Hornsea 4

Ørsted

Hornsea Project Four: Preliminary Environmental Information Report (PEIR)

Volume 6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment

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Glossary

Term	Definition
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
Cumulative effects	The combined effect of Hornsea Project Four in combination with the effects from a number of different projects, on the same single receptor/resource.
Cumulative impact	Impacts that result from changes caused by other past, present or reasonably foreseeable actions together with Hornsea Project Four.
Design Envelope	A description of the range of possible elements that make up the Hornsea Project Four design options under consideration, as set out in detail in the project description. This envelope is used to define Hornsea Project Four for Environmental Impact Assessment (EIA) purposes when the exact engineering parameters are not yet known. This is also often referred to as the "Rochdale Envelope" approach.
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.
EIA Directive	European Union Directive 85/337/EEC, as amended by Directives 97/11/EC, 2003/35/EC and 2009/31/EC and then codified by Directive 2011/92/EU of 13 December 2011 (as amended in 2014 by Directive 2014/52/EU.
EIA Regulations	The Infrastructure Planning (Environmental Impact Assessment) Regulations 2009 (as amended).
Environmental Impact Assessment (EIA)	A statutory process by which certain planned projects must be assessed before a formal decision to proceed can be made. It involves the collection and consideration of environmental information, which fulfils the assessment requirements of the EIA Directive and EIA Regulations, including the publication of an Environmental Impact Assessment (EIA) Report.
Environmental Impact Assessment (EIA) Report	A document reporting the findings of the EIA and produced in accordance with the EIA Directive as transposed into UK law by the EIA Regulations.
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.
Export cable corridor (ECC) search area	The broad offshore corridor of seabed (seaward of the MHWS) and land (landward of MHWS) from the Hornsea Project Four array area to the Creyke Beck National Grid substation considered within this Scoping Report, within which the refined ECC corridor will be located.
Habitats Regulations Assessment (HRA)	A process which helps determine likely significant effects and (where appropriate) assesses adverse impacts on the integrity of European conservation sites and Ramsar sites. The process consists of up to four

Term	Definition
	stages of assessment: screening, appropriate assessment, assessment of alternative solutions and assessment of imperative reasons of over-riding public interest (IROPI).
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.
Hornsea Project Four offshore wind farm	The proposed Hornsea Project Four offshore wind farm project; the term covers all elements within the Development Consent Order (i.e. both the offshore and onshore components). Hereafter referred to as Hornsea Four.
Orsted Hornsea Project Four Ltd.	The Applicant of proposed Hornsea Project Four offshore wind farm.

Acronyms

Acronym	Definition
DCO	Development Consent Order
EIA	Environmental Impact Assessment
FRA	Flood Risk Assessment
NPS	National Policy Statement
NSIP	Nationally Significant Infrastructure Project
PEIR	Preliminary Environmental Information Report
PFRA	Preliminary Flood Risk Assessment
PINS	Planning Inspectorate
SFRA	Strategic Flood Risk Assessment
SoCC	Statement of Community Consultation

Units

Unit	Definition
GW	Gigawatt (power)
kV	Kilovolt (electrical potential)
kW	Kilowatt (power)

1 Introduction

1.1 Introduction

1.1.1 Project background

1.1.1.1 Orsted Hornsea Project Four Limited (the Applicant) is proposing to develop the Hornsea Project Four Offshore Wind Farm (hereafter Hornsea Four). Hornsea Four will be located approximately 65 kilometres (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 connection to the electricity transmission network. The Hornsea Four boundary combines the search areas for the onshore and offshore infrastructure.

1.1.1.2 Royal HaskoningDHV was commissioned by the Applicant to undertake a Flood Risk Assessment (FRA) of Hornsea Four to accompany the Hornsea Four Preliminary Environmental Information Report (PEIR) and subsequent Environmental Statement (ES). This FRA is included as an annex to **Volume 3, Chapter 2: Hydrology and Flood Risk**.

1.1.2 Aims and objectives

1.1.2.1 The overall objective 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.

1.1.2.2 The aims of this FRA are:

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

1.2 Methodology

1.2.1.1 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).

1.2.1.2 The 2019 Climate Change Allowance guidance sets out the Environment Agency's (EA) recommended climate change allowances for development when considering flood risk and coastal change for planning purposes (Environment Agency, 2016). 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 this FRA.

1.2.1.3 Within the design of the project, several embedded mitigation measures have been included to address flood risk both during construction and once operational. Details of these embedded mitigation measures are included within **Volume 3, Chapter 2: Hydrology and Flood Risk**.

1.2.2 Study Area

1.2.2.1 The Hornsea Four Onshore Export Cable Corridor (ECC), which houses the electrical export cables for the project, is approximately 40 kilometres (km) in length from landfall to the Creyke Beck National Grid Electricity Transmission (NGET) substation. Flood risk varies across the project footprint. Therefore, to aid this assessment the onshore project infrastructure has been divided into three key sections associated with the Hornsea Four PEIR boundary ():

- 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 temporary access tracks. These components are located near Fraisthorpe;
- Onshore Export Cable Corridor (ECC) - is the proposed route the onshore export cables will take between landfall and the onshore substation (OnSS). This includes associated temporary access tracks, link boxes, transition joint bays, and temporary logistics compounds; and
- Onshore substation (OnSS) – located to the west of the Creyke Beck National Grid Electricity Transmission (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 connection area) is then required to connect the OnSS to the Creyke Beck NGET substation.

1.2.2.2 The flood risk to the landfall, onshore export cable corridor (ECC) and onshore substation (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 4.2: Landfall.

Onshore ECC (including temporary 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
- Section 4.10: 400 kV onshore ECC area.

1.2.2.3 This FRA is structured to introduce all relevant polices and guidance for FRAs and identify the existing flood risk within the project area. Following the definition of flood hazard, mitigation measures related to the construction of each element is discussed.

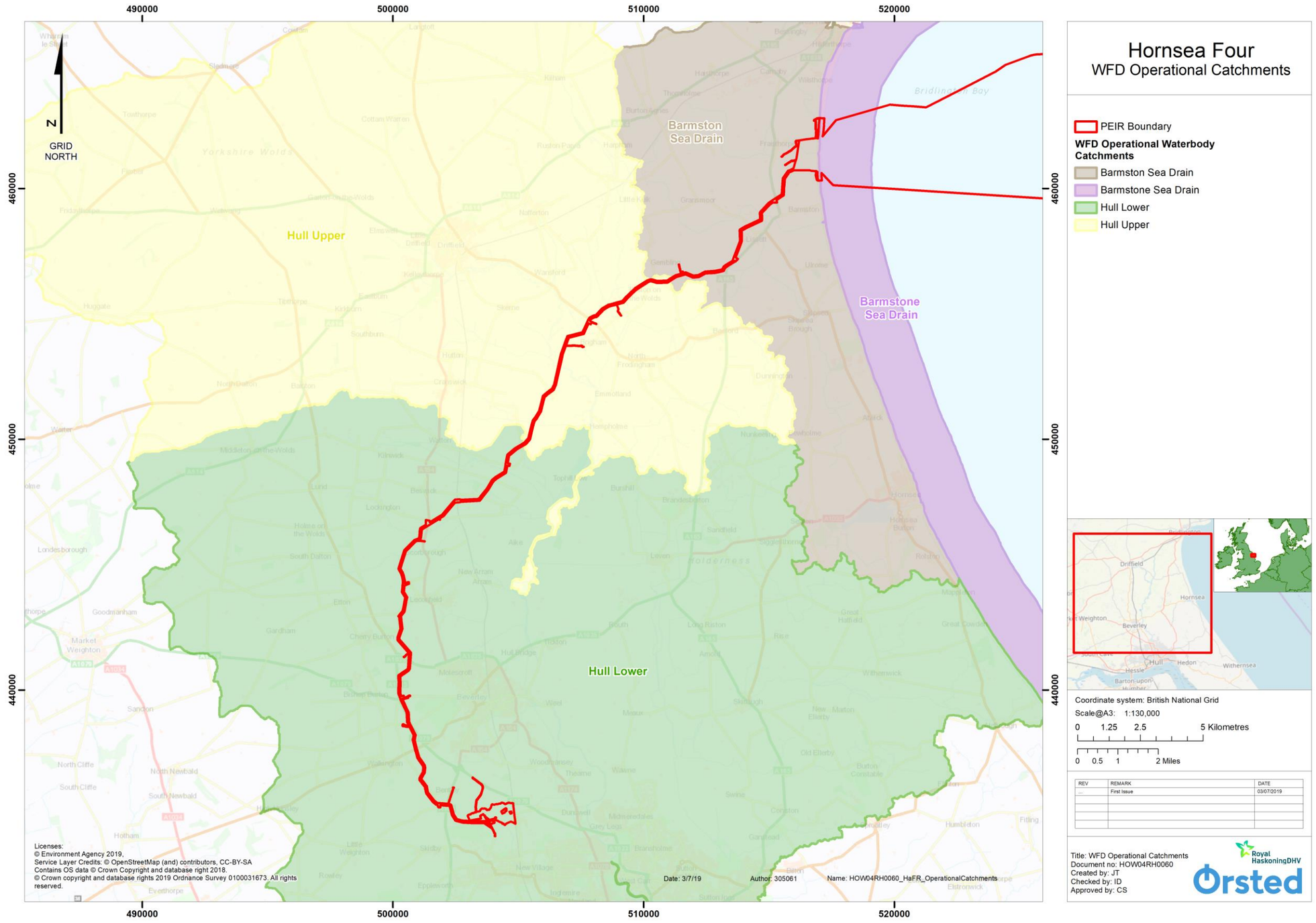


Figure 1: WFD Operational Catchments (Not to Scale). Data Sources.

1.2.2.4 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 EA 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 (beach and coastal) data was provided. It was confirmed within the Product 4 and 5 data delivery from the Environment Agency that no Product 8 (breach analysis) had been undertaken within, or in proximity to the Hornsea Four PEIR boundary.

1.2.2.5 **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 1m, this allows analysis of topography to be conducted and conclusions be drawn regarding potential flow routes of water. Accessible online at: https://environment.data.gov.uk/DefraDataDownload/?Mode=survey.
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.
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 PEIR boundary.
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 PEIR boundary. 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/.
Environment Agency Risk of Flooding from Surface Water	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
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.
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.

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 on the proposed development 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 2019
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,

2019) 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 extracted from Table 1of 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 projects 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. 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 PEIR boundary is entirely located within the unitary authority area of East Riding of Yorkshire Council (ERYC).

