

West of Loughborough Sustainable Urban Extension

Flood Risk Assessment

On behalf of **William Davis and Persimmon Homes**



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Contents

1	EXECUTIVE SUMMARY	3
2	INTRODUCTION	4
3	PROPOSED DEVELOPMENT SITE	5
	3.1 Site Location.....	5
	3.2 Site Topography	5
	3.3 Hydrological Context.....	5
	3.4 Geological Context.....	7
	3.5 Existing Site Drainage.....	8
	3.6 Proposed Development.....	8
4	ASSESSMENT OF FLOODING	11
	4.1 Sequential Test.....	11
	4.2 Exception Test.....	11
	4.3 Fluvial Flooding: Review of Data	12
	4.4 Fluvial Flooding: Detailed Assessment	14
	4.5 Groundwater Flooding.....	15
	4.6 Surface Water Flooding	15
	4.7 Reservoir Flooding.....	16
5	FLOOD MITIGATION STRATEGY	18
	5.1 Principles for Flood Mitigation Strategy.....	18
	5.2 Sequential Approach.....	18
	5.3 Finished Floor Levels.....	19
	5.4 Access Routes.....	19
	5.5 Bridge Crossings.....	19
	5.6 Floodplain Storage and Flowpath Compensation.....	20
6	SURFACE WATER MANAGEMENT	21
	6.1 Existing Surface Water Regime.....	21
	6.2 Potential Impact of Proposed Development.....	21
	6.3 Principles For Surface Water Management Strategy	21
	6.4 Proposed Strategy	22
	6.5 Other Considerations	24
7	CONCLUSION	25

Figures

Figure 1: EA on line Flood Map for West of Loughborough site.....	6
Figure 2: Illustrative Masterplan FPCR drawing 1005-L-0 rev B, August 2014.....	10
Figure 3: EA on line Flood Map for Loughborough.....	12
Figure 4: EA On line mapping: Surface Water Flooding.....	16
Figure 5: EA On line mapping: Reservoir Flooding	17

Tables

Table 6.1 – Preliminary estimate of surface water storage requirements.....	23
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Appendices

Appendix A	Site Location Plan
Appendix B	Topographical Survey
Appendix C	Illustrative Masterplan
Appendix D	Charnwood BC Sequential Test
Appendix E	Hydraulic Modelling Reports
Appendix F	Floodplain Mapping
Appendix G	Bridge Crossing: Hydraulic Modelling
Appendix H	Floodplain Storage Compensation
Appendix I	Surface Water Drainage Strategy
Appendix J	EA Meeting Notes

1 EXECUTIVE SUMMARY

- 1.1.1 A mixed use urban extension is proposed at the land to the west of Loughborough, identified in Charnwood Borough Council's Core Strategy as the preferred location for a Sustainable Urban Extension. The overall site is predominantly greenfield and covers an area of approximately 466ha.
- 1.1.2 According to the Environment Agency (EA) online Flood Map the majority of the site is located in Flood Zone 1 as defined in National Planning Policy Framework (NPPF) table 1. This is an area with a Low Probability of Flooding. Some parts of the site are potentially affected by flooding from the Black Brook, Shortcliff Brook and Oxley Gutter that flow within the site and these areas are shown to be in Flood Zones 2 and 3 with a Medium or High Probability of Flooding.
- 1.1.3 The proposals for residential development and other uses constitute More Vulnerable and Less Vulnerable land uses respectively, as defined in NPPF table 2. According to NPPF, this type of development is suitable in Flood Zone 1. The development is also suitable for Flood Zones 2 and 3, although the development proposals will seek to locate only essential infrastructure and POS (water compatible uses) within the floodplain.
- 1.1.4 The Black Brook flows through the site and into Loughborough and two small tributaries of the Black Brook (the Shortcliff Brook and Oxley Gutter) flow through the southern part of the site. There are floodplains associated with these watercourses and, in some areas, these extend into the site. There are also existing problems of flooding from the Black Brook, a tributary of the River Soar, further downstream and flood defences have been constructed in some areas of Loughborough.
- 1.1.5 Detailed modelling studies have been completed based on the EA's existing modelling of the Black Brook with detailed site survey data. These have been used to define the floodplain constraint and provide an understanding of the floodplain flow routing and storage functions. Maintaining the river corridor along the Black Brook and responding to the floodplain constraint has been a key tenet of the masterplanning and development strategy for the site. All development apart from the strategic road link are located outside the floodplain, using the sequential approach and flood mitigation measures include floodplain storage compensation, appropriate bridge design and setting finished flood levels and road levels above the design flood.
- 1.1.6 With the development of a greenfield site there will be substantial impacts on the surface water runoff regime. Surface water discharges primarily into the watercourses within the site and infiltration potential is generally limited within the site. An overarching strategy for the development comprising SuDS has been agreed in principle with the EA and Leicestershire CC (as the future SAB) with discharge restricted to the greenfield runoff rate for each event. This includes strategic attenuation areas and swales and will ultimately include further SuDS within each phase of the development.
- 1.1.7 Charnwood Borough Council has completed the Sequential Test for the proposed SUE at the site and this demonstrates that the site is suitable for the proposed development. Part 1 of the Exception Test is demonstrated in the planning statement that outlines the need and wider benefits of the development, and the FRA includes details of the proposed strategies for managing flooding and surface water runoff from the new development to address part 2 of the Exception Test.
- 1.1.8 This Flood Risk Assessment (FRA) confirms that the proposed development complies with NPPF, which is the planning policy for Development and Flood Risk.

2 INTRODUCTION

- 2.1.1 PBA has completed a FRA on behalf of William Davis and Persimmon Homes in support of an outline planning application at a site to the West of Loughborough for residential development up to 3,200 dwellings; up to 16 ha of employment land of B1/B2 and B8 uses, a mixed use Community Hub of up to 4ha comprising a local convenience retail unit (2,000 sqm); up to 1,000 sqm of other A1 retail, A2 financial and professional services, A3 food and drink, B1 business and D1 uses; sites for gypsies, travellers and travelling showpeople totalling 1 ha, two primary schools up to 2 ha each; strategic open space including allotments; access roads and Strategic Link Road; open space / landscaping and associated works; principal means of access; restoration of Garendon Park and assets; all other matters to be reserved.
- 2.1.2 The FRA has been completed in accordance with the following policy and guidance:
- National Planning Policy Framework (NPPF)
 - Planning Practice Guidance (PPG)
 - Charnwood Level 1 SFRA (April 2008) and SFRA Update (June 2014)
- 2.1.3 In completing the FRA the following key stakeholders have been consulted:
- Environment Agency (EA)
 - Charnwood Borough Council (CBC)
 - Severn Trent Water (STW)
 - Leicestershire County Council (LCC)
 - Sport England
- 2.1.4 Part of the site is located within the floodplain of the Black Brook or its tributaries so an NPPF Sequential Test has been undertaken by CBC in consultation with the EA for all sites identified in the draft core strategy, including West of Loughborough. The Sequential Test confirms that West of Loughborough is a suitable site for the proposed SUE development.
- 2.1.5 The FRA includes details of the overall development strategy for the SUE which takes full account of the floodplain of the Black Brook, Oxley Gutter and Shortcliff Brook within the site including recommendations for flood management. It also includes key design principles for the overall strategy for managing surface water runoff within the site as agreed with the EA and LCC.
- 2.1.6 With the flood management and surface water management strategies, the FRA demonstrates that the proposals meet the requirements of the Exception Test (as defined in NPPF) such that the development is safe for its lifetime and does not have an adverse impact on flood risk elsewhere.

