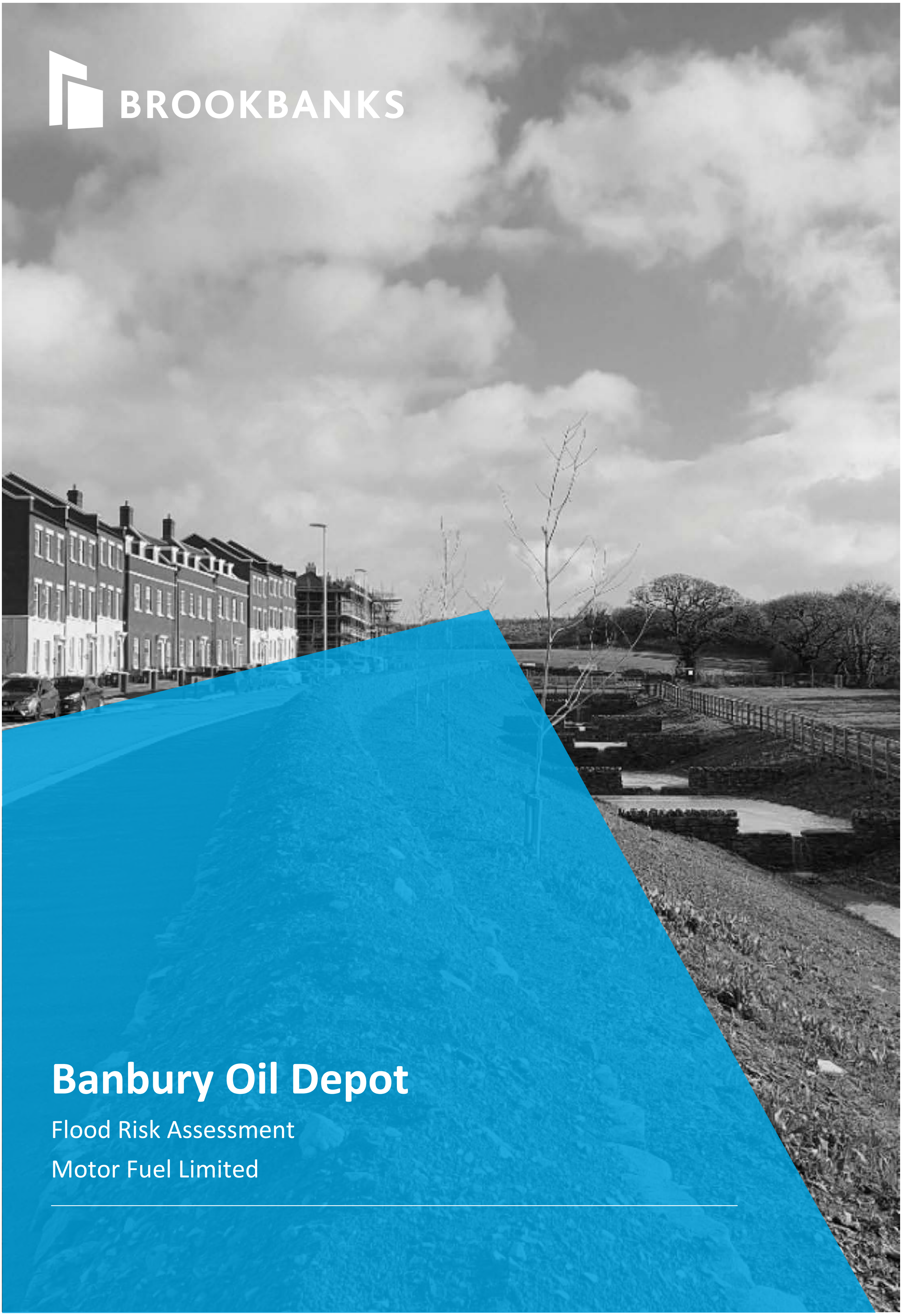

BROOKBANKS

Banbury Oil Depot

Flood Risk Assessment

Motor Fuel Limited

Document Control Sheet

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Debbie Jones – Framptons for Motor Fuel Ltd	0	1	2	3		

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1 Introduction

1.1 Brookbanks is appointed by Motor Fuel Ltd to complete a Flood Risk Assessment for a proposed mixed use development at Banbury Oil Depot, Oxfordshire.

1.2 The objective of the study is to demonstrate the development proposals are acceptable from a flooding risk and drainage viewpoint.

1.3 This report summarises the findings of the study and specifically addresses the following issues in the context of the current legislative regime:

- Flooding risk
- Surface water drainage
- Foul water drainage

1.4 Plans showing the existing and proposed development are contained within the appendices.

Planning Application

1.5 This Flood Risk Assessment has been produced in order to provide information for an outline planning application.

1.6 The proposed development is an allocated site within the local plan. Therefore, the LLFA has determined that the site is suitable for development in accordance with the NPPF, sequential and exception testing.

1.7 Everything designed within this report is to illustrate that the drainage strategy can be successfully designed and applied for the development site.

1.8 No flood modelling has been completed for this FRA, flood extents and depths have been taken from the EA flood map for planning and Cherwell Level 2 Strategic Flood Risk Assessment.

1.9 This FRA addresses comments from the Lead Local Flood Authority (LLFA) and Environment Agency (EA) from the original application (LLFA Ref: 21/01119/OUT).

1.10 The FRA will then be the subject of a reserved matters application where detailed design layouts and criteria will be provided.

2 Background Information

Location and Details

2.1 The proposed development is a brownfield site that lies within Banbury City Centre. The site is bound to the north and south by existing employment land, to the east by Banbury train station and the River Cherwell to the west.

2.2 The site location and boundary are shown indicatively on **Figure 2-1.**

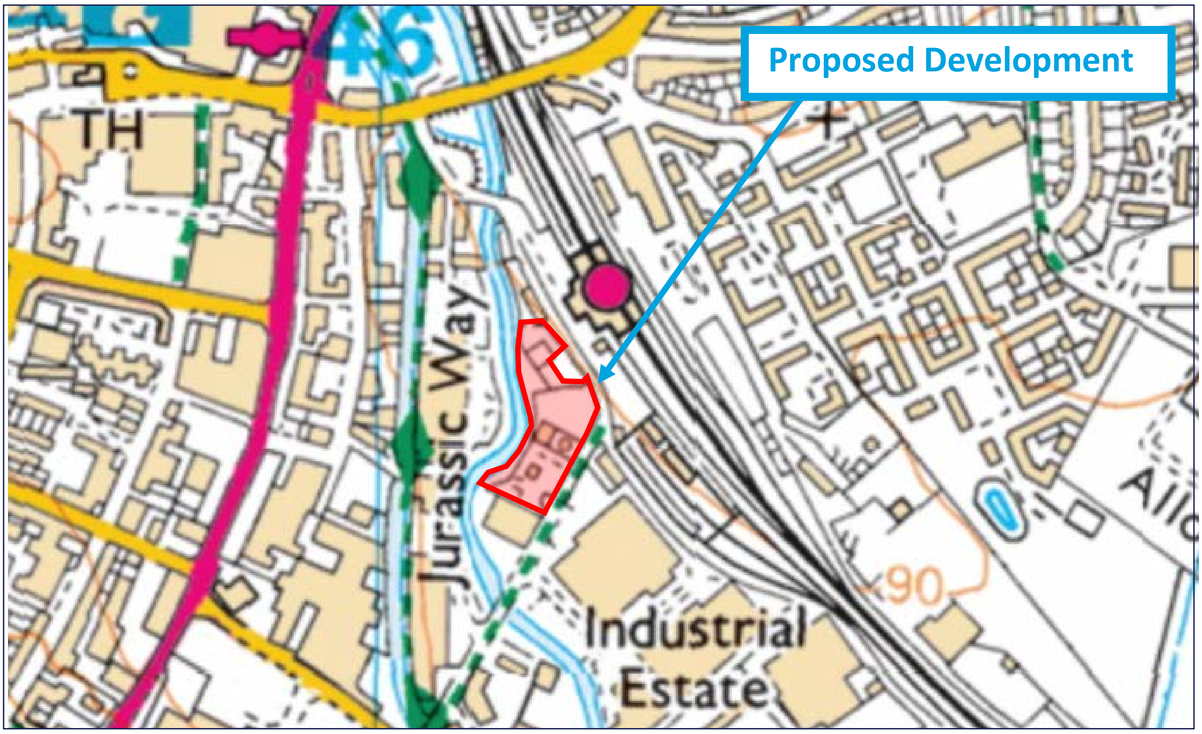


Figure 2-1: Site Location (Bing Maps, 2021)

Development Criteria

2.3 Outline planning application for the redevelopment of the Banbury Oil Depot, to include the demolition/removal of buildings and other structures associated with the oil depot use and the construction of up to 110 residential apartments, and up to 166m² of community/retail/commercial space, with all matters (relating to appearance landscaping, scale and layout) reserved except for access off Tramway Road.

Sources of Information

2.4 The following bodies have been consulted while completing the study:

- Thames Water - Storm & foul water drainage
- Environment Agency - Flood risk and storm drainage
- Cherwell District Council - Flood risk, drainage and associated policy

2.5 The following additional information has been available while completing the study:

- Mastermap Data - Ordnance Survey
- Published Geology - British Geological Survey
- Preliminary Flood Risk Assessment - Oxfordshire County Council, June 2011
- Regional Flood Risk Appraisal for - Halcrow on behalf of the Southeast
- Southeast England England Regional Assembly, October 2008
- RFRA Summary - November 2008
- Level 1 Strategic Flood Risk Assessment Oxfordshire District - Cherwell District Council & West Council, April 2009
- Thames Catchment Flood Management Plan - Environment Agency, December 2009 – Summary Report

3 National Planning Policy

National Planning Policy

3.1 The National Planning Policy Framework (NPPF), updated in July 2021, sets out Governmental Policy on a range of matters, including Development and Flood Risk. The policies were largely carried over from the former PPS25: Development & Flood Risk, albeit with certain simplification. The allocation of development sites and local planning authorities' development control decisions must be considered against a risk-based search sequence, as provided by the document.

3.2 Allocation and planning of development must be considered against a risk-based search sequence, as provided by the NPPF guidance. In terms of fluvial flooding, the guidance categorises flood zones in three principal levels of risk, as follows in **Table 3-1**.

Flood Zone	Annual Probability of Flooding
Zone 1: Low probability	< 0.1 %
Zone 2: Medium probability	0.1 – 1.0 %
Zone 3a / 3b: High probability	> 1.0 %

Table 3-1: NPPF Flood Risk Parameters

3.3 The Guidance states that Planning Authorities should:

"apply a sequential, risk-based approach to the location of development to avoid where possible flood risk to people and property and manage any residual risk, taking account of the impacts of climate change."

3.4 According to the NPPF guidance, residential development at the proposed site, being designated as "More Vulnerable" classifications, should lie outside the envelope of the predicted 1 in 100 year (1%) flood, with preference given to sites lying outside the 1 in 1,000 (0.1%) year events and within Flood Zone 1.

3.5 Sites with the potential to flood during a 1 in 100 (1%) year flood event (Flood Zone 3a) are not normally considered appropriate for proposed residential development unless on application of the "Sequential Test", the site is demonstrated to be the most appropriate for development and satisfactory flood mitigation can be provided. Additionally, proposed residential developments within Flood Zone 3a are required to pass the "Exception Test", the test being that:

- The development is to provide wider sustainability benefits
- The development will be safe, not increase flood risk and where possible reduce flood risk.

3.6 All flood risk mechanisms are reviewed in accordance with sequential testing in Chapter 6: Flood Risk.

Regional Policy

3.7 **Regional Flood Risk Assessment** (RFRA) identifies at a regional level the general locations of flood risk and flooding issues which are to be considered by local planning authorities within their Strategic Flood Risk Assessments. The South of England RFRA was prepared in October 2008 by Halcrow, on behalf of the Southeast England Regional Assembly.

