EP UK Investments

South Humber Bank Energy Centre Project

Planning Inspectorate Reference: EN010107

South Marsh Road, Stallingborough, DN41 8BZ

The South Humber Bank Energy Centre Order

Document Ref: 6.4 Environmental Statement – Volume III Appendix 14A: Flood Risk Assessment

The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (as amended) Regulation 5(2)(a)

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 - Regulation 5(2)(a) and 5(2)(e)

Applicant: EP Waste Management Ltd
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DOCUMENT HISTORY

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GLOSSARY

Abbreviation	Description
AEP	Annual Exceedance Probability
CFMP	Catchment Flood Management Plan
CIRIA	Construction Industry Research and Information Association
EA	Environment Agency
EfW	Energy from Waste
EIA	Environmental Impact Assessment
EPH	Energetický a Průmyslový Holding
FGT	Flue Gas Treatment
FRA	Flood Risk Assessment
Ha	Hectare
IDB	Internal Drainage Board
IED	Industrial Emissions Directive
LFA	Local Flood Authority
LFRMS	Local Flood Risk Management Strategy
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
mAOD	Meters Above Ordnance Datum
mODN	Meters Ordnance Datum (Newlyn)
PEI	Preliminary Environmental Information
NELC	North East Lincolnshire Council
NLC	North Lincolnshire Council
NPPF	National Planning Policy Framework
NSTS	Non-Statutory Technical Standards for SuDS
PFRA	Preliminary Flood Risk Assessment
PPG	Planning Policy Guidance
RDF	Refuse Derived Fuel
RSS	Regional Spatial Strategy
SFRA	Strategic Flood Risk Assessment
SHBEC	South Humber Bank Energy Centre
SMP	Shoreline Management Plan
SPZ	Source Protection Zone
SuDS	Sustainable Drainage Systems

Abbreviation	Description
UK	United Kingdom

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1.0 INTRODUCTION

1.1 Background

1.1.1. AECOM Infrastructure and Environment Ltd (AECOM) were commissioned by EP Waste Management Ltd ('the Applicant') to prepare a Flood Risk Assessment (FRA) for the Proposed Development of the South Humber Bank Energy Centre (SHBEC). The Proposed Development Site ('the Site') is located adjacent to the South Humber Bank Power Station (SHBPS) off South Marsh Road, Stallingborough in North East Lincolnshire centred at Ordnance Survey National Grid Reference (OSNGR) 523019, 413263. More details of the Site are provided in Section 2.0.

1.1.2. The Applicant is proposing to develop land located adjacent to and to the east of the existing SHBPS. The Proposed Development is for the construction and operation of a new energy from waste (EfW) power station. More details of the Proposed Development are provided in Section 2.0.

1.2 The Purpose and Scope of this Document

1.2.1. The Environment Agency (EA)'s 'Flood Map for Planning' (EA, 2019) identifies that the Site is located wholly within Flood Zone 3a, defined by the National Planning Policy Framework (NPPF) (Ministry of Housing, Communities and Local Government, 2019) and Planning Policy Guidance: Flood risk and coastal change (PPG) (Ministry of Housing, Communities and Local Government, 2019), as land with a high probability of flooding (>1% Annual Exceedance Probability (AEP)) (1 in 100 or greater annual chance of river flooding), or a >0.5% AEP (1 in 200 or greater annual chance) of flooding from the sea.

1.2.2. As the Site comprises an area in excess of one hectare (ha) and is located within Flood Zone 3, a FRA is required to accompany any planning application for the development of the Site, as per the requirements of the NPPF.

1.2.3. The aim was to undertake a FRA that is appropriate to the nature and scale of the Proposed Development, which would meet the necessary requirements of current planning guidance (see Section 3.0), and which will be sufficient to support the planning application for the Proposed Development. In order to meet this aim, the following was undertaken:

- consultation with and obtaining data from North East Lincolnshire Council (NELC), the EA and North East Lindsey Internal Drainage Board (NELIDB) in regard to the Proposed Development, the flood risks posed to the Site and the necessary measures that would be required to protect the Proposed Development from flooding;
- review of publicly available data to determine the flood risks associated with all sources of flooding including the Humber Estuary, Main Rivers, Ordinary Watercourses, (including those under the jurisdiction of the NELIDB), groundwater, artificial sources, surface water runoff/ overland flow and drainage and surrounding areas; and

- review of the Proposed Development design in light of the identified flood risks and identification of measures, where necessary, that would manage any residual flood risk to the Site to acceptable levels.

1.3 Data Sources

1.3.1. The baseline conditions for the Site were established through a desk based study and via consultation with the EA and other key statutory consultees. This information has been used to inform the assessment made within the FRA. Data collected during the course of this assessment is detailed in Table 1.

Table 1: Data sources to inform this FRA

PURPOSE	SOURCE	COMMENTS
Identification of Hydrological Features	1:10,000 Ordnance Survey (OS) mapping EA 1m resolution LiDAR data (EA, 2017)	Identifies the location of local hydrological features and provides topographic elevations
Identification of Land Use	StreetCheck (2019)	Identifies the type of land use
Identification of Geology	British Geological Survey (BGS) records (BGS, 2018) Soilscapes map (Cranfield Soil and Agrifood Institute, 2019)	Provides details of geology (bedrock and superficial deposits) and soil type in the vicinity of the Site
	EA Groundwater Vulnerability, Groundwater Source Protection Zone map, and Aquifer Designation maps (EA, 2019c)	Identification of groundwater vulnerability, Groundwater Source Protection Zones and aquifer designations in the vicinity of the Site
Identification of Existing Flood Risk	1:10,000 OS mapping	Provides indicative ground levels of the Site and surrounding area
	EA Flood Map for Planning (EA, 2019)	Identifies fluvial/ tidal inundation extents
	EA Flood Risk from Surface Water Map (EA, 2019b)	Identification of flood risk from surface water runoff from land
	EA Flood Risk from Reservoirs Map (EA, 2019b)	Provides information on the risk of flooding from reservoirs (artificial sources)

PURPOSE	SOURCE	COMMENTS
	North Lincolnshire Preliminary Flood Risk Assessment (PFRA) (Entec, 2011)	Indicative risk of flooding from the local drainage system and minor watercourses within the vicinity of the Site
	North and North East Lincolnshire Strategic Flood Risk Assessment (SFRA) (North Lincolnshire Council (NLC) and NELC, 2011) and Addendum (NLC and NELC, 2016)	Assesses local flood risk from fluvial/ tidal, sewers, overland flow, groundwater and artificial sources
	North Lincolnshire Local Flood Risk Management Strategy (LFRMS) (Amec Foster Wheeler, 2016)	Provides details of flood risk within the Borough and which statutory authorities are responsible for the management of local flood risk. The report does not consider flood risk from Main Rivers
	Humber Flood Risk Management Strategy (HFRMS) (EA, 2014)	The EA's long term plan for managing flood risk from the Humber Estuary
	Grimsby and Ancholme Catchment Flood Management Plan (CFMP) (EA, 2009)	Outlines flood risk sources within the plan area and how these may be managed in the future
	Flamborough Head to Gilbraltar Point Shoreline Management Plan (SMP) (Scott Wilson & Humber Estuary Coastal Authorities Group, 2010)	Outlines the proposals for how the tidal flood risk in the area will be managed by the EA in the future
Identification of Historical Flooding	North Lincolnshire PFRA (Entec, 2011)	Details of historical flooding and local flooding records
	North and North East Lincolnshire SFRA (NLC and NELC, 2011)	
	North Lincolnshire LFRMS (Amec Foster Wheeler, 2016)	

PURPOSE	SOURCE	COMMENTS
	EA pre-development response	
Details of the Scheme	Proposed Development Design Drawings provided by Fichtner Consulting Engineers	Provides the layout of the Proposed Development
Surface Water Drainage Plans	1:10,000 OS Mapping Existing Site Drainage Plans	Identified existing site drainage, public drainage system near the Site and details of existing surface water runoff from the Site

Consultation with Key Stakeholders

1.3.2. Consultation was undertaken with the EA, NELIDB, NELC and Anglian Water to inform the FRA for the Consented Development. Further consultation has been carried out where required for the Proposed Development, including updating data requests. Responses to date are provided in Annexes 1, 2, 3 and 4 to this report respectively. Any advisory recommendations and consultation responses are summarised and addressed in Sections 3.0, 5.0 and 6.0 of this report.

2.0 SITE DESCRIPTION

2.1 Location

2.1.1. The Site is defined by the development consent application boundary which comprises approximately 23 hectares (ha) and is located approximately 5.6 kilometres (km) north-west of Grimsby in North East Lincolnshire, centred at OSNGR 523019, 413263. Figure 1 illustrates the Site location and hydrological context.

2.2 Existing Land Use

2.2.1. Within the Site there is an area which is defined as the Main Development Area (as illustrated in Figure 1). This is also referred to as Work No. 1 and comprises the proposed electricity generating station itself (with the locations of the stacks and administration block constrained to Work Nos. 1A and 1B respectively). The Works Plan (Document Ref. 4.3) defines the areas within which each element of the Proposed Development will be located.

2.2.2. The Main Development Area comprises approximately 7 ha of undeveloped land which is crossed by a number of existing buried services, underground cooling water pipes connecting the SHBPS in the west of the Site to the cooling water pumping station located to the east, and an associated access road to the pumping station. The two man-made ponds shown on OS mapping within the Main Development Area were drawn down and infilled during 2019.

2.2.3. The remainder of the Site comprises the existing SHBPS and areas which will be used for construction laydown and the site compound during construction, as well as for ecological habitat creation and utilities connections.

Access

2.2.4. The Site is currently accessed through the main entrance of the SHBPS off South Marsh Road and is intersected by an internal access road which links the power station to the cooling water pumping station in the east of the Site. This cooling water pumping station located approximately 60 m to the east of the Site is associated with the existing SHBPS.

2.2.5. South Marsh Road provides highway access to SHBPS and also to Synthomer (UK) Limited and the NEWLINCS Integrated Waste Management Facility, both located to the north of the Site. It is understood that South Marsh Road is also used by the EA to access flood defences along the bank of the Humber Estuary to the east of the existing pumping station.

2.3 Hydrology and Flood Risk Management Infrastructure

2.3.1. The Site is located approximately 175 m west of the Humber Estuary. The nearest watercourse is Oldfleet Drain located approximately 140 m to the south of the Site (at its closest point) which is classed by the EA as a Main River. Middle Drain, an Ordinary Watercourse is located approximately 340 m to the north (at its closest point). A series of minor land drainage ditches (also Ordinary Watercourses) run along the northern, western, eastern and southern boundaries

of the Site and convey surface water runoff discharges from the greenfield areas of the Site into Middle Drain and Oldfleet Drain towards the Humber Estuary. These land drains are illustrated in more detail on Figure 14.1 in ES Volume II (Document Ref. 6.3).

2.3.2. Fluvial flood defences are present along Oldfleet Drain upstream of the Site, located approximately 270 m south-west, upstream of the railway line. According to the information provided by the EA, these defences reduce the risk of flooding to a >1% AEP (1 in 100 chance) event.

2.3.3. Middle Drain discharges via a pumping station located approximately 550 m north of the Site, and Oldfleet Drain that outfalls via a flapped culvert into the estuary approximately 450 m south-east of the Site. The tidal outfall of Oldfleet Drain comprises a flapped twin culvert through the raised coastal flood defence that enables runoff to discharge whilst tide levels are low enough and the flaps are open. Two additional outfalls from a land drain alongside the raised sea defence between the Site and the Middle Drain pumping station comprise two 150 mm diameter un-flapped pipes.

2.3.4. The EA's 'Flood Map for Planning' (see Annex 1, and EA, 2019) identifies there to be existing tidal flood defences located approximately 160 m to the east of Site, extending from north-west to south-east alongside the Humber Estuary and reducing the risk of flooding up to a 0.5% AEP (1 in 200 chance) event.

Surrounding Land Use

2.3.5. There is a body of standing water (see Figure 1) located approximately 80 m to the east of the Site next to the cooling water pumping station associated with the SHBPS. This is a holding chamber for water in and out of the cooling pipes.

2.3.6. The Site is located on the South Humber Bank which is an area of mixed agricultural and industrial use with no residential receptors located in close proximity to the Site (within 500 m). The closest residential properties (individual receptors) are located approximately 1 km to the west and south-west; these are:

- Poplar Farm (located on South Marsh Road); and
- Primrose Cottage (accessed via Station Road, north of the A180).

