



UK Flood Risk
Flood Risk Consultants

Site Drainage Strategy (Sustainable Urban Drainage Systems SuDS)

**Proposed Residential Development
Rear of Cornfields,
Nutts Lane, Hinckley LE10 3EG**

**Project Ref: QFRA 2254
Version: 1.0**

Date: 15/02/2023

UK Flood Risk
41 Stanham Road
Dartford DA1 3AN

Tel: 020 3468 1540

**Email: ukfloodrisk@gmail.com
www.ukfloodrisk.co.uk**

Revision Records

Issued	Report Version	Comments	Issued to
February 2023	1.0	1 st Issue	Mr Simon Cheshire

Prepared by	SG	Senior Flood Risk Consultant	15/02/2023
-------------	----	------------------------------	------------

Issue Date: 15/02/2023

DISCLAIMER

This document has been prepared solely as a SuDS Drainage Strategy for the owner of this site. UK Flood Risk Consultants accepts no responsibility or liability for any use that is made of this document other than by the owner for the purpose for which it was originally commissioned and prepared.

UK Flood Risk
41 Stanham Road
Dartford DA1 3AN

Executive Summary

UK Flood Risk Consultants has been commissioned to develop a Sustainable Urban Drainage Systems (SuDS) Strategy in support of a proposal consisting of a residential development with the erection of 9 no. residential dwellings at the land to the rear of Cornfields, Nutts Lane, Hinckley LE10 3EG.

The main sources of information to develop the SuDS strategy are the guidelines of the National Planning Policy Framework (NPPF, July 2021) and the Environment Agency's Flood Risk Assessment (FRA) Guidance Notes along with the best practice guidance in flood risk and drainage including the Non-Statutory Technical Standards for Sustainable Drainage Systems (March 2015).

The overall risk of surface water flooding to the site is low.

The surface runoff will be improved by implementing appropriate SuDS measures.

The British Geological Survey's Infiltration SuDS Report for the site indicated that there was a very significant potential for one or more hazards associated with infiltration. The report shows that the site is located within an area that might have ground instability problems and increased infiltration may result in ground instability problem. In addition, the report finds that the site is located in an area with very high likelihood of persistent or seasonally shallow groundwater. Also, an inspection of the British Geological Survey's geological maps show that the bedrock of the site comprises Mercia Mudstone Group – Mudstone with superficial deposits of Alluvium - Clay, Silt, Sand and Gravel. On this basis it is considered that soakaways are not a viable option. In order to discharge surface water flows to a watercourse would require crossing significant third-party land, therefore it is proposed that flows generated from the site will discharge into the existing public sewer (i.e. Foul Sewer) located on Nutts Lane.

The proposed SuDS drainage scheme will therefore include an underground Geocellular attenuation storage with the controlled outflow discharge by using a Hydrobrake. The size of the proposed attenuation storage is as follows: Length = 28m, Width = 5m, Depth = 0.75m.

The maximum flow control of 1 litre per second has been adopted for all events up to and including 1% AEP + 40%CC with no flooding.

Severn Trent's sewer asset map shows that a Foul Sewer runs along Nutts Lane. The controlled outflow from the attenuation storage will be discharged into the Foul Sewer on Nutts Lane using a 150mm linear drainpipe with the controlled discharge rate not more than 1 litre/sec.

In addition, a permeable paving on access drive and rain gardens will be implemented in order to further improve the surface runoff from the site.

The landowners will be fully responsible for the repair and management of the implemented SuDS throughout the lifetime of the proposed development.

Contents

1.0	BACKGROUND	1
2.0	SURFACE WATER DRAINAGE REQUIREMENTS	1
3.0	GENERAL DESCRIPTION OF THE SITE AND THE PROPOSALS.....	2
3.1.	Description of the site	2
3.2.	Proposed Development	2
4.0	SUSTAINABLE URBAN DRAINAGE SYSTEMS (SUDS) POLICIES.....	3
4.1.	Flood and Water Management Act 2010	3
4.2.	Non-Statutory Technical Standards for Sustainable Drainage Systems	4
4.3.	Flood Risk Planning Policy Guidance.....	4
4.4.	Building Regulations 2010 Part H Drainage & Waste Disposal.....	5
5.0	ASSESSMENT OF SURFACE RUNOFF FLOOD RISK	5
6.0	SUSTAINABLE URBAN DRAINAGE SYSTEMS (SUDS)	5
6.1.	Existing Drainage.....	6
6.2.	Greenfield Runoff Estimation.....	6
6.3.	Estimation of Permeable and Impermeable Areas	7
6.4.	Estimation of peak surface runoff rates	8
6.5.	Hierarchy of SuDS Measures	10
6.6.	General Assessment of SuDS Measures for the site	12
6.7.	Drainage Hierarchy and Disposal Options.....	12
6.8.	Proposed SuDS Measures	13
7.0	OUTLINE DESIGN OF SUDS	14
7.1.	Proposed Surface Water Management	14
8.0	EXCEEDANCE FLOW PATHS	16
8.1.	SuDS Management and Maintenance Plan.....	16
9.0	CONCLUSION.....	21

