PROPOSED SPORTS HALL AT QUEENSWOOD SCHOOL, SHEPHERDS WAY, HATFIELD, HERTFORDSHIRE

FLOOD RISK ASSESSMENT AND SURFACE WATER DRAINAGE/SUDS STRATEGY

NOVEMBER 2016

REPORT REF: 1731/RE/11-16/01

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CONTRACT

Evans Rivers and Coastal Ltd has been commissioned by Ball Hall (Project Management) Ltd to carry out a Flood Risk Assessment and Surface Water Drainage/SUDS Strategy for a proposed Sports Hall at Queenswood School, Shepherds Way, Hatfield, Hertfordshire.

QUALITY ASSURANCE, ENVIRONMENT AND HEALTH AND SAFETY

Evans Rivers and Coastal Ltd operates a Quality Assurance, Environmental, and Health and Safety Policy.

This project comprises various stages including data collection; hydrological and hydrogeological assessments; surface water drainage designs; and reporting. Quality will be maintained throughout the project by producing specific methodologies for each work stage. Quality will also be maintained by initiating internal quality procedures including the validation of third party deliverables; creation of an audit trail to record any changes made; and document control using a database and correspondence log file system.

To adhere to the Environmental Policy, data will be obtained and issued in electronic format and alternatively by post. Paper use will also be minimised by communicating via email or telephone where possible. Documents and drawings will be transferred in electronic format where possible and all waste paper will be recycled. Meetings away from the office of Evans Rivers and Coastal Ltd will be minimised to prevent unnecessary travel, however for those meetings deemed essential, public transport will be used in preference to car journeys.

The project will follow the commitment and objectives outlined in the Health and Safety Policy operated by Evans Rivers and Coastal Ltd. All employees will be equipped with suitable personal protective equipment prior to any site visits and a risk assessment will be completed and checked before any site visit. Other factors which have been taken into consideration are the wider safety of the public whilst operating on site, and the importance of safety when working close to a water source and highway. Any designs resulting from this project and directly created by Evans Rivers and Coastal Ltd will also take into account safety measures within a “designers risk assessment”.

Report carried out by:

Rupert Evans, BSc (Hons), MSc, CEnv, C.WEM, MCIWEM, PIEMA

DISCLAIMER

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CONTENTS

1. INTRODUCTION

1.1 Project Scope

1.1.1 Evans Rivers and Coastal Ltd has been commissioned by Ball Hall (Project Management) Ltd to carry out a Flood Risk Assessment and Surface Water Drainage/SUDS Strategy for a proposed Sports Hall at Queenswood School, Shepherds Way, Hatfield, Hertfordshire.

1.1.2 It is understood that this assessment will be submitted to the Planning Authority as part of a planning application. Specifically, this assessment intends to:

1) Carry out an assessment of the practical use of sustainable drainage (SUDS) measures using the relevant soil maps, software and other literature;

2) Determine the existing surface water drainage regime across the site using appropriate methods;

3) Develop a post-development management plan/drainage strategy for surface water across the site, which considers the use of SUDS and alternative methods of surface water disposal;

4) Make an assessment of the flood risk to the site during return period events up to the climate change enhanced 1 in 100 year storm event and recommend mitigation measures accordingly;

5) Carry out an appraisal of flood risk from any other sources such as groundwater as required by NPPF;

6) Report findings and recommendations.

1.1.3 This assessment is carried out in accordance with the requirements of the National Planning Policy Framework (NPPF) dated March 2012. Other documents which have been consulted include:

- Woods-Ballard., et al. 2015. *The SUDS Manual, Report C753*. London: CIRIA.
- Woods-Ballard., et al. 2007. *The SUDS Manual, Report C697*. London: CIRIA.
- BS8582:2013 entitled *Code of practice for surface water management for development sites*.
- DEFRA document entitled *Sustainable Drainage Systems – Non statutory technical standards for sustainable drainage systems* dated March 2015.
- LASOO document entitled *Non statutory technical standards for sustainable drainage systems – Best Practice Guidance* dated 2015.
- DEFRA/EA document entitled *Rainfall runoff management for developments* dated 2013.
- Communities and Local Government 2007. *Improving the Flood Performance of New Buildings*. HMSO.
- DEFRA/EA document entitled *The flood risks to people methodology (FD2321/TR1),* 2006;

- EA *Supplementary Note on Flood Hazard Ratings and Thresholds for Development Planning and Control Purpose*, 2008;

- National Planning Practice Guidance – Flood Risk and Coastal Change.

- LLFA Summary Guidance for developers.

- Lead Local Flood Authority SUDS Policy Statement – Meeting Sustainable Drainage System Standards in Hertfordshire dated March 2015.

- SUDS Design Guidance for Hertfordshire Version 2 dated March 2015.

- UK Government's climate change allowances guidance dated February 2016.

- Local Flood Risk Management Strategy for Hertfordshire 2013-2016.

- Welwyn Hatfield Council Level 1 and 2 Strategic Flood Risk Assessment (SFRA 2016 hereafter) dated 2016.

- Welwyn Hatfield Council Level 1 Strategic Flood Risk Assessment (SFRA 2009 hereafter) dated 2009.

2. DATA COLLECTION

2.1 To assist with this report, the data collected included:

- Ordnance Survey 1:10,000 street view map (Evans Rivers and Coastal Ltd OS licence number 100049458).
- 1:250,000 *Soil Map of Eastern England* (Sheet 4) published by Cranfield University and Soil Survey of England and Wales 1983.
- 1:625,000 *Hydrogeological Map of England and Wales*, published in 1977 by the Institute of Geological Sciences (now the British Geological Survey).
- British Geological Survey, *Online Geology of Britain Viewer*.
- British Geological Survey, *Groundwater Flooding Susceptibility Map*.
- Topographical survey of the site shown on Drawing Number 22968A/02.

2.2 All third party data used in this study has been checked and verified prior to use in accordance with Evans Rivers and Coastal Ltd Quality Assurance procedures.

3. SITE CHARACTERISTICS

3.1 Existing Site Characteristics and Location

3.1.1 The site is located at Queenswood School, Shepherds Way, Hatfield, Hertfordshire. The approximate Ordnance Survey (OS) grid reference for the site is 526796 203531 and the location of the site is shown on Figure 1.

