LW Developments Ltd

Flood Risk Assessment for Sports Village Development at Cheshunt Football Club, Hertfordshire

Report K0753/1

September, 2016

Prepared and submitted by

Hydro-Logic Services
(part of Hydro International Ltd)
18-20 West End Road,
Mortimer, Reading,
Berkshire RG7 3TF

T: 01189 331 325
F: 01189 331 486

enquiries@hydro-logic.co.uk

http://www.hydro-logic.co.uk/

EXECUTIVE SUMMARY OF REPORT

This Report documents work undertaken by Hydro-Logic Services for LW Developments Ltd during summer 2016.

The purpose of the work was:

- To assess flood risk at this site in terms of the National Planning Policy Framework (NPPF) and, where necessary, to recommend measures to achieve compliance.

The scope of the work included and was limited to the following, by agreement with Dean Williamson:

- FRA for a proposed stadium and sports village at Cheshunt Football Club, Hertfordshire.
- Review and digest of the surface water management plan proposed by Peter Dann Consulting Engineers including liaison with Peter Dann and confirmation of the dimensions of the northern section of the perimeter swale.

The key outcomes of the work are:

- It has been proposed that Cheshunt Football Club ground is redeveloped with improved stands incorporating accommodation for the football club, commercial and residential units. 50 houses will be constructed on the neighbouring practice ground.
- The site of proposed development is situated in fluvial Flood Zone 1 and at 'low' risk of surface water flooding. The development is classified as predominantly "More Vulnerable" with some areas "Less Vulnerable".
- Existing peak runoff rates and volumes for the site have been calculated.
- The increase in impermeable area will lead to increased rates and volumes of runoff. Runoff is to be attenuated via a tank system discharging into the Theobald's Brook at each end of the site. The attenuation system has been designed by Peter Dann Consulting Engineers.

The work delivered the following outputs:

- This report.

Contributors for Hydro-Logic Services:

Paul Webster	Project Director
Alison Clare-Dalgleish	Project Manager and Reporting

Document Status and Revision History:

Version	Date	Author(s)	Project Manager	Authorisation	Status/Comment
0	July 2016	Alison Clare-Dalgleish	Alison Clare-Dalgleish	Alan Corner	Incomplete draft for Client review
1	Sept. 2016	Alison Clare-Dalgleish	Alison Clare-Dalgleish	Paul Webster	Final
1 Rev 1	Sept. 2016	Alison Clare-Dalgleish	Alison Clare-Dalgleish	Paul Webster	Final inc. updated text for revision to SWMS

Limitation of liability and use

TABLE OF CONTENTS

1. Introduction

1.1 Purpose of this Report

This Report presents a Flood Risk Assessment (FRA) for a proposed sports stadium and residential development at a site in Cheshunt, Hertfordshire. The purpose of this Report is to assess flood risk at the site in relation to the proposed use and to devise a surface water management plan, to ensure that the proposed development does not increase flood risk elsewhere within the catchment.

1.2 Background

The site was originally a gravel pit and become a local rubbish tip in the 1930s. Between February and October 1949 the site was cleared, levelled and a football pitch was laid. Cheshunt FC opened the ground on the 29th October 1949 but drainage problems forced the club to abandon the stadium before the end of the 1949/50 season. The club returned to the stadium in 1952/53 but again left after a season due to a poor playing surface. The club returned to the stadium again at the end of the 1957/58 season. In 2011 Cheshunt Sports & Leisure Ltd took over the Club with Dean Williamson installed as Chairman. Cheshunt Sports & Leisure is looking to take the club forward with a vision to produce a Conference standard football club and academy together with first class sports and business facilities that will allow Cheshunt FC to become a centre of sporting excellence.

Since 2013 the northern part of the site has been redeveloped as sports practice pitches. A flood risk assessment for this initial development was carried out by Hydro-Logic Services in June 2013. There are now proposals for the development of the southern part of the site including an upgraded pitch and stand with commercial facilities and a neighbouring residential development.

It is a requirement of the Planning Application that a full Flood Risk Assessment (FRA) be undertaken for this development. LW Developments Ltd has appointed Hydro-Logic Services through Dean Williamson, LW Developments to conduct this 'Level 2' FRA. The planning application site area is approximately 5.19 ha.

The principal issues to be demonstrated in any flood risk assessment are as follows (CLG, 2009):

- whether any proposed development is likely to be affected by current or future flooding from any source;
- satisfying the LPA that the development is safe and where possible reduces flood risk overall;
- whether it will increase flood risk elsewhere; and
- the measures proposed to deal with these effects and risks. Any necessary flood risk management measures should be sufficiently funded to ensure that the site can be developed and occupied safely throughout its proposed lifetime;

The Planning Guidance for Development and Flood Risk was revised, with NPPF, the National Planning Policy Framework (CLG, 2012) replacing Planning Policy Statement 25 (PPS25, CLG, 2010). The policy principles however remain unchanged. A suggested proforma for undertaking FRAs has been included within the NPPF Practice Guide[1]. The pro-forma has been reproduced as Appendix A of this FRA with the content highlighting the sections in the FRA that address specific points in the pro-forma.

[1] http://planningguidance.communities.gov.uk/blog/guidance/flood-risk-and-coastal-change/

1.3 Sources of Information and Consultation

A walk over survey of the site was carried out by Iain Hissett, Hydro-Logic Services on 24th April 2013. During the visit local flood conditions, site boundaries, and the overall topography were examined and discussed with Lee Williamson. The weather was dry and there was no evidence of water on the site.

Plans of the proposed development have been provided by Dean Williamson of LW Developments and Ian Sargent of Peter Dann Consulting Engineers. Additional information, including details of the surface water management strategy was provided by John Bowstead and Ian Sargent of Peter Dann Consulting Engineers.

The Flood Estimation Handbook (FEH) was used, together with published information on soil and geology to determine the extent and characteristics of the catchment in which the site is located. The existing greenfield runoff has been calculated from design rainfall totals and hydrographs derived from the FEH web service and ReFH v2. Flood risk from a range of sources was investigated using Environment Agency online mapping and the Strategic Flood Risk Assessment (SFRA) for the area.

1.4 Structure of Report

The Report has been structured in order to deal with each of the points raised in the NPPF Practice Guide (reproduced as Appendix A of this Report). Each of the points is referenced in the appropriate headings. Thus, A3a refers to Section 3a of Appendix A.

- Section 2 refers to spatial planning considerations by reference to the proposed land use and flood zoning.
- Section 3 presents an assessment of the existing flood risk at the application site.
- Section 4 presents an assessment of flood risks associated with the proposed development along with any mitigation that may be required.
- Section 5 presents a summary of the main findings.

Additional Appendices are provided that deal with the following:

- Appendix A: Check List of NPPF Flood Risk Guidance
- Appendix B: Existing Site Plan
- Appendix C: Surface Water Management Plan provided by Peter Dann Consulting Engineers

2. Spatial Planning Considerations

2.1 Location Plan and Site Plan (A1a)

The site of proposed development is on the southwest edge of Cheshunt, north of Theobald's Lane and covers an area of 5.52 ha. The site is at approximately 25-30 mAOD and is shown in (Figure 2-1). The existing site layout is shown in Figure 2-2 and Appendix B . The proposal is for a redeveloped football stadium including associated facilities, residential and commercial development and parking. In addition, further residential development is proposed in the eastern half of the site (Figure 2-3). Table 2-1 provides grid reference details for the site.

