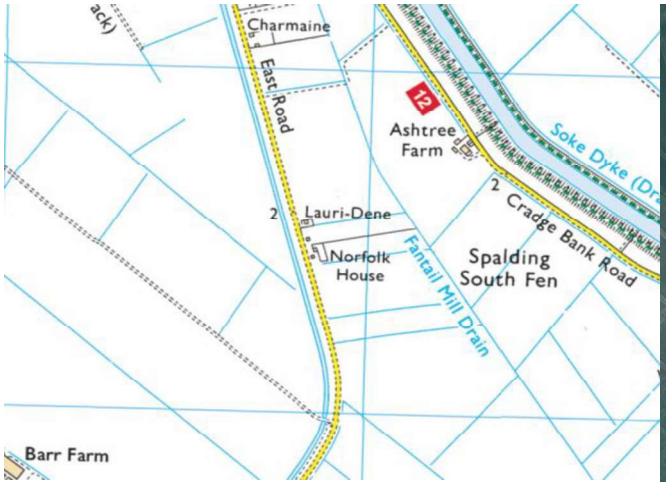
WtFR Ltd

Flood Risk Assessment

Development at

Lucksbridge Farm, South Drove, Spalding, PE11 3ED





On behalf of
Anna Avery

Date: 14th September 2021

Reference: WTFR-FRA-2020/12/Q08_RevB

Issue sheet

Revision	Prepared by	Date	Checked by	Date
0	JS	20/01/21	JH	13/01/21
A	JS	12/08/21		
B	JH	14/09/21		

Revision A – Inclusion of updated plans.

Revision B – Revision of text associated with figures 6 and 7, following EA feedback.

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1. Introduction

WtFR Ltd has been commissioned by Anna Avery to undertake a Flood Risk Assessment (FRA) in connection with the planning application for the proposed development at Lucksbridge Farm, South Drove, Spalding, PE11 3ED.

This FRA has been produced to demonstrate how risks from all sources of flooding to the site and flood risk to others from the development will be managed, in order to satisfy the requirements, set out in the National Planning Policy Framework (NPPF).

A full assessment of the flood risk to the site and consideration of the surface water management as a result of the development has been considered as part of this analysis.

Data has been gathered from a number of other sources including: the Environment Agency (EA), the British Geological Society (BGS), National Soil Research Institute (NSRI), aerial photographs, Ordnance Survey (OS), commercially available historical mapping and relevant strategic documents developed by the South Holland District Council and Lincolnshire Council, in their capacity as the Local Planning Authority and Lead Local Flood Authority, respectively.

2. Site Description

Area Size: 1000m^2

Grid reference: TF 23384 19062

The proposals are for the demolition of existing building and construction of 1 new dwelling at Lucksbridge Farm, South Drove, Spalding, PE11 3ED.

Figures 1 and 2 below show location details of the development site. Figure 3 shows an oblique aerial photograph of the development site.

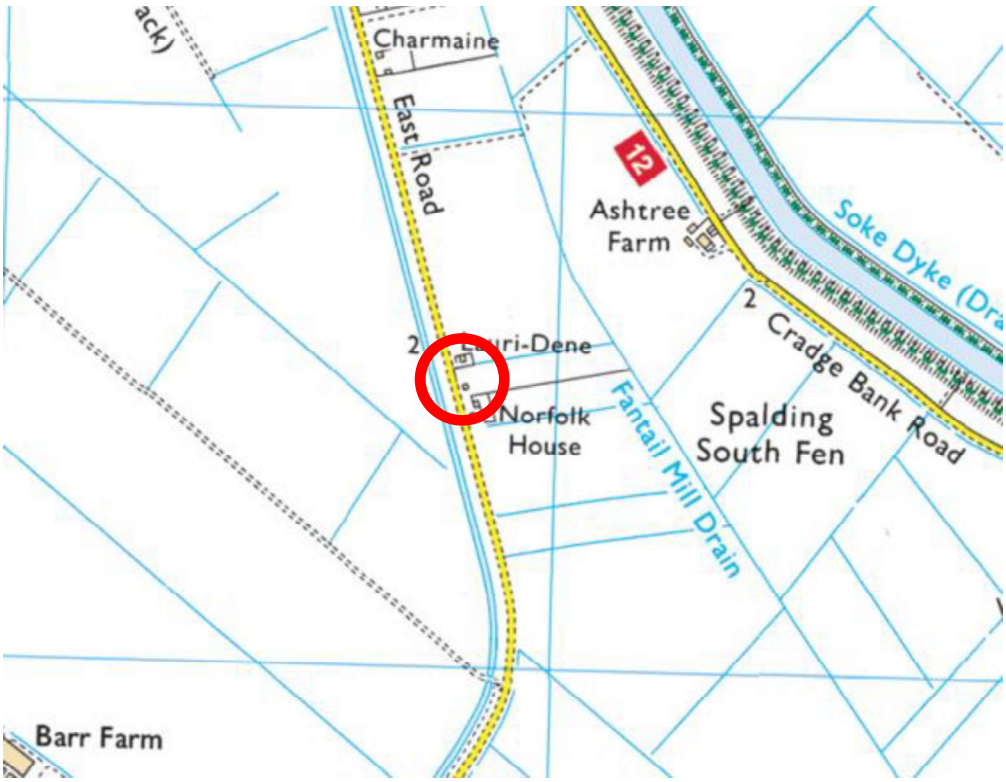


Figure 1 – Location of the site, highlighted.

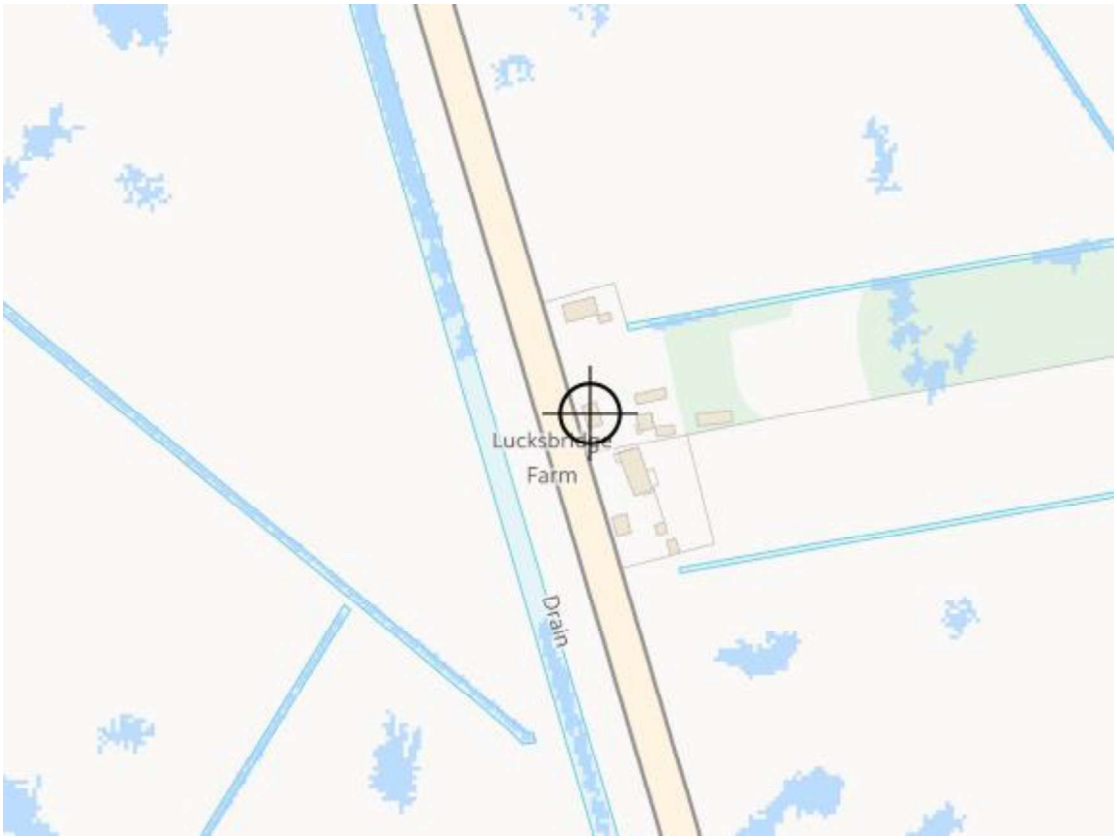


Figure 2 –detailed location of the development site, highlighted.



Figure 3 – aerial photograph of the development site.

3. Flood Risk Assessment

3.1 National Planning Policy

Paragraph 163 of the NPPF states "When determining any planning applications, local planning authorities should ensure that flood risk is not increased elsewhere. Where appropriate, applications should be supported by a site-specific flood-risk assessment[50]. Development should only be allowed in areas at risk of flooding where, in the light of this assessment (the sequential and exception tests, as applicable) it can be demonstrated that:

a) within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location;

b) the development is appropriately flood resistant and resilient;

c) it incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate;

d) any residual risk can be safely managed; and

e) safe access and escape routes are included where appropriate, as part of an agreed emergency plan".

Footnote 50 states "A site-specific flood risk assessment should be provided for all development in Flood Zones 2 and 3. In Flood Zone 1, an assessment should accompany all proposals involving: sites of 1 hectare or more; land which has been identified by the Environment Agency as having critical drainage problems; land identified in a strategic flood risk assessment as being at increased flood risk in future; or land that may be subject to other sources of flooding, where its development would introduce a more vulnerable use".

