall.

Finished Floor Levels and Thresholds

6.2. It is proposed that finished floor levels be set 150mm above the surrounding ground levels. In addition, safe access and egress is available to the site via the wider highway network as it is located in Flood Zone 1.

6.3. The surface water runoff from the development will be captured in the drainage system and exceedance routes will ensure the internal highways network direct flows away from the proposed dwellings.

6.4. The measures set out above will mitigate any risk of flooding to the individual properties.

7. CONCLUSIONS

7.1. This FRA and Drainage Strategy is based on observations, a review of published data, a topographic survey and geotechnical investigations.

7.2. The site is assessed to be within Flood Zone 1 and therefore not at risk of flooding from fluvial or tidal sources.

7.3. Flood risk from groundwater, canals and artificial sources, pluvial sources and overland flows are all considered to be low following the application of the proposed surface water drainage strategy outlined in **Section 6** and residual risk management strategy in **Section 7**.

7.4. Various SuDS techniques have been considered viable for this development and have been integrated within the proposals to form a SuDS management train. Cascading attenuation basins are proposed in the north-west corner of the site.

7.5. The SuDS have been designed to achieve adequate surface water treatment in line with CIRIA C753 guidance.

7.6. The proposed drainage system will be capable of managing runoff from all rainfall events up to and including the critical duration of a 1 in 100-year storm event plus 40% allowance for climate change. Residual surface water runoff will be wholly stored on-site before discharging to a nearby ditch in the north-west corner of the site by means of a series of SuDS features. Discharge of surface water will mimic existing conditions, with discharge rates limited to existing greenfield run-off rates.

7.7. The proposed foul sewer network within the development will drain by gravity to the existing foul sewer network to the south west of the site. Thames Water has confirmed capacity within the existing sewer network to serve the development.

7.8. In accordance with the requirements of Chapter 10 of the NPPF, the proposed development has been assessed for flood risk. Consideration has been given both to risk to the site, and to risk elsewhere caused by the anticipated development. Based on our assessment of the site setting and the proposed development, it is considered that the

proposed development can be constructed and operated safely and will not increase flood risk elsewhere.

Appendix A

Site Layouts

A1

NOTES

 DO NOT scale from this drawing.
Contractors, Sub Contractors and Suppliers are to check all relevant dimensions and levels of the site and building before commencing any shop drawings or building work. Any discrepancies should be recorded to the Architect.
Where applicable this drawing is to be read in conjunction with the Consultants' drawings.

REV	DESCRIPTION	DATE	AUTHOR	CHK'D
A	Status changed to Planning	11.10.18	KK	RP
B	Issued for planning	23.11.18	KK	RP

ACCOMMODATION SCHEDULE

PRIVATE

House Type	No of Bedrooms	SqFt	No	Total SqFt
301	3B	907	3	2721
319	3B	1047	2	2094
307	3B	1190	3	3570
404	4B	1281	5	6405
407	4B	1397	4	5588
409	4B	1494	3	4482
416	4B	1743	4	6972
434	4B	1784	3	5352
417	4B	1808	3	5424
502	5B	1970	5	9850
TOTALS			35	52458

Private housing plot areas (sqft)	52458

AFFORDABLE *

House Type	No of Bedrooms	SqFt	No	Total SqFt
2B FLAT	2B	667	6	4002
2AH	2B	775	11	8525
3AH	3B	893	6	5358
TOTALS			23	17885

Affordable housing plot areas (sqft)	17885

SITE TOTALS	58	70343

scale 1:500
0 10m 20m 30m

COUNTRYSIDE
Places People Love

PLANNING

thrive. architects
Portishead Office
Unit 5, Middle Bridge Business Park, Bristol Road, Portishead, BS20 6PN
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PROJECT
Land at Cuffley Hill
Goffs Oak
For: Countryside Properties

DRAWING
Site Layout

SCALE	DATE	AUTHOR	CHK'D
1:500 @ A1	Jun 18	KK	TW

JOB NO.	DRAWING NO.	REV
COUN180506	SL.01	B

CLIENT REF.

Appendix B

Topographical Survey

NOTE:
PETER NE□ SON S□R□E□ NO. 913006
SHO□ N IN FEINT LINE.

Rev	Date	By	Description	Chk'd
B	24/7/18	LH	DITCH DETAIL ADDED TO NORTH WEST CORNER	
A	20/10/16	LH	NORTHERN BOUNDARY DETAIL ADDED	

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title:
TOPOGRAPHICAL SURVEY UPDATE / BOUNDARY CHECK

scale: @A1	1/500	drawn by:	LH
date:	23/09/16	checked:	

drawing no:
SURV 2329

sheet no: **Sheet 1 of 1**

revision: **B**

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Appendix C

Thames Water Correspondence

Mr. George Brandy
ARDENT
41-43 St Mary 's Gate
Nottingham
NG1 1PU

Wastewater pre-planning
Our ref DS6050933

27 July 2018

Pre-planning enquiry: Confirmation of sufficient capacity

Dear Mr. Brandy,

Thank you for providing information on your development at *Land on the North of Cuffley Hill, Waltham Cross, Herts, EN7 5EX for Development proposal for 65 houses, foul discharge by gravity into MH TL31026952. No Surface Water proposal, assumed soakaways.*

We have completed the assessment of the foul water flows and surface water run-off based on the information submitted in your application with the purpose of assessing sewerage capacity within the existing Thames Water sewer network.

Foul Water

If your proposals progress in line with the details you've provided, we're pleased to confirm that there will be sufficient sewerage capacity in the adjacent foul water sewer network to serve your development.

This confirmation is valid for 12 months or for the life of any planning approval that this information is used to support, to a maximum of three years.

You'll need to keep us informed of any changes to your design – for example, an increase in the number or density of homes. Such changes could mean there is no longer sufficient capacity.

Surface Water

No surface water proposal, therefore we have assumed that the discharge will drain via soakaways and there will be no discharge into the Thames Water surface water sewer.

Contd…

What happens next?

Please make sure you submit your connection application, giving us at least 21 days' notice of the date you wish to make your new connection/s.

If you've any further questions, please contact me on 0203 577 9018 / 07747 640 273.

Yours sincerely

David Stamateris

Adoptions Engineer

Thames Water

Planning your wastewater

We've put together some information on sewerage to help you plan your new development.

How long does it take to get consent to connect to a sewer?

If you're applying for consent to connect to a sewer under Section 106 of the Water Industry Act 1991, you'll need to give us 21 days' notice.

I think I'll need to connect to a trunk sewer – is that possible?

Connecting directly to trunk sewers can be complex and dangerous, and we won't permit this at all in London. If you're considering a trunk sewer as a point of connection, please contact us as soon as possible to discuss.

How do I handle trade effluent and groundwater discharges?

You mustn't discharge non-domestic waste to our sewers without a valid trade effluent consent - doing this is an offence under Section 109(1) of the Water Industry Act 1991. You can call our trade effluent team on 0203 577 9200 to get help with trade effluent consents and ground water discharge permits.

Where can I discharge surface water?

The Lead Local Flood Authority, or if you are in a London Borough, 'The London Plan', advises that your development should utilise sustainable drainage systems (SuDS) unless there are practical reasons for not doing so. You should aim to achieve greenfield run-off rates and ensure you manage surface water run-off as close to its source as possible in line with the following drainage hierarchy:

1. Store rainwater for later use.
2. Use infiltration techniques, such as porous surfaces in non-clay areas.
3. Attenuate rainwater in ponds or open water features for gradual release.
4. Attenuate rainwater by storing in tanks or sealed water features for gradual release.
5. Discharge rainwater direct to a watercourse.
6. Discharge rainwater to a surface water sewer or drain.
7. Discharge rainwater to a combined sewer.

Please note that if you're discharging surface water anywhere other than to a public sewer – such as to a watercourse – you'll need approval from the relevant authority, for example the Environment Agency, the local authority or the Canals and Rivers Trust.

If you don't follow the surface water hierarchy you may not be granted planning permission, and Thames Water may seek to put conditions on the planning application.

There's no right of discharge of highway drainage into the public sewerage system, and we'd need to agree this with the relevant highway authority under Section 115 of the Water Industry Act 1991. You can contact us to discuss this further.

What can I do about redundant sewers and rising mains on my site?

On brownfield sites where existing sewers or rising mains need to be made redundant or diverted, the developer will need to fund the work, as set out in Section 185 of the Water Industry Act. If there's no practical way of making a diversion, we'll apply the standoff distances in Sewers for Adoption 7th edition to assess the width of easement required.

Appendix D

Geotechnical Investigation Results

ROLTON GROUP
ENGINEERING THE FUTURE™

18-0446

GEO-ENVIRONMENTAL AND GEOTECHNICAL REPORT

FOR

COUNTRYSIDE PROPERTIES

AT

CUFFLEY HILL, GOFFS OAK HERTFORDSHIRE

REVISION 1.0

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PREFACE

a) The comments given in this report and the opinions expressed are based on the ground conditions encountered during the site work and on the results of tests made in the field and laboratory. However, there may be special conditions prevailing at the site which have not been disclosed by the investigation and which have not been taken into account in the report. Accordingly, a careful watch should be maintained in any future groundworks and the findings and recommendations of this report reviewed, if necessary, as work proceeds.

b) The comments on groundwater conditions are based on observations made at the time the site work was carried out. It should be noted that groundwater levels vary owing to seasonal and other effects.