3.8 The RFRA includes the Oxfordshire region which lies within the Thames Catchment and includes the River Cherwell. It is reported that the Thames Valley is subject to groundwater flooding caused by gravel deposits underlying the river floodplain. Surface water flooding in West Oxfordshire was reported after extensive flooding in 2007. The following recommendations are given for locating development where there may be groundwater and/or surface water flood risk:

"Where it is necessary to locate new development in areas of groundwater flood risk such developments should be focussed within areas where:

- *A permanent dry access route is provided (as groundwater flooding can last),*
- *The effect of development and permanent dry access do not adversely affect groundwater, which could result in increased flood risk elsewhere,*
- *The development and in particular its foundations are designed as flood resistant against long periods of groundwater flooding,*
- *The habitable ground floor levels are set above the highest groundwater level recorded.*

Where it is necessary to locate new development in Flood Zone 1 & 2 but there is a risk from surface water flooding, it is recommended that development should be focussed within areas where:

- *It is possible to divert the surface water risk to open areas within the new development (carparks, wetlands, ponds) provided that the diverted flood risk hazard is acceptable,*
- *It is viable to reduce the risk to an acceptable level, by adopting SuDS measures,*
- *Adequate drainage infrastructure is provided (with contribution from the developers) to reduce the existing risk to an acceptable level, while allowing for additional runoff from the new development. An effective Surface Water Management Plan could ensure in particular that the cumulative effects of incremental development are not overlooked."*

3.9 A **Catchment Flood Management Plan** (CFMP) is a high-level strategic plan through which the Environment Agency seeks to work with other key-decision makers within a river catchment to identify and agree long-term policies for sustainable flood risk management.

3.10 The Thames Catchment Flood Management Plan (December 2009), outlines that the Thames River Basin District has been divided into 9 sub-catchments. The Site is shown to be situated within Sub-area 1 Towns and villages in open floodplain (north and west) which is covered by the following policy:

"Policy 6: Areas of low to moderate flood risk where we will take action with others to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits.

This policy will tend to be applied where there may be opportunities in some locations to reduce flood risk locally or more widely in a catchment by storing water or managing run-off. The policy has been applied to an area (where the potential to apply the policy exists) but would only be implemented in specific locations within the area, after more detailed appraisal and consultation."

4 Local Planning Policy Compliance

4.1 Banbury lies within Oxfordshire, in which Oxfordshire County Council (OCC) is the Lead Local Flood Authority (LLFA). A **Preliminary Flood Risk Assessment** (PFRA) was produced in 2011 by OCC according to the guidance and information provided by DEFRA. The PFRA identifies flood risk from local flood sources and extreme events occurrence.

4.2 Strategic Flood Risk Assessment: To support local planning policy, NPPF guidance recommends that local planning authorities produce a Strategic Flood Risk Assessment (SFRA). The SFRA should be used to help define the Local Plan and associated policies; considering potential development zones in the context of the sequential test defined in the guidance.

4.3 Cherwell District Council & West Oxfordshire District Council published a Level 1 SFRA in April 2009. The document outlines the results of a review of available flood risk related policy and data across the region and sets out recommendations and guidance in terms of flood risk and drainage policy that generally underpin national guidance.

4.4 The document makes no specific reference to the site however assess the risk of flooding in Banbury, which forms one of three major urban centres in the district of Cherwell. The following sources will be discussed further in this document: Fluvial Flooding, Sewer Flooding, Pluvial Flooding, Groundwater Flooding and Artificial Sources.

4.5 Following on from this, in May 2017 Cherwell District Council produced a Level 2 SFRA.

4.6 The flood levels identified within the SFRA are identified and explained in further detail in Chapter 7: Flood Risk Vulnerability.

4.7 Oxfordshire County Council published the **Local Flood Risk Management Strategy** (LFRMS) which offers Guiding Principals in managing flood risk and a structure of managing strategy, in addition to that provided in the SFRA.

4.8 Development Flood Risk Assessment: At a local site by site level, the NPPF and guidance and supporting documents advocate the preparation of a Flood Risk Assessment (FRA). The NPPF requires that developments covering an area of greater than one hectare prepare a FRA in accordance with the guidance. The FRA is required to be proportionate to the risk and appropriate to the scale, nature and location of the development.

4.9 This document forms a Flood Risk Assessment (FRA), to accord with current guidance and addresses national, regional and local policy requirements in demonstrating that the proposed development lies within the acceptable flood risk parameters.

Supplementary Planning Document (SPD)/ Local Plan Policies

4.10 The proposed drainage strategy and will be designed in full compliance with the Banbury Canalside SPD (2009) and local plan policies (2015) that have been identified within the local plan.

4.11 The following statement outlines the SPD requirements followed by the local plan policies directly relating to flood risk and drainage:

Flood risk management

The comprehensive redevelopment of Canalside requires the prior completion of the Banbury Flood Alleviation Scheme by the Environment Agency. Development proposals should be accompanied by a Flood Risk Assessment that demonstrates how they accord with the recommendations of the adopted Level 2 Strategic Flood Risk Assessment for Canalside. The design of the masterplan, including the positioning of buildings and highways will be determined by the flood risk assessment.

4.12 This flood risk assessment includes a review of the sequential test (Chapter 7) in order to determine the most appropriate location for the proposed housing development. This report also looks at the flood levels identified within the SFRA level 2 and how the finish floor levels will be above the maximum flood level.

Policy ESD 6: Sustainable Flood Risk Management

Development proposals will be assessed according to the sequential approach and where necessary the exceptions test as set out in the NPPF and NPPG. Development will only be permitted in areas of flood risk when there are no reasonably available sites in areas of lower flood risk and the benefits of the development outweigh the risks from flooding. In addition to safeguarding floodplains from development, opportunities will be sought to restore natural river flows and floodplains, increasing their amenity and biodiversity value. Building over or culverting of watercourses should be avoided and the removal of existing culverts will be encouraged.

Existing flood defences will be protected from damaging development and where development is considered appropriate in areas protected by such defences it must allow for the maintenance and management of the defences and be designed to be resilient to flooding.

Site specific flood risk assessments will be required to accompany development proposals in the following situations:

- *All development proposals located in flood zones 2 or 3*
- *Development proposals of 1 hectare or more located in flood zone 1*
- *Development sites located in an area known to have experienced flooding problems*

Development sites located within 9m of any watercourses. Flood risk assessments should assess all sources of flood risk and demonstrate that:

- *There will be no increase in surface water discharge rates or volumes during storm events up to and including the 1 in 100 year storm event with an allowance for climate change (the design storm event)*
- *Developments will not flood from surface water up to and including the design storm event or any surface water flooding beyond the 1 in 30 year storm event, up to and including the design storm event will be safely contained on site.*

Development should be safe and remain operational (where necessary) and proposals should demonstrate that surface water will be managed effectively on site and that the development will not increase flood risk elsewhere, including sewer flooding.

4.13 No watercourse or existing open drainage features will be culverted or diverted, and the site lies downstream of the Banbury flood alluviation scheme.

4.14 This FRA has been produced to accompany the Banbury Oil Depot development.

4.15 No built development is proposed within 9m of the River Cherwell.

4.16 The proposed SuDS have been designed to accommodate the 1 in 100 year plus 40% climate change storm event. The attenuation tank has a discharge rate of QBAR being a betterment of 73% on existing greenfield rates. The calculations showing the 1 in 1 and the 1 in 30 year storm event are also provided in **Appendix C.**

Policy ESD 7: Sustainable Drainage Systems (SuDS)

All development will be required to use sustainable drainage systems (SuDS) for the management of surface water run-off.

Where site specific Flood Risk Assessments are required in association with development proposals, they should be used to determine how SuDS can be used on particular sites and to design appropriate systems.

In considering SuDS solutions, the need to protect ground water quality must be considered, especially where infiltration techniques are proposed. Where possible, SuDS should seek to reduce flood risk, reduce pollution and provide landscape and wildlife benefits. SuDS will require the approval of Oxfordshire County Council as LLFA and SuDS Approval Body, and proposals must include an agreement on the future management, maintenance and replacement of the SuDS features.

4.17 A SuDS design has been proposed for this development. The design has ensured that surface water from the developed areas will be conveyed, attenuated and discharged to a rate no greater than QBAR.

4.18 Infiltration testing has yet to be completed, but due to the previous use of the site infiltration will be ruled out as a discharge feature due to the risk of groundwater contamination.

4.19 Chapter 8 of this FRA outlines which SuDS features have been proposed and what features could be considered at reserved matters.

Policy ESD 8: Water Resources

The Council will seek to maintain water quality, ensure adequate water resources and promote sustainability in water use. Water quality will be maintained and enhanced by avoiding adverse effects of development on the water environment.

Development proposals which would adversely affect the water quality of surface or underground water bodies, including rivers, canals, lakes and reservoirs, as a result of directly attributable factors, will not be permitted. Development will only be permitted where adequate water resources exist or can be provided without detriment to existing uses. Where appropriate, phasing of development will be used to enable the relevant water infrastructure to be put in place in advance of development commencing.

4.20 The proposed SuDS network will convey and store all surface water from the developed areas. This will provide at least 1 level of treatment before the storm water is discharged back into the existing watercourse network. At the detailed design stage there will be an opportunity to review the network and include additional treatment stages should the design be viable.

5 Baseline Conditions

Present Day

5.1 The proposed development site is located on disused brownfield land that use to house an oil depot. Banbury train station is located adjacent to the eastern boundary with the River Cherwell adjacent to the western boundary.

5.2 Surface water currently drains into the existing sewer network that existing on site or flows uncontrolled directly into the River Cherwell.

5.3 **Figure 5-1** below illustrates the site at present.

Figure 5-1: Existing Land Use (Google Maps, 2021)

Topography & Site Survey

5.4 The site falls in a westerly direction towards the River Cherwell, from a high point of circa 90mAOD.

Geology & Hydrogeology

5.5 With reference to the British Geological Survey map, the site is shown to be underlain by mudstone bedrock geology belonging to the Charmouth Mudstone Formation. The site includes superficial deposits comprising Alluvium - Clay, Silt, Sand and Gravel.

5.6 The published site geology is illustrated on **Figure 5-2.**

Figure 5-2: BGS Published Geology

5.7 The underlying bedrock geology forms a secondary (undifferentiated) aquifer across the whole site and the superficial deposits form a Secondary A Aquifer.

5.8 The EA provides the following definitions for Aquifers:

Secondary Aquifers *- These include a wide range of rock layers or drift deposits with an equally wide range of water permeability and storage. Secondary aquifers are subdivided into two types:*

Secondary A *- 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. These are generally aquifers formerly classified as minor aquifers.*

Secondary Undifferentiated *- has been assigned in cases where it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type.*

5.9 The EA Groundwater Vulnerability Zones (GVZ) Mapping summarises the overall risk to groundwater, considering groundwater vulnerability, the types of aquifer present (superficial and/or bedrock) and their designation status, as discussed previously.

