Land to the North East of KGV Playing Fields, Cuffley

Flood Risk Assessment

June 2015

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Lands Improvement

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Executive Summary

Flooding Risk

In terms of fluvial and tidal flood risk, the proposed development can be seen to lie within Flood Zone 1, and hence has a low probability of flooding from this mechanism.

Assessment of other potential flooding mechanisms shows the land to have a low probability of flooding from overland flow, ground water and sewer flooding.

Accordingly, the proposed development land is in a preferable location for residential development when appraised in accordance with the NPPF Sequential Test and local policy. The Site should be considered preferable to other potential developments that may lie wholly within Flood Zone 2 or Flood Zone 3.

Surface Water Drainage

A strategy for storm drainage at the Site (excluding the playing field to the south) has been developed to meet both national and local policy. The proposals outline the viability of the Site to employ means of drainage to comply with NPPF guidance, together with the Welwyn Hatfield Borough Council SFRA and other national and local guidance.

The proposed residential development drainage system will manage storm water by way of a SuDS management train and ensure peak discharges from the developed land are reduced to circa 69% below the appraised baseline rates. The system will also provide improvements to the quality of water discharged from the development.

Surface water will be collected using source control measures and directed to a system of gravity sewers. These will convey flows to a swale and two attenuation basins with outfalls into an existing ordinary water course near the Site boundary.

The key objectives for the Site drainage will be:

- Implementation of a sustainable drainage scheme in accordance with current national and local policy together with principles of good practice design.
- Control of peak discharges from the residential development Site to a rate circa 69% below the baseline conditions, during all storm events.
- Development of storm water management proposals that improve water quality and biodiversity of the Site.
- Implementation of the storm water management system prior to first occupation of dwellings.

Foul Water Drainage

Thames Water has confirmed that a connection can be made to the existing 150mm diameter foul sewer which bisects the development on a north to south rough route at its mid-point. Thames Water has confirmed that no offsite reinforcement measures are necessary to serve this scheme

This FRA has identified no prohibitive engineering constraints in developing the proposed Site for the proposed residential usage.

1 Introduction

1.1 Brookbanks Consulting Limited is appointed by Lands Improvement to complete a Flood Risk Assessment for a proposed residential development on land to the north east of King George V Playing Fields.

1.2 The objective of the study is to demonstrate the development proposals are acceptable from a flooding risk and drainage viewpoint.

1.3 This report summarises the findings of the study and specifically addresses the following issues in the context of the current legislative regime:

- Flooding risk
- Surface water drainage
- Foul water drainage

2 Background Information

Location & Details

2.1 The Site is located to the south of Cuffley, is 4.89ha in size and is currently in agricultural use. It is bound by existing residential development to the north and north-west; the grounds of Cuffley Primary School also adjoin the Site along its northern boundary. The railway line and Northaw Road East (B156) form strong eastern and western boundaries respectively. The southern boundary is defined by a mature hedgerow and tree belt lining the Hertfordshire Way footpath. Beyond the footpath to the south west of the Site is King George V Playing Field, which contains three sports pavilions, a recreation area with hard surfaced Multi Use Games Areas (MUGA), sports pitches and a small area of formal play equipment.

2.2 The Site also includes a 0.63ha rectangular parcel of land, in agricultural use, which is located to the south west of King George V Playing Field. Northaw Road East forms the western boundary of the land, beyond which lies a small number of residential properties and buildings associated with agricultural use. Further agricultural land lies to the south whilst tennis courts, sports pavilions and a bowling green are located to the north east and south east of the Site.

2.3 The Site is currently undeveloped and the land is not thought to have been historically subject to any significant built development. The Site location and boundary is shown indicatively on Figure 2a.

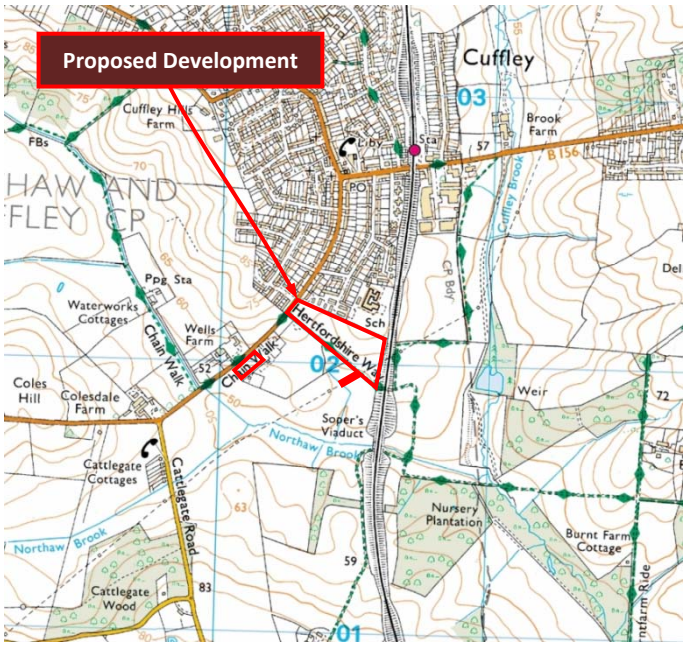

Figure 2a: Site location

Description of the Development

2.4 The proposed development is to comprise:

"Residential development of up to 121 dwellings, associated infrastructure and a change of use from agricultural land to an extension of the King George V playing fields. All matters reserved except for the new vehicular access to serve the site, the provision of surface water discharge points and the levels of the development platforms".

Sources of Information

2.5 The following bodies have been consulted while completing the study:

- Thames Water - Storm & foul water drainage
- Environment Agency - Flood risk and storm drainage

2.6 The following additional information has been available while completing the study:

- Mastermap Data - Ordnance Survey
- Published Geology - British Geological Survey
- Regional Flood Risk Assessment - East of England Plan, May 2008
- Level 1 Strategic Flood Risk Assessment - Welwyn Hatfield Borough Council, May 2009

Topography & Site Survey

2.7 Topography across the Site is characterised by moderate gradients falling in a south easterly direction from a localised high point of approximately 69.11m AOD. Higher ground levels are shown in the north, adjacent to the existing school and residential properties along South Drive.

2.8 A Topographical Survey of the Site was carried out in August 2014, the plans of which are included within Appendix A.

Ground Conditions

2.9 With reference to the British Geological Survey map, the Site is shown to be underlain by bedrock geology comprising clay, silt and sand belonging to the London Clay Formation. Areas of superficial deposits identified on the Site comprise sand and gravel, belonging to the Dollis Hill Gravel Member. The Sites rectangular parcel to the south-west is shown to comprise clay, silt and sand belonging to the Lambeth Group. The published geology of the Site is shown in Figure 2b, below.

Figure 2b: BGS Published Geology

Watercourse Systems & Drainage

On-Site

2.10 Along the southern boundary of the Site a field drain is identified, conveying flows generally in a south easterly direction. Approximately two thirds of the way long the Site boundary the watercourse is culverted under the track and flows southerly to meet the watercourse discussed in paragraph 2.11 below.

Off-Site

2.11 The River Lee is situated approximately 6.5km to the east of the Site boundary. The following watercourses form part of the River Lee-Stort/Thames catchment area: Northaw Brook situated approximately 225m to the south, Hempshill Brook located 400m to the west and Cuffley Brook approximately 425m to the east.

2.12 With reference to the Flood Estimation Handbook CD dataset V3 the Site is shown to lie within the immediate catchment of Northaw Brook. Having an URBEXT2000 value of 0.0215 the catchment can be described as *"essentially rural".* The FEH catchment is shown in Figure 2c.

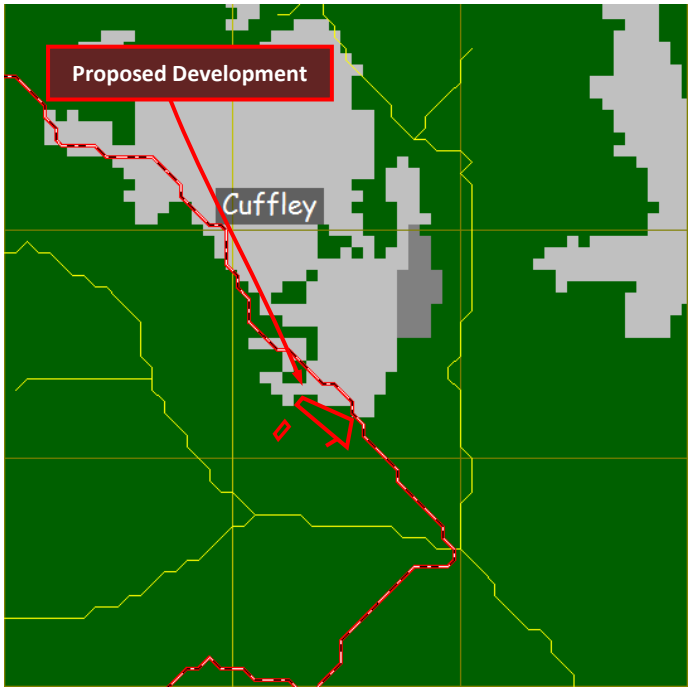

Figure 2c: FEH reported catchment

2.13 With the exception of the watercourse features outlined above, a site inspection shows the presence of a ditch approximately 75m to the south of the Sites boundary. Surface water flows from this ditch are directed southwards into Northaw Brook which flows eastwards into Cuffley Brook (a tributary of the River Lee).

3 Flooding Risk

National Planning Context

3.1 The National Planning Policy Framework (NPPF) was introduced in March 2012, with the aim at rationalising and simplifying planning guidance. The Policy is supported by a Technical Guide, which provides advice in relation to Flood Risk and Drainage matters at Paragraphs 2 to 9. This element of the Technical Guide largely follows the principles set out in the earlier adopted planning guidance on flood risk and drainage, being PPS25.

3.2 Allocation and planning of development must be considered against a risk based search sequence, as provided by the NPPF guidance. In terms of fluvial flooding, the guidance categorises flood zones in three principal levels of risk, as follows:

Flood Zone	Annual Probability of Flooding
Zone 1: Low probability	< 0.1 %
Zone 2: Medium probability	0.1 – 1.0 %
Zone 3a / 3b: High probability	> 1.0 %

Figure 3a: NPPF Flood Risk Parameters

3.3 The Guidance states that Planning Authorities should *"apply a sequential, risk-based approach to the location of development to avoid where possible flood risk to people and property and manage any residual risk, taking account of the impacts of climate change."*

3.4 According to the NPPF guidance, residential development at the proposed site, being designated as "More Vulnerable" classifications, should lie outside the envelope of the predicted 1 in 100 year (1%) flood, with preference given to sites lying outside the 1 in 1,000 (0.1%) year event and within Flood Zone 1.

