



NSCC Project, Twycross Zoo.

Flood Risk Assessment and Drainage Strategy.

Prepared for Twycross Zoo.

09.10.2023

Carl Dawson
Senior Civil Engineer
Carl.Dawson@clancy.co.uk

21440-CCL-XX-XX-RP-C-001 Rev 1

Clancy Consulting Limited
Dunham Court
2 Dunham Road
Altrincham
Cheshire
WA14 4NX

Caveat

"This document has been prepared for the titled project, or named part thereof, and should not be relied upon or used for any other project, or part, without an independent check being made on it. Clancy Consulting shall not be liable for the consequences of using this document other than for the purpose for which it was commissioned, and any user and any other person using or relying on this document for such other purpose, agrees and will be such use or reliance be taken to confirm this agreement to indemnify Clancy Consulting for all loss or damage resulting therefrom".

Document Origin

Revision	Date	Revision Description		Name	Signature
0	29.09.2023	Planning Issue	Prepared	C Dawson	
			Checked	C Bebbington	
			Approved	D Singh	
1	09.10.2023	Planning Issue – Minor Updates	Approved	D Singh	

CONTENTS

1.0 INTRODUCTION

- 1.1 Project Background
- 1.2 Scope of Assessment
- 1.3 Proposed Development

2.0 EXISTING SITE DETAILS

- 2.1 History and Current Use
- 2.2 Topography
- 2.3 Existing Drainage
- 2.4 Existing Watercourse and Other Waterbodies
- 2.5 Geology
- 2.6 Hydrogeology and Hydrology

3.0 DEVELOPMENT AND FLOOD RISK

- 3.1 NPPF and PPG
- 3.2 Flood Risk Category
- 3.3 Flood Zone Compatibility
- 3.4 Sequential Test

4.0 HYDRAULIC ASSESSMENT

- 4.1 Sources of Flood Risk
- 4.2 Flooding from Rivers and Seas
- 4.3 Reservoir Flooding
- 4.4 Flooding from Groundwater
- 4.5 Public Sewers or Highway Drainage Flooding
- 4.6 Canal Flooding
- 4.7 Surface Water Flooding to the site
- 4.8 Surface Water Flooding from the site
- 4.9 Historical Flooding

5.0 FLOOD RISK MITIGATION

- 5.1 Sources of Flood Risk
- 5.2 Flooding from Rivers and Seas Mitigation
- 5.3 Flooding from Groundwater Mitigation
- 5.4 Surface Water Flooding to the site Mitigation
- 5.5 Surface Water Flooding from the site Mitigation

6.0 DRAINAGE STRATEGY

- 6.1 Existing Drainage
- 6.2 Proposed Foul Water Drainage
- 6.3 Proposed Surface Water Drainage
- 6.4 Sustainable Drainage Systems (SuDS)

7.0 MAINTENANCE

- 7.1 Strategy
- 7.2 SuDS and Drainage Features

Appendix A – Proposed Development Plans

Appendix B – Topographical Survey

Appendix C – Drainage Records

Appendix D – Infiltration Testing

Appendix E – Flood Maps for Planning

Appendix F – Catchments

Appendix G – Drainage drawings

Appendix H – Correspondence

Appendix I – Flood Exceedance Plan

Appendix J – Calculations

Appendix K – Outline Drainage Maintenance Strategy

1.0 INTRODUCTION

1.1 Project Background

- 1.1.1 Clancy Consulting Ltd has been appointed by Twycross Zoo to provide a Flood Risk Assessment (FRA) and Drainage Strategy (DS) for the proposed NSCC Project at Twycross Zoo.
- 1.1.2 The proposed development encompasses a full planning application for the construction of a National Science and Conservation Centre (NSCC). The Centre will comprise two buildings including an orangutan enclosure and visitor centre, and a higher education campus building with educational, research and ancillary residential facilities. Refer to Figure 2.
- 1.1.3 The report provides information on the nature of flood risk at the site and follows Government guidance regarding development and flood risk.
- 1.1.4 The report is based on current available information and preliminary discussions.
- 1.1.5 Proposals contained or forming part of this report represent the design intent and may be subject to alteration or adjustment in completing the detailed design for this project. Where such adjustments are undertaken as part of the detailed design and are deemed a material deviation from the intent contained in this document, prior approval shall be obtained from the relevant authority in advance or commencing such works.
- 1.1.6 Where the proposed works to which this report refers are undertaken more than twelve months following the issue of this report, Clancy Consulting Ltd shall reserve the right to re-validate the findings and conclusions by undertaking appropriate further investigations at no cost to Clancy Consulting Ltd.
- 1.1.7 This report is prepared solely for the benefit of the Client. This report may not be assigned without prior written permission from Clancy Consulting Ltd.

1.2 Scope of Assessment

- 1.2.1 The assessment is to be undertaken in accordance with the standing advice and requirements of the Environment Agency (EA) for the Flood Risk Assessment as outlined in the communities and local Government Planning Policy Guidance to the National Planning Policy Framework (NPPF).
- 1.2.2 The assessment will:
 - Investigate all potential risks of flooding to the site,
 - Consider the impact the development may have elsewhere with regards to flooding,
 - Consider design proposals to mitigate any potential risk of flooding determined to be present, and
 - Consider foul and surface water drainage proposals for the proposed development.

- 1.2.3 The total site area is approximately 2.0ha and following scrutiny of the EA flood maps it has been identified that the site lies within Flood Zone 1. See Figure 1 below.

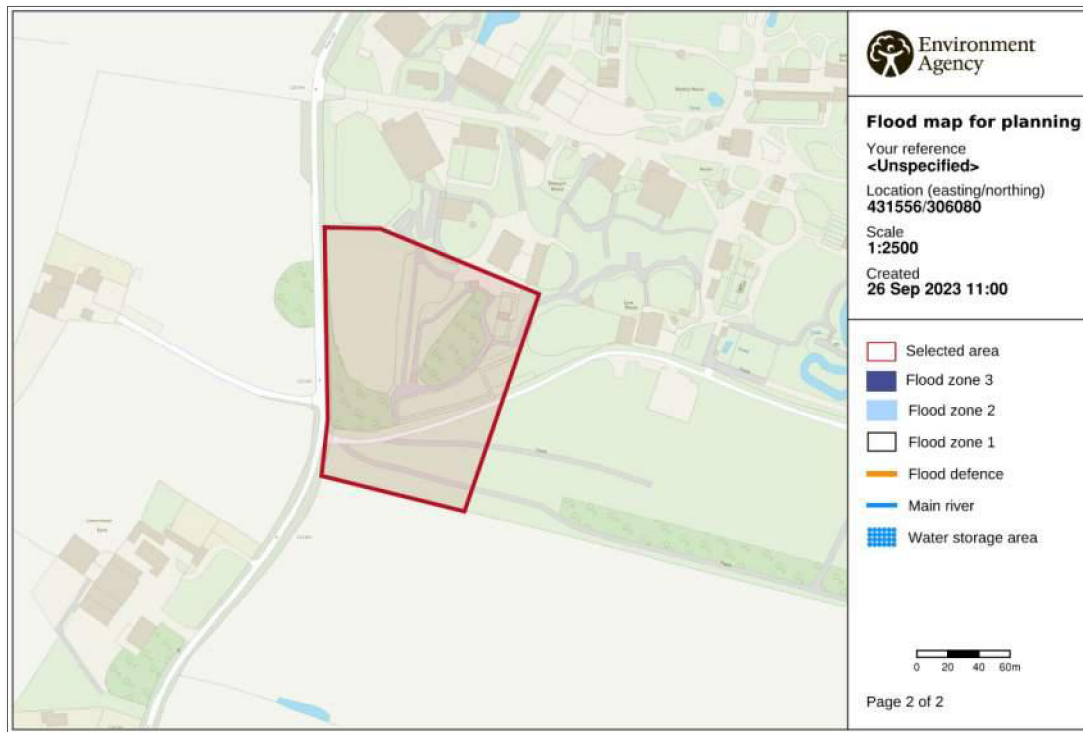


Figure 1 – EA Flood map for planning

- 1.2.4 Following review of Leicester.go.uk online mapping system and Hinckley and Bosworth SFRA, no evidence suggests that the site is located within the Critical Drainage Area (CDA).
- 1.2.5 As the site is greater than 1 ha therefore meets the requirements for a Flood Risk Assessment to be submitted as part of the planning application.
- 1.2.6 In April 2015, the Government made changes to the NPPF which made Sustainable Urban Drainage Systems (SuDS) a material consideration in the determination of planning applications for 'Major' developments.
- 1.2.7 A Drainage Strategy will therefore be required as part of the Planning Application for the development, as the site is considered to be a 'major' development by the Town and County Planning Order 2015.
- 1.2.8 The Flood Risk Assessment and Drainage Strategy reviews the following information:
- Flood maps from the Environment Agency published online.
 - UK Government Flood Warning Information Service maps for surface water flooding and reservoir flooding.
 - Strategic Flood Risk Assessment (SFRA) for Hinckley and Bosworth.