5.10 The site is shown (**Figure 5-3**) to be situated within a 'medium risk', in terms of groundwater vulnerability.

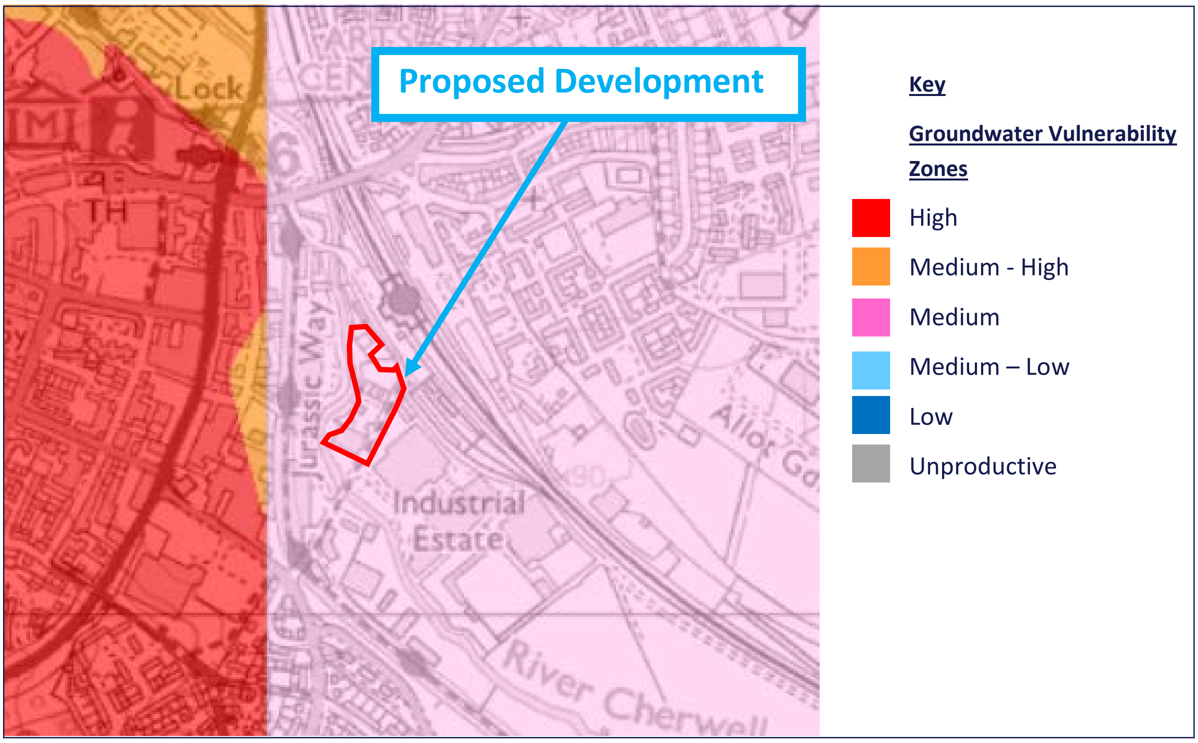


Figure 5-3: EA Groundwater Vulnerability Zones Map

5.11 The EA provides the following definition for the underlying GVZ:

Medium - *these are medium priority groundwater resources that have some natural protection resulting in a moderate overall groundwater risk. Activities in these areas should as a minimum follow good practice to ensure they do not cause groundwater pollution.*

Drainage Network and FEH Catchment Data

5.12 Reference to the online Flood Estimation Handbook (FEH) shows the site to located within the urban area of Banbury, where the site is bound by the River Cherwell to the west.

5.13 FEH catchment data has been used in the drainage design calculations.

5.14 **Figure 5-4** illustrates the watercourses and feature described above.

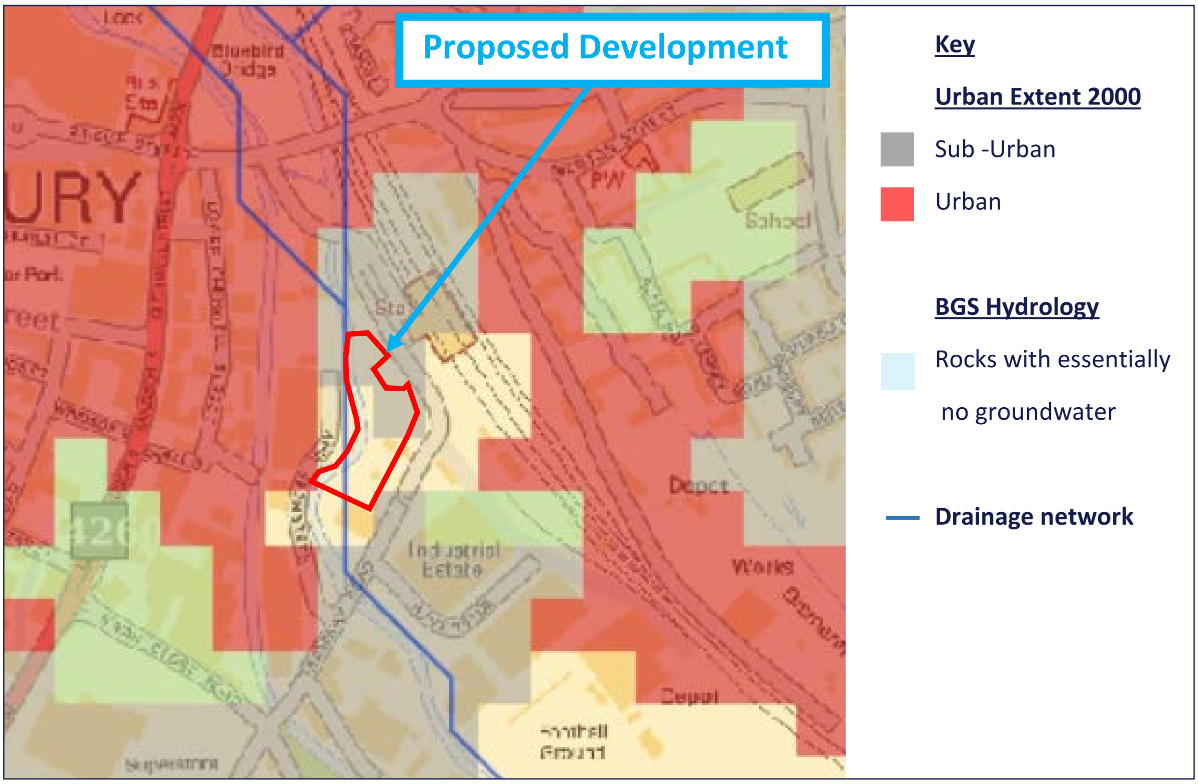


Figure 5-4: FEH web service – Urban Extent 2000 and BGS Hydrology and Drainage Network

6 Flood Risk

Flood Mechanisms

6.1 Having completed a site hydrological desk study and walk over inspection, the possible flooding mechanisms at the site are identified as follows in **Table 6-1**.

Mechanisms	Potential	Comment
Coastal & Tidal	N	The site lies a considerable distance from a tidal watercourse.
Fluvial	Y	The River Cherwell bounds the western boundary. The entire site lies within FZ2.
Overland Flow (Pluvial)	Y	There is a medium risk of surface water flooding on the site.
Groundwater	N	No groundwater flooding was identified within the SFRA and therefore the risk of same is considered low.
Sewers	N	The SFRA identifies between 0-5 incidences of flooding in Banbury.
Reservoirs, Canals etc	Y	There is a risk of flooding from reservoirs from Byfield Reservoir.

Table 6-1: Flooding Mechanisms

6.2 Where potential risks are identified in **Table 6-1**, above, more detailed assessments have been completed and are outlined and discussed further within the following sections.

Coastal Flooding

6.3 The site lies a significant distance from the nearest tidal watercourse and the coast. As such there is no risk of tidal or coastal flooding at this location.

Fluvial Flooding

6.4 The Environment Agency's (EA) National Generalised Modelling (NGM) Flood Zones Plan indicates predicted flood envelopes of Main Rivers across the UK. In many circumstances, the NGM is based on basic catchment characteristic data and modelling techniques. Where appropriate, more accurate Section 105 / SFRM models are produced using more robust analysis techniques.

6.5 The mapping on **Figure 6-1** shows that the majority of the site lies within Flood Zone 2; being an area of medium Probability with land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% – 0.1%). There is a small area in the northeast of the site that lies within an area of FZ3, however, this land is defended.

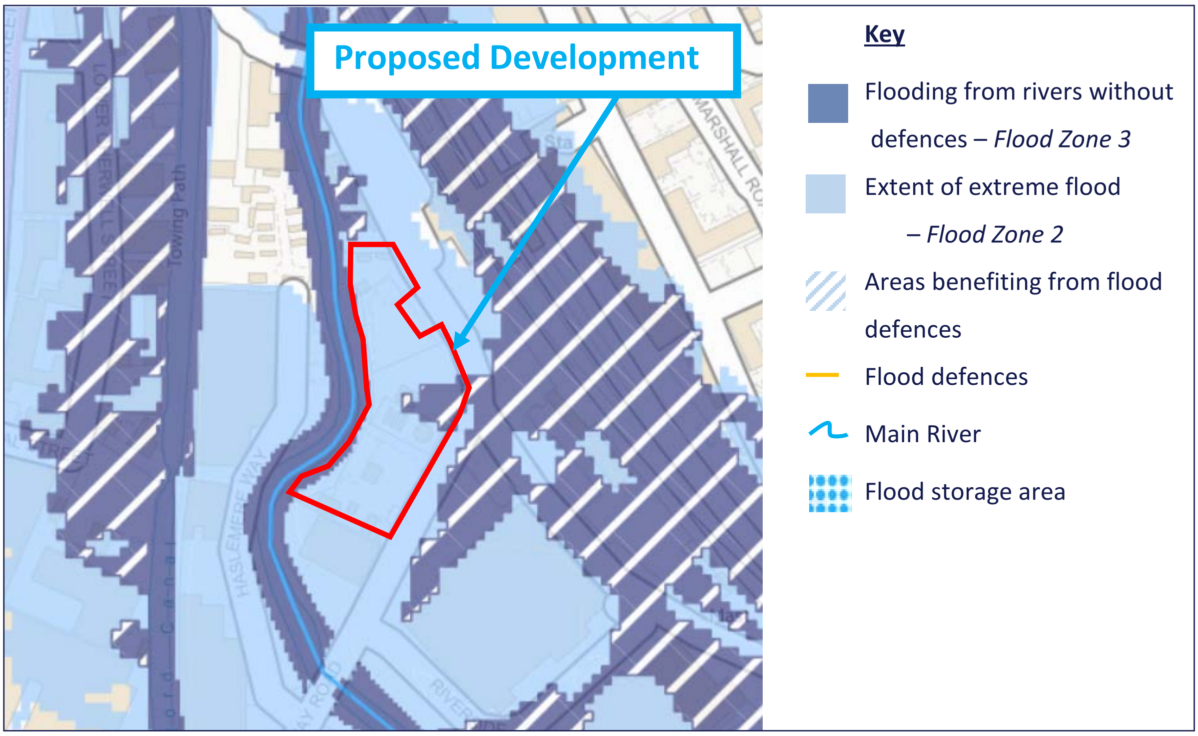


Figure 6-1: EA Flood Zone Plan showing 1 in 100 & 1 in 1,000 year floodplains

Surface Water Modelling

6.6 Surface water modelling is based on high level fluvial assessment models and terrain data. It is not based on observed or recorded flooding but is an extremely broad brush tool for seeing where water could collect given the topography.

6.7 In the design however this surface water mapping has been acknowledged and the SuDS basins are placed in these low areas of flooding as shown the surface water mapping. SuDS are obviously water compatible development and have the effect of keeping the built environment to the edge of the surface water flooding shown the mapping.

Overland Flow (Pluvial)

6.8 Overland flow mechanisms result from the inability of unpaved ground to infiltrate rainfall or due to inadequacies of drainage systems in paved areas to accommodate flow directed to gullies, drainage downpipes or similar. In minor cases, local ponding may occur. In more extreme events, flows accumulate and may be conveyed across land following the topography.

6.9 The Environment Agency, in partnership with lead local flood authorities, produced a series of surface water flood maps for many parts of the UK.

6.10 **Figure 6-2** illustrates areas of risk from surface water flooding.

6.11 The mapping above identifies that most of the site has a very low risk of surface water flooding. However, there are small areas of low risk within the site and a high risk along the western boundary.