3.5 Sites with the potential to flood during a 1 in 100 (1%) year flood event (Flood Zone 3a) are not normally considered appropriate for proposed residential development unless on application of the "Sequential Test", the Site is demonstrated to be the most appropriate for development and satisfactory flood mitigation can be provided. Additionally, proposed residential developments within Flood Zone 3a are required to pass the "Exception Test", the test being that:

- The development is to provide wider sustainability benefits
- The development will be safe, not increase flood risk and where possible reduce flood risk.

Regional & Local Policy

3.6 **Strategic Flood Risk Assessment:** To support local planning policy, NPPF guidance recommends that local planning authorities produce a Strategic Flood Risk Assessment (SFRA). The SFRA should be used to help define the Local Plan and associated policies; considering potential development zones in the context of the sequential test defined in the guidance.

3.7 Welwyn Hatfield Borough Council published a Level 1 Strategic Flood Risk Assessment in May 2009. The document outlines the results of a review of available flood risk related policy and data across the region and sets out recommendations and guidance in terms of flood risk and drainage policy that generally underpin national guidance.

3.8 The document makes no specific reference to the Site however assess the risk of flooding in the wider Herefordshire area from the following sources which will be discussed further in this document:

- Fluvial Flooding
- Sewer Flooding
- Pluvial Flooding
- Groundwater Flooding
- Artificial Sources

3.9 **Development Flood Risk Assessment:** At a local site by site level, the NPPF guidance and supporting documents advocate the preparation of a Flood Risk Assessment (FRA). The NPPF requires that developments covering an area of greater than one hectare prepare an FRA in accordance with the guidance. The FRA is required to be proportionate to the risk and appropriate to the scale, nature and location of the development.

3.10 This document forms a Flood Risk Assessment (FRA), to accord with current guidance and addresses national, regional and local policy requirements in demonstrating that the proposed development lies within the acceptable flood risk parameters.

Flood Mechanisms

3.11 Having completed a site hydrological desk study and walk over inspection, the possible flooding mechanisms at the Site are identified as follows:

Mechanisms	Potential?	Comment
Fluvial (Annex C: C4)	N	No major watercourses lie within an influencing distance of the proposed development. A land drain is situated approximately 75m to the south of the site boundary.
Coastal & tidal (Annex C: C5)	N	No tidal watercourses lie within an influencing distance of the proposed development.
Overland flow (Annex C: C6)	Y	The risk of overland flow relates primarily to the developed land to the north of the site, existing site topography and a land drain to the south of the site.
Ground water (Annex C: C7)	N	Geology underlying the site is of a potentially low permeability. No groundwater flooding was identified within the SFRA and therefore the risk of same is considered low.
Sewers (Annex C: C8)	Y	An adopted foul sewer is present within the site boundary however Thames Water report of no problems in their adjacent network.
Reservoirs, Canals etc. (Annex C: C9)	N	No artificial sources lie within an influencing distance of the proposed development

Figure 3b: Flooding mechanisms

3.12 Where potential risks are identified in Figure 3b, above, more detailed assessments have been completed and are outlined within the following paragraphs, along with further background information.

Fluvial Flooding: C4

3.13 The Environment Agency's (EA) National Generalised Modelling (NGM) Flood Zones Plan indicates predicted flood envelopes of Main Rivers across the UK. In many circumstances, the NGM is based on basic catchment characteristic data and modelling techniques. Where appropriate, more accurate Section 105 / SFRM models are produced using more robust analysis techniques.

3.14 The following watercourses form part of the River Lee-Stort/Thames catchment and are within proximity of the Site:

- Northaw Brook situated approximately 225m to the south,
- Hempshill Brook located 400m to the west, and
- Cuffley Brook approximately 425m to the east.

3.15 The Flood Zone mapping identifies flooding along these brooks, with flows seen to come out of bank during the 1 in 100 (1% AEP) and 1 in 1,000 year (0.1% AEP) events.

3.16 The nearest surface water feature to the Site is a land drain situated approximately 75m to the south. Surface water flows are directed into Northaw Brook which flows into Cuffley Brook, a tributary of the River Lee.

3.17 The mapping shows that the entire Site lies within Flood Zone 1; being an area of Low Probability of flooding, outside both the 1 in 100 (1% AEP) and 1 in 1,000 (0.1% AEP) year flood events. The EA Flood Zone plan is reprinted below as Figure 3c.

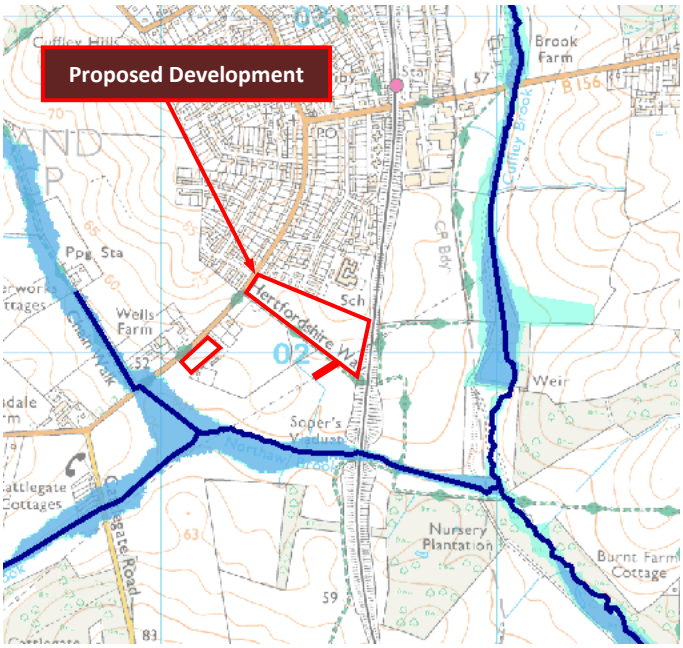

Figure 3c: EA Flood Zone Plan showing 1 in 100 & 1 in 1,000 year floodplain

3.18 Site inspection evidence in relation to the length of drain to the south of the Site provides no suggestion of fluvial flooding, which given the characteristics of the feature and the localised rural catchment is to be expected.

Coastal Flooding C5

3.19 The Site lies a significant distance from the nearest tidal watercourse and the coast. As such there is no risk of tidal or coastal flooding at this location.

Overland Flow: C6

3.20 Overflow flow mechanisms result from the inability of unpaved ground to infiltrate rainfall or due to inadequacies of drainage systems in paved areas to accommodate flow directed to gullies, drainage downpipes or similar. In minor cases, local ponding may occur. In more extreme events, flows accumulate and may be conveyed across land following the topography.

3.21 The Environment Agency have recently produced a series of surface water flood maps for many parts of the UK. The plan containing the proposed development Site is reprinted as Figure 3d.

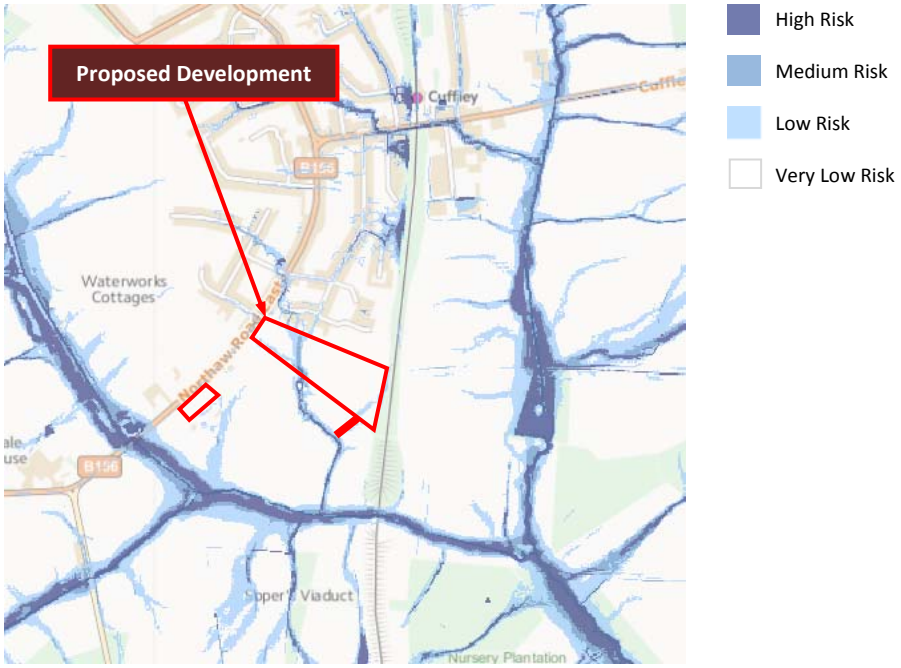

Figure 3d: Environment Agency Risk of Surface Water Flooding Mapping

3.22 The mapping provided by the EA identifies a small area of surface water flooding within the Site boundary, as a result of runoff from the built development to the north of the Site. The surface water flooding is shown to follow the topography of the Site towards the ditch to the south which flows into Northaw Brook. The majority of the proposed development will be directed within areas that potentially have a very low risk of flooding from surface water.

3.23 The following figures are extracts from the SFRA and are based on additional information obtained from Hertfordshire Highways flooding database. Figure 3e shows there to be a low frequency of flooding events along the roads adjacent to the west and north of the Site.

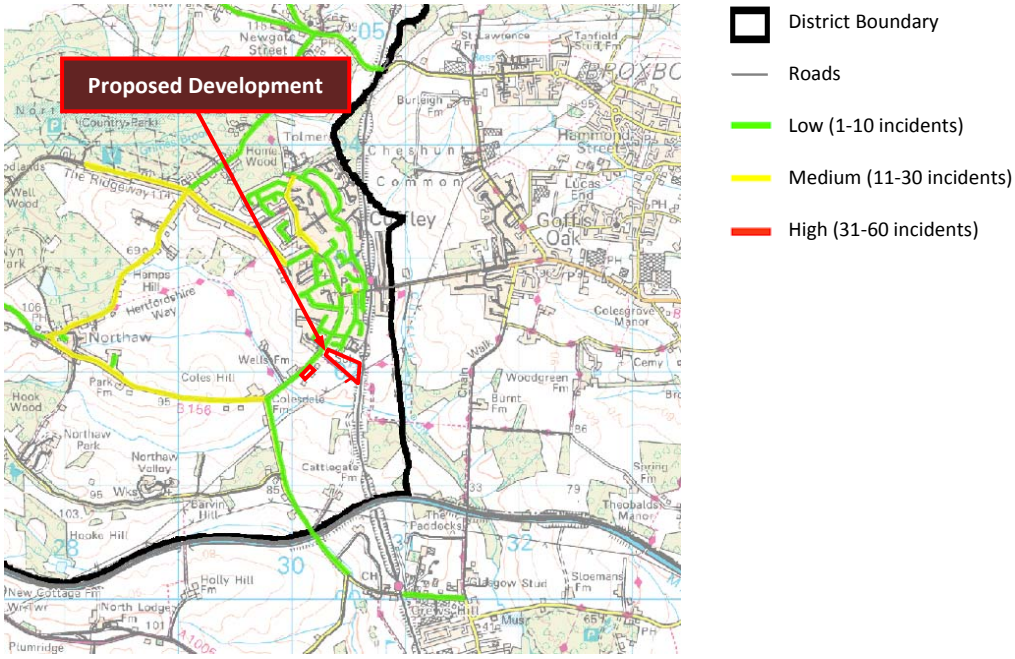

Figure 3e: Frequency of road flooding events

3.24 Figure 3f shows there to be a low frequency of flooding events along Northaw Road West and Cattlegate Road, to the south-west of the Site.