3 PROPOSED DEVELOPMENT SITE

3.1 Site Location

3.1.1 The site at West of Loughborough covers 466 ha and is located at the western edge of Loughborough. An essentially greenfield site, it comprises an historic landscape park and arable farmland with associated buildings and infrastructure. The site is located to the west of the Thorpe Acre residential development and south of the village of Hathern. The M1 forms the western boundary, with the A512 to the south, Shepshed Road to the north-west and the A6 to the north east. A site location plan is provided in drawing 29231-001-011 in **Appendix A**.

3.2 Site Topography

3.2.1 The topography across the site varies considerably and the site is broadly split by the Black Brook into northern and southern areas. Detailed topographical survey data is provided in **Appendix B**.

3.2.2 Within the northern area of the site a ridge of high ground at a level of approximately 77.00m AOD traverses the site from the western to the eastern site boundary. A similar area of high ground is located towards the south western site boundary with ground levels reaching approximately 88.00m AOD. In the central parts of the site ground levels fluctuate between 55.00m AOD and 44.00m AOD and there is a general eastward sloping gradient as ground levels fall towards the eastern site boundary following the gradient of the Black Brook floodplain.

3.3 Hydrological Context

3.3.1 Three watercourses flow through the site as shown in drawing 29231-001-011 in **Appendix A** which are:

- The Black Brook
- The Oxley Gutter
- The Shortcliff Brook (a tributary of the Burleigh Brook)

3.3.2 The Black Brook is designated Main River whilst the Oxley Gutter and Shortcliff Brook are ordinary watercourses through the site and these are described in further detail in the following sections.

The Black Brook

3.3.3 The Black Brook is a tributary of the River Soar and its total catchment covers an area of 54.03km², receiving approximately 691mm of rainfall per annum. The watercourse originates in Charnwood Forest close to Bess Bagley, flowing in a north-westerly direction before passing underneath the M1 and into Black Brook reservoir. The Black Brook then flows in a north-easterly direction and again passes underneath the M1 and through Garendon. Downstream of the site, the Black Brook passes through Thorpe Acre before its confluence with the River Soar at Bishops Meadow Nature Reserve to the north of Loughborough.

3.3.4 The upper catchment reaches a maximum elevation of 200m AOD, falling to approximately 35m AOD at the confluence of the Black Brook and the River Soar. The catchment is primarily rural, although there is a significant urban component at Shepshed. The catchment is also significantly influenced by the attenuating effect of the Black Brook Reservoir.

- 3.3.5 Throughout the site the watercourse remains in a natural and partially vegetated river channel. There are three formal crossing points over the Black Brook in close proximity to the Garendon site. These are the Hathern Road crossing at the western site boundary, the Hathern Drive crossing at the Bridleway towards the east of the site and Stonebow Bridge, a packhorse-style bridge with medieval origins at the eastern site boundary. Downstream of the site, at Thorpe Acre, the channel has been concrete lined and a flood defence embankment provides protection to the existing residential properties on the left bank. The Black Brook is designated as Main River throughout the site.
- 3.3.6 The EA Flood Map (available at www.environment-agency.gov.uk) indicates an extensive floodplain associated with the Black Brook through the site. In some locations the Black Brook floodplain through the site is approximately 300m wide. A copy of the EA's Flood Map with the approximate site boundary is provided in **Figure 1**.

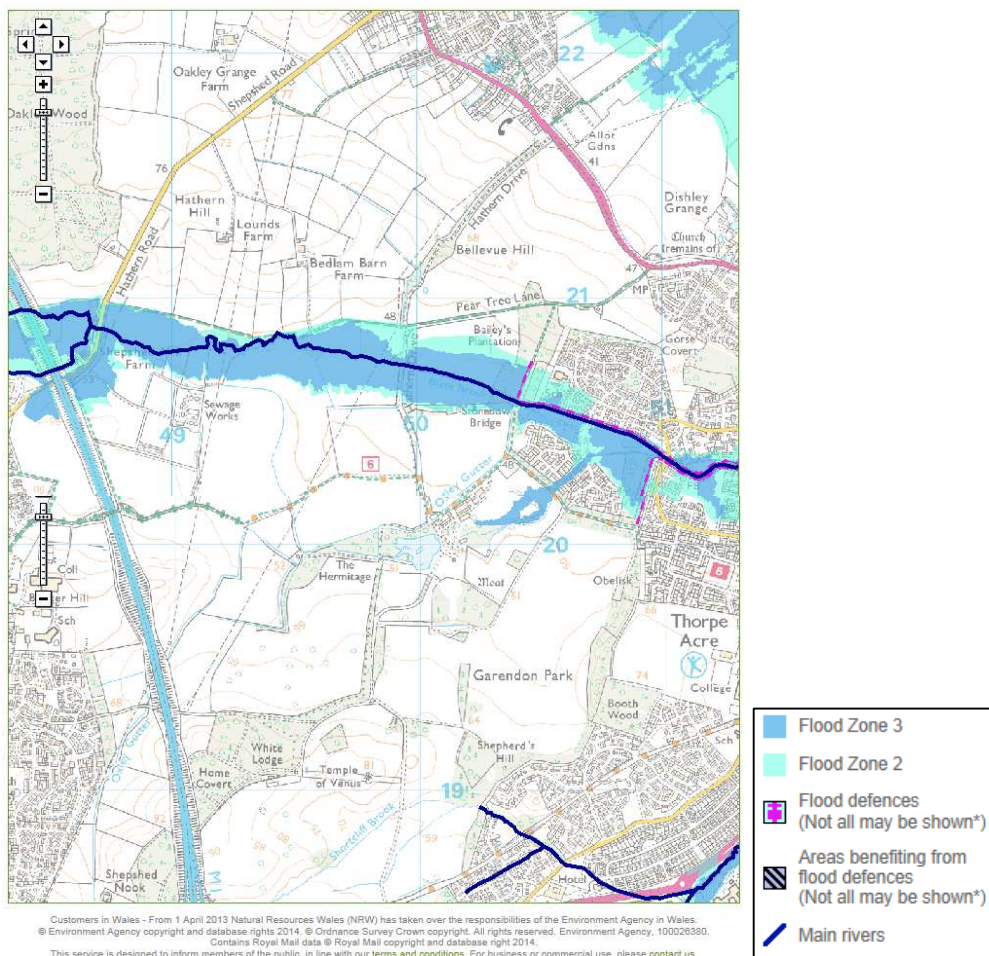


Figure 1: EA on line Flood Map for West of Loughborough site

The Oxley Gutter

- 3.3.7 The Oxley Gutter originates at Shepshed Nook immediately to the south east of Shepshed and has a total catchment area of 3.73km². The watercourse is a tributary to the Black Brook and flows in an easterly to north-easterly direction before joining the Black Brook at two locations at Thorpe Acre.