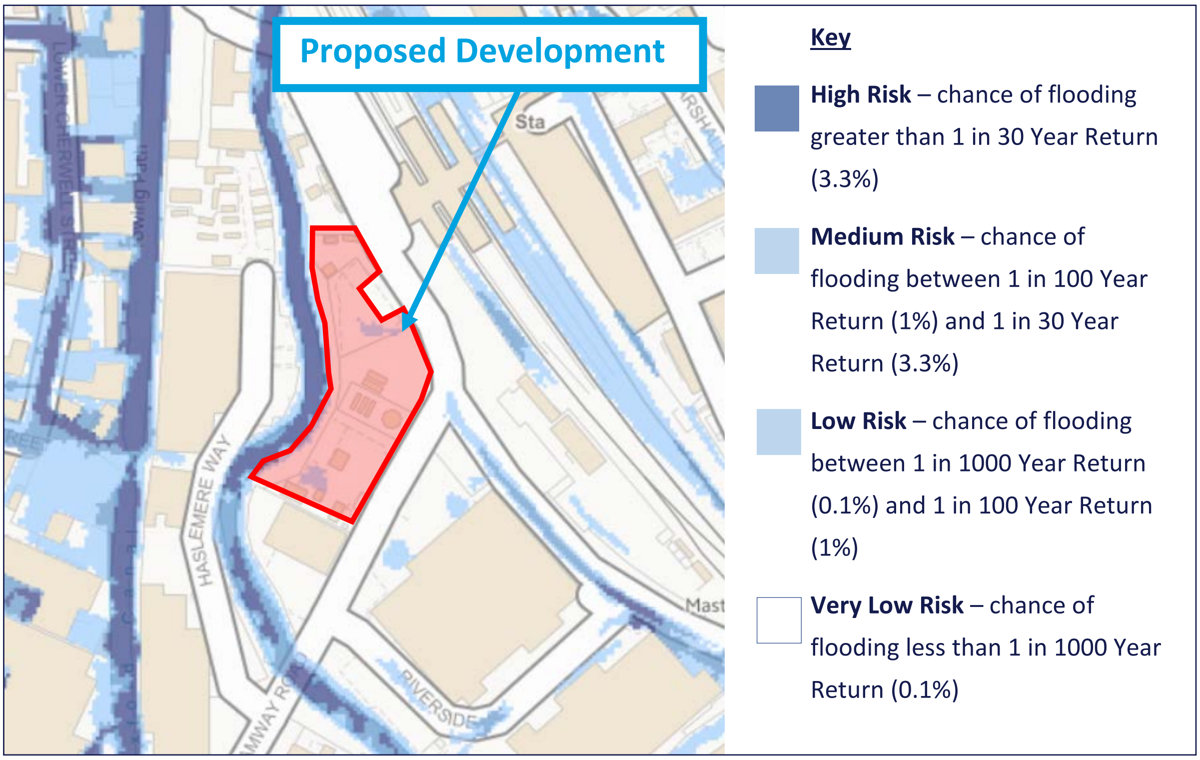


Figure 6-2: EA Long Term Flood Risk Maps – Flood risk from Surface Water (Gov.Uk website)

6.12 Initial investigations suggest that the risk of overland flow relates primarily to the topography of the site; low areas of the site naturally store water limiting the surface runoff in concentrated areas. As part of the development, the topography will be altered, providing a rationalised surface for water runoff.

6.13 Recognising the risk of overland flow mechanisms, published guidance in the form of the Design and Construction Guidance for Foul and Surface Water Sewers and the Environment Agency document Improving the Flood Performance of New Buildings: Flood Resilient Construction et al advocate the design of developments that implement infrastructure routes through the development that will safely convey flood waters resulting from sewer flooding or overland flows away from buildings and along defined corridors. Further to protect the Proposed Development, current good practice measures defined by guidance will be incorporated. However, given the nature of the development this is unlikely to be onerous or to have any material effect on layout.

6.14 Given the baseline site characteristics and further mitigating measures to be implemented residual flood risk from an overland flow mechanism is considered of a low probability.

Groundwater

6.15 Groundwater flooding is characterised by low-lying areas often associated with shallow unconsolidated sedimentary aquifers which overly non-aquifers. These aquifers are reported to be susceptible to flooding, especially during the winter months, due to limited storage capacity.

6.16 Groundwater related flooding is fortunately quite rare, although where flooding is present, persistent issues can arise that are problematic to resolve. Such mechanisms often develop due to construction activities that may have an unforeseen effect on the local geology or hydrogeology.

6.17 The Environment Agency's national dataset, Areas Susceptible to Groundwater Flooding (AStGWF), provides the main dataset used to assess the future risk of groundwater flooding. The AStGWF map uses four susceptibility categories to show the proportion of each 1 km grid square where geological and hydrogeological conditions show that groundwater might emerge.

6.18 This mapping identifies that the area lies within a of a >= 25% susceptibility to groundwater flooding.

6.19 Within the SFRA it is reported that:

"The underlying superficial geology of the area is predominately clay, particularly in the north. This can result in flash runoff and a rapid response of fluvial networks to rainfall events. This area of the Cherwell District is therefore likely to present a low risk of groundwater flooding. This is reflected in the AStGWF map where the majority of the district is either shown not to be susceptible".

6.20 Positive drainage systems incorporated into the Proposed Development will further reduce the risk as a result of permeable pipe bedding materials and filter drains incorporated within elements of the built development.

6.21 Given the baseline site characteristics and further mitigating measures to be implemented, residual flood risk from a ground water mechanism is considered to be of a low probability.

Sewerage Systems

6.22 Flooding related to sewerage systems is a result of there being insufficient capacity within an existing sewerage system (combined and surface water sewers) or from there being a blockage within the system.

6.23 The SFRA investigated flooding from sewers by collecting historic flooding incidents data from Thames Water. The report identifies 0-5 incidences of sewer flooding in Banbury.

6.24 Positive drainage measures incorporated on site, coupled with sustainable drainage systems (SuDS) will ensure that no increase in surface water will result from the site. Flood risk associated with sewer flooding is therefore considered to be a low probability.

Artificial Water Bodies - Reservoirs & Canals

6.25 Non-natural or artificial sources of flooding comprises of reservoirs, canals and lakes where water is retained above the natural ground level. However unlikely, reservoirs, canals and other artificial sources have a potential to cause flooding due to the release of large volumes of water, resulting from a dam or bank failure.

6.26 The Environment Agency has produced mapping to indicate a worst case scenario of flooding that would be caused, as a result of unlikely structural failure or damage of a reservoir as shown in **Figure 6-3.**

6.27 The site is shown to be affected by flooding from the Byfield and Clattercote reservoirs, that lie approximately 12.6 and 8.2km north of the site.

6.28 Cherwell District Council will have to have an emergency plan in place should there be a reservoir failure.

Figure 6-3: EA Long Term Flood Risk Maps – Flood risk from Reservoirs (Gov.Uk website)

Objectives

6.29 The key development objectives that are recommended in relation to flooding are:

- Work collaboratively with the Environment Agency to identify potential flooding.
- Compliance with the Design and Construction Guidance for Foul and Surface Water Sewers and EA guidance in relation to flood routing through the Proposed Development in the event of sewer blockages.

7 Flood Risk Vulnerability

7.1 In accordance with the NPPF technical guidance when building within a Flood Zone, the vulnerability of the development must be taken into consideration. The impacts of flooding will affect types of development differently.

7.2 The EA's vulnerability classification table is illustrated below in **Table 7-1**. The table outlines the NPPF technical guidance for flood risk vulnerability and Flood Zone compatibility assessment to propose which type of development is appropriate for which sites.

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	✓

Table 7-1: Environment Agency's Flood Risk Vulnerability Classification Table

7.3 In accordance with **Table 7-1**, More Vulnerable features are allowed to be developed within Flood Zone 2. The following are classified as More Vulnerable features:

- 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.

Sequential Testing

7.4 The aim of a sequential test is to ensure that new development is steered towards sites with the lowest probability of flooding.

7.5 The proposed development consists of up to 143 residential apartments, and up to 166m² of community/retail/commercial space and 95 under-croft and external car parking spaces.

7.6 The entire site lies within FZ2, where the River Cherwell bounds the western boundary of the site.

7.7 As it is not possible for the development to be located within FZ1, the dwellings have been located along the eastern boundary, with a green space buffer to the River.

7.8 Should the development within the Flood Zone be considered as Highly Vulnerable an exception test must be completed.

Exception Test

7.9 If sequential testing shows that it is not possible to put development within FZ1 an exception test will need to be completed should the development considered to be:

1) highly vulnerable and in flood zone 2,
2) essential infrastructure in flood zone 3a or 3b, or
3) more vulnerable in flood zone 3a,

7.10 The exception test 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."

7.11 The exception test assesses the suitability of locations within the site for development that are appropriate to the relevant levels of flood risk.

7.12 As the residential properties have been located along the eastern boundary with a green space buffer and are considered to be More Vulnerable features, an exception test is not required. Therefore, the proposed development is suitable for development.

Proposed Development

7.13 The development is an allocated site within Banbury's Local Plan and therefore designated for residential and commercial uses.

7.14 PBA produced a Level 2 Strategic Flood Risk Assessment (SFRA) 2012 for the Banbury Canalside development, which informed the Local Plan and supplementary planning documents.

7.15 The SFRA splits the Canalside development into 7 areas, each with there own identified flood risk.

7.16 This proposed site lies within the wider Canalside development, within the Station and the Riverside areas.

7.17 The SFRA compares the existing maximum fluvial flood depth and the maximum fluvial flood depth after the completion of the Banbury Flood Alleviation Scheme (FAS) in 2007. The Banbury FAS has been completed and operational since late 2012 effectively protecting Banbury from flooding events.

7.18 The site lies within the southern half of the Station area which has a defended maximum flood depth of 0.4m as illustrated in **Figure 7-1** and the northern half of Riverside **Figure 7-2**.

7.19 Mitigation measures against the flood risk across the development site are proposed to include:

- the dwellings have been located within the areas with the lowest maximum flood depth levels, and;
- the finished floor levels for the residential dwellings located on the ground floor will be designed above the 0.4m flood depth within Table 5.8.3 of the SFRA. Details of the final finished flood levels will be provided at reserved matters.

7.20 These mitigation measures will remove the risk of fluvial flooding from the proposed developments.

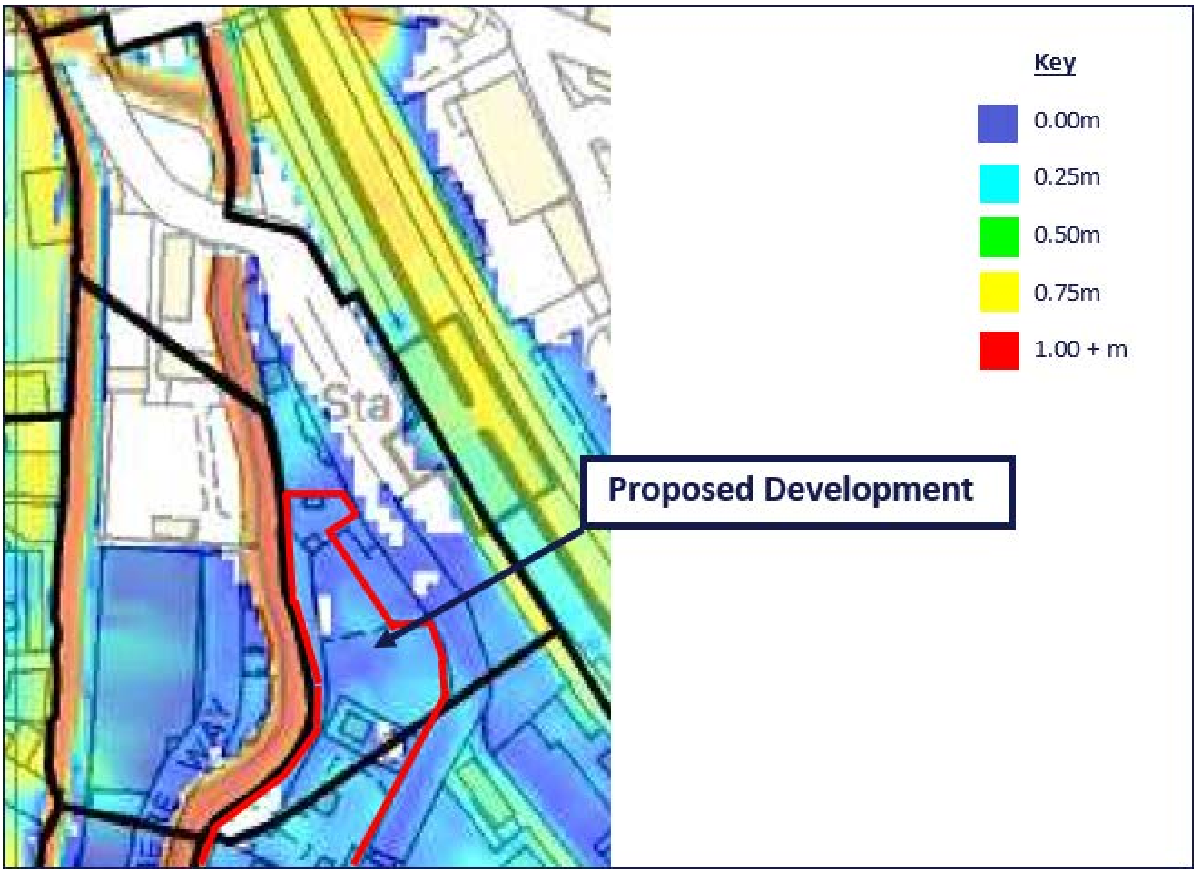


Figure 7-1: Flood Depths - Defended 0.1% annual probability (1 in 1000 year) event – Station

