



WORKHOUSE LANE, BURBAGE

FLOOD RISK ASSESSMENT





WORKHOUSE LANE, BURBAGE

FLOOD RISK ASSESSMENT

REPORT (RV0) CONFIDENTIAL

PROJECT NO. 70060615

OUR REF. NO. RP-CV-0500

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EXECUTIVE SUMMARY

This Flood Risk Assessment has been undertaken to accompany the outline planning application for the proposed development at Workhouse Lane, Burbage largely in accordance with the guidelines set out in the National Planning Policy Framework (NPPF) published in February 2019, along with other relevant local and national guidance including CIRIA C624 Development and Flood Risk.

Item	Overview
Site Location	The site is located south of Burbage, Hinckley, Leicestershire. OS Co-ordinates: 444214, 291819
Development Proposals	A residential development is proposed of up to 40 dwellings with associated public open space and infrastructure.
Environment Agency Flood Zone(s)	The site is located wholly within Flood Zone 1, in accordance with the publicly available Flood Map for Planning.
Vulnerability Classification(s)	More Vulnerable
Fluvial Flood Risk	Low
Tidal Flood Risk	Very Low
Surface Water Flood Risk	Low
Groundwater Flood Risk	Medium
Sewer Flood Risk	Low
Artificial Flood Risk	Low
Storm Drainage	It is proposed to utilise sustainable drainage systems (SuDS) to manage surface water run-off from the proposed development site in line with current best practice recommendations. It is proposed to attenuate surface water run-off to the site-specific QBar greenfield rate for all events up to and including the 100 year plus climate change event.
Foul Drainage	A sewer requisition is proposed to discharge proposed foul water flows into the Severn Trent Water sewer network surrounding the proposed development site. A pumped solution is proposed to ensure a connection can be made.

1. INTRODUCTION

1.1. BACKGROUND

- 1.1.1. WSP has been appointed by Central Midlands Estates Ltd to prepare a Flood Risk Assessment (FRA) and Drainage Strategy to support the outline planning application at the Workhouse Lane, Burbage, (approximate Post Code: LE10 3AS).
- 1.1.2. The objective of the study is to demonstrate that the site may be developed safely, without exposing the development to an unacceptable degree of flood risk or increasing the flood risk to third parties. The objectives are to:
- Identify sources of potential flooding which may affect the site;
 - Undertake an appraisal of the flood risk posed to the site and potential impact of the development on flood risk elsewhere; and,
 - Provide a sustainable surface water drainage strategy for the proposed development.

1.2. LIMITATIONS

- 1.2.1. WSP has prepared this report in accordance with the instructions of their client, Central Midlands Estates Ltd, for their sole and specific use. Any person who uses any information contained herein do so at their own risk. © WSP UK Ltd 2020.
- 1.2.2. The conclusions and recommendations contained herein are limited by the availability of background information and the planned use for the site.
- 1.2.3. Third party information has been used in the preparation of this report, which WSP UK Ltd, by necessity assumes is correct at the time of writing. Whilst all reasonable checks have been made on data sources and the accuracy of the data, WSP UK Ltd accepts no liability for same.

1.3. CONSTRUCTION (DESIGN AND MANAGEMENT) REGULATIONS 2015

- 1.3.1. The revised Construction (Design and Management) Regulations 2015 (CDM Regulations) came into force on April 2015 to update certain duties on all parties involved in a construction project, including those promoting the development. One of the designer's responsibilities under clause 9 (1) is to ensure that the client organisation, in this instance Central Midlands Estates Ltd, is made aware of their duties under the CDM Regulations.

1.4. SCOPE OF ASSESSMENT

- 1.4.1. The assessment has been undertaken largely in accordance with the overarching national requirements for Flood Risk Assessments for proposed developments including, but not limited to, the following:
- National Planning Policy Framework (NPPF)
 - Development and Flood Risk (C624)
 - The SuDS Manual (CIRIA C753)
 - Flood Risk Assessments: Climate Change Allowances 2016
 - DEFRA R&D Technical Report W5-074/A/TR/1 Revision D

- Rainfall Runoff Management for Developments Report – SC030219

1.4.2. The flood risk assessment is solely to be used to support the outline planning application for the proposed residential development at Workhouse Lane, Burbage.

1.5. CONSULTATION

1.5.1. Ahead of production of this report, initial pre-application consultation requests were issued to the relevant stakeholders with the following responses received.

Table 1 - Stakeholder Consultation Summary

Stakeholder	Date Received	Comments
Leicestershire County Council Lead Local Flood Authority (LLFA)	14.08.2019	A number of incidents of flooding were identified within 1km of the site from various sources and identified a need for a masterplanning approach to surface water drainage on the proposed development site, as generally required by the LLFA.
Environment Agency (EA)	14.08.2019	Product 4 information was received from the Environment Agency which confirmed that they hold no historic flood records for the site
Severn Trent Water	NA	Severn Trent Water were contacted in relation to historic flood records within the vicinity of the site in August 2019. At the time of writing, no response has been received.

1.5.2. The full consultation responses are contained in Appendix C and have been thereafter used, where relevant, within the report.

2. SITE SETTING

2.1. LOCATION

- 2.1.1. The site is located south of Burbage, Hinckley, Leicestershire (approximate postcode LE10 3AS).
- 2.1.2. The site is bound to the south and west by agricultural land and to the north and east by existing residential development.
- 2.1.3. The site location plan is shown in Figure 1 and is also included in Appendix A.

Figure 1 – Site Location



Key

- Approximate Site Boundary

2.2. DEVELOPMENT PROPOSALS

- 2.2.1. A residential-led development is proposed of up to 40 dwellings with associated public open space and infrastructure.
- 2.2.2. A proposed masterplan is available in Appendix A.

2.3. TOPOGRAPHY

- 2.3.1. A detailed topographic survey was undertaken by NJC Surveys Ltd dated November 2018. The survey identifies that the site generally slopes from north-east to south-west from a level of 117.95mAOD in the north-eastern corner to 108.95mAOD in the south-western corner.
- 2.3.2. A copy of the topographic survey is contained within Appendix A.

2.4. EXISTING DRAINAGE NETWORK

- 2.4.1. From a review of the topographic survey and also identified on Ordnance Survey mapping, a spring emerges in the south-western corner of the site. This follows the field boundary south of the site where it joins a watercourse before flowing in an existing culvert under the M69. An image of the existing spring emerging on site is available in Figure 2.

Figure 2 – Spring Emerging on Site



- 2.4.2. Further to this, there are two attenuation basins located north of the site which are understood to serve the existing, adjacent residential development. The western attenuation basin discharge is managed via pumping station, which pumps the surface water at a controlled rate off-site. The eastern basin has no known formal outfall and is therefore expected to free-discharge into the site once overtopped, an image of this basin is contained in Figure 3.

Figure 3 – Existing Eastern Attenuation Basin



- 2.4.3. In addition, an existing 300mm Severn Trent Water combined rising main bisects the site, which has a 5m easement associated with it. The Severn Trent Water sewer maps are available within Appendix C.

