

HPV (Wardentree Lane) Ltd

Wardentree Lane, Spalding

Flood Risk Assessment & Surface Water Drainage Strategy

890253-R1(1)-FRA

THE QUEEN'S AWARDS FOR ENTERPRISE: INTERNATIONAL TRADE 2016

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RSK GENERAL NOTES

Project No.: 890253-R1(1)-FRA

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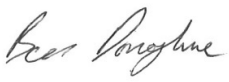
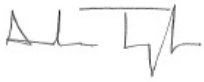
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Where field investigations have been carried out, these have been restricted to a level of detail required to achieve the stated objectives of the work.

This work has been undertaken in accordance with the quality management system of RSK LDE Ltd.

CONTENTS

1 INTRODUCTION 1
2 CONTEXT AND SCOPE OF WORK 2
3 SITE DESCRIPTION 3
3.1 Location 3
3.2 Land use and topography 3
3.3 Hydrology 4
3.4 Geology 4
3.5 Hydrogeology 4
3.6 History 5
4 DEVELOPMENT PROPOSALS 6
5 LEGISLATION AND POLICY CONTEXT 7
5.1 National policy 7
5.2 Regional policy 8
5.3 Local policy 9
6 SOURCES OF INFORMATION 11
6.1 Environment Agency consultation 11
6.2 Lincolnshire County Council 12
6.3 South Holland District Council 12
6.4 Internal Drainage Board 12
6.5 Canal & River Trust 13
6.6 Site walkover 13
6.7 Relevant studies 14
6.8 Drainage 16
7 SOURCES OF FLOOD RISK 18
7.1 Criteria 18
7.2 Flooding from rivers (fluvial flood risk) 18
7.3 Flooding from the sea (tidal flood risk) 21
7.4 Flooding from the land (overland pluvial flood risk) 23
7.5 Flooding from groundwater 24
7.6 Flooding from sewers 25
7.7 Other sources of flooding 26
7.8 Flood risk resulting from the development 28
8 PLANNING CONTEXT 29
8.1 Application of planning policy 29
8.2 Land use vulnerability 29
8.3 Sequential Test 29
9 SURFACE WATER DRAINAGE ASSESSMENT 31
9.1 Scope 31
9.2 Pre-development situation 31
9.3 Off-site discharge options and limits 31
9.4 Post-development situation 32
10 FLOOD MITIGATION MEASURES 37

10.1 Overview 37
10.2 Overland flood flow 37
10.3 Finished floor levels 37
10.4 Internal Drainage Board watercourse easement 37
10.5 Flood compensation 38
10.6 Safe access/egress 38
10.7 Flood resistance and resilience measures 38
10.8 Flood management plan 38
11 CONCLUSIONS AND RECOMMENDATIONS 40
12 REFERENCES 41

TABLES

Table 3.1: Site setting 3
Table 3.2: Existing site land uses 3
Table 4.1: Proposed site land uses 6
Table 5.1: National legislation and policy context 7
Table 5.2: Regional policy legislation and policy context 8
Table 5.3: Local policy context 9
Table 6.1: Relevant studies 14
Table 7.1: Environment Agency modelled river levels for nodes 259, 10770, 10776.1 20
Table 7.2: Tidal Breach Hazard Mapping 22
Table 8.1: Flood risk vulnerability and flood zone 'compatibility' 29
Table 9.1: IOH 124 surface water runoff (greenfield) 31
Table 9.2: Quick storage estimates 33
Table 9.3: Water quality – level of hazard 35
Table 9.4: Minimum number of treatment stages to groundwater 35
Table 9.5: Minimum number of treatment stages to surface water 35
Table 9.6: Extract of SuDS Manual Table 26.2: Pollution hazard indices for different land use classifications 36
Table 9.7: Extract of Table 26.3: Indicative SuDS mitigation indices for discharges to surface waters 36

FIGURES

Figure 3.1: Site location map 3
Figure 6.1: Internal Drainage Board Assets 13
Figure 7.1: Environment Agency 'Flood map for planning' 18
Figure 7.2: Environment Agency 'Flood risk from rivers or the sea' map 19
Figure 7.3: Modelled Node Points along Watercourse Site 20
Figure 7.4: Environment Agency 'Flood risk from surface water' map 23
Figure 7.5: Environment Agency 'Flood risk from reservoirs' map 27

APPENDICES

APPENDIX A RSK GROUP SERVICE CONSTRAINTS
APPENDIX B TOPOGRAPHIC SURVEY
APPENDIX C ARCHITECTURAL PLANS
APPENDIX D ENVIRONMENT AGENCY CORRESPONDENCE
APPENDIX E LINCOLNSHIRE COUNTY COUNCIL CORRESPONDENCE
APPENDIX F WELLAND AND DEEPINGS INTERNAL DRAINAGE BOARD CORRESPONDENCE
APPENDIX G ANGLIAN WATER SEWER RECORDS
APPENDIX H CLIMATE CHANGE CALCULATIONS
APPENDIX I DRAINAGE CALCULATIONS
APPENDIX J INDICATIVE SURFACE WATER DRAINAGE STRATEGY

1 INTRODUCTION

RSK Land and Development Engineering Ltd (RSK) was commissioned to carry out a Flood Risk Assessment (FRA) for HPV (Wardentree Lane) Ltd (the 'client'). The assessment is in support of the outline planning submission for a small commercial estate at land off Wardentree Lane, Spalding (the 'site').

The assessment has been prepared in accordance with the National Planning Policy Framework (NPPF) (Ref. 1) and its accompanying Planning Practice Guidance (Ref. 2), the Interim Code of Practice for Sustainable Drainage (Ref. 3), BS 8533-2011 Assessing and Managing Flood Risk in Development Code of Practice (Ref. 4), BS 8582:2013 Code of practice for surface water management for development sites (Ref. 5) and the Non-statutory technical standards for sustainable drainage systems (Ref. 6), with site-specific advice from the Environment Agency (EA), the Lead Local Flood Authority (LLFA), the Local Planning Authority (LPA), Internal Drainage Board (IDB), the architect and the client.

The NPPF sets out the criteria for development and flood risk by stating that inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk, but where development is necessary, making it safe without increasing flood risk elsewhere.

The key definitions within the PPG are:

- "Flood risk" is a combination of the probability and the potential consequences of flooding from all sources – including from rivers and the sea, directly from rainfall on the ground surface and rising groundwater, overwhelmed sewers and drainage systems, and from reservoirs, canals and lakes and other artificial sources; and
- "Areas at risk of flooding" means areas at risk from all sources of flooding. For fluvial (river) and sea flooding, this is principally land within Flood Zones 2 and 3. It can also include an area within Flood Zone 1 which the EA has notified the local planning authority as having critical drainage problems.

For this site, the key aspects that require the assessment are:

- The EA's indicative flood zone map shows that the site is located within Flood Zone 3; and
- The site area is approximately 0.6ha therefore surface water drainage should be considered, and sustainable drainage systems (SuDS) incorporated, where possible.

The comments given in this report and opinions expressed are subject to RSK Group Service Constraints provided in **Appendix A**.

2 CONTEXT AND SCOPE OF WORK

A key element of project development is to prepare a FRA to establish the flood risk associated with the proposed development and to propose suitable mitigation, if required, to reduce the risk to a more acceptable level.

The scope of work relating to a FRA is based on the guidance provided in Section 14 of the NPPF (Ref. 1) and its accompanying Planning Practice Guidance (Ref. 2).

A site-specific FRA 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. The scope of this assessment therefore comprises the following elements:

- To review architect plans, planning information and other studies to determine existing site conditions;
- To obtain information on the hydrology and hydrological regime in and around the site;
- To obtain the views of the EA/LLFA including scope, location and impacts;
- To determine the extent of new flooding provision and the influence on the site;
- To assess the impact on the site from climate change effects and anticipated increases in rainfall over a 60-year period for a commercial use;
- To review site surface water drainage based on the proposed layout and, if necessary, to determine the extent of infrastructure required; and
- To prepare a report including calculations and summaries of the source information and elements reviewed.

Reliance has been placed on factual and anecdotal data obtained from the sources identified. RSK cannot be held responsible for the scope of work, or any omissions, misrepresentation, errors or inaccuracies with the supplied information. New information, revised practices or changes in legislation may necessitate the re-interpretation of the report, in whole or in part.

3 SITE DESCRIPTION

3.1 Location

Site Name and Address: Land off Wardentree Lane, Spalding, PE11 3ZN

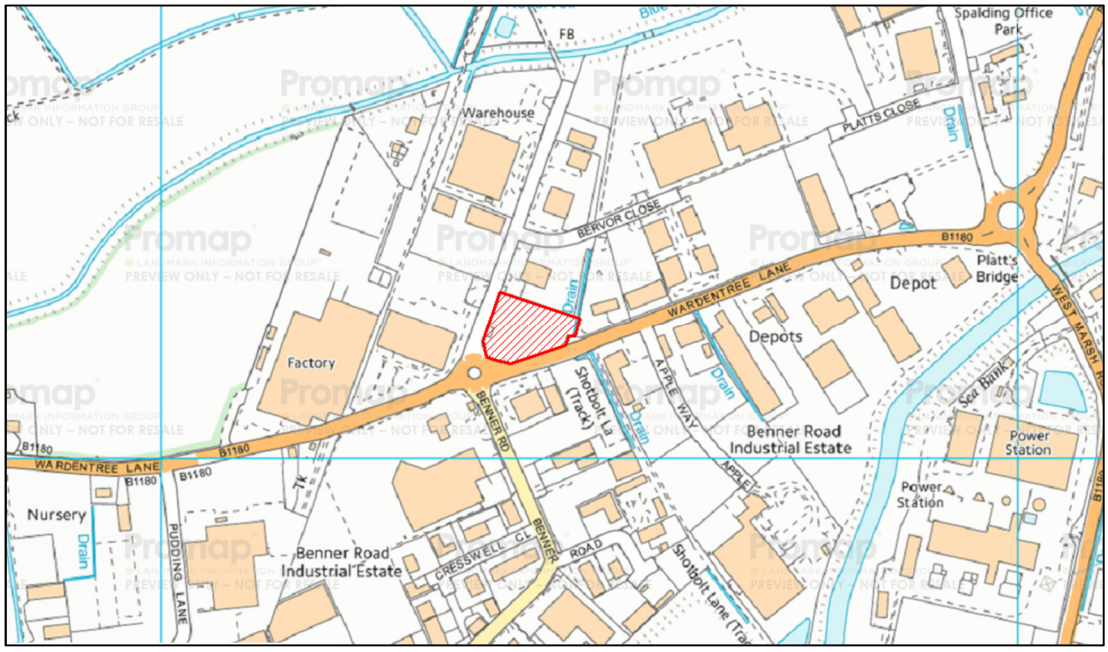
Site National Grid Reference: 525428, 32516543

The site is approximately 0.6ha and is located on Wardentree Lane (B1180) in Spalding, Lincolnshire. Figure 3.1 shows a site location map.

Table 3.1: Site setting

Direction	Characteristic
North	Commercial units, Blue Gowt Drain
East	Commercial units, drainage ditch
South	Commercial units
West	Commercial units

Figure 3.1: Site location map



3.2 Land use and topography

The site is currently open scrub land surrounded by roads and industrial complexes.

The approximate land use of the site is as follows:

Table 3.2: Existing site land uses

Land use	Area (m^2)	Percentage
Impermeable	0	0
Permeable	5995	100%
Total	5995	100%

Review of the local OS explorer 1:1250 mapping shows that the closest spot height level is 3metres above ordnance datum (m AOD) although this is at a point approximately 280m to the west along Wardentree Lane.

A more detailed topographical survey of the site has been produced by Henry Riley in November 2018. This has confirmed the site levels vary between 2.78m AOD to 3.50m AOD. The highest area of the site is along its southern boundary, at the south-west corner, before the land falls away very slightly towards the central western part of the site.

The topographical survey for the site is included in **Appendix B**.

3.3 Hydrology

The nearest EA Main River to the site is the River Welland, located approximately 750m to the south-east. There is a drainage ditch (known as Scraggs Dyke) located directly to the east of the site and Vernatt's Drain is located approximately 380m to the south-east of the site. There is a network of drainage ditches surrounding the site. Blue Gowt Drain is located approximately 245m to the north.

The topographical survey in **Appendix B** has confirmed that Scraggs Dyke has a bank top elevation of 3.16m AOD with a ditch base of 1.82m AOD.

3.4 Geology

Based on published geological records for the area (British Geological Survey online mapping and paper map No. 144 - Spalding), the site exhibits the following geology:

- Superficial Geology: Tidal Flat Deposits – Clay and Silt; and
- Base rock Geology: Oxford Clay Formation – Mudstone.

The closest BGS Borehole TF22NE69 is located approximately 3m to the east of the site however its data is not publicly available. Another borehole TF22NE78 on the opposite side of Wardentree Lane in the Morrisons Car Park (approximately 100metres south-east of the site) shows made ground overlying moist silty/sandy clay with bands of clayey sand.

At the time of writing, no Site Investigation data has been made available for review to confirm the exact site ground conditions.

3.5 Hydrogeology

Hydrogeological information was obtained from the online Magic Maps service. These maps indicate that the site is not underlain by a superficial or bedrock aquifer.