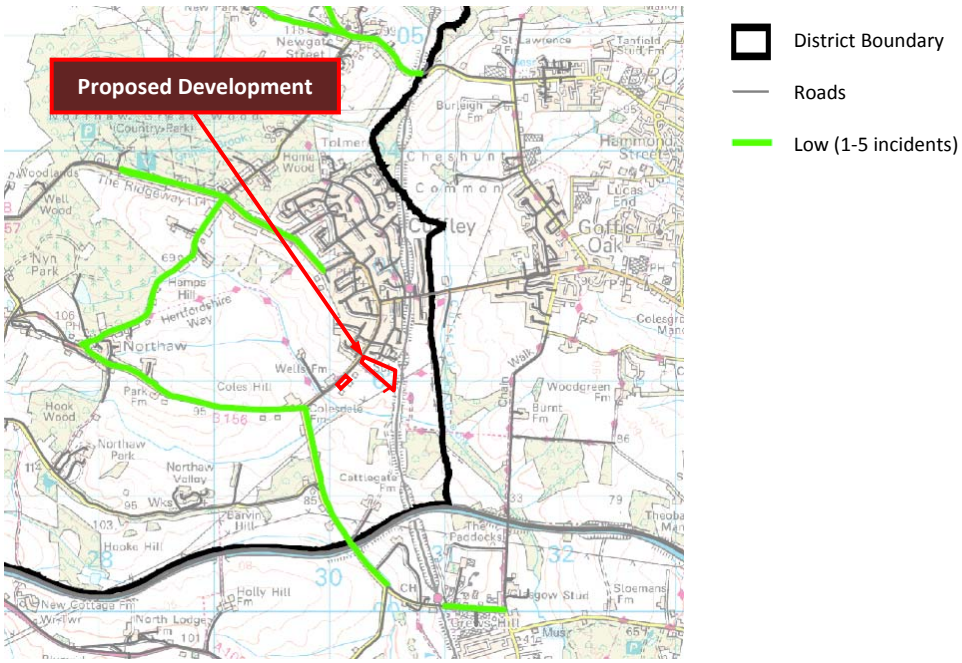

Figure 3f: Flooding frequency ditch problems

3.25 Figure 3g shows there to be a low frequency of flooding events due to blocked gullies, along the adjacent roads to the north and west of the Site.

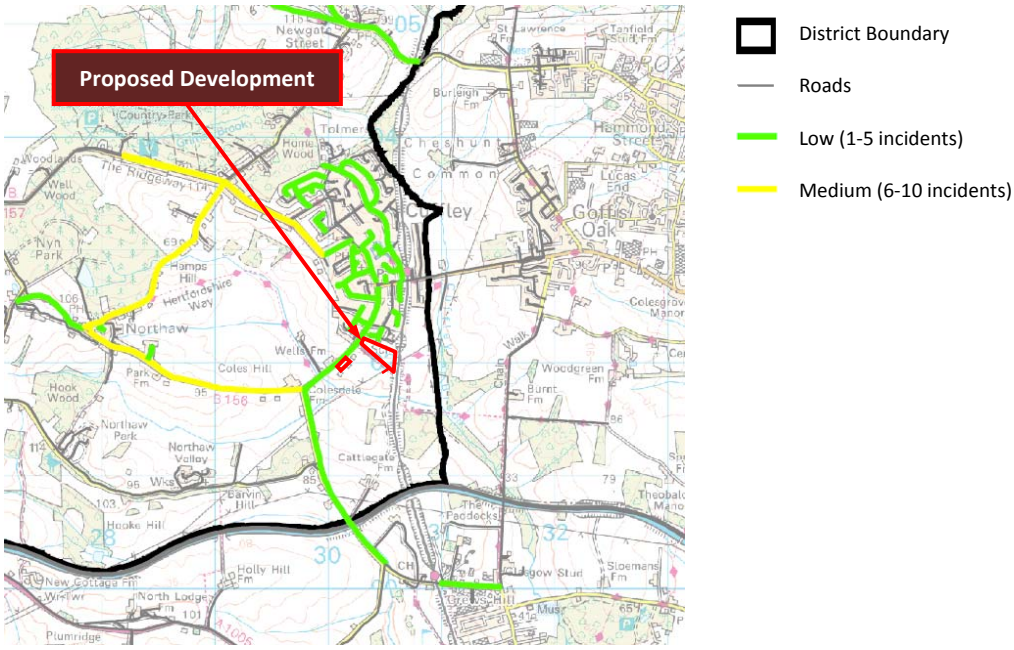

Figure 3g: Flooding frequency blocked gully

3.26 Figure 3h shows there to be a low frequency of flooding events to footways to the north the Site.

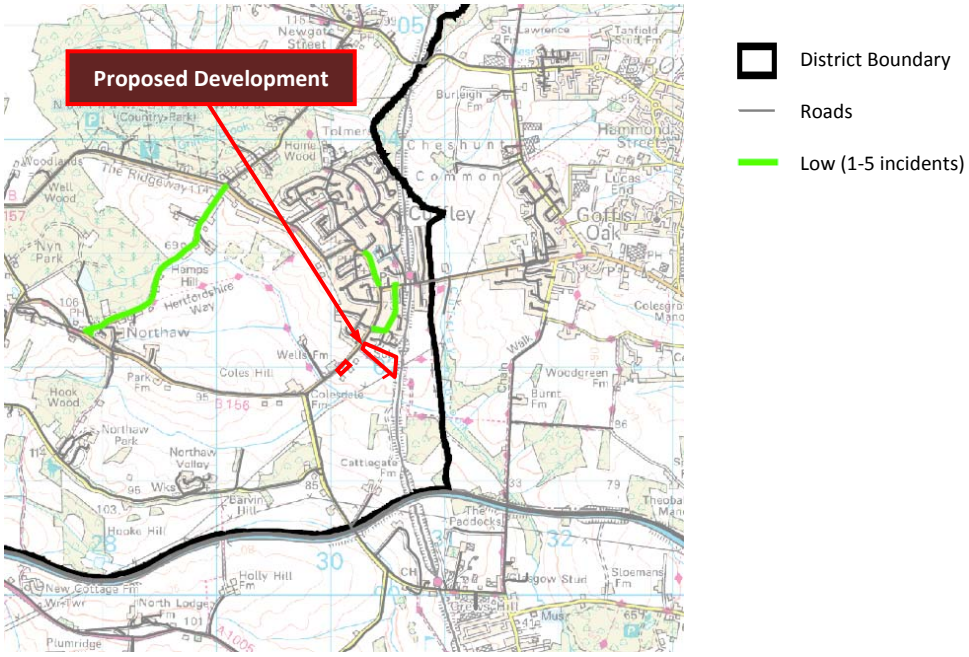

Figure 3h: Flooding frequency footway flooded

3.28 Figure 3i shows there to be a low frequency of reported property damage to the north and west of the Site.

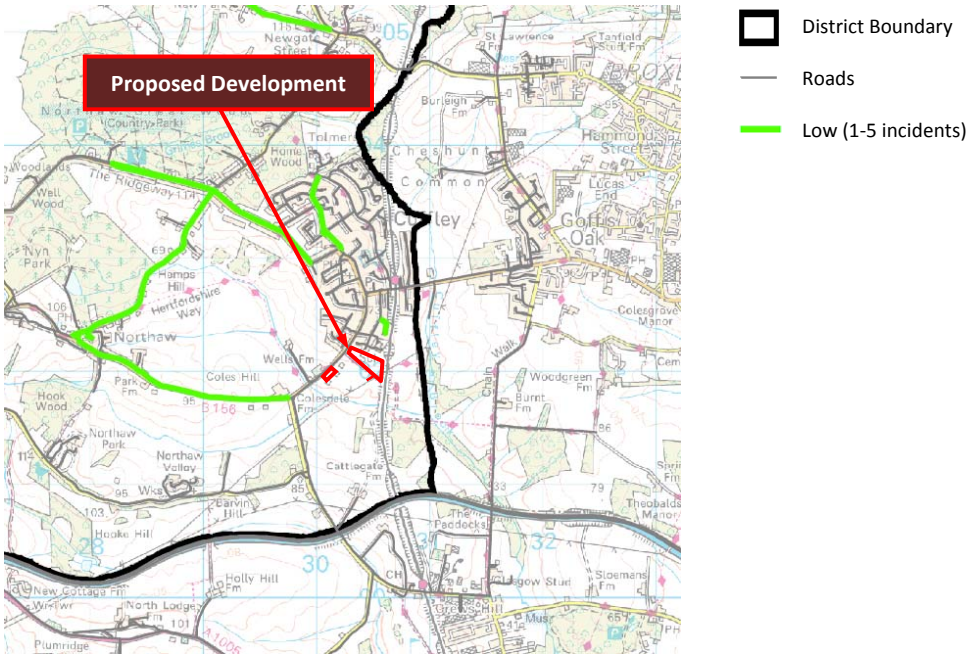

Figure 3i: Flooding frequency property damage

3.29 Given the available evidence and Site characteristics, the proposed development land is considered to have a low-medium probability of overland flow flooding risk.

3.30 Recognising the risk of overland flow mechanisms, published guidance in the form of Sewers for Adoption 7th Edition and the Environment Agency document *Improving the Flood Performance of New Buildings: Flood Resilient Construction et al* advocate the design of developments that implement infrastructure routes through the development that will safely

convey flood waters resulting from sewer flooding or overland flows away from buildings and along defined corridors. Further to protect the proposed development, current good practice measures defined by guidance will be incorporated.

3.31 Given the baseline Site characteristics and further mitigating measures to be implemented residual flood risk from an overland flow mechanism is considered to be a low probability.

Ground Water: C7

3.32 Ground water related flooding is caused by ground water levels rising through permeable geology, up to the ground's surface, and within low lying areas. It is fortunately quite rare, although where flooding is present, persistent issues can arise that are problematic to resolve. Such mechanisms often develop due to construction activities that may have an unforeseen affect on the local geology or hydrogeology.

3.33 Whilst no site specific investigations have been completed, information from the Level 1 SFRA has not identified any incidents of groundwater flooding within the Site boundary.

3.34 Positive drainage systems incorporated into the proposed development will further reduce the risk as a result of permeable pipe bedding materials and filter drains incorporated within elements of the built development.

3.35 Given the baseline Site characteristics (clay geology and a Non Aquifer) and further mitigating measures to be implemented, residual flood risk from a ground water mechanism is considered to be a low probability.