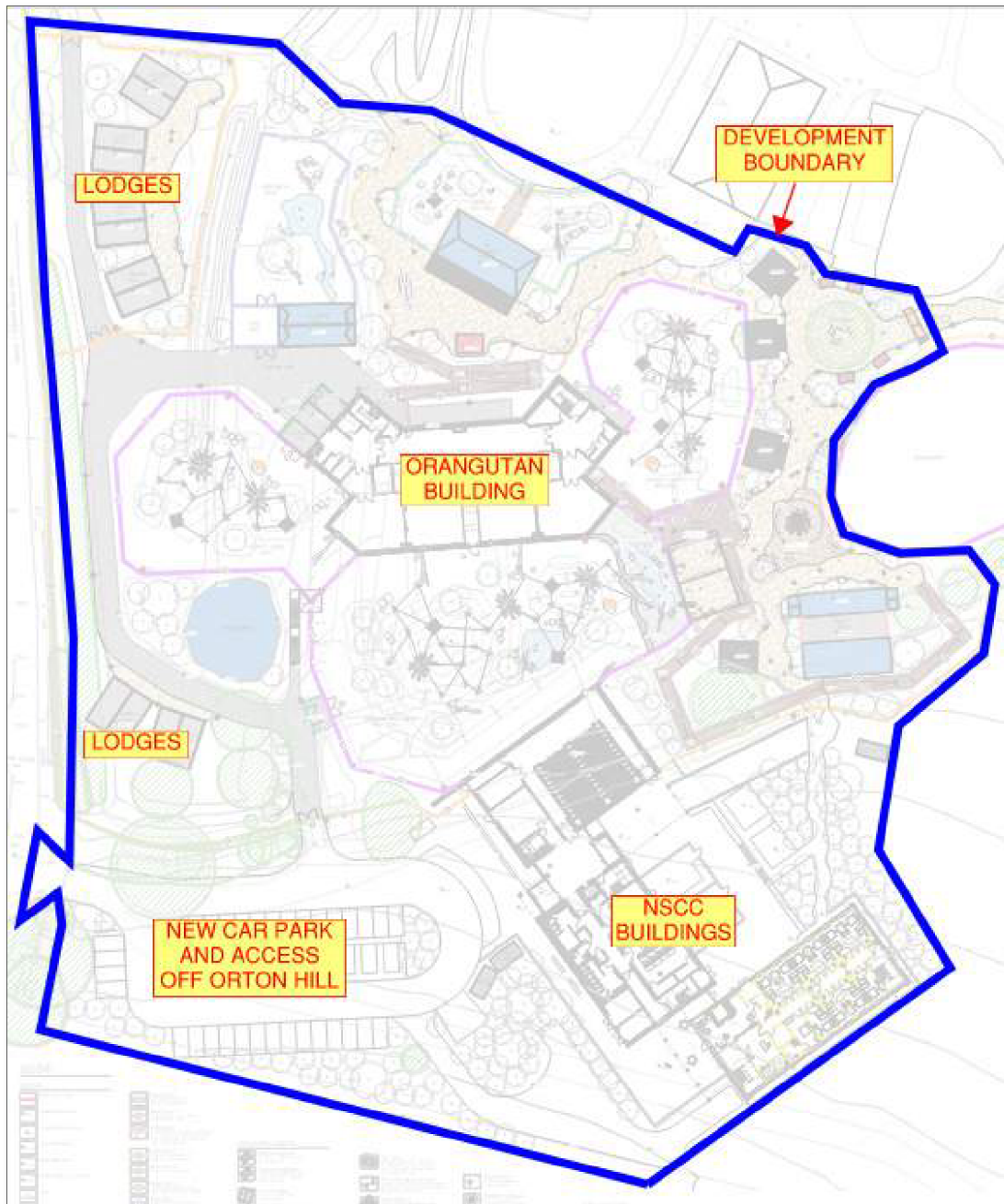
- *Environment Agency ground water vulnerability maps*
- *Sewer Mapping records – Reviewed however none available.*
- *Topographical Survey – 1301-108_2D (A0-8&A0-14)*
- *Utility Survey - 1301-108_U (A0-8&A0-14)*
- *Phase 1 Geo environmental Site Investigation Report – 10/2197/001 Rev.00.*
- *Phase 2 Geo environmental Site Investigation Report – Not available at time of writing this report.*
- *BRE Digest 365 Infiltration Testing – Structural Soils Ltd, March 13/09/2023*

1.3 Proposed Development

- 1.3.1 The proposed development encompasses a full planning application for the construction of a National Science and Conservation Centre (NSCC). The Centre will comprise two buildings including an orangutan enclosure and visitor centre, and a higher education campus building with educational, research and ancillary residential facilities.
- 1.3.2 The NSCC will be a purpose-built centre adjacent to the main Zoo, offering researchers from around the world the opportunity to study orangutans, as well as over 100 endangered species in naturalistic environments, and supporting conservationists and scientists within a world class facility.
- 1.3.3 The existing orangutan enclosure is currently located to the centre of the Zoo and is surrounded on all sides by other buildings and enclosures, limiting the opportunities for its expansion and redevelopment. To enable the NSCC to come forward the enclosure needs to be located adjacent to a higher education campus to allow students and researchers the optimum opportunity to study the animals directly. The enclosure will therefore be relocated to this new site so that the NSCC can come forward as a single development due to their proximity. A new two-storey habitat and visitor centre will be built on the site, and will accommodate two male, one female and juvenile group of orangutans, as well as facilities for visitors and researchers.
- 1.3.4 The higher education facilities include research and breakout rooms, labs, classrooms and a c.200-seater lecture theatre/ conference centre. In addition to the educational facilities, the campus building will provide c.23 en-suite bedrooms with shared social space and kitchen and utilities facilities to accommodate students and researchers visiting the centre. These facilities will all be contained within a two-storey building. In addition to these facilities, there will be six on-site lodges that would also support overnight stays for academics where required.
- 1.3.5 The teaching and research facilities contained within the campus will focus on conservation, animal welfare, biosciences, STEM activities and public engagement with science. The proposed higher education campus represents a major expansion of the Zoo's award-winning education programme which aims to increase visitors' awareness, knowledge and understanding of animals and their plight in the wild. In addition to serving higher education purposes the facilities will also accommodate children on educational / school visits.
- 1.3.6 Primary visitor access will be from the main Zoo, whilst the new access to the southwest of the site from Orton Hill will be utilised as a dedicated access for the NSCC.
- 1.3.7 It is anticipated that the proposed development will be constructed in a single phase and construction will commence in 2024 and fully operational end of 2025.

1.3.8 Refer to Appendix A for the development proposals.

1.3.9 See Figure 2 below showing an extract of the proposed development.



*Figure 2 – Extract taken from
P22009-00-001-DZ-0110-02 Combined Landscape Masterplan.*

2.0 EXISTING SITE DETAILS

2.1 Current Use

- 2.1.1 The site is located within the overall Zoo boundary, comprising land partly in the current area open to the public and part in land to the south, which has been used as a compound for other zoo developments. The approximate National Grid Reference of the centre of the site is SK 31532 06070, E431532, N306070.
- 2.1.2 The site is c.0.8km to the south-west of Norton-Juxta-Twycross and c.1.8km to the north-west of Twycross. The site is c.2.0ha predominantly comprising fields and green space, with a small area of hardstanding accommodating vehicle parking and various small shed-like structures associated with the Zoo. There is a tree belt that runs east-west through the centre of the site, which forms part of the boundary for the existing lemur enclosure and defines the extent of the Zoo's licence boundary.
- 2.1.3 The site is bordered to the north and east by land and buildings associated with the Zoo. To the south, the site is bound by a hedgerow, beyond which lie agricultural fields. To the west the site is bound by Orton Hill, beyond which lie further agricultural fields and some associated agricultural buildings, sheds and other structures.
- 2.1.4 The site can be seen in Figure 3 below (bounded blue) with the proposed development to the southwest of the existing zoo (bounded red).
- 2.1.5 The site area is made up of 15% hardstanding and 85% soft landscaping. On this basis, we have classified this as an existing greenfield site.

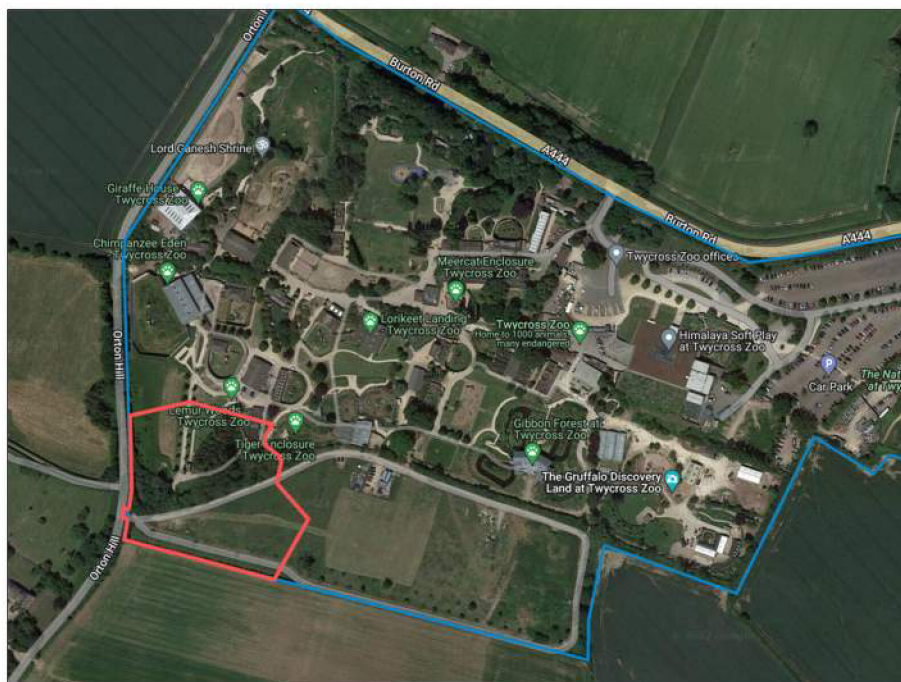


Figure 3 – Site Location Plan.