2.5. GEOLOGICAL AND HYDROGEOLOGICAL CONTEXT

Geology

- 2.5.1. Reference to the British Geological Survey (BGS) published mapping identifies the site to be underlain by bedrock of Mercia Mudstone, with overlying superficial deposits of Wolston Sand & Gravel crossing through the centre of the site from north-east to south west. In addition, Alluvium is identified south-west of the site and appear to follow the line of the spring which emerges within the site boundary. An extract of the BGS map is shown in Figure 4.

Figure 4 – BGS Map Extract



- 2.5.2. There are no boreholes registered within the site boundary. The closest borehole where records are publicly available is found located within 250m of the site boundary, south of the site and has a maximum depth of 5.5m, its profile is provided in Table 2.

Table 2 - BGS Borehole Summary

Description	Approximate Depth [mBGL]
Topsoil	0.00 – 0.30
Firm Brown Silty Sandy Clay	0.30 – 2.35
Brown Silty Sand and Gravel	2.35 – 3.40
Stiff Brown Boulder Clay with traces of Chalk and Marl.	3.40 – 5.50

- 2.5.3. Furthermore, a ground investigation was undertaken by WSP in November 2019 in which five windowless borehole samples were installed and four trial pits were excavated. This identified the strata as indicated in Table 3. The locations of these boreholes are shown on a plan which is available in Appendix A.

Table 3 – Summary of On-Site Strata Encountered

Stratum Name	Depth to Base of Strata (mBGL)*	Elevation of Base of Strata (mAOD)*	Thickness (m)*
Made Ground	0.60 to 0.60	112.67 to 112.67	0.40 to 0.40
Topsoil	0.30 to 0.80	115.02 to 109.99	0.30 to 0.55
Alluvium	0.60 to 1.80	114.72 to 108.99	0.30 to 1.40
Oadby Member	2.00 to 4.10	112.60 to 106.19	1.20 to 2.80
Wolston Sand and Gravel	3.45 to 3.45 (5.00)	108.81 to 108.81	2.90 to 2.90 (3.20)
Mercia Mudstone Group	Not proven (5.00)	Not proven (105.29)	Not proven (1.55)

* Brackets indicate maximum unproven depth and thickness and the minimum elevation

Hydrogeology

- 2.5.4. According to the Source Protection Zone map provided by the Environment Agency, the site does not lie within any Source Protection Zone.
- 2.5.5. The online BGS Aquifer Map (Superficial Deposits Designation) indicates that the site is underlined by a 'Secondary Undifferentiated' aquifer. That is: *"has been assigned in cases where it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type."*
- 2.5.6. The online BGS Aquifer Map (Bedrock Designation) indicates that the site comprises stratum that is considered a 'Secondary B' aquifer. That is *"predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering. These are generally the water-bearing parts of the former non-aquifers."*
- 2.5.7. Ground conditions therefore demonstrate that the site may be unsuitable for infiltration, given the cohesive nature of the underlying geology.

3. POLICY CONTEXT

3.1. NATIONAL PLANNING POLICY FRAMEWORK 2019

- 3.1.1. The Updated National Planning Policy Framework (NPPF) was published in February 2019 and sets out the Government's national policies for flood risk management in a land use planning context within England.
- 3.1.2. Paragraph 155 of the NPPF states *"Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk (whether existing or future). Where development is necessary in such areas, the development should be made safe for its lifetime without increasing flood risk elsewhere."*
- 3.1.3. The guidance further states that local planning authorities should *"ensure that flood risk is not increased elsewhere. Where appropriate, applications should be supported by a site-specific flood-risk assessment."*
- 3.1.4. Allocation and planning of development must therefore be considered against a risk-based search sequence as provided by the guidance.

3.2. LOCAL PLANNING POLICY

Local Flood Risk Management Strategy

- 3.2.1. The Local Flood Risk Management Strategy (LFRMS) published in August 2015, by Leicestershire County Council in their role of Lead Local Flood Authority (LLFA) for the area, sets out a number of objectives for managing local flood risk. This includes enhancing the natural and historical environment, where the Leicestershire County Council states it actively encourages the de-culverting and naturalisation of watercourses.
- 3.2.2. Other objectives include promotion of engaging with other Risk Management Authorities, improving understanding and awareness, improving resilience, encouraging sustainable development, using resources effectively and promoting riparian responsibilities.
- 3.2.3. Leicestershire County Council will *"encourage development to actively reduce run-off rates, volume and flood risk"* and the Local Planning Authorities should consider this as part of the planning application.
- 3.2.4. To comply with the LFRMS, the proposed development aims to reduce surface water run-off rates from the proposed development and therefore reduce flood risk.

Preliminary Flood Risk Assessment

- 3.2.5. URS-Scott Wilson was commissioned to produce a Preliminary Flood Risk Assessment (PFRA) for Leicestershire County Council, which was published in June 2011.
- 3.2.6. It states that Leicestershire County Council supports the Local Planning Authorities to ensure flood risk management is given proper consideration through the planning process.
- 3.2.7. The PFRA confirms that there have been no significant flood events within the vicinity of the site. It also outlines that few historic flood events in Leicestershire have been considered to have had *"significant harmful consequences"*. However, they cite that this may be due to insufficient documentation of historic flood information. Leicestershire County Council as the Lead Local Flood

Authority, Severn Trent Water and the Environment Agency have subsequently been consulted for historic flood record they hold.

- 3.2.8. Leicestershire County Council hold a number of flooding records in the vicinity of the site, however no recorded incidents within the site. Environment Agency confirm that they hold no records of flooding at the site and Severn Trent Water did not provide a consultation response.

Strategic Flood Risk Assessment (SFRA)

- 3.2.1. JBA Consulting produced an SFRA on behalf of Hinckley and Bosworth Borough Council in July 2019, which included Burbage in its study area.
- 3.2.2. The SFRA identifies that the Battle Brook, Harrow Brook and Sketchley Brook pose a fluvial flood risk in Hinckley and Burbage, these watercourses are not within close proximity to the proposed development site.
- 3.2.3. The available SFRA mapping, the site is contained within Appendix E3 of the SFRA, does not identify any sources of flood risk to the proposed development and no specific sites were reviewed through this SFRA.
- 3.2.4. As such, this site-specific FRA will review flood risk from all know sources to the proposed development.

4. ASSESSMENT OF FLOOD RISK

4.1. OVERVIEW

- 4.1.1. Having completed a site walkover and desk-based assessment, the possible flooding mechanisms at the site are summarised below:

Table 4 - Flood Risk Overview

Mechanism	Risk	Comment
Fluvial	Low	The site is located wholly within Flood Zone 1, as shown in the publicly available Flood Map for Planning. Where the spring emerges within the site, no development is proposed within the vicinity of the spring.
Tidal	Very Low	The site is located in land.
Surface Water	Low	There are two surface water flow paths identified crossing the site. Proposed mitigation measures, such as a cut off ditch along the northern boundary of the site, are proposed to manage surface water flows.
Groundwater	Medium - Low	High groundwater levels have been identified across the site. Given this, mitigation measures may be put in place to minimise the risk to the proposed development.
Sewers	Low	Whilst a foul water rising main runs through the site, there have been no reported incidents of flooding relating to this.
Artificial Sources	Low	There are no artificial sources of flood risk within close proximity to the site.