Sewerage Systems: C8

3.36 Flooding related to sewerage systems is a result of there being insufficient capacity within an existing sewerage system (combined and surface water sewers) or from there being a blockage within the system.

3.37 Investigations with Thames Water provide no evidence of present or historic sewer flooding at the Site.

3.38 The SFRA produced by Welwyn Hatfield Borough Council further reviewed sewer records from Thames Water by accessing their DG5 Asset Register. It resulted in inadequate data which the EA advised to ignore as being a source of flooding in the SFRA.

3.39 Positive drainage measures incorporated on Site, coupled with sustainable drainage systems (SuDS) will ensure that no increase in surface water will result from the Site. Flood risk associated with sewer flooding is therefore considered to be a low probability.

Artificial Water Bodies - Reservoirs & Canals: C9

3.40 No artificial sources are identified within an influencing distance of the Site boundary.

3.41 It may therefore be concluded that there is a low risk of flooding associated with artificial water bodies at the proposed development.

Climate Change

3.42 A 20% increase in peak river flow is predicted by the year 2115, due to the effects of climate change. The SFRA includes modelled climate change scenarios for the 1 in 100 year event for the River Lee and its tributaries. Figure 3j is an extract

of the map produced which illustrates the fluvial floodplains and sources of flooding and forms part of the Sequential Test.

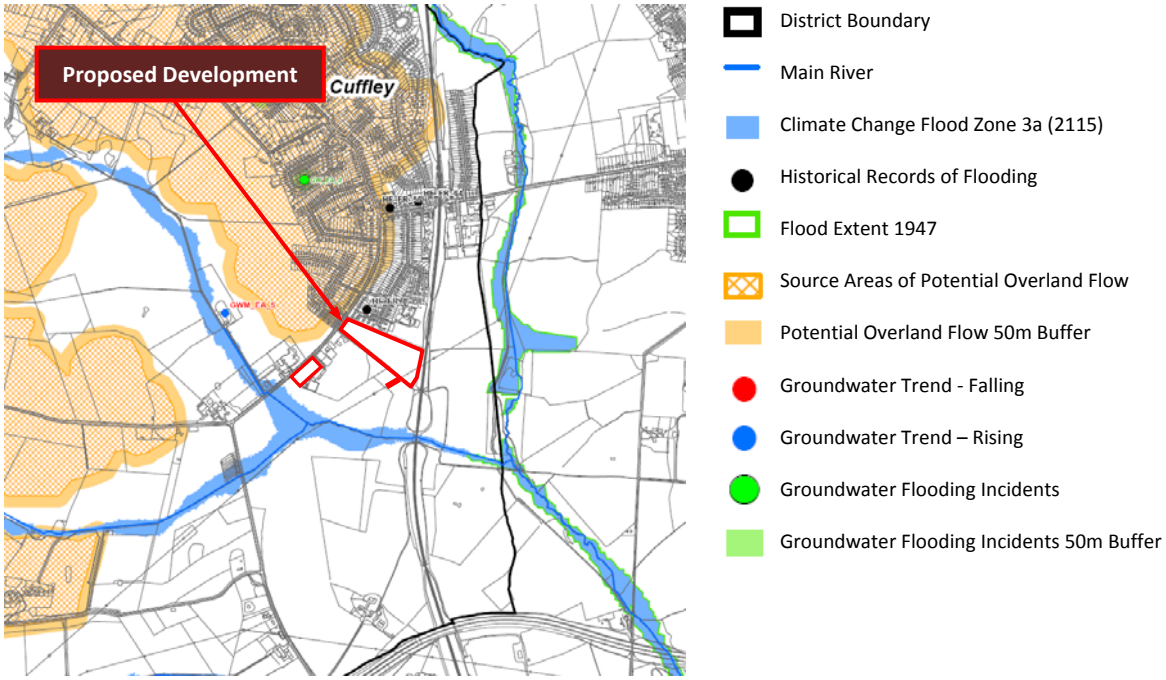

Figure 3j: 2115 Sequential Test Flood Zones

3.43 Taking into account climate change the proposed development Site is predicated to be in Flood Zone 1 in the year 2115, as shown above in the modelled fluvial flood map.

3.44 Historical flood data provided by the EA and Hertfordshire Fire and Rescue Service has been mapped together and the general locations of the incidents are illustrated in Figure 3j. There are three incidents recorded been December 2005 and February 2007 and are shown to the north of the Site. The closest incident reported to the Site occurred in 2007 and is shown to the north-west of the Site, the cause of which was not provided.

3.45 The Site is also shown to be outside a 50m buffer from potential overland flow resulting from runoff from the urbanised area to the north of the Site.

3.46 An EA ground water monitoring station is located approximately 525m to the west of the Site. Groundwater monitoring data collected from March 1986 to October 2007 reports of a rising trend in groundwater levels. However there have been no reports of groundwater flooding incidents on Site. The nearest recorded incident is shown approximately 700m north-west of the Site, where it was reported that groundwater seepage entered an occupiers garden through their neighbour's wall.

Residual Flood Risk

3.47 An FRA should consider the Residual Flood Risk once development activities are complete, ensuring that appropriate mitigation is proposed to ensure risks are not increased as a result of the activities. This FRA promotes, within the main body of the text, a series of proposals that will be employed to ensure the post development situation is acceptable and that residual flood risk is managed. The following list summarises the main proposals that will adequately control residual flood risk:

- All development is to lie within Flood Zone 1.

- Compliance with guidance in terms of flood routing and resilience for new developments.
- Provision of a multi-tier storm water SuDS management system (see Section 4).
- Connection to a point of adequacy on the foul water drainage network with completion of necessary downstream reinforcements to ensure adequate conveyance and treatment capacity (see Section 5).
- Provision of ongoing maintenance for SuDS features.
- Adoption and associated ongoing maintenance of development storm and foul drainage system.

Summary

3.48 In terms of fluvial and tidal flood risk, the proposed development can be seen to lie within Flood Zone 1, and hence has a low probability of flooding from this mechanism.

3.49 Assessment of other potential flooding mechanisms shows the land to have a low probability of flooding from overland flow, ground water and sewer flooding.

3.50 Accordingly, the proposed development land is in a preferable location for residential development when appraised in accordance with the NPPF Sequential Test and local policy. The Site should be considered preferable to other potential developments that may lie wholly within Flood Zone 2 or Flood Zone 3.

Objectives

3.51 The key development objectives that are recommended in relation to flooding are:

- Compliance with SFA 7th Edition and EA guidance in relation to flood routing through the proposed development in the event of sewer blockages.
- Implementation of a 150mm slab freeboard above the level of the proposed flood routes, to protect buildings in the event of a localised blockage.

4 Storm Drainage

Background

4.1 To understand the baseline provision for storm drainage in the area, a copy of the Thames Water sewerage network records has been obtained. Public storm water sewers are present within the residential areas to the north of the proposed development.

4.2 The Site is presently not serviced by a positive storm water drainage network. It is believed that storm water currently discharges to the drainage ditch to the south of the Site which flows into Northaw Brook.

Drainage Options

4.3 The following paragraphs in this section outline the proposed drainage strategy to meet national and local design requirements and guidance.

4.4 Current guidance[1] requires that new developments implement means of storm water control, known as SuDS (Sustainable Drainage Systems), to maintain flow rates discharged to the surface water receptor at the pre-development 'baseline conditions' and improve the quality of water discharged from the land.

4.5 It is proposed to implement a SuDS scheme consistent with local and national policy at the proposed development.

4.6 When appraising suitable storm water discharge options for a development site, Part H of the Building Regulations 2002 (and associated guidance) provides the following search sequence for identification of the most appropriate drainage methodology.

"Rainwater from a system provided pursuant to sub-paragraphs (1) or (2) shall discharge to one of the following, listed in order of priority -

(a) an adequate soakaway or some other adequate infiltration system; or where that is not reasonably practicable,

(b) a watercourse; or where that is not reasonably practicable,

(c) a sewer. "

4.7 Dealing with the search order in sequence:

(a) Source control systems treat water close to the point of collection, in features such as soakaways, porous pavements, infiltration trenches and basins. The use of some can have the benefit of discharging surface water back to ground rather than just temporarily attenuating peak flows before discharging it to a receiving watercourse or sewer.

As source control measures generally rely upon the infiltration of surface water to ground, it is a prerequisite that the ground conditions are appropriate for such. Site ground investigations specific to flood risk have confirmed that the underlying geology is unsuitable for a wholly infiltration based drainage strategy and as such, source control measures will therefore be primarily restricted to detention and conveyance systems placed close to source by way of measures such as lined permeable pavements and conveyance strips.

(b) Next in the search sequence, defined by Part H, is discharge to a watercourse or suitable receiving water body. Where coupled with appropriate upstream attenuation measures, this means of discharge can provide a sustainable drainage scheme that ensures that peak discharges and flood risk in the receiving water body are not increased.

The drainage ditch and tributary of Northaw Brook situated approximately 75m to the south of the Site is considered an appropriate receptor for storm water discharge and as such, has the potential to receive flows from the proposed development, once restricted to the pre-existing 'greenfield' rates of run-off.

(c) Last in the search sequence is discharge to a sewer. In the context of SuDS this is the least preferable scheme as it relies on 'engineered' methods to convey large volumes of water from development areas, has a higher likelihood of flooding due to blockage and provides less intrinsic treatment to the water.

[1] NPPF, CIRIA C522, C609, C697 et al.

The nearest storm water sewer identified in the Thames Water records is located at the junction of Colesdale road and Northaw Road East, to the west of the Site. Another sewer is located to the north of the Site at South Drive.

4.8 The search sequence outlined above indicates that the ditch to the south of the Site is the most appropriate receptor of storm water from the proposed development, having the potential to employ source control measures and detention features to control peak discharges to no greater than the baseline conditions.

4.9 Proposals have been developed to inform the strategic drainage network across the development. It is proposed that the drainage system for the Site utilises a multi SuDS system including detention features and where appropriate, source control in the form of porous paving as the primary storm water management scheme.

4.10 Accordingly, a two plans showing two conceptual drainage options for the Site are contained within Appendix B and Appendix C as drawing 10316/DR/02 & 10316/DR/10. Option 1 utilises two outfall points, whereas Option 2 utilise a single outfall. Both ultimately discharge into the existing ditch to the south of the Site.

4.11 Coupled with the storm water control benefits, the use of SuDS can also provide betterment on water quality. National guidance in the form of CIRIA 609 outlines that by implementing SuDS, storm water from the Site can be polished to an improved standard thus ensuring the development proposals have no adverse affects on the wider hydrology.

4.12 The following paragraphs outline the potential SuDS features appropriate for use on Site and their place within a multi tiered system.

Primary Drainage Systems (source control)

4.13 At the head of the drainage network, across the Site, source control measures will be implemented to reduce the amount of run-off being conveyed directly to piped drainage systems. As Site specific infiltration testing has confirmed the underlying geology is not suitable for a wholly infiltration based drainage strategy, source control will be limited to detention type systems, albeit that systems will be unlined and therefore provide for an element of infiltration.