2.2 Topography

- 2.2.1 The topographical survey suggests the site typically falls in a south to southwest direction.
- 2.2.2 Site levels to the northern part of the site are c.130 to 130.5m AOD. Levels to the southern part of the site are c.124.5 to 125m AOD. An overall fall of c.5m north to south. The lowest level recorded on site is 124.58 to the centre of the southern boundary and the highest level recorded on site is 132.0m AOD to the centre of the northern boundary.
- 2.2.3 Orton Hill carriageway directly to the west, falls in a southern direction.
- 2.2.4 Refer to Appendix B for Topographical Survey.

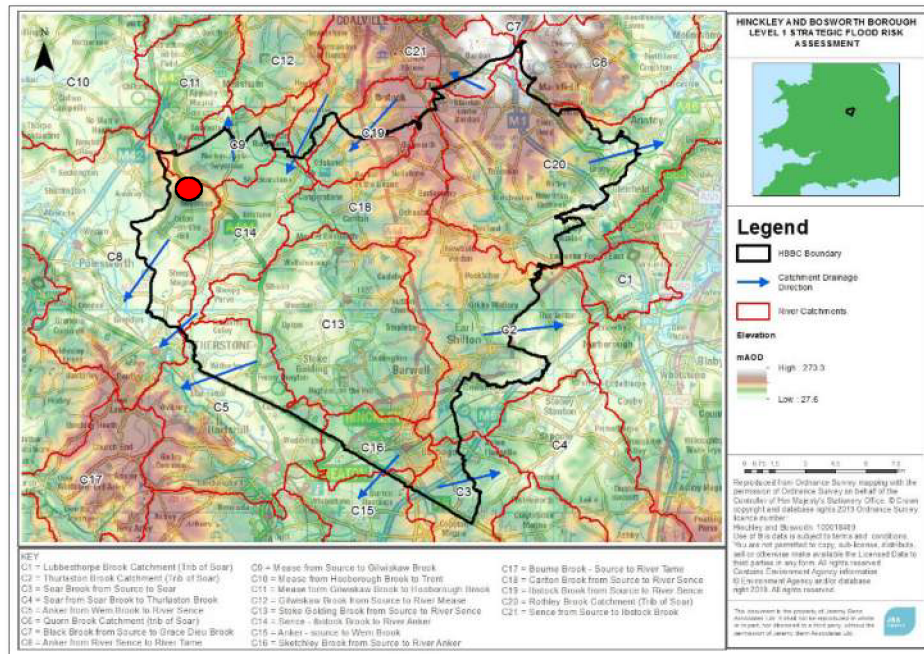
2.3 Existing Drainage

- 2.3.1 Existing drainage records can be found in Appendix C.
- 2.3.2 Following review of online sewer records, none are recorded in the vicinity of the site.
- 2.3.3 The site existing private drainage records have been recorded and traced as part of the utility survey enclosed in Appendix C. Records suggest 2 x 150mm Surface Water drains entering the site from the north (central), combining to a single 150mm drain which continues south, discharging to a ditch. A 225mm surface water drain enters the site from the north (west), discharging to an existing ditch. There are multiple surface drainage features to the eastern part of the site which appear to discharge to the main zoo drainage system to the east of the site.
- 2.3.4 The drainage records confirm that the site is positively draining however unclear if the Zoo's main foul and surface water drainage systems are separate. The main Zoo drainage system conveys flows east to a 300mm diameter drain that exits the site in a southern direction. It is unclear currently where this discharges to.
- 2.3.5 Further drainage survey is recommended to confirm any live drainage entering the site remains live, maintained or diverted where required.

2.4 Existing Watercourses and Other Waterbodies

- 2.4.1 An existing drainage ditch is located just south of the centre of the site. Levels suggest these falls in a south westerly direction. A 300mm diameter pipe links the ditch at a vehicle crossing point, at the existing fence line between the Zoo and the compound area to the south. It is unclear from records where this ditch discharges to, however it is assumed at this stage that it connects to another ditch, adjacent to Orton Hill.
- 2.4.2 Adjacent to Orton Hill, on the eastern side of the road, a ditch is located between the proposed site and the road. This ditch falls in a southern direction, assumed at this time to follow the line of the road.

- 2.4.3 Further drainage survey is recommended to confirm where the two above mentioned ditches discharge to.
- 2.4.4 South of the site, there are a number of watercourses/drainage ditches. Following a review of Hinckley and Bosworth SFRA it is noted that the catchment for this area discharges southwest and received by River Anker. See Figure 4 below, site denoted with a red dot.



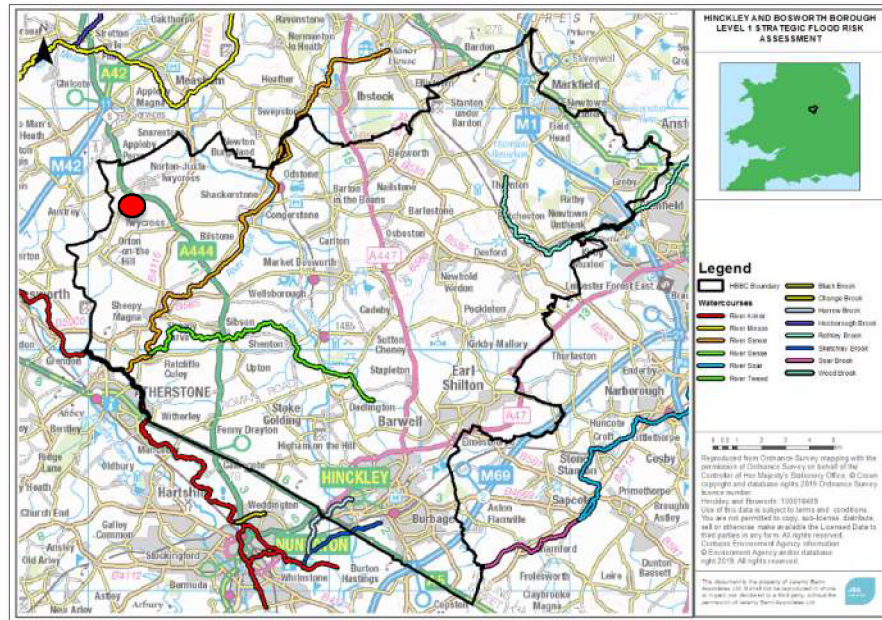


Figure 5 – Map of the principal rivers within and around Hinckley and Bosworth Borough.

2.5 Geology

- 2.5.1 British Geological Survey mapping indicates that the site is underlain by Glaciofluvial Deposits and the Thrussington Member overlying mudstone of the Gunthorpe Member.
- 2.5.2 Given the development history of the site, a significant thickness of Made Ground is not anticipated to be present beneath the site. No site investigation information has been reviewed in order to confirm this.
- 2.5.3 The site is not located with a Groundwater Source Protection Zone.
- 2.5.4 Refer to separate document 10/2197/001 Rev. 00 for the Phase 1 Preliminary Risk Assessment. At the time of writing this report the Phase 2 study was not available.

2.6 Hydrogeology and Hydrology

- 2.6.1 The Glaciofluvial Deposits, indicated to be present beneath the site is classified by the Environment Agency (EA) as a Secondary A Aquifer. These are permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.
- 2.6.2 The Thrussington Member is classified as an Undifferentiated Secondary Aquifer. These are soil layers with varying permeability in different areas.
- 2.6.3 The underlying Gunthorpe Member is classified as a Secondary B Aquifer. These are mainly lower permeability layers that may store and yield limited amounts of groundwater in fissures and openings or eroded layers.

- 2.6.4 According to EA data, the site is not located within a groundwater Source Protection Zone (SPZ). There are no records of licensed groundwater abstractions located within 500m of the site.
- 2.6.5 Groundwater quality beneath the site has not been classified under an EA Local River Basin Management Plan
- 2.6.6 Two unnamed ponds are present to the north, on the wider Twycross Zoo site. A number of land drains are also indicated to be present on agricultural land in the vicinity of the site.
- 2.6.7 There are no records of licensed surface water abstractions located within 500m of the site.
- 2.6.8 There are records of a number of Discharge Consents associated with the wider Twycross Zoo, relating to the discharge of treated sewage effluent and process water.
- 2.6.9 There is a record of a Category 3 (minor) incident relating to a traffic accident in 1999, located approximately 390m to the east the site. This involved the release of oils into drainage. There are no records of significant or major pollution incidents to controlled waters recorded within 500m of the site.
- 2.6.10 Refer to separate document 10/2197/001 Rev. 00 for the Phase 1 Preliminary Risk Assessment. At the time of writing this report the Phase 2 study was not available.

3.0 DEVELOPMENT AND FLOOD RISK

3.1 NPPF and PPG

- 3.1.1 The Department of Communities and Local Government published the National Planning Policy Framework document (NPPF – published on 27th March 2012 with recent revision date 25th August.2022) and the Planning Practice Guidance (PPG – published 6th March 2014) which provided guidance on how flood risk should be assessed during the planning and development process.
- 3.1.2 See below Table 1 extract from PPG flood zone classifications. These Flood Zones refer to the probability of river and sea flooding, ignoring the presence of defences. They are shown on the Environment Agency's Flood Maps for Planning, available online.

