The Keadby 3 Low Carbon Gas Power Station Project

PINS Ref: EN010114

The Keadby 3 Low-Carbon Gas Power Station Order

Land at and in the vicinity of the Keadby Power Station site, Trentside, Keadby, North Lincolnshire

Preliminary Environmental Information (PEI) Report Volume II - Appendix 12A: Flood Risk Assessment

The Planning Act 2008

The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017

Applicant: SSE Generation Limited

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GLOSSARY

Abbreviation	Description
AEP	Annual Exceedance Probability
AGI	Above Ground Installation
AOD	Above Ordnance Datum
ANNWLMB	North Nottinghamshire Water Level Management Board
BGS	British Geological Survey
CCP	Carbon Capture Plant
CCGT	Combined Cycle Gas Turbine
CCR	Carbon Capture Ready
CCUS	Carbon Capture, Utilisation and Storage
CCP	Carbon Capture Plant
CCGT	Combined Cycle Gas Turbine
CEMP	Construction Environmental Management Plan
CO2	Carbon Dioxide
CRT	Canal and River Trust
CO2	Carbon Dioxide
DCO	Development Consent Order
DEMP	Decommissioning Environmental Management Plan
DMRB	Design Manual for Roads and Bridges
DTM	Digital Terrain Model
EA	Environment Agency
EIA	Environmental Impact Assessment
ES	Environmental Statement
FRA	Flood Risk Assessment
HCA	Homes and Communities Agency

Abbreviation	Description
kV	Kilovolt
MAGIC	Multi-agency geographical information for the countryside
MMO	Marine Management Organisation
MW	Megawatt
NPPF	National Planning Policy Framework
NPS	National Policy Statement
NSIP	Nationally Significant Infrastructure Project
NTS	Non-Technical Summary
PFA	Pulverised Fuel Ash
PINS	Planning Inspectorate
PRoW	Public Right of Way
PWS	Private Water Supply
SFRA	Strategic Flood Risk Assessment
SPA	Special Protection Area
SPZ	Source Protection Zone
SSSI	Site of Special Scientific Interest
TCPA	Town and Country Planning Application
TWh	Terawatt hours
RBMP	River Basin Management Plan
WFD	Water Framework Directive

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ANNEXES

TABLES

1.0 INTRODUCTION

1.1 Overview

1.1.1 AECOM Infrastructure and Environment Limited ('AECOM') has been commissioned by the Applicant to prepare a Flood Risk Assessment (FRA) in support of a Development Consent Order (DCO) application for a proposed low carbon gas fired generating station on the Keady Power Station site at Keadby, Scunthorpe DN17 3EF (hereafter referred to as the 'Proposed Development').

1.1.2 Sections 1 - 4 of this appendix provide the Flood Risk Assessment for the Proposed Development whilst Sections 5 - 6 relate to the Conceptual Drainage Strategy for the Proposed Development Site.

1.2 The Purpose and Scope of this Document

1.2.1 The Environment Agency's 'Flood Map for Planning'[1] identifies that the Proposed Development Site is located across Flood Zones 2 and 3, with the majority lying in Flood Zone 3. Flood Zone 3 is defined by the National Planning Policy Framework[2] (NPPF) Planning Policy Guidance: Flood risk and coastal change[3] (PPG), 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. Flood Zone 2 is defined as 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).

1.2.2 The North Lincolnshire Strategic Flood Risk Assessment (SFRA) defines the Proposed Development Site as in the Tidal Flood Zone 3a. It is not defined as in Zone 3b; land where water has to flow or be stored in times of flood, as the Proposed Development does not act as a functional floodplain due to existing Environment Agency defences which prevent natural flooding from occurring.

1.2.3 As the Proposed Development comprises an area in excess of one hectare (Ha) and is located within Flood Zone 3, a Flood Risk Assessment (FRA) is required to accompany any planning application for the development of the Proposed Development, as per the requirements of the National Planning Policy Framework (NPFF)[1].

1.2.4 This document comprises an FRA that is appropriate to the nature and scale of the Proposed Development, meets the necessary requirements of current planning guidance (NPPF), to support the planning application for the Proposed Development. In producing this FRA, the following was undertaken.

1 Environment Agency (2018) Flood Map for Planning (Rivers and Sea). Available at https://flood-map-for-planning.service.gov.uk/
2 Ministry of Housing, Communities and Local Government. (2019a). National Planning Policy Framework. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/733637/National_Planning_Policy_Framework_web_accessible_version.pdf
3 Ministry of Housing, Communities and Local Government. (2019b) . Planning Practice Guidance: Flood risk and coastal change. Available at: https://www.gov.uk/guidance/flood-risk-and-coastal-change

- consultation with and obtaining data from North Lincolnshire Council (NLC), and from the Environment Agency as well as consultation with Isle of Axholme and North Nottinghamshire Water Level Management Board (IoAaNNWLMB) in regard to the Proposed Development, the flood risks posed to Proposed Development 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 IoAaNNWLMB), 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 Proposed Development Site to acceptable levels.

1.3 Data Sources

1.3.1 The baseline conditions for the Proposed Development Site were established through a desk-based study and via consultation with the Environment Agency 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	Identifies the position of the Site, local hydrological features, and riparian owners
Historical Land Use and Hydrological Features	Historic OS maps dating back from 1842- Present[4]	Identifies historical land use change and hydrological features over the last 176 years.
Identification of Existing Flood Risk	Environment Agency Flood Map for Planning[5]	Identifies fluvial/ tidal inundation extents.
	Environment Agency Flood Risk from Surface Water Map[6]	Identification of flood risk from surface water.

[4] Ordnance Survey. Maps from 1857-1986. Available at: http://www.oldmapsonline.org/

[5] Environment Agency (2018) Flood Map for Planning (Rivers and Sea). Available at https://flood-map-for-planning.service.gov.uk/

[6] Environment Agency. Flood Risk from Surface Water Available at: https://flood-warning-information.service.gov.uk/long-term-flood-risk/map?map=SurfaceWater

Purpose	Source	Comments
Identification of Existing Flood Risk	Environment Agency Flood Inundation Mapping[7]	Provides information on the risk of flooding from reservoirs (artificial sources).
	Environment Agency Groundwater Conditions Map[8]	Identification of groundwater designations through geology.
	North and North East Lincolnshire Strategic Flood Risk Assessment (SFRA)[9]	Assesses flood risk across the NLC boundary area. Includes flood risk from fluvial/tidal, sewers, overland flow and groundwater.
	North Lincolnshire Preliminary Flood Risk Assessment (PFRA)[10]	
	NLC Local Flood Risk Management Strategy (LFRMS)[11]	
	British Geological Survey (BGS) records[12]	Provides details of geology and hydrogeology in the vicinity of the Site.
Identification of Historical Flooding	SFRA	Provides details of historical flooding.
	PFRA	
	NLC Consultation	
	Environment Agency Historic Flood Map[13]	
Details of the Scheme	Indicative Site Layout – **Figure 3.2** and **Figure 4.1** of PEI Report Volume III	Provides layout of the Proposed Development

[7] Environment Agency. Flood Risk from Reservoirs. Available at: https://flood-warning-information.service.gov.uk/long-term-flood-risk/map?map=Reservoirs

[8] Environment Agency. Groundwater. Available at: http://magic.defra.gov.uk/MagicMap.aspx

[9] North East Lincolnshire Council (2011). North and North East Lincolnshire SFRA. Available at: https://www.nelincs.gov.uk/wp-content/uploads/2016/06/2011-Strategic-Flood-Risk-Assessment.compressed.pdf

[10] North Lincolnshire Council (2011). North Lincolnshire PFRA. Available at: https://www.nelincs.gov.uk/wp-content/uploads/2016/03/Preliminary-Flood-Risk-Assessment-2011.pdf

[11] North Lincolnshire Council (2016). NLC Local Flood Risk Management Strategy. Available at: https://www.northlincs.gov.uk/wp-content/uploads/2018/07/Local-Flood-Risk-Management-Strategy.pdf

[12] British Geological Survey. Geology Viewer Available at: http://mapapps.bgs.ac.uk/geologyofbritain/home.html

[13] Environment Agency, Historic Flood Map Download. Available at: https://data.gov.uk/dataset/76292bec-7d8b-43e8-9c98-02734fd89c81/historic-flood-map

Consultation with Key Stakeholders

1.3.2 Consultation was undertaken with the Environment Agency and NLC as part of this FRA. The data request letters, and their responses are provided in **Annex A** and **Annex B** respectively. These advisory recommendations are summarised and addressed in Sections **Error! Reference source not found.**, **Error! Reference source not found.** and **Error! Reference source not found.**. At the time of writing, a response from NLC has not been received.