SUMMARY

CLIENT DETAILS	Countryside Properties.
PROPOSED DEVELOPMENT	Residential houses and flats, with private front and rear gardens, served by new roads. An area of public open space is proposed in the north west of the site.
THE SITE	
Location	North of Cuffley Hill in the west of Goffs Oak, Hertfordshire.
National Grid Ref	531717, 203075.
Topography	Ground level falls from around 101.5mAOD at the north eastern corner of the site to around 91.5mAOD in the south west.
Description	The majority of the site is grassed open space with many mature trees. In the east of the site is a light industrial compound formed of steel containers and heras fencing. There is an area of maintained lawn in the south east of the site.
Site History	The site was historically agricultural fields before use as commercial Nurseries between 1898 and 1999.
ENVIRONMENTAL SETTING	
Geology	BGS mapping shows the site to be underlain by the Lowestoft Formation (superficial Boulder Clay) with London Clay bedrock.
Hydro-geology	The Lowestoft Formation is indicated to be a Secondary Undifferentiated aquifer; the London Clay is Unproductive Strata.
Hydrology	There are drains and ditches at field boundaries within 500m of the site. The nearest is around 50m west. Cuffley Brook is present around 600m west of site.
Radon	No Radon protection measures are required for new dwellings.
LAND USES	
Surroundings	Land to the east and south is predominantly residential housing; there is a light industrial area and an area of woods to the immediate west. Wider land to the north and west is agricultural fields.
Landfills	There are no registered active landfills or waste treatment facilities on site or in the near vicinity. Historic landfills are recorded to the west and northwest; the nearest is 714m away and is indicated to have taken inert and industrial wastes between 1955 and 1968.
Coal Mining / Cavities	The site is not located in a coal mining area. Records indicate a gravel pit as being present around 235m west of site.

GROUND CONDITIONS	
Soils/Rock	Ground conditions consist of clayey gravelly sand topsoil overlying firm to stiff sandy gravelly clay, locally being more granular. The topsoil locally contained large amounts or glass. Made ground was recorded to 600mm depth in one location in the east of the site.
Groundwater	Groundwater was encountered in 2 of the 11 trial pits at 2.80m and 2.85m depth respectively. Damp soils were encountered locally, associated with more granular strata.
Excavations	Excavations should be possible with normal backhoe plant. Some pit wall instability was encountered below 2.1m and 2.7m.
FOUNDATION DESIGN	
Type	Trench fill foundations to 1.0m depth with deepening required in proximity to trees and shrubs, plus heave protection as necessary. Due to the presence of shrinkable soils and trees, foundations are likely to exceed 2.5m depth across much of the site; an alternative foundation solution should be considered. Driven or bored piling is technically feasible – bored CFA may be preferred to reduce noise and vibration.
Bearing Pressure	Minimum 125kN/m^2 for trench fill foundations.
Concrete Mix	Shallow mass concrete conditions: DS-2, AC-3z. Based on foundations placed in natural soils with mobile groundwater.
GROUND FLOOR SLABS	
	Ground bearing slabs are not recommended due to the presence of trees and shrinkable soils. Suspended precast ground floors are recommended throughout over a minimum 300mm ventilated void. No gas protection measures are required (for Radon or landfill gases).
INFRASTRUCTURE DESIGN	
Soakaways	The predominantly clay soils across the site are unlikely to be suitable for disposal of stormwater by soakaways.
Roads and Hardstandings	CBR testing gave values in the range 2.7% - 7.4%. A preliminary design CBR of at least 3% is recommended.

CONTAMINATION AND REMEDIATION WORKS	
Soil Contamination	No asbestos detected (8 samples tested). Lead is elevated above guidance in 6 out of 11 samples tested. Some recorded TPH but not above guidance. Two locations have PAH exceeding guidance. Generally, elevated concentrations are in the eastern part of the site.
Topsoil	Topsoil is not compliant with BS3882 (1 sample tested); non-compliance is for organic content, stone content and nutrients.
Remedial Works / Mitigation Measures	Private gardens will require clean imported topsoil. The existing topsoil may remain in public open spaces provided that it is covered with at least 300mm of clean soils including imported topsoil cover.
Waste Classification	Natural soil arisings are likely to be classed as inert. Topsoil and made ground may be classified as non-hazardous.
Water Supply Mains	Protective materials may be required. The suitability of polymer water supply mains should be confirmed by the water supplier.
ADDITIONAL INVESTIGATIONS	
	It is anticipated that some foundations may exceed 2.5m depth and an alternative foundation solution will be required. Additional deep boreholes will be required for the design of piled foundations. Additional sampling and testing will be required beneath the compound in the east of the site.

1.0 INTRODUCTION

Countryside Properties (the Client) are proposing to develop a parcel of land off Cuffley Hill, Goffs Oak, Hertfordshire, with low-rise residential housing and flats. Rolton Group Ltd (RGL) has been appointed by the Client to undertake a geo-environmental desk study and intrusive investigation of the site for the purposes of assessing contamination presence and to provide recommendations for the design of foundations, ground floors and infrastructure.

The central and western parts of the site are predominantly grassed open space with many mature trees. In the east of the site is a small light industrial compound formed of steel containers and Heras fencing. There is an area of maintained lawn in the south east of the site currently being used by an adjacent property. This site covers an area of around 3.2 hectares.

This report presents the findings of the desk study and describes the investigation works undertaken, producing the findings together with an interpretation of the ground conditions and an assessment of engineering considerations with respect to the design of foundations, ground floors and infrastructure. An assessment of contamination presence and need for any remediation or other mitigation measures is also presented.

The intrusive investigations were carried out in general accordance with the procedures and recommendations of *British Standard BS 5930:2015, Code of Practice for Site Investigations* (Ref. 8.1). The assessment of contamination presence was undertaken in general accordance with the guidance and recommendations of *CLR11* The Model Procedures for the Management of Land Contamination (Ref. 8.2) published by the Environment Agency.

Although comments are given on hydrology this report does not constitute a Flood Risk Assessment; a Flood Risk Assessment report may be required for the site in support of any Planning application.

This report does not generally consider the potential presence of invasive plant species such as Japanese Knotweed or protected flora and fauna (including newts and badgers) unless specifically stated otherwise.

The topsoil currently on site is not suitable to remain in private gardens. It is recommended that a 300mm thickness of clean imported topsoil is placed in private gardens. The imported soils should be sampled and tested and a validation report produced upon completion.

Additional investigation including sampling and testing is recommended in the east of the site beneath the existing compound area following its removal, to determine the presence of any made ground or possible contamination.

Due to the presence of shrinkable soils and mature trees, it is anticipated that a number of plots will have foundations exceeding 2.5m depth; where this is the case, a piled foundation solution could be considered. Additional deep boreholes will be required to facilitate the design of piled foundations.

2.0 THE SITE

2.1 GENERAL COMMENTS

The following Section describes the site and surrounding land and their environmental features and setting. Much of the information is taken from the Envirocheck report in Appendix B – this collates information in the public domain from bodies such as the Environment Agency, Local Planning Authority, British Geological Survey and Natural England; other sources are indicated as appropriate.

Please note the northern site boundary indicated on the Envirocheck Report (Appendix B) is inaccurate – the boundary is shown to extend further north than the actual site boundary. A truer representation can be found on the Site Location Plan in Appendix A.

2.2 SITE LOCATION AND DESCRIPTION

The site is located to the north of Cuffley Hill in the west of Goffs Oak, south Hertfordshire. The site is roughly rectangular measuring approximately 150m by 250m at its widest extents and covering an area of around of 3.2 hectares. The site is shallowly west-dipping although locally undulating; ground level falls from around 101.5m AOD at the north eastern corner of the site to around 91.5m AOD in the south west. Access to the site is via a gated track at the south eastern corner leading off Cuffley Hill. The centre of the site is approximately National Grid Reference 531717 203075.

The eastern part of the site comprises a small light industrial compound including the following:-

- Steel containers;
- Abandoned vehicles;
- Storage containers and racking;
- Areas of hardstanding and gravel surfacing;
- General building materials and machinery (steel piping, bricks, paving slabs and cement mixer);
- Other general waste including: plastic jerry cans, step ladders, wheel barrows, industrial-use trolleys, paint cans, crockery, wood, paper and scrap metal.

Much of the eastern part of the site is also covered with dense nettles and brambles.

A maintained grass lawn of around 0.19 hectares occupies the south eastern part of site – this appears to be associated with the adjacent property and includes children's play equipment and a chicken coop.

The remainder of the site, covering the central and western parts, comprises a variety of mature and semi-mature trees, areas of dense bramble and other vegetation. In the central part of the site there are a number of narrow strips of hardstanding/concrete likely associated with the site's former usage as a commercial plant nursery.

The site boundary is generally formed of trees and hedgerows.

A Site Location Plan is included in Appendix A to this report.

2.3 SITE ENVIRONS

Land to the immediate east and south is predominantly low-rise residential housing with local amenities. There is a light industrial area, apparently associated with a landscaping company (CG Edward Ltd), and an area of woodland to the immediate west.

Wider land to the north, west and south is agricultural fields.

2.4 ENVIRONMENTAL SETTING

2.4.1 Geology

The British Geological Survey (BGS) map for the area, Sheet 239 'Hertford' (1:50,000) (Ref. 8.3) and the BGS online geology viewer (Ref. 8.4) show the site and the surrounding land to be underlain by superficial deposits of the Lowestoft Formation (Boulder Clay); this is described as 'chalky till with sands and gravels, silts and clays'.

Outcropping adjacent to the Lowestoft Formation (and possibility underlying it) are superficial deposits of the Dollis Hill Gravel Member (Pebble Gravel), described as 'gravel, sandy and clayey in part, with some laminated silty beds'.

The bedrock geology at depth is the London Clay Formation, this is described as 'blue-grey or grey-brown silty clays and clayey silts'.

The BGS map does not indicate any geological faults on site or in the immediate vicinity.

2.4.2 Hydro-geology

Mapping presented in the Envirocheck Report shows the Lowestoft Formation to be classified as a 'Secondary Undifferentiated' aquifer; the Dollis Hill Gravel Member is classified as a 'Secondary A Aquifer'. The London Clay Formation is shown to be classified as 'Unproductive Strata'.

Secondary Undifferentiated aquifers are soils or rocks that may have previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type. Secondary Aquifers can support water supplies at a local scale and can be a source of base flow to rivers.

The nearest groundwater abstraction, dating from April 2008, relates to groundwater taken for horticultural watering purposes around 400m north east of the site – it is not indicated if this supply is still in use.

2.4.3 Hydrology

There are drains and ditches at field boundaries within 500m of the site. The nearest is around 50m west; these generally all flow to the west. Cuffley Brook is located around 600m west of site, flowing roughly north to south.