- 3.3.8 Within the site, the Oxley Gutter is fed by a number of small field drains and ditches and splits into two separate channels at the Hermitage in the centre of the site. The southern channel flows into a lake and is culverted for 50m before continuing on to the confluence with the Black Brook downstream of Mt Grace Drive at Thorpe Acre. Throughout the 2km reach within the site the watercourse remains in a natural, partially vegetated, well-maintained (in certain sections) trapezoidal channel. According to EA on line mapping, the watercourse is not designated Main River at any point to the confluence with the Black Brook.
- 3.3.9 The EA's Flood Map for the Oxley Gutter confirms that the land immediately downstream of the lake is in an 'area at risk of flooding'. As the catchment of the Oxley Gutter in the vicinity of the lake is relatively small, it is possible that the upstream reaches have not been considered as part of the EA's Flood Risk Mapping. However, this is not necessarily an indication that there is no flood risk associated with the watercourse.

The Shortcliff Brook

- 3.3.10 The catchment of the Shortcliff Brook comprises an area of approximately 4km², covering an area towards the south and south east of the site, down to the confluence with the Burleigh Brook. The watercourse flows in a north easterly to easterly direction through the historic parkland in the southern part of the site. Beyond the site it flows through Thorpe Acre and into the Burleigh Brook that passes through Loughborough and eventually outfalls into the River Soar.
- 3.3.11 Throughout the site, the watercourse remains in a natural, partially vegetated, well-maintained (in certain sections) trapezoidal channel. The watercourse is surrounded by cultivated farmland with an extensive area of low lying ground to the south and steeply rising ground to the north towards the Temple of Venus. According to EA on line mapping only the downstream extent of the Shortcliff Brook, from the sites eastern boundary to its confluence with the Burleigh Brook is designated Main River
- 3.3.12 The EA's Flood Map for the area does not indicate that the land immediately surrounding the Shortcliff Brook is within an area at risk of flooding. However, this is most likely due to the relatively small catchment area of the Shortcliff Brook (4km²) and the strategic nature of the Flood Map and does not necessarily indicate low flood risk.

3.4 Geological Context

- 3.4.1 A review of readily available geological information for the West of Loughborough site has been undertaken to assess the potential suitability of ground conditions for infiltration drainage.
- 3.4.2 The Phase I Site Appraisal (completed by GRM in April 2014) and an 'Envirocheck Report' confirm that the British Geological Sheet for this area shows the superficial deposits within the site boundary to comprise:
- *Alluvium* – associated with the tracts of the three watercourses that cross (west to east) the site, namely the Black Brook, Oxley Gutter and Shortcliff Brook. These deposits are known to comprise up to 2m of mottled grey and brown silts which in the main floodplain of the river Soar (to the east) is underlain by up to 5m of gravel;
 - *Wanslip Sand and Gravel* – These are River Terrace Deposits and generally comprise sand-rich gravels. They occur as an elongate outlier between the Black Brook and the Oxley Gutter, and to the south of the latter watercourse;
 - *Birstall Sand and Gravel* - These also are River Terrace Deposits, and again comprise sand-rich gravels. Within the study site only a small outlier is recorded in the southern part of the site;

- *Glaciofluvial Sand and Gravel* – These are generally of thin and limited extent in the district and typically comprise red to brown sands with gravelly lenses.
 - *Thrussington Till* – This typically comprises red to brown gravelly glacial clay;
 - *Head* – This is a periglacial deposit that is extremely variable in composition but typically is a stony clay-silt and can be up to 3m in thickness. The deposit can locally overlie and mask older River Terrace and glacial deposits.
- 3.4.3 The solid geology is indicated to comprise the Gunthorpe Member (Mudstone, red-brown; beds of red sandstone and green dolomitic siltstone). The Gunthorpe Formation is indicated to outcrop over significant areas of the site more particularly in the south and west, where it has weathered to a clay.
- 3.4.4 The Phase I Deskstudy states that localised made ground material may be present along farm access routes, however, the extensive development of made ground is not anticipated.
- 3.4.5 Based on the available information, some areas south of the Black Brook and at the northern part of the Garendon Park are assessed as being potentially suitable for soakaway drainage.
- 3.4.6 At this stage, the alluvial tract along the Black Brook is not considered likely to be suitable for use on the basis that the gravel deposits will be substantially waterlogged. This however should be verified at a later stage.
- 3.4.7 All other areas of the site are expected to be underlain by a ‘clay-soil’ and thus unlikely to be considered suitable in general for soakaway infiltration.
- 3.4.8 According to on line EA mapping, the site is located some distance (more than 2km) from a Groundwater Source Protection Zone so there are no specific additional restrictions related to discharge to groundwater, should these be feasible on the basis of the ground conditions.

3.5 Existing Site Drainage

- 3.5.1 The site is generally undeveloped and there is no formal surface water drainage infrastructure within the site itself. Land drainage measures for the various parcels of agricultural land include a number of ditches that feed into the Oxley Gutter. Based on topography and site observations it is evident that these serve only localised catchments within the site.
- 3.5.2 Review of Severn Trent Water asset plans confirms that there is local sewerage infrastructure located within the surrounding road networks but these do not extend into the site.

3.6 Proposed Development

- 3.6.1 The proposals are for outline planning permission for:
- Residential development up to 3,200 dwellings;
 - up to 16 ha of employment land of B1/B2 and B8 uses, a mixed use Community Hub of up to 4ha comprising a local convenience retail unit (2,000 sqm);
 - up to 1,000 sqm of other A1 retail, A2 financial and professional services, A3 food and drink, B1 business and D1 uses;
 - sites for gypsies, travellers and travelling showpeople totalling 1 ha, two primary schools up to 2 ha each;
 - strategic open space including allotments;

- access roads and Strategic Link Road;
- open space / landscaping and associated works;
- principal means of access;
- restoration of Garendon Park and assets.

3.6.2 The proposed development is shown on the illustrative masterplan in **Figure 2** and FPCR drawing 1005-L-04 rev B, dated August 2014 in **Appendix C**.



Figure 2: Illustrative Masterplan FPCR drawing 1005-L-04 rev B, August 2014

4 ASSESSMENT OF FLOODING

4.1 Sequential Test

4.1.1 In accordance with NPPF development of any site in or partially within either Flood Zone 2 or 3 should only be allowed where a Sequential Test has been completed. The Sequential Test aims to steer new development to areas with the lowest probability of flooding i.e. sites in Flood Zone 1. If no sites are available in Flood Zone 1 then the Test is used to consider reasonably available sites in Flood Zone 2 and then in Flood Zone 3 in the context of the vulnerability of the proposed land use and goes on to identify where the Exception Test must also be passed.