2.0 THE PROPOSED DEVELOPMENT AND SITE DESCRIPTION

2.1 The Proposed Development

2.1.1 The Proposed Development would comprise a low carbon gas fired power station with a gross electrical output capacity of up to 910MWe and associated buildings, structures and plant, including:

- a carbon capture enabled electricity generating station including a CCGT plant with integrated cooling infrastructure and CCP, including compression equipment and associated utilities, various pipework, water treatment plant, wastewater treatment, firefighting equipment, emergency diesel generator, control room, workshops, stores and gatehouse and a permanent laydown and turnaround area for maintenance;
- chemical storage facilities, other minor infrastructure and auxiliaries/ services, and natural gas receiving facility (all located in the **Proposed Power and Carbon Capture (PCC) Site**);
- natural gas pipeline from the existing National Grid Gas high pressure (HP) gas pipeline within the Proposed Development Site to supply the Proposed PCC Site, including an above ground installation (AGI) for both National Grid Gas's apparatus and the Applicant's (**Gas Connection Corridor**);
- electrical connection works to and from the existing National Grid 400kV Substation (**Electrical Connection Area to National Grid 400kV Substation)** for export of power;
- Electrical connection from the existing Northern Powergrid 132kV Substation (**Potential Electrical Connection to Northern Powergrid 132kV Substation**) for supply of power to the Proposed PCC Site during start-up of plant and equipment);
- Water Connection Corridors including:
  - a water intake within the Stainforth and Keadby Canal, which could be utilised for cooling water and make-up water subject to ongoing engagement with the Canal and Rivers Trust and Environment Agency (**Canal Water Abstraction Option)**;
  - in the event that water from the Stainforth and Keadby Canal is not available or there is insufficient capacity for provision of water for the Proposed Development, an intake to provide cooling and make-up water from the River Trent (**River Water Abstraction Option**);
  - disposal of used cooling water to the River Trent (**Water Discharge Corridor**);
  - towns water connection pipeline from existing water supply within the Keadby Power Station for potable water;
- AGI for connection to third party CO_2 export infrastructure including compression facilities;
- permanent access to the Proposed Development Site from A18 and means of permanent emergency access via Chapel Lane, including improvement works to existing routes;

- a new surface water drainage system comprising pond(s) and/ or a tank or similar, including a new surface discharge connection to a drainage channel;
- associated development including:
  - temporary construction and laydown area including weighbridges, contractor facilities/ cabins and parking;
  - temporary retention, improvement and use of an existing Waterborne Transport Offloading Area and Additional Abnormal Indivisible Load (AIL) Route;
  - site preparation including earthworks;
  - pipeline and cable connections between part of the Proposed Development Site;
  - landscaping and biodiversity enhancement areas, internal access roads, roadways and footpaths;
  - gatehouses, security and fencing; and
  - lighting.

2.1.2 Further details of the Proposed Development are set out in Section 2.6 of this chapter and within **Chapter 4:** The Proposed Development (PEI Report Volume I)**.** The areas of the Proposed Development Site described above are shown in **Figure 3.2** and an indicative Site Layout Plan is included as **Figure 4.1** (PEI Report Volume III).

2.2 Location

2.2.1 The Proposed Development Site encompasses an area of approximately 88.1ha, of which approximately 17.7ha of land is currently under evaluation to determine the suitability for potential construction laydown. The Proposed Development Site is approximately centred on national grid reference (NGR) 482351, 411796.

2.2.2 The Proposed Development Site comprises land within the boundary of the existing Keadby Power Station site near Scunthorpe, North Lincolnshire and falls within the administrative area of NLC. The Keadby Power Station site currently encompasses the operational Keadby 1 Power Station and Keadby 2 Power Station (under construction), both owned and under control of the Applicant.

2.2.3 The Proposed Development Site is bordered by the tidal River Trent to the east, by Stainforth and Keadby Canal to the south, by agricultural land and Keadby Wind Farm to the north, and by the former Keadby Ash Tip and scrubland to the west. The Proposed Development Site is surrounded on all sides by numerous drains.

2.2.4 Full details of the Proposed Development Site and its surroundings can be found in **Chapter 3:** The Site and Surrounding Area (PEI Report Volume I). The location of the Proposed Development Site is shown in **Figure 1.1**: Site Location (PEI Report Volume III); an indicative Site Layout Plan is included as **Figure 4.1** (PEI Report Volume III).

2.3 Existing Land Use

2.3.1 The Proposed Development Site compromises industrial land including the existing Keadby 1 and Keadby 2 Power Stations, an existing 400kV Substation (owned and operated by National Grid) and 132kV Substation (owned and operated by Northern Powergrid) , car parking, agricultural land and derelict industrial land. Existing roads

within the Proposed Development Site include Trent Road, Chapel Lane and Bonnyhale Road.

Access

2.3.2 Existing access to the existing Keadby Power Station site from the east is by Trent Road off the B1392. This allows access from Keadby village on the banks of the River Trent.

2.3.3 Access to the Proposed Development Site during construction and operation would be via the existing access roads from the A18. Perpendicular and skewed construction access points off the A18, built for construction vehicles during construction of Keadby Wind Farm and currently used by all construction vehicles associated with the Keadby 2 Power Station, would be used to access the Proposed Development Site. The skewed access would be used, where required to transport oversized AIL into the Proposed Development Site. Additional routes for AIL are also available from the Waterborne Transport Offloading Area and via Ealand, along Bonnyhale Road (refer to **Chapter 10**: Traffic and Transportation (PEI Report Volume I).

2.4 Hydrology and Flood Risk Management Infrastructure

Surface Waterbodies

2.4.1 The Proposed Development Site lies immediately west of the tidal River Trent, which flows in a northerly direction.

2.4.2 Approximately 300m to the north of the Proposed Development Site, beyond Keadby Common, is Warping Drain (otherwise known as Eastoft Moor Drain). Warping Drain, an ordinary watercourse, flows east and into the tidal River Trent via sluice gates. This waterbody consists of two separate watercourses, Warping Drain and Paupers Drain approximately 13km long and drains an area of around 32km^2. It is an artificial waterbody. The drain is artificial in its character, being overwide, straight, and with flood embankments either side. Flows will also be influenced by tidal locking.

2.4.3 To the west of the Proposed Development Site is the Keadby Boundary Drain, an ordinary watercourse, which runs south to north and appears to flow into Warping Drain, although this remains to be confirmed. At the point where the Keadby Boundary Drain joins Warping Drain via a sluice, there are flood gates on Warping Drain.

2.4.4 South of the Proposed PCC Site there are a number of watercourses running west to east in parallel with each other. These include the North Soak Drain and the South Soak Drain, which flow either side of the Sheffield and South Yorkshire Navigation – Stainforth and Keadby Canal. This waterbody is approximately 26km long and drains an area of around 56km^2. The North and South Soak Drains flow into the Three Rivers a short distance to the south, and this then connects with the River Trent via sluice gates and Keadby Pumping Station, which is a major pump draining the Isle of Axholme. These three watercourses, plus the River Trent, are all main rivers.

2.4.5 The Sheffield and South Yorkshire Navigation – Stainforth and Keadby Canal is linked to the River Trent via Keadby Locks. It is managed by the Canal & River Trust (CRT).

Surrounding Land Use

2.4.6 To the north, land use is predominantly agricultural with the Keadby Wind Farm being located immediately north of the Proposed Development Site. To the east, the village of Gunness is located across the tidal River Trent; a small village on the eastern floodplain. Agricultural land also makes up the majority of land west of the Proposed Development Site, before reaching the small town of Crowle 3km west of the Proposed Development Site. A large landfill site is located immediately west of the Proposed Development Site.

2.4.7 Between the Three Rivers and Stainforth and Keadby Canal land drains are spaced every 150m across agricultural fields orientated in a north-south direction. The Isle of Axholme lies just south of here.

2.5 Topography

2.5.1 Review of LiDAR data indicates that the land surrounding the Proposed Development Site is largely flat with ground elevations ranging from approximately 0.5m Above Ordnance Datum (AOD) to the east of the existing Power Stations to approximately 1.2m AOD immediately to their west.

2.5.2 The scrubland on the west side of the Proposed Development Site is higher than surrounding land ranging between 5 and 8m AOD. To the west of the Proposed Development Site boundary elevation reaches up to 19.6m AOD on top of landfill associated with historic coal-fired power use.

2.5.3 Flood defences along the River Trent at the east side of the site are between 6.2m to 6.3m AOD. On the Stainforth and Keadby Canal levees are 1.3m AOD.

2.6 Geology

2.6.1 The British Geological Survey (BGS) Map Sheet 88 (Doncaster, 1:50,000 scale) and Map Sheet 79 (Goole) indicates that the Proposed Development Site geology comprises superficial Warp (artificially induced alluvium comprising clay and silt) over the majority of the Proposed Development Site. Where these are absent, alluvium (clay, silt, sand and gravel) is mapped to be present in the far-eastern part of the Main Site. The alluvium is associated with the River Trent. Drift deposits (25-Foot Drift of Vale of York) comprising sands, silts and clays are also anticipated beneath the alluvium.

2.6.2 The published superficial geology is indicated to overlie the Mercia Mudstone Group. Made ground is also expected across the Proposed Development Site given the historical phases of development that have taken place.

2.6.3 Based on a review of selected historical BGS borehole records from the Proposed PCC Site, the geology is characterised by approximately 12m to 17m of alluvium and drift deposits of clay, silt and sand, with occasional peat layers recorded at various depths between 0.45m and 1.6m thickness. These superficial deposits overlie the Mercia Mudstone Formation which shows evidence of near surface weathering, the extent to which decreases with increasing depth.

2.6.4 The Soilscape for England published by the National Soil Resources Institute describes the soils at the site as "Loamy and clayey soils of coastal flats with naturally high groundwater" (Cranfield Soil and Agrifood Institute, 2018). These soils are naturally wet and drain predominantly to local groundwater and marginal ditches.

2.6.5 Levels within the historical borehole records indicate generally shallow groundwater levels within the superficial geology of between 0.9m and 3.0m below ground level (bgl). Occasionally, deeper groundwater strikes were recorded between 5.4m and 6.9m bgl. There is insufficient information to conclude at this stage whether these levels are representative of true groundwater levels across the wider area.

2.6.6 The Environment Agency classifies the underlying superficial geology as Secondary A aquifer and the Mercia Mudstone as a Secondary B aquifer. The Environment Agency defines a Secondary A aquifer as an aquifer with '*permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers'* and a Secondary B aquifer as an aquifer with '*predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering'*. The extent to which groundwater is used as a local resource is currently not known at this stage.

2.6.7 There are no groundwater SPZ within the study area according to the MAGIC website (DEFRA, 2020).

2.7 The Proposed Development

2.7.1 The application for Development Consent will seek permission for the construction, operation (including maintenance) and decommissioning of the Proposed Development. For further details, please refer to **Chapter 4:** The Proposed Development (PEI Report Volume I).