2.3.7. The nearest settlement is the village of Stallingborough located over 2 km to the south-west.

2.4 Topography

1.1.1 A review of 1 m resolution LiDAR data published by the EA (EA, 2017) identified that the Site is situated on generally flat land with levels ranging between 1.90 metres Above Ordnance Datum (mAOD) and 4.25 mAOD (see Figure 2). The levels of the Site gently fall from west to east, towards the Humber Estuary. These levels have also been confirmed through completion of a topographical survey for the Site in February 2020.

2.5 Geology

2.5.1. The British Geological Survey, Geology of Britain Viewer (BGS, 2018) was used to identify the bedrock and superficial deposits beneath the Site. The following findings were confirmed by the ground investigation (Socotec, 2019) (see Appendices 12B and 12C). The superficial deposits present beneath the Site are identified as tidal flat deposits (clay and silt) possibly underlain by glacial deposits. These are designated as unproductive strata with low permeability; however permeable sand layers are likely to contain groundwater.

2.5.2. The bedrock underlying the Site is the Flamborough Chalk Formation and is designated as a 'Principal Aquifer', defined as "*layers of rock or drift deposits that…usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale*". Available groundwater monitoring data indicates that groundwater within the chalk is likely to be confined beneath the overlying low-permeability superficial deposits.

2.5.3. There are no recorded geological faults identified beneath the Site.

2.5.4. Soils at the Site are described on the Soilscapes mapping website (Cranfield Soil and Agrifood Institute, 2019) as *"loamy and clayey soils of coastal flats with naturally high groundwater"*.

2.5.5. The Site is not located within an EA designated groundwater Source Protection Zone (SPZ) (EA, 2019c). The nearest SPZs to the Site are located approximately 1.2 km to the south-west and north-west and are associated with potable water abstractions from the chalk aquifer. The nearest Inner Zone (Zone 1) Groundwater Source is located in Healing, approximately 1.6 km to the south-west. Groundwater within the chalk is likely to be confined beneath the overlying superficial deposits.

2.5.6. The EA's Groundwater Vulnerability Map (EA, 2019c) illustrates that the western extent of the Site lies within an area defined as 'Low' vulnerability and the remaining majority of the Site lies within an area defined as 'Medium' vulnerability.

2.5.7. These classifications will be taken into account in detail when the proposed surface water runoff mitigation measures (see Section 5.0) are developed further at the detailed design stage.

2.6 The Proposed Development

2.6.1. The Applicant proposes to develop the Site to construct and operate a new EfW power station with a gross electrical output of up to 95 MW.

2.6.2. The building envelope of the Proposed Development is approximately 210 m long and 110 m wide at its greatest extent. The nominal design capacity of the facility is 616,500 tonnes per annum of refuse derived fuel (RDF) based on a design net calorific value (NCV) of 11 MJ/kg and average availability. It is expected that the Proposed Development will be capable of maintaining the maximum electrical output while combusting fuel in a range of NCVs between 9 and 14 MJ/kg.

Proposed Access

2.6.3. It is proposed that the Site will be accessed from the A180 via the A1173, Kiln Lane, Hobson Way and South Marsh Road via a new access from South Marsh Road to the east of the existing SHBPS entrance. The Proposed Development will maintain access to the pumping station for SHBPS via a redirected roadway.

Proposed Development Drawings

2.6.4. A set of drawings illustrating the Proposed Development proposals are provided in Volume II of the ES (Document Ref. 6.3). These include:

- Site Location Plan — Figure 1.1
- Proposed Development Site Layout Plan — Figure 4.1

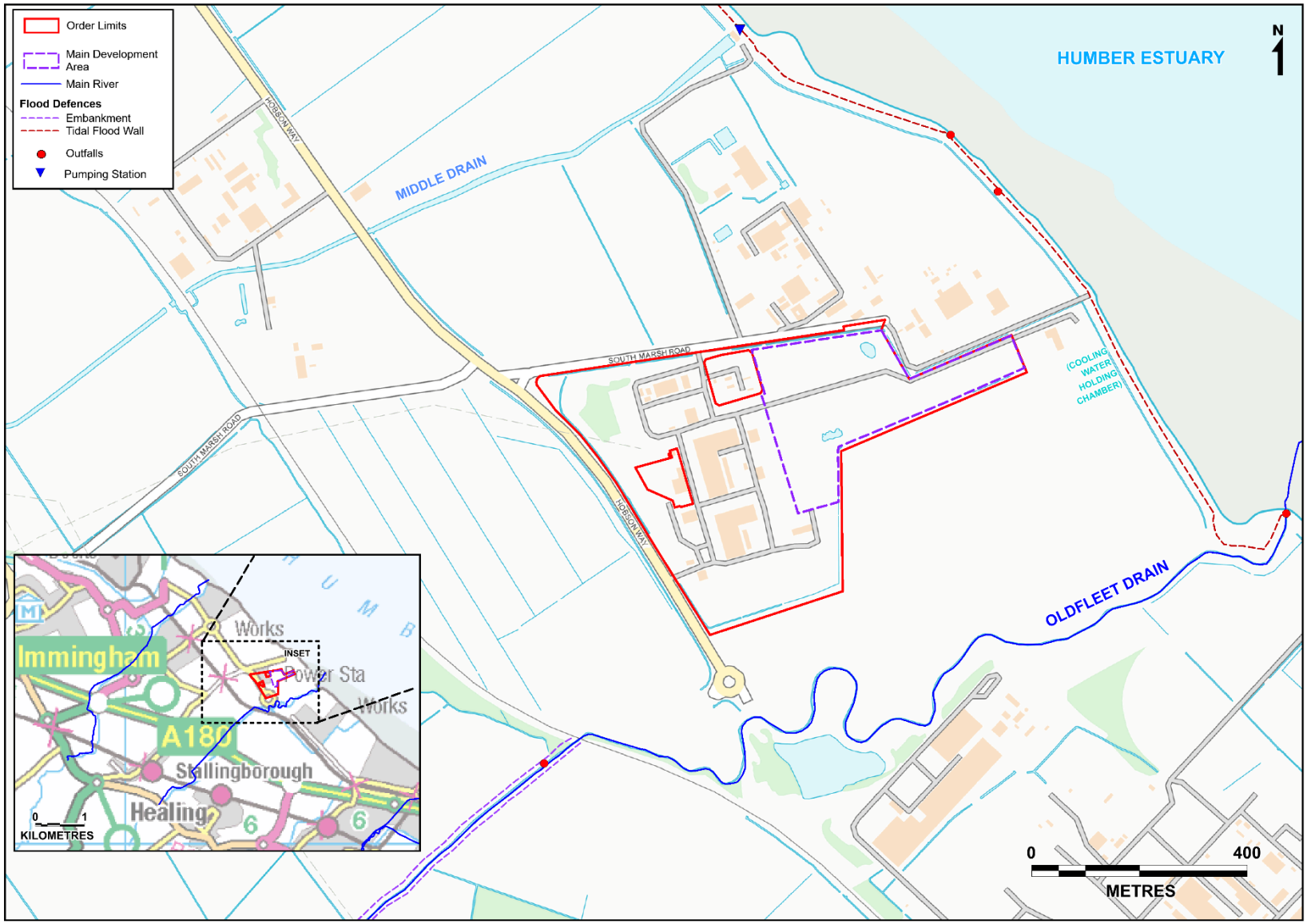

Figure 1: Site location plan

Contains Ordnance Survey Data © Crown Copyright and database right 2020

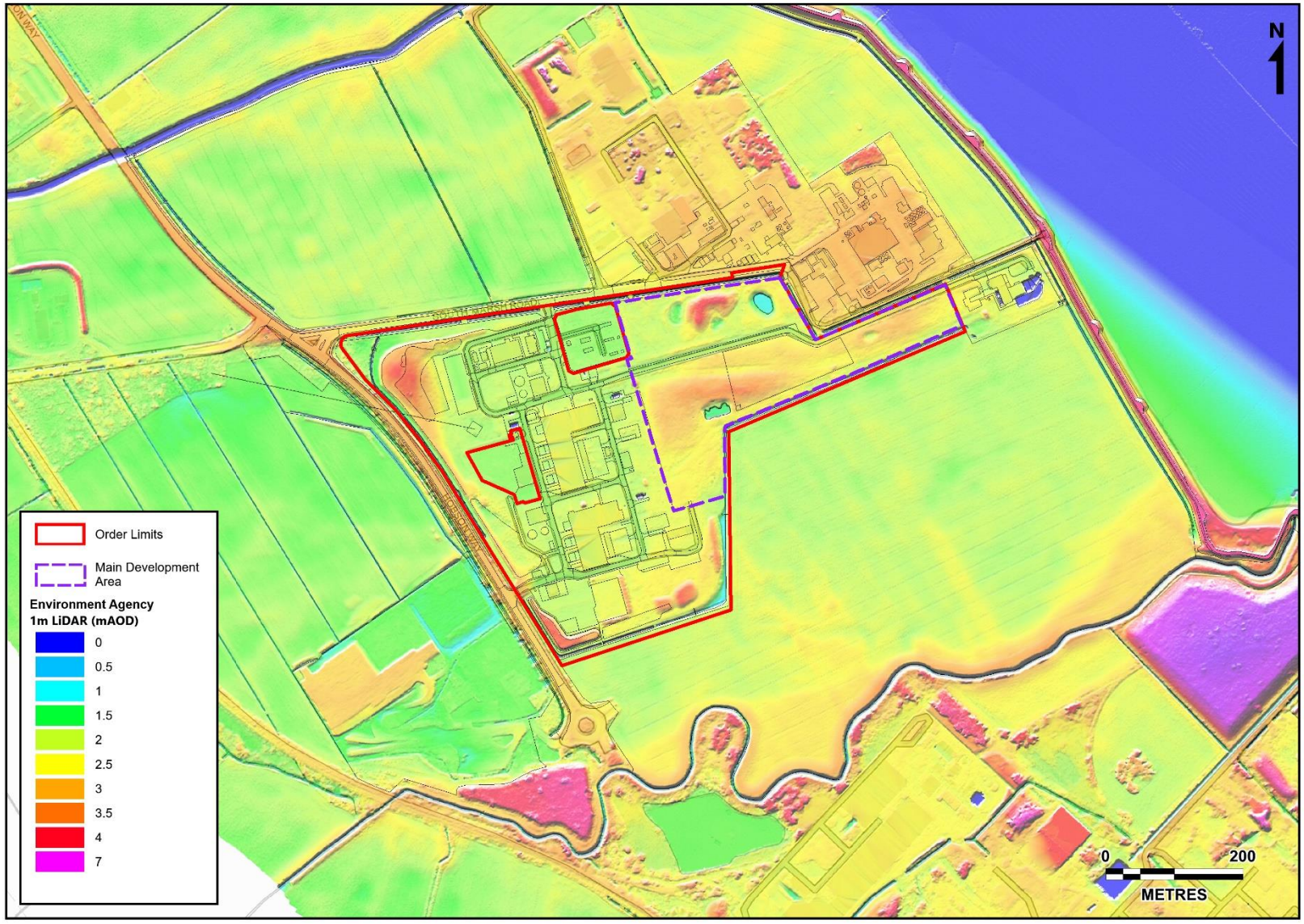

Figure 2: Site topography – EA 1m LiDAR

Contains Ordnance Survey Data © Crown Copyright and database right 2020

3.0 PLANNING POLICY

3.1 Introduction

3.1.1. The Sections below consider the planning policies and guidance of relevance to the Site with regards to the flood risks from all sources and appropriate mitigation measures which should be considered.

3.2 National Policy

National Policy Statements

3.2.1. The Overarching National Policy Statement (NPS) for Energy (EN-1), Section 5.7 (Flood Risk) (Department for Energy and Climate Change, 2011a) details that projects of 1 hectare (ha) or greater in Flood Zone 1 in England and all proposals for energy projects located in Flood Zones 2 and 3 in England should be accompanied by a FRA.

3.2.2. The requirements for FRAs are that they should:

- be proportionate to the risk and appropriate to the scale, nature and location of the project;
- consider the risk of flooding arising from the project in addition to the risk of flooding to the project;
- take the impacts of climate change into account, clearly stating the development lifetime over which the assessment has been made;
- be undertaken by competent people, as early as possible in the process of preparing the proposal;
- consider both the potential adverse and beneficial effects of flood risk management infrastructure, including raised defences, flow channels, flood storage areas and other artificial features, together with the consequences of their failure;
- consider the vulnerability of those using the Site, including arrangements for safe access;
- consider and quantify the different types of flooding (whether from natural and human sources and including joint and cumulative effects) and identify flood risk reduction measures, so that assessments are fit for the purpose of the decisions being made;
- consider the effects of a range of flooding events including extreme events on people, property, the natural and historic environment and river and coastal processes;
- include the assessment of the remaining (known as ‘residual’) risk after risk reduction measures have been taken into account and demonstrate that this is acceptable for the particular project;
- consider how the ability of water to soak into the ground may change with development, along with how the proposed layout of the project may affect drainage systems;

- consider if there is a need to be safe and remain operational during a worst-case flood event over the development's lifetime; and
- be supported by appropriate data and information, including historical information on previous events.

