REPORT

Flood Risk and Drainage Feasibility Study

Honingham Thorpe

Client: Brown &Co.

Reference: PB7750WATRP1811221623

Revision: 1.0/Final

Date: 30th November 2018

HASKONINGDHV UK LTD.

Burns House
Harlands Road
Haywards Heath
West Sussex
RH16 1PG
Water
VAT registration number: 792428892

+44 1444 458551 **T**
info.haywards.heath@uk.rhdhv.com **E**
royalhaskoningdhv.com **W**

Document title: Flood Risk and Drainage Feasibility Study

Document short title:
Reference: PB7750WATRP1811221623
Revision: 1.0/Final
Date: 30th November 2018
Project name: PB7750 - Honingham Thorpe
Project number: PB7750
Author(s): Robin Warner

Drafted by: Robin Warner

Checked by: Helena Wicks

Date / initials: 29/11/18 HW

Approved by:

Date / initials:

Classification
Internal use only

Royal HaskoningDHV

Table of Contents

Table of Tables

Table of Figures

1 Introduction

Royal HaskoningDHV has been commissioned by Brown and Co. to provide a Flood Risk and Drainage Strategy Feasibility Report for the proposed development at Honingham Thorpe, Norfolk.

The Site contains a number of sub-sites which have been submitted during the Regulation 18 planning stage. The majority of these are identified as potentially suitable for development in the Greater Norwich Local Plan, under the Housing and Economic Land Availability Assessment (HELAA) published in December 2017 and the corresponding Addendum published in October 2018. The Constraints Analysis of the assessment identified that there are potential constraints relating to flood risk in the proposed sites which could be overcome through the development of an appropriate design.

The Feasibility Report has:

- Reviewed the national and local guidelines of relevance to the proposed development in relation to flood risk;
- Assessed the flood risk sources to the Site using data available at the time of writing;
- Carried out a preliminary calculation of greenfield runoff rates and likely storage volumes; and
- Provided indicative drainage solutions and Sustainable Drainage Systems (SuDS) approaches appropriate to the potential sites.

In summary, it is concluded that the Site is suitable for development, given the flood risk from different sources and the potential for storage.

2 Site Description and Location

2.1 Existing Site Description

The proposed development Site consists of several existing fields, wooded areas and smaller roads in the area between Honingham, Colton, Marlingford and Easton, approximately 10 km east of Norwich in Norfolk, as shown in Figure 1. The northern part of the Site is located within the Broadland District Council administrative area and the southern part of the Site is located within the South Norfolk District Council administrative area.

The Site boundary is formed predominantly by roads to the north, roads and existing field boundaries to the east, the River Yare to the south, and by new and existing field boundaries and roads to the west.

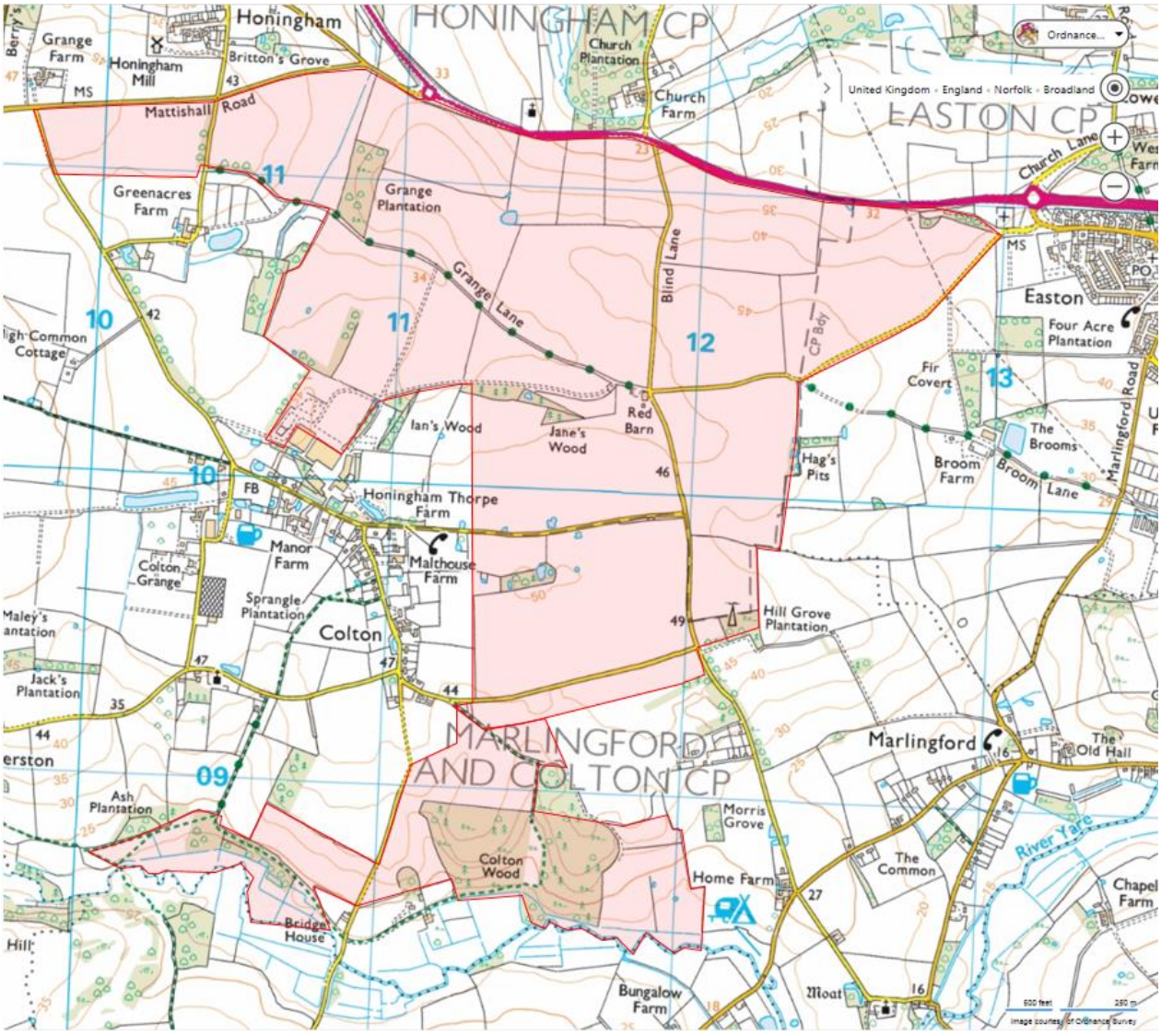

Figure 1: The approximate red line boundary of the proposed development (Source: Microsoft Bing / Ordnance Survey – Accessed 26/11/2018)

2.2 Proposed Development

The red line boundary of the proposed development Site is shown in Figure 1. The proposed development area is 353 ha in total and includes:

- 72 hectares of employment space including the Greater Norwich Food Enterprise Zone;
- 198 hectares of residential land to include at least 4,000 units, with a further 13 hectares reserved for future housing;
- 81 hectares of Country Park; and
- 2 hectares of nature reserve.