Furthermore paragraph 30 of the Planning Practice Guide on Flood Risk and Climate Change states "A site-specific flood risk assessment is carried out by (or on behalf of) a developer to assess the flood risk to and from a development site. Where necessary, the assessment should accompany a planning application submitted to the local planning authority. The assessment should demonstrate to the decision-maker how flood risk will be managed now and over the development's lifetime, taking climate change into account, and with regard to the vulnerability of its users.

The objectives of a site-specific flood risk assessment are to establish:

- whether a proposed development is likely to be affected by current or future flooding from any source;
- whether it will increase flood risk elsewhere;
- whether the measures proposed to deal with these effects and risks are appropriate;
- the evidence for the local planning authority to apply (if necessary) the Sequential Test, and;
- whether the development will be safe and pass the Exception Test, if applicable".

Continuing paragraph 31 of the Planning Practice Guidance quotes "The information provided in the flood risk assessment should be credible and fit for purpose. Site-specific flood risk assessments should always be proportionate to the degree of flood risk and make optimum use of information already available, including information in a Strategic Flood Risk

Assessment for the area, and the interactive flood risk maps available on the Environment Agency's web site.

A flood risk assessment should also be appropriate to the scale, nature and location of the development. For example, where the development is an extension to an existing house (for which planning permission is required) which would not significantly increase the number of people present in an area at risk of flooding, the local planning authority would generally need a less detailed assessment to be able to reach an informed decision on the planning application. For a new development comprising a greater number of houses in a similar location, or one where the flood risk is greater, the local planning authority would need a more detailed assessment".

3.2 Local Planning Policy

Local Authorities consider flood risk through relevant environmental and climate change policies which enforce the requirements of the NPPF. Relevant local policy, as outlined by the South Holland District Council and Lincolnshire Council, is contained within the;

i) Strategic Flood Risk Assessment
ii) Local Flood Risk Management Strategy

The Strategic Flood Risk Assessment (SFRA) and the Local Flood Risk Management Strategy (LFRMS) are key sources of flood risk specific information for the area. The SFRA provides a more detailed review of flood risks and recommendations for ensuring developments can be constructed and operated safely in accordance with the NPPF.

3.3 Flood Risk Zones, Vulnerability and Classification

These Flood Zones refer to the probability of river and sea flooding, ignoring the presence of defences. They are shown on the Environment Agency's Flood Map for Planning available on the Environment Agency's web site, as indicated in the table below.

Table 1 – Flood Zones

Flood Zone	**Definition**
Zone 1 *Low Probability*	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*	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*	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 *The 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 Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. (Not separately distinguished from Zone 3a on the Flood Map)

Table 2 – Flood Risk Vulnerability Classification

Essential Infrastructure
• Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk. • Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood. • Wind turbines.
Highly Vulnerable
• Police and ambulance stations; fire stations and command centres; telecommunications installations required to be operational during flooding. • Emergency dispersal points. • Basement dwellings. • Caravans, mobile homes and park homes intended for permanent residential use. • Installations requiring hazardous substances consent (Where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as 'Essential Infrastructure').
More Vulnerable
• Hospitals • Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels. • Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels. • Non–residential uses for health services, nurseries and educational establishments. • Landfill* and sites used for waste management facilities for hazardous waste. • Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.
Less Vulnerable
• Police, ambulance and fire stations which are **not** required to be operational during flooding. • Buildings used for shops; financial, professional and other services; restaurants, cafes and hot food takeaways; offices; general industry, storage and distribution; non-residential institutions not included in the 'More Vulnerable' class; and assembly and leisure. • Land and buildings used for agriculture and forestry. • Waste treatment (except landfill* and hazardous waste facilities). • Minerals working and processing (except for sand and gravel working). • Water treatment works which do not need to remain operational during times of flood. • Sewage treatment works, if adequate measures to control pollution and manage sewage during flooding events are in place.

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

* Landfill as defined in Schedule 10 to the Environmental Permitting (England and Wales) Regulations 2010.

Table 3 - 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 is appropriate

✗ Development should not be permitted.

Notes to table 3:

- This table does not show the application of the Sequential Test which should be applied first to guide development to Flood Zone 1, then Zone 2, and then Zone 3; nor does it reflect the need to avoid flood risk from sources other than rivers and the sea;
- The Sequential and Exception Tests do not need to be applied to minor developments and changes of use, except for a change of use to a caravan, camping or chalet site, or to a mobile home or park home site;

- Some developments may contain different elements of vulnerability and the highest vulnerability category should be used, unless the development is considered in its component parts.

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

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

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

4. Sources of flooding

4.1 Fluvial/Tidal

The Environment Agency's Flood Map for Planning (Rivers and Sea) identifies fluvial and tidal flood zones, and provides an indication of whether or not these zones are protected, due to the presence of flood defences (also highlighted). Figure 4, below, presents the Flood Map for the surrounding area.

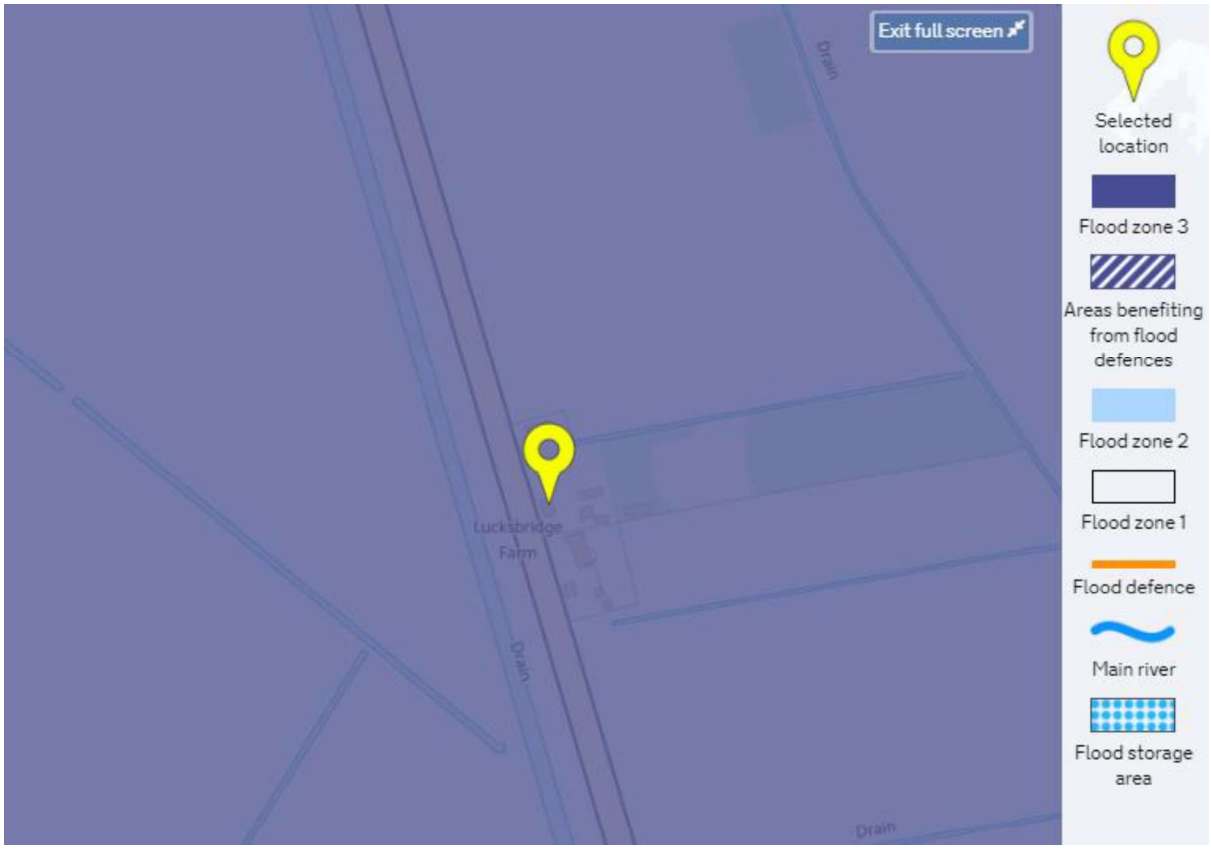


Figure 4 – Fluvial flood risk – EA Flood Map.

The EA Flood Map identifies the development site to lie within Flood Zone 3, where the chance of flooding in any given year is greater than 1 in 100 (1%).

Modelled flood information is also available from the River Welland Model, which was completed in 2016 using a 1D ISIS - TUFLOW model.

Figure 5, below, provides a map with the model node location points shown, with corresponding modelled flood levels for a range of Annual Exceedance Probability events provided in Table 4.