Flood Zone	Definition
Zone 1 Low Probability	Land having a less than 0.1% annual probability of river or sea flooding. (Shown as 'clear' on the Flood Map for Planning – all land outside Zones 2, 3a and 3b)
Zone 2 Medium Probability	Land having between a 1% and 0.1% annual probability of river flooding; or land having between a 0.5% and 0.1% annual probability of sea flooding. (Land shown in light blue on the Flood Map)
Zone 3a High Probability	Land having a 1% or greater annual probability of river flooding; or Land having a 0.5% or greater annual probability of sea. (Land shown in dark blue on the Flood Map)
Zone 3b The Functional Floodplain	This zone comprises land where water from rivers or the sea has to flow or be stored in times of flood. The identification of functional floodplain should take account of local circumstances and not be defined solely on rigid probability parameters. Functional floodplain will normally comprise: • land having a 3.3% or greater annual probability of flooding, with any existing flood risk management infrastructure operating effectively; or • land that is designed to flood (such as a flood attenuation scheme), even if it would only flood in more extreme events (such as 0.1% annual probability of flooding). Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. (Not separately distinguished from Zone 3a on the Flood Map)

Table 1 – Flood Zone classification.

3.1.3 See below Table 2 extract from PPG - Flood Risk Vulnerability Classification.

Annex 3: Flood risk vulnerability classification

Information on flood risk vulnerability classification.

Essential infrastructure

- Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk.
- Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including infrastructure for electricity supply including generation, storage and distribution systems; including electricity generating power stations, grid and primary substations storage; and water treatment works that need to remain operational in times of flood.
- Wind turbines.
- Solar farms.

Highly vulnerable

- Police and ambulance stations; fire stations and command centres; telecommunications installations required to be operational during flooding.
- Emergency dispersal points.
- Basement dwellings.
- Caravans, mobile homes and park homes intended for permanent residential use.
- Installations requiring hazardous substances consent. (Where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as 'Essential Infrastructure'.)

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.

Less vulnerable

- Police, ambulance and fire stations which are not required to be operational during flooding.
- Buildings used for shops; financial, professional and other services; restaurants, cafes and hot food takeaways; offices; general industry, storage and distribution; non-residential institutions not included in the 'more vulnerable' class; and assembly and leisure.
- Land and buildings used for agriculture and forestry.
- Waste treatment (except landfill* and hazardous waste facilities).
- Minerals working and processing (except for sand and gravel working).
- Water treatment works which do not need to remain operational during times of flood.
- Sewage treatment works, if adequate measures to control pollution and manage sewage during flooding events are in place.
- Car parks.

Water-compatible development

- Flood control infrastructure.
- Water transmission infrastructure and pumping stations.
- Sewage transmission infrastructure and pumping stations.
- Sand and gravel working.
- Docks, marinas and wharves.
- Navigation facilities.
- Ministry of Defence installations.
- Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location.
- Water-based recreation (excluding sleeping accommodation).
- Lifeguard and coastguard stations.
- Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms.
- Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.

Table 2 - Flood Risk Vulnerability Classification.

3.1.4 See below Table 3 extract from PPG - Flood Risk Vulnerability and Flood Zone Compatibility.

Flood Zones	Flood Risk Vulnerability Classification				
	Essential infrastructure	Highly vulnerable	More vulnerable	Less vulnerable	Water compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test required	✓	✓	✓
Zone 3a †	Exception Test required †	X	Exception Test required	✓	✓
Zone 3b *	Exception Test required *	X	X	X	✓*

Key:

✓ Exception test is not required

X Development should not be permitted

Notes to table 2:

- This table does not show the application of the [Sequential Test](#) which should be applied first to guide development to the lowest flood risk areas; nor does it reflect the need to avoid flood risk from sources other than rivers and the sea;
- The Sequential and [Exception Tests](#) do not need to be applied to those developments set out in [National Planning Policy Framework footnote 56](#). The Sequential and Exception Tests should be applied to 'major' and 'non major' development;
- Some developments may contain different elements of vulnerability and the highest vulnerability category should be used, unless the development is considered in its component parts.

"†" In Flood Zone 3a essential infrastructure should be designed and constructed to remain operational and safe in times of flood.

"*" In Flood Zone 3b (functional floodplain) essential infrastructure that has passed the Exception Test, and water-compatible uses, should be designed and constructed to:

- remain operational and safe for users in times of flood;
- result in no net loss of floodplain storage;
- not impede water flows and not increase flood risk elsewhere.

Paragraph: 079 Reference ID: 7-079-20220825

Revision date: 25 08 2022

Table 3 - Flood Risk Vulnerability and Flood Zone Compatibility.

3.2 Flood Risk Category

- 3.2.1 To assess the flood risk classification for the site, UK Government online 'Flood Maps for Planning' has been reviewed. This is used to inform planning of the sites Flood Zone and the probability of flooding from Rivers and Seas. This doesn't consider the presence of flood defences or climate change.
- 3.2.2 UK Government online 'Long Term Flood Risk Assessment for Locations in England' should also be assessed to identify the long-term flood risks from rivers and seas, surface water and reservoirs.
- 3.2.3 The flood Map for Planning report is included in Appendix E and it can be noted that the proposed development site is classified as within Flood Zone 1.
- 3.2.4 Refer to Section 4 of this report for site specific Flood Risk assessment.

3.3 Flood Zone Compatibility

- 3.3.1 The proposed development site is likely to fall between two categories shown in Table 2 above as.
- Buildings used for dwelling houses, **student halls of residence**, drinking establishments, nightclubs and hotels.
 - Non-residential uses for health services, nurseries and **educational establishments**.
- 3.3.2 Both of the above are classed as '**More Vulnerable**' development in the above Table 2 - Flood Risk Vulnerability Classification.
- 3.3.3 The site has been identified as located in Flood Zone 1, for which a 'More Vulnerable' development is deemed to be appropriate.

3.4 Sequential Test

- 3.4.1 Sequential test is not necessary for this site due to the site being categorised as a 'More Vulnerable' development and lies within Flood Zone 1. See Table 3 above.

4 HYDROLOGICAL ASSESSMENTS

4.1 Sources of Flood Risk

4.1.1 This section assesses the risk of flooding from different sources of flooding to and from the development, taking into consideration climate change as well as how flood risk should be managed.

4.1.2 The sources of flooding to be assessed are.

- Flooding from Rivers and Seas (Fluvial, Coastal or Estuarine).
- Reservoir Flooding.
- Flooding from Groundwater.
- Flooding from Public Sewers or Highway Drains.
- Canal Flooding.
- Surface Water flooding to the site.
- Surface Water flooding from the site.

4.2 Flooding from Rivers and Seas (Fluvial)

4.2.1 The map shown below in Figure 6 shows that the site is located within Flood Zone 1 and therefore the land is assessed as having a less than 1 in 1,000 annual probabilities of river or sea flooding (<0.1%). See Appendix E.

4.2.2 The site is not considered at risk of fluvial flooding.

4.2.3 The site is not shown to be in an area which benefits from flood defences.

4.2.4 There is currently no flood risk identified on the EA flood maps for the site and it is therefore not considered at risk from tidal flooding (Coastal or Estuarine).

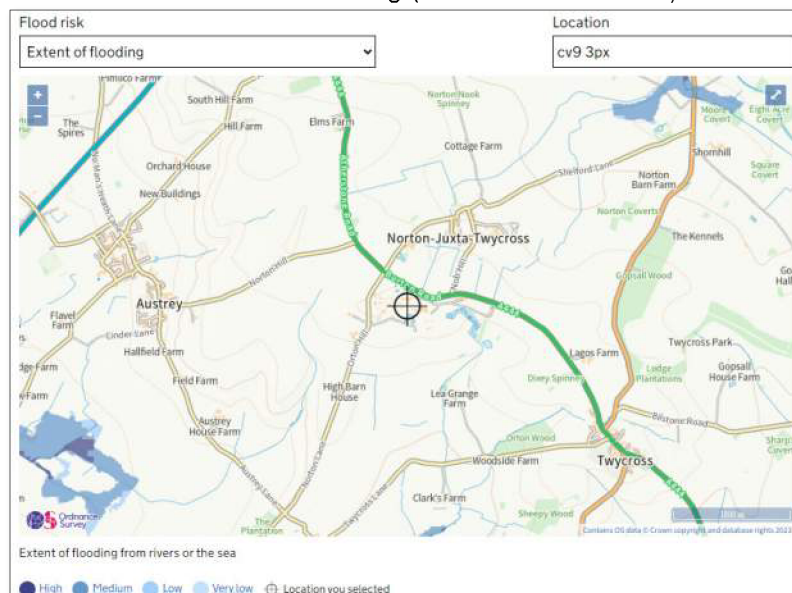


Figure 6 – Environment Agency (EA) Flood Zone Map – Flooding from rivers and sea.

4.3 Reservoirs Flooding

- 4.3.1 The Long-Term Flood Risk Assessment (from Reservoirs) map shows the site not to be flooded if a reservoir were to fail and release the water it holds. See Figure 7 below.
- 4.3.2 The site is located outside of the extent of a reservoir flood risk according to Flood Maps.
- 4.3.3 The government state that if a reservoir flood event were to occur, even in the worst-case scenario many areas shown as possibly being at risk of flooding would be expected to receive no more than a few centimetres of flood water.
- 4.3.4 Reservoir flooding is extremely unlikely to happen and there has been no loss of life in the UK from reservoir flooding since 1925. The Environment Agency is the enforcement authority and ensures that reservoirs are inspected regularly, and essential safety work is carried out.