The proposed spatial layout of the different land uses within the Site is shown in Figure 2. The proposed development Site consists of 7 sub-sites which have been submitted during the Regulation 18 planning stage. The location and name of each of the sub-sites is shown in Figure 3 and Figure 4. A full list of the sub-sites is shown in Table 6.

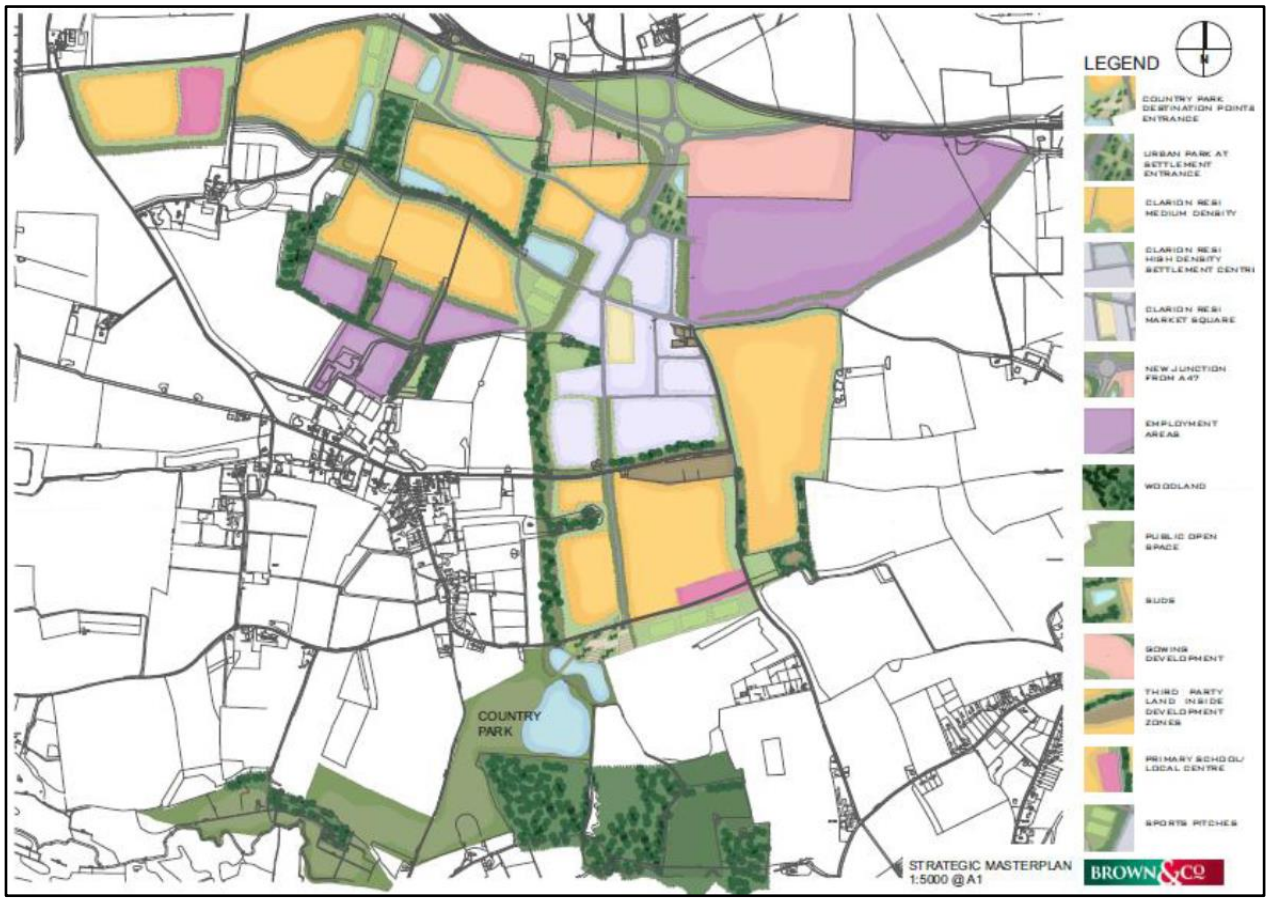

Figure 2: Proposed Development land uses. Not to scale (Source: Honingham Thorpe Proposal Information Pack – Brown & Co.; Clarion Housing Group, 9th August 2018)

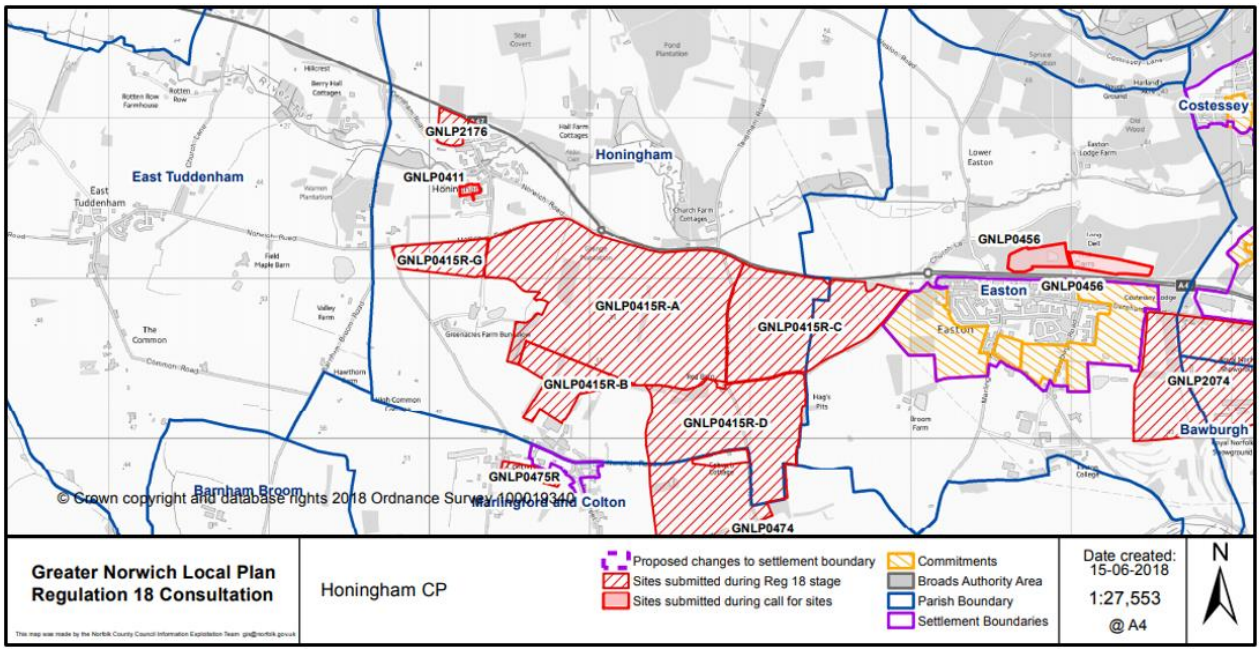

Figure 3: Greater Norwich Local Plan Regulation 18 Consultation – Honingham CP (Source: Norfolk County Council Date: 15/06/2018)

