Land South and East of Adastral Park, Ipswich
Updated Flood Risk Assessment

5th July 2017

1 Introduction

Brookbanks Consulting Limited (BCL) is commissioned by Carlyle Land Ltd and Commercial Estates Group to provide technical advice on viability and delivery on a proposed mixed-use development at Adastral Park, Martlesham Heath, Suffolk.

An outline planning application has been submitted which, amongst other things, contains a Flood Risk Assessment. This document provides technical evidence to demonstrate robustness of the proposed drainage related mitigation measures proposed.

An Updated Flood Risk Assessment has been produced to respond to queries raised by Suffolk County Council.

The Updated Flood Risk Assessment is attached. The purpose of this cover sheet is to provide a brief summary of the additional information contained within the document.

2 Updated Flood Risk Assessment – Additional Contents

INFILTRATION TESTS

Onsite infiltration tests were requested for the site, this was completed by GEG Ltd on 30th June. The largely positive results, which are included within the Appendix of the Flood Risk Assessment, have shown a range of infiltration rates across the site and the proposed drainage strategy has been adapted to suite.

Land south and east of Adastral Park

Updated Flood Risk Assessment

Carlyle Land Ltd and CEG

Brookbanks

Document Control Sheet

Document Title: Updated Flood Risk Assessment

Document Ref: 10391/FRA/01

Project Name: Land south and east of Adastral Park, Ipswich

Project Number: 10391

Client: Carlyle Land Ltd and CEG

Document Status

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Name / Date & Revision	09.12.16	10.03.17	15.06.17	04.07.17		
David Lewis – CEG	1	2	3	4		

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1 Introduction

1.1 Brookbanks Consulting Limited is appointed by Carlyle Land Ltd and CEG, to complete a Flood Risk Assessment for a proposed development at Land south and east of Adastral Park in Ipswich, Suffolk.

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.

2 Background Information

Location & Details

2.1 The proposed development Site boundary measures an area of approximately 161ha and comprises of BT's Adastral Park (which is to be retained) to the north and north-west. The remainder of the Site (which is to be developed), composes of undeveloped land and is situated to the south and south east of Adastral Park. The Site is bound to the west by the A12 and to the north-west by Barracks Square, Gloster Road and Belts Avenue, which form boundaries to Adastral Park. The south of the Site is bound by Newbourne Road and Ipswich Road, with the east of the Site bound a by a footpath which separates the current surrounding agricultural land.

2.2 The proposed development area is outlined in red, as shown on Figure 2a, below:

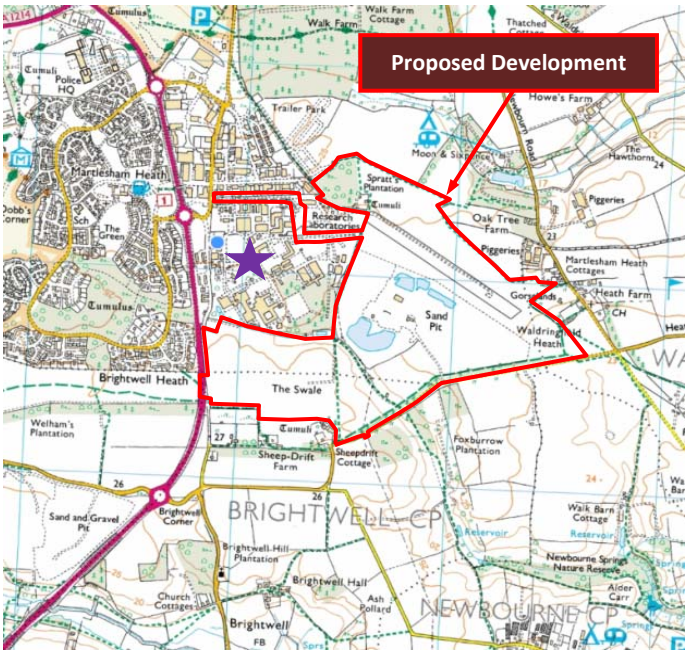

Figure 2a: Site Location

Development Criteria

2.3 Outline application for Up to 2,000 homes, an employment area of c0.6ha (use class B1), primary local centre (comprising use classes A1, A2, A3, A4, A5, B1, C3, D1 and D2), secondary local centre (comprising possible use classes A1, A3, A5 and D2), a school, green infrastructure (including Suitable Accessible Natural Greenspace (SANGs), outdoor play areas, sports ground and allotments / community orchards), public footpaths and cycleways, vehicle accesses and associated infrastructure.

Sources of Information

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

- Anglian Water - Storm & foul water drainage
- Environment Agency - Flood and Coastal Management (FCRM)
- Suffolk County Council (SCC) - Surface water and drainage

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

- Mastermap Data - Ordnance Survey
- Published Geology - British Geological Survey
- Level 1 Strategic Flood Risk Assessment - Suffolk Coastal and Waveney District Councils, February 2008
- Suffolk Flood Risk Management Strategy (SFRMS) - Suffolk County Council, March 2016
- Appendix A SFRMS - Suffolk County Council, March 2016

Ground Conditions

Geology

2.6 With reference to the British Geological Survey map, the Site is shown to be underlain by bedrock geology comprising sand from the Crag Formation, with areas of overlying superficial deposits of sand and gravel belonging to the Kesgrave Catchment Subgroup.