Appendices

APPENDIX A SITE LOCATION MAPS	I
APPENDIX B GEOLOGICAL MAP.....	II
APPENDIX C LAND USE & TOPOGRAPHIC MAP	III
APPENDIX D GROUNDWATER VULNERABILITY MAP.....	IV
APPENDIX E EXISTING SITE AND PROPOSED PLANS.....	V
APPENDIX F SURFACE WATER FLOOD MAPS.....	VI
APPENDIX G EXISTING DRAINAGE AND SEWER ASSET MAP DATA.....	VII
APPENDIX H GREENFIELD RUNOFF RATES.....	VIII
APPENDIX I RAINFALL RUNOFF MODELLING SUMMARY 1 IN 1 YR EVENT.....	IX
APPENDIX J RAINFALL RUNOFF MODELLING SUMMARY 1 IN 2 YR EVENT.....	X
APPENDIX K RAINFALL RUNOFF MODELLING SUMMARY 1 IN 5 YR EVENT.....	XI
APPENDIX L RAINFALL RUNOFF MODELLING SUMMARY 1 IN 10 YR EVENT.....	XII
APPENDIX M RAINFALL RUNOFF MODELLING SUMMARY 1 IN 30 YR EVENT.....	XIII
APPENDIX N RAINFALL RUNOFF MODELLING SUMMARY 1 IN 50 YR EVENT.....	XIV
APPENDIX O RAINFALL RUNOFF MODELLING SUMMARY 1 IN 100 YR EVENT.....	XV
APPENDIX P INFILTRATINO SUDS REPORT.....	XVI
APPENDIX Q PROPOSED SURFACE RUNOFF IMPROV. MEASURES SUDS.....	XVII
APPENDIX R ATTENUATION STORAGE MODELLING SUMMARY.....	XVIII
APPENDIX S EXCEEDANCE FLOW ROUTES.....	XIX

Abbreviations

Abbreviation	Description
mAOD	Metres Above Ordnance Datum
DEFRA	Department for Environment, Food, and Rural Affairs
EA	Environment Agency
LLFA	Lead Local Flood Authority
NPPF	National Planning Policy Framework
SFRA	Strategic Flood Risk Assessment
PFRA	Preliminary Flood Risk Assessment
SuDS	Sustainable Drainage Systems

1.0 Background

UK Flood Risk Consultants has been commissioned to develop a Sustainable Urban Drainage Systems (SuDS) Strategy in support of a proposal consisting of a residential development with the erection of 9 no. residential dwellings at the land to the rear of Cornfields, Nutts Lane, Hinckley LE10 3EG.

The sustainable drainage assessment is presented with reference to the hydrological and hydrogeological context of the development. This Sustainable Urban Drainage Systems (SuDS) Strategy has been developed in accordance with the guidelines and the requirements of the National Planning Policy Framework (NPPF, July 2021) and the Environment Agency's Flood Risk Assessment (FRA) Guidance Notes along with the best practice guidance in flood risk and drainage including the Non-Statutory Technical Standards for Sustainable Drainage Systems (March 2015).

2.0 Surface Water Drainage Requirements

A surface water drainage assessment should be undertaken to demonstrate that surface water runoff from the proposed development can be effectively managed without increasing flood risk elsewhere. A surface water drainage assessment should include the following:

- Assessment of whether the development will increase the overall discharge from the site by calculating the change in area covered by roofs and hard-standing.
- Details of how overland flow from the new development can be intercepted to prevent flooding of adjacent land.
- Details of how additional onsite surface water attenuation can be provided to mitigate against known flooding problems or as a result of incapacity on the drainage systems.
- Demonstration that overland flows will not increase flood risk to both existing development and receiving watercourses.

3.0 General Description of the Site and the Proposals

3.1. Description of the site

The proposal site is located at the land to the rear of Cornfields, Nutts Lane, Hinckley LE10 3EG approximately centred on the OS NGR SP 40924 92760 (**Appendix A Figure 1**). The site is located within the administrative boundary of Hinckley and Bosworth Borough Council which is the Local Planning Authority.

The site is currently a vacant piece of land covered with grass and shrubs which occupies an area of approximately 0.40ha. The site is bound by a train line to the north and west, residential houses to the east and open fields to the south. The access to the site is via Nutts Lane. The surrounding area consists of mix of residential, commercial and agricultural uses (**Appendix A Figure 2**).