Figure 2-1 General location of the proposed development (site boundary shown in red)

Reproduced under Licence 100041271

Table 2-1 Grid reference details for the site

Reference	Value
OS X (Eastings)	535555
OS Y (Northings)	201352
Nearest Post Code	EN8 8RU
LR	TL355014

Figure 2-2 Existing site layout (site boundary shown in red)

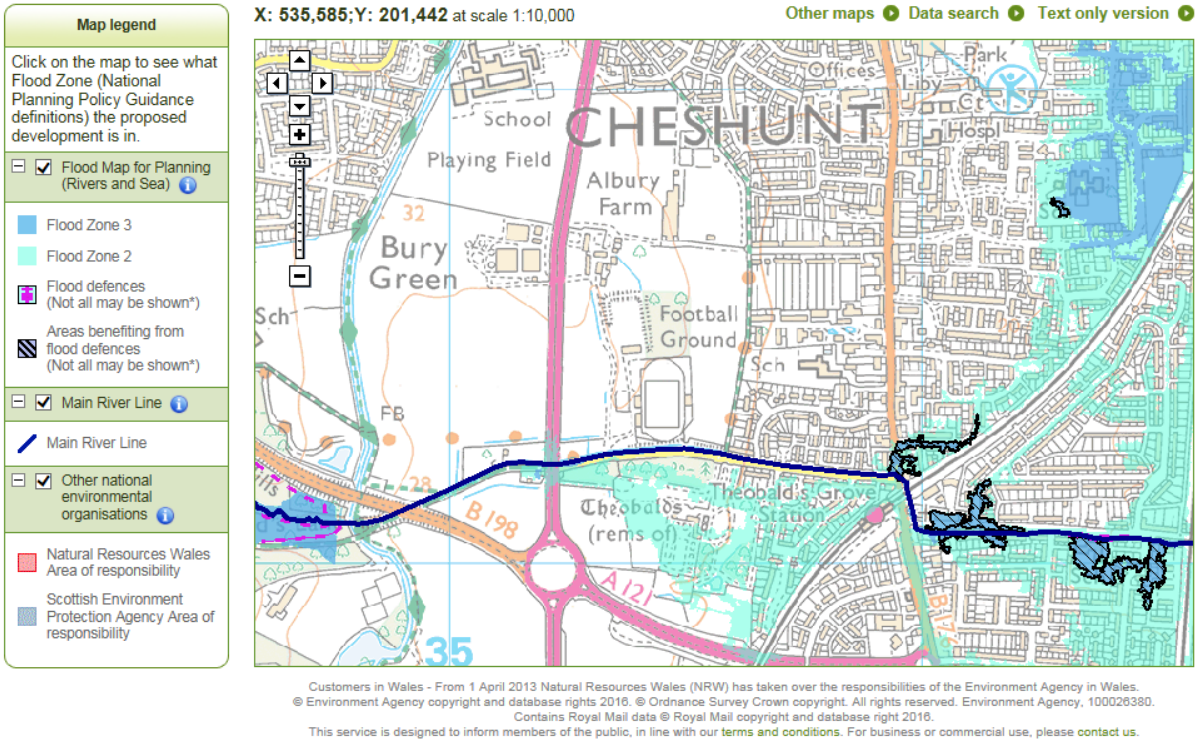
Figure 2-3 Location of the proposed units (top of plan is east)

Source: LW Developments, drawn by Bryant and Moore Architects

2.2 Environment Agency Flood Zone (A3a)

The Environment Agency online fluvial Flood Zone map is reproduced as Figure 2-4. This shows the proposed development to be within Flood Zone 1, with less than a 1:1000 annual probability of flooding (<0.1% AEP). The nearest watercourse is Theobald's Brook (referred to in the SFRA as Trinity Marsh Ditch) which runs west to east between the southern edge of the site and the northern edge of Theobald's Lane. The section of the brook adjacent to the site is classified as main river. The brook lies at the bottom of a steep bank, approximately 3 m below the level of the site and 2 m below the level of the road. The 'New River', approximately 500 m west of the site, is actually a canalised system dating back to Tudor times (London Footprints). There is no recognised flood risk from this watercourse.

Figure 2-4 Environment Agency fluvial flood risk map



Copyright Environment Agency (accessed May 2016)

2.3 The SFRA and Sequential Test (A1b, A1c, A1d, A3b)

The area is covered by the Broxbourne Borough Council SFRA (JBA, 2016). Numerous references are made in that document to the Theobald's Brook, Theobald's Lane and Trinity Marsh Brook but there is no record of historical flooding occurring at the site. The NPPF includes a table to highlight which types of development are appropriate in each flood zone (DCLG, 2012b, p.8), which is reproduced here as Table 2-2. The proposed development would be classed as a combination of More Vulnerable (residential) and Less Vulnerable (non-residential commercial and liesure) in accordance with the classification in Table 2-3.

The site is shown to lie within Flood Zone 1 (Figure 2-4); the Sequential Test is therefore not required (Table 2-2).

Table 2-2 Flood risk vulnerability and flood zone compatibility

Flood Zone	Definition	Essential Infrastructure	Water compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
1	T>1,000	✔	✔	✔	✔	✔
2	$100<T_{fluv}<1,000$ $200<T_{tidal}<1,000$	✔	✔	Exc	✔	✔
3a	$T_{fluv}<100$ $T_{tidal}<200$	Exc.	✔	✕	Exc	✔
3b (functional floodplain)	$T_{fluv}<20$	Exc	✔	✕	✕	✕

Table 3 from the NPPF Technical Guide (DCLG, 2012b)

Notes:

✔ development is appropriate
✕ development should not be permitted
T return period (fluv = fluvial)
Exc exception test should be applied

Table 2-3 Flood risk vulnerability classification

Essential Infrastructure (EI)
Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk.
Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood.
Wind turbines.
Highly Vulnerable (HV)
Police stations, Ambulance stations and Fire stations and Command Centres and telecommunications installations required to be operational during flooding.
Emergency dispersal points.
Basement dwellings.
Caravans, mobile homes and park homes intended for permanent residential use.
Installations requiring hazardous substances consent.[19] (Where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as 'Essential Infrastructure'[20]).
More Vulnerable (MV)
Hospitals.
Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels.
Buildings used for: dwelling houses; student halls of residence; drinking establishments; nightclubs; and hotels.
Non–residential uses for health services, nurseries and educational establishments.
Landfill and sites used for waste management facilities for hazardous waste.
Sites used for holiday or short-let caravans and camping, **subject to a specific warning and evacuation plan**.
Less Vulnerable (LV)
Police, ambulance and fire stations which are not required to be operational during flooding
Buildings used for: shops; financial, professional and other services; restaurants and cafes; hot food takeaways; offices; general industry; storage and distribution; non–residential institutions not included in 'more vulnerable'; and assembly and leisure.
Land and buildings used for agriculture and forestry.
Waste treatment (except landfill and hazardous waste facilities).
Minerals working and processing (except for sand and gravel working).
Water treatment works which do not need to remain operational during times of flood
Sewage treatment works (if adequate measures to control pollution and manage sewage during flooding events are in place).
Water-compatible Development (WC)
Flood control infrastructure.
Water transmission infrastructure and pumping stations.

Table 2 from NPPF Technical Guide (DCLG, 2012b, pp.6-7)

3. Flood Hazard for Existing Site

3.1 Topography

The western half of the site is flat while the east half drops away gently eastwards. Steep embankments down to the neighbouring land run along south and east boundaries. Figure 3-1 and Figure 3-2 show the areas of the proposed residential and stadium developments respectively.

Figure 3-1 Photograph of the site of proposed residential development, looking south.