4.14 Through work on other similar strategically sized projects, BCL has shown that peak discharges of circa 15% in residential areas can readily be achieved without unacceptable reductions in net developable land or prohibitive financial implications.

4.15 Through consultations at outline planning stage, it has been agreed that the nature of source control measures to be implemented will need to remain flexible, providing a ‘toolkit’ of options to reach an agreed target for peak discharge reduction and water treatment. The following paragraphs describe a number of options available.

Permeable Paving

4.16 Permeable Paving is approved by many Local Authorities for implementation on the development road network and can act as a receptor for surface water run-off from nearby house roofs. However, the system is perhaps best suited to managed parking areas and shared surfaces where block paving is typically used as the surface treatment.

4.17 There is little need for underground pipes or gullies, and the attenuation afforded within the sub-base layer helps to reduce the volume of storage required elsewhere.

4.18 The following Figure 4a is an example of permeable paving.

Figure 4a: Permeable paving

Filter Strips

4.19 Filter strips have been used in the drainage of highways for many years. The absence of traditional pipe work in such a system frees the drainage design to employ shallow gradients on both channels and drains, which in turn also act as a means of passive treatment to improve water quality.

4.20 Highways within the development could potentially incorporate filter drains. Alternatively, filter strips can be used to collect flows from areas such as a group of houses. Figure 4b shows an example of a filter strip in a road corridor.

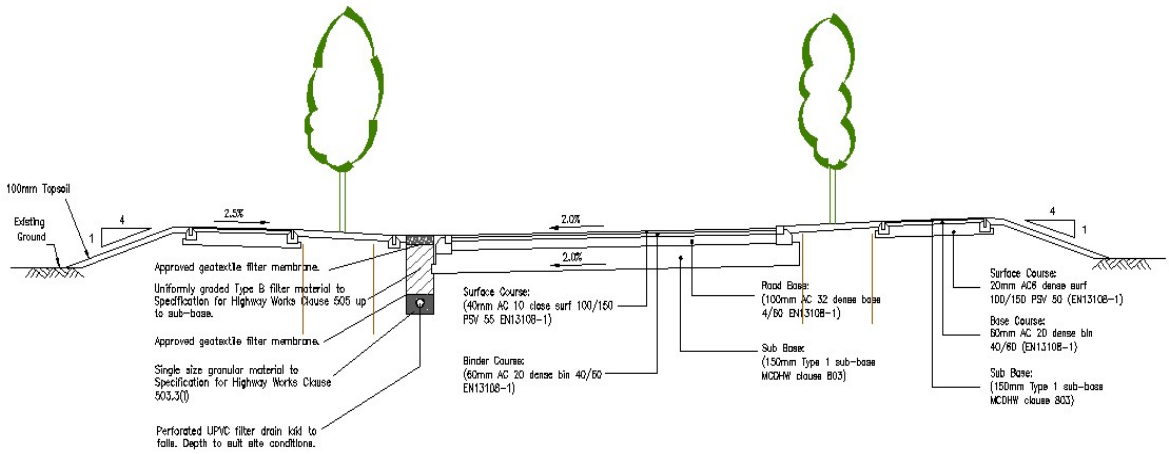

Figure 4b: Filter Strip along highway

Ditches

4.21 Ditches may be used along highways and in common areas to infiltrate, attenuate and convey flows from hard surfaces across the development before being discharged in to the secondary system. Linear features, such as ditches and filter strips provide an efficient means of improving water quality.

Swales

4.22 While swales implemented at development parcel level can be very land hungry, costly to maintain and provide difficulties with frontage access, the opportunity potentially exists to implement a swale on the eastern boundary of the site, through the development. Green space being incorporated along the highways could be designed to allow 'over the edge' flows to be directed into the swale for infiltration, attenuation and conveyance. A typical highway swale is show in Figure 4c:

Figure 4c: Swale along road corridor

Attenuation Drainage Systems

4.23 Attenuation drainage systems collect partially treated excess water from the primary source control systems at a local level, thereafter providing both flow and water quality attenuation and flow conveyance through the Site towards the main outfall.

4.24 It is anticipated that two basins will be utilised and designed to primarily be dry with permanently wet low flow channels to convey run-off in periods of low rainfall, which will in turn provide the passive treatment benefits offered within the remainder of the surface water management network.

4.25 The primary aims of the basin will therefore be:

- Final flow and water quality conditioning
- Provide landscaping, amenity and ecological benefits

4.26 The following Figure 4d is an example of a storage basin.

Figure 4d: Storage Basin

Preliminary Drainage Proposals

4.27 Preliminary assessment of the requirements for storm drainage have been based on the following criteria:

Residential Site Area:	4.89 ha
Developed Area:	3.26 ha
Landscaped Area:	1.63 ha
Impermeability – Residential:	0.55
Sewer design return period[2]	1 in 1 years
Sewer flood protection[2]	1 in 30 years
Fluvial / Development flood protection[1]	1 in 100 years
M5-60[3]	20.0 mm
Ratio r[2]	0.450
Minimum cover to sewers[1]	1.2 m
Minimum velocity[1]	1.0 m/sec
Pipe ks value[1]	0.6 mm
Allowance for climate change[4]	30%

4.28 National policy[1] requires that new developments control the peak discharge of storm water from a site to the baseline, undeveloped, site conditions. Over very large development areas, the baseline rate of run-off is normally estimated using the FEH methodologies. However, Paragraph 3.1.2 of the FEH guidance states:

[2] Sewers for Adoption 7th Edition
[3] Wallingford Report
[4] NPPF requirements for residential development

"The frequency estimation procedures can be used on any catchment, gauged or ungauged, that drains an area of at least 0.5km^2. The flood estimation procedures can be applied on smaller catchments only where the catchment is gauged and offers simple flood peak or flood event data".

4.29 On undeveloped and ungauged catchments of less than 0.5km^2 in area, it is correct to complete baseline site discharge assessments using the nationally accepted IoH124 methodology for small rural catchments. Local policy is to employ IoH124 in a manner set out by CIRIA C697. This methodology requires that, for catchments of less than 50ha, the IoH assessment is completed for a 50ha area with the results linearly interpolated to determine the flow rate value based on the ratio of the development to 50ha.

4.30 The overall application boundary is below the 50ha threshold, thus the IoH124 methodology is therefore the most appropriate for appraising the baseline run-off from the development.

4.31 The baseline IoH run-off rates are shown on Figure 4e below and are contained within Appendix D.

Event	IoH 124 (50ha)	IoH 124 Scaled to 1ha
1 in 1 year (l/s)	165.1	3.30
Qbar (l/s)	194.2	3.88
1 in 100 year (l/s)	619.4	12.39

Figure 4e: IoH124 baseline discharge rates

4.32 In order to determine the permitted rates of run-off from the proposed residential development, the future impermeable catchment areas must be derived. This has been based on a BCL measured ratio from previous projects. Calculations below show these ratios and areas and how these correlate to the rates of discharge.

4.33 However, the development proposals have the potential to provide betterment to the surrounding area by reducing the peak run-off from the proposed development. Coupled with the mitigation of increased volume of run-off associated with built development, by reducing peak flows in the 1 in 100 year event to the mean annual flow (Qbar) it is possible for the development to achieve a circa 69% betterment in stormwater run-off. The calculations for this are shown in Figure 4f below:

Catchment	Land Use	Developable Area (ha)	Impermeable Area (ha)	Existing 100 Year Run-off (l/s)	Proposed 100 Year Run-off (l/s)	Betterment [%]
A	Residential	1.06	0.58	7.22	2.26	69
B	Residential	2.20	1.21	14.99	4.70	69
						69

Figure 4f: Run-off calculation

4.34 Using these methods, development at the Site will comply with the requirements set out in paragraph 9 of the Technical Guide to the National Planning Policy Framework (NPPF), with the discharge of surface water from the proposed developments not exceeding that of the existing greenfield sites, thus ensuring that there is no material increase in the flood risk to surrounding areas.

4.35 Assessments have thereafter been completed to determine the characteristics of proposed SuDS features to be situated within the development. Best practice methods have been employed by performing detention routing calculations for both the 1 in 1 and 1 in 100 year inlet and outlet return periods using the WinDES Source Control module. Employing the lower and upper end return periods with common characteristics provides for detention that will ensure peak outflows

are within the baseline return discharges for the full range of storm events. The summary calculations are contained within Appendix E.

Catchment A

4.36 Calculations demonstrate that storm water detention storage extending to maximum 433m^3 will be required to attenuate storm water discharges from the Site during the critical 1 in 100 year event storm. This will limit the peak discharges to 2.26l/s, being equivalent to the mean annual storm (Qbar), estimated by the IoH124 calculations above, representing a circa 69% reduction on peak greenfield rates. Figure 4g, below summarises the overall detention requirements. The summary calculations are contained within Appendix E.

Catchment	Catchment Area (ha)	Impermeable Area (ha)	1 in 100 Year Run-off (l/s)	Detention Volume for 1 in 100 Year Event (m^3) +30%
A	1.06	0.58	2.26	433

Figure 4g: Summary run-off & detention assessment output

Catchment B

4.37 Calculations demonstrate that storm water detention storage extending to maximum 815m^3 will be required to attenuate storm water discharges from the Site during the critical 1 in 100 year event storm. This will limit the peak discharges to 4.70l/s, being equivalent to the mean annual storm (Qbar), estimated by the IoH124 calculations above, representing a circa 69% reduction on peak greenfield rates. Figure 4h, below summarises the overall detention requirements. The summary calculations are contained within Appendix E.

Catchment	Catchment Area (ha)	Impermeable Area (ha)	1 in 100 Year Run-off (l/s)	Detention Volume for 1 in 100 Year Event (m^3) +30%
B	2.20	1.21	4.70	815

Figure 4h: Summary run-off & detention assessment output

4.38 In accordance with legislative requirements, the detention proposals have been assessed for the potential effects of climate change. The 1 in 100 year (1% AEP) return events have been modelled for 30% climate change (including peak rainfall intensity). Calculations for the climate change scenarios are contained within the Appendix E. Climate change assessments show each detention feature to perform adequately by retaining the additional flows within the system without overflow.

4.39 A side overflow weir will be provided on the detention features, at a level above the 1 in 100 year + 30% flood level to allow more extreme event flows to safely be conveyed away from properties, while at the same time not increasing flood risk to surrounding areas, in line with current good practice recommendations. The detailed design stage will provide further detail into the positioning of overflows and direction of flow.

4.40 A schematic layout for the drainage system has been developed that shows the strategic conveyance and detention features close to the existing water bodies, this can be found within Appendix C. Open channels are proposed where appropriate to act as conveyance systems and to enhance the SuDS management train. The system has been designed so that it remains operational in times of flood.