2.7.2 The Proposed PCC Site comprises an integrated power generation and carbon capture train located within the north-west corner of the Proposed Development Site..

2.7.3 It is situated adjacent to the 840MW CCGT Keadby 2 Power Station which, following the grant of a Variation to an existing Section 36 consent in 2016, commenced construction in April 2019 on land adjacent to Keadby 1 Power Station. Keadby 1 Power Station was built on the site of a former coal fired power station which was operational between 1952 and 1984. The Keadby 1 Power Station was commissioned in 1996. It is recognised that it is likely that Keadby 1 Power Station would not be in operation concurrently with the Proposed Development, however uncertainty regarding plans for the timing of future closure of Keadby Power Station mean that the removal of Keadby 1 Power Station structures has not been considered in the assessment in this assessment. .

2.7.4 The design life of the Proposed Development is approximately 25 years from the completion of construction. At the end of operation, it is expected that the Proposed Development will have some residual life remaining and an investment decision would then be made based on the market conditions prevailing at that time. If the operating life were to be extended, the Proposed Development would be upgraded in line with the legislative requirements at that time. Such a scenario may give rise to a greater operational lifetime of around 35 years.

2.7.5 For the purposes of the FRA and to reflect the likely period of operation and occupation, it has been assumed that the Proposed Development will become operational between Q3 2025 and 2032, (depending on planning and construction programming), which would therefore result in decommissioning between 2060 and 2067.

Proposed Access

2.7.6 As described in Section 2.3, the preferred access to the Proposed Development Site would be via the existing road access road from the A18 (centred at OSNGR 480331, 410012) which passes via the existing Pilfrey Bridge over the Stainforth and Keadby Canal and the Scunthorpe to Doncaster passenger rail line (refer to **Figure 3.2** in PEI Report Volume III). Vehicles would access the Proposed Development Site from the A18, via this existing access road/ Bonnyhale Road/ existing private access roads and a new main access road to be constructed into the Proposed PCC Site. Access to the Proposed Development Site is by the road.

2.7.7 Included in the indicative DCO order limits is also a connection corridor to the Waterborne Transport Off-Loading Area at the south-east corner of the Proposed Development Site. This has been used throughout the construction of the Keadby 2 Power Station to transport Abnormal Indivisible Loads (AIL) to the power station site. It is understood that this is due to be reinstated following cessation of construction works. A similar approach is anticipated for The Proposed Development whereby the haul road will be recommissioned, utilised and then reinstated following completion of construction.

2.7.8 An emergency vehicle access route is also proposed from Chapel Lane, bordering the northern edge of The Proposed Development Site in order to provide access for emergency vehicles to the Proposed PCC Site.

Proposed Development Drawings

2.7.9 A set of drawings illustrating the Proposed Development proposals are provided as part of the PEI Report Volume III. Figures which may aid in the review of this Appendix are summarised below:

- **Figure 1.1**: Site Location Plan (PEI Report Volume III)
- **Figure 3.1**: Indicative DCO Site (PEI Report Volume III)
- **Figure 3.2**: Indicative DCO Layout Site (PEI Report Volume III)
- **Figure 4.1**: Indicative Site Layout Plan (PEI Report Volume III)
- **Figure 12.1**: Surface Water Features and their Attributes (PEI Report Volume III);
- **Figure 12.2**: Groundwater Features and their Attributes (PEI Report Volume III);
- **Figure 12.3**: Ecological Designations (PEI Report Volume III);
- **Figure 12.4**: Environment Agency Fluvial Flood Zones (PEI Report Volume III); and
- **Figure 12.5**: Flood Risk from Surface Water (PEI Report Volume III).

3.0 PLANNING POLICY

3.1 Introduction

3.1.1 A full overview of the legislative and policy context that is relevant to the Proposed Development is provided within **Chapter 7:** Legislative Context and Planning Policy (PEI Report Volume I).

3.1.2 The Sections below consider the planning policies and guidance of relevance to the Proposed Development 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 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, 2019b) 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.

National Planning Policy Framework (NPPF) (2019a)

3.2.6 The NPPF (July 2019) is currently supported by the PPG (March 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.

3.2.7 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.

3.2.8 The Flood Zone definitions as presented in Table 1 of the PPG are defined in Table 2. As discussed in Section **Error! Reference source not found.**, the Environment Agency's 'Flood Map for Planning' (EA, 2018) identifies that the Proposed Development Site is located across Flood Zones 2 and 3. The Flood Zones are assessed without taking into account any flood defences which may be present.

Table 2: Environment Agency 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

3.2.9 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'

3.2.10 According to Table 2 of the PPG, the Proposed Development of a Power Station comprises the vulnerability classification of 'Essential Infrastructure'. The definition of Essential Infrastructure includes 'Essential Utility Infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations' 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 Infrastructure	**Water Compatible**	**Highly Vulnerable**	**More Vulnerable**	**Less Vulnerable**
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

3.2.11 As Table 3 indicates, application of the Exception Test is required for the Proposed Development. 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.

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

Environment Agency Climate Change Guidance (2020)

3.2.13 The Environment Agency published updated climate change allowances in March 2020[14] to support 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.

[14] Environment Agency. (2020) Flood risk assessments: climate change allowances. Available at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

3.2.14 These should be considered within a FRA in regard to future impacts from climate change on site specific planning applications. The Environment Agency guidance outlines how and when allowances should be applied for FRAs.

Tidal Climate Change Allowances

3.2.15 Table 4 is an extract replicated from Table 3 of the Environment Agency guidance detailing the anticipated rise in sea levels up to 2065; (i.e. enveloping the maximum anticipated operational lifetime of the development).

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

Area of England	Allowance	2000 to 2035 (mm)	2036 to 2065 (mm)	2066 to 2095 (mm)	Cumulative rise 2000 to 2095 (metres)
Humber	Higher central	5.5 (193)	8.4 (252)	11.1 (333)	0.78
Humber	Upper end	6.7 (235)	11 (330)	15.3 (459)	1.03

Fluvial Climate Change Allowances

3.2.16 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: Environment Agency Climate Change Allowances to apply based upon the Flood Zone and Development Lane Use Vulnerability

	Water Compatible	Less Vulnerable	More Vulnerable	Highly Vulnerable	Essential Infrastructure
Flood Zone 2	NA	CA	Assess CA & HCA	Assess HCA & UEA	Assess HCA & UEA
Flood Zone 3a	CA	Assess CA & HCA	Assess HCA & UEA	X	UEA
Flood Zone 3b 'Functional Floodplain'	CA	X	X	X	UEA
NA = No Allowance; CA = Central Allowance; HCA = Higher Central Allowance; UEA = Upper End Allowance; X = Development not permitted					

3.2.17 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. The +30% fluvial flow increase for climate change is therefore applicable to the Proposed Development as the proposed lifespan is 35 years.

Table 6: Environment Agency Peak River Flow Climate Change Allowances for the Humber River Basin District

	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)
Upper End Allowance	20%	30%
Higher Central Allowance	15%	20%
Central Allowance	10%	15%

Pluvial Climate Change Allowances

3.2.18 To account for the anticipated changes in rainfall intensity, the Environment Agency guidance (as shown in Table 7) states that a FRA for an expected 35 year 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.

Table 7: Environment Agency Peak River Flow Climate Change Allowances for the Humber River Basin District

	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)
Upper End Allowance	10%	20%
Central Allowance	5%	10%

3.2.19 Therefore, a +20% increase in rainfall to account for climate change is applicable to the Proposed Development. 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 Site.

3.2.20 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

3.2.21 The Department for Environment, Food and Rural Affairs (Defra) published their Sustainable Drainage Systems: Non-Statutory Technical Standards (NSTS) in March

2015[15] setting the requirements for the design, construction, maintenance and operation of SuDS. The NSTS are intended to be used alongside the NPPF and PPG.

3.2.22 The NSTS that are mainly relevant to the consideration of flood risk to and from the Proposed Development relate to runoff destinations, peak flow control and volume control.

3.2.23 These standards are summarised in Table 1 of the Conceptual Drainage Strategy which is provided within this appendix. Additional guidance is provided for structural integrity, designing for maintenance considerations and construction.

3.3 Regional Policy

Trent Catchment Flood Management Plan

3.3.1 The Trent Catchment Flood Management Plan (CFMP) (EA, 2010) is a document produced by the Environment Agency to understand the scale and extent of flooding and sets policies for managing flood risk in the catchment. The CFMP identifies the Proposed Development Site as being within the 'Axholme and NW Lincolnshire' region, recognising that there is an extensive risk from flooding to agricultural land on both sides of the Trent.

3.3.2 The CFMP also states that essential infrastructure, including Keadby Power Station, would only be affected in an extreme event (0.1% AEP). However, it is recognised that climate change and sea level rise will lead to more frequent overtopping of tidal River Trent defences, potentially causing them to fail. If this was the case then it is estimated that in the next 50 to 100 years 25,000 properties would be at risk in the Axholme and NW Lincolnshire sub area during a 1% flood event.

3.3.3 Within the Axholme and NW Lincolnshire regions the CFMP identifies that flood risk management activities are to be focused on mitigating the impacts of climate change.

North Lincolnshire Preliminary Flood Risk Assessment

3.3.4 In accordance with the Flood Risk Regulations 2009 NLC are designated as a Lead Local Flood Authority (LLFA) and has produced a Preliminary Flood Risk Assessment (PFRA). This was submitted to the Environment Agency in 2011. The PFRA reports on sources of flooding which the LLFA is responsible for under the requirements of the Flood Risk Regulations which are: ordinary watercourses, surface water, groundwater, artificial sources and flooding which results from the interaction of local sources and sources (tidal and main river) which the Environment Agency is responsible for. It does not include fluvial flood risk from main rivers, tidal flood risk and risk of flooding from large reservoirs.