Flood mapping indicates the site is not likely to be affected by flooding from rivers; the nearest affected area is located adjacent to Cuffley Brook around 600m west of the site. Mapping shows a few narrow strips forming low-points on the site surface, predominantly in the north and south of the site, to have a low to medium risk of flooding from surface water.

2.4.4 Radon

No Radon measures are indicated as necessary for the site.

2.5 SITE HISTORY

The table below summarises the features on the historic Ordnance Survey maps for the site and surrounding area. Not all maps are described if features are unchanged from one edition to the next. For full details reference should be made to the maps in the Envirocheck report in Appendix B.

Please note the site boundary indicated on the Envirocheck Report (Appendix B) is inaccurate. The boundary extends too far to the north. A truer representation can be found in the Site Location Plan in Appendix A.

MAP DATE & SCALE	ON SITE	SURROUNDING LAND
1873-1881 (1:2,500) & 1882 (1:10,560)	A number of field boundaries are present on site and at the perimeter.	Most of the surrounding land appears to be open fields with generally tree lined boundaries. An area of trees and rough grass is indicated immediately west of site. Cuffley Hill (a road) is located around 35m south of site. The settlement of Goffs Oak, comprising mostly farms, is shown around 450m east of site. Poydon Pits is shown around 650m south east of site [possible brick or gravel pits]. Cuffley Brook is indicated some 600m west of site.
1898 (1:2,500) & 1898-1899 (1:10,560)	The northern and central part of the site now comprises four smaller fields. A 'Nursery' and a 'Pump' are shown to occupy part of the south east corner of site. A group of smaller glazed buildings and a 'Well' are indicated as encroaching over the southern boundary of site.	A 'Nursery' is shown to the south of site. The wooded area to the west is shown extending to Cuffley Hill. Poplars Farm comprising a cluster of small units is indicated to be around 75m north east of site. Additional Nurseries are shown around 85m south and 180m north east of site. A cluster of Old Chalk and Gravel Pits are indicated around 600-850m north west of site.
1913-1914 (1:2,500) & 1916-1921 (1:10,560)	The Nursery buildings in the south east of the site have been extended. The Pump and the central field are no longer shown. Trees are shown on the south of site.	Additional units are shown immediately south of site. The Nurseries indicated 85m south and 180m north east have expanded. A Nursery is also indicated at Lucas End, around 650m north east of site. Enfield Branch Extension railway is shown around 980m west of site.
1935-1938 (1:2,500) & 1938 (1:10,560)	Two additional buildings are shown in the east of the site.	A Nursery is now present immediately west of the site. The wooded area immediately west of site is shown split into smaller areas. Housing development appears to be taking place along Cuffley Hill and on the land immediately east of site. Further Nurseries are shown around 500-950m north of site.
1945 Aerial Photo	The site appears largely unchanged.	Nurseries are shown around 220m south east of site and in the area around 500m-1km east and north east of site. The remaining land appears largely unchanged.
1960 (1:10,000)	Further buildings are indicated along the eastern boundary of site [likely associated with Nursery]. Two small buildings are shown on the centre of site with a track leading south.	Housing has been built on the land within 450m north of site.
1971-1973 (1:2,500) & 1974 (1:10,000)	The buildings occupying the north east of site are identified as a Nursery. The Nursery in the south east is identified as 'Fairmead Nursery'. Tanks are indicated between the two main Nursery buildings. Trees are indicated in the north and west of site. The buildings located in the centre and south of site are no longer shown. The northern boundary of site is defined by a new field boundary.	A handful of small buildings are shown on the land immediately west of site; the Nursery in this area is no longer present. Housing occupies most of the land to the north, east and south of site within 250-500m radius; Nurseries in this area have been replaced by housing. Nurseries occupy most of the land to the north east and east of site between 450m-1km.

MAP DATE & SCALE	ON SITE	SURROUNDING LAND
1988 (1:10,000)	The site appears unchanged.	Much of the land within 500m of site remains unchanged.
1999 Aerial Photo & 1999 (1:10,000)	The central and western fields on site are shown to be covered by trees and scrub. The Nurseries and Tanks in the east are no longer shown; some small units remain in the central eastern area. A field is shown occupying the south east corner.	Much of the land within 500m of site appears unchanged. A large number of Nurseries have been replaced with housing between 500m and 1km east and north east of site.
2018 (1:10,000)	The site appears unchanged.	Much of the land within 500m of site appears unchanged.

Table 1 – Historic Mapping Summary

2.6 ENVIRONMENTAL SETTING

The following summarises the most relevant environmental features of the site and surrounding land – for full details reference should be made to the Envirocheck report in Appendix B.

- No active landfills are located within 1km of the site;
- A historic landfill of relatively small size is indicated around 730m north west of site, at Lucas House farm - license dated January 1997. The waste type accepted is not specified;
- No Waste Management licenses are recorded within 1km of site;
- The site is not in an area associated with coal mining;
- There are two recorded active or historic mineral sites within 500m of site;
- A record of Man-Made Mining Cavities, described as Possible Crown Hole Collapses, is very approximately located around 186m south east of site [this does not match with any other activities or any other records, identifiable on historical maps];
- Historic Opencast extraction of the Dollis Hill Gravel Member at Poplars Farm Pit is indicated around 236m west of site – extraction indicated to have **ceased**.

A number of current and past industries (or industrial features) are recorded in the vicinity – these may have (or have had) the potential to release contaminants – the nearest are:-

- Tanks [for above ground storage?] - around 8m east of site;
- Washing Machine Servicing and Repairs – recorded as 106m north east of site and **active**;
- Commercial Cleaning Services – 157m south west of site and inactive;
- Road Haulage Services – 287m north of site and **active**;
- Laundries and Laundrettes – 398m east of site and **active**;
- Garage Services – 407m east of site and **active**.

The nearest Fuel Station is recorded as 393m east of site.

The site is not indicated to be in close proximity to any Site of Special Scientific Interest (SSSI), Nature Reserve or other similar sensitive land use.

3.0 PROPOSED DEVELOPMENT

A preliminary Site Layout was provided by the client (drawing number SL.01, dated 25/06/18). The development is understood to comprise the following:-

- 60 residential dwellings comprising a mixture of detached, semi-detached, terraced houses and flats;
- New access road leading off Cuffley Hill from the south;
- The properties will have private front and rear gardens;
- The site will include general and private use parking areas;
- Existing trees are shown largely preserved across the site with new tree/shrub and hedge planting proposed along new access roads and in gardens;
- About a quarter of the site in the north will be public open space incorporating a stormwater storage basin.

There would appear no reason to significantly alter site ground levels to facilitate the development although some local regrading will be required.

Based on the properties being built in brick and block cavity walling, loads to foundations will likely be of the order of 25-75kN/m.run for the houses and up to 150kN/m.run for the flats.

4.0 INVESTIGATIONS

4.1 FIELDWORK

From the above desk studies it was concluded that intrusive site investigation works should be undertaken, initially by machine excavated trial pits. These would identify the general geology across the site and allow sampling and testing of near surface soils. Based on the results of initial trial pit investigation the requirement for boreholes could then be determined.

The investigation locations were determined by RGL to give general coverage of the site. The investigations were undertaken in general accordance with BS 5930 (Ref. 8.1).

The most southern segment of site, where the proposed new site access will be located (indicated on the Exploratory Hole Location Layout – Appendix A), was not accessible at the time of our investigation due to the presence of dense vegetation. Access was also restricted in parts of the east of the site due to the presence of the compound and further dense vegetation adjacent to the eastern site boundary.

It should be borne in mind that the ground investigation was undertaken following a period of extended warm weather, and this may have a bearing on the apparent strength of shallow soils and occurrence of desiccation.

On 11 July 2018 eleven trial pits (TP2-TP12) were excavated across the site. Ten of the trial pits were dug to between 2.9m and 3.2m depth; trial pit TP11 in the south east of the site was dug to 400mm depth to investigate topsoil and shallow soils only. The trial pits were formed with a JCB-3CX backhoe excavator under the supervision of an RGL engineer. The pits were logged as excavation proceeded and the holes were backfilled with arisings upon completion. Selected soil samples were recovered for chemical and geotechnical laboratory testing.

Samples for contamination testing were taken of topsoil or any made ground on the basis that any contaminants were likely to be present here resulting from surface release or deposition. Samples were sealed in amber jars supplied by the testing laboratory and kept in 'cool boxes' prior to dispatch to the laboratory.

California Bearing Ratio (CBR) testing was undertaken at 10 locations (CBR01-CBR10) across the site along the routes of the proposed roads. Testing was undertaken by Socotec, a construction materials specialist, by use of an insitu plunger from the back of a 4x4 vehicle. The topsoil or surface soil was excavated to a depth of around 400mm and the test was performed on the underlying strata.

An Exploratory Hole Location Layout is presented in Appendix A. Exploratory hole logs are presented in Appendix C. CBR test results are presented in Appendix D.

4.2 LABORATORY TESTING

Geotechnical laboratory tests were scheduled by RGL on 28 representative soil samples from up to 3.1m depth across the site. The testing was undertaken by Geotechnics, in accordance with BS1377 (Ref. 8.7). Geotechnical tests included:-

- Moisture Content (18 samples);
- Atterberg Limit (18 samples);
- Water Soluble Sulphate (15 samples);
- pH measurement (15 samples).

Chemical laboratory tests were initially scheduled by RGL for 11 selected shallow soil samples (including topsoil and made ground). Chemical analyses for a broad range of determinands were undertaken by Chemtest Ltd, a UKAS (United Kingdom Accreditation Service) accredited laboratory. Chemical testing included:-

- Heavy Metals – Cadmium, Chromium (Total and Hexavalent), Lead, Nickel, Selenium & Mercury;
- Phytotoxic Metals – Copper & Zinc;
- Organic Compounds – Phenols & Soil Organic Matter;
- Speciated Polycyclic Aromatic Hydrocarbons (PAH);
- Total Petroleum Hydrocarbons (TPH);
- Other compounds – Arsenic, Cyanide, Boron & Sulphate;
- Asbestos.