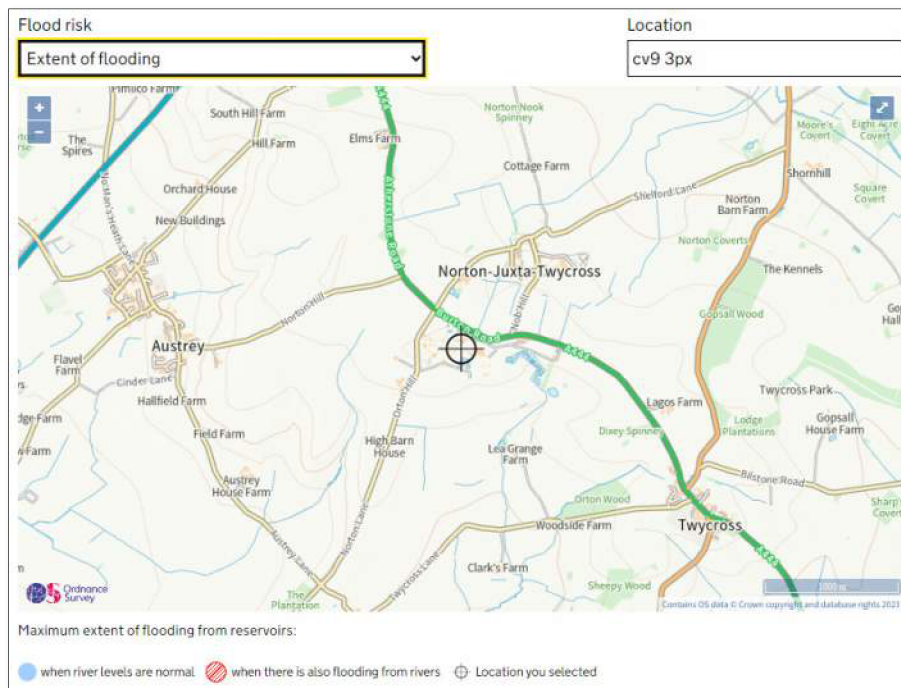


Figure 7 – Reservoir flood map.

4.4 Flooding from Groundwater

- 4.4.1 Following review of the Strategic Flood Risk Assessment (SFRA) for Hinckley and Bosworth, there are no known reports of groundwater flooding in area of the site.
- 4.4.2 At the time of writing this report, ground water monitoring results were not available.
- 4.4.3 It is recommended to review the groundwater levels once available to assess any impact these may have to the proposed development.

4.4.4 The site does not fall within the Groundwater Source Protection Zone, see Figure 8 below.

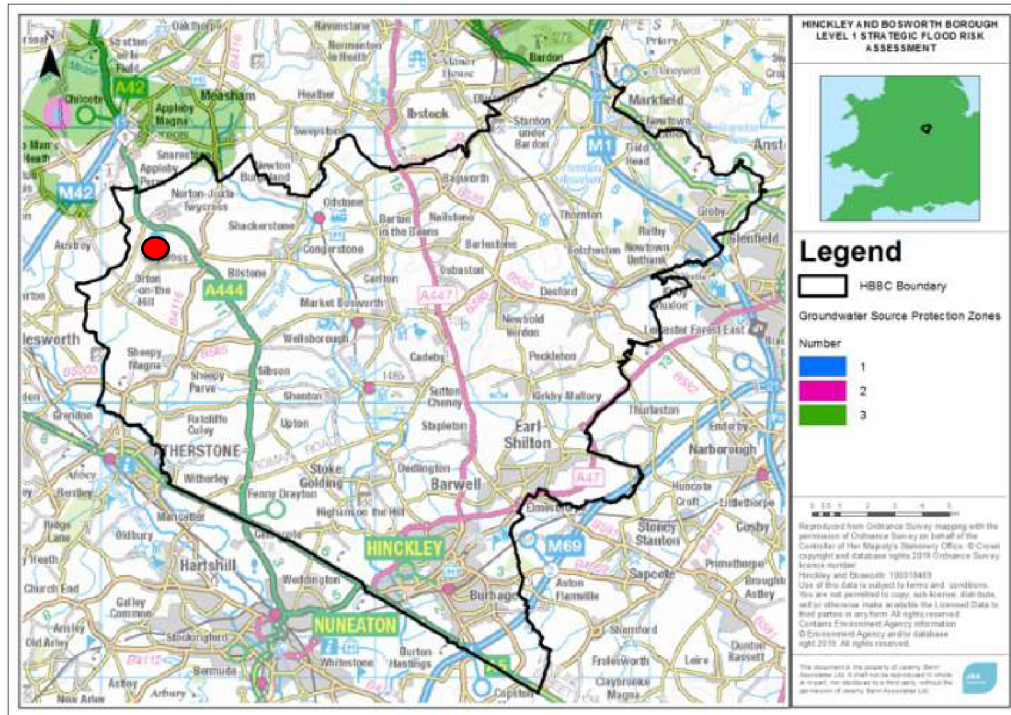


Figure 8 – Groundwater Source Protection Zone.

4.5 Public Sewers or Highway Drainage Flooding

4.5.1 No public sewers located in close proximity to the site.

4.6 Canal Flooding

4.6.1 There are no canals within the vicinity of the site. The closest canals are the Coventry Canal located circa 5.6km to the southwest of the site and Ashby Canal located circa 3.7km to the northeast of the site.

4.6.2 The canals identified in the SFRA are not generally posing a direct flood risk as they are a controlled water body. Therefore, the residual risk of canal flooding is usual associated with lower probability event such as overtopping and/or the breaching or embankments.

4.6.3 Figure 9, shows the locations of all recorded incidents of Canal breaches and overtopping in the study area of Hinchley and Bosworth, see below map.

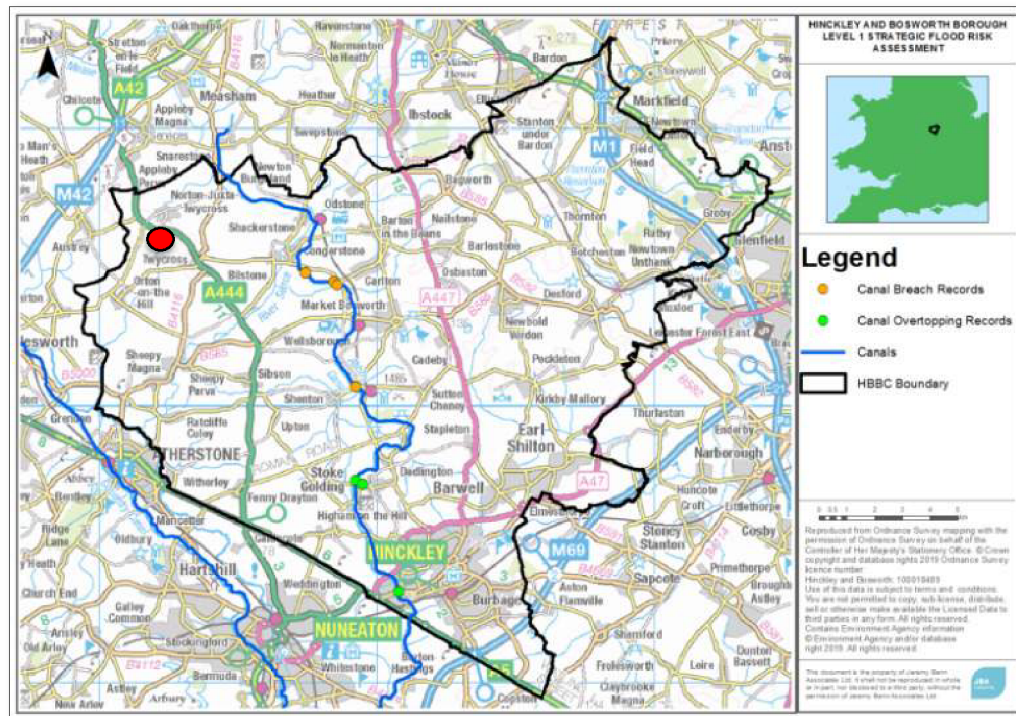


Figure 9 – Canal breaches and overtopping.

4.6.4 Given the above information, canals are not considered as a risk canal flooding to the site.

4.7 Surface Water Flooding to the site

4.7.1 Surface water flooding to the site can be caused when rainwater during extreme rainfall events does not drain away through the normal drainage system or soakaway into the ground. Surcharging or blocked sewers can result in overland flows which can potentially pose a risk of flooding should the source of this flooding be at a higher elevation than the development.

4.7.2 From the UK Governments Flood Risk from surface water map.

- Where a site is located in a clear unshaded area, this indicates that the site is at **very low risk** of flooding, where flooding occurs as a result of rainfall with less than a 1 in 1000 (0.1%) chance in any one year.
- Where the site is located in a light blue shaded area, this indicates that the site is at **low risk** of flooding, where flooding occurs as a result of rainfall between 1 in 1000 (0.1%) and 1 in 100 (1%) chance in any one year.
- Where the site is located in a blue shaded area, this indicates that the site is at **medium risk** of flooding, where flooding occurs as a result of rainfall between 1 in 100 (1%) and 1 in 30 (3.3%) chance in any one year.
- Where the site is located in a dark blue shaded area, this indicates that the site is at **high risk** of flooding, where flooding occurs as a result of rainfall with a greater than 1 in 30 (3.3%) chance in any one year.

- 4.7.3 The extent of flooding to the site from surface water is indicated in Figure 10 below. This indicates that the site is identified as being 'very low' risk of flooding from surface water.