4.41 The basin, being an above ground naturally landscaped feature, will be designed to enhance the biodiversity and landscape character of the site, while also acting as functional features to control storm discharges from the Site and improve water quality.

4.42 The storm water management system will provide features that are designed to provide extended detention of storm water collected from within the development. This approach will maximise the passive treatment characteristics of the system and improve water quality discharged to the wider Northaw Brook catchment. Source control by way of permeable pavements may be employed, where appropriate, in high risk parking areas that provide for the efficient removal of silts and hydrocarbons ahead of discharge to the proposed network.

4.43 Furthermore, based on FRA work undertaken to support previous applications, it is recognised and accepted that in addition to the developments strategic attenuation basins, the implementation of source control measures can achieve a minimum 15% betterment in peak run-off from each development parcel, thus should this be a viable option, a further betterment may be achieved.

4.44 The proposed strategic drainage options are shown illustratively on drawings 10316/DR/02 & 10316/DR/10 contained within Appendix B & C.

4.45 Being an outline planning application, without the benefit of a detailed layout, it is not possible to provide a final drainage layout. However, the development framework plan coupled with the criteria set out in this report will form the framework of the final design at reserved matters stage.

Change of Use – Agricultural Land to Playing fields

4.46 With regards to the change of land use, the existing agricultural field has no positive drainage measures and prevailing levels suggest that surface water generally makes its way south to the Hempshill Brook. There are no anecdotal records of flooding within this field and it is not proposed that any positive drainage measures are installed to serve the playing fields as part of this application. However, the area could feasibly be drained by a series of narrow filter strips and either attenuated and linked into the Bowls Club drainage, or a positive route (swale or pipe) could be formed from the field to the Hempshill Brook to the south.

4.47 The land presently falls to the south at a gradient of approximately 1 in 30 as described above. To implement usable playing fields it is likely that minor earthworks will be required to provide a suitable platform. However, this activity is not a prohibitive engineering constraint to this change of land use from agricultural land to playing fields.

Water Quality

4.48 Impermeable surfaces collect pollutants from a wide variety of sources including cleaning activities, wear from car tyres, vehicle oil and exhaust leaks and general atmospheric deposition (source: CIRIA C609). The implementation of SuDS in development drainage provides a significant benefit in removal of pollutant from development run-off.

4.49 In most cases, contaminants become attached to sediment particles either before entering the water body or upon entry. CIRIA 609 reports that up to 90% of certain contaminants, usually trace elements, are transported in this way leaving a dissolved concentration of circa 10%.

4.50 Many SuDS systems rely on the infiltration of water through the ground layer into permeable sub soils or through sedimentation in low flow storage basins. This settling and filtering of contaminated run off through a fine grained matrix separates the suspended contaminated sediment from the body of water subsequently causing the water to leave the SuDS device in a more polished form than how it entered; porous paving is a prime example of this.

4.51 Furthermore, by implementation of SuDS features it is possible to optimize overall pollutant removal as water will undergo this process of filtering before being discharged to an appropriate receptor. The overall percentage of removal can be calculated individually for each differing SuDS technique, this is shown by the formula:

Overall pollutant removal = (TPLxC1) + (RPLxC2) + (RPLxC3) +…..for each other control in series
Where: TPL – Total Pollutant Load
RPL – Remaining Pollutant Load (after previous treatment(s)
C(x) – Suds Control removal efficiency

Figure 4i: Pollutant removal formula as set out in CIRIA C609

4.52 At present, the Site and surrounding area does not benefit from any additional measures of stormwater treatment.

4.53 Due to the need to provide wider sustainability benefits and view the development at a strategic level, SuDS will be implemented to passively treat run off from the development so as to have a positive impact on the surrounding natural environment.

4.54 The Site will employ two SuDS features, porous paving (where applicable) and a detention basin as these are widely accepted to be of high pollutant removal efficiency (CIRIA 609). This provides for two stages of treatment onsite.

4.55 As the Site is not presently served by any means of storm water treatment mechanisms, by providing the afore mentioned SuDS within the proposed development it will be possible to maintain present water quality in the area and thus the development can be seen to be having no significant environmental impact in relation to water.

Implementation Proposals

4.56 The conceptual drainage proposals have been developed in a manner that will allow the Site wide system to be designed to encourage passive treatment of discharged flows and to improve the water quality by removing the low level silts, oils and metal associated with urban run-off. Final design will provide for appropriate geometry and planting to maximise this benefit. The detention features will provide open channel outfalls to the ordinary watercourse receptors.

4.57 The storm water management features will be constructed and operational prior to the first occupation of dwellings across the Site.

4.58 The storm water management features to be implemented will be designed to enhance the biodiversity and landscape character of the Site, while also providing amenity space and acting as a functional feature to control storm discharges from the Site and improve water quality.

4.59 It has previously been the case that the functionality of the storm water management system would be ensured by ongoing maintenance, completed by the Local Authority, Drainage Authority, Parish Council or a private maintenance company as appropriate.

4.60 It was usual for the following maintenance regime to be implemented:

Frequency	Operation
Post major storm events	Inspection and removal of debris.
Every two months	Grass mowing (growing season) & litter removal.
Annual	Weeding & vegetation maintenance. Minor swale clearance. Sweeping of permeable pavements.
2 years	Tree pruning.
5-10 years	Desilting of channels. Remove silt around inlet and outlet structures.
15-20 years	Major vegetation maintenance and watercourse channel works.

Figure 4j: Framework maintenance of detention / retention system

4.61 The Floods and Water Management Act gained royal ascent in April 2010. This confers the responsibility to adopt and maintain the SuDS systems to the Local Authority by requiring SuDS Approving Bodies (SAB's) to be set up within each council's.

4.62 The SAB will have a duty to adopt the drainage systems and in accordance with Schedule 3; Para 22 of the Floods and Water Management Act:

22 (1) Where an approving body adopts a drainage system it becomes responsible for maintaining the system.
(2) In maintaining the system the adopting body must comply with national standards for sustainable drainage.

4.63 The SAB will therefore be responsible for developing their framework management plan for maintenance and operation procedures; adjusting the nature of the processes and timing as necessary to ensure the successful operation of the drainage systems.

4.64 The conceptual drainage masterplan proposals outlined in this report will be used for final drainage design and detailing. The storm water management system will be constructed and operational in full prior to occupation of the relevant phase of development.

Summary

4.65 A strategy for storm drainage at the Site has been developed to meet both national and local policy. The above options outline the viability of the Site to employ means of drainage to comply with NPPF guidance, together with the Welwyn Hatfield Borough Council SFRA and other national and local guidance.

4.66 The proposed residential development drainage system will manage storm water by way of a SuDS management train and ensure peak discharges from the developed land are reduced to circa 69% below the appraised baseline rates. The system will also provide improvements to the quality of water discharged from the development.

Objectives

4.67 The key objectives for the Site drainage will be:

- Implementation of a sustainable drainage scheme in accordance with current national and local policy together with principles of good practice design.
- Control of peak discharges from the proposed residential Site to a rate circa 69% below the baseline conditions, during all storm events.
- Development of storm water management proposals that improve water quality and biodiversity of the Site.
- Implementation of the storm water management system prior to first occupation of dwellings.

5 Foul Drainage

Background

5.1 A copy of the Thames Water sewerage network records has been obtained to confirm the presence of adopted foul sewers in the vicinity of the Site. Adopted foul sewers service the existing residential development areas to the north and west of the Site. An extract of the sewer map is presented in the following Figure 5a.

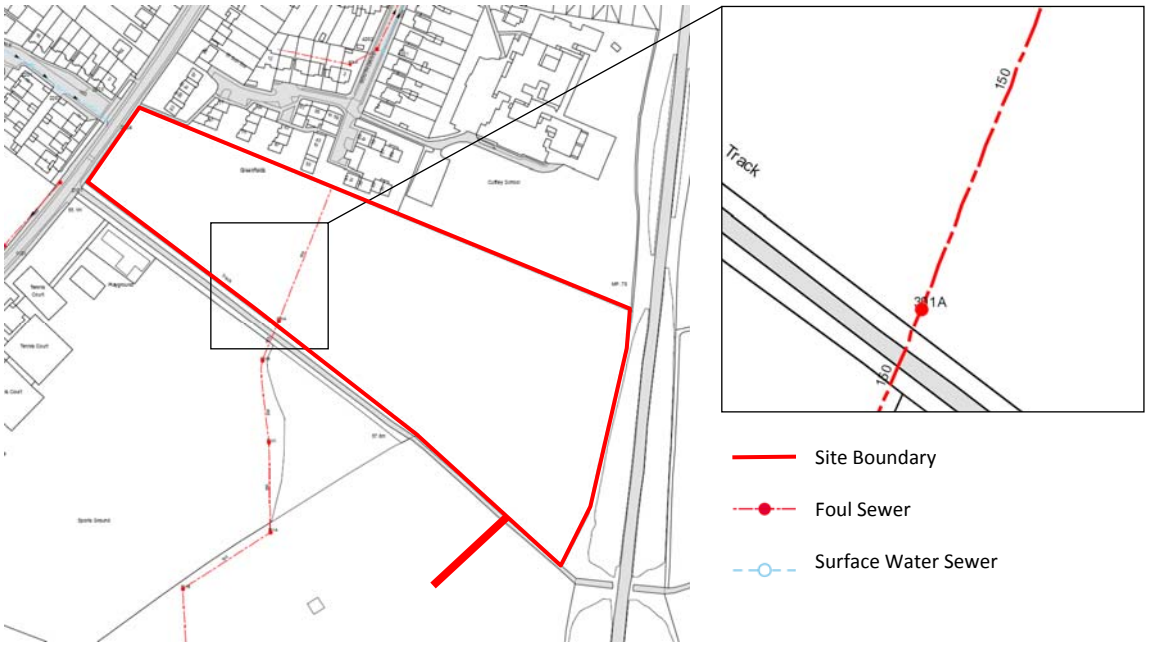

Figure 5a Thames Water Asset Location Search Sewer Map – ALS / ALS Standard / 2014_282911

5.2 A 150mm foul sewer shown in the north of the Site (adjacent to South Drive) crosses the Site to the south (adjacent to the sports field). The nearest potential point of connection shown is manhole 301A in the south of the Site.

Design Criteria / Network Requirements

5.3 Peak design discharges have been calculated based on the current development criteria as described in Section 2 of this report and for the following:

Domestic peak	=	4,000 litres / dwelling / day (peak)[5]

5.4 Assessed in accordance with SFA 7th Edition requirements, the development will have a design peak discharge of approximately 5.60 l/s.

Network Requirements / Options

5.5 Discussions with Thames Water have confirmed there is sufficient capacity within the existing foul sewer to accept flows from the proposed development.

Thames Water state: *"From the information you have provided, I can confirm that the existing foul water sewer does have sufficient capacity to accommodate the proposed foul water discharge from the proposal as specified in your application".*

5.6 In addition, a 3m easement has been issued by Thames Water either side of the existing foul sewer which crosses the development Site, to ensure access for any future repair and maintenance of the pipe. This has been taken into account, with regards to the formulation of the illustrative Masterplan for the purpose of proving the layout.