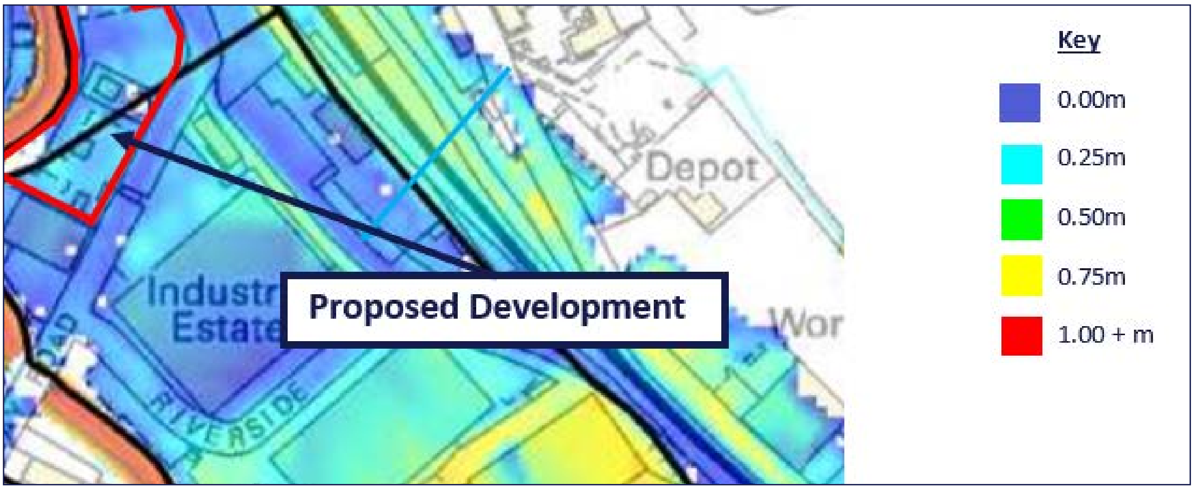


Figure 7-2: Flood Depths – Defended 0.1% annual probability (1 in 1000 year) event – Riverside

8 Storm Drainage

Background

8.1 To understand the baseline provision for storm drainage in the area, a copy of Thames Water network records will need to be obtained.

8.2 As the site is currently brownfield, it is thought that storm water currently drains into the existing sewer network or directly into the River Cherwell.

SuDS Components

8.3 It is proposed to implement a SuDS scheme consistent with local and national policy at the proposed development.

8.4 At the head of the drainage network, across the site, source control measures could be implemented to reduce the amount of run-off being conveyed directly to piped drainage systems.

8.5 Through consultations at outline planning stage, it has been agreed that the nature of source control measures to be implemented will need to remain flexible, providing each house builder with a ‘toolkit’ of options to reach an agreed target for peak discharge reduction and water treatment.

8.6 **Table 8-1** is an extract of Table 7.1 from the CIRIA SuDS Manual C753 which outlines a number of options available.

Component Types	Description	Collection Mechanism	Design Criteria					
			Water Quantity			Water Quality	Amenity	Biodiversity
			Peak Runoff Rate	Runoff Volumes				
				Small Events	Large Events			
Rainwater Harvesting Systems	Systems that collect runoff from the roof of a building or other paved surface for use	P		●	●		●	
Green Roofs	Planted soil layers on the roof of buildings that slow and store runoff	S	○	●		●	●	●
Infiltration Systems	Systems that collect and store runoff, allowing it to infiltrate into the ground	P	●	●	●	●	●	●
Proprietary Treatment System	Subsurface structures designed to provide treatment of runoff	P				●		

Filter Strips	Grass strips that promote sedimentation and filtration as runoff is conveyed over the surface	L		●		●	○	○
Filter Drains	Shallow stone filled trenches that provide attenuation, conveyance and treatment of runoff	L	●	○		●	○	○
Swales	Vegetated channels (sometimes planted) used to convey and treat runoff	L	●	●	●	●	●	●
Bioretention Systems	Shallow landscaped depressions that allow runoff to pond temporarily on the surface, before filtering through vegetation and underlying soils	P	●	●	●	●	●	●
Trees	Trees within soil-filled tree pots, tree planters or structural soils used to collect, store and treat runoff	P	●	●		●	●	●
Pervious Pavements	Structural paving through which runoff can soak and subsequently be stored in the sub-base beneath, and/or allowed to infiltrate into the ground below	S	●	●	●	●	○	○
Attenuation Storage Tanks	Large, below ground voided spaces used to temporarily store runoff before infiltration, controlled release or use	P	●					
Detention Basins	Vegetated depressions that store and treat runoff	P	●	●		●	●	●
Ponds and Wetlands	Permanent pools of water used to facilitate treatment runoff – runoff can also be stored in an attenuation zone above the pool	P	●			●	●	●

Table 8-1: Ciria Guidance Table 7.1 (SuDS Component Delivery of Design Criteria)

*** Key**

P - Point, L - Lateral, S – Surface

● Likely Valuable Contribution ○ Some Potential Contribution to Delivery of Design Criterion **T**

Drainage Hierarchy

8.7 The following paragraphs in this section outline the proposed drainage strategy to meet national and local design requirements and guidance.

8.8 Current guidance1 requires that new developments implement means of storm water control, known as SuDS (Sustainable Drainage Systems), to maintain flow rates discharged to the surface water receptor at the pre-development 'baseline conditions' and improve the quality of water discharged from the land.

8.9 When appraising suitable storm water discharge options for a development site, Part H of the Building Regulations 2002 (and associated guidance) provides the following search sequence for identification of the most appropriate drainage methodology.

"Rainwater from a system provided pursuant to sub-paragraphs (1) or (2) shall discharge to one of the following, listed in order of priority -

a) an adequate soakaway or some other adequate infiltration system; or where that is not reasonably practicable,

b) a watercourse; or where that is not reasonably practicable,

c) a sewer. "

8.10 Dealing with the search order in sequence:

a) Source control systems treat water close to the point of collection, in features such as soakaways, porous pavements, infiltration trenches and basins. The use of same can have the benefit of discharging surface water back to ground rather than just temporarily attenuating peak flows before discharging it to a receiving watercourse or sewer.

As source control measures generally rely upon the infiltration of surface water to ground, it is a prerequisite that the ground conditions are appropriate for such. Site ground investigations specific to flood risk have yet to be completed however published geology suggests the presence of potentially impermeable formations within the site.

Due to the previous land uses of the site, an infiltration system will not be used.

b) Next in the search sequence, defined by Part H, is discharge to a watercourse or suitable receiving water body. Where coupled with appropriate upstream attenuation measures, this means of discharge can provide a sustainable drainage scheme that ensures that peak discharges and flood risk in the receiving water body are not increased.

The River Cherwell bounds the western boundary of the proposed development site and as such represents an appropriate receptor for storm water discharge, have the potential to receive flows from the proposed development once restricted to the pre-existing 'greenfield' rates of run-off.

c) Last in the search sequence is discharge to a sewer. In the context of SuDS this is the least preferable scheme as it relies on 'engineered' methods to convey large volumes of water from development areas, has a higher likelihood of flooding due to blockage and provides less intrinsic treatment to the water.

A copy of Thames Water records will need to be obtained in order to confirm the presence of public combined, storm and foul sewers in the site and surrounding area that could be employed should the need arise.

uirements for residential development

8.11 **Table 8-2** outlines which options will be used within the outline application, and which will be considered at reserved matters.

Component Types	To be Considered at Outline	To be Considered at Reserved Matters
Rainwater Harvesting Systems		✓
Green Roofs		
Infiltration Systems		
Proprietary Treatment System		
Filter Strips		
Filter Drains		✓
Swales	✓	✓
Bioretention Systems		
Trees		✓
Pervious Pavements		✓
Attenuation Storage Tanks	✓	✓
Detention Basins		
Ponds and Wetlands		

Table 8-2: Types of SuDS Components to be Considered

8.12 The search sequence outlined above indicates that the River Cherwell is the most appropriate receptor of storm water from the proposed development, having the potential to employ source control measures and on-line SuDS to control peak discharges to no greater than the baseline conditions.

8.13 Proposals have been developed to inform the strategic drainage network across the development. It is proposed that the drainage system for the site utilises a SuDS system as the primary storm water management scheme.

8.14 Accordingly, a plan showing the conceptual drainage masterplan for the site is contained within **Appendix A** as drawing **10682-DR-02 A.**

8.15 Coupled with the storm water control benefits, the use of SuDS can also provide betterment on water quality. National guidance in the form of CIRIA 753 outlines that by implementing SuDS, storm water from the site can be polished to an improved standard thus ensuring the development proposals have no adverse effects on the wider hydrology.

9 Preliminary Drainage Proposals

Primary Drainage Systems (source control)

9.1 The common aims of a Primary Drainage System are:

- Reduction in peak discharges to the agreed site wide run-off rate from the development areas.
- Provide water quality treatment where appropriate

9.2 Preliminary assessment of the requirements for storm drainage have been based on the following criteria as shown in **Table 9-1**.

Criteria	Measure/Rate/Factor
Application Site Area	0.87 ha
Developed Area	0.51 ha
Landscaped Area	0.36 ha
Impermeability - Residential	1.00
Sewer design return period(2)	1 in 1 year
Sewer flood protection(2)	1 in 30 years
Fluvial / Development flood protection (1)	1 in 100 years
C (1km)*	-0.025
D1 (1km)*	0.348
D2 (1km)*	0.347
D3 (1km) *	0.231
E (1km) *	0.297
F (1km)*	2.511
Minimum cover to sewers (1)	1.2 m
Minimum velocity (1)	1.0 m/sec
Pipe ks value (1)	0.6 mm
Allowance for climate change (3)	40%

Table 9-1: Drainage Criteria and Measure

* FEH Catchment Descriptors- Site constants for calculating rainfall depths

Attenuation Storage Tanks

9.3 National policy1 requires that new developments control the peak discharge of storm water from a site to the baseline, undeveloped, site conditions. Over very large development areas, the baseline rate of run-off is normally estimated using the FEH methodologies. However, Paragraph 3.1.2 of the FEH guidance states:

[2] Design and Construction Guidance for Foul and Surface Water Sewers
[3] NPPF requirements for residential development

"The frequency estimation procedures can be used on any catchment, gauged or ungauged, that drains an area of at least 0.5km2. The flood estimation procedures can be applied on smaller catchments only where the catchment is gauged and offers simple flood peak or flood event data".

9.4 On undeveloped and ungauged catchments of less than 0.5km2 in area, it is correct to complete baseline site discharge assessments using the nationally accepted IoH124 methodology for small rural catchments. Local policy is to employ IoH124 in a manner set out by CIRIA C697. This methodology requires that, for catchments of less than 50ha, the IoH assessment is completed for a 50ha area with the results linearly interpolated to determine the flow rate value based on the ratio of the development to 50ha.

9.5 The baseline IoH run-off rates are shown on **Table 9-2** below:

Event	IoH 124 (1ha)	IoH 124 Scaled to 0.86ha
1 in 1 year (l/s)	3.79	3.30
Qbar (l/s)	4.46	3.88
1 in 100 year (l/s)	14.22	12.37

Table 9-2: IoH124 baseline discharge rates

9.6 In order to determine the permitted rates of run-off from the development, the future impermeable catchment areas must be derived.