4.1.2 The Sequential Test is applied by the LPA and forms part of the Evidence Base for the Local Plan. CBC has completed the Sequential Test to inform the Charnwood Local Plan Core Strategy which sets out where development will be located across Charnwood up to 2028.

4.1.3 CBC has finalised the Sequential Test in consultation with the EA and it confirms:

- All key development option sites within the Sub Regional Centre of Loughborough and identified in the Core Strategy are partly within Flood Zones 2 and 3
- The West of Loughborough site has a large area with 86% of it lying within Flood Zone 1. However, to deliver the target housing quantum, only part of this area would need to be developed and masterplanning for the site demonstrates that a sequential approach to layout is possible with more vulnerable and less vulnerable uses within Flood Zone 1.
- Masterplanning for the West of Loughborough site also demonstrates that water compatible uses can be located within areas of flood risk and although essential infrastructure (access) would need to cross the Black Brook and its floodplain (which is in Flood Zone 3), this is consistent with other reasonable alternatives.
- The West of Loughborough site has a similar level of flood risk as other reasonable alternatives, but has been selected on the basis of a range of other social, economic and environmental criteria which are laid out in the Sustainability Appraisal Report March 2013.

4.1.4 The Sequential Test is provided in **Appendix D**.

4.2 Exception Test

4.2.1 PPG states that the Exception Test, as set out in paragraph 102 of NPPF, is a method to demonstrate and help ensure that flood risk to people and property will be managed satisfactorily, while allowing necessary development to go ahead in situations where suitable sites at lower risk of flooding are not available.

4.2.2 Essentially, the two parts to the Test require proposed development to show that it will provide wider sustainability benefits to the community that outweigh flood risk and that it will be safe for its lifetime without increasing flood risk elsewhere and where possible reduce flood risk overall.

4.2.3 The spatial strategy outlined in the Core Strategy followed an appraisal of a range of 'reasonable alternatives' and the sustainability benefits of each reasonable alternative were considered by CBC within the Sustainability Appraisal Supplementary Report (October 2013) which sets out the reasons for either selecting or rejecting different options. CBC confirms that this addresses Part 1 of the NPPF Exception Test.

- 4.2.4 For Part 2 of the Exception Test to be passed CBC confirms that a site specific flood risk assessment must demonstrate that a development will be safe for its lifetime taking account of the vulnerability of its users.
- 4.2.5 Part 2 of the Exception Test is addressed in the following sections of the FRA that consider the criteria to assess potential flood risk issues at the site and resulting from the proposed development and that outline strategies to manage flood risk and surface water runoff (and its potential impact elsewhere) as part of the scheme.

4.3 Fluvial Flooding: Review of Data

- 4.3.1 As noted earlier, three key watercourses flow through the site. There is the potential for flooding from these watercourses to affect the site, particularly given the predominantly undeveloped nature of the site and broadly natural channel form.
- 4.3.2 Data from various sources has been reviewed to determine the nature of flood risk at the site and this is summarised in the following sections.

EA Flood Map

- 4.3.3 The EA on line Flood Map, which is reproduced in **Figure 1** in section 3.3, indicates the potential extent of the floodplains associated with these watercourses at the site.
- 4.3.4 A larger scale extract of the Flood Map, reproduced in **Figure 3**, shows the flooding context, including the impacts of the Black Brook floodplain on the Loughborough itself, downstream of the West of Loughborough site.

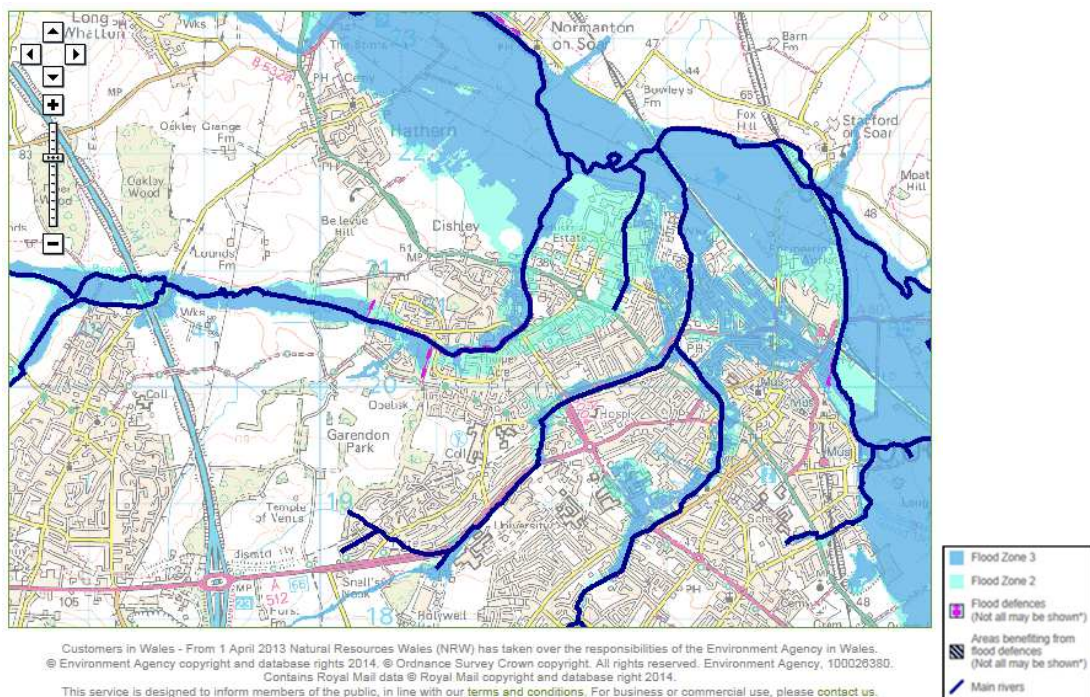


Figure 3: EA on line Flood Map for Loughborough

- 4.3.5 It is noted that there are downstream flooding issues related to the Black Brook and the Shortcliff Brook and flood defence infrastructure on the Black Brook immediately downstream of the West of Loughborough site.

- 4.3.6 The floodplain extent for the Black Brook is based on hydraulic modelling undertaken by the EA. No modelling was completed for the Shortcliff Brook or Oxley Gutter to inform the EA Flood Map.