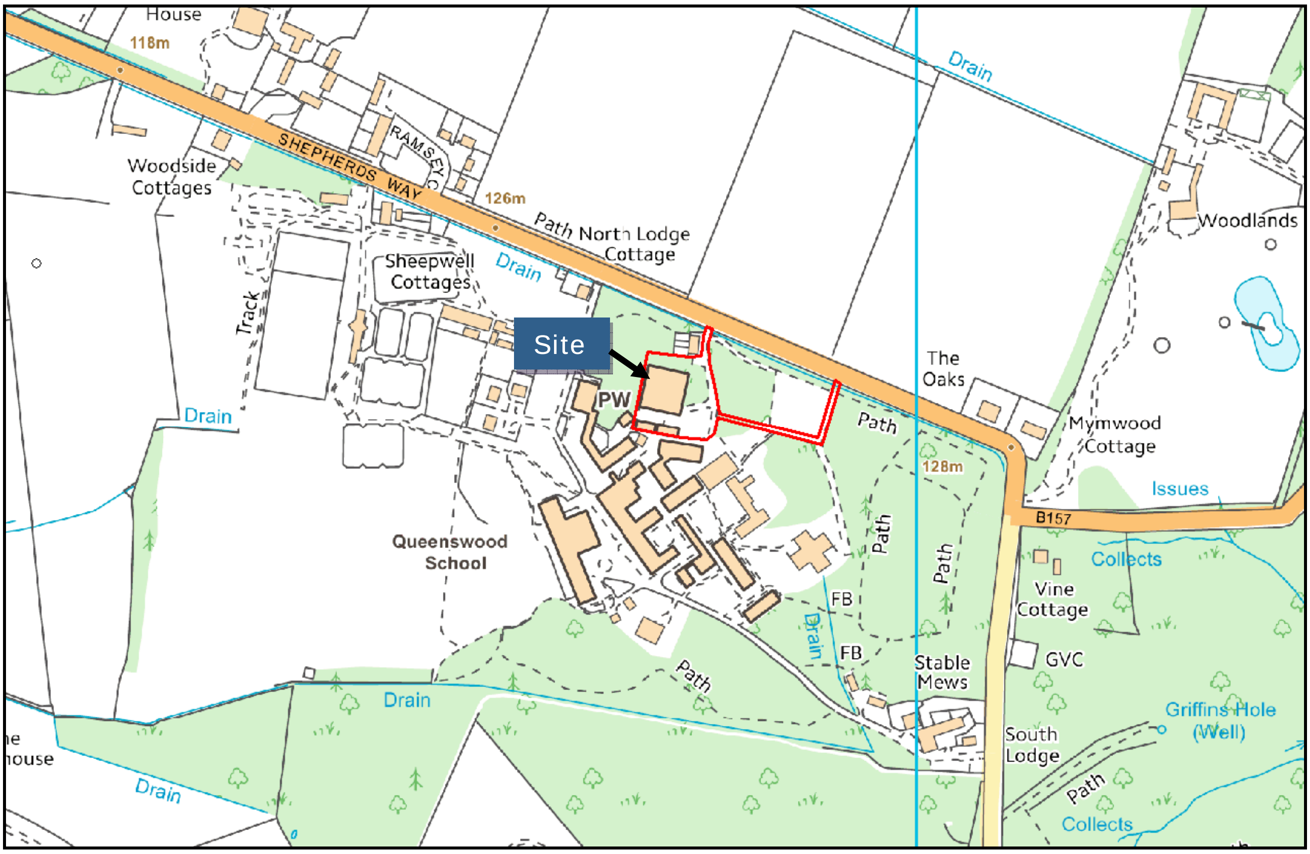


Figure 1: Site location plan (Source: Ordnance Survey)

3.1.2 The site is located across the Queenswood School campus and comprises an existing Sports Hall building together with two separate classroom buildings. The site is accessed from Shepherds Way to the north east of the site. Other buildings and open space associated with the School are located adjacent to the remaining frontages of the site.

3.1.3 A topographical survey of the site can be seen on Drawing Number 22968A/02, and inspection of the data indicates that there is little variation in ground level across the site and that the existing floor level of the Sports Hall is set at 49.98m AOD.

3.2 Site Proposals

3.2.1 It is the Client's intention to demolish the existing Sports Hall and classrooms and construct a new Sports Hall across a slightly larger footprint. The site proposals can be seen on Drawing Number 22968A/03.

4. BASELINE INFORMATION

4.1 Environment Agency Flood Zone Map

4.1.1 The Environment Agency Flood Map (Figure 2), Appendix C of the SFRA 2016 and Figure 5 of the SFRA 2009 shows that the site is located within the NPPF Flood Zone 1, 'Low Probability' which comprises land as having less than a 1 in 1000 year annual probability of fluvial or tidal flooding (i.e. an event more severe than the extreme 1 in 1000 year event). NPPF states that all uses of land are appropriate in this zone.

4.1.2 A drainage ditch runs adjacent to Shepherds Way to the north of the site. Figure 15C of the SFRA 2009 shows that there is a negligible risk of flooding to the site from this ditch.

4.1.3 Figure 7 of the SFRA 2009 shows that there have been no historical incidents of fluvial flooding at the site.

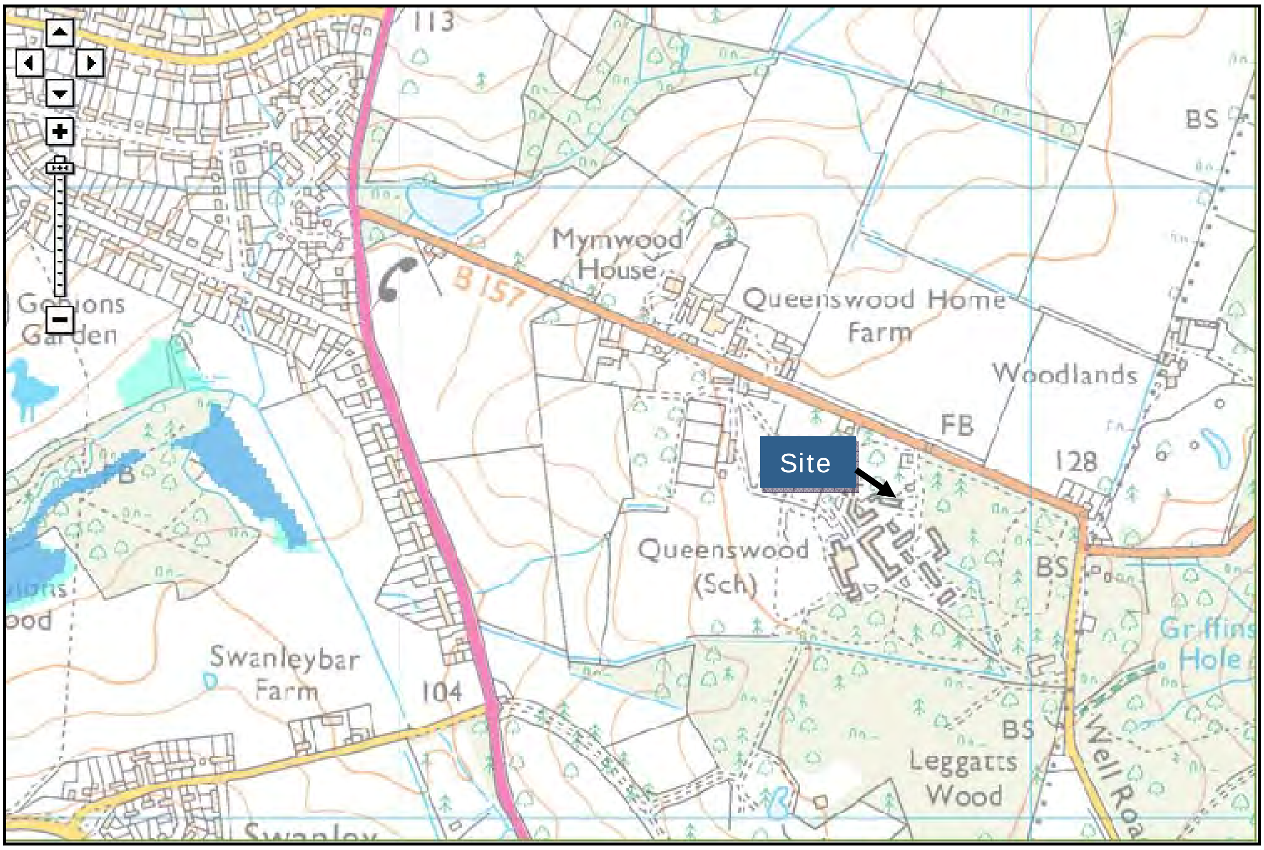
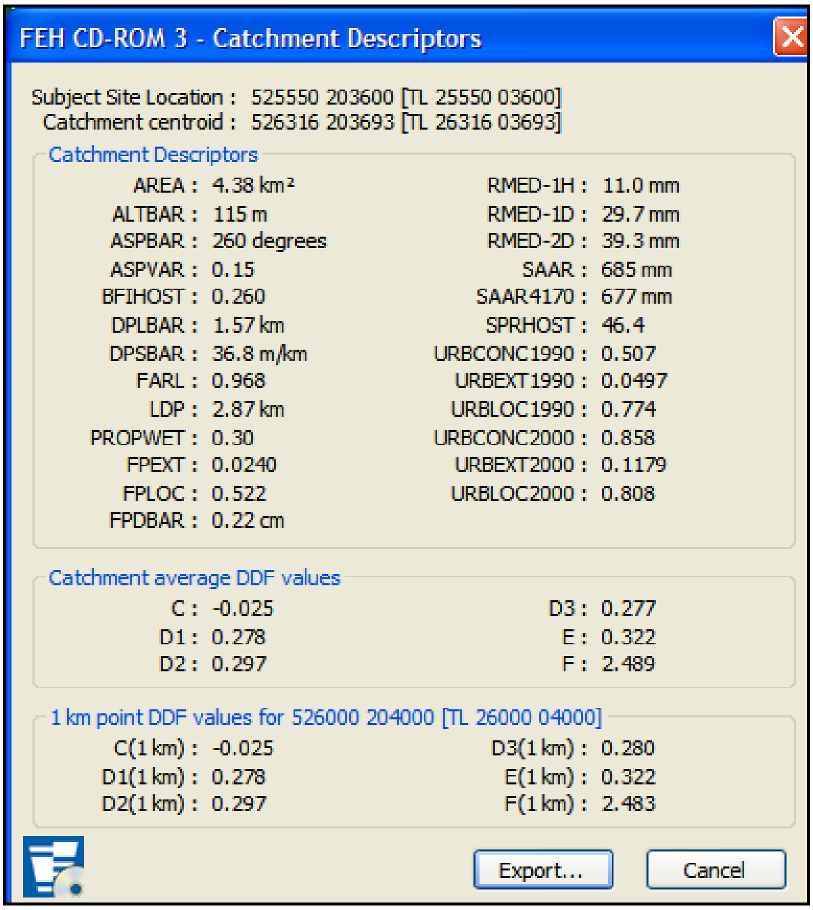