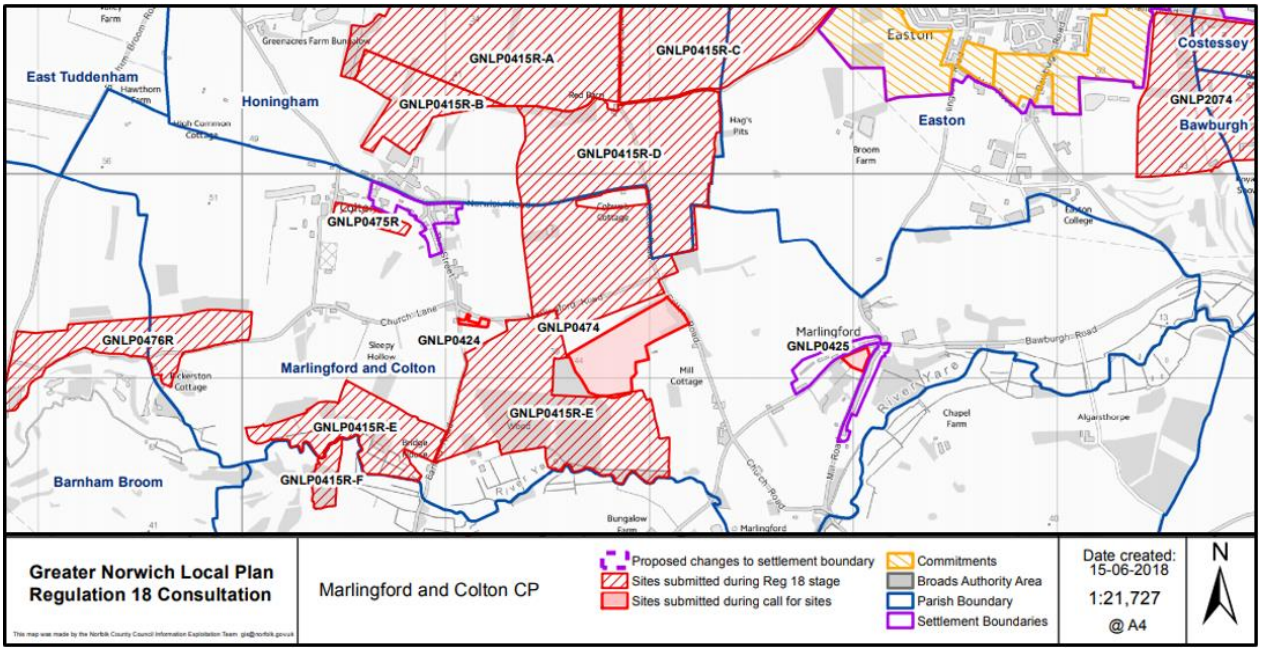

Figure 4: Greater Norwich Local Plan Regulation 18 Consultation – Marlingford and Colton CP (Source: Norfolk County Council Date: 15/06/2018)

2.3 Existing Drainage System

The existing Site is predominantly comprised of agricultural land and therefore is believed to be permeable. On this basis, there is likely to be a limited formal drainage network serving each of the sub-sites.

A linear watercourse is identifiable on Ordnance Survey mapping in the northwest of the sub-site GNLP0415R-A leading from a wooded area to the River Tud which may be a land drainage ditch. No other land drainage ditches are identifiable from Ordnance Survey mapping. However, aerial photography of the Site indicates the presence of land drainage ditches within several of the existing fields, primarily located along the field boundary.

Anglian Water is understood to be the local waste and wastewater company for the Site. It is therefore likely that any public surface water sewer or foul water sewers are operated by Anglian Water.

2.4 Geology

Geology information has been obtained from the British Geological Survey (GBS), accessed via online maps[1]. The bedrock geology of the Site is identified as White Chalk, which is permeable.

The superficial geology of the Site is predominantly formed of the Lowestoft Formation, consisting of chalky white till with outwash sands and gravels, silts and clays. The superficial geology of the Site also consists of proportionally small areas of Lowestoft Formation consisting of diamicton, and Happisburgh Glacienic Formation consisting of sands and gravels. Given the geology, the superficial geology is expected to be largely permeable.

2.5 Hydrology

As shown in Figure 1 the proposed development Site is located between the River Tud, to the north, and the River Yare, to the south, each flowing east. The River Tud and River Yare are classified as “Main Rivers” by the Environmental Agency. The River Tud is a tributary of the River Wensum, which it flows into approximately 10 km to the east of the Site. Approximately 12 km to the east of the Site the River Wensum then flows into the River Yare.

A single linear watercourse is identifiable on Ordnance Survey mapping in the northwest of the sub-site GNLP0415R-A leading from a wooded area to the River Tud which may be a land drainage ditch. As shown in Figure 1 there are several small bodies of surface water across the Site, most of which are located close to Honingham Thorpe Farm.

There may be other open or culverted Ordinary Watercourses in the area, however these cannot be identified from Ordnance Survey mapping.

Aquifer information is provided from the Department of Food and Rural Affairs, accessed via online maps[2]. The bedrock aquifer is classified as Principal Aquifer. The superficial drift aquifer is classified as Secondary (Undifferentiated) aquifer.

[1] *British Geological Survey (BGS; 2017) GeoIndex (Onshore) Online Map. http://mapapps2.bgs.ac.uk/geoindex/home.html Accessed 26/11/2018*
[2] *Department of Food and Rural Affairs. Magic Online Map. https://magic.defra.gov.uk/MagicMap.aspx. Accessed 26/11/218*

3 Policy and Local Guidance

3.1 National Planning Policy Framework (NPPF)

The National Planning Policy Framework (NPPF) Planning Practice Guidance (PPG) for Flood Risk and Coastal Change[3] and the Environment Agency's Climate Change Allowance Guidance[4] provides direction on how flood risk should be considered at all stages of the planning and development process. The planning system should ensure that new development is safe and not exposed unnecessarily to the risks associated with flooding.

3.2 Local Development Documents

3.2.1 The Greater Norwich Local Plan

The north of the Site is located within the Broadland District Council administrative area and the south of the Site is located within the South Norfolk District Council administrative area. The Greater Norwich Local Plan (GNLP), developed by the Greater Norwich Growth Board, is applicable within both district councils.

The Site has been identified as being potentially suitable for development within the GNLP under the Housing and Economic Land Availability Assessment (HELAA) published in December 2017[5] and the Addendum published in October 2018[6]. The GNLP will build upon the Joint Core Strategy for the area, and will ensure that housing and employment needs for the area are continued to be met to 2036. The suitability of each sub-site within the proposed development Site is shown in Table 6.