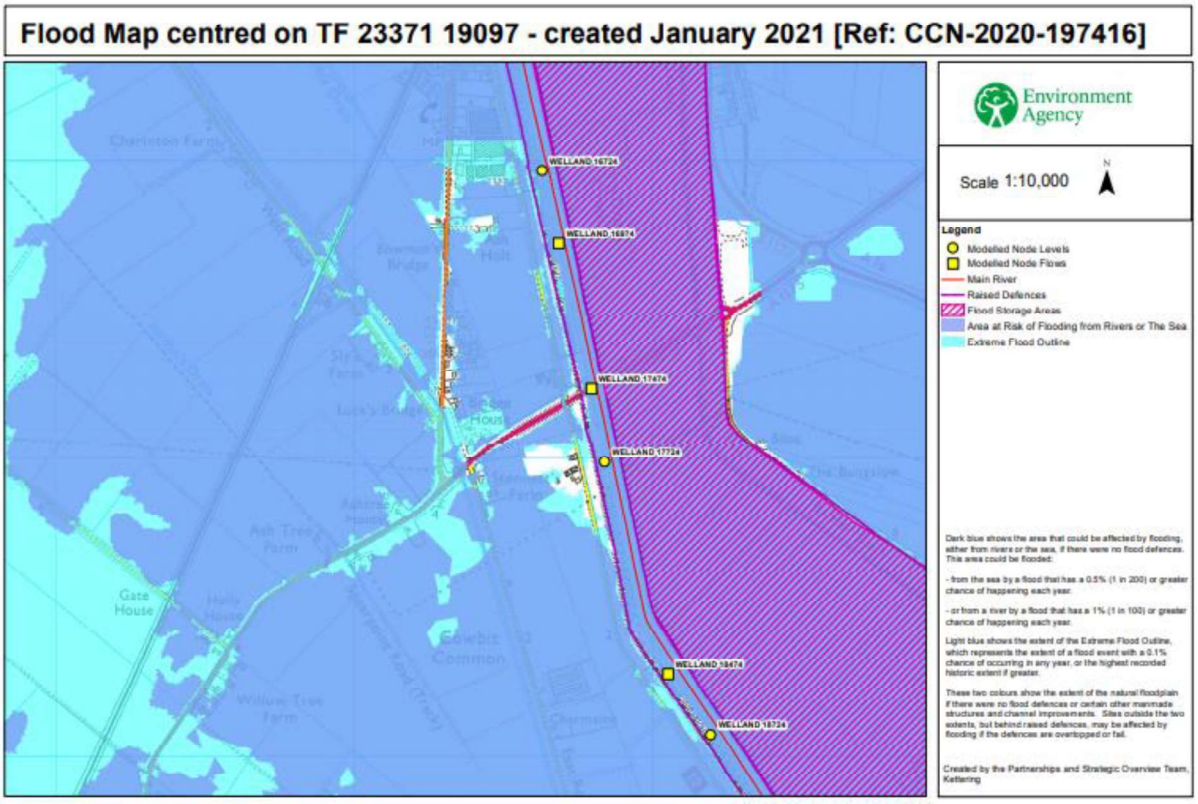


Figure 5 – Map showing model node location points.

			Annual Exceedance Probability - Maximum Water Levels (mODN)										
Node Label	Easting	Northing	50% (1 in 2)	20% (1 in 5)	10% (1 in 10)	5% (1 in 20)	2% (1 in 50)	1.33% (1 in 75)	1% (1 in 100)	1% (1 in 100) inc 20% Climate Change	0.5% (1 in 200)	0.1% (1 in 1000)	0.1% (1 in 1000) inc 20% Climate Change
WELLAND 16724	523630	319964	3.70	3.99	4.19	4.44	4.53	4.53	4.54	4.54	4.55	4.66	4.66
WELLAND 17724	523840	318987	3.70	4.01	4.20	4.45	4.54	4.54	4.55	4.55	4.56	4.65	4.65
WELLAND 18724	524196	318072	3.71	4.01	4.22	4.46	4.55	4.56	4.56	4.56	4.57	4.65	4.65

Table 4 – Modelled flood levels.

Node WELLAND 18724 is the closest point to the development site that indicates flooding, with a flood level of 4.56mAOD for the 1% event and 4.56mAOD for the 1% (+20%CC) event, and it is proposed that these figures are used to determine the recommended ground floor level for the development.

However, it is normal to consider the latest climate change guidance when assessing long term flood risk. Table 5 below provides an extract from the latest guidance, giving a range of percentage increases to flood levels over varying timescales.

River basin district	Allowance category	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Anglian	H++	25%	40%	80%
	Upper end	25%	35%	65%
	Higher central	15%	20%	35%
	Central	10%	15%	25%

Table 5 – Climate change allowances.

For more vulnerable developments in Flood Zone 3 the 'higher central' (35%) climate change allowance is the EA minimum benchmark for flood risk mitigation. In sensitive locations it may be necessary to use the 'upper end' (65%) allowance.

However, there is no change in flood level from the 1 in 100 event and the 1 in 100+20% event. Therefore, it is assumed that there would also be no change in the higher central and upper end allowance.

A topographic survey of the site has been provided, this shows the ground levels range between 1.7mAOD and 2.13mAOD. It is proposed that the finished floor level is set as high as possible and extensive flood resistance and resilience measures are incorporated into the development.

Figures 6 and 7 show the 1 in 100+CC% hazard and depth maps, the development site lies within future hazard category 'low hazard' and 'danger for some'. The site could experience flood depths of between 0–0.5 metres arising from a breach in the defences during a flood that has a 1% fluvial / 0.5% tidal chance of occurring in any one year up to 2115.

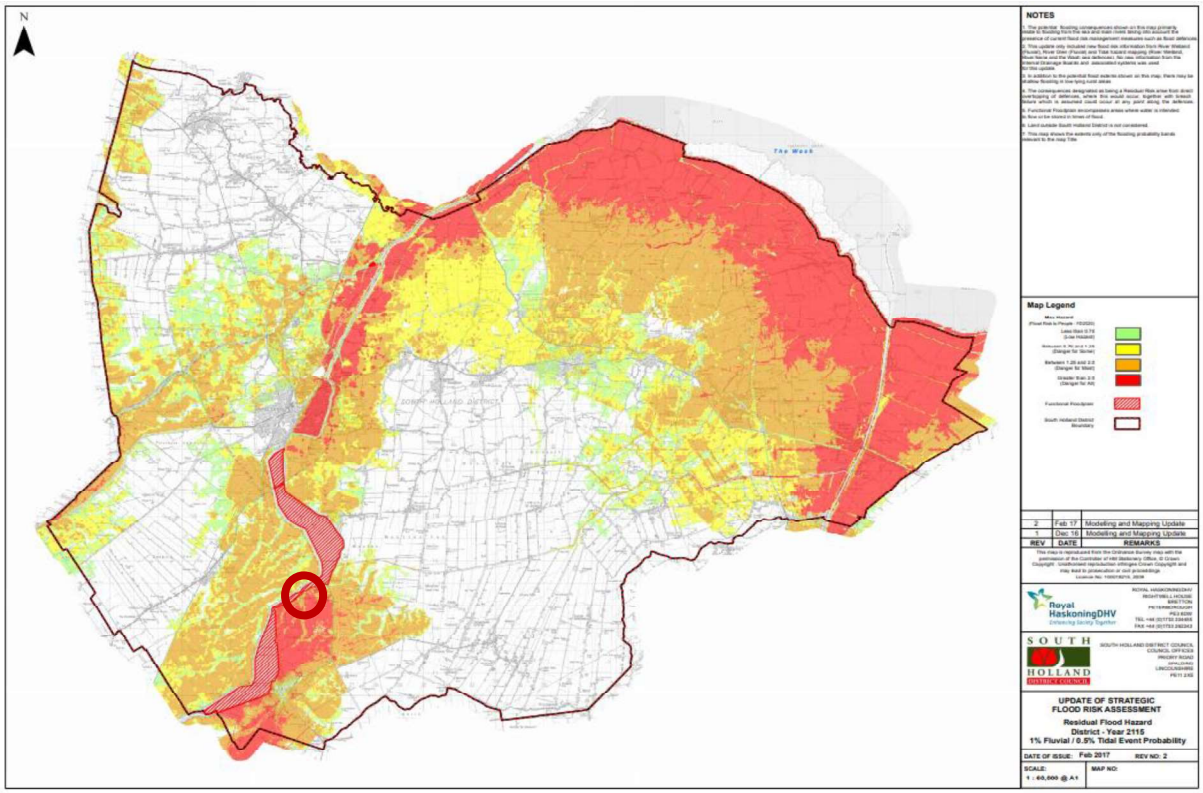


Figure 6 – 1 in 100+CC% hazard map.