9.7 In accordance with Oxfordshire County Council's Local Standards and Guidance for Surface Water Drainage on Major development in Oxfordshire document:

"Brownfield sites are strongly encouraged to discharge at the greenfield rate wherever possible. Where proven that greenfield rates cannot be achieved the best discharge rate needs to be quantified. As a minimum, brownfield sites should reduce the discharge by 40% to account for the impacts of climate change, from the existing site runoff."

9.8 The calculations for this are shown in **Table 9-3.**

Land Use	Developable Area (ha)	Impermeable Area (ha)	Existing Greenfield 100 Year Run-off (l/s)	Proposed Run-off (l/s) (Existing 100 Year – 40%)
Residential	0.87	0.51	6.31	1.68

Table 9-3: Run-off calculation

9.9 Using these methods, development at the site will comply with the requirements set out in paragraph 9 of the Technical Guide to the National Planning Policy Framework (NPPF), with the discharge of surface water from the proposed developments not exceeding that of the existing greenfield sites, thus ensuring that there is no material increase in the flood risk to surrounding areas.

9.10 Assessments have thereafter been completed to determine the characteristics of proposed SuDS features to be situated within the development. Best practice methods have been employed by performing detention routing calculations for both the 1 in 1 and 1 in 100 years + 40% climate change.

Catchment

9.11 Calculations demonstrate that storm water detention storage extending to maximum 450m3 will be required to attenuate storm water discharges from the site during the critical 1 in 100 year event storm. This will limit the peak discharges to 1.68 l/s, being equivalent to the mean annual storm (Qbar), estimated by the IoH124 calculations above, representing a circa 73% reduction on peak greenfield rates. Table 9-4 below summarises the overall detention requirements.

9.12 The summary calculations are contained in **Appendix C.**

Catchment Area (ha)	Impermeable Area (ha)	1 in 100 Year Run-off (l/s)	Detention Volume for 1 in 100 Year Event (m^3)
0.87	0.51	1.68	450

Table 9-4: Summary run-off & detention assessment output

9.13 In accordance with legislative requirements, the detention proposals have been assessed for the potential effects of climate change. The 1 in 100 year (1% AEP) return events have been modelled for 40% climate change (including peak rainfall intensity). Calculations for the climate change scenarios are contained within the Appendix. Climate change assessments show each detention feature to perform adequately by retaining the additional flows within the system without overflow.

9.14 A hydro-brake will be provided on the detention features, at a level above the 1 in 100 year + 40% flood level to allow more extreme event flows to safely be conveyed away from properties, while at the same time not increasing flood risk to surrounding areas, in line with current good practice recommendations. The detailed design stage will provide further detail into the positioning of overflows and direction of flow.

9.15 The proposed strategic drainage masterplan is shown illustratively on drawing 10682-DR-02 A contained in **Appendix A**.

Objectives

9.16 The key objectives for the site drainage will be:

- Implementation of a sustainable drainage scheme in accordance with current national and local policy together with principles of good practice design.
- Control of peak discharges from the site to a rate commensurate with the baseline conditions.
- Development of storm water management proposals that maintain water quality and biodiversity of the site.
- Implementation of the storm water management system prior to first use of the site.

10 SuDS Management

Water Quality

10.1 Impermeable surfaces collect pollutants from a wide variety of sources including cleaning activities, wear from car tyres, vehicle oil and exhaust leaks and general atmospheric deposition (source: CIRIA C609). The implementation of SuDS in development drainage provides a significant benefit in removal of pollutant from development run-off.

10.2 The SuDS Manual C753 describes a 'Simple Index Approach' for assessing the pollution risk of surface run-off to the receiving environment using indices for likely pollution levels for different land uses and SuDS performance capabilities.

10.3 CIRIA document C753 Table 26.2, as shown in **Table 10-1** below, indicates the minimum treatment indices appropriate for contributing pollution hazards for different land use classifications. To deliver adequate treatment, the selected SuDS components should have a total pollution mitigation index (for each contaminant type) that equals or exceeds the pollution hazard index.

Land Use	Pollution Hazard Level	Total suspended solids (TSS)	Metals	Hydro-carbons
Residential roofs	Very Low	0.2	0.2	0.05
Individual property driveways, residential car parks, low traffic roads (e.g. cul-de-sacs, home zones and general access roads) and non-residential car parking with infrequent change (e.g. schools, offices) i.e. < 300 traffic movements/day	Low	0.5	0.4	0.4
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

Table 10-1: **CIRIA 753 Table 26.2 Pollution Hazard Indices**

10.4 For a residential development, roof water requires a very low treatment of 0.2 for total suspended solids, 0.2 for heavy metals and 0.05 for hydrocarbons, and run-off from low traffic roads such as cul-de-sacs and individual property driveways requires low treatment of 0.5 for total suspended solids, 0.4 for heavy metals and 0.4 for hydrocarbons.

10.5 To provide the correct level of treatment, an assessment needs to be made of the mitigation provided by each SuDS feature. Tables 26.3 of The SuDS Manual CIRIA document C753 shown as **Table 10-2** for discharges to surface waters and groundwater respectively indicate the treatment mitigation indices provided by the SuDS features that could be used at the detailed design stage.

Type of SuDS component	Total suspended solids (TSS)	Metals	Hydro-carbons
Filter Drain	0.4	0.4	0.4
Swale	0.5	0.6	0.6
Permeable pavement	0.7	0.6	0.7
Proprietary treatment systems	These must demonstrate that they can address each of the contaminant types to acceptable levels for frequent events up to approximately the one in 1-year return period event, for inflow concentrations relevant to the contributing drainage area.		

Table 10-2: CIRIA 753 Table 26.3 SuDS Mitigation Indices for discharges to surface waters.

10.6 Where more than one mitigation feature is to be used, CIRIA guidance states that the total mitigation index shall be calculated as follows:

Total SuDS mitigation index = Mitigation Index 1 + 0.5 x Mitigation Index 2

10.7 At present, the site and surrounding area does not benefit from any additional measures of stormwater treatment.

10.8 Due to the need to provide wider sustainability benefits and view the development at a strategic level, SuDS will be implemented to passively treat run off from the development so as to have a positive impact on the surrounding natural environment.

10.9 The site will employ underground storage, which will provide for one stage of treatment onsite. Coupled with this however, the unknown watercourse should also be seen as an additional stage of treatment as the sedimentation process is not limited to artificial drainage systems but is taken from the natural processes observed within the water cycle. This gives 2-3 stages of treatment, providing an extensive system by which to effectively decrease pollutant load within stormwater run-off.

10.10 As the site is not presently served by any means of storm water treatment mechanisms, by providing the afore mentioned SuDS within the proposed development it will be possible to maintain present water quality in the area and thus the development can be seen to be having no significant environmental impact in relation to water.

Exceedance Flows

10.11 Careful regard has to be made in respect of potential exceedance flows, being events that are more extreme than current design criteria. Various national guidance has been published on the matter of exceedance flows and measures that should be incorporated into a development to ensure the safety of occupiers and those using the infrastructure.

10.12 The principal aim is to direct any exceedance flows away from properties and along defined corridors. At a local level, this may mean water being conveyed along a length of highway, as long as the predicted flow depths and velocities are acceptable. More strategically, the implementation of conveyance corridors is important in avoiding deep and high velocity flows that present a high risk.

10.13 Careful and considered design in other areas, can also reduce the risk.

Implementation Proposals

10.14 The conceptual drainage proposals have been developed in a manner that will allow the site wide system to be designed to encourage passive treatment of discharged flows and to improve the water quality by removing the low-level silts, oils which could be attributed to track/parking area run off of this nature. Final design will provide for appropriate geometry and planting to maximise this benefit.

10.15 The storm water management features will be constructed and operational prior to the first use of the site, derived on a phase-by-phase requirement.

10.16 It has previously been the case that the functionality of the storm water management system would be ensured by ongoing maintenance, completed by the Local Authority, Drainage Authority, or a private maintenance company as appropriate. It is proposed that, for this development, a private maintenance company will be appointed to carry out the maintenance regime below in **Table 10-3**.

10.17 It is usual for the following maintenance regime to be implemented:

Regular Maintenance		
1	**Litter Management**	
1.1	Pick up all litter in SuDS and Landscape areas and remove from site.	Monthly
2	**Landscape Maintenance**	
2.1	Mow all grass verges at 35-50mm with 75mm max and remove from site.	As required or monthly
2.2	Mow all SuDS basins and margins to low flow channels at 100mm with 150mm max.	4-8 visits as required annually
2.3	Weeding and invasive plant control.	As required or 1 visit annually
2.4	Tree and shrub maintenance.	As required or once every 2 years
2.5	Aquatic and shoreline vegetation management.	As required or 1 visit annually
3	**Inlet and Outlet Structures**	
3.1	Inspect monthly, remove silt from slab aprons and debris. Strim 1m round for access.	Monthly and after every named storm or storm with designated return period
Regular Maintenance		
4	**Proprietary Systems**	
4.1	Inspect and clean flow control.	
Occasional Maintenance		
5	**Inspection**	
5.1	Annual inspection remove silt and check free flow.	1 visit annually
5.2	Inspection and removal of debris.	Post major storm events
6	**Silt Management**	
6.1	Inspect basin annually for silt accumulation.	1 visit annually
6.2	Excavate silt, stack and dry, spread, rake and over-seed.	As required
7	**Vegetation Management**	

7.1	Major vegetation maintenance and watercourse channel works.	Once every 15 - 20 years
Remedial Maintenance		
8	**Inspection**	
8.1	Structure rehabilitation/repair	As required after annual inspection

Table 10-3: Framework maintenance of detention / retention system

10.18 The conceptual drainage masterplan proposals outlined in this report will be used for final drainage design and detailing. The storm water management system will be constructed and operational in full prior to first use of the relevant phase of development.

11 Foul Drainage

Background

11.1 A copy of the Thames Water sewerage network records will need to be obtained in order to confirm the presence of adopted combined, storm, and foul sewers on or adjacent to the site.

Design Criteria / Network Requirements

11.2 Peak design discharges have been calculated based on the current development criteria as described in Section 2 of this report and for the following:

Domestic peak (peak)	=	*4,000 litres / dwelling / day*

11.3 Assessed in accordance with the Design and Construction Guidance for Foul and Surface Water Sewers requirements, the development will have a design peak discharge of approximately 6.9l/s.

Network Requirements / Options

11.4 A pre-planning enquiry from Thames Water has confirmed that the existing network are unable to meet the needs of the proposed development.

11.5 Thames Water will need to undertake modelling on their network in order to determine the upgrade works required.

Treatment Requirements

11.6 Water companies have a statutory obligation through the Water Industry Act 1991, 2003 et al., to provide capital investment in strategic treatment infrastructure to meet development growth. This investment planning is managed and regulated by OFWAT through the Asset Management Plan (AMP) process. The five yearly cyclical process requires that water companies allocate finances to a range of strategic projects to meet their statutory obligations.

11.7 Where development programming requirements necessitate the reinforcement of facilities ahead of allocation in an AMP period, mechanisms are available to ensure the infrastructure can be delivered in a timely fashion, to meet the development programme.

Implementation Proposals

11.8 The proposed drainage network across the site will be designed to current Design and Construction Guidance for Foul and Surface Water Sewers standards, employing a point of connection agreed with Southern Water. The system will be offered for the adoption of Southern Water under S104 of the Water Industry Act 1991.

Summary

11.9 A site drainage strategy has been developed that meets with current regulatory requirements by discharging drainage to a sewerage network with capacity to accommodate the flows.

11.10 Once development is complete, the network conveying flows from the site will be adopted by Thames Water and be maintained as part of their statutory duties.

Objectives

11.11 The key development objectives required for the site drainage scheme are:

- Implementation of a drainage scheme to convey water to the local Southern Water network which is designed and maintained to an appropriate standard.

12 Summary and Conclusion

12.1 This FRA has identified no prohibitive engineering constraints in developing the proposed site for the proposed developments.

12.2 Assessment of fluvial flood risk shows the land to lie within Flood Zone 2 and is in a preferable location once NPPF sequential testing has been completed. Assessment of other potential flooding mechanisms shows the land to have a low probability of flooding from overland flow, ground water and sewer flooding.