The British Geological Survey's geological maps show that the bedrock of the site comprises Mercia Mudstone Group – Mudstone that formed between 252.2 and 201.3 million years ago during the Triassic period (**Appendix B**). The superficial deposits consist of Alluvium - Clay, silt, sand and gravel that formed between 11.8 thousand years ago and the present during the Quaternary period.

The nearest Main River from the site is the Sketchley Brook which runs approximately 300m to the south. However, the site is located outside of its floodplain.

The site topography is relatively flat and level with the general elevations varying from 89.50mAOD to 90.20mAOD (**Appendix C**).

The Groundwater Vulnerability Maps show the vulnerability of groundwater to a pollutant discharged at ground level based on the hydrological, geological, hydrogeological and soil properties. The Groundwater Vulnerability Map for the site shows that the vulnerability of groundwater to a pollutant discharged at ground level is 'medium' (**Appendix D**).

3.2. Proposed Development

The proposal consists of a residential development with the erection of 9 no. residential dwellings along with access and landscaping. The total footprint area of the proposed dwellings is approximately 1,175m² Further details about the proposals have been provided in **Appendix E**.

4.0 Sustainable Urban Drainage Systems (SuDS) Policies

Sustainable Urban Drainage Systems (SUDS) policies are guidelines and regulations that promote the use of SUDS in urban areas. These policies aim to reduce the negative impact of surface water runoff on the environment, reduce the risk of flooding, and improve water quality. Suitability of different SuDS will be governed by prevailing site conditions, such as the type and scale of development, topography, ground conditions (soil permeability, ground stability, depth to water table), local hydrogeology and risk of groundwater contamination (presence of sensitive aquifers and source protection zones) etc.

The specific details of SUDS policies can vary depending on various factors, but they often include requirements for new development projects to incorporate SUDS, guidelines for retrofitting existing areas with SUDS, and financial incentives to encourage the adoption of SUDS. The policies can also include specifications for design, maintenance, and performance of SUDS. The goal of SUDS policies is to promote more sustainable and environmentally-friendly urban drainage practices.

4.1. Flood and Water Management Act 2010

The Flood and Water Management Act 2010 sets out a framework for the rollout of drainage systems, a sustainable drainage system approving body, and national standards on design, construction, operation, and maintenance. It also makes the right to connect surface water runoff to public sewers conditional upon a drainage system being approved before any construction work can start.

The method of drainage of surface water from the site is bound by the Flood and Water Management Act 2010. Schedule 3 Paragraph 5 of the Flood and Water Management Act 2010 states that the following hierarchy is to be applied to surface water runoff in the following order or priority:

- Discharge into the ground (infiltration)
- Discharge to a surface water body (lake, river, drain);
- Discharge to a surface water sewer, highway drain or another drainage system; or Discharge into a combined sewer.

4.2. Non-Statutory Technical Standards for Sustainable Drainage Systems

The Non-Statutory Technical Standards for Sustainable Drainage Systems (March 2015) contains non-statutory technical standards for the design, maintenance and operation of sustainable drainage systems to drain surface water from housing, non-residential or mixed-use developments for the lifetime of the developments. Development proposals should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible in line with the following drainage hierarchy as set out by the Non-Statutory Technical Standards for Sustainable Drainage Systems (March 2015):

1. rainwater harvesting (including a combination of green and blue roofs)
2. infiltration techniques and green roofs
3. rainwater attenuation in open water features for gradual release
4. rainwater discharge direct to a watercourse (unless not appropriate)
5. rainwater attenuation above ground (including blue roofs)
6. rainwater attenuation below ground
7. rainwater discharge to a surface water sewer or drain
8. rainwater discharge to a combined sewer.

4.3. Flood Risk Planning Policy Guidance

The Guidance on Flood Risk and Coastal Change advises how to take account of and address the risks associated with flooding and coastal change in the planning process. Consideration of sustainable drainage systems early in the design process for development, including at the pre-application or master-planning stages, can lead to better integration, multi-functional benefits and reduced land-take.

The NPPF recognises that flood risk and other environmental damage can be managed by minimising changes in the volume and rate of surface run-off from development sites through the use of Sustainable Drainage Systems (SuDS), this being complementary to the control of development within the floodplain.

SuDS are required in accordance with the National Planning Policy Framework, to reduce delays in the planning process, applicants need to submit a sustainable

drainage strategy containing proportionate information on the proposed sustainable drainage systems as part of their planning application (including outline applications), having regard to the nature and scale of the development proposed.