The site is not located within a Groundwater Source Protection Zone.

3.6 History

From looking at historical maps it appears that the site has been agricultural until at least 1992.

4 DEVELOPMENT PROPOSALS

The proposed development is for the construction of 5 commercial units on the site with associated car parking and areas of hard and soft landscaping.

The approximate land uses of the proposed site are summarised in Table 4.1 below.

Table 4.1: Proposed site land uses

Land use	Area (m^2)	Percentage
Impermeable	4569	76.2%
Permeable	1427	23.8%
Total	5996	100%

The proposed site plans are shown in **Appendix C**.

5 LEGISLATION AND POLICY CONTEXT

5.1 National policy

Table 5.1: National legislation and policy context

Legislation	Key provisions
National Planning Policy Framework (2018) (Ref. 1)	The aims of planning policy on development and flood risk are to ensure that flood risk is taken into account at all stages in the planning process to avoid inappropriate development in areas at risk of flooding, and to direct development away from areas at highest risk. Where new development is, exceptionally, necessary in such areas, policy aims to make it safe without increasing flood risk elsewhere and where possible, reducing flood risk overall.
Planning Practice Guidance (2014) (Ref. 2)	The NPPF is supported by an online Planning Practice Guidance, which provide additional guidance on flood risk.
Flood and Water Management Act 2010 (Ref. 7)	The Flood and Water Management Act (FWMA) aims to implement the findings of the 2007 Pitt Review and co-ordinate control of drainage and flood issues. There are a number of increased responsibilities within the Act that affect adoption of SuDS features and the role of the EA to expand on the mapping data they provide. The implementation of SuDS features has many beneficial impacts on the treatment of surface water during remediation works.
Water Resources Act 1991 (Ref. 8)	Section 24 – The EA is empowered under this Act to maintain and improve the quality of 'controlled' waters Section 85 – It is an offence to cause or knowingly permit pollution of controlled waters Section 88 – Discharge consents are required for discharges to controlled waters
Water Framework Directive (2000) (Ref. 9)	The Water Framework Directive (WFD) requires all inland and coastal waters to reach 'good' chemical and biological status by 2015. Flood risk management is unlikely to have a significant impact on chemical water quality except where maintenance works disturb sediment (such as de-silting) or where pollutants are mobilised from contaminated land by floodwaters. The main impact of the WFD on flood risk management, both now and in the future, relates to the ecological quality of water bodies. Channel works, such as straightening and deepening, or flood risk management schemes that modify geomorphological processes can change river morphology. The WFD aims to protect conservation sites identified by the EC Habitats Directive and Birds Directive that have water-related features, by designating them as 'protected sites'.

5.2 Regional policy

Table 5.2: Regional policy legislation and policy context

Legislation	Key provisions
East Midlands Regional Flood Risk Appraisal (Consultation Report) - East Midlands Regional Assembly October 2009 (Ref. 10)	The latest Regional Spatial Strategy (RSS) for the East Midlands was published in March 2009 and sets out a broad development strategy for the Region for the next 15 to 20 years. It identifies the scale and distribution of new housing and priorities for the environment, transport, infrastructure, economic development, agriculture, energy, minerals, and waste treatment and disposal. In February 2006 EMRA commissioned AECOM, to undertake an appraisal of the flood risk within their Region to inform their draft RSS. This commission was carried out at the same time as the draft Planning Policy Statement (PPS25) was being considered and was the first Regional Flood Risk Appraisal (RFRA) to be undertaken in the country. • The East Midlands RFRA was completed in July 2006 and was used as evidence at the EiP in 2007; • As part of their review of the current RSS, EMRA require the original RFRA to be updated to provide the robust evidence base for the Partial Review, starting with the options appraisal consultation in June 2009; and • This revised RFRA will take account of the current allowances for climate change, recently completed CFMPs, emerging SMPs, and completed Strategic Flood Risk Assessments (SFRA). Based on the level of flood risk and amount of proposed housing the RFRA has allocated one of three policy options to each LPA to avoid strategically significant land use and growth being allocated in areas of high flood risk. • All three policies require the local authorities to fully explore options to restore existing brownfield sites in Flood Zone 3 to natural floodplain and/or green infrastructure before other development alternatives are considered. This will allow less vulnerable development types to be substituted for those which are incompatible with the level of flood risk; • The RFRA has considered the flood risk management measures proposed in CFMPs and SMPs when deciding on the appropriate policy to ensure any flood risk is controlled to reduce the impact on new development; • Where there may be a need to locate strategically significant land use and growth in Flood Zones 3 and 2 the RFRA has recommended that a Level 2 SFRA is undertaken and the sequential and exception tests applied. If it is deemed necessary to locate development in these areas it will be necessary for the LPAs to ensure appropriate mitigation measures are in place. A strategic approach to managing flood risk arising from such developments may be appropriate;

Legislation	Key provisions
	• The RFRA recommends that LPAs use the Areas Susceptible to Surface Water Flooding Maps when producing SFRAs; • Flood risk will be reduced by considering changing the balance of the housing allocations across a number of the HMAs to move the allocation to local authorities with less flood risk; • Flood risk will be reduced in some local authority areas by adopting a different policy option from 2021; and • Flood risk will be reduced by the restoration of brownfield sites in Flood Zone 3 and 2 to more compatible uses.

5.3 Local policy

Local policies ensure that flood risk is taken into account at all stages in the planning process to avoid inappropriate development in areas at risk of flooding and making development safe without increasing flood risk elsewhere and where possible, reducing flood risk.

Table 5.3: Local policy context

LDF document	Key provisions and policies
Central Lincolnshire Local Plan 2012-2036 2017 ([Ref.11])	**Policy LP14: Managing Water Resources and Flood Risk Flood Risk** All development proposals will be considered against the NPPF, including application of the sequential and exception tests. Through appropriate consultation and option appraisal, development proposals should demonstrate: • that they are informed by / take account of the best available information from all sources of flood risk and site-specific flood risk assessments; • no increased risk of flooding to the development site or existing properties; • the development will be safe during its lifetime, does not affect integrity of existing flood defences and flood mitigation measures are agreed with relevant bodies; • adoption, ongoing maintenance and management of any mitigation measures; and • a positive approach to reducing overall flood risk • have incorporated Sustainable Drainage Systems (SuDS) in to the proposals unless they can be shown to be impractical. Protecting the Water Environment Development proposals that are likely to impact on surface or ground water should consider the requirements of the Water Framework Directive. Development proposals should demonstrate: • water is available;

LDF document	Key provisions and policies
	• that development contributes positively to the water environment / ecology and does not adversely affect surface and ground water quality (in line with the requirements of the Water Framework Directive); • that development with the potential to pose a risk to groundwater resources is not located in sensitive locations; • how SuDS deliver improvements to water quality; • that relevant site investigations, risk assessments and necessary mitigation measures for source protection zones have been agreed with the relevant bodies; • that adequate foul water treatment and disposal already exists or can be provided; • that surface water connections to the combined or surface water system are only made in exceptional circumstances and where there is no detriment to existing users; • no combined sewer overflows are created in areas served by combined sewers, • foul and surface water flows are separated; • suitable access is safeguarded for the maintenance; and • adequate provision is made to safeguard the future maintenance of discharge water bodies.
Lincolnshire Coastal Study (2007) ([Ref.12])	Following the Examination in Public (EiP) for the RSS held in Leicester and Lincoln in summer 2007 the Independent Panel produced a report containing their recommendations. At the EiP the risks to areas of the Lincolnshire coast which could be subject to severe flooding due to marine inundation or other causes were discussed at length. Having heard arguments on both sides the Panel has recommended that a strategy should be drawn up to examine in more detail the best way forward in planning for growth and regeneration in these coastal areas.

6 SOURCES OF INFORMATION

6.1 Environment Agency consultation

6.1.1 Flood zone maps

The EA Flood Zone mapping study for England and Wales is available on their website at: https://flood-map-for-planning.service.gov.uk.

The current displayed map is reproduced as **Figure 7.1** and shows the site to lie wholly within Flood Zone 3, showing the site with high risk of flooding from fluvial or tidal sources.

In December 2013, the EA released an additional form of mapping 'Risk of Flooding from Rivers and Sea', which is available at:

https://flood-warning-information.service.gov.uk/long-term-flood-risk

This map has been reproduced as **Figure 7.2** and shows the EA's assessment of the likelihood of flooding from rivers and the sea at any location and is based on the presence and effect of all flood defences, predicted flood levels, and ground levels.

The relevant guidance note from the EA is available online through the following link: https://www.gov.uk/planning-applications-assessing-flood-risk

6.1.2 Site specific consultation

The EA was formally consulted as part of this assessment, with request for flood related information (including flood levels) included in the consultation. Their full response to both the pre-planning enquiry and the flood data request can be found in **Appendix D**. The EA also provided details of their river model of the Welland (and Spalding Channel), which have been used in this assessment and is discussed further in Section 7.

The Product data request confirms the following points:

- The site is entirely covered by Flood Zone 3;
- Historical flooding mapping indicates there are no known past flood incidents on the site; and
- Both sides of the River Welland and the Spalding Channel have raised defences. The fluvial and tidal defences reducing the risk of flooding to this site consist of earth embankments. They are in fair condition and reduce the risk of flooding to a 1% (1 in 100) chance of occurring in any year. We inspect these defences routinely to ensure potential defects are identified.

Flood levels in relation to the site are explored in detail in Section 7.

The pre-application response confirms the following points:

- A full FRA report is recommended including recommended mitigation such as raised finished floor levels, flood resilience and flood warning; and
- The development is affected by Hazard Mapping which shows the consequences should a breach or overtopping of defences occur. Further information regarding depths and mitigation can be found in the South East Lincolnshire Strategic Flood Risk Assessment (SFRA), detailed in Table 6.1 and Section 7 below;

6.2 Lincolnshire County Council

Lincolnshire City Council (LCC) is the Lead Local Flood Authority (LLFA) for the area and was contacted in September 2018 to establish the LLFA's guidance on any constraints related to the site and any historic flooding records. The enquiry and responses can be found in **Appendix E**. The responses confirmed:

- As Lead Local Flood Authority (LLFA) for Lincolnshire, LCC is responsible for managing the flood risk from local sources (i.e. surface water, ground water and ordinary watercourses);
- In the event of flooding (all sources) LCC will investigate in accordance with Section 19 of the Flood & Water Management Act. The outcomes of these Section 19 investigations are available on the LCC website; and
- There are no Section 19 investigations for Wardentree Lane, Spalding however records only go back as far as April 2012, when LCC acquired its Section 19 duties.

6.3 South Holland District Council

South Holland District Council (SHDC) is the Local Planning Authority (LPA) for the area, and was contacted in September 2018 to establish any guidance on any constraints related to the site and any historic flooding records. At the time of writing, no response was received from SHDC.

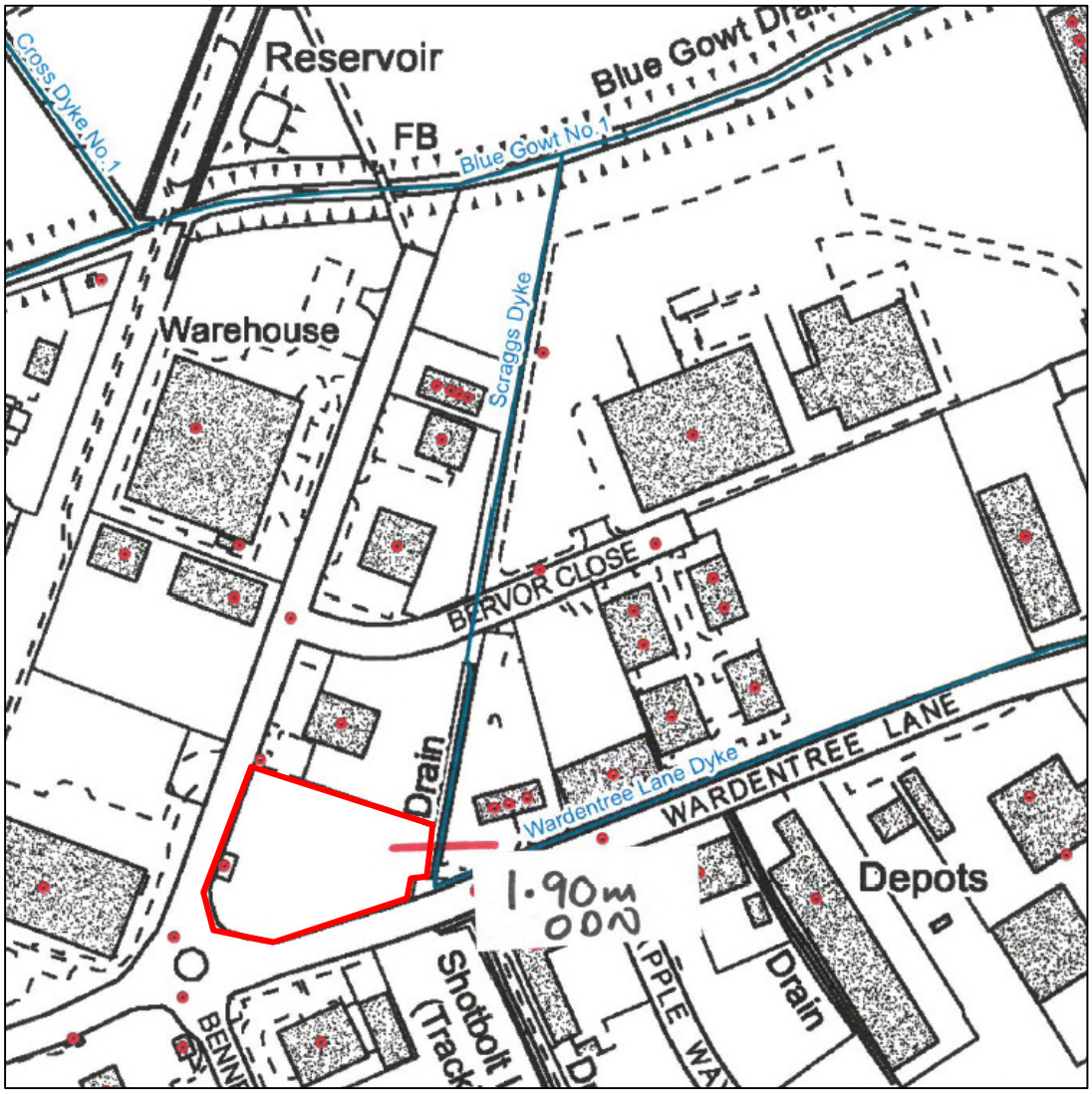
6.4 Internal Drainage Board

The Welland and Deepings Internal Drainage Board (IDB) was contacted in September 2018 for any information and constraints regarding watercourses within the vicinity of the site. The response can be found in **Appendix F** and confirms the following points:

- Correspondence with the Welland and Deepings Internal Drainage Board has provided a plan confirming the board-maintained watercourses and known connected private pipe drains (**Appendix F**). Figure 6.1 shows these IDB assets.
- The Boards "Scraggs Dyke" runs along the eastern boundary of the site. As a Boards drain it is afforded the protection of byelaws and the most pertinent one to any site layout is the 9 metres byelaw. No development will be permitted within 9 metres of the top edge of the watercourse. The Board need to access the drain for regular maintenance and may need to undertake improvements in the future;
- This dyke connects to the Blue Gowt Drain which flows to the Pinchbeck Marsh Pumping Stations which then pump the water into the Blue Gowt Outfall drain. This watercourse gravitates into the River Glen just upstream of Surfleet Reservoir;
- The 1:100-year modelled water level in Scraggs Dyke adjacent to the site is approximately 1.90m ODN. The site levels are confirmed to range from 2.78m AOD to 3.5m AOD and so the site lies above this flood level;
- The IDB has no records of flooding in the area;
- The Board would be prepared to accept flows at its accepted Greenfield rate of 1.4litres/sec/ha into its system subject to completion of the relevant consent application form and agreement of technical details;
- The IDB believe that this site maybe a serviced plot with a connection into the Anglian Water system already available. This would need to be confirmed with the site owner. If a connection is already available then the Board may accept a flow greater than the Greenfield Rate, subject to an application, agreement of technical details and also payment of a Development Contribution; and

- The Boards Riddington Pumping Station at Pinchbeck Marsh was designed and constructed to accommodate additional flows into the system from future industrial development in this area.

Figure 6.1: Internal Drainage Board Assets



6.5 Canal & River Trust

There are no Canal & River Trust assets within the site area.

6.6 Site walkover

A site walkover was undertaken on 9th October 2016. The following key points have been noted:

- The site is heavily overgrown by scrub and tall grasses with blown rubbish and some fly-tipping;

- The Anglian Water pumping station is present, fenced off and in good condition with its own driveway and parking access. Maintaining the area should be simple and the area lies outside the proposed development area;
- The neighbouring Scragg Dyke is clear and well maintained however the Wardentree Lane Dyke (as shown in Figure 6.1 above) is seemingly no longer present; and
- A second dyke system is present on the south side of Wardentree Lane, flowing from the south, and connecting with Scragg Dyke through a 1200mm culvert under Wardentree lane. This dyke appears functional but filled with reeds.

6.7 Relevant studies

Table 6.1: Relevant studies

Study	Comments
SFRA: South East Lincolnshire Strategic Flood Risk Assessment 2017 (Ref. 13)	The principle aim of the SFRA was to map all forms of flood risk in order to provide an evidence base to locate new development. It also aims to provide appropriate policies for the management of flood risk, and identify the level of detail required for site-specific FRAs. The SFRA contains information and maps detailing flood sources and risks. Information relevant to the site is detailed in Section 7 of this report.
SFRA: Update of South Holland Strategic Flood Risk Assessment - Modelling and Mapping Note 2017 (Ref.14)	Additional 2D flood modelling outputs were used to update the Strategic Flood Risk Assessment. The outputs were used to map maximum flood depth, velocity, hazard and extent for a range of flood probabilities. Two new detailed TUFLOW models were developed to represent likely flood extents as a result of breaching of the defences from the Crowland and Cowbit Washes and from the River Glen at Surfleet. Only fluvial flooding was considered in this update. In addition to the new modelling, a review of the detailed modelling for Spalding was carried out to address anomalies identified in the results of the previous SFRA outputs. This led to an update of a couple of breaches where they were not applied consistently across different flood probabilities. The whole of the tidal flooding information was replaced by the mapping from the latest EA Tidal Hazard mapping. Where the mapping for an area contains both fluvial and tidal components, the more severe of the two was presented.
PFRA: Lincolnshire Preliminary Flood Risk Assessment 2011 (Ref. 15)	Preliminary Flood Risk Assessments are produced by Lead Local Flood Authorities (LLFAs) in England and Wales. A Preliminary Flood Risk Assessment (PFRA) is the first part of the planning cycle for flood risk management as set out in the Flood Risk Regulations (2009), which implement the requirements of the European (EU) Floods Directive (2007). The EU Floods Directive aims to provide a consistent approach to managing flooding across Europe. The PFRA is organised by the River Basin District (in this case the Anglian River Basin District) and produced by the LLFA (in this case LCC). The PFRA considers local sources of flooding that the LLFA is responsible for: ordinary watercourses, surface water, groundwater and sewers where flooding is wholly or partially

Study	Comments
	caused by rainwater or other precipitation entering or affecting the system. Information is gathered from existing sources on past floods and flood models to identify Flood Risk Areas. No new flood risk areas with national level significant harmful consequences have been identified in Lincolnshire. However, as shown on the latest EA Flood Map for Surface Water (Deep), approximately 2.3% – 2.6% of all property in Lincolnshire has been either flooded in the past or may be at risk of surface water flooding in the future.
CFMP: River Welland Catchment Flood Management Plan 2009 (Ref. 16)	Catchment Flood Management Plans (CFMP) give an overview of the flood risk from inland sources across each river catchment and recommend ways of managing those risks now and over the next 50-100 years. The EA is responsible for producing CFMPs. The site falls within the 'Spalding' sub-catchment and the policy applicable to this site is Policy Option 4 which states "Areas of low, moderate or high flood risk where we are already managing the flood risk effectively but where we may need to take further actions to keep pace with climate change". As well as the increase in future flooding from overtopping of the defences, as flood flows increase, the risk of failure of the flood embankments will increase. Flood embankments will be more liable to breach in the future as higher flows place increasing pressure on defences. It is considered that the most effective way to manage flood risk may be to improve the existing defences or create new flood defences. The CFMP provides the following key proposed actions: • In the short term, continue with the current flood risk management activities; • Future flood risk should be managed by improving the existing flood defences through the town; and • Flood awareness and emergency response plans should be used to manage the consequences of flooding from the existing defences failing.
SMP: East Anglia "The Wash" Shoreline Management Plan 2010 (Ref. 17)	Shoreline Management Plans (SMPs) give an overview of the flood risk from coastal sources. The EA and local authorities collaborate to produce SMPs. The site is more than 5km from the SMP area which extends inland up to the Hobhole drain outfall. Therefore, shoreline plans are considered to have no impacts on the site.
Anglian River Basin Management Plan 2009 (Ref.18)	The Welland catchment lies within the county of Lincolnshire. The River Welland rises south of Hothorpe Hill, Northamptonshire, passes through Market Harborough, Stamford, Spalding and drains to The Wash at Fosdyke. Drainage has historically had a significant effect on the catchment; much of the Fen areas are below sea level. Here, local Internal Drainage Boards maintain a network of dykes and land drains, which control water levels.

Study	Comments
	This is a key infrastructure link for managing water resources, maintaining summer water levels and meeting agricultural, public water supply and industrial needs. Large areas of hinterland lie below sea level, currently being defended by a combination of natural defences, old sea walls and newer sea defences. There are several areas becoming susceptible to flooding, and long-term strategies to manage the flood defences are currently being developed in conjunction with Shoreline Management Plans. Some key actions for the shoreline and coast under the plan include: • Improvements to a number of sewage treatment works will reduce the impact of nutrient and faecal indicator organisms; • England catchment sensitive farming delivery initiative projects provide advice on reducing rural diffuse pollution entering marine waters; • Development of habitat creation to offset losses of important coastal habitats through coastal squeeze; • Ports and Harbours will apply national guidance frameworks on dredging and disposal where appropriate locally, and Defra's maintenance dredging protocol; and • Sea fisheries committees will produce code of conduct for commercial fisheries and sea anglers and help to establish marine protected areas.

6.8 Drainage

6.8.1 Public sewer

Sewer details have been referenced from sewer record plans obtained from Anglian Water. The plans are contained in **Appendix G** and indicate the following network of sewers around the site:

- No public sewer networks lie within the site boundaries although the IDB correspondence suggests the site has a historic connection to the public Anglian Water surface water sewer network. A decommissioned sewer is shown to lie across the very south-west corner of the site;
- A 225mm foul sewer flows north and south down Wardentree Estate (and Bervor Close) before diverting into the existing Pumping Station on the sites western border. This conveys flows, via a pressurised rising main, north and then west through the commercial estate and up to the Blue Gowt pumping station hub that gathers multiple rising mains from around the region;
- A 750mm surface water sewer flows north along Wardentree Estate and diverting east down Bervor Close (and expanding to 1050mm) before outfalling into Scraggs Dyke; and
- Both of these public networks serve the surrounding commercial areas.

6.8.2 Private drainage

No details of the site's existing on-site drainage were provided, although the IDB correspondence suggests the site has a historic connection to the public Anglian Water sewer network. Confirmation is recommended via an on-site CCTV survey.

7 SOURCES OF FLOOD RISK

7.1 Criteria

In accordance with the NPPF [Ref. 1] and advice from the EA, a prediction of the flood sources and levels is required along with the effects of climate change from the present for the design life of the development (in this case assumed to be 60 years).

Changes to climate change guidance in February 2016 indicate that increased allowances in peak river flow and rainfall intensity should now be incorporated within any assessment. The appropriate allowance for peak river flow is based on the sites location in the country, the lifetime of development, the relevant flood zone and the vulnerability of the proposed end use.

The flood risk elements that need to be considered for any site are defined in BS 8533 as the "Forms of Flooding" and are listed as:

- Flooding from rivers (fluvial flood risk);
- Flooding from the sea (tidal flood risk);
- Flooding from the land;
- Flooding from groundwater;
- Flooding from sewers (sewer and drain exceedance, pumping station failure etc); and
- Flooding from reservoirs, canals and other artificial structures.

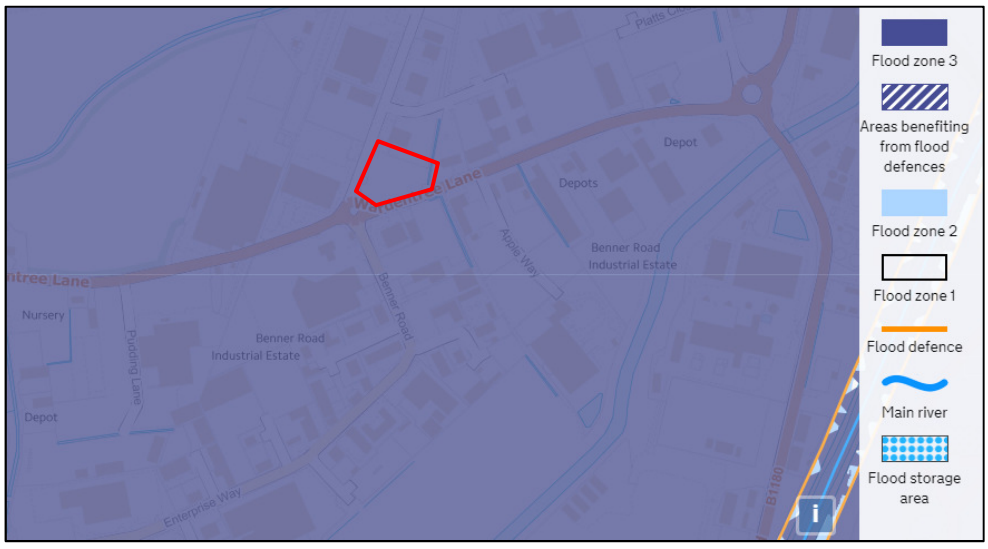
The following section reviews each of these in respect of the subject site.