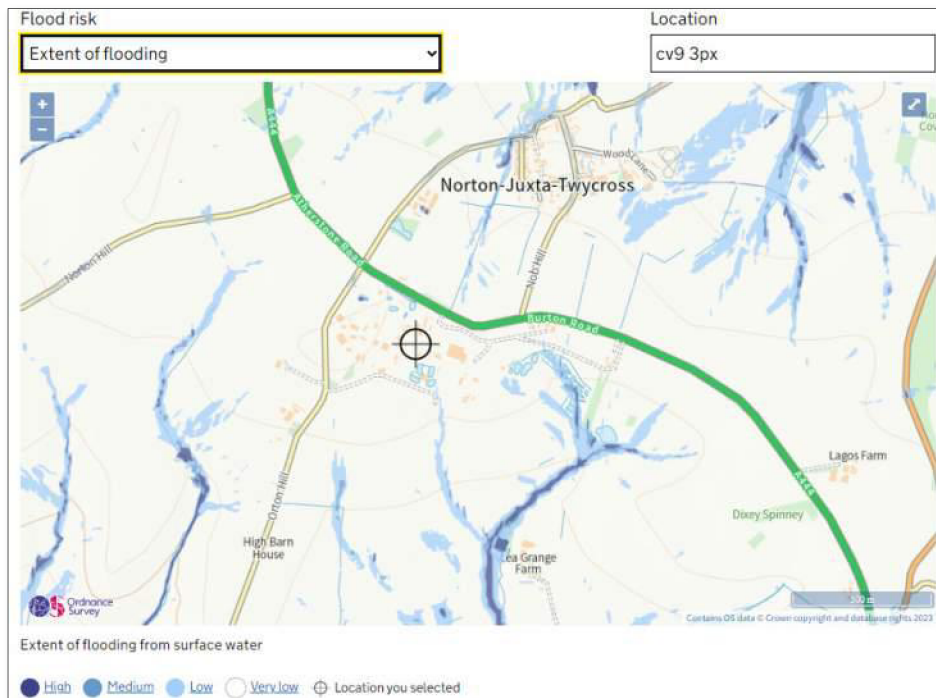


Figure 10 – Surface Water flood map.

4.8 Surface Water Flooding from the site

- 4.8.1 Developers are responsible for ensuring that new developments do not increase the flood risk elsewhere. Where new developments are proposed, the proposed surface water drainage network shall be designed to not flood in a 30 year storm event and flood water generated up to the critical 1 in 100 year plus climate change storm event shall be controlled and constrained within areas on site so as not to cause damage to buildings, essential services or adjoining developments and services.
- 4.8.2 The development has the potential to increase flood risk where additional run-off from proposed hardstanding areas is discharged freely into the downstream drainage network.
- 4.8.3 It is encouraged to propose sustainable drainage methods where possible.
- 4.8.4 Section 6 of this report describes in detail the proposed Drainage Strategy for the site and how surface water run-off/flows will be managed.

4.9 Historical Flooding

- 4.9.1 At the time of writing this report, no information has been obtained or provided, showing records of flooding to the site or in the vicinity of the site.

4.9.2 The Environment Agency and Leicestershire County Council (LCC) have been contacted to request any records of historical flooding to the site. At the time of writing this report, a response had not been received.

4.9.3 Refer to Appendix H for correspondence.

5 FLOOD RISK MITIGATION

5.1 Sources of Flood Risk

5.1.1 This section advises on flood risk mitigation measures from the different types of flooding that could potentially increase risk of flooding to the site, albeit considers as low-very low risk of flooding as described in Section 4.

- Flooding from Rivers and Seas (Fluvial, Coastal or Estuarine).
- Flooding from Groundwater.
- Surface Water flooding to the site.
- Surface Water flooding from the site.

5.1.2 This section will not consider mitigation measures for the following types of flooding due to the improbable risk of flooding to the site.

- Reservoir Flooding – not consider due to very low risk.
- Flooding from Public Sewers or Highway Drains.
- Canal Flooding.

5.2 Flooding from Rivers and Seas (Fluvial, Coastal or Estuarine) Mitigation

5.2.1 The site is shown to be located within the Flood Zone 1 extent. This means the site is considered to be at less than 0.1% risk of flooding from rivers and seas.

5.2.2 It is recommended that the proposed finished floor levels are designed to match existing to remain classified as Flood Zone 1.

5.2.3 As a precaution, external ground levels across the site should fall away from the proposed buildings and ensure that the creation of low points is avoided (other than those used intentionally for drainage features) in order to direct water safely away from the buildings on site.

5.2.4 Providing the above mitigation measures were imposed, the risk from flooding would be considered to be low, post development.

5.3 Flooding from Groundwater Mitigation

5.3.1 Groundwater flooding tends to be more persistent than other sources of flooding, typically lasting for weeks or months rather than hours or days. Groundwater flooding does not generally pose a significant risk to life, due to the slow rate at which the water level rises, however it can cause significant risk to property.

5.3.2 Generally, floor levels will be at or above ground levels and there are no basements proposed. Therefore, the risk of ground water flooding to the area is considered low.

- 5.3.3 External ground levels across the site should fall away from proposed buildings and ensure that the creation of low points is avoided (other than those used intentionally for drainage features) in order that in the unlikely event of groundwater flooding, the flood water is safely routed away from the buildings on site.
- 5.3.4 Providing the above mitigation measures were imposed, the risk from groundwater flooding would be considered to be low, post development.

5.4 Surface Water Flooding to the site Mitigation

- 5.4.1 The UK Government Long Term Flood Risk Assessment surface water flood maps indicate that the site is at very low to low risk of surface water flooding. However, the proposed building is assumed to be constructed at the same or above existing levels, which is above the current extent of flooding.
- 5.4.2 Measures outlined in this section are recommended therefore the risk of surface water flooding post-development shall not be increased and shall be reduced where possible.
- 5.4.3 It is assumed that the surface water drainage outside of the site boundary will be subject to the relevant landowner's regular drainage maintenance schedule.
- 5.4.4 Any drainage ditches within or outside of the boundary will be subject to the relevant landowner's regular drainage maintenance schedule.
- 5.4.5 Providing the above measures were imposed, the risk to the development from surface water flooding would be considered to be low, post development.

5.5 Surface Water Flooding from the site Mitigation

- 5.5.1 Any new development site drainage should be designed in accordance with current best practice to provide adequate capacity not to flood in a 30 year storm event and flood water generated up to the critical 1 in 100 year plus climate change storm event shall be controlled and constrained within areas on site so as not to cause damage to buildings, essential services or adjoining developments and services.
- 5.5.2 Climate change allowances for peak rainfall intensities which should be applied to new developments.
- 5.5.3 Figure 11 and 12 below (Extract of the Environment Agency Guidance) demonstrates the climate change allowance with central and upper end allowances being considered.
- 5.5.4 Based on the nature of the development, a lifespan in excess of 60 years is anticipated. Therefore, the potential climate change allowance for 2061-2115 ranges between 25% for the central allowance and 40% for the upper end allowance. As such, an allowance of 40% for climate change on peak rainfall intensity will be included in the calculations.

Soar Management Catchment peak rainfall allowances		
3.3% annual exceedance rainfall event		
Epoch	Central allowance	Upper end allowance
2050s	20%	35%
2070s	25%	35%
1% annual exceedance rainfall event		
Epoch	Central allowance	Upper end allowance
2050s	20%	40%
2070s	25%	40%
*Use '2050s' for development with a lifetime up to 2060 and use the 2070s epoch for development with a lifetime between 2061 and 2125.		

Figure 11 – EA Climate change allowance.

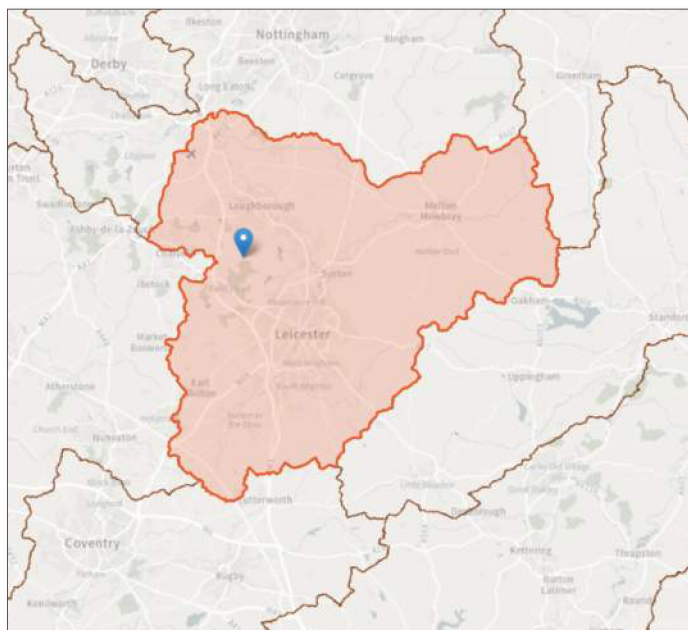


Figure 12 – EA Climate change allowance Map.

- 5.5.5 A 10% allowance for Urban Creep is also to be included in the calculation.
- 5.5.6 Section 6 reviews the surface water discharge options and is subject to agreement with the approving authorities.
- 5.5.7 To minimise localised flooding within the site, the drainage design should ensure that any drainage features are suitably sized to accommodate peak storm flows.
- 5.5.8 Flood water exceedance routes should be identified, both on and off site. Refer to Appendix I for flood exceedance plan.
- 5.5.9 For any sustainable drainage systems (SuDS) employed in the development, an appropriate management and maintenance plan for the SuDS lifetime should be submitted and include.
- Any arrangements for adoption by an appropriate public body or statutory undertaker, management and maintenance by Residents Management Company.
 - Arrangements concerning appropriate funding mechanisms for its on-going maintenance of all elements of the SuDS system (i.e., regular inspection and maintenance).
 - Means of access for maintenance and easements where applicable.
- 5.5.10 Assuming the proposed drainage system is designed to provide adequate capacity, and that the private drainage is maintained in accordance with that set out in the maintenance strategy, it can be assumed that there will be minimal risk of flooding from the proposed development.
- 5.5.11 The final design of the drainage network shall be in accordance with the legislation set by the Environment Agency and Local Authority.