Figure 3-2 Existing pitch, looking towards the east stand

3.2 Soils and Geology

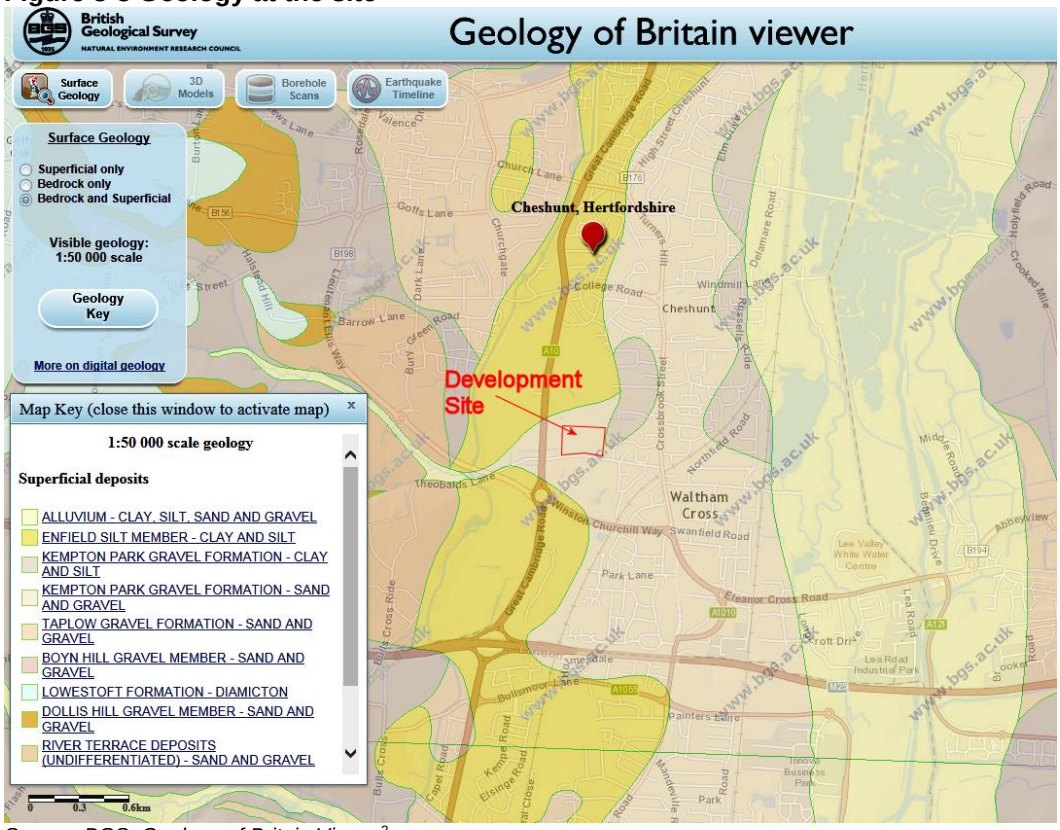
The site is shown on the British Geological Society (BGS): Geology of Britain viewer as having a bedrock of “London Clay Formation”, which is overlain by superficial deposits of “Kempton Park Gravel Formation” (Figure 3-3).

The National Soil Resources Institute (NSRI) Soil Map (Figure 3-4) reflects the BGS superficial geology with freely draining soils at the site. This contrasts with the FEH catchment characteristics with SPRHOST indicating an impermeable catchment more in line with the bedrock geology.

As a capped former land fill within an old gravel working, the site now consists of made ground covered by approximately 20 cm of relatively impermeable topsoil (Figure 3-5).

A geotechnical investigation has been carried out by Environmental Protection Strategies Ltd. (EPS 2016). The findings were as follows. Typically, the granular fill extended down to the clay at around 7m although, in places dense sands and gravels were found below the fill materials. Groundwater levels were between 2.150m and 3.796m below ground. Although infiltration testing indicated that the soils may be suitable for the use of soakaways, given the nature and extent of the fill material, the use of shallow infiltration methods is not recommended. There may be potential for a deep soakaway beneath any made ground and landfill, provided adequate measure are taken to prevent contamination.

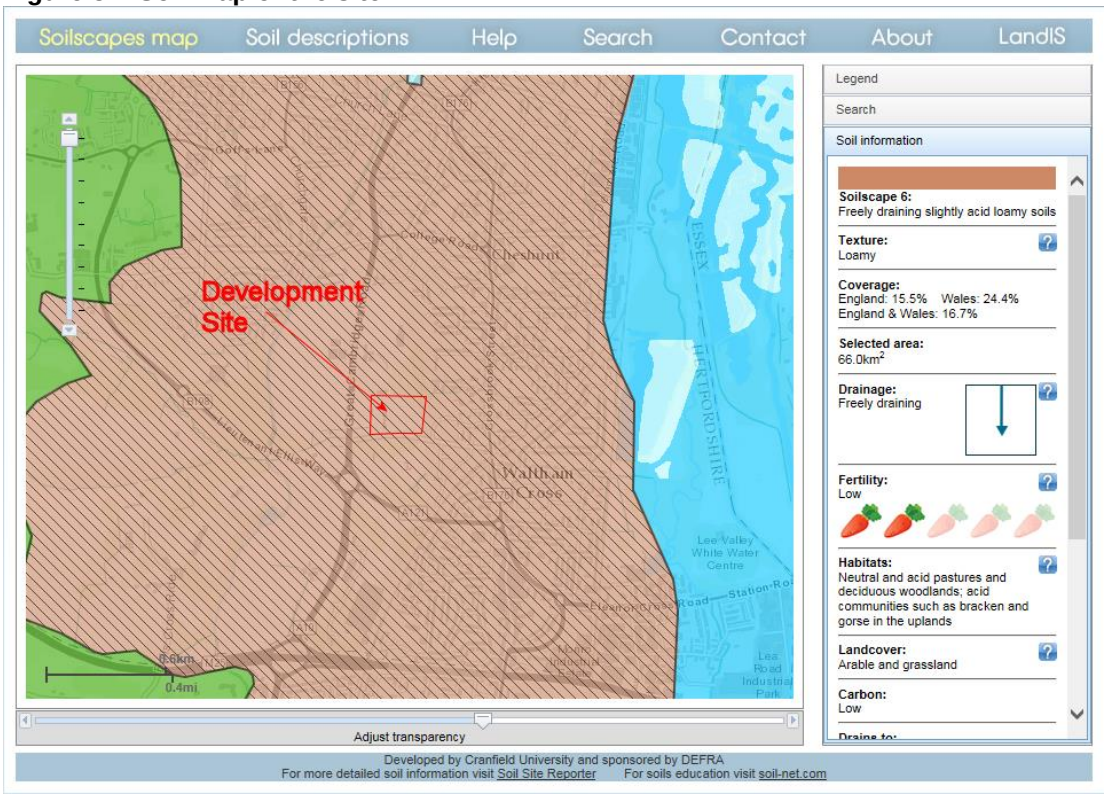
Figure 3-3 Geology at the site



Source: BGS, Geology of Britain Viewer[2]

[2] http://mapapps.bgs.ac.uk/geologyofbritain/home.html

Figure 3-4 Soil map of the site



Source: Cranfield University Soil Mapping[3]

Figure 3-5 Trial Pit

Source: Pre-Application Design Statement'

[3] http://www.landis.org.uk/soilscapes2/

3.3 Catchment Characteristics

The catchment draining the site is mapped in Figure 3-6, on which the approximate location of the site has been marked. The catchment descriptors are listed in Table 3-1. The development is situated within a 4.255 km^2 catchment of Theobald's Brook, which flows east of the Lee Valley. The potential run-off from the catchment (the SPRHOST characteristic) at 43.08% is high in a UK context where values usually range from 10% to 50%. The measure of base flow (the BFIHOST characteristic) is moderate with an index of 0.431. The average annual rainfall for the catchment (the SAAR characteristic) is 654 mm and the catchment is wet (the PROPWET characteristic) 30% of the time.