2.3.1.2 ERYC is the Lead Local Flood Authority (LLFA) covering the Hornsea Four PEIR boundary. Under the Flood and Water Management Act (UK Parliament, 2010), LLFAs are responsible for managing flooding from surface water, groundwater 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 Internal Drainage Board (IDB) are responsible for maintaining 263 km of watercourses, many of which intersect the Hornsea Four PEIR boundary. The majority of the watercourses that they 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).

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, 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, 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 PEIR boundary, 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 PEIR boundary falls 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 PEIR boundary 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 PEIR boundary is covered by the Hull and Coastal Streams Catchment Flood Management Plan, 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 Beverly and the OnSS are located in the Lower Hull subarea.

2.8.1.3 The CFMP (EA, 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 PEIR boundary is 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, the 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 7th June 2019. Following a review of the modelling report a number of clarifications related to the extent and detail were submitted to ERYC on 1st July 2019. As Hornsea Four is awaiting a response, high level Information relating to the COPFAS modelling has been considered, where appropriate and available within this FRA.

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 PEIR boundary is proposed to cross.

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

2.11.1.3 The East Riding of Yorkshire Council as the LLFA 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.

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

- Environment Agency:
    - **Standard**: 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
- East Riding of Yorkshire Council: Application for Ordinary Watercourse Land Drainage Consent.

2.11.1.6 Upon identification of all Main Rivers and ordinary watercourses to be crossed, application consents shall be made to the appropriate authority. These will be submitted as part of the Development Consent Order (DCO) for Hornsea Four.

2.11.2 Consultation

2.11.2.1 Statutory consultees have been consulted at a series of Expert Technical Panel meetings including, but not limited to, the Environment Agency, ERYC and the Beverley and North Holderness IDB.

2.11.2.2 Consultation responses have been summarised in **Volume 3, 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 This FRA aims to consider all the stakeholder comments in terms of the impact of Hornsea Four on potential flood risk and drainage issues.

2.12 Commitments

2.12.1.1 Hornsea Four has brought forward a number of Commitments (a term used interchangeably with mitigation(s)) which will be adhered to (**Volume 4, Annex 5.2: Commitments Register**), forming embedded mitigation for the project. These are primary design principles intrinsic to the project, which avoid impacts or reduce impacts as far as possible. Further Commitments (adoption of best practice guidance) are embedded as an inherent aspect of the EIA process.

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	Measure Proposed	How the measure will be secured
Co1	Primary: All 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.	DCO Requirement 16 (Code of construction practice)
Co14	Tertiary: A Construction Drainage Scheme will be developed for the temporary construction works, to ensure that existing land drainage is maintained during construction. Specific drainage measures for each area of land will be specified 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, Environment Agency and relevant Internal Drainage Board.	DCO Requirement 12 (Surface and foul water drainage)
Co18	Secondary: HDD entry and exit points will be located at least 9 m away from surface watercourses and the onshore export cable will be installed at least 1.2 m beneath the bed of any watercourses. The optimal clearance depth beneath watercourses will be agreed with the relevant authorities prior to construction. Where Hornsea Four crosses sites of particular sensitivity (e.g. SSSIs) 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.	DCO Requirement 16 (Code of construction practice)
Co19	Tertiary: An Onshore Infrastructure Drainage Strategy will be developed for the permanent operational development along the onshore cable corridor and the onshore substation, and will	DCO Requirement 12

Commitment ID	Measure Proposed	How the measure will be secured
	include measures to ensure that existing land drainage is reinstated and maintained, and measures to limit discharge rates and attenuate flows such that pre-development run-off rates to surrounding land are retained. The Onshore Infrastructure Drainage Strategy will be developed in consultation with the Environment Agency, Lead Local Flood Authority and relevant Internal Drainage Board as appropriate.	(Surface and foul water drainage)
Co25	Primary: The onshore export cable corridor 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 16 (Code of construction practice) DCO Requirement 19 (Restoration of land used temporarily for construction)
Co65	Tertiary: A Site Waste Management Plan (SWMP) will be developed with consideration of the latest relevant available guidance.	DCO Requirement 16 (Code of construction practice)
Co68	Secondary: All logistics compounds will be removed and sites restored to their original condition when construction has been completed.	DCO Requirement 16 (Code of construction practice) DCO Requirement 19 (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	DCO Requirement 16 (Code of

Commitment ID	Measure Proposed	How the measure will be secured
	residential properties, recreational users, and existing land users.	construction practice)
Co127	Secondary: An Onshore Decommissioning Plan will be developed prior to decommissioning. 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 pollution prevention and avoidance of ground disturbance. The Onshore Decommissioning Plan will be in line with the latest relevant available guidance.	DCO Requirement 21 (onshore decommissioning)
Co147	Tertiary: Appropriate liaison will take place with the Internal Drainage Board during construction.	DCO Requirement 16 (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 unavoidable damage will be repaired and reinstated as soon as reasonably practical.	DCO Requirement 16 (Code of construction practice)
Co170	Secondary: Joint bays and link boxes will be minimum 20 m away from main rivers.	DCO Requirement 16 (Code of construction practice)
Co172	Secondary: The bed and banks of watercourses will be instated to their pre-construction condition following the removal of any temporary structures.	DCO Requirement 16 (Code of construction practice)
Co175	Secondary: A pre and post construction condition survey will be undertaken at each of the crossing location on primary and secondary watercourses where infrastructure (e.g. A Bailey bridge) is emplaced upon banks.	DCO Requirement 16 (Code of construction practice)
Co183	Secondary: Where possible the design of all temporary access tracks will replicate or be as consistent with existing ground levels as possible, to limit any effects on future flood risk."	DCO Requirement 16 (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 existing	DCO Requirement 16 (Code of

Commitment ID	Measure Proposed	How the measure will be secured
	ground elevations to ensure continued floodplain capacity and/or flow conveyance, where possible.	construction practice)

3 Baseline Environment

3.1 Existing surface water drainage system

3.1.1.1 The Hornsea Four PEIR boundary will primarily be 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 PEIR boundary as Chalk, overlain by superficial deposits of Devensian till (diamicton), head, sand and gravel, silt and sand alluvium, and clay throughout.

3.2.1.2 Regionally, the principal groundwater body underlying the majority of the Hornsea Four PEIR boundary 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 PEIR boundary, 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 **Volume 6, 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 PEIR boundary. Appendix I of the Level 1 SFRA (ERYC, 2010) indicates the majority of the Hornsea Four PEIR boundary falls within a groundwater emergence zone, based on the 2004 Defra Groundwater Flooding Scoping Study.

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 ().

The Hornsea Four PEIR boundary is located within three Water Framework Directive (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 square kilometres (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. 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 1.2.2**. 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 7**.

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 Any watercourse that is not classified as a Main River is termed an ordinary watercourse. This covers any streams, drains, ditches and passages through which water flows that do not form the network of Main Rivers, including the IDB maintained watercourses. It is acknowledged that there may be a flood risk associated with 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, Main River, IDB maintained or other ordinary watercourses will be agreed with the relevant stakeholders e.g. third-party asset owners and other statutory consultees. These will be agreed with the Environment Agency, Internal Drainage Board and / or relevant Local Authority, as relevant.

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 cables will take place, and where the landfall logistics compound and transition joints will be located) is situated to the south of Bridlington and includes a stretch of coastline approximately 2.5 km from Fraisthorpe in the north, to Hamilton Hill Road in the south (**Figure 2**). The landfall extends inland between 0.2 and 0.9 km and consists of agricultural land.

4.2.1.2 The techniques used to carry out the landfall works broadly fall in to two categories; open cut installation or trenchless techniques (i.e. HDD). The preference for the project is to carry out the landfall works using HDD. However, as described in **Volume 1, Chapter 4: Project Description** no geophysical / geotechnical information, of sufficient spatial resolution is currently available to confirm the feasibility of HDD at landfall. On this basis, within this FRA it is necessary to consider that the landfall works may be carried out using either HDD or open cut techniques.

4.2.1.3 The acquisition of further geophysical and geotechnical data is not anticipated to conclude until the post-consent and pre-construction phase (earliest construction start date is August 2023). Upon the acquisition of the additional geotechnical information, the technical feasibility of using HDD 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 (EA, 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).

4.2.3.2 Although the landfall is located 1.75 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 through the centre 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 1.75 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 centre of the landfall. Flood Zone 2 and 3 are mapped as extending approximately 20 metres (m) either side 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 (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 landfall located at a ground level of approximately 6.5 m AOD which is approximately 3-4 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. If the cable is brought onshore using trenchless techniques (e.g. Horizontal Directional Drilling (HDD)) there would be no flood risk to the cable as it makes landfall.

4.2.6.6 Should there be a need to bring the cable onshore using open cut techniques then there may be a risk of flooding from the sea. However, appropriate design measures e.g. cofferdams and / or dewatering will be included within the design of the landfall works to ensure the continuation of the coastal defence line such that the potential impact of flooding from the sea is mitigated.

4.2.6.7 Therefore, the landfall is at low risk of flooding from the sea assuming either the use of HDD techniques or open cut installation.

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 some 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 1.2m below ground. 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). 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 (Co19). This is secured in the **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 CoCP, 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 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 some specific and restricted areas at a higher risk of flooding associated with the land in proximity to the 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 (EA, 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 a low risk of flooding associated with tidal / coastal flood risk to the landfall assuming that HDD techniques are utilised. In the event that open cut installation is progressed for the landfall then design measures are proposed to ensure the continuation of the coastal defence line and to mitigate the risk of tidal / coastal flooding.