Table 6: Sub-site reference numbers, County Parish Designations, HELAA 2017 Suitability Assessment Conclusion Designations, and HELAA 2018 Addendum Capacity Assessment Conclusion Designations

Sub – Site Reference	County Parish Designation	HELAA 2017 Suitability Assessment Conclusion	HELAA 2018 Addendum Capacity Assessment Conclusion
GNLP0415R-A	Honingham	Suitable	Suitable
GNLP0415R-B	Honingham	Suitable	Suitable
GNLP0415R-C	Honingham	Suitable	Suitable
GNLP0415R-D	Honingham; Marlingford and Colton	Suitable	Suitable, if constraints overcome
GNLP0415R-E	Marlingford and Colton	Not discussed	Not discussed
GNLP0415R-G	Honingham	Suitable	Suitable, if constraints overcome
GNLP0474	Marlingford and Colton	Suitable	Not discussed

[3] *Ministry of Housing, Communities and Local Government (2014) National Planning Policy Framework., Flood Risk and Coastal Change. [Available Online] https://www.gov.uk/guidance/flood-risk-and-coastal-change#making-development-safe-from-flood-risk. Accessed 19/03/2018.*
[4] *Environment Agency (2016) Flood risk assessments: climate change allowances. [Available Online] https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances. Accessed 19/03/2018.*
[5] *Greater Nowrich Local Plan Houseing and Economic Land Availability Assessment (HELAA) December 2017. Source: Greater Norwich Growth Board https://gnlp.jdi-consult.net/documents/pdfs_14/helaa_-_reg_18_-_dec_2017.pdf Acccessed 26/11/2018*
[6] *Greater Nowrich Local Plan Houseing and Economic Land Availability Assessment (HELAA) Addendum October 2018. December 2017. Source: Greater Norwich Growth Board https://gnlp.jdi-consult.net/documents/pdfs_14/helaa_addendum_2018_final.pdf Accessed 26/11/2018*

It is noted: *"The inclusion of a site as potentially suitable for development within the HELAA DOES NOT confer any planning status on that site, or any commitment that it will be brought forward for development. In addition, sites excluded from the HELAA assessment can still be subject to more detailed site assessment and be considered for allocation through the Local Plan process*."

The potential objectives of relevance to the development of the Site and specifically to flood risk which are outlined within the GNLP growth options[7], are:

- '*Homes – to enable delivery of high quality homes of the right size, mix and tenure to meet people's needs throughout their lives*
- *Environment – to protect and enhance the built and natural environment, make best use of natural resources, mitigate against and adapt to climate change.'*

In the context of flooding, the GNLP will steer new development away from flood risk areas as far as possible and that development mitigates against or is adapted to flood risk.

The favoured approach to flood risk, which the GNLP will take is Option FR1 – '*Require all relevant application undertake a site-specific FRA and to provide a Surface Water Drainage Strategy showing how any SuDS infrastructure will be maintained in perpetuity.'*

The GNLP should be informed by the Broadland Rivers Catchment Flood Management Plan (CFMP) to ensure development is guided away from areas with a high probability of flooding.

3.2.2 Broadland Rivers Catchment Flood Management Plan

The Broadland Rivers Catchment Flood Management Plan[8] (CFMP) identifies the main sources of flood risk to the Broadland Rivers catchment are river flooding from the River Bure, tidal flooding, tide locking, failure of pumping stations and breaching of embankments. These main sources may not all be appropriate to the Site. The flood risk sources most appropriate to the sub-sites are described in more detail in Section 4.

The proposed Site is located within Sub-Area No. 4 – Fluvial Rivers. For this Sub-area Policy No. 2 applies:

"Areas of low to moderate flood risk where we can generally reduce existing flood risk management actions This policy will tend to be applied where the overall level of risk to people and property is low to moderate. It may no longer be value for money to focus on continuing current levels of maintenance of existing defences if we can use resources to reduce risk where there are more people at higher risk. We would therefore review the flood risk management actions being taken so that they are proportionate to the level of risk."

3.2.3 Greater Norwich Area Strategic Flood Risk Assessment (SFRA)

The Greater Norwich Area Strategic Flood Risk Assessment[9] (SFRA) produced in 2017, aims to assess the potential sources of flooding, assess the potential impact of climate change on the flood risk, provide guidance for developers and recommend the criteria that should be used to assess future development. The SFRA should form part of the evidence base of the Local Plan and can be used to inform the Sustainability Appraisal.

---

[7] *The Greater Norwich Development Partnership (2018) Greater Norwich Local Plan Regulation 18 Consultation – Growth Options. [Available Online] http://www.gnlp.org.uk/assets/Uploads/Reg.18-Growth-Options-document-final050218.pdf. Accessed 26/11/2018.*

[8] *Environment Agency (2009) Broadland Rivers Catchment Flood Management Plan. [Available Online] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/288882/Broadland_Rivers_Catchment_Flood_Management_Plan.pdf. Accessed 26/11/2018.*

[9] *Greater Norwich Partnership (2017) Greater Norwich Area Strategic Flood Risk Assessment. [Available Online] http://www.broads-authority.gov.uk/__data/assets/pdf_file/0006/1037355/2017s5962-Greater-Norwich-Area-SFRA-Final-v2.0.pdf#Norwich. Accessed 26/11/2018.*

There are many flood risk sources outlined in the SFRA which are relevant to the Site which are included in more detail throughout Section 4 of this feasibility report.

The SFRA outlines that Sustainable Drainage Systems should be considered during preparation of the initial site conceptual layout to ensure well-designed, appropriate and effective systems are implemented. This guidance must be considered in any forthcoming development of the Site.

3.2.4 Norfolk Local Flood Risk Management Strategy (LFRMS)

The Norfolk Local Flood Risk Management Strategy[10] (LFRMS) produced by Norfolk County Council, in their role as the Lead Local Flood Authority, aims to inform all stakeholders in flood risk and flood management. It identifies the extent and characteristics of flood risk in Norfolk and establishes a framework of policies to ensure a consistent approach to flood management is adopted throughout the region. The GNLP is expected to be consistent with the policies set out in the LFRMS.

Relevant to the development of the Site, is the conclusion within the LFRMS that states 'there is a need to introduce more sustainable drainage systems in to the area'. Consideration of this point must be given in any forthcoming development of the Site.

[10] *Norfolk County Council (2015) Norfolk Local Flood Risk Management Strategy. [Available Online] https://www.norfolk.gov.uk/what-we-do-and-how-we-work/policy-performance-and-partnerships/policies-and-strategies/flood-and-water-management-policies/local-flood-risk-management-strategy. Accessed 26/11/2018.*

4 Definition of Flood Hazard

4.1 Probability of Flooding – Flood Zones

Table 7 outlines the definition of each Flood Zone and associated probability, which has been taken from Table 1 of the NPPF PPG. The NPPF, through the application of the Sequential Test, aims to steer development towards areas at lowest risk of flooding (Flood Zone 1) and away from medium and high flood risk areas (Flood Zones 2 and 3).