4.2. HISTORIC FLOODING

- 4.2.1. Leicestershire County Council as the LLFA identified the following historic incidents of flood risk within the vicinity of the site:
- Groundwater encountered whilst construction was taking place. Temporary de-watering works carried out. – Lutterworth Road, Burbage (0.15km Southeast) – January 2018.
 - External property flooding and highway flooding due to unknow issues within the existing drainage system. – Britannia Road, Burbage (0.4km North) – July 2013.
 - External property flooding from highway – Coventry Road, Burbage (0.6km North).

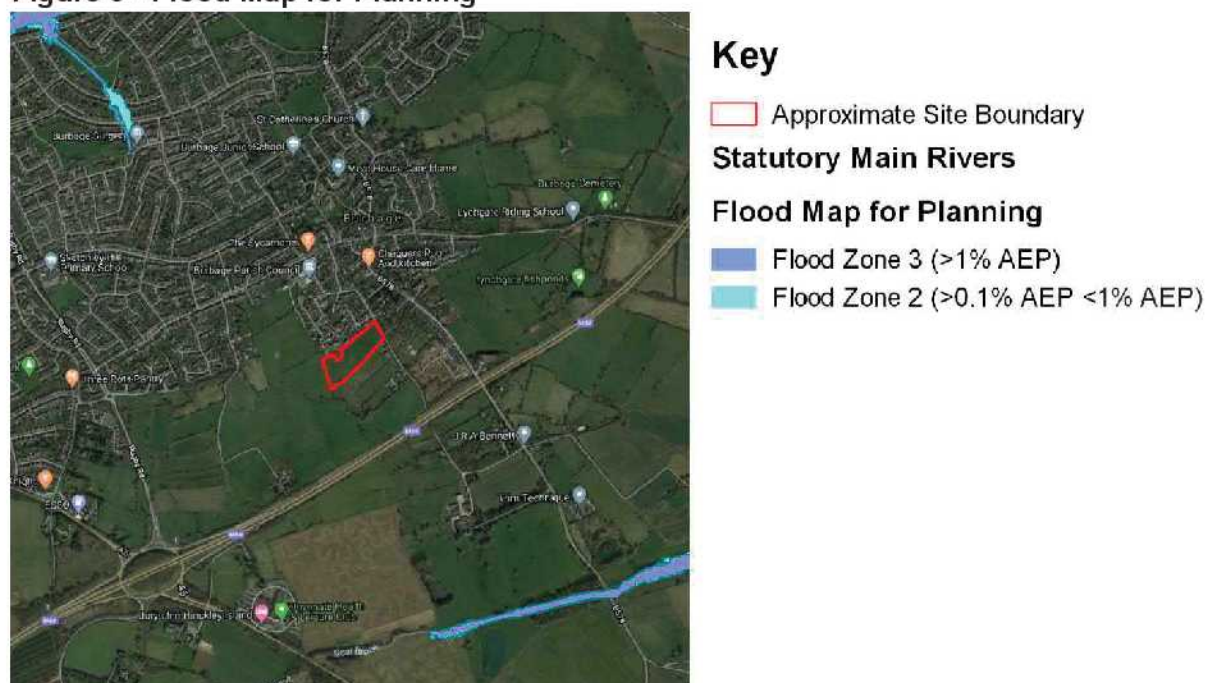
- 4.2.2. The Environment Agency confirmed that they have no historic incidents of flooding for the proposed development site.

4.3. FLUVIAL FLOOD RISK

- 4.3.1. Reference to the publicly available Flood Map for Planning identifies the site to currently lie wholly within Flood Zone 1, outside of both the 1 in 100 and 1 in 1,000 year flood events of any nearby Main Rivers.

- 4.3.2. The Flood Map for Planning is reprinted as Figure 5.

Figure 5 - Flood Map for Planning



Vulnerability Classification

- 4.3.3. The development is classified as 'More Vulnerable' under the NPPF which is defined as follows:

"More Vulnerable

- 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."

- 4.3.4. Given the sites location within Flood Zone 1, in accordance with current national guidance, the site is not required to undertake the Sequential and Exception Tests and is considered to be in an appropriate location for development.

- 4.3.5. A spring is identified as emerging in the south-west of the site, a sequential approach to masterplanning has been undertaken with no development proposed within the vicinity of the spring.

- 4.3.6. As such, the flood risk from fluvial sources to the site is considered low.

Identified Fluvial Flood Risk: Low

4.4. TIDAL FLOOD RISK

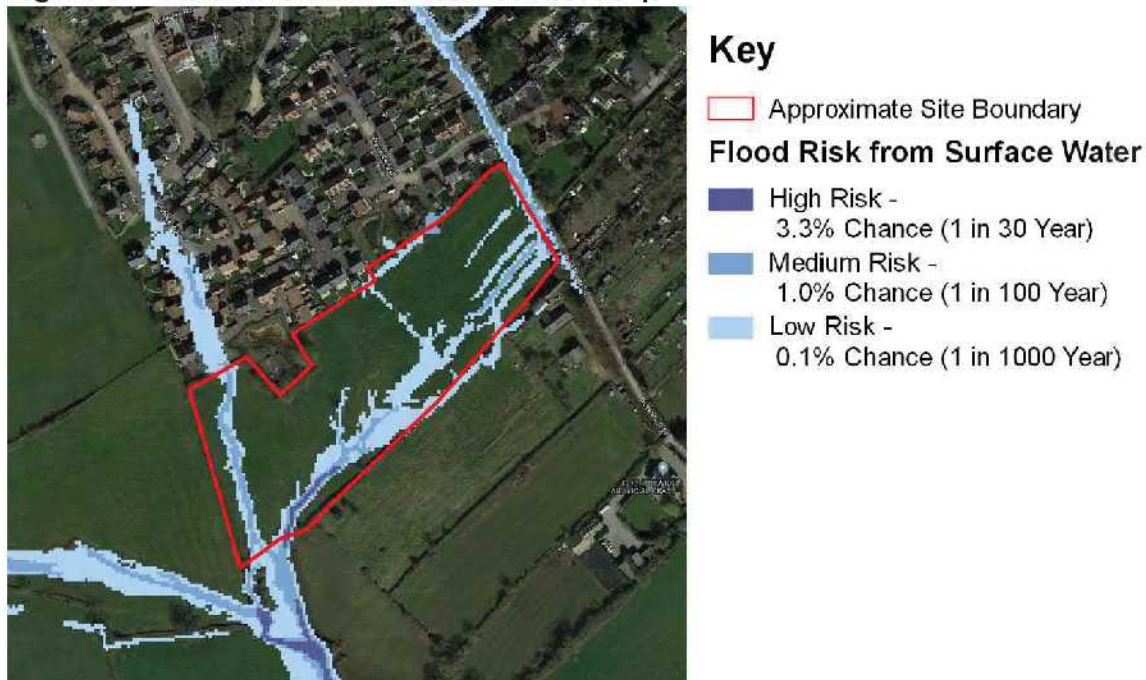
- 4.4.1. Due to its inland location, tidal flooding is not considered a risk to this site.

Identified Tidal Flood Risk: Very Low

4.5. SURFACE WATER FLOOD RISK

- 4.5.1. The 'Long Term Flood Risk Information,' in particular relating to the 'Flood Risk from Surface Water,' as published by the Environment Agency, was reviewed and identifies two surface water flow paths through the site as shown in Figure 6.
- 4.5.2. The Flood Risk from Surface Water map is reprinted as Figure 6.