7.2 Flooding from rivers (fluvial flood risk)

7.2.1 Main River

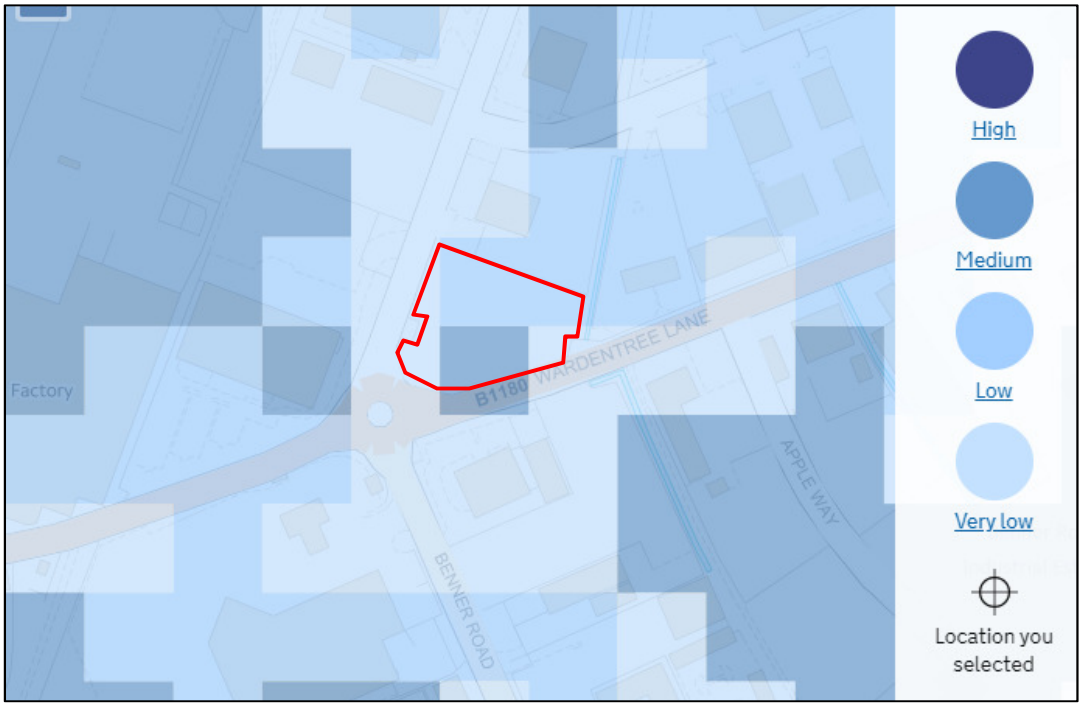
The latest EA published flood zone map (Figure 7.1) shows that the site (and the entire Spalding area) lies within Flood Zone 3, representing a 1 in 100 year or greater probability of flooding from fluvial sources or a 1 in 200 year probability of flood from tidal sources.

Figure 7.1: Environment Agency 'Flood map for planning'



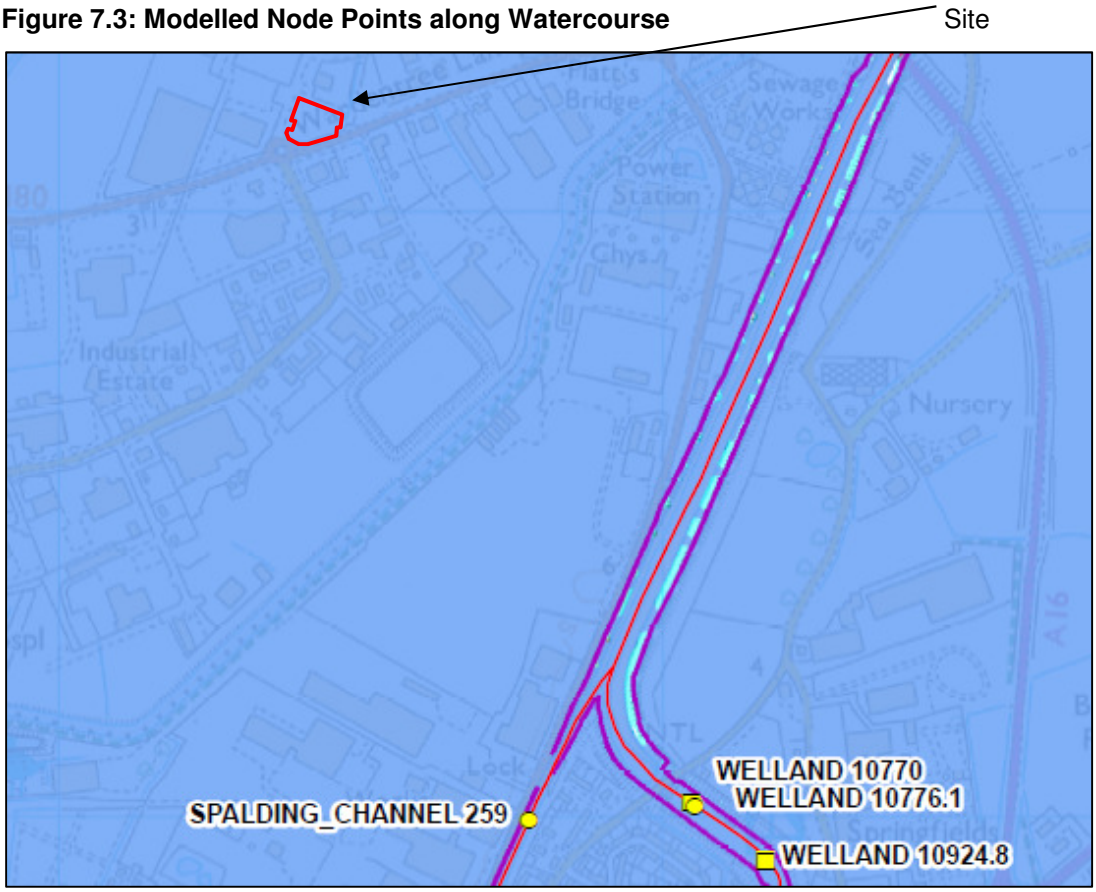
The latest 'Flood risk from rivers or the sea' map (**Figure 7.2**) indicates that the site is at 'very low', 'low' and 'medium' risk of flooding, taking into account the presence of defences.

Figure 7.2: Environment Agency 'Flood risk from rivers or the sea' map



River levels have been supplied by the EA for a number of nodes within the vicinity of the site (**Appendix D**). The closest river nodes to the site are nodes 'Spalding _Channel 259' and 'Welland 10776.1'; which are approximately 1.15km and 1.30km from the site respectively.

Figure 7.3: Modelled Node Points along Watercourse



The river levels for key flood events are given in Table 7.1. These levels take account of fluvial flows in the watercourse.

Table 7.1: Environment Agency modelled river levels for nodes 259, 10770, 10776.1

Node	Annual probability of occurrence						
	10%	5%	2%	1%	1% (+20% cc)	0.5%	0.1%
Spalding_Channel 259	4.17	4.45	4.51	4.52	4.68	4.53	4.56
Welland 10776.1	4.10	4.36	4.38	4.43	4.68	4.44	4.45

For a 1 in 200 (0.5%) year annual probability of flooding the maximum predicted water level is 4.53m AOD. Ground levels on the site have been confirmed by topographical survey (**Appendix B**) to be in the region of 2.78m AOD to 3.50m AOD, which highlights that the site lies within Flood Zone 3.

The EA confirm that the fluvial and tidal defences in this area reduce the risk of flooding to a 1% (1 in 100) chance of occurring in any year. Full review of breach analysis data is contained within Section 7.3 below.

The SFRA notes that within the Lincolnshire County, there has been no significant or widespread flooding from either fluvial or tidal sources within the Borough since 2002

(*RSK Note. The SFRA was published before the 2013 tidal flood surge event*). This has been confirmed by the Borough Council and the IDB.

Despite the extreme weather conditions and resultant severe flooding on 25th/27th June 2007, no serious strategic level flooding was reported in the Spalding area; although at least 60 properties were reported flooded in Spalding during this event.

Development in areas beyond the Level 2 SFRA boundaries (and the fluvially dominant areas of Spalding) and within a Flood Zone will need to undertake their own assessment, relative to the scale and nature of the proposed development to inform appropriate mitigation.

The SFRA also confirms that a large part of the South Holland District is at a high probability of flooding. Approximately 74% of South Holland lies within the floodplain (68% in Flood Zone 3, 6% in Flood Zone 2) resulting in 29,922 residential and 1,296 commercial properties being at risk.

The PFRA comments that due to the topography of Lincolnshire (hills and steep valleys in the Wolds to the low lying coastal fringes and fenland areas around the Wash); many communities are at potential risk of flooding from a combination of rainfall and surface water flooding. It also states that significant historic flooding has occurred in Lincoln, Louth, Horncastle, Grantham and Sleaford.

The SWMP notes multiple flood events throughout Lincolnshire which have involved an ordinary watercourse and many of the Land Drainage systems (embankments, dykes, and land drainage systems), often in conjunction with overland flow and main river flooding during high precipitation events. The SWMP does mention the South Holland area as being historically affected by watercourse flooding.

Fluvial flood risk levels to the site are high, as the site lies within Flood Zone 3. The River Welland poses a significant risk of flooding to the site and the entire Spalding region, due to the shallow elevation differences between their location and the site.

There is a network of drainage ditches located in the vicinity of the site, that could present a secondary fluvial flood risk to the site. Any flooding at the site from these ditches is considered unlikely to inundate the site to levels in excess of those caused by the River Welland. Therefore, the mitigation suggested in Section 10 should provide adequate freeboard in the event of any overtopping from these ditches.

The overall risk of fluvial flooding is considered **medium**.

7.2.2 Climate change

Fluvial flooding is likely to increase as a result of climate change. A greater intensity and frequency of precipitation is likely to raise river levels and increase the likelihood of a river overtopping its banks. Climate change guidance for river modelling was updated by the EA in February 2016.

7.3 Flooding from the sea (tidal flood risk)

Tidal flooding occurs when an exceptionally high tide, almost always accompanied by a storm tide surge, overtops and/or breaches the tidal defences along a coastline or tidal

estuary. The site is considered to be at risk from tidal flooding due to its location off the tidal section of the River Welland.

Tidal levels have been supplied by the EA for nodes within the vicinity of the site (**Appendix D**). The closest tidal node to the site is the Marsh Road (Welland Tidal), which is approximately 1.3km to the south of the site. The River Wellands discharge can be restricted for significant periods of time when there is a high tide which has implications for fluvial flood risk upstream.

The EA data indicates the following tidal Water Levels for the Marsh Road (Welland Tidal) at grid reference 526000, 324000:

- 1 in 1 year: 5.04mAOD
- 1 in 10 year: 5.44mAOD
- 1 in 50 year: 5.73mAOD
- 1 in 100 year: 5.85mAOD
- 1 in 200 year: 5.98mAOD

In theory, flood depths on site could therefore reach up to approximately 3m, during the 1 in 200 year tidal flood event.

In their formal response, the EA confirm that the fluvial and tidal defences reducing the risk of flooding to a 1% (1 in 100) chance of occurring in any year. Although embankments are referenced, no mention is made of the Boston Barrier scheme, the construction of which began in September 2018. Data from the EA's online sources suggest that once completed (scheduled for c. 2021) the barrier will provide a level of tidal protection up to 6.3mAOD, equivalent to the 1 in 300-year flood event.

The 2013 tidal surge event recorded a water level of approximately 6.08mAOD.

The site is located in both the 2006 and 2115 Tidal Breach Hazard Mapping extents, with maps contained within the South East Lincolnshire SFRA.

Table 7.2 summarises the hazard, depth and velocities expected on the site.

Table 7.2: Tidal Breach Hazard Mapping

	2006 (200 yr)	2006 (1000 yr)	2115 (200 yr)	2115 (1000 yr)
Hazard	No hazard	Low hazard	Danger for most	Danger for most
Depth	0m	0 – 0.5m	0.25 – 1.0m	0.25 – 1.0m
Velocity	0m/s	0 – 0.3m/s	0 – 0.3m/s	0 – 0.3m/s

The overall risk of tidal flooding affecting the site is currently considered **medium** to **high**, however, once completed it is considered that the Boston Barrier scheme will reduce this risk to **low**.

Notwithstanding the above, given the low-lying ground levels on site and in the surrounding area, any breach or overtopping tidal flood events have the potential to cause widespread flooding and damage and could potentially endanger life. The effects of tidal flooding are likely to increase as a result of climate change.

7.3.1 Climate change

Tidal flooding is likely to increase as a result of climate change.