2.7 There is no Artificial Ground/ Made Ground or Landslip areas reported on Site.

2.8 The Site geology, as described above is illustrated on Figure 2b.

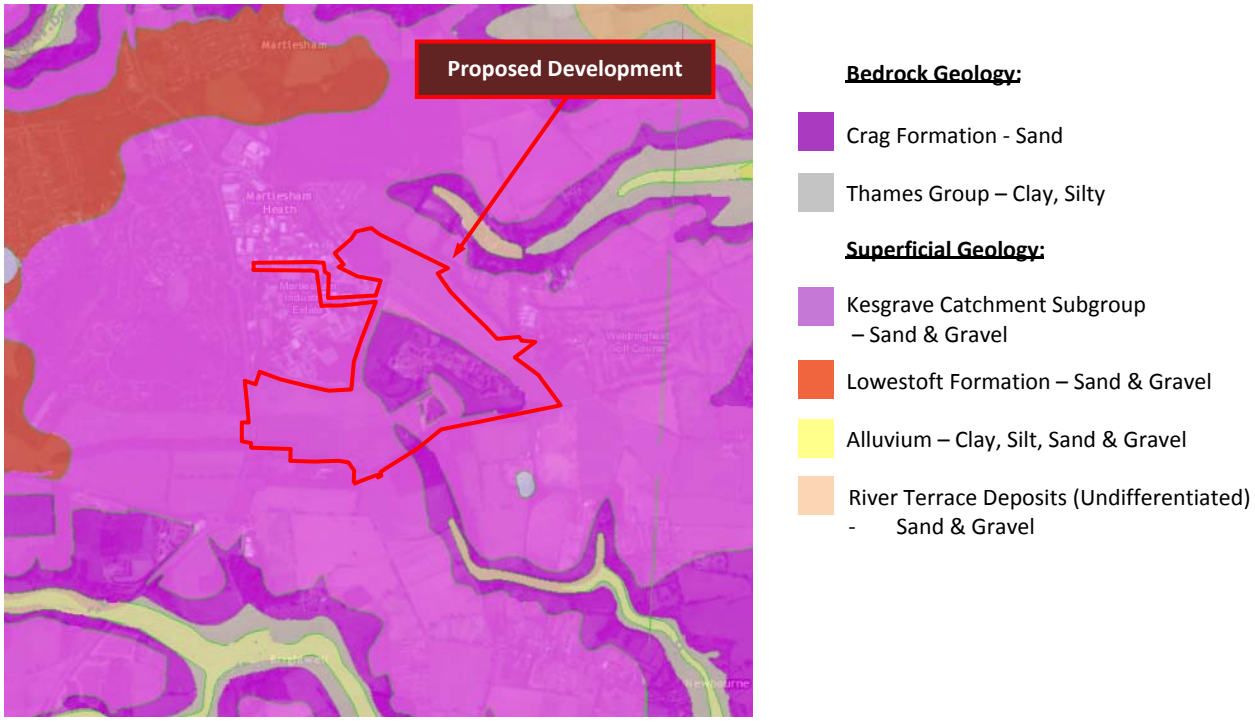

Figure 2b: BGS Published Geology

Watercourse Systems & Drainage

2.9 Reference to the Flood Estimation Handbook (FEH) CD dataset v3 shows the majority of the land to lie within the catchment of the Mill River, some of the land is developed. Having an URBEXT2000 value of 0.217, the catchment can be described as "Heavily Urbanised". The FEH catchment is shown in Figure 2c, below:

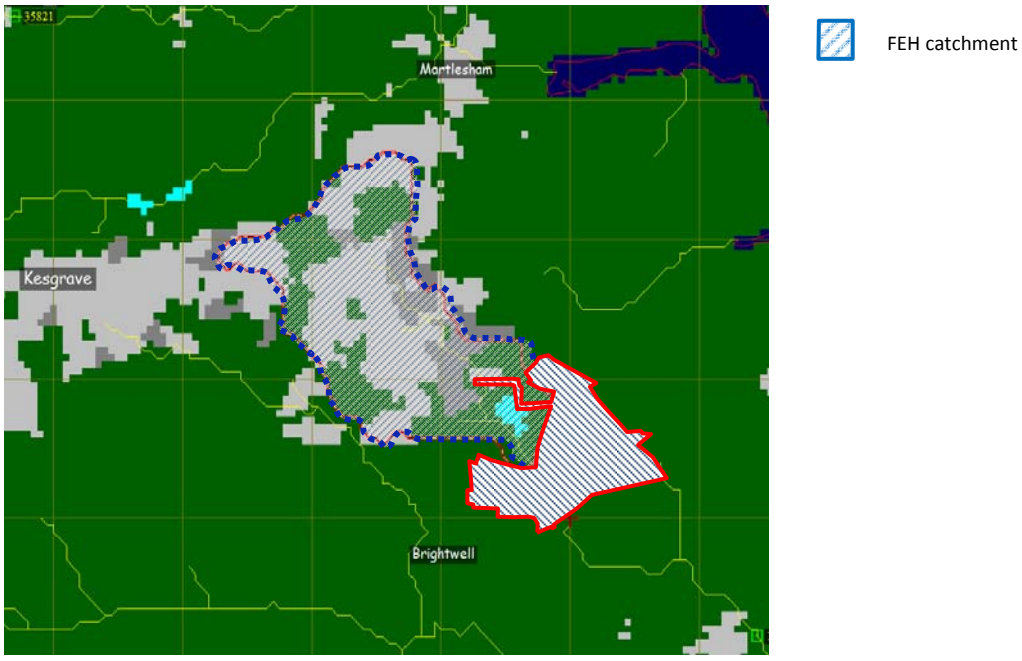

Figure 2c: FEH reported catchment for study area

3 Flooding Risk

National Planning Context

3.1 The National Planning Policy Framework (NPPF) (DCLG 2012) advocates the steering of development away from areas at high risk of flooding. However, the document acknowledges that development is necessary and that a key aim should be to ensure that flood risk is not increased elsewhere.

3.2 The NPPF states that local 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….'

3.3 The NPPF requires that developments covering an area of greater than one hectare prepare a Flood Risk Assessment (FRA). The FRA is required to be proportionate to the risk and appropriate to the scale, nature and location of the development.

3.4 More detailed guidance on flood risk has been provided in the Government's Planning Practice Guidance (DCLG 2014). This guidance reiterates that allocation and planning of development must be considered against a risk based search sequence. In terms of fluvial flooding, the guidance categorises flood zones in to four principal levels of risk, as follows:

Flood Zone	Annual Probability of Flooding	Definition
Zone 1: Low probability	< 0.1 %	Land having a less than 1 in 1,000 annual probability of river or sea flooding. (Shown as 'clear' on the Flood Map – all land outside Zones 2 and 3)
Zone 2: Medium probability	0.1 – 1.0 %	Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or Land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding. (Land shown in light blue on the Flood Map)
Zone 3a: High probability	> 1.0 %	Land having a 1 in 100 or greater annual probability of river flooding; or Land having a 1 in 200 or greater annual probability of sea flooding. (Land shown in dark blue on the Flood Map)
Zone 3b: Functional Floodplain	> 1.0 %	This zone comprises land where water has to flow or be stored in times of flood. Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. (Not separately distinguished from Zone 3a on the Flood Map)

Figure 3a: NPPF Flood Risk Parameters

3.5 The guidance sets out categories of flood risk vulnerability, using the classifications: essential infrastructure, highly vulnerable, more vulnerable, less vulnerable and water compatible. According to this scale, residential and education development would fall within the 'more vulnerable' category, while buildings used for shops or non-residential institutions would be considered 'less vulnerable' and amenity open space, space for nature conservation, outdoor sports and recreation areas would fall into the 'water compatible' category.

3.6 According to the guidance, development within the 'more vulnerable' category should be located outside Flood Zone 3b and located outside of Flood Zone 3a, unless on application of the 'Sequential Test', the site is demonstrated to be the most appropriate for the proposed development and satisfactory flood mitigation can be provided. Additionally, 'more vulnerable' development proposed within Flood Zone 3a is required to pass the 'Exception Test'. The 'Exception Test' requires that:

- The development provides wider sustainability benefits to the community that outweigh the flood Risk; and
- The development will be safe, not increase flood risk and where possible reduce flood risk overall.