3.3.5 The PFRA uses locally agreed significance thresholds to assess the consequences of past and future flooding in North Lincolnshire. The PFRA reviewed the local sources of flooding and through an assessment of the potential consequences of this flooding, concluded that there were no areas in North Lincolnshire which reached the national

[15] Defra. (2015). Sustainable Drainage Systems: Non-Statutory Technical Standards. Available at: https://www.gov.uk/government/publications/sustainable-drainage-systems-non-statutory-technical-standards

thresholds for the identification of Flood Risk Areas (i.e. 30,000 people at risk in one area).

North and North East Lincolnshire Strategic Flood Risk Assessment

3.3.6 The Level 1 SFRA was published in 2011 to support the LPA assessment for development sites in relation to flood risk. The SFRA was completed in consultation with the Council, the Environment Agency and IDB to provide information on the probability of flooding. The report also takes into account the impacts of climate change.

3.3.7 It is intended that the SFRA will be used by NLCs planning and building control department to inform the application of the Sequential Test when allocating land or determining applications, in line with the NPPF.

3.3.8 The SFRA recognises that the western floodplain of the Trent, originally marshland, was reclaimed in the 16th and 17th Centuries and is very fertile but relies on an extremely complex drainage system, almost entirely pumped, to maintain water levels low enough for arable agriculture to take place.

North Lincolnshire Council Local Flood Risk Management Strategy

3.3.9 As LLFA, NLC has a responsibility to develop a Local Flood Risk Management Strategy (LFRMS) which sets out a clear plan for future flood risk management in the region, ensuring people, businesses communities and other risk management authorities have an active role in how flood risk is managed.

3.3.10 The strategy is for the residents and businesses of North Lincolnshire and sets out how the Council intends to manage local flood risks, as well as contribute to management from non-local sources, and to engage and inform residents on their own responsibilities, and enable them to contribute to the management of flood risk.

3.4 Local Policy

3.4.1 The Proposed Development Site lies entirely within the administrative area of North Lincolnshire Council. The statutory development plan for the area currently comprises the following documents:

- North Lincolnshire Core Strategy[16] - adopted June 2011;
- Employment and Land Allocations (North Lincolnshire Council, 2017) - adopted March 2016; and
- Saved Policies of North Lincolnshire Local Plan[17] - adopted May 2003, saved September 2007.

16 North Lincolnshire Council (2011). Available at:
http://www.planning.northlincs.gov.uk/planningreports/corestrategy/adopteddpd/FullCoreStrategy.pdf

17 Local Development Frameworks Government Office for Yorkshire and The Humber (2007). Available at:
https://www.northlincs.gov.uk/planning-and-environment/planning-policy-the-north-lincolnshire-local-plan/#1593095254001-ec189f5a-67c8

3.4.2 It is considered that these documents may be 'important and relevant' as defined by EN-1 (DECC, 2011a). The following policies are considered relevant to the Proposed Development:

Core Strategy (2011)

- CS2 - Delivering More Sustainable Development;
- CS5 - Delivering Quality Design in North Lincolnshire;
- CS11 - Provision and Distribution of Employment Land;
- CS16 - North Lincolnshire's Landscape, Greenspace and Waterscape;
- CS17 – Biodiversity;
- CS18 - Sustainable Resource Use and Climate Change;
- CS19 - Flood Risk;
- CS20 - Sustainable Waste Management; and
- CS25 - Promoting Sustainable Transport;

Local Plan (2003)

3.4.3 The following saved policies are considered relevant from the Local Plan:

- IN10 – Wharves;
- RD1 – Development involving High Quality Agricultural Land;
- RD2 - Development in the Open Countryside;
- T1 – Location of Development;
- T2 – Access to Development;
- T5 - Green Travel Plans;
- T6 - Pedestrian Routes and Footpaths;
- T8 - Cyclists and Development;
- T14 - The North Lincolnshire Strategic Road Network (NLSRN);
- T23 - Water Freight;
- C1 - Special Protection Areas, Special Areas of Conservation and Ramsar Sites;
- LC2 - Sites of Special Scientific Interest and National Nature Reserves;
- LC7 - Landscape Protection;
- DS10 - New Hazardous Installations and Pipelines;
- DS11 - Polluting Activities;
- DS13 – Groundwater Protection and Land Drainage;
- DS14 - Foul Sewage and Surface Water Drainage;
- DS15 - Water Resources; and

- DS16 - Flood Risk.

3.4.4 To the south of the Proposed Development Site is the Stainforth and Keadby Canal. The locks at the junction of the canal and the River Trent are grade II listed and are designated by North Lincolnshire Council as a heritage asset in their adopted Local Plan. The lock is located approximately 200m to the south of the 'Water Connection Corridor'.

3.4.5 The River Trent, immediately to the east of the Site is part of the designated Ramsar, SSSI and SAC for the Humber Estuary.

3.4.6 The Stainforth and Keadby Canal is designated as a Local Wildlife Site.

3.4.7 The Proposed Development Site is predominantly within the open countryside, albeit the proposed 'Water Connection Corridor' is adjacent to the Keadby 2 Development Boundary.

Emerging Policy

3.4.8 North Lincolnshire Council is preparing a new Local Plan to 2036. Once agreed (formally adopted), it will replace the current North Lincolnshire Local Plan, the Core Strategy and the Housing and Employment Land Allocations Development Plan Documents (DPD).

3.4.9 The Council undertook their Regulation 18 'Preferred Options' between February and March 2020.

North Lincolnshire Council's SuDS and Flood Risk Guidance Document

3.4.10 North Lincolnshire Council, as LLFA, has produced a SuDS and Flood Risk Guidance Document Supplementary Guidance Document (SGD) (North Lincolnshire Council, 2017) providing developers and designers with guidance on SuDS and guidance on what type of SuDS are appropriate to a particular development, depending on the size and location. It also provides advice regarding adoption and maintenance of SuDS, riparian responsibilities and specific North Lincolnshire Council requirements, which include that:

- the LLFA drainage team should be consulted at pre-application stage;
- SuDS are required for all developments;
- no water should be stored above ground up to and including the 1 in 100 year event unless stored in a SuDS component;
- surface water runoff should be limited for all new developments to the greenfield runoff rate;
- storage components should not be constructed in private land;
- infiltration should only be viable for areas where the infiltration rate of soils are above 1 x 10-6m/s. Infiltration testing should be undertaken over a period of time, preferably over various seasons; and
- the level of betterment will be considered on a site by site basis for all brownfield sites.

3.4.11 A more comprehensive review of prevailing policy and guidance is presented in **Chapter 12**: Water Resources and Flood Risk (PEI Report Volume I) that this appendix accompanies.

4.0 FLOOD RISK SOURCES

4.1 Introduction

4.1.1 The NPPF requires the effects of all forms and sources of flood risk to and from the Proposed Development 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).

4.2 Historical Flooding Incidents

4.2.1 The Environment Agency's Historic Flood Map demonstrates that the majority of fluvial flooding on the Trent around the Proposed Development Site is confined to the eastern floodplain. Any historic flooding within the vicinity of the Proposed Development has been confined to the off-loading area for waterborne transport where there is a small functional gap in the fluvial defences. In addition, a small amount of flooding is noted on Chapel Lane at the east of the Proposed Development Site.

4.3 Tidal Sources

4.3.1 The River Trent is considered tidal from the Humber Estuary to Keadby Bridge, just upstream of the Proposed Development Site.

Flood Map for Planning

4.3.2 The Environment Agency's 'Flood Map for Planning' available to view on their website[1] 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.

4.3.3 The Flood Map for Planning illustrates that the entire Proposed Development Site and surrounding environs (other than a small, slightly elevated area between Keadby Common in the east, Keadby Boundary Drain in the west, and the canal to the south, and around Crowle) is within the Environment Agency's indicative Flood Zone 3. Flood Zone 3 is land assessed as having a 1 in 200 or greater annual probability of flooding from the sea (>0.5% AEP) in any year. The River Trent is tidal adjacent to the site and tidal food risk (flooding from the sea) is the dominant source of flooding. The Proposed Development Site does however benefit from Environment Agency maintained flood defences (embankments) along the River Trent.

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 0.5% AEP (1 in 200 chance) event taking into account the potential impacts of climate change.

4.3.5 The Environment Agency's 'Flood Map for Planning' (**Annex A**) identifies there to be existing tidal flood defences located immediately adjacent to the Proposed

Development Site. The Environment Agency Asset Management Dataset demonstrates that the tidal defences are 6.2m to 6.3m AOD and have been built to provide a 1 in 200-year level of protection. According to the additional information provided by the Environment Agency (**Annex A**), the tidal defences protecting this area consist of predominantly embankments along with concrete floodwalls. The concrete walls are in 'poor' to 'fair' condition and the embankments are in 'fair' condition. The Environment Agency inspect 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, especially as the concrete floodwall which is in poor condition could result in high likelihood of a breach.

Modelled Tidal Water Levels

4.3.6 The Environment Agency provided modelled tidal peak water levels for the South Humber Bank area to inform this FRA (**Annex A**). The Environment Agency model indicates that during a 0.1% AEP (1 in 1000 year) event, tidal levels in the Humber Estuary could rise up to 5.27 mODN at the Grimsby gauge to the south-east of the Proposed Development Site, and 5.47 mODN at the Harborough gauge north-west of the Proposed Development Site.