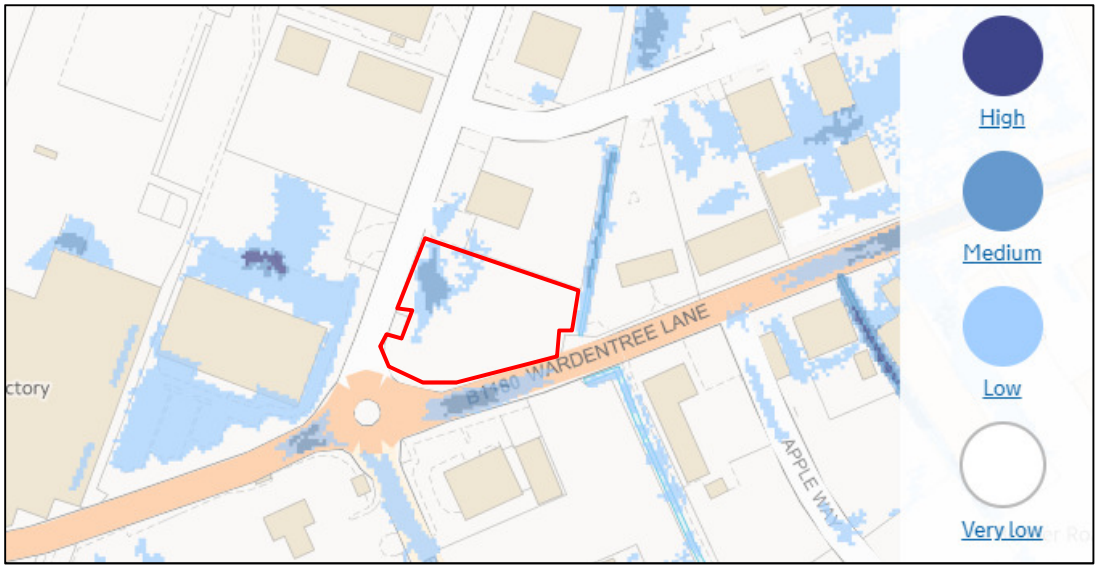
7.4 Flooding from the land (overland pluvial flood risk)

If intense rain is unable to soak into the ground or be carried through manmade drainage systems, for a variety of reasons, it can run off over the surface causing localised floods before reaching a river or other watercourse.

Generally, where there is impermeable surfacing or where the ground infiltration capacity is exceeded, surface water runoff can occur. Excess surface water flows from the site are believed to drain naturally to the local water features, either by overland flow or through infiltration.

The EA's surface water flood map (**Figure 7.4**) shows that small sections of the site in its north-western corner (due to a local topographical low point) are at a risk of flooding from pluvial sources. As such the overall risk of pluvial flooding to the site can be considered **Low** to **Medium** and this will be taken into account within the detailed surface water design and layout of the site.

Figure 7.4: Environment Agency 'Flood risk from surface water' map



The SFRA notes the soil types of the district are generally poor draining clays, and that this makes the area particularly susceptible to significant overland flows developing in high rainfall events. The SFRA contains the Areas Susceptible to Surface Water Flooding (AStSWF) map which indicates the site is not at risk of pluvial flooding and there are no historical records of surface water flooding in the site vicinity.

The PFRA recognises that pluvial flooding is a significant part of historical and future flood threats to the South Holland area. The Spalding area has been stated to have experienced pluvial flooding during the June 2007 event with at least 60 dwellings flooded.

The SWMP makes note of the nature of Lincolnshire's undulating hills and underlying soil/bedrock which makes it particularly prone to overland surface flow during high precipitation events. A large portion of historical flooding events and the 2007 flood events were greatly influenced by surface water runoff causing pluvial flooding, particularly in areas where valleys channel water towards developed zones and spring lines along the border of the Wolds.

The topography on site shows the current site falls away towards the small low point in the north-west, however, the modifications resulting from the proposed buildings is likely to alleviate this. The proposed development is likely to generate significant quantities of on-site surface water runoff, which needs to be controlled to prevent surface water flooding elsewhere. This is discussed further in Section 9.

The risk of surface water flooding at the site is considered to be l**ow** to **medium**.

7.4.1 Climate change

Surface water flooding is likely to increase as a result of climate change in a similar ratio to fluvial flooding. Increased intensity and frequency of precipitation is likely to lead to reduced infiltration and increased overland flow. Climate change guidance for rainfall intensity has recently been updated by the EA in late February 2016. Revised allowances for climate change have been included in the indicative drainage strategy below.

7.5 Flooding from groundwater

Groundwater flooding tends to occur after much longer periods of sustained high rainfall. Higher rainfall means more water will infiltrate into the ground and cause the water table to rise above normal levels. Groundwater tends to flow from areas where the ground level is high, to areas where the ground level is low. In low-lying areas, the water table is usually at shallower depths anyway, but during very wet periods, with all the additional groundwater flowing towards these areas, the water table can rise up to the surface causing groundwater flooding.

The SFRA and PFRA notes that flooding from groundwater and canals is of no relevance in the Spalding area. The SWMP notes that there are records of groundwater flooding in the Sleaford area due to the presence of limestone, however this is not the case in Spalding.

Available geological mapping indicates the underlying geological layers are moist given the proximity to the sea and main rivers. There is no ground investigation data available for the site to confirm the geology and groundwater levels on the site.

The proposed development does not include any basement proposals. Therefore, aside from shallow foundations works, the proposals will have no material impact on the risk of groundwater flooding both to and from the development. The resulting risk of groundwater flooding to the site is assessed as low. It is possible that perched groundwater may be encountered during the groundworks phase, and therefore could present a risk to the site at the construction stage. During the operational phase, the absence of basement features within the proposals minimises the potential hazards posed by groundwater flooding.

The resultant groundwater flood risk is considered to be **low**.

7.5.1 Climate change

Climate change could increase the risk of groundwater flooding as a result of increased precipitation filtering into the groundwater body. If winter rainfall becomes more frequent and heavier, groundwater levels may increase. Higher winter recharge may however be balanced by lower recharge during the predicted hotter and drier summers. This is less likely to cause a significant change to flood risk than from other sources since groundwater flow is not as confined. It is probable that any locally perched aquifers may be more affected, but these are likely to be isolated. The change in flood risk is likely to be low.

7.6 Flooding from sewers

Flooding from artificial drainage systems occurs when flow entering a system, such as an urban storm water drainage system, exceeds its conveyance capacity, the system becomes blocked or it cannot discharge due to a high water level in the receiving watercourse. A sewer flood is often caused by surface water drains discharging into the combined sewer systems; sewer capacity is exceeded in large rainfall events causing the backing up of floodwaters within properties or discharging through manholes.

Most adopted surface water drainage networks are designed to the criteria set out in Sewers for Adoption (Ref. 19). One of the design parameters is that sewer systems be designed such that no flooding of any part of the site occurs in a 1 in 30 year rainfall event. By definition a 1 in 100 year event would exceed the capacity of the surrounding sewer network as well as any proposed drainage.

When exceeded, the surcharged pipe work could lead to flooding from backed up manholes and gully connections. This could lead to immediate flooding within highways surrounding the site.

The SFRA has stated that in many urban areas in Lincolnshire, surface water (rainwater) and foul sewage were historically drained by a single sewer pipe. These combined sewers generally have insufficient capacity to convey all flows during a significant flood event. During such times, excess flows are discharged into adjacent drainage systems, usually a watercourse, via combined sewer overflows.

The PFRA notes that the severity of flooding involving sewers exceeding capacity is often severe in Lincolnshire, due to the proximity of many sewers to critical infrastructure and the fact that many of the older public sewer networks are combined (surface and foul) in a single system and are often under capacity for the areas they administer.

Similar to the PFRA, the SWMP also notes the contribution of sewers to the majority of past major flood events in Lincolnshire. The site area does not have any records of sewer related flooding and has not been highlighted as a particularly at-risk area in the SWMP flood risk matrix.

Due to the presence of a public 750mm surface water and a 225mm foul sewer running down the road to the west of the site, there is some risk of flooding to the development if this were to surcharge. Surcharged water would likely follow the topography and flow in a northerly direction towards the Blue Gowt drain. There is also the possibility that the water would also be retained by the road and not pose a risk to the development.

Development has the potential to cause an increase in impermeable area, an associated increase in surface water runoff rates and volumes, and a consequent potential increase in downstream flood risk due to overloading of sewers, watercourses, culverts and other drainage infrastructure.

To ensure that sewer and surface water flooding is not exacerbated; surface water must be considered within the design of the site. This ensures that any additional surface water and overland flows are managed correctly, to minimise flood risk to the site and the surrounding area. The proposed surface water network on the site should be designed to ensure exceedance of the network has been considered.

The resultant sewer flood risk is considered to be **low**.

7.6.1 Climate change

The impact of climate change is likely to be negative regarding flooding from sewers. Increased rainfall and more frequent flooding put existing sewer and drainage systems under additional pressure resulting in the potential for more frequent surcharging and potential flooding. This would increase the frequency of local sewer flooding but would not be significant in terms of the proposed development.

7.7 Other sources of flooding

7.7.1 Reservoirs

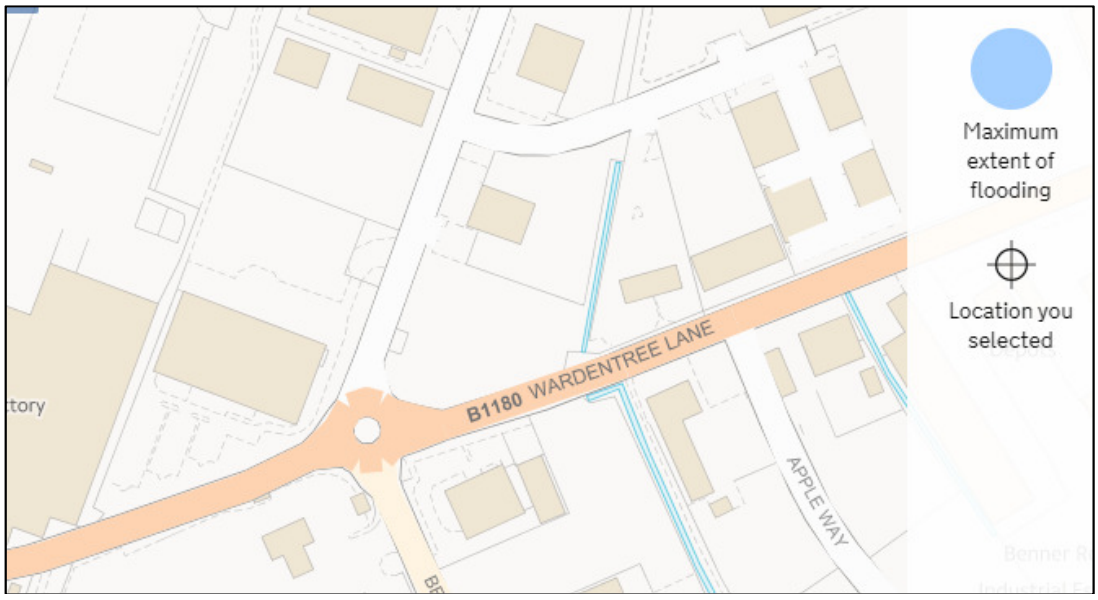
Flood events can occur from a sudden release of large volumes of water from reservoirs, canals and artificial structures.

The EA reservoir flood map (reproduced as **Figure 7.5**) shows the largest area that might be flooded if a reservoir were to fail and release the water it holds. Since this is a prediction of a worst-case scenario, it is unlikely that any actual flood would be this large. According to the EA Reservoir flood maps the site is not at risk of flooding from reservoirs.

Reservoir flooding is also extremely unlikely. There has been no loss of life in the UK from reservoir flooding since 1925. Since then reservoir safety legislation has been introduced to ensure reservoirs are maintained. The resultant flood risk is therefore considered to be **low**.

Reservoirs can be managed over time, controlling inflow/outflow of water and therefore there is the capacity to control the effects of climate change. Increased rainfall has the potential to increase base flow, but this should be minimal. It is unlikely that there will be a substantial change to the risk of flooding for this site.

Figure 7.5: Environment Agency 'Flood risk from reservoirs' map



7.7.2 Canals

There are no Canal & River Trust owned canals within proximity of the site.

7.7.3 Blockages of artificial drainage systems

There is a possibility that flooding may result due to culverts and/or sewers being blocked by debris or structural failure. This can cause water to backup and result in localised flooding, as well as placing areas with lower ground levels at risk.

The SFRA, PFRA and SWMP all highlight that blockages of sewers can be a major factor to consider with regard to the severity of sewer flooding and flooding in general. Many also make reference to the emphasis by Anglian Water, as the water board, to ensure that local councils carry out regular sewer maintenance to reduce the risk of blockages and ultimately flooding.

It is understood that Scragg's Dyke is culverted beneath Wardentree Lane, which, if blocked, could present a risk of flooding to the site. Given the large culvert diameter, the risk of full blockage is considered to be low.

The risk of flooding from artificial drainage systems is considered to be **low**.

Climate change is unlikely to affect the flooding risk to the site from such blockages.

7.7.4 Tide Locking

Tide locking occurs when a high rainfall event coincides with a high tide rather than a fluvial flood. Tide locking can often be a regular and frequent occurrence. However, the period of tide lock is confined to the peak of the tide and therefore its duration is generally limited, and any flooding is both minor and localised.

As the site is shown to discharge directly into the Internal Drainage Board land drainage network, the risk of tide locking is considered minimal as the sewer network should have sufficient controls to ensure surface water is discharged under these conditions.