Figure 2: Environment Agency Flood Map (Source: Environment Agency, 2016)

4.2 Catchment Characteristics

4.2.1 Figure 2 of the SFRA 2009 shows that the site is located within the Colne catchment. Catchment descriptors extracted from the FEH CD-ROM Version 3 (Figure 3) indicate that the area receives a standard average annual rainfall (SAAR) of 685mm. The catchment has a moderate to steep gradient (DPSBAR = 36.8m/km) and is of high elevation (ALTBAR = 115).



FEH CD-ROM 3 - Catchment Descriptors

Subject Site Location : 525550 203600 [TL 25550 03600]
Catchment centroid : 526316 203693 [TL 26316 03693]

Catchment Descriptors

AREA :	4.38 km²	RMED-1H :	11.0 mm
ALTBAR :	115 m	RMED-1D :	29.7 mm
ASPBAR :	260 degrees	RMED-2D :	39.3 mm
ASPVAR :	0.15	SAAR :	685 mm
BFIHOST :	0.260	SAAR4170 :	677 mm
DPLBAR :	1.57 km	SPRHOST :	46.4
DPSBAR :	36.8 m/km	URBCONC1990 :	0.507
FARL :	0.968	URBEXT1990 :	0.0497
LDP :	2.87 km	URBLOC1990 :	0.774
PROPWET :	0.30	URBCONC2000 :	0.858
FPEXT :	0.0240	URBEXT2000 :	0.1179
FPLOC :	0.522	URBLOC2000 :	0.808
FPDBAR :	0.22 cm		

Catchment average DDF values

C :	-0.025	D3 :	0.277
D1 :	0.278	E :	0.322
D2 :	0.297	F :	2.489

1 km point DDF values for 526000 204000 [TL 26000 04000]

C(1 km) :	-0.025	D3(1 km) :	0.280
D1(1 km) :	0.278	E(1 km) :	0.322
D2(1 km) :	0.297	F(1 km) :	2.483

Export... Cancel

Figure 3: Catchment descriptors (Source: FEH CD-ROM Version 3)

5. OTHER SOURCES OF FLOODING

5.1 Groundwater Flooding

5.1.1 In order to assess the potential for groundwater flooding during higher return period rainfall events, the Jacobs/DEFRA report entitled *Strategy for Flood and Coastal Erosion Risk Management: Groundwater Flooding Scoping Study*, published in May 2004, was consulted, together with the guidance offered within the document entitled *Groundwater flooding records collation, monitoring and risk assessment (ref HA5)*, commissioned by DEFRA and carried out by Jacobs in 2006.

5.1.2 According to Cobby et al (2009), groundwater flooding can be defined as flooding caused by the emergence of water originating from subsurface permeable strata. The greatest risks of groundwater flooding are considered to be from either:

- a rise of groundwater in unconfined permeable strata, such as Chalk, after prolonged periods of extreme rainfall;
- a rise of groundwater in unconsolidated, permeable superficial deposits, which are in hydraulic continuity with local river water levels and where the hydraulic gradient of the water table is low.

5.1.3 As described above, it is widely accepted that groundwater flooding generally occurs from both permeable strata (e.g. Chalk) and superficial deposits (e.g. sands and gravels). In particular, unconfined water-bearing deposits (i.e. those with permeable soils above them) are susceptible to a rise in groundwater during prolonged, extreme rainfall and during periods of high recharge throughout autumn and winter. Antecedent conditions, such as, above average groundwater levels prior to the rainfall event, are also a contributing factor to a variation in the water table.

5.1.4 Permeable superficial deposits can also hold quantities of groundwater, although these tend to be insignificant compared to the stored quantities within consolidated aquifers. Unconsolidated deposits such as sand and gravels are sufficiently permeable to store water; however such deposits which yield a low quantity of water are commonly termed a non-aquifer.

5.1.5 Deposits comprising a mixture of permeable and impermeable soils can lead to a presence of perched water. Perched water tables are located above less permeable deposits such as clay and are located within water-bearing soils such as sand and gravel. If perched water is unconfined then the potential for recharge and groundwater flooding can be high. If the perched water is confined by less permeable clay deposits, then the clay deposits will have a buffering effect on percolating surface water and thus the recharge potential and rise in the water table is low.

Soil and Geology at the Site

5.1.6 It can be seen from the various soil and hydrogeological data, listed in Section 2, together with Figure 4 of the SFRA 2009 that the soils beneath the site comprise sand and gravel overlying London Clay.

Groundwater Flooding Potential at the Site

5.1.7 There have been no recorded groundwater flood events across the area between 2000 and 2003, as indicated by the Jacobs study. The BGS Groundwater Flooding Susceptibility Map indicates that the site has a “Limited Potential for Groundwater

Flooding to Occur". Appendix G of the SFRA 2016 indicates that there is a less than 25% susceptibility of groundwater flooding at the site. Figure 11 of the SFRA 2009 shows that there have been no historical incidents of groundwater flooding at the site.

5.1.8 The SFRA 2009 states that groundwater flooding is not a regular or frequently occurring source of flooding within the study area.

5.2 Surface Water Flooding and Sewer Flooding

5.2.1 Surface water and sewer flooding across urban areas is often a result of high intensity storm events which exceed the capacity of the sewer thus causing it to surcharge and flood. Poorly maintained sewer networks and blockages can also exacerbate the potential for sewer flooding. Surface water flooding can also occur as a result of overland flow across poorly drained rural areas.

5.2.2 Figure 14 of the SFRA 2009 indicates that according to the DG5 register there have been sewer flood incidents across this postcode district, however, the map covers a broad area and is not property specific.

5.2.3 Figure 10 of the SFRA 2009 shows that the site is not located across an area which a source of potential overland flow. Appendix F of the SFRA 2016 shows that around the existing Sports Hall there is a 1 in 1000 year and 1 in 100 year surface water flood risk.

5.2.4 The Agency's Surface Water Flooding Map (Figure 4) indicates that there is a very low surface water flooding risk across the existing buildings (i.e. less than 1 in 1000 year chance).