4.3.7 In closer proximity to the Proposed Development Site, the Environment Agency have provided modelled tidal peak water levels from the Tidal Trent SFRM (Mott MacDonald, 2013) (**Annex A**). The model indicates that during a 0.1% AEP (1 in 1000 year) tidal event, levels in the North and South Soak Drains could rise up to 0.73mAOD (Table 8). This is below the level of the defences on the canal (1.3mAOD). The levels on the Trent during the same event are 6.09m AOD (Table 8). This is also below the height of the embankments which are a minimum of 6.2mAOD. As a result, there is currently a low risk from tidal flooding. There is however a risk of overtopping of defences during scenarios with climate change up to 2067, the maximum date of operation (Table 9).

Table 8: Modelled water levels on North and South Soak Drains during tidal event (Mott MacDonald, 2013).

	Level (mAOD)
0.5% AEP	0.73
0.5% AEP + CC	0.72
0.1% AEP	0.73

Table 9: Modelled water levels on the River Trent during tidal event (Mott MacDonald, 2013).

	Level (mAOD)
0.5% AEP	6.01
0.5% AEP +35yr CC (2025-2060) (Higher Central)	6.34
0.5% AEP +35yr CC (2032-2067) (Higher Central)	6.4
0.5% AEP +35yr CC (2025-2060) (Upper End)	6.43
0.5% AEP +35yr CC (2032-2067) (Upper End)	6.51
0.1% AEP	6.09

Modelled Overtopping and Breach Failure Water Levels Behind the Defences

4.3.8 Analysis undertaken at the Keadby 2 Power Station site in 2015 provides information on the potential residual flood risks arising from a breach of the tidal Trent within the vicinity of the Proposed Development.

4.3.9 The 2015 breach modelling (Wallingford, 2015) for the Keadby 2 FRA (0.5% AEP tidal event including a 50 year allowance for climate change with a breach level of 4.6m AOD) has shown that in the unlikely event of a breach of the Trent tidal defences the flood level would be at 2.2m AOD across the site. This is a depth of approximately 0.25-0.5m at the location of the Proposed Development.

Summary

4.3.10 Based on the information provided by the Environment Agency, it has been determined that the Proposed Development 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 (1 in 200 chance) of flooding.

4.3.11 During a future scenario resulting from climate change up to the year 2055 however, the impacts are more significant. The Proposed Development Site is potentially at a 'high' residual risk of flooding as a result of overtopping during events that exceed a 0.5% AEP (1 in 200 chance) of flooding on the River Trent. The Proposed Development is however at a 'low' residual risk of tidal flooding originating from the North and South Soak Drains.

4.3.12 In the event that the defences were to breach during either the 0.5% or 0.1% AEP (1 in 1000 chance) events, the hazard to the Proposed Development would be 'high' as flood waters would enter. However, the probability of this occurring is 'low', and this is a residual risk.

4.4 Fluvial Sources

4.4.1 A review of OS mapping identified that the nearest main watercourse is the River Trent to the immediate east of the Proposed Development Site. Other main watercourses in proximity of the Proposed Development Site include the Three Rivers and the North and South Soak Drains. The SFRA states that high water levels on the River Trent is one of the main sources of flooding in the area. This is because the high embankments allow water levels on the Trent to rise much higher than the surrounding watercourses and much of the Isle of Axholme drainage (including the Three Rivers and North and South Soak Drains is lifted by pumping into the Trent.

4.4.2 Ordinary watercourses in proximity to the Proposed Development Site include the Stainforth and Keadby Canal, Warping Drain (to the north) and Keadby Boundary Drain (to the west). The SFRA states that the failure of the network of watercourses to drain the marshland surrounding the river is another main source of flooding.

Flood Map for Planning

4.4.3 The Environment Agency's 'Flood Map for Planning' identifies that the Proposed Development Site is located across Flood Zones 2 and 3, with the majority lying in Flood Zone 3. Flood Zone 3 is defined by the National Planning Policy Framework[2]

(NPPF) Planning Policy Guidance: Flood risk and coastal change[3] (PPG), as land with a high probability of flooding (>1% Annual Exceedance Probability (AEP)) (1 in 100 or greater annual chance of river flooding). Flood Zone 2 is defined as 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). However, this map does not differentiate between the tidal/ fluvial sources of risk and the flood defences are not taken into account.

Modelled Fluvial Water Levels and Extents

4.4.4 The Environment Agency have provided modelled fluvial peak water levels from the Tidal Trent SFRM (Mott MacDonald, 2013) (**Annex A**). The model demonstrated that during a 0.1% AEP (1 in 1000 year) event, fluvial water levels in the North and South Soak Drains could rise up to 1.69 mAOD (Table 10).

Table 10: Modelled water levels on North and South Soak Drains during fluvial event.

	Level (mAOD)
0.5% AEP	0.73
0.5% AEP + CC	0.72
0.1% AEP	1.69

Fluvial Flood Defences

4.4.5 The Environment Agency's 'Flood Map for Planning' (**Annex A**) identifies there to be existing fluvial flood defences on the North and South Soak Drains. These defences consist largely of earth embankments and higher ground at 1.3mAOD and are in fair to good condition. These are sufficiently high enough to prevent overtopping during events with a 0.5% AEP and 0.5% AEP + CC but not the 0.1% AEP event (Table 10). However, there is a raised strip of land no lower than 2.0mAOD to the south of the Proposed Development Site on which the access road is located. This also acts as a barrier to fluvial flooding onto the Proposed Development Site.

Unmodelled Land Drains

4.4.6 The land drains surrounding the Proposed Development Site drain predominantly into Warping Drain, North and South Soak Drains and the Three Rivers.

4.4.7 Due to the very flat and low-lying nature of the surrounding area, the Proposed Development Site is surrounded to the north, south and west by a complex drainage system from agricultural fields as represented within **Figure 12.1** (PEI Report Volume III). These land drains are currently unmodelled. The land drainage system relies on pumping and as a result, pumping capacity and condition have the potential to influence flood risk, alongside meteorological factors.

Summary

4.4.8 Based on the information provided by the Environment Agency, it has been determined that the Proposed Development Site is at a 'low' risk of flooding from fluvial sources with the defences in place or resulting from overtopping of the defences during events

that exceed a 0.5% AEP (1 in 200 chance) and 0.1% AEP. There is a residual risk associated with breach of the defences.

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 Historical data indicates that the Proposed Development Site is not at risk from reservoir flooding and groundwater flooding based on the geological setting of the wider area encompassed by Keadby 1 and Keadby 2 (Mott MacDonald, 1991). Based on the previous assessment undertaken as part of the Keadby 2 Power Station ES (ERM, 2016), groundwater flooding is understood to be effectively managed via the extensive drainage system serving Keadby 1 and Keadby 2 Power Stations.

4.5.3 The 'Areas Susceptible to Groundwater Flooding' (AStGWF) dataset provided by the Environment Agency to inform the NLC SFRA can be used to identify areas where geological conditions could enable groundwater flooding to occur and where groundwater may come close to the ground surface. This information is shown as a proportion of 1km grid squares where there is potential for groundwater emergence. The data does not show where flooding is likely to occur, but instead should be used at a strategic level to indicate areas for further investigation.

4.5.4 The areas around the Proposed Development Site are artificially drained by various land drains and pumping stations, which help to maintain the groundwater level. These are expected to remain operational through the lifetime of the development, contributing to a low risk of groundwater emergence at the Proposed Development Site.

4.5.5 In addition, a significant proportion of the Proposed Development Site is covered in impermeable hardstanding surface, reducing natural infiltration potential as part of the Proposed Development. As a result, due to hardstanding ground intercepting groundwater and preventing it from reaching the surface, the likelihood of localised groundwater reaching the surface and causing flooding is reduced.

4.5.6 Based on the information provided, the Proposed Development Site is considered to be at low risk of flooding from groundwater sources.

4.6 Surface Water Runoff to the Site

4.6.1 Surface water flooding is caused by overland flow that results from rainfall that cannot drain into the ground through infiltration, instead travelling over the ground surface. This can be exacerbated where the permeability of the ground is low due to the type of soil (such as clayey soils) and geology or land use including urban developments with impermeable surfaces.

Overland Flow of Rainfall Runoff

4.6.2 The Environment Agency 'Risk of Flooding from Surface Water' (RoFSW) maps indicate areas at risk from surface water flooding when rainwater does not drain away

through the normal drainage systems or soak into the ground, but instead lies on or flows over the ground.

4.6.3 The RoFSW[6] flood map for the Proposed Development can be viewed on the Environment Agency website. It identifies that the Proposed Development Site is generally not at risk from surface water flooding, classifying the majority of the land to be at 'very low' risk of flooding from surface water. The Environment Agency define 'very low risk' as an area that has a less than a 1 in 1000 (0.1%) probability of flooding in any given year. Mapping shows that there are isolated areas at low and medium risk along existing roads and paths on the Proposed Development Site, and one small area of high risk along East Road within the existing (operational) Keadby 1 Power Station site.

4.6.4 As the Proposed Development will increase the impermeable area and therefore increase the rate of surface water runoff from the Proposed Development Site, drainage infrastructure to mitigate this has been considered in **Section 5.0** of this appendix.

Existing Drainage Infrastructure

4.6.5 Extensive site drainage already exists as a result of the Keadby 1 and Keadby 2 Power Stations (under construction). Aside from existing infrastructure for Keadby 1 Power Station, information supplied by the Applicant[18] confirms that the Keadby 2 Power Station drainage system will comprise of three sub-systems:

- surface water system;
- oily-waste system; and
- condensate polishing plant wastewater system.

4.6.6 The surface water system is designed to collect all water generated by precipitation up to a 1 in 200-year storm event. The system separately collects surface water running off from building roofs and surface water running off from paved areas such as roads, due to the potential for oil contamination of the wastewater resulting from car parking and roads.

4.6.7 Rainwater from the roofs of buildings is collected by rainwater down comers and connected to nearby manholes. These manholes are connected to the surface water drainage system by underground gravity pipework and routed directly to the detention basin. Surface water from paved areas in the power island is collected by combined kerb drainage channels at the sides of the roads, with regular silt traps. The surface water collected from the roads is routed via gravity fed pipes to the detention basin through a bypass oil separator.