12.3 Means to discharge storm and foul water drainage have been established that comply with current guidance and requirements of Thames Water.

12.4 Foul water drainage will need to be discharged to the existing network in compliance with current guidance and requirements of Thames Water.

12.5 When designed in accordance with the Banbury Canalside SFRA, mitigation measures including ground raising and designing the finish floor levels above the maximum flood levels will remove the risk of fluvial flooding from the proposed developments.

12.6 The site is fully able to comply with NPPF guidance together with associated local and national policy guidance.

13 Limitations

13.1 The conclusions and recommendations contained herein are limited to those given the general availability of background information and the planned usage of the site.

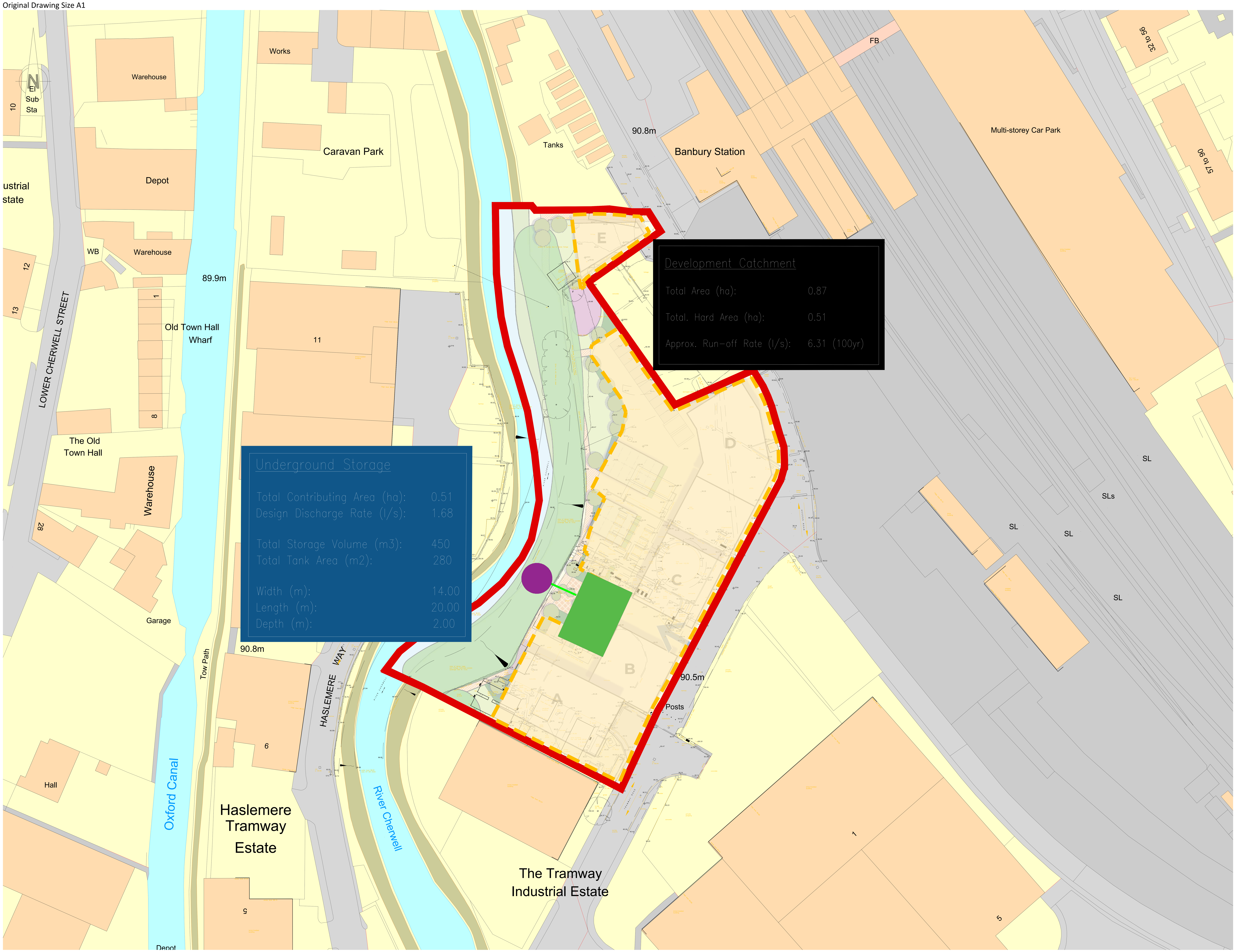
13.2 Third party information has been used in the preparation of this report, which Brookbanks, by necessity assumes is correct at the time of writing. While all reasonable checks have been made on data sources and the accuracy of data, Brookbanks accepts no liability for same.

13.3 The benefits of this report are provided solely to Motor Fuel Ltd for the proposed development at Banbury Oil Depot only.

13.4 Brookbanks excludes third party rights for the information contained in the report.

Appendix A – SuDS Drainage Plan (10682-DR-02 A)

Original Drawing Size A1



Construction Design and Management (CDM)
Key Residual Risks

Contractors entering the site should gain permission from the relevant land owners and/or principle contractor working on site at the time of entry. Contractors shall be responsible for carrying out their own risk assessments and for liaising with the relevant services companies and authorities. Listed below are Site Specific key risks associated with the project.

1) Overhead and underground services
2) Street Lighting Cables
3) Working adjacent to water courses and flood plain
4) Soft ground conditions
5) Working adjacent to live highways and railway line
6) Unchartered services
7) Existing buildings with potential asbestos hazards

NOTES:

1. Do not scale from this drawing.
2. All dimensions are in metres unless otherwise stated.
3. Brookbanks Consulting Ltd has prepared this drawing for the sole use of the client. The drawing may not be relied upon by any other party without the express agreement of the client and Brookbanks Consulting Ltd. Where any data supplied by the client or from other sources has been used, it has been assumed that the information is correct. No responsibility can be accepted by Brookbanks Consulting Ltd for inaccuracies in the data supplied by any other party. The drawing has been produced based on the assumption that all relevant information has been supplied by those bodies from whom it was requested.
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KEY:

- Red Line Boundary
- Catchment Boundary
- Underground Storage
- Proposed Outfall Location
- Exceedance Flow

A	Updated Masterplan	KM	JK	JK	18.01.22
-	First Issue	KM	JK	JK	22.10.21

BROOKBANKS

6150 Knights Court, Solihull Parkway, Birmingham, B37 7WY
T +44 (0)203 958 5400 E mail@brookbanks.com
W brookbanks.com

Motor Fuel Ltd

Banbury Oil Depot
Banbury

Illustrative Surface Water Drainage Strategy

Status		Status Date
Draft		JAN 2022
Drawn	Checked	Date
KM	JK	22.12.21
Scale	Number	Rev
1:500	10682-DR-02	A

0 10 20 30 40 50
METRES

UNTIL TECHNICAL APPROVAL HAS BEEN OBTAINED FROM THE RELEVANT LOCAL AUTHORITIES, IT SHOULD BE UNDERSTOOD THAT ALL DRAWINGS ARE ISSUED AS PRELIMINARY AND NOT FOR CONSTRUCTION. SHOULD THE CONTRACTOR COMMENCE SITE WORK PRIOR TO APPROVAL BEING GIVEN, IT IS ENTIRELY AT HIS OWN RISK.

Appendix B - IoH Greenfield Runoff Rates

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Katherine Miller
Site name:	Banbury Oil Depot
Site location:	Banbury

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be
the basis for setting consents for the drainage of surface water runoff from sites.

Site Details

Latitude:	52.05955° N
Longitude:	1.32828° W
Reference:	1339816327
Date:	Oct 23 2020 12:26

Runoff estimation approach IH124

Site characteristics

Total site area (ha): 1

Methodology

Q_{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics

	Default	Edited
SOIL type:	4	4
HOST class:	N/A	N/A
SPR/SPRHOST:	0.47	0.47

Hydrological characteristics

	Default	Edited
SAAR (mm):	654	654
Hydrological region:	6	6
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 30 years:	2.3	2.3
Growth curve factor 100 years:	3.19	3.19
Growth curve factor 200 years:	3.74	3.74

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):	4.46	4.46
1 in 1 year (l/s):	3.79	3.79
1 in 30 years (l/s):	10.26	10.26
1 in 100 year (l/s):	14.22	14.22
1 in 200 years (l/s):	16.68	16.68

Appendix C - WinDES Detention Calculations

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.682	0.682	1.2	191.0	O K
30 min Summer	0.784	0.784	1.2	219.4	O K
60 min Summer	0.898	0.898	1.3	251.3	O K
120 min Summer	1.022	1.022	1.3	286.3	O K
180 min Summer	1.099	1.099	1.4	307.7	O K
240 min Summer	1.153	1.153	1.4	322.9	O K
360 min Summer	1.228	1.228	1.5	343.7	O K
480 min Summer	1.277	1.277	1.5	357.5	O K
600 min Summer	1.311	1.311	1.5	367.1	O K
720 min Summer	1.335	1.335	1.5	373.9	O K
960 min Summer	1.373	1.373	1.5	384.4	O K
1440 min Summer	1.400	1.400	1.6	392.0	O K
2160 min Summer	1.386	1.386	1.5	388.1	O K
2880 min Summer	1.363	1.363	1.5	381.6	O K
4320 min Summer	1.254	1.254	1.5	351.0	O K
5760 min Summer	1.163	1.163	1.4	325.7	O K
7200 min Summer	1.085	1.085	1.4	303.9	O K
8640 min Summer	1.016	1.016	1.3	284.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	201.096	0.0	90.8	27
30 min Summer	115.868	0.0	92.4	42
60 min Summer	66.761	0.0	192.6	72
120 min Summer	38.466	0.0	196.2	130
180 min Summer	27.862	0.0	200.2	190
240 min Summer	22.164	0.0	204.7	250
360 min Summer	16.054	0.0	212.5	368
480 min Summer	12.770	0.0	217.5	488
600 min Summer	10.693	0.0	220.9	608
720 min Summer	9.250	0.0	223.1	726
960 min Summer	7.396	0.0	226.2	964
1440 min Summer	5.397	0.0	226.5	1442
2160 min Summer	3.938	0.0	423.1	1964
2880 min Summer	3.148	0.0	424.9	2308
4320 min Summer	2.220	0.0	405.3	3072
5760 min Summer	1.733	0.0	634.8	3912
7200 min Summer	1.430	0.0	653.9	4696
8640 min Summer	1.222	0.0	667.2	5536

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
10080 min Summer	0.953	0.953	1.3	266.7	O K
15 min Winter	0.764	0.764	1.2	214.0	O K
30 min Winter	0.878	0.878	1.3	245.9	O K
60 min Winter	1.007	1.007	1.3	281.9	O K
120 min Winter	1.148	1.148	1.4	321.5	O K
180 min Winter	1.235	1.235	1.5	345.9	O K
240 min Winter	1.298	1.298	1.5	363.4	O K
360 min Winter	1.385	1.385	1.5	387.7	O K
480 min Winter	1.443	1.443	1.6	404.0	O K
600 min Winter	1.485	1.485	1.6	415.7	O K
720 min Winter	1.515	1.515	1.6	424.3	O K
960 min Winter	1.564	1.564	1.6	437.9	O K
1440 min Winter	1.608	1.608	1.7	450.4	O K
2160 min Winter	1.610	1.610	1.7	450.9	O K
2880 min Winter	1.578	1.578	1.6	441.9	O K
4320 min Winter	1.449	1.449	1.6	405.8	O K
5760 min Winter	1.331	1.331	1.5	372.7	O K
7200 min Winter	1.224	1.224	1.5	342.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	1.070	0.0	647.8	6360
15 min Winter	201.096	0.0	91.8	27
30 min Winter	115.868	0.0	97.6	41
60 min Winter	66.761	0.0	195.9	70
120 min Winter	38.466	0.0	203.5	128
180 min Winter	27.862	0.0	211.7	188
240 min Winter	22.164	0.0	217.7	246
360 min Winter	16.054	0.0	225.7	362
480 min Winter	12.770	0.0	230.7	480
600 min Winter	10.693	0.0	234.0	596
720 min Winter	9.250	0.0	236.2	714
960 min Winter	7.396	0.0	238.9	944
1440 min Winter	5.397	0.0	238.4	1400
2160 min Winter	3.938	0.0	450.6	2056
2880 min Winter	3.148	0.0	452.6	2624
4320 min Winter	2.220	0.0	430.7	3284
5760 min Winter	1.733	0.0	710.5	4208
7200 min Winter	1.430	0.0	730.6	5120