Table 7: Summary of Flood Risk Definitions

Flood zone	Probability of flooding	Return periods
1	Low	Land having a less than 1 in 1,000 annual probability of river or sea flooding.
2	Medium	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.
3a	High	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.
3b	High – Functional Floodplain	This zone comprises land where water has to flow or be stored in times of flood. Local planning authorities should identify in their SFRAs areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency.

4.2 Historic Flooding

Following a review of the Greater Norwich Area SFRA it does not identify any historical flood events within or near to the Site. This does not mean that localised flooding has not occurred, rather that there have been no recorded incidents.

4.3 Flooding from Rivers

The Site is located primarily within Flood Zone 1 as defined by the Environment Agency Online flood map for planning[11] and shown in Figure 5.

The majority of the Site is within Flood Zone 1 with only areas at the very southern extent, adjacent to the River Yare located within Flood Zone 2 and Flood Zone 3. These areas are proposed to be woodland and public open space within the current development layout.

The flood risk from the linear watercourse in the north-west of the Site, which is likely to be a land drainage ditch, is unclear.

[11] *Environment Agency (2018) Environment Agency flood map for planning. [Available Online] https://flood-map-for-planning.service.gov.uk/. Accessed 26/11/2018.*

Environment Agency Product 4 data identifying modelled water levels (m AOD) for the area has been requested, but at the time of writing have not been received. The assessment of this data may enable the fluvial flood risk to be evaluated in greater detail and used to inform the design layout of the proposed development.

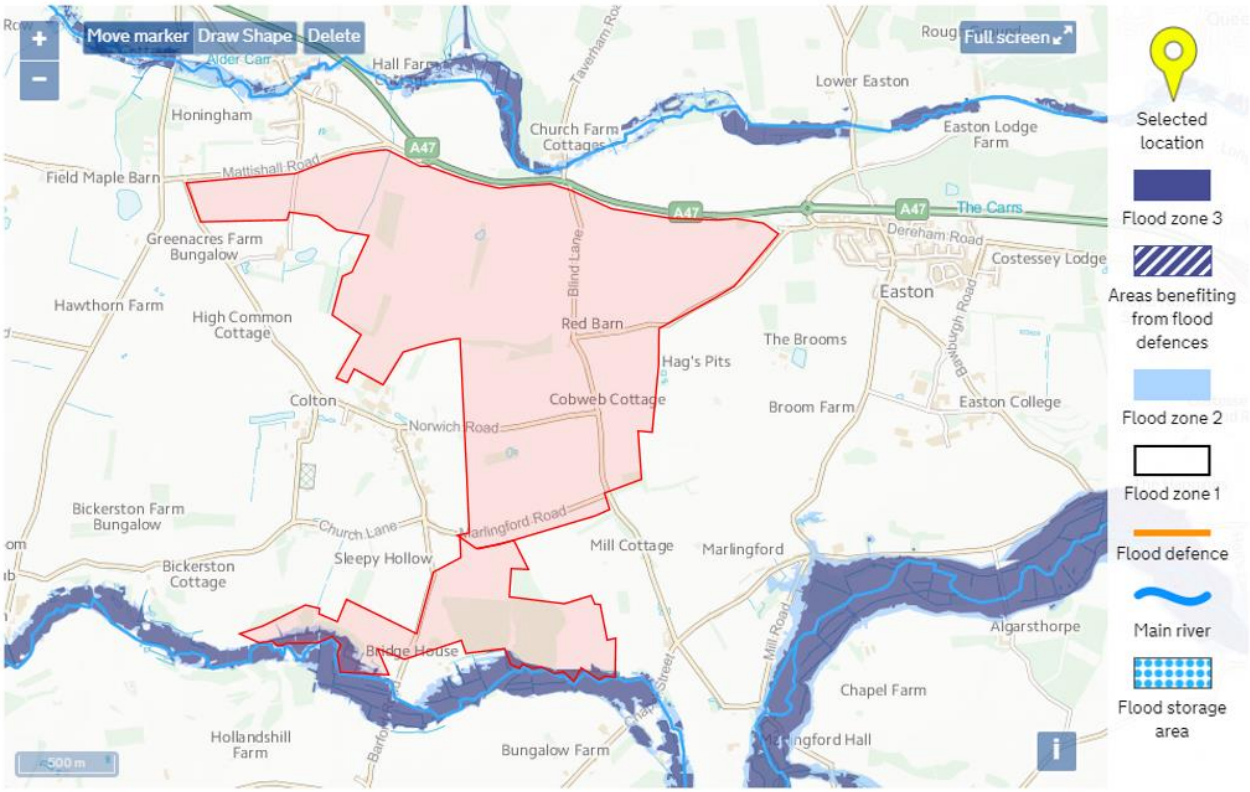

Figure 5: Flood map for planning indicating fluvial flood zones and approximate red line boundary. Not to scale. Source: Environment Agency Flood Map for Planning. Accessed 26/11/2018

4.4 Flooding from the sea

The Greater Norwich Area SFRA does not identify any location within proximity to the Site as being at risk of flooding from the sea. As the Site is located inland, over 40km from the coast, the risk of tidal flooding is negligible.

4.5 Flooding from groundwater

Owing to the underlying chalk aquifer in the district, described in Section 2.5, flooding from groundwater may pose a risk to the proposed sites. Forthcoming development should consider the potential groundwater flood risk and carry out ground investigations to detail this risk.

4.6 Flooding from surface water

The Environment Agency Surface Water Flood Map, shown in Figure 6, identifies the majority of the site as being at very low risk of surface water flooding. However, there are some low-lying areas which are at low, medium and high risk, which are primarily linked to field boundaries, access tracks and existing land drainage.

The greatest risk of surface water flooding is identified as being to the north of Honingham Thorpe Farm, and along the land drainage ditch in the north west of the Site. There are also small areas at medium and low risk of surface water flood risk in both the northern and southern areas of the Site.