Figure 6 – Flood Risk from Surface Water Map



- 4.5.3. The production of this mapping has been undertaken at a national scale to provide the first publicly available generation of surface water flood risk mapping. The two previous generations were primarily developed for regulator use as the approach and risk was refined. For example, the first did not include any allowance for sewers, whilst the second incorporated a national loss coefficient.
- 4.5.4. Although this generation incorporates local estimates of the sewer infiltration loss, generally at a LLFA level along with various other refinements in runoff estimation, it does not allow for local improvements to the underlying Digital Terrain Model (DTM). This means that local features such as the adjoining highways are represented as determined from the LiDAR without any consideration to drainage features such as culverts or small watercourses which typically provide the associated surface water drainage.
- 4.5.5. A surface water flow path emerges from the existing residential development north of the site. This development is managed by an existing attenuation basin which may not be accounted for within the existing surface water flood mapping. Furthermore, as part of the site proposals, a cut off ditch is proposed along the northern border of the site which will intercept surface water flows arising from this development.

- 4.5.6. An additional surface water flow path is identified emerging from the highway east of the site and flows from east to west through the site boundary. No development is proposed where the flow route is identified as 'High Risk' in the west of the site. Furthermore, the surface water mapping may not represent the associated highway drainage present in Workhouse Lane which will manage surface water flows before they enter the site.
- 4.5.7. As part of the final site design, to ensure that there is no increase to the flood risk to the development or third-party land, appropriate measures will be implemented in accordance with best practice guidance to ensure any surface water is directed away from the existing and proposed properties.
- 4.5.8. Given the proposed mitigation measures, including cut off ditches, and the coarse nature of the available mapping, the flood risk to the proposed development from surface water is considered low.

Identified Surface Water Flood Risk: Low

4.6. GROUND WATER FLOOD RISK

- 4.6.1. Whilst the Strategic Flood Risk Assessment and nearest BGS borehole indicate that the site is at low risk from groundwater flooding, the emergence of a spring on site presents evidence of high groundwater.
- 4.6.2. Given this, ground investigation works were undertaken by WSP in November 2019 whereby a number of boreholes were excavated across the site. Groundwater monitors were installed and examined over a 3-week period. A summary of the groundwater levels identified is contained in Table 5, the locations of each trial pit and borehole excavated on site is available within Appendix A.

Table 5 – Groundwater Monitoring Results

Location	Ground Level (m AOD)	Visit One (21/11/2019)				Visit Two (13/12/2019)			
		Depth to Water		Depth to Base		Depth to Water		Depth to Base	
		m bgl	m AOD	m bgl	m AOD	m bgl	m AOD	m bgl	m AOD
WS01	110.29	0.250	110.04	-	-	0.050	110.24	4.94	105.35
WS02	112.26	0.620	111.64	-	-	0.380	111.88	4.43	107.83
WS03	111.55	0.470	111.08	-	-	0.455	111.10	3.9	107.65
WS04	115.20	0.920	114.28	-	-	0.795	114.40	4.59	110.61
WS05	115.29	0.580	114.71	-	-	0.400	114.89	4.24	111.05

- 4.6.3. It should be noted that groundwater monitoring was undertaken 3 weeks apart in winter and therefore is not representative of the annual worst-case ground levels or provide an indication of the long-term hydrogeologic regime of the site.
- 4.6.4. The results indicate shallow groundwater is present across the site, particularly the west of the site where the spring emerges. Given this, no development is proposed in the west of the site where the peak groundwater levels were identified.
- 4.6.5. Significant earthworks may be required to lift levels on site to minimise the risk to the proposed development to groundwater flooding.

- 4.6.6. Furthermore, it would be expected that proposed surface water drainage features would be fully lined to help prevent groundwater ingress on site and that further groundwater monitoring may be required to gain a better understanding of seasonal groundwater variations across the site.
- 4.6.7. Given the above, groundwater flood risk to the proposed development site is considered medium.

Identified Groundwater Flood Risk: Medium

4.7. SEWER FLOOD RISK

- 4.7.1. Sewer flooding occurs as a result of a number of influencing factors. It is most likely to occur during storms, when large volumes of rainwater enter the sewers. However, it can also occur when pipes become blocked or damaged.
- 4.7.2. Existing sewerage systems are present on land surrounding the site, by way of existing highway and adopted public sewers serving built development.
- 4.7.3. A Severn Trent Water combined 300mm water rising main is present bisecting the proposed development site which has a 5m associated easement.
- 4.7.4. Severn Trent Water were consulted in August 2019 with regards to historic flood risk records however, at the time of writing no response has been received.
- 4.7.5. Leicestershire County Council as the LLFA identified one incident of external property flooding 400m from the site associated with an unknown issue with the drainage system. Drainage systems should be maintained by the operator and owner of the drainage system, which should help prevent flooding from this source.
- 4.7.6. Given the above, the flood risk from sewers to the proposed development site is considered low.

Identified Sewer Flood Risk: Low

4.8. ARTIFICIAL SOURCE FLOOD RISK

Reservoirs

- 4.8.1. The publicly available Flood Risk from Reservoir Flooding Map shows that the site lies outside of the zone of influence for the nearby reservoirs.
- 4.8.2. The nearest reservoirs are identified 4.2km west of the site near Shelford. The reservoir mapping indicates that in the event of failure, water from these would be directed away from Burbage along the River Anker.
- 4.8.3. As such, flood risk from reservoirs is considered low.

Identified Flood Risk from Reservoirs: Low

Canals

- 4.8.4. Canal flooding is generally rare and the canal network is designed in such a way so as to direct all additional water beyond the navigation capacity to impounding areas or surrounding watercourses to be conveyed downstream. The risk from canal flooding becomes more of a concern where the structure is elevated on an earth embankment and if there is a rare instance of a catastrophic breach,

leading to a sudden drain-down of the pound and resultant overland flow flood risk to development immediately downstream.

- 4.8.5. The Ashby de la Zouch Canal is located approximately 2.8km west of the site and as such, canal flooding is not considered a risk to the proposed development.

Identified Flood Risk from Canals: Low

4.9. DEVELOPMENT EXCEEDANCE FLOWS

- 4.9.1. Careful regard has to be made in respect of potential exceedance flows, being events that are more extreme than current design criteria. Various national guidance has been published on the matter of exceedance flows and measures that should be incorporated into a development to ensure the safety of occupiers and those using the infrastructure.
- 4.9.2. Published guidance in the form of Sewers for Adoption 7th Edition and the Environment Agency document "*Improving the Flood Performance of New Buildings: Flood Resilient Construction*" advocate the design of developments that implement infrastructure routes that will safely convey flood waters resulting from sewer flooding or overland flows away from buildings and along defined corridors.
- 4.9.3. The principal aim is to direct exceedance flows away from properties and along defined corridors. At a local level, this may mean water being conveyed along a length of highway, as long as the predicted flow depths and velocities are acceptable. More strategically, the implementation of conveyance corridors are important in avoiding deep and high velocity flows that present a high risk.
- 4.9.4. At the property level, this includes measures such as ensuring finished floor levels are elevated 150mm above adjacent external ground levels. Or where this is not possible, such as the need to provide flush entrances, ground levels should fall away from any entrances to ensure surface water exceedance is not directed towards properties.
- 4.9.5. Whilst many of the measures for dealing with exceedance flows must be dealt with at detailed design stage, the strategic layout for the site provides a framework that can effectively deal with any future exceedance flows. An indicative exceedance flow route plan is contained within Appendix A, which is subject to detailed levels design and earthworks on site.
- 4.9.6. Furthermore, a cut-off ditch is proposed which will manage exceedance routes arising from the existing residential development, north of the proposed development site.
- 4.9.7. Given the baseline site characteristics and further mitigation measures to be implemented, the risk of flooding from exceedance flows is considered low.

