Hornsea Project Four: Environmental Statement (ES)

PINS Document Reference: A6.2.2.
APFP Regulation 5(2)(a)

Volume A6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment

Prepared Royal HaskoningDHV, July 2021
Checked Ant Sahota, Orsted,, July 2021
Accepted Thomas Watts Orsted, August 2021
Approved Julian Carolan, Orsted, September 2021

A6.2.2
Version B

Table of Contents

List of Tables

List of Figures

Glossary

Term	Definition
Attenuation feature(s)	Area within which Sustainable Drainage Systems (SuDs) measures are to be adopted to facilitate attenuation and/ or storage of surface water drainage. Measure can be, but are not limited to, the use of filter drains, swales, attenuation and flow control structures.
Code of Construction Practice (CoCP)	A document detailing the overarching principles of construction, contractor protocols, construction-related environmental management measures, pollution prevention measures, the selection of appropriate construction techniques and monitoring processes.
Commitment	A term used interchangeably with mitigation and enhancement measures. The purpose of Commitments is to reduce and/or eliminate Likely Significant Effects (LSEs), in EIA terms. Primary (Design) or Tertiary (Inherent) are both embedded within the assessment at the relevant point in the EIA (e.g. at Scoping, Preliminary Environmental Information Report (PEIR) or ES). Secondary commitments are incorporated to reduce LSE to environmentally acceptable levels following initial assessment i.e. so that residual effects are acceptable.
Development Consent Order (DCO)	An order made under the Planning Act 2008 granting development consent for one or more Nationally Significant Infrastructure Projects (NSIP).
Effect	Term used to express the consequence of an impact. The significance of an effect is determined by correlating the magnitude of the impact with the importance, or sensitivity, of the receptor or resource in accordance with defined significance criteria.
Energy balancing infrastructure (EBI)	The onshore substation includes energy balancing Infrastructure. These provide valuable services to the electrical grid, such as storing energy to meet periods of peak demand and improving overall reliability.
Exception Test	The Exception Test is a method to demonstrate and help ensure that flood risk to people and property will be managed satisfactorily, while allowing necessary development to go ahead in situations where suitable sites at lower risk of flooding are not available. The two parts to the Exception Test require proposed development to show that it will provide wider sustainability benefits to the community that outweigh flood risk, and that it will be safe for its lifetime, without increasing flood risk elsewhere and where possible reduce flood risk overall.
Export cable corridor (ECC)	The specific corridor of seabed (seaward of Mean High Water Springs (MHWS)) and land (landward of MHWS) from the Hornsea Project Four array area to the Creyke Beck National Grid substation, within which the export cables will be located.
High Voltage Alternating Current (HVAC)	High voltage alternating current is the bulk transmission of electricity by alternating current (AC), whereby the flow of electric charge periodically reverses direction.
High Voltage Direct Current (HVDC)	High voltage direct current is the bulk transmission of electricity by direct current (DC), whereby the flow of electric charge is in one direction.

Term	Definition
Hornsea Project Four Offshore Wind Farm	The term covers all elements of the project (i.e. both the offshore and onshore). Hornsea Four infrastructure will include offshore generating stations (wind turbines), electrical export cables to landfall, and connection to the electricity transmission network. Hereafter referred to as Hornsea Four.
Landfall	The generic term applied to the entire landfall area between Mean Low Water Spring (MLWS) tide and the Transition Joint Bay (TJB) inclusive of all construction works, including the offshore and onshore ECC, intertidal working area and landfall compound. Where the offshore cables come ashore east of Fraisthorpe.
Main River	Main rivers are usually larger rivers and streams, designated as such, and shown on the Main River Map. The Environment Agency carries out maintenance, improvement or construction work on main rivers to manage flood risk. Other rivers are called 'ordinary watercourses' (see definition below).
Mitigation	A term used interchangeably with Commitment(s) by Hornsea Four. Mitigation measures (Commitments) are embedded within the assessment at the relevant point in the EIA (e.g. at Scoping or PEIR or ES).
National Grid Electricity Transmission (NGET) substation	The grid connection location for Hornsea Four at Creyke Beck.
Onshore substation (OnSS)	Comprises a compound containing the electrical components for transforming the power supplied from Hornsea Project Four to 400 kV and to adjust the power quality and power factor, as required to meet the UK Grid Code for supply to the National Grid. If a HVDC system is used the OnSS will also house equipment to convert the power from HVDC to HVAC.
Order Limits	The limits within which Hornsea Project Four (the 'authorised project') may be carried out.
Ordinary Watercourse	Ordinary watercourses include every other river, stream, ditch, drain, cut, dyke, sluice, sewer and passage through which water flows and which does not form part of a Main River.
Orsted Hornsea Project Four Ltd.	The Applicant of proposed Hornsea Project Four Offshore Wind Farm Development Consent Order (DCO).
Planning Inspectorate (PINS)	The agency responsible for operating the planning process for Nationally Significant Infrastructure Projects (NSIPs).
Sequential Test	The Sequential Test is designed to ensure that areas at little or no risk of flooding from any source are developed in preference to areas at higher risk. The aim should be to keep development out of medium and high flood risk areas (Flood Zones 2 and 3) and other areas affected by other sources of flooding where possible.
Trenchless Techniques	Also referred to as trenchless crossing techniques or trenchless methods. These techniques include Horizontal Directional Drilling (HDD), thrust boring, auger boring, and pipe ramming, which allow ducts to be installed under an obstruction without breaking open the ground and digging a trench.

Acronyms

Acronym	Definition
AP	Access Point
BGS	British Geological Survey
CDAs	Critical Drainage Areas
CFMP	Catchment Flood Management Plan
CoCP	Code of Construction Practice
COPFAS	Cottingham and Orchard Park Flood Alleviation Scheme
DCO	Development Consent Order
DSM	Digital Surface Model
EBI	Energy Battery Infrastructure
ECC	Export cable corridor
EIA	Environmental Impact Assessment
ERY	East Riding of Yorkshire
ES	Environmental Statement
FRA	Flood Risk Assessment
FWEP	Flood Warning and Evacuation Plan
GIS	Geographical Information System
HDD	Horizontal Directional Drilling
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IDB	Internal Drainage Board
IEMA	Institute of Environmental Management and Assessment
LFRMS	Local Flood Risk Management Strategy
LiDAR	Light Detection and Ranging
LLFA	Lead Local Flood Authority
MHWS	Mean High Water Spring
MLWS	Mean Low Water Spring
NGET	National Grid Electricity Transmission
NPPF	National Planning Policy Framework
NPS	National Policy Statement
NSIP	Nationally Significant Infrastructure Project
OnSS	Onshore Substation
OS	Ordnance Survey
PEIR	Preliminary Environmental Information Report
PFRA	Preliminary Flood Risk Assessment
PINS	Planning Inspectorate
PPG	Planning Practice Guidance
SFRA	Strategic Flood Risk Assessment
SMP	Shoreline Management Plan
SoCC	Statement of Community Consultation
SuDS	Sustainable Drainage System(s)
WFD	Water Framework Directive
YCDB	York Consortium of Drainage Boards

Units

Unit	Definition
km	kilometres
km^2	square kilometres
kV	kilovolt
m	metres
m AOD	metres Above Ordnance Datum

1 Introduction

1.1 Project background

1.1.1.1 Orsted Hornsea Project Four Limited (the 'Applicant') is proposing to develop Hornsea Project Four Offshore Wind Farm (hereafter 'Hornsea Four'). Hornsea Four will be located approximately 69 km offshore the East Riding of Yorkshire in the Southern North Sea and will be the fourth project to be developed in the former Hornsea Zone. Hornsea Four will include both offshore and onshore infrastructure including an offshore generating station (wind farm), export cables to landfall, and on to an onshore substation (OnSS) with energy balancing infrastructure (EBI), and connection to the electricity transmission network.

1.1.1.2 Royal HaskoningDHV was commissioned to undertake a Flood Risk Assessment (FRA) within the Hornsea Four Order Limits (i.e. the landfall, onshore export cable corridor (ECC), the OnSS including EBI, and 400 kV National Grid Electricity Transmission (NGET) connection area).

1.1.1.3 This technical annex has been produced to characterise the baseline environment to inform and support the impact assessments summarised in the 'Hydrology and Flood Risk' section of **Volume A4, Annex 5.1: Impacts Register**. The baseline environment, project basis for assessment are set out in **Volume A3, Chapter 2: Hydrology and Flood Risk** of the Hornsea Four Environmental Statement (ES).

1.2 Aims

1.2.1.1 The aim of this FRA is to provide sufficient justification to regulators and other stakeholders that Hornsea Four is appropriate and in line with planning and national policy requirements regarding flood risk.

1.2.1.2 The aims of this FRA are to:

- provide information required to support the ES with regards to flooding, supported by the application of the Sequential Test and, where necessary, the Exception Test;
- establish whether Hornsea Four is likely to be affected by current or future flooding from any source and whether it will increase flood risk elsewhere;
- inform potential flood risk mitigation options; and
- provide recommendations on potential measures required to reduce flood risk, if applicable.

1.3 Data Limitations

1.3.1.1 With the exception of the results of the geomorphological walkover survey (**Annex 2.1: Geomorphological Baseline Survey Report**), the data used to inform this FRA has largely been obtained from archive sources (as summarised in **Table 1**). On this basis it is acknowledged that although only secondary survey information is available to inform the ES, the Applicant has committed to contracting a specialist with local knowledge of the area to undertake pre- and post-construction land drainage surveys with the aim of understanding the location, dimensions and details of existing land drainage. This is to ensure

that land drainage can be maintained during construction and to ensure it is reinstated following construction (Co14) (**Table 5** and **Volume A4, Annex 5.2: Commitments Register**).

1.3.1.2 At the water and flood risk Evidence Plan Technical Panel meeting on 27 June 2019 and attended by the Environment Agency, the availability of flood risk modelling and data was discussed. At this meeting the Environment Agency acknowledged that their information derived from archive sources was published several years ago (e.g. Environment Agency modelling from 2013, **Table 1**) and as a result baseline conditions may have changed since the publication of this data (ON-HYD-1.4). However, the most up-to-date datasets published by the relevant authorities and regulators have in all instances been consulted (as summarised in **Table 1**) in order to minimise the potential for any significant changes in baseline conditions. This includes the Environment Agency Product 4, 5 and 8 data (received on 03/04/19). In addition, detailed modelling information from 2016 for the OnSS area, which has been obtained from National Grid (received on 29/11/19) for the adjacent Creyke Beck NGET substation (Mott MacDonald 2016) has been used to inform this FRA.

1.3.1.3 Since publication on the Preliminary Environmental Information Report (PEIR) (Orsted 2019), the Hornsea Four Order Limits have been refined (as detailed in **Volume A1, Chapter 3: Site Selection and Consideration of Alternatives**). However, this refinement has had no impact on the baseline information used to inform this FRA as the water bodies within the Hornsea Four hydrology and flood risk study area have remained the same and therefore is no material change between PEIR and DCO submissions (**Figure 1**).

1.3.1.4 The baseline assessment carried out in the PEIR is therefore considered to characterise current conditions within the Hornsea Four Order Limits to an acceptable level. Consultation with key stakeholders (see **Section 2.11.2** for further details), at water and flood risk Evidence Plan Technical Panel meetings held on the 15 September 2019, 5 November 2019, 5 February 2020 and 15 May 2020 discussed and agreed the data utilised and the baseline assessment presented in **Volume A3, Chapter 2: Hydrology and Flood Risk** (ON-HYD-1.1 and ON-HYD-6.1). It was confirmed that the FRA is based on appropriate baseline data, subject to the inclusion of the detailed modelling information carried out for Creyke Beck NGET substation (ON-HYD-1.4).

1.4 Methodology

1.4.1.1 This FRA has been prepared in accordance with the methodology and guidance set out in EN-1 Overarching National Policy Statement (NPS) for Energy, National Planning Policy Framework (NPPF), Planning Practice Guidance (PPG) for Flood Risk and Coastal Change (Department of Energy and Climate Change 2014), and the Environment Agency's climate change allowance guidance (Environment Agency 2016).

1.4.1.2 The Environment Agency's climate change allowance guidance was updated on the 17th December 2019 and the 16th March 2020 (Environment Agency 2020). There were a number of amendments including, but not limited to; updated sea level rise allowances using UKCP18 projections; additional guidance on the use of peak rainfall allowances to help design drainage systems; how to assess and design access and escape routes for less vulnerable developments and updated guidance on how to apply peak river flow

allowances so the approach is the same for both Flood Zones 2 and 3. The relevance and applicability of the updated guidance has been considered within this FRA.

1.4.1.3 The 2020 Climate Change Allowance guidance sets out the Environment Agency's recommended climate change allowances for development when considering flood risk and coastal change for planning purposes (Environment Agency 2020). The principal aim of these policies and guidance documents is to avoid inappropriate development in areas at risk of flooding and, wherever possible, to direct development away from the areas at highest flood risk. The appropriate climate change allowances have been reviewed and included within **Section 6** of this FRA.

1.4.1.4 Within the design of the project, several embedded mitigation measures for example, the use of HDD (or other trenchless technologies) to cross EA Main Rivers (Co1); wherever reasonably practicable the storage of topsoil and subsoil will be outside of Flood Zone 2 and 3 (Co183 and Co 197) and the attenuation of surface water run-off from the OnSS have been included to address flood risk both during construction and once operational (Co191). Details of these embedded mitigation measures are included within **Volume A3, Chapter 2: Hydrology and Flood Risk**. All mitigation measures related to this FRA are provided in full in **Table 5**.

1.4.2 Study Area

1.4.2.1 The Hornsea Four onshore ECC, which houses the electrical export cables for the project, is approximately 39 km in length from landfall to the Creyke Beck NGET substation. Flood risk varies across the Hornsea Four Order Limits. Therefore, to aid this assessment the onshore project infrastructure has been divided into three key sections associated with the Hornsea Four Order Limits (see **Figure 1**):

- **Landfall** – where the offshore export cables will connect to the onshore export cables. This area will include a temporary logistics compound (including transition pit and cable laydown) and an access track. These components are located east of Fraisthorpe;
- **Onshore ECC** - is the proposed route the onshore export cables will take between landfall and the OnSS. This includes associated access tracks, link boxes, transition joint bays, and temporary logistics compounds; and
- **OnSS** – located to the west of the Creyke Beck NGET substation and includes a temporary access track, permanent access track, temporary and permanent working areas. Hornsea Four's proposed grid connection point is located to the east of the OnSS, where a further section of the onshore export cables (within the 400 kV NGET connection area) is then required to connect the OnSS to the Creyke Beck NGET substation.

1.4.2.2 The flood risk to the landfall, onshore ECC and OnSS are each identified independently within this report. Furthermore, the assessment relating to flood risk connected to the onshore ECC and OnSS are further sub-divided into three categories based on Water Framework Directive (WFD) Operational Catchments and temporary or permanent works areas respectively (**Figure 1**), as outlined below:

Landfall

- **Section 0**: Landfall.

Onshore ECC (including access tracks and logistics compounds)

- **Section 4.4**: Barmston Sea Drain WFD catchment;
- **Section 4.5**: Hull Upper WFD catchment; and
- **Section 4.6**: Hull Lower WFD catchment.

OnSS

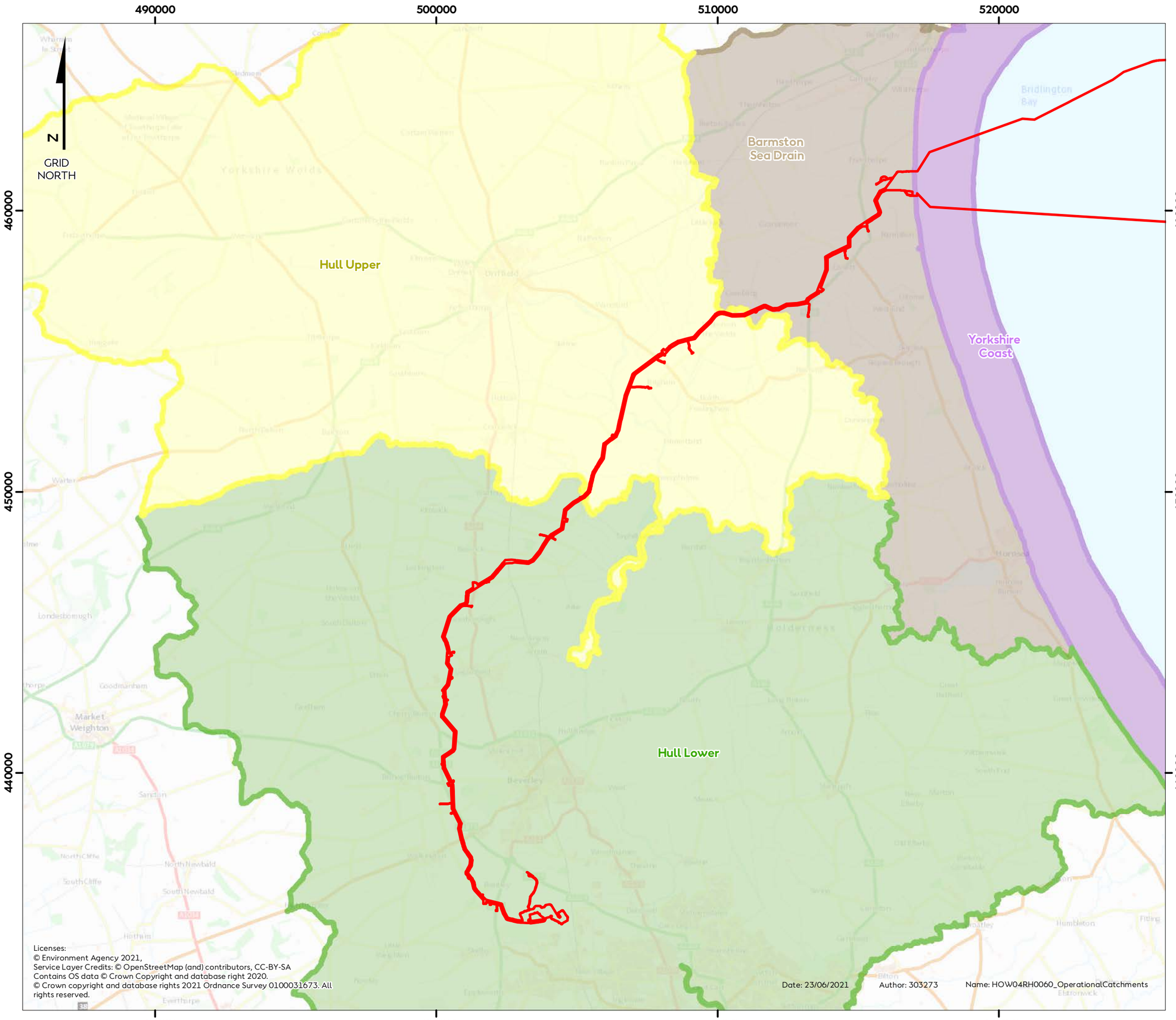
- **Section 4.8**: Temporary OnSS area;
- **Section 4.9**: Permanent OnSS area and access track; and
- **Section 4.10**: 400 kV NGET connection area.

1.4.2.3 This FRA is structured first to introduce all relevant polices and guidance for FRAs and to identify the existing flood risk within the Hornsea Four Order Limits. Following the identification of the flood risk of each element of Hornsea Four, mitigation measures related to the construction and operation of these elements is then discussed to ensure that there is no increase in flood risk either to, or as a result of, Hornsea Four.

Hornsea Four

Figure 1

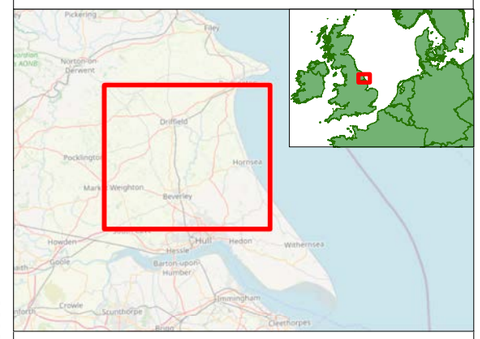
WFD Operational Catchments



Order Limits

WFD Operational Waterbody Catchments

- Barmston Sea Drain
- Hull Lower
- Hull Upper
- Yorkshire Coast



Coordinate system: British National Grid

Scale@A3: 1:130,000

0 2 4 6 Kilometres

0 2 4 Miles

REV	REMARK	DATE
	First Issue for PEIR	03/07/2019
A	Updated following PEIR consultations, for DCO	23/06/2021

Title: WFD Operational Catchments
Document no: HOW04RH0060
Created by: AZ
Checked by: ID
Approved by: CS

Royal HaskoningDHV

Ørsted

1.4.2.4 To accurately ascertain potential flood risk to the site, several data sources were reviewed. The Environment Agency Product 4, 5 and 8 data packages were requested from the Environment Agency and subsequently used to inform this FRA. They include:

- Product 4 - consisting of flood zones, defences and storage areas, areas benefiting from defences, statutory main river designations, historic flood event outlines and more detailed information from computer river models (including model extent, information on one or more specific points, flood levels and flood flows);
- Product 5 data for the River Hull and Holderness Drain - consisting of fluvial modelling reports, guidelines and technical notes; and
- No Product 8 (breach and coastal) data was provided. Within the Product 4 and 5 data delivery from the Environment Agency (via email dated 03/04/2019) it was confirmed that no Product 8 (breach analysis) had been undertaken within, or in proximity to, the Hornsea Four Order Limits.

1.4.2.5 **Table 1** identifies all other data sources that have been used throughout this FRA to identify flood risk for Hornsea Four.

Table 1: Data Sources consulted to inform this FRA.

Data Source	Data Owner	Description of Data
Digital Surface Model (DSM)	Environment Agency	Light Detection and Ranging (LiDAR) collected by the Environment Agency is used to create a DSM of the land. At a resolution of 1 m, this allows analysis of topography to be conducted and conclusions to be drawn regarding potential flow routes of water. Accessible online at: https://environment.data.gov.uk/DefraDataDownload/?Mode=survey. (downloaded on 24/04/2019)
Internal Drainage Board Map	York Consortium of Drainage Boards	PDF map of the Beverley and North Holderness IDB, georeferenced into GIS to aid watercourse identification and associated flood risk. Accessible online at: http://www.yorkconsort.gov.uk/img/maps/beverleymap.pdf. (downloaded on 24/04/2019)
LLFA watercourse shapefiles	East Riding of Yorkshire	Geographical Information System (GIS) dataset provided by the LLFA detailing all watercourses that intersect and are in proximity to the Hornsea Four Order Limits. (received on 21/03/2019)
Bing Maps (OS 50k)	Ordnance Survey	Freely accessible Ordnance Survey map used to confirm location of ordinary watercourses provided by LLFA and their relative location to towns and villages. Accessible online at: https://www.bing.com/maps.
Geology	British Geological Survey (BGS)	1:50 000 scale online viewer used to identify geology for the Hornsea Four Order Limits. Accessible online at: http://mapapps.bgs.ac.uk/geologyofbritain/home.html.
Environment Agency Flood map for Planning	Environment Agency	Online viewer that can be used to identify Flood Zones. Accessible online at: https://flood-map-for-planning.service.gov.uk/. (received on 03/04/2019)
Environment Agency Risk of	Environment Agency	Online viewer that can be used to identify surface water flood risk. Accessible online at: https://flood-warning-information.service.gov.uk/long-term-flood-risk/map.

Data Source	Data Owner	Description of Data
Flooding from Surface Water		(received on 03/04/2019)
Environment Agency Risk of Flooding from Reservoirs	Environment Agency	Online viewer that can be used to identify reservoir flood risk. Accessible online at: https://flood-warning-information.service.gov.uk/long-term-flood-risk/map. (received on 03/04/2019)
MAGIC	Natural England	The MAGIC website provides authoritative geographic information about the natural environment. The information is presented in an interactive map. Accessible online at: https://magic.defra.gov.uk/MagicMap.aspx.
National Grid Asset Flood Resilience DRAFT Flood Risk Assessment Creyke Beck 400 kV Substation	National Grid	Report produced by Mott MacDonald (2016) and provided by National Grid in relation to the modelling carried out for the adjacent Creyke Beck NGET substation. Information within the report has been used to assess fluvial and surface water flood risk at the Hornsea Four OnSS. (received on 29/11/2019)

2 Policy, Guidance and Consultation

2.1 Policy and Guidance Introduction

2.1.1.1 Table 2 outlines all documents that are referenced in this FRA. Beneath the table, the documents and their constraints to Hornsea Four are discussed in greater detail.

Table 2: Policy or Guidance documents referenced in this FRA.

Policy or Guidance Document	Author/ Produced on behalf of	Year Published
National Planning Policy Framework	Ministry of Housing, Communities and Local Government	2012, updated 2019
Planning Practice Guidance (NPPF PPG) for Flood Risk and Coastal Change	Ministry of Housing, Communities & Local Government	2014
Flood risk assessments: climate change allowances guidance	Environment Agency	2016, updated in 2019 and 2020
Preliminary Flood Risk Assessment (PFRA)	East Riding of Yorkshire Council	2011
Strategic Flood Risk Assessment (SFRA) Level 1	East Riding of Yorkshire Council	2010
Local Flood Risk Management Strategy (LFRMS)	East Riding of Yorkshire Council	2015
East Riding Local Plan - Flood Risk Note for the Planning Application Process	East Riding of Yorkshire Council	2018
Hull and Coastal Streams Catchment Flood Management Plan (CFMP)	Environment Agency	2010
SMP3: Flamborough Head to Gibraltar Point Shoreline Management Plan (SMP)	Humber Estuary Coastal Authorities Group	2010

2.2 National Planning Policy Framework (NPPF)

2.2.1.1 NPPF (Ministry of Housing, Communities and Local Government 2019), NPPF PPG for Flood Risk and Coastal Change (Ministry of Housing, Communities and Local Government 2014) and 'Flood risk assessments: climate change allowances guidance' (Environment Agency 2020) provide direction on how flood risk should be considered at all stages of the planning and development process. The planning system should ensure that new development is safe and not exposed unnecessarily to the risks associated with flooding. This FRA sets out the planning and wider context within which the project needs to be considered along with the flood risk to Hornsea Four under each scenario.

2.2.2 Probability of Flooding – Flood Zones

2.2.2.1 Table 3 has been extracted from Table 1 of the NPPF PPG (Ministry of Housing, Communities and Local Government 2014). Through the application of the Sequential Test, the NPPF PPG (Ministry of Housing, Communities and Local Government 2014) aims to steer development towards areas at lowest risk of flooding (Flood Zone 1). Where there are no reasonably available sites in Flood Zone 1, local planning authorities in their decision making should take into account the flood risk vulnerability of land uses and consider reasonably available sites in Flood Zones 2 and 3, applying the Exception Test if required.

Table 3: Summary of Flood Zone Definitions.

Flood zone	Probability of flooding	Return periods
1	Low	Land having a less than 1 in 1,000 annual probability of river or sea flooding.
2	Medium	Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or Land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding.
3a	High	Land having a 1 in 100 or greater annual probability of river flooding; or Land having a 1 in 200 or greater annual probability of sea flooding.
3b	High – Functional Floodplain	This zone comprises land where water has to flow or be stored in times of flood. Local planning authorities should identify in their SFRAs areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency.