5.7 Any proposed development within this zone will require approval from Thames Water.

5.8 Correspondence from Thames Water is provided within Appendix F.

Treatment Requirements

5.9 Discussions with Thames Water have outlined that the existing foul water network conveys flows towards Cuffley Brook Sewage Pumping Station which it is understood directs flows onto Deephams Sewage Treatment Works, approximately 9.6km to the south-east of the Site.

5.10 Thames Water confirm that the Sewage Treatment Works has sufficient headroom to accommodate the flows from the proposed development.

5.11 Water companies have a statutory obligation through the Water Industry Act 1991, 2003 *et al*, to provide capital investment in strategic treatment infrastructure to meet development growth. This investment planning is managed and regulated by OFWAT through the Asset Management Plan (AMP) process. The five yearly cyclical process requires that water companies allocate finances to a range of strategic projects to meet their statutory obligations.

5.12 Where development programming requirements necessitate the reinforcement of facilities ahead of allocation in an AMP period, mechanisms are available to ensure the infrastructure can be delivered in a timely fashion, to the meet the development programme.

Implementation Proposals

5.13 The proposed drainage network across the Site will be designed to current Sewers for Adoption 7th Edition Standards, employing a point of connection agreed with Thames Water. The system will be offered for the adoption of Thames Water under S104 of the Water Industry Act 1991.

Summary

5.14 A Site drainage strategy has been developed that meets with current regulatory requirements by discharging drainage to a sewerage network with capacity to accommodate the flows.

5.15 A 3m easement has been issued by Thames Water either side of the existing foul sewer which crosses the development Site, to ensure access for any future repair and maintenance of the pipe. Any proposed development within this zone will require approval from Thames Water.

5.16 Once development is complete, the network conveying flows from the Site will be adopted by Thames Water and be maintained as part of their statutory duties.

Objectives

5.17 The key development objectives required for the Site drainage scheme are:

- Implementation of a drainage scheme to convey water to the local Thames Water network which is designed and maintained to an appropriate standard.

[5] Sewers for Adoption 7th Edition

6 Summary

6.1 This FRA has identified no prohibitive engineering constraints in developing the proposed Site for the proposed residential usage, or in the proposed change of use of the stand-alone parcel from agricultural land to playing fields.

6.2 Assessment of fluvial flood risk shows the land to lie in Flood Zone 1 and hence be a preferable location for residential development when considered in the context of the NPPF Sequential Test. Assessment of other potential flooding mechanisms shows the land to have a low probability of flooding from overland flow, ground water and sewer flooding.

6.3 Means to discharge storm and foul water drainage have been established that comply with current guidance and requirements of Thames Water.

6.4 Storm water discharged from the development will be directed to the ditch to the south of the Site. Foul water will discharge to the existing Thames Water network.

6.5 A 3m easement has been issued by Thames Water either side of the existing foul sewer which crosses the development Site, to ensure access for any future repair and maintenance of the pipe. Any proposed development within this zone will require approval from Thames Water.

6.6 The Environment Agency (EA) has confirmed that with the measures proposed for this Site, flood risk grounds would not be a basis for objection to this application. The relevant correspondence from the EA is included within Appendix G.

6.7 The Site is fully able to comply with NPPF guidance together with associated local and national policy guidance.

7 Limitations

7.1 The conclusions and recommendations contained herein are limited to those given the general availability of background information and the planned usage of the Site.

7.2 Third party information has been used in the preparation of this report, which Brookbanks Consulting Ltd, by necessity assumes is correct at the time of writing. While all reasonable checks have been made on data sources and the accuracy of data, Brookbanks Consulting Ltd accepts no liability for same.

7.3 The benefits of this report are provided solely to Lands Improvement for the proposed development of Land to the north east of King George V Playing Fields in Cuffley only.

7.4 Brookbanks Consulting Ltd excludes third party rights for the information contained in the report.

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Appendix A

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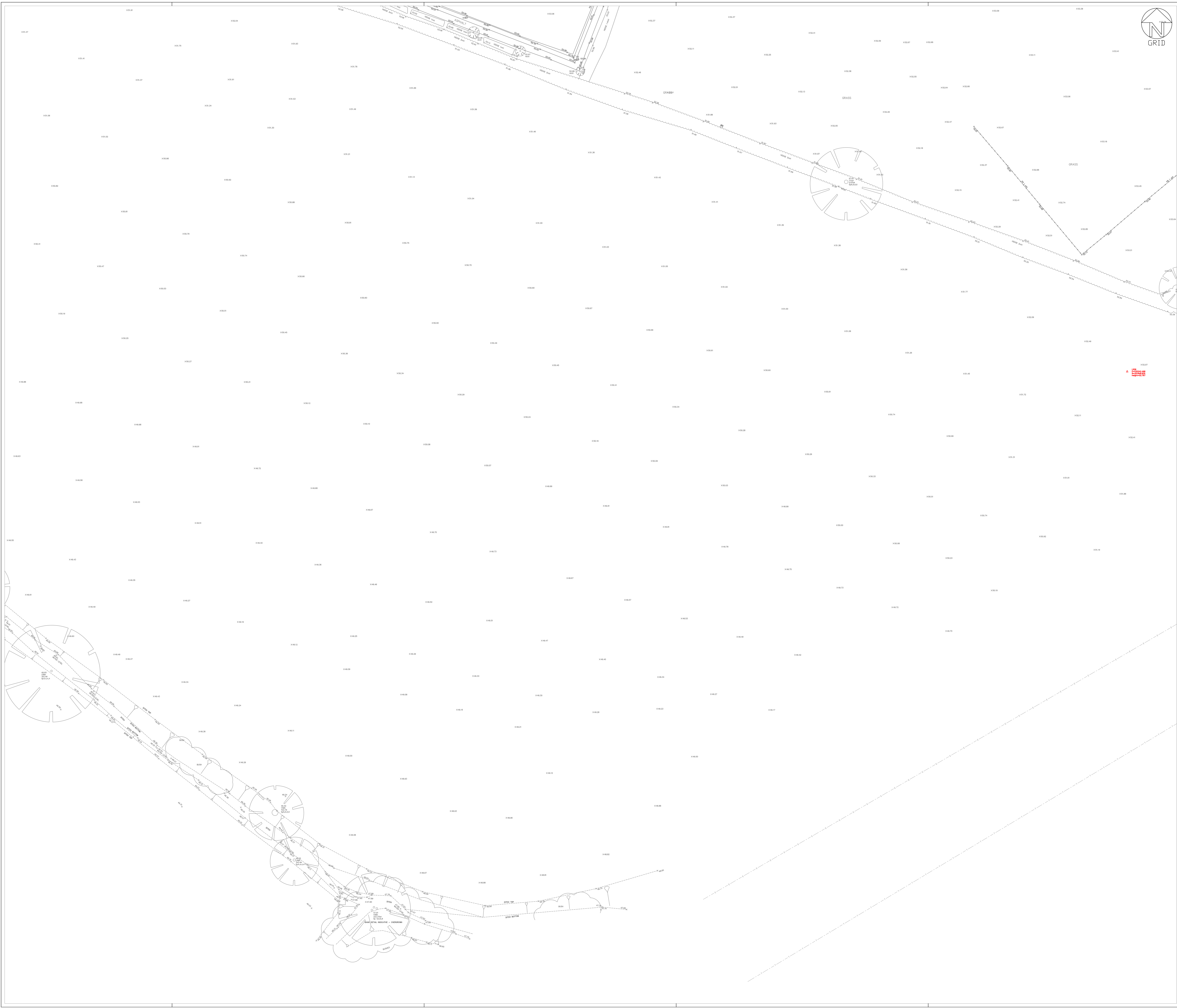

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Topographical Survey

Land surrounding Cuffley Football Club

Sheet 10 of 10
August 2014

Scale
1:200

Horizontal Datum: Supplied by client
Vertical Datum: Supplied by client
Units: Metres

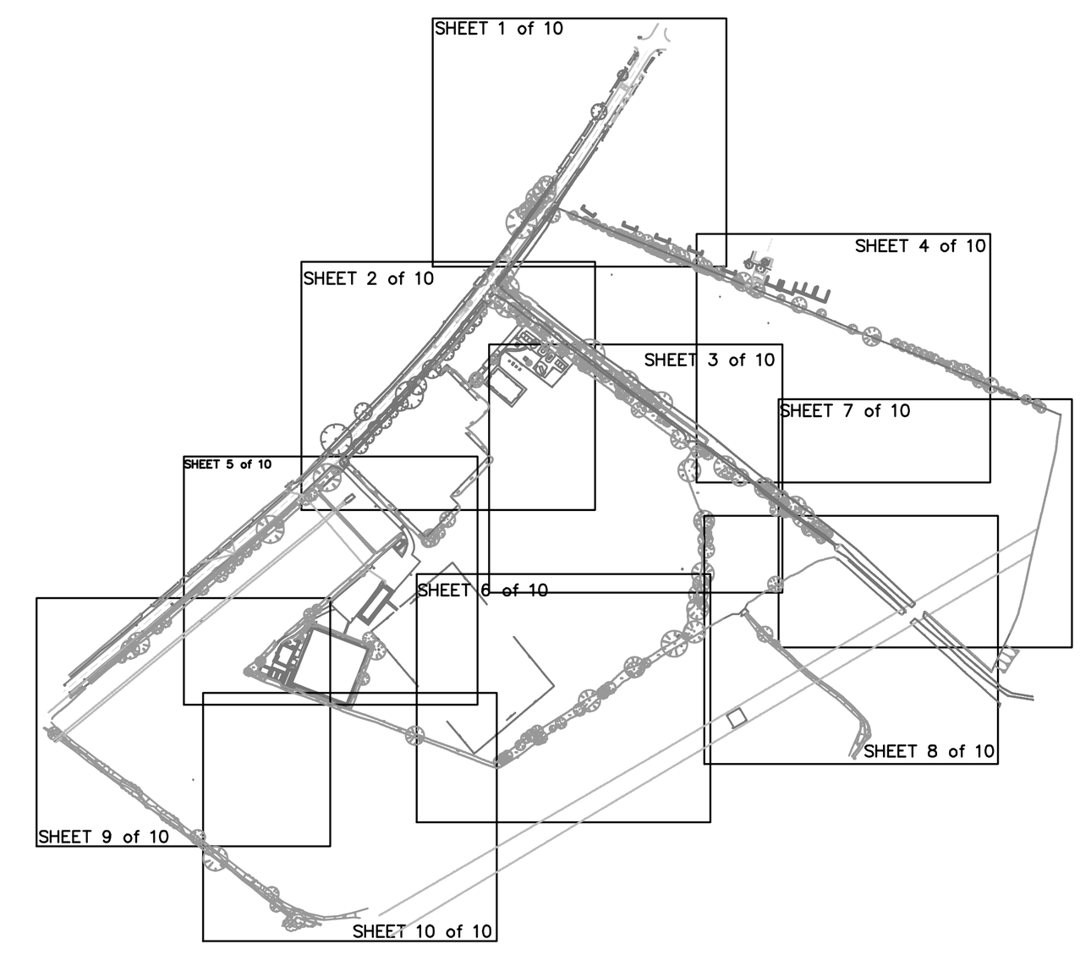
0 5 10 15 20
metres

Survey Notes

1) This drawing contains elements from drawing S-08-431-01 as supplied by client.