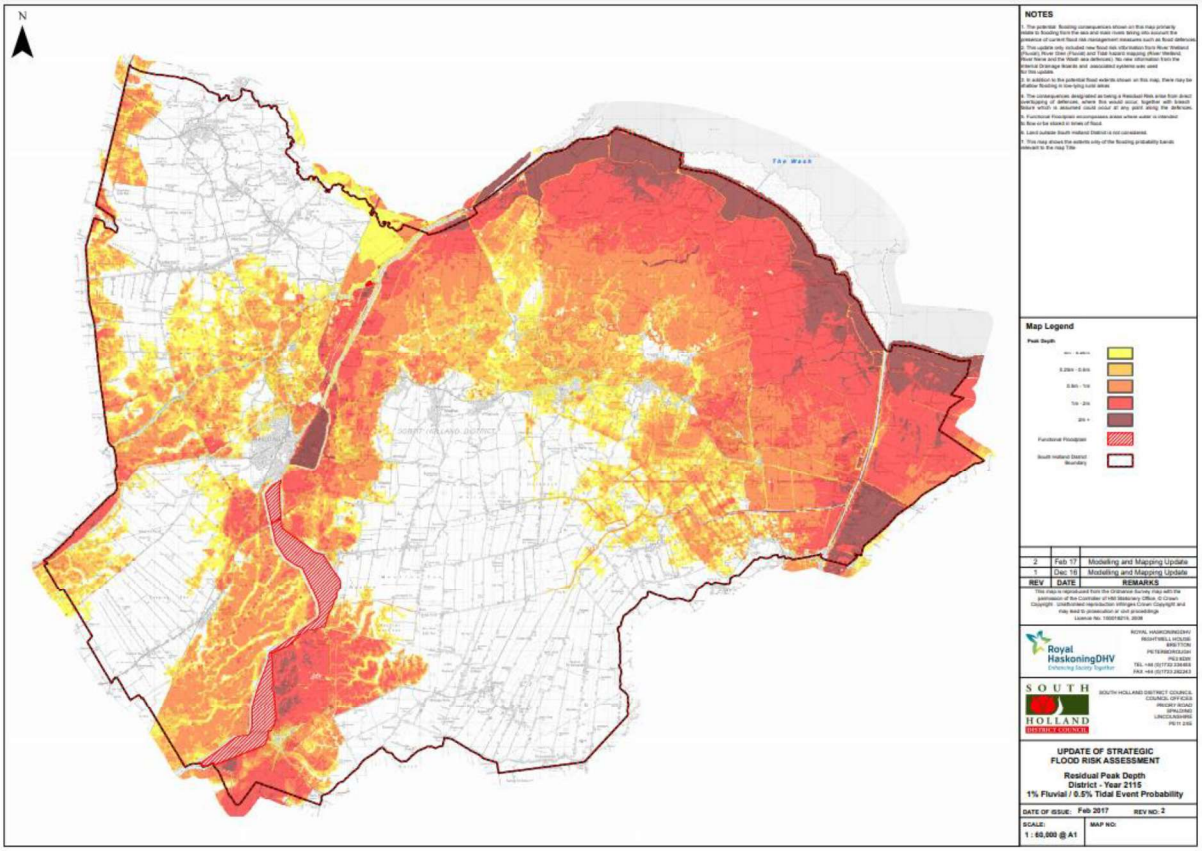


Figure 7 – 1 in 100+CC% depth map.

4.2 Historic Flooding

The EA does not have records of historic flood events from rivers affecting the area local to this property. Further analysis of strategic flood risk documents developed by the South Holland District Council and Lincolnshire Council does not indicate flooding from other sources.

4.3 Surface Water Flooding

The Environment Agency's updated Flood Map for Surface Water (uFMfSW) identifies pluvial flood risk. Figure 8, below, presents the uFMfSW for the development site and the surrounding area.

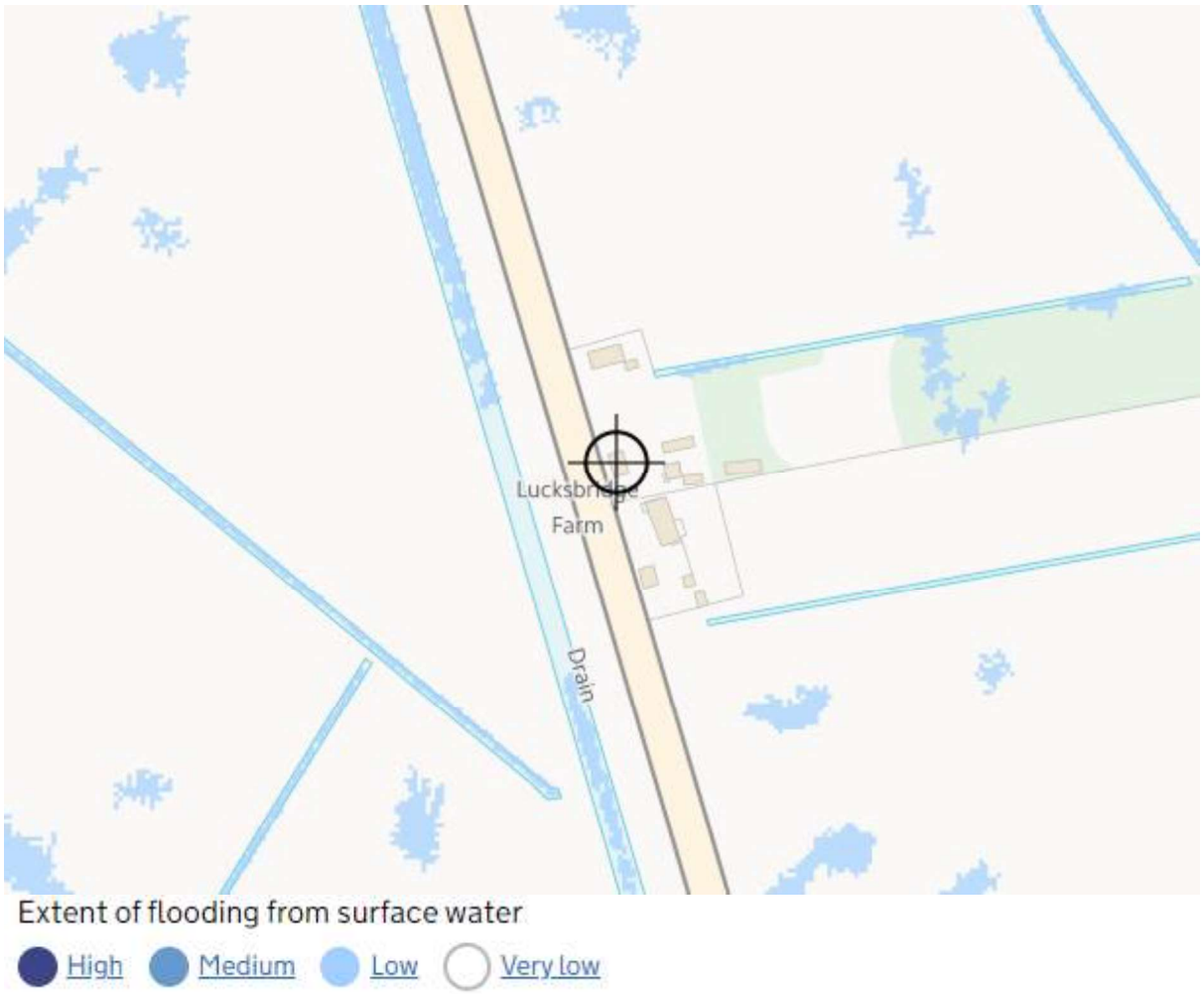


Figure 8 – Flooding from surface water sources, uFMfSW, site highlighted.

The uFMfSW shows that area in the vicinity of the development site is at very low risk of surface water flooding. Very low risk means that the probability of flooding in any given year is less than 1 in 1000 (0.1%).

4.4 Reservoir

The Environment Agency's Risk of Reservoir Flooding Map identifies the maximum extent of flooding that may be expected in the unlikely event that a reservoir dam failed. Figure 9 below, presents the risk map for development site and the surrounding area. The development is at risk of flooding.

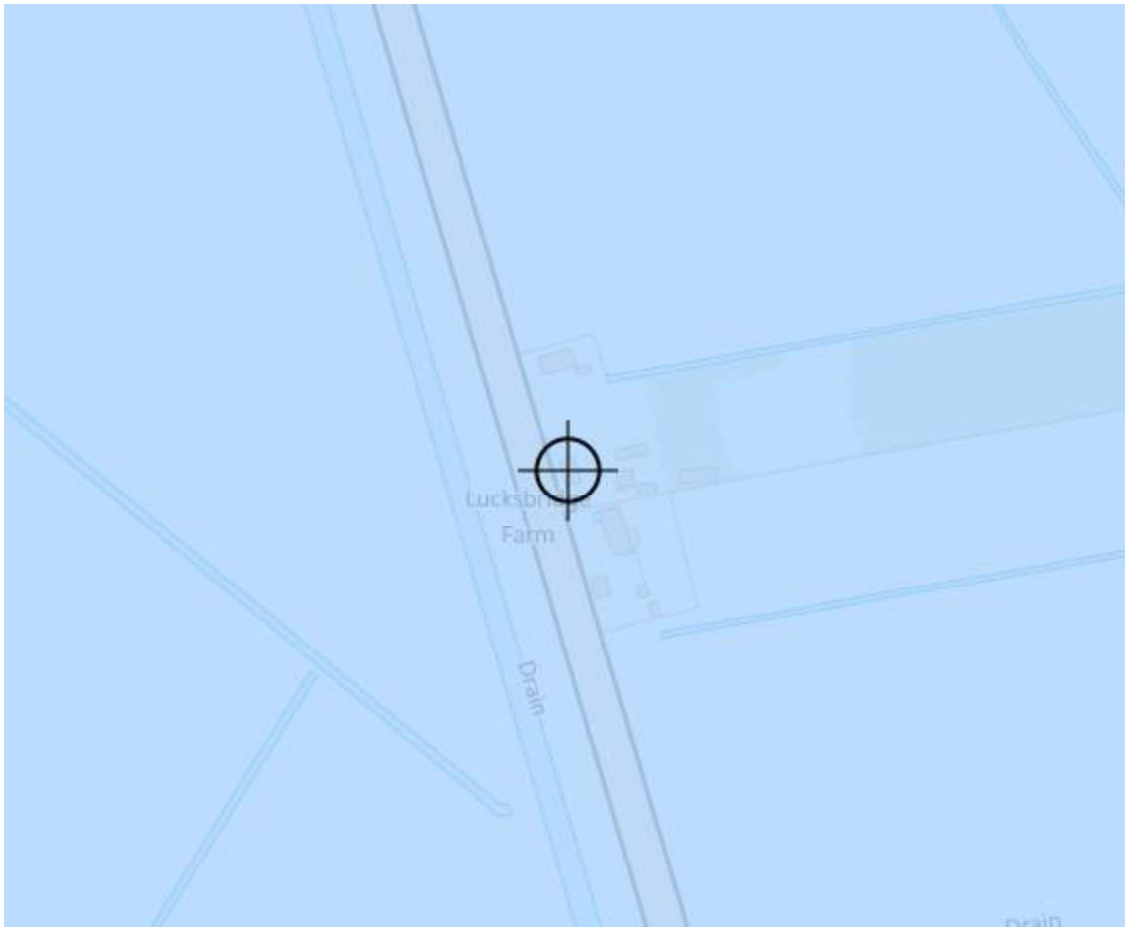


Figure 9 – Flooding from reservoir flooding.