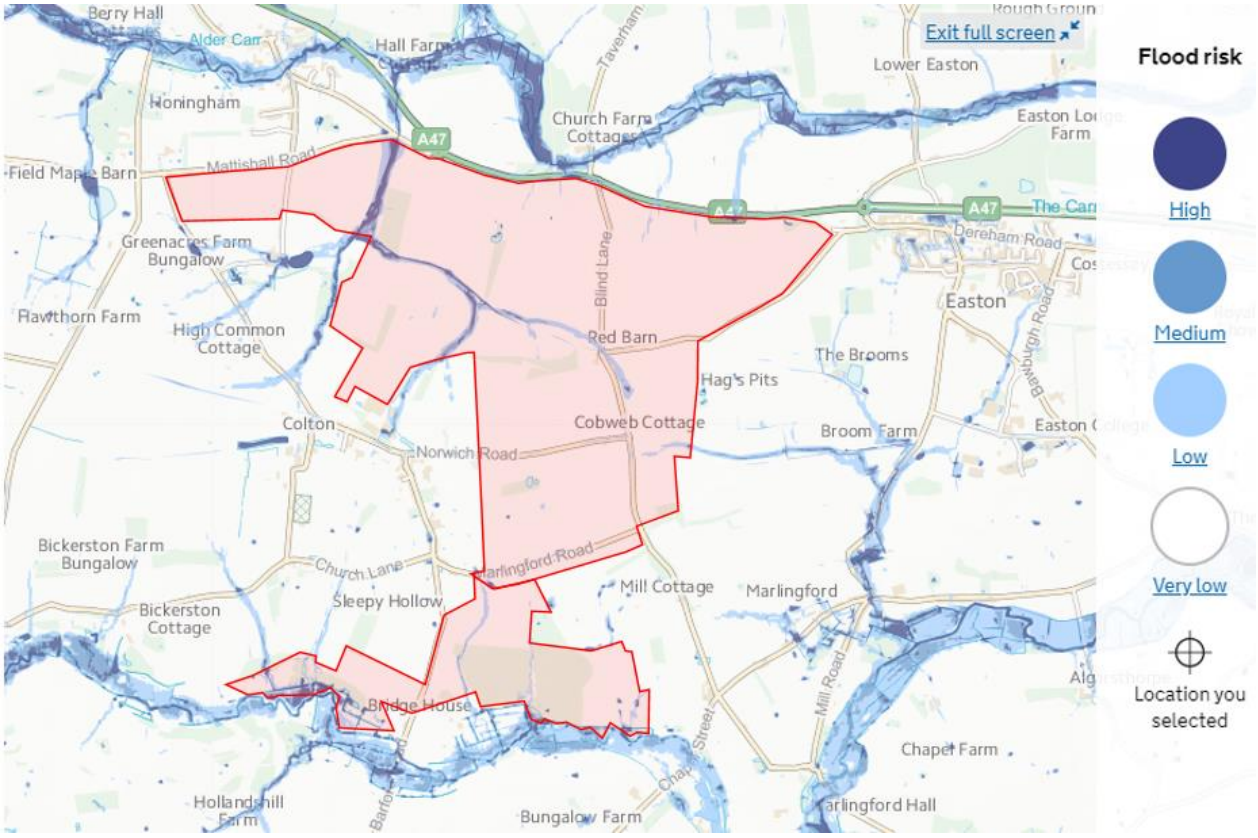

Figure 6: Surface water flood map and approximate red line boundary. Not to scale. Source: Environment Agency Long term flood risk information. Accessed 26/11/2018

4.7 Flooding from sewers

The Greater Norwich Area SFRA does not identify recorded flood incidents due to flooding of sewers in the area of the Site.

As the Site is predominantly agricultural land, the risk of flooding from sewers is likely to be low. However, around the settlement of Honingham Thorpe this may be increased due the presence of sewers which may be either private or connected to the wider public sewer network.

4.8 Flooding from reservoirs, canals and artificial sources

Areas in the northwest and the southwest of the proposed Site are within the maximum extent of flooding from reservoirs as defined by the Environment Agency long term flood risk information[12].

Due to the rigorous legislation regarding reservoirs a failure of the earthworks is extremely unlikely, therefore the risk of flooding from reservoirs is considered to be low.

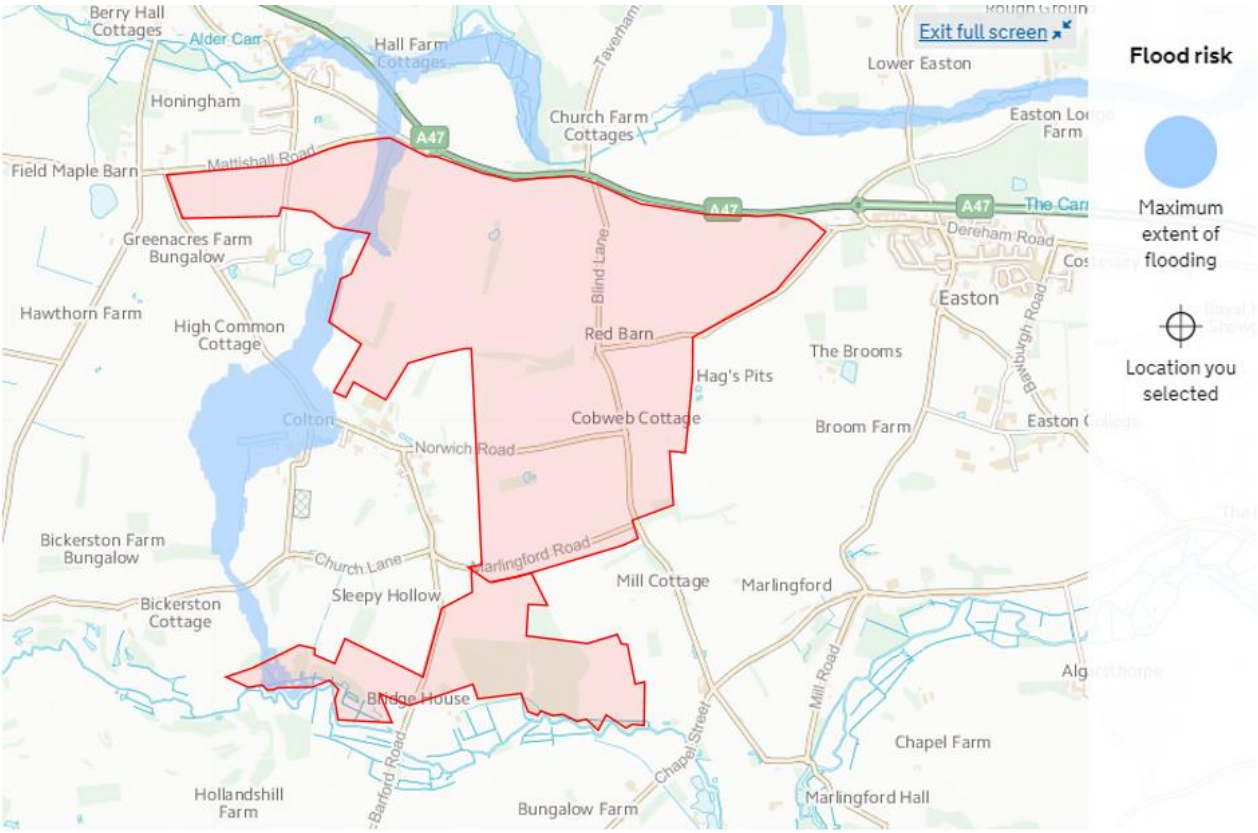

Figure 7: Maximum extent of reservoir flooding and approximate red line boundary. Not to scale. Source: Environment Agency Long term flood risk information. Accessed 26/11/2018

4.9 Summary of Flooding Sources

The Site is predominantly located within Flood Zone 1 and therefore at low risk of flooding from fluvial sources. Small areas to the south of the Site, adjacent to the River Yare, are located within Flood Zone 2 and 3 with a medium to high risk of fluvial flooding, however these areas are proposed as public open space.