Figure 3-6 Catchment boundary (FEHweb)

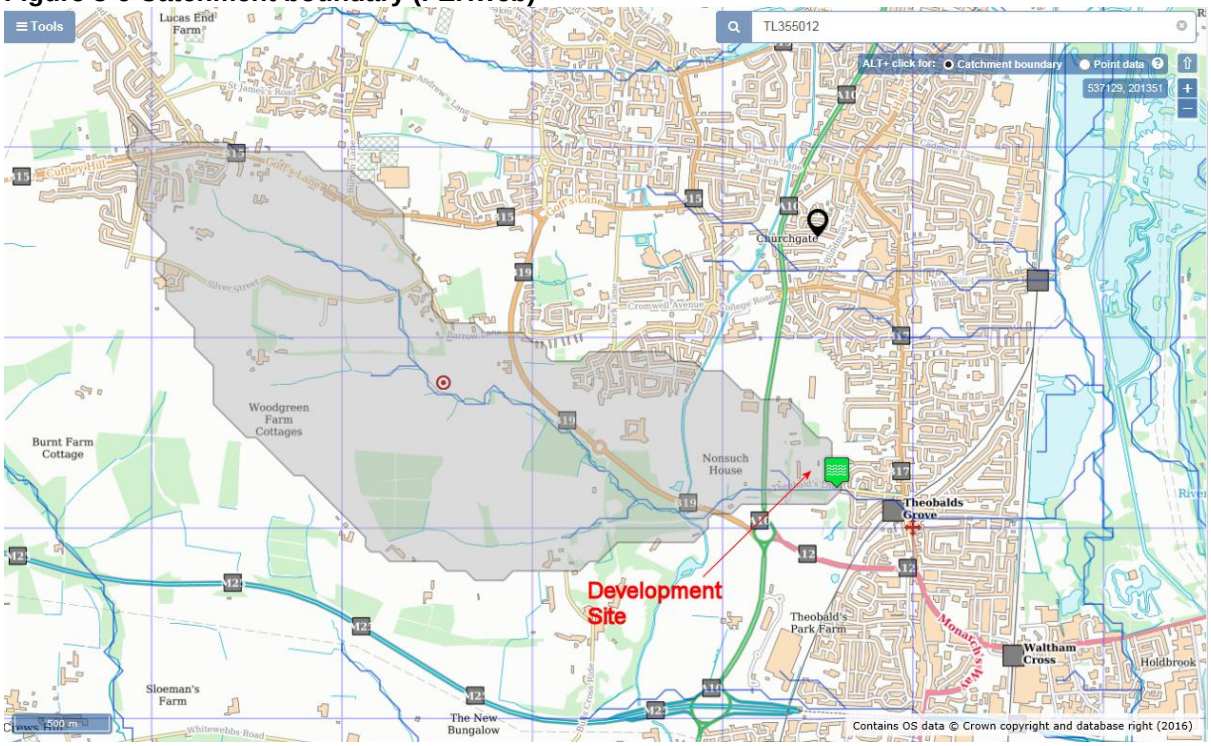


Table 3-1 Characteristics of the catchment

	Location:	Cheshunt
	NGR:	TL 35600 01200
AREA	**Catchment area (km²)**	4.255
ALTBAR	Mean elevation (m)	61
ASPBAR	Mean aspect	105
ASPVAR	Variance of aspect	0.55
BFIHOST	Base flow index	0.431
DPLBAR	Mean drainage path length (km)	2.74
DPSBAR	Mean drainage path slope	40.3
FARL	**Index of lakes**	1
FPEXT	Prop. of catchment in1% FP	0.0535
FPDBAR	Mean flood depth (catchment)	0.399
FPLOC	Avg dist of FP to outlet	0.388
LDP	Longest drainage path (km)	5.12
PROPWET	Proportion of time soil is wet	0.3
RMED-1H	Median 1 hour rainfall (mm)	11
RMED-1D	Median 1 day rainfall (mm)	31
RMED-2D	Median 2 day rainfall (mm)	39.3
SAAR	**Average annual rainfall (mm)**	654
SAAR4170	Ditto for 1941-1970 (mm)	643
SPRHOST	**Percentage runoff**	43.08
URBEXT1990	**Urban extent 1990**	0.757
URBEXT2000	**Urban extent 2000**	0.0425

Theobalds Brook or Trinity Marsh Ditch is classified as partly Main River partly Ordinary Watercourse. The Theobalds Brook rises around the Isabelle Close and Doverfield area of Goff's Oak, flowing in a south-easterly direction. At Silver Street, the Theobald's Brook changes from Ordinary Watercourse to Main River. The watercourse continues and starts to flow in an easterly direction, parallel to Theobald's Lane and then Trinity Lane, in Waltham's Cross. Downstream of the railway bridge in Trinity Lane, the watercourse's name changes from Theobald's Brook to Trinity Marsh Ditch and flows in a predominantly south-easterly direction joining the Small River Lee at Holdbrook. The Trinity Marsh Ditch is culverted from approximately TL 36789 00431, upstream of the A121 road, to its confluence with the Small River Lee. (JBA 2016)

3.4 Source Of Flood Risk (A2a, A2b)

A review of flooding sources is given in Table 3-2, which shows possible causes at the site. The site is located within the Broxbourne Borough Council planning boundary. The Strategic Flood Risk Assessment (SFRA) was prepared by JBA in May 2016. Fluvial flooding is regarded as very low risk (<0.1% AEP), as the site is located in Flood Zone 1 (Figure 2-4).

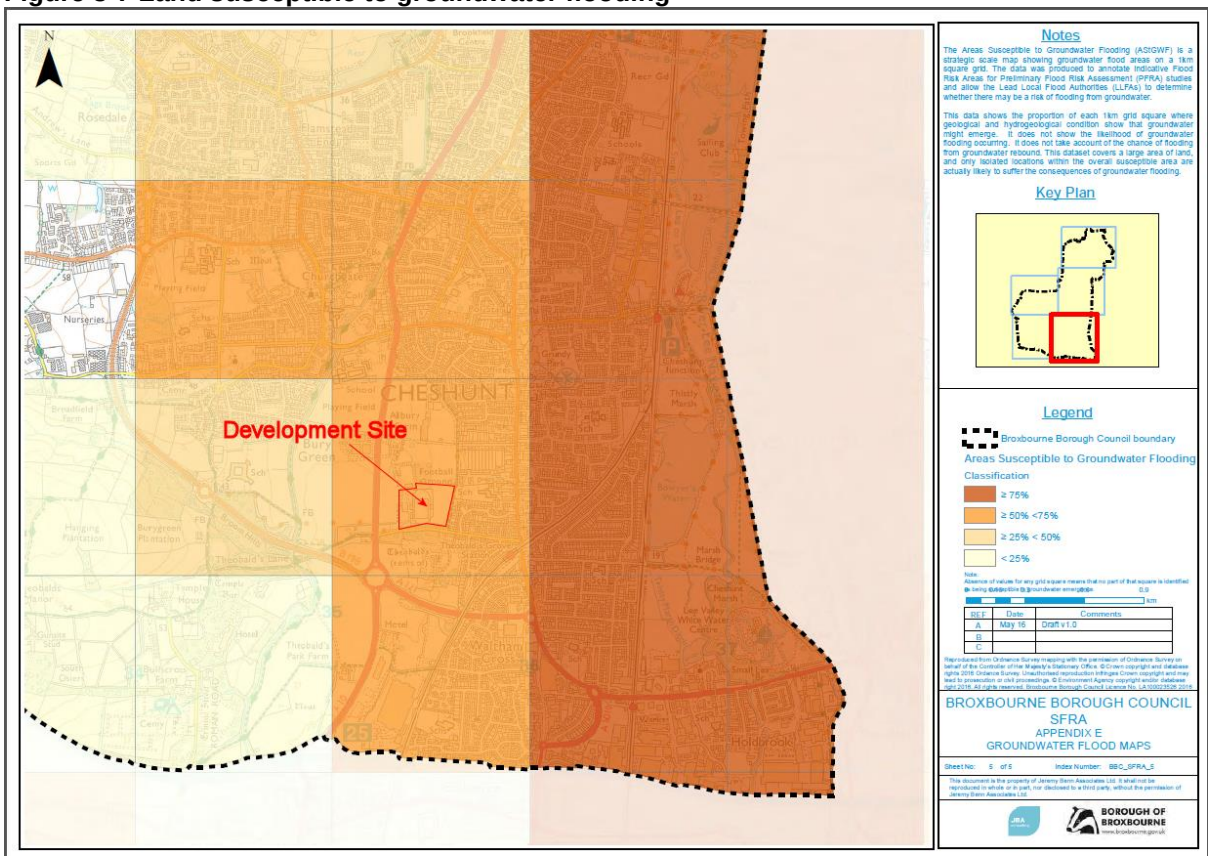
There are no historical records of groundwater flooding at the site. The SFRA (JBA, 2016,) provides a map indicating susceptibility to groundwater flooding (Figure 3-7). The map is resolved to 1 km squares and Section 5.7 of the SFRA states that:

"*This data shows the proportion of each 1km grid square, where geological and hydrogeological conditions indicate that groundwater might emerge. It does not show the*

likelihood of groundwater flooding occurring. It does not take account of the chance of flooding from groundwater rebound. This dataset covers a large area of land, and only isolated locations within the overall susceptible area are actually likely to suffer the consequences of groundwater flooding."

As the site is now covered by made ground and at least 20cm of impermeable topsoil (section 3.2) it is unlikely to be subject to groundwater flooding. The site investigation (EPS 2016) found the groundwater level to be between 2.15m and 3.80m below ground.

Figure 3-7 Land susceptible to groundwater flooding



Source:SFRA (JBA 2016)

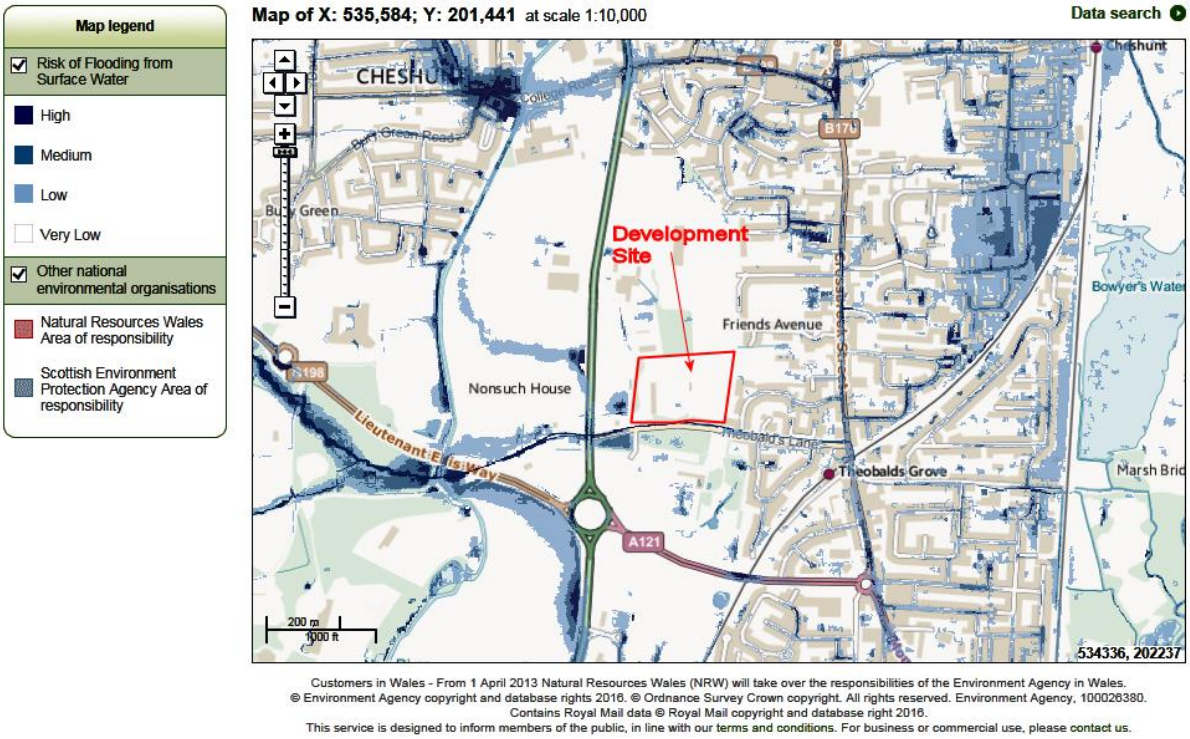
The Environment Agency surface water flood risk is mapped in Figure 3-8, which shows the site to be at 'very low' risk of flooding although there is anecdotal evidence of surface water ponding following heavy rainfall. This has been associated with the slowly permeable clay topsoil and is known to lie for several hours (Figure 3-9) before infiltrating naturally (section 1.2 and Table 3-2). The SFRA shows the site at lower than 0.1% risk of flooding from surface water There is no known infrastructure at or near the site whose failure could cause flooding at the site.

Table 3-2 Possible sources of flood risk

Key sources of flooding	Possibility at Site
Fluvial (Rivers)	*The site lies within Flood Zone 1, with less than a 0.1% AEP (Figure 2-4) Fluvial flooding of the Theobald's Brook, Theobald's Lane and Trinity Marsh ditch has been recorded on the following occasions:* Theobalds Brook — 1979, 1987 Theobalds Lane / Trinity Marsh Ditch — 1947, 1968, 1974, 1979, 1982, 1983, 2000 Trinity Marsh Ditch — 1974, 1878, 1982, 2000 *SFRA (JBA, 2016, pp34). The Environment Agency and SFRA flood maps and the SFRA flood warning map show the southern side of the brook (away from the site) at greater risk of flooding due to the considerably lower bank. There has been consultation between the Environment Agency and Borough of Broxbourne to tackle limited culvert capacity, diverted/perched channels and urban extensions in the SFRA study area. There is no specific mention of fluvial flooding at the site in the SFRA and it is not shown at risk on any flood maps..*
Tidal	*N/A, due to lack of proximity to tidal reaches of watercourses.*
Groundwater	*Low. Though groundwater flooding is mentioned as having been observed at a number of locations in the SFRA, there is no specific mention of groundwater flooding at the site. The 1km square containing the site has between 50% and 75% susceptibility of groundwater flooding (*Figure 3-7*). Only isolated locations within this area are likely to suffer.*
Sewers	*Low. The SFRA states 15 historical flood events resulting from drainage and sewerage infrastructure in the post code area of the site. There is however no specific mention of drainage and/or sewerage flooding at this particular site.*
Surface water	*Very low to low risk of surface water flooding (Figure 3-8) The site is relatively flat with a slowly permeable topsoil. Heavy rainfall has resulted in some ponding on site before, this rainfall infiltrates naturally.* *There are some steep gradients along the east boundary of the site, though the slope length is so short that no significant surface water run-off has been observed on the adjacent path as a result of them (Lee Williamson, 24th April 2013)* *The site has a <0.1% risk of surface water flooding based on the SFRA flood map.*
Infrastructure failure	*None shown on the SFRA map due to lack of proximity to infrastructure (JBA 2016).*

List taken from NPPF Practice Guide, Paragraph 2

Figure 3-8 Surface water flood risk near the site



Copyright Environment Agency (accessed May 2016)