The development is at risk of flooding from Rutland Water, Empingham reservoir (owned by Anglian Water Services Ltd) and the Crowlands Cowbit Washes reservoir (owned by Environment Agency)

Reservoir flooding is extremely unlikely to happen. There has been no loss of life in the UK from reservoir flooding since 1925. All large reservoirs must be inspected and supervised by reservoir panel engineers. As the enforcement authority for the Reservoirs Act 1975 in England, the Environment Agency ensures that reservoirs are inspected regularly, and essential safety work is carried out.

4.5 Groundwater

The Environment Agency's Groundwater Vulnerability Map indicates that the development site is situated over an unproductive groundwater vulnerability area, as shown in Figure 10. Further analysis shows that the development site is not situated over a Groundwater Source Protection Zone as shown in Figure 11.

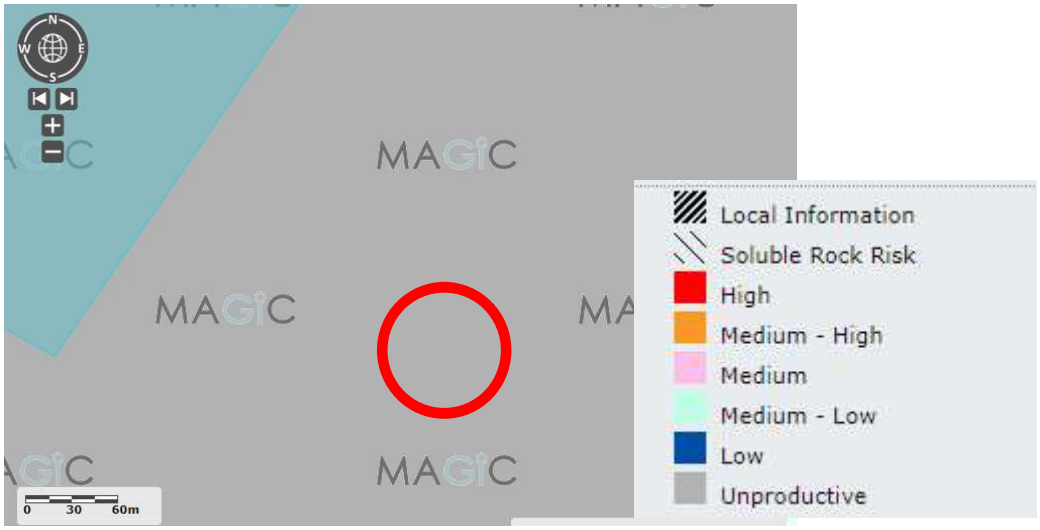


Figure 10 – Groundwater vulnerability map, site highlighted.

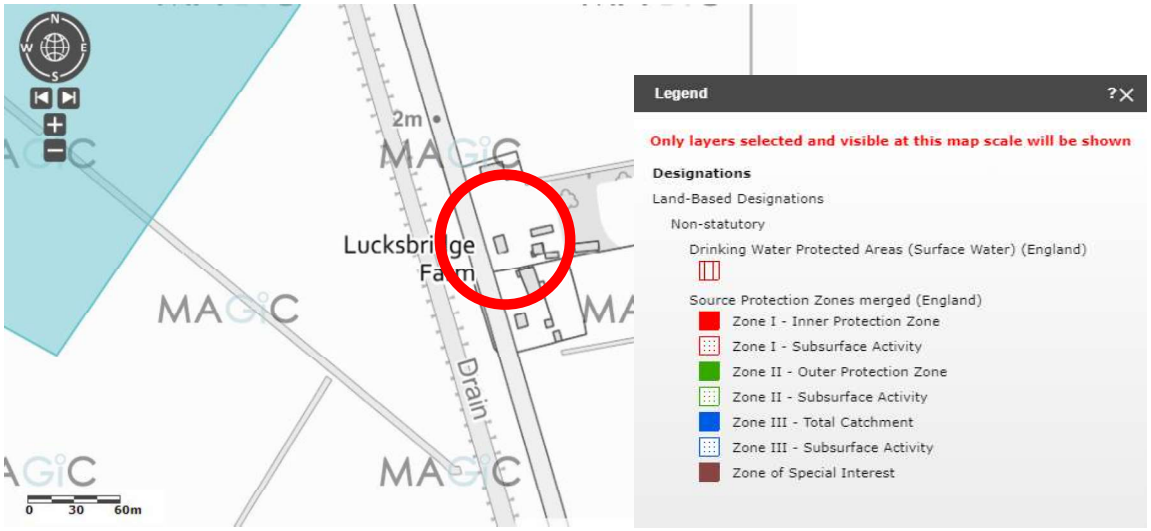


Figure 11 – Groundwater source protection zones, site highlighted.

Due to the minimal groundworks (for the construction of shallow foundations) the impact on groundwater is considered to be negligible.

4.6 Geology

Figures 12 and 13 present information from the British Geological Survey.

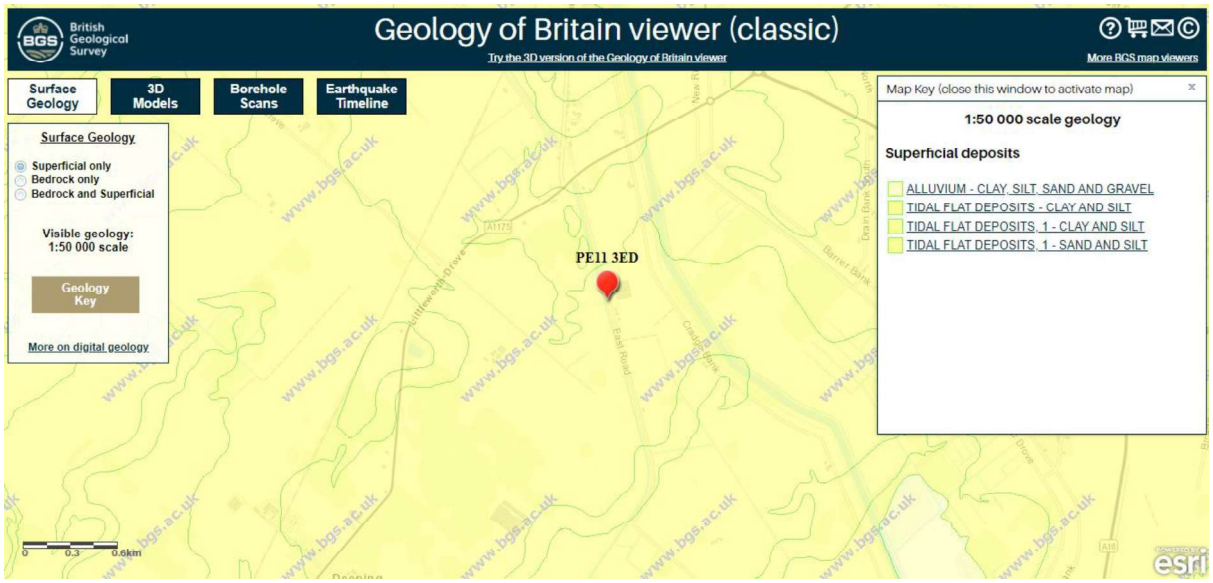


Figure 12 – Superficial Geology of the development.

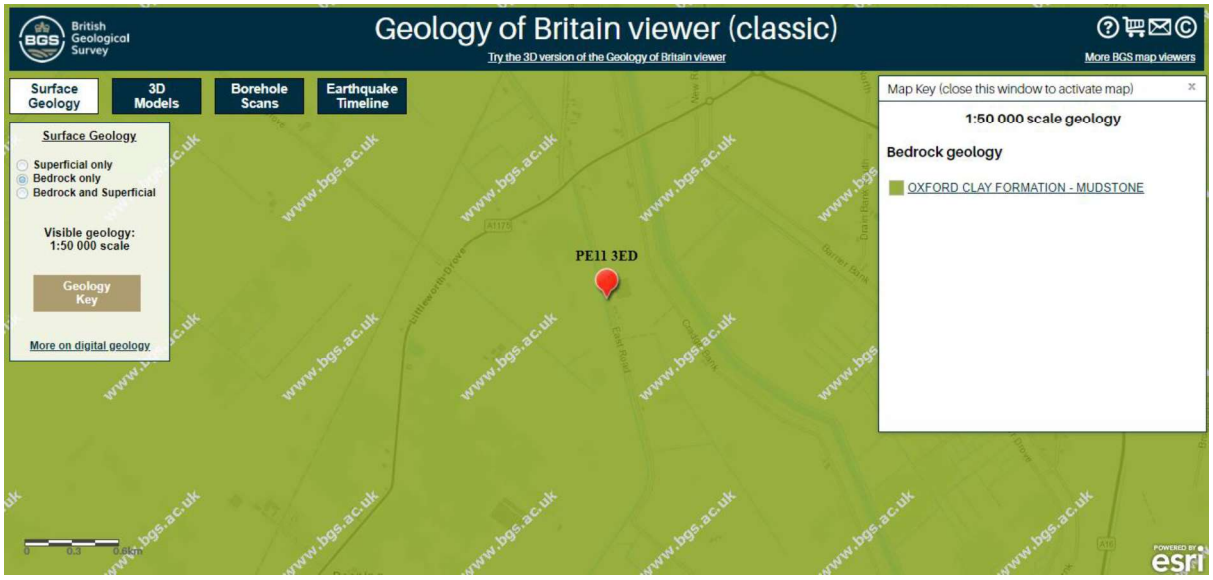


Figure 13 – Bedrock geology of the development

The superficial deposits at the development site are described as the Tidal Flat Deposits, 1 - Clay and Silt. The superficial deposits formed up to 3 million years ago in the Quaternary Period. The local environment was previously dominated by shorelines (U).