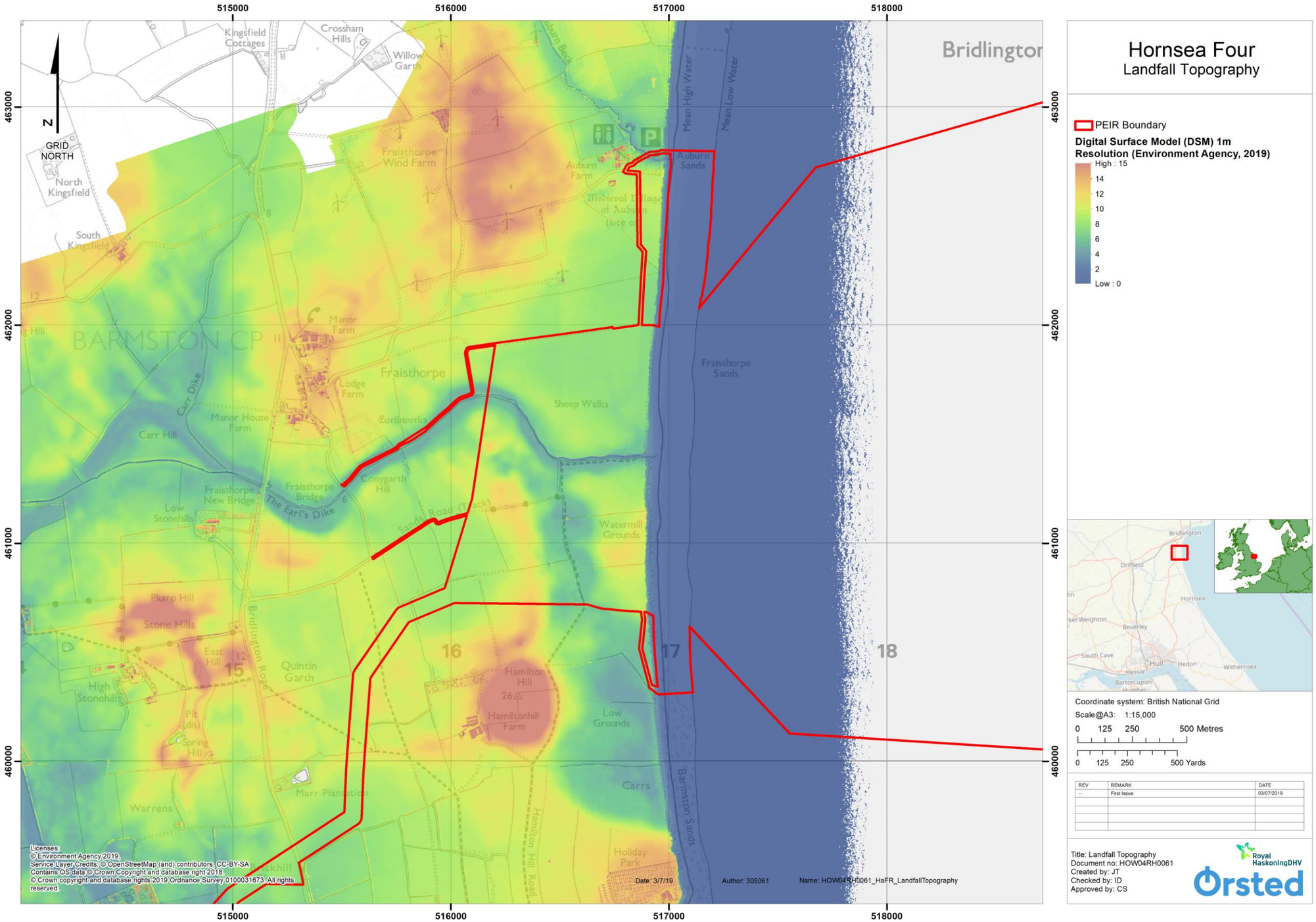


Figure 2: Landfall Topography (Not to Scale).

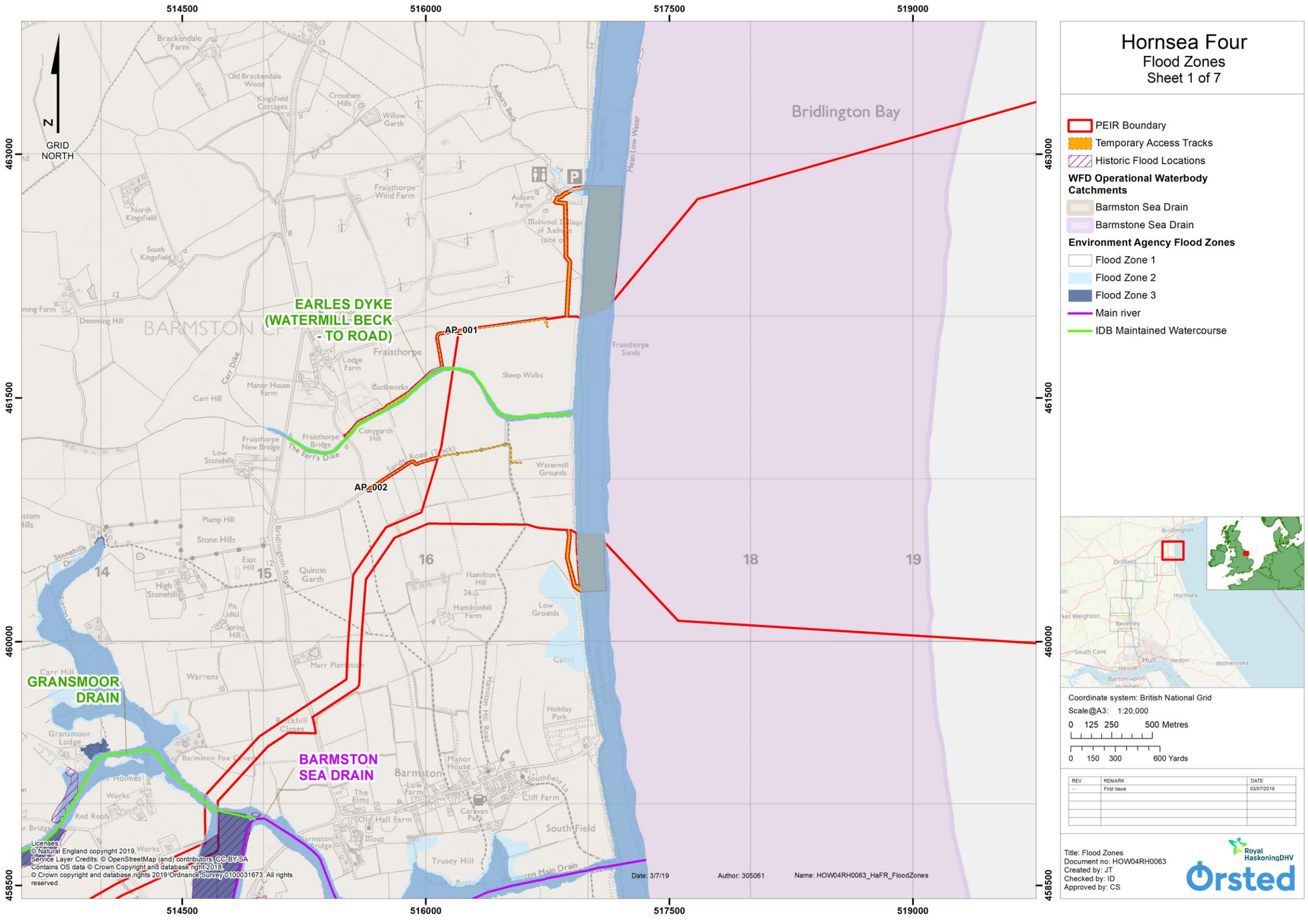
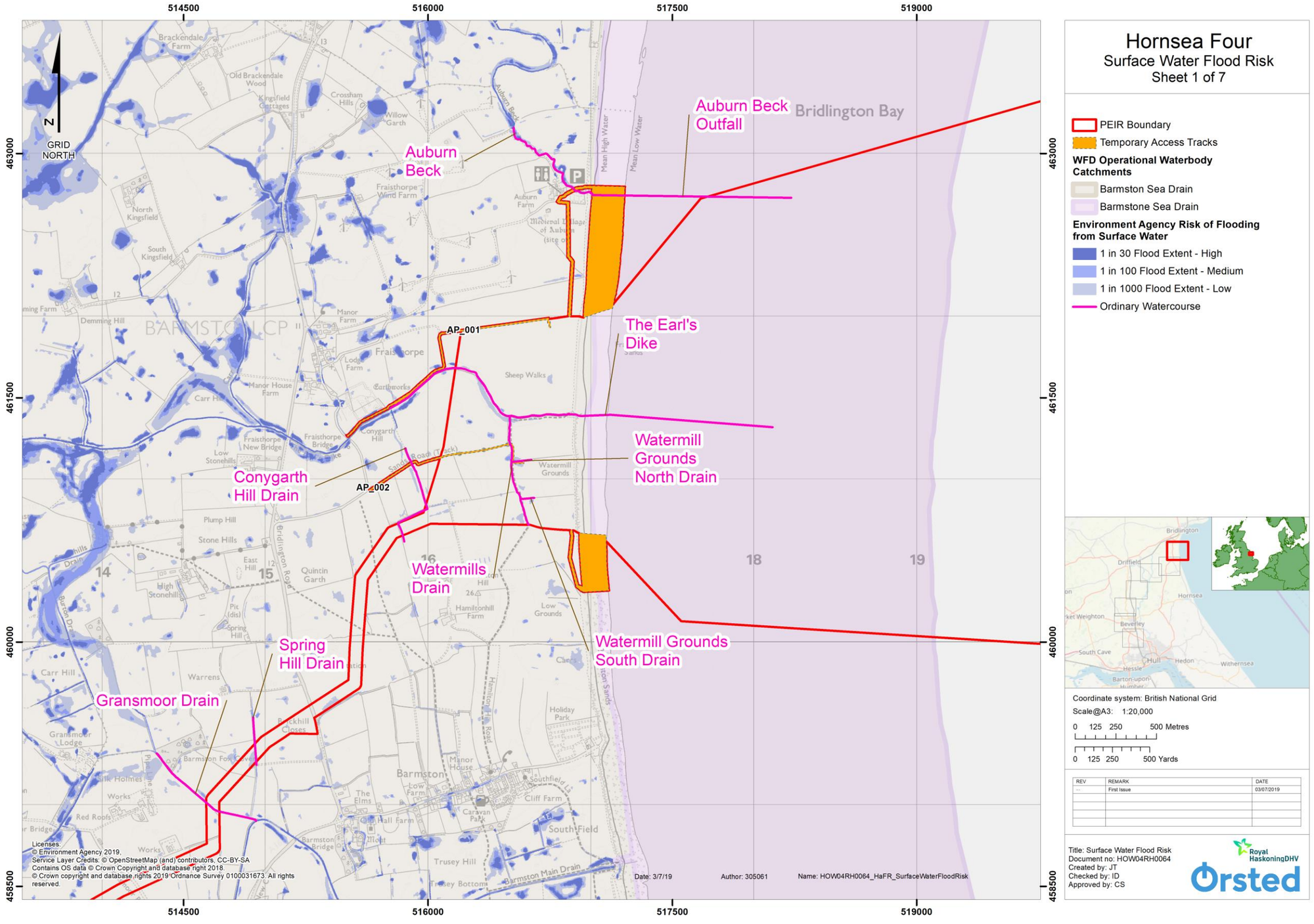


Figure 3: Flood Zones Sheet 1 of 7 (Not to Scale).