4.4. Building Regulations 2010 Part H Drainage & Waste Disposal

The Building Regulations Requirement H33 stipulates that rainwater from roofs and paved areas is carried away from the surface to discharge to one of the following, listed in order of priority:

- an adequate soakaway or other adequate infiltration system,
- a watercourse or, where that is not practicable,
- a sewer.

5.0 Assessment of Surface Runoff Flood Risk

The surface water flooding arises when the infiltration capacity of land or the drainage capacity of a local sewer network is exceeded and the excess rainwater flows overland. The severity of surface water flooding depends on several factors such as the degree of saturation of the soil before the event, the permeability of soils and geology, hill slope steepness and the intensity of land use.

Information on the risk of surface water flooding is held by the Environment Agency. The Environment Agency's Surface Water Flood Risk Maps are provided in **Appendix F Figure 1 and Figure 2** which indicate that the risk of surface water flooding to the site is 'low'.

6.0 Sustainable Urban Drainage Systems (SuDS)

SUDS (Sustainable Urban Drainage Systems) refers to a type of drainage system designed to mimic the natural water cycle and reduce the impact of surface water runoff on the environment. Sustainable drainage systems slow the rate of surface water run-off and improve infiltration, by mimicking natural drainage in both rural and urban areas. This reduces the risk of "flash-flooding" which occurs when rainwater rapidly flows into the public sewerage and drainage systems.

Sustainable drainage systems (SuDS) are designed to control surface water run off close to where it falls, combining a mixture of built and nature-based techniques to mimic natural drainage as closely as possible, and accounting for the predicted impacts of climate change. SuDS systems use a combination of techniques such as permeable paving, rain gardens, green roofs, and detention ponds to reduce the risk of flooding. Also, they provide benefits for water quantity, water quality, biodiversity and amenity.

The Hinckley and Bosworth Borough Council strongly encourages the principles of SuDS on all forms of development. The developer should seek the most sustainable SuDS solution in order to reduce flood risk, improve water quality and improve the environment overall.

The Leicestershire County Council, in its role as Lead Local Flood Authority (LLFA), is a statutory consultee in the planning process for major development proposals which have surface water implications. The LLFA encourages the developers to provide SuDS on major developments while paying due regard to the National Planning Policy Framework (NPPF), Planning practice guidance, Non-statutory technical standards for sustainable drainage systems and the District local plan policies.

6.1. Existing Drainage

The site is a vacant piece of land which is covered by soft landscaping. Most of the surface runoff infiltrates into the ground. There is a foul sewer running along Nutts Lane (**Appendix G**). However, the site is not currently served by this sewer.

6.2. Greenfield Runoff Estimation

The estimation of the Greenfield Runoff rate has been undertaken using the HR Wallingford's Greenfield Runoff Estimation tool available on the website: http://www.uksuds-.com/greenfieldrunoff_js.htm. The aim of the tool is to provide flow rate information based on a minimum amount of data so that anybody can use the tool. The methodology is built around the concept that a flow rate discharge constraint is needed for storm water runoff from a site, resulting in attenuation volume being needed. In addition, current drainage criteria include the requirement for the 100 year 6hr volume to be controlled.

The tool is based on the results of simple model analysis and correlating the results against key known site parameters. As such the results need to be treated as providing indicative information only and should not be used to produce final designs of drainage

systems without additional modelling being carried out. The peak flow estimation can now be estimated using two different formulae.

- 1) The formula developed in IH124 (IH 1994) and use of the FSSR growth curve information for regions of the UK (FSSR 14),
- 2) The use of FEH statistical correlation equation revised in 2008.

However, only the IH124 method can be used without providing specific parameter values. Therefore, this method has been used for estimating greenfield runoff rate from the proposed development site. Details about the parameters used in the estimation are provided in **Appendix H** and the results are summarised in **Table 1** below. The total site area of 0.40ha has been used. The proposed development will consider the greenfield runoff rates for addressing surface water discharge requirements from the developed site. The greenfield runoff rates will also be utilised for developing the drainage strategy for the site.

Table 1 – Greenfield Runoff Rates

Events	Greenfield runoff rates (l/s) (Estimated)
Qbar	1.75
1 in 1 year	1.45
1 in 30 year	3.50
1 in 100 year	4.50

6.3. Estimation of Permeable and Impermeable Areas

The changes in land cover have been summarised in **Table 2** below. It can be seen that the proposed development will lead an increase of impermeable area by 2,115m². This means the surface runoff will be increased as a result of the proposed development.