2) The survey control is based on the following stations within the above drawing
S2 **E**530199.246 N202117.783 Level 62 .74
S3 E530247.144 N202176.436

Sheet Layout



Legend

1 E=1000.000 N=2000.000 Height=100.000	Survey Control Station	117.18 3mH	Tree with elevation, height in metres and spread to scale
× 101.84	Spot Level N.B. Spot levels at road edge relate to channel line		Gate
2.0m	Major Contour 1m Interval	255.84 255.76	Top of bank
1.5m	Minor Contour 0.5m Interval	250.06 249.75	Bottom of bank
T	Overhead Telecoms		Tree Canopy
E	Overhead Electric		Foliage/Hedge edge

Abbreviations

PP	Post and Panel Fenceline	ER	Earth Rod	TPO	Telegraph Pole
PR	Post and Rail Fenceline	MW	Monitoring Well	EPO	Elecricity Pole
PW	Post and Wire Fenceline	CR	Cable Riser	RS	Road Sign
SM	Post and Steel Mesh Fenceline	EPO	Electric Pole	BO - C	Bollard - Concrete
mH	Height in Metres			BO - S	Bollard - Steel
		GSV	Gas Valve	BO - W	Bollard - Wooden
IC	Inspection Cover	GM	Gas Meter	LB	Litter Bin
CL	Cover Level	GR	Gas Riser	PI	Pillar
IL	Invert Level			RS	Road Sign
G	Gully	AV	Air Valve	TS	Tree Stump
DP	Down Pipe	WST	Stop Tap	TCB	Telephone Call Box
RWP	Rain Water Pipe	WSV	Sluice Valve	FP	Flag Pole
FWP	Foul Waste Pipe	WM	Water Meter	TP	Tactile Paving
VC	Vent Cover	WO	Wash Out	FP	Fuel Pump
RE	Rodding Eye			TIL	Traffic Induction Loop
VP	Vent Pipe	SL	Street Light	LA	Ladder
FWS	Foul Water Sewage	PLM	Pipeline Marker	FB	Flower Bed
SWS	Surface Water Sewage	CAB	Street Cabinet	DK	Dropped Kerb

Prepared for: **Lands Improvement**
10 Lower Grosvenor Place
London
SW1W 0EN

Surveyed by: C. Whiteley, R. Baker
Date: 14th - 22nd August 2014

Drawing Reference	Rev	Date	Description	Filename	Drawn By	Checked By	Approved By
1667_200_10	0	29/08/14	First issue	1667_0	CWh/RBa	MBe	MBe

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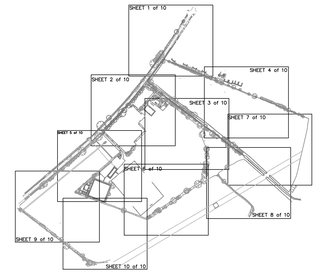

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mH	Height in Metres			BO - S	Bollard - Steel
		GSV	Gas Valve	BO - W	Bollard - Wooden
IC	Inspection Cover	GM	Gas Meter	LB	Litter Bin
CL	Cover Level	GR	Gas Riser	PI	Pillar
IL	Invert Level			RS	Road Sign
G	Gully	AV	Air Valve	TS	Tree Stump
DP	Down Pipe	WST	Stop Tap	TCB	Telephone Call Box
RWP	Rain Water Pipe	WSV	Sluice Valve	FP	Flag Pole
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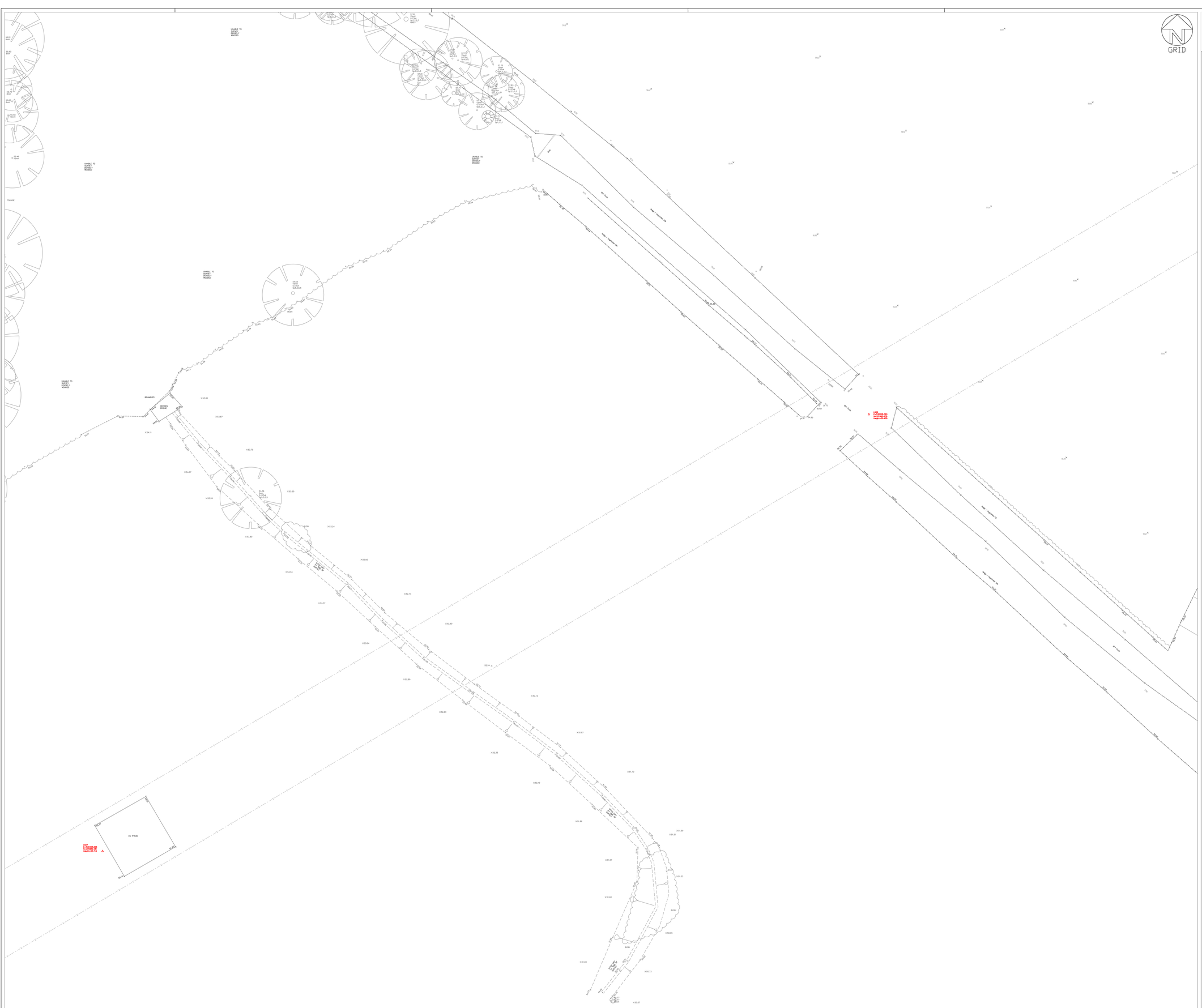
Drawing Reference	Rev	Date	Description	Filename	Drawn By	Checked By	Approved By
1667_200_9	0	29/08/14	First issue	1667_0	CWH/RBa	MBe	MBe



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Topographical Survey

Land surrounding Cuffley Football Club

Sheet 8 of 10
August 2014

Scale
1:200

Horizontal Datum: Supplied by client
Vertical Datum: Supplied by client
Units: Metres

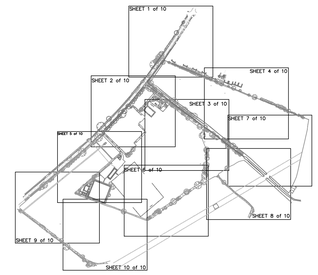
0 5 10 15 20
metres

Survey Notes

1) This drawing contains elements from drawing S-08-431-01 as supplied by client.

2) The survey control is based on the following stations within the above drawing.
S2 E530199.246 N202117.783 Level 62..74
S3 E530247.144 N202176.436

Sheet Layout



Legend

L=100.000 N=200.000 Height=50.000	Survey Control Station		Tree with elevation, height in metres and spread to scale
x 101.84	Spot Level N.B. Spot levels at road edge relate to channel line		Gate
0.5m	Major Contour 1m Interval		Top of bank
0.5m	Minor Contour 0.5m Interval		Bottom of bank
T	Overhead Telecoms		Tree Canopy
E	Overhead Electric		Foliage/Hedge edge

Abbreviations

PP	Post and Panel Fenceline	ER	Earth Rod	TPO	Telegraph Pole
PR	Post and Rail Fenceline	MW	Monitoring Well	EPO	Elecricity Pole
PW	Post and Wire Fenceline	CR	Cable Riser	RS	Road Sign
SM	Post and Steel Mesh Fenceline	EPO	Electric Pole	BO - C	Bollard - Concrete
mH	Height in Metres			BO - S	Bollard - Steel
		GSV	Gas Valve	BO - W	Bollard - Wooden
IC	Inspection Cover	GM	Gas Meter	LB	Litter Bin
CL	Cover Level	GR	Gas Riser	PI	Pillar
IL	Invert Level			RS	Road Sign
G	Gully	AV	Air Valve	TS	Tree Stump
DP	Down Pipe	WST	Stop Tap	TCB	Telephone Call Box
RWP	Rain Water Pipe	WSV	Sluice Valve	FP	Flag Pole
FWP	Foul Waste Pipe	WM	Water Meter	TP	Tactile Paving
VC	Vent Cover	WO	Wash Out	FP	Fuel Pump
RE	Rodding Eye			TIL	Traffic Induction Loop
VP	Vent Pipe	SL	Street Light	LA	Ladder
FWS	Foul Water Sewage	PLM	Pipeline Marker	FB	Flower Bed
SWS	Surface Water Sewage	CAB	Street Cabinet	DK	Dropped Kerb

Prepared for: **Lands Improvement**
10 Lower Grosvenor Place
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Surveyed by: C. Whiteley, R. Baker
Date: 14th - 22nd August 2014

Drawing Reference	Rev	Date	Description	Filename	Drawn By	Checked By	Approved By
1667_200_8	0	29/08/14	First issue	1667_0	CWh/RBa	MBe	MBe