Hornsea Four
Surface Water Flood Risk
Sheet 1 of 7

- PEIR Boundary
- Temporary Access Tracks

WFD Operational Waterbody Catchments

- Barmston Sea Drain
- Barmstone Sea Drain

Environment Agency Risk of Flooding from Surface Water

- 1 in 30 Flood Extent - High
- 1 in 100 Flood Extent - Medium
- 1 in 1000 Flood Extent - Low
- Ordinary Watercourse

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

0 125 250 500 Metres

0 125 250 500 Yards

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Title: Surface Water Flood Risk
Document no: HOW04RH0064
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Figure 4: Surface Water Flood Risk Sheet 1 of 7 (Not to Scale).

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 80m and permanent easement of 60m. 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 km 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, however work is expected to progress along the onshore ECC with a typical total active construction duration of three months at any particular location.

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 4, Annex 4.2: Onshore Crossing Schedule**.

4.3.2.3 The haul road will be contained within the 40 km ECC for the full construction duration of 30 months. Main Rivers and IDB maintained watercourses will be crossed used HDD (see Co 1 in **Volume 4, Annex 5.2: Commitments Register**). However, accesses may be required across watercourses to facilitate construction activities (see **Volume 4, 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 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 (see).

WFD Operational Catchment	Main River Crossings	IDB Maintained Watercourse Crossings	Ordinary Watercourse Crossings
Barmston Sea Drain	0	3	3
Upper Hull	5	4	7
Lower Hull	2	4	17

4.3.3 Export Cable Corridor Logistics Compounds

4.3.3.1 Eight onshore ECC logistics compounds, as described in **Volume 1, 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. 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 All onshore ECC logistics compounds are located in Flood Zone 1, with the exception of the proposed logistics compound at Carr Lane). This logistics compound is 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.

4.3.3.3 All onshore ECC logistics compounds are located in areas at 'very low' risk of surface water flooding, with the exception of the York Road compound, which is located off the A1035/1079 roundabout. This is located in the path of a possible surface water flow route and therefore intersects an area at 'High' risk of surface water flooding.

4.3.3.4 This FRA suggests that the York Road logistics compound should either reduce its foot print, or alternatively be relocated to the south of York road, in order to fully mitigate the risk of surface water flooding.

4.3.3.5 It is envisaged that each onshore ECC logistics compound 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	3
Lower Hull	5	15

4.3.4 Trenchless Crossing / HDD Compounds

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

4.3.4.2 HDD compounds will be required along the 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 80m temporary works area of the ECC and 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 9 m away from all Main Rivers, 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 locations of these tracks are associated with river crossings. Where possible the design of

the access tracks should replicate the existing ground levels to limit the impact of flood risk into the future (Co183).

4.3.5.3 The following temporary access tracks intersect Flood Zones 2 or 3:

- The temporary access track (AP_001) adjoining an unnamed road off the A165 (Bridlington Road), to the north of the landfall runs parallel to, and in places intersects, Flood Zone 2 and 3 extents (**Figure 3**);
- The temporary access track (AP_009) to the onshore ECC to the west of Brigham, starting at the River Hull, is entirely located within Flood Zone 3 (**Figure 7**);
- The temporary access track (AP_016) to the onshore ECC west of the A164 (Beverly Road) intersects small areas of Flood Zone 3 (**Figure 11**);
- The temporary access track (AP_018) to the onshore ECC east of Miles Lane is entirely located in Flood Zone 3 (**Figure 11**);
- The temporary access track (AP_026) to the onshore ECC that runs parallel to the A164 crosses an area of Flood Zone 3 (**Figure 13**);
- The temporary access track (AP_025) to the OnSS that runs off the A1079 crosses an area of Flood Zone 3 (**Figure 13**);
- The temporary access track (AP_031) to the OnSS that runs west from Park Lane crosses an area of Flood Zone 3 (**Figure 13**).

4.3.5.4 All temporary access tracks follow existing lanes or tracks where they have been possible to use. 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 routes will be removed and the land reinstated.

4.3.5.5 Flood risk to these temporary access routes will need to be considered during construction and management measures will be included within the Code of Construction Practice (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.

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', 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 4.2**). 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 **Volume 6, Annex 1.1: Land Quality Preliminary Risk Assessment**.

4.4.7.2 The Level 1 SFRA (ERYC, 2010) identifies that a large proportion of the ERYC 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. 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 1.2m below ground (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 (Co19).

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 Co19, and to be implemented during the construction phase, through the development of an appropriate CoCP (Co124), so as to 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 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 6** 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

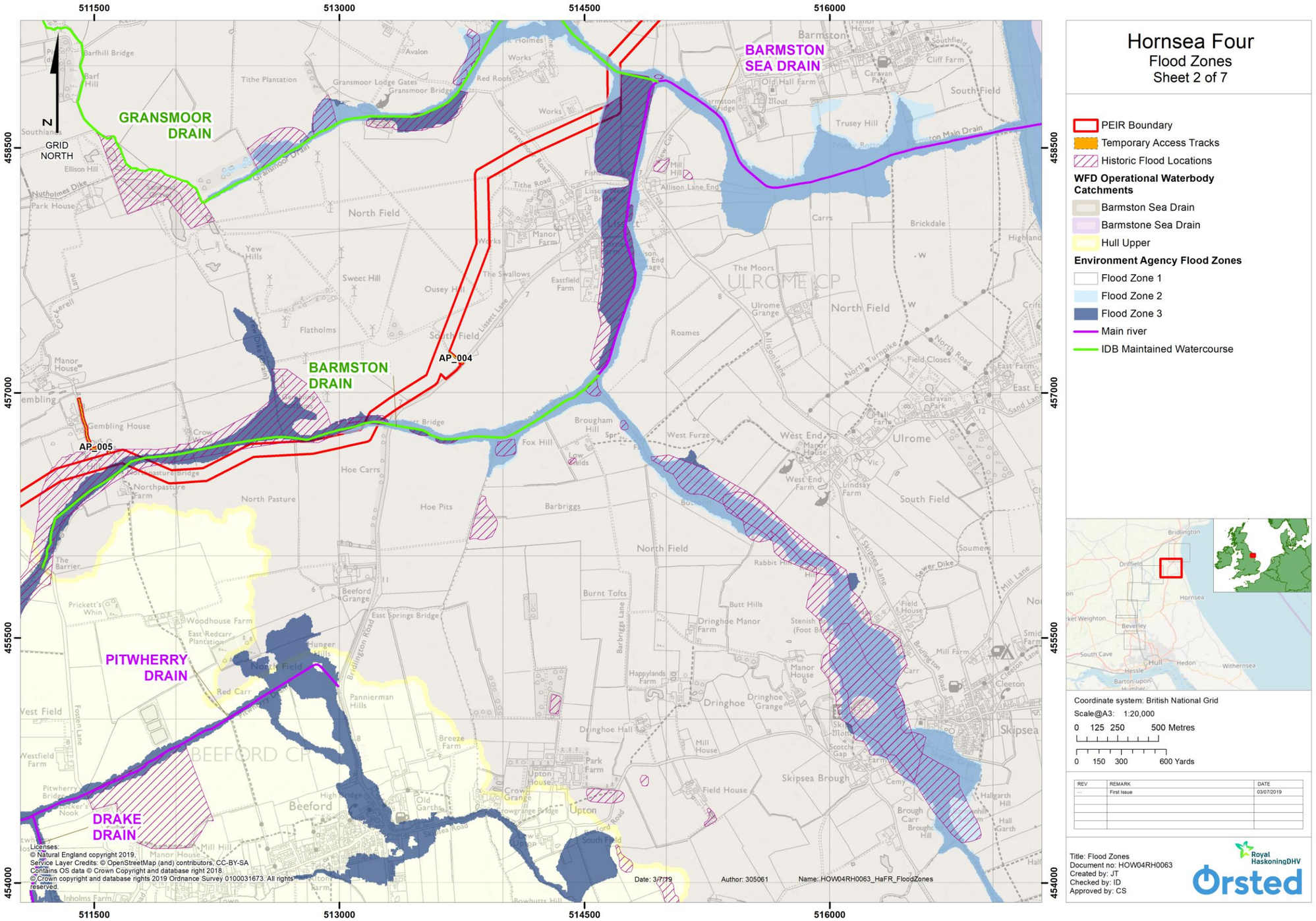
4.4.10.1 Flooding from reservoirs is defined based on the implications of a large uncontrolled release of water from registered reservoirs i.e. greater than 25,000m^3. The Environment Agency Flood Risk from Reservoirs map shows the site is not at risk of reservoir flooding (Environment Agency, 2019).

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 once operational as it will be located within sealed ducts. There is a high level of flood risk associated with Main Rivers and 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
Flood Zones
Sheet 2 of 7

- PEIR Boundary
- Temporary Access Tracks
- Historic Flood Locations

WFD Operational Waterbody Catchments

- Barmston Sea Drain
- Barmstone Sea Drain
- Hull Upper

Environment Agency Flood Zones

- Flood Zone 1
- Flood Zone 2
- Flood Zone 3
- Main river
- IDB Maintained Watercourse

Coordinate system: British National Grid
Scale@A3: 1:20,000
0 125 250 500 Metres
0 150 300 600 Yards