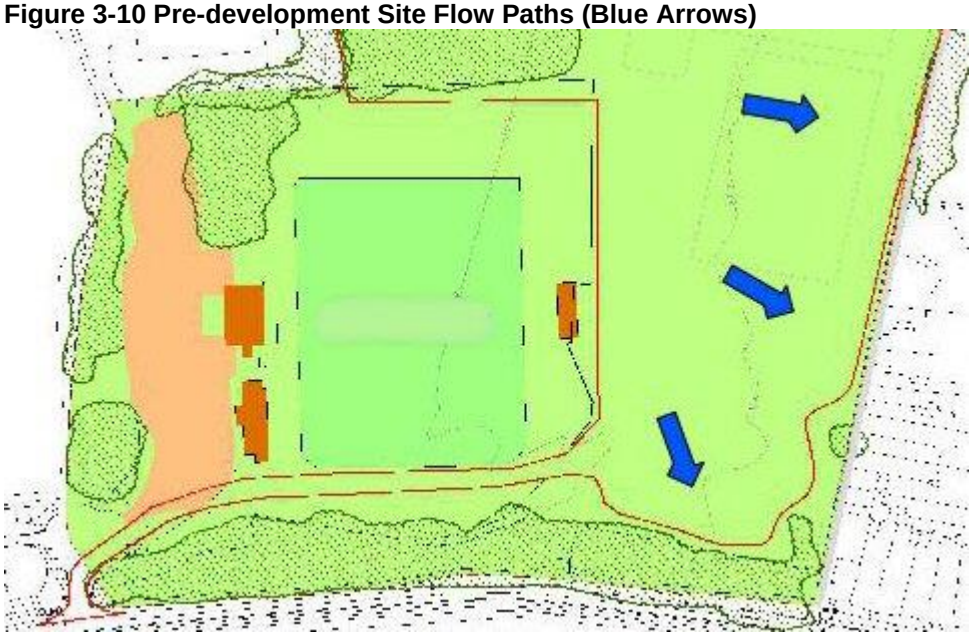
Figure 3-9 Surface water ponding on the site

Source: LW Developments

3.5 Existing Surface Water Drainage Arrangements (A2c, A3d)

The development site is located on the western edge of Cheshunt, and consists of a football pitch and training field. There are no existing surface water drainage arrangements as such at the present as all run-off from the site infiltrates into the slowly permeable soils or drains east and south down a shallow gradient to the Theobald's Brook (**Figure 3-10**). Roof runoff from the existing buildings enters the local combined sewer system. There are no surface water sewers within the vicinity of the site.

Figure 3-10 Pre-development Site Flow Paths (Blue Arrows)



Based on Grading Plan (SPDP, 2013)

The rainfall runoff modelling approach of ReFH Version 2 (ReFH2) Revitalised FEH rainfall runoff method has been used to estimate existing runoff rates for a variety of return periods. ReFH2 was released in 2015. With significance for the current site, ReFH2 incorporates an adjustment for "plot scale" conditions. This is a specific adjustment to address the use of data and models for catchments to the individual development plots. This is important since such plots tend to be much smaller than conventional topographic catchments.

The calculations were based on catchment parameters downloaded from the Flood Estimation Handbook (FEH) web service. As discussed in sections 3.2 and 3.3 the site is relatively impermeable. Peak rate runoff estimations for the critical duration summer storms are given in Table 3-3 with volumes in Table 3-4. The proposed surface water drainage system will also serve an area of sports fields to the north of the site. Accordingly, runoff from this area has been included in the table.

Table 3-3 Run-off Peak Rate Estimation.

		Based on	Peak rate of run-off (m^3/s)		
			Years return period event		
			2	30	100
Site Pre-development event run-off (5.25 / 6.25 hr critical storm)		ReFH2 FEH 2013 DDF model Summer storm	0.0323	0.0763	0.1076
Site Pre-development event run-off with climate change	20%		0.0387	0.0915	0.1291
	40%		0.0452	0.1068	0.1506
Northern Area pre-development event runoff (5.25 / 6.25 hr critical storm)			0.0291	0.0688	0.0970
Northern Area pre-development event runoff with climate change	20%		0.0349	0.0825	0.1165
	40%		0.0407	0.0963	0.1359

Table 3-4 Run-off volume Estimation.

	Based on	Run-off (m^3)	Run-off (m^3)	Run-off (m^3)
Volume of run-off		**2 yr**	**30 yr**	**100 yr**
Site Area existing run-off (5.25 / 6.25 hr critical storm)	ReFH2 FEH 2013 DDF model Summer storm	642	1313	1753
North area existing run-off (5.25 / 6.25 hr critical storm)		548	1121	1496
Annual volume of run-off				
Site Area existing run-off	654 mm (Average annual rainfall)	16469		
North area existing run-off		14055		

3.6 Probability Of Site Flooding (A3c)

The site of proposed development is situated entirely within fluvial Flood Zone 1, at a less than 0.1% risk of flood (Figure 2-4). The majority of the site is at “very low” risk of surface water flooding (Figure 3-8) with some areas of the pitch at “low” risk.

3.7 Historical Flooding (A2b)

There is no record of fluvial, groundwater, infrastructure or sewer related flooding onsite. Some minor surface water ponding following heavy rainfall has been associated with the slowly permeable clay topsoil. This water is known to lie for several hours (Figure 3-9) before infiltrating naturally.

4. Review of Development Proposals

4.1 Development Process (A5)

The layout and location of the proposed development is shown in Figure 4-1 and comprises the following:

- Construction of 50 houses on the eastern third of the site.
- Increasing the hard standing area of the site to include access roads, paths and parking spaces.
- Improvement of the existing football stadium and stands and to include commercial and residential development as well as accommodation for the football club.
- Surface water drainage system to serve the development currant proposals include permeable paving, water reuse for irrigation (rainwater harvesting) and tanked attenuation.(Appendix C)

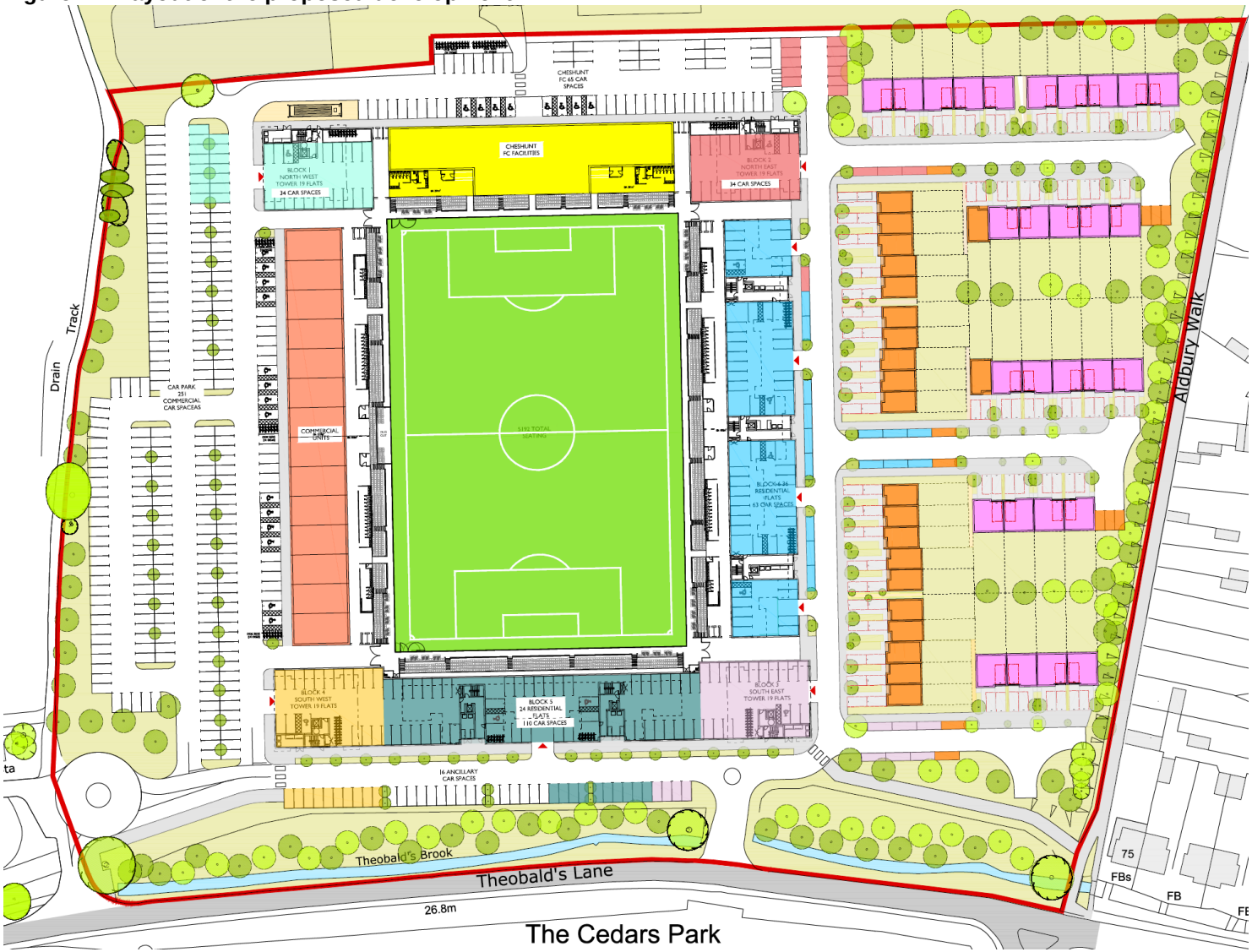
Figure 4-2 gives the different surface types within the development.