The effect of tide locking could be exacerbated by climate change as a result of more frequent higher tides and increased surface runoff.

7.8 Flood risk resulting from the development

In theory any development can increase flood risk downstream, if it is not designed properly. This potential is much increased where the site is on greenfield land, as development tends to increase impermeable surfaces, resulting in increased runoff from the site.

In contrast, redevelopment of brownfield sites may offer opportunities to reduce peak runoff, as well as removing connectivity to foul or combined sewerage systems, with consequent benefits for reducing sewer flooding and the potential of pollution from combined sewer overflows.

The proposed development will use the latest best practice guidance to ensure that flood risk is not increased as a result of the development. This will require the provision of a suitable surface water management plan to ensure that the surface water generated from the site does not exceed the pre-development rates; this is investigated further in Section 9 of this report.

8 PLANNING CONTEXT

8.1 Application of planning policy

Section 14 of the NPPF includes measures specifically dealing with development planning and flood risk using a sequential characterisation of risk based on planning zones and the EA Flood Map. The main study requirement is to identify the flood zones and vulnerability classification relevant to the proposed development, based on an assessment of current and future conditions.

8.2 Land use vulnerability

Planning Practice Guidance (PPG) includes a list of appropriate land uses in each flood zone dependent on vulnerability to flooding. In applying the Sequential Test, reference is made to Table 8.1 below, reproduced from Table 3 of PPG.

Table 8.1: Flood risk vulnerability and flood zone 'compatibility'

Flood Risk Vulnerability Classification		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	Zone 1	Appropriate	Appropriate	Appropriate	Appropriate	Appropriate
	Zone 2	Appropriate	Appropriate	Exception Test Required	Appropriate	Appropriate
	Zone 3a	Exception Test Required	Appropriate	Should not be permitted	Exception Test Required	Appropriate
	Zone 3b functional floodplain	Exception Test Required	Appropriate	Should not be permitted	Should not be permitted	Should not be permitted

With reference to Table 2 of the PPG, the proposed development, based on its commercial use, is classed as 'less vulnerable'. This classification of development is appropriate for areas within Flood Zone 3 and therefore appropriate for the subject site.

8.3 Sequential Test

The Sequential Test is required to assess flood risk and the PPG recommends that the test be applied at all stages of the planning process to direct new development to areas with the lowest probability of flooding (Flood Zone 1).

According to the NPPF, if there is no reasonably available site in Flood Zone 1, the flood vulnerability of the proposed development (see Planning Practice Guidance Table 2) can be taken into account in locating development in Flood Zone 2 and then Flood Zone 3. Within each Flood Zone new development should be directed to sites at the lowest probability of flooding from all sources.

The development proposal is for a 'Less Vulnerable' commercial use to be developed on the site. With reference to Table 8.1 above, this development would be appropriate for areas within Flood Zone 3.

The site lies wholly within Flood Zone 3, so there is no available land on the site within Flood Zone 1. It should be noted that this site has been developed previously, and the whole of the Pinchbeck and Spalding area has historically been allocated as a principal area for both residential and commercial use. It is therefore considered that this commercial development is likely to be acceptable in principle.

9 SURFACE WATER DRAINAGE ASSESSMENT

9.1 Scope

This section discusses the potential quantitative effects of the development on both the risk of surface water flooding on-site and elsewhere within the catchment, as well as the type of potential SuDS features that could be incorporated as part of the masterplan.

The NPPF states that SuDS should be considered wherever practical. The use of SuDS is also encouraged by regional and local policy (see Section 5). In accordance with the relevant guidance, the surface water drainage strategy should seek to implement a SuDS hierarchy that aspires to achieve reductions in surface water runoff rates to greenfield rates.

In addition, Building Regulations Part H (Ref. 20) requires that the first choice of surface water disposal should be to discharge to an adequate soakaway or infiltration system, where practicable. If this is not reasonably practicable then discharge should be to a watercourse, the least favourable option being to a sewer (surface water before combined). Infiltration techniques should therefore be applied wherever they are appropriate.

9.2 Pre-development situation

The existing site area is 0.6ha and has 0% existing impermeable areas.

The pro-rata IoH 124 method (Ref. 21) has been used to estimate the Greenfield surface water runoff for the site. Calculations are contained in **Appendix I**.

Table 9.1: IOH 124 surface water runoff (greenfield)

Return period	Peak flow (l/s)
QBar	1.3
1 in 1 year	1.2
1 in 30 year	3.2
1 in 100 year	4.8

9.3 Off-site discharge options and limits

9.3.1 Infiltration

Infiltration should be considered as the primary option to discharge surface water from the developed site. The effectiveness of infiltration is completely dependent on the physical conditions at the site. Potential obstacles include:

- Local variations in permeability preventing infiltration – It is understood from the local geology and BGS geological sections that the site is situated on an area of Oxford

Clay, which is not considered suitable for the use of soakaways due to its low permeability;

- Shallow groundwater table - For infiltration drainage devices, Building Regulation approved document H2 states that these *"should not be built in ground where the water table reaches the bottom of the device at any time of the year".* The BGS records show the closest section (TF34SW31) indicates a relatively high-water table (2m below ground level) which potentially further limits soakage potential; and
- Source Protection Zones - As discussed above, the site is not located within a Groundwater Source Protection Zone.

Infiltration is therefore not considered a viable option as part of the drainage strategy.

9.3.2 Discharge to watercourse

Investigations with Welland and South Holland Internal Drainage Board has confirmed that the Board has an existing network of land drainage systems in the area. The closest feature is Scragg's Dyke along the site's eastern border. This dyke connects to the Blue Gowt Drain which flows to the Pinchbeck Marsh Pumping Stations which then pump the water into the Blue Gowt Outfall drain.

Discharging surface water to the IDB surface water dyke network (specifically Scragg Dyke) is considered the most feasible option for the site. Correspondence with the board has stated that *"the Board will expect any discharge from the site to be attenuated as much as possible, preferably to the catchment greenfield discharge rate of 1.4l/s/Ha".* Calculations included in **Appendix I** have defined the Qbar rate as 1.3l/s.

The exact current bank top and invert/water levels of Scragg Dyke are not known, and should be confirmed before the detailed design stage particularly regarding the surface water outfall. However, the site walkover has confirmed that the banks are steep and the dyke itself is at least 1.5m deep. For this reason, the geo-cellular unit has been designed with a depth of two cells (0.8m) to make the system sufficiently shallow to drain via gravity to Scragg Dyke without the need for pumping.

Given the size of the dyke system and is culverts (approx. 1200mm), it is considered that capacity will be available, however, this will need to be confirmed with Welland IDB at the detailed design stage, along with proposed connections.

9.3.3 Discharge to surface water sewer

The IDB believes there may be an existing connection within the site area to the existing public sewerage system under Wardentree Lane. It is not known whether this connection exists, and further CCTV investigation of the network would be required to prove this. This could be explored as an alternative solution, should it not prove feasible to discharge via the IDB Scraggs Dyke.

9.4 Post-development situation

The proposed development is approximately 76.2% impermeable, which will result in an increase in surface water across the site. It will therefore be necessary to manage surface water on-site in order to limit the discharge of surface water off-site to an agreed rate (as above), to provide sufficient on-site attenuation up to the 1 in 100-year climate change rainfall event and to provide improvements to water quality through appropriate source treatment.

9.4.1 Storage estimates

To determine the approximate volume of attenuation storage that would be required on the site, the WinDes 'Quick Storage' calculation has been used. WinDes 'Quick Storage' calculations provide a range of volumes as an approximation of the storage requirement. These volumes can be later revised at detail design stage by the introduction of specific flow control methods.

It is intended that surface water runoff from the proposed development will be discharged into the existing IDB operated drain since infiltration and public sewer systems are not available.

Calculations have been run using an IDB specified discharge rate of 1.4l/s and an impermeable area of 4569m^2. No allowance is included in the calculations for infiltration and therefore the results illustrate a worst-case scenario. Calculations can be found in **Appendix I**.

Table 9.2: Quick storage estimates

Return period	Quick Storage volume (m^3)	
	Minimum	Maximum
1 in 30 year	177	245
1 in 100 year	264	346
1 in 100 year +20% CC	330	429

The maximum storage required on-site to accommodate the 1 in 100 year plus 20% climate change rainfall event is approximately 429m^3. Note: due to the development lifetime, the allowance of 20% climate change is considered sufficient for the purpose of this assessment.

9.4.2 Proposed drainage strategy

The proposed SuDS for the site include permeable paving installed in the sites parking bays and a modular storage tank beneath the roadway and parking areas. The proposed permeable paving is designed to provide approximately 77m^3 of storage. The excess required storage volume will be retained within the underlying geo-cellular storage unit, providing sufficient storage up to the 1 in 100 plus 20% climate change event. The SuDS measures are outlined in the Indicative Surface Water Strategy as attached in **Appendix J**.

The dimensions, volumes and location of the SuDS features will need to be revised as the masterplan develops and during the detailed planning stage. Detailed design of individual features is not part of the scope of this report. Preliminary design criteria have been based upon guidance given in the CIRIA publication 'The SUDS Manual' (Ref. 22).

In principle, the strategy contains the following features and criteria:

- Permeable paving can potentially be incorporated within on-site parking bays. This will be used to collect and store runoff from the parking area and surrounding hardstanding areas before joining the on-site surface water network. Access roads

will not be constructed using permeable paving due to ownership and future maintenance issues;

- Modular storage tanks have been located mainly beneath shared permeable paved areas to provide storm volumes. Modular storage has only been indicated as two cells deep (0.8m). It should be noted that in areas of high groundwater levels, these tanks may need to be lined to prevent groundwater ingress. Floatation issues should also be considered at the detailed design stage;
- Filter drains can be located in open spaces around some of the car parking areas with depths up to 200mm;
- Rainwater harvesting is recommended on the commercial units;
- Green roofs are not part of the proposal; and
- It is considered likely that infiltration techniques will be unsuitable on site due to the impermeable nature of the underlying geology, however site-specific soakage testing could be used to confirm of any feasibility for infiltration features.

The SuDS features have a preliminary design to accommodate the 1 in 30 year event fully underground within permeable paving. The overflow from the 1 in 100 year plus 20% climate change event is accommodated within the underground geo-cellular storage unit.

Temporary drainage should be established for the construction phase of development to prevent silt mobilisation, potentially impacting on flow regimes and silt pollution downstream. The construction of SuDS should be considered in the early stages of site design.

9.4.3 Adoption and Maintenance

The long-term maintenance of the various SuDS features within the site boundary will most likely be undertaken by a management company, although Anglian Water may consider adopting SuDS. The layout and position of the SuDS on the site would appear suitable for adoption, although as this is subject to change at the detailed planning stage, this would need to be confirmed.

Maintenance of SuDS features should be undertaken in line with maintenance schedules outlined in the SuDS Manual (Ref. 22) and if adopted, any Anglian Water maintenance guidance. Full maintenance schedules should be confirmed at the detailed design stage in consultation with appropriate product suppliers.

9.4.4 Water quality

Surface water generated from the site will be directed through a drainage treatment train, which will include the use of SuDS where possible.

As quoted from the National Standards for Sustainable Drainage (Ref. 23) 'the minimum number of treatment stages depends on the potential hazards on the site together with the sensitivity of the receiving water body to pollution'. Table 9.3 classifies the hazard level of surface runoff from different sources.

Table 9.3: Water quality – level of hazard

Hazard	Example
Low	Roof drainage
Medium	Residential, amenity, commercial, industrial uses include car parking and roads
High	Areas used for handling and storage of chemicals and fuels, handling and storage of waste (including scrap-yards). Lorry, bus or coach parking or turning areas

The following tables indicate the number of treatment stages required before surface runoff should reach the infiltration/ water body. The minimum number of treatment stages must be in accordance with the following Table 9.4 and Table 9.5.

Table 9.4: Minimum number of treatment stages to groundwater

Classification	Example	Low	Med	High
G1	Source Protection Zone 1, within 50m of a well, spring or borehole that supplies potable water	1	3	Consult the Environment Agency
G2	Into or immediately adjacent to a sensitive receptor that could be influenced by infiltrated water. includes designated nature conservation, heritage and landscape sites – including Biodiversity Action Plan (BAP) habitats and Protected Species	1	3	
G3	Source Protection Zone II and III or Principal Aquifer	1	3	
G4	Secondary Aquifer	1	2	
G5	Unproductive strata	1	2	

Table 9.5: Minimum number of treatment stages to surface water

Hazard	Normal Surface Water	Sensitive Surface Water
Low	0	1
Medium	2	3
High	Consult the Environment Agency	

The SUDS Manual contains guidance on how to assess water quality, stating *"Determining the hazard posed by the land use activities at a site and the extent to which underlying soil layers and/or proposed treatment components reduce the associated risk can be done using a variety of methods that vary in complexity and data requirements."*

In accordance with Table 4.3 of the SuDS Manual, the proposed development for the site can be summarised with the following pollution hazard levels and management requirements for discharge to the receiving surface water (there will be no infiltration on site, therefore receiving groundwater is not considered here):

- Commercial yard and delivery areas, non-residential car parking with frequent change (e.g. hospitals retail), all roads except low traffic roads and trunk roads/motorways – **Medium** Pollution Hazard – Simple Index Approach

It is therefore considered appropriate to use the Simple Index Approach for the purpose of this assessment.