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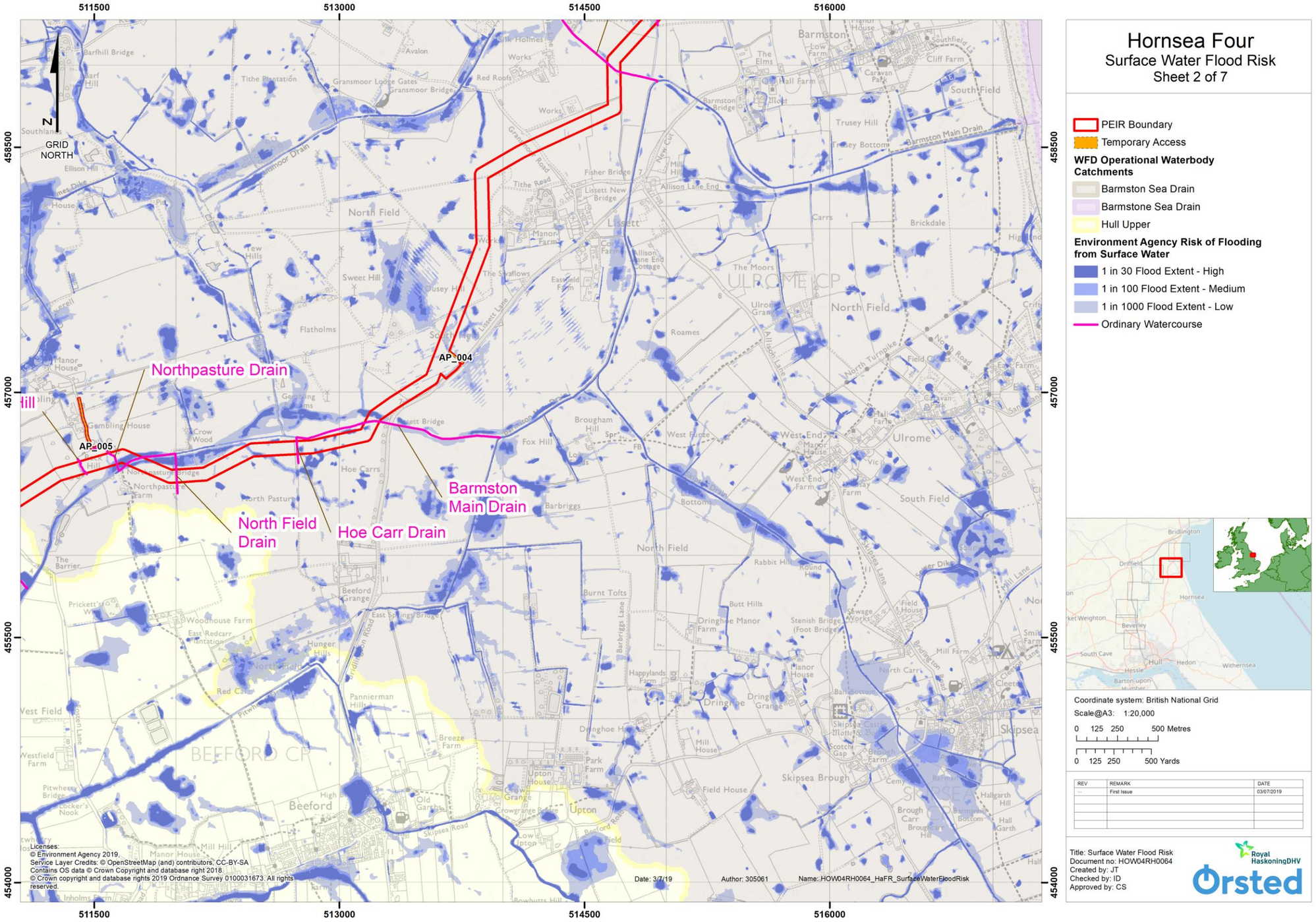
Figure 5: Flood Zones Sheet 2 of 7 (Not to Scale).



Hornsea Four
Surface Water Flood Risk
Sheet 2 of 7

- PEIR Boundary
- Temporary Access

WFD Operational Waterbody Catchments

- Barmston Sea Drain
- Barmstone Sea Drain
- Hull Upper

Environment Agency Risk of Flooding from Surface Water

- 1 in 30 Flood Extent - High
- 1 in 100 Flood Extent - Medium
- 1 in 1000 Flood Extent - Low
- Ordinary Watercourse

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

0 125 250 500 Metres

0 125 250 500 Yards

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Figure 6: Surface Water Flood Risk Sheet 2 of 7 (Not to Scale).

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 Product 4 data provided by the Environment Agency 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 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.

4.5.2.3 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:

- 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**);
- A 2.1 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**);

- A 225 m length of the onshore ECC to the west of Rotsea, associated with the Rotsea Drain IDB Watercourse ID017 (Figure 8).

- A 75 m length of the onshore ECC to the south of Rotsea, associated with the Scruf 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 cable, transition joint bays and link boxes sealed (Co25 and Co28) from water egress.

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;
- Driffeld 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 and Co28) 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.

4.5.7.2 The Level 1 SFRA (ERYC, 2010) identifies that a large proportion of the ERYC 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. 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). Furthermore, any water flowing into the trenches during the construction period will be discharged into local ditches or drains via temporary interceptor drains (Co19).

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 Co19, and to be implemented during the construction phase, through the development of an appropriate CoCP (Co124), so as to 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 3.7 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 6** 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 once operational 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 a risk of fluvial flooding associated with Main Rivers and IDB maintained watercourses. However, for IDB maintained watercourses this risk is limited to where the onshore ECC crosses over the IDB maintained watercourse.

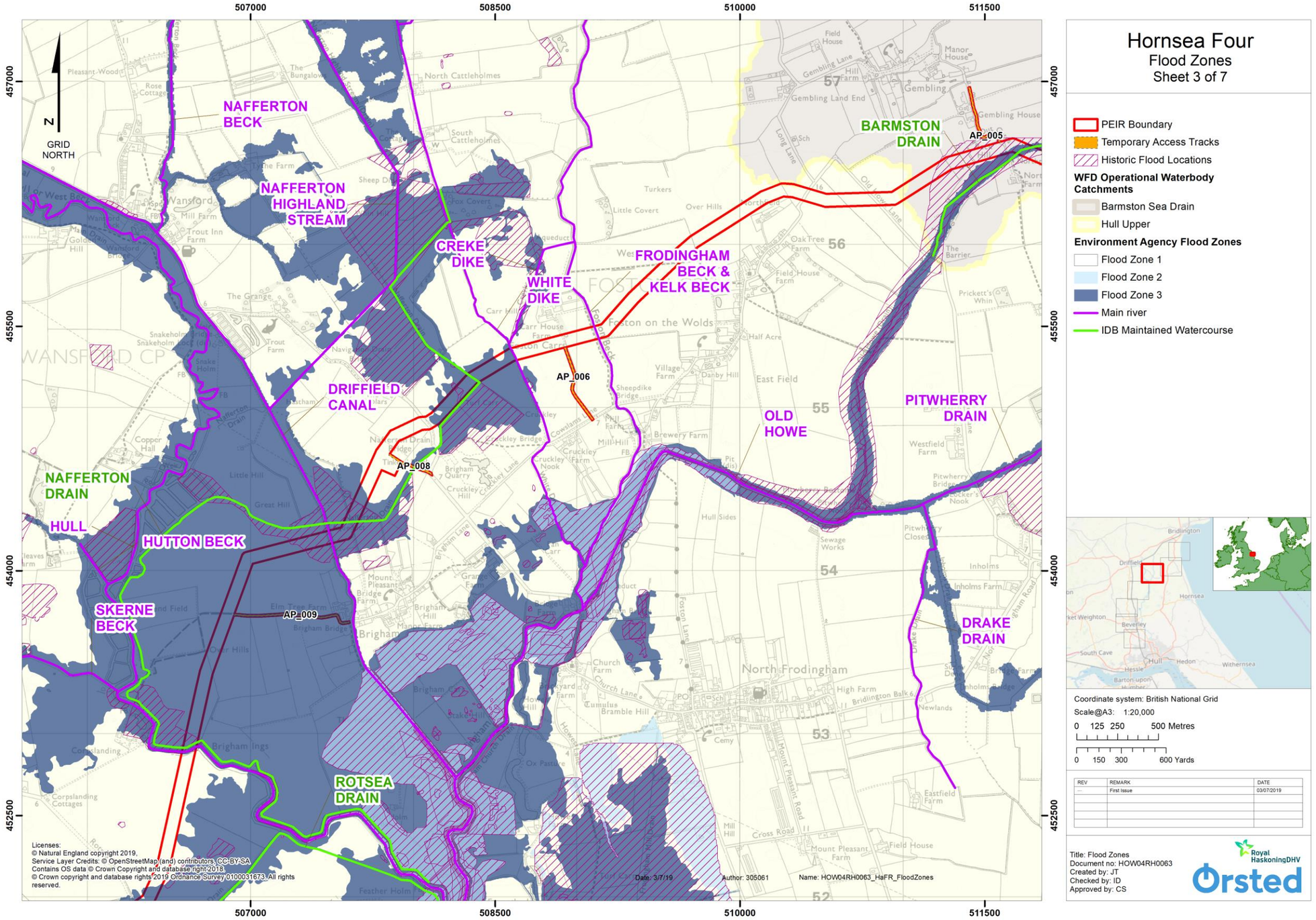


Figure 7: Flood Zones Sheet 3 of 7 (Not to Scale).