CBC Strategic Flood Risk Assessment

- 4.3.7 CBC has also produced a **Level 1 Strategic Flood Risk Assessment (SFRA) in April 2008 and a SFRA Update**, which was made publicly available in July 2014.
- 4.3.8 The Level 1 SFRA has the principal aim of classifying all land within the Borough into the Flood Risk Zones defined in PPS25 (which has now been superseded by NPPF). This information provides the basis for undertaking the Sequential Test and informing the emerging CBC Local Development Framework (Charnwood 2026). The study presents indicative information in respect of the nature of flood risk associated with both the Black Brook and the Burleigh Brook, but details for the Oxley Gutter and Shortcliff Brook are not included in the report. The SFRA is informed primarily by EA data.
- 4.3.9 The objectives of the SFRA Update are a hybrid approach involving a general update and review of the 2008 SFRA, which covers the whole of the Borough (level 1) and a more detailed assessment of allocations included in the emerging draft Core Strategy. Whilst the SFRA Update does expand on the information in the Level 1 SFRA, and considers other potential sources of flooding, it does not include any more detailed studies of fluvial flood risk from the Black Brook, Oxley Gutter or Shortcliff Brook.
- 4.3.10 Overarching guidance from the SFRA Update for new development is summarised as:

Development and Flood Risk

- 4.3.11 All development should adhere to the advice in the Charnwood Borough Strategic Flood Risk Assessment Update and the guidance provided on Flood Risk Assessment requirements in order to:
- **protect floodplains from inappropriate development;**
 - **ensure no increase in flood risk;**
 - **where possible provide flood risk betterment; and**
 - **ensure development is safe.**

Protection and Enhancement of Watercourses

- 4.3.12 Planning permission for development should only be granted where:
- the natural watercourse system which provides drainage of land is not adversely affected;
 - a minimum 8m width access strip is provided adjacent to the top of both banks of any watercourses for maintenance purposes and is appropriately landscaped for open space and Biodiversity benefits, this width may be reduced in particular circumstances with agreement from the Environment Agency and LPA;
 - it would not result in the loss of open water features through draining, culverting or enclosure by other means and culverts are opened up where ever possible;
 - surface water drainage is delivered by sustainable drainage systems (SuDS); and

- betterment in the surface water runoff regime is ensured; with any residual risk of flooding, from drainage features either on or off site not placing people and property at unacceptable risk.

4.3.13 Specifically, the review of the West of Loughborough site highlights the following:

Potential flood risks relating to the development of this site include:

- Potential fluvial flooding from the Black Brook, Oxley Gutter and the un-named tributary of the Burleigh Brook
- There is additional flood risk from surface water flooding and overland flows generated within the proposed development site and from adjacent developments
- With further development and creation of impermeable ground surfaces, surface water flooding may become a problem
- Potential risks from blockages or insufficient capacity of culverts or bridges
- This site has the potential to be used to reduce flood risk downstream through attenuation of flows.

4.3.14 The SFRA mapping is generally based on the EA data although it includes a more extensive assessment of the Oxley Gutter within the site and indicates the extent of Flood Zone 3b.

4.4 Fluvial Flooding: Detailed Assessment

4.4.1 The readily available data is generally of a coarse or strategic nature and a more detailed assessment has been completed to more accurately define the potential floodplain extent within the site.

4.4.2 The methodology for this assessment has been agreed and subsequently reviewed by the EA and it comprises the following:

- Update the EA Black Brook model (1-D channel model using ISIS)
- Produce a 1-D channel model for the Oxley Gutter (using HECRAS)
- Produce a 1-D channel model for the Shortcliff Brook (using HECRAS)
- Define the floodplain extent for key scenarios using detailed site survey data

4.4.3 A brief summary of the baseline modelling for each of the watercourses is provided in the following sections and full information on the modelling studies is included in **Appendix E**.

Black Brook Baseline Model

4.4.4 The EA model and resulting mapping has been updated to include:

- Additional channel cross sections at key locations to allow for the assessment of the potential impacts of the proposed scheme (i.e. at the location for the proposed bridge crossing)
- Detailed topographical survey data for the site
- Additional sensitivity testing and review of hydrology

Oxley Gutter Baseline Model

- 4.4.5 Topographical survey data for the site and key structures including channel cross sections has been used to produce a 1-D channel model for the Oxley Gutter. The model extends 2km from the site's western boundary at the M1 to the confluence with the Black Brook and model results from the Black Brook model study are used to inform the downstream boundary condition.
- 4.4.6 The schematisation has been informed by site observations and detailed site survey to confirm connectivity and key flow routes within the ditch network.
- 4.4.7 Inflows have been estimated for the upstream catchment using FEH statistical, ReFH and loH124 methods. The final baseline model has been run with the ReFH hydrology.

Shortcliff Brook Baseline Model

- 4.4.1 Topographical survey data for the site and key structures including channel cross sections has been used to produce a 1-D channel model for the Shortcliff Brook. The model extends from the site's south western corner to the eastern boundary, a length of 1.27km and model results from the Black Brook are used to inform the downstream boundary condition.
- 4.4.2 The schematisation has been informed by site observations and detailed site survey to confirm connectivity and key flow routes within the ditch network.
- 4.4.3 Inflows have been estimated for the upstream catchment using FEH statistical, ReFH and loH 124 methods. The final baseline model has been run with the ReFH hydrology.

Summary of Fluvial Flood Risk to Site

- 4.4.4 The baseline modelling studies have confirmed the extent of the floodplain within the site during key events. This is shown in drawing 29231-001-002 in **Appendix F**.

4.5 Groundwater Flooding

- 4.5.1 Mapping provided in the SFRA indicates areas susceptible to groundwater flooding based on coarse geological characteristics of the area. It shows that susceptibility to groundwater flooding in the areas within the 1km (OS) grid squares that follow the route of the Black Brook is between 25% and 50%. In the remainder of the site the risk reduces to 25% or less.
- 4.5.2 The mapping is based on geological and hydrogeological indicators for groundwater emergence and does not show the likelihood of groundwater flooding actually occurring. The SFRA states that the data should not be used in isolation to assess the potential for groundwater flooding.
- 4.5.3 Stakeholder consultation does not highlight any known incidents of groundwater flooding and the risk is not considered further within this FRA.

4.6 Surface Water Flooding

- 4.6.1 Mapping in the SFRA shows the flooding that takes place from the 'surface runoff' generated by rainwater which is on the ground surface and has not yet entered a watercourse, drainage system or sewer. The maps indicate the potential extent of surface water flooding for the 1 in 30 year, 100 year and 1,000 year storms.
- 4.6.2 On line EA mapping also provides an indication of the potential areas affected by surface water flooding and an extract is shown in Figure 4.