One topsoil sample was tested to topsoil compliance to BS3882:2015 (Ref 8.17).

The results of all the laboratory tests are presented in Appendix E.

5.0 GROUND CONDITIONS

5.1 STRATA ENCOUNTERED

Full details of strata encountered can be found in the Exploratory Hole Logs presented in Appendix C.

5.1.1 Topsoil

The site is generally covered by a dark brown clayey gravelly sand topsoil of between 300mm and 410mm thickness. The gravel was identified as being fine to medium flint and mudstone. Fragments of glass of up to 100mm length were also observed in 7 of 11 trial pits.

5.1.2 Concrete and Made Ground

Concrete strips and pads were observed in the central and eastern parts of the site. The strip immediately adjacent to TP06 in the centre of the site was found to be of 300mm thickness at the edge.

Made ground was found in TP08 in the south east of the site to 620mm depth. This comprised a clayey gravelly sand – gravel included flint, mudstone, brick (whole and fragments), pipe, ash, and glass fragments.

5.1.3 Natural Ground

The natural ground conditions across the site are consistent with the anticipated geology (Lowestoft Formation) based on published mapping. Soils generally comprised sandy gravelly clays and clayey gravelly sands; the sandy soils were generally found towards the southern half of site.

The following localised variable conditions were also encountered on site:-

- Friable clay between 1.3m and 3.0m depth in TP02 in the north west of the site;
- Sand between 2.8m and 3.0m depth in TP05 in the west of the site;
- Dark grey sandy clay between 2.3m to 2.4m depth in TP07 in the east of the site;
- Gravelly sand between 1.4m and 2.9m depth in TP12 in the south of the site.

Soils were generally assessed as firm to stiff where cohesive, or medium dense where granular.

Soil strength was assessed by the resistance to excavation, visual appearance and the short-term stability of trial pits; soils encountered were too friable or granular to enable reliable use of a hand shear vane.

Laboratory testing shows the soils to have a plasticity index in the range 1.5% to 51.5% (when adjusted for granular content); most results were in the range 10-38%.

5.2 GROUNDWATER

During the site investigation fieldwork slight to moderate groundwater flow was encountered in 2 of the 11 trial pits; at 2.8m depth in TP5 in the west of the site, and at 2.85m depth in TP12 in the south of the site. Damp to wet soils were also encountered in:-

- TP09 between 1.5m-2.3m depth;
- TP10 between 2.6m - 3.2m depth;
- TP12 between 2.1m - 2.9m depth.

The groundwater seepages and dampness were generally observed in the predominantly granular soils.

It should be borne in mind however that groundwater levels may vary seasonally and according to prevailing weather conditions and the ground investigation was undertaken following an extended period of dry weather.

6.0 ENGINEERING ASSESSMENT

6.1 SITE CLEARANCE

The proposed redevelopment includes preserving many of the mature trees across the site, however some vegetation including brambles and shrubs will need to be cleared from the east and south of the site. A record should be kept of all cleared vegetation and any removed trees, to assist with foundation design. Care should be taken during all future groundworks to prevent, as far as possible, causing damage to existing trees to remain or their root systems.

Demolition/removal of the compound area in the east of the site is still to be undertaken. The majority of the structures appear temporary/modular however it is not known if they are on concrete bases or foundations. There is a significant proportion of waste and rubbish in this area of the site – a hazardous material survey should be undertaken prior to removal. It should be noted that the metal storage containers were not entered as part of our investigation. Further sampling and testing should be undertaken following the clearing of this area of the site to determine the presence of any made ground and identify if the underlying soils have been contaminated.

Concrete pads and slabs are present in the central and south eastern part of the site – these would appear suitable for crushing and reuse as hardcore.

6.1.1 Topsoil

A number of locations across the site encountered a high proportion of glass within the topsoil. Elevated concentrations of contaminates were also recorded at a number of locations across the site.

One sample of topsoil taken from the central part of the site was tested for topsoil compliance to BS3882 *Specification for topsoil* (Ref 8.17). This shows that the topsoil tested was non-complaint due to insufficient organic matter, high stone content and insufficient available nutrients.

For the above reasons, the topsoil currently present on site would not appear suitable for re-use in private gardens. This is discussed further in Section 7.5 below.

6.2 GROUND STABILITY

The site is only shallowly sloping locally and therefore slope stability is not considered to present problems for development.

The area is not associated with mining.

The exploratory holes did not identify any voids, or especially soft or compressible soils.

It is anticipated that the site will be suitable for normal construction activities without the need for special measures to stabilise the ground – provided that demolition and site clearance is suitably undertaken with all voids appropriately backfilled. It should be noted that the predominantly clay soils may degrade and soften when wet.

6.3 FOUNDATIONS

6.3.1 Traditional Foundations

The sand, gravel and clay soils are considered suitable to provide adequate bearing pressures for conventional trench fill foundations for the low-rise housing proposed.

Plasticity testing shows modified plasticity indices in the range 1.5% to 51.48%; the soils on site should therefore be classified as of '**high**' volume change potential based on NHBC guidance (Ref. 8.10). The foundations should be taken beneath the topsoil, disturbed material or made ground to bear within competent natural ground at a minimum depth of 1.0m.

Additional deepening will be required in proximity to existing trees, trees that will be removed and also proposed trees and shrubs, in order to be beneath soils liable to experience moisture related movements – shrinkage and/or swelling. The basis for such deepening should be NHBC Standards Chapter 4.2 'Building Near Trees' (Ref. 8.10).

In addition, where founding near existing or removed trees and shrubs, foundations should be protected as necessary against the effects of possible heave recovery, by the provision of a compressible liner such as 'claymaster'. Again, guidance is given in NHBC Standards. Note – the Lowestoft Formation can be naturally chalky and dry, and so it will be difficult to differentiate between desiccated and un-desiccated ground. A precautionary approach should be adopted by the foundation designer and clay heave protection measures should not be changed on site without reference to the designer.

Foundations competently designed to the above criteria may adopt a maximum safe bearing pressure of 125kN/m², which will provide an adequate factor of safety against bearing failure and limit total settlements to less than 25mm.

Where mixed foundation formations are encountered (clay and granular soils) there would be no merit in attempting to found any building entirely in one material by attempting, for example, to excavate beneath granular soils where encountered. The above bearing pressure is reasonably conservative, given the soil strengths encountered in the investigation, and the differential settlement that may result from varying soil types will be insignificant. Similarly, there would be no merit in providing reinforcement where formations vary from clay to granular soils.

6.3.2 Special Foundations (Piling)

Because of the presence of trees and shrubs across most of the site and at the boundaries, it is envisaged that all foundations will require significant deepening to the above guidance; where deepening would exceed 2.0-2.5m a piled foundation should be considered.

The site geology is technically suitable for either driven or bored piles; the proximity of existing houses may preclude driven piles because of vibration and noise but a suitable piling specialist should be consulted.

Piles and ground beams will also need to be designed to cater for possible heave recovery of the ground where the ground has been affected by existing or removed trees. Piles will need to be designed to resist any uplift forces; ground beams will require compressible liners beneath them and to inside faces to absorb heave movements. Guidance is given in NHBC Standards (Ref. 8.9).

If a piled foundation solution is adopted further investigation by deep boreholes will be required to facilitate foundation design.

6.4 GROUND FLOOR SLABS

Because of the presence of shrinkable clay and many trees and shrubs, it is recommended that all ground floor slabs are suspended precast concrete. A minimum ventilated void of at least 300mm depth will be required to cater for heave recovery of the ground.

All topsoil or organic matter should be removed under buildings.

The site is not within an area requiring Radon protection measures. There are no plausible sources of hazardous ground gases and therefore no gas protection measures are required to ground floor slabs.

6.5 ROADS AND HARDSTANDINGS

California Bearing Ratio (CBR) testing was undertaken on soils beneath any topsoil at 10 locations across the site – generally along the routes of the proposed roads. Results were in the range 2.7% to 7.4%, with the average of 5.3%. For preliminary design purposes a CBR design value of 3.0% would appear reasonable on natural undisturbed soils.

All topsoil, degradable material and soft soils should be removed from road and hardstanding formations and replaced with suitable well-compacted capping material – all roads and highways works to be in accordance with the recommendations of the Specification for Highway Works (Ref. 8.11).

6.6 EXCAVATIONS AND GROUNDWATER CONTROL

Excavations at the site should generally be readily formed by backhoe excavator. The more granular soils are likely to become unstable quickly (particularly if there is any groundwater in wetter conditions) and excavations should be planned accordingly.

It is essential that all excavation works carried out during construction at the site (and especially any requiring man access) strictly adhere to current legislation & guidance (Refs. 9.5-9.8), including, but not limited to, design, inspections, reporting and provision of appropriate support or other safety measures.

Care should be taken when excavating, especially to depth, in proximity to the trees to remain both on site and close to the boundaries. In general it is less damaging to trees if excavations are not undertaken so as to cut across roots radiating from the tree bowl – in general excavations that are positioned running towards the tree trunk or away from it are preferred. Advice should be taken from a tree specialist.

Groundwater was only encountered at depth in two of the 11 trial pits. It should also be borne in mind that exploratory holes were formed following a period of prolonged dry weather and groundwater conditions can vary seasonally. Perched seepages (in granular layers or at the base of any made ground for example) may result following prolonged periods of wet weather.

6.7 SOAKAWAYS AND DRAINAGE

The trial pits by RGL across the site indicated predominantly clayey soils. The Lowestoft Formation has been demonstrated to be high plasticity and therefore effectively impermeable. The site is not therefore suitable for the adoption of soakaways for the disposal of stormwater.

6.8 CHEMICAL ATTACK ON BURIED CONCRETE

Laboratory testing results taken from topsoil across the site show mildly acidic soils in the range 5.0 to 7.8 with generally low concentrations of soluble sulphates in the range <0.01 g/litre - 0.38g/litre. Testing on natural soils at depth (between 800mm and 2.9m) show mildly acidic soils in the range 4.76 to 7.39 and soluble sulphate in the range 0.02 g/litre - 1.89 g/litre.