3.2.3. In determining an application for development consent, the Planning Inspectorate should be satisfied that where relevant:

- the application is supported by an appropriate FRA;
- the Sequential Test has been applied as part of site selection;
- a sequential approach has been applied at the site level to minimise risk by directing the most vulnerable uses to areas of lowest flood risk;
- the proposal is in line with any relevant national and local flood risk management strategy;
- priority has been given to the use of sustainable drainage systems (SuDs); and
- in flood risk areas the project is appropriately flood resilient and resistant, including safe access and escape routes where required, and that any residual risk can be safely managed over the lifetime of the development.

3.2.4. Section 5.7.12 of NPS EN-1 also states that in England development should not be consented in Flood Zone 3 or Zone C unless it is satisfied that the Sequential and Exception Test requirements have been met. The technology-specific NPSs set out some exceptions to the application of the sequential test. However, when seeking development consent on a site allocated in a development plan through the application of the Sequential Test, informed by a strategic flood risk assessment, applicants need not apply the Sequential Test, but should apply the sequential approach to locating development within the site. Details of the Sequential Test and Exception Test requirements are provided in Sections 5.7.13-5.7.17 of the NPS EN-1; however, the PPG (Ministry of Housing, Communities and Local Government, 2019) provides more up to date policy definitions of these, as discussed below. These have subsequently been considered as part of this FRA.

3.2.5. Section 5.15 of NPS EN-1 details that where the project is likely to have effects on the water environment, the applicant for development consent should undertake an assessment of the existing status of, and impacts of the proposed project on, water quality, water resources and physical characteristics of the water environment as part of the ES or equivalent.

3.2.6. Overarching National Policy Statement for Renewable Energy Infrastructure (EN-3) (Department of Energy & Climate Change, 2011b) provides the following general guidance relating to flood risk assessments and climate change pertaining to renewable energy production facilities:

- consider how the proposal would be resilient to effects of rising sea levels and increased risk from storm surge and tidal flooding resulting from climate change; and
- consider how plant will be resilient to increased risk of flooding and increased risk of drought affecting river flows.

National Planning Policy Framework (NPPF) (2019)

3.2.7. The NPPF (Ministry of Housing, Communities and Local Government, 2019) is currently supported by the PPG (Ministry of Housing, Communities and Local Government, 2019). These constitute the most up to date guidance for Local Planning Authorities (LPAs) and decision-takers, both in drawing up plans and as a material consideration in determining applications. Section 10 of the NPPF and PPG provides guidance for planning with respect to flood risk.

3.2.8. The NPPF advocates a 'Sequential' approach for the planning process in order to steer development to areas with the lowest possible risk of flooding. The guidance states that only where there are no reasonably available sites in Flood Zones 1 or 2 should the suitability of sites in Flood Zone 3 be considered, taking into account the flood risk vulnerability of land uses and applying the Exception Test if required.

3.2.9. The flood zone definitions as presented in Table 1 of the PPG are defined in Table 2. As discussed in Section 1.0, the EA's 'Flood Map for Planning' (EA, 2019) identifies that the Site is located wholly within Flood Zone 3a.

Table 2: NPPF PPG flood zone definitions

FLOOD ZONE	DEFINITION
Flood Zone 1	Land that has a low probability of flooding (less than 1 in 1,000 annual probability of river or sea flooding (<0.1% AEP)
Flood Zone 2	Land that has a medium probability of flooding (between 1 in 100 and 1 in 1,000 annual probability of river flooding (0.1-1% AEP), or between 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.1-0.5% AEP)
Flood Zone 3a	Land that has a high probability of flooding (1 in 100 year or greater annual probability of river flooding (>1% AEP), or a 1 in 200 or greater annual probability of flooding from the sea (>0.5% AEP)
Flood Zone 3b (Functional floodplain)	Land where water has to flow or be stored in times of flood (Not separately distinguished from Zone 3a on the Flood Map).

Sequential Test

3.2.10. A Sequential Test is required to assess flood risks across strategic development sites and the NPPF 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). However, the PPG also confirms that:

> *"The Sequential Test does not need to be applied for individual developments on sites which have been allocated in development plans through the Sequential Test"*

3.2.11. Section 2.1 of NELC's Flood Risk Sequential and Exception Tests' Guidance Note (NELC, 2016) states that the Sequential Test is not required when:

> *"The Council has already sequentially tested the site as part of an allocation for development within the development plan"*

3.2.12. The Site is located within Flood Zone 3 as defined in the EA's 'Flood Map for Planning' (see paragraph 1.2.1, and EA, 2019) and the Proposed Development is for power generation, which while not a formal B-class use is an important type of employment use as identified in the Local Plan 2013 to 2032 (NELC, 2018, paragraphs 12.17-12.19) (see Section 3.4.1).

3.2.13. The Local Plan process considered the most appropriate sites allocated for such uses taking into account flood risk. The Site has been allocated as an 'existing employment area' being part of the operational area of the existing SHBPS, and is therefore safeguarded for such uses. It is also in close proximity to a number of sites allocated for 'proposed employment'. It is therefore considered that the Local Plan allocation process has dealt with the Sequential Test and that this is a suitable and preferred site, in flood risk terms, for the Proposed Development.

3.2.14. According to Table 2 of the PPG, the Proposed Development of a Power Station comprises the vulnerability classification of 'Essential Infrastructure'. Table 3 within the PPG (replicated in Table 3 below) provides a matrix identifying which vulnerability classifications are appropriate within each flood zone.

Table 3: NPPF PPG flood risk vulnerability and flood zone 'compatibility'

	FLOOD RISK VULNERABILITY CLASSIFICATION				
	ESSENTIAL INFRA-STRUCTURE	**WATER COMPAT-IBLE**	**HIGHLY VULNER-ABLE**	**MORE VULNER-ABLE**	**LESS VULNER-ABLE**
Flood Zone 1	✓	✓	✓	✓	✓
Flood Zone 2	✓	✓	Exception Test required	✓	✓
Flood Zone 3a	Exception Test required	✓	×	Exception Test required	✓

Flood Zone 3b 'Functional Floodplain'	Exception Test required	✓	×	×	×
Key: ✓ Development is appropriate × Development should not be permitted.					

Exception Test

3.2.15. As Table 3 indicates, application of the Exception Test is required for this Site. The PPG states that for the Exception Test to be passed:

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

3.2.16. Both elements of the test have to be passed for development to be allocated or permitted. Element two has been demonstrated for the Proposed Development in Sections 4.0, 6.0 and 7.0 of this site-specific FRA.

Environment Agency Climate Change Guidance (2020)

3.2.17. The EA published updated climate change allowances in March 2020 (EA, 2020) to support the NPPF, which supersede all previous allowances written in the 'PPG: Flood Risk & Coastal Change' and are predictions of anticipated change for:

- peak river flow by River Basin District;
- peak rainfall intensity;
- sea level rise; and
- offshore wind speed and extreme wave height.

3.2.18. These should be considered within a FRA in regard to future impacts from climate change on site specific planning applications. The EA's guidance (EA, 2020) outlines how and when allowances should be applied for FRAs.

Tidal Climate Change Allowances

3.2.19. Table 4 is an extract replicated from Table 3 of the EA guidance (EA, 2020) detailing the anticipated rise in sea levels up to 2125. The anticipated lifetime of the development is approximately 30 years. Therefore, the minimum climate change increases up to the year 2065 should be considered.

Table 4: Sea level allowance for each epoch in millimetres (mm) per year with cumulative sea level rise for each epoch in brackets (use 1981 to 2000 baseline)

AREA OF ENGLAND	ALLOW-ANCE	2000 TO 2035 (mm)	2036 TO 2065 (mm)	2066 TO 2095 (mm)	2096 TO 2125 (mm)	CUMULA-TIVE RISE 2000 TO 2125 (metres (m))
Humber	Upper End	6.7 (235)	11 (330)	15.3 (459)	17.6 (528)	1.55 m
	Higher central	5.5 (193)	8.4 (252)	11.1 (333)	12.4 (372)	1.15

Fluvial Climate Change Allowances

3.2.20. For proposed developments in areas of fluvial flood risk, the flood risk vulnerability classification, flood zone and lifetime of development are of particular importance to determine the correct climate change allowance as detailed in Table 5.

Table 5: EA climate change allowances to apply based upon the flood zone and development land use vulnerability

	WATER COMPAT-IBLE	LESS VULNER-ABLE	MORE VULNER-ABLE	HIGHLY VULNER-ABLE	ESSENTIAL INFRA-STRUCTUR E
Flood Zone 2	NA	CA	Assess CA & HCA	Assess HCA & UEA	Assess HCA & UEA
Flood Zone 3a	CA	Assess CA & HCA	Assess HCA & UEA	×	UEA
Flood Zone 3b	CA	×	×	×	UEA
NA = No Allowance; CA = Central Allowance; HCA = Higher Central Allowance; UEA = Upper End Allowance; × = Development not permitted					

3.2.21. As the Proposed Development is defined as 'Essential Infrastructure' from the vulnerability classifications in Table 2 of the NPPF, the corresponding percentages that should be assessed at sites within the Humber River Basin District are listed in Table 6 (replicated from Table 1 of the EA guidance (EA,

2020) detailing the anticipated increase in peak flows up to 2115). The anticipated lifetime of the development is approximately 30 years. Therefore, a minimum of the +30% allowance for climate change is applicable to the Proposed Development.

Table 6: EA peak river flow climate change allowances for the Humber River Basin District (use 1961 to 1990 baseline)

	TOTAL POTENTIAL CHANGE ANTICIPATED FOR THE '2020s' (2015 TO 2039)	TOTAL POTENTIAL CHANGE ANTICIPATED FOR THE '2050s' (2040 TO 2069)	TOTAL POTENTIAL CHANGE ANTICIPATED FOR THE '2080s' (2070 TO 2115)
Upper End Allowance	20%	30%	50%
Higher Central Allowance	15%	20%	30%
Central Allowance	10%	15%	20%

Pluvial Climate Change Allowances

3.2.22. To account for the anticipated changes in rainfall intensity, the EA's guidance (as shown in Table 7) states that a FRA for an expected lifespan of the Proposed Development should assess the 'Upper End' allowance to understand the potential impact and make suitable decisions to mitigate against pluvial flooding. As the anticipated lifetime of the development is approximately 30 years, a minimum of the +20% allowance should be considered as part of this FRA.

Table 7: EA peak rainfall intensity climate change allowances across England in small and urban catchments (use 1961 to 1990 baseline)

	TOTAL POTENTIAL CHANGE ANTICIPATED FOR THE '2020s' (2015 TO 2039)	TOTAL POTENTIAL CHANGE ANTICIPATED FOR THE '2050s' (2040 TO 2069)	TOTAL POTENTIAL CHANGE ANTICIPATED FOR THE '2080s' (2070 TO 2115)
Upper End Allowance	10%	20%	40%
Central Allowance	5%	10%	20%

3.2.23. Therefore, a +40% allowance for climate change for peak rainfall intensity is applicable to the Proposed Development at the Site. This has been taken into account in the calculations of surface water runoff rates and volumes in the

Outline Drainage Strategy for the Proposed Development (refer to Appendix 14B in ES Volume III (Document Ref. 6.4).

3.2.24. When assessing a range of allowances for peak river flow or rainfall intensity, the following must be considered:

- likely depth, speed and extent of flooding for each of the assessed climate change allowances;
- vulnerability of the proposed development types or land use allocations to flooding;
- 'built in' resilience measures used, for example, raised floor levels; and
- capacity or space in the development to include additional resilience measures in the future, using a 'managed adaptive' approach.

Non-Statutory SuDS Guidance

3.2.25. Defra published their Sustainable Drainage Systems: Non-Statutory Technical Standards (NSTS) in March 2015 (Defra, 2015) setting the requirements for the design, construction, maintenance and operation of SuDS. The NSTS are intended to be used alongside the NPPF and PPG.

3.2.26. The NSTS that are mainly relevant to the consideration of flood risk to and from development relate to runoff destinations, peak flow control and volume control. These standards are summarised in Table 1 of the SHBEC Outline Drainage Strategy (refer to Appendix 14B in ES Volume III (Document Ref. 6.4). Additional guidance is provided for structural integrity, designing for maintenance considerations and construction.