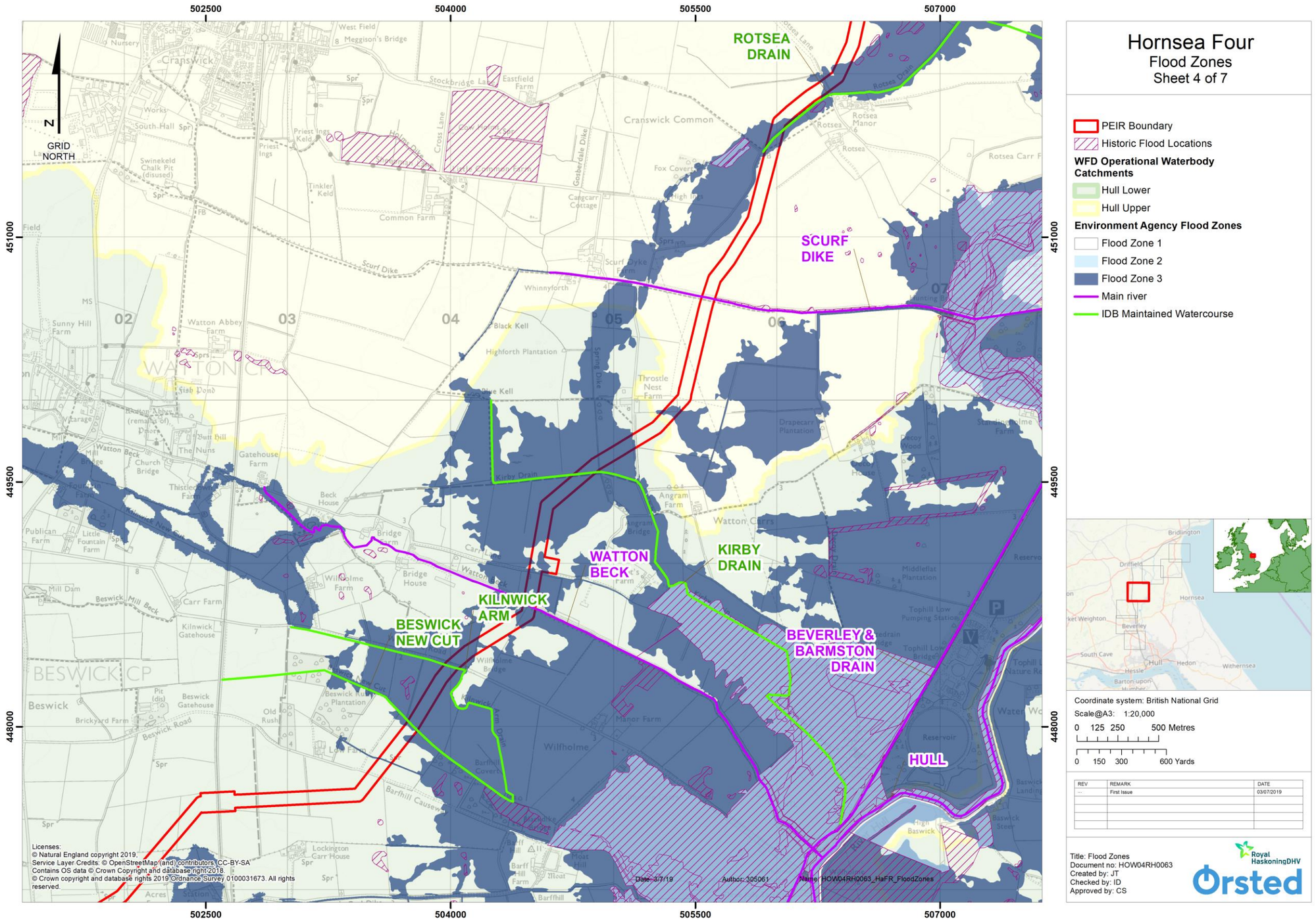
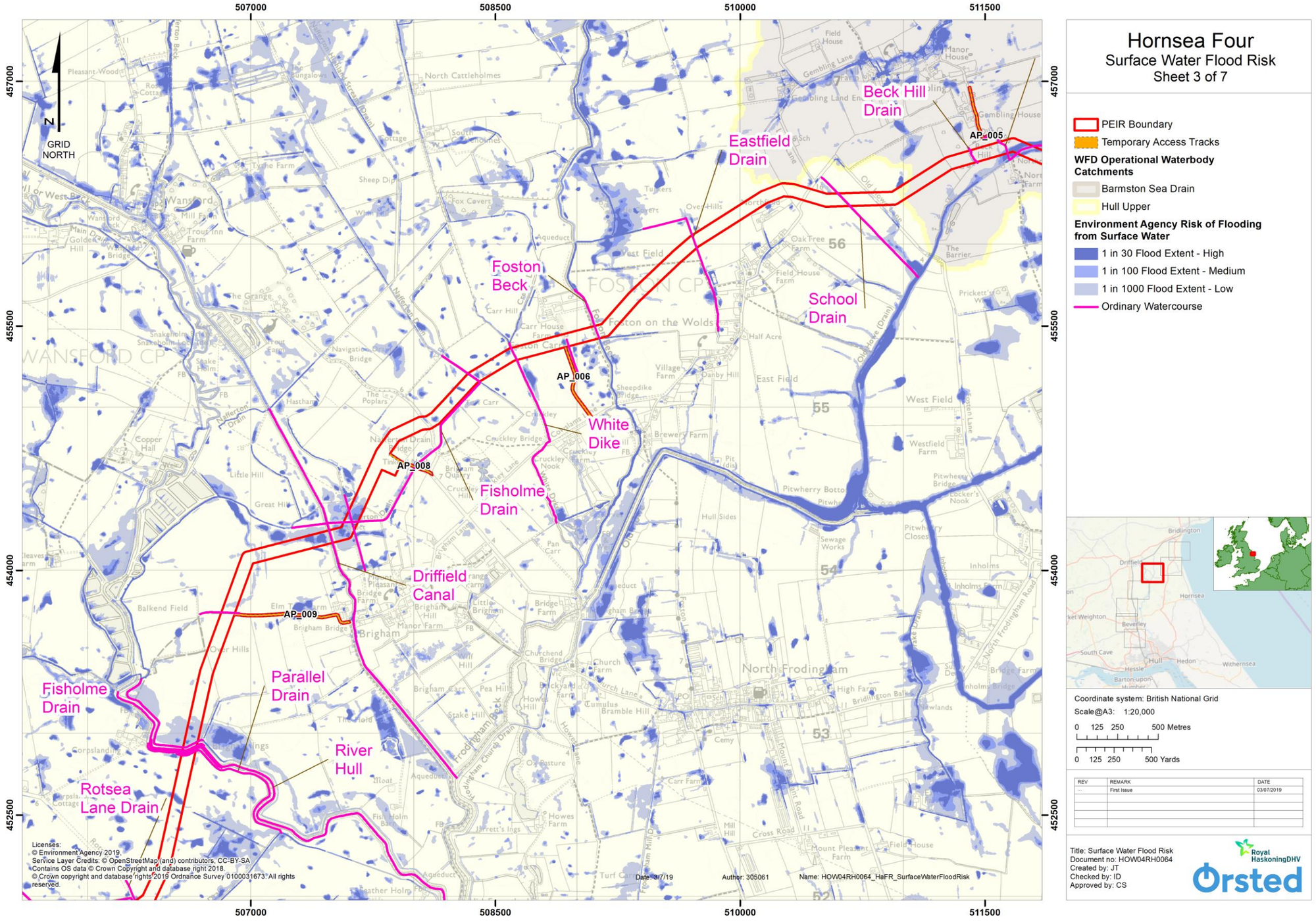


Figure 8: Flood Zones Sheet 4 of 7 (Not to Scale).



Hornsea Four
Surface Water Flood Risk
Sheet 3 of 7

- PEIR Boundary
- Temporary Access Tracks

WFD Operational Waterbody Catchments

- Barmston Sea Drain
- Hull Upper

Environment Agency Risk of Flooding from Surface Water

- 1 in 30 Flood Extent - High
- 1 in 100 Flood Extent - Medium
- 1 in 1000 Flood Extent - Low
- Ordinary Watercourse

Coordinate system: British National Grid
Scale@A3: 1:20,000
0 125 250 500 Metres
0 125 250 500 Yards

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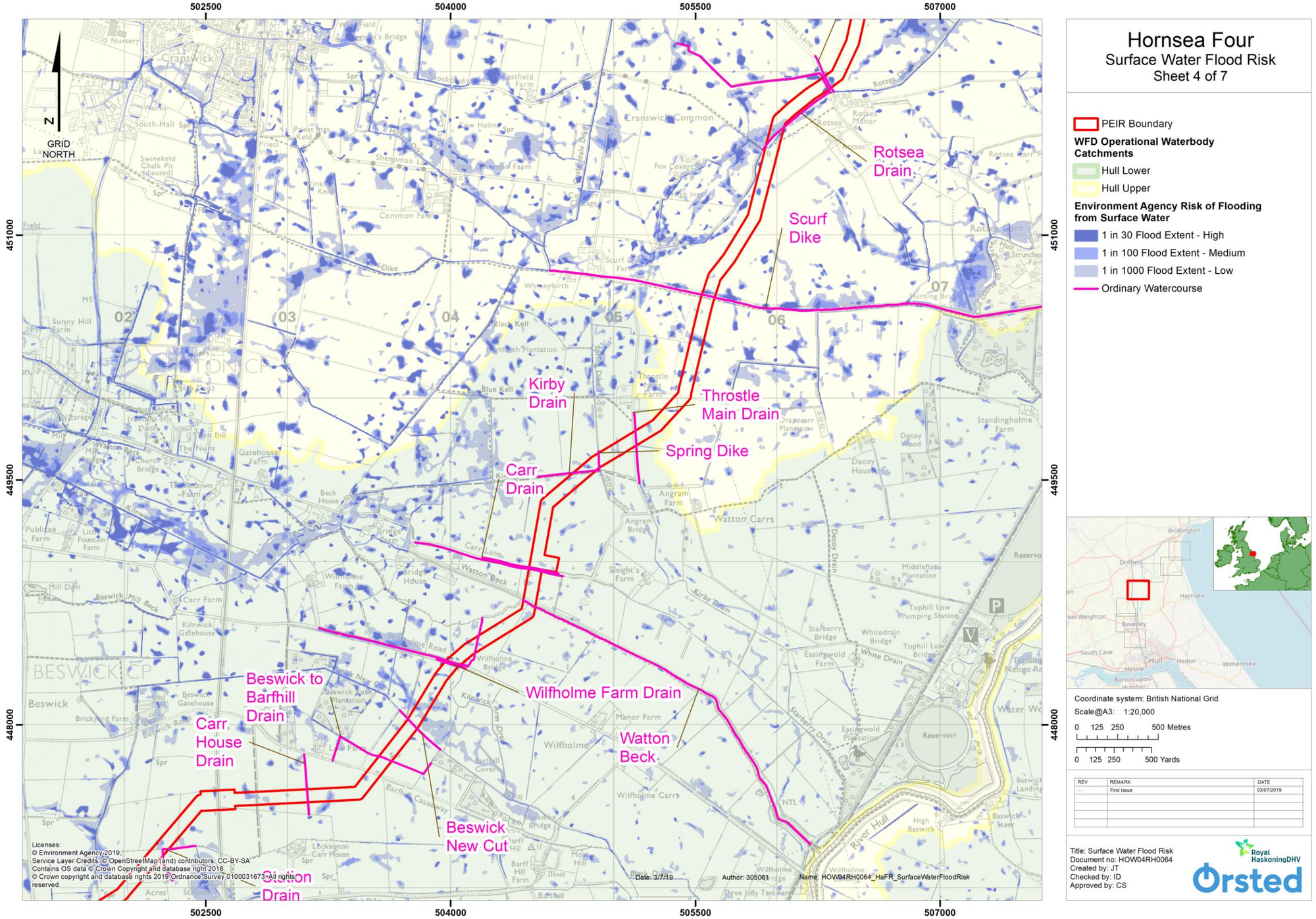
Figure 9: Surface Water Flood Risk Sheet 3 of 7 (Not to Scale).



Hornsea Four
Surface Water Flood Risk
Sheet 4 of 7

PEIR Boundary

WFD Operational Waterbody Catchments

Hull Lower

Hull Upper

Environment Agency Risk of Flooding from Surface Water

1 in 30 Flood Extent - High

1 in 100 Flood Extent - Medium

1 in 1000 Flood Extent - Low

Ordinary Watercourse

Coordinate system: British National Grid

Scale@A3: 1:20,000

0 125 250 500 Metres

0 125 250 500 Yards

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Figure 10: Surface Water Flood Risk Sheet 4 of 7 (Not to Scale).

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 Product 4 data provided by the Environment Agency 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:

- A 2.3 km stretch of the onshore ECC to the east of Beswick 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;
- A 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**). However, this area is identified as benefiting from defences within the Environment Agency Product 4 data;
- 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, transition joint bays and link boxes (Co25 and Co28) sealed from water egress.