2.2.2.2 The Exception Test is a method to demonstrate and help ensure that flood risk to people and property will be managed satisfactorily, while not being prohibitive to development where suitable sites at lower risk of flooding are not available.

2.2.2.3 The two parts that make up the Exception Test require proposed developments to show:

- Firstly, that the development will provide wider sustainability benefits to the community which outweigh flood risk; and
- Secondly, that they will be safe for the duration of the project's lifetime, without increasing flood risk elsewhere. Where possible the proposed projects should reduce flood risk overall (Ministry of Housing, Communities & Local Government 2014).

2.2.2.4 Flood Zones are informed by modelling undertaken by the Environment Agency and refer to the probability of fluvial or tidal / coastal flooding, without accounting for the presence of defences. The extent of the modelling includes all designated Main Rivers. Some of the larger ordinary watercourses and Internal Drainage Board (IDB) maintained watercourses can also be included in the modelling and therefore may be included within the extent of the Flood Zone datasets.

2.2.2.5 Any watercourse that is not classified as a Main River is referred to as an ordinary watercourse. This covers streams, drains, ditches and passages through which water flows that do not form the network of main rivers.

2.2.2.6 It is critical that FRAs also identify and mitigate against risks of surface water flooding. The Environment Agency provides national datasets on surface water flood risk, classified into four categories; 'Very low', 'Low', 'Medium' and 'High' (Table 4).

Table 4: Summary of Surface Water Flood Risk Definitions.

Probability of surface water flooding	Return periods
Very low	Land with less than 1 in 1,000 annual probability of surface water flooding (< 0.1%).
Low	Land with between 1 in 1,000 and 1 in 100 annual probability of surface water flooding (0.1% - 1%).
Medium	Land with between 1 in 100 and 1 in 30 annual probability of surface water flooding (1% - 3.3%).
High	Land with greater than 1 in 30 annual probability of surface water flooding (>3.3%).

2.3 Local Policy and Guidance Introduction

2.3.1.1 The Hornsea Four Order Limits are entirely located within the unitary authority area of the East Riding of Yorkshire Council (ERYC).

2.3.1.2 ERYC is the Lead Local Flood Authority (LLFA) covering the Hornsea Four Order Limits. Under the Flood and Water Management Act (UK Parliament 2010), LLFAs are responsible for managing flooding from surface water, ground water and ordinary watercourses. Among other responsibilities they are required to deliver a strategy for local flood risk management in their areas, to investigate flooding and to maintain a register of flood risk assets.

2.3.1.3 The Beverley and North Holderness IDB are responsible for maintaining 263 km of watercourses, many of which intersect the Hornsea Four Order Limits. The majority of the watercourses that the Beverley and North Holderness IDB maintain, discharge into Environment Agency Main Rivers. This IDB is part of the larger York Consortium Drainage Boards (YCDB), a collective of five IDBs who are responsible for maintaining key ordinary watercourses and granting ordinary watercourse consent within the region.

2.4 Preliminary Flood Risk Assessment

2.4.1.1 The most recent Preliminary Flood Risk Assessment (PFRA) for the County was produced by ERYC in 2011 (ERYC 2011).

2.4.1.2 The PFRA (ERYC 2011) provides a high-level overview of the potential risk of flooding from local sources and identifies areas at flood risk which may require more detailed studies. The PFRA (ERYC 2011) is used to inform the Local Flood Risk Management Strategy (LFRMS) (see **Section 2.6**).

2.4.1.3 The PFRA (ERYC 2011) summarises future flood risk from surface water, ordinary watercourses, groundwater and sewer flooding. Whilst it does not directly consider coastal or main river flooding, it is acknowledged within the PRFA (ERYC 2011) that they have the potential to interact with future surface water flood events.

2.4.1.4 The PFRA (ERYC 2011) shows that coastal flood risk is most prevalent for low lying land on the banks of the Humber estuary. Fluvial flood risk is identified through the centre of East Riding of Yorkshire (ERY), associated with the River Hull Main River, as well as a number of smaller Main Rivers and IDB maintained watercourses in the region. The onshore ECC crosses these areas identified as at risk, particularly within the Upper Hull WFD operational catchment (see **Section 4.5** for more information).

2.4.1.5 The PFRA (ERYC 2011) also shows surface water flood risk and groundwater to be most prevalent in the catchment of the River Hull, this is due to the complex network of watercourses, including Main Rivers, IDB maintained and ordinary watercourses, that are located in this region. The onshore ECC crosses some of the areas identified as at risk, particularly within the Upper and Lower Hull WFD operational catchments (see **Section 4.5** and **Section 4.6** for more information).

2.5 Strategic Flood Risk Assessment

2.5.1.1 A Strategic Flood Risk Assessment (SFRA) is a high-level strategic document carried out by local planning authorities to assess the risk to an area from flooding, at present and into the future. An SFRA takes into consideration the impacts of climate change and assesses the impact that land use changes and development are likely to have on flood risk.

2.5.1.2 A Level 1 Strategic Flood Risk Assessment (SFRA) was produced for ERYC in January 2010, as required under the Flood and Water Management Act (UK Parliament 2010). A subsequent Level 2 SFRA was produced for Goole in 2011, as it was identified as an area of new development in a location of flood risk. The lack of Level 2 SFRA for the Hornsea Four

Order Limits, indicates that it is likely to be at less risk of flooding than other parts of the region.

2.5.1.3 The Hornsea Four Order Limits fall within the Level 1 SFRA study area. The Level 1 SFRA (ERYC 2010) informs the Local Plan for development by delineating areas of 'low', 'medium' and 'high' probability of flooding, through application of the Sequential Test using Environment Agency data.

2.6 Local Flood Risk Management Strategy

2.6.1.1 ERYC produced a LFRMS in 2015 (ERYC 2015). The LFRMS outlines the aims and objectives of the Council as the LLFA up to 2027 and beyond, and provides policies based on these aims.

2.7 East Riding Local Plan – Flood Risk Note for the Planning Application Process

2.7.1.1 Initially drafted in 2010, the July 2018 East Riding Local Plan – Flood Risk Note for the Planning Application Process (ERYC 2018) was prepared to provide assistance to local developers, applicants, and Local Planning Authority officers on how to apply local and national planning policy using, amongst other evidence, the Council's SFRA (ERYC 2010).

2.7.1.2 Critical Drainage Areas (CDAs) are defined in the Town and Country Planning (General Development Procedure) (Amendment) (No. 2) (England) Order (UK Parliament 2006), as 'an area within Flood Zone 1 which has critical drainage problems.' Consideration of CDAs is necessary to inform key flood risk priorities. The LFRMS did not identify any locations within the Hornsea Four Order Limits that are designated as CDAs.

2.8 Catchment Flood Management Plan (CFMP)

2.8.1.1 Catchment Flood Management Plans (CFMPs) consider all types of inland flooding including from rivers, groundwater, surface water and tidal flooding. Flooding directly from the sea (coastal flooding) is covered in Shoreline Management Plans (SMPs) (see **Section 2.9**). CFMPs consider the likely impacts of climate change, the effects of how we manage the land and how areas can be developed sustainably.

2.8.1.2 The Hornsea Four Order Limits are covered by the Hull and Coastal Streams CFMP, published in December 2010 (Environment Agency 2010). The landfall and majority of the onshore ECC are located in the Upper Hull subarea as defined within the CFMP. The onshore ECC, starting south of Beverley and the OnSS are located in the Lower Hull subarea.

2.8.1.3 The CFMP (Environment Agency 2010) identifies that in the lower sections of the Upper Hull subarea, the River Hull is perched above and disconnected from its natural floodplain. Water from the floodplain therefore has to be pumped into the river. As a result, there is a complex network of existing artificial field drains regulated by a series of pumping stations within the floodplain.

2.8.1.4 The CFMP (Environment Agency 2010) identifies that in the Lower Hull Catchment the main sources of flood risk are river, tidal and surface water / sewer flooding. It identifies that as a result of the low lying flat land in the area there are few physical constraints to floodwaters,

hence there are many potential interactions with adjoining subareas (as described in Paragraph 2.8.1.2).

2.9 Shoreline Management Plan (SMP)

2.9.1.1 Shoreline Management Plans (SMPs) are non-statutory plans for coastal defence management planning. They aim to identify the best ways to manage flood and erosion risk and to develop an 'intent of management' for the shoreline.

2.9.1.2 The Hornsea Four Order Limits are covered within SMP3: Flamborough Head to Gibraltar Point Shoreline Management Plan (Humber Estuary Coastal Authorities Group 2010). Specifically, the landfall is located within Policy Unit C: Wilsthorpe to Atwick.

2.9.1.3 The preferred policy for this Unit is 'No Active Intervention' (Scott Wilson 2010) for the next three epochs.

2.10 Cottingham and Orchard Park Flood Alleviation Scheme (COPFAS)

2.10.1.1 In response to the 2007 surface water flood event, ERYC undertook integrated catchment modelling in the wider Hull area, including the area around Cottingham, to better understand the multiple mechanisms and sources of flooding and the overall risk posed to the area.

2.10.1.2 The resulting model was then used as an optioneering tool to develop and assess potential flood mitigation measures. Following a data request to ERYC the modelling report for the COPFAS project was supplied on 7 June 2019. Following a review of the modelling report a number of clarifications related to the extent of the study area considered within the scheme (i.e. whether it extended to the Hornsea Four Order Limits) and the detail of the modelling carried out (i.e. which watercourses are included) were submitted to ERYC via email on 1 July 2019. A response to these clarification queries was received from ERYC via email on the 7 August 2019, which confirmed that the works focused on the area around Cottingham Parks Drain and downstream of this point. Therefore, it was unlikely to extend upstream to the location of the Hornsea Four OnSS.

2.10.1.3 A review of this information and the COPFAS modelling report was undertaken, which identified that there was limited information within the modelling report provided that was of direct relevance to Hornsea Four. High level Information relating to the background to flooding issues in the wider area and the approaches being adopted by local authorities to modelling and surface water flood risk have been considered, where appropriate, within this FRA. Overall, the COPFAS project report provided limited information of direct relevance to Hornsea Four. This was discussed and agreement at a water and flood risk evidence plan technical panel meeting on the 15 May 2020 (ON-HYD-7.1).

2.11 Flood Risk Stakeholders and Consultation

2.11.1 Key flood risk stakeholders

2.11.1.1 The Environment Agency is a key flood risk stakeholder, due to their management of the Main Rivers that the Hornsea Four Order Limits are proposed to cross.

2.11.1.2 The Hornsea Four Order Limits also crosses multiple ordinary watercourses that are managed / maintained by the Beverley and North Holderness IDB.

2.11.1.3 ERYC is the LLFA and therefore is also a key stakeholder.

2.11.1.4 Any works, either temporary or permanent, which will alter the flow of water along a watercourse or require the erection of a culvert, bridge or modification to the channel will require consent from the corresponding relevant authorities such as the Environment Agency, LLFA or IDB (Co147 and Co186). Details of all onshore crossings is presented in **Volume A4, Annex 4.2: Onshore Crossing Schedule**.

2.11.1.5 As set out in the Environmental Permitting (England and Wales) Regulations 2016, a permit or exemption is required for any activities which will take place:

- On or within 8 metres (m) of a Main River (16 m, if the Main River is tidal);
- On or within 8 m of a flood defence structure or culverted main river (16 m, if Main River is tidal);
- Any activity within 16 m of a sea defence structure;
- quarrying or excavation within 16 m of any Main River, flood defence (including a remote defence) or culvert; and/or
- Activities carried out on the floodplain of a Main River, more than 8 m from the riverbank, culvert or flood defence structure (or 16 m, if the Main River is tidal) and planning permission has not already been obtained.

2.11.1.6 The key types of watercourse consent required for the Hornsea Four can be split by consenting authority as follows:

- Environment Agency:
    - **Exclusions**: Permission is not required for defined excluded activities with operations taking place within the description and conditions of the exclusion. Exclusions include, but are not limited to, when working in an emergency, if a Marine Management Organisation licence has been applied for, using ladders and scaffold towers, services crossing a river within an existing structure (Further details can be found at: https://www.gov.uk/government/publications/excluded-flood-risk-activities-environmental-permits/excluded-flood-risk-activities)
    - **Exemptions**: Application for a permit is not required if an activity meets the description and conditions of one of the exempt flood risk activities. Exemptions must be registered with the Environment Agency before any work can be carried out. Exemptions include, but are not limited to, electrical cable service crossing

over a main river, service crossing below the bed of a main river not involving an open cut technique, temporary dewatering of a work area for no more than 4 weeks, maintaining a raised river defence or sea defence (Full details can be found at: https://www.gov.uk/government/publications/environmental-permitting-regulations-exempt-flood-risk-activities/exempt-flood-risk-activities-environmental-permits

- **Standard Rules**: Application for an environmental permit Part B11 – Flood Risk Activity Standard rules application; and
- **Bespoke**: Application for an environmental permit Part B10 – Flood Risk Activities.

- Beverley and North Holderness IDB: Application for Consent for Works Affecting Watercourses; and
- ERYC: Application for Ordinary Watercourse Land Drainage Consent.

2.11.1.7 All Main Rivers and ordinary watercourses identified to be crossed by Hornsea Four to date have been identified in **Volume A4, Annex 4.2: Onshore Crossing Schedule**. Hornsea Four is in consultation with the Environment Agency in seeking to disapply the Environmental Permitting (England and Wales) Regulations 2016 through the DCO. All necessary application consents will be made to the appropriate authority and agreed prior to construction. Further information on these consents can be found in **Volume F1, Chapter 5: Consents Management Plan**.

2.11.2 Consultation

2.11.2.1 Statutory consultees have been consulted as part of the water and flood risk Evidence Plan Technical Panel meeting process. Further information on this consultation can be found at **Volume B1, Annex 1.1: Evidence Plan**. Consultees include, but are not limited to, the Environment Agency, ERYC and the Beverley and North Holderness IDB.

2.11.2.2 Consultation responses are summarised in Section 2.4 of **Volume A3, Chapter 2: Hydrology and Flood Risk**. Key concerns and comments relevant to flood risk centred around the following themes:

- Local sources of flooding are not accounted for by the Environment Agency Flood Map for Planning including, but not limited, to water table level, poorly draining soils, and local topography;
- Removal and / or alteration of existing land drains;
- Localised (surface water) flood risk issues associated with ordinary watercourses, including IDB maintained watercourses and those that are landowner maintained; and
- Increased surface water runoff from the OnSS.

2.11.2.3 Following submission of the PEIR, consultation responses have been received via the Section 42 process from a number of key stakeholders and the responses collated (see **Volume A1, Chapter 6: Consultation)**. The responses have been reviewed and subsequently addressed and incorporated within the ES, where appropriate. In addition, a number of water and flood risk Evidence Plan Technical Panel meetings were held on the 15 September 2019, 5

November 2019, 5 February 2020 and 15 May 2020 to discuss and agree the data to be utilised, the baseline assessment (ON-HYD-1.1 and ON-HYD-6.1) and changes to the project as a result of the consultation process (as detailed in **Volume A1, Chapter 3: Site Selection and Consideration of Alternatives**).

2.11.2.4 This FRA considers all stakeholder comments in terms of the impact of Hornsea Four on potential flood risk and drainage issues.

2.11.2.5 A review of the validity of all baseline data underpinning the FRA was undertaken to ensure that it remains a robust and valid baseline used to inform and support a rigorous Environmental Impact Assessment (EIA). The conclusion of the review was discussed with the Environment Agency during an evidence plan technical panel meeting held on the 7 September 2021. At this meeting the availability of updated flood risk data and climate change allowances was discussed. It was agreed with the Environment Agency that this did not alter the conclusions of the FRA and that flood risk to and from Hornsea Four remains unchanged (ON-HYD-7.6, ON-HYD-7.7, ON-HYD-7.8 and ON-HYD-7.9).

2.12 Commitments

2.12.1.1 Hornsea Four has brought forward a number of Commitments (a term used interchangeably with mitigation) that will be adhered to (**Volume A4, Annex 5.2: Commitments Register**), helping avoid or reduce likely significant adverse environmental effects. Such mitigation includes those defined in line with the Institute of Environmental Management and Assessment (IEMA) 'Guide to Shaping Quality Development' (IEMA,2016) definitions, as follows:

- Primary (inherent) mitigation: are measures that form an intrinsic part of the design that are described in the design evolution narrative and included within the project description e.g. all Environment Agency main rivers, IDB maintained drains, main roads and railways will be crossed by Horizontal Directional Drilling (HDD) or other trenchless techniques (Co1) ;
- Secondary (foreseeable) mitigation: those measures that require further activity in order to achieve the anticipated outcome, e.g. HDD entry and exit points will be located at least 9 m away from IDB and Ordinary surface watercourses and 20 m from Environment Agency surface watercourses (Co18); and
- Tertiary (inexorable): are measures which will be required regardless of the EIA process as they are imposed e.g. as a result of legislative requirements and/or standard industry practices e.g. an Onshore Infrastructure Drainage Strategy will be developed for the permanent onshore operational development in accordance with the Outline Onshore Infrastructure Drainage Strategy (Co19).

2.12.1.2 The Commitments adopted by Hornsea Four that relate to the flood risk assessment are presented in **Table 5**. Principally, these Commitments have resulted in the positioning of Hornsea Four having taken consideration of the historic environment, ensuring impacts upon it are minimised, wherever possible, from the outset.

Table 5: Relevant Flood Risk Assessment Commitments.

Commitment ID	Type	Measure Proposed	How the measure will be secured
Co1	Primary	All Environment Agency main rivers, Internal Drainage Board (IDB) maintained drains, main roads and railways will be crossed by HDD or other trenchless technology as set out in the Onshore Crossing Schedule. Where HDD technologies are not practical, the crossing of ordinary watercourses may be undertaken by open cut methods. In such cases, temporary measures will be employed to maintain flow of water along the watercourse. Main Rivers will not be temporarily dammed and/or rerouted.	DCO Requirement 17 (Code of construction practice)
Co13	Tertiary	Where cable trenching or road widening of the construction accesses is required across perched or near-surface secondary A or B aquifers, measures will be implemented to protect groundwater quality. These will be detailed within the Pollution Prevention Plan (PPP) (Co4). Additionally, in such areas, thermally insulated cables will be used to minimise effects on groundwater temperature. Furthermore, measures to ensure that the cable trench does not become a conduit for groundwater flow will also be implemented. All such measures will be identified following consultation with the Environment Agency and will be reported within the CoCP (Co124) and in line with the requirements of Section 23-25 of the Land Drainage Act 1991, or the latest relevant available guidance.	DCO Requirement 17 (Code of construction practice)
Co14	Tertiary	A Construction Drainage Scheme will be developed for the temporary onshore construction works in accordance with the Outline Onshore Infrastructure Drainage Strategy. The Construction Drainage Scheme will ensure that existing land drainage is maintained during construction and will identify specific drainage measures for each area of land based on information identified and recorded by a Land Drainage Consultant prior to construction. The Construction Drainage Scheme will be developed in consultation with landowners, the Lead Local Flood Authority (ERYC), Environment Agency and relevant Internal Drainage Board.	DCO Requirement 13 (Surface and foul water drainage)
Co18	Secondary	HDD entry and exit points will be located at least 9 m away from IDB and Ordinary surface watercourses and 20 m from Environment Agency surface watercourses or the landward toe of the Environment Agency surface watercourse's flood defences. Where a surface watercourse is to be crossed by HDD, the onshore export cables will be installed at least 1.2 m beneath the hard bed of any watercourses and the optimal clearance depth beneath watercourses will be agreed with the relevant authorities prior to construction. Where Environment Agency flood defences are present, a minimum 1.2m vertical clearance will be maintained between the hard bed of the	DCO Requirement 17 (Code of construction practice)

Commitment ID	Type	Measure Proposed	How the measure will be secured
		watercourse and the landward toe of those flood defences. Where Hornsea Four crosses sites of particular sensitivity (e.g. embanked Environment Agency watercourses, SSSIs or groundwater Inner Source Protection Zones (SPZs)) a hydrogeological risk assessment will be undertaken to inform a site-specific crossing method statement which will also be agreed with the relevant authorities prior to construction.	
Co19	Tertiary	An Onshore Infrastructure Drainage Strategy will be developed for the permanent onshore operational development in accordance with the Outline Onshore Infrastructure Drainage Strategy. The Onshore Infrastructure Drainage Strategy will include measures to ensure that existing land drainage is reinstated and/or maintained. This will include measures to limit discharge rates and attenuate flows to maintain greenfield run-off rates at the Onshore Substation. The Onshore Infrastructure Drainage Strategy will be developed in line with the latest relevant drainage guidance notes in consultation with the Environment Agency, Lead Local Flood Authority (ERYC) and relevant Internal Drainage Board, as appropriate.	DCO Requirement 13 (Surface and foul water drainage) DCO Requirement 15 (Surface water)
Co25	Primary	The onshore export cable corridor (inclusive of the 400 kV export cables) will be completely buried underground for its entire length. No overhead pylons will be installed as part of the consented works for Hornsea Four.	DCO Schedule 1, Part 1 Authorised Development
Co28	Primary	Joint Bays will be completely buried, with the land above reinstated except where access will be required from ground level, e.g. via link box chambers and manholes.	DCO Requirement 17 (Code of construction practice) DCO Requirement 20 (Restoration of land used temporarily for construction)
Co41	Primary	All HDD crossings will be undertaken by non-impact methods in order to minimise construction vibration beyond the immediate location of works.	DCO Requirement 17 (Code of construction practice)
Co64	Tertiary	Topsoil and subsoil will be stored in separate stockpiles in line with DEFRA Construction Code of Practice for the Sustainable Use of Soils on Construction Sites PB13298 or the latest relevant available guidance. Any suspected or confirmed	DCO Requirement 17 (Code of construction practice)

Commitment ID	Type	Measure Proposed	How the measure will be secured
		contaminated soils will be appropriately separated, contained and tested before removal (if required).	DCO Requirement 14 (Contaminated land and groundwater scheme)
Co68	Secondary	All logistics compounds will be removed and sites will be reinstated when construction has been completed.	DCO Requirement 17 (Code of construction practice) DCO Requirement 20 (Restoration of land used temporarily for construction)
Co124	Tertiary	A Code of Construction Practice (CoCP) will be developed in accordance with the outline CoCP. The outline CoCP will include measures to reduce temporary disturbance to residential properties, recreational users, and existing land users.	DCO Requirement 17 (Code of construction practice)
Co127	Tertiary	An Onshore Decommissioning Plan will be developed prior to decommissioning in a timely manner. The Onshore Decommissioning Plan will include provisions for the removal of all onshore above ground infrastructure and the decommissioning of below ground infrastructure and details relevant to flood risk, pollution prevention and avoidance of ground disturbance. The Onshore Decommissioning Plan will be in line with the latest relevant available guidance.	DCO Requirement 24 (onshore decommissioning)
Co143	Secondary	The landfall site will avoid the Barmston Main Drain.	DCO Works Plan - Onshore
Co147	Tertiary	Appropriate liaison will take place with the Internal Drainage Board during construction.	DCO Requirement 17 (Code of construction practice)
Co157	Secondary	Fences, walls, ditches and drainage outfalls will be retained along the onshore export cable corridor and landfall, where possible. Where it is not possible to retain them, any damage will be repaired and reinstated as soon as reasonably practical. The Environment Agency must be notified if damage occurs to	DCO Requirement 17 (Code of construction practice)

Commitment ID	Type	Measure Proposed	How the measure will be secured
		any Environment Agency Main River or related flood infrastructure.	
Co170	Secondary	Joint bays and link boxes will be located a minimum of 20 m away from Environment Agency Main Rivers.	DCO Requirement 17 (Code of construction practice)
Co172	Secondary	The bed and banks of watercourses will be reinstated to their pre-construction condition following the removal of any temporary structures. Culverts will not be used for temporary access track crossings across Environment Agency Main Rivers. Where a temporary access track crossing across an Environment Agency Main River may be required, clear span/ bailey bridges will be used. There will be no loss of cross-sectional area to Environment Agency Main Rivers.	DCO Requirement 17 (Code of construction practice)
Co175	Secondary	A pre and post construction condition survey will be undertaken at each Environment Agency Main River crossings, including any flood defences to be crossed. The scope and methodology of the survey will be agreed in advance with the Environment Agency. On completion of the project, details of the surveys under each Main River and flood defence will be submitted to the Environment Agency .	DCO Requirement 17 (Code of construction practice)
Co183	Secondary	Where possible the design of all temporary access tracks within the floodplain of Environment Agency Main Rivers (defined as areas of Flood Zone 2 and 3, as shown on the Environment Agency Flood Map for Planning), areas at risk of surface water flooding (as shown on the Risk of Flooding from Surface Water maps), or in areas included on the historic flood map (from any source) will replicate or be as consistent with existing ground levels as possible, to limit any effects on future flood risk.	DCO Requirement 17 (Code of construction practice)
Co184	Secondary	Where the permanent access track to the OnSS may be required to pass over an existing watercourse, the crossing will be appropriately designed to maintain floodplain capacity and/or flow conveyance, where possible. This shall include an allowance for the predicted effects of climate change.	DCO Requirement 17 (Code of construction practice)
Co185	Secondary	Where the permanent access track to the OnSS is within areas of flood risk (as shown on the Environment Agency Flood Map for Planning) it will be appropriately designed to maintain existing ground elevations to ensure continued floodplain capacity and/or flow conveyance, where possible.	DCO Requirement 17 (Code of construction practice)
Co186	Tertiary	Where works to an Environment Agency Main River or ordinary watercourse are necessary, the appropriate permits and consents will be sought from the relevant authority as required. Details of the locations and works undertaken on any Environment Agency Main River or associated flood defences,	DCO Requirement 17 (Code of construction practice)

Commitment ID	Type	Measure Proposed	How the measure will be secured
		including any reports or records, will be submitted to the Environment Agency.	
Co187	Secondary	The installation of the offshore export cables at landfall will be undertaken by Horizontal Directional Drilling or other trenchless methods.	DCO Requirement 17 (Code of construction practice)
Co191	Secondary	The drainage design at the onshore substation will include SuDs measures including filter drains, swales, attenuation and flow control structures for the operational drainage of the Onshore Substation. Surface water will be discharged from the site at a controlled rate which will be determined during the detailed design stage. Appropriate consideration will be given to maintaining the existing floodplain capacity and / or flow conveyance during extreme rainfall events. These principles are provided in the Outline Onshore Infrastructure Drainage Strategy with which the Onshore Infrastructure Drainage Strategy will be developed.	DCO Requirement 15 (Surface Water)
Co197	Secondary	Where reasonably practicable, topsoil & subsoil stockpiling within the floodplain (defined as areas of Flood Zone 2 or 3 as identified on the Environment Agency Flood Map for Planning) of any Environment Agency Main River will be avoided at the Onshore Substation.	DCO Requirement 17 (Code of construction practice)

3 Baseline Environment

3.1 Existing surface water drainage system

3.1.1.1 The Hornsea Four Order Limits is primarily located on rural, agricultural land where there are limited existing formal surface water drainage systems. However, there are a large number of agricultural land drains, ordinary watercourses and IDB maintained watercourses, especially along the onshore ECC.