3.7 'More vulnerable' development may be appropriate in Flood Zones 1 and 2. Development in the 'less vulnerable' category should be directed towards Flood Zones 1, 2 or 3a, while water compatible development may be appropriate in any flood zone.

Regional Policy

3.8 The NPPF sets out the Government's planning policies for England and how these are expected to be applied. It sets out the Government's requirements for the planning system to the extent it is relevant, proportionate and necessary to do so. The statement provides a framework within which the local authority can produce policies that communities can use in neighbourhood planning.

3.9 **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.

3.10 The councils of Suffolk Coastal Council and Waveney District Council formed a partnership to commission a joint SFRA of both districts. The Level 1 Strategic Flood Risk Assessment was commission to Scott Wilson and published in February 2008. 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 underpins national guidance.

3.11 The Level 1 SFRA maps of Flood Zones 2 and 3 for the entire Suffolk Coastal and Waveney District, are based on the Environment Agency's Flood Zones, as per NPPF Table 1 ignoring the presence of existing flood defences. However, these Flood Zones have some limitations in places, such as not necessarily following the alignment of watercourses shown on Ordnance Survey background maps due to the coarse nature of the digital terrain used in the Flood Zone modelling.

3.12 As part of the new planning system in England, local authorities have to prepare a Local Plan for the whole district which would have statutory Development Plan Document status. The Local Plan must aim to achieve the objective of sustainable development and be consistent with the National Planning Policy Framework (published 27th March 2012) including the presumption in favour of sustainable development. Local Plans should address the spatial implications of environmental, economic and social change and set out the strategic priorities to deliver housing, economic growth, infrastructure and other development.

3.13 Suffolk County Council produced a Flood Risk Management Strategy for Suffolk in March 2016, the strategy is an important tool to help everyone understand and manage flood risk within the county. The local Flood Risk Management Strategy is a statutory document, which will impact on the activity of all flood risk management activities of all flood risk management authorities.

3.14 Appendix A to the Suffolk Flood Risk Management Strategy (SFRMS) provides a SuDS Guidance, Standards and Information within the county. Planning Practice Guidance5 Paragraph 50 states: "Local authorities and developers should seek opportunities to reduce the overall level of flood risk in the area and beyond. This can be achieved, for instance, through the layout and form of development, including green infrastructure and the appropriate application of sustainable drainage systems, through safeguarding land for flood risk management, or where appropriate through designing off-site works required to protect and support development in ways that benefit the area more generally.

3.15 The SFRMS states: the guiding principles for SuDS in Suffolk will be:

- Early consideration of sustainable flood and coastal risk management in production of Local Plans and master planning– promoting and protecting 'blue and green corridors'.
- Wherever possible, the use of multifunctional, above ground SuDS that deliver drainage, enhancement of biodiversity, improvements in water quality and amenity benefits.
- Ensuring that land owners realise both the importance of reducing flood risk and how properly designed sustainable drainage systems can be an asset to their development.
- Ensuring no increase in flood risk from new development wherever possible and contributing to reducing existing risk if feasible.
- Ensuring water flows around properties when the design capacity of drainage systems is exceeded by extreme rainfall.

Flood Mechanisms

3.15 Having completed a site hydrological desk study and walk over inspection, the possible flooding mechanisms at the site are identified as follows in Figure 3b.

Mechanisms	Potential?	Comment
Fluvial (Annex C: C4)	N	No watercourse within the site boundary.
Coastal & tidal (Annex C: C5)	N	No tidal watercourses lie within an influencing distance of the proposed development.
Overland flow (Annex C: C6)	N	Small section of land located around the existing ponds is shown on the EA's flood map to be at low to moderate risk of overland flow.
Groundwater (Annex C: C7)	N	Geology underlying the site is of a potentially high permeability. No groundwater flooding was identified within the SFRA.
Sewers (Annex C: C8)	N	No sewerage lies within the site. Anglian Water report of lack of capacity in their adjacent network.
Reservoirs, Canals etc (Annex C: C9)	N	No Reservoirs lie within an influencing distance of the proposed development.

Figure 3b: Flooding mechanisms

3.16 Where potential risks are identified in Figure 3c, above, more detailed assessments have been completed and are outlined below. Further background is also outlined below.

Fluvial Flooding: C4

3.17 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.

3.18 The mapping shows that the site lies within Flood Zone 1; being an area of Low Probability of flooding, outside both the 1 in 100 (1% AEP) and 1 in 1,000 (0.1% AEP) year flood events. The EA Flood Zone plan reprinted as Figure 3c below.

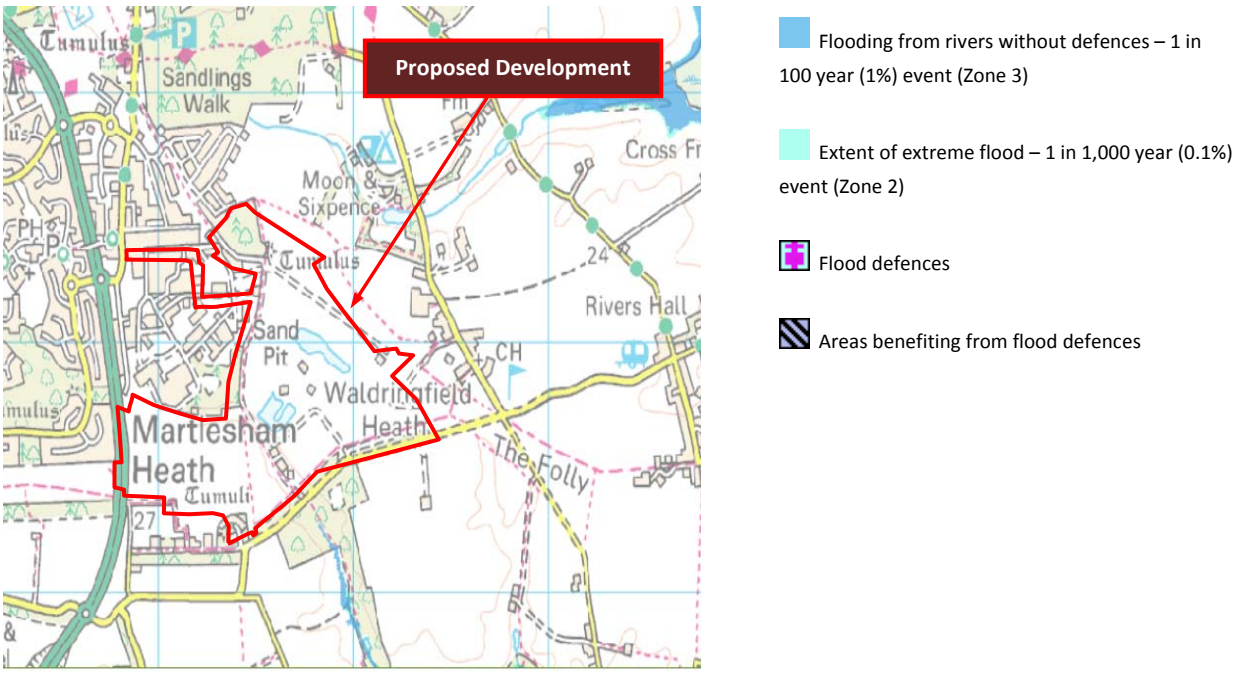

Figure 3c: EA Flood Zone Plan showing 1 in 100 & 1 in 1,000 year floodplain

Coastal Flooding: C5

3.19 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.