3.3 Regional Policy

Grimsby and Ancholme Catchment Flood Management Plans (2009)

3.3.1. The role of Catchment Flood Management Plans are to identify flood risk management policies which will assist all key decision makers in the catchment to deliver sustainable flood risk management for the long term. The Site is located within the Grimsby and Ancholme CFMP study area. The region specific CFMP (EA, 2009b) considers all types of inland flooding, from rivers, ground water, surface water and tidal flooding, but not flooding directly from the sea (coastal flooding).

3.3.2. The report identifies Oldfleet Drain (Main River) to be a main source of fluvial flood risk to the Humber Trade Zone Industrial Area, where the Site is located.

Flamborough Head to Gibraltar Point Shoreline Management Plan (SMP) (2010)

3.3.3. The Site is potentially vulnerable to tidal flooding from the Humber Estuary and the Site location falls into 'Sub Area 4: Immingham, Grimsby and Buck Beck' of the local Flamborough Head to Gilbraltar Point SMP (Scott Wilson & Humber Estuary Coastal Authorities Group, 2010).

3.3.4. The purpose of a SMP is to identify the most sustainable approach to managing the flood and coastal erosion risks to the coastline in the short-term (0 to 20 years), medium term (20 to 50 years) and long term (50 to 100 years).

3.3.5. The report identifies the Site to be within an area ranging from low to high flood risk during different scenarios where the LLFA and the EA are already working towards managing the risk. However, it is also an area that will be affected by climate change due to the low-lying land and its coastal location, and so will need ongoing maintenance and defence improvements.

Humber Flood Risk Management Strategy (HFRMS) (2008)

3.3.6. The Site lies within 'Area 24 - Immingham to West Grimsby' of the Humber FRMS (Environment Agency, 2008). This FRMS contains policies to manage the risk of flooding in this area which include those in the list below:

- defences here will be improved as necessary to protect the large number of people, businesses and nationally important industry from tidal flooding;
- develop plans to improve the defences near North Killingholme and Stallingborough within the next five years;
- work closely with other authorities and developers to ensure we manage the risk effectively together; and
- aiming to avoid any new development immediately behind the existing defences in case they have to be moved in the future.

3.4 Local Policy

North East Lincolnshire Local Plan (2018)

3.4.1. The North East Lincolnshire Local Plan 2013 to 2032 (NELC, 2018) was adopted in March 2018. The following policies from the Local Plan are considered relevant in regard to flood risk to the Proposed Development:

- **SO2 – Climate Change**: Address the causes and effects of climate change by promoting development that minimises natural resource and energy use; reduces waste and encourages recycling; reduces pollution; brings about opportunities for sustainable transport use; responds to increasing flood risk; and incorporates sustainable construction practices. Promote appropriate distribution of development and the role of green infrastructure in mitigating aspects of flood risk. Recognise the increased stress on habitats and species that climate change causes.
- **Policy 33 – Flood Risk**: In order to minimise flood risk impacts and mitigate against the likely effects of climate change, development proposals should demonstrate that:

  a) where appropriate, a site-specific FRA has been undertaken, which takes account of the best available information related to all potential forms of flooding;

  b) there is no unacceptable increased risk of flooding to the development site or to existing properties;

c) the development will be safe during its lifetime;

d) SuDS have been incorporated into the development unless their use has been deemed inappropriate;

e) opportunities to provide natural flood management and mitigation through green infrastructure have been assessed and justified, based upon sound evidence, and, where appropriate, incorporated, particularly in combination with delivery of other aspects of green infrastructure in an integrated approach across the site;

f) arrangements for the adoption, maintenance and management of any mitigation measures have been established and the necessary agreements are in place;

g) access to any watercourse or flood defence asset for maintenance, clearance, repair or replacement is not adversely affected; and

h) the restoration, improvement or provision of additional flood defence infrastructure represents an appropriate response to local flood risk, and does not conflict with other Plan policies.

- **Policy 34 – Water Management**: Development proposals should consider how water will be used on the site and ensure that appropriate methods for management are incorporated into the design, considering the objectives and programme of measures set out by the Humber River Basin Management Plan.

North and North East Lincolnshire Strategic Flood Risk Assessment (2011) and Addendum (2016)

3.4.2. The North and North East Lincolnshire SFRA (NLC and NELC, 2011) was written in 2011 and provides the LPAs with information to make objective judgments about flooding, both when making decisions on land allocations for development plans and when determining planning applications for development in their areas.

3.4.3. The SFRA provides a series of maps detailing the hydrological features in the vicinity of the Site, identifying the responsibilities for these by the NELIDB (Significant Ordinary Watercourses) and the EA (Main Rivers), and presents records of historical flooding incidents in the vicinity. The SFRA identifies the South Humber Bank as a strategic employment site as defined in the NELC Local Plan, and also provides site-specific guidance for developers to consider in regard to mitigation of any identified flood risks from all sources.

3.4.4. An Addendum to the SFRA was completed in April 2016 containing updated maps for a tidal defence breach hazard scenario provided by the EA. No specific policies are presented in relation to the Site.

North and North East Lincolnshire Preliminary Flood Risk Assessment (2011)

3.4.5. The North and North East Lincolnshire PFRA (Entec, 2011) was a high-level screening exercise that compiled information on significant local flood risk from past and future floods, based on readily available information at the time. The

PFRA also included the identification of 'flood risk areas', and outlines the responsibilities of key stakeholders.

3.4.6. Local flood risk was defined in the PFRA as flood risk originating from sources other than Main Rivers, the sea and large reservoirs; principally meaning flood risk from surface water runoff, groundwater and Ordinary Watercourses. This main definition of 'local flood risk' was further clarified:

a) it includes lakes and ponds;

b) it does not consider flooding from sewers unless this is wholly or partly caused by rainwater or other precipitation entering or otherwise affecting the system;

c) it does not include flooding from water supply systems (for example burst water mains); and

d) it considers the interaction with flooding from main rivers, the sea and sewers.

North East Lincolnshire Local Flood Risk Management Strategy (LFRMS)

3.4.7. As the Lead Local Flood Authority (LLFA), NELC is responsible for managing flood risk from 'local' sources. Their LFRMS (NELC, 2015) report presents the summary of North East Lincolnshire's preferred strategy for managing flood risk from the following 'local' sources:

- surface run-off;
- groundwater; and
- Ordinary Watercourses (generally small rivers and streams).

3.4.8. The LFRMS contains a list of objectives for the strategy, which include:

- Objective 1 – to improve the understanding (of both communities and flood risk management partners) of the roles and responsibilities for flood risk management in North Lincolnshire;
- Objective 2 – to improve the understanding of local flood risk;
- Objective 3 – to reduce the risk of flooding from local sources in the communities;
- Objective 4 – seek to implement flood risk management actions that contribute to wider social, economic and environmental outcomes and sustainable development;
- Objective 5 – create a strong collaborative approach across stakeholders to address risks from all sources of flooding;
- Objective 6 – raise public awareness and engage with local people about local flood risks, and help the communities to manage their own risks;
- Objective 7 – contribute to planning and development decisions to ensure new development is appropriate; and
- Objective 8 – contribute to effective emergency flood response.

3.4.9. The LFRMS refers to the South Humber bank as the 'energy estuary', and states that managing flood risk will be important in ensuring that these businesses can

operate in a safe environment. Disruption from flooding could lead to significant disruption to these businesses which could affect the local economy.

3.4.10. It continues to state that in order to develop stronger communities NELC aims to establish a new relationship with the community to promote a culture of independence. The LFRMS acknowledges that communities will also need to play a greater role than before in reducing their own flood risks, becoming more resilient and ensuring that they are prepared for flooding without relying on the Council to provide all the solutions.

North East Lincolnshire Council SuDS Guide (2016)

3.4.11. The NELC SuDS Guide (NELC, 2016) provides introductory advice on how best to approach the development of SuDS proposals within schemes. The report is designed to reiterate the wide range of industry guidance already available and to highlight the importance of SuDS. It states the aims of SuDS as being to:

- reduce the risk and impacts of flooding;
- remove pollutants from urban runoff at source;
- provide amenity benefits; and
- contribute to improving and enhancing biodiversity.

3.4.12. The guidance also provides information on the criteria needed to support planning application submissions and reiterates that under the NPPF, all major developments must incorporate SuDS and must ultimately succeed in all four of the aims listed above.

3.4.13. The guide acknowledges each site will warrant a different approach to the composition of SuDS applied, dependent on many factors such as, topography, shape, size and underlying permeability. The LPA offers pre-application advice on development proposals, and therefore it is recommended prior to the detailed design process, the LLFA (NELC) be consulted.

Environment Agency - Lincolnshire and Northamptonshire Area

3.4.14. The EIA Scoping Opinion response (Planning Inspectorate, October 2019) provided in Appendix 1B in ES Volume III (Document Ref. 6.4) identified the following additional requirements for the ES and related FRA and drainage strategy from the EA's Lincolnshire and Northamptonshire planning team:

- Under the Environmental Permitting (England and Wales) Regulations 2016, permission must be obtained from the EA for any proposed activities which will take place:
  - in, over, under or within 8 metres of a Main River (16 m if tidal);
  - on or within 8 m of a flood defence structure or culvert (16 m if tidal) or on or within 16 m of a sea defence;
  - within 16 m of any main river, flood defence (including a remote defence) or culvert for quarrying or excavation; and

  - in a flood plain more than 8 m from the river bank, culvert or flood defence structure (16 m if tidal) if planning permission has not already been granted for the works.

- Any additional impacts / mitigation measures (from the Proposed Development compared to the Consented Development) will be identified as part of an updated assessment. It is noted that no additional mitigation measures have been identified for the Proposed Development compared to the Consented Development.

3.4.15. As part of the Section 42 consultation on the Preliminary Environmental Information (PEI) Report (December 2019), the EA was made aware of the primary and potential additional mitigation strategies provided within the Outline Drainage Strategy (see Appendix 14B in ES Volume III, Document Ref. 6.4). The EA's response to the Section 42 consultation from their Lincolnshire and Northamptonshire planning team included the following comments:

- this FRA is appropriate to the scale, nature and location of the Proposed Development and it is recommended that:
  - critical equipment shall be set no lower than 4.6 mAOD, or otherwise ensure they are adequately protected;
  - an area of safe refuge above 4.6 mAOD is proposed;
  - flood resilience and resistance measures will to be incorporated into the development.
- it was noted that *"additional mitigation strategies will be considered, which include providing flood resistance and resilience measures into the design of the buildings; and designing for failure, maintenance and capacity exceedance of the surface water drainage network"*;
- the EA support the suggestion in the FRA that future occupants sign up to Floodline Warnings Direct to receive advance warning of flooding; and
- the EA support the intention for the Applicant to develop a Flood Emergency Response Plan through consultation with NELC in accordance with the NPPF PPG.

3.4.16. As demonstrated in its consultation response, the EA was satisfied with the additional mitigation strategies to be considered by the Applicant detailed in Section 5.0 and Section 6.0.

3.4.17. In addition, further consultation was carried out with the EA in April 2020 prior to submission of the DCO application in relation to updated Climate Change Allowances guidance (December 2019) published by the EA. Annex 1 of this FRA presents the letter issued to the Planning Inspectorate which summarises the outcome of this consultation.

4.0 FLOOD RISK SOURCES

4.1 Introduction

4.1.1. The NPPF, PPG and NPS's require the effects of all forms and sources of flood risk to and from the Site to be considered within a FRA. There should be demonstration of how these risks should be managed so that the development remains safe throughout its lifetime, taking into account current climate change predictions.

4.1.2. This Section discusses these potential risks in relation to tidal, fluvial, surface water runoff, groundwater and man-made/ artificial sources (e.g. canals, reservoirs, pumping station failure). Risks from public foul sewers are also considered.

4.2 Historical Flooding Incidents

4.2.1. The EA provided details of historical flooding events in the local vicinity of the Site. Annex 1 of this FRA contains a map which illustrates that the entire Site was flooded during a major tidal flood event in January 1953. This event occurred prior to the coastal flood defences being improved, which were installed in response to the 1953 event.

4.2.2. Map 6 of the 2011 SFRA illustrates no additional records of reported historical flooding incidents in the immediate vicinity of the Site. The nearest reported incidents were located in the industrial estate approximately 1.1 km to the north-west. The 'River and Tidal Flood Risk Map' on page 9 of the 2011 PFRA contains no additional records of historical flooding to those in the vicinity of the Site.

4.2.3. No further major historical incidents are recorded in the vicinity on the Chronology of British Hydrological Events website (University of Dundee, 2018).