Table 2 Changes in Land Cover Areas

Land Cover	Pre-development, m ²	Post-development, m ²	Change, m ²
Impermeable Surface Area			
Hard standing	0	940	
Building footprint (along with garage)	0	1175	
Total Impermeable	0	2,115	(+) 2,115
Permeable Surface Area			
Grass cover	4020	565	
Permeable surface (access road and parking area)	0	1,340	
Total Permeable	4020	1,905	(-) 2,115
Total Area	4020	4020	

6.4. Estimation of peak surface runoff rates

Pre-development Peak Runoff Rates

The greenfield runoff rates are provided in **Table 1** above.

Post-development Peak Runoff Rates based on land cover area

The Rational Method has been used in order to estimate the peak surface runoff from the site.

The Rational Equation is given by:

$$Q = A_r \times P \times R_i$$

Where, A_r = Effective catchment area, m²

P = Impermeability factor

R_i = Rainfall Intensity, mm/hr

Q = Peak surface runoff, m³/s

The peak surface runoff rates for the existing site condition are summarised in **Table 3** below. An impermeability factor of 0.90 has been used for the site. Information on the maximum rainfall intensity for a range of return period events has been taken from the MicroDrainage Model developed for the site. The rainfall intensities have been taken from the modelling output which are included in **Appendices from I to O**. The impermeable surface areas in **Table 2** have been used as catchment for the calculations.

Table 3 Estimation of Peak Runoff Rates from the site (Post-development condition) based on the land cover area

Return Periods	Max Rainfall Intensity, Ri mm/hr	Catchment Area, A m ²	Impermeability factor, P	# Peak Runoff, Q, m ³ /sec	Peak Runoff, Q, litres/sec
1/ 1 year	30.99	2115	0.9	0.01639	16.39
1/2 year	40.05	2115	0.9	0.02118	21.18
1/5 year	51.58	2115	0.9	0.02727	27.27
1/10 year	59.93	2115	0.9	0.03169	31.69
1/30 year	76.03	2115	0.9	0.04020	40.20
1/50 year	84.92	2115	0.9	0.04490	44.90
1/100 year	98.68	2115	0.9	0.05218	52.18
1/100 year + 40% CC	148.02	2115	0.9	0.07827	78.27

$Q = (Ri/1000 \times A \times P)/3600$

Ri taken from MicroDrainage model (**Appendix I to O**).

Post-development Peak Runoff Rates (with attenuation storage)

The peak surface runoff from the post-development condition will be limited to 1 litre/sec (which is less than the greenfield runoff rate of 1.75 Litre/sec) with the implementation of the attenuation storage system. The surface runoff rates for a range of events for the site are summarised in **Table 4** below.

Table 4 Summary of Peak Runoff Rates from the site (Post-development condition with the provision of attenuation storage)

Return Periods	Peak Runoff Rate, Q, Litre/sec
1/ 1 year	1
1/2 year	1
1/5 year	1
1/10 year	1
1/30 year	1
1/100 year	1
1/100 year + 40% CC	1

6.5. Hierarchy of SuDS Measures

The surface runoff from the site will be improved by implementing appropriate SuDS. The requirements for SuDS will ensure that any redevelopment or new development does not negatively contribute to the surface water flood risk of other properties and instead provides a positive benefit to the level of risk in the area. It will also ensure that appropriate measures are taken to increase the flood resilience of new properties and developments in surface water flood risk areas, such as those identified as being locally important flood risk areas.

The SuDS hierarchy and management train has been discussed in the SuDS Manual (C753) which aims to mimic the natural catchment processes as closely as possible. The general hierarchy of the SuDS measures is provided in **Table 5** below.

Table 5 General Hierarchy of SuDS Measures

Measures	Definition/Description
Prevention	The use of good site design and housekeeping measures to prevent runoff and pollution (e.g. rainwater harvesting/reuse).
Source control	Control of runoff at or very near its source (e.g. soakaways, porous and pervious surfaces, green roofs).
Site control	Management of water in a local area on site (e.g. routing water to large soakaways, infiltration or detention basins)
Regional control	Management of runoff from a site or several sites (e.g. balancing ponds, wetlands).

Assessment of Infiltration option for the site

The Groundwater Vulnerability Maps show the vulnerability of groundwater to a pollutant discharged at ground level based on the hydrological, geological, hydrogeological and soil properties. The Groundwater Vulnerability Map for the site shows that the vulnerability of groundwater to a pollutant discharged at ground level is 'medium' (**Appendix D**).

The British Geological Survey's geological maps show that the bedrock of the site comprises Mercia Mudstone Group – Mudstone (**Appendix B**). This implies that the potential for infiltration option is low.

In addition, an Infiltration SuDS Report was obtained for the site from the British Geological Survey (BGS) (**Appendix P**). This report provides information on the suitability of the subsurface for the installation of infiltration sustainable drainage systems (SuDS). It provides information on the properties of the subsurface with respect to significant constraints, drainage, ground stability and groundwater quality protection.