With regards to the bedrock, the site is underlain by the Oxford Clay Formation - Mudstone. The sedimentary bedrock formed approximately 157 to 166 million years ago in the Jurassic Period. The local environment was previously dominated by shallow seas.

5. Proposed development

This FRA is prepared to support a planning application for the demolition of existing building and construction of 1 new dwelling at Lucksbridge Farm, South Drove, Spalding, PE11 3ED.

Buildings used for residential dwellings are classified as being **More Vulnerable** development within Table 2 of the Planning Practice Guidance. More Vulnerable developments are acceptable within Flood Zone 3, subject to the sequential test.

Figure 14 shows the proposed ground floor layout and Figure 15 shows the proposed first floor layout.

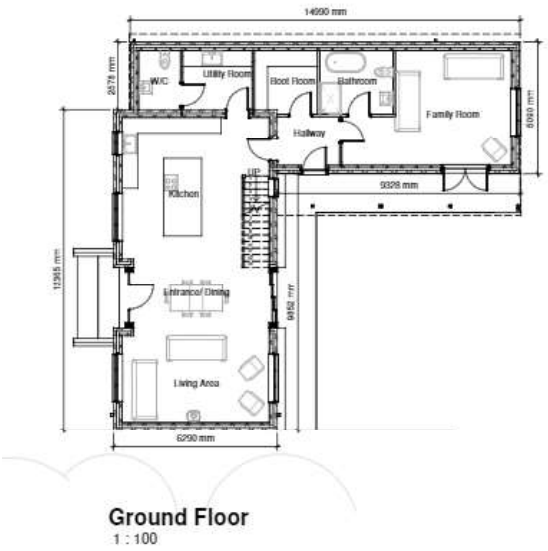


Figure 14 – Proposed ground floor layout.

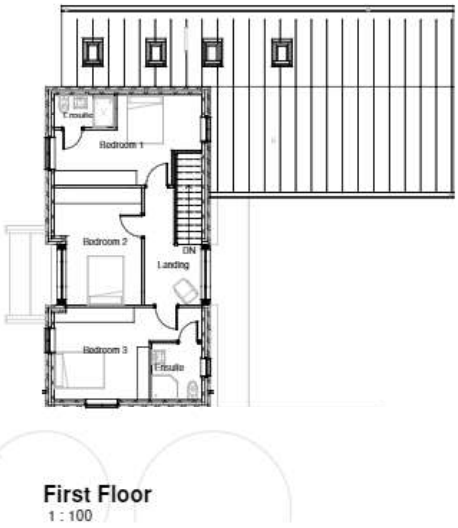
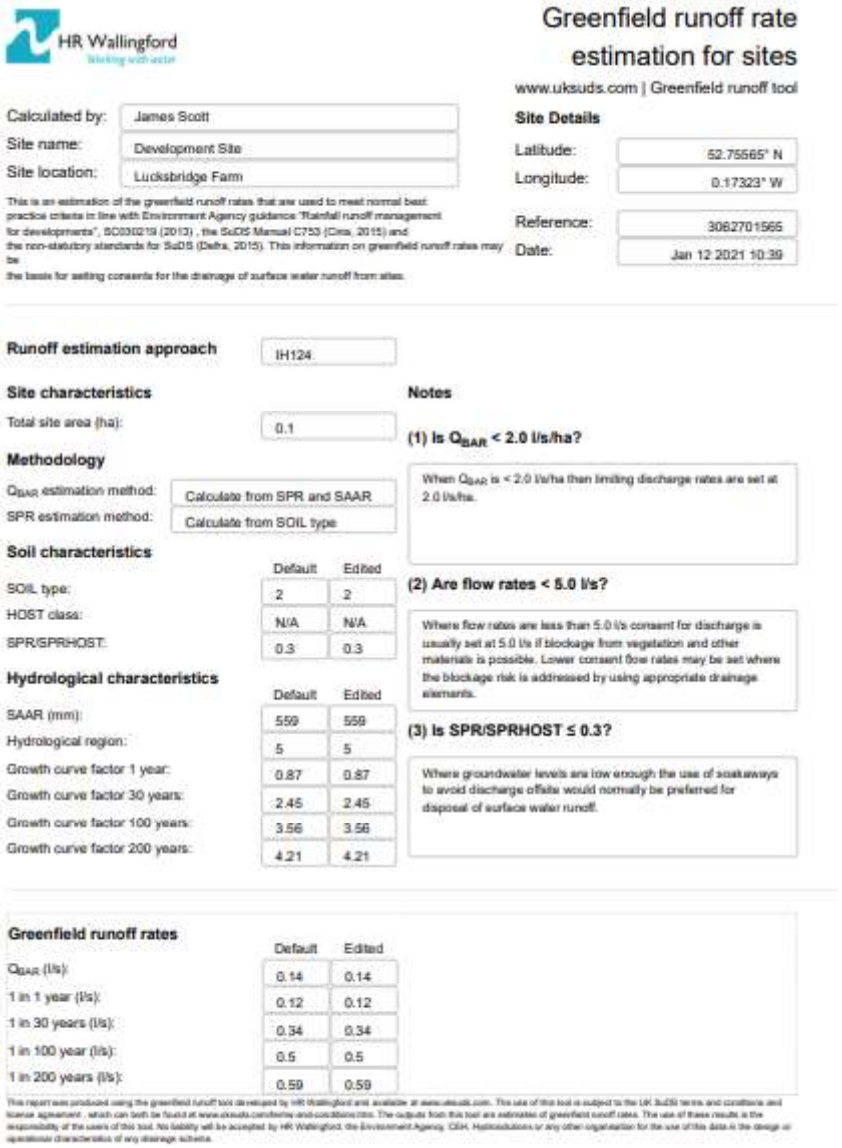


Figure 15 – Proposed first floor layout.

6. Surface Water Drainage

The greenfield runoff rate has been calculated using IH124 methodology. Table 5 below shows the calculations to determine the existing greenfield runoff rate.



HR Wallingford

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	James Scott
Site name:	Development Site
Site location:	Lucksbridge Farm

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

Site Details

Latitude:	52.75565° N
Longitude:	0.17323° W
Reference:	3082701565
Date:	Jan 12 2021 10:39

Runoff estimation approach IH124

Site characteristics

Total site area (ha): 0.1

Methodology

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

SPR estimation method: Calculate from SOIL type

Soil characteristics

	Default	Edited
SOIL type:	2	2
HOST class:	N/A	N/A
SPR/SPRHOST:	0.3	0.3

Hydrological characteristics

	Default	Edited
SAAR (mm):	559	559
Hydrological region:	5	5
Growth curve factor 1 year:	0.87	0.87
Growth curve factor 30 years:	2.45	2.45
Growth curve factor 100 years:	3.56	3.56
Growth curve factor 200 years:	4.21	4.21

Notes

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

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

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

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

(3) Is SPR/SPRHOST ≤ 0.3?

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

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):	0.14	0.14
1 in 1 year (l/s):	0.12	0.12
1 in 30 years (l/s):	0.34	0.34
1 in 100 year (l/s):	0.5	0.5
1 in 200 years (l/s):	0.59	0.59