Due to the location of the Site significantly inland and not affected by tidal rivers, the risk of flooding from the sea is negligible. Due to the presence of a primary aquifer below the site the risk of groundwater flooding may exist; however currently with the available data this risk cannot be qualified. Flood risk from sewers is also considered to be low.

Flooding from surface water represents the greatest flood risk with a number of areas across the Site at medium and high risk. These areas correlate to topographic low points and appear to be linked to field boundaries, existing access tracks and land drains.

[12] *Environment Agency (2018) Long term flood risk information [Available Online] https://flood-warning-information.service.gov.uk/long-term-flood-risk/. Accessed 26/11/2018.*

Flooding from reservoirs and other artificial sources is considered to be very low given the strict legislation regarding the building and maintenance of reservoirs.

5 Flood Vulnerability

5.1 Sequential and Exception Tests

The aim of the NPPF PPG Sequential Test is to ensure that a sequential approach is adopted to steer new development to areas with the lowest probability of flooding i.e. Flood Zone 1. Where there are no reasonably available sites in Flood Zone 1 the Local Planning Authority (LPA), Norfolk County Council, can consider reasonably available sites in Flood Zone 2. Only where there are no reasonably available sites for development in Flood Zone 1 and 2, should the suitability of sites in Flood Zone 3 be considered.

Following the application of the Sequential Test, if it is not possible for the development to be located in zones with a lower probability of flooding, the Exception Test may be required. For the Exception Test to be passed:

- It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a Strategic Flood Risk Assessment where one has been prepared.

- A site-specific flood risk assessment must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

Both elements of the test will have to be passed for development to be allocated or permitted. Within each flood zone, surface water and other sources of flooding also need to be considered in applying the sequential approach to the location of development.

5.2 Sequential Test Vulnerability Assessment

The vulnerability of different types of development is classified in the NPPF Technical Guidance for Flood risk and coastal change. The descriptions of Highly Vulnerable, More Vulnerable, Less Vulnerable and Water Compatible from the guidance are as follows:

- ***Highly Vulnerable*** *– Buildings used for: Police, ambulance and fire stations and command centres; basement dwellings; caravans and mobile homes; and installations requiring hazardous substances consent.*
- ***More Vulnerable*** *– Buildings used for: hospitals; dwellings and accommodation; residential institutional accommodation; non-residential health services, educational facilities; drinking establishments; nightclubs and hotels.*
- ***Less Vulnerable*** *– Buildings used for: shops; financial, professional and other services; restaurants and cafes; hot food and takeaways; offices; general industry and storage etc.*
- ***Water Compatible*** *– Development used for: flood control infrastructure; amenity open space, nature conservation and outdoor sports facilities; water / sewerage pumping stations; docks marinas and wharves; and navigation facilities.*

The NPPF Technical Guidance also defines what should be classed as suitable development given the flood risk vulnerability of the development and the flood zone it is located within. This table is reproduced here as Table 8.

Table 8: Flood risk vulnerability and flood zone 'compatibility'

Flood Zones	Flood Risk Vulnerability Classification				
	Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test required	✓	✓	✓
Zone 3a	Exception Test required	✗	Exception Test required	✓	✓
Zone 3b	Exception Test required	✗	✗	✗	✓

Key: ✓development should be permitted, ✗ development should not be permitted.

5.3 Site Vulnerability Assessment

Under the NPPF Planning Practice Guidance the proposed development types would be considered as More Vulnerable (accommodation), Less Vulnerable (shops and offices) and Water Compatible (open space).

Under the NPPF Guidance, developments classified as More Vulnerable and Less Vulnerable are considered to be appropriate within Flood Zone 1 and Flood Zone 2, while developments classified as Water Compatible are considered to be appropriate within flood Zone 3a and 3b as shown in Table 8.

Given the proposed location of land uses within the Site, it is considered that the development should be permitted according to NPPF Guidance.

5.4 Development Potential

The Site has been identified as being located within Flood Zone 1, Flood Zone 2 and Flood Zone 3 and no elements of the proposed development are classified as Essential Development or Highly Vulnerable. Therefore, the development in accordance with the NPPF is appropriate.

The flood risk to the Site can be managed appropriately, ensuring the development layout is designed so that the most vulnerable uses are restricted to higher ground at lower risk of flooding. This may mean potentially limiting development within areas of increased flood risk to 'Water Compatible' developments. Potential mitigation measures are considered in more detail in section 7.

5.5 Climate Change

Given the potential sources of flooding at the Site, climate change is likely to impact the Site through increased rainfall intensity and duration which may amplify surface water flooding.

The Environment Agency issued updated guidance in February 2017 on climate change allowances to be considered within Flood Risk Assessments (FRAs), and therefore further consideration of this matter will be required at this stage.

6 High Level Surface Water Drainage Strategy

6.1 Existing Drainage Strategy

As discussed in Section 2.3, the Site is predominantly greenfield land. In these areas there are no known formal drainage systems and water is assumed to drain via the existing land drainage network to the northwest of the Site. For the existing buildings within the Site there is expected to be a formal drainage network, however at the current time it is not known whether this is private drainage or whether it is connected to the external drainage infrastructure.

6.2 High Level Surface Water Drainage Strategy

The proposed development seeks allocation for multiple land uses across the Site. A full Drainage Strategy will need to be developed along with the full Flood Risk Assessment to accompany any forthcoming planning application.

As shown on the Ordnance Survey mapping and surface water flood maps, there are topographical low points across the Site where water drains into the existing drainage channel in the northwest of the Site.

A network of channels could be provided which flow towards this existing drainage channel to the northwest of the Site which would then flow into the River Tud.

In addition, a network of channels could be provided which would flow towards the topographical low point in the southwest of the Site which would then flow into the River Yare.

An indication of the system's required storage capacity is set out in the following section.

6.3 Surface Water Drainage Strategy Calculations

The greenfield runoff rates were calculated using the IH124 Method. The IH124 method is a recognised industry approach recognised by the Environment Agency and Local Planning Authorities. The runoff calculation uses the Standard Percentage Runoff (SPR). It is recommended that the infiltration characteristics of the present soil in the Site is studied in more detail in the full Drainage Strategy.

The Norfolk County Council guidance document[13] related to their Lead Local Flood Authority role as a Statutory Consultee to planning, provides information on how SuDS proposals for new developments will be determined. It states that greenfield runoff rates should not exceed the 1% (1 in 100 year) plus climate change allowance rainfall event.