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
8640 min Winter	1.127	1.127	1.4	315.4	O K
10080 min Winter	1.037	1.037	1.4	290.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Winter	1.222	0.0	728.1	5976
10080 min Winter	1.070	0.0	689.4	6864

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 446150 240150 SP 46150 40150
C (1km)	-0.024
D1 (1km)	0.315
D2 (1km)	0.333
D3 (1km)	0.249
E (1km)	0.301
F (1km)	2.480
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.510

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.170	4	8	0.170	8	12	0.170

Model Details

Storage is Online Cover Level (m) 2.000

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	280.0	2.000	280.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0054-1700-1700-1700
Design Head (m)	1.700
Design Flow (l/s)	1.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	54
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.700	1.7	Kick-Flo®	0.484	1.0
Flush-Flo™	0.240	1.2	Mean Flow over Head Range	-	1.3

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.0	1.200	1.4	3.000	2.2	7.000	3.3
0.200	1.2	1.400	1.6	3.500	2.4	7.500	3.4
0.300	1.2	1.600	1.6	4.000	2.5	8.000	3.5
0.400	1.1	1.800	1.7	4.500	2.6	8.500	3.6
0.500	1.0	2.000	1.8	5.000	2.8	9.000	3.7
0.600	1.1	2.200	1.9	5.500	2.9	9.500	3.8
0.800	1.2	2.400	2.0	6.000	3.0		
1.000	1.3	2.600	2.1	6.500	3.1		

Appendix D – Thames Water Pre-Planning Enquiry

Mr Adam Melia
Sent via email:
Adam.Melia@brookbanks.com

Wastewater pre-planning
Our ref DS6076592

18 September 2020

Pre-planning enquiry: Capacity concerns

Dear Adam,

Thank you for providing information on your development at Banbury where you propose to connect 150 new apartments with an estimated peak foul flow of 1.9l/s to foul MH SP46401101. No information has been provided for the surface water.

We have completed the assessment of the foul water flows based on the limited information submitted in your application with the purpose of assessing sewerage capacity within the existing Thames Water sewer network.

Foul Water

We've assessed your **foul water** proposals and concluded that we're unable to meet the needs of your development at this time.

In order to ensure we make the appropriate upgrades – or 'off-site reinforcement' – to serve the remainder of your development, we'll need to carry out modelling work, design a solution and build the necessary improvements. This work is done at our cost.

Once we've begun modelling, we may need to contact you to discuss changing the connection point for capacity reasons. Please note that we'll pay the cost of covering any extra distance if the connection needs to be made at a point further away than the nearest practicable point of at least the same diameter.

How long could modelling and reinforcement take?

Typical timescales for a development of your size are:

Modelling: 8 months
Design: 6 months
Construction: 6 months
Total: 20 months

If the time you're likely to take from planning and construction through to first occupancy is longer than this, we'll be able to carry out the necessary upgrades in time for your development. If it's shorter, please contact me on the number below to discuss the timing of our activities.

What do you need to tell us before we start modelling?

We will only carry out modelling once we're confident that your development will proceed. In order to have this confidence, we'll need to know that you **own the land and have either outline or full planning permission**. Please email this information to us as soon as you have it.

If you'd like us to start modelling work ahead of this point, we can do this if you agree to underwrite the cost of modelling and design. That means we'll fund the work – but you agree to pay the cost if you don't achieve first occupancy within five years. You will also be required to provide **ALL** of the information requested in out previous letter dated 20th August 2020.

If the modelling shows we need to carry out reinforcement work, then before we start construction we'll need you to supply us with notification that you've confirmed your F10 – Notification of construction project - submission to the Health and Safety Executive.

Surface Water

In accordance with the Building Act 2000 Clause H3.3, positive connection of surface water to a public sewer will only be consented when it can be demonstrated that the hierarchy of disposal methods have been examined and proven to be impracticable. Before we can consider your surface water needs, you'll need written approval from the lead local flood authority that you have followed the sequential approach to the disposal of surface water and considered all practical means.

The disposal hierarchy being:

1. store rainwater for later use.
2. use infiltration techniques where possible.
3. attenuate rainwater in ponds or open water features for gradual release.
4. attenuate rainwater by storing in tanks or sealed water features for gradual release.
5. discharge rainwater direct to a watercourse.
6. discharge rainwater to a surface water sewer/drain.
7. discharge rainwater to the combined sewer.
8. discharge rainwater to the foul sewer

Where connection to the public sewerage network is still required to manage surface water flows we will accept these flows at a discharge rate in line with CIRIA's best practice guide on SuDS or that stated within the sites planning approval.

Please see the attached 'Planning your wastewater' leaflet for additional information.

What do I need to do next?

If you've satisfied the points above, then you should compare your own timeline with the typical timescales we've suggested for our activities. If the time you're likely to take from planning and construction through to first occupancy is **more** than the total time we're likely to take, we'll be able to carry out the necessary upgrades in time for your development.

If it's **less** than this, you might want to ask us to start modelling earlier – in which case we'll require you to underwrite the cost, as noted above.

Your sincerely
Dan Rees
Developer Services – Adoptions Engineer

Appendix E – Pro-Forma

SuDS Flows and Volumes - LLFA Technical Assessment Pro-forma

This form identifies the information required by Oxfordshire County Council LLFA to enable technical assessment of flows and volumes determined as part of drainage I SuDS calculations.

*Note : * means delete as appropriate; Numbers in brackets refer to accompanying notes.*

SITE DETAILS

1.1 Planning application reference

1.2 Site name

1.3 Total application site area (1 ....m² ....ha

1.4 Is the site located in a CDA or LFRZ Y/N

1.5 Is the site located in a SPZ Y/N

VOLUME AND FLOW DESIGN INPUTS

2.1 Site area which is positively drained by SuDS (2 ....m²

2.2 Impermeable area drained pre development (3 ....m²

2.3 Impermeable area drained post development (3) ....m²

2.4 Additional impermeable area (2.3 minus 2.2) ....m²

2.5 Predevelopment use (4 Greenfield / Brownfield / Mixed*

2.6 Method of discharge (5 Infiltration / waterbody / storm sewer/ combined sewer*

2.7 Infiltration rate (where applicable) ....m/hr

2.8 Influencing factors on infiltration

2.9 Depth to highest known ground water table..............................mAOD

2.10 Coefficient of runoff (Cv) (6

2.11 Justification for Cv used

2.12 FEH rainfall data used (Note that FSR is no longer the preferred rainfall calculation method) Y/N

2.13 Will storage be subject to surcharge by elevated water levels in watercourse/ sewer Y/N

2.14 Invert level at outlet (invert level of final flow control) ....mAOD

2.15 Design level used for surcharge water level at point of discharge(14) ....mAOD

SuDS Flows and Volumes - LLFA Technical Assessment Pro-forma

CALCULATION OUTPUTS

Sections 3 and 4 refer to site where storage is provided by attenuation and I or partial infiltration. Where all flows are infiltrated to ground omit Sections 3 -5 and complete Section 6.

3.0 Defining rate of runoff from the site

3.2 Max. discharge for 1 in 1 year rainfall ....l/s/ha, ...l/s for the site

3.2 Max. discharge for Qmed rainfall ....l/s/ha, ...l/s for the site

3.3 Max. discharge for 1 in 30 year rainfall ....l/s/ha, ...l/s for the site

3.4 Max. discharge for 1 in 100 year rainfall ....l/s/ha, ...l/s for the site

3.5 Max. discharge for 1 in 100 year plus 40%CC ....l/s/ha, ...l/s for the site

4.0 Attenuation storage to manage peak runoff rates from the site

4.1 Storage - 1 in 1 year ....m^3 ....m^3/m^2 (of developed impermeable area)

4.2 Storage -1in 30 year (7 ....m^3 ....m3/m2

4.3 Storage -1in 100 year (8) ....m^3 ....m3/m2

4.4 Storage - 1 in 100 year plus 40%CC (9) ....m3 ....m3/m2

5.0 Controlling volume of runoff from the site

5.1 Pre development runoff volume(10) .... m^3 for the site

5.2 Post development runoff volume (unmitigated) (10) .... m^3 for the site

5.3 Volume to be controlled/does not leave site (5.2-5.1).............. m^3 for the site

5.4 Volume control provided by
Interception losses(11) m3
Rain harvesting(12) m3
Infiltration (even at very low rates) m3
Separate area designated as long term storage(13) m3

5.5 Total volume control (sum of inputs for 5.4) m3 (15)

6.0 Site storage volumes (full infiltration only)

6.1 Storage - 1in 30 year (7 ....m^3 ....m^3/m^2 (of developed impermeable area)

6.2 Storage - 1 in 100 year plus CC (9 ....m3 ....m3/m2

SuDS Flows and Volumes - LLFA Technical Assessment Pro-forma

Notes

1. All area with the proposed application site boundary to be included.
2. The site area which is positively drained includes all green areas which drain to the SuDS system and area of surface SuDS features. It excludes large open green spaces which do not drain to the SuDS system.
3. Impermeable area should be measured pre and post development. Impermeable surfaces includes, roofs, pavements, driveways and paths where runoff is conveyed to the drainage system.
4. Predevelopment use may impact on the allowable discharge rate. The LLFA will seek for reduction in flow rates to GF status in all instances. The design statement and drawings explain/ demonstrate how flows will be managed from the site.
5. Runoff may be discharge via one or a number of means.
6. Sewers for Adoption 6th Edition recommends a Cv of 100% when designing drainage for impermeable area (assumes no loss of runoff from impermeable surfaces) and 0% for permeable areas. Where lower Cv's are used the application should justify the selection of Cv.
7. Storage for the 1 in 30 year must be fully contained within the SuDS components. Note that standing water within SuDS components such as ponds, basins and swales is not classified as flooding. Storage should be calculated for the critical duration rainfall event.
8. Runoff generated from rainfall events up to the 1 in 100 year will not be allowed to leave the site in an uncontrolled way. Temporary flooding of specified areas to shallow depths (150-300mm) may be permitted in agreement with the LLFA.
9. Climate change is specified as 40% increase to rainfall intensity, unless otherwise agreed with the LLFA / EA.
10. To be determined using the 100 year return period 6 hour duration rainfall event.
11. Where Source Control is provided Interception losses will occur. An allowance of 5mm rainfall depth can be subtracted from the net inflow to the storage calculation where interception losses are demonstrated. The Applicant should demonstrate use of subcatchments and source control techniques.
12. Please refer to Rain harvesting BS for guidance on available storage.
13. Flow diverted to Long term storage areas should be infiltrated to the ground, or where this is not possible, discharged to the receiving water at slow flow rates (maximum 2 l/s/ha). LT storage would not be allowed to empty directly back into attenuation storage and would be expected to drain away over 5-10 days. Typically LT storage may be provided on multi-functional open space or sacrificial car parking areas.
14. Careful consideration should be used for calculations where flow control / storage is likely to be influenced by surcharged sewer or peak levels within a watercourse. Storm sewers are designed for pipe full capacity for 1 in 1 to 1 in 5 year return period. Beyond this, the pipe network will usually be in conditions of surcharge. Where information cannot be gathered from Thames Water, engineering judgement should be used to evaluate potential impact (using sensitivity analysis for example).
15. In controlling the volume of runoff the total volume from mitigation measures should be greater than or equal to the additional volume generated.

Design and Credit to: McCloy Consulting Ltd

Head Office Address
6150 Knights Court,
Solihull Parkway,
Birmingham Business Park,
Birmingham.
B37 7WY

T +44(0)121 329 4330
brookbanks.com