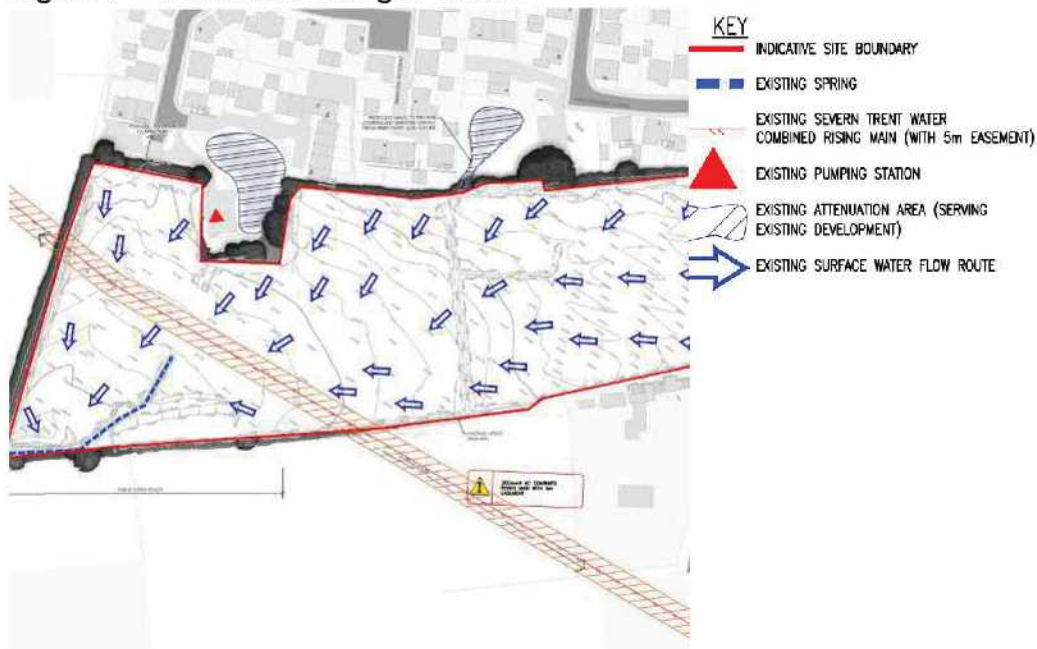
Identified Flood Risk from Exceedance Flows: Low

5. SURFACE WATER DRAINAGE

5.1. EXISTING SURFACE WATER DRAINAGE REGIME

- 5.1.1. Existing surface water flows on site fall from north-east to south-west with the existing topography of the site. There are no existing formal surface water sewers within the site boundary, a 300mm diameter Severn Trent Water combined water rising main bisects the site.
- 5.1.2. There are two existing attenuation features north of the site which serve the existing residential development, one of which has an associated pumping station.
- 5.1.3. The baseline drainage features described above are shown indicatively in Figure 7 and drawing WHL-WSP-XX-XX-SK-CV-0500 contained in Appendix A.

Figure 7 – Baseline Drainage Features




5.2. DRAINAGE STRATEGY

Discharge Location

- 5.2.1. In order to determine the most appropriate receptor for storm water discharges from the proposed development, PPG guidance provides the following order of priority, supported by the Environment Agency and Leicestershire County Council.

Table 6 - SuDS Drainage Hierarchy

	Discharge Location	Availability	Comments
<div style="display: flex; align-items: center;"> <div style="writing-mode: vertical-rl; transform: rotate(180deg);">Search Sequence</div> <div style="margin-left: 10px;">  </div> </div>	Re-Use	x	Space for future re-use may be further considered at a later design stage but based on the current size and scale of the development has not been proposed.
	Infiltration	x	Given the underlying mudstone geology and high groundwater levels, infiltration has not been proposed.
	Watercourse	✓	Surface water is proposed to discharge to the proposed spring which emerges on site, forming a watercourse.
	Surface Water Sewer	✓	There is a Severn Trent Water surface water sewer north-east of the site in Workhouse Lane, should the need arise.
	Combined Sewer	x	There are no public combined water sewers within the vicinity of the proposed development site.
	Foul Sewer	x	There are no public foul water sewers within the vicinity of the proposed development site.

5.2.2. In accordance with the above search sequence, it is proposed to discharge surface water flows to the existing spring which emerges on site, forming a watercourse.

5.2.3. Severn Trent Water surface water sewers are present north-east of the site in Workhouse Lane, should the need for a connection arise.

SuDS Proposals

5.2.4. Current guidance requires that all new developments implement Sustainable Drainage Systems (SuDS) as the primary means of controlling surface water run-off in order to maintain flow rates and volumes discharged to the identified receptor post development.

5.2.5. In addition to the water control benefits, The SuDS Manual (CIRIA C753) states that *“SuDS can treat and clean surface water runoff from urban areas so that the receiving environment is protected, while at the same time conveying, storing and infiltrating surface water to protect flood risk, river morphology and water resources, and delivering amenity and biodiversity value for the development.”*

5.2.6. At the proposed site, a surface water drainage strategy has been prepared in conjunction with the masterplan development thus making space for multi-function SuDS within the site boundary. Table 7 provides a summary of the SuDS selection process and confirms the features that are proposed as part of the site drainage strategy.

Table 7 - Summary of SuDS Selection

Feature	Description	Selection
Green Roofs	Green roofs are systems which cover a building's roof with vegetation. They are laid over a drainage layer, with other layers providing protection, waterproofing and insulation.	✖ Given the residential nature of this development, green roofs have not been proposed.
Filter Strips	These are wide, gently sloping areas of grass or other dense vegetation that treat runoff from adjacent impermeable areas.	✓ / ✖ The use of filter strips has not been proposed at this design stage however, this may be reviewed at a later design stage.
Pervious Surfaces	Pervious surfaces allow rainwater to infiltrate through the surface into an underlying storage layer, where water is stored before infiltration to the ground, reuse, or release to surface water.	✓ / ✖ Whilst permeable paving has not been proposed at this design stage, it could be proposed within private driveway areas at a later design stage.
Bio-retention / raingardens	Bioretention systems are areas of vegetation into which rainwater and runoff can be directed. These are particularly affected at providing water quality improvements.	✓ / ✖ Rain gardens and bioretention has not been proposed at this design stage but could be incorporated at a later design stage.
Swales	Swales are broad, shallow channels covered by grass or other suitable vegetation. They are designed to convey and/or store runoff and can infiltrate the water into the ground (if ground conditions allow).	✓ A conveyance swale has been proposed to carry flows from the proposed attenuation basin to the proposed outfall.
Infiltration Basins	Infiltration basins are depressions in the surface that are designed to store runoff and infiltrate the water to the ground. They may also be landscaped to provide aesthetic and amenity value.	✖ Infiltration is not proposed on this site given the high groundwater levels and underlying site geology.
Wet Ponds	Wet ponds are basins that have a permanent pool of water for water quality treatment. They provide temporary storage for additional storm runoff above the permanent water level. Wet ponds may provide amenity and wildlife benefits.	✓ An attenuation basin is proposed on site. Given this, the exact wet-dry nature of this feature is subject to detailed design.
Detention Basins	Detention basins are normally dry, though they may have small permanent pools at the inlet and outlet. They are designed to detain a certain volume of runoff as well as providing water quality treatment.	✓ An attenuation basin is proposed on site. Given this, the exact wet-dry nature of this feature is subject to detailed design.