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 (Co25 and Co28).

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.

4.6.7.2 The Level 1 SFRA (ERYC, 2010) identifies that a large proportion of the ERYC 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. 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). Furthermore, any water flowing into the trenches during the construction period will be discharged into local ditches or drains via temporary interceptor drains (Co19).

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 an appropriate CoCP (Co124), so as to 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 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 6 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 (EA, 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. 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.

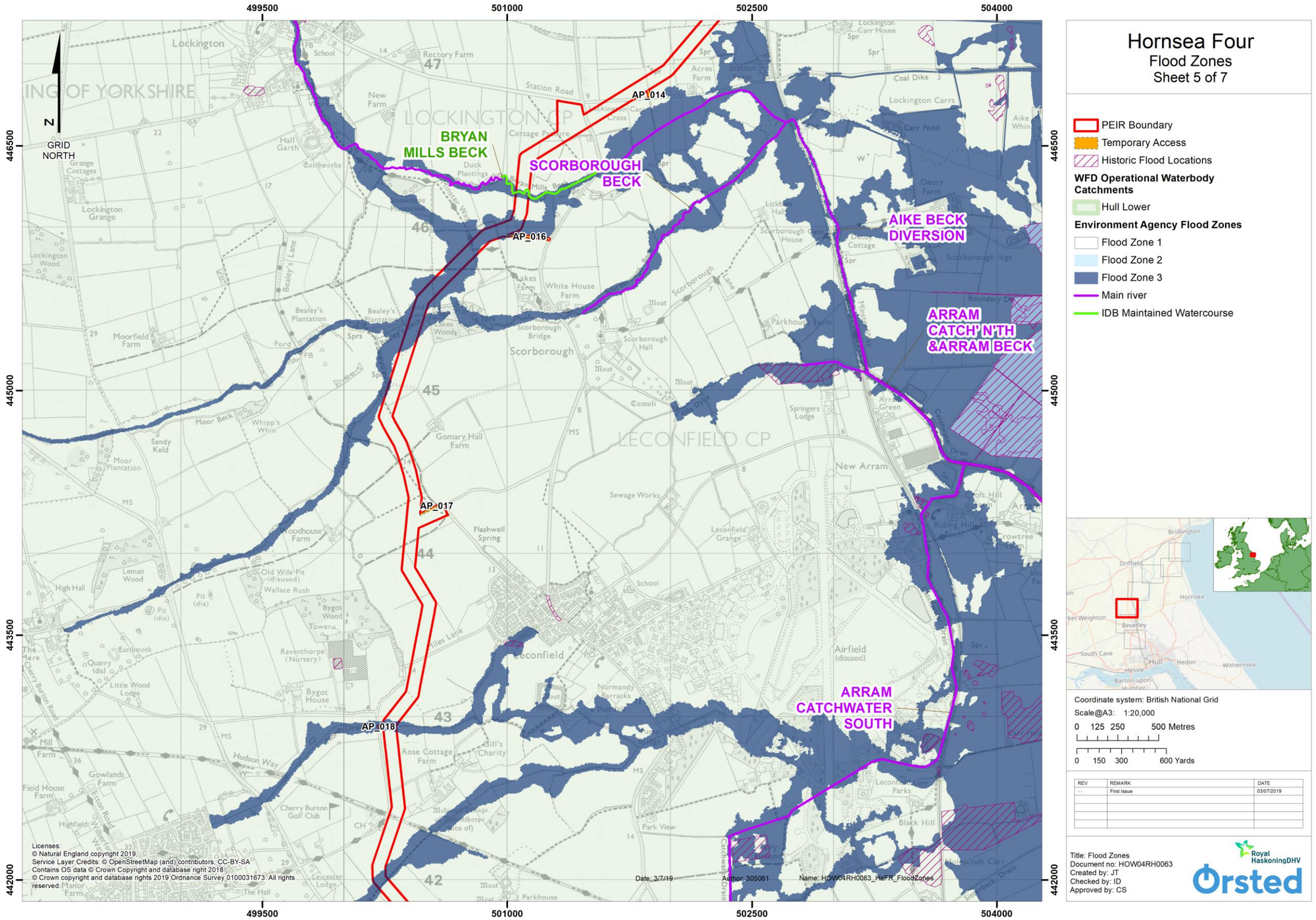


Figure 11: Flood Zones Sheet 5 of 7 (Not to Scale).

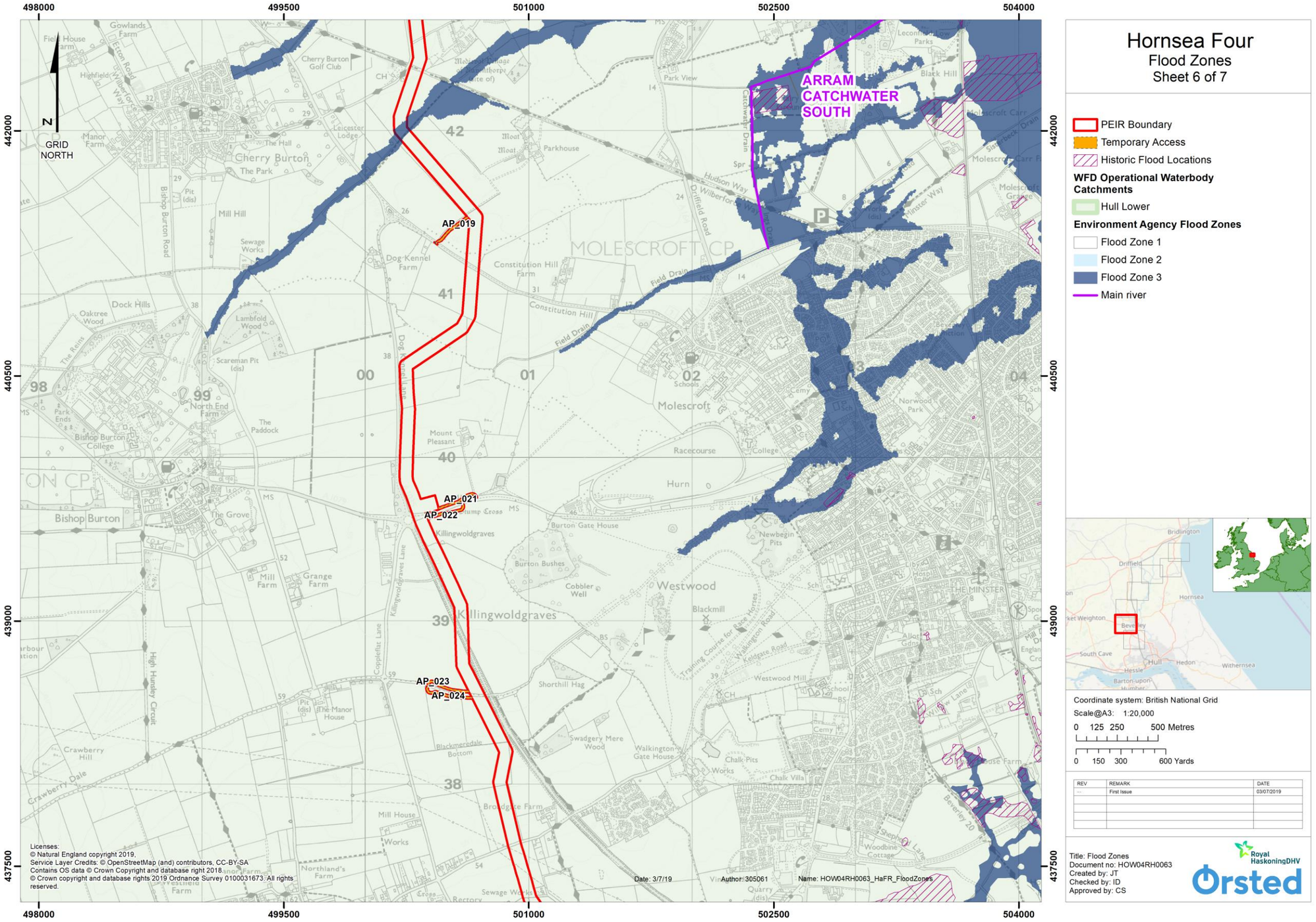


Figure 12: Flood Zones Sheet 6 of 7 (Not to Scale).