The report shows that in terms of the drainage potential, whether the ground is suitable for infiltration SuDS, the site has very significant constraints. There is a very significant potential for one or more hazards associated with infiltration. Also, the report shows that the site is located within an area that might have ground instability problems and increased infiltration may result in ground instability problem.

In addition, the report finds that the site is located in an area with very high likelihood of persistent or seasonally shallow groundwater. Considering these findings, it is reasonable to conclude that infiltration SuDS such as a Soakaway will not be feasible for the site.

An inspection of the British Geological Survey's geological maps show that the bedrock of the site comprises Mercia Mudstone Group – Mudstone with superficial deposits of Alluvium - Clay, Silt, Sand and Gravel (**Appendix B**). On this basis we consider that soakaways are not a viable option. In order to discharge surface water flows to a watercourse would require crossing significant third-party land, therefore we anticipate that flows generated from the site will discharge into the existing public sewer (i.e. Foul Sewer) located on Nutts Lane.

There is sufficient space on site to construct a suitable surface water storage system which will comprise a cellular storage structure and a hydrobrake or similar vortex flow control device. The onsite attenuation system will need to cater for flows up to a 1 in 30 year storm ensuring that all storm water remains within the surface water drainage system. The system will also be checked for a 1 in 100 year storm + 40% for climate change, any flooding from this storm event will be contained on site and not affect any properties or any offsite areas.

There is no evidence on site of any positive connections to the existing public sewer system therefore the discharge rate we propose is 1 l/s as this is widely accepted as the lowest achievable restriction rate, anything lower than this would likely to have a small orifice less than 75mm which would be susceptible to blockages and causing flood risk.

Foul Water Drainage

A Foul Sewer is located on Nutts Lane (**Appendix G**). It is intended that a new connection will be made to this sewer to serve the development subject to Severn Trent's approval. The contractor will be responsible for applying for connection to the public sewer system and submitting an application form. A new foul water system will be constructed for this development and will be operated and maintained by the Client/Site Owner. A copy of Severn Trent's sewer records map is located in **Appendix G**.

6.8. Proposed SuDS Measures

Based on the general assessment of the potential SuDS measures above, an underground attenuation storage will be implemented in order to attenuate the surface runoff from the design 1 in 100-year 6-hour rainfall event plus 40% Climate Change. Also, rain gardens and permeable paving on the access drive will be provided in order to improve the surface runoff from the site.

7.0 Outline Design of SUDS

7.1. Proposed Surface Water Management

Attenuation Storage

An open ground attenuation storage will not be feasible at the site due to the limited space available. Therefore, an underground geo-cellular storage will be implemented in order to temporarily store storm water from the site.

The proposed scheme will therefore include an underground Geo-cellular attenuation storage with the controlled outflow discharge by using a Hydrobrake. The size of the proposed attenuation storage is as follows:

Length = 28m, Width = 5m, Depth = 0.75m

The maximum flow control of 1 litre per second has been adopted for all events up to and including 1% AEP + 40%CC with no flooding. The proposed drainage layout plan has been provided in **Appendix Q**.

Severn Trent's sewer asset map shows that a Foul Sewer runs along Nutts Lane (**Appendix G**). The controlled outflow from the attenuation storage will be discharged into the Foul Sewer on Nutts Lane using a 150mm linear drainpipe as shown in **Appendix Q**.

Hydraulic Modelling

The proposed drainage scheme has been modelled by using Micro Drainage Source Control to understand the evolving flow regime under flood conditions and the potential for flooding. The site area considered for the modelling is 0.21ha, which is the total impermeable surface area post-development (**Table 2**). The attenuation storage has been modelled considering the 1 in 100 year (1%AEP) plus 40% climate change event.

Both summer and winter profiles of the storm events have been considered for a range of duration, from 15 minutes to 8640 minutes. All input parameters (i.e. rainfall and model details) have been provided in **Appendix R**. The summary of the model output for the 1 in 100 year plus 40% climate change event is provided in **Table 7** below.

It can be seen from **Table 7** that for the maximum volume of 129.60m³ will be generated by the 480 minutes Winter event, and there will be no flooding for this event. Therefore, the adopted attenuation storage will provide full storage for the surface runoff generated from the design event of 1 in 100 year plus 40% climate change event.

Table 7 – Summary of Model Output (1 in 100 year plus 40% climate change)

Events	Rainfall mm/hr	Max Volume m ³	Discharge Volume M ³	Max Overflow M ³	Flooded Volume M ³
480 min (Winter)	11.62	129.60	162.10	19.70	0.0

The location and layout of the proposed storage and its dimensions (area and depth) can be changed to suit the site conditions. This will be to the client's discretion ensuring that the required attenuation storage volume is provided within the site.