Overland Flow: C6

3.20 Overflow 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.

3.21 Site inspections and research completed as part of the assessment process identifies low to moderate risk of surface water in a small area of within the site, the majority of overland flow situates around the existing ponds on site. Furthermore, the rest of the site lies on a fairly high point for the surrounding area and as such, the risk of an overland flow mechanism affecting the site from outside the site boundary is considered very low to low.

3.22 The Environment Agency has recently produced a series of surface water flood maps for many parts of the UK. The plan containing the proposed site is reprinted as Figure 3d.

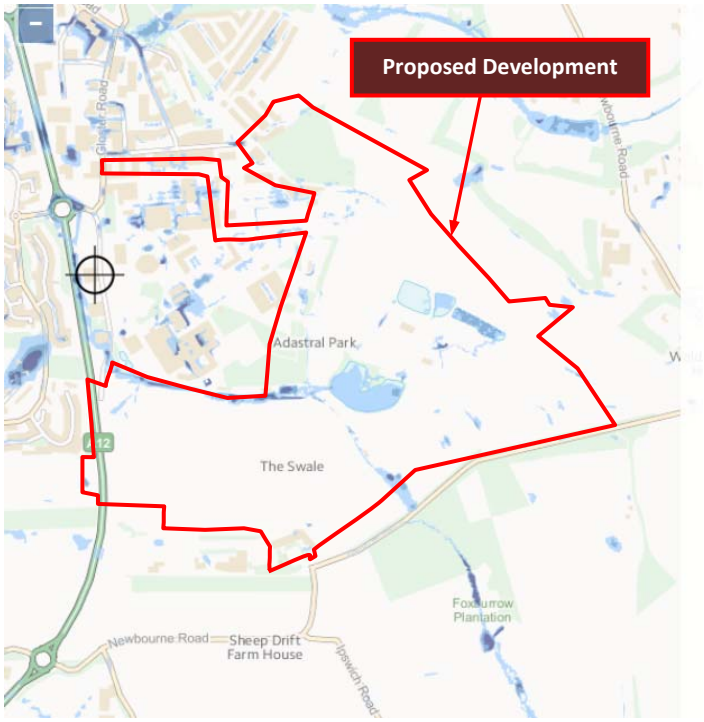

Figure 3d: EA Surface Water Mapping

High – chance of flooding greater than 1 in 30 (3.3%)
Medium – Chance of flooding between 1 in 100 (1%) and 1 in 30 (3.3%)
Low – Chance of flooding between 1 in 1,000 (0.1%) and 1 in 100 (1%)
Very Low – Chance of flooding less than 1 in 1,000 (0.1%)

3.23 The mapping provided by the EA identifies small areas of surface water flooding within the site boundary along the ponds and low lying areas within the site boundary.

3.24 The findings of the BCL and EA assessments have been taken into account as part of the master planning proposals for the site and accordingly it is proposed to ensure all built development remains outside any identified significant surface water flooding areas.

3.25 Recognising the risk of overland flow mechanisms, published guidance in the form of Sewers for Adoption 7th Edition and the Environment Agency document *Improving the Flood Performance of New Buildings: Flood Resilient Construction* 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.

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

Groundwater: C7

3.27 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 affect on the local geology or hydrogeology.

3.28 The EA mapping for groundwater flooding shows the site to be above a minor aquifer and outside of areas at risk of groundwater flooding.

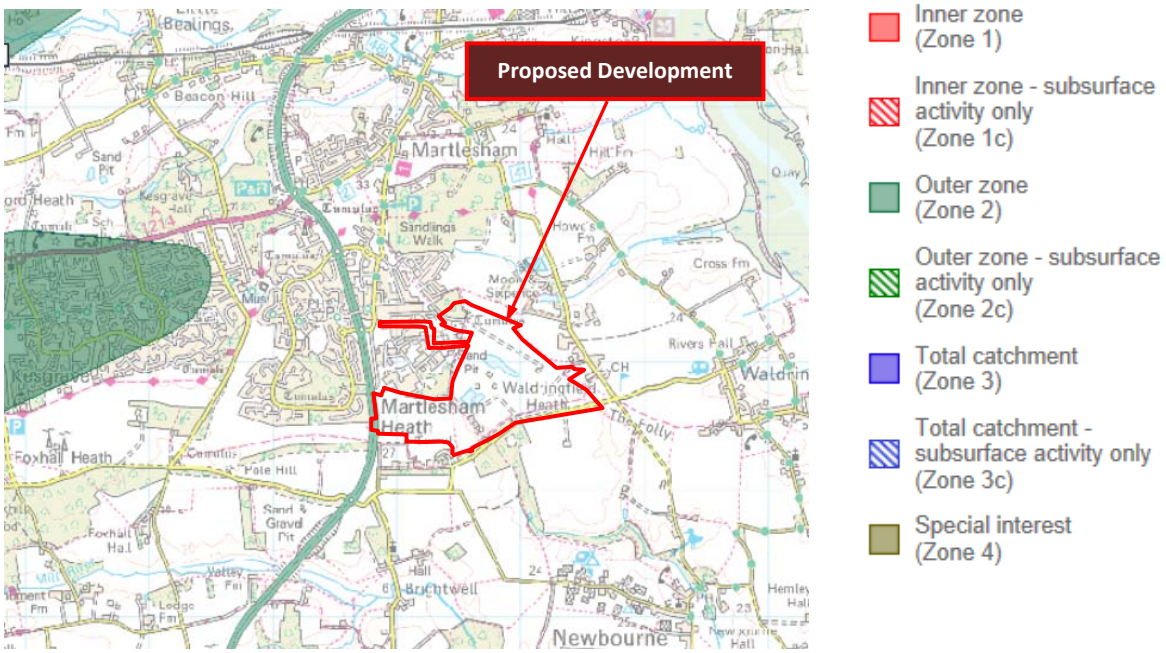

Figure 3e: EA Groundwater Protection zone Mapping

3.29 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.