6 DRAINAGE STRATEGY

6.1 Existing Drainage

- 6.1.1 Refer to Section 2.3 for existing drainage description.
- 6.1.2 Existing drainage records can be found in Appendix C of this report.
- 6.1.3 Records confirm that the wider zoo site hard standing areas are positively draining, and some area catchments drain to local ditches which pass through the proposed development, as described in Section 2.3.
- 6.1.4 As part of the development proposals, it will be necessary to divert existing private drainage network in parts, to prevent clashes with proposed buildings.
- 6.1.5 To the west/northwestern part of the site, there is an existing ditch falling south to an existing pond. This receives flows from the wider zoo site via a 225mm diameter surface water drain. As part of the proposed development, an access road and Orangutan habitat is located above the ditch, approximately midway, therefore it is proposed to maintain the natural line of the ditch and replace the section built over with a large diameter pipe to match the existing cross section of the ditch, therefore, not to throttle or restrict existing flows to the pond. Consideration was given to maintain the open cut ditch, however due to the nature of the development, safety of animals it was deemed appropriate to culvert this section. The pond then discharges to another ditch via a 150mm dia surface water drain.
- 6.1.6 The ditch/watercourse one third up from the southern boundary, falls in a westerly direction. Its outfall location isn't clear following review of the survey; however it is assumed that it connects to the ditch/watercourse to the southwestern corner. Additional investigation into the outfall location of this ditch is recommended.
- 6.1.7 As part of the scheme proposals, buildings intercept the line of this ditch. Therefore local diversions will be required. It is preferred to have open cut sections of ditch to match existing, however may be necessary to pipe/culvert the ditch in places, due to the location in animal closures, for the same reasons as described above.
- 6.1.8 The proposed site area is 2.18ha with 85% made up of soft landscaping and 15% roof areas, tracks and footways. The site has therefore been classed as a greenfield site.
- 6.1.9 Following review of the topographical survey and Hinckley and Bosworth Borough Council SFRA catchment maps, the existing site greenfield catchment discharges southwest towards the existing ditch/watercourse following the natural topography of the land.
- 6.1.10 Flows have been calculated for 100% the existing site to determine the greenfield run-off rate. The IH124 equation predicts a greenfield peak flow rate estimate for the mean annual flood call Qbar (a return period of approximately 1:2.3 years). This value is then factored by a growth rate parameter to give a flow rate for other return periods as set out below. The return periods analysed are 1yr, 30yr and 100yr. Qbar has been calculated at 9.2 l/s, see Appendix J.

- 6.1.11 As noted, 15% of the existing site is made up of hardstanding areas, positively drained. To understand the existing run-off rate from these areas, HR Wallingford Modified Rational Method (WMRM) has been used, to calculate the 1 in 2-year run-off rate. The results are as follows.

$$2.78 \times 0.75 \times 1.3 \times 50 \text{ (mm/hr)} \times 0.327 \text{ (ha)} = 44 \text{ l/s.}$$

- 6.1.12 Refer to Appendix F for Existing Catchments Plan.

6.2 Proposed Foul Water Drainage

- 6.2.1 It is proposed to separate foul and surface water networks within the development.
- 6.2.2 Foul water from the proposed development is to discharge via a new foul water private drainage system.
- 6.2.3 No foul or combined public sewers have been identified within the vicinity of the site, it is therefore proposed to incorporate a sewage treatment plant (STP), within the site prior to discharge.
- 6.2.4 The proposed discharge location is to the existing ditch to the west of the site. It is assumed at this stage that treated flows will require to be pumped due to ditch levels. The flow will be pumped to a suitable location into a break chamber, prior to discharging to the ditch/watercourse via gravity.
- 6.2.5 The treated flow connecting direct to the existing ditch will require approval from the approving authority.
- 6.2.6 The Environment Agency (EA) will need to be notified of treated discharge to the watercourse and permits/consent of treatment will be required.
- 6.2.7 Its currently unclear who the owner of the ditch is, as it lies outside of the development boundary, however consent from owner will be required. The LLFA have been contacted to confirm ownership.
- 6.2.8 The foul discharge rate for the development is currently unknown however to be confirmed at detailed design stage of the scheme.
- 6.2.9 The proposed sewage treatment plant is an environmentally friendly solution for treating and discharging flows into existing waterways.
- 6.2.10 In addition to the STP, a phosphate and ammonia reduction chamber is proposed prior to discharging flows to the ditch/watercourse.
- 6.2.11 Its understood that a full nutrient assessment will be required by a specialist.
- 6.2.12 It is noted within the education block, a Bio-Science lab is proposed. It is to be confirmed by the Architect if foul flows from this zone are more that domestic flows. Should the discharged flows require not to be connected the proposed sites foul system, a separate holding tank may be required and treated/discharged accordingly, either taken offsite or connected back into the foul system once treated.

- 6.2.13 It is not anticipated that any animal foul waste will be discharged to the proposed foul sewage treatment plant and is assumed that all animal waste will be disposed of as part of the existing zoo waste management plan. Wash down facilities in the Orangutan living quarter will be required. It is anticipated that this can be discharged into the proposed foul water system. The Architect/Zoo specialist is to confirm otherwise.
- 6.2.14 There are no proposals for foul water drainage to be adopted at this stage however the sewage treatment plant should be managed and maintained in accordance with the manufacture's guidance.
- 6.2.15 The proposed Drainage Strategy layout is enclosed in Appendix G.

6.3 Proposed Surface Water Drainage

- 6.3.1 Any new development site drainage should be designed in accordance with current best practice to provide adequate capacity not to flood in a 30 year storm event and flood water generated up to the critical 1 in 100 year plus climate change storm event shall be controlled and constrained within areas on site so as not to cause damage to buildings, essential services or adjoining developments and services.
- 6.3.2 Based on the nature of the development, a lifespan in excess of 60 years is anticipated. Therefore, the potential climate change allowance for 2061-2125 ranges between 25% for the central allowance and 40% for the upper end allowance. As such, an allowance of 40% for climate change on peak rainfall intensity will be included in the calculations.
- 6.3.3 An additional 10% allowance for urban creep will be incorporated into the design.
- 6.3.4 In following the standard hierarchy of drainage solutions, consideration should firstly be given to the discharge of surface water run-off by sustainable methods such as infiltration.

Infiltration

- 6.3.5 The first consideration for discharging surface water should be via infiltration.
- 6.3.6 Infiltration testing in accordance with BRE Digest 365 has been undertaken and the test results confirm that disposal of surface water into the ground is suitable for self-sufficient areas, however not for discharging additional hardstanding/roof areas due to the low permeability of the underlying ground.
- 6.3.7 As part of the site investigation works, two locations were investigated for infiltration. SA1 and SA2 and the results are $6 \times 10^{-7} \text{m/s}$ and $9 \times 10^{-7} \text{m/s}$ respectively. Refer to Appendix D for infiltration results and locations.
- 6.3.8 Where possible it is proposed to discharge surface water to ground via infiltration. The proposed southern part of the car park presents opportunity to use this method, receiving flows solely from the catchment area it receives.
- 6.3.9 It is proposed to incorporate a permeable paving infiltration system for this part of the car park using SA1 results ($6 \times 10^{-7} \text{m/s}$) as this location is closest to the area. No additional flows should discharge to this system.

6.3.10 The next consideration for surface water discharge should be watercourse.

Watercourse

- 6.3.11 To the southwest of the site, an existing ditch/watercourse is located south of the existing/proposed access road into the site. This would be a practical location to discharge the proposed sites surface water flows, given the naturally topography of the land falls in this direction, therefore likely already received greenfield runoff from the site.
- 6.3.12 Given the proximity of this drainage feature, discharging flows from this site to this location is proposed however approval from the Lead Local Flood Authority (LLFA) will be required prior to connection.
- 6.3.13 The site will therefore discharge surface water flows using a hybrid drainage system of part infiltration (System 1) and part discharge to watercourse (System 2).
- 6.3.14 The proposed site levels and depth of the receiving ditch, dictate which part of the site hardstanding area can positively discharge to the ditch via gravity (System 2). This area is shown on the below sketch coloured orange. Flows will be attenuated and restricted to the proposed discharge rate. The remainder of the site hardstanding area hatched pink, which cannot discharge to the ditch via gravity, will discharge to ground via infiltration, attenuating flows within permeable paving sub-base voids (System 1).



6.3.15 Should the above method of discharging surface water be deemed not acceptable by the LLFA, alternative means of discharging surface water is to be determined. Given the proposed site levels, and distance from any other possible receiving drainage feature, unsustainable methods i.e. pumping may be required.

6.3.16 Its worth noting that consideration was given to discharge the full proposed site hardstanding area to ground, however due to the steep falls of the site, poor infiltration rate, and area of hardstanding, this was recognised as unachievable within the sites constraints.

6.3.17 It is recommended to trace the existing ditch/watercourse to the southwest of the site (intended to discharge to), to confirm its function, condition and end outfall location.