Severn Trent's sewer asset map shows that a Foul Sewer runs along Nutts Lane (**Appendix G**). The controlled outflow from the attenuation storage will be discharged into the Foul Sewer on Nutts Lane using a 150mm linear drainpipe as shown in **Appendix Q**.

Permeable Paving

Permeable paving will be provided on the access drive as shown in **Appendix Q**.

Rain Garden

Small rain gardens will be provided as part of the site landscaping as shown in **Appendix Q**.

8.0 Exceedance Flow Paths

It is inevitable that as a result of heavy or extreme rainfall, the capacities of sewers and other drainage systems will be exceeded on occasion. Drainage exceedance will occur when the rate of surface water runoff exceeds the inlet capacity of the drainage system, when the receiving water or pipe system becomes overloaded, when the outfall becomes restricted due to flood levels in the receiving water, or due to poor maintenance of the SuDS features.

The proposed attenuation storage has been designed for the 1 in 100 year plus 40% climate change event. Any extreme event greater than this design event may lead to the situation where the rate of surface water runoff exceeds the inlet capacity of the drainage system. In such circumstances, the flow routes from the site will naturally follow towards south following the general slope gradient in that direction, as this will be the only open area for the floodwater to flow across the site. The exceedance flow routes are shown in **Appendix S**.

8.1. SuDS Management and Maintenance Plan

The site owners will be fully responsible for regular repair and maintenance of the proposed SuDS measures as required for the lifetime of the development. The SuDS at this site have been designed for easy maintenance to comprise:

Geo-cellular Storage System

Remedial work for repairing damage will be carried out whenever necessary. The repair and maintenance will include regular inspection of silt traps, manholes, pipework and pre-treatment devices, with removal of sediment and debris as required. **Table 8** provides further details on the regular maintenance of the Geo-cellular storage system.

Table 8 Regular Maintenance and remedial measures for Geo-cellular storage system

Regular Maintenance	Actions/Remedial measures
Monthly	- Inspect and identify any areas that are not operating correctly. If required, take remedial action. (for 3 months following installation) - Debris removal from catchment surface (where may cause risks to performance) - Inspect systems as specified by the manufacturer - Where rainfall infiltrates into blocks from above, check surface of filter for blockage by silt, algae or other matter. Remove and replace surface infiltration medium as necessary.
Six monthly	Inspect and identify any areas that are not operating correctly. If required, take remedial action (following initial 3 month period).
Annually	- Remove sediment from pre-treatment structures (e.g. upstream silt- traps or Vortex flow control upstream) and geocellular system where required (High pressure water jetting) - Inspect and document the presence of wildlife.
Following all significant storms	Inspect and carry out essential recovery works to return the feature to full working order.

Flow control structures

Remedial work for repairing any damage to flow control structures/devices will be carried out whenever necessary. **Table 9** provides further details on the regular maintenance of the flow control structures/devices.

Table 9 Regular Maintenance and remedial measures for flow control structures

Regular Maintenance	Actions/Remedial measures
Monthly	Inspect and identify any areas that are not operating correctly. If required, take remedial action (for 3 months following installation).
Six monthly	- Inspect and identify any areas that are not operating correctly. If required, take remedial action. - Remove sediment from pre-treatment structures.
Following all significant storms	Inspect and carry out essential recovery works to return the feature to full working order.

Permeable Paving

The landowners will be fully responsible for regular maintenance of the proposed permeable paving. **Table 10** provides further details on the regular maintenance of the proposed Permeable Paving.

Table 10 Regular Maintenance and remedial measures for permeable paving

Regular Maintenance	Actions/Remedial measures
Monthly	- Refer to manufacturer specifications - For sealed systems, inspection of outfalls should be undertaken.

Six Monthly	Brushing and vacuuming to manufacturer requirements. Re-grit where necessary after brushing.
As Required	- Inspect/check all inlets, outlets, inspection chambers, surface and overflows (where required) to ensure that they are in good condition, free from blockages and operating as designed. Take action where required (for 3 months following installation) - Removal of weeds where required - Stabilizing and mowing of contributing areas where required.
Following all significant storm events	Inspect and carry out essential recovery works to return the feature to full working order

Rain Garden

The landowners will be fully responsible for regular maintenance of the proposed Rain Garden. **Table 11** provides further details on the regular maintenance of the proposed Rain Garden.