3.30 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: C8

3.31 Investigations with Anglian Water provide no evidence of present or historic sewer flooding at the site.

3.32 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: C9

3.33 No artificial sources are identified within an influencing distance of the Site boundary.

3.34 It may therefore be concluded that there is a low risk of flooding associated with artificial water bodies at the proposed development

Residual Flood Risk

3.35 An FRA should consider the Residual Flood Risk once development activities are complete, ensuring that appropriate mitigation is proposed to ensure risks are not increased as a result of the activities. This FRA promotes, within the main body of the text, a series of proposals that will be employed to ensure post development situation is acceptable and that

residual flood risk is managed. The following list summarises the main proposals that will adequately control residual flood risk:

- All development is to lie within Flood Zone 1 / Zone A.
- Compliance with guidance in terms of flood routing and resilience for new developments.
- Provision of a multi-tier storm water SuDS management system (see Section 4).
- Connection to a point of adequacy on the foul water drainage network with completion of necessary downstream reinforcements to ensure adequate conveyance and treatment capacity (see Section 5).
- Provision of ongoing maintenance for SuDS features.
- Adoption and associated ongoing maintenance of development storm and foul drainage system.

Summary

3.36 In terms of fluvial and tidal flood risk, the proposed development can be seen to lie within Flood Zone 1 / Zone A, and hence has a low probability of flooding from this mechanism.

3.37 Assessment of other potential flooding mechanisms show the land to have a low probability of flooding from overland flow, ground water and sewer flooding.

3.38 Accordingly, the proposed development land is in a preferable location for residential development when appraised in accordance with the national and local policy. The site should be considered preferable to other potential developments that may lie wholly within areas of increased flood risk.

Objectives

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

- Compliance with SFA 7th Edition and NRW guidance in relation to flood routing through the proposed development in the event of sewer blockages.
- Implementation of a 150mm slab freeboard above the level of the proposed flood routes, to protect buildings in the event of a localised blockage.

4 Storm Drainage

Background

4.1 To understand the baseline provision for storm drainage in the area, a copy of the Anglian Water sewerage network records has been obtained. No public or private surface water sewers or combined sewers are present on the site however the surrounding development land is serviced by an adopted sewer network.

4.2 Site inspections confirm the majority of the land presently discharges storm water to the existing ponds along within site boundary, due to the characteristics of the site, surface water is thought to infiltrate into the ground.

4.3 Due to the high level of groundwater at the location of the existing ponds, it is proposed not to utilise the existing ponds to discharge surface water from the site.

Figure 4a: Existing Pond

Drainage Options

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

4.5 Current guidance[1] 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.

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

4.7 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. "

[1] NPPF, CIRIA C522, C609, C697 et al.

4.8 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. Published geology for the area suggests the presence of potentially permeable formations within the site, which is further supported by the results of a site specific Infiltration Investigation completed by GEG Ltd on the 30th June 2017 (further details provided within Section 4 and the Appendix).

While the ground formations may not be possible for a wholesale infiltration based drainage strategy, where the investigation has shown infiltration is viable locally to work, this may be incorporated into the design. As such, source control measures will therefore be primarily restricted to detention and conveyance systems placed close to source by way of measures such as lined permeable pavements and conveyance strips.

(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.

(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.

4.9 The search sequence outlined above indicates that discharge to the underlying geology via infiltration, where viable, is the most appropriate receptor for stormwater discharges from the proposed development, having the potential to employ source control measures and detention features to control peak discharges to no greater than the baseline conditions.

4.10 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 multi SuDS system including detention features and where appropriate, source control in the form of porous paving as the primary storm water management scheme.

4.11 Accordingly, a plan showing the conceptual drainage masterplan for the site is contained within the Appendix as drawing 10391/DR/01 B.

4.12 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.

4.13 The following paragraphs outline the potential SuDS features appropriate for use on site and their place within a multi-tiered system.

Primary Drainage Systems (source control)

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

4.15 Through work on other similar strategically sized projects, BCL has shown that peak discharges of circa 15% in residential areas can readily be achieved without unacceptable reductions in net developable land or prohibitive financial implications.

4.16 The nature of source control measures to be implemented will need to remain flexible, providing a 'toolkit' of options to reach an agreed target for peak discharge reduction and water treatment. The following paragraphs describe a number of options available.

Permeable Paving

4.17 Permeable Paving is approved by many Local Authorities for implementation on the development road network and can act as a receptor for surface water run-off from nearby house roofs. However, the system is perhaps best suited to managed parking areas and shared surfaces where block paving is typically used as the surface treatment and ongoing maintenance can be ensured by way of a management company or the like.

4.18 There is little need for underground pipes or gullies, and the attenuation afforded within the sub-base layer helps to reduce the volume of storage required elsewhere.

Figure 4b: Permeable paving

Swales

4.19 Swales are shallow, flat bottomed, vegetated open channels designed to convey, treat and often attenuate surface water runoff. When incorporated into site design, they can enhance the natural landscape and provide aesthetic and biodiversity benefits. They are often used to drain roads, paths or car parks, where it is convenient to collect distributed inflows of runoff, or as a means of conveying runoff on the surface while enhancing access corridors or other open space. Swales can have a variety of profiles, can be uniform or non-uniform, and can incorporate a range of different planting strategies, depending upon the site characteristics and system objectives.

4.20 Swales can replace conventional pipework as a means of conveying runoff, and the use of adjacent filter strips and/or flow spreaders can also remove the need for kerbs and gullies.

4.21 The standard swale channel is broad and shallow and covered by vegetation, usually grass, to slow the water - facilitating sedimentation, filtration through the root zone and soil matrix, evapotranspiration and infatuation into the underlying soil. A swale can have check dams or berms installed across the flow path, that temporarily pond runoff to increase pollutant retention and infatuation and further decrease flow velocity particularly useful for sites with steeper gradients.

Figure 4c: Swale along a road

Filter Strips

4.22 Filter strips have been used in the drainage of highways for many years. The absence of traditional pipe work in such a system frees the drainage design to employ shallow gradients on both channels and drains, which in turn also act as a means of passive treatment to improve water quality.

4.23 Highways within the development could potentially incorporate filter drains. Alternatively, filter strips can be used to collect flows from areas such as a group of houses. Figure 4d shows an example of a filter strip in a road corridor.