4.6.8 There is a detention pond which has a capacity of approximately 1,300 cubic meters (m^3) and is located in the north-west corner of the Keadby 2 Power Station plant area. Water from the detention basin is discharged in a controlled manner using a hydro

[18] SSE (2019). Keadby 2 Power Station. Environmental Permit Variation: Supporting Information. Available at: https://consult.environment-agency.gov.uk/psc/dn17-3ef-keadby-generation-limited/supporting_documents/Supporting%20Information.pdf

brake (to control flow) to the Keadby Common Drain at the new proposed discharge point W11. Keadby Common Drain is connected to a wider drainage network managed by the IoAaNNWLMB.

4.6.9 The Keadby 2 Power Station surface water drainage system is designed to comply with the following SuDS requirements:

- no damage shall occur to any buildings, plant, equipment or assets within the Site, or downstream of the Site as a result of a 1 in a 200-year storm event;
- no flooding of property or public roads during a 1 in 200 rainfall event. The event shall be contained on-site without damage to property;
- on-site storage provided for up to 1 in 30-year event;
- nominal flow modelled, (1 in 30 years): 47 l/s, Peak flow (1 in 100 years + 20% climate change): 68.4 l/s; and
- an allowable discharge from the Site set at brownfield runoff rate with 30% betterment. As a result, the increased hardstanding introduced during construction will not increase the rate of runoff from the site and the system will increase retention as compared to existing conditions.

4.6.10 Further review of the Keadby 2 Power Station Drainage Strategy (Including Surface Water Calculations) will be undertaken throughout the EIA process to help inform the FRA and final conceptual drainage strategy to be submitted with the DCO Application.

Summary

4.6.11 Based on the above information, the risk to the Proposed Development Site from overland flow of surface water generated adjacent to, or from waterbodies located within the Proposed Development Site is considered to be 'low' to 'very low'.

4.7 Artificial Sources

Reservoirs

4.7.1 The Proposed Development Site is not considered at risk from reservoir flooding

4.7.2 The Reservoir Act 1975 as amended by the Flood and Water Management Act 2010 in England applies to reservoirs which hold over 25,000m^3 of water and sets out safety and maintenance requirements. The Environment Agency have assessed the flood hazards associated with the breach or failure of large reservoirs or high risk reservoirs and the Environment Agency map of Flood Risk from Reservoirs shows that the Proposed Development Site is not located in an area at residual risk of flooding from reservoirs in the event of a structural failure or breach.

Canals

4.7.3 The Sheffield and South Yorkshire Navigation – Stainforth and Keadby Canal is directly adjacent to the south of the Proposed Development Site but given its' shallow gradient and that it drains into the River Trent by a sluice, the risk of flooding is likely to be low. If any overtopping of the canal were to occur, this would drain into the North and South Soak drains located at a lower elevation on either side of the canal and drain away.

However, the canal levels are monitored and maintained by the Canal & Rivers Trust. As a result, overtopping is unlikely and so the site is at low risk of flooding from the canal.

Summary

4.7.4 The risk of flooding from artificial waterbodies is considered to be low.

5.0 MANAGEMENT OF SURFACE WATER FROM THE PROPOSED DEVELOPMENT SITE

5.1 Introduction

5.1.1 This Section summarises the approach taken in the Conceptual Drainage Strategy to define the scale of surface water runoff at the Proposed Development Site, and the choice of surface water management measures investigated.

5.2 Planning Policy and Guidance

5.2.1 The NPPF, the Environment Agency, the NSTS SuDS Guidance[19], the NLC Local Plan[17] (2018) and the NLC SuDS Guide[20] require that new developments should not increase flood risk to the site or the surrounding area. Therefore, surface water runoff rates discharging from the proposed development at the Proposed Development Site should not exceed the existing runoff rates.

5.2.2 The Environment Agency's general advisory recommendations require the existing greenfield runoff rates to be maintained after development using SuDS where practicable to provide adequate storage up to the 1% Annual Exceedance Probability (AEP) event (1 in 100 chance in any year) including an allowance for climate change.

5.3 Existing Surface Water Runoff Rates

5.3.1 The Proposed Development Site boundary is shown on **Figure 3.1**: Indicative DCO Site (PEI Report Volume III). This boundary is provisional and for the purposes of the PEI Report. The final Proposed Development Site boundary for the purposes of the DCO Application, including land for associated connections and temporary land required during construction of the Proposed Development, will be refined through on-going studies).

5.3.2 Within this preliminary FRA for the purposes of providing PEI, the consideration of existing surface water runoff is focused on two principle areas: The Proposed PCC Site and the temporary Construction Laydown Areas (including contractor facilities and parking).

5.3.3 The Proposed PCC Site comprises an area of 18.7ha and includes areas of Keadby Common that are not hardstanding, and areas that have been developed as laydown areas for Keadby 2 construction as shown on Plate 1 below.

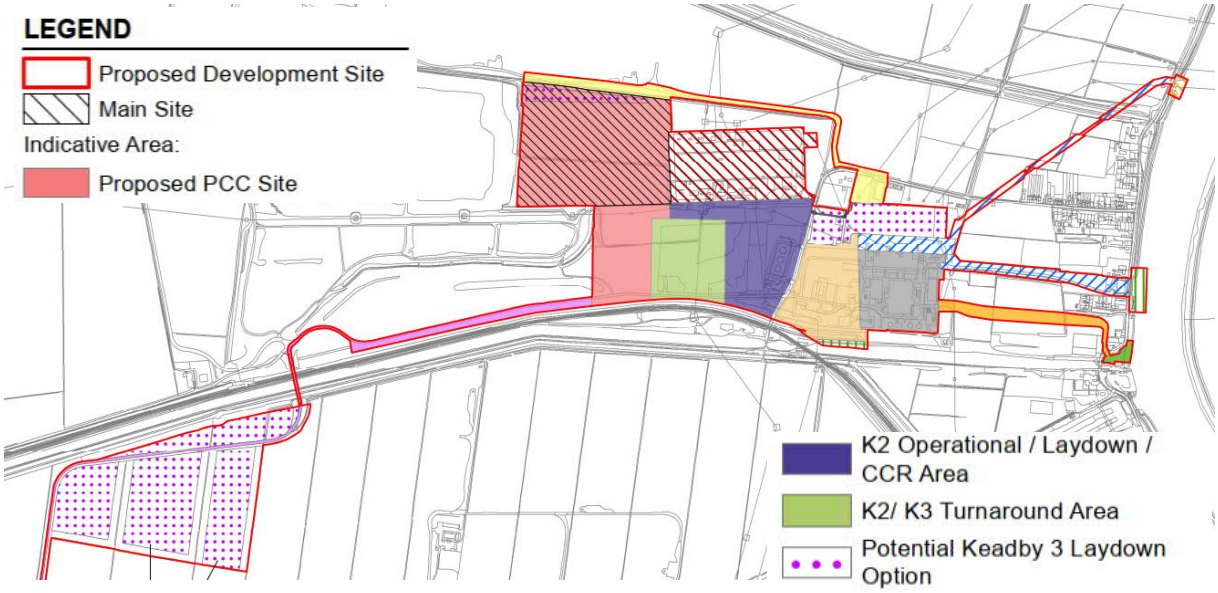
[19] Defra. (2015). Sustainable Drainage Systems: Non-Statutory Technical Standards. Available at: https://www.gov.uk/government/publications/sustainable-drainage-systems -non-statutory-technical-standards

[20] NLC (2016). North East Lincolnshire Council SuDS Guide. Available at: http://archive.nelincs.gov.uk/council/planning-policy/evidence-base/local-documents/infrastructure/sustainable-urban-drainage-systems-guide/

Plate 1: View of Proposed PCC Site (looking south-east)

5.3.4 For the Proposed Development, approximately 13.5ha (the 'Main Site') on the northern part of Keadby Common will require adequate hardstanding to provide the development platform for CCGT and CCP buildings and equipment. A further 4.8ha of land south of the Main Site will require hardstanding, where buildings, plant or equipment including tanks are proposed, or may remain as greenfield, as no development can take place beneath the existing 400kV overhead lines that bisect the Proposed PCC Site (shown in Plate 1).

Plate 2: Areas of the Proposed Development Site



5.3.5 As shown on Plate 2, a number of areas of land are currently under evaluation to determine the suitability for potential construction laydown. At this preliminary stage, it is anticipated that up to approximately 17.7ha of land may be required for temporary laydown with areas to be refined through ongoing studies and assessment. As depicted by **Plate 2**, this includes agricultural land to the south of the Proposed PCC

Site and an area of land near the former Keadby 1 substation to the east of the Proposed PCC Site ('Potential Keadby 3 Laydown Option').

5.3.6 As shown I Plate 1, in some areas, there is existing development or hardstanding including the former Keadby 1 substation site area and temporary laydown areas for Keadby 2 Power Station construction site (approximately 14%), whilst the remainder of areas under consideration are currently greenfield.

5.3.7 For concept drainage design and for the purposes of this FRA, it is assumed that existing runoff rates will be equivalent to the greenfield runoff rate. Notwithstanding, as the design for the Proposed Development evolves and the layout is refined, this will be reviewed and adjusted, where required. Discussions with the IDB and the Environment Agency are ongoing to help refine the approach to assessment of surface water runoff.

5.3.8 The greenfield runoff rate for the Proposed PCC Site and temporary construction and laydown areas have been estimated using the ReFH2 software with FEH 2013 data. The peak greenfield runoff rates for both areas are given in Table 11 and Table 12 respectively.