4.3 Tidal Sources

4.3.1. The Humber Estuary is located approximately 175 m to the east of the Site. The Humber Estuary poses the primary and most significant risk of flooding to the Site, but the Site benefits from existing flood defences.

Flood Map for Planning

4.3.2. The EA's 'Flood Map for Planning' available to view on their website (EA, 2019) identifies areas subject to fluvial/ tidal flood risk for the present day but does not include the benefits or impacts of any existing flood defences or climate change respectively.

4.3.3. A copy of the EA Flood Map is provided in Annex 1. This illustrates that the Site is wholly located within Flood Zone 3 ('high' risk) defined as land having a >0.5% AEP (greater than a 1 in 200 chance) of sea flooding (refer to Table 2).

Tidal Flood Defences

4.3.4. In accordance with the NPPF, the requirements are to ensure any proposed developments are built to withstand tidal flooding up to a 1% AEP (1 in 100 chance) event taking into account the potential impacts of climate change.

4.3.5. The EA's 'Flood Map for Planning' (refer to Annex 1, and Environment Agency, 2019) identifies there to be existing tidal flood defences located approximately 160 m to the east of site, extending from north-west to south-east alongside the Humber Estuary. According to the additional information provided by the EA (refer to Annex 1), the tidal defences protecting this Site consist of concrete floodwalls. They are in 'good' condition and reduce the risk of flooding currently up to a 0.5% AEP (1 in 200 chance in any year) event. The EA inspects these defences routinely to ensure potential defects are identified. The residual risk of flooding in the event of a defence breach scenario needs to be considered.

Modelled Tidal Water Levels

4.3.6. The EA provided modelled tidal peak water levels for the South Humber Bank area to inform this FRA (refer to Annex 1). The EA's model demonstrated that during a 0.1% AEP (1 in 1000 chance) event based upon the existing (2014) scenario, tidal levels in the Humber Estuary could rise up to 5.27 mODN at the Grimsby gauge to the south-east of Site, and 5.47 m above Ordnance Datum Newlyn (ODN) at the Haborough gauge north-west of the Site.

4.3.7. Table 8 details the modelled tidal water levels provided by the EA (refer to Annex 1). These are the current best estimate for extreme tide levels in the vicinity.

Table 8: EA modelled flood levels at Grimsby and Haborough Marsh

					ANNUAL CHANCE (1 IN X / % AEP) OF TIDE LEVEL (mODN)				
EA Node Ref	**Location**	**Easting**	**Northing**	**1 (>99%)**	**10 (10%)**	**50 (2%)**	**100 (1%)**	**200 (0.5%)**	**1000 (0.1%)**
H060	Grimsby	527878	411346	4.10	4.43	4.70	4.82	4.95	5.27
H080	Haborough Marsh	520790	415740	4.26	4.61	4.88	5.01	5.14	5.47

Modelled Overtopping and Breach Failure Water Levels Behind the Defences

4.3.8. The EA has modelled simulations for breach failure and overtopping scenarios of the tidal flood defences located approximately 160 m east of the Site at their nearest point. Overtopping was demonstrated during scenarios where the design standard of protection (SoP) of the defences would be exceeded, and the breach failure scenarios were undertaken along the defences at specific locations. The nearest breach location simulated in the model was approximately 270 m north east of the Site.

4.3.9. The breach and overtopping scenarios were modelled for the 0.5% AEP and 0.1% AEP events. The scenarios were performed for both the existing (2006) scenario and future (2115) scenario taking into account the effects of a predicted increase in tidal water levels resulting from climate change (as per the UKCP09 projections).

4.3.10. The EA provided maximum modelled *depth, velocity and hazard* maps from the 2010 Northern Area Tidal Modelling results (refer to Annex 1). The corresponding peak flood depth results in the vicinity of the Site are summarised in Table 9. .

Table 9: EA peak modelled flood depth bands within the Main Development Area at the Site

		FLOOD DEPTH (m) BAND	
	Scenario	**0.5 % AEP (1 in 200) event**	**0.1 % AEP (1 in 1000) event**
Breach	2006 (Existing)	0.25 - >1.6	0.5 - >1.6
	2115 (inc. UKCP09 Climate Change)	1.0 – 2.75	1.0 – 2.75
Overtopping	2006 (Existing)	0 – 1.6	0 - > 1.6
	2115 (inc. UKCP09 Climate Change)	1.0 - > 1.6	>1.6

4.3.11. In October 2019, the EA also provided the peak *water level* information (in mAOD) from the hydraulic model for a tidal defence breach failure event at the nearest modelled breach location to the Site during the 0.5% AEP and 0.1% AEP flood events including allowances for climate change up to the year 2115 (as per the UKCP09 projections).

4.3.12. This data illustrated that modelled peak water levels vary across the Site. Analysis was therefore undertaken of the water levels within the area of the proposed main buildings; these have been summarised in Table 10.

Table 10: EA modelled peak flood levels in the vicinity of the proposed buildings within the Main Development Area at the Site

		PEAK FLOOD WATER LEVEL (mAOD)	
	Scenario	**0.5 % AEP (1 in 200) event**	**0.1 % AEP (1 in 1000) event**
Breach	2006 (Existing)	3.9	3.95
	2115 (inc. UKCP09 Climate Change)	4.5	4.6

4.3.13. The peak 0.1% AEP water level resulting from a breach event taking into account the impacts of future climate change up to 2115 (as per the UKCP09 projections) is approximately 4.60 mAOD.

4.3.14. This water level estimate has therefore been used to inform the mitigation proposals for elevating critical equipment and provision of a place of safe refuge for occupants at the Site in Section 6.0. This is considered a robust assessment based on the available information.

4.3.15. Additional maps illustrating the flood depth, velocity, hazard classifications and rate of inundation for the largest magnitude event modelled are presented in Annex 1. These illustrate that during a 0.1% AEP breach failure event with climate change allowances up to the year 2115, the Site could flood in under 20 minutes of a breach occurring. This emphasises the requirement for the place of safe refuge within the Site.

4.3.16. In the event of a defence overtopping scenario occurring in the present-day, the modelled hazard classifications range from ‘Low’ hazard’ to ‘Danger to Some’ in the central-southern area of the Site and along the southern boundary.

4.3.17. In the event of a defence overtopping 0.5% AEP scenario taking into account the impacts of future climate change up to 2115, during the 0.5% AEP and 0.1% AEP breach scenarios occurring during the present day (2006) and 0.1% AEP event with future climate change scenario up to 2115, the modelled hazard classifications range from small areas with ‘Danger to Most’ to largely ‘Danger to All’ across the entire Site.

4.3.18. No modelling results are available from the EA for the climate change epoch up to the year 2065 under the UKCP18 projections as required by Table 4, relative to the anticipated lifetime of the Proposed Development (approximately 30 years). It is understood that this is because no hydraulic modelling has yet been undertaken by the EA for this scenario.

4.3.19. The modelled tidal level change estimate for the UKCP09 epoch up to 2115 (+450 mm, previously quoted in Table 3 of the EA’s February 2019 version of the climate change allowance guidance for FRAs), resulted in the peak water level within the Site of 4.6 mAOD as defined above. This is in excess of what tidal level increase is now projected to occur by the UKCP18 by the end of the

anticipated lifetime of the Proposed Development (approximately 30 years) (+330 mm); as presented by the epoch up to 2065 (see Table 4).

4.3.20. This demonstrates that, based on the most recent EA data available, the recommended level of 4.6 mAOD defined in this FRA above which to locate critical equipment and provide a place of safe refuge is therefore, considered sufficiently precautionary.

4.3.21. As a result, it is not considered to be necessary to re-model these scenarios applying the UKCP18 tidal level changes - once these are available from the EA - to inform this FRA, as it would not materially affect the outcome of the recommendation made in this FRA.

Summary

4.3.22. Based on the information provided by the EA, it has been determined that during the existing scenario the Site is at a 'low' risk of flooding from tidal sources with the defences in place, or resulting from overtopping of the defences during events that exceed a 0.5% AEP of flooding in any year. If these defences were to fail and breach during the existing scenario, the Site would be at a 'high' risk of flooding during either the 0.5% AEP or 0.1% AEP events.

4.3.23. During a future scenario taking climate change up to 2115 into account however, the impacts are more significant. The Site is potentially at a 'high' *residual* risk of flooding as a result of overtopping during events that exceed a 0.5% AEP of flooding in any year, or in the event that the defences were to breach during either the 0.5% AEP +CC, 0.1% AEP or 0.1% AEP +CC events.

4.4 Fluvial Sources

4.4.1. A review of OS mapping identified that the nearest watercourse is Oldfleet Drain (Main River) which is located approximately 140 m to the south of the Site (at its closest point) and flows in a north-easterly direction. Middle Drain, a Significant Ordinary Watercourse as defined by the SFRA, managed by the NELIDB, is located approximately 340 m to the north (at its closest point). A series of minor land drainage ditches (also Ordinary Watercourses) run along the northern, western and southern boundaries of the Site, and to the east of the Site, and convey surface water runoff discharges from the greenfield areas of the Site to Oldfleet Drain and Middle Drain. These watercourses all pose a potential risk of fluvial flooding to the Site.

Flood Map for Planning

4.4.2. The EA's 'Flood Map for Planning' (Environment Agency, 2019) (refer to Annex 1) illustrates that the Site is wholly located within Flood Zone 3 (high risk) defined as land having a >1%/0.5% AEP (greater than a 1 in 100 / 1 in 200 chance in any year) of river or sea flooding respectively (see Table 2). However, this map does not differentiate between the tidal/ fluvial sources of risk and the tidal defences are not taken into account.

Modelled Fluvial Water Levels & Extents

4.4.3. The site-specific information provided by the EA derived from the 'Oldfleet Drain and Stallingborough North Beck Model' (April 2009) (refer to Annex 1) illustrates the Site to have a 'very low' risk of fluvial flooding, as it is located outside of the modelled defended 0.1% AEP +20% climate change allowance event flood extent for Oldfleet Drain and Middle Drain. No modelled flood extents are available specifically for the land drains. However, Oldfleet Drain is considered to be the primary source of fluvial flood risk.

4.4.4. The EA also provided modelled peak fluvial flood levels for three model nodes along Oldfleet Drain alongside the Site from this model that produced these flood extents (refer to Annex 1). The model demonstrated that peak flows would reach a maximum of 4.34 m^3/s during a 0.1% AEP event. The modelled 1% AEP event peak water level at each of the three nodes during the defended scenario is 2.58 mODN. A negligible flood level increase is demonstrated for all modelled events up to the 0.1% AEP event plus a 20% allowance for climate change.

4.4.5. The +30% climate change allowance on the peak 1% AEP flow scenario currently required for consideration by this FRA (relative to the anticipated lifetime of the Proposed Development (approximately 30 years), see Table 6), has not yet been modelled by the EA. However, based on the information provided above in paragraphs 4.4.3 and 4.4.4, it is considered, using engineering judgement, that the 1% AEP +30% CC event would also not be of significant additional magnitude to progress across the wide floodplain towards and inundate the Site. This demonstrates that, despite the UKCP18 projections not being available from the EA, the fluvial flood risk identified for this Site is robust for the scale and nature of the Proposed Development and purposes of this FRA.

Fluvial Flood Defences

4.4.6. The EA's 'Flood Map for Planning' (refer to Annex 1, and Environment Agency, 2019) identifies there to be existing fluvial flood defences upstream of the Site, located approximately 270 m south-west along Oldfleet Drain, upstream of the railway line. According to the information provided by the EA, these fluvial flood defences comprise earth embankments. Their condition is 'fair' and will reduce the risk of flooding up to a 1% AEP (1 in 100 chance) event. The EA regularly inspect the defences to ensure potential defects are identified.

4.4.7. The EA confirmed that the Oldfleet Drain channel capacity (downstream of the railway line) is sufficient to convey flows in excess of a 1% AEP (1 in 100 chance) event.

Un-modelled Land Drains

4.4.8. The proposed access from South Marsh Road will cross the land drainage ditch in the north-eastern corner of the Main Development Area (Land Drain 1 in Figure 14.1 presented in ES Volume II (Document Ref. 6.3). The design will comprise either a new culvert or a clear-span bridge. There is subsequently the potential for an increased risk of fluvial flooding from this watercourse as a culvert could reduce the conveyance capacity of the drain, potentially causing floodwater to

back up westwards along the drain. However, the bed levels of the drain are relatively flat and so the scale of any water level afflux on the upstream face of the bridge would be very limited. This would likely only impact a short, very localised reach of the watercourse and as the adjacent ground levels of the Site and South Marsh Road are relatively flat, any additional flood water overtopping the banks would continue to follow its existing route eastwards.