Table 26.1 of the SUDS Manual indicates that for the Simple Index Approach:

- Simple pollution hazard indices should be based on land use (e.g., Table 26.2); and
- Risk reduction for Surface Water should be done using Simple SuDS hazard mitigation indices (e.g., Table 26.3)

Extracts of Tables 26.2 and 26.3 are replicated below, highlighting the relevant features applicable to this site:

Table 9.6: Extract of SuDS Manual Table 26.2: Pollution hazard indices for different land use classifications

Land use	Pollution Hazard Level	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Commercial yard and delivery areas, non-residential car parking with frequent change (e.g. hospitals retail), all roads except low traffic roads and trunk roads/motorways	**Medium**	0.7	0.6	0.7

Table 9.7: Extract of Table 26.3: Indicative SuDS mitigation indices for discharges to surface waters

Land use	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Permeable pavement	0.7	0.6	0.7
Filter drain	0.4	0.4	0.4

The SuDS Manual States:

Total SuDS mitigation index ≥ pollution hazard index

(for each contaminant type) (for each contaminant type)

In conclusion, the combination of SuDS features listed in Table 26.3 is shown to be in excess of the requirement for a commercial yard (Table 26.2). It should be noted that all surface water runoff will pass through a treatment train of at least two features and therefore the water quality requirements are considered to be met.

10 FLOOD MITIGATION MEASURES

10.1 Overview

The site is located within Flood Zone 3, however, given the potential scale of flooding, the commercial function of the site, the small scale of development and low-lying nature of the land, no site-specific fluvial/tidal flood mitigation is considered necessary. The site is currently protected up to the 1 in 100-year standard from fluvial flooding, and once completed, the strategic defences will offer protection up to the 1 in 300-year standard from tidal flooding.

10.2 Overland flood flow

No further overland flow control measures are proposed as all surface water runoff up to the 1 in 100-year climate change storm will be stored on site and discharged to the nearby IDB drainage network. Surface flows may be generated due to drainage capacity exceedance, which can be conveyed into the SuDS features via surface flows along the new roads.

10.3 Finished floor levels

The EA pre-app response states *"FFL's should be raised as high as practicable for 'less vulnerable' development, but a minimum of 300mm above existing ground levels. Please note that single storey buildings should be built above the maximum flood depths. This information can be found in the Hazard Mapping. If this is not practicable then an area of safe refuge will need to be incorporated that is located about the maximum flood depths. Alternatively, an appropriate flood warning and evacuation strategy will need to be submitted to, and approved in writing by, the local planning authority (LPA)."*

Based on the potential for flood depths up to 1m in the 2115 (200 yr) tidal flood event, it is not considered feasible to raise ground levels in excess of this flood level.

Considering the type of development requiring level vehicular and pedestrian access and the low lying surrounding ground levels, it is not considered feasible to raise finished floor levels on site.

In terms of the construction of the development, reference should be made to "Preparing for Floods" a DEFRA publication (Ref. 24), CIRIA guidance C624 "Development and flood risk" (Ref. 25) and the CLG document "Improving the flood performance of new buildings" (Ref. 26).

10.4 Internal Drainage Board watercourse easement

As the Scraggs Dyke flows directly adjacent to the site, the development layout has incorporated the recommended 9m IDB easement on the western side of the watercourse to ensure that future maintenance access is maintained.

The IDB state in relation to the Scraggs Dyke that as a Board's drain it is afforded the protection of byelaws and the most pertinent one to any site layout is the 9 metres byelaw.

No development will be permitted within 9 metres of the top edge of the watercourse. The Board need to access the drain for regular maintenance and may need to undertake improvements in the future.

10.5 Flood compensation

Whilst floodplain compensation would in theory be required, the site is located in an area that is wholly within Flood Zone 3 and defended to a good standard of protection. Site levels are set at a very low-lying level, therefore there is no scope to provide floodplain compensation.

10.6 Safe access/egress

The EA response states *"An area of safe refuge will need to be incorporated that is located about the maximum flood depths. Alternatively, an appropriate flood warning and evacuation strategy will need to be submitted to, and approved in writing by, the local planning authority (LPA)."*

Given that the whole surrounding area lies within Flood Zone 3, it is not considered feasible to provide a safe access route from the site to an area that lies outside the floodplain.

It is not considered feasible to analyse in detail the predicted flood depths on site and in the surrounding area, however, an initial summary is given. As discussed previously, the Tidal Hazard Mapping indicates that, for the 2115 scenario, the site could be impacted by flood waters during a 200 year breach event, with the site experiencing water depths in excess of 1m. Even assuming a low velocity of floodwater of between 0 and 0.3m/s in the vicinity of the site, according to Table 13.1 in FD2320 (Ref. 27), this would represent "danger to most".

Therefore, the default position for future users of the site will be dependent on flood warning and a Flood Risk Management Plan (see Section 10.8 below).

10.7 Flood resistance and resilience measures

As a precautionary measure, flood resistant and flood resilient techniques could be incorporated. Flood Resistant measures are used to prevent floodwater reaching or entering properties and include demountable barriers, bunds and external waterproofing measures. Flood Resilient measures are methods to minimise damage caused by floodwaters and include internal water-resistant materials and siting of electrical services above flood levels.

10.8 Flood management plan

The site is located within Flood Zone 3a in an area benefitting from defences. Whilst it has been shown that the site is in an area of medium to low residual risk in the event of a breach of the Witham and the Heaven defences, other forms of flooding such as surface water or sewer flooding, as well as uncertainty over the impacts of climate change, it is considered prudent to consider the implementation of a flood management plan.

Forecasting of tidal flooding on the River Welland and Vernatts Drain is well developed through 24 hour monitored telemetry and flood forecasting models allowing around 36 hours' notice of an impending storm surge

The site is located within the EA Flood warning area classified as 'Lower River Witham' and 'Areas near the tidal River Witham, the Haven, and the Wash frontage'. The EA charter is to provide a minimum 2 hours advance warning, which would provide sufficient time for site users to be evacuated to an area of safe refuge.

It is therefore recommended that future users of the site ensure they are registered with the EA's Flood Warning system (Floodline Warning Direct) to provide adequate forewarning in the event of a predicted flood in the neighbourhood in order to decrease the overall risk to a 'safe' level.

If deemed necessary by the Local Authority a full Flood Management Plan and a flood evacuation plan should be developed for future users, which should highlight the extent of the floodplains surrounding the site and highlight the safest route of escape in the event of extreme flooding occurring. It should also include the contact details of the relevant emergency services.

11 CONCLUSIONS AND RECOMMENDATIONS

This FRA complies with the NPPF and Planning Practice Guidance and demonstrates that flood risk from all sources has been considered in the proposed development. It is also consistent with the Local Planning Authority requirements with regard to flood risk.

The proposed development site lies in an area designated by the EA as Flood Zone 3.

NPPF sets out a Sequential Test, which states that preference should be given to development located within Flood Zone 1, however this option is not available in the Spalding area. This flood risk assessment demonstrates that the requirements of the Sequential Test have been met, with the location of the site within Flood Zone 3 and 'Less Vulnerable' classification of the development.

This flood risk assessment has concluded that:

- The location at which the proposed development is located within Flood Zone 3, and as such is at a medium/high risk of flooding from fluvial/tidal sources;
- The site is protected to the 1 in 100-year standard from fluvial flooding and will be protected from tidal flooding up to the 1 in 300-year event once the Boston Barrier is completed;
- Flooding from Scraggs Dyke is constrained and does not affect the site;
- Flood risk from surface water is considered low-medium at the site;
- Flood risk from other sources – groundwater, sewers, reservoirs and artificial sources – is demonstrated to be low;
- The development will have no impact on other forms of flooding; and
- The proposed development will mimic the current off site greenfield runoff rates from the site to the surrounding IDB and provide sufficient attenuation to accommodate the 1 in 100 year climate change storm on the site.
- As the Scraggs Dyke flows directly adjacent to the site, the development layout has incorporated the recommended 9m IDB easement on the western side of the watercourse to ensure that future maintenance access is maintained.

Overall, taking into account the above points, the development of the site should not be precluded on flood risk grounds.

12 REFERENCES

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APPENDIX A
RSK GROUP SERVICE CONSTRAINTS

1. This report and the drainage design carried out in connection with the report (together the "Services") were compiled and carried out by RSK LDE Ltd (RSK) for HPV (Wardentree Lane) Ltd (the "client") in accordance with the terms of a contract between RSK and the "client" dated September 2018. The Services were performed by RSK with the skill and care ordinarily exercised by a reasonable civil engineer at the time the Services were performed. Further, and in particular, the Services were performed by RSK taking into account the limits of the scope of works required by the client, the time scale involved and the resources, including financial and manpower resources, agreed between RSK and the client.

2. Other than that expressly contained in paragraph 1 above, RSK provides no other representation or warranty whether express or implied, in relation to the Services.

3. Unless otherwise agreed in writing, the Services were performed by RSK exclusively for the purposes of the client. RSK is not aware of any interest of or reliance by any party other than the client in or on the Services. Unless expressly provided in writing, RSK does not authorise, consent or condone any party other than the client relying upon the Services. Should this report or any part of this report, or otherwise details of the Services or any part of the Services be made known to any such party, and such party relies thereon that party does so wholly at its own and sole risk and RSK disclaims any liability to such parties. Any such party would be well advised to seek independent advice from a competent environmental consultant and/or lawyer.

4. It is RSK's understanding that this report is to be used for the purpose described in the introduction to the report. That purpose was a significant factor in determining the scope and level of the Services. Should the purpose for which the report is used, or the proposed use of the site change, this report may no longer be valid and any further use of or reliance upon the report in those circumstances by the client without RSK's review and advice shall be at the client's sole and own risk. Should RSK be requested to review the report after the date of this report, RSK shall be entitled to additional payment at the then existing rates or such other terms as agreed between RSK and the client.

5. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should not be relied upon in the future without the written advice of RSK. In the absence of such written advice of RSK, reliance on the report in the future shall be at the client's own and sole risk. Should RSK be requested to review the report in the future, RSK shall be entitled to additional payment at the then existing rate or such other terms as may be agreed between RSK and the client.

6. The observations and conclusions described in this report are based solely upon the Services, which were provided pursuant to the agreement between the client and RSK. RSK has not performed any observations, investigations, studies or testing not specifically set out or required by the contract between the client and RSK. RSK is not liable for the existence of any condition, the discovery of which would require performance of services not otherwise contained in the Services. For the avoidance of doubt, unless otherwise expressly referred to in the introduction to this report, RSK did not seek to evaluate the presence on or off the site of asbestos, electromagnetic fields, lead paint, heavy metals, radon gas or other radioactive or hazardous materials.

7. The Services are based upon RSK's observations of existing physical conditions at the site gained from a walk-over survey of the site together with RSK's interpretation of information including documentation, obtained from third parties and from the client on the history and usage of the site. The Services are also based on information and/or analysis provided by independent testing and information services or laboratories upon which RSK was reasonably entitled to rely. The Services clearly are limited by the accuracy of the information, including documentation, reviewed by RSK and the observations possible at the time of the walk-over survey. Further RSK was not authorised and did not attempt to independently verify the accuracy or completeness of information, documentation or materials received from the client or third parties, including laboratories and information services, during the performance of the Services. RSK is not liable for any inaccurate information or conclusions, the discovery of which inaccuracies required the doing of any act including the gathering of any information which was not reasonably available to RSK and including the doing of any independent investigation of the information provided to RSK save as otherwise provided in the terms of the contract between the client and RSK.

8. The phase II or intrusive environmental site investigation aspects of the Services is a limited sampling of the site at pre-determined borehole and soil vapour locations based on the operational configuration of the site. The conclusions given in this report are based on information gathered at the specific test locations and can only be extrapolated to an undefined limited area around those locations. The extent of the limited area depends on the soil and groundwater conditions, together with the position of any current structures and underground facilities and natural and other activities on site. In addition chemical analysis was carried out for a limited number of parameters [as stipulated in the contract between the client and RSK] [based on an understanding of the available operational and historical information,] and it should not be inferred that other chemical species are not present.

9. Any site drawing(s) provided in this report is (are) not meant to be an accurate base plan, but is (are) used to present the general relative locations of features on, and surrounding, the site. Features (boreholes, trial pits etc) annotated on site plans are not drawn to scale but are centred over the appropriate location. Such features should not be used for setting out and should be considered indicative only.