From the above, assuming potentially mobile groundwater and that concrete is placed in natural soils, it is considered that buried concrete in accordance with BRE Special Digest 1: 2005 Concrete in Aggressive Ground (Ref. 8.12) should be designed to DS-2 and AC-3z.

7.0 GEO-ENVIRONMENTAL ASSESSMENT

7.1 LEGISLATION AND GUIDANCE

Prior to any development, the Local Planning Authority is required to satisfy itself that the potential for contamination has been properly assessed and that any necessary remedial works will be appropriately incorporated within the development. For any future development, it is the responsibility of the landowner and/or developer to carry out the necessary investigation, assessment and remediation.

Current governmental legislation defines contaminated land in the Environment Act 1995 and Part IIA of the Environmental Protection Act 1990 (Ref. 8.13), as:-

'Any land which appears to the local authority to be in such a condition, by reasons of substances in, on or under the land, that:-

- significant harm is being caused or there is significant possibility of such harm being caused;

Or

- pollution of controlled waters is being, or is likely to be caused'.

Current legislation and guidance recommends the use of source – pathway – receptor linkage model to assess the risk of contamination within a site. These three essential elements are described as:-

Source – a contaminant or hazard which is in, on or under the land and has the potential to cause harm or pollution of controlled waters.
Pathway – means by which a receptor can be exposed to, or affected by, a contaminant or hazard.
Receptor – something that could be adversely affected by a contaminant or hazard e.g. end-users and controlled waters.

A risk can only exist if all three elements are present. For example, even if a contaminant and a receptor are present, they can only create a risk when there is a pathway link between them. The table below (Table 2) represents a Conceptual Site Model with respect to possible contamination presence; it considers plausible pollutant linkages given the site's history, its environmental setting and the initial visual and physical findings of the investigation. This is then used to determine the appropriate chemical testing and risk assessment.

7.2 CONCEPTUAL SITE MODEL

The following table presents a Conceptual Site Model for the site (comments made on the condition of the site were accurate at the time of intrusive investigation works – July 2018):-

CONTAMINATIVE SOURCE	PATHWAY	RECEPTOR(S)	INITIAL RISK ASSESSMENT
Spillages of fuels or oils from vehicles (agricultural plant and Nursery vehicles). Contaminants are likely to be mobile Petroleum Hydrocarbons.	Ingestion, inhalation or direct contact.	Residents, construction personnel	There was no visual evidence of above ground fuel storage tanks currently on site. The Envirocheck report however indicates that 'Tanks' may have been present part way along the eastern boundary between 1971 and 1992. The arrangements for storage and refuelling of machinery and vehicles on site during usage as a Nursery is unknown. The main risk would be chronic exposure to residents in private gardens. Construction personnel would be at less risk due to the short exposure and basic health and safety measures that should be standard practice. The initial risk is assessed as **Moderate.**
	Seepage to depth or leaching to groundwater and flow off site or to surface waters.	Controlled waters.	The Lowestoft Formation underlying the site is classified as a Secondary Undifferentiated aquifer but does not represent a significant resource here – predominantly clay soils were encountered. There was no visual evidence of above ground fuel storage tanks currently on site. The nearest surface water feature is located around 50m west of the site. The initial risk is assessed as **Low to moderate.**
	Direct contact.	Buried services – mainly water supply mains.	Polymer water supply mains can be affected by even low concentrations of hydrocarbons but the effect is tainted water rather than a significant risk to health. The initial risk is assessed as **Low.**
Deposition of wastes at the surface or of burnt wastes or combustion products. Contaminants are likely to be metals, sulphates, asbestos or Polyaromatic Hydrocarbons.	Ingestion, inhalation or direct contact.	Residents, Construction personnel	There is some waste deposited around the container compound and some localised evidence of burning. The main risk would be chronic exposure to residents in private gardens. Construction personnel would be at less risk due to the short exposure and basic health and safety measures that should be standard practice. The initial risk (to residents) is assessed as **Moderate.**
	Leaching to groundwater and flow off site or to surface waters.	Controlled waters.	Groundwater was encountered at around 2.8m below the surface in the Lowestoft Formation. The Lowestoft Formation is classified as a Secondary Undifferentiated aquifer but does not represent a significant resource here. Predominantly clay soils were encountered. The initial risk is assessed as **Low to moderate.**
	Direct contact.	Buried building materials – mainly concrete.	The main risk would appear to be to concrete from potential sulphates. The initial risk is assessed as **Low.**

CONTAMINATIVE SOURCE	PATHWAY	RECEPTOR(S)	INITIAL RISK ASSESSMENT
Landfill gas from degradable buried wastes on site or nearby.	Inhalation and asphyxiation.	Residents, construction personnel	There are no recorded landfills within at least 700m of the site. There is no indication of likely infilled land on site or within the near vicinity and with the potential to generate hazardous gases. The initial risk is assessed as **low.**

Table 2 – Conceptual Site Model

The most significant plausible source-pathway-receptor pollutant linkage is considered to be that of residents (children mainly and to a lesser degree adults) at the site coming into long-term/repeated contact with soils by direct contact or inhalation or ingestion as a result of normal domestic activities in private gardens.

There appears likely to be little risk to controlled waters, construction workers or building materials.

A series of guideline values has been published by the Environment Agency to facilitate assessment of risk of soil contamination in the UK for several types of land use (Ref. 8.14). For residential housing with private gardens these consider 10 potential routes by which site users/occupiers may be exposed to contaminants in soils either directly, as outlined above, and also by consumption of site-grown vegetables. The CLEA Soil Guideline Values (SGVs) have been issued for a restricted range of contaminants however and therefore reference is made to other generally accepted criteria for the assessment of contaminated land.

The Chartered Institute of Environmental Health (CIEH) and Land Quality Management (LQM) have developed a series of Suitable For Use Levels (S4ULs) which identify concentrations of contaminants in soils regarded as posing a negligible risk to human health (Ref. 8.15).

There is no longer a SGV for Lead and no S4UL has been developed to replace the disused criteria. DEFRA has developed a series of Category 4 Screening Levels also for the assessment of risk to human health from contaminated land (Ref. 8.16). The C4SL for Lead represents a more cautious criterion for Lead than the old SGV and although only issued on a provisional basis represents current science.

7.3 ASSESSMENT OF CHEMICAL TEST RESULTS

7.3.1 Assessment of Soil Results

From the above model it was considered appropriate to test near-surface soils for a broad range of contaminants. Chemical analysis in a UKAS accredited laboratory was initially undertaken on 11 soil samples from across the site.

The table below summarises the chemical test results and compares these against SGVs or S4ULs for Residential housing use of the site.

DETERMINAND	CONCENTRATION (mg/kg)		RELEVANT GUIDANCE VALUE* (mg/kg)
	RANGE	AVERAGE	
Arsenic	8.3 - 34	15.8	SGV = 32 S4UL = 37
Boron	0.64 – 1.70	1.08	S4UL = 290
Cadmium	<0.10 – 1.40	<0.457	SGV = 10
Total Chromium	18 - 63	31	S4UL (Cr III) = 910
Chromium VI	All <0.5	All <0.5	S4UL = 6
Copper	8.3 – 96.0	42.4	S4UL = 2400
Lead	60 - 1000	337.6	provC4SL = 82 - 210
Mercury	<0.10 – 0.47	<0.27	SGV = 1.0
Nickel	8.5 - 29	16.5	SGV = 130
Selenium	0.31 – 0.72	0.50	SGV = 350
Zinc	40 - 300	148.8	S4UL = 3700
Cyanide	<0.5 – 0.6	<0.51	NA
Total Petroleum Hydrocarbons (TPH)	<10 - 160	<27.1	NA
Polyaromatic Hydrocarbons (PAH)	<2.0 – 38	<10.5	NA
Benzo[a]pyrene (BaP)	<0.1 - 1.8	<0.58	S4UL = 2.2 (1% soil organic matter)
Phenols	All <0.3	All <0.3	S4UL = 280
Other soil properties:			
Asbestos (8 samples)	None Detected	NA	NA
pH	5.0 – 7.8	6.61	NA
Organic matter (%)	1.9 - 11	5.25	NA
Soluble Sulphate (g/l)	<0.01 - 0.038	<0.015	NA

Table 3 – Chemical Test Results for Typical Contaminants in Soils

NA= Not Available or Not Applicable
* Where different values are indicated dependent on the form of the compound or the nature of the soil the lower value has been used.

From the results presented here and the full set of results presented in Appendix E the following observations can be made:-

- Slightly elevated Arsenic was recorded for a single sample, exceeding the SGV of 34mg/kg however below the S4UL limit of 37mg/kg (TP11 topsoil recorded 34mg/kg);
- The Lead provC4SL upper limit of 210mg/kg was exceeded by 6 of the 11 samples with a maximum recorded value of 1000mg/kg recorded in TP11. The average result also exceeds the provC4SL upper limit – the source of the elevated Lead is unknown;
- Other metals are present at low concentrations;
- Petroleum hydrocarbons are present but at low concentrations;
- Polyaromatic Hydrocarbons are generally below the guidance values for residential use but the residential guidance value for Dibenz(a,h)Anthracene was exceeded in 4 of the 11 samples tested;
- Asbestos was not detected in any samples.

7.4 RECOMMENDATIONS WITH RESPECT TO CONTAMINATION PRESENCE

7.4.1 Remediation Works or Mitigation Measures

Much of the topsoil on site is contaminated with broken glass. Most of the topsoil has elevated Lead and/or Dibenzo(ah)Anthracene – unsuitable for residential gardens.

The topsoil on site is not therefore considered suitable to remain in private gardens. Private gardens will require clean imported topsoil (recommended at least 300mm thick to provide a suitable growing medium).

The existing topsoil may remain in public open spaces provided that it is covered with at least 300mm of clean soils including imported topsoil cover.

The topsoil at the surface should be subject to testing to confirm it is suitable and clean and the placed thickness should be confirmed insitu.

The topsoil should be placed on suitably un-compacted subsoil. Guidance for the placement and storage of topsoil is given by DEFRA (Ref. 8.8).