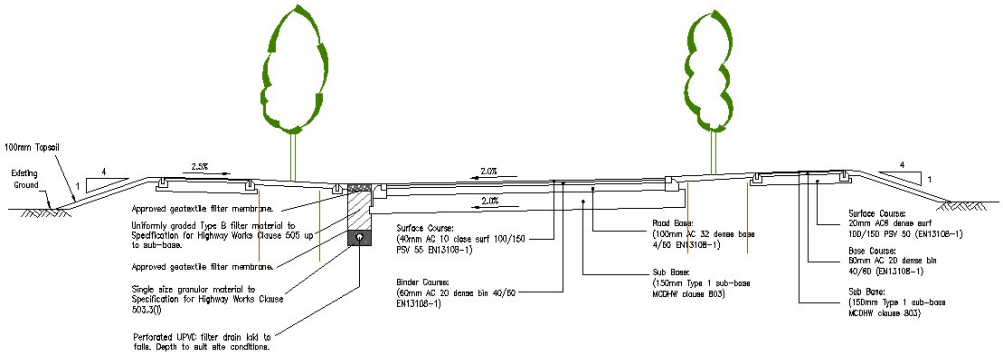

Figure 4d: Filter Strip along highway

Attenuation Drainage Systems

4.24 Attenuation drainage systems collect partially treated excess water from the primary source control systems at a local level, thereafter providing both flow and water quality attenuation and flow conveyance through the site towards the main outfall. A typical drainage basin is shown in Figure 4e.

4.25 It is anticipated that a basin will be utilised and designed to primarily be dry with permanently wet low flow channels to convey run-off in periods of low rainfall, which will in turn provide the passive treatment benefits offered within the remainder of the surface water management network.

4.26 The primary aims of the basin will therefore be:

- Final flow and water quality conditioning
- Provide landscaping, amenity and ecological benefits

Figure 4e: Storage Basin

Preliminary Drainage Proposals

4.27 Preliminary assessment of the requirements for storm drainage have been based on the following criteria:

Total Developed Area:	113.3 ha
Total Landscaped Area:	68 ha
Impermeability – Residential:	0.55
Impermeability – Commercial:	0.85
Impermeability – School:	0.45
Sewer design return period[2]	1 in 1 years
Sewer flood protection[2]	1 in 30 years
Fluvial / Development flood protection[1]	1 in 100 years
M5-60[3]	21.0mm
Ratio r[2]	0.370
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[4]	40%

4.28 The storm water management system has been developed having a series of drainage cells, each contributing to local infiltration systems. The proposed system has been developed close to source, in accordance with guidance, thereby avoiding reliance on a regional treatment system.

4.29 A site specific Infiltration Investigation completed by GEG Ltd in June 2017, provides a range of largely positive infiltration rates across the site. However, access was restricted within the centre of the site, as this is currently an active area being worked by Brett Aggregates Ltd.

[2] Sewers for Adoption 7th Edition
[3] Wallingford Report
[4] NPPF requirements for residential development

4.30 The results and a location plan illustrating the position of each exploratory hole across the site are included within the Appendix.

4.31 The infiltration test results are summarised in Table 4f:

Trial Pit	Infiltration Test 1 rate (m/s)	Infiltration Test 2 rate (m/s)	Infiltration Test 3 rate (m/s)	'Worst Case' Infiltration Rate (m/s)
TP01C	2.34×10^{-06}	N/A	N/A	**2.34×10^{-06}**
TP02	1.73×10^{-05}	2.05×10^{-05}	2.42×10^{-05}	**1.73×10^{-05}**
TP03	3.82×10^{-05}	2.76×10^{-05}	1.86×10^{05}	**1.86×10^{05}**
TP04	2.77×10^{-06}	8.22×10^{-06}	6.98×10^{-06}	**2.77×10^{-06}**
TP05	1.58×10^{-05}	1.65×10^{-05}	2.25×10^{-05}	**1.58×10^{-05}**
TP06	1.45×10^{-05}	1.65×10^{-05}	2.10×10^{-05}	**1.45×10^{-05}**
TP07	1.58×10^{-05}	1.65×10^{-05}	2.25×10^{-05}	**1.58×10^{-05}**
TP08	2.08×10^{-05}	2.10×10^{-05}	1.77×10^{-05}	**1.77×10^{-05}**
TP09	1.19×10^{-05}	1.53×10^{-05}	3.04×10^{-05}	**1.19×10^{-05}**
TP10	6.86×10^{-06}	N/A	N/A	**6.86×10^{-06}**
TP11A	1.26×10^{-05}	8.68×10^{-06}	N/A	**8.68×10^{-06}**
TP12	N/A	N/A	N/A	**N/A**
TP13B	2.00×10^{-05}	2.58×10^{-05}	2.22×10^{-05}	**2.00×10^{-05}**
TP14	1.10×10^{-05}	3.06×10^{-05}	3.92×10^{-05}	**1.10×10^{-05}**
TP15	N/A	N/A	N/A	**N/A**
TP16	1.09×10^{-05}	1.71×10^{-05}	8.85×10^{-05}	**1.09×10^{-05}**
TP17	3.65×10^{-06}	1.33×10^{-05}	N/A	**3.65×10^{-06}**
TP18	2.13×10^{-04}	1.48×10^{-04}	N/A	**1.48×10^{-04}**
TP19	1.14×10^{-06}	N/A	N/A	**1.14×10^{-06}**
TP20	7.13×10^{-05}	1.51×10^{-04}	7.99×10^{-05}	**7.13×10^{-05}**

Table 4f: Infiltration rates across the site

4.32 As a conservative approach, the slowest infiltration rates in each trial pit has been selected (as highlighted above), which provides a 'worst case' infiltration rate.

4.33 The proposed development has been indicatively divided into development catchments and an average rate has been calculated per catchment, based on the worst case rates detailed in Table 4f.

Catchment	Use	Trial Pits	Average Infiltration Rate (m/s)
A	Residential	TP01, TP02, TP03, TP04, TP05, TP010, TP11A,	**1.03×10^{-5}**
B	Residential	TP06, TP07, TP08, TP09	**1.50×10^{-5}**
C	Residential	Restricted access area – assumed infiltration rate similar to adjacent Catchment A	**1.03×10^{-5}**
D	Residential	TP12 - assumed infiltration rate similar to adjacent Catchment E	**1.05×10^{-5}**
E	Residential	TP013B, TP14, TP15, TP16	**1.05×10^{-5}**
F	Residential	TP017, TP18, TP19, TP20	**5.6×10^{-5}**

Figure 4g: Average infiltration rates

Drainage Design Proposals

4.34 As part of the proposed drainage design, the residential development area has been assessed using the WinDES Source Control module on an individual plot by plot basis. Without the benefit of a detailed masterplan, it has not been possible to measure the plot area of each individual residential unit; therefore, the assessment has been based on previous experience and using an open market size which suggests the use of a general plot area of 140m^2 per residential unit.

4.35 Assumptions have been made for the infiltration rates for the residential Catchment D and the School, where data has not been possible due to access restrictions. These areas may be further assessed where necessary once at the detailed design stage of the proposed development.