5.2.5 However, to the east and south of the existing Sports Hall there is a low to medium flood risk (i.e. chance of flooding of between 1 in 1000 years and 1 in 30 years). The data associated with the EA map indicates that the depth of water would generally be less than 0.3m and the velocity less than 0.25 m/s. The hazard to people would be *Very low* according to the hazard equation outlined in paragraph 13.7.2 of *FD2320/TR2.*

5.2.6 The map generally shows lower areas of ground where water may pond during storm events and identify areas which receive subsequent runoff from surrounding land during heavy rainfall events (i.e. these parts of the site are acting as small basins).

5.2.7 The map shows that a small localised area adjacent to the existing Sports Hall would have a depth of between 0.3m and 0.9m, however, the topographical survey does not indicate that the ground levels are significantly different across this area and the higher flood depth could therefore be an anomaly.

5.2.8 By comparing the proposed site layout and the surface water flood map, the new Sports Hall will extend southwards into the low risk area. In order to prevent surface water flooding across the new building it is recommended that finished ground floor levels are set 0.3m higher than existing ground levels.

5.2.9 The Agency's map also shows that there will be a very low surface water flood risk along Shepherds Way adjacent to the site and to the south east. Figure 15 of the SFRA 2009 suggests that there is a low frequency of road flooding events. Therefore, safe access/egress will be achieved for people, vehicles and emergency services.

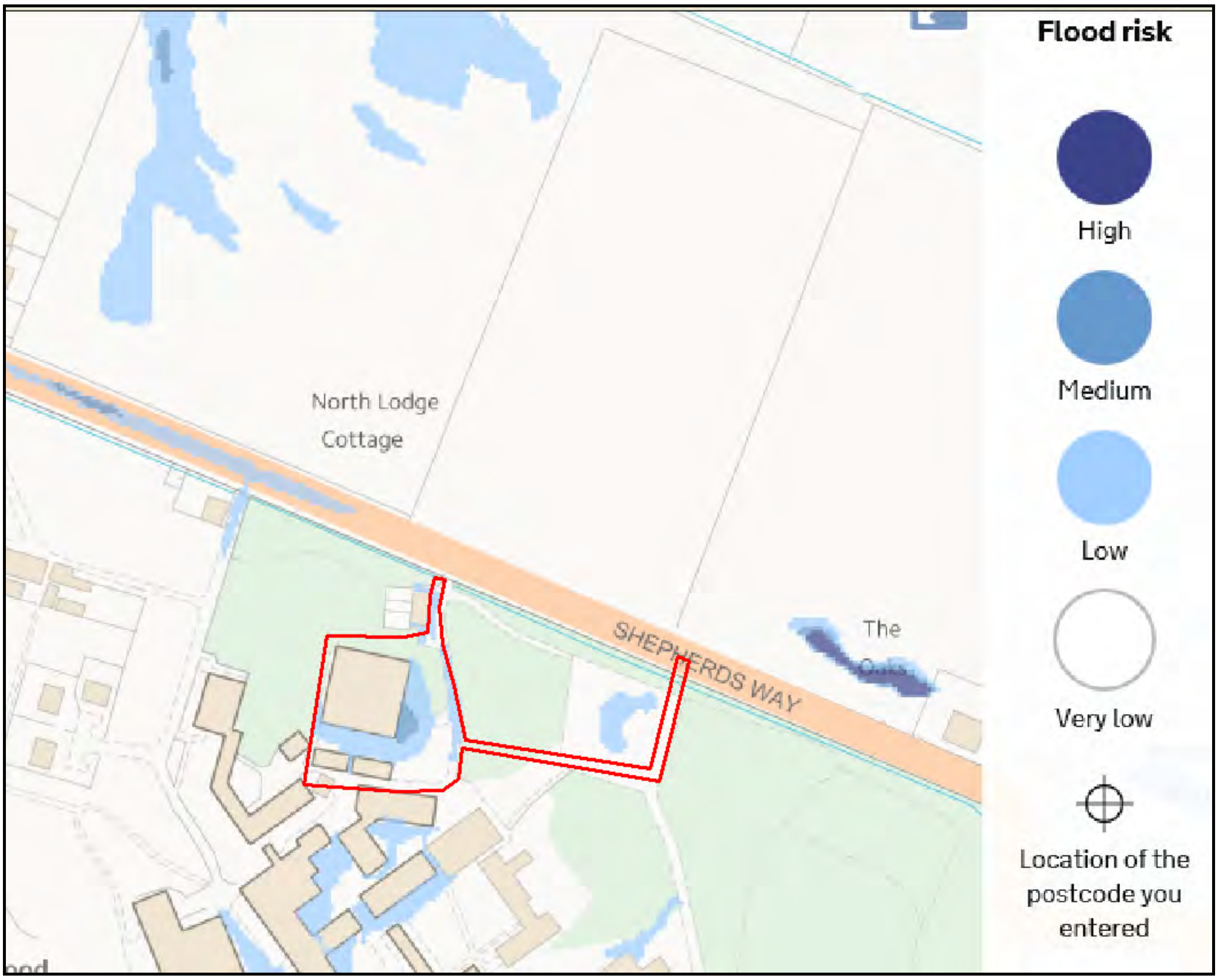


Figure 4: Environment Agency Surface Water Flooding Map and site extent (Source: Environment Agency, 2016)

5.3 Reservoirs, Canals And Other Artificial Sources

5.3.1 The failure of man-made infrastructure such as flood defences and other structures can result in unexpected flooding. Flooding from artificial sources such as reservoirs, canals and lakes can also occur suddenly and without warning, leading to high depths and velocities of flood water which pose a safety risk to people and property.

5.3.2 The Environment Agency's "Risk of flooding from reservoirs" map suggests that the site is not at risk from such features. Figure 16 of the SFRA 2009 and Appendix J of the SFRA 2016 also confirm that the site is not at risk from artificial sources.

6. SURFACE WATER DRAINAGE AND SUDS

6.1 Introduction

6.1.1 Planning policy recommends the maximum practical use of Sustainable Drainage Systems (SUDS) within proposals for new sites. There is a requirement that sustainable drainage systems (SUDS) be installed where appropriate, in order to limit the amount of surface water runoff entering drainage systems and to return surface water into the ground to follow its natural drainage path.

6.1.2 The National Planning Policy Framework (NPPF) and the Environment Agency require that the effects of climate change to be considered in any assessment of flood risk for developments. When considering the impacts of climate change on rainfall intensity, Table 2 of the UK Government's climate change allowances guidance dated February 2016, advises that when designing surface water drainage systems, an increase in peak rainfall intensity of up to 40% should be considered.

6.1.3 In addition to the consideration of the design event for the SUDS techniques adopted in this report, the possibility of exceedance has been considered further in Section 6.7, and as outlined in CIRIA 635 entitled *Designing for exceedance in urban drainage – good practice,* and the CIRIA/HR Wallingford document entitled *Drainage of development sites – a guide* dated 2004. Although the guidance does not specify a return period event, the exceedance event is usually considered as the event which would exceed the design requirements of the drainage system in question. For example, SUDS attenuation/infiltration devices are usually designed to consider the climate change 1 in 100 year event and therefore the exceedance event in this instance could be considered as the 1 in 1000 year storm event.

6.2 Existing Surface Water Drainage

6.2.1 The existing runoff rate from the buildings can be calculated using the Modified Rational Method equation as the site is predominantly urbanised. Further details of this method are outlined in *The Wallingford Procedure: Design and Analysis of Urban Storm Drainage,* published by HR Wallingford in 1981.

Q (l/s) = Cv x Cr x (2.78 x I (mm/hr) x A (ha)

where:

Cv = volumetric runoff coefficient
Cr = constant routing factor
I = rainfall intensity
A = impermeable area

6.2.2 Under summer rainfall conditions, CIRIA 753 states that Cv (the volumetric runoff coefficient) should be between 0.8 and 1.