[13] *Norfolk County Council (2017) Lead Local Flood Authority Statutory Consultee for Planning, Guidance Document. [Available Online] https://www.norfolk.gov.uk/rubbish-recycling-and-planning/flood-and-water-management/information-for-developers. Accessed 20/03/2018.*

6.3.1 Results

6.3.1.1 Greenfield Runoff Estimation

Using the methodology described in Section 6.3, greenfield runoff rates have been estimated which are shown in Table 9. These calculations are indicative only, and assume the whole of the existing Site is greenfield and therefore permeable.

Table 9: Greenfield Runoff Rates Estimation

Greenfield Runoff Rates Estimation		
	(l/s)	(l/s/ha)
Qbar	724	2.1
1 in 1 year	630	1.8
1 in 30 year	1775	5.0
1 in 100 year	2,579	7.3

6.3.1.2 Surface Water Storage Volume Estimation

Using the methodology described in Section 6.3, indicative surface water storage volume estimates have been calculated for the proposed development. Calculations have been based on 40%, 60% and 80% of the Site being impermeable post-development.

Table 10: Surface Water Storage Volume Estimation

Surface Water Storage Volume Estimation	
Assumed proposed impermeable area (%, ha)	**Indicative Total Storage (excluding treatment) (m^3)**
40%, 141.2 ha	152,884
60%, 211.8 ha	231,717
80% 282.4 ha	311,218

6.4 Management and Maintenance of Drainage Systems

Any private on-site drainage structures (such as pipes, attenuation structures, interceptors, pumping stations, outfalls) will remain in the ownership and responsibility of the site occupiers who will be required to maintain these appropriately.

The maintenance and repair of any public sewers will be the responsibility of the local Water and / or Sewerage Company. Any public highway drains will be the responsibility of the Local Highways Authority to maintain. The ordinary watercourses are the responsibility of the riparian owner. This is normally defined on the title plan and register of the land registry documents. In instances where this is not defined each adjacent land owner is responsible up to the centreline of the watercourse for its maintenance.

The drainage network will need to be operated in accordance with the design specification. A maintenance plan will be developed for the site and should implement appropriate practices in accordance with industry standards to maintain the design capacity of the drainage system. The management and maintenance plan shall also include the arrangements for adoption by any public authority or statutory undertaker and any other arrangements.

7 Mitigation Measures

When determining planning applications, local planning authorities should ensure that flood risk is not increased elsewhere and consider if development is appropriate for the level of flood risk. There are a number of opportunities to reduce flood risk to the proposed development during their lifetime, which would help satisfy concerns of the Environment Agency and improve the chances of receiving planning permission from the Local Planning Authority. These are considered below along with a qualitative indication of the construction and maintenance.

7.1 Surface Water Flooding Recommendations

The surface water flood risk should be assessed by working with the architect to develop the layout to ensure that overland flow routes are identified as part of any future development. These could be swales, SuDs, green spaces, play areas etc. The surface water flood risk should be managed through careful profiling of any housing development and where needed adequately high finished floor levels. This approach would need to be agreed with the Local Planning Authority.

7.2 Sustainable Drainage Systems (SuDS)

Surface water runoff will need to be controlled to ensure no flooding of property, and no increase in the existing surface water runoff rate to a receiving watercourse during a 1 in 100 year plus climate change allowance event.

Sustainable Drainage Systems (SuDS) can be installed to reduce the causes and impacts of flooding and remove urban pollutants from urban runoff at source. Whether the use of SuDS should be considered or not, and the practicality of the different types of SuDS, will ultimately depend upon the proposed development and its location.

The Greater Norwich Area SFRA states that:

'SuDS must be considered at the outset, during preparation of the initial site conceptual layout to ensure that enough land is given to design spaces that will be an asset to the development rather than an after-thought. This will assist with the delivery of well designed, appropriate and effective SuDS'.

Chapter 9 of the Greater Norwich Area SFRA describes the different guidance on SuDS in this area, and describes effects of SuDS, types of SuDS and the management of SuDS.

The Norfolk County Council guidance document, regarding their Lead Local Flood Authority role as a Statutory Consultee to planning, provides information on how SuDS proposals for new developments will be determined. It details:

'The proposed method for draining the site should be in accordance with the sustainable drainage hierarchy; with a preference for shallow (<2 m deep) infiltration measures, followed by measures to drain to a nearby watercourse, otherwise discharging to a surface water sewer. The last method of draining a site would be to either a combined/foul sewer, or via deep infiltration methods (>2 m below ground level).'

In conducting the full Drainage Strategy, it is recommended that both documents are reviewed.

The Site is located within an Outer Zone 2 Source Protection Zone which could influence the use of infiltration SuDS. As part of the ground investigations, infiltration testing would be required in accordance with BRE digest 365 to confirm whether these types of SuDS are appropriate.

Opportunities for source and site control measures should be considered where practicable. Measures including filter strips or drains and permeable paving would limit the impermeable proportion of the development. There is the potential for a detention basin or pond within isolated low-lying areas of the development to store surface water runoff.

8 Summary

This Feasibility Study aims to provide an initial high-level Flood Risk Assessment and Drainage Strategy for the proposed development Site at Honingham Thorpe, Norfolk. It is based upon existing publicly available data. It aims to assess the flood risk and drainage constraints to inform the decision-making process as to whether the Site is suitable for development given the existing flood risk and possible drainage strategies available.

This Feasibility Study has identified the following key conclusions:

- The Site is predominantly existing greenfield land;
- The proposed development consists of a total of 353 ha containing employment space, residential, country park and nature reserve land uses;
- The Site consists of 7 sub-sites submitted at Regulation 18 planning stage;
- As the Site is greenfield there is likely to be a limited formal drainage network;
- The Site is located between the River Tud to the north and the River Yare to the south;
- The bedrock geology is White Chalk, and the superficial is a mixed lithology which is expected to be largely permeable;
- The bedrock aquifer is classified as Principle Aquifer. The superficial drift aquifer is classified as Secondary (Undifferentiated) aquifer;
- The Site is located predominantly within Flood Zone 1, with small areas at the southern extent of the Site in Flood Zone 2 and 3, however these are proposed as open public spaces;
- The risk of fluvial flooding is low across the majority of the Site, except for the small areas in Flood Zone 2 and 3, were the risk is medium to high;
- The risk of flooding from the sea is negligible;
- Flooding from groundwater may pose a risk to the Site; however, this requires further investigation;
- The risk of flooding from surface water is low for the majority of the site, however in low-lying areas there is a medium to high risk;
- The risk of flooding from sewers is likely to be low;
- The risk of flooding from reservoirs is considered to be low;
- The Sequential Test and vulnerability assessment concludes that the proposed development of the Site is acceptable;
- Preliminary greenfield runoff rates and indicative surface water volume storage estimates have been calculated based on 40%, 60% and 80% of the Site being impermeable post-development; and
- Mitigation measures including SuDS should be included in the proposed development.

On the basis of the currently available data this Feasibility Study concludes that the Site is suitable for the proposed development.