3.2 Geology and hydrogeology

3.2.1.1 The British Geological Survey (BGS) solid and superficial geology maps identify the bedrock underlying the Hornsea Four Order Limits as Chalk, overlain by superficial deposits of Devensian till (diamicton), head, sand and gravel, silt and sand alluvium, and clay throughout (illustrated in Figure 2 to Figure 6 of **Annex 1.1: Land Quality Preliminary Risk Assessment** (PRA).

3.2.1.2 Regionally, the principal groundwater body underlying the majority of the Hornsea Four Order Limits is the Hull and East Riding Chalk. The chalk bedrock is designated as a Principal Aquifer. These are layers of rock that have high intergranular and / or fracture permeability meaning they usually provide a high level of water storage.

3.2.1.3 A number of Source Protection Zones (SPZs) are identified within the Hornsea Four Order Limits, with both inner and outer zones of the SPZ areas extending across the southern section of the onshore ECC and the OnSS.

3.2.1.4 The superficial deposits within the area are predominantly classified as secondary aquifers, deemed to be formed of permeable layers capable of supporting local water supplies. Refer to **Annex 1.1: Land Quality Preliminary Risk Assessment** for more information and corresponding figures relating to the geology and ground conditions in and around the Hornsea Four Order Limits. Appendix I of the Level 1 SFRA (ERYC 2010) indicates the majority of the Hornsea Four Order Limits fall within a groundwater emergence zone, based on the Defra Groundwater Flooding Scoping Study (Jacobs 2004). Measures set out in Co13 will be implemented to protect groundwater quality.

3.3 Surface hydrology

3.3.1.1 The Environment Agency's WFD river water body catchments (Environment Agency 2019) are based on surface hydrological catchments and have therefore been used to delineate the boundaries of each surface water drainage catchment within the FRA.

3.3.1.2 The Hornsea Four Order Limits are located within three WFD operational catchments (**Figure 1**). From north to south, these are:

- The Barmston Sea Drain catchment, which covers approximately 8.5 km of the length of the landfall and onshore ECC. The catchment is approximately 135 km^2, covering the area south of Bridlington including the urbanised areas of Skipsea and Hornsea and surrounding settlements such as Rolston and Southorpe with some agricultural land. The largest feature is Hornsea Mere itself. The main watercourse is the Stream Dike which flows from Hornsea Mere to the North Sea. Small coastal streams including Barmston Sea Drain and Skipsea Drain are also present, However, these are all located south of the landfall and onshore ECC (as a result of Co143). The Earl's Dike watercourse runs through the landfall before entering the North Sea;

- The Hull Upper catchment, which covers approximately 9.5 km of the length of the onshore ECC. The catchment is approximately 575 km^2, largely centring on Driffield and the surrounding area to the north of the onshore ECC. It covers the Wolds from Thixendale in the west to Kilham in the north, Foston on the Wolds in the east, and Hutton Cranswick in the south. The area is characterised by rolling chalk hills and dry valleys on the Wolds and the land use is predominantly arable. The River Hull is sourced from chalk streams located to the north and west of Driffield, which flow south towards Driffield Beck where they are joined by the Driffield Trout Stream, becoming the River Hull which continues south into the Hull Lower catchment; and

- The Hull Lower catchment, which covers approximately 21 km of the length of the landfall and onshore ECC (including the OnSS). In total the catchment is approximately 425 km^2 from Walton in the north down to the City of Hull, the Humber estuary in the south, Bishop Burton in the west and Great Cowden on the East Yorkshire coast. It contains the urban areas of Hull and surrounding settlements such as Cottingham, Hessle, Willerby and Beverley. Much of the catchment and surrounding land is at or

below sea level presenting a significant flood risk from fluvial and tidal sources. The Beverley and Barmston Drain is primarily a land drainage ditch and water levels are managed and pumped accordingly. The River Hull and Holderness Drain Main Rivers both discharge south into the Humber Estuary (Environment Agency, no date).

4 Definition of Flood Hazard

4.1.1.1 This section explores the risk of flooding to each of the three key project elements (landfall, onshore ECC and OnSS), as outlined in **Section 1.4.2**. This section should be read in conjunction with figures that are embedded within this document to aid interpretation. Where flood risk is identified, appropriate mitigation methods are discussed within **Section 8**.

4.1.2 Flood Zones

4.1.2.1 The NPPF PPG, through the application of the Sequential Test, aims to steer development towards areas at lowest risk of flooding (Flood Zone 1) and away from medium and high flood risk areas (Flood Zones 2 and 3) (**Table 3**).

4.1.2.2 Flood Zones are informed by the extent of modelling undertaken by the Environment Agency. All designated Main Rivers, as well as some of the larger IDB maintained watercourses and ordinary watercourses included in the modelling, are considered within the Flood Zone datasets.

4.1.2.3 It is acknowledged that there may be a flood risk associated with ordinary watercourses which are intercepted by the onshore ECC. However, due to the relative size and frequency of these watercourses and the associated information related to flood risk they are considered independently from Main Rivers, as well as within the surface water flood risk section for each of the project elements.

4.1.3 Watercourse Crossings

4.1.3.1 The detailed methodology for all watercourse crossings, Environment Agency Main River, IDB maintained (Co147) or other ordinary watercourses will be agreed with the relevant stakeholders e.g. third-party asset owners and other statutory consultees. The proposed crossing methodology for all onshore crossings identified to date is provided in **Volume A4, Annex 4.2: Onshore Crossing Schedule**. The principles related to watercourse crossings have been summarised in Co1 and Co18 (as detailed in **Volume A4, Annex 5.2: Commitments Register**). These have been subject to ongoing discussions with key stakeholders throughout the DCO process, as part of the water and flood risk Evidence Plan Technical Panel meetings (ON-HYD-3.1 and ON-HYD-3.17) and further details will be agreed with the Environment Agency, IDB and / or relevant Local Authority, as relevant post-consent and pre-construction (Co147 and Co186).

4.2 Landfall

4.2.1 Overview of Proposed Activities

4.2.1.1 The landfall (i.e. the onshore area where the transition jointing of the offshore and onshore export cables will take place, and where the landfall logistics compound and transition joints will be located) is situated to the east of Fraisthorpe and includes a stretch of coastline approximately 0.9 km to the south-east of Fraisthorpe (Co143). The Earls Dike watercourse is located immediately to the north (**Figure 2**). The landfall extends inland approximately 0.6 km and consists of agricultural land. A temporary access track will be required for beach access. This is expected to be either a stone aggregate track or trackway, a maximum 10 m wide to allow for around a 6 m running track.

4.2.1.2 Hornsea Four has committed to undertake the landfall works using HDD or other trenchless technologies (Co187).

4.2.1.3 The acquisition of further geophysical and geotechnical data will not be available until the post-consent and pre-construction phase (earliest construction start date is 2024). Once the additional geotechnical information is available, the technical suitability of HDD compared with other trenchless techniques, at the landfall, will be confirmed.

4.2.2 Historic Flooding

4.2.2.1 Absence of a historic flood record does not necessarily confirm that flooding has not occurred. However, both the Product 4 data package (Environment Agency 2019) and the information within the Level 1 SFRA (ERYC 2010) shows the landfall to have been unaffected by historic tidal or fluvial flood events.

4.2.3 Flood Zones

4.2.3.1 The landfall is largely located within Flood Zone 1, as defined by the Environment Agency online Flood Map for Planning (Environment Agency, undated) and confirmed by the Product 4 data obtained in April 2019 (**Figure 3**). The temporary access track to the beach is located in Flood Zone 3 (**Figure 3**); however, this is temporary in nature during the construction phase and does not comprise any permanent above ground features and therefore does not have an impact on flood risk.

4.2.3.2 Although the landfall is located approximately 2 km north of the nearest Environment Agency Main River, small parts of the landfall fall within Flood Zones 2 and 3. This is due to its proximity to the Earl's Dike IDB maintained watercourse that drains into Bridlington Bay and runs along the northern boundary of the landfall. The flood risk associated with this IDB maintained watercourse is discussed in **Section 4.2.5**.

4.2.4 Flooding from Main Rivers

4.2.4.1 The landfall is located approximately 2 km north of the nearest Environment Agency Main River, and from information contained within the Product 4 data, is not at risk of flooding from this source (Figure 3).

4.2.5 Flooding from IDB maintained watercourses

4.2.5.1 The Earl's Dike IDB maintained watercourse (ID088) drains into Bridlington Bay at the north of the landfall. Flood Zone 2 and 3 are mapped as extending approximately 20 m to the south of the watercourse (Figure 3).

4.2.5.2 Review of the LiDAR data in this location indicates the watercourse is located within a relatively well-defined channel. Therefore, the flood extent associated with this watercourse appears to be limited to areas immediately adjacent to the channel and confined by the existing topography.

4.2.5.3 Therefore, the landfall is at low risk of flooding from this source.

4.2.6 Flooding from the Sea

4.2.6.1 As identified in Section 4.2.3, the landfall is primarily located within Flood Zone 1, with small areas falling within Flood Zones 2 and 3 related to the presence of the Earl's Dike IDB maintained watercourse to the north (Figure 3).

4.2.6.2 The Level 1 SFRA (ERYC 2010) contains limited information on the risk of tidal flooding, and no analysis of potential flood risk from tidal sources was included for the landfall.

4.2.6.3 The Environment Agency Product 4 data identifies that the landfall is protected from flooding by the sea by linear natural defences in the form of high ground. The Product 4 data states that these cliffs provide up to a 1 in 1,000 year standard of protection from the sea.

4.2.6.4 A review of LiDAR data further confirms this raised elevation, with the cliffs protecting the landfall located at ground levels ranging from approximately 4.9 m AOD to 10 m AOD, which is approximately 1 m to 7 m above the highest beach levels (Figure 2).

4.2.6.5 The beach in front of the landfall is identified as Flood Zone 3. As the offshore export cables are to be connected onshore using trenchless techniques (e.g. HDD) there would be no flood risk to the cable as it makes landfall.

4.2.6.6 Therefore, the landfall is at low risk of flooding from the sea based on the use of HDD or other trenchless techniques.

4.2.7 Flooding from Groundwater

4.2.7.1 The Level 1 SFRA (ERYC 2010) identifies that a large proportion of the East Riding of Yorkshire is characterised by chalk geology and following heavy rainfall elevated groundwater levels are often experienced. The SFRA groundwater emergence map (ERYC

2010) shows that much of the landfall area is classified as being within a Groundwater Emergence Zone. However due to the resolution of data available, the full extent of this risk to the landfall is not clear. This FRA meets the requirement of the Level 1 SFRA, in providing a 'detailed' FRA in line with the, now superseded, PPS25 Development Control Recommendations, due to the identification of groundwater flood risk.

4.2.7.2 The effect the landfall shall have on groundwater flows once operational is likely to be low, as the buried cable will be located at a target depth of 1.2 m below ground. However, in some areas it will be further dependent on the specific area for burial. Embedded mitigation measures related to the effect of the landfall during the construction phase, have been incorporated in the design to limit the impact on groundwater disturbance and to limit the impact on the hydraulic connectivity between groundwater and surface water. These measures include the location of the buried cable at a target depth of 1.2 m below ground (i.e. limiting interaction to shallow or near surface groundwater) (see **Volume A1, Chapter 4: Project Description** for further details). Furthermore, any water flowing into the trenches during the construction period will be intercepted before being discharged into local ditches or drains via temporary interceptor drains (Co14). This is secured in **Volume F2, Chapter 6: Outline Onshore Infrastructure Drainage Strategy**.

4.2.7.3 Due to the nature of the proposed landfall, there is a low risk of groundwater flooding. However, the inclusion of embedded mitigation measures, as outlined above, within the design and to be implemented during the construction phase, through the development of an appropriate Code of Construction Practice (CoCP) (Co124), means that the groundwater flood risk is therefore considered to be low.

4.2.8 Flooding from Surface Water

4.2.8.1 The Environment Agency's Long-Term Flood Risk Information map (Environment Agency, undated) and **Figure 4** show the landfall to be located almost entirely in an area at 'Very Low' risk of surface water flooding i.e. primarily outside the extent of the 1 in 1,000 year surface water flooding event.

4.2.8.2 Three ordinary watercourses are located within the landfall (**Figure 4**). Two drains (Watermills Grounds North and South Drains) run west across the southern section of the landfall, into the Watermills Drain which flows north before entering the Earl's Dike IDB maintained watercourse. At these locations, there are isolated areas at low risk (i.e. land which has a chance of flooding of between 0.1% and 1%) through to high risk (i.e. land which has a chance of flooding of greater than 3.3%) of surface water flooding.

4.2.8.3 The risk of surface water flooding within the landfall is therefore considered overall to be 'very low' with specific areas at a higher risk of flooding associated with the land in proximity to ordinary watercourses.

4.2.9 Flooding from Sewers

4.2.9.1 No DG5 (sewer flood record) information is available to support this FRA. The landfall is located on existing agricultural land. Therefore, it is likely that there is no foul sewer network within proximity of this location. As such, it is considered that there is no risk of flooding from sewer sources.

4.2.10 Flooding from Reservoirs, Canals and Other Artificial Sources

4.2.10.1 Flooding from reservoirs is defined based on the implications of a large uncontrolled release of water from registered reservoirs i.e. greater than 25,000 m^3. The Environment Agency Flood Risk from Reservoirs map shows the site is not at risk of reservoir flooding (Environment Agency 2019).

4.2.10.2 There are no canals or other artificial sources within the landfall. Therefore, there is no risk of flooding from reservoirs, canals or other artificial sources to the landfall.

4.2.11 Summary of Flooding Sources to the landfall

4.2.11.1 Overall, the landfall is not at risk from Main Rivers, sewers, reservoirs, canals or other artificial sources. There is a low level of flood risk associated with the IDB maintained watercourse and groundwater. The risk of surface water flooding is generally low with some specific and restricted areas at high risk.

4.2.11.2 There is also a low risk of flooding associated with tidal / coastal flood risk to the landfall on the basis that HDD or other trenchless techniques are to be utilised.

Hornsea Four

Figure 2

Landfall Topography

515000 516000 517000 518000

463000 462000 461000 460000

N

GRID NORTH

Kingsfield Cottages
Crossham Hills
Willow Garth
Auburn Beck
Mean High Water
Mean Low Water
Bridlington
Fraisthorpe Wind Farm
Auburn Farm
Auburn Sands
Medieval Village of Auburn (site of)
North Kingsfield
South Kingsfield
BARMSTON CP
Manor Farm
Fraisthorpe
Lodge Farm
Fraisthorpe Sands
Sheep Walks
Carr Dike
Manor House Farm
Earthworks
Carr Hill
Fraisthorpe New Bridge
Fraisthorpe Bridge
The Earl's Dike
Conygarth Hill
Low Stonehills
Sands Road (Track)
Watermill Grounds
AP_002
HC_003
HC_004
Plump Hill
Stone Hills
Bridlington Road
East Hill
Quintin Garth
16
17
18
Hamilton Hill
Hamiltonhill Farm
High Stonehills
Pit (dis)
Spring Hill
Low Grounds
Marr Plantation
Warrens
Carrs
Barmston Sands
Hamilton Hill Road
AP_040
AP_003
Holiday Park

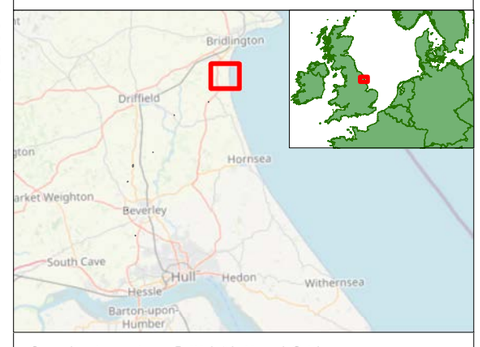
Order Limits

Haul Road Crossing Access Point

Public Highway Access Point

Digital Surface Model (DSM)
1m Resolution (Environment Agency, 2019)

High : 15
12
9
6
3
Low : 0



Coordinate system: British National Grid
Scale@A3: 1:15,000

0 200 400 600 800 Metres
0 200 400 600 800 Yards

REV	REMARK	DATE
	First Issue for PEIR	03/07/2019
A	Updated following PEIR consultations, for DCO	23/06/2021

Title: Landfall Topography
Document no: HOW04RH0061
Created by: AZ
Checked by: ID
Approved by: CS

Royal HaskoningDHV

Ørsted

Date: 23/06/2021 Author: 303273 Name: HOW04RH0061_LandfallTopography

Hornsea Four

Figure 3

Flood Zones - Sheet 1 of 7

514500 516000 517500 519000

463000 461500 460000 458500

GRID NORTH

Bridlington Bay

Mean Low Water

BARMSTON CP

Brackendale Farm
Old Brackendale Wood
Kingsfield Cottages
Crossham Hills
Willow Garth
Auburn Beck
Fraisthorpe Wind Farm
Auburn Farm
Medieval Village of Auburn (site of)
North Kingsfield
South Kingsfield
Demming Hill
Manor Farm
Fraisthorpe
Lodge Farm
Earthworks
Sheep Walks
Fraisthorpe Sands
Carr Dike
Carr Hill
The Earl's Dike
Fraisthorpe New Bridge
Fraisthorpe Bridge
Conygarth Hill
Low Stonehills
Stonehills Drain
Plump Hill
Stone Hills
East Hill
Quintin Garth
High Stonehills
Hamilton Hill
Hamiltonhill Farm
Low Grounds
Pit (dis)
Spring Hill
Marr Plantation
Warrens
Burton Drain
Carrs
Holiday Park
Granamoor Lodge
Barmston Fox C
Gransmoor Drain
Red Roofs
Barmston
Manor House
Low Farm
Southfield La
Cliff Farm
Caravan Park
South Field
The Elms
Moat
Trusey Hill
Barmston Sea Drain
Hamilton Hill Road
Bridlington Road
Barmston Main Drain

AP_002
HC_003
HC_004
HC_068
AP_003
AP_040
LC_001
HC_006
HC_007
HC_008

14 15 16 18 19

(Track)

Date: 11/08/2021 Author: 303273 Name: HOW04RH0063_FloodZones

- Order Limits
- Temporary Access Track
- Logistics Compound
- Onshore Export Cable Corridor
- Landfall Compound Areas
- Landfall Connection Works
- Haul Road Crossing Access Point
- Public Highway Access Point
- Main River
- IDB Maintained Watercourse
- Ordinary Watercourse
- Historic Flood Locations

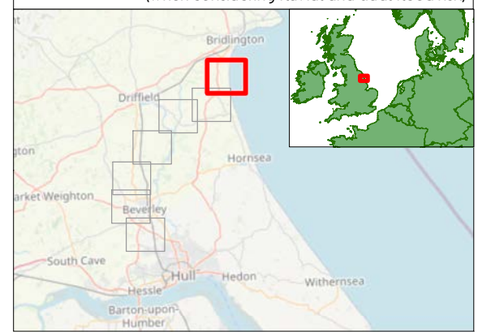
Environment Agency Flood Zones*

- Flood Zone 2
- Flood Zone 3

WFD Operational Waterbody Catchments

- Barmston Sea Drain
- Yorkshire Coast

*All areas not shown as being located in either Flood Zone 2 or 3 are classed as Flood Zone 1 (when considering fluvial and tidal flood risk)



Coordinate system: British National Grid

Scale@A3: 1:20,000

0 250 500 750 Metres

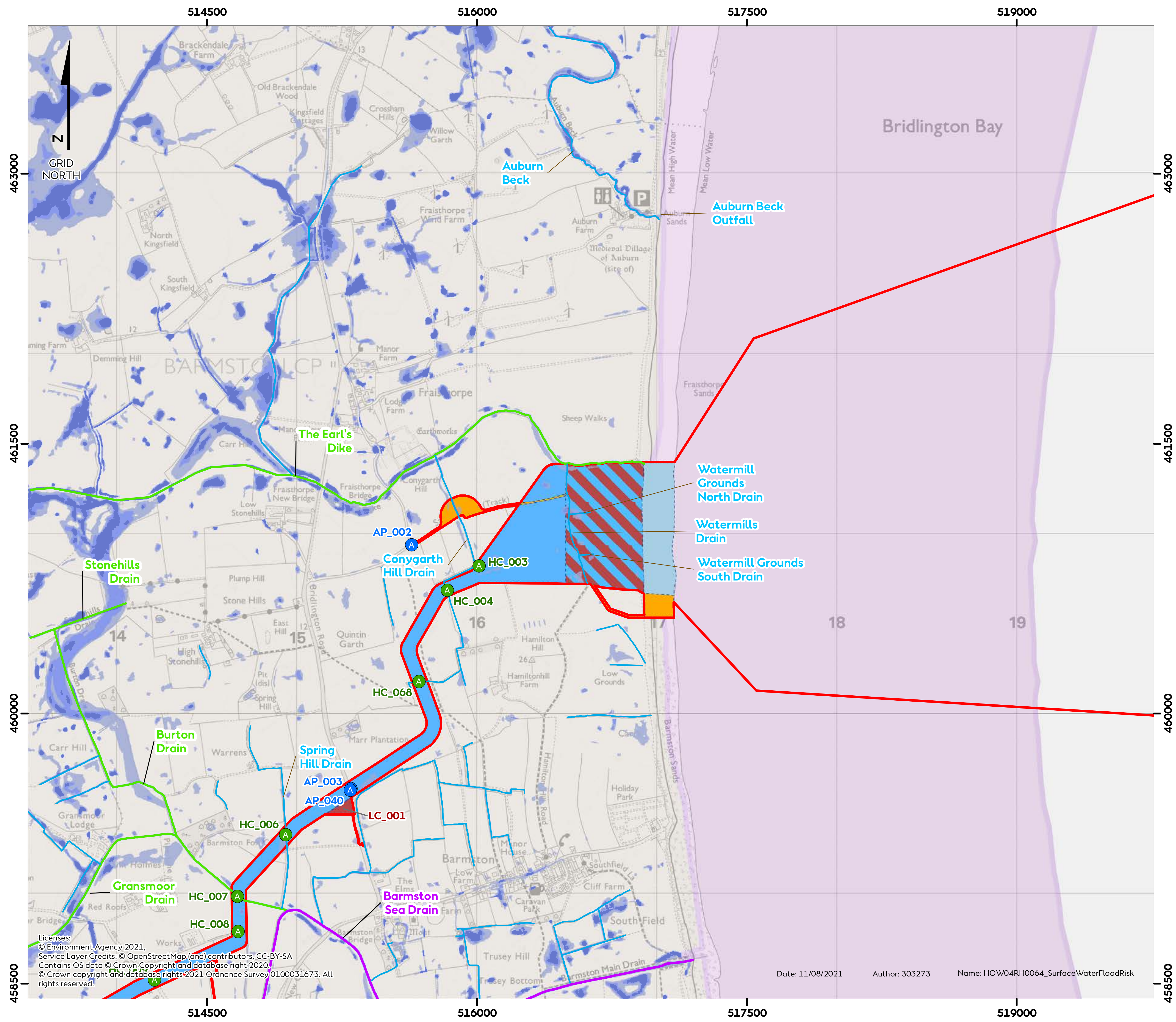
0 250 500 750 Yards

REV	REMARK	DATE
	First Issue for PEIR	03/07/2019
A	Updated following PEIR consultations, for DCO	11/08/2021

Title: Flood Zones
Document no: HOW04RH0063
Created by: AZ
Checked by: ID
Approved by: CS

Royal HaskoningDHV

Ørsted


514500
516000
517500
519000
463000
461500
460000
458500
N
GRID NORTH
Bridlington Bay
Auburn Beck
Auburn Beck Outfall
The Earl's Dike
Watermill Grounds North Drain
Watermills Drain
Watermill Grounds South Drain
Stonehills Drain
AP_002
Conygarth Hill Drain
HC_003
HC_004
HC_068
Burton Drain
Spring Hill Drain
AP_003
AP_040
LC_001
HC_006
HC_007
HC_008
Gransmoor Drain
Barmston Sea Drain
14
15
16
17
18
19
Licenses:
© Environment Agency 2021,
Service Layer Credits: © OpenStreetMap (and) contributors, CC-BY-SA
Contains OS data © Crown Copyright and database right 2020
© Crown copyright and database rights 2021 Ordnance Survey 0100031673. All rights reserved.
Date: 11/08/2021
Author: 303273
Name: HOW04RH0064_SurfaceWaterFloodRisk

Hornsea Four

Figure 4

Surface Water Flood Risk - Sheet 1 of 7

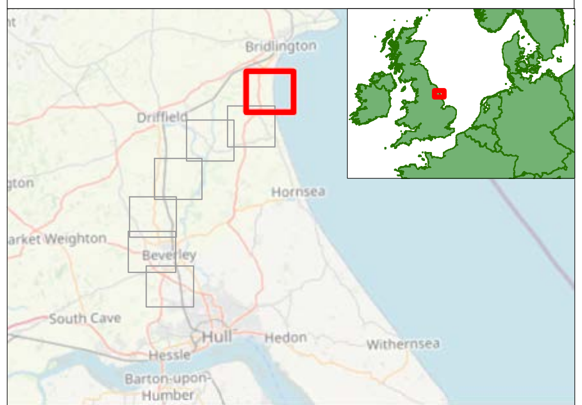
- Order Limits
- Temporary Access Track
- Logistics Compound
- Onshore Export Cable Corridor
- Landfall Compound Areas
- Landfall Connection Works
- Public Highway Access Point
- Haul Road Crossing Access Point
- Main River
- IDB Maintained Watercourse
- Ordinary Watercourse

Environment Agency Flood Map for Surface Water

- High Risk (Greater than 1 in 30 Annual Probability of Flooding)
- Medium Risk (Between 1 in 100 and 1 in 30 Annual Probability of Flooding)
- Low Risk (Between 1 in 1,000 and 1 in 100 Annual Probability of Flooding)

WFD Operational Waterbody Catchments

- Barmston Sea Drain
- Yorkshire Coast



Coordinate system: British National Grid
Scale@A3: 1:20,000

0 250 500 1,000 Metres
0 250 500 1,000 Yards

REV	REMARK	DATE
	First Issue for PEIR	03/07/2019
A	Updated following PEIR consultations, for DCO	11/08/2021

Title: Surface Water Flood Risk
Document no: HOW04RH0064
Created by: AZ
Checked by: ID
Approved by: CS

Royal HaskoningDHV
Ørsted

4.3 Onshore ECC and Associated Project Infrastructure

4.3.1 Overview of Proposed Activities

4.3.1.1 The onshore ECC will be a temporary working area width of 80 m and permanent easement of 60 m, except at the Network Rail Crossing near Beswick, on the approach to landfall and the OnSS where the working width has been extended (see Co7 and Section 4.10.1 of **Volume A1, Chapter 4: Project Description**). The cables will be buried using up to six trenches, each containing one cable circuit. The onshore ECC will typically be installed in sections of between 750 m and 3,000 m at a time. Link boxes and joint bays will be required at locations along the route to facilitate maintenance and construction of the onshore ECC. Eight temporary onshore ECC logistics compounds will be required to operate as support bases for the onshore construction works as the cable work passes through an area.

4.3.1.2 The installation of the onshore ECC is expected to take up to 30 months, with a maximum construction duration of 36 months for logistics compounds.