Greenfield Run-Off

- 5.2.7. National policy dictates that new developments control the peak discharge of storm water from a site to the baseline, undeveloped site conditions. Over very large development areas, the baseline rate of run-off is normally estimated using the FEH methodologies. However, Paragraph 3.1.2 of the Flood Estimation Handbook (FEH) guidance states:
- "The frequency estimation procedures can be used on any catchment, gauged or ungauged, that drains an area of at least 0.5km². The flood estimation procedure can be applied on smaller catchments only where the catchment is gauged and offers simple flood peak or flood event data"*
- 5.2.8. On undeveloped and ungauged catchments of less than 0.5km in area, the accepted methodology is to complete baseline site discharge assessments using the nationally accepted loH124 methodology for small rural catchments in a manner set out by the Environment Agency document SC030219 Rainfall Runoff Management for Developments.
- 5.2.9. This methodology requires that, for catchments of less than 50ha, the loH assessment is completed for a 50ha area with the results linearly interpolated to determine the flow rate value based on the ratio of the development to 50ha.
- 5.2.10. The overall application boundary is below the 50ha threshold, thus the loH124 methodology is therefore the most appropriate for appraising the baseline run-off from the development. The baseline loH run-off rates are shown on Table 8 and contained in Appendix B.

Table 8 - Greenfield Run-Off Rates

Event	50ha (l/s)	1ha (l/s)
1 Year	182.30	3.65
QBar	219.70	4.39
100 Year	564.50	11.29

Development Run-Off & Attenuation

- 5.2.11. As the site is currently undeveloped, the proposals will result in an increase in impermeable area, which will increase the overall rate of water discharging from the site if left un-attenuated.
- 5.2.12. The strategy drawing WHL-WSP-XX-XX-SK-CV-0501 in Appendix A indicates a single site catchment based on the site topography as confirmed in Table 9.

Table 9 - Site Run-Off Assessment

Catchment	Developed Area (ha)	Impermeable Area (ha)	1 in 1 Year Runoff (l/s)	QBar Runoff (l/s)	1 in 100 Year Runoff (l/s)
Total Site	1.37	0.89	5.0	6.0	15.5

- 5.2.13. Where long-term storage is not proposed, in order to mitigate for the increased volume of run-off associated with built development, peak flows in the 1 in 100 year event must be attenuated to the mean annual flow (QBar).

- 5.2.14. Assessments have thereafter been completed to determine the characteristics of the SuDS features required. The Micro Drainage Source Control module has been utilised to provide routing calculations for the 1 in 100 year flood event to identify the size and nature of storage required, ensuring the peak outflows are in line with those identified in Table 9.
- 5.2.15. A summary of the nature of SuDS proposed is contained in Table 10, whilst the surface water drainage strategy is shown on WHL-WSP-XX-XX-SK-CV-0501 in Appendix A and Micro Drainage summary calculations are contained in Appendix B.

Table 10 - Site Attenuation Requirements

Catchment	Proposed Discharge Rate (l/s)	Storage Volume Required in 1 in 100 year + 40% CC Event (m ³)	SuDS Controls
Total Site	6.0	560	Attenuation Basin

- 5.2.16. In accordance with legislative requirements, the detention proposals have also been assessed for the potential effects of climate change. The 1 in 100 year (1% AEP) return events have been modelled for 40% climate change (including peak rainfall intensity). Calculations for the climate change scenarios are also contained in the Appendix B.
- 5.2.17. Climate change assessments show each attenuation feature to perform adequately by retaining the additional flows within the system without overflow or unacceptable consequences.
- 5.2.18. The surface water drainage system will be designed in accordance with Sewers for Adoption (7th Edition) such that the proposed network will not surcharge during the critical 1 in 2 year event and will not flood during the 1 in 30 year event. For the 1 in 100 year return period, the sewer network will be designed so that surface flooding will be contained and conveyed within the highway boundary and directed to the attenuation basin.
- 5.2.19. The 1 in 30 year criterion meets the requirements of BS EN 752 and is also in accordance with Sewers for Adoption 7th Edition. However, the design of the system exceeds the requirements of these documents by accommodating the volumes and flow rates generated by the 1 in 100 year event.
- 5.2.20. The drainage strategy is based upon the site masterplanning details at the time of production. Changes to the site development profile, impermeable areas across the site or other such aspects of the scheme will result in the need to revise the calculations.

Development Creep

- 5.2.21. Over the lifetime of a development, it is possible that the overall impermeable area within the site could increase by as much as 10% through the house buyers undertaking activities such as property extensions and introducing paved gardens.
- 5.2.22. Table 11 shows how this increase in impermeable area relates to the primary catchments within the site.

Table 11 - Development Creep Assessment

Catchment	Impermeable Area (ha)	10% Creep (ha)	Total Impermeable Area (ha)
Total Site	0.89	0.089	0.98

- 5.2.23. Micro Drainage calculations contained in Appendix B confirm that the proposed SuDS system has sufficient capacity to accommodate a 10% increase in impermeable area during the 1 in 100 year +40% event without overflow.
- 5.2.24. In addition to this, during the detailed design phase, the positive impacts of the potential source control measures (permeable paving et al.,) should be further considered.
- 5.2.25. Without the benefit of a detailed plot level masterplan, it is not possible to appraise the function of the individual source control systems down to plot level. Source control measures should be further considered during detailed design and implemented as far as reasonably practicable.
- 5.2.26. As such, the impacts of development creep on the proposed SuDS system are not considered to pose a significant risk to the site.

Climate Change

- 5.2.27. The purpose of the proposed drainage strategy is to ensure that the proposed scheme does not exacerbate any existing flood risks upstream or downstream of the site, in accordance with the principles set out within the NPPF.
- 5.2.28. SuDS will be implemented throughout this development scheme. The conceptual SuDS strategy for the proposed development has been devised using the principles outlined within the current published guidance in the form of the NPPF, PPG and CIRIA amongst others.
- 5.2.29. The impact of climate change is a key factor when determining a drainage strategy. The NPPF and PPG guidance advocate a “development lifespan” approach for dealing with climate change allowances.
- 5.2.30. In light of this and in accordance with local requirements, an increase of 40% in peak rainfall intensity has been used as the allowance for climate change within the proposed drainage design to determine the performance of the drainage system.
- 5.2.31. Climate change assessments show each attenuation feature to perform adequately by retaining the additional flows within the system without overflow or unacceptable consequences. Calculations for the climate change scenarios are also contained in the Appendix B.