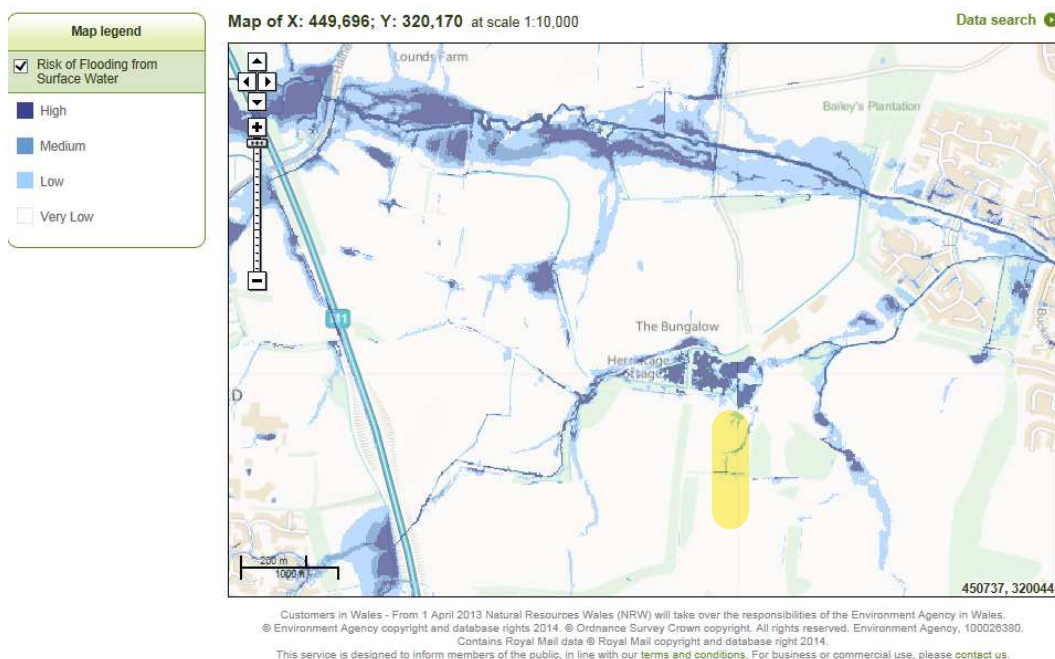


Figure 4: EA On line mapping: Surface Water Flooding

- 4.6.3 The EA and SFRA mapping picks out the local watercourses and natural channels with localised areas affected in the 1 in 30 year storm and 1 in 100 year event and a slightly more extensive area particularly around the Black Brook or within the lake areas on the Oxley Gutter shown to be affected during the 1 in 1,000 year storm.
- 4.6.4 The development of the site will include localised reprofiling where necessary to provide suitable development platforms and to manage overland flows. As such the surface water flood risk to the existing site is not assessed further and a suitable surface water management strategy will be implemented as part of the scheme to manage this risk for the new development.

4.7 Reservoir Flooding

- 4.7.1 On line EA mapping provides an indication of the maximum extent of potential inundation in the event of a reservoir breach. An extract is provided in **Figure 5**.
- 4.7.2 On the Black Brook approximately 4km upstream of the site, is the Black Brook Reservoir. The Black Brook corridor within the site is shown to be within the maximum extent of flooding from a reservoir breach.



Figure 5: EA On line mapping: Reservoir Flooding

- 4.7.3 Whilst this does not affect the flood zone classification for the site, all potential sources of flooding should be considered as part of a site specific FRA.
- 4.7.4 Review of historical records has confirmed that there was a breach of the reservoir in 1799 shortly after it was first constructed and this affected much of Shepshed and areas of Loughborough. The current gravity dam was constructed in 1906.
- 4.7.5 Liaison with the EA and Leicestershire County Council confirms that the reservoir is well maintained. Based on the good condition of the reservoir, its distance from the site and the presence of physical barriers to overland flow (i.e. the motorway) the EA and LCC confirmed that the actual potential for reservoir flooding to affect the site is very low and does not need to be assessed further.
- 4.7.6 In determining the flood mitigation strategy for the new development, reservoir flooding is not considered directly. However, the maximum extent of inundation generally coincides with the Black Brook corridor and by applying the sequential approach in locating the more vulnerable elements of the scheme and by setting suitable freeboard for finished floor levels to manage the fluvial flood risk, the extremely low residual risk of reservoir flooding is also mitigated.

5 FLOOD MITIGATION STRATEGY

5.1 Principles for Flood Mitigation Strategy

- 5.1.1 Charnwood BC's Sequential Test recognises that essential infrastructure, which for this development includes a new bridge crossing of the Black Brook, will need to traverse the floodplain including areas within Flood Zones 2 and 3. Otherwise it states that applying the sequential approach will ensure that appropriate land uses are located within the different flood zones within the site. This approach has been a key driver in the masterplanning strategy.
- 5.1.2 In accordance with NPPF, and to meet the requirements of Part 2 of the Exception Test, the flood risk mitigation strategy must ensure that the proposed development will be safe for its lifetime without increasing flood risk elsewhere and where possible reduce flood risk overall.
- 5.1.3 This can be achieved through:
- Locating the more vulnerable uses in the areas with lower probability of flooding (i.e. not placing new residents or occupiers of the site in areas with significant probability of flooding)
 - Locating only essential infrastructure within areas defined as Flood Zones 2 and 3
 - Recommending suitable finished floor levels for the new buildings with an appropriate freeboard above the design flood level
 - Providing compensation for any loss of floodplain storage resulting from reprofiling of the floodplain or surrounding areas
 - Providing suitable pedestrian and vehicular access routes that remain safe in the design flood event
- 5.1.4 The flood mitigation strategy has been developed using standard guidelines and following consultation with the EA including a meeting held on 30th January 2014.
- 5.1.5 The design flood event for this site has been taken as the 1 in 100 year event with climate change impacts included. The potential flood levels for this event have been determined through the hydraulic modelling studies for the Black Brook, Oxley Gutter and Shortcliff Brook.

5.2 Sequential Approach

- 5.2.1 The masterplanning process has been steered by key existing constraints within the site and aspirations for the new development to meet sustainability criteria and achieve wider benefits to the local community and new residents alike. Potential flood risk from the three watercourses within the site has been a consideration throughout this process and the proposed land uses across the site have been selected with an aim to create a viable scheme whilst matching the vulnerability of the land use with the likelihood of flooding.
- 5.2.2 Areas within and around the Black Brook corridor have been identified for 'water compatible' uses including public open space, habitat creation or enhancement and playing fields with essential infrastructure comprising the only 'development' located within the floodplain.
- 5.2.3 The local centre including 'less vulnerable' community uses, retail and commercial development have been located beyond the indicative floodplain for the Black Brook.
- 5.2.4 'More vulnerable' residential development has been located further from the floodplain.

5.2.5 This sequential approach is demonstrated in the illustrative masterplan in **Figure 2**.

5.3 Finished Floor Levels

5.3.1 As outlined in section 5.2, buildings will not be located in areas affected during the design flood event i.e. within the floodplain for the 1 in 100 year with climate change event on each watercourse.

5.3.2 As further resistance to floodwater entering properties, the finished floor levels for all dwellings is recommended to be set a minimum of 300mm above the 1 in 100 year with climate change flood level at that location.

5.3.3 It should be noted that flood levels vary across the site for each watercourse to reflect the gradient of the channel and floodplain. As such the recommended minimum finished floor levels for the new development should be confirmed for each phase as it comes forward.

5.4 Access Routes

5.4.1 Safe access routes will be available from all parts of the site to an area outside the floodplain during the design flood event. Where possible, and from all residential development, these routes will be set above the design flood level (i.e. the 1 in 100 year with climate change flood level).