Further soil sampling and chemical testing is recommended in the area around the compound in the east of the site to determine the presence of any made ground and identify any possible contamination.

7.4.2 General Considerations

The possibility of encountering further 'hotspots' of local contamination cannot be ruled out. Should suspicious material be encountered during the course of the development works (e.g. obvious waste or highly coloured or malodorous materials) they should be reported to RGL immediately for assessment and appropriate action.

7.4.3 Waste Classification

The natural soils (below the topsoil or any made ground) arising from excavation at the site are likely to be classified as inert for disposal purposes. The topsoil and any made ground may be classified as non-hazardous, this should be confirmed by the proposed receiving tip which should be provided with the results of the chemical testing carried out for this report.

7.4.4 Water Supply Pipes

Based on the ground investigation undertaken there would appear no requirement to use special materials for water supply mains. It is essential that this report is supplied to the relevant local water authority for them to assess their specific requirements for water pipe and associated construction materials.

7.4.5 Further Investigation

Additional investigations including chemical testing, are recommended for the area beneath the existing light industrial compound in the east of the site. The investigation should confirm the depth and type of any made ground and determine the presence of any contaminants.

The area in the south of the site that will form the site entrance was not accessible at the time of our investigation due to dense vegetation; it is anticipated that this area of the site is likely to be similar to the ground conditions encountered in the vicinity, however confirmatory investigations may be required to facilitate the design of the new access road and junction.

The clean topsoil required for placement in private gardens will require testing to confirm its suitability and validation of its placed thickness.

8.0 REFERENCES

8.1 British Standard 5930:2015, 'Code of Practice for Site Investigations'.

8.2 Defra & Environment Agency, 'CLR11: The Model Procedures for the Management of Land Contamination' (2004)

8.3 British Geological Survey, Sheet 221 'Hitchin' (1:50,000), 1995.

8.4 British Geological Survey, website: http://mapapps.bgs.ac.uk/geologyofbritain/home.html

8.5 British Standard 1377:1990, Part 2, 'Methods of Test for Soils for Civil Engineering Purposes: Classification Tests'.

8.6 British Standard 1377:1990, Part 9, 'Methods of Test for Soils for Civil Engineering Purposes: In-Situ Tests'.

8.7 British Standard 1377:1990, 'Methods of Test for Soils for Civil Engineering Purposes'.

8.8 Defra, 'Construction Code of Practice for the Sustainable Use of Soils on Construction Sites', 2009.

8.9 National House Building Council, NHBC Standards 2017

8.10 National House Building Council Standards - Chapter 4.2 'Building near trees'.

8.11 Highways Agency, 'Specification for Highway Works', 2014 with latest amendments.

8.12 Building Research Establishment, BRE Special Digest 1:2005 3rd edition, 'Concrete in Aggressive Ground'.

8.13 Defra, 'Environmental Protection Act 1990: Part 2A – Contaminated Land Statutory Guidance', 2012.

8.14 Environment Agency/DEFRA, 2009, Contaminated Land Exposure Assessment.

8.15 Chartered Institute of Environmental Health and Land Quality Management, 'The LQM/CIEH S4ULs for Human Health Risk Assessment', 2015.

8.16 DEFRA, 'Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination', 2014.

8.17 British Standard 3882:2015, 'Specification for Topsoil'.

Appendix E

Surface Water Drainage Calculations

Cascade Summary of Results for East Catchment - Storage 180830.srcx

Upstream Structures	Outflow To	Overflow To
(None)	West Catchment - Storage 181029.srcx	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	95.522	0.572	2.0	202.9	O K
30 min Summer	95.648	0.698	2.0	260.6	O K
60 min Summer	95.761	0.811	2.0	316.9	O K
120 min Summer	95.862	0.912	2.0	370.4	O K
180 min Summer	95.913	0.963	2.0	398.9	O K
240 min Summer	95.944	0.994	2.0	417.0	O K
360 min Summer	95.981	1.031	2.1	438.4	O K
480 min Summer	96.003	1.053	2.1	451.8	O K
600 min Summer	96.017	1.067	2.1	459.9	O K
720 min Summer	96.025	1.075	2.1	464.7	O K
960 min Summer	96.030	1.080	2.1	467.8	O K
1440 min Summer	96.016	1.066	2.1	459.8	O K
2160 min Summer	95.978	1.028	2.0	436.5	O K
2880 min Summer	95.942	0.992	2.0	415.5	O K
4320 min Summer	95.878	0.928	2.0	379.7	O K
5760 min Summer	95.822	0.872	2.0	348.8	O K
7200 min Summer	95.768	0.818	2.0	320.7	O K
8640 min Summer	95.717	0.767	2.0	294.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	143.954	0.0	164.2	27
30 min Summer	92.629	0.0	153.9	42
60 min Summer	56.713	0.0	308.3	72
120 min Summer	33.583	0.0	314.7	130
180 min Summer	24.424	0.0	313.6	190
240 min Summer	19.389	0.0	313.2	250
360 min Summer	13.924	0.0	313.2	368
480 min Summer	11.018	0.0	314.2	488
600 min Summer	9.182	0.0	315.9	606
720 min Summer	7.908	0.0	318.0	726
960 min Summer	6.245	0.0	320.3	964
1440 min Summer	4.471	0.0	319.1	1440
2160 min Summer	3.197	0.0	624.7	1844
2880 min Summer	2.518	0.0	608.5	2220
4320 min Summer	1.796	0.0	561.3	2992
5760 min Summer	1.413	0.0	772.3	3816
7200 min Summer	1.172	0.0	800.7	4624
8640 min Summer	1.006	0.0	824.3	5456

Cascade Summary of Results for East Catchment - Storage 180830.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m^3)	Status
10080 min Summer	95.665	0.715	2.0	269.1	O K
15 min Winter	95.577	0.627	2.0	227.6	O K
30 min Winter	95.712	0.762	2.0	292.2	O K
60 min Winter	95.835	0.885	2.0	355.6	O K
120 min Winter	95.943	0.993	2.0	416.2	O K
180 min Winter	95.998	1.048	2.1	449.0	O K
240 min Winter	96.033	1.083	2.1	470.0	O K
360 min Winter	96.074	1.124	2.1	495.5	O K
480 min Winter	96.101	1.151	2.2	512.0	O K
600 min Winter	96.117	1.167	2.2	522.7	O K
720 min Winter	96.128	1.178	2.2	529.5	O K
960 min Winter	96.138	1.188	2.2	535.9	O K
1440 min Winter	96.133	1.183	2.2	532.9	O K
2160 min Winter	96.099	1.149	2.2	510.8	O K
2880 min Winter	96.055	1.105	2.1	483.7	O K
4320 min Winter	95.980	1.030	2.1	437.7	O K
5760 min Winter	95.905	0.955	2.0	394.3	O K
7200 min Winter	95.831	0.881	2.0	353.5	O K
8640 min Winter	95.757	0.807	2.0	314.7	O K
10080 min Winter	95.682	0.732	2.0	277.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m^3)	Discharge Volume (m^3)	Time-Peak (mins)
10080 min Summer	0.884	0.0	844.3	6264
15 min Winter	143.954	0.0	160.4	27
30 min Winter	92.629	0.0	150.4	41
60 min Winter	56.713	0.0	315.5	70
120 min Winter	33.583	0.0	314.9	128
180 min Winter	24.424	0.0	315.8	188
240 min Winter	19.389	0.0	317.5	246
360 min Winter	13.924	0.0	322.1	362
480 min Winter	11.018	0.0	327.3	480
600 min Winter	9.182	0.0	330.6	596
720 min Winter	7.908	0.0	332.6	712
960 min Winter	6.245	0.0	334.2	942
1440 min Winter	4.471	0.0	331.7	1394
2160 min Winter	3.197	0.0	638.0	2036
2880 min Winter	2.518	0.0	622.7	2316
4320 min Winter	1.796	0.0	591.9	3240
5760 min Winter	1.413	0.0	864.9	4152
7200 min Winter	1.172	0.0	896.7	5048
8640 min Winter	1.006	0.0	922.9	5960
10080 min Winter	0.884	0.0	944.7	6768

Cascade Rainfall Details for East Catchment - Storage 180830.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.450	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.760

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.253	4	8	0.253	8	12	0.253

Cascade Model Details for East Catchment - Storage 180830.srcx

Storage is Online Cover Level (m) 96.500

Tank or Pond Structure

Invert Level (m) 94.950

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	278.0	1.550	795.0

Complex Outflow Control

Hydro-Brake® Optimum

Unit Reference	MD-SHE-0068-2200-1200-2200
Design Head (m)	1.200
Design Flow (l/s)	2.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	68
Invert Level (m)	94.950
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	2.2
Flush-Flo™	0.297	2.0
Kick-Flo®	0.602	1.6
Mean Flow over Head Range	-	1.8

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.7	1.200	2.2	3.000	3.4	7.000	5.0
0.200	1.9	1.400	2.4	3.500	3.6	7.500	5.1
0.300	2.0	1.600	2.5	4.000	3.8	8.000	5.3
0.400	2.0	1.800	2.6	4.500	4.0	8.500	5.5
0.500	1.9	2.000	2.8	5.000	4.3	9.000	5.6
0.600	1.6	2.200	2.9	5.500	4.4	9.500	5.8
0.800	1.8	2.400	3.0	6.000	4.6		
1.000	2.0	2.600	3.1	6.500	4.8		