4.2 Flood Risk Management Measures (A5, A6)

It has been demonstrated in Section 2 that the site is not at risk from flooding and accordingly, no mitigation is required. However, one of the problems that has historically affected the site is surface water ponding due to poor drainage of the existing soils on the site. One of the benefits of the proposed redevelopment will be to improve the drainage of the soils. This will reduce the frequency and impacts of waterlogging and lead to improved suitability for use.

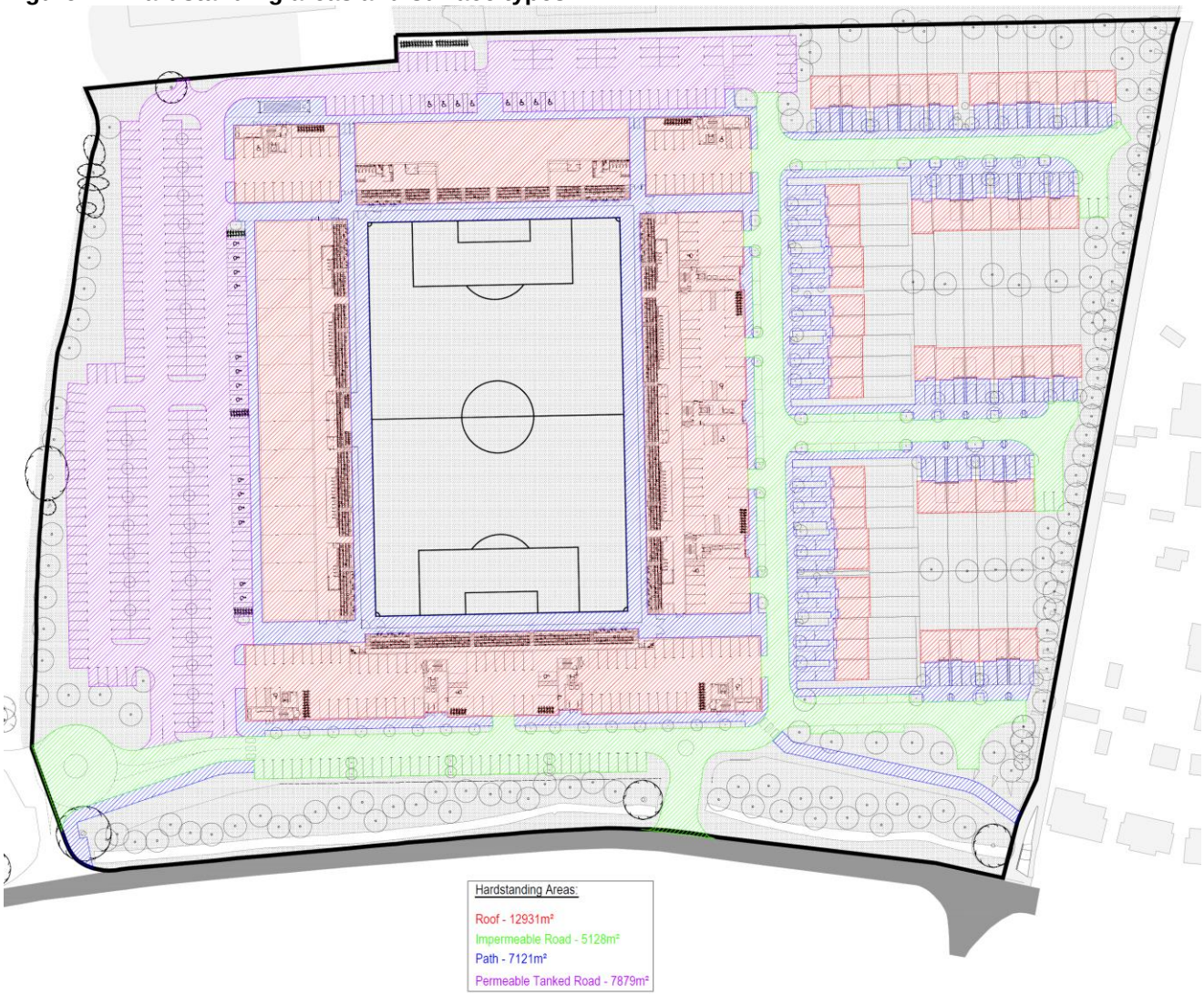
Appendix C gives details of the Surface Water Management Plan proposed for the site. Further details are provided in (Peter Dann 2016a). This has been designed by Peter Dann Consulting Engineers and predominantly takes the form of attenuation with outfalls to Theobald's Brook. The attenuation scheme also has capacity to take restricted outfall, limited to 18 l/s from the attenuation tanks for the sports pitches and playing fields north of the site.

Figure 4-1 Layout of the proposed development



Source: Peter Dann Consulting Engineers, drawing by Bryant and Moore Architects

Figure 4-2 Hardstanding areas and surface types



Source: Peter Dann Consulting Engineers

4.3 Off Site Impacts (A7a, A3d, A7b)

It is necessary to ensure that no aspect of the design could increase flood risk elsewhere in the catchment. The site is not in a flood zone so the development will not take up flood plain storage and pass the risk elsewhere.

The impermeable area of the site will increase, potentially resulting in increased runoff from the site. The stands and the roofs of the houses are impermeable, as are the access roads and footpaths. A surface water management plan has been designed for the site. This is detailed in Appendix C and has been designed by Peter Dann Consulting Engineers.

The surface water runoff from the stadium roof, hardstanding and pitch will be collected in a 1039 m^3 tank under the east side of the carpark. Some of this water will be used for irrigation and the remainder attenuated to below greenfield runoff rates. The car park will comprise permeable paving over attenuation crates with a restricted outfall into the main system. This will then outfall to Theobalds brook at the west end of the site with a maximum discharge rate of 10.8 l/s.

Surface water from the residential properties will be attenuated to below greenfield rates within culverted drainage under the roads with a 540 m^3 storage tank to the far south of the area. The restricted outflow from this tank will combine with the controlled flow from the practice pitches (section 4.2) outfalling to Theobalds brook at a maximum rate of 21.5 l/s.

It is understood these limiting flows hold true for all return periods. The combined outflow of 32.3 l/s is less than the combined 50% (1in 2 year) greenfield flow of 61.4 l/s given in section 3.5.