Table 11 Regular Maintenance and remedial measures for rainwater garden

Routine Maintenance Task	Frequency
The tree pits should be routinely weeded to prevent the build-up of weeds. It is a good practice to make sure that the maintained tree pit is identified with a band of colour ribbon wrapped around the base of the tree to clearly identify that the tree pit is being maintained. - Litter and debris removal - Mulching (where required) - Inspect/check all inlets, outlets, surface and overflows (where required) to ensure that they are in good condition, free from	Monthly

blockages and operating as designed. Take action where required.	
Remove nuisance and invasive vegetation	6 monthly
• Pruning and trimming of trees • Inspect and document the presence of wildlife • Check for poor vegetation growth due to lack of sunlight or dropping of leaf litter and cut back adjacent vegetation where required.	Annually
• Repair erosion or other damage by re-mulching or re-seeding • Re-seed areas of poor vegetation growth. Alter plant types to better suit conditions, if required • Scarify and spike topsoil layer to improve infiltration performance, break up silt deposits and prevent compaction of the soil surface (typically every 60-month period) • Remove build-up of sediment, reinstate design levels (typically every 60 month period) • Remove and dispose of oils or petrol residues using safe standard practices	As required
Carry out cleaning/maintenance work carefully to ensure that plants are not damaged.	As required
Only hand tools (e.g. a trowel) should be used within the tree pit to avoid damaging tree roots.	As required
Do not raise the soil level around the tree stem which can lead to the death of the tree.	As required
Water the plant/tree especially during the time of prolonged heat or drought.	As required
The soil level around a tree should not be changed from the soil level at which it was planted. Adding soil can smother roots and rot a tree's trunk. Digging soil out can damage shallow roots.	As required
Avoid planting woody perennials which will compete with the tree for water and may impede tree inspections.	As required
Keep garbage and de-icing salt out of the tree pit.	As required

9.0 Conclusion

The proposal consists of a residential development with the erection of 9 no. residential dwellings at the land to the rear of Cornfields, Nutts Lane, Hinckley LE10 3EG.

The overall risk of surface water flooding to the site is low.

The surface runoff will be improved by implementing appropriate SuDS measures.

The British Geological Survey's Infiltration SuDS Report for the site indicated that there was a very significant potential for one or more hazards associated with infiltration. The report shows that the site is located within an area that might have ground instability problems and increased infiltration may result in ground instability problem. In addition, the report finds that the site is located in an area with very high likelihood of persistent or seasonally shallow groundwater. Also, an inspection of the British Geological Survey's geological maps show that the bedrock of the site comprises Mercia Mudstone Group – Mudstone with superficial deposits of Alluvium - Clay, Silt, Sand and Gravel. On this basis it is considered that soakaways are not a viable option. In order to discharge surface water flows to a watercourse would require crossing significant third-party land, therefore it is proposed that flows generated from the site will discharge into the existing public sewer (i.e. Foul Sewer) located on Nutts Lane.

The proposed SuDS drainage scheme will therefore include an underground Geocellular attenuation storage with the controlled outflow discharge by using a Hydrobrake. The size of the proposed attenuation storage is as follows: Length = 28m, Width = 5m, Depth = 0.75m. The maximum flow control of 1 litre per second has been adopted for all events up to and including 1% AEP + 40%CC with no flooding.

Severn Trent's sewer asset map shows that a Foul Sewer runs along Nutts Lane. The controlled outflow from the attenuation storage will be discharged into the Foul Sewer on Nutts Lane using a 150mm linear drainpipe with the controlled discharge rate not more than 1 litre/sec.

In addition, a permeable paving on access drive and rain gardens will be implemented in order to further improve the surface runoff from the site.

The landowners will be fully responsible for the repair and management of the implemented SuDS throughout the lifetime of the proposed development.

Appendix A Site Location Maps

Appendix B Geological Map

Appendix C Land Cover and Topographic Map

Appendix D Ground Water Vulnerability Map

Appendix E Existing Site and Proposed Plans

Appendix F Environment Agency's Surface Water Flood Risk Maps

Appendix G Existing Drainage & Sewer Assets Map

Appendix H Greenfield Runoff Rates

Appendix I Rainfall Runoff Modelling Summary (1 in 1 Year event)

Appendix J Rainfall Runoff Modelling

Summary (1 in 2 Year event)

Appendix K Rainfall Runoff Modelling Summary (1 in 5 Year event)

Appendix L Rainfall Runoff Modelling Summary (1 in 10 Year event)

Appendix M Rainfall Runoff Modelling Summary (1 in 30 Year event)

Appendix N Rainfall Runoff Modelling Summary (1 in 50 Year event)

Appendix O Rainfall Runoff Modelling Summary (1 in 100 Year event)

Appendix P Infiltration SuDS Report

Appendix Q Proposed Surface Runoff Improvement Measures (SuDS)

Appendix R Attenuation Storage Modelling Output Summary (1 in 100 Year plus 40% Climate Change event)

Appendix S Exceedance Flow Routes