6.3.18 Refer to Appendix F for Proposed Catchments Plan.

Surface Water Sewers

6.3.19 There are no surface water sewers within close proximity of vicinity of the site.

6.3.20 The next consideration for surface water discharge should be combined water sewer.

Combined or Foul Sewers

6.3.21 There are no combined or foul water sewers within close proximity of vicinity of the site.

Flow Rates

6.3.22 As sated above, greenfield rates have been used to determine existing flows from the site. See below.

Qbar	-	9.2 l/s
1 in 1 year	-	7.6 l/s
1 in 30 year	-	18.3 l/s
1 in 100 year	-	23.51 l/s

6.3.23 Refer to Appendix J for Greenfield runoff rate calculations for the site.

6.3.24 It's also worth noting that the existing hardstanding areas of the site generate a flow of 44l/s for the 1 in 2 year storm event, calculated using WMRM.

6.3.25 Taking the existing flows into consideration, it is proposed to restrict flows to the existing ditch, to a maximum rate of **10 l/s** for all storms up to and including 1 in 100 year plus 40% for climate change and 10% for urban creep.

6.3.26 The proposed discharge rate provides a significant betterment on the existing flows, especially in the more extreme events.

6.3.27 The proposed site impermeable area discharging to System 1 is 0.126ha. A quick storage estimate has been calculated using hydraulic modelling software. Based on 6x10⁻⁷m/s and 1 in 100 year plus 45% climate change a maximum storage estimated volume of circa 120m³ will be required. See below.

Storage Estimate	
Return Period (years)	100
Climate Change (%)	40
Impermeable Area (ha)	0.126
Peak Discharge (l/s)	0.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)	0.00216
Required Storage (m³)	Calc
from	123
to	123
With infiltration (m³)	
from	76
to	121

6.3.28 The proposed site impermeable area discharging to System 2 is 0.861ha. A quick storage estimate has been calculated using hydraulic modelling software. Based on 10 l/s and 1 in 100 year plus 45% climate change a maximum storage estimated volume of maximum circa 700m³ will be required. See below.

Storage Estimate	
Return Period (years)	100
Climate Change (%)	40
Impermeable Area (ha)	0.861
Peak Discharge (l/s)	10.000
Infiltration Coefficient (m/hr) (leave blank if no infiltration)	
Required Storage (m³)	Calc
from	537
to	700
With infiltration (m³)	
from	
to	

6.3.29 The proposed surface water catchments to the ditch, should be restricted to the above-mentioned flows using flow control devices i.e. Hydro-brake or similar approved.

- 6.3.30 Attenuation for the required storage volumes is to be housed in below ground storage i.e., Cellular Storage.
- 6.3.31 Surface water run-off from any impermeable areas at risk of contamination should receive water quality treatment. Roof drainage is considered very low hazard and external areas with the site boundary i.e., footways are considered to be very low risk, in terms of contamination.
- 6.3.32 Figure 13 illustrates the pollution hazard indices for the different land use classifications from the CIRIA SuDS Manual C753 (2015).
- 6.3.33 Figure 14 illustrates the SuDS Component mitigation indices from the CIRIA SuDS Manual C753 (2015).
- 6.3.34 The selection of treatment should ensure that the SuDS Mitigation component index exceeds the pollution hazard index. Where two stages of treatment are required, the second stage of treatment should account for reduced performance due to lower inflows; therefore 0.5 (mitigation index) should be used.
- 6.3.35 The proposed development has a car parking area. This area is currently shown at >800m². Therefore combined treatment of permeable paving and full retention separator are proposed prior to discharging flows to the watercourse.
- 6.3.36 It is recommended that spillages within the car park areas are treated locally and disposed of correctly in accordance with the proposals set out in the maintenance strategy section, to further prevent risk of contamination to the public sewers.
- 6.3.37 The proposals for pollution protected should be agreed with the LLFA.
- 6.3.38 There are no proposals for surface water drainage to be adopted.
- 6.3.39 The final design of the drainage network shall be in accordance with the legislation set by the Environment Agency and LLFA.

TABLE 26.2 Pollution hazard indices for different land use classifications				
Land use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydrocarbons
Residential roofs	Very low	0.2	0.2	0.05
Other roofs (typically commercial/ industrial roofs)	Low	0.3	0.2 (up to 0.8 where there is potential for metals to leach from the roof)	0.05
Individual property driveways, residential car parks, low traffic roads (eg cul de sacs, homezones and general access roads) and non-residential car parking with infrequent change (eg schools, offices) ie < 300 traffic movements/day	Low	0.5	0.4	0.4
Commercial yard and delivery areas, non-residential car parking with frequent change (eg hospitals, retail), all roads except low traffic roads and trunk roads/motorways ¹	Medium	0.7	0.6	0.7
Sites with heavy pollution (eg haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites), sites where chemicals and fuels (other than domestic fuel oil) are to be delivered, handled, stored, used or manufactured; industrial sites; trunk roads and motorways ¹	High	0.8 ²	0.8 ²	0.9 ²

Figure 13 – CIRIA Pollution Hazard Indices.

TABLE 26.3 Indicative SuDS mitigation indices for discharges to surface waters			
Type of SuDS component	Mitigation indices ¹		
	TSS	Metals	Hydrocarbons
Filter strip	0.4	0.4	0.5
Filter drain	0.4 ²	0.4	0.4
Swale	0.5	0.6	0.6
Bioretention system	0.8	0.8	0.8
Permeable pavement	0.7	0.6	0.7
Detention basin	0.5	0.5	0.6
Pond ⁴	0.7 ³	0.7	0.5
Wetland	0.8 ³	0.8	0.8
Proprietary treatment systems ^{5,6}	These must demonstrate that they can address each of the contaminant types to acceptable levels for frequent events up to approximately the 1 in 1 year return period event, for inflow concentrations relevant to the contributing drainage area.		

Notes

- 1 SuDS components only deliver these indices if they follow design guidance with respect to hydraulics and treatment set out in the relevant technical component chapters.
- 2 Filter drains can remove coarse sediments, but their use for this purpose will have significant implications with respect to maintenance requirements, and this should be taken into account in the design and Maintenance Plan.
- 3 Ponds and wetlands can remove coarse sediments, but their use for this purpose will have significant implications with respect to the maintenance requirements and amenity value of the system. Sediment should normally be removed upstream, unless they are specifically designed to retain sediment in a separate part of the component, where it cannot easily migrate to the main body of water.
- 4 Where a wetland is not specifically designed to provide significantly enhanced treatment, it should be considered as having the same mitigation indices as a pond.
- 5 See Chapter 14 for approaches to demonstrate product performance. A British Water/Environment Agency assessment code of practice is currently under development that will allow manufacturers to complete an agreed test protocol for systems intended to treat contaminated surface water runoff. Full details can be found at: <http://tinyurl.com/qf7yu7>
- 6 SEPA only considers proprietary treatment systems as appropriate in exceptional circumstances where other types of SuDS component are not practicable. Proprietary treatment systems may also be considered appropriate for existing sites that are causing pollution where there is a requirement to retrofit treatment. SEPA (2014) also provides a flowchart with a summary of checks on suitability of a proprietary system.

Figure 14 – CIRIA SuDS Mitigation Indices.

6.4 Sustainable Drainage System (SuDS)

- 6.4.1 Green infrastructure should always be considered at early stages of design. The benefit green infrastructure has on the environment are considered extremely positive. Green infrastructure such as Ponds, Swales and SuDS roofs (Green/blue/brown roofs) have been considered for this scheme.
- 6.4.2 Green infrastructure i.e., ponds and swales have been considered however discounted due to the proposed site constraints. Its worth noting that existing ditches/swales and ponds within the proposed development are to be maintained.
- 6.4.3 Above ground SuDS i.e., green/blue/brown roofs etc have also been considered however due to the proposed pitched roofs, cannot be incorporated into the scheme.
- 6.4.4 As part of the drainage strategy, we will be proposing permeable paving for the car park and pedestrian walkways, large green landscaped areas, attenuation in the form of below ground cellular storage and flow restrictions, to maximise sustainable drainage where possible.
- 6.4.5 Rainwater harvesting should also be considered by the client and wider design team. Opportunities to incorporate these features to the lodges, animal enclosures and buildings would be an improved addition to attenuating surface water run-off at source.
- 6.4.6 Refer to Appendix G for the Drainage Strategy Layout.
- 6.4.7 Hydraulic calculation have been included in Appendix J.

7 MAINTENANCE

7.1 Strategy

- 7.1.1 All onsite drainage systems will be privately maintained, and a specialist management company will be appointed to oversee the maintenance of these. A long-term maintenance regime should be implemented for the lifetime of the development. In addition to a long-term maintenance regime, it is recommended that all drainage elements implemented on site should be inspected following the first rainfall event post-construction and monthly for the first quarter following construction.
- 7.1.2 It is recommended that the drainage system is inspected as a minimum twice a year, with the system also being inspected after any major storm events. Significant sediment deposition is likely in areas used for storage, so a post clean-up operation may be required including the removal of little vegetation, sewerage debris and larger objects.
- 7.1.3 Proposals to deal with spillages within car parking areas from vehicles should be confirmed and agreed by the management company.
- 7.1.4 Proposals to manage and maintain the proposed sewage treatment plant should be confirmed and agreed by the management company, considering guidance set and recommendations by selected manufacturer.
- 7.1.5 The Maintenance Strategy document should be developed as the scheme progresses following confirmation of all SuDS features and proprietary products being selected.
- 7.1.6 The Maintenance Strategy should form part of the building O&M manual and all the measures and designs will need to be adhered to in order to maintain the design life and design capacity of the surface and foul water drainage systems.
- 7.1.7 Refer to Appendix K for Outline Drainage Maintenance Strategy.

7.2 SuDS and Drainage Features

- 7.2.1 Photographic evidence should be provided of all installed drainage features by the selected contractor. This evidence is to be included in the O&M manual along with the Drainage Maintenance Strategy.