APPENDIX B
TOPOGRAPHIC SURVEY

Drawing No. SS-HRL-003 | Revision

SUBVISION SURVEYS LTD

Unit A6 – The Seedbed Centre
Vanguard Way
Shoeburyness
Essex, SS9 9QY
Tel: 0845 5675677

PLAN GRID NORTH

SURVEY LEGEND

GENERAL

ATT	ADDED FROM RECORDS	LB	LETTER BOX
A/R	ASSUMED ROUTE	LH	LAMP HOLE
AV	AIR VALVE	LP	LAMP POST
BD	BACKDROP	MH	MANHOLE
BH	BOREHOLE	MP	MILE POST
BO	BOLLARD	MW	MONITORING WELL
BS	BUS STOP		
BTC	TELECOMMUNICATIONS MANHOLE	ND	NO DEPTH
BWW	BRICK WALL	NIA	NO VISIBLE INLET
		NVO	NO VISIBLE OUTLET
CC	CATTLE GRID	NVP	NO VISIBLE PIPE
CH	CHANNEL LEVEL	OH	OVERHEAD
CL	COVER LEVEL	OSBM	ORDNANCE SURVEY BENCH MARK
Conc	CONCRETE		
Corr	CORRUGATED	PE	PENSTOCK
CP	COPING LEVEL	PM	PARKING METER
CPS	CONCRETE PAVING SLABS	PO	POST
CSE	RED-CONFINED SPACE ENTRY REQUIRED	PZ	PIEZOMETER
CW	COMBINED WATER		
CWMH	COMBINED WATER INSPECTION COVER	RB	RUBBISH BIN
		RE	RODDING EYE
DP	DOWN PIPE	RG	RAIN GAUGE
		RS	ROAD SIGN
EB	ELECTRICITY BOX	RTW	RETAINING WALL
EL	EAVE LEVEL		
E.O.T.	END OF TRACE	SA	SAPLING
E.O.L.	END OF LINE	SJ	SUMMIT JUNCTION
EP	ELECTRICITY POLE	SP	STOP POCK
ER	EARTHING ROD	SC	SERVICE (UNIDENTIFIED)
		SL	SOFFIT LEVEL
FH	FIRE HYDRANT	SP	SIGN POST
FIR	FURTHER INVESTIGATION REQUIRED	STN	SURVEY STATION
FM	FLOW METER	SV	SLUICE VALVE
FP	FENCE POST	SW	SURFACE WATER
FWMH	FOUL WATER INSPECTION COVER	SWMH	SURFACE WATER INSPECTION COVER
GB	GAUGE BOARD	TBM	TEMPORY BENCH MARK
GG	GAS GRID	TCB	TELEPHONE CALL BOX
GL	GROUND LEVEL	TH	TRIAL HOLE
GP	GATE POST	TL	TRAFFIC LIGHT
GU	GULLY	TP	TELEGRAPH POLE
GV	GAS VALVE	TS	TREE STUMP
H	HIGH	UD/CF	UNKNOWN DUCT/CABLE FORMATION
HOR	HEAD OF RUN	UTI	UNABLE TO LIFT
HW	HEADWALL	UTL	UNABLE TO SURVEY
		UTT	UNABLE TO TRACE
IC	INSPECTION COVER		
IL	INVERT LEVEL	VA	VALVE
ML	MANGE LOST	VP	VENT PIPE
JB	JUNCTION BOX		
		WL	WATER LEVEL
KG	KERB INLET GULLY	WM	WATER METER
		WO	WASH OUT
		WP	WOODEN POST
		WV	WATER VALVE

FENCE TYPES

BWF	BARBED WIRE FENCE	WF	INTERWOVEN FENCE
CBF	CLOSE BOARDED FENCE	LLF	LARCH LAP FENCE
CLF	CHAINLINK FENCE	PRF	POST & RAIL FENCE
CPF	CHESTNUT PALING FENCE	PWF	POST & WIRE FENCE
CWF	CHICKEN WIRE FENCE	TR	TRELLIS
IRF	IRON RAILING FENCE		

TREE TYPES

AA	ACACIA	EM	ELM	PO	POLLARDED
AB	ASH	HA	HAZEL	PP	POPLAR
AL	ALDER	HB	HORNBEAM	RW	REDWOOD
AN	ASPEN	HC	HORSE CHESTNUT	SB	SILVER BIRCH
AP	APPLE	HN	HAWTHORN	SC	SWEET CHESTNUT
BH	BEECH	HY	HOLLY	SU	SPRUCE
CB	CRABTREE	LA	LARCH	SY	SYCAMORE
CE	CHERRY	LI	LIME	WA	WALNUT
CH	CEDAR	LN	LONDON PLANE	WT	WHITEBEAM
CY	CYPRESS	ME	MAPLE	WW	WILLOW
DD	DEAD	OK	OAK	YW	YEW
ED	ELDER	PE	PINE		

TYPE/DIAMETER/HEIGHT
CU/0.4/25

BUILDING SURVEY

C204	FLOOR TO CEILING HEIGHT (cm)	SP	SPRINGLER
D150	FLOOR TO HEAD DOOR		
B194	FLOOR TO UNDERSIDE OF BEAM	LG	LIGHTING
SP194	FLOOR TO SPRINGER POINT		
		OLG	
S108	FLOOR TO CILL HEIGHT		
H219	FLOOR TO HEAD HEIGHT	Light	STRIP LIGHT
RADIATOR			
FIRE ALARM / EXTINGUISHER		+	POWER SOCKET

Banking | Top | Bottom | Bush | Spread Shown to Scale
Hedge | Wall
Gate | Building
Fence

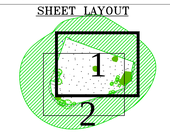
LEGEND & ABBREVIATIONS

E Electricity Unknown	CCTV CCTV Cable
EL Street Light	FO Fibre Optic Cables
LV Low Voltage Cable	TCSU Traffic Sensor
HV High Voltage Cable	TS Traffic Signal Cable
EHV Extra High Voltage Cable	ED Empty Duct
XX Overhead Elec (LV/EL)	U Unknown Service
XX Overhead HV Cable	SD Surface Water Drainage
XX Overhead EHV Cable	FW Foul Water Drainage
ER Earth Cable	CW Combined Drainage
GP Low Pressure Gas Pipe	FM Fuel Main
GIP Medium Pressure Gas Pipe	FS Ferric Sulphate
GIP Intermediate Pressure Gas Pipe	OP Oil Pipe Line
GIP High Pressure Gas Pipe	OL Oil Pipe Line
W Water Pipe	Overhead Pipe
BT Cable	Bond Of Utility
Overhead BT Cable	Assumed Route
Communication Cable	Chamber
CATV Cable TV Cable	Survey extents
GPR Unknown Service Located Using GPR	Inaccessible area

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SHEET LAYOUT



LEVELLING NOTES
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Henry Riley
part of riley consulting

Project title	Land Off Of Wardentree Lane, Pinchbeck, Spalding PE11 3ZN
Drawing title	Full 2D Topographical Survey
Client	Henry Riley LLP
Scales	1:100
Drawn by	KB
Sheet size	AO
Surveyed by	GP
Checked by	KC
Approved by	JH
Date	NOVEMBER 2018

Drawing No. SS-HRL-003 | Revision

SUBVISION SURVEYS LTD

Unit A6 – The Seedbed Centre
Vanguard Way
Shoeburyness
Essex, SS9 9QY
Tel: 0845 5675677

PLAN GRID NORTH

SURVEY LEGEND

GENERAL

ATR	ADDED FROM RECORDS	LB	LETTER BOX
A/R	ASSUMED ROUTE	LH	LAMP HOLE
AV	AIR VALVE	LP	LAMP POST
BD	BACKDROP	MH	MANHOLE
BH	BOREHOLE	MK	MARKER POST
BO	BOLLARD	MP	MILE POST
BO	BOLLARD	MW	MONITORING WELL
BS	BUS STOP		
BTC	TELECOMMUNICATIONS MANHOLE	ND	NO DEPTH
BWW	BRICK WALL	NM	NO VISIBLE INLET
		NMO	NO VISIBLE OUTLET
CC	CATTLE GRID	NP	NO VISIBLE PIPE
CH	CHANNEL LEVEL	OH	OVERHEAD
CL	COVER LEVEL	OSBM	ORDNANCE SURVEY BENCH MARK
Conc	CONCRETE		
Corr	CORRUGATED	PE	PENSTOCK
CP	COPING LEVEL	PM	PARKING METER
CPS	CONCRETE PAVING SLABS	PO	POST
CSE	RES-CONFINED SPACE ENTRY REQUIRED	PZ	PIEZOMETER
CW	COMBINED WATER		
CWIH	COMBINED WATER INSPECTION COVER	RB	RUBBISH BIN
		RE	RODDING EYE
DP	DOWN PIPE	RL	ROOF LEVEL
		RS	ROAD SIGN
EB	ELECTRICITY BOX	RTW	RETAINING WALL
EL	EAVE LEVEL		
E.O.T.	END OF TRACE	SA	SAPLING
E.O.L.	END OF LINE	SC	SUMMIT CHAMBER
EP	ELECTRICITY POLE	SD	STOP DOCK
ER	EARTHING ROD	SE	SERVICE (UNIDENTIFIED)
		SL	SOFFIT LEVEL
FH	FIRE HYDRANT	SP	SIGN POST
FIR	FURTHER INVESTIGATION REQUIRED	STN	SURVEY STATION
FM	FLOW METER	SV	SLUICE VALVE
FV	FLOW VALVE	SW	SURFACE WATER
FWIH	FOUL WATER INSPECTION COVER	SWIH	SURFACE WATER INSPECTION COVER
GB	GAUGE BOARD	TBM	TEMPORY BENCH MARK
GG	GAS GRID	TCB	TELEPHONE CALL BOX
GL	GROUND LEVEL	TH	TELEPHONE HUT
GP	GATE POST	TL	TRAFFIC LIGHT
GU	GULLY	TP	TELEGRAPH POLE
GV	GAS VALVE	TS	TREE STUMP
H	HIGH	UD/CF	UNKNOWN DUCT/CABLE FORMATION
HOR	HEAD OF RUN	UG	UNABLE TO GET
HW	HEADWALL	UTL	UNABLE TO LOCATE SURVEY
		UT	UNABLE TO TRACE
IC	INSPECTION COVER		
IL	INVERT LEVEL	VA	VALVE
ML	MANGE LOST	VP	VENT PIPE
JB	JUNCTION BOX		
		WL	WATER LEVEL
KG	KERB INLET GULLY	WM	WATER METER
		WO	WASH OUT
		WP	WOODEN POST
		WV	WATER VALVE

FENCE TYPES

BWF	BARBED WIRE FENCE	IWF	INTERWOVEN FENCE
CBF	CLOSE BOARDED FENCE	LLF	LARCH LAP FENCE
CLF	CHAINLINK FENCE	PRF	POST & RAIL FENCE
CPF	CHESTNUT PALING FENCE	PWF	POST & WIRE FENCE
CWF	CHICKEN WIRE FENCE	TR	TRELLIS
IRF	IRON RAILING FENCE		

TREE TYPES

AA	ACACIA	EM	ELM	PD	POLLARDED
AB	ALDER	HA	HAZEL	PL	POPLAR
AL	ALDER	HB	HORNBEAM	RW	REDWOOD
AN	ASPEN	HC	HORSE CHESTNUT	SB	SILVER BIRCH
AP	APPLE	HN	HAWTHORN	SC	SWEET CHESTNUT
BH	BEECH	HY	HOLLY	SU	SPRUCE
CB	CRABTREE	LA	LARCH	SY	SYCAMORE
CD	CONIFER	LB	LIMBA	WA	WALNUT
CH	CEDAR	LN	LONDON PLANE	WT	WHITEBEAM
CY	CYPRESS	ME	MAPLE	WW	WILLOW
DD	DEAD	OK	OAK	YW	YEW
ED	ELDER	PE	PINE		

TYPE/DIAMETER/HEIGHT
CU/0.45/25

BUILDING SURVEY

C204	FLOOR TO CEILING HEIGHT (cm)	SP	SPRINGLER
D150	FLOOR TO HEAD DOOR	LG	LIGHTING
B154	FLOOR TO UNDERSIDE OF BEAM	OLG	
W104	FLOOR TO UNDERSIDE OF ARCH		
SP104	FLOOR TO ARCH SPRING POINT	Light	STRIP LIGHT
S108	FLOOR TO CILL HEIGHT		
H219	FLOOR TO HEAD HEIGHT		
	RADIATOR	+	POWER SOCKET
	FIRE ALARM / EXTINGUISHER		

Banking (Top / Bottom) | Bush | Spread Shown to Scale

Hedge | Wall

Gate | Building

Fence

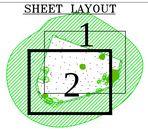
LEGEND & ABBREVIATIONS

E — Electricity Unknown
SL — Street Light
LV — Low Voltage Cable
HV — High Voltage Cable
EHV — Extra High Voltage Cable
Overhead Elec (LV/SL)
Overhead HV Cable
Overhead EHV Cable
Earth Cable
LP — Low Pressure Gas Pipe
MP — Medium Pressure Gas Pipe
IP — Intermediate Pressure Gas Pipe
HP — High Pressure Gas Pipe
W — Water Pipe
BT — BT Cable
Overhead BT Cable
Communication Cable
CATV — Cable TV Cable
GPR — Unknown Service Located Using GPR
CCTV — CCTV Cable
FO — Fibre Optic Cables
TCSU — Traffic Sensor
Traffic Signal Cable
Empty Duct
Unknown Service
Surface Water Drainage
FW — Foul Water Drainage
CW — Combined Drainage
Fuel Main
Ferric Sulphate
Heating Pipe
DI — DI Pipe Line
Overhead Pipe
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