4.3.2 Watercourse Crossings

4.3.2.1 Within this FRA, the definition of the flood hazard to the onshore ECC has been considered within each of the three WFD Operational catchments (**Figure 1**).

4.3.2.2 The onshore ECC crosses several 'Main Rivers' (as designated by the Environment Agency), a number of IDB maintained watercourses and a large number of ordinary watercourses. These crossings are detailed in **Volume A4, Annex 4.2: Onshore Crossing Schedule**.

4.3.2.3 The haul road will be contained within the 39 km ECC for the full construction duration of 30 months. Main Rivers and IDB maintained watercourses will be crossed using HDD (see Co1 in **Volume A4, Annex 5.2: Commitments Register**). However, accesses may be required across watercourses to facilitate construction activities (see **Volume A4, Annex 4.2: Onshore Crossing Schedule** for further details of these locations).

4.3.2.4 The onshore ECC and haul road will be required to cross smaller watercourses, land drains and agricultural ditches along the route, where open cut crossings are proposed. The design related to temporary water crossings will be developed to prevent impoundment and maintain flows as detailed in **Volume F2, Chapter 2: Outline Code of Construction Practice** (Co124)). The methodology to be used for any temporary construction at crossing points over existing ditches and watercourses shall be agreed with the Environment Agency, relevant Local Authority and / or the IDB. **Table 6** identifies the number of watercourses being crossed both by HDD and crossed by the onshore ECC within each WFD operational catchment.

Table 6: Number of Watercourse Crossings by the onshore ECC and Haul Road in each WFD Operational Catchment.

WFD Operational Catchment	Main River Crossings	IDB Maintained Watercourse Crossings	Ordinary Watercourse Crossings
Barmston Sea Drain	0	3	9
Upper Hull	5	4	7
Lower Hull	2	3	21

4.3.3 Export Cable Corridor Logistics Compounds

4.3.3.1 Eight onshore ECC logistics compounds, as described in **Volume A1, Chapter 4: Project Description**, will be required to operate as support bases for the onshore construction works as the cable work passes through an area. These logistics compounds are considered in comparison with existing Flood Zones (for fluvial and tidal flood risk) as well as all other sources of flood risk. They are likely to comprise portable offices, welfare facilities, localised stores, as well as acting as staging posts for localised secure storage for equipment and component deliveries. **Table 7** identifies the number of onshore ECC logistics compounds within each WFD operational catchment.

4.3.3.2 The Level 1 SFRA (ERYC 2010) identifies that a large proportion of the East Riding of Yorkshire is characterised by chalk geology and following heavy rainfall elevated groundwater levels are often experienced. The Level 1 SFRA (ERYC 2010) groundwater emergence map shows that some of the ECC logistics compounds are classified as being within a Groundwater Emergence Zone. However due to the resolution of data available, the full extent of this risk is not clear.

4.3.3.3 All onshore ECC logistics compounds are located in areas defined as having a 'very low' risk of surface water flooding (less than 0.1% or a 1 in 1,000 year probability).

4.3.3.4 No DG5 (sewer flood record) information is available to support this FRA. The onshore ECC logistics compounds are located on existing agricultural land. Therefore, it is likely that there is no foul sewer network within proximity of these locations. As such, it is considered that there is no risk of flooding from sewer sources.

4.3.3.5 A review of the Environment Agency Flood Risk from Reservoirs map found that none of the ECC logistics compounds are at risk of reservoir flooding (Environment Agency 2019).

4.3.3.6 Seven of the currently identified eight onshore ECC logistics compounds are located in Flood Zone 1. Two of the ECC logistics compounds have areas which mean they are partially located within the Flood Zone 3 extent. As an embedded mitigation measure, where possible, the ECC logistics compounds have been located outside Flood Zone 3. However,

where this cannot be avoided the stockpiling of any material will be stored in accordance with DEFRA guidance (Co64).

4.3.3.7 The proposed ECC logistics compound north of Brigham (LC_003) (see **Figure 7**) has been relocated since PEIR. It is now located further north on the B1249. Whilst it is predominantly located in Flood Zone 1, including the access point onto the B1249 a small area of the ECC logistics compound intersects Flood Zone 3, along the south-eastern boundary. However, the area of the ECC logistics compound located in Flood Zone 3 accounts for less than 5% of the total area of the site (i.e. 8,000 m^2) and can be sequentially laid out to avoid this area.

4.3.3.8 The proposed onshore ECC logistics compound at Carr Lane (LC_004) (**Figure 8**), is partially located in an area identified as being in Flood Zone 3. However, this is also a location currently identified from the Environment Agency Product 4 data as benefitting from defences, meaning it is not currently at risk of flooding from fluvial sources. Where the onshore ECC logistics compound cannot be located outside Flood Zone 3 the stockpiling of any material will be stored in accordance with DEFRA guidance (Co64).

4.3.3.9 Following the PEIR submission, a review of the design was carried out and the ECC logistics compound on York Road (now LC_007) (**Figure 15**), relocated approximately 40 m to the south, away from an area of 'high' surface water flood risk.

4.3.3.10 All onshore ECC logistics compounds are now located in areas at 'very low' risk of surface water flooding.

4.3.3.11 It is envisaged that each onshore ECC logistics compounds will be in place for periods of up to 36 months after which they will be removed and the land reinstated (Co68). Due to the reinstatement of ground following completion, there will be no long-term impact on surface water flood risk associated with these features.

Table 7: Onshore ECC infrastructure in each WFD Operational Catchment.

WFD Operational Catchment	Onshore ECC logistics compounds	Temporary access tracks
Barmston Sea Drain	2	4
Upper Hull	1	6
Lower Hull	5	4

4.3.4 Trenchless Crossing / HDD Compounds

4.3.4.1 Hornsea Four is committed to the use of HDD or other non-impact trenchless techniques for all major crossing locations along the onshore ECC, including main roads, railways, Environment Agency Main Rivers and IDB maintained watercourses (Co1 and Co41).

4.3.4.2 HDD compounds will be required along the onshore ECC to support the HDD methodology, with a compound either side of the feature that is to be crossed. Areas for HDD compounds are contained within the 80 m temporary works area of the onshore ECC and therefore are not additional. It is anticipated that access to the HDD compounds will be from the haul road or from the existing road network.

4.3.4.3 It is envisaged that each HDD compound will be in place for a period of approximately one month. Wherever possible, HDD compounds will be located in Flood Zone 1. However, this may not be possible due to proximity to Main Rivers, IDB maintained watercourses and associated flood extents. All HDD entry / exit pits and HDD compounds will be located a minimum of 20 m away from all Main Rivers and 9 m away from all IDB maintained watercourses and ordinary watercourses (Co18).

4.3.4.4 Where possible HDD compounds will be located in areas at 'very low' risk of surface water flooding. Additionally, wherever possible, level ground should be used to reduce any risk of materials washing away in the event of heavy rainfall. This FRA anticipates that compounds will only be used to temporarily hold materials and machinery and that there will be no permanent change to ground conditions, as they will remain permeable after construction.

4.3.5 Temporary Access Tracks

4.3.5.1 Temporary access tracks shall be used during the construction phase of the project, to facilitate cable installation, and will be removed following the completion of the construction phase.

4.3.5.2 Access tracks located within Flood Zones 2 or 3 are at greatest risk of fluvial flooding. The location of these tracks are primarily associated with river crossings. Where possible the design of the access tracks will replicate the existing ground levels to limit the impact of flood risk into the future (Co183).

4.3.5.3 A review of the temporary access tracks has been carried out to identify those which include track and are not an access point only from the existing highway. Details of the temporary access tracks which intersect Flood Zones 2 or 3 are summarised in **Table 8**.

Table 8: Temporary Access Tracks in relation to Flood Zones 2 and 3 and Surface Water Flood Risk.

Access Point (AP)	Flood Zone	Surface water flood risk	Description of Location
AP_008	FZ3	Very Low	The temporary access track to the onshore ECC, is located to the north of Brigham from the B1249 it crosses a small section of Flood Zone 3 (Figure 7);
AP_009	FZ3	High	The temporary access track to the onshore ECC, is located to the west of Brigham, starting at the River Hull, it is entirely located within Flood Zone 3 (Figure 7);
AP_010	FZ3	High	The temporary access track to the onshore ECC, is located off Rotsea Lane to the north of Rotsea, and is entirely located within Flood Zone 3, albeit on the edge of the flood extent (Figure 8).
AP_011	FZ3	Very Low	The temporary access track to the onshore ECC, is located off Carr Lane and adjacent to the ECC logistics compound. It is entirely located within Flood Zone 3 (Figure 8).
AP_012	FZ3	Low	The temporary access track to the onshore ECC, is located off Wilfholme Road. It is entirely located within Flood Zone 3 (Figure 8).
AP_016	FZ3	Low	The temporary access track to the onshore ECC, is located west of the A164 (Beverly Road) and although mainly in Flood Zone 1 it runs alongside and appears to intersect small areas of Flood Zone 3 (Figure 11);
Gembling Diversion	FZ3	Very Low	The temporary haul road access track diverted south of the onshore ECC, located south of Gembling, intersects small areas of Flood Zone 3 (Figure 5).

4.3.5.4 All temporary access tracks follow existing lanes or tracks where they have been possible to use (see Section 4.3.1 in **Volume A4, Annex 3.3: Site Selection and Refinement of the Onshore Infrastructure**). Therefore, whilst the characteristics of the ground will not change, some routes may require upgrading to facilitate vehicular access. However, following cable installation the temporary access tracks will be removed and the land reinstated.

4.3.5.5 Flood risk to these temporary access tracks will need to be considered during construction and management measures will be included within the CoCP (Co124 and Co183). This would include a plan to check the conditions of the access tracks and temporary bridges to ensure they are safe prior to use (particularly in higher-risk areas adjacent to watercourses) during inclement weather when the risk of flooding is likely to be increased.

4.4 Onshore ECC Section 1 - Barmston Sea Drain WFD catchment

4.4.1.1 For the purpose of identifying flood risk in this FRA, the onshore ECC is divided into three sections based upon the boundaries of the WFD operational catchments (**Figure 1**). This first section runs from the landfall in the north-east, approximately 8.5 km in a south-westerly direction, before crossing into the adjacent Hull Upper WFD operational catchment at the hamlet of Gembling.

4.4.2 Historic Flooding

4.4.2.1 Absence of historic flood record does not necessarily confirm that flooding has not occurred. The Product 4 data provided by the Environment Agency shows a historic flood extent outlines that intersect this section of onshore ECC in two locations:

- 800 m north of Lissett there was a historic flood event in June 2007 which appears to be associated with IDB Watercourse ID086/082 and an Ordinary Watercourse (identified within the LLFA dataset as UFRN AFW655, see **Table 1** and **Figure 5**); and

- South of Gembling there was a historic flood event in June 2007 which appears to be associated with an Ordinary Watercourse (identified within the LLFA dataset as UFRN AFX151) and IDB Watercourse ID79 which runs adjacent to and crosses the onshore ECC (**Figure 5**).

4.4.2.2 Data within the Level 1 SFRA (ERYC 2010) shows this section of onshore ECC to have been unaffected by historic tidal or fluvial flood events. However, it is known that the historic surface water flood event in June 2007 was largely a result of heavy rainfall overwhelming drainage systems resulting in extensive flooding in the area.

4.4.2.3 Review of the historic flooding data suggests that this section of the onshore ECC has historically been at risk from surface water events, with the 2007 flooding causing IDB maintained watercourses to breach and wider surface water flooding.

4.4.3 Flood Zones

4.4.3.1 The onshore ECC intersects two Flood Zone 3 extents within this section. These flood zones mirror the historic flood extent outlined in the Environment Agency Product 4 data:

- 800 m north of Lissett, associated with IDB Watercourse ID086/082 and an Ordinary Watercourse (identified within the LLFA dataset as UFRN AFW655) (**Figure 5**); and

- Two locations where the onshore ECC crosses IDB Watercourse ID79 along a 4 km length of the onshore ECC, to the south of Gembling. These are understood to have been affected by the historic flooding in June 2007 associated with IDB Watercourse ID79 and an Ordinary Watercourse (identified within the LLFA dataset as UFRN AFX151) (**Figure 5**).

4.4.3.2 The risk of flooding to the onshore ECC will be removed upon completion of the cable laying phase, as all infrastructure will be located underground, with the cables, link boxes and transition joint bays (Co25,and Co28) sealed from water egress. The entry and exit pits for the HDD (or other trenchless technology) used will be located a minimum of 20 m away from EA Main Rivers and 9 m from IDB maintained drains (Co170).

4.4.4 Flooding from Main Rivers

4.4.4.1 This section of the onshore ECC is located, at its closest point, 150 m west of the Main River 'Barmston Sea Drain' (Co143), with associated Flood Zone 3 extents encroaching into the wider onshore ECC (**Figure 3**). Therefore, this section of the onshore ECC is considered to be at medium risk of fluvial flooding, although upon completion of the cable laying this risk will be fully mitigated with all infrastructure located below ground (Co25 and Co28).

4.4.5 Flooding from IDB maintained watercourses

4.4.5.1 The onshore ECC crosses IDB maintained watercourses in three locations as follows:

- IDB Watercourse ID086/082, approximately 800 m North of Lissett (**Figure 5**); and
- IDB Watercourse ID079, in two locations to the south of Gembling (**Figure 5**).

4.4.5.2 Due to the flood risk associated with these IDB maintained watercourses where they intersect the onshore ECC, there is a high risk of fluvial flooding in these locations. However, this is relatively localised and limited to the location where the onshore ECC crosses over the IDB maintained watercourse.

4.4.6 Flooding from the Sea

4.4.6.1 The onshore ECC is closest to the sea as it leaves the landfall (see **Section 0**). However, this section is located in Flood Zone 1 and as such, the flood risk from the sea for this section of the onshore ECC is very low. Further details of flooding from the sea can be found in **Section 4.2.6**.

4.4.7 Flooding from Groundwater

4.4.7.1 The Barmston Sea Drain WFD catchment is located over bedrock designated as a Principal Aquifer, usually providing a high level of water storage. For the further detail on the ground conditions associated with Hornsea Four see **Annex 1.1: Land Quality Preliminary Risk Assessment**. Measures set out in Co13 will be implemented to protect groundwater quality.

4.4.7.2 The Level 1 SFRA (ERYC 2010) identifies that a large proportion of ERY is characterised by chalk geology and following heavy rainfall elevated groundwater levels are often experienced. The groundwater emergence map (ERYC 2010) is used to highlight these areas. For this section of onshore ECC, a large proportion of its length is classified as being within a Groundwater Emergence Zone. As detailed in the Level 1 SFRA (ERYC 2010), this requires a 'detailed' FRA to be completed in line with the, now superseded, PPS25 Development Control Recommendations.

4.4.7.3 The effect the onshore ECC shall have on groundwater flows once operational is likely to be low as the buried cable will be located at a target depth of 1.2 m below ground, although this will be subject to localised variations (i.e. limiting interaction to shallow or near surface groundwater). Furthermore, any water flowing into the trenches during the construction period will be discharged into local ditches or drains via temporary interceptor drains (Co14).

4.4.7.4 Based on the above information there is likely to be a groundwater flood risk along the onshore ECC. However, this risk will be mitigated within the design as part of the embedded mitigation measures outlined in Co14, and to be implemented during the construction phase, through the development of the Onshore Infrastructure Drainage Strategy (Co19) (**Volume F2, Chapter 6: Outline Onshore Infrastructure Drainage Strategy**). This will limit the potential impact of groundwater emergence on the onshore ECC both during construction and once operational.

4.4.8 Flooding from Surface Water

4.4.8.1 From the landfall, the first 5 km of the onshore ECC is classed as being entirely at 'Very Low' risk of surface water flooding i.e. outside the extent of the 1 in 1,000-year surface water flooding event.

4.4.8.2 As the onshore ECC crosses IDB watercourse ID079 there are small sections of 'High' surface water flood risk that intersect the onshore ECC. Most notably immediately to the west of IDB watercourse ID079. This is due to the complex array of channels and drains associated with the main IDB channel (**Figure 6**).

4.4.8.3 Any surface water flood risk to the onshore ECC will be temporary in nature and removed once construction is complete as all onshore infrastructure associated with the onshore ECC will be located below ground (Co25 and Co28). The land will be reinstated, and existing ground levels will be maintained. Mitigation during construction is discussed in **Section 7** in relation to both surface water and ordinary watercourses.

4.4.8.4 The risk of flooding from surface water is therefore considered to be generally low for this section of the onshore ECC with some specific and restricted areas at an increased risk of flooding associated with ordinary watercourses.

4.4.9 Flooding from Sewers

4.4.9.1 No DG5 (sewer flood record) information is available to support this FRA. The onshore ECC is located within existing agricultural land and, therefore, it is likely that there is no foul sewer network within proximity of this location. The risk of flooding from sewers is therefore considered to be low for this section of the onshore ECC.

4.4.10 Flooding from Reservoirs, Canals and Other Artificial Sources

4.4.10.1 Flooding from reservoirs is defined based on the implications of a large uncontrolled release of water from registered reservoirs i.e. greater than 25,000 m^3. The Environment Agency Flood Risk from Reservoirs map shows the site is not at risk of reservoir flooding (Environment Agency 2019).

4.4.10.2 There are no canals or other artificial sources within the onshore ECC. Therefore, there is no risk of flooding from reservoirs, canals or other artificial sources to the onshore ECC.

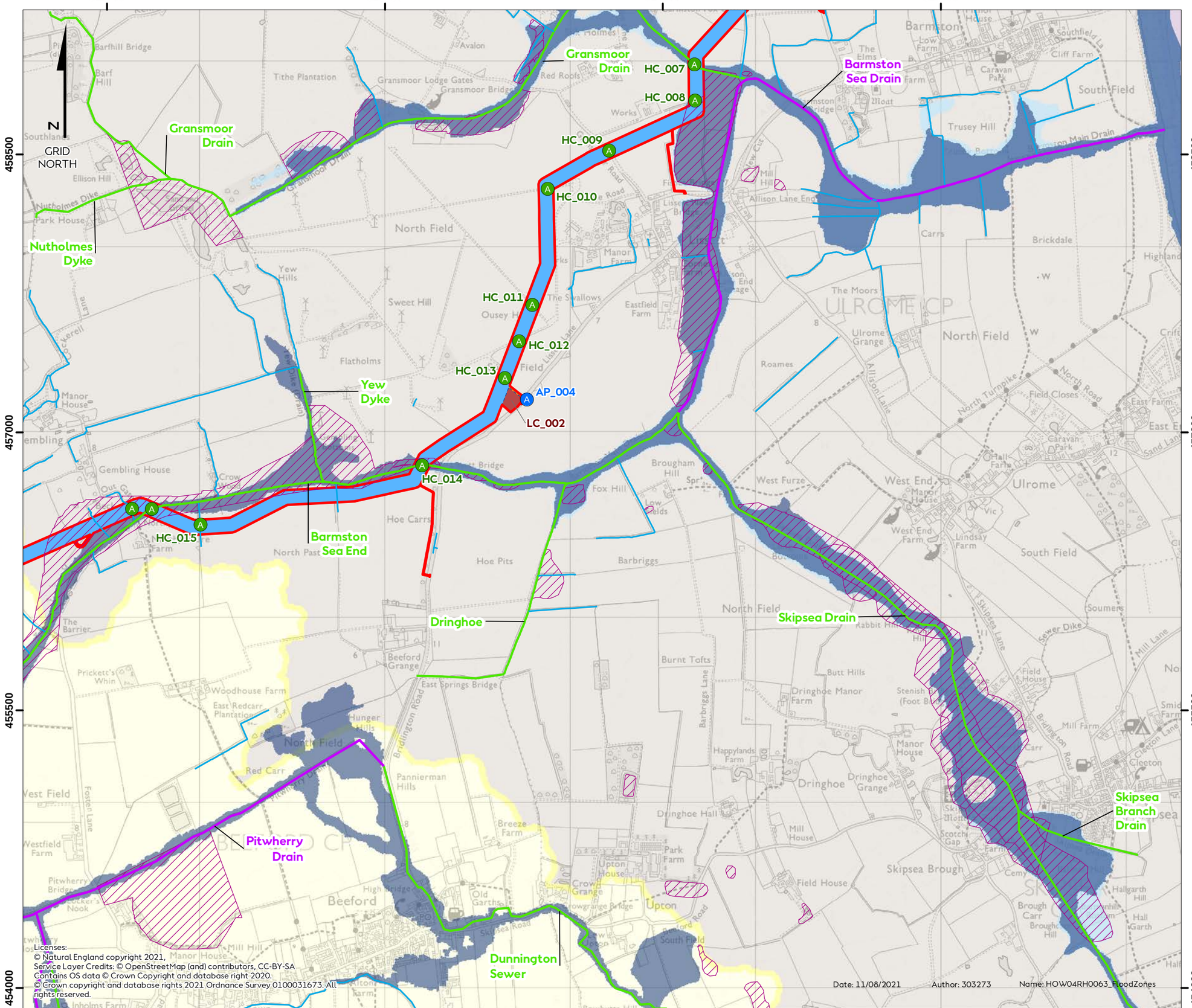
4.4.11 Summary of Flooding Sources to the onshore ECC Section 1

4.4.11.1 Overall, this section of the onshore ECC is not at risk from the sea, sewers, reservoirs, canals or other artificial sources. There is a low level of flood risk associated with surface water and groundwater flooding. Whilst groundwater flood risk is identified as a potential risk to the onshore ECC, this will be managed during construction (Co14 and Co19), and once operational as it will be located within sealed ducts. There is a medium level of fluvial flood risk associated with Main Rivers (Barmston Sea Drain) and a high risk of fluvial flooding from the IDB maintained watercourses. However, for IDB maintained watercourses this risk is limited to where the onshore ECC crosses over the IDB maintained watercourse.

Hornsea Four

Figure 5

Flood Zones - Sheet 2 of 7



Licenses:
© Natural England copyright 2021,
Service Layer Credits: © OpenStreetMap (and) contributors, CC-BY-SA
Contains OS data © Crown Copyright and database right 2020.
© Crown copyright and database rights 2021 Ordnance Survey 0100031673. All rights reserved.

Date: 11/08/2021 Author: 303273 Name: HOW04RH0063_FloodZones

- Order Limits
- Temporary Access Track
- Logistics Compound
- Onshore Export Cable Corridor
- Haul Road Crossing Access Point
- Public Highway Access Point
- Main River
- IDB Maintained Watercourse
- Ordinary Watercourse
- Historic Flood Locations

Environment Agency Flood Zones*

- Flood Zone 2
- Flood Zone 3

WFD Operational Waterbody Catchments

- Barmston Sea Drain
- Hull Upper
- Yorkshire Coast

*All areas not shown as being located in either Flood Zone 2 or 3 are classed as Flood Zone 1 (when considering fluvial and tidal flood risk)

Coordinate system: British National Grid
Scale@A3: 1:20,000

0 250 500 750 Metres

0 250 500 750 Yards

REV	REMARK	DATE
	First Issue for PEIR	03/07/2019
A	Updated following PEIR consultations, for DCO	11/08/2021

Title: Flood Zones
Document no: HOW04RH0063
Created by: AZ
Checked by: ID
Approved by: CS

Royal HaskoningDHV

Ørsted

Hornsea Four

Figure 6
Surface Water Flood Risk
- Sheet 2 of 7

511500 513000 514500 516000

458500 457000 455500 454000

N
GRID NORTH

Gransmoor Drain
Nutholmes Dyke
Yew Dyke
Northpasture Drain
Beck Hill Drain
Barmston Sea End
Barmston Main Drain
Hoe Carr Drain
North Field Drain
Dringhoe
Pitwherry Drain
Dunnington Sewer
Barmston Sea Drain
Skipsea Drain
Skipsea Branch Drain

HC_007
HC_008
HC_009
HC_010
HC_011
HC_012
HC_013
AP_004
LC_002
HC_014
HC_016
HC_015
HC_060

Licenses:
© Environment Agency 2021,
Service Layer Credits: © OpenStreetMap (and) contributors, CC-BY-SA
Contains OS data © Crown Copyright and database right 2020.
© Crown copyright and database rights 2021 Ordnance Survey 0100031673. All rights reserved.

Date: 11/08/2021 Author: 303273 Name: HOW04RH0064_SurfaceWaterFloodRisk

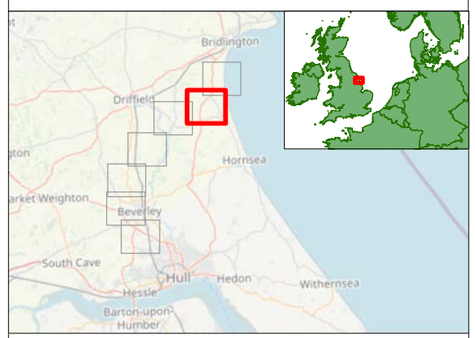
- Order Limits
- Temporary Access Track
- Logistics Compound
- Onshore Export Cable Corridor
- Public Highway Access Point
- Haul Road Crossing Access Point
- Main River
- IDB Maintained Watercourse
- Ordinary Watercourse

Environment Agency Flood Map for Surface Water

- High Risk (Greater than 1 in 30 Annual Probability of Flooding)
- Medium Risk (Between 1 in 100 and 1 in 30 Annual Probability of Flooding)
- Low Risk (Between 1 in 1,000 and 1 in 100 Annual Probability of Flooding)

WFD Operational Waterbody Catchments

- Barmston Sea Drain
- Hull Upper
- Yorkshire Coast



Coordinate system: British National Grid
Scale@A3: 1:20,000

0 250 500 1,000 Metres
0 250 500 1,000 Yards

REV	REMARK	DATE
	First Issue for PEIR	03/07/2019
A	Updated following PEIR consultations, for DCO	11/08/2021

Title: Surface Water Flood Risk
Document no: HOW04RH0064
Created by: AZ
Checked by: ID
Approved by: CS

Royal HaskoningDHV
Ørsted

4.5 Onshore ECC Section 2 - Hull Upper WFD catchment

4.5.1.1 For the purpose of identifying flood risk in this FRA, the onshore ECC is divided into three sections based upon the boundaries of the WFD operational catchments (**Figure 1**). The second section runs from the edge of the Barmston Sea Drain WFD operational catchment at the hamlet of Gembling in the north east, approximately 9.5 km in a south-westerly direction, before crossing into the Lower Hull WFD operational catchment at Carr Lane.

4.5.2 Historic Flooding

4.5.2.1 Absence of historic flood record does not necessarily confirm that flooding has not occurred. The Environment Agency Product 4 data shows historic flood extent outlines that intersect this section of cable route in three locations:

- 500 m north of Brigham Quarry, there was a historic flood event associated with surface water flooding in June 2007 (**Figure 7**);
- 500 m north of Brigham, there was a historic flood event associated with fluvial flooding in June 2007 from the Ordinary Watercourse known as Fisholme / Nafferton Drain (identified within the LLFA dataset as UFRN AFG565) and IDB Watercourse ID18 (**Figure 7**); and
- 500 m east of Corpslanding Road, there was a historic flood event associated with surface water flooding in June 2007 (**Figure 7**).