4.4 Residual Risks (A8a, A8b)

Residual risks include the need to manage storms of a significantly greater magnitude than those considered in the design of the attenuation system. A dry swale has been included along the Eastern boundary of the site to manage this eventuality. There is also the need to maintain the systems which manage surface water runoff. Since both the systems and the consequent flow rates are considered in Appendix C , residual risks are also considered in detail in this Appendix.

4.5 Climate Change (A4a)

The general impacts of climate change on flood behaviour in England and Wales remain unclear. The FEH (Institute of Hydrology, 1999) describes a review of flood peak data to investigate possible trends. The analyses do not show that climate change has affected UK flood behaviour, but neither do they prove that it has not affected it. The Environment Agency and NPPF require a consideration of the impacts of climate change on the flood risk for any proposed development. In February 2016, the Environment Agency updated the climate change allowances required in Flood Risk Assessments (Environment Agency, 2016); this advice updates previous climate change allowances to support NPPF (2012). The Environment Agency (2016) state,

> *"Making an allowance for climate change in your flood risk assessment will help to minimise vulnerability and provide resilience to flooding and coastal change in the future. The climate change allowances are predictions of anticipated change for:*

- *peak river flow by river basin district*
- *peak rainfall intensity*
- *sea level rise*
- *offshore wind speed and extreme wave height."*

The suggested mechanism for this is to allow for increases in peak flows according to the anticipated changes to peak flow by river basin district. The Flood Zone in which the proposed development will be located and the appropriate flood risk vulnerability classification should be considered, to decide which allowance should be applied to the development. For this site at Cheshunt FC located within Flood Zone 1, there is no requirement to allow for the impact of climate change on peak river flows. Typically, the 1:100+CC is close to the Flood Zone 2 outline.

Peak river flow allowances are given in **Table 4-1**. The 'Central' allowance is based on the 50th percentile, meaning that there is an equal chance that peak flows will increase by less than the 'Central' value (of 25%) or by more than this value. The 'Higher Central' allowance is based on the 70th percentile, meaning that 70%of the possible scenarios fall below the 'Higher Central' value (of 35%). In other words, there is a 70% chance that peak flows will increase by less than this value (35%) and there remains a 30% chance that peak flows will increase by more. This is a significant change to the previous NPPF requirements.

Table 4-1 Peak river flow allowances

River basin district	Allowance category	Total potential change anticipated for '2020s'(2015 to 39)	Total potential change anticipated for '2050s'(2040 to 2069)	Total potential change anticipated for '2080s'(2070 to 2115)
Thames	Upper end	25%	35%	70%
	Higher central	15%	25%	35%
	Central	10%	15%	25%

For Flood Zone 1 the impact of climate change on precipitation is more important. Table 4-2 shows anticipated changes in small catchments, recommending a progressive increase, reaching a range of 20% to 40% by 2115. As with river flow the central value is based on the 50th percentile, meaning that 50% of the possible scenarios fall below this value (20%) i.e. there is a 50% chance that rainfall will increase by less than this value (20%) and there remains a 50% chance that rainfall will increase by more. The upper end is based on the 70th percentile.

Table 4-2 Peak rainfall intensity allowance in small and urban catchments

Applies across all of England	Total potential change anticipated for 2010 to 2039	Total potential change anticipated for 2040 to 2059	Total potential change anticipated for 2060 to 2115
Upper end	10%	20%	40%
Central	5%	10%	20%

The central allowance of 20% has been used in the design of the surface water management system for this site. The upper end 40% allowance has been used for sensitivity analysis. The drainage scheme for the access road stadium and carparks has capacity for the 1 in 100 yr storm + 40% CC. The drainage scheme for the residential area had capacity for the 1 in 100 yr + 20% CC with the 40% CC being contained within the kerb lines.

5. Summary

This report is a flood risk assessment for the redevelopment of the stands at Cheshunt Football Club with commercial and residential accommodation and construction of 50 houses on a neighbouring plot at Cheshunt FC. The development includes associated access roads, footpaths and carparking. The main findings are as follows:

1. The development construction of 50 houses and redevelopment of the stadium to incorporate new stands, residential and business units. The existing car park will be enlarged and marked out with formal bays.

2. In terms of the National Planning Policy Framework (NPPF), land and buildings used for sports and leisure are classified as “Less Vulnerable” while residential buildings are “More Vulnerable”.

3. The development site is wholly within Environment Agency Flood Zone 1. The nearest watercourse to the site is the Theobald’s Brook running from west to east along the southern edge of the site The site is not at risk from the Theobald’s Brook since it is located about 3m above the Brook.

4. The site of proposed development is located within an area at ‘low’ risk of surface water flooding on Environment Agency online mapping.

5. The increase in impermeable area will lead to increased rates and volumes of runoff. Rainfall is to be routed to irrigation and attenuation tanks distributed around the site. From here run-off will discharge into the Theobald’s Brook at less than the Greenfield run-off rate. The attenuation system has been designed by Peter Dann Consulting Engineers (Appendix C).

6. Allowance for climate change has been made by increasing the design rainfall by 20% and 40%, the NPPF and Environment Agency recommended “Central” and “Upper End” allowance for the potential change in peak rainfall between 2060 and 2115.

7. Residual risks include a rainstorm with a magnitude above the design value and possible blockage of the flow controls. Raised tables are included in the residential areas to control flood water if the design storm is exceeded. The site owners will be provided with an “Owners Manual” for the drainage scheme to ensure the system is managed and maintained properly.

It is found that the risks to the development are low and the potential impact on other receptors is negligible. The development is therefore in accordance with the requirements of the NPPF.

6. References

Author	Date	Title/Description
Centre for Ecology and Hydrology.	2009	The Flood Estimation Handbook CD-ROM 3. Centre for Ecology & Hydrology, Wallingford, Oxon, UK.
Centre for Ecology and Hydrology.	2016	The Flood Estimation Handbook web service. Available at: https://fehweb.ceh.ac.uk/ (last accessed 27th June 2016)
CIRIA	2012	C753 The SUDS Manual
DCLG	Mar 2012a	National Planning Policy Framework.
DCLG	Mar 2012b	Technical Guidance to the National Planning Policy Framework.
DEFRA / Environment Agency	2013	Rainfall Runoff Management for Development Report SC030219.
Hertfordshire County Council		(Lead Local Flood Authority) Surface Water Guidance
Environment Agency	Feb 2016	Flood risk assessments: climate change allowances. Available at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances#high-allowances (last accessed 15th April 2016)
Environmental Business Solutions	Feb 2013	Ecological Walkover Assessment and Protected Species Survey
EPS	August 2016	Phase I & II Geo-Environmental Assessment Proposed Cheshunt Sports Village EPS Ref: UK16.2295
JBA	May 2016	Stratigic Flood Risk Assessment for Broxbourne Borough Council
Institute of Hydrology	1994	Flood Estimation for Small Catchments, Report 124; Marshall and Bayliss
London-Footprints	2010	London Footprints - New River Information (Available 06/03/13 at http://www.london-footprints.co.uk/wknewriveradd.htm)
LW Developments, Bryant & Moore Architects	2015	Development Plans
Peter Dann	2016a	Cheshunt Football Club – Drainage Strategy for LW Developments Limited

Author	Date	Title/Description
Peter Dann	2016b	Plans: Existing site areas (Drawing No. 10-6561_XX-DR-C150, Rev P1) and Proposed drainage strategy working drawing.
Sports Pitch Design Build	May 2013	Grading Plan Drawing Number: 551.02 Rev B
Wallingford HydroSolutions Ltd	2015	ReFH v2, The revitalised FRS/FEH rainfall-runoff method.
Weller Designs	Jan 2013	Cheshunt FC Pre-Application Design Statement
	2011	Sewers for Adoption- A Design and Construction Guide for Developers Seventh Edition