Orifice

Diameter (m) 0.100 Discharge Coefficient 0.600 Invert Level (m) 96.150

Cascade Summary of Results for West Catchment - Storage 181029.srcx

Upstream Structures	Outflow To	Overflow To
East Catchment - Storage 180830.srcx	(None)	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	92.430	0.680	8.3	168.0	O K
30 min Summer	92.575	0.825	9.7	212.7	O K
60 min Summer	92.697	0.947	10.7	253.2	O K
120 min Summer	92.785	1.035	11.3	283.9	O K
180 min Summer	92.812	1.062	11.5	293.5	O K
240 min Summer	92.816	1.066	11.5	294.9	O K
360 min Summer	92.812	1.062	11.5	293.6	O K
480 min Summer	92.806	1.056	11.5	291.3	O K
600 min Summer	92.796	1.046	11.4	287.7	O K
720 min Summer	92.783	1.033	11.3	283.1	O K
960 min Summer	92.753	1.003	11.1	272.6	O K
1440 min Summer	92.688	0.938	10.6	250.3	O K
2160 min Summer	92.598	0.848	9.9	220.3	O K
2880 min Summer	92.524	0.774	9.2	196.7	O K
4320 min Summer	92.417	0.667	8.2	164.3	O K
5760 min Summer	92.347	0.597	7.4	144.0	O K
7200 min Summer	92.301	0.551	6.8	131.1	O K
8640 min Summer	92.271	0.521	6.4	122.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	143.954	0.0	322.8	26
30 min Summer	92.629	0.0	361.5	40
60 min Summer	56.713	0.0	569.9	68
120 min Summer	33.583	0.0	622.9	124
180 min Summer	24.424	0.0	651.2	182
240 min Summer	19.389	0.0	671.5	222
360 min Summer	13.924	0.0	700.7	280
480 min Summer	11.018	0.0	724.2	344
600 min Summer	9.182	0.0	744.1	412
720 min Summer	7.908	0.0	761.0	480
960 min Summer	6.245	0.0	787.0	616
1440 min Summer	4.471	0.0	820.6	884
2160 min Summer	3.197	0.0	1163.9	1276
2880 min Summer	2.518	0.0	1174.3	1648
4320 min Summer	1.796	0.0	1168.8	2380
5760 min Summer	1.413	0.0	1422.6	3072
7200 min Summer	1.172	0.0	1474.9	3760
8640 min Summer	1.006	0.0	1518.4	4496

Cascade Summary of Results for West Catchment - Storage 181029.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
10080 min Summer	92.247	0.497	6.0	116.3	O K
15 min Winter	92.496	0.746	9.0	188.1	O K
30 min Winter	92.654	0.904	10.3	238.7	O K
60 min Winter	92.787	1.037	11.3	284.8	O K
120 min Winter	92.886	1.136	12.0	320.7	O K
180 min Winter	92.918	1.168	12.2	332.9	O K
240 min Winter	92.925	1.175	12.3	335.4	O K
360 min Winter	92.912	1.162	12.2	330.7	O K
480 min Winter	92.900	1.150	12.1	326.1	O K
600 min Winter	92.882	1.132	12.0	319.4	O K
720 min Winter	92.861	1.111	11.8	311.5	O K
960 min Winter	92.814	1.064	11.5	294.4	O K
1440 min Winter	92.720	0.970	10.8	261.2	O K
2160 min Winter	92.597	0.847	9.9	219.9	O K
2880 min Winter	92.500	0.750	9.0	189.2	O K
4320 min Winter	92.369	0.619	7.7	150.1	O K
5760 min Winter	92.292	0.542	6.7	128.4	O K
7200 min Winter	92.250	0.500	6.0	116.9	O K
8640 min Winter	92.228	0.478	5.6	111.2	O K
10080 min Winter	92.215	0.465	5.2	107.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	0.884	0.0	1555.1	5240
15 min Winter	143.954	0.0	339.1	26
30 min Winter	92.629	0.0	384.8	39
60 min Winter	56.713	0.0	606.5	68
120 min Winter	33.583	0.0	661.9	122
180 min Winter	24.424	0.0	695.9	178
240 min Winter	19.389	0.0	721.1	232
360 min Winter	13.924	0.0	758.7	294
480 min Winter	11.018	0.0	788.4	368
600 min Winter	9.182	0.0	811.2	444
720 min Winter	7.908	0.0	829.6	520
960 min Winter	6.245	0.0	857.9	666
1440 min Winter	4.471	0.0	894.1	946
2160 min Winter	3.197	0.0	1242.5	1344
2880 min Winter	2.518	0.0	1258.6	1728
4320 min Winter	1.796	0.0	1274.5	2432
5760 min Winter	1.413	0.0	1593.2	3120
7200 min Winter	1.172	0.0	1651.7	3712
8640 min Winter	1.006	0.0	1700.0	4416
10080 min Winter	0.884	0.0	1740.0	5176

Cascade Rainfall Details for West Catchment - Storage 181029.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.450	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.640

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.213	4	8	0.213	8	12	0.213

Cascade Model Details for West Catchment - Storage 181029.srcx

Storage is Online Cover Level (m) 93.500

Tank or Pond Structure

Invert Level (m) 91.750

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	200.0	1.750	490.0

Complex Outflow Control

Hydro-Brake® Optimum

Unit Reference	MD-SHE-0096-3300-0300-3300
Design Head (m)	0.300
Design Flow (l/s)	3.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	96
Invert Level (m)	91.750
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.300	3.3
Flush-Flo™	0.138	3.3
Kick-Flo®	0.241	3.0
Mean Flow over Head Range	-	2.6

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.1	1.200	6.3	3.000	9.7	7.000	14.7
0.200	3.2	1.400	6.7	3.500	10.4	7.500	15.2
0.300	3.3	1.600	7.2	4.000	11.1	8.000	15.7
0.400	3.8	1.800	7.6	4.500	11.8	8.500	16.2
0.500	4.2	2.000	8.0	5.000	12.4	9.000	16.7
0.600	4.5	2.200	8.3	5.500	13.0	9.500	17.2
0.800	5.2	2.400	8.7	6.000	13.6		
1.000	5.8	2.600	9.0	6.500	14.2		

Orifice

Diameter (m) 0.058 Discharge Coefficient 0.600 Invert Level (m) 92.150

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.450
Area (ha)	0.920	Urban	0.000
SAAR (mm)	675	Region Number	Region 6

Results l/s

QBAR Rural	3.9
QBAR Urban	3.9
Q100 years	12.4
Q1 year	3.3
Q30 years	8.8
Q100 years	12.4

Appendix F

Drainage Strategy

KEY

- SITE BOUNDARY
- EXISTING DITCH
- EXISTING SURFACE WATER SEWER (THAMES WATER)
- PROPOSED SURFACE WATER SEWER
- PROPOSED SWALE
- PROPOSED HEADWALL
- PROPOSED ATTENUATION BASIN
- 95.05 PROPOSED GROUND LEVEL
- (97.50) EXISTING GROUND LEVEL
- SW EXCEEDANCE ROUTES
- EAST CATCHMENT
- WEST CATCHMENT
- EXISTING LIDAR CONTOURS

RETAINED TREES

- BLUE - CAT B GROUPS/HEDGES/TREES OF MODERATE QUALITY AND VALUE.
- GREY - CAT C GROUPS/HEDGES/TREES OF LOW QUALITY AND VALUE.
- RED - CATEGORY U TREE IN IRREVERSIBLE DECLINE OR DEAD
- ROOT PROTECTION AREA AS CALCULATED IN ACCORDANCE WITH BS 5837:2012

PROPOSED DRAINAGE STRATEGY REQUIRES REMOVAL OF SOME LOW QUALITY TREES. REFER TO ARBORICULTURAL DETAILS

PROPOSED ATTENUATION BASIN (WEST CATCHMENT)
BASE LEVEL 91.50
BASE AREA 200m²
MIN. TOP OF BANK LEVEL 93.30
TOP OF BANK AREA 750m²
ATTENUATION VOLUME 335m³
SIDE SLOPES 1:3 (1:2 AT PINCH POINTS)

PROPOSED SWALE TO CONNECT TO EXISTING DITCH

FLOW CONTROL DEVICE
DISCHARGE RATE
3.3 l/s (1:1) / 12.4 l/s (1:100)
CL 93.50
IL 91.70

FLOW CONTROL LIMITING DISCHARGE TO 2.2l/s TO PROVIDE. OVERFLOW INSTALLED FOR HIGH RAINFALL INTENSITIES
CL 96.50
IL 94.95

PROPOSED ATTENUATION BASIN (EAST CATCHMENT)
BASE LEVEL 94.95
BASE AREA 278m²
MIN. TOP OF BANK LEVEL 96.50
TOP OF BANK AREA 1160m²
ATTENUATION VOLUME 535m³
SIDE SLOPES 1:3 (1:2 AT PINCH POINTS)

6m EASEMENT REQUIRED FOR ADOPTABLE SEWERS WITHIN PRIVATE LAND. HIGHWAYS TO REMAIN PRIVATE - SEWER EASEMENTS NOT SHOWN FOR CLARITY

EAST CATCHMENT AREA 1.26 HA

WEST CATCHMENT AREA 1.06 HA

SW EXCEEDANCE ROUTES FOLLOW EXISTING TOPOGRAPHY. EXCEEDANCE RUNOFF WILL DRAIN TO EXISTING DITCH TO WEST OF SITE. PROPOSED SW DRAINAGE NETWORK DESIGNED TO ACCOMODATE 100 YR + 40% CC

SW EXCEEDANCE ROUTES FOLLOW EXISTING TOPOGRAPHY. EXCEEDANCE RUNOFF WILL DRAIN TO EXISTING DITCH TO WEST OF SITE. PROPOSED SW DRAINAGE NETWORK DESIGNED TO ACCOMODATE 100 YR + 40% CC

SW MH CL 94.80 IL 91.66
SW MH CL 96.10 IL 92.00
SW MH CL 97.15 IL 95.15
SW MH CL 99.25 IL 95.40 (300) IL 95.25 (450)
SW MH CL 95.25 IL 92.15
SW MH CL 97.25 IL 95.675 (225) IL 95.60 (300)
SW MH CL 99.50 IL 97.75
SW MH CL 95.10 IL 92.475 (225) IL 92.40 (300) IL 92.25 (450)
SW MH CL 96.50 IL 93.85
SW MH CL 94.25 IL 92.575
SW MH CL 96.80 IL 95.30
SW MH CL 97.30 IL 95.85
SW MH CL 100.75 IL 99.25