4.5.2.2 Data within the Level 1 SFRA (ERYC 2010) shows this section of onshore ECC to has been unaffected by historic tidal or fluvial flood events. However, it is known that the historic surface water flood event in June 2007 was largely a result of heavy rainfall overwhelming drainage systems resulting in extensive flooding in the area.

4.5.2.3 Therefore, review of the historic flooding data suggests that this section of the onshore ECC has historically been at risk from surface water events, with the 2007 flooding causing IDB maintained watercourses to breach and wider surface water flooding.

4.5.3 Flood Zones

4.5.3.1 The onshore ECC intersects four Flood Zone 3 extents within this section:

- Approximately 650 m of the onshore ECC to the south-west of Foston on the Wolds, associated with a combination of the Foston Beck Main River and the Fisholme Drain IDB Watercourse ID018 (**Figure 7**);
- Approximately 2 km length of the onshore ECC to the west of Brigham, associated with a combination of watercourses including the Driffield Canal and West Beck Main Rivers, Fisholme Drain IDB Watercourse ID018, and a number of smaller ordinary watercourses (**Figure 7**);

- Two approximately 200 m lengths of the onshore ECC to the west of Rotsea, associated with the Rotsea Drain IDB Watercourse ID017 (Figure 8).

- Approximately 75 m length of the onshore ECC to the south of Rotsea, associated with the Scurf Dike Main River (Figure 8).

4.5.3.2 The risk of flooding to the onshore ECC will be removed upon completion of the cable laying phase, as all infrastructure will be located underground, with the cables, link boxes and transition joint bays (Co25,and Co28) sealed from water egress and located a minimum of 20 m away from Environment Agency Main Rivers (Co170).

4.5.4 Flooding from Main Rivers

4.5.4.1 The onshore ECC crosses five Main Rivers in this section. From north-east to south-west, these are:

- Foston Beck;
- White Dike;
- Driffield Canal;
- River Hull (also known as West Beck) (Figure 7); and
- Scurf Dike (Figure 8).

4.5.4.2 This section of the onshore ECC intersects multiple Flood Zone 2 and 3 extents, most notably associated with the River Hull (Figure 7). However, it is also noted that other Main Rivers contribute to the Flood Zone extents in the area. Due to the onshore ECC crossing the River Hull floodplain, this section is at the highest risk of fluvial flooding when considering all three of the onshore ECC sections.

4.5.4.3 The risk of flooding to the onshore ECC will be removed upon completion of the cable laying phase, as all infrastructure will be located underground, with the cable, transition joint bays and link boxes sealed (Co25, Co28 and Co170) from water egress. Therefore, whilst large parts of this section of the onshore ECC are at high risk of fluvial flooding, these risks will be mitigated once the onshore ECC is operational, because all infrastructure will be located below ground (Co25 and Co28).

4.5.5 Flooding from IDB maintained watercourses

4.5.5.1 The onshore ECC crosses two IDB maintained watercourses:

- Fisholme Drain (IDB Watercourse ID018) in two locations (Figure 7); and
- Rotsea Drain (IDB Watercourse ID017) (Figure 8).

4.5.5.2 Due to the flood risk associated with these IDB maintained watercourses where they intersect the onshore ECC, there is a high risk of fluvial flooding in these locations. However, this is relatively localised and limited to the location where the onshore ECC crosses over the IDB maintained watercourse.

4.5.6 Flooding from the Sea

4.5.6.1 This section of onshore ECC is located 7 km inland, therefore there is no risk of flooding from the sea.

4.5.7 Flooding from Groundwater

4.5.7.1 The Hull Upper WFD catchment is located over bedrock designated as a Principal Aquifer. Principal aquifers are considered to provide a high level of water storage. Measures set out in Co13 will be implemented to protect groundwater quality.

4.5.7.2 The Level 1 SFRA (ERYC 2010) identifies that a large proportion of the ERY is characterised by chalk geology and following heavy rainfall elevated groundwater levels are often experienced. The groundwater emergence map is used to highlight these areas. For this section of the onshore ECC, a large proportion is classified as a Groundwater Emergence Zone. As detailed in the Level 1 SFRA (ERYC 2010), this requires a 'detailed' FRA to be completed in line with the, now superseded, PPS25 Development Control Recommendations.

4.5.7.3 The effect the onshore ECC shall have on groundwater flows once operational is likely to be low as the buried cable will be located at a target depth of 1.2 m below ground, although this will be subject to localised variations. (i.e. limiting interaction to shallow or near surface groundwater). Furthermore, any water flowing into the trenches during the construction period will be discharged into local ditches or drains via temporary interceptor drains (Co14).

4.5.7.4 Based on the above information there is likely to be a groundwater flood risk along the onshore ECC. However, this risk will be mitigated within the design as part of the embedded mitigation measures outlined in Co14, and to be implemented during the construction phase, through the development of the Onshore Infrastructure Drainage Strategy (Co19) (**Volume F2, Chapter 6: Outline Onshore Infrastructure Drainage Strategy**). This will limit the potential impact of groundwater emergence on the onshore ECC both during construction and once operational.

4.5.8 Flooding from Surface Water

4.5.8.1 There is minimal surface water flood risk for this section of the onshore ECC, largely as the onshore ECC is located on land with a higher elevation. There remain areas of increased surface water flood risk associated with watercourse channels and isolated low spots.

4.5.8.2 The surface water flood risk for this section of the onshore ECC is as follows:

- The first 2 km is primarily at 'Very Low' risk of surface water flooding i.e. outside the extent of the 1 in 1,000 year surface water flooding event (**Figure 9**);
- Within this 2 km stretch, there are two areas of 'High' risk associated with the Ordinary Watercourse known as the Eastfield Drain (identified within the LLFA dataset as UFRN AFD592) and Foston Beck Main River. However, the extents are contained within the watercourse channel (**Figure 9**);
- The following 2.3 km has several small areas of 'Low' to 'High' areas of surface water flood risk (**Figure 9**);
- A 1.5 km stretch to the west of Brigham has 'Very Low' risk of surface water flooding. This is the same area as that dominated by increased fluvial flooding and shown as being located in Flood Zone 3 (**Figure 9**); and
- The remaining approximately 4 km has small areas of 'Low' to 'High' areas of surface water flood risk but is predominantly at 'Very Low' risk of surface water flooding (**Figure 9** and **Figure 10**).

4.5.8.3 Any flood risk associated with the above watercourses will be temporary in nature and removed once construction has finished. The permanent infrastructure associated with the onshore ECC will be wholly located below ground (Co25 and Co28). The land will be reinstated, and the existing ground levels will be reinstated. Mitigation during construction is discussed in **Section 7** in relation to both surface water and ordinary watercourses.

4.5.8.4 The risk of flooding from surface water is therefore considered to be low for this section of the onshore ECC, with some localised areas at increased risk of surface water flooding.

4.5.9 Flooding from Sewers

4.5.9.1 No DG5 (sewer flood record) information is available to support this FRA. The onshore ECC is located within existing agricultural land and, therefore, it is likely that there is no foul sewer network within proximity of this location. The risk of flooding from sewers is therefore considered to be low for this section of the onshore ECC.

4.5.10 Flooding from Reservoirs, Canals and Other Artificial Sources

4.5.10.1 Flooding from reservoirs is defined based on the implications of a large uncontrolled release of water from registered reservoirs i.e. greater than 25,000 m^3. The Environment Agency Flood Risk from Reservoirs map shows the site is not at risk of reservoir flooding (Environment Agency 2019).

4.5.10.2 There are no canals or other artificial sources within the onshore ECC. Therefore, there is no risk of flooding from reservoirs, canals or other artificial sources to the onshore ECC.

4.5.11 Summary of Flooding Sources to onshore ECC Section 2

4.5.11.1 Overall, this section of the onshore ECC is not at risk from the sea, sewers, reservoirs, canals or other artificial sources. Whilst groundwater flood risk is identified as a potential risk to the onshore ECC, this will be managed during construction (Co14), and once operational (Co19) as the infrastructure will be located within sealed ducts. There are several small areas of 'High' flood risk associated with surface water throughout this section. There is an increased risk of fluvial flooding associated with Main Rivers, most notably the River Hull, and the IDB maintained watercourses. However, for IDB maintained watercourses this risk is limited to where the onshore ECC crosses over the IDB maintained watercourse.

Hornsea Four

Figure 7

Flood Zones - Sheet 3 of 7

507000 508500 510000 511500

457000 455500 454000 452500

N

GRID NORTH

Nafferton Highland Stream
Nafferton Beck
Driffield Canal
White Dike
Kelk Beck Soak Dike
Wanlass Drain
Creyke Dike
Foston Beck
Waterloo
Foston Side Beck
Frodingham Side
Old Howe
Nafferton Lowlands Drain
Brigham Drain
Drake Drain
Inholmes Drain
Skerne Beck
River Hulll
Fisholmes Drain
Frodingham Mills Drain
Rotsea Drain

HC_018 HC_019 HC_017 HC_020 HC_022 HC_023 HC_070 HC_025 HC_026 HC_027

AP_005 AP_039 AP_007 AP_006 AP_008 AP_009 AP_010 AP_038

LC_003

- Order Limits
- Temporary Access Track
- Logistics Compound
- Onshore Export Cable Corridor
- Haul Road Crossing Access Point
- Public Highway Access Point
- Main River
- IDB Maintained Watercourse
- Ordinary Watercourse
- Historic Flood Locations

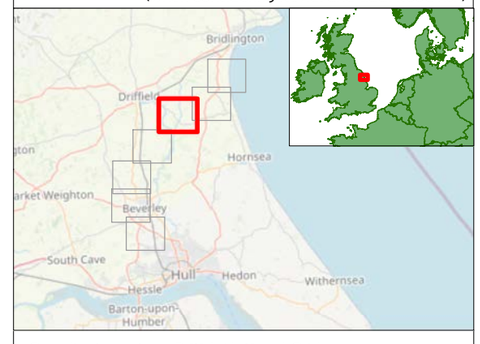
Environment Agency Flood Zones*

- Flood Zone 2
- Flood Zone 3

WFD Operational Waterbody Catchments

- Barmston Sea Drain
- Hull Upper

*All areas not shown as being located in either Flood Zone 2 or 3 are classed as Flood Zone 1 (when considering fluvial and tidal flood risk)



Coordinate system: British National Grid

Scale@A3: 1:20,000

0 250 500 750 Metres

0 250 500 750 Yards

REV	REMARK	DATE
	First Issue for PEIR	03/07/2019
A	Updated following PEIR consultations, for DCO	11/08/2021

Title: Flood Zones
Document no: HOW04RH0063
Created by: AZ
Checked by: ID
Approved by: CS

Royal HaskoningDHV

Ørsted

Date: 11/08/2021 Author: 303273 Name: HOW04RH0063_FloodZones

Hornsea Four

Figure 8

Flood Zones - Sheet 4 of 7

502500 504000 505500 507000

451000 449500 448000

N
GRID NORTH

Holmes Dike
Gobersdale Dike
Rotsea Drain
AP_010
AP_038
HC_027
HC_028
North Old Rivers
Scurf Dike
HC_029
Scurf Dike
South Old Rivers
Watton Beck
HC_031
HC_030
HC_032
Throstlenest Drain
Decoy Drain
LC_004
AP_037
AP_011
HC_033
HC_034
Kilnwick New Cut
Kilnwick Arm
Watton Beck
Kirby Drain
Decoy House Drain
Beverley and Barmston Drain
HC_035
HC_036
AP_012
AP_036
Beswick New Cut
HC_037
HC_038
AP_035
HC_039
AP_013
HC_041
HC_040
Black Dike
Baswick Steer Drain
Leven North Carr Drain
Coal Dike

Date: 11/08/2021 Author: 303273 Name: HOW04RH0063_FloodZones

- Order Limits
- Temporary Access Track
- Logistics Compound
- Onshore Export Cable Corridor
- Haul Road Crossing Access Point
- Public Highway Access Point
- Main River
- IDB Maintained Watercourse
- Ordinary Watercourse
- Historic Flood Locations

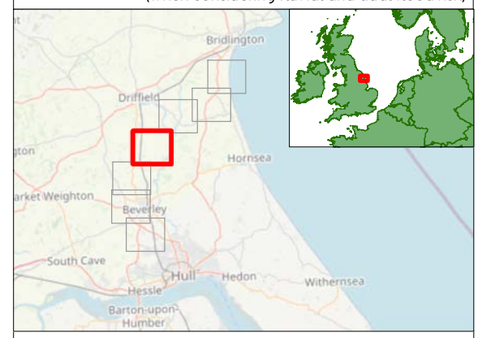
Environment Agency Flood Zones*

- Flood Zone 2
- Flood Zone 3

WFD Operational Waterbody Catchments

- Hull Lower
- Hull Upper

*All areas not shown as being located in either Flood Zone 2 or 3 are classed as Flood Zone 1 (when considering fluvial and tidal flood risk)



Coordinate system: British National Grid
Scale@A3: 1:20,000

0 250 500 750 Metres
0 250 500 750 Yards

REV	REMARK	DATE
	First Issue for PEIR	03/07/2019
A	Updated following PEIR consultations, for DCO	11/08/2021

Title: Flood Zones
Document no: HOW04RH0063
Created by: AZ
Checked by: ID
Approved by: CS

Royal HaskoningDHV
Ørsted

Hornsea Four

Figure 9
Surface Water Flood Risk
- Sheet 3 of 7

507000 508500 510000 511500

457000 455500 454000 452500

N GRID NORTH

Nafferton Highland Stream
Nafferton Beck
Driffield Canal
White Dike
Kelk Beck
Soak Dike
Northpasture Drain
Beck Hill Drain
HC_060
HC_016
AP_005
HC_017
HC_019
HC_018
AP_039
HC_020
Eastfield Drain
School Drain
Wanlass Drain
Foston Beck
Dreyke Dike
HC_022
HC_023
LC_003
Foston Beck
Waterloo
AP_007
White Dike
AP_006
Fisholme Drain
AP_008
Foston Side Beck
HC_070
HC_025
Frodingham Side
Old Howe
Nafferton Lowlands Drain
Driffield Canal
HC_026
Brigham Drain
AP_009
Drake Drain
Inholmes Drain
Fisholme Drain
Skerne Beck
River Hull
Parallel Drain
River Hull
Fisholmes Drain
Frodingham Mills Drain
Rotsea Drain
AP_010
AP_038

Licenses:
© Environment Agency 2021,
Service Layer Credits: © OpenStreetMap (and) contributors, CC-BY-SA
Contains OS data © Crown Copyright and database right 2020.
© Crown copyright and database rights 2021 Ordnance Survey 0100031673. All rights reserved.

Date: 11/08/2021 Author: 303273 Name: HOW04RH0064_SurfaceWaterFloodRisk

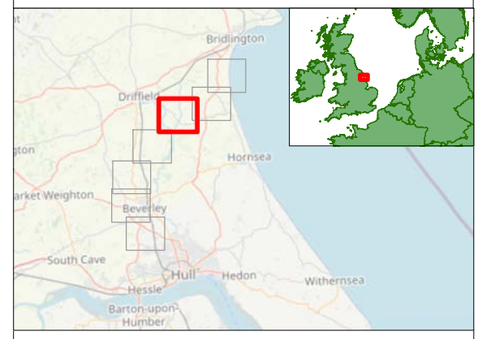
- Order Limits
- Temporary Access Track
- Logistics Compound
- Onshore Export Cable Corridor
- Public Highway Access Point
- Haul Road Crossing Access Point
- Main River
- IDB Maintained Watercourse
- Ordinary Watercourse

Environment Agency Flood Map for Surface Water

- High Risk (Greater than 1 in 30 Annual Probability of Flooding)
- Medium Risk (Between 1 in 100 and 1 in 30 Annual Probability of Flooding)
- Low Risk (Between 1 in 1,000 and 1 in 100 Annual Probability of Flooding)

WFD Operational Waterbody Catchments

- Barmston Sea Drain
- Hull Upper



Coordinate system: British National Grid
Scale@A3: 1:20,000

0 250 500 1,000 Metres
0 250 500 1,000 Yards

REV	REMARK	DATE
	First Issue for PEIR	03/07/2019
A	Updated following PEIR consultations, for DCO	11/08/2021

Title: Surface Water Flood Risk
Document no: HOW04RH0064
Created by: AZ
Checked by: ID
Approved by: CS

Royal HaskoningDHV
Ørsted

Hornsea Four

Figure 10

Surface Water Flood Risk

- Sheet 4 of 7

502500 504000 505500 507000

451000 449500 448000

GRID NORTH

Gobersdale Dike
Holmes Dike
Rotsea Lane Drain
Rotsea Drain
AP_038
AP_010
HC_027
HC_028
Rotsea Drain
North Old Rivers
Scurf Dike
HC_029
Scurf Dike
Scurf Dike
South Old Rivers
Watton Beck
Kirby Drain
HC_030
HC_031
Throstle Main Drain
HC_032
Carr Drain
Throstlenest Drain
Spring Dike
Decoy Drain
Decoy House Drain
Kilnwick New Cut
AP_037
LC_004
AP_011
HC_033
HC_034
Kilnwick Arm
Watton Beck
Kirby Drain
Beverley and Barmston Drain
HC_035
AP_036
AP_012
HC_036
Wilfholme Farm Drain
Watton Beck
Beswick New Cut
Beswick to Barfhill Drain
HC_037
Black Dike
Carr House Drain
HC_038
AP_013
HC_039
AP_035
HC_041
HC_040
Baswick Steer Drain
Leven North Carr Drain
Coal Dike

Licenses:
© Environment Agency 2021,
Service Layer Credits: © OpenStreetMap (and) contributors, CC-BY-SA
Contains OS data © Crown Copyright and database right 2020.
© Crown copyright and databaserights 2021 Ordnance Survey 0100031673. All rights reserved.

Date: 11/08/2021 Author: 303273 Name: HOW04RH0064_SurfaceWaterFloodRisk

Legend

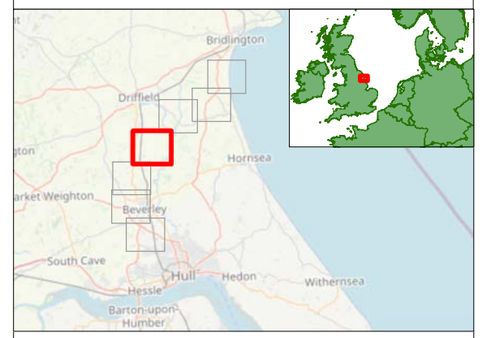
- Order Limits
- Temporary Access Track
- Logistics Compound
- Onshore Export Cable Corridor
- Public Highway Access Point
- Haul Road Crossing Access Point
- Main River
- IDB Maintained Watercourse
- Ordinary Watercourse

Environment Agency Flood Map for Surface Water

- High Risk (Greater than 1 in 30 Annual Probability of Flooding)
- Medium Risk (Between 1 in 100 and 1 in 30 Annual Probability of Flooding)
- Low Risk (Between 1 in 1,000 and 1 in 100 Annual Probability of Flooding)

WFD Operational Waterbody Catchments

- Hull Lower
- Hull Upper



Coordinate system: British National Grid

Scale@A3: 1:20,000

0 250 500 1,000 Metres

0 250 500 1,000 Yards

REV	REMARK	DATE
	First Issue for PEIR	03/07/2019
A	Updated following PEIR consultations, for DCO	11/08/2021

Title: Surface Water Flood Risk
Document no: HOW04RH0064
Created by: AZ
Checked by: ID
Approved by: CS

Royal HaskoningDHV

Ørsted

4.6 Onshore ECC Section 3 Hull Lower WFD catchment

4.6.1.1 For the purpose of identifying flood risk in this FRA, the onshore ECC is divided into three sections based upon the boundaries of the WFD operational catchments (**Figure 1**). The third section runs from the edge of the Upper Hull WFD operational catchment at Carr Lane, for approximately 21.5 km before reaching the OnSS north of Cottingham.

4.6.2 Historic Flooding

4.6.2.1 Absence of historic flood record does not necessarily confirm that flooding has not occurred. However, both the Environment Agency Product 4 data and Level 1 SFRA (ERYC 2010) shows this section of the onshore ECC to have been unaffected by historic tidal or fluvial flood events.

4.6.3 Flood Zones

4.6.3.1 The onshore ECC intersects six Flood Zone 3 extents within this section:

- Approximately 2.3 km stretch of the onshore ECC to the east of Beswick, either side of Carr Lane, falls within Flood Zone 3 (**Figure 7**). This Flood Zone is associated with the Watton Beck Main River; and IDB watercourses Kirby Drain, Kilnwick Arm and Beswick New Cut, However, this area is identified as benefiting from defences within the Environment Agency Product 4 data;

- Approximately 1.1 km stretch of the onshore ECC to the west of Scorborough, associated with Bryan Mills Beck Main River (IDB035) and Beakey's Beck (identified in the LLFA dataset as UFRN AFE262) fall within Flood Zone 3 (**Figure 11**);

- 75 m of the onshore ECC, associated with the Ordinary Watercourse known as North Drain (identified in the LLFA dataset as UFRN AFS372) (**Figure 11**);

- 80 m of the onshore ECC, associated with the Ordinary Watercourse known as Washdike Drain (identified in the LLFA dataset as UFRN AFS371) (**Figure 11**);

- 50 m of the onshore ECC, associated with the Ordinary Watercourse known as Atkin's Keld (identified in the LLFA dataset as UFRN AFS365) (**Figure 13**); and

- 170 m of the onshore ECC, associated with the Ordinary Watercourse known as Park Drain (identified in the LLFA dataset as UFRN AFG262) (**Figure 13**).

4.6.3.2 The risk of flooding to the onshore ECC will be removed upon completion of the cable laying phase, as all infrastructure will be located underground, with the cables, link boxes and transition joint bays (Co25,and Co28) sealed from water egress and located a minimum of 20 m away from Environment Agency Main Rivers (Co170).

4.6.4 Flooding from Main Rivers

4.6.4.1 The onshore ECC crosses two Main Rivers, close to the OnSS, these are:

- Watton Beck (Figure 8); and
- Bryan Mills Beck (IDB ID035) (Figure 11).

4.6.4.2 This section of the onshore ECC is primarily protected from fluvial flooding and intersects only small sections of Flood Zone 2 and 3, most notably associated with Bryan Mills Beck and smaller IDB maintained watercourses (Figure 11). However, these areas are largely confined to areas adjacent to the watercourses, with the significant proportion of the onshore ECC located in Flood Zone 1 (Figure 11).

4.6.4.3 Following construction of the onshore ECC there will be no permanent above ground elements. Although there are small sections of the onshore ECC located in Flood Zone 3, these risks will be mitigated once the onshore ECC is operational with the cables, transition joint bays and link boxes being located below ground level, sealed from water egress (Co25 and Co28) and located a minimum of 20 m away from Environment Agency Main Rivers (Co170)

4.6.5 Flooding from IDB maintained watercourses

4.6.5.1 The onshore ECC crosses four IDB watercourses in this catchment. One of these is also classified as a Main River:

- Kirby Drain (IDB Watercourse ID012) (Figure 8);
- Kilnwick Arm Drain (IDB Watercourse ID011) (Figure 8);
- Beswick New Cut (IDB Watercourse ID009) (Figure 8); and
- Bryan Mills Beck (IDB Watercourse ID035) also classified as a Main River (Figure 11).

4.6.5.2 Due to the flood risk associated with these IDB maintained watercourses where they intersect the onshore ECC, there is a high risk of fluvial flooding in these locations. However, this is relatively localised and limited to the location where the onshore ECC crosses over the IDB maintained watercourse.

4.6.6 Flooding from the Sea

4.6.6.1 This section of onshore ECC is located a minimum of 9 km inland and situated on higher ground, therefore there is no risk of flooding from the sea.

4.6.7 Flooding from Groundwater

4.6.7.1 The Hull Lower WFD catchment is located over bedrock designated as a Principal Aquifer. Principal Aquifers are considered to provide a high level of water storage. Measures set out in Co13 will be implemented to protect groundwater quality.

4.6.7.2 The Level 1 SFRA (ERYC 2010) identifies that a large proportion of the ERY is characterised by chalk geology and following heavy rainfall elevated groundwater levels are often

experienced. The groundwater emergence map is used to highlight these areas. For this section of cable route, a large proportion is classified as a Groundwater Emergence Zone. As detailed in the Level 1 SFRA (ERYC 2010), this requires a 'detailed' FRA to be completed in line with the, now superseded, PPS25 Development Control Recommendations.

4.6.7.3 The effect the onshore ECC shall have on groundwater flows once operational is likely to be low as the buried cable will be located at a target depth of 1.2 m below ground, although this will be subject to localised variations. (i.e. limiting interaction to shallow or near surface groundwater). Furthermore, any water flowing into the trenches during the construction period will be discharged into local ditches or drains via temporary interceptor drains (Co14).

4.6.7.4 Based on the above information there is likely to be a groundwater flood risk along the onshore ECC. However, this risk will be mitigated within the design as part of the embedded mitigation measures, as outlined above, and to be implemented during the construction phase, through the development of the through the development of the Onshore Infrastructure Drainage Strategy (Co19) (**Volume F2, Chapter 6: Outline Onshore Infrastructure Drainage Strategy**).. This will limit the potential impact of groundwater emergence on the onshore ECC both during construction and once operational.

4.6.8 Flooding from Surface Water

4.6.8.1 The areas where the onshore ECC crosses the Ordinary Watercourses are identified as having a 'High' risk of surface water flooding. However, this is primarily limited to the width of the watercourse channel.

4.6.8.2 The Ordinary Watercourse known as Beakey's Beck is identified as having a 'High' risk of surface water flooding, with the flood extent stretching the width of the onshore ECC for approximately 250 m (**Figure 14**).

4.6.8.3 The Ordinary Watercourse known as Blackmere Dale Bottom Drain is identified as having a 'High' risk of surface water flooding, affecting the width of the onshore ECC for 80 m (**Figure 15**).

4.6.8.4 Overall, the onshore ECC in this section comprises areas at 'Very Low' risk of surface water flooding. Locations where there is an increased risk are detailed below:

- Large area of 'High' risk within the onshore ECC approximately 1.1 km west of Scorborough (**Figure 14**);
- Isolated area of 'High' risk within the onshore ECC 1.5 km north-west of Leconfield (**Figure 14**);
- Isolated area of 'High' risk within the onshore ECC, immediately south of Malton Road, to the west of Molescroft (**Figure 15**);

- Potential surface water drainage route adjacent to the A1035/A1079 roundabout to the south-west of Molescroft (Figure 15); and

- Potential surface water drainage route that appears to be a tributary of the Autherd Drain ordinary watercourse that runs across the width of the onshore ECC 220 m north of Moor Lane (Figure 16).

4.6.8.5 Any surface water flood risk to the onshore ECC will be temporary in nature and removed once construction is complete as all onshore infrastructure associated with the onshore ECC will be located below ground (Co25 and Co28). The land will be reinstated, and existing ground levels will be maintained. Mitigation during construction in discussed in Section 7 in relation to both surface water and ordinary watercourses.

4.6.8.6 The risk of flooding from surface water is therefore considered to be generally low for this section of the onshore ECC, with some areas at increased risk of surface water flooding.