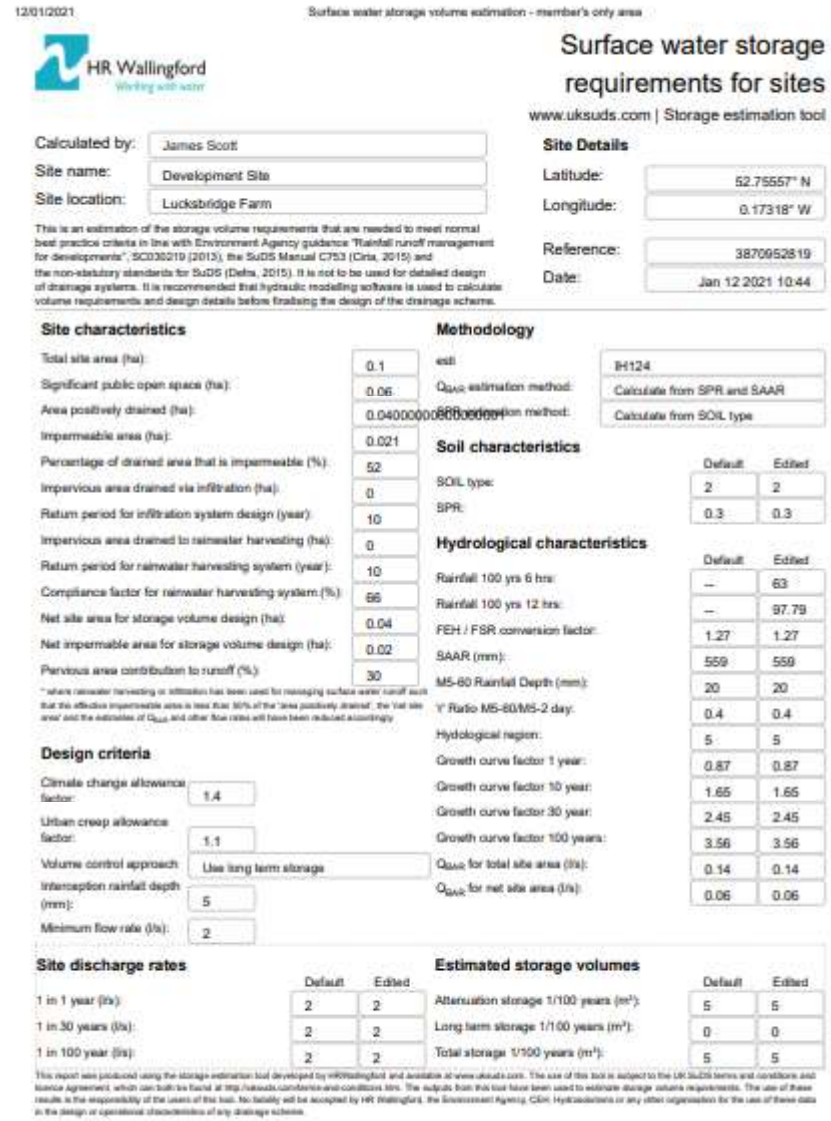
This report was produced using the greenfield runoff tool developed by HR Wallingford and available at www.uksuds.com. The use of this tool is subject to the UK SuDS terms and conditions and licence agreement , which can both be found at www.uksuds.com/terms-and-conditions.htm. The outputs from this tool are estimates of greenfield runoff rates. The use of these results is the responsibility of the users of this tool. No liability will be accepted by HR Wallingford, the Environment Agency, CIRIA, Hydrosolutions or any other organisation for the use of this data in the design or operational characteristics of any drainage scheme.

Table 5 – Greenfield runoff calculations.

The Qbar Greenfield runoff rate is 0.14l/s. It is recommended that post development discharge rates are limited to 5l/s in accordance with industry best practice.

Table 6 below looks at the required attenuation that will be required on site. The figures include an allowance of 1.4 (+40%) for climate change.

The calculations show that 5m^3 of attenuation storage is required, with a restricted discharge rate of 5l/s.



12/01/2021 Surface water storage volume estimation - member's only area

HR Wallingford

Surface water storage requirements for sites

www.uksuds.com | Storage estimation tool

Calculated by:	James Scott
Site name:	Development Site
Site location:	Lucksbridge Farm

This is an estimation of the storage volume requirements that are needed to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013), the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). It is not to be used for detailed design of drainage systems. It is recommended that hydraulic modelling software is used to calculate volume requirements and design details before finalising the design of the drainage scheme.

Site Details

Latitude:	52.75557° N
Longitude:	0.17318° W
Reference:	3870952819
Date:	Jan 12 2021 10:44

Site characteristics

Total site area (ha):	0.1
Significant public open space (ha):	0.06
Area positively drained (ha):	0.040000000000000001
Impermeable area (ha):	0.021
Percentage of drained area that is impermeable (%):	52
Impervious area drained via infiltration (ha):	0
Return period for infiltration system design (year):	10
Impervious area drained to rainwater harvesting (ha):	0
Return period for rainwater harvesting system (year):	10
Compliance factor for rainwater harvesting system (%):	66
Net site area for storage volume design (ha):	0.04
Net impermeable area for storage volume design (ha):	0.02
Pervious area contribution to runoff (%):	30

* where rainwater harvesting or infiltration has been used for managing surface water runoff such that the effective impermeable area is less than 30% of the 'area positively drained', the 'net site area' and the estimates of Q_{BAR} and other flow rates will have been reduced accordingly.

Methodology

esti	IH124
Q_{BAR} estimation method:	Calculate from SPR and SAAR
[illegible] estimation method:	Calculate from SOIL type

Soil characteristics

	Default	Edited
SOIL type:	2	2
SPR:	0.3	0.3

Hydrological characteristics

	Default	Edited
Rainfall 100 yrs 6 hrs:	--	63
Rainfall 100 yrs 12 hrs:	--	97.79
FEH / FSR conversion factor:	1.27	1.27
SAAR (mm):	559	559
M5-60 Rainfall Depth (mm):	20	20
'r' Ratio M5-60/M5-2 day:	0.4	0.4
Hydological region:	5	5
Growth curve factor 1 year:	0.87	0.87
Growth curve factor 10 year:	1.65	1.65
Growth curve factor 30 year:	2.45	2.45
Growth curve factor 100 years:	3.56	3.56
Q_{BAR} for total site area (l/s):	0.14	0.14
Q_{BAR} for net site area (l/s):	0.06	0.06

Design criteria

Climate change allowance factor:	1.4
Urban creep allowance factor:	1.1
Volume control approach:	Use long term storage
Interception rainfall depth (mm):	5
Minimum flow rate (l/s):	2

Site discharge rates

	Default	Edited
1 in 1 year (l/s):	2	2
1 in 30 years (l/s):	2	2
1 in 100 year (l/s):	2	2

Estimated storage volumes

	Default	Edited
Attenuation storage 1/100 years (m³):	5	5
Long term storage 1/100 years (m³):	0	0
Total storage 1/100 years (m³):	5	5

This report was produced using the storage estimation tool developed by HRWallingford and available at www.uksuds.com. The use of this tool is subject to the UK SuDS terms and conditions and licence Agreement, which can both be found at http://uksuds.com/terms-and-conditions.htm. The outputs from this tool have been used to estimate storage volume requirements. The use of these results is the responsibility of the users of this tool. No liability will be accepted by HR Wallingford, the Environment Agency, CIRIA, Hydrasystems or any other organisation for the use of these data in the design or operational characteristics of any drainage scheme.

Table 6 – Estimated attenuation calculations.

7. Hierarchy of disposing surface water

The Planning Practice Guidance and part H of the Building Regulations state that "generally, the aim should be to discharge surface run off as high up the following hierarchy of drainage options as reasonably practicable:

- into the ground (infiltration);
- to a surface water body;
- to a surface water sewer, highway drain, or another drainage system;
- to a combined sewer".

7.1 Infiltration

Records from the British Geological Survey show that the proposed development is underlain by the Oxford Clay Formation. This generally has a poor infiltration coefficient and are not generally appropriate for infiltration.

As such, infiltration is not a viable option for disposal of surface water for this development.

7.2 Surface Water Body

There is a watercourse to the West of the development, approximately 40m away, and it is assumed that the existing method if surface water disposal at the development site is via this watercourse. It is proposed this is continued post development.

7.3 Surface Water or Combined Sewer

If drainage via the watercourse is not the existing method of surface water disposal it is assumed that a public surface water or combined sewer is available and serves the development site. As such, it is recommended that surface water is continued to be discharged to the public sewerage system.

8. Use of SuDS

The NPPF, Planning Practice Guide and the Ministerial Statement look at the use of SuDS as a priority to aid the disposal of surface water from new developments. Below is a list of different SuDS options and their appropriateness for this development.

An effective SuDS scheme controls both runoff quantity and quality and can provide amenity value. A range of different SuDS techniques are described below.

Source Control

Rain water harvesting / water butts

This is the direct capture of runoff on site. Rainfall runoff can be extracted for domestic use e.g. flushing toilets. Simple devices such as water butts can be installed for a relatively low cost and are easy to construct, install and operate.

Permeable Paving

Permeable paving provides a surface suitable for pedestrian and/or vehicular traffic, while allowing rainwater to infiltrate through the surface and into the underlying layers. The water is temporarily stored before infiltration into the ground (which may not be appropriate at this location), reuse, or discharge into a watercourse or other drainage system.

The CIRIA document C753 – The updated SuDS Manual states that permeable paving offers such advantages as "suitable for installation in high density development", "low maintenance" and "eliminates surface ponding and surface ice".

Green Roofs

Green roofs comprise a multi-layered system that covers the roof of a building or podium structure with vegetation cover over a drainage layer. They are designed to intercept and retain precipitation, reducing the volume of runoff and attenuating peak flows.

The advantages of green roofs are that they can be applied in high density developments, require no additional land take, improve air quality and can insulate buildings against temperature extremes.

Infiltration devices

Soakaways

Soakaways are square or circular excavations, with filled with rubble or lined with brickwork, pre-cast concrete or polyethylene rings/perforated storage structures surrounded by granular backfill. Some of the advantages for these devices are that they require minimal land take, provide groundwater recharge and are generally easy to construct and operate. However, it must be stressed that these are not suitable for poor draining soils.

Infiltration basins

Infiltration basins are vegetated depressions designed to store runoff and infiltrate it gradually into the ground. The advantages of using infiltration basins include being simple and cost-effective to construct, they reduce the volume of runoff from a drainage area and can be very effective at pollutant removal via filtering through the soils.

Conveyance

Swales

Swales are linear vegetated drainage features in which surface water can be stored or conveyed. They can be designed to allow infiltration, where appropriate. Roadside swales can replace conventional gullies and drainage pipes.

Advantages of using swales are that they are easy to incorporate into landscaping, they reduce runoff rates and volumes and that maintenance can be incorporated into general landscape management.

Rills and canals

Rills and canals are open surface water channels with hard edges. They can have a variety of cross sections to suit the urban landscape and can also be planted to provide water treatment. In dense urban developments where space can be at a premium they are an effective way of providing SuDS and can also act as pre-treatment to remove silt before water is conveyed into further SuDS features.