6.2.3 The aforementioned CIRIA document also advises that the rainfall intensity (mm/hr) should be used in conjunction with the "time of concentration" across the site (i.e. when the whole site contributes together and all of the rainfall is constant and contributing to the flow). Time of concentration values are typically in the range of 3 to 5 minutes, however 5 minutes is generally used for a site of this size.

6.2.4 Section 24.6 of CIRIA 753 states that a value of 35mm/hr or 50mm/hr can be used for rainfall intensity. However, a calculation using the Microdrainage rainfall generator indicates that for the 1 in 1 year, 1 in 30 year and 1 in 100 year event the rainfall intensity is 11.977 mm/hr, 35.614 mm/hr and 52.681 mm/hr respectively (i.e. average intensity is used in the Modified Rational Method equation).

Therefore using the Modified Rational Method:

Q (l/s) = Cv x Cr x (2.78 x I (mm/hr) x A (ha)

where:
Cv = 0.75;
Cr = 1.3;
I = 11.977 mm/hr during 1 in 1 year event, 35.614 mm/hr during 1 in 30 year event and 52.681 mm/hr during 1 in 100 year event;
A = 0.169 ha.

6.2.5 The result of the above calculation is a runoff rate of 5.5 l/s during the 1 year event, 16.3 l/s during the 1 in 30 year event and 24.1 l/s during the 1 in 100 year event.

6.2.6 Applying 40% climate change to the 1 in 100 year figure increases it to 33.7 l/s.

6.3 Soil Types and SUDS Suitability

6.3.1 Part H of the Building Regulations and Section 3.2.3 of CIRIA 753 prioritises discharges to the ground and then a watercourse, with discharge to a sewer only to be considered when both infiltration and discharge to a watercourse is not reasonably practicable.

6.3.2 By consulting the information outlined in Section 5.1 the soils at the site comprise sand and gravel overlying London Clay. Therefore, the soil types and expected infiltration rates are considered sufficient for the infiltration of surface water. Based on the information provided in Table 25.1 of CIRIA 753, an infiltration rate of 3×10^{-5} m/s has been assumed for the purposes of this report.

6.3.3 In order to drain the roof area of the proposed building it is recommended that a Geocellular or modular system is used to construct a soakaway which could be positioned across the open space area to the south of the proposed building (i.e. this area has little tree coverage).

6.3.4 Pervious surfaces will also be used to reduce the amount of impermeable area across the proposed site. It is understood that all new surfaces across the proposed site such as paths will remain permeable and will include, for example, encapsulated gravel which permits surface water through its structure and sub-base.

6.4 Roof Drainage

6.4.1 In order to drain the roof area of the proposed building it is recommended that a Geocellular or modular system is used to construct a soakaway which could be positioned across the open space area to the south of the proposed building. These systems provide a higher porosity (i.e. up to 95%) which will promote more efficient infiltration of surface water (see Chapters 13 and 21 of CIRIA 753).

6.4.2 *BRE Digest 365* requires soakaways to be located at least 5m away from any other structure with foundations, however, this requirement cannot be achieved due to the existing adjacent infrastructure and buildings. An impermeable membrane can be introduced to protect the foundations of the new building if foundation design alterations are not possible. Therefore, it is considered that this approach remains viable providing that an appropriate technical professional is consulted throughout the foundation design.

6.4.3 The soakaway design has been based on the guidance provided by Polypipe and considers a Polystorm-Lite design which is appropriate for untrafficked areas. The typical dimension of each geocellular unit is 1m x 0.5m x 0.4m. The design guidance suggests a minimum depth between the top of the device and ground surface of 0.5m and a maximum effective depth of 2m.

6.4.4 Section 25.6 of CIRIA 753 states that infiltration devices are commonly designed for return periods up to the 1 in 100 year event plus an allowance for climate change. Therefore, the model was run to consider the 1 in 100 year plus 40% climate change rainfall event and the DDF rainfall characteristics from the FEH CD-ROM Version 3 have also been entered into the software.

6.4.5 The proposed roof area of 1880 sq m has been used in order to provide an example of the performance of the soakaway. Additionally, a 10% increase in impermeable area has been included in the roof area calculations in order to consider urban creep as specified by BS8582:2013 and Section 24.7.2 of CIRIA 753 (i.e. area increases to 2068 sq m).

6.4.6 In accordance with Table 25.2 of CIRIA 753 (Table 1 below) and Section 20.5 CIRIA 753, a safety factor of 10 has been applied to the infiltration rate in the software to represent the gradual silting up effects of the soakaway over its design life due its proximity to the new building.

Table 1: Recommended safety factors applied to infiltration rate (CIRIA, 753)

TABLE 25.2 Suggested factors of safety, F, for use in hydraulic design of infiltration systems (designed using Bettess (1996). Note: not relevant for BRE method)

Size of area to be drained	Consequences of failure		
	No damage or inconvenience	Minor damage to external areas or inconvenience (eg surface water on car parking)	Damage to buildings or structures, or major inconvenience (eg flooding of roads)
< 100 m²	1.5	2	10
100–1000 m²	1.5	3	10
> 1000 m²	1.5	5	10

6.4.7 In order to determine the size of the soakaway and its performance up to the design 1 in 100 year plus climate change (40%) event, the *Source Control – Cellular Storage* function within the Microdrainage software, Version 2016.1.1, has been used together with the DDF rainfall characteristics from the FEH CD-ROM Version 3.

6.4.8 The optimum dimensions of the soakaway are 7m wide x 38m long and 1.2m effective depth. The results in Appendix A show that the soakaway is sufficiently sized to accommodate surface water without surface flooding during the design climate change (40%) 1 in 100 year event.

6.4.9 BRE Digest 365 and Section 13.4 of CIRIA 753 require that the time taken for infiltration devices to empty to 50% should be within 24 hours and the results indicate that this will be achieved during the design event.