4.6.9 Flooding from Sewers

4.6.9.1 No DG5 (sewer flood record) information has been obtained to support this FRA. The onshore ECC is located within existing agricultural land. Therefore, it is likely that there is no foul sewer network within proximity of this location. The risk of flooding from sewers is therefore considered to be low for this section of the onshore ECC.

4.6.10 Flooding from Reservoirs, Canals and Other Artificial Sources

4.6.10.1 Flooding from reservoirs is defined based on the implications of a large uncontrolled release of water from registered reservoirs i.e. greater than 25,000 m^3. The Environment Agency Flood Risk from Reservoirs map shows the site is not at risk of reservoir flooding (Environment Agency 2019).

4.6.10.2 There are no canals or other artificial sources within the onshore ECC. Therefore, there is no risk of flooding from reservoirs, canals or other artificial sources to the onshore ECC.

4.6.11 Summary of Flooding Sources to onshore ECC Section 3

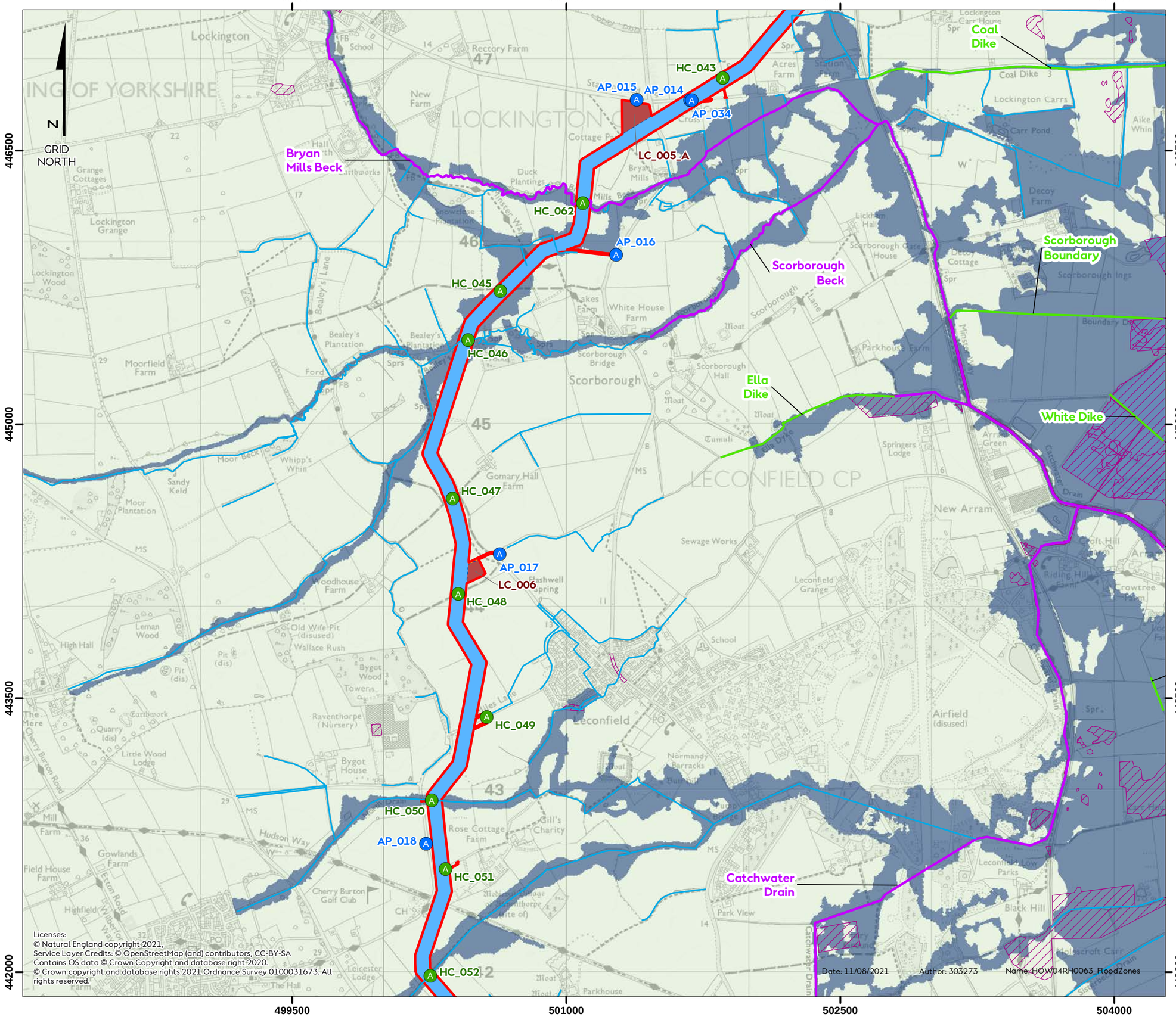
4.6.11.1 Overall, this section of the onshore ECC is not at risk from the sea, sewers, reservoirs, canals or other artificial sources. There is an increased risk of fluvial flooding associated with Main Rivers, most notably the Bryan Mills Beck, and the IDB maintained watercourses. However, for IDB maintained watercourses this risk is limited to where the onshore ECC crosses over the IDB maintained watercourse.

4.6.11.2 Whilst varying levels of groundwater, surface water and fluvial flood risk have been identified, these risks will be mitigated once operational, with all infrastructure located below ground. Whilst groundwater flood risk is identified as a potential risk to the onshore ECC, this will be managed once operational as it will be located within sealed ducts.

Hornsea Four

Figure 11

Flood Zones - Sheet 5 of 7



Licenses:
© Natural England copyright 2021,
Service Layer Credits: © OpenStreetMap (and) contributors, CC-BY-SA
Contains OS data © Crown Copyright and database right 2020.
© Crown copyright and database rights 2021 Ordnance Survey 0100031673. All rights reserved.

Date: 11/08/2021 Author: 303273 Name: HOW04RH0063_FloodZones

- Order Limits
- Temporary Access Track
- Logistics Compound
- Onshore Export Cable Corridor
- Haul Road Crossing Access Point
- Public Highway Access Point
- Main River
- IDB Maintained Watercourse
- Ordinary Watercourse
- Historic Flood Locations

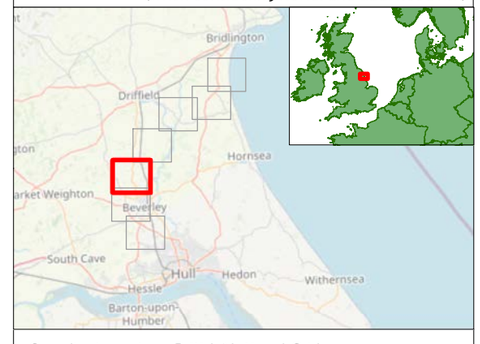
Environment Agency Flood Zones*

- Flood Zone 2
- Flood Zone 3

WFD Operational Waterbody Catchments

- Hull Lower

*All areas not shown as being located in either Flood Zone 2 or 3 are classed as Flood Zone 1 (when considering fluvial and tidal flood risk)



Coordinate system: British National Grid

Scale@A3: 1:20,000

0 250 500 750 Metres

0 250 500 750 Yards

REV	REMARK	DATE
	First Issue for PEIR	03/07/2019
A	Updated following PEIR consultations, for DCO	11/08/2021

Title: Flood Zones
Document no: HOW04RH0063
Created by: AZ
Checked by: ID
Approved by: CS

Royal HaskoningDHV

Ørsted

Hornsea Four

Figure 12

Flood Zones - Sheet 6 of 7

498000 499500 501000 502500 504000

442000 440500 439000 437500

GRID NORTH

HC_051 HC_052 HC_053 HC_054 AP_032 AP_020 AP_021 AP_022 LC_007 AP_023 AP_024 HC_063 HC_057 HC_064

Catchwater Drain

Model Farm

Mill Dam Drain

Willow Lane Drain

Cherry Burton MOLESCROFT CP Molescroft Bishop Burton Westwood Hurn Beverley

- Order Limits
- Temporary Access Track
- Logistics Compound
- Onshore Export Cable Corridor
- Haul Road Crossing Access Point
- Public Highway Access Point
- Main River
- IDB Maintained Watercourse
- Ordinary Watercourse
- Historic Flood Locations

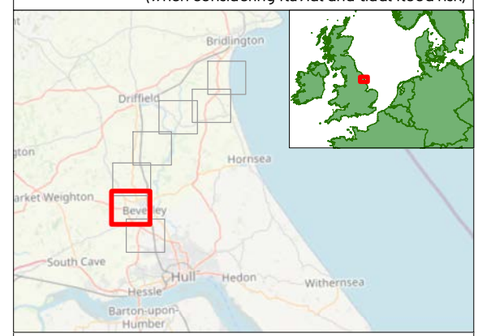
Environment Agency Flood Zones*

- Flood Zone 2
- Flood Zone 3

WFD Operational Waterbody Catchments

- Hull Lower

*All areas not shown as being located in either Flood Zone 2 or 3 are classed as Flood Zone 1 (when considering fluvial and tidal flood risk)



Coordinate system: British National Grid

Scale@A3: 1:20,000

0 250 500 750 Metres

0 250 500 750 Yards

REV	REMARK	DATE
	First Issue for PEIR	03/07/2019
A	Updated following PEIR consultations, for DCO	11/08/2021

Title: Flood Zones
Document no: HOW04RH0063
Created by: AZ
Checked by: ID
Approved by: CS

Date: 11/08/2021 Author: 303273 Name: HOW04RH0063_FloodZones

Hornsea Four

Figure 13

Flood Zones - Sheet 7 of 7

501000 502500 504000 505500

437500 436000 434500 433000

HC_057 HC_064 HC_065 HC_066 HC_067 HC_069 HC_061

AP_025 AP_026 AP_027 AP_028 AP_030

LC_008

Beverley Parks Sewer

Oxgang Drain

Western Drain

Fox Drain

Riley Drain

Cottingham Drain

Wanlass Beck

Creyke Beck

Broadlane Beck

Beverley Parks

Platwoods Fields

Risby Head

Skidby

- Order Limits
- Permanent Access Track
- Temporary Access Track
- Logistics Compound
- Onshore Export Cable Corridor
- Grid Connection Works
- Onshore Substation (Permanent Space)
- Onshore Substation (Temporary Works)
- Haul Road Crossing Access Point
- Public Highway Access Point
- Main River
- IDB Maintained Watercourse
- Ordinary Watercourse
- Historic Flood Locations

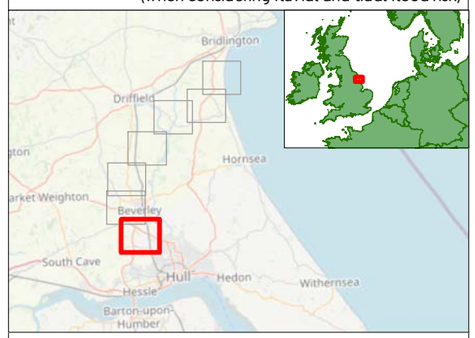
Environment Agency Flood Zones*

- Flood Zone 2
- Flood Zone 3

WFD Operational Waterbody Catchments

- Hull Lower

*All areas not shown as being located in either Flood Zone 2 or 3 are classed as Flood Zone 1 (when considering fluvial and tidal flood risk)



Coordinate system: British National Grid

Scale@A3: 1:20,000

0 250 500 750 Metres

0 250 500 750 Yards

REV	REMARK	DATE
	First Issue for PEIR	03/07/2019
A	Updated following PEIR consultations, for DCO	11/08/2021

Title: Flood Zones
Document no: HOW04RH0063
Created by: AZ
Checked by: ID
Approved by: CS

Royal HaskoningDHV

Ørsted

Date: 11/08/2021 Author: 303273 Name: HOW04RH0063_FloodZones

Hornsea Four

Figure 14

Surface Water Flood Risk

- Sheet 5 of 7

499500 501000 502500 504000

446500 445000 443500 442000

N

GRID NORTH

Bryan Mills Beck

Station Drain

Coal Dike

HC_043

AP_015

AP_014

AP_034

LC_005_A

HC_062

Bryan Mills Beck

AP_016

Scorborough Beck

Scorborough Boundary

HC_045

Beakey's Beck

HC_046

Ella Dike

White Dike

HC_047

AP_017

LC_006

HC_048

HC_049

HC_050

AP_018

HC_051

North Drain

Catchwater Drain

Washdike Drain

HC_052

Lockington

Scorborough

Leconfield

Beverley

Hornsea

Bridlington

Driffield

Hull

Withernsea

Order Limits

Temporary Access Track

Logistics Compound

Onshore Export Cable Corridor

Public Highway Access Point

Haul Road Crossing Access Point

Main River

IDB Maintained Watercourse

Ordinary Watercourse

Environment Agency Flood Map for Surface Water

High Risk (Greater than 1 in 30 Annual Probability of Flooding)

Medium Risk (Between 1 in 100 and 1 in 30 Annual Probability of Flooding)

Low Risk (Between 1 in 1,000 and 1 in 100 Annual Probability of Flooding)

WFD Operational Waterbody Catchments

Hull Lower

Coordinate system: British National Grid

Scale@A3: 1:20,000

0 250 500 1,000 Metres

0 250 500 1,000 Yards

REV	REMARK	DATE
	First Issue for PEIR	03/07/2019
A	Updated following PEIR consultations, for DCO	11/08/2021

Title: Surface Water Flood Risk
Document no: HOW04RH0064
Created by: AZ
Checked by: ID
Approved by: CS

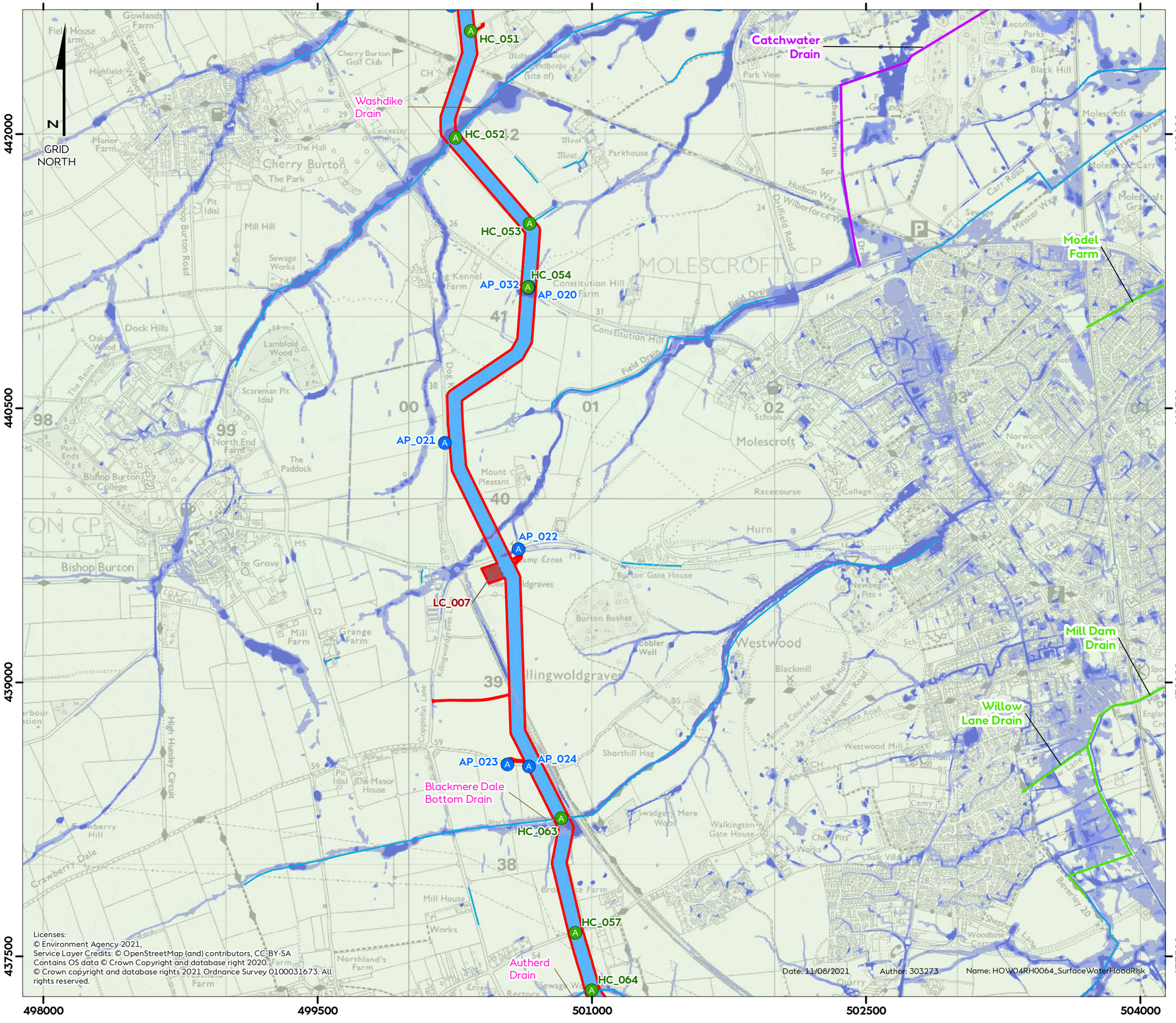
Date: 11/08/2021 Author: 303273 Name: HOW04RH0064_SurfaceWaterFloodRisk

Hornsea Four

Figure 15

Surface Water Flood Risk

- Sheet 6 of 7



Date: 11/08/2021 Author: 303273 Name: HOW04RH0064_SurfaceWaterFloodRisk

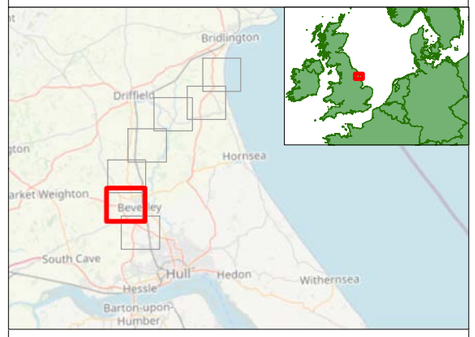
- Order Limits
- Temporary Access Track
- Logistics Compound
- Onshore Export Cable Corridor
- Public Highway Access Point
- Haul Road Crossing Access Point
- Main River
- IDB Maintained Watercourse
- Ordinary Watercourse

Environment Agency Flood Map for Surface Water

- High Risk (Greater than 1 in 30 Annual Probability of Flooding)
- Medium Risk (Between 1 in 100 and 1 in 30 Annual Probability of Flooding)
- Low Risk (Between 1 in 1,000 and 1 in 100 Annual Probability of Flooding)

WFD Operational Waterbody Catchments

- Hull Lower



Coordinate system: British National Grid

Scale@A3: 1:20,000

0 250 500 1,000 Metres

0 250 500 1,000 Yards

REV	REMARK	DATE
	First Issue for PEIR	03/07/2019
A	Updated following PEIR consultations, for DCO	11/08/2021

Title: Surface Water Flood Risk
Document no: HOW04RH0064
Created by: AZ
Checked by: ID
Approved by: CS

Royal HaskoningDHV

Ørsted

Hornsea Four

Figure 16

Surface Water Flood Risk - Sheet 7 of 7

501000 502500 504000 505500

437500 436000 434500 433000

N

GRID NORTH

HC_057 HC_064 HC_061 HC_067 HC_066 HC_065 HC_069

AP_025 AP_027 AP_030 AP_028 AP_026

LC_008

Autherd Drain

Beverley Parks Sewer

Oxgang Drain

Western Drain

Atkin's Keld

Poplar South Drain

Fox Drain

Birkhill Wood Drain

Cottingham Parks Drain

Wanlass Drain

Riley Drain

Wanlass Beck

Signal Drain

Cottingham Drain

Burn Park Farm Drain

Park Drain

Wilson Drain

Creyke Beck

Broadlane Beck

Beverley Parks

Platwoods Fields

Woodmansey

Skidby

Risby Head

Eppleworth

Date: 11/08/2021 Author: 303273 Name: HOW04RH0064_SurfaceWaterFloodRisk

Licenses:
© Environment Agency 2021,
Service Layer Credits: © OpenStreetMap (and) contributors, CC-BY-SA
Contains OS data © Crown Copyright and database right 2020.
© Crown copyright and database rights 2021 Ordnance Survey 0100031673. All rights reserved.

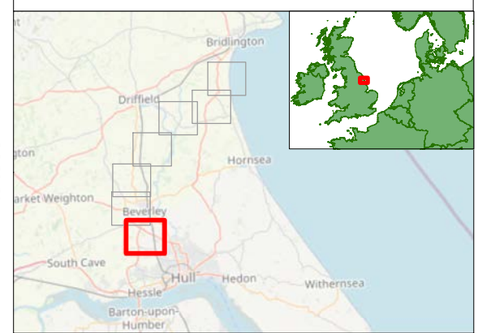
- Order Limits
- Permanent Access Track
- Temporary Access Track
- Logistics Compound
- Onshore Export Cable Corridor
- Grid Connection Works
- Onshore Substation (Permanent Space)
- Attenuation Area
- Existing Landscaping
- Landscape Mitigation Area
- Substation Permanent Space
- Onshore Substation (Temporary Works)
- Public Highway Access Point
- Haul Road Crossing Access Point
- Main River
- IDB Maintained Watercourse
- Ordinary Watercourse

Environment Agency Flood Map for Surface Water

- High Risk (Greater than 1 in 30 Annual Probability of Flooding)
- Medium Risk (Between 1 in 100 and 1 in 30 Annual Probability of Flooding)
- Low Risk (Between 1 in 1,000 and 1 in 100 Annual Probability of Flooding)

WFD Operational Waterbody Catchments

- Hull Lower



Coordinate system: British National Grid
Scale@A3: 1:20,000

0 250 500 1,000 Metres

0 250 500 1,000 Yards

REV	REMARK	DATE
	First Issue for PEIR	03/07/2019
A	Updated following PEIR consultations, for DCO	11/08/2021

Title: Surface Water Flood Risk
Document no: HOW04RH0064
Created by: AZ
Checked by: ID
Approved by: CS

Royal HaskoningDHV

Ørsted

4.7 Onshore Substation (OnSS) and 400 kV NGET connection area

4.7.1 Overview of Proposed Activities

4.7.1.1 The OnSS and the related flood risk is separated into three areas in this FRA:

- Section 4.8: Temporary OnSS area;
- Section 4.9: Permanent OnSS area and permanent access track; and
- Section 4.10: 400 kV NGET connection area.

4.7.1.2 The temporary OnSS area is located adjacent to the permanent OnSS (Figure 17) and will be reinstated (Co68) once all construction has been completed. This could include two to three storey offices, communication mast for internet communication, stores, delivery and offloading areas, welfare facilities, parking areas and security accommodation. More detail pertinent to the OnSS and 400 kV NGET connection area can be found in Section 4.10 and Volume A1, Chapter 4: Project Description.

4.7.1.3 The permanent OnSS will have a permanent operational access from the north using the A1079 and utilising the same route as temporary access track (AP_025, Figure 16). Flood risk associated with this access route is discussed in Section 4.8.10.2.

4.8 Temporary OnSS area

4.8.1 Historic Flooding

4.8.1.1 Absence of historic flood record does not necessarily confirm that flooding has not occurred. The Environment Agency Product 4 data shows no flooding to have occurred within the temporary OnSS area.

4.8.2 Flood Zones

4.8.2.1 The temporary OnSS area is entirely located in Flood Zone 1 and is therefore at low risk of fluvial and tidal flooding (Figure 18).

4.8.3 Flooding from Main Rivers

4.8.3.1 The temporary OnSS area is located approximately 1 km to the west of Wanless Beck, the nearest Main River and is therefore not at risk from fluvial flooding (Figure 18).

4.8.4 Flooding from IDB maintained watercourses

4.8.4.1 There are no IDB maintained watercourses within the temporary OnSS area and therefore there is no flood risk associated with fluvial flooding from IDB maintained watercourses.

4.8.5 Flooding from the Sea

4.8.5.1 The temporary OnSS area is located approximately 9 km inland and situated on higher ground, therefore there is no risk of flooding from the sea.

4.8.6 Flooding from Groundwater

4.8.6.1 The temporary OnSS area is located over bedrock designated as a Principal Aquifer. Principal Aquifers are usually considered to provide a high level of water storage. Measures set out in Co13 will be implemented to protect groundwater quality.

4.8.6.2 The Level 1 SFRA (ERYC 2010) identifies that a large proportion of ERY is characterised by chalk geology and following heavy rainfall elevated groundwater levels are often experienced. The groundwater emergence map is used to highlight these areas. For the temporary OnSS area, the entire area is classified as being within a Groundwater Emergence Zone. As detailed in the Level 1 SFRA (ERYC 2010), the identification of this risk requires a 'detailed' FRA to be completed in line with the, now superseded, PPS25 Development Control Recommendations.

4.8.6.3 Based on the above information there is likely to be a groundwater flood risk to the temporary OnSS area. However, due to the temporary nature of this element, this risk will be removed following the completion of construction.

4.8.7 Flooding from Surface Water

4.8.7.1 The majority of the temporary OnSS area is at 'Very Low' risk of surface water flooding (**Figure 19**).

4.8.7.2 The temporary OnSS area has a surface water flow route running from north-west to south-east across the centre of the site. This is characterised by predominantly 'Medium' risk; however, there are also small areas at 'High' risk (**Figure 19**).

4.8.8 Flooding from Sewers

4.8.8.1 No DG5 (sewer flood record) information has been obtained to support this FRA. The temporary OnSS area is located within existing agricultural land and, therefore, it is likely that there is no foul sewer network within proximity of this location. As such, there is a low risk of flooding from sewer sources.

4.8.9 Flooding from Reservoirs, Canals and Other Artificial Sources

4.8.9.1 Flooding from reservoirs is defined based on the implications of a large uncontrolled release of water from registered reservoirs i.e. greater than 25,000 m^3. The Environment Agency Flood Risk from Reservoirs map shows the site is not at risk of reservoir flooding (Environment Agency 2019).

4.8.9.2 There are no canals or other artificial sources within the temporary OnSS area. Therefore, there is no risk of flooding from reservoirs, canals or other artificial sources to the temporary OnSS area.

4.8.10 Summary of Flooding Sources to the Temporary OnSS area

4.8.10.1 Overall, the temporary OnSS area is not at risk from Main Rivers, IDB maintained watercourses, sea, sewers, reservoirs, canals or other artificial sources. Whilst groundwater flooding is identified as a potential risk, it will be mitigated once operational as the site will be returned to its previous condition.

4.8.10.2 The main risk to the temporary OnSS area is the surface water flow route and associated areas of 'High' flood risk. However, this risk will be mitigated through the adoption of standard measures, such as attenuation and adoption of appropriate discharge rates within the drainage design (Co14 and Co197). Furthermore, the risk will be removed entirely following completion of construction, with the site being returned to its previous state (Co68).

4.9 Permanent OnSS area and access track

4.9.1 Historic Flooding

4.9.1.1 Absence of historic flood record does not necessarily confirm that flooding has not occurred. The Product 4 data provided by the Environment Agency shows previous flood extent outlines that intersect the permanent OnSS in one location.

4.9.1.2 An isolated area of land to the north of the permanent OnSS flooded during the 2007 surface water event. This appears to be associated with an Ordinary Watercourse (identified in the LLFA dataset as UFRN AFR848) (**Figure 18**).