5.4.2 As well as safe access routes within the site during flood events, the access routes off the site to key destinations such as the M1 and Loughborough centre are broadly unaffected by fluvial flooding during the design flood events.

5.5 Bridge Crossings

5.5.1 A vehicular crossing of the Black Brook is required as part of the scheme to provide connectivity between the northern and southern parts of the new development and to complete the strategic route between the A512 and the A6.

5.5.2 This crossing will be designed to ensure that there is no impact on flood levels or flows beyond the site (both upstream and downstream) during the 1 in 100 year with climate change flood event.

5.5.3 Preliminary design principles for the form and arrangement of an appropriate crossing have been agreed with the EA, based on the proposed location for the new crossing as shown in the illustrative masterplan, in Figure 2 as follows:

- Bridge soffit to be set at a level of a minimum of 600mm above the 1 in 100 year +CC modelled flood level
- Open span section to be provided across the channel and beyond top of bank on both sides of the channel- suggested clear span of 12-15m (to be confirmed by assessment of floodplain and with consideration to ecological requirements)
- Culvert openings under the roadway through the right bank (southern) floodplain are to be provided for, say, 2/3 of the floodplain width- i.e. approx. 60-70m beyond the clear span section (to be confirmed by assessment of floodplain and consideration to ecological constraints) – the size and form of openings to be confirmed (subject to design for safety and from assessment of floodplain flows) but possibly 1m high
- Floodplain storage compensation to be provided to mitigate the impacts of the roadway within the floodplain- an area upstream of the bridge on the northern bank of the Black Brook was identified for lowering to provide this compensation and it would be assessed

on a volume for volume basis for a given event (the level upstream would be higher than at the bridge crossing itself so not true 'level for level') for 100mm bands

- 5.5.4 It was agreed that the proposed bridge crossing and associated floodplain reprofiling works would be tested by producing a 'with scheme' model to demonstrate that any impacts of the scheme on water levels and flows are localised and can be managed in an acceptable manner within the site itself. i.e. upstream of the site and downstream of the site there would be negligible impacts on levels or flows for the range of return periods considered. It was also agreed that the model runs for the 'with scheme' scenario would include suitable sensitivity checks for a bridge culvert blockage of 25%.
- 5.5.5 Technical Note 29231-001-TN01 dated 24th April 2014 and provided in Appendix G presents the findings of this modelling to test the proposed bridge crossing.
- 5.5.6 New pedestrian/cycle crossings of the Black Brook are also shown on the current masterplan. It was agreed with the EA that modelling of such crossings was not required as long as the new crossings will be constructed in a suitable form and design that might include:
- bridge soffit above the 1 in 100 year + CC modelled flood level
 - or
 - broadly 'open' structure above deck- i.e. to allow water to flow over the bridge deck
 - and
 - floodplain storage compensation for any structure within the floodplain
- 5.5.7 Principles for other minor crossings of the Oxley Gutter and Shortcliff Brook within the new development were also agreed with the EA although the final consenting for these structures would need to be agreed with the lead local flood authority and highways authority (LCC).

5.6 Floodplain Storage and Flowpath Compensation

- 5.6.1 As highlighted in the Sequential Test and outlined in earlier sections, a vehicular crossing of the Black Brook will be provided as part of the scheme. This road will be routed through the floodplain and to maintain flow across the floodplain the area will be reprofiled and culverts provided under the roadway for a substantial portion of the floodplain.
- 5.6.2 Reprofiling of the areas south and north of the Black Brook will be undertaken to provide useable areas above the design flood level for pitches and other areas. A strategy for floodplain storage compensation will be implemented as shown in drawing 29231-001-003 in **Appendix H**.
- 5.6.3 This strategy provides volume for volume compensation on an event basis which is a principle agreed with the EA.

6 SURFACE WATER MANAGEMENT

6.1 Existing Surface Water Regime

6.1.1 The existing drainage regime at the site is defined by the site topography and the location of the existing watercourses and drainage ditches crossing the site. In simple terms the site can be considered as 4 distinct drainage catchments;

- Land to the north east which drains into the River Soar via a network of field drains located to the north side of the A6;
- Land to the north of the Black Brook which drains into the Black Brook;
- Land to the south of the Black Brook which drains into the Black Brook;
- Land to the south which drains into the Oxley Gutter (tributary of Black Brook).

6.1.2 With the exception of the strategic road, there is no built development proposed in the southern most portion of the site which drains into the Shortcliff Brook. Apart from this area and the area to the north draining into the River Soar, all other surface water runoff from the site will ultimately drain into the Black Brook.

6.1.3 The location of the principal watercourses and drains is shown on the site location plan, **drawing 29231-001-001** in **Appendix A**.

6.1.4 Peak rates of runoff from the site have been estimated using the **Greenfield runoff rate methodology and ICP SUDS calculator in WinDes** for the site location. The site area and general characteristics of the catchment have been determined using the topographical data for the site. Rainfall and catchment descriptors have been determined using **FEH CD-ROM** (version 3) data for the area. The Greenfield runoff rates for the site are as follows (a copy of the calculations is provided in **Appendix I**):

- Qbar: 3.3 l/s/ha
- Q100: 8.4 l/s/ha.

6.1.5 The existing runoff rates from each existing sub catchment will be used to determine the storage requirements. The proposed discharge rates are set out in **Table 6.1**.

6.2 Potential Impact of Proposed Development

6.2.1 The proposed development will increase the area of impermeable surfacing within the site which could affect flows in the receiving systems and, therefore, flood risk.

6.2.2 However, a strategy for the management of surface water runoff from the proposed development has been prepared to ensure flood risk to the site and wider area is not increased.

6.3 Principles For Surface Water Management Strategy

6.3.1 The preliminary surface water drainage strategy has been prepared based on the following guidance:

- The Charnwood Borough Council SFRA Level 1 report (2008) refers to general national guidance (PPS25 – now superseded by the NPPF PPG) on the management of surface water.
- Policy 11: Infrastructure Provision of the Charnwood 2021 Core Strategy Preferred Options set out a requirement for planning permission to be granted for proposals which meet the identified requirements for the improvement or provision of new physical and community infrastructure necessary to support the development. It states that;
 - 'Developers may be invited to provide and contribute towards: i) the provision of off-site sustainable transport and drainage infrastructure;'
- The EA have confirmed that **our proposed approach** to the management of surface water is appropriate (during a meeting held 24th June 2009) as follows:
 - Reducing proposed runoff rates to the Q100 greenfield runoff rate of 8.4l/s/ha and using complex controls is acceptable.
 - The preference is for the provision of attenuation in above ground features such as swales and attenuation basins which incorporate permanently wet areas.
 - The SUDS designs should follow the approach and guidance laid out in CIRIA C697 'The SUDS Manual'.