SuDS Management Train

- 5.2.32. The SuDS Manual (CIRIA C753) states the SuDS Management Train is a central design concept for SuDS. SuDS should not be thought of as an individual component, but as an interconnected system designed to manage, treat and make best use of surface water, from where it falls as rain to the point at which it is discharged into the receiving environment beyond the boundaries of the site.
- 5.2.33. There are six specific functions provided by SuDS components (rainwater harvesting, pervious surface systems, infiltration systems, conveyance systems, storage systems and treatment systems), which are not independent with one component being able to provide two or more functions.

- 5.2.34. There are many types of SuDS components which means that SuDS can be delivered anywhere, tailored to individual local contexts. Wherever possible, runoff should be managed at source with residual flows then conveyed downstream to further storage or treatment components.
- 5.2.35. Treatment design should implement SuDS components that use a range of treatment processes to reduce contaminant level in runoff to acceptable levels. This can be facilitated by the SuDS management train of a number of components in series that provide a range of treatment processes, delivering gradual improvement in water quality and providing an environmental buffer for accidental spills or unexpected high pollutant loadings from the site
- 5.2.36. The above has been considered in applying SuDS into the proposed development to help provide; prevention in terms of pollution, source control and site controls.
- 5.2.37. The proposed development will utilise an attenuation basin to provide attenuation storage on site. Flows will be limited, via a flow control device (e.g. Hydrobrake) to ensure that maximum peak discharge rates does not exceed 6.0l/s for any event up to and including the 1 in 100 year plus climate change event.

Health and Safety

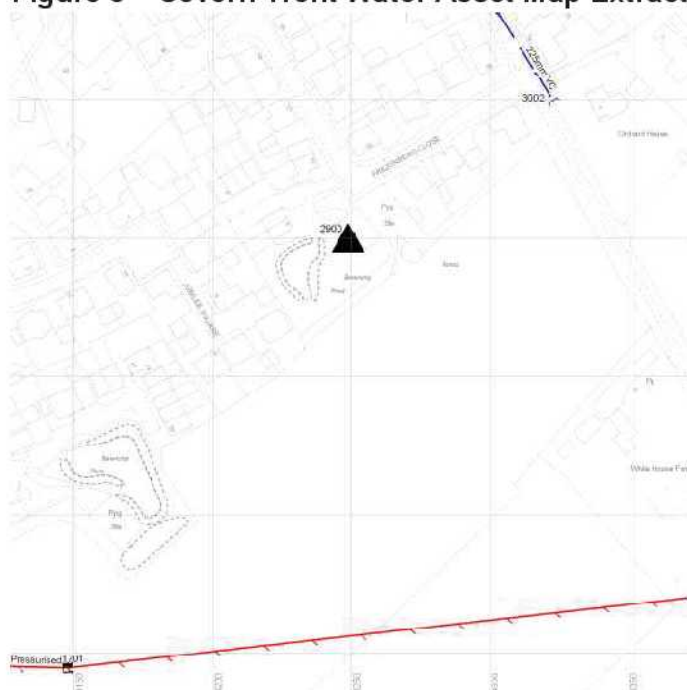
- 5.2.38. The proposed layout of the SuDS features will be designed in accordance with the best practice SuDS guidance documents and national standards, supplemented, where appropriate, with Leicestershire County Council guidance and the requirements of the water company and maintenance company to ensure the features are effective not only in terms of their hydraulic design but also from a safety perspective during construction, operation and maintenance.
- 5.2.39. Detailed health and safety risk assessments should be completed for the individual drainage features proposed as part of the final site design, setting out the risks and incorporating proposals for how these are to be managed.
- 5.2.40. The guidance provided in chapter 36 of The SuDS Manual has been used to ensure that the SuDS design fulfils regulatory and legal requirements, and SuDS health and safety risk assessments are in line with BS EN 31010.

6. FOUL DRAINAGE

6.1. EXISTING FOUL WATER DRAINAGE REGIME

- 6.1.1. Network sewerage plans, as requested from Severn Trent Water are available within Appendix C and an extract is available within Figure 8.

Figure 8 – Severn Trent Water Asset Map Extract



- 6.1.2. This identifies a 300mm combined foul rising main bisecting the site from east to west. There are no other Severn Trent Water foul water assets identified within the vicinity of the site.
- 6.1.3. Given this, the proposed development north of the site has a foul water sewerage system operating and serving the existing residential development as identified on the information to support the proposed Engineering Layout Plan Rev J (Stephen Daykin Consulting Ltd, 23-5-7) available on the public planning portal to support the Discharge of Conditions, associated with 12/00154/FUL for the residential development north of the site.
- 6.1.4. It is unknown whether the existing foul drainage system here has been formally adopted by Severn Trent Water and their existing asset maps have not yet been updated or whether the system here remains unadopted. Should it have been formally adopted, a connection could be made into the wet well of the existing pumping station, identified on site.
- 6.1.5. Given this, the Engineering Layout plan for this development and the associated Topographic Survey (undertaken by NJC Surveys Ltd in November 2011), available on the public planning portal to support 12/00154/FUL, identifies an existing foul water manhole and an associated 300mm diameter foul sewer in Britannia Road, north of the site. This is the proposed outfall location of the existing residential development north of the site and a potential outfall location for

the proposed development. Should the network serving the residential development north of the site remain private a sewer requisition to this manhole could be made.

6.2. PROPOSED FOUL FLOWS

- 6.2.1. Peak design discharges have been calculated based on the current development criteria as described in Section 2 of this report and for the following:
- 40 residential units at 4,000 litres / dwelling / day (peak) = 1.38l/s (peak)
- 6.2.2. Assessed in accordance with Sewers for Adoption requirements, it is anticipated that the planned development will produce a peak flow discharge of approximately 1.38l/s.

6.3. NETWORK CAPACITY AVAILABILITY

- 6.3.1. Severn Trent Water have not been consulted with regards to the proposed development, given the low peak flow foul discharge expected from the site, sewer capacity should be available in the surrounding network.
- 6.3.2. Severn Trent Water should be consulted with regards to whether the foul drainage serving the north of the site has been formally adopted. If this has been adopted, a connection could be made into the pumping station north of the site. Should this remain in private ownership, a sewer requisition for a foul rising main could be made into a manhole north of the site, potentially in Britannia Road.

6.4. IMPLEMENTATION PROPOSALS

- 6.4.1. The proposed pumped drainage network across the site will be designed to current Sewers for Adoption Standards.
- 6.4.2. Following discussions at a later design stage with Severn Trent Water, a connection point north of the site will be confirmed. An indicative foul water drainage strategy, identifying a potential point of connection into the pumping station north of the site is available on WHL-WSP-XX-XX-SK-CV-0503 contained within Appendix A.
- 6.4.3. The proposed foul water drainage, including pumping station should be designed to current Sewers for Adoption standards.