4.4.9. The proposed ramped access to the tipping hall which will be at a height of approximately 5.5 mAOD will be located in close proximity (approximately 10 m) to the right/ southern bank of Land Drain 1 which requires consideration for this FRA. No flood extents specifically pertaining to Land Drain 1 are currently defined in the EA's 'Flood Map for Planning'. No hydraulic modelling has been undertaken to provide any fluvial flood extents or flood level information to compare to the location of the proposed ramps or buildings within the Main Development Area to determine if they intersect.

4.4.10. However, as Land Drain 1 only provides a drainage mechanism for surface water runoff generated by the local greenfield land use, and water levels within the drain are managed by the Middle Drain pumping station that discharges flows into the tidal Humber Estuary, it is not considered to pose any significant flood risk to the Site. If the discharge from the Middle Drain pumping station was restricted by high tide levels, flooding from this channel resulting from overtopping due to capacity exceedance could potentially occur. However, the layout of the ramps and buildings are not orientated in a manner that would significantly obstruct flow routing and therefore, a requirement for any fluvial flood volume compensation is not considered necessary.

4.4.11. During the detailed design phase, a detailed assessment of the local topography (through acquisition of detailed survey along the drain) and of the small catchment hydrology will be undertaken to determine the flow capacity of and flow estimates likely to be conveyed along the drain respectively to inform the adequate sizing and levels of a culvert/ clear-span bridge necessary to prevent any obstruction to flow.

Summary

4.4.12. Based on the information provided by the EA, it has been determined that the Site is at a 'very low' risk of fluvial flooding from Oldfleet Drain or Middle Drain.

4.5 Groundwater Sources

4.5.1. Groundwater flooding can occur when groundwater levels rise above ground surface levels. The underlying geology has a major influence on where this type of flooding takes place; it is most likely to occur in low-lying areas underlain by permeable rocks (aquifers).

4.5.2. The EA's 'Areas Susceptible to Groundwater Flooding' map is illustrated (refer to Annex 2 of the Joint Lincolnshire Flood Risk and Drainage Management Strategy (Lincolnshire County Council, 2012)). The map is divided into 1 km^2 grid-squares in which a percentage is given for what proportion of the 1 km^2 is considered to be susceptible to groundwater emergence. This map illustrates that the Site lies

within a 1 km grid square of which up to 25% of the area is considered to potentially be at risk of groundwater emergence.

4.5.3. In 2006, RSK Group was commissioned by Centrica to undertake a ground investigation as part of the design phase for a Site Protection and Monitoring Program (SPMP) for the SHBPS. The following summary from the ground investigation is based on the document 'Site Protection and Monitoring Programme Review for South Humber Bank Power Station' (September 2011). This document states that the intrusive ground investigation inferred that groundwater flowed towards the south-east and recorded resting groundwater depths across a monitoring well network ranging from 0.22 m below casing top (bct) to 1.55 m bct. A pre-construction ground investigation, including groundwater level monitoring within a series of installations, was undertaken between August and November 2019 (see Appendices 12B and 12C in ES Volume III, Document Ref. 6.4). This monitoring demonstrated generally shallow groundwater depths between 0.24 and 3.62 m below ground level.

4.5.4. The risk of groundwater flooding within the Main Development Area is therefore considered to be 'low' to 'medium'.

4.6 Surface Water Runoff to the Site

Overland Flow of Rainfall Runoff

4.6.1. The EA 'Flood Risk from Surface Water' map available on their website (EA, 2019b) identifies the vast majority of the Site to be at a 'very low' risk from surface water flooding (<0.1% AEP event). Small areas along the roads and along adjacent land drains within the Site are identified to be at a 'low', 'medium' and 'high' risk from surface water flooding (>0.1% AEP, 3.3% to 1% AEP event and >3.3% AEP event respectively). The Proposed Development area within the Site is illustrated as being predominantly at a 'very low' risk from surface water flooding, with very small areas at 'low risk' at the topographic low points.

4.6.2. Additionally, this information is supported by the fact that there are no significantly raised ground levels adjacent to the Site that could generate sufficient rates/ volumes of surface water runoff to pose a risk of overland flow coming into the Site.

4.6.3. The risk of surface water flooding within the Main Development Area within the Site from elsewhere is therefore considered to be 'low' to 'very low'.

Existing Drainage Infrastructure

4.6.4. The existing surface water drainage infrastructure within Site is illustrated in drawing 'Surface, foul, oily water HRSG blowdown services DRGDS2506' provided in the Outline Drainage Strategy (refer to Appendix 14B in ES Volume III, Document Ref. 6.4) and consists of a series of surface water drainage features servicing the existing man-made facilities of the SHBPS.

4.6.5. The effluent from the boiler facilities of the SHBPS discharge into effluent basins with buried outlet pipes connected to the cooling water pumping station at the far eastern extent of the Site. Surface water from the rooftop and access road areas

of the Site that are already developed is currently collected via gullies and conveyed into these effluent basins via buried surface water pipelines. A body of standing water located to the east of the Site next to the cooling water pumping station is a holding channel for water in and out of the cooling pipes (see Figure 1). The combined water is discharged via this holding channel into the Humber Estuary.

4.6.6. It is assumed that the land drains located around the perimeter of the Site accept lateral drainage of surface water from the greenfield areas of the Site. No level information however has been provided for these drains.

4.6.7. A review of OS mapping and the EA's 1 m LiDAR data identified that the holding chamber to the east is also elevated at lower ground elevations that the Site (i.e. they are not elevated above any adjacent ground levels so do not create a pathway of flooding towards the Site). It is therefore considered to pose a 'very low' risk of surface water flooding to the Main Development Area.

Summary

4.6.8. The risk to the Site from overland flow of surface water generated adjacent to the Site, or from waterbodies located within the Site is considered to be 'low' in small areas, but largely 'very low'.

4.7 Artificial Sources

Reservoirs

4.7.1. The EA defines a reservoir as an artificial body of water which can hold >25,000 cubic meters or more of water, above ground level as specified in The Reservoirs Act (1975) (HMSO, 1975).

4.7.2. The closest reservoir to the Site is located approximately 13 km south-east of Site north of Rothwell, west of Cuxwold. The EA 'Flood Risk from Reservoirs' map (Environment Agency, 2019b) illustrates that there is very low flood risk to Site from reservoirs in the event of a breach scenario.

Canals

4.7.3. There are no canals in close proximity to the Site, and therefore it is considered that there is no flood risk posed to the Site from this source.

Summary

4.7.4. There are no artificial sources of flood risk, such as reservoirs or canals in close proximity to the Site. It is therefore considered that there these sources pose very low flood risk to the Site.

4.8 Foul Drainage Sources

4.8.1. Flood risk to the Site from foul drainage (public sewers) has been considered in response to comments from Anglian Water.

4.8.2. As the nearest public sewer is over 1 km from the Site, there is considered to be no risk to the Site from foul drainage flooding.

5.0 MANAGEMENT OF SURFACE AND FOUL DRAINAGE FROM THE SITE

5.1 Introduction

5.1.1. This Section summarises the approach taken in the Outline Drainage Strategy (refer to Appendix 14B in ES Volume III, Document Ref. 6.4) to define the scale of surface water runoff at the Site, and the choice of surface water management measures investigated. Options for the management of foul drainage are also described.

5.2 Policy and Guidance

5.2.1. The NPS (Department for Energy and Climate Change, 2011a), NPPF (Ministry of Housing, Communities and Local Government, 2019), the EA, the NSTS SuDS Guidance (Defra, 2015) the NELC Local Plan (NELC, 2018) and the NELC SuDS Guide (NELC, 2016) require that new developments should not increase flood risk to the site and the surrounding area. Therefore, surface water runoff rates discharging from the propped development at the Site should not exceed the existing runoff rates.

5.2.2. General advisory recommendations of the EA require the existing greenfield runoff rates and volumes to be maintained from any proposed development using SuDS where practicable to provide adequate storage up to the 1% AEP rainfall event (1 in 100 chance in any year) including an allowance for climate change. Flooding must also not occur on any part of the development during the 1 in 30 year (3.3% AEP) rainfall event. More information on the EA's requirements can be found in Section 2.0 of the Outline Drainage Strategy (refer to Appendix 14B in ES Volume III, Document Ref. 6.4).

5.2.3. Following consultation for the Consented Development with the NELIDB and NELC (refer to Annex 2 and Annex 3 respectively), they provided the following comments:

- no development should be commenced until the LPA has approved in writing a scheme to their satisfaction for the provision, implementation and future maintenance of a surface water drainage system;
- the NELIDB would support the use of SuDS and the drainage policies of NELC;
- any discharge should be limited to the greenfield rate; however, Middle Drain Pump Station was designed to allow for areas of development (to the design standard of the time). Any potential increase in discharge would be subject to the drainage system being able to convey the flows (modelling required) and a development charge payable to the NELIDB; and
- under the terms of the Land Drainage Act 1991 the prior written consent of the NELIDB is required for any proposed temporary or permanent works or structures within any watercourse including infilling or a diversion.

5.2.4. Anglian Water's surface water drainage policy (Anglian Water, 2019) as confirmed in their consultation response for the Consented Development (refer

to Annex 4) requires that the disposal hierarchy of preference as presented below should be followed:

- discharge by infiltration to the ground;
- discharge to an open surface water body;
- discharge to a surface water sewer;
- discharge to a combined sewer; and
- discharge to a foul sewer;

5.2.5. It must be demonstrated that the Proposed Development does not increase flood risk both within the Site and elsewhere, and that the surface water disposal hierarchy above has been considered.

5.2.6. The EIA Scoping Consultation response from Anglian Water stated that the use of SuDS for the Proposed Development is encouraged and provided a guidance document on the use of SuDS and an overview of the adoption policy should a developer seek to connect into an Anglian Water asset.

5.2.7. The EIA Scoping Opinion response (Planning Inspectorate, October 2019) provided in Appendix 1B in ES Volume III, Document Ref. 6.4 identified the following additional requirements for the ES and related FRA and drainage strategy from Anglian Water and the NELIDB:

- consideration to all potential sources of flooding - including foul drainage, sewage treatment and water services;
- consideration of whether the Proposed Development would lead to alterations in the drainage patterns around the Site;
- Anglian Water fully supports the use of SuDS as an alternative to discharging surface water to the public sewerage network and welcomes further details of the proposed method of surface water disposal including the SuDS attenuation feature being provided for comment;
- consideration of any increased flood risks linked to climate change;
- the surface water discharge will be limited to the greenfield rate; and
- under the terms of the Land Drainage Act 1991 the prior written consent of the NELIDB is required for any proposed temporary or permanent works or structures within any watercourse including infilling or a diversion.

5.2.8. The Section 42 PEI Report Consultation response (December 2019) from Anglian Water (see Annex 4) provided the following comments:

- Anglian Water is supportive that the proposed surface water storage pond is a preferable option, but other techniques should also be considered during the detailed design phase;
- Anglian Water wish to have further discussions with the Applicant at the detailed design phase regarding the provision, implementation and future maintenance of the SuDS scheme;

- there have been pre-application discussions with Anglian Water in relation to a foul connection to the public sewerage network although the specific requirements have yet to be confirmed. Anglian Water wish to continue to have discussions with the Applicant as part of the application process including the post consent stage; and
- Anglian Water wishes to be part of any further discussion regarding the preparation in of a foul water strategy.

5.2.9. The detailed design of the drainage scheme will take these considerations above into account. Further information on foul drainage for the Proposed Development is provided in Appendix 14B (ES Volume III, Document Ref. 6.4).

5.3 Existing Surface Water Runoff Rates

5.3.1. The existing surface water greenfield runoff rates for the Main Development Area within the Site (approximately 7.3 ha) were calculated. The detailed calculation parameters used for the runoff rates can be found in Section 3.0 of the Outline Drainage Strategy (refer to Appendix 14B in ES Volume III, Document Ref. 6.4).