Residential plots

4.36 Figure 4h below, indicates the average likely cellular soakaway requirements for the individual residential units, designed to accommodate a 1 in 100 (+40%) year event storm across the site.

Catchment	Average Infiltration Rate (m/s)	Average Infiltration Coefficient (m/hr)	Average Cellular soakaway volume (m^3)
A	1.03 x10^{-5}	0.0371	**9.0**
B	1.50 x10^{-5}	0.0540	**8.3**
C	1.03 x10^{-5}	0.0371	**9.0**
E	1.05 x10^{-5}	0.0378	**9.0**
F	5.6 x10^{-5}	0.2016	**6.1**

Figure 4h: Infiltration storage volumes for proposed cellular soakaways

Residential Catchment D, Commercial/ local centre and School

4.37 Figure 4i below, indicates the likely storage requirements for the residential catchment D, the commercial/ local centre units and the school.

Drained Area	Area (ha)	Impermeable area (ha)	Infiltration Rate (m/s)	Infiltration Storage (m^3)	Storage Area (m^2)	Storage Structure
Commercial/ local centre	0.60	0.51	**1.55 x10^{-5}**	**3,696**	**4,457**	**Infiltration Basin**
School (restricted access area)	6.23	2.80				
Residential (Catchment D)	4.44	2.44				
Total	**11.3**	**5.75**				

Figure 4i: Proposed Infiltration Basin storage volume

4.38 The above remaining development areas have been assessed using the WinDES Source Control module using a combined proposed commercial area of 11.3ha. It is proposed to potentially utilise an infiltration basin for these units.

Highways

4.39 Highways England have confirmed the roads will be piped to adequate sewers and adopted.

4.40 The Sustainable Drainage Systems (SUDS), being an above ground naturally landscaped features, will be designed to enhance the biodiversity and landscape character of the site, while also acting as functional features to control storm discharges from the site and improve water quality.

4.41 The storm water management system will provide features as soakaways that are designed (to accommodate a 1 in 100 (+40%) year event storm), to provide extended detention of storm water collected from within the development. Indicative soakaway volumes have been calculated based on 100m2 of drained highway areas for the following catchments:

Catchment	Average Infiltration Rate (m/s)	Average Infiltration Coefficient (m/hr)	Average soakaway volume (m^3)
A	1.03×10^{-5}	0.0371	**6.4**
B	1.50×10^{-5}	0.0540	**5.9**
C	1.03×10^{-5}	0.0371	**6.4**
E	1.05×10^{-5}	0.0378	**6.4**
F	5.6×10^{-5}	0.2016	**4.4**

Figure 4j: Infiltration storage volumes for proposed highway soakaways

4.42 This approach will maximise the passive treatment characteristics of the system and improve water quality discharged to the wider catchment. Source control by way of permeable pavements may be employed, where appropriate, in high risk parking areas that provide for the efficient removal of silts and hydrocarbons ahead of discharge to the proposed network.

4.43 Being an outline planning application, without the benefit of a detailed layout, it is not possible to provide a final drainage layout. However, the development framework plan coupled with the criteria set out in this report will form the framework of the final design at reserved matters stage.

4.44 Drawing 10391-DR-01B contained in the Appendix, illustrates the development cells and the potential strategic storm water management system proposed.

Water Quality

4.45 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 C753). The implementation of SUDS in development drainage provides a significant benefit in removal of pollutant from development run-off.

4.46 In most cases, contaminants become attached to sediment particles either before entering the water body or upon entry. CIRIA 753 reports that up to 90% of certain contaminants, usually trace elements, are transported in this way leaving a dissolved concentration of circa 10%.

4.47 Many SUDS systems rely on the infiltration of water through the ground layer into permeable sub soils or through sedimentation in low flow storage basins. This settling and filtering of contaminated run off through a fine-grained matrix separates the suspended contaminated sediment from the body of water subsequently causing the water to leave the SuDS device in a more polished form than how it entered; porous paving is a prime example of this.

4.48 Furthermore, by implementation of SUDS features it is possible to optimize overall pollutant removal as water will undergo this process of filtering before being discharged to an appropriate receptor. The overall percentage of removal can be calculated individually for each differing SUDS technique, this is shown by the formula:

Overall pollutant removal = (TPLxC1) + (RPLxC2) + (RPLxC3) +.....for each other control in series

Where: TPL – Total Pollutant Load
RPL – Remaining Pollutant Load (after previous treatment(s))
C(x) – Suds Control removal efficiency

Figure 4k: Pollutant removal formula as set out in CIRIA C753

4.49 At present, the site and surrounding area does not benefit from any additional measures of storm water treatment.

4.50 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.

4.51 The site will employ SUDS features, porous paving (where applicable) and attenuation features such as detention basin as these are widely accepted to be of high pollutant removal efficiency (CIRIA 753). This provides for two stages of treatment onsite.

4.52 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

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

4.54 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 are important in avoiding deep and high velocity flows that present a high risk. The drainage system being promoted for Adastral Park provides a good opportunity to incorporate exceedance flow routes into the design.

4.55 Careful and considered design in other areas, can also reduce the risk. For example the strategic SuDS system being promoted for Adastral Park, provides a layered and disbursed system of treatment across the site, thereby avoiding a traditional and more risky design that might, for example, have all storm water being collected in a strategic spine sewer that conveys flows to a large basin at the bottom of the catchment. This latter system concentrates peak discharges into a single corridor, that if blocked can have unacceptable consequences.

4.56 Other more local measures also should be incorporated. Overflow weirs or the like will be provided on drainage systems, at a level above the 1 in 100 year + 30% flood level, safely to allow more extreme event flows be conveyed away from properties, while at the same time not increasing flood risk to surrounding areas.

4.57 Clearly, many of the measures for dealing with exceedance flows must be dealt with at detailed design stage. However, the strategic layout for proposed development at Adastral Park provides the framework of a network that can effectively deal with any future exceedance problems.

4.58 The detailed design stage will comply with national standards for protection against exceedance flows.

Implementation Proposals

4.59 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 and metal associated with urban run-off. Final design will provide for appropriate geometry and planting to maximise this benefit.

4.60 The storm water management features will be constructed and operational prior to the first occupation of dwellings across the site.

4.61 The storm water management features to be implemented will be designed to enhance the biodiversity and landscape character of the site, while also providing amenity space and acting as a functional feature to control storm discharges from the site and improve water quality.

4.62 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.

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

Frequency	Operation
Post major storm events	Inspection and removal of debris.
Every two months	Grass mowing (growing season) & litter removal.
Annual	Weeding & vegetation maintenance. Minor swale clearance. Sweeping of permeable pavements.
2 years	Tree pruning.
5-10 years	Desilting of channels. Remove silt around inlet and outlet structures.
15-20 years	Major vegetation maintenance and watercourse channel works.