Attenuation features

Detention basins

Detention basins are surface storage basins or facilities that provide flow control through attenuation of storm water runoff. According to The CIRIA document C697 – The SuDS Manual, they "can be used where the groundwater is vulnerable, if lined", "simple and easy to construct" and "easy to maintain".

Ponds

Ponds can provide both storm water attenuation and treatment. They are designed to support emergent and submerged aquatic vegetation along their shoreline. Runoff from each rain event is detained and treated in the pool.

Attenuation is required to control runoff quantity, and could be provided by subsurface storage or, if the levels are suitable and land is available, pocket wetlands. To control the quality of runoff, other components such as filter trenches and permeable paving could be provided upstream of the attenuation to treat the surface water.

Summary of SuDS for the development

It is recommended that permeable paving is used within the development, water butts and rainwater gardens are also encouraged, in order to minimise surface water runoff. Due to the size of the site development basins and ponds may be incorporated to provide the necessary attenuation. Any hardstanding through the development should be made of a permeable material, where practicable.

9. Management of flood risk

9.1 Fluvial

The analysis of flooding from fluvial and tidal sources shows that the building is in Flood Zone 3 and hence is at a risk of flooding from events greater than 1 in 100 (1%) year events.

Table 2 of this report details that residential developments are classified as More Vulnerable; Table 3 of the report shows that More Vulnerable developments in Flood Zone 3, subject to the sequential test.

The results from the River Welland Model indicate that the long-term flood level in the vicinity of the development site is 4.55mAOD, which equates to the 1 in 100+20% event.

A topographic survey of the site has been provided, this shows the ground levels range between 1.7mAOD and 2.13mAOD. It is proposed that the finished floor level is set as high as possible and at least the same height as the previous dwelling. Additional, extensive flood resistance and resilience measures are incorporated into the development. Suitable measures are specified in section 9.4 of this report.

It is also recommended that the residents of the dwelling register for the EA Flood Warning Service, which is available in the area, and develop a flood plan that may be implemented in the event of extreme flooding. Details of a flood plan are set out in section 9.5 of this report.

9.2 Surface Water

The development site is described as being at very low risk from surface water flooding, which means that the flood risk is less than 1 in 1000 (0.1%) in any year.

There is a watercourse to the West of the development, approximately 40m away, and it is assumed that the existing method if surface water disposal at the development site is via this

watercourse. It is proposed this is continued post development. If drainage via the watercourse is not the existing method of surface water disposal it is assumed that a public surface water or combined sewer is available and serves the development site. As such, it is recommended that surface water is continued to be discharged to the public sewerage system.

The calculations show that 5m^3 of attenuation storage is required, with a restricted rate of 5l/s.

Appropriate SuDS features and measures will be incorporated within the development to minimise surface water discharges.

As such, the proposed development will not increase the risk of flooding elsewhere from surface water sources.

9.3 Safe access and egress

The proposed development is for a two-storey dwelling. In the event of flooding, all residents will have access to a safe refuge on the first floor of the dwelling.

It is recommended that residents of the property register for the EA Flood Warning Service, which is available within the area and which aims to give a minimum 2 hours advance notification of potential flooding, giving adequate time to implement safety procedures.

In the event of having to evacuate the building, a suitable emergency egress route is available by turning North onto South Drove, at the end of the road turn West onto A1175. Travel down this road for approximately 5.5km to reach Flood Zone 1.

9.4 Flood Resistance and Resilience Measures

It is proposed the development will incorporate flood resilience and resistance measures. This would ensure that any extreme flooding and flooding in exceedance events could be mitigated against. Such measures could include:

- External walls rendered resistant to flooding to higher level;
- Automatic Flood Doors;
- External ventilation outlets, utility points and air bricks fitted with removable waterproof covers;
- Ground level electrical main ring run from higher level; and on separately switched circuit from first floor;
- Electrical incomer and meter situated at higher level;
- Boilers, control and water storage / immersion installed at higher level;
- Gas meter installed at higher level;
- Plumbing insulation of closed-cell design;
- Non-return valves fitted to all drain and sewer outlets;
- Manhole covers secured;
- Anti-siphon fitted to all toilets;
- Kitchen units of solid, water resistant material;
- Use of MDF carpentry (i.e. skirting, architrave, built-in storage) avoided at ground floor level.

9.5 Flood plan

As the development is situated in Flood Zone 3 it would be prudent for a flood warning and evacuation plan to be set up and implemented post development. This plan would include residents signing up to the Environment Agency flood warning service.

The flood warning service has three types of warning that will help residents to prepare for flooding and take action.

Flood Warning	Flood Alert	Flood Warning	Severe Flood Warning
			
What it means?	Flooding is possible. Be prepared.	Flooding is expected. Immediate action required.	Severe flooding. Danger to life.
When it's used?	Two hours to two days in advance of flooding.	Half an hour to one day in advance of flooding.	When flooding poses a significant threat to life.
What to do?	Be prepared to act on your flood plan. Prepare a flood kit of essential items. Monitor local water levels and the flood forecast on our website.	Move family, pets and valuables to a safe place. Turn off gas, electricity and water supplies if safe to do so. Put flood protection equipment in place.	Stay in a safe place with a means of escape. Be ready should you need to evacuate from your home. Co-operate with the emergency services. Call 999 if you are in immediate danger.

Recommended Flood Plan:

Before a flood

- Find out if you are at risk of flooding;
- Find out if you can receive flood warnings;
- Prepare and keep a list of all your contacts to hand or save them on your mobile phone/tablet;
- Think about what items you can move now and what you would want to move to safety during a flood such as pets, cars, furniture and electrical equipment;
- Know how to turn off gas, electricity and water supplies;
- Prepare a flood kit of essential items and keep it handy. It can include copies of important documents, a torch, a battery-powered or wind-up radio, blankets and warm clothing, waterproofs, rubber gloves and a first aid kit including all essential medication.

On receipt of a flood warning

- Tune into your local radio station on a battery or wind-up radio;
- Fill jugs and saucepans with water;
- Grab your already prepared flood kit;
- Collect blankets, torch, first aid kit, medication and food;
- Move important documents, personal items, valuables and lightweight belongings upstairs or to high shelves;

- Raise large items of furniture, or put him in large bags if you have them;
- Move people, outdoor belongings, cars and pets to higher ground;
- Switch off water, gas and electricity at mains when water is about to enter your home. Do not touch sources of electricity when in standing water;
- Fit flood protection products, if you have them, for example flood boards, airbrick covers and sandbags;
- If you do not have non-return valves fitted, plug water inlet pipes with towels or cloths; Know your means of escape;
- Listen to the advice of the emergency service and evacuate if told to do so;
- Avoid walking or driving through flood water. 300mm of fast flowing water can knock over an adult and two feet of water can move a car.

<u>After a flood</u>

- If you have flooded, contact your insurance company as soon as possible;
- Take photographs and videos of your damaged property as a record for your insurance company;
- If you don't have insurance, contact your local authority for information on grants and charities that may help you;
- Flood water can contain sewage, chemicals and animal waste. Always wear waterproof outwear, including gloves, wellington boots and a face mask;
- Have your electrics, central heating and water checked by qualified engineers before switching them back on.

10. Conclusions

The analysis of flooding from fluvial and tidal sources shows that the building is in Flood Zone 3 and hence is at a risk of flooding from events greater than 1 in 100 (1%) year events.

Table 2 of this report details that residential developments are classified as More Vulnerable; Table 3 of the report shows that More Vulnerable developments in Flood Zone 3, subject to the sequential test.

The results from the River Welland Model indicate that the long-term flood level in the vicinity of the development site is 4.55mAOD, which equates to the 1 in 100+20% event.

The development site lies within future hazard category 'low hazard' and 'danger for some'. The site could experience flood depths of between 0–0.5 metres arising from a breach in the defences during a flood that has a 1% fluvial / 0.5% tidal chance of occurring in any one year up to 2115.

A topographic survey of the site has been provided, this shows the ground levels range between 1.7mAOD and 2.13mAOD. It is proposed that the finished floor level is set as high as possible and at least the same height as the previous dwelling. Additional, extensive flood resistance and resilience measures are incorporated into the development.

The development site is at very low risk of surface water flooding.

There is a watercourse to the West of the development, approximately 40m away, and it is assumed that the existing method if surface water disposal at the development site is via this watercourse. It is proposed this is continued post development. If drainage via the watercourse is not the existing method of surface water disposal it is assumed that a public surface water or combined sewer is available and serves the development site. As such, it is recommended that surface water is continued to be discharged to the public sewerage system.

The calculations show that 5m^3 of attenuation storage is required, with a restricted rate of 5l/s.

Appropriate SuDS features and measures will be incorporated within the development to minimise surface water discharges.

As such, the proposed development will not increase the risk of flooding elsewhere from surface water sources.

The development is a risk from reservoir failure.

There is no evidence of historic flooding of the development site.

The proposed development is for a two-storey dwelling. In the event of flooding, all residents will have access to a safe refuge on the first floor of the dwelling.

It is recommended that residents of the property register for the EA Flood Warning Service, which is available within the area and which aims to give a minimum 2 hours advance notification of potential flooding, giving adequate time to implement safety procedures.

In the event of having to evacuate the building, a suitable emergency egress route is available by turning North onto South Drove, at the end of the road turn West onto A1175. Travel down this road for approximately 5.5km to reach Flood Zone 1.

Based on the likely flooding risk, it is considered that the proposed development can be operated safely in flood risk terms, without increasing flood risk elsewhere and is therefore appropriate development in accordance with the NPPF.

Disclaimer

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