4.9.2 Flood Zones

4.9.2.1 The permanent OnSS intersects one Flood Zone 3 extent (**Figure 18**) at the south-east corner of the permanent OnSS area, associated with an Ordinary Watercourse known as Cottingham Parks Drain (identified in the LLFA dataset as UFRN ARF258).

4.9.2.2 The Environment Agency acknowledged uncertainties with their existing hydraulic modelling, supplied as part of the Product 4 dataset, which was used to determine the fluvial flood zones and extents in this location. At the water and flood risk Evidence Plan Technical Panel meeting on 5 April 2019, the Environment Agency noted that a more detailed model had been carried out for development at the adjacent National Grid Creyke Beck NGET substation (ON-HYD-1.4).

4.9.2.3 A copy of the report entitled National Grid Asset Flood Resilience DRAFT Flood Risk Assessment Creyke Beck 400 kV Substation National Grid Ref: PDD-30744-2-REP-121, dated April 2016 (Mott MacDonald 2016) has been provided. Further modelling report information obtained from the Creyke Beck NGET substation and the information from this report has also been incorporated into this assessment.

4.9.2.4 The existing flood zones indicate that following construction of the permanent OnSS, the risk from fluvial flooding is likely to be addressed as the key infrastructure is proposed to be

located, at an increased elevation, and therefore within Flood Zone 1. Further details of the assessment related to fluvial flooding is summarised in Section 4.9.3.

4.9.3 Flooding from Main Rivers

4.9.3.1 Although part of the permanent OnSS is located in Flood Zone 3, the nearest Main River (Wanless Beck) is located approximately 500 m to the west on lower ground. The flood extent provided within the Environment Agency Product 4 indicates that this does not pose a risk to the built elements of the OnSS (Figure 18).

4.9.3.2 As noted previously, the Environment Agency has identified uncertainties associated with the hydraulic modelling used to determine the fluvial flood extents and maximum modelled water levels. Information in relation to maximum flood water levels and flood depths has been obtained from the National Grid (Mott MacDonald 2016). The information in the Creyke Beck FRA has been presented for the pre-scheme (prior to construction works at Creyke Beck) and post-scheme scenarios. The key information from both scenarios has been extracted and considered alongside 1 m LiDAR data for the permanent OnSS site to assess the potential flood risk.

4.9.3.3 The pre-scheme 1 in 100 year plus climate change results indicate that the modelled maximum water level in the south east corner of the permanent OnSS area is between 10.2 m AOD and 10.4 m AOD.

4.9.3.4 A conservative approach has been taken for the 1 in 100 year plus climate change modelled results and therefore it has been assumed that the maximum modelled flood water level is 10.4 m AOD in the south east corner of the permanent OnSS area.

4.9.3.5 The pre-scheme 1 in 200 year plus climate change and 1 in 1,000 year plus climate change modelled water levels are both indicated as being > 10.4 m AOD.

4.9.3.6 For the 1 in 200 year plus climate change and 1 in 1,000 year plus climate change events a comparison has been carried out between the modelled flood extents, modelled water levels and 1 m LiDAR data. For both of these events areas with a ground level in excess of 10.5 m AOD do not fall within the modelled flood extent.

4.9.3.7 The post-scheme 1 in 100 year plus climate change results also indicate that the modelled maximum water level in the south east corner of the permanent OnSS area is between 10.2 m AOD and 10.4 m AOD, where the flood zone maps indicate the existing presence of the Flood Zone 3 extent.

4.9.3.8 A conservative approach has been taken for the 1 in 100 year plus climate change modelled results and therefore it has been assumed that the maximum modelled flood water level is 10.4 m AOD in the south-east corner of the permanent OnSS area, where the flood zone maps indicate the existing presence of the Flood Zone 3 extent.

4.9.3.9 The post-scheme 1 in 200 year plus climate change and 1 in 1,000 year plus climate change modelled water levels are both indicated as being > 10.4 m AOD.

4.9.3.10 For the 1 in 200 year plus climate change and 1 in 1,000 year plus climate change events a comparison has been carried out between the modelled flood extents, modelled water levels and 1 m LiDAR data. For both of these events areas with a ground level in excess of 10.5 m AOD do not fall within the modelled flood extent.

4.9.3.11 In summary the modelled water level information indicates that the permanent OnSS area would experience flooding up to 10.4m AOD during the 1 in 100 year plus climate change event, both pre- and post-scheme.

4.9.3.12 In addition, the modelled water level information indicates that the permanent OnSS area would experience flooding up to 10.5 m AOD during the 1 in 200 year plus climate change and 1 in 1,000 year plus climate change event, both pre- and post-scheme.

4.9.3.13 The permanent OnSS infrastructure is anticipated to be set at the design levels set out below. However, these levels will be dependent on the detailed design to be developed post-consent. As such, the final site levels will be agreed in consultation with the relevant authorities, including the Environment Agency and LLFA, as necessary:

- The area identified in the indicative HVAC and HVDC layouts for the OnSS are anticipated to be set at approximately 13 m AOD – This is 2.5 m above the maximum modelled flood extent for the 1 in 1,000 year plus climate change event and therefore inherently includes a significant natural freeboard; and

- The area identifies in the indicative HVAC and HVDC layouts for the EBI are anticipated to be set at approximately 14.5 m AOD – This is 4 m above the maximum modelled flood extent for the 1 in 1,000 year plus climate change event and therefore inherently includes a significant natural freeboard.

4.9.3.14 As a result, the permanent OnSS site is considered to be in Flood Zone 1, except for the south east corner which is located in Flood Zone 3. Therefore, the key infrastructure associated with the permanent OnSS is not considered to be at risk of fluvial flooding during an extreme event and has a significant natural freeboard above maximum modelled water levels. This was discussed and agreed with the Environment Agency at the Hornsea Four water and flood risk Evidence Plan Technical Panel meeting on 15 May 2020 (ON-HYD-7.1).

4.9.4 Flooding from IDB maintained watercourses

4.9.4.1 There are no IDB maintained watercourses within the permanent OnSS site and therefore there is no flood risk associated with fluvial flooding from IDB maintained watercourses.

4.9.5 Flooding from the Sea

4.9.5.1 The permanent OnSS site is located approximately 9 km inland and situated on higher ground, therefore there is no risk of flooding from the sea.

4.9.6 Flooding from Groundwater

4.9.6.1 The permanent OnSS site is located over bedrock designated as a Principal Aquifer. Principal Aquifers are usually considered to provide a high level of water storage. Measures set out in Co13 will be implemented to protect groundwater quality.

4.9.6.2 The Level 1 SFRA (ERYC 2010) identifies that a large proportion of ERY is characterised by chalk geology and following heavy rainfall elevated groundwater levels are often experienced. The groundwater emergence map is used to highlight these areas. For the permanent OnSS area, the entire area is classified as being within a Groundwater Emergence Zone. As detailed in the Level 1 SFRA (ERYC 2010), the identification of this risk requires a 'detailed' FRA to be completed in line with the, now superseded, PPS25 Development Control Recommendations.

4.9.6.3 Based on the above information there is likely to be a groundwater flood risk to the permanent OnSS area. However, this minimal risk can be mitigated within the design by limiting the use of basements [as for example, some basements may be required for cable entry], sloping ground away from the key infrastructure and raising it up off the ground so as to limit the potential impact should there be a limited risk of groundwater emergence on the permanent OnSS area both during construction and once operational.

4.9.7 Flooding from Surface Water

4.9.7.1 The majority of the permanent OnSS area is at 'Very Low' risk of surface water flooding (**Figure 19**).

4.9.7.2 The permanent OnSS area has a surface water flow route running along the southern boundary of the site, identified as being at 'High' risk of flooding as well as an area to the north (**Figure 19**). These are in accordance with the fluvial flood extents obtained from the National Grid modelling and therefore have been discussed in **Section 4.9.3**.

4.9.7.3 There is one permanent access track serving the permanent OnSS, running south from the A1079 (AP_025, **Figure 16**). From the A1079 the permanent access track will head south over agricultural land (**Figure 19**). The permanent access track crosses over the Atkin's Keld watercourse which is shown as being at 'High' surface water flood risk and located within Flood Zone 3. This area of flood risk appears to be limited to the location where the permanent access track passes over the existing watercourse. Therefore, this FRA suggests that construction of the permanent access track should be designed to retain sufficient floodplain capacity and / or flow conveyance, to ensure continued floodplain capacity and/or flow conveyance, where reasonably practicable (Co184 and Co185). This was discussed and agreed with the Environment Agency and Beverley and North Holderness IDB

at a Hornsea Four water and flood risk Evidence Plan Technical Panel meeting held on 5 November 2019 (ON-HYD-3.12).

4.9.7.4 Further information related to flood risk issues along the permanent access track, variations in ground levels and existing flow paths will be obtained as part of the pre-construction survey (Co19) and during to the detailed design stages. This will inform the development of appropriate mitigation measures to limit any restriction in flow (Co185).

4.9.8 Flooding from Sewers

4.9.8.1 No DG5 (sewer flood record) information has been obtained to support this FRA. The permanent OnSS area is located within existing agricultural land and, therefore, it is likely that there is no foul sewer network within proximity of this location. As such, there is a low risk of flooding from sewer sources.

4.9.9 Flooding from Reservoirs, Canals and Other Artificial Sources

4.9.9.1 Flooding from reservoirs is defined based on the implications of a large uncontrolled release of water from registered reservoirs i.e. greater than 25,000 m^3. The Environment Agency Flood Risk from Reservoirs map shows the site is not at risk of reservoir flooding (Environment Agency 2019).

4.9.9.2 There are no canals or other artificial sources within the permanent OnSS site. Therefore, there is no risk of flooding from reservoirs, canals or other artificial sources to the permanent OnSS site.

4.9.10 Summary of Flooding Sources to the Permanent OnSS

4.9.10.1 Overall, the permanent OnSS area is not at risk from Main Rivers, IDB maintained watercourses, the sea, sewers, reservoirs, canals or other artificial sources. Whilst groundwater flooding is identified as a potential risk, it can be mitigated within the design by omitting the use of basements, sloping ground away from the key infrastructure and raising it up off the ground so as to limit the potential impact of groundwater emergence on the permanent OnSS.

4.9.10.2 The main risks to the permanent OnSS relate to the Flood Zone 3 extent at the southern corner of the site and the associated surface water flow route in this location (**Figure 18** and **Figure 19**). A review of the modelling carried out by National Grid for the adjacent Creyke Beck site, and which extends to the permanent OnSS area, found that the flood extent is similar to the Environment Agency modelled flood extent. Therefore, the permanent OnSS is located in Flood Zone 1 with an area to the south east corner located in Flood Zone 3.

4.9.10.3 This FRA suggests that any risk from fluvial and surface water flooding can be mitigated through the design of the surface water drainage system (Co19 and Co191). As stated in Co19 (**Volume A4, Annex 5.2: Commitments Register**), an Onshore Infrastructure Drainage Strategy will be developed for the permanent onshore operational development in accordance with the Outline Onshore Infrastructure Drainage Strategy. The Onshore Infrastructure Drainage Strategy will include measures to ensure that existing land drainage

is reinstated and/or maintained. This will include measures to limit discharge rates and attenuate flows to maintain greenfield run-off rates at the OnSS (Co191). The Onshore Infrastructure Drainage Strategy will be developed in line with the latest relevant drainage guidance notes in consultation with the Environment Agency, LLFA and relevant IDB as appropriate.

4.10 400 kV NGET connection

4.10.1 Historic Flooding

4.10.1.1 Absence of historic flood record does not necessarily confirm that flooding has not occurred. The Environment Agency Product 4 data shows previous flood extent outlines that intersect the 400 kV NGET connection area in two locations (**Figure 18**). These historic surface water flooding events from June 2007 are located in two small areas along the northern boundary of the 400 kV NGET connection area. These events appear to be associated the Cottingham Parks Drain watercourse (identified in the LLFA dataset as UFRN AFR848).

4.10.1.2 Overall review of the historic flooding data suggests that the 400 kV NGET connection area has historically been at risk from surface water events, with the 2007 flooding causing surface water flooding.

4.10.2 Flood Zones

4.10.2.1 The 400 kV NGET connection area intersects one Flood Zone 3 extent (**Figure 18**):

- 130 m at the south of the 400 kV NGET connection area, associated with an Ordinary Watercourse known as Cottingham Parks Drain (identified in the LLFA dataset as UFRN AFR551).

4.10.3 Flooding from Main Rivers

4.10.3.1 There is an Environment Agency Main River running immediately adjacent to the 400 kV NGET connection area (**Figure 18**). This Main River is the Wanless Beck, which runs south immediately to the east of the Creyke Beck substation. However, the Flood Zone associated with this watercourse does not intersect the 400 kV NGET connection area.

4.10.4 Flooding from IDB maintained watercourses

4.10.4.1 There are no IDB maintained watercourses within the 400 kV NGET connection area and therefore there is no flood risk associated with fluvial flooding from IDB maintained watercourses.

4.10.5 Flooding from the Sea

4.10.5.1 The 400 kV NGET connection area is located approximately 9 km inland and situated on higher ground, therefore there is no risk of flooding from the sea.

4.10.6 Flooding from Groundwater

4.10.6.1 The 400 kV NGET connection area is located over bedrock designated as a Principal Aquifer. Principal Aquifers are usually considered to provide a high level of water storage. Measures set out in Co13 will be implemented to protect groundwater quality.

4.10.6.2 The Level 1 SFRA (ERYC 2010) identifies that a large proportion of ERY is characterised by chalk geology and following heavy rainfall elevated groundwater levels are often experienced. The groundwater emergence map is used to highlight these areas. For the 400 kV NGET connection area, the entire area is classified as being within a Groundwater Emergence Zone. As detailed in the Level 1 SFRA (ERYC 2010), the identification of this risk requires a 'detailed' FRA to be completed in line with the, now superseded, PPS25 Development Control Recommendations.

4.10.6.3 Based on the above information there is likely to be a groundwater flood risk to the 400 kV NGET connection area.

4.10.6.4 The effect the 400 kV NGET connection area shall have on groundwater flows once operational is likely to be low as the buried cable will be located at a target depth of 1.2 m below ground, although this will be subject to localised variations. (i.e. limiting interaction to shallow or near surface groundwater). Furthermore, any water flowing into the trenches during the construction period will discharged into local ditches or drains via temporary interceptor drains (Co14 and Co18).

4.10.6.5 Based on the above information there is likely to be a groundwater flood risk to the 400 kV NGET connection area. However, this risk will be mitigated within the design as part of the embedded mitigation measures, as outlined above, and to be implemented during the construction phase, through the development of the Onshore Infrastructure Drainage Strategy (Co19) (**Volume F2, Chapter 6: Outline Onshore Infrastructure Drainage Strategy**). This will limit the potential impact of groundwater emergence on the onshore ECC both during construction and once operational.

4.10.7 Flooding from Surface Water

4.10.7.1 The majority of the 400 kV NGET connection area is at 'Very Low' risk of surface water flooding **(Figure 19**).

4.10.7.2 The 400 kV NGET connection area has multiple surface water flow routes that appear to be associated with the ordinary watercourses that cross the site. The main area of surface water flood risk runs from west to east through the centre of this site to the north of the Creyke Beck NGET substation.

4.10.8 Flooding from Sewers

4.10.8.1 No DG5 (sewer flood record) information has been obtained to support this FRA. The 400 kV NGET connection area is located within existing agricultural land and, therefore, it is likely

that there is no foul sewer network within proximity of this location. As such, there is a low risk of flooding from sewer sources.

4.10.9 Flooding from Reservoirs, Canals and Other Artificial Sources

4.10.9.1 Flooding from reservoirs is defined based on the implications of a large uncontrolled release of water from registered reservoirs i.e. greater than 25,000 m^3. The Environment Agency Flood Risk from Reservoirs map shows the site is not at risk of reservoir flooding (Environment Agency 2019).

4.10.9.2 There are no canals or other artificial sources within the 400 kV NGET connection area. Therefore, there is no risk of flooding from reservoirs, canals or other artificial sources to the 400 kV NGET connection area.

4.10.10 Summary of Flooding Sources to the 400 kV NGET connection area

4.10.10.1 Overall, the 400 kV NGET connection area is not at risk from IDB maintained watercourses, the sea, sewers, reservoirs, canals or other artificial sources. Whilst groundwater flood risk is identified as a potential risk to the 400 kV NGET connection area, this will be managed once operational as it will be located within sealed ducts.

4.10.10.2 There is a small section at the south of the site located in Flood Zone 3. There is also a surface water flow route that appears to run from west to east through the centre of this site (**Figure 18** and **Figure 19**).

4.10.10.3 Based on the proposed location of the 400 kV NGET connection area, surface water flood risk can be mitigated through the drainage design (Co19), which will need to include attenuation, adoption of appropriate discharge rates, preferential flow routes and identification of appropriate access / egress routes.

4.10.11 Summary of Flood Risk to Hornsea Four

4.10.11.1 Hornsea Four is predominantly located in Flood Zone 1. Sections of the onshore ECC are located in Flood Zones 2 and 3. However, following construction there will be no risk to this onshore ECC infrastructure, as it will be located below ground (Co25 and Co28).

4.10.11.2 There are a number of Main Rivers and IDB maintained watercourses that will be crossed by the onshore ECC. It is anticipated that there will be no flood risk associated with these features due to the proposed use of trenchless crossing techniques (Co1).

4.10.11.3 The risk of surface water flooding is identified as predominantly 'Very Low', with small isolated areas of 'High' risk identified along the onshore ECC and its associated access routes. However, upon completion of cable installation the risk of surface water flooding will be removed, with all infrastructure located below ground.

4.10.11.4 The OnSS site has some areas of 'High' surface water flood risk, primarily associated with flow paths that run across the site. These will be mitigated within the drainage design

including measures such as attenuation , adoption of appropriate discharge rates, preferential flow routes (Co191) and identification of appropriate access / egress route as stated in **Volume F2, Chapter 6: Outline Onshore Infrastructure Drainage Strategy** (Co19) (**Figure 19**).

4.10.11.5 Surveys conducted prior to construction work will identify all ordinary watercourses (including agricultural ditches) that will be crossed by the onshore ECC (Co14 and Co157). This will ensure that land is reinstated following the laying of the cable as to not adversely affect flood risk along the onshore ECC.

4.10.11.6 There is no risk of flooding from the sea.

4.10.11.7 The information on risk of groundwater flooding for the area is high level. However, it is acknowledged that much of the infrastructure is located in areas that are identified as potentially at risk from groundwater flooding and appropriate mitigation measures (e.g. Co14, Co19, Co124, Co184, Co186 and Co191) will be incorporated into the design.

4.10.11.8 The onshore project infrastructure is located on agricultural land and as such there is limited risk of flooding from sewers. Risk of flooding from reservoirs, canals and other sources is deemed to be low for the onshore project infrastructure.

503200 504000 504800

436000 435200 434400

N
GRID NORTH

HC_067
HC_066
HC_065
HC_069

Jillywood Farm
Poplar Farm
Wanless Farm
Sharry Gangs
Burn Park Farm
Burn Park Cottages
Wanlass Beck
Crowle Park
Spring Park Farm

Date: 19/07/2021 Author: 303273 Name: HOW04RH0062_SubstationTopography

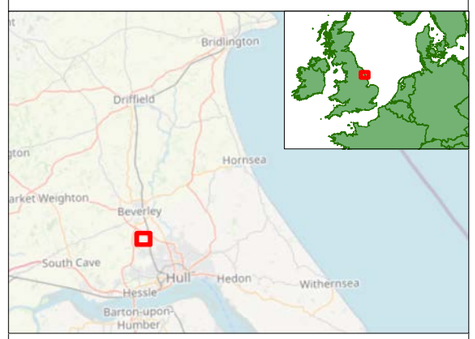
Hornsea Four

Figure 17
Onshore Substation Topography

- Order Limits
- Onshore Export Cable Corridor
- Permanent Access Track
- HOW04_TemporaryAccessTracks_v17
- Onshore Substation (Temporary Works)
- Attenuation Area
- Existing Landscaping
- Landscape Mitigation Area
- Substation Permanent Space
- Grid Connection Works
- A Haul Road Crossing Access Point

Digital Surface Model (DSM)
1m Resolution (Environment Agency, 2019)

- High : 25
- 20
- 15
- 10
- Low : 5



Coordinate system: British National Grid
Scale@A3: 1:7,000

0 125 250 Metres

0 125 250 Yards

REV	REMARK	DATE
	First Issue for PEIR	03/07/2019
A	Updated following PEIR consultations, for DCO	19/07/2021

Title: Onshore Substation Topography
Document no: HOW04RH0062
Created by: AZ
Checked by: ID
Approved by: CS

Royal HaskoningDHV
Ørsted

Hornsea Four

Figure 18

Onshore Substation Flood Zones

503200 504000 504800

436000 435200 434400

N

GRID NORTH

HC_067 HC_066 HC_065 HC_069

Fox Drain

Wanlass Beck

Jillywood Farm
Birkhill Wood
Jillywoods
Poplar Farm
Wanlass Farm
Sharry Gangs
Burn Park Farm
Burn Park Cottages
Crowle Park
Spring Park Farm

- Order Limits
- Onshore Export Cable Corridor
- Permanent Access Track
- Temporary Access Track
- Onshore Substation (Temporary Works)
- Attenuation Area
- Existing Landscaping
- Landscape Mitigation Area
- Substation Permanent Space
- Grid Connection Works
- A Haul Road Crossing Access Point
- Main River
- IDB Maintained Watercourse
- Ordinary Watercourse
- Historic Flood Locations

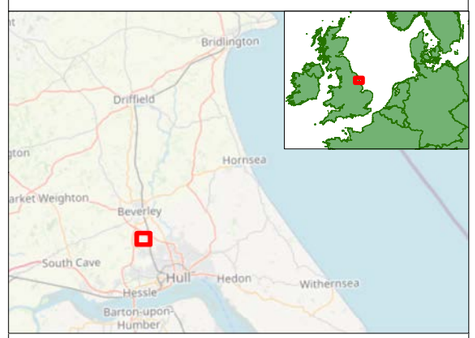
Environment Agency Flood Zones

- Flood Zone 1
- Flood Zone 2

WFD Operational Waterbody Catchments

- Hull Lower

*All areas not shown as being located in either Flood Zone 2 or 3 are classed as Flood Zone 1 (when considering fluvial and tidal flood risk)



Coordinate system: British National Grid

Scale@A3: 1:7,000

0 125 250 Metres

0 125 250 Yards

REV	REMARK	DATE
	First Issue for PEIR	03/07/2019
A	Updated following PEIR consultations, for DCO	23/07/2021

Title: Onshore Substation Flood Zones
Document no: HOW04RH0065
Created by: AZ
Checked by: ID
Approved by: CS

Royal HaskoningDHV

Ørsted

Date: 23/07/2021 Author: 303273 Name: HOW04RH0065_FloodZonesOnSS

Hornsea Four

Figure 19

Onshore Substation
Surface Water Flood Risk

503200 504000 504800

436000 435200 434400

N
GRID NORTH

Atkin's Keld
Fox Drain Tributary
Poplar Drain
Foz Drain
Birkhill Wood Drain
Birkhill Drain
Cottingham Parks Drain
Wanlass Drain
Platwoods Drain
HC_067
HC_066
Wanlass Beck
HC_065
Signal Drain
HC_069
Burn Park Farm Drain
Park Drain
Spring Drain
Crossing Drain

Jillywood
Birkhill Wood
Poplar Farm
Jillywoods
Burn Park Farm
Burn Park Cottages
Crowle Park
Spring Park Farm
Sharry Gates
Wanlass Beck

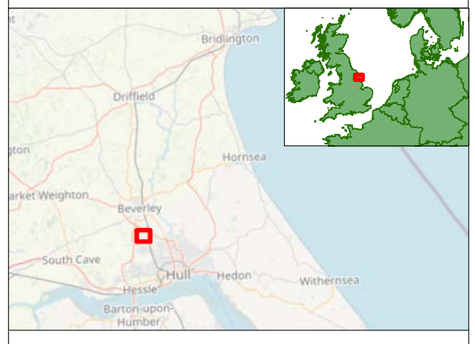
- Order Limits
- Onshore Export Cable Corridor
- Permanent Access Track
- Temporary Access Track
- Onshore Substation (Temporary Works)
- Attenuation Area
- Existing Landscaping
- Landscape Mitigation Area
- Substation Permanent Space
- Grid Connection Works
- A Haul Road Crossing Access Point
- Main River
- IDB Maintained Watercourse
- Ordinary Watercourse

Environment Agency Flood Map for Surface Water

- High Risk (Greater than 1 in 30 Annual Probability of Flooding)
- Medium Risk (Between 1 in 100 and 1 in 30 Annual Probability of Flooding)
- Low Risk (Between 1 in 1,000 and 1 in 100 Annual Probability of Flooding)

WFD Operational Waterbody Catchments

- Hull Lower



Coordinate system: British National Grid
Scale@A3: 1:7,000

0 125 250 Metres

0 125 250 Yards

REV	REMARK	DATE
	First Issue for PEIR	29/05/2019
A	Updated following PEIR consultations, for DCO	19/07/2021

Title: Onshore Substation Surface Water Flood Risk
Document no: HOW04RH0066
Created by: AZ
Checked by: ID
Approved by: CS

Royal HaskoningDHV
Ørsted

Date: 19/07/2021 Author: 303273 Name: HOW04RH0066_SurfaceWaterFloodRiskOnSS

5 Consideration of the Sequential and Exception Test

5.1.1.1 The aim of the NPPF PPG Sequential Test is to ensure that a sequential approach is adopted to steer new development to areas with the lowest probability of flooding, i.e. Flood Zone 1. Where there are no reasonably available sites in Flood Zone 1, the local authority can consider reasonably available sites in Flood Zone 2. Only where there are no reasonably available sites for development in Flood Zone 1 or 2, should the suitability of sites in Flood Zone 3 be considered.

5.1 Vulnerability Classification

5.1.1.1 Under the NPPF PPG Flood Risk and Coastal Change, the project is considered as 'Essential Infrastructure', which is defined as:

- Essential transport infrastructure (including mass evacuation routes), which must cross the area at risk;
- Essential utility infrastructure which must be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood; and
- Wind turbines.

5.2 Application of the Sequential Test and Exception Test

5.2.1.1 The Hornsea Four Order Limits are located within Flood Zones 1, 2 and 3, as defined by the Environment Agency's online Flood Map for Planning (Environment Agency undated). The Sequential Test has been considered in accordance with the NPPF PPG. Development classed as 'Essential Infrastructure' and located within Flood Zone 3 is required to pass the Exception Test (Table 9).

Table 9: Flood Risk Vulnerability Classification.

Flood Zones	Flood Risk Vulnerability Classification				
	Essential Infrastructure	*Highly Vulnerable*	*More Vulnerable*	*Less Vulnerable*	*Water Compatible*
1	✓	✓	✓	✓	✓
2	✓	Exception test required	✓	✓	✓
3a	Exception test required	×	Exception test required	✓	✓
3b	Exception test required	×	×	×	✓

5.2.1.2 The parts of the Hornsea Four Order Limits located within Flood Zone 3 are required to pass the Exception Test by demonstrating that the project provides wider sustainability benefits

to the community which outweigh flood risk, and that the project will be safe for its lifetime without increasing flood risk elsewhere.