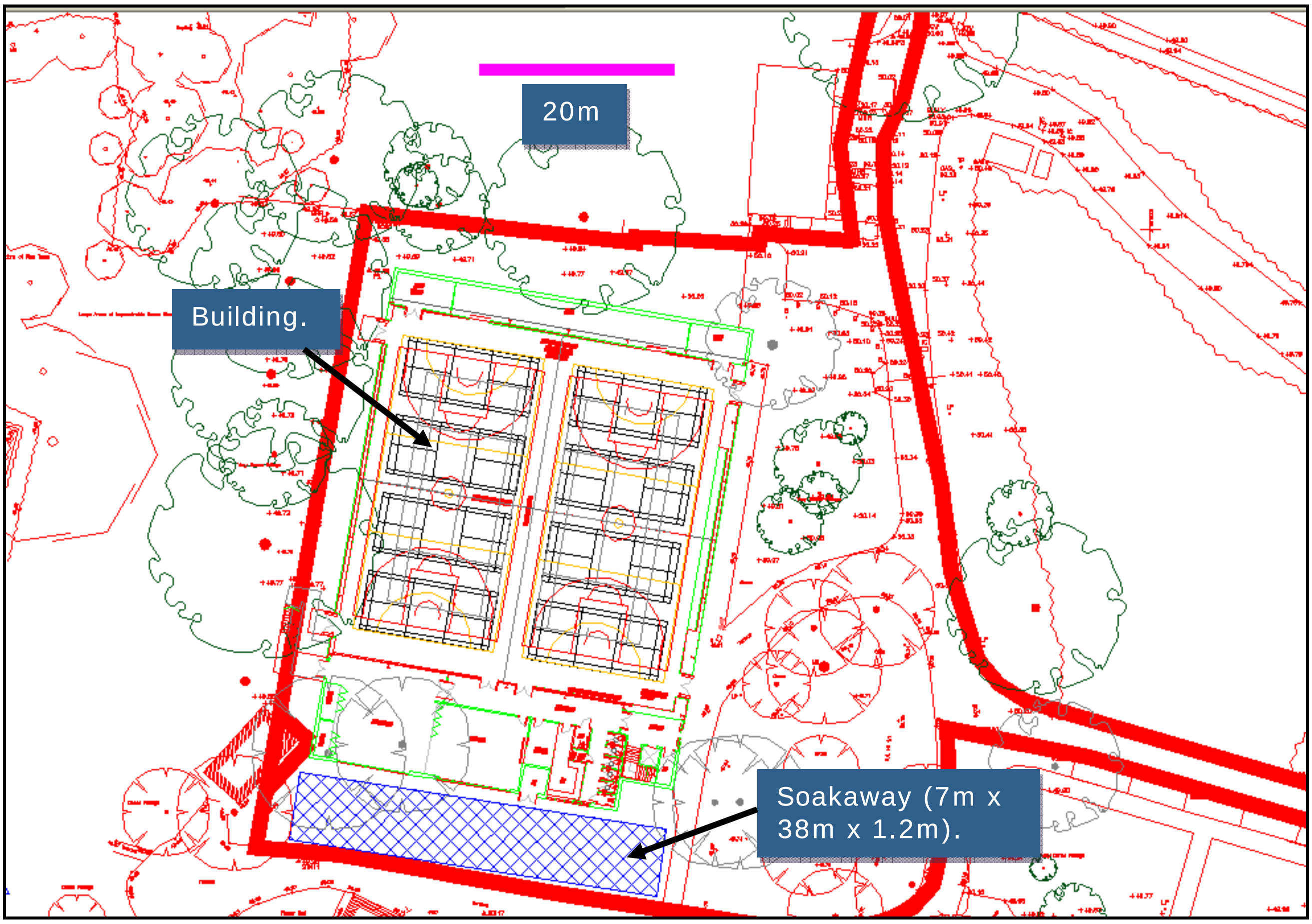


Figure 5: SUDS Strategy

6.5 Pollution Prevention

6.5.1 Table 26.2 of CIRIA 753 shows that roof water has a very low pollution hazard level.

6.5.2 Section 13.5 of CIRIA 753 states that the acceptability of infiltration design when considering groundwater protection will depend on the extent of the likely runoff contamination (i.e. very low from roof areas according to Table 26.2 of CIRIA 753). Chapter 13 of CIRIA 697 states that geocellular systems have a low potential to remove suspended solids and heavy metals and no potential to remove nutrients. CIRIA 753 states in Section 21.6 that geocellular systems do not provide any form of treatment of surface water runoff and should therefore be combined in a Management Train.

6.5.3 In accordance with the Simple Index Approach outlined in Section 26.7.1 of CIRIA 753 and more specifically Table 26.4 of CIRIA 753, proprietary treatment systems will be used to cleanse the roof water before it enters the soakaway. Section 13.2 of CIRIA 753 states that effective upstream pre-treatment is required to remove sediment and silt loads to prevent long-term clogging.

6.5.4 Chapter 16 of CIRIA 697 and Chapter 14 of CIRIA 753 suggests that pre-treatment measures could comprise, for example, proprietary filtration systems which trap particulates and soluble pollutants from the runoff prior to discharge into the soakaway. Section 21.9.9 of CIRIA 753 indicates that a sediment sump could be included or sediment traps.

6.5.5 It is therefore considered that (collectively) the SUDS measures included within this report will sufficiently improve water quality across the proposed site and comply with Box 4.3 of CIRIA 753.

6.5.6 When considering water quality treatment, the Simple Index Approach set out in 26.7.1 of CIRIA 753 needs to be considered. Using Tables 26.2 and 26.4 in CIRIA 753, it can be seen on Table 2 below, that the use of proprietary treatment systems upstream of the soakaway will be sufficient to cleanse surface water from roofs and will meet the pollution mitigation requirements (i.e. values in Table 2 for SUDS components should be equal to, or greater than the values for Land Use).

Table 2: Simple Index Approach

Land Use	Total Suspended Solids index	Metals index	Hydrocarbons index
Roofs	0.2	0.2	0.05
SUDS Component for treatment	**Total Suspended Solids index**	**Metals index**	**Hydrocarbons index**
Proprietary treatment systems	Designed and specified to cleanse surface water from access road and to meet indices above.		

6.6 Adoption and Maintenance

6.6.1 The SUDS measures across the site will be privately adopted and maintained (perhaps by a management company).

6.6.2 The soakaway and proprietary treatment systems should be maintained in accordance with Table 13.1 and 14.2 respectively of CIRIA 753, shown as Tables 3 and 4 hereafter.

Table 3: Maintenance regime for soakaway (Source: taken from Table 13.1 of CIRIA 753)

TABLE 13.1 Operation and maintenance requirements for soakaways

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Inspect for sediment and debris in pre-treatment components and floor of inspection tube or chamber and inside of concrete manhole rings	Annually
	Cleaning of gutters and any filters on downpipes	Annually (or as required based on inspections)
	Trimming any roots that may be causing blockages	Annually (or as required)
Occasional maintenance	Remove sediment and debris from pre-treatment components and floor of inspection tube or chamber and inside of concrete manhole rings	As required, based on inspections
Remedial actions	Reconstruct soakaway and/or replace or clean void fill, if performance deteriorates or failure occurs	As required
	Replacement of clogged geotextile (will require reconstruction of soakaway)	As required
Monitoring	Inspect silt traps and note rate of sediment accumulation	Monthly in the first year and then annually
	Check soakaway to ensure emptying is occurring	Annually

Table 4: Maintenance regime for proprietary treatment system (Source: taken from Table 14.2 of CIRIA 753)

TABLE 14.2 An example of operation and maintenance requirements for a proprietary treatment system		
Maintenance schedule	**Required action**	**Typical frequency**
Routine maintenance	Remove litter and debris and inspect for sediment, oil and grease accumulation	Six monthly
	Change the filter media	As recommended by manufacturer
	Remove sediment, oil, grease and floatables	As necessary – indicated by system inspections or immediately following significant spill
Remedial actions	Replace malfunctioning parts or structures	As required
Monitoring	Inspect for evidence of poor operation	Six monthly
	Inspect filter media and establish appropriate replacement frequencies	Six monthly
	Inspect sediment accumulation rates and establish appropriate removal frequencies	Monthly during first half year of operation, then every six months

6.7 Designing For Exceedance

6.7.1 Section 3.2.6 of CIRIA 753 states that the designated drainage system may include areas that are only designed to flood on an infrequent basis such as car parks, roads and recreational areas. For larger events, the site layout should be designed so that exceedance flows are managed in safe conveyance and storage zones so that the risk of flooding is acceptable for all people and property. Section 13.4.5 of CIRIA 753 states that an exceedance flow route or temporary storage area will be required for rainfall events that exceed the design capacity of the system.

6.7.2 The soakaway calculations in this FRA consider the climate change (40%) 1 in 100 year event and therefore is designed to accommodate flows during the design event. The exceedance return period event for the soakaway has been assumed to be the 1 in 1000 year event as this yields a storage depth and volume higher than the design event.

6.7.3 The results in Appendix B indicate that the soakaway is able to accommodate all of the surface water during the exceedance return period event without surface flooding.

7. CONCLUSIONS

7.1 A review of the relevant guidance documents and various types of data collected at the site has enabled a full assessment of the flood risks to be quantified.

7.2 The site is located within the Flood Zone 1 therefore all uses of land are appropriate in this zone.

7.3 This assessment has investigated the possibility of groundwater flooding and flooding from other sources at the site. It is considered that there will be a low risk of groundwater flooding and from artificial sources.

7.4 There will generally be a very low surface water flooding risk across the site, however, the proposed building will extend into an area of low surface water flooding risk. It is proposed that the finished floor level is set 300mm higher than existing ground levels to prevent internal flooding during this event.