HEADWALL IL 91.55
HEADWALL IL 91.85
HEADWALL IL 91.60
HEADWALL IL 95.00
HEADWALL IL 95.05

450mm 1:500
450mm 1:81
450mm 1:385
300mm 1:8
300mm 1:25
300mm 1:240
225mm 1:20
225mm 1:21
225mm 1:170
225mm 1:60

Shelter

92.2m

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NOTES:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE RELEVANT SPECIFICATION AND ALL OTHER RELATED DRAWINGS ISSUED BY THE ENGINEER.
2. DO NOT SCALE FROM THIS DRAWING. WORK FROM FIGURED DIMENSIONS ONLY.
3. ALL DIMENSIONS SHOWN ON THIS DRAWING ARE IN METERS UNLESS OTHERWISE STATED.
4. ALL DIMENSIONS, LEVEL AND SURVEY GRID CO-ORDINATES ARE TO BE CHECKED ON SITE AND THE ENGINEER NOTIFIED IMMEDIATELY OF ANY DISCREPANCIES PRIOR TO THE COMMENCEMENT OF WORKS.
5. NO DEVIATION FROM THE DETAILS SHOWN ON THIS DRAWING IS PERMITTED WITHOUT PRIOR PERMISSION FROM THE ENGINEER.
6. ANY WORKS OUTSIDE RED SITE BOUNDARY ARE FOR INFORMATION PURPOSES ONLY. UNLESS SPECIFICALLY NOTED, ALL WORKS OUTSIDE THE SITE BOUNDARY WILL BE UNDERTAKEN BY OTHERS UNDER A SEPARATE.
7. ALL EXISTING SERVICE ROUTES HAVE BEEN TRANSCRIBED FROM THE RESPECTIVE UNDERTAKERS RECORDS AND AS SUCH NO RESPONSIBILITY IS ACCEPTED BY ARDENT CONSULTING ENGINEERS FOR THE ACCURACY OF ROUTES SHOWN.
8. THE AVOIDANCE AND PROTECTION OF SERVICES DURING THE WORKS IS THE RESPONSIBILITY OF THE CONTRACTOR.
9. THE CONTRACTOR IS REMINDED OF HIS OBLIGATION TO VERIFY THE ROUTE OF ALL SERVICES ON SITE PRIOR TO THE COMMENCEMENT OF THE WORKS.
10. THE CONTRACTOR SHOULD ALLOW FOR ANY NECESSARY LIAISON WITH THE STATUTORY UTILITIES DURING THE COURSE OF THE WORKS TO AVOID ANY DISRUPTION TO RETAINED SERVICES.
11. THE CONTRACTOR SHOULD NOTE THAT THE SERVICES SHOWN ARE NOT TO BE CONSIDERED EXHAUSTIVE. PRIVATE SERVICES MAY BE PRESENT WITHIN THE LIMIT OF WORKS AND CARE SHOULD BE TAKEN TO LOCATE AND AVOID THESE DURING CONSTRUCTION.
12. TREES SURVEY INFORMATION HAS BEEN TAKEN FROM JAMES BLAKE ASSOCIATES DRAWING DATED 15/09/2016 DRAWING NO. JBA 15 365 TS02

FOR PLANNING

Rev	Description	Drn	Chk	App	Date
F	SITE LAYOUT UPDATED.	AW	FY	BB	11.12.18
E	SITE LAYOUT UPDATED.	AW	FY	BB	29.10.18
D	SW DRAINAGE ROUTE AMMENDED FOR NORTH-WESTERN BASIN.	AW	FY	BB	15.10.18
C	REVISED LAYOUT	AMG	FY	BB	11.10.18
B	REVISED LAYOUT	RM	FY	BB	19.09.18
A	UPDATED WITH NEW TREE SURVEY AND LAYOUT	FY	FY	BB	31.08.18

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Client: COUNTRYSIDE PROPERTIES (UK) Ltd

Project Title: CUFFLEY HILL, GOFFS OAKS

Drawing Title: DRAINAGE STRATEGY

A1 Scale	Date	Designed by
1:500	03.07.18	GHB
Drawn by	Checked by	Approved by
GHB	FY	BB

Drawing Number: 162101 - 004 Rev F

File Location: y:\ardent projects\162101 - cuffley hill, goffs oak (planning application)\technical\acad\drawings\162101-004 - drainage strategy.dwg

Appendix G
SuDS Treatment Methods

Pollution hazard indices for different land use classifications (land use shaded grey applicable for the development)

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

Indicative SuDS mitigation indices for discharges to surface waters (SuDS components shaded grey applicable to this development)

	Mitigation indices		
Type of SuDS component	**TSS**	**Metals**	**Hydrocarbons**
Filter strip	0.4	0.4	0.5
Filter drain	0.4	0.4	0.4
Swale	0.5	0.6	0.6
Bio retention system	0.8	0.8	0.8
Permeable pavement	0.7	0.6	0.7
Detention basin	0.5	0.5	0.6
Pond	0.7	0.7	0.5
Wetland	0.8	0.8	0.8
Proprietary treatment systems	These must demonstrate that they can address each of the contaminant types to acceptable levels for frequent events up to approximately the 1 in 1 year return period event, for inflow concentrations relevant to the contributing drainage area.		

Indicative SuDS mitigation indices for discharges to groundwater

(SuDS components shaded grey applicable to this development)

	Mitigation indices		
Characteristic of the material overlying the proposed infiltration surface, through which the runoff percolates	**TSS**	**Metals**	**Hydro-carbons**
A layer of dense vegetation underlain by a soil with good contaminant attenuation potential of at least 300mm in depth	0.6	0.5	0.6
A soil with good contaminant attenuation potential of at least 300mm in depth	0.4	0.3	0.3
Infiltration trench underlain by a soil with good contaminant attenuation potential of at least 300mm in depth	0.4	0.4	0.4
Constructed permeable paving underlain by a soil with a good contaminant attenuation potential of at least 300mm in depth	0.7	0.6	0.7
Bio retention underlain by a soil with good contaminant attenuation potential of at least 300mm in depth	0.8	0.8	0.8
Proprietary treatment systems	These must demonstrate that they can address each of the contaminant types to acceptable levels for inflow concentrations relevant to the contributing drainage area.		

Indicative SuDS mitigation indices for discharges to surface waters

For surface water discharge from Residential Parking Areas and Low Traffic Roads <300 traffic movements/day			
	Required mitigation indices		
Source	**TSS**	**Metals**	**Hydrocarbons**
Low	0.5	0.4	0.4
Drainage Network			
Detention Basin	0.5	0.5	0.6
Check	+0.0	+0.1	+0.2

Total SuDS mitigation index = mitigation index$_1$ + (0.5 x mitigation index$_2$)

Appendix H

SuDS Maintenance & Management Plan

Maintenance and Management

The swale and attenuation basins would be maintained by a management company set up by the developer. As construction has not yet commenced, the process of finalising the management company contract has not yet commenced. The developer will ensure that the measures as outlined below form part of the management company contract details, for the ongoing maintenance of all SuDS features on site.

The indicative maintenance requirements for each proposed SuDS component is given below. Taken from CIRIA report C753 "The SuDS Manual".

Drainage Pipes

Maintenance schedule	Required action	Typical frequency
Regular Maintenance	Remove sediment and debris from inspection chambers and hydrobrake chambers	Annually
	Cleaning of gutters and any filters on downpipes	Annually
	Remove any root ingress	As required
Occasional Maintenance	CCTV survey of drains to check alignment, cracking and joint displacement	10 year intervals

Swales/Filter Drains

MAINTENANCE SCHEDULE	REQUIRED ACTION	FREQUENCY
Regular Maintenance	Litter and debris removal	Monthly (or as required)
	Grass cutting – to retain grass height within specified design range	Monthly (during growing season, or as required
	Manage other vegetation and remove nuisance plants	Monthly (at start, then as required
Occasional Maintenance	Check for poor vegetation growth due to lack of sunlight or dropping of leaf litter, and cut back adjacent vegetation where possible	Annually

	Re-seed areas of poor vegetation growth.	Annually, or if bare soil is exposed over 10% or more of the swale treatment area
Remedial Actions	Repair erosion or other damage by re-turfing or reseeding	As required
	Re-level uneven surfaces and reinstate design levels	As required
	Scarify and spike topsoil layer to improve infiltration performance, break up silt deposits and prevent compaction of the soil surface	As required
	Remove build-up of sediment on gravel trench, flow spreader or at top of filter strip	As required
	Remove and dispose of oils or petrol residues using safe standard practices	As required
Monitoring	Inspect inlets, outlets and overflows for blockages, and clear if required	Monthly
	Inspect inlets and facility surface for silt accumulation. Establish appropriate silt removal frequencies	Half Yearly

Detention Basins

MAINTENANCE SCHEDULE	REQUIRED ACTION	FREQUENCY
Regular Maintenance	Litter and debris removal	Monthly (or as required)
	Cut the grass – for spillways and access routes	Monthly (during growing season, or as required)
	Cut the meadow grass in and around the basin	Half yearly (spring, before nesting season, and autumn)
	Manage other vegetation and remove nuisance plants	Monthly (at start, then as required)
	Inspect inlets, outlets and overflows for evidence of blockage and clear if required	Monthly
	Inspect banksides, structures, pipework etc for evidence of physical damage	Monthly
	Inspect inlets and facility structure for all silt accumulation. Establish appropriate silt removal frequencies	Monthly (for first year) then annually or as required
	Check any mechanical devices e.g. penstocks	Half yearly
	Tidy all dead growth before start of growing season	Annually
	Remove sediment from inlet, outlet and forebay	Annually or as required
	Manage wetland plants in outlet pool – where provided	Annually
Occasional Maintenance	Re-seed areas of poor vegetation growth	As required
	Prune and trim any trees and remove cuttings	Every 2 years, or as required
	Remove sediment from inlets, outlets, forebay and main basin where required	Every 5 years, or as required (likely to be minimal requirements where effective upstream source control is provided)

Remedial Actions	Repair erosion or other damage by re-turfing or reseeding	As required
	Relevel uneven surfaces and reinstate design levels	As required
	Realign rip-rap	As required
	Repair / rehabilitate inlets, outlets and overflows	As required