Table 11. Proposed PCC Site Greenfield Runoff Rates

Return Period (years)	Greenfield Runoff Rate (l/s)
1	12.2
2	14.1
5	21.0
10	26.2
30	35.1
50	39.8
75	43.8
100	46.9
200	55.4
1000	84.3

Table 12. Temporary Construction and Laydown Area Greenfield Runoff Rates

Return Period (years)	Greenfield Runoff Rate (l/s)
1	9.5
2	11.0
5	16.4
10	20.4
30	27.4

Return Period (years)	Greenfield Runoff Rate (l/s)
50	31.1
75	34.2
100	36.6
200	43.3
1000	65.7

5.4 Un-attenuated Proposed Surface Water Runoff Rates

5.4.1 Storage volume calculations have been undertaken for the critical storm duration of the 100-year return period storm event plus climate change allowance. A discharge of 46.9l/s for the Proposed PCC Site and 36.6l/s for the temporary construction laydown areas has been calculated as equal to the existing 100-year return period greenfield runoff rate.

5.5 Surface Water Volume Attenuation Requirements

5.5.1 The storage volume estimate has been made using the quick storage estimate tool within the Microdrainage 2019.1 Source Control Program; results are shown in Table 13. FEH 2013 point descriptors were used to undertake this analysis.

5.5.2 Detailed attenuation calculations would be undertaken as part of the drainage design as the Proposed Development progresses and attenuation solutions would be specified at this stage.

Table 13. Required Attenuation Volumes

Area	Rainfall Event	Impermeable Area (ha)	Minimum Storage Requirement (m^3)	Maximum Storage Requirement (m^3)
Proposed PCC Site	1 in 100 years +40% Climate Change	11.84	8075	10094
Temporary construction laydown areas	1 in 100 years +40% Climate Change	5.85	3678	4540

5.6 Proposed Surface Water Attenuation Solution

Consideration of Appropriate SuDS Techniques

5.6.1 In line with Environment Agency advisory recommendations, the Construction Industry Research and Information Association (CIRIA) SuDS manual best practice guidelines and local planning policy, sustainable drainage systems should be used as a preferential option. A summary of sustainable drainage systems is given in Table 14.

At this preliminary stage, this is not an exhaustive list and other options will be considered further throughout the EIA process as the conceptual drainage design develops. Additionally, as the areas required for the Proposed Development are refined, the determination of appropriate SuDS techniques will be reviewed. The SuDS management train should be taken into account during detailed drainage design with an aim of capturing surface water as close to the source as possible.

5.6.2 As the runoff rates generated will be greater than the greenfield runoff rate, attenuation systems will be required to store runoff prior to discharge. Attenuation for the Proposed PCC Site and Temporary Construction and Laydown Area may be considered independently from each other, however if a pumped discharge system is used, there may be operational benefits to combining the discharge systems in one location. This may be upstream, or downstream of attenuation.

5.6.3 As the topography may limit the maximum depth of attenuation features, source control methods such as rainwater harvesting, and permeable paving should be considered to reduce the burden on attenuation systems.

Table 14: Sustainable Drainage Systems

Technique	Description	Restrictions of use
Storage Pond	Storage ponds can be used to attenuate overland runoff and slowly release it into a watercourse or sewer. These systems do not offer water quality benefits unless additional water quality measures are added such as filters or sedimentation volume.	Storage ponds may require substantial earthworks and thus incur high costs during the construction phase. Additionally, large ponds which store water above ground level may be classified as reservoirs which are subject to a range of legislative requirements. Land take requirements for storage ponds are likely to be substantial. Below ground attenuation depths may be limited by topography and the groundwater table.
Permeable Paving	Permeable paving allows rainwater to infiltrate through a hard-standing surface to underlying soils or drainage infrastructure. From which it may infiltrate or be directed to a local watercourse or sewer.	Permeable pavements may be restricted by the presence of basements or groundwater levels as well as high imposed loads.
Rainwater Harvesting	Rainwater from roofs and hard surfaces can be stored and used for non-potable purposes. This can provide a reduction of surface water runoff through control at source as well as reducing the demand on the water supply system. In the case of the proposed development harvested rainwater could be used to supplement cooling water supplies.	Rainwater harvesting is dependent on a consistent supply of rainwater which cannot be ensured. As such it should be used as a supplement to conventional water supply only. Filtration is required for rainwater that is harvested from areas where sediment pick-up is likely.

Technique	Description	Restrictions of use
Below Ground Attenuation	Below ground storage tanks will attenuate surface water flows in much the same way as surface water ponds, although with reduced land take. Storage tanks will typically require a hydro brake to ensure steady and controlled discharge.	Upfront costs are likely to be high for buried storage tanks. The maintenance regime may be onerous or involve heightened health and safety risks due to enclosed spaces. Depth of below ground attenuation may be limited by the groundwater table, although this may be accounted for in design of buried tanks.

5.6.4 As the Proposed Development Site is underlain by soils with low permeability, it is unlikely that infiltration will be a viable method of surface water discharge. Additionally, the ground water table depth is not known, nor is the extent to which it varies. As the EIA progresses and the design for the Proposed Development evolves, these areas of uncertainty will be addressed further in order to progress toward the design for an infiltration system.

Foul Drainage Strategy

5.6.5 As the Proposed Development will be an active industrial site controlled by an Environmental Permit and regulated by the Environment Agency, pollution control measures will be required to demonstrate Best Available Techniques (BAT) in order to prevent accidental discharge of pollutants such as hydrocarbons to surface water systems. Pollution prevention measures considered would include (but not be limited to).

- the design of oil interceptors shall be undertaken based on manufacturer supplied information;
- foul flows and effluent arising from the Proposed Development operation will be kept separate from the surface drainage network;
- areas which are expected to be sources of frequent pollutant spills to be isolated through the use of bunds; and
- during construction, the Contractor will adhere to all relevant pollution prevention guidelines[21] which will be set out in the Framework CEMP to accompany the application.

[21] The construction of the Proposed Development would be in accordance with good practice guidance. A series of Guidance for Pollution Prevention (GPP) is in development, which provides updated good practice guidance to the UK. Where new GPP documents are yet to be published, previous Pollution Prevention Guidance (PPG) documents still continue to provide useful advice on the management of construction to avoid, minimise and reduce environmental impacts, although they should not be relied upon to provide accurate details of the current legal and regulatory requirements and processes. For further information, please refer to **Chapter 12:** Water Environment and Flood Risk (PEI Report Volume I).

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

6.1 Overview

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 Proposed Development Site, or in the event of heavy rainfall that could result in surface water flooding at the Proposed Development Site, should the design capacity of the drainage network be exceeded.

6.1.2 The Applicant does not intend to build new flood defences for the Proposed Development Site. Rather, the Proposed Development will be designed taking into account the requirements to prevent flood damage to its own assets and to prevent displacement of flood water that could negatively impact land uses elsewhere off-Site.

6.1.3 This Section therefore provides recommendations in accordance with the guidance provided in the NPPF, the local SFRA and by the Environment Agency on how the measures that will be considered by the Applicant in the design to withstand predicted tidal flood levels and mitigate potential impacts. The following mitigation measures have been considered to protect the Proposed Development 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 Any required mitigation related to flood risk will be considered further throughout the consenting process and informed by engagement with relevant stakeholders. It is proposed that required mitigation, including protection of critical infrastructure, would be secured by requirements of the Draft DCO.

6.2 Flood Resistance and Resilience Measures

6.2.1 The following flood resilience and resistance mitigation measures have been considered to ensure the operation of the 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 NLC SFRA[9] (2011) states that a FRA 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 design internal finished floor levels are elevated above the modelled breach event peak flood level.

6.2.3 CIRIA Report C688 (2010) 'Flood Resilience and Resistance for Critical Infrastructure' , 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 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 to minimise the risk from exceedance flows and any overland flow entering the Proposed Development buildings;
- landscaping of the Proposed Development Site to direct or divert floodwater away from buildings; and
- SuDS designed to manage surface water flood risk and water quality.

6.2.5 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 0.3m and 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 type of 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.

6.2.6 In order to protect against the residual risk of breach and the future risk from defence overtopping, the vulnerable power infrastructure will be raised above the predicted water levels on site in a 0.5% AEP +35yr climate event (Table 9) and the predicted level from a breach. Wholesale land raising of the Proposed Development Site is not considered necessary to manage the risk and would require large scale import of material which is not sustainable. Further engagement with the Environment Agency is proposed in order to agree the levels to which the critical power infrastructure will be raised; such levels will be secured via requirements of the Draft DCO and reported as parameters in **Chapter 4**: The Proposed Development of the final ES.

6.2.7 The risk of overtopping in the future and as a result of climate change driven sea level rise assumes that in the intervening period no raising of the Trent tidal defences occurs. This is a highly conservative assumption and given the areas of land and property at risk across the wider area it would be reasonable to assume that future defence raising, and upgrades may continue to protect the Proposed Development Site, mitigating the overtopping risk. This cannot however be relied upon.

6.2.8 Based on the flood depth band information provided by breach model (Wallingford, 2015), the predicted peak flood level for the Proposed Development Site following a breach in the tidal flood defences during a 0.5% AEP (1 in 200 chance) flood event including a 50 year allowance for climate change is 2.2mAOD. This estimation is based on the worst-case scenario of a breach occurring in the immediate vicinity of the Proposed Development Site. It is therefore recommended that in order to protect all critical equipment assets forming part of the Proposed Development, these items be elevated above the estimated peak flood level. This could either comprise being located on elevated internal floor levels or on platforms upon stilts.

6.2.9 Relevant critical equipment is considered to include:

- electrical equipment, switchboards and control panels;
- transformers;
- main boiler feed pumps;

- condensate extraction pumps; and
- primary air fan and induced draught fans.