5.2.1.3 Above ground compounds / structures are primarily to be located within Flood Zone 1. Subterranean development is also located primarily in Flood Zone 1, with some locations in Flood Zone 2 and 3 where it is required to pass under, or in proximity to, existing watercourses.

5.2.1.4 Subterranean development will only be at potential risk of flooding during the construction phase. Once operational, the flood risk to the onshore ECC will have been removed as the transition joint bays, cables and link boxes will be wholly located underground (Co25, Co28 and Co170), with the latter sealed through a watertight manhole cover with no interaction with the above ground Flood Zones.

5.2.1.5 Based on the modelling information available it has been confirmed that the built elements of the permanent OnSS area will be located within Flood Zone 1. The permanent access route is located primarily in Flood Zone 1, except for the locations where it passes over the existing Atkin's Keld watercourse where it will be within the Flood Zone 3 extent.

5.2.1.6 The permanent access route requires consideration of the Exception Test. On the basis that it forms part of the wider nationally significant project, it is considered to pass the first part of the Exception Test. However, it is necessary to demonstrate that it will be safe throughout its lifetime without increasing flood risk elsewhere. Where the permanent access track to the OnSS may be required to pass over an existing watercourse, the crossing will be appropriately designed to maintain floodplain capacity and/or flow conveyance, where possible. This shall include an allowance for the predicted effects of climate change (Co184 and Co185).

5.2.1.7 The final decision regarding the application of the Sequential Test and Exception Test is for the planning authority to confirm whether they agree that the project satisfactorily passes both tests. However, this assessment concludes that the sequential approach has been adopted, and the wider benefits associated with the provision of renewable energy ensures that the project is in accordance with the guidance related to the Sequential and Exception Test.

6 Climate Change

6.1.1.1 The risk of flooding from potential sources will be amplified as a result of the predicted increase in rainfall associated with climate change. Given the potential sources of flooding identified in this FRA, there are two main aspects of climate change which are likely to impact the project. These are an increase in peak river flows and an increase in the duration and intensity of rainfall events likely to increase the magnitude of surface water flooding.

6.1.1.2 Current guidance on climate change allowances (Environment Agency 2020), states 'Essential Infrastructure' developments within Flood Zone 2 or 3 should use the 'Upper End'

climate change allowance when considering impacts on fluvial flood risk due to climate change.

6.1.1.3 The Hornsea Four Order Limits is located within the Humber river basin. Assuming construction commences in 2023, the peak river flow climate change allowance would comprise an additional 30% in Flood Zone 2 and Flood Zone 3 assuming 35 years of operation, as shown in **Table 10**.

Table 10: Climate Change Allowance for the Humber.

River basin district	Allowance Category	Total potential change anticipated for '2020s' (2015 – 2039)	Total potential change anticipated for '2050s' (2040 – 2069)	Total potential change anticipated for '2080s' (2070 – 2115)
Humber	Upper End	20%	30%	50%
	Higher Central	15%	20%	30%
	Central	10%	15%	20%

6.1.1.4 The climate change allowance related to peak river flow and fluvial flooding is only likely to be relevant to the OnSS, as all other elements of the project will be below ground (Co25 and Co28) once constructed.

6.1.1.5 The River Hull and Holderness Drain Flood Mapping Study (Halcrow 2013) identifies that fluvial flooding under climate change scenarios is predominantly consistent with the same areas as current day flood extents. Areas where flood risk may increase are identified as:

- Nafferton Drain, near the town of Brigham;
- Three Jolly Tars Farm, north of the cable route;
- Dunswell, to the east of the substation in proximity to the River Hull;
- Decoy Farm;
- Hull Bridge;
- Tophill Low Sewage Works;
- Rotsea Carr Farm;
- Weel Road in Beverley;
- Beverley Sewage Works;
- Thearne and surrounding farms; and
- Dunswell and the City of Hull.

6.1.1.6 This indicates that increased fluvial flooding relating to climate change will not affect the OnSS, which is the only onshore infrastructure that will not be located below ground following construction. This is supported by the results of the modelling carried out by National Grid for the adjacent Creyke Beck site (Mott MacDonald 2016). Therefore, the effects of climate change from fluvial sources will not impact the Hornsea Four onshore infrastructure.

6.1.1.7 When considering surface water flood risk, the ERYC guidance requires drainage design to accommodate a 30% increase, by either increasing peak rainfall in hydraulic calculations or by increasing on-site storage, as set out in the SuDS Combined Planning Note and Standing Advice (ERYC 2016) (Co14 and Co19).

6.1.1.8 This FRA suggests that the design of surface water management measures and the drainage system for above ground structures (i.e. the OnSS) should include the above allowance as a minimum, to take into account the potential increase in surface water flood risk resulting from climate change. Particular attention should be given to the reinstatement of land drains disturbed by the onshore ECC, to mitigate any potential long-term effects (Co19).

7 Surface Water Drainage

7.1 Onshore Infrastructure Pre-Construction Work

7.1.1.1 Prior to commencement of the construction works, detailed drainage surveys will be undertaken to feed into a detailed drainage design for all elements of the onshore infrastructure (Co14 and Co19).

7.1.1.2 **Volume F2, Chapter 2: Outline Onshore Infrastructure Drainage Strategy** has been developed as part of the DCO application. The Onshore Infrastructure Drainage Strategy will be developed in accordance with Outline Onshore Infrastructure Drainage Strategy and will be agreed with the appropriate regulators where relevant and implemented to minimise water within the working areas, ensure ongoing drainage of surrounding land and that there is no increase in surface water flood risk (Co14 and Co19). This will assess the current and proposed runoff rates, volume of storage required and the proposed approach for discharge of water from the site.

7.1.1.3 A local specialised drainage contractor will undertake surveys, locate drains, create drawings pre- and post-construction, to ensure appropriate reinstatement (Co157). A pre-construction Onshore Infrastructure Drainage Strategy will include provisions to minimise flood risk within the working area and ensure ongoing drainage of surrounding land (Co14 and Co19).

7.2 Landfall and onshore ECC Surface Water Drainage

7.2.1.1 The onshore ECC will only be at risk of surface water flooding during construction. However, there is risk that drainage ditches and surface water flow routes could be adversely affected if ground reinstatement is not carefully managed.

7.2.1.2 Hornsea Four is committed to using trenchless crossing techniques at key watercourse crossing locations, including all IDB maintained watercourses and Main Rivers (Co1). In these locations the HDD will be confirmed and agreed with the regulators to be located a sufficient distance below the bed of the channel and therefore (Co18), there will be no impact on flood risk as all proposed elements will be located below ground (Co25, Co28 and Co41).

7.2.1.3 Where the onshore ECC crosses land drains and minor ditches during cable installation, it is likely that any existing field drainage could be severed. In these locations, the design related

to temporary water crossings will be developed to ensure that flow along the watercourse is maintained and there is no increase in flood risk as a result of the temporary works (as detailed in **Volume F2, Chapter 2: Outline Code of Construction Practice** (Co124)). The methodology to be used for any temporary construction at crossing points over existing ditches and watercourses shall be agreed with the Environment Agency, Local Authority and / or IDB (Co147). To manage this ahead of the main works the Principal Contractor will develop a Surface Water and Drainage Strategy in consultation with the landowner (Co14 and Co19).

7.2.1.4 Initial works encompass the installation of preconstruction drainage, the purpose of which is to bypass the existing drainage system to enable wider excavations whilst maintaining field drainage that may be only seasonally wet.

7.2.1.5 It will be necessary to install additional field drainage parallel to the cable trenches along the Hornsea Four onshore ECC to ensure the existing drainage characteristics of the land are maintained and there is no increase in flood risk to on and off-site receptors during and after construction (Co14). These drains would be installed either by small trenching machines, open cut trenching or similar. All temporary drainage would pass through a silt interceptor before being discharged.

7.2.1.6 The detailed methodology for all crossings will be agreed with the relevant stakeholders such as third-party asset owners and other statutory stakeholders (Co124 and Co186).

7.3 Onshore ECC Post-Construction

7.3.1.1 Following construction of the Landfall and onshore ECC there will be no permanent above ground elements. Additionally, it is proposed that drainage will be reinstated to match the existing baseline condition (Co14). As such there would be no impact on surface water drainage. Furthermore, all temporary logistics compounds, and temporary access tracks will be fully reinstated and would have no operational use (Co68).

7.3.1.2 The backfilling of material, within both construction drainage channels and along the onshore ECC itself will prevent a conduit from forming and ensure there are no changes to the local flow rates due to permeability changes. This will be detailed in **Volume F2, Chapter 2: Outline Onshore Infrastructure Drainage Strategy.**

7.4 Onshore Substation (OnSS) Surface Water Drainage

7.4.1.1 Surface water drainage requirements will be dictated by the Onshore Infrastructure Drainage Strategy (Co19) and will be designed to meet the requirements of the NPPF, NPS EN-1, NPS EN-5, and the CIRA SuDs Manual C753 (CIRA 2015) with runoff limited where feasible, through the use of infiltration techniques which can be accommodated within the area of the development (Co191).

7.4.1.2 Changes in surface water runoff as a result of the increase in impermeable area from the OnSS will be attenuated and discharged at a controlled rate, in consultation with the LLFA and Environment Agency.

7.4.1.3 The Onshore Infrastructure Drainage Strategy will be developed according to the principles of the SuDS discharge hierarchy (Co19 and Co191). Generally, the aim will be to discharge surface water runoff as high up the following hierarchy of drainage options as reasonably practicable:

i) into the ground (infiltration);
ii) to a surface water body;
iii) to a surface water sewer, highway drain or another drainage system; or
iv) to a combined sewer.

7.4.1.4 The final impermeable areas of the OnSS are not yet defined; however sufficient storage will be provided to attenuate surface water and discharge at a controlled rate during surface water events. The volume and location of the attenuation will be detailed within the Onshore Infrastructure Drainage Strategy (Co19), which will be based on the outline Onshore Infrastructure Drainage Strategy (**Volume F2, Chapter 6: Outline Onshore Infrastructure Drainage Strategy**) (post DCO consent). Attenuation features will be required to restrict the surface water runoff to the existing 1 in 1 year rate for a 1 in 100 year rainfall event plus climate change.

7.4.1.5 Drainage systems installed for the permanent OnSS will include suitably sized attenuation features (Co191). The proposed location for the attenuation storage is likely to be towards the southeast corner of the permanent OnSS as this is the lowest point of the site (as shown in **Figure 17**, **Figure 18** and **Figure 19**, however the exact position will be confirmed during detailed design, post-consent. Should there be a need to utilise this area to attenuate and store water from the permanent OnSS, it will be sized appropriately to ensure it will store the existing volume of flood water during an event as well as any water arising from the proposed development. As a result, there will be no displacement of flood water as a result of this attenuation feature.

7.4.1.6 The controlled runoff rate will be equivalent to the greenfield runoff rate. The resultant storage / attenuation volume provided will be sufficient to ensure that during the 1 in 100 year event plus an allowance for climate change there will be no increase in runoff from the site. This will include an allowance for the advised 30% increase to allow for future climate change.

7.4.1.7 The full specification for the size, dimensions and location of the attenuation storage and the Onshore Infrastructure Drainage Strategy will be addressed as part of detailed design pre-construction.

8 Flood Risk Management and Mitigation Measures

8.1.1.1 There is always a potential for there to be a residual flood risk to people and property due to the failure of systems and defences. Residual risk will remain after flood management or mitigation measures have been installed. Therefore, this FRA has considered residual flood risk and measures to manage residual flood risk where appropriate.

8.2 Design Mitigation

8.2.1.1 The Hornsea Four Order Limits are primarily located in Flood Zone 1, i.e. outside of Flood Zones 2 and 3 wherever possible, in areas at low risk of flooding from fluvial or tidal sources.

8.2.1.2 At landfall, where the works have the potential to affect the tidal / coastal flood risk, the project proposes carrying out the landfall works using HDD or other trenchless techniques. However, as described in **Volume A1, Chapter 4: Project Description** no geophysical / geotechnical information, of sufficient spatial resolution is currently available to confirm the design of the HDD or trenchless techniques at landfall.

8.2.1.3 During construction, the onshore ECC will be designed such that it will be bounded by parallel drainage channels (one on each side) to intercept drainage within the working corridor. Additional drainage channels will be installed to intercept water from the cable trench.

8.2.1.4 Where water enters the trenches during installation, this will be discharged at a controlled rate into local ditches or drains via temporary interceptor drains. Depending upon the precise location, water from the channels will be infiltrated or discharged into the drainage network (Co14 and Co19).

8.2.1.5 Temporary access tracks have been located where there is an existing opening in hedgerows and trees in use as an existing access, where this has been possible (see Section 4.3.1 in **Volume A4, Annex 3.3: Site Selection and Refinement of the Onshore Infrastructure**). The adoption of this additional design measure aims to limit the potential for an increase in the risk associated with surface water flooding through the use of existing routes, where possible (Co183 and Co197).

8.2.1.6 The permanent access route to the OnSS will be required to pass over an existing watercourse where there is an increased risk of flooding (i.e. partially crossing the Flood Zone 3 extent). In this location the design will include appropriately sized crossings over the watercourse and retain existing ground elevations, wherever possible, to ensure continued floodplain capacity and / or flow conveyance (Co184 and Co185).

8.2.1.7 The permanent OnSS will be designed such that the key infrastructure is located as far as possible within Flood Zone 1. A small section along the southern boundary is located in Flood Zone 3 and this is linked to surface water flood risk. The permanent OnSS infrastructure is likely to be set at the levels outlined in **Section 4.9.3**.

8.2.1.8 Additionally, there is the potential for the construction of the OnSS and associated infrastructure to result in the addition of low permeability surfacing, increasing the rate of

surface water runoff from the site without appropriate mitigation. Therefore, a detailed surface water drainage scheme will be developed to ensure the existing runoff rates to the surrounding water environment are maintained at pre-development rates (Co19 and Co197).

8.2.1.9 Existing land drains both along the onshore ECC and at the OnSS will need to be reinstated (Co14 and Co19) with at least the same capacity as the pre-construction channel to prevent impacts on flood risk (identified during the pre-construction survey secured under Co14 and Co19).

8.3 Flood Warning and Evacuation Plan

8.3.1.1 A flood warning and evacuation plan is a list of steps to be taken in case of a flood, although it can also include steps such as taking out the relevant insurance or using recommended flood mitigation products.

8.3.1.2 Specific flood warning and evacuation plans should be produced for the construction phase of the Landfall, OnSS and the onshore ECC, specifically related to construction works at watercourse crossing locations where personnel or materials may be located, albeit temporarily, within Flood Zones 2 and 3.

8.3.1.3 All personnel using the access routes should be made aware of those access routes which are partially located within Flood Zones 2 and 3, including the permanent access route from the OnSS. Any flood warnings issued for those areas should result in the relevant access routes being cleared of all project personnel and, where possible, all project plant / materials.

8.3.1.4 A site-specific flood warning and evacuation plan should include practical steps for protecting the project, be easy to communicate and consider delegated responsibility, or whether personnel are likely to require additional support during a flood event.

8.3.1.5 The Environment Agency has produced guidance for 'Preparing Businesses for Flooding' (Environment Agency 2015). It provides check lists and supporting guidance for preparing for a flood event. Whilst the project is not of the same scale as those considered within these documents, it is anticipated that the project will require a comprehensive Flood Warning and Evacuation Plan including elements of this guidance which should form the foundation of any flood plan considerations. The following aspects need to be considered:

- A list of important contacts, including Floodline, utilities companies and insurance providers;
- A description or map showing locations of service shut-off points;
- Basic strategies for protecting property, including moving assets to safety where possible, turning off / isolating services and moving to safety; and
- Safe access and egress routes.

8.3.1.6 The Environment Agency provide a free flood alert ("flooding is possible") and warning ("flooding is expected") service. It is recommended that the Flood Warning and Evacuation

Plan (FWEP) considers how receipt of one of these flood alerts or warnings may affect their operations.

8.3.1.7 However, it should be noted that large parts of the onshore ECC are in rural undeveloped areas, that are not covered by flood warnings. Furthermore, it is important to note that flood alerts and warnings are not issued in response to surface water flooding. As such the FWEP will include independent checks alongside any alerts or warnings issued by the Environment Agency. These checks will also account for risks outside of the alerts / warnings in areas that may be at risk from failure of defences (such as a breach). This will enable contractors and site managers to consider how this information will affect planned works, especially in areas in close proximity to key watercourses.

8.3.1.8 During construction, contractors and management should liaise with the LLFA and the Environment Agency so they are aware of any forecast related to heavy rainfall events. The potential for flooding can then be assessed to enable work to stop, especially in areas in close proximity to key watercourses and the site cleared of all personnel in this instance.

8.4 Access and Egress

8.4.1.1 The permanent OnSS area shall be located within Flood Zone 1, and as such any personnel within the OnSS shall be at low risk of flooding from rivers or the sea.

8.4.1.2 Flood risk associated with temporary access routes during construction have been identified in **Section 4.3.5**. The short duration of construction will mitigate any long-term risks and the development of Flood Warning and Evacuation Plans (**Section 8.3**) will reduce the risk during construction to an acceptable level using flood forecasting methods.

8.4.1.3 The one proposed permanent access track for the OnSS, crosses a small area of Flood Zones 2 and 3, associated with an existing watercourse. A review of the Environment Agency mapping and data indicates this may be related to surface water flooding, with appropriate mitigation, such as appropriately sized crossings over watercourses and retention of existing ground elevations, wherever possible, to be included to enable continuation of surface water flow routes (Co184 and Co185).

8.4.1.4 Although the permanent access track for the OnSS is shown to be at surface water flood risk and crosses small areas of Flood Zone 3 the wider area surrounding the permanent OnSS area primarily comprises Flood Zone 1. Therefore, emergency access and egress from the permanent OnSS may be maintained via public footpaths to the wider area for the efficient evacuation of personnel. In addition, once operational the maintenance of the OnSS will be transient in nature i.e. there will be no requirement to remain on site overnight and the site can be evacuated, upon receipt of a warning of heavy rainfall, either via the permanent access track or utilising adjacent public footpaths, prior to flooding occurring.

8.5 Flood risk during Decommissioning

8.5.1.1 The effects of decommissioning will be equal to, or less than those experienced during construction. Project Commitments, management and mitigation measures used for construction will be applicable for decommissioning also, and a decommissioning plan will be produced to include measures for flood risk, pollution prevention, and the avoidance of

ground disturbance, as well as being in line with the latest relevant available guidance (Co127). Decommissioning activities are provided in Section 4.13 of **Volume A1, Chapter 4: Project Description**, and are summarised below.

8.5.2 Landfall

8.5.2.1 To minimise the environmental disturbance during decommissioning at the landfall, the buried cables will be left in place in the ground with the cable ends cut, sealed and securely buried as a precautionary measure. Alternatively, partial removal of the cable may be achieved by pulling the cables back out of the ducts. This may be preferred to recover and recycle the copper and/or aluminium and steel within them.

8.5.2.2 Due to the temporary nature of the decommissioning, the below ground nature of the infrastructure that will be retained and no permanent above ground structures at the landfall there will be no impact on flood risk during decommissioning.

8.5.3 Onshore ECC

8.5.3.1 To minimise the environmental disturbance during decommissioning, the onshore export cables will be left in place in the ground with the cable ends cut, sealed and securely buried as a precautionary measure. The structures of the jointing pits and link boxes will be removed only if it is feasible with minimal environmental disturbance or if their removal is required to return the land to its current agricultural use.

8.5.3.2 Due to the temporary nature of the decommissioning, the below ground nature of the infrastructure that will be retained and no permanent above ground structures there will be no impact on flood risk during decommissioning.

8.5.4 OnSS

8.5.4.1 If complete decommissioning is required, then all the electrical infrastructure will be removed, and any waste arising disposed of in accordance with relevant regulations. Foundations will be broken up and the site reinstated to its original condition or for an alternative use. If partial decommissioning is carried out the flood risk to the onshore substation will remain unchanged to the operational state. If full decommissioning is carried out the flood risk will be in accordance with the baseline flood risk, allowing for any changes related to climate change impacts.

9 Conclusions

9.1.1.1 The landfall is primarily located within Flood Zone 1, at low risk of flooding from fluvial or tidal sources. The cables will be required to pass through Flood Zones 2 and 3. However, as the cables are below ground infrastructure (Co25 and Co28) they will not be at risk from flooding once the use of trenchless technologies, such as HDD, at crossing locations is implemented (Co1). The landfall logistics compound is temporary in nature and therefore would not be subject to the managed coastal retreat proposed for this area.

9.1.1.2 The onshore ECC will pass primarily through Flood Zone 1, with some locations in Flood Zone 2 and 3. Whilst undertaking watercourse crossings the construction areas may be at risk of flooding, as well as posing an increased risk of flooding elsewhere. Therefore, the design related to temporary water crossings will be developed to prevent impoundment and maintain flows (as detailed in **Volume F2, Chapter 2: Outline Code of Construction Practice** (Co124)). Once operational there will be no flood risk posed to the onshore ECC from fluvial, tidal, surface or sewer flooding. A residual risk of flooding from groundwater shall be mitigated using suitable waterproofing of the cables, link boxes and transition joint bays.

9.1.1.3 The permanent OnSS site is primarily located within Flood Zone 1, at low risk of flooding from fluvial sources. The permanent OnSS site is also located primarily within areas of very low and low surface water flood risk. The FRA notes that any risk from fluvial and surface water flooding can be mitigated through the design of the surface water drainage system.

9.1.1.4 During the construction works any temporary damming and re-routeing of watercourses along the onshore ECC will be designed such that the original flow volumes and rates are maintained to ensure flood risk is not increased (as detailed **Volume F2, Chapter 2: Outline Code of Construction Practice** (Co124)).

9.1.1.5 Post-construction, watercourses will be reinstated to pre-construction depths to ensure flood risk is not affected (Co172 and Co175).

10 References

British Geological Survey Geology of Britain Viewer. [Online] Available from: http://mapapps.bgs.ac.uk/geologyofbritain/home.html (Accessed 20/03/2020)

Clear Environmental Consultants (2010). Hull and Haltemprice Catchment Flood Modelling and Alleviation: Cottingham and Orchard Park Flood Alleviation Scheme.

DEFRA (2019). Magic Map. Available at: https://magic.defra.gov.uk/MagicMap.aspx (Accessed 20/03/2020).

East Riding of Yorkshire Council (2010). Strategic Flood Risk Assessment Report. [Online] Available from: https://www.eastriding.gov.uk/environment/planning-and-building-control/planning-policy/strategic-flood-risk-assessment/ (Accessed 20/03/2020)

East Riding of Yorkshire Council (2010). Strategic Flood Risk Assessment Appendix I, Groundwater Emergence Map. [Online] Available from: https://www.eastriding.gov.uk/EasySiteWeb/GatewayLink.aspx?alId=99092

East Riding of Yorkshire Council (2011). Preliminary Flood Risk Assessment Report. [Online] Available from: https://www.eastriding.gov.uk/EasySiteWeb/GatewayLink.aspx?alId=697533 (Accessed 20/03/2020)

East Riding of Yorkshire Council (2015). East Riding Local Plan - Flood Risk Note for the Planning Application Process Report. [Online] Available from: https://www.eastriding.gov.uk/EasySiteWeb/GatewayLink.aspx?alId=457468 (Accessed 20/03/2020)

East Riding of Yorkshire Council (2015). Local Flood Risk Management Strategy Report. [Online] Available from: https://www.eastriding.gov.uk/council/plans-and-policies/other-plans-and-policies-information/flood-risk/local-flood-risk-management-strategy/ (Accessed 20/03/2020)

East Riding of Yorkshire Council (2016). Sustainable Drainage Systems (SuDS) & Surface Water Drainage Requirements For New Development. Design and Maintenance. Combined Planning Note and Standing Advice. [Online] Available from: https://www.eastriding.gov.uk/environment/planning-and-building-control/design-of-surface-water-drainage-systems/ (Accessed 20/03/2020)

Environment Agency (2010). Hull and Coastal Streams Catchment Flood Management Plan (CFMP) Report. [Online] Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/289265/River_Hull_and_Coastal_Streams_Catchment_Flood_Management_Plan.pdf (Accessed 20/03/2020)

Environment Agency (2016). Flood risk assessments: climate change allowances. [Online] Available from: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances (Accessed 20/04/2020)

Environment Agency (undated). Flood map for planning. [Online] Available from: https://flood-map-for-planning.service.gov.uk/ (Accessed 20/03/2020)

Environment Agency (2019). Catchment Data Explorer. [Online] Available from: https://environment.data.gov.uk/catchment-planning/ (Accessed 20/03/2020)

Environment Agency (2019). Long Term Flood Risk Information. [Online] Available from: https://flood-warning-information.service.gov.uk/long-term-flood-risk (Accessed 20/03/2020)

Environment Agency (2020). Flood risk assessments: climate change allowances. [Online] Available from: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances (Accessed 17/03/2020)

Environmental Permitting (Amendment) Regulations 2018, No. 110. Available at: http://www.legislation.gov.uk/uksi/2018/110/contents/made (Accessed 28/06/2019).

Flood and Water Management Act (2010) c.29. Available at: https://www.legislation.gov.uk/ukpga/2010/29/contents (Accessed 20/03/2020).

Humber Estuary Coastal Authorities Group (2010). Flamborough Head to Gibraltar Point

IEMA (2016). Guide to Shaping Quality Development, IEMA Lincoln.

Jacobs (2004). Strategy for Flood and Coastal Erosion Risk Management: Groundwater Flooding Scoping Study (Defra),Ministry of Housing, Communities & Local Government (2012). National Planning Policy Framework. [Online] Available from: https://www.gov.uk/government/publications/national-planning-policy-framework--2/ (Accessed 20/03/2020)

Ministry of Housing, Communities & Local Government (2014). Flood Risk and Coastal Change. [Online] Available from: https://www.gov.uk/guidance/flood-risk-and-coastal-change#site-specific-flood-risk-assessment-all (Accessed 20/03/2020)

Mott MacDonald (2016). National Grid Asset Flood Resilience DRAFT Flood Risk Assessment Creyke Beck 400 kV Substation National Grid Ref: PDD-30744-2-REP-121, dated April 2016

Orsted (2019). Hornsea Project Four Preliminary Environmental Information Report, Volume 3, Chapter 2: Hydrology and Flood Risk https://orstedcdn.azureedge.net/-/media/www/docs/corp/uk/hornsea-project-four/01-formal-consultation/pier/volume-3/peir-volume-3-chapter-2-hydrology-and-flood-risk.ashx?la=en&rev=cfcdb818aad4420aa8d0adc566754323&hash=ADA5A7F4EE484B447631D57831D40F51

Shoreline Management Plan. [Online] Available from: https://www.eastriding.gov.uk/EasySiteWeb/GatewayLink.aspx?alId=128637 (Accessed 20/03/2020)

Town and Country Planning (General Development Procedure) (Amendment) (No. 2) (England) Order 2006. No. 2375. Available at: https://www.legislation.gov.uk/uksi/2006/2375/contents/made (Accessed 28/03/2020).