7. OPERATION AND MAINTENANCE

7.1. SURFACE WATER FEATURES

- 7.1.1. The proposed on-site surface water and foul water drainage strategies will be designed to the current version of Sewers for Adoption and will be offered for adoption by Severn Trent Water.
- 7.1.2. With regards to SuDS, in view of the central government decision not to create SuDS Approval Bodies (SAB's) in England, some uncertainty remains regarding by whom and how these features will be adopted and maintained. With the above in mind, it is likely that, should the SuDS be offered to the council for adoption and maintenance, commuted sums will be required for all adoptable SuDS processes.
- 7.1.3. As an alternative, it is becoming increasingly common for SuDS features to be operated and maintained by a third-party private maintenance company. Should this be necessary, a third-party management company would be established to maintain the features in perpetuity. An adoption agreement between the final site developer and Maintenance Company would be based upon the CIRIA ICoP MA2 SuDS Maintenance Framework Agreement.
- 7.1.4. In addition, Sewers for Adoption 8 is coming into force during 2020. This gives the ability for sewerage undertakers to adopt SuDS features under certain conditions such as conveying flows. There may therefore be the potential for SuDS features to be adopted by Severn Trent Water.
- 7.1.5. A typical maintenance schedule of the attenuation and flow control devices proposed on site are shown in tables below.

Table 12 – Indicative Flow Control Maintenance Schedule

Frequency	Action
Monthly	<ul style="list-style-type: none"> Inspect and identify any areas that are not operating correctly. If required, take remedial action (for three months following installation)
Six Monthly	<ul style="list-style-type: none"> Inspect and identify any areas that are not operating correctly. If required, take remedial action. Remove sediment from pre-treatment structures
Annually	<ul style="list-style-type: none"> N/A
Following all significant storm events	<ul style="list-style-type: none"> Inspect and carry out essential recovery works to return the feature to full working order.

Table 13 – Indicative Swale Maintenance Schedule

Frequency	Action
Monthly	<ul style="list-style-type: none"> ▪ Litter and debris removal. ▪ Mow grasses (where required to promote lateral runoff inflow) and remove resultant clippings (during growing season only). ▪ Remove nuisance and invasive vegetation (for 12 months following installation). ▪ Inspect/check all inlets, outlets, surface and overflows (where required) to ensure that they are in good condition, free from blockages and operating as designed. Take action where required.
Six Monthly	<ul style="list-style-type: none"> ▪ Remove nuisance and invasive vegetation.
Annually	<ul style="list-style-type: none"> ▪ Check for poor vegetation growth due to lack of sunlight or dropping of leaf litter, and cut back adjacent vegetation where required. ▪ Re-seed areas of poor vegetation growth. Alter plant types to better suit conditions, where required. ▪ Inspect and document the presence of wildlife.
As-Required	<ul style="list-style-type: none"> ▪ Repair erosion or other damage by re-turfing, reseeding or replacing filter material. ▪ Scarify and spike topsoil layer to improve infiltration performance, break up silt deposits and prevent compaction of the soil surface where required. ▪ (typically every 60 month period). ▪ Remove build-up of sediment on upstream gravel trench, flow spreader or at top of filter strip, where required. ▪ Remove and dispose of oils or petrol residues using safe standard practices.
Following all significant storm events	<ul style="list-style-type: none"> ▪ Inspect and carry out essential recovery works to return the feature to full working order.

Table 14 – Indicative Attenuation Basin Maintenance Schedule

Frequency	Action
Monthly	<ul style="list-style-type: none"> ▪ Litter and debris removal. ▪ Mow grasses (where required to promote lateral runoff inflow) and remove resultant clippings (during growing season only). ▪ Remove nuisance and invasive vegetation (for 12 months following installation). ▪ Inspect/check all inlets, outlets, surface and overflows (where required) to ensure that they are in good condition, free from blockages and operating as designed. Take action where required.
Six Monthly	<ul style="list-style-type: none"> ▪ Remove nuisance and invasive vegetation.
Annually	<ul style="list-style-type: none"> ▪ Remove all dead growth prior to the start of growing season. ▪ Re-seed areas of poor vegetation growth. Alter plant types to better suit conditions, where required. ▪ Inspect and document the presence of wildlife. ▪ Remove sediment from inlets, outlet and forebay ▪ Manage wetland plants, where required
As-Required	<ul style="list-style-type: none"> ▪ Prune and trim trees and remove cuttings. ▪ Remove sediment from forebay, when 50% full and from micropools if volume reduced by more than 25% ▪ Repair erosion or other damage by re-turfing or reseeding ▪ Re-level uneven surfaces and reinstate design levels (typically once every 60 month period) ▪ Remove and dispose of oils or petrol residues using safe standard practices
Following all significant storm events	<ul style="list-style-type: none"> ▪ Inspect and carry out essential recovery works to return the feature to full working order.

- 7.1.6. The proposed maintenance regimes for the devices should be in accordance with The SuDS Manual (CIRIA C753) and other best practice guidelines and in accordance with manufacturer's recommendations. This will ensure the design performance, structural integrity and where applicable-appearance of each feature is maintained throughout its lifetime.
- 7.1.7. The details of the party responsible for maintenance of each feature will be confirmed prior to occupation of the proposed development. Until such times as this may be determined.

7.2. FOUL DRAINAGE NETWORK

- 7.2.1. The foul drainage system will be offered for the adoption of Severn Trent Water under S104 of the Water Industry Act 1991.

8. CONCLUSIONS & RECOMMENDATIONS

8.1. CONCLUSIONS

- 8.1.1. The risk of flooding to and from the proposed development has been assessed largely in accordance with the NPPF February 2019. This assessment demonstrates that the site lies within an appropriate location for the proposed land uses in accordance with the vulnerability classifications of the NPPF and supported by the Leicestershire County Council and the Environment Agency.
- 8.1.2. Management of extreme event flood risk may be achieved through ensuring the finished floor levels of the proposed building are set at a minimum of 150mm above adjacent roads and open space levels in areas where designated overland flood routes are identified. Furthermore, a cut-off ditch is proposed which prevents exceedance run off from the existing residential development north of the site entering the proposed development.
- 8.1.3. Safe access and egress will be available to and from the site for events up to and including the 1 in 100 year plus climate change (40%) rainfall events.
- 8.1.4. This report demonstrates that the proposed development may be undertaken in a sustainable manner without increasing the flood risk either at the site or to any third-party land in line with NPPF requirements.
- 8.1.5. In addition to the NPPF, the proposed surface water drainage strategy complies with local policy and site-specific requirements. The proposed surface water drainage strategy aims to mimic the behaviour of the site pre-development (greenfield), through the utilisation of pervious pavements, attenuation storage, and flow control devices (e.g. hydrobrake). The maximum peak rate of discharge from the site will be 6.0l/s and the total storage volume required is 560m³ for the critical 1 in 100 year event plus climate change.
- 8.1.6. The responsibility for the operation and maintenance of each SuDS feature will be confirmed prior to construction. The SuDS used on site will be maintained in accordance with manufacturer's recommendations and current best practice and guidelines to ensure routine operation.

8.2. RECOMMENDATIONS

- 8.2.1. With regard to the proposed development, it is recommended that the following works are undertaken, with respect to flood risk and drainage, at the next stage of design:
 - Long term seasonal groundwater monitoring
 - Detailed drainage and earthworks design based on the results of groundwater monitoring and informed by drainage and exceedance design.
 - Liaison with Severn Trent Water to confirm a point of connection for the proposed foul network and gain understanding of the existing network capacity and implementation of further mitigation measures, should they be required.