5.3.2. Table 11 details the existing runoff rates calculated during the 1%, 3.3% and >99% AEP events.

Table 11: Calculated greenfield surface water runoff rates for the Main Development Area (7.3 ha)

RAINFALL EVENT (AEP/ 1 IN X YEARS)	GREENFIELD RUNOFF RATE (REFH2) (l/s/ha)	TOTAL RUNOFF FROM THE EXISTING SITE (7.3 ha) (l/s)
>99% (1 in 1)	0.5	3.7
3.3% (1 in 30)	1.2	8.8
1% (1 in 100)	1.6	11.5

5.4 Un-attenuated Proposed Surface Water Runoff Rates

5.4.1. The runoff rate from the proposed land use within the Main Development Area will increase due to an increase in impermeable area (hardstanding and roofing). The anticipated un-attenuated surface runoff rates, assuming up to 6.5 ha will all be changed to impermeable land use, were calculated in the Outline Drainage Strategy (refer to Appendix 14B in ES Volume III, Document Ref. 6.4), and replicated in Table 12

Table 12Table 12: Calculated impermeable surface water runoff rates for the proposed land use within the Main Development Area (assuming up to 6.5 ha impermeable area) – un-attenuated (including allowances for climate change) (EA, 2020)

FLOOD EVENT (% AEP/ 1 IN X YEARS)	TOTAL RUNOFF (l/s) FOR A RANGE OF RAINFALL DURATIONS								
	15 mins	30 mins	1 hr	2 hr	3 hr	5 hr	12 hr	24 hr	48 hr
50% (2)	440	289	181	127	100	71	39	23	14
20% (5)	775	503	316	201	151	104	53	31	18
10% (10)	1,008	660	416	254	188	127	63	36	21
3.3% (30)	1,390	917	579	340	247	163	80	45	26
2% (50)	1,561	1,036	656	381	275	181	88	50	28
1% (100)	1,811	1,207	766	439	316	207	100	57	32
1% (100) + 20% CC	2,173	1,448	919	527	379	248	120	68	38
1% (100) + 40% CC	2,535	1,690	1,072	615	442	290	140	80	45

5.5 Surface Water Volume Attenuation Requirements

5.5.1. In order to ensure that flood risk is not increased elsewhere, in accordance with the NPPF, NPSs, EA, NELC and NELIDB requirements (see Section 3.2), discharge of surface water runoff from the Main Development Area within the Site will be restricted to the existing greenfield runoff rates and volumes to prevent an increased risk of flooding downstream. The Outline Drainage Strategy (refer to Appendix 14B in ES Volume III, Document Ref. 6.4) identifies that a surface water attenuation solution will be implemented on Site to ensure the greenfield runoff rates presented in Table 11 are not exceeded up to a 1% AEP (1 in 100) event including a +40% allowance for climate change.

5.5.2. The minimum achievable discharge from outfall control structures, for example a HydroBrake, is usually 5 l/s. Consultation with the NELIDB for the Consented Development (see Annex 2) concluded with an agreement in principle that a maximum discharge rate of 5 l/s during the 1 in 1 year event into their land drainage network is acceptable for the total runoff from the Main Development Area following completion of the Proposed Development.

5.5.3. The storage volumes of the attenuation solution required relating to the existing greenfield runoff rates (provided in Table 11) are detailed in Table 13

5.5.4. Table 13. The areas required for the storage solution needed in order to accommodate these volumes under two different scenarios (free discharge, and no discharge resulting from high tide levels) are also provided. This assumes the depth of the storage area is 2 m, reflective of the depth of the land drains around the perimeter of the Site.

Table 13: Calculated surface water runoff attenuation volumes and areas for attenuation ponds for the Main Development Area (assuming up to 6.5 ha impermeable land use)

SCENARIO	RAIN-FALL EVENT (AEP/ 1 IN X YEAR)	TOTAL STORAGE VOLUME (m^3) – MINIMUM	TOTAL STORAGE VOLUME (m^3) – MAXIMUM	TOTAL STORAGE PLAN AREA (ASSUMING 2 m DEPTH) (m^2) - MINIMUM	TOTAL STORAGE PLAN AREA (ASSUMING 2 m DEPTH) (m^2) - MAXIMUM
Free Discharge	**1% (100) + 40% CC**	7,535	7,935	3,768	3,968
No Discharge	**1% (100) + 40% CC**	8,106		4,053	

5.5.5. These storage volumes are preliminary estimates, and further detailed surface water modelling will be undertaken as part of a detailed design phase to more

accurately assess the storage volume requirements once the exact extent of proposed impermeable area is confirmed.

5.6 Proposed Surface Water Attenuation Solution

Consideration of Appropriate SuDS Techniques

5.6.1. In line with the NPPF, NPSs, Defra, EA, NELC and NELIDB advisory recommendations, best practice guidelines and local planning policy, SuDS techniques detailed in the CIRIA SuDS Manual (Ciria, 2015) should be used as a preferential option. A summary of potential SuDS techniques which could be used at the Site are found in Table 5 of the Outline Drainage Strategy (refer to Appendix 14B of in ES Volume III, Document Ref. 6.4). This is not an exhaustive list of techniques and so other options could be explored at the detailed drainage design stage.

Attenuation Storage

5.6.2. Surface water runoff is to be collected on site and conveyed to a surface water attenuation pond SuDS feature via the use of drainage gullies, ditches/ swales where possible. Site topography is conducive for flows to be gravity drained to a surface water attenuation area located at the eastern edge of the Main Development Area (see Figure 2) where opportunity is presented for attenuation-based SuDS. The extent of this basin illustrated in Figure 2 will accommodate the total storage plan area required (as presented in Table 13) assuming a 2 m depth.

5.6.3. It is proposed that the discharge from this attenuation pond will outfall into one of the existing NELIDB land drainage ditches located along the southern or northern boundary of the Site using a flow control mechanism such as a Hydro-Brake to limit the discharge to greenfield rates to 5 l/s/ha (i.e. so that there will be no change to the existing surface water runoff rate into the drainage ditch). The detailed drainage design stage will confirm that the bed levels of the local land drains into which the attenuation solution will discharge are appropriate relative to the bed levels of the storage solution to ensure they are positively drained by gravity (i.e. to confirm that no additional pumping is required).

5.6.4. As the Middle Drain pumping station discharges into the tidal Humber Estuary, it may be the case that during some high-tide events, discharges into either the southern or northern drains become restricted. Design for this will be allowed for during the detailed design phase of the project. To illustrate the effect that this may have on the storage volume, a conservative assumption that no discharge is allowed into the drain during the duration of the critical storm has been applied. An indicative storage volume for this scenario was calculated and is also presented in Table 13.

5.6.5. A detailed drainage design stage will confirm the storage volumes required once the exact impermeable area of the Main Development Area is confirmed, and it will confirm the exact location and feasibility of the outfall from the pond into the existing land drainage network following further consultation with the NELIDB to obtain their agreement.

5.7 Foul Drainage Strategy

5.7.1. Options for the disposal of foul drainage from the Proposed Development comprise: discharge to foul sewer; septic tank and tankering off Site; or treatment on Site using a package treatment plant discharging with the surface water.

5.7.2. At this stage, a connection to foul sewer appears to be unfeasible due to the distance from the Site to the nearest existing foul sewer (over 1 km). As septic tanks are not favoured by the Environment Agency due to the potential risk of soil and groundwater pollution, it is currently considered that an on Site package treatment plant is the most likely preferred solution for foul drainage. Treated flows would be discharged to one of the surface water ditches on Site, and ultimately to the Humber Estuary. The volume contribution is expected to be too small to require a Permit. The package treatment plant would be located within the Main Development Area. Details will be developed and agreed at the detailed design stage in accordance with a DCO requirement.

6.0 MITIGATION OF FUTURE AND RESIDUAL FLOOD RISKS AND OFF-SITE IMPACTS

6.1 Introduction

6.1.1. Consideration should be given to measures that protect the Proposed Development from the residual risk of flooding in the event that the existing tidal defences fail in the vicinity of the Site, or in the event of heavy rainfall that could result in surface water flooding at the Site if the design capacity of the drainage network is exceeded.

6.1.2. The EA recommended a series of flood mitigation measures to reduce this risk to occupiers and equipment within the Site for the Consented Development, which will also apply to the Proposed Development (Annex 1). The Applicant does not intend on building their own new flood defences but wish to build the Proposed Development to the requirements expected in order to prevent flood damage to their own assets and to prevent displacement of flood water that could negatively impact land uses elsewhere off site, following agreement with the EA.

6.1.3. This Section therefore provides recommendations in accordance with the guidance provided in the NPPF, SFRA and by the EA on how the Applicant can design their development to withstand predicted tidal flood levels and mitigate the impact. The following mitigation measures were considered to protect the Proposed Development within the Site in accordance with the legislative and regulatory authority requirements:

- flood resistance and resilience measures;
- flood emergency response plans;
- flood warnings and alerts;
- emergency access and egress; and
- design capacity exceedance.

6.1.4. The EA welcomes these recommendations (see S42 consultation response on the PEI Report (December 2019) in Annex 1).

6.1.5. Mitigation will be secured by DCO requirements.

6.2 Flood Resistance and Resilience Measures

6.2.1. The following flood resilience and resistance mitigation measures were considered to ensure the operation of the Proposed Development is maintained during inundation, and to ensure the safety of people:

- flood resistant / resilient design;
- raising external ground levels; and
- elevating critical plant equipment and/ or internal finished floor levels above the peak flood inundation level.

6.2.2. The NELC SFRA (NLC and NELC, 2011) states that FRAs should demonstrate that a proposal will be safe for its lifetime, including taking into account the

potential impacts of climate change. This includes a requirement to demonstrate that the designed internal finished floor levels are elevated above the modelled breach event peak flood level.

6.2.3. CIRIA Report C688 'Flood Resilience and Resistance for Critical Infrastructure' (Ciria, 2010), states that "*Flood resilience involves designing an infrastructure asset, or adapting an existing infrastructure asset so that although it comes into contact with floodwater during floods, no permanent damage is caused, structural integrity is maintained and, if operational disruption does occur, normal operation can resume rapidly after a flood has receded. Flood resistance involves designing an infrastructure asset, or adapting and existing infrastructure asset so that floodwater is excluded during flood events and normal operation can continue with no disruption occurring to the essential services the asset provides*".

6.2.4. The following measures are potentially appropriate for inclusion in the Proposed Development:

- pipelines and storage tanks designed to withstand the water pressures associated with high return period event flooding;
- tanks securely tethered in such a way to ensure the infrastructure remains secure should flooding occur;
- electrical supply entering the Proposed Development from height and down to required connections;
- use of flood barriers on access points;
- protecting wiring for operational control of the Proposed Development, telephone, internet and other services by suitable insulation in the distribution ducts to prevent damage;
- materials with low permeability up to 0.3 m and which accept water passage through building at higher water depths;
- flood proofing including the use of flood resistant building materials, use of water-resistant coatings, use of galvanised and stainless steel fixings and raising electrical sockets and switches;
- utilising floor materials that are able to withstand exposure to floodwater without significant deterioration and that can be easily cleaned, e.g. concrete-based or stone;
- incorporating water resistant services within the buildings, i.e. avoid services using ferrous materials;
- design development to drain water away after flooding;
- provide access to all spaces to permit drying and cleaning;
- carefully considering the usage and layout of ground floor areas to minimise the potential impact on business operations following a flood; and
- suitable waterproofing measures to development located below ground i.e. tanking below ground storage areas etc.

6.2.5. The following measures are potentially appropriate for inclusion in the design/ layout of the Proposed Development:

- boundary walls and fencing could be designed with high water resistance materials and/ or effective seals to minimise water penetration for low depth, short duration floods;
- tanks can be bunded to a level higher than the 0.5% AEP plus climate change breach flood level;
- pollution control considered to prevent/ reduce the chance of any fuel/ material stored on site leaking;
- site drainage and landscape design following such guidance as CIRIA C635 (Ciria, 2006) to minimise the risk from exceedance flows and any overland flow entering the Proposed Development buildings;
- landscaping of the Site or building curtilage to direct or divert floodwater away from buildings; and
- sustainable drainage systems (SuDS) designed to manage surface water flood risk and water quality.

6.2.6. There are no proposals to raise land for the purposes of protecting the Proposed Development. Therefore, flood water will not be displaced, and this will not pose an increased risk of flooding off-site to adjacent land uses. As this is also a residual risk of flooding, no flood volume compensation will be required for the building footprints or ramps beneath this water level in accordance with the NPPF PPG.

6.2.7. The predicted peak flood level for the Site following a breach in the tidal flood defences during a 0.1% AEP (1 in 1000 chance) flood event including climate change up to 2115 is defined by EA North Area Tidal Modelling to be around 4.60 mAOD. This estimation is based on the worst case scenario of a breach occurring in the immediate vicinity of the Site. It is therefore recommended that in order to protect all critical equipment assets on site, where possible these items are elevated above the estimated peak flood level. This could either comprise being located on elevated internal floor levels or on platforms upon stilts. However, where this is not possible, alternative mitigation such as localised flood resistance and resilience measures or the storage of critical spares could be arranged.

6.2.8. Relevant pieces of critical equipment include:

- electrical equipment, switchboards and control panels;
- transformers;
- main boiler feed pumps;
- condensate extraction pumps;
- primary air fans; and
- induced draught fans.