7.5 An assessment of the practical use of sustainable drainage techniques has been carried out. As the soil types will support the effective use of infiltration devices, it is proposed that surface water from paths is cleansed and infiltrated through the use of pervious surfaces. Surface water from the roof area will be drained using a soakaway with pre-treatment devices to reduce the possible sediment and pollution load.

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APPENDIX A – SOAKAWAY CALCULATIONS

Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 1434 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	0.357	0.357	0.9	90.1	O K
30 min Summer	0.397	0.397	0.9	100.4	O K
60 min Summer	0.440	0.440	0.9	111.2	O K
120 min Summer	0.483	0.483	0.9	122.0	O K
180 min Summer	0.506	0.506	0.9	128.0	O K
240 min Summer	0.521	0.521	0.9	131.7	O K
360 min Summer	0.538	0.538	0.9	135.9	O K
480 min Summer	0.544	0.544	0.9	137.6	O K
600 min Summer	0.546	0.546	0.9	137.9	O K
720 min Summer	0.543	0.543	0.9	137.3	O K
960 min Summer	0.536	0.536	0.9	135.5	O K
1440 min Summer	0.512	0.512	0.9	129.5	O K
2160 min Summer	0.480	0.480	0.9	121.4	O K
2880 min Summer	0.451	0.451	0.9	114.1	O K
4320 min Summer	0.395	0.395	0.9	99.8	O K
5760 min Summer	0.346	0.346	0.9	87.3	O K
7200 min Summer	0.301	0.301	0.9	76.1	O K
8640 min Summer	0.261	0.261	0.9	66.0	O K
10080 min Summer	0.225	0.225	0.9	57.0	O K
15 min Winter	0.400	0.400	0.9	101.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	235.345	0.0	19
30 min Summer	131.747	0.0	34
60 min Summer	73.753	0.0	64
120 min Summer	41.287	0.0	124
180 min Summer	29.405	0.0	184
240 min Summer	23.113	0.0	242
360 min Summer	16.461	0.0	362
480 min Summer	12.939	0.0	482
600 min Summer	10.734	0.0	602
720 min Summer	9.215	0.0	722
960 min Summer	7.283	0.0	960
1440 min Summer	5.227	0.0	1210
2160 min Summer	3.752	0.0	1576
2880 min Summer	2.965	0.0	1964
4320 min Summer	2.113	0.0	2772
5760 min Summer	1.662	0.0	3584
7200 min Summer	1.380	0.0	4392
8640 min Summer	1.185	0.0	5112
10080 min Summer	1.042	0.0	5856
15 min Winter	235.345	0.0	19

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
30 min Winter	0.445	0.445	0.9	112.5	O K
60 min Winter	0.494	0.494	0.9	124.8	O K
120 min Winter	0.543	0.543	0.9	137.3	O K
180 min Winter	0.571	0.571	1.0	144.3	O K
240 min Winter	0.589	0.589	1.0	148.8	O K
360 min Winter	0.610	0.610	1.0	154.1	O K
480 min Winter	0.620	0.620	1.0	156.7	O K
600 min Winter	0.624	0.624	1.0	157.7	O K
720 min Winter	0.624	0.624	1.0	157.7	O K
960 min Winter	0.621	0.621	1.0	157.0	O K
1440 min Winter	0.599	0.599	1.0	151.3	O K
2160 min Winter	0.557	0.557	0.9	140.8	O K
2880 min Winter	0.519	0.519	0.9	131.1	O K
4320 min Winter	0.439	0.439	0.9	110.9	O K
5760 min Winter	0.366	0.366	0.9	92.5	O K
7200 min Winter	0.301	0.301	0.9	76.0	O K
8640 min Winter	0.243	0.243	0.9	61.3	O K
10080 min Winter	0.191	0.191	0.8	48.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
30 min Winter	131.747	0.0	34
60 min Winter	73.753	0.0	64
120 min Winter	41.287	0.0	122
180 min Winter	29.405	0.0	180
240 min Winter	23.113	0.0	240
360 min Winter	16.461	0.0	356
480 min Winter	12.939	0.0	474
600 min Winter	10.734	0.0	590
720 min Winter	9.215	0.0	702
960 min Winter	7.283	0.0	926
1440 min Winter	5.227	0.0	1356
2160 min Winter	3.752	0.0	1684
2880 min Winter	2.965	0.0	2136
4320 min Winter	2.113	0.0	3028
5760 min Winter	1.662	0.0	3872
7200 min Winter	1.380	0.0	4688
8640 min Winter	1.185	0.0	5448
10080 min Winter	1.042	0.0	6160

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 525550 203600 TL 25550 03600
C (1km)	-0.025
D1 (1km)	0.278
D2 (1km)	0.297
D3 (1km)	0.280
E (1km)	0.322
F (1km)	2.483
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.206

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.206

Model Details

Storage is Online Cover Level (m) 1.200

Cellular Storage Structure

Invert Level (m) 0.000 Safety Factor 10.0
Infiltration Coefficient Base (m/hr) 0.10800 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.10800

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	266.0	266.0	1.300	0.0	374.0
1.200	266.0	374.0			

APPENDIX B – SOAKAWAY EXCEEDANCE

Summary of Results for 1000 year Return Period

Half Drain Time : 1848 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	0.582	0.582	1.0	147.0	O K
30 min Summer	0.623	0.623	1.0	157.5	O K
60 min Summer	0.665	0.665	1.0	168.1	O K
120 min Summer	0.705	0.705	1.0	178.1	O K
180 min Summer	0.725	0.725	1.0	183.1	O K
240 min Summer	0.736	0.736	1.0	186.0	O K
360 min Summer	0.747	0.747	1.0	188.7	O K
480 min Summer	0.748	0.748	1.0	189.1	O K
600 min Summer	0.745	0.745	1.0	188.3	O K
720 min Summer	0.738	0.738	1.0	186.6	O K
960 min Summer	0.724	0.724	1.0	183.0	O K
1440 min Summer	0.682	0.682	1.0	172.3	O K
2160 min Summer	0.626	0.626	1.0	158.1	O K
2880 min Summer	0.580	0.580	1.0	146.6	O K
4320 min Summer	0.501	0.501	0.9	126.7	O K
5760 min Summer	0.436	0.436	0.9	110.3	O K
7200 min Summer	0.380	0.380	0.9	96.0	O K
8640 min Summer	0.330	0.330	0.9	83.4	O K
10080 min Summer	0.285	0.285	0.9	72.1	O K
15 min Winter	0.652	0.652	1.0	164.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	382.768	0.0	19
30 min Summer	205.878	0.0	34
60 min Summer	110.735	0.0	64
120 min Summer	59.560	0.0	124
180 min Summer	41.439	0.0	184
240 min Summer	32.035	0.0	244
360 min Summer	22.289	0.0	362
480 min Summer	17.231	0.0	482
600 min Summer	14.112	0.0	602
720 min Summer	11.988	0.0	722
960 min Summer	9.319	0.0	960
1440 min Summer	6.534	0.0	1344
2160 min Summer	4.581	0.0	1668
2880 min Summer	3.561	0.0	2048
4320 min Summer	2.479	0.0	2852
5760 min Summer	1.918	0.0	3640
7200 min Summer	1.571	0.0	4464
8640 min Summer	1.335	0.0	5192
10080 min Summer	1.164	0.0	5952
15 min Winter	382.768	0.0	19