6.4 Proposed Strategy

- 6.4.1 Notes from the meeting with LCC and notes of the meeting with the EA dated 24th June 2009 and 30th January 2014 provided in **Appendix J**, confirm that the proposed strategy, outlined below, is appropriate for an outline planning application.
- 6.4.2 The site area is approximately 466 ha and the illustrative masterplan indicates that approximately 130 ha will be 'developed' to provide residential areas, two schools, a local centre and employment land uses.
- 6.4.3 The local Bedrock geology comprises of Gunthorpe Member Mudstone. This is overlaid by areas of alluvium and Made Ground. In addition there are some outliers of the Wanslip Sand and Gravel and a small outlier of Glaciofluvial Sand and Gravel. However there are also tracts where the surface cover comprises alluvial soils.
- 6.4.4 Although the superficial deposits may be permeable, the underlying bedrock provides very limited potential for infiltration to ground water. Therefore the surface water strategy for the development is to maintain the existing drainage regime by discharging surface water at greenfield runoff rates to the receiving watercourses. If at a later stage of the project, site investigation works confirm the viability of using infiltration drainage techniques in some areas of the site, then consideration will be given at the detailed design stage to incorporating infiltration drainage into the design of the proposed SUDS features.
- 6.4.5 SUDS measures will be provided to ensure that peak flow rates of discharge off the site are attenuated to the Q100 greenfield runoff rate of 8.4l/s/ha for the existing catchments.
- 6.4.6 The **conceptual surface water drainage strategy** is outlined in the sections below and shown on **drawing 29231-001-004** in **Appendix I**.
- 6.4.7 Based on the illustrative Masterplan the proposed impermeable areas have been estimated and the surface water storage requirements determine using WinDes Quick Storage estimates shown in **Table 6.1** (a copy of the calculations is included in **Appendix I**) and are based on the following:

- limiting discharge rate based on 100yr greenfield runoff rate of 8.4l/s/ha
- assumed residential impermeable area of 70%
- assumed employment impermeable area of 80%
- assumed school impermeable area of 50%
- assumed local centre impermeable area of 70%
- assumed strategic highway impermeable area of 100%
- 30% additional allowance on rainfall intensity to account for the potential impacts of climate change
- FEH rainfall data and Cv of 0.85 used in Quick Storage Estimates.

Sub Catchment	Developable Area (ha)	Assumed Impermeable Area (ha)	Allowable Discharge Rate (l/s)	Average Storage Volume Required (1 in 100 yr + 30% CC) m ³
A	6.3	4.7	15	3,286
B	41.2	28.9	244	20,209
C	6.7	5.1	43	3,556
E	5.2	4.2	35	2,912
F	7.6	6.2	52	4,305
G	4.1	3.4	29	2,408
H	13.8	9.3	78	6,482
I	11.6	8.1	69	5,684
J	5.7	4.0	34	2,793
L	9.5	6.8	58	4,788
M	9.3	6.5	55	4,557
N	8.4	6.1	51	4,235

Table 6.1 – Preliminary estimate of surface water storage requirements

- 6.4.8 The indicative strategy includes the use of attenuation basins and swales. The indicative location of the attenuation basins is shown on **drawing 29231-001-004** in **Appendix I**.

6.5 Other Considerations

Pollution Control

- 6.5.1 Pollution control measures will be included to minimise the risk of contamination or pollution entering the receiving water bodies from surface water runoff from the development.
- 6.5.2 The drainage system will therefore be designed to comply with the requirements of the SUDS treatment train as laid out by CIRIA 697 'The SUDS Manual'.
- 6.5.3 In accordance with CIRIA 697 runoff from residential areas and residential roads will include two stages of treatment. Initial treatment will be provided in catch-pits and trapped gullies as part of the conventional drainage network serving the site, which will act to remove sediment. The second stage of treatment will be provided by retention of surface water in the above ground SUDS features. The SUDS features will also act to filter surface water runoff to facilitate the further removal of sediment and pollutants.

Adoption and Management

- 6.5.4 Long term management of surface water drainage assets is essential. SUDS require maintenance in the same way as other drainage systems. Legal issues with regard to the long term management of SUDS will be resolved through the Flood and Water Management Act. This will give powers to SABs to both approve the design and construction of SUDS and later to adopt them. In this case the SAB will be the county council.
- 6.5.5 Approval of the design by the SAB is not required at the Outline Planning Application stage and at this date the SAB has not been formally set up by the county council. The full surface water drainage scheme is to be agreed in consultation with the county council (as future SAB) and the final form of the features will be designed such that side slopes, water depths and planting are sympathetic to the existing ecological context whilst ensuring suitable arrangements and access for maintenance. The provision of a surface water management strategy to ensure no adverse impact on flood risk elsewhere demonstrates compliance with part 2 of the Exceptions Test.

Exceedence

- 6.5.6 The piped system will be designed to accommodate runoff during storm events up to the 1 in 30 year event. For more extreme events up to the 1 in 100 year storm event with an allowance for the impact of climate change it is possible that the design standard for the system will be exceeded.
- 6.5.7 The final scheme will consider the consequences of such an event and the proposed ground levels and plot levels will be designed to direct flows via the carriageway and swales towards the above ground attenuation. If a more extreme event occurs and the design standard for the system is exceeded, ground levels and plot levels will be designed such that surface water runoff is directed away from properties firstly towards the onsite attenuation and thereafter towards the eastern and western ditches and away from development.

7 CONCLUSION

- 7.1.1 This FRA has been completed for the proposed residential led mixed use development at West of Loughborough and concludes that:
- The majority of the site is in FZ1 and proposed development is located in areas outside the 1 in 1,000 year floodplain
 - CBC has completed Sequential Test which supports the site allocation
 - There is a potential for fluvial flooding in some areas alongside the watercourses within the site during flood events including the 1 in 25 year event
 - As part of masterplanning for the overall site, a sequential approach has been adopted which aims to locate the least vulnerable uses within or closest to the floodplain. Residential development is located further from the watercourses and finished floor levels will be set above both the modelled flood level for the 1 in 100 year + CC event and above surrounding ground levels.
 - Some reprofiling of the areas within the floodplain is proposed, for instance to provide suitably level surfaces for pitches and also to provide suitable areas for surface water attenuation measures and also to provide the key strategic access link crossing the Black Brook and its floodplain. Floodplain storage compensation will be provided within the scheme to mitigate these impacts and, as agreed with the EA, the final scheme may lead to localised changes in water levels or flows within the site, but will ensure no impact on water levels beyond the site.
 - A surface water drainage strategy restricting discharge from the new development to the greenfield runoff rate has been outlined and key design principles presented in the FRA. This comprises a series of attenuation basins generally located within the Black Brook corridor. As each phase is progressed a more detailed strategy will be developed and key surface water drainage infrastructure will be provided at each key stage in accordance with the overall strategy and any specific requirements of LCC as the LLFA and future SAB.
- 7.1.2 The FRA therefore provides evidence of compliance with part 2 of the Exception Test as it comprises a site specific flood risk assessment that demonstrates that the proposed development will be safe for its lifetime taking account of the vulnerability of its users.
- 7.1.3 In conclusion, the proposed scheme complies with NPPF with respect to flood risk and is an appropriate development at this location.

Appendix A Site Location Plan