6.2.10 The Applicant will undertake identification of critical items for which spares can be kept on site, and storage of those items on site would 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 Although the Proposed Development Site is at a low residual risk of flooding, in the event of defence failure the hazard would potentially be very high, and the onset of flooding could be very fast. Therefore, a system would be put in place to safeguard the workers.

6.3.2 A Flood Emergency Response Plan would be developed within the existing operating system of the Keadby Power Station emergency response and subsequent management system procedures for the Proposed Development 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 and over holiday periods.

6.3.3 A Flood Emergency Response Plan will be prepared in consultation with the Environment Agency. This will define access and egress routes from the site and will ensure that the development is registered to receive flood warnings from the Environment Agency'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 Proposed Development Site will be evacuated to an appropriate safe place of refuge should the water level in the Trent become high and the probability of breach subsequently increase, as the safety of all occupants is essential. However, it is also important to ensure that the site is only evacuated when it is absolutely necessary.

6.4 Flood Warnings and Alerts

6.4.1 The EA operates a Flood Warning Service[22] 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

[22] Environment Agency. (2019d) Flood Warning Service- Flood warnings for England. Available at: https://flood-warning-information.service.gov.uk/warnings

- 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 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 Environment Agency'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 Environment Agency, 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 Proposed Development Site is located within a designated EA Flood Alert Area (short code **034WAB420** covering tidal flooding of the Trent for riverside areas from Gainsborough to the Humber confluence, including West Stockwith, Wildsworth, East Ferry, East and West Butterwick, Derrythorpe, Gunness and Keadby).

6.4.7 The Proposed Development Site is located within two designated EA Flood Warning Areas (FWA) (short code names **034FWBTRKEADBY** covering the River Trent at Scunthorpe including isolated properties from the M180 to the Humber Confluence, and **034FWBTRCROWLE** covering the River Trent at Crowle including isolated properties from the M180 to the Humber Confluence). 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 EA, 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 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 Keadby 2 Power Station breach modelling (see Section 4.0) has illustrated that the Site and immediate surrounding area is located in an area of 'high' hazard during the event of a breach. As a result, the Proposed Development Site will be evacuated immediately upon receipt of a flood warning unless it is unsafe to do so, in which case a place of safe refuge will be provided and sought on site.

6.6 Place of Safe Refuge

6.6.1 Safe places of refuge are generally considered an acceptable approach to flood risk management in areas adjacent to tidal river 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 It is currently proposed that, if appropriate, a room above ground floor level of the development be allocated and adapted to provide adequate facilities to provide a place of safe refuge including welfare facilities for all employees occupying the Proposed PCC Site in the extremely rare and unlikely event that the defences were to breach. The internal finished floor level of this refuge area will be elevated above the modelled 0.5% AEP (1 in 200 chance) event (including a 50 year allowance for climate change) defence breach maximum flood level of 2.2mAOD. A freeboard of 300mm should be added to this, with final floor levels in the refuge area being at 2.5mAOD.

6.7 Drainage System Failure, Capacity Exceedance and Maintenance

6.7.1 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 Proposed Development Site and the surrounding area.

6.7.2 In order to reduce the risks, maintenance of the system will be incorporated in general site management. 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. The Applicant will 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 (CIRIA, 2015).

6.7.3 CIRIA C6352 9 (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).

6.8 Construction Mitigation

6.8.1 Construction works undertaken adjacent to, beneath and within watercourses would comply with relevant guidance during construction, including the requirements of any Environmental Permit, Ordinary Watercourse Consent, Environment Agency Pollution Guidance of Prevention of Pollution (GPP).

6.8.2 Activities carried out within the floodplain of a main river are considered regulated activities and as such require permission from the Environment Agency to carry out. As the Proposed Development will not require development within 16m of the bank of a tidal watercourse, a Bespoke Permit under the Environmental Permit (Flood Risk Activities) - The Environmental Permitting (England and Wales) Regulations 2016 - will not be required.

6.8.3 Due to the residual risk to construction personnel and equipment resulting from a breach of defences on the River Trent, construction works should not take place during times of high flow when there is a Flood Alert.

6.8.4 A CEMP would incorporate measures aimed at preventing an increase in flood risk during construction works, as far as reasonably practicable. This would include:

- topsoil and other construction materials would be stored outside of the 1 in 100-year (1% AEP) floodplain extent (Flood Zone 3). This would be to the laydown area at the western side of the site where elevations are higher;
- adequate containment of storage areas, to ensure that material does not wash away and cause pollution and damage to infrastructure;
- the construction laydown area site office and supervisor would be notified of any potential flood occurring by use of the Flood line Warnings Direct service;
- the Contractor would be required to produce a Method statement outlining appropriate temporary dewatering/ pumping measures to be employed in the event of a breach; and
- the Contractor would be required to produce a Flood Risk Management Action Plan which would provide details of the response to flooding in the event of a breach.

6.8.5 Potentially hazardous materials, construction equipment/vehicles and well welfare utilities would be located at locations that are outside of Flood Zones 2 and 3, or on raised areas.

6.8.6 A site-specific Emergency Response Plan would be produced detailing emergency evacuation procedures in the event of a breach of defences.

6.8.7 Provision will be made for the safe access and egress from all working areas of the Site in case of flooding.

7.0 SUMMARY AND CONCLUSIONS

7.1 Flood Risk Summary

Tidal Sources

7.1.1 Based on the information provided by the Environment Agency, it has been determined that the Proposed Development 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 (1 in 200 chance) of flooding.

7.1.2 During a future scenario resulting from climate change up to 2067 however, the impacts are more significant. The Proposed Development Site is potentially at a 'high' residual risk of flooding as a result of overtopping during events that exceed a 0.5% AEP (1 in 200 chance) of flooding on the River Trent (Table 9) where defences are 6.2 to 6.3mAOD. The Proposed Development Site is however at 'low' residual risk of tidal flooding originating from the North and South Soak Drains (Table 8) where defences are 1.3mAOD.

7.1.3 The risk of overtopping in the future and as a result of climate change driven sea level rise assumes that in the intervening period no raising of the Trent tidal defences occurs. This is a highly conservative assumption and given the areas of land and property at risk across the wider area it would be reasonable to assume that future defence raising, and upgrades may continue to protect the site, mitigating the overtopping risk. This cannot however be relied upon.

7.1.4 In the event that the defences were to breach during either the 0.5% or 0.1% AEP (1 in 1000 chance) events the hazard to the Proposed Development Site would be 'high' as flood waters would enter the area. However, the probability of this occurring is 'low', meaning that the residual risk remains 'low'.

7.1.5 Appropriate mitigation measures are therefore required to be implemented at the Proposed Development 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.

Fluvial Sources

7.1.6 The Environment Agency's Flood Map for Planning, identifies that the Proposed Development Site is located across Flood Zones 2 and 3, with the majority lying in Flood Zone 3. Modelled fluvial peak water levels from the Tidal Trent SFRM (Mott MacDonald, 2013) demonstrate that during a 0.1% AEP (1 in 1000 year) event, fluvial water levels in the North and South Soak Drains could rise up to 1.69 mAOD. This is above the raised embankment levels of 1.3mAOD, however, a raised strip of land (2mAOD) on the south side of the Proposed Development Site will act as a barrier to fluvial flooding on the Site from the drains.

7.1.7 The SFRA states that the failure of the network of watercourses to drain the marshland surrounding the river is another main source of flooding.

7.1.8 Based on the information provided by the Environment Agency, it has been determined that the Proposed Development Site is at a 'low' risk of flooding from fluvial sources

with the defences in place or resulting from overtopping of the defences during events that exceed a 0.5% AEP (1 in 200 chance) and 0.1% AEP.

Surface Water Runoff to the Proposed Development

7.1.9 The risk of surface water flooding within the Proposed Development Site from elsewhere (or generated within) is considered to be 'low' to 'very low'.

7.1.10 Extensive drainage infrastructure already exists across the site due to the Keadby 1 and Keadby 2 power stations. As noted above, further assessment of the role which Keadby 2 Power Station's drainage infrastructure may play for the Proposed Development will be considered as the EIA progresses.

Groundwater

7.1.11 The risk of groundwater flooding within the Proposed Development area within the Site is considered to be 'low'.

7.1.12 Based on historical assessment as part of the Keadby 2 Power Station ES (ERM, 2016), groundwater flooding is currently understood to be effectively managed via a well-developed drainage system serving Keadby 1 and Keadby 2 Power Stations.

Artificial Sources

7.1.13 The Proposed Development Site is not considered at risk from reservoir flooding.

7.1.14 The Stainforth and Keadby Canal is close to the Proposed Development Site but given its' shallow gradient and that it drains into the River Trent by a sluice, the risk of flooding is likely to be low. If any overtopping of the canal were to occur, this would drain into the North and South Soak drains located at a lower elevation on either side of the canal and drain away. However, the canal levels are monitored and maintained by the Canal & Rivers Trust. As a result, overtopping is unlikely and so the site is at low risk of flooding from the canal.

7.1.15 Overall, the risk of flooding from artificial waterbodies is therefore considered to be 'low'.

7.2 Management of Surface Water Runoff from the Site

7.2.1 In order to ensure that the development does not increase the flood risk elsewhere, surface water discharge from the Proposed PCC Site within will be restricted to the existing greenfield runoff rate in accordance with the requirements of the NPPF, EA and NLC. 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. As noted in Section 5, the surface water calculations runoff calculations and any attenuation requirements will be refined further informed by design and layout prior to DCO submission.

7.3 Residual Risk Mitigation Measures

7.3.1 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, consideration should be given to measures that protect the Proposed Development from the residual risk of flooding.

7.3.2 Proposed residual risk mitigation measures include:

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

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ANNEX A ENVIRONMENT AGENCY CONSULTATION

ANNEX B NORTH LINCOLNSHIRE COUNCIL CONSULTATION