Summary of Results for 1000 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
30 min Winter	0.699	0.699	1.0	176.6	O K
60 min Winter	0.746	0.746	1.0	188.6	O K
120 min Winter	0.792	0.792	1.0	200.1	O K
180 min Winter	0.816	0.816	1.0	206.1	O K
240 min Winter	0.830	0.830	1.0	209.8	O K
360 min Winter	0.845	0.845	1.0	213.4	O K
480 min Winter	0.849	0.849	1.0	214.6	O K
600 min Winter	0.848	0.848	1.0	214.3	O K
720 min Winter	0.844	0.844	1.0	213.2	O K
960 min Winter	0.833	0.833	1.0	210.6	O K
1440 min Winter	0.796	0.796	1.0	201.3	O K
2160 min Winter	0.728	0.728	1.0	184.0	O K
2880 min Winter	0.673	0.673	1.0	170.0	O K
4320 min Winter	0.567	0.567	1.0	143.4	O K
5760 min Winter	0.476	0.476	0.9	120.3	O K
7200 min Winter	0.395	0.395	0.9	99.8	O K
8640 min Winter	0.324	0.324	0.9	81.8	O K
10080 min Winter	0.261	0.261	0.9	65.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
30 min Winter	205.878	0.0	34
60 min Winter	110.735	0.0	64
120 min Winter	59.560	0.0	122
180 min Winter	41.439	0.0	182
240 min Winter	32.035	0.0	240
360 min Winter	22.289	0.0	358
480 min Winter	17.231	0.0	474
600 min Winter	14.112	0.0	590
720 min Winter	11.988	0.0	708
960 min Winter	9.319	0.0	934
1440 min Winter	6.534	0.0	1382
2160 min Winter	4.581	0.0	1792
2880 min Winter	3.561	0.0	2192
4320 min Winter	2.479	0.0	3112
5760 min Winter	1.918	0.0	3976
7200 min Winter	1.571	0.0	4824
8640 min Winter	1.335	0.0	5616
10080 min Winter	1.164	0.0	6352

Rainfall Details

Rainfall Model	FEH
Return Period (years)	1000
FEH Rainfall Version	1999
Site Location	GB 525550 203600 TL 25550 03600
C (1km)	-0.025
D1 (1km)	0.278
D2 (1km)	0.297
D3 (1km)	0.280
E (1km)	0.322
F (1km)	2.483
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.206

Time (mins) From:	To:	Area (ha)
0	4	0.206

Model Details

Storage is Online Cover Level (m) 1.200

Cellular Storage Structure

Invert Level (m) 0.000 Safety Factor 10.0
Infiltration Coefficient Base (m/hr) 0.10800 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.10800

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	266.0	266.0	1.300	0.0	374.0
1.200	266.0	374.0			

DRAWINGS

Queenswood School

Proposed New Sports Facility

NOTES:

Do Not Scale.

Report all discrepancies, errors and omissions.

Verify all dimensions on site before commencing any work on site or preparing shop drawings.

All materials, components and workmanship are to comply with the relevant British Standards, Codes of Practice, and appropriate manufacturers recommendations that from time to time shall apply.

For all specialist work, see relevant drawings.

Rev	Date	Description

BALL HALL LIMITED

Ball Hall

Project Title

Proposed New Sports Hall

Queenswood School
Shepherds Way
Hatfield
Hertfordshire
AL9 6NS

Drawing Description

Existing Survey

Scale	Drawn by
1:500 @ A1	LB
Date	**Checked by**
Oct 2016	

CLAGUE ARCHITECTS

62 Burgate, Canterbury
Kent CT1 2BH — 01227 762060

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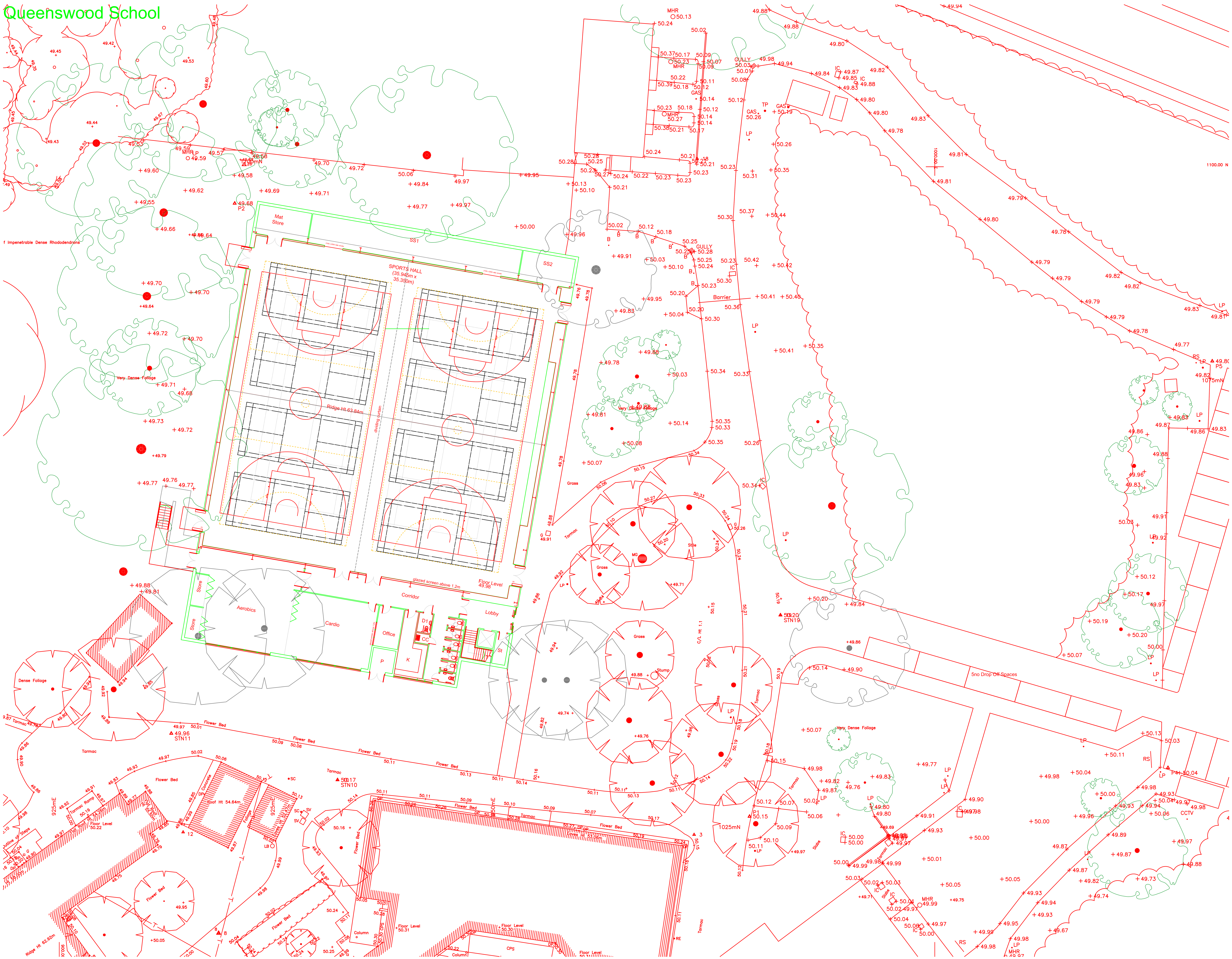
4th Floor, 99 Charterhouse Street
London EC1M 6HR — 0203 597 6112

CANTERBURY LONDON HARPENDEN

Drawing Number	Revision
22968A / 02	

Queenswood School



Proposed New Sports Facility

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For all specialist work, see relevant drawings.

Rev	Date	Description

0 5m 10m

BALL HALL LIMITED

Ball Hall

Project Title

Proposed New Sports Hall

Queenswood School
Shepherds Way
Hatfield
Hertfordshire
AL9 6NS

Drawing Description

Proposed Site Plan

Scale	Drawn by
1:200 @ A1	LB
Date	**Checked by**
Oct 2016	

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CANTERBURY LONDON HARPENDEN

Drawing Number: 22968A / 03

Revision:

EVANS

Rivers and Coastal