Figure 4l: Framework maintenance of detention / retention system

4.64 A private maintenance company will have the responsibility to adopt and maintain the SuDs.

Summary

4.65 A strategy for storm drainage at the site has been developed to meet both national and local policy. The above options outline the viability of the site to employ means of drainage to comply with NPPF guidance, together with the AVDC SFRA and other national and local guidance.

4.66 The development drainage system will manage storm water by way of a SUDS management train and ensure peak discharges from the developed land are reduced to below the appraised baseline rates. The system will also provide improvements to the quality of water discharged from the development.

Objectives

4.67 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 below the baseline conditions.
- Development of storm water management proposals that improve water quality and biodiversity of the site.
- Implementation of the storm water management system prior to first occupation of dwellings.

5 Foul Drainage

Background

5.1 Anglian water has indicated that a direct connection to the public foul sewerage system is likely to have a detrimental effect on the existing sewerage network.

5.2 No foul water sewers are recorded to be present within the proposed development site. The proposed connection point for the proposed development is - B.T. Research SP pumping station, manhole MAPOSP (TM2483444792) located of Barrack Square (as shown on Figure 5a). Anglian water indicate that a gravity connection is not feasible. Consequently, the connection will be via a pumped regime.

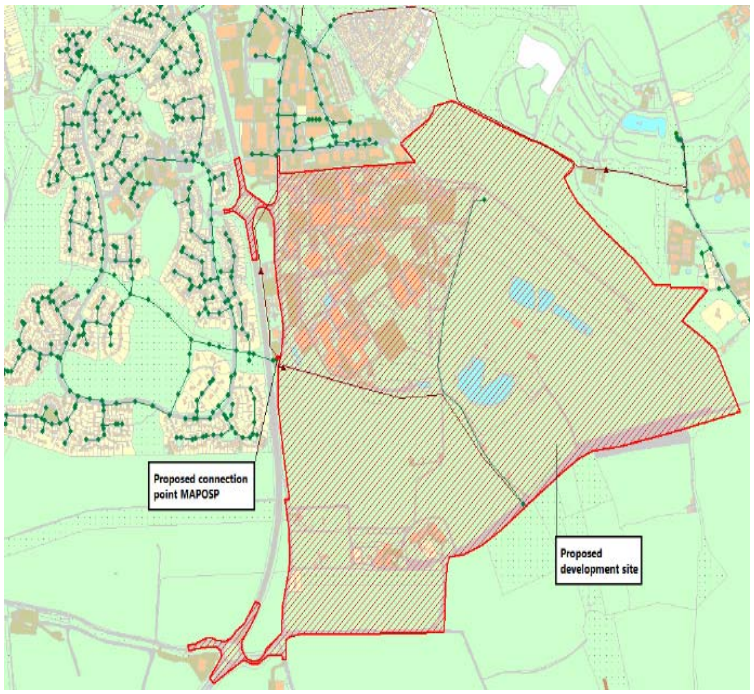

Figure 5a: Location of proposed connections

Design Criteria / Network Requirements

5.3 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	=	4,000 litres / dwelling / day (peak)

5.4 Assessed in accordance with SFA 7th Edition requirements, the development will have a design peak discharge of approximately 92.6l/s.

Network Requirements

5.5 A hydraulic model was ran to determine the existing sewer performance during a 1 in 20-year critical storm event. The model was the re-run with the estimated flows from the site connecting to Martlesham – B.T. Research SP pumping station.

5.6 The model predicts a significant increase in flooding at the connection point and 12 manholes of which four are located directly upstream of the proposed connection point.

5.7 A copy of the Anglian Water model report is available in the Appendix.

5.8 The assessment has considered a sensitivity study for a phased delivery of property count, however as the proposed connection point is already at capacity at baseline flow it is therefore considered that there is no capacity from any flows from the proposed development prior to mitigation measures being fully implemented.

Mitigation Solution

5.9 Anglian water have provided several solutions to help prevent detriment to the existing sewerage network performance during a 1 in 30-year critical storm event.

5.10 The proposed mitigation solution comprises:

- Provide storage of 352m3 off Barrack Square at Martlesham-B.T. Research SP.
- Upsize Martlesham-B.T. Research SP from 25 l/s to 50 l/s and increase the existing emergency storage by 237m3.
- Provide offline storage of 781m3 off Felixstowe Road at Martlesham-Hilton RD SP.
- Provide offline storage of 174.5m3 in the green area adjacent to Main Road.

5.11 The estimated capital cost for the proposed off-site reinforcement only solution is £1,898,398 with a £347,802 predicted direct contribution from the developer.

5.12 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.

5.13 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

5.14 Due to the potential approach being taken across the site with flows being conveyed to a number of different locations, multiple points of connection will be required on the foul drainage network. At the detailed design stage, further investigations will be completed with Anglian Water accurately to define the most appropriate points of connection for the development at each stage.

5.15 The proposed drainage network across the site will be designed to current Sewers for Adoption 7th Edition Standards, employing a point of connection agreed with Anglian Water. The system will be offered for the adoption of Anglian Water under S104 of the Water Industry Act 1991.

Summary

5.16 Anglian Water modelling indicates predicted flows from the proposed development will cause detriment to the existing sewer network.

5.17 Anglian Water outlined several mitigation solutions to provide capacity for foul water from the proposed development

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

Objectives

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

- Implementation of a drainage scheme to convey water to the local Anglian Water network which is designed and maintained to Sewers for Adoption 7th Edition.

6 Summary

6.1 This FRA has identified no prohibitive engineering constraints in developing the proposed site for the proposed residential usage.

6.2 Assessment of fluvial flood risk shows the land to lie completely in Flood Zone 1 and hence be a preferable location for residential development when considered in the context of the NPPF Sequential Test.

6.3 Assessment of other potential flooding mechanisms shows the land to have a low probability of flooding from overland flow, ground water and sewer flooding.

6.4 Means to discharge storm and foul water drainage have been established that comply with current guidance and requirements of Anglian Water. Sustainable storm drainage (SuDS) will be provided in accordance with current guidance and infiltrated into the ground, thereby reducing flood risk in the area.

6.5 Foul drainage will connect to a point of adequacy on the Anglian Water network after a feasible foul drainage solution is established.

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

7 Limitations

7.1 Third party information has been used in the preparation of this report, which Brookbanks Consulting Ltd, 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 Consulting Ltd accepts no liability for same.

7.2 The benefits of this report are provided solely to Carlyle Land Ltd and CEG for the proposed development Land south and east of Adastral Park, Ipswich only.

7.3 Brookbanks Consulting Ltd excludes third party rights for the information contained in the report.