6.2.9. The Applicant has confirmed that items of critical plant for which a selection of spares can be kept on Site will be identified, and storage of those items on Site

will be implemented to reduce the potential recovery time in the event of a major flood event.

6.3 Flood Emergency Response Plan

6.3.1. When operational the Proposed Development, will be operational and manned 24 hours, 7 days a week. The Site is at a high residual risk of flooding and therefore a system should be put in place to safeguard the workers at the Site in the event of defence failure.

6.3.2. It is recommended that a Flood Emergency Response Plan be developed to ensure the residual risk to the site is sufficiently managed and mitigated. A management system will be implemented to respond to a variety of emergency situations both during normal hours (24/7) and over holiday periods.

6.3.3. A Flood Emergency Response Plan will be prepared in consultation with the EA. This will define access and egress routes from the site and will ensure that the development is registered to receive flood warnings from the EA's 'Floodline Warnings Direct' service to inform if there is a risk of flooding from a tidal storm surge type event which could result in overtopping or breach of defences. This will include the recommendation of at least one Flood Warden for the plant.

6.3.4. As the Flood Emergency Response Plan will be set up to manage the residual risk of flooding, careful consideration will be undertaken as to what action will be taken at each level of warning. The plan will define how occupants of the Site will be evacuated to an appropriate place of safe refuge should there be a real risk of flooding if a defence breach were to occur, as the safety of all occupants is essential. However, it is also important to ensure that the Site is only evacuated when it is really necessary.

6.4 Flood Warnings and Alerts

6.4.1. The EA operates a Flood Warning Service (EA, 2019d) for many areas at risk of fluvial and tidal flooding. The service currently consists of three stages:

- **Flood Alert** - flooding is possible and that you need to be prepared;
- **Flood Warning** - flooding is expected and that you should take immediate action. Action should be taken when a flood warning is issued and not wait for a severe flood warning; and
- **Severe Flood Warning** - there is severe flooding and danger to life. These are issued when flooding is posing significant risk to life or disruption to communities.

6.4.2. Designated EA Flood Alert codes are assigned to areas. Each code gives an indication of the expected level of danger. Although some members of the public find Flood Watches useful, they are predominantly targeted towards professional partners, alerting them to expected flooding of low lying land and roads.

6.4.3. All stages of warning are disseminated via the 'Floodline Warnings Direct', which is a free service that provides warnings to registered customers by telephone, mobile, email, SMS text message and fax. Local radio, TV, loudhailers, sirens and Floodline are also used to deliver flood warning messages. The Floodline

number is 0845 988 1188, and it is always kept up to date with the EA's latest flooding information.

6.4.4. More detailed information on the likely extent and time scale of these warnings can be obtained by request from the EA, by their 'Quickdial' recorded information service, or via their website.

6.4.5. For any proposed commercial or industrial developments within a designated floodplain (as in the case of the Proposed Development), a system for monitoring flood warnings should be developed with designated responsible persons (site managers) able to monitor and disseminate the warnings. This will provide more time to enable emergency access and egress of staff occupants away from the local area which may become flooded during a flood event (including routes for egress) prior to inundation. They should also enable sufficient time to implement protection measures for any equipment on site through sealing all external doors to prevent flood inflow into such buildings as a precaution.

6.4.6. The Site is located within a designated EA Flood Alert Area (short code **053WAT600SHBa** covering tidal flooding of areas near the South Humber Bank from Winteringham to Humberston).

6.4.7. The Site is located within two designated EA Flood Warning Areas (FWA) (short code names **053FWTIMM2** covering the wider area at risk of tidal flooding from Immingham to Pyewipe, and **053FWTGRIM1** covering low-lying areas in Grimsby and Pyewipe). Due to the 24 hour a day nature of the operations at the Site, the Site will be registered with the EA's Flood Warnings Direct service and monitoring of the warnings is adopted at the Site to mitigate the residual risk of tidal/ fluvial flooding in the event of defence failure in the vicinity.

6.5 Emergency Access and Egress to/ from the Site

6.5.1. An emergency access and egress route is a route that is 'safe' for use by occupiers without the intervention of the emergency services or others. A route can only be completely 'safe' in flood risk terms if it is dry at all times.

6.5.2. For developments located in areas at flood risk, the EA consider 'safe' access and egress to be in accordance with paragraph 039 of the NPPF PPG, and 'FRA Guidance for new Developments FD2320' (Defra and Environment Agency, 2005), where the requirements for safe access and egress from new developments are as follows in order of preference:

- safe, dry route for people and vehicles;
- safe, dry route for people;
- if a dry route for people is not possible, a route for people where the flood hazard (in terms of depth and velocity of flooding) is low and should not cause risk to people; and
- if a dry route for vehicles is not possible, a route for vehicles where the flood hazard (in terms of depth and velocity of flooding) is low to permit access for emergency vehicles.

6.5.3. For ‘essential infrastructure’ development, it is considered that dry access and egress from the Site will be desirable during times of extreme floods. However, areas behind sea defences are at particular risk from rapid onset of fast-flowing and deep water flooding, with little or no warning if defences are overtopped or breached. The EA’s breach modelling has illustrated that the Site and immediate surrounding area is located in an area of ‘high’ hazard during the event of a breach. The Site will be evacuated upon receipt of a flood warning unless it is unsafe to do so, in which case a place of safe refuge will be provided on Site.

6.6 Place of Safe Refuge

6.6.1. Places of safe refuge are generally considered an acceptable approach to flood risk management in areas adjacent to sea defences as in the event of a defence breach, inundation is likely to be rapid and therefore evacuation from the Site and local area can sometimes be an unsafe option.

6.6.2. The administration building (Work No. 1B) will include a minimum of three floors. It is currently proposed that the control room will be allocated and adapted to provide adequate facilities to provide a place of safe refuge including welfare facilities for all employees occupying the Site in the extremely unlikely event that the sea defences were to breach. The internal finished floor level of this refuge area will be elevated above the EA’s modelled 0.1% AEP (1 in 1000 chance) event defence breach maximum flood level, defined by EA North Area Tidal Modelling to be around 4.60 mAOD.Drainage System Failure, Capacity Exceedance and Maintenance

6.6.3. Following the completion of the Proposed Development, an additional residual risk relates to maintenance of the on-site drainage infrastructure. Failure, blockage and capacity exceedance above that of the design events for the drainage system are a potential risk to the Site and the surrounding area.

6.6.4. In order to reduce the risks, maintenance of the system will be incorporated in general site management and will remain the responsibility of the Applicant. A manual will be prepared detailing each drainage feature on Site, the maintenance required, timescales for maintenance and who is responsible for undertaking the maintenance. It is expected the Site owners will ultimately be responsible for maintenance of the site drainage system including all pipes, discharge structures and any SuDS implemented on site in accordance with the recommendations in the SuDS Manual.

6.6.5. CIRIA C635 (Ciria, 2006) provides guidance on measures that can be incorporated into the detailed design of developments to steer surface water that has exceeded the capacity of the drainage system away from buildings and route it towards the intended point of attenuation and discharge (for example along swales and roads using raised kerbing and through parking areas). The overspill feature of the surface water attenuation solution on the Site will be designed to convey water towards either of the land drains found along the southern or northern boundary of the Site, in the event of overtopping.

7.0 SUMMARY AND CONCLUSIONS

7.1 Flood Risk Summary

Tidal Sources

7.1.1. Based on the information provided by the EA, it has been determined that during the existing scenario the Site is at a 'low' risk of flooding from tidal sources resulting from overtopping of the defences during events that exceed a 0.5% AEP (1 in 200 chance) of flooding. If these defences were to fail and breach during the existing scenario, the Site would be at a 'high' risk of flooding during either the 0.5% or 0.1% AEP (1 in 1000 chance) events.

7.1.2. During a future scenario resulting from climate change up to 2115 however, the impacts are more significant. The Site is potentially at a 'high' risk of flooding as a result of the defences overtopping during events that include and exceed a 0.5% AEP (1 in 200 chance) of flooding, or in the event that the defences were to breach during either the 0.5% or 0.1% AEP (1 in 1000 chance) events.

7.1.3. Appropriate mitigation measures are therefore required to be implemented at the Site to mitigate this residual risk and ensure the occupiers of the site are safe and critical equipment can continue to function at the Site in the event of such inundation, thus satisfying the requirements of the Exception Test.

Fluvial Sources

7.1.4. The information provided by the EA (see Annex 1), identifies the Proposed Development area within the Site to be at 'very low' risk of fluvial flooding from Oldfleet Drain or Middle Drain.

7.1.5. The new access at the north-eastern corner of the Main Development Area has the potential to increase the risk of flooding from Land Drain 1. During the detailed design phase, a detailed assessment will be undertaken to determine the flow capacity and flow estimates likely to be conveyed along the drain to inform the adequate sizing and levels of a culvert/ clear-span bridge necessary to prevent any obstruction to floodwater.

Surface Water Runoff to the Site

7.1.6. The risk of surface water flooding within the Main Development Area from elsewhere or generated within the Site is considered to be 'low' to 'very low'.

Groundwater

7.1.7. The risk of groundwater flooding within the Main Development Area is considered to be 'low' to 'medium'.

Artificial Sources

7.1.8. There are no artificial sources of flood risk, such as canals or reservoirs in close proximity to the Site. It is therefore considered that there are no flood risks posed to the Site from these sources.

Foul Drainage Sources

7.1.9. As the nearest public sewer is over 1 km from the Site, there is no flood risk to the Site from foul drainage sources.

7.2 Management of Surface Water Runoff from the Site

7.2.1. In order to ensure that the Proposed Development does not increase the flood risk elsewhere, surface water discharge from the Main Development Area will be restricted to the existing greenfield runoff rate in accordance with the requirements of the NPPF, EA and NELIDB. Surface water runoff attenuation will be provided to ensure existing greenfield runoff rates are maintained up to the 1% AEP event plus a 40% allowance for climate change.

7.2.2. It is proposed that a surface water attenuation pond SuDS feature will be located at the eastern edge of the Main Development Area. It is proposed that the discharge rates from this attenuation pond will be controlled through a system such as a HydroBrake and released into an existing ditch along either the southern or northern boundary of the Site. Water will then continue to follow the existing drainage mechanism connecting into a further drain along the western boundary of Site, before out-falling into the Humber Estuary either via two existing flapped outfalls from this land drain, through Middle Drain pumping station, or via the Oldfleet flapped outfall.

7.2.3. The detailed drainage design will confirm the storage volumes required once the exact impermeable area of the proposed land use is confirmed, and it will confirm the exact location and feasibility of the outfall from the pond into the existing land drainage network.

7.3 Management of Foul Drainage from the Site

7.3.1. Options for the disposal of foul drainage from the Proposed Development comprise: discharge to foul sewer; septic tank and tankering off Site; or treatment on Site using a package treatment plant discharging with surface water. As the nearest foul sewer is located over 1 km from the Site and septic tanks are not favoured by the EA, the most likely preferred option appears to be an on Site package treatment plant.

7.4 Residual Risk Mitigation Measures

7.4.1. The predicted peak flood level for at the Site during a 0.1% AEP (1 in 1000 chance) flood event due to a breach in the tidal flood defences including an allowance for climate change up to the year 2115 is defined by EA Northern Area Tidal Modelling to be around 4.60 mAOD.

7.4.2. In accordance with the recommendations made by the EA during consultation, it is therefore proposed that an internal floor level providing a place of safe refuge for the occupiers within the control room of the Proposed Development will be elevated above a level of 4.60 mAOD.

7.4.3. In accordance with the recommendations made by the EA during consultation, the Applicant does not intend to raise existing ground levels of the Main

Development Area, but will either elevate all critical equipment assets above a level of 4.60 mAOD or otherwise ensure they are adequately protected.

7.4.4. A number of additional mitigation strategies will be considered during the design process for the Proposed Development to ensure the operation of the Site is maintained in the event of a flood. These strategies include: developing a Flood Emergency Response Plan through consultation with the NELC and signing up to the Floodline Warnings Direct service provided by the EA; providing flood resistance and resilience measures into the design of the buildings; and designing for failure, maintenance and capacity exceedance of the surface water drainage network.

7.4.5. The EA welcomes these recommendations (see PEI Report consultation response (December 2019) in Annex 1).

7.4.6. Mitigation will be secured by DCO requirements.

7.5 Comparison of Consented Development and Proposed Development Flood Risk Assessment

7.5.1. The overall conclusions of the FRA for the Proposed Development are the same as the conclusions of the FRA for the Consented Development. The only change has been the refinement of the modelled flood level for the Site (based on new data from the EA) at 4.60 mAOD, which will inform the development of mitigation during the detailed design of the Proposed Development.

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