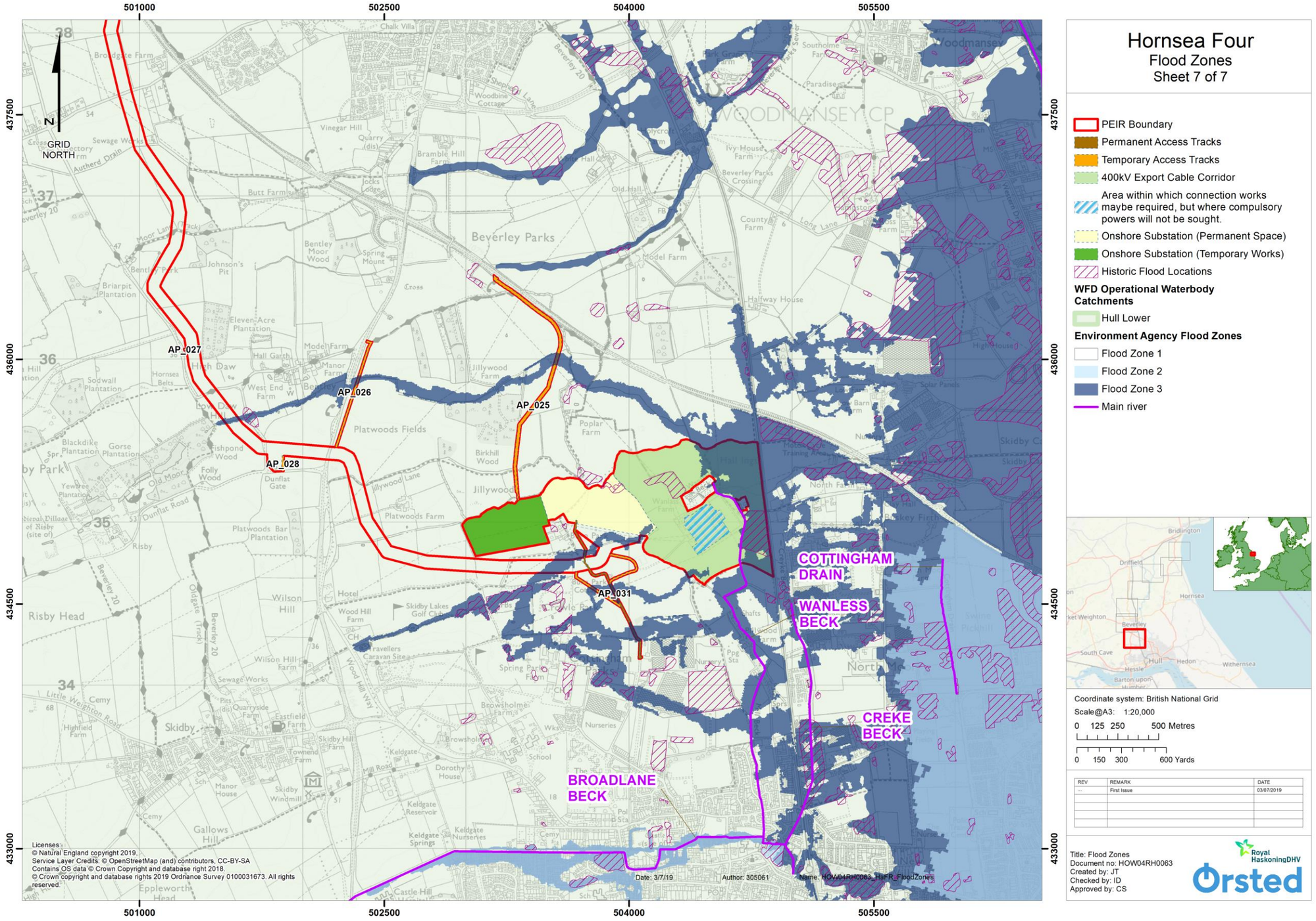
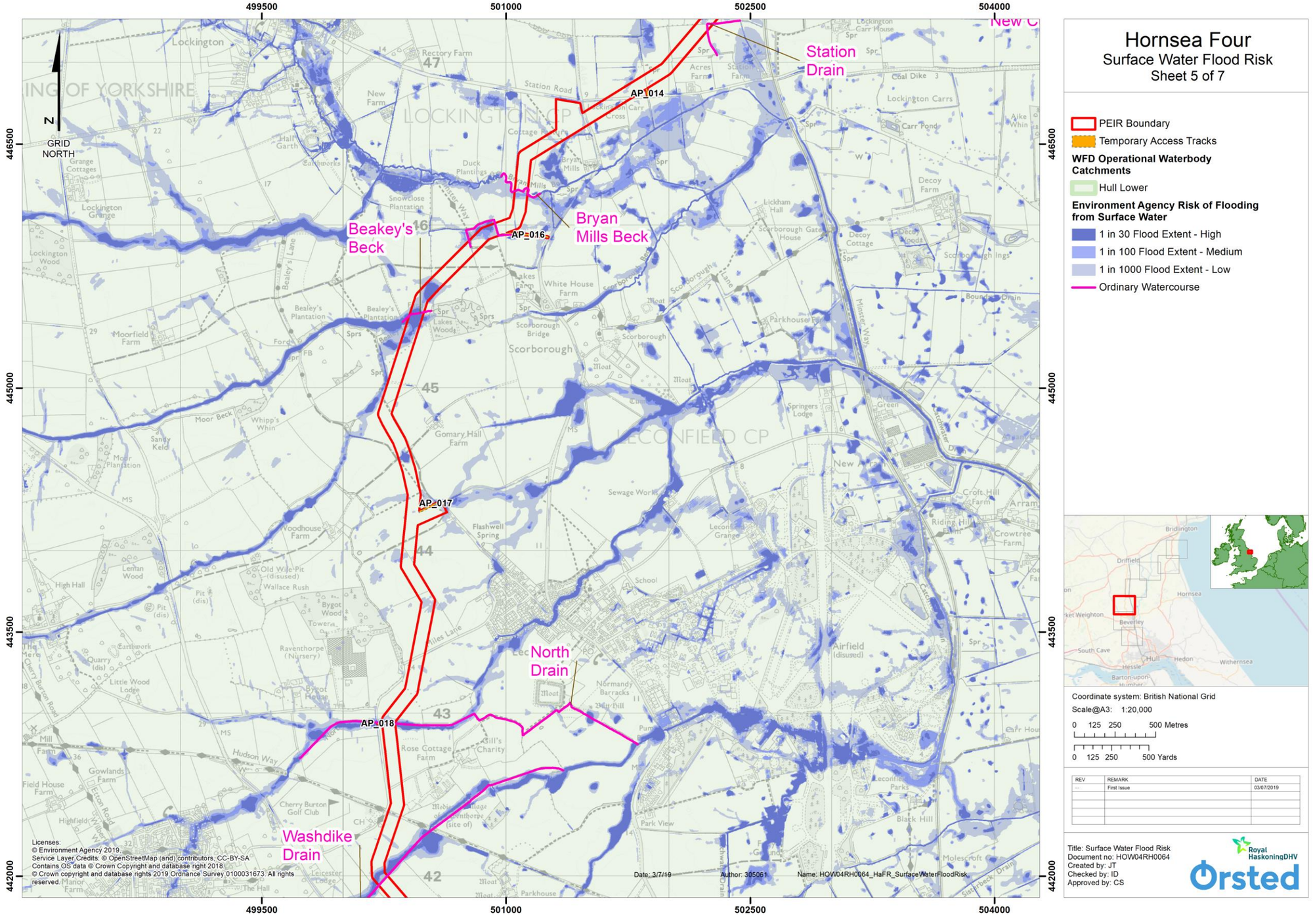


Figure 13: Flood Zones Sheet 7 of 7 (Not to Scale).



Hornsea Four
Surface Water Flood Risk
Sheet 5 of 7

PEIR Boundary
Temporary Access Tracks

WFD Operational Waterbody Catchments

Hull Lower

Environment Agency Risk of Flooding from Surface Water

1 in 30 Flood Extent - High
1 in 100 Flood Extent - Medium
1 in 1000 Flood Extent - Low
Ordinary Watercourse

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

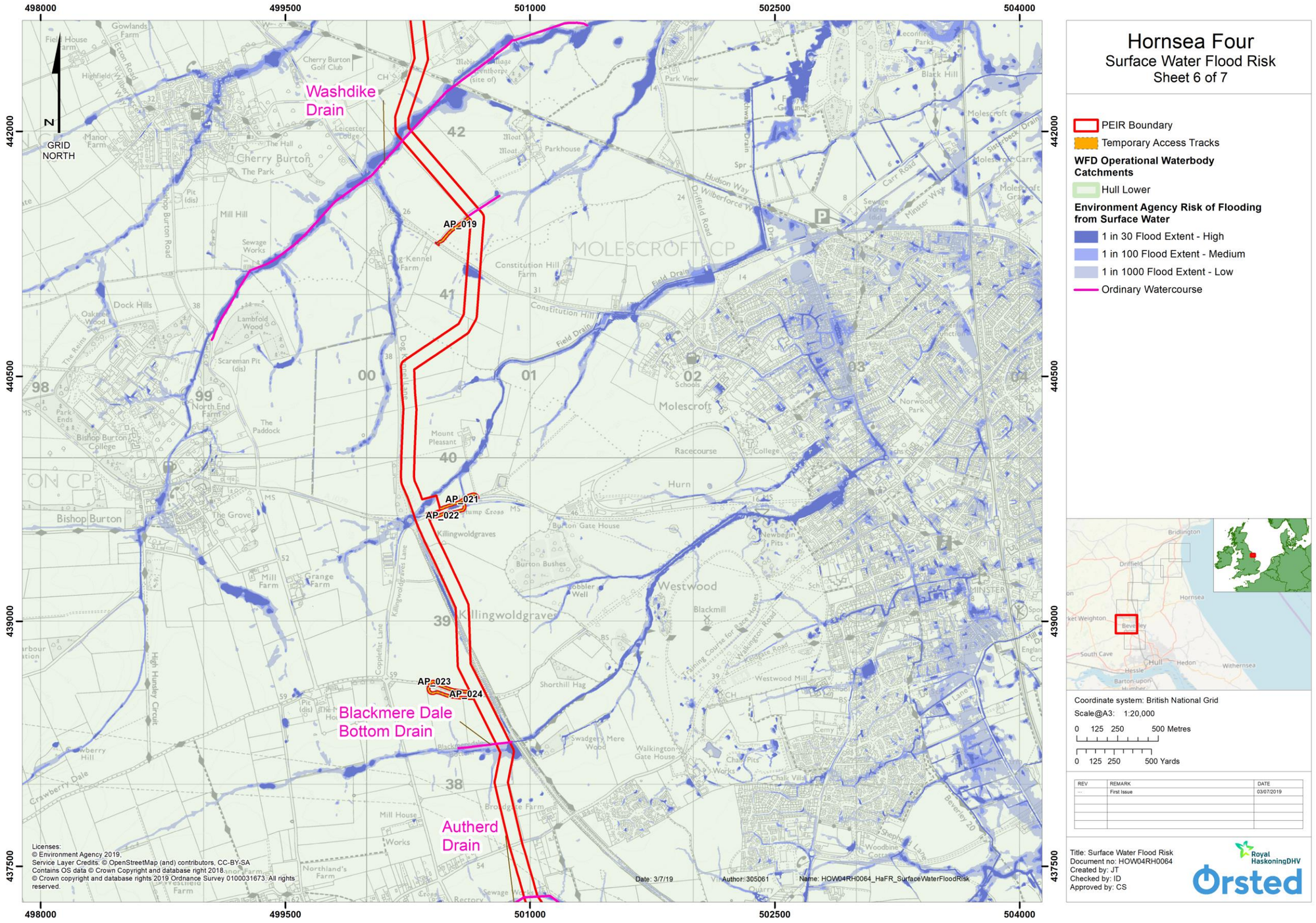
0 125 250 500 Metres
0 125 250 500 Yards

REV	REMARK	DATE
---	First Issue	03/07/2019

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

Royal HaskoningDHV
Ørsted

Figure 14: Surface Water Flood Risk Sheet 5 of 7 (Not to Scale).



Hornsea Four
Surface Water Flood Risk
Sheet 6 of 7

- PEIR Boundary
- Temporary Access Tracks

WFD Operational Waterbody Catchments

- Hull Lower

Environment Agency Risk of Flooding from Surface Water

- 1 in 30 Flood Extent - High
- 1 in 100 Flood Extent - Medium
- 1 in 1000 Flood Extent - Low
- Ordinary Watercourse

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

0 125 250 500 Metres

0 125 250 500 Yards

REV	REMARK	DATE
---	First Issue	03/07/2019

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

Royal HaskoningDHV

Ørsted

Figure 15: Surface Water Flood Risk Sheet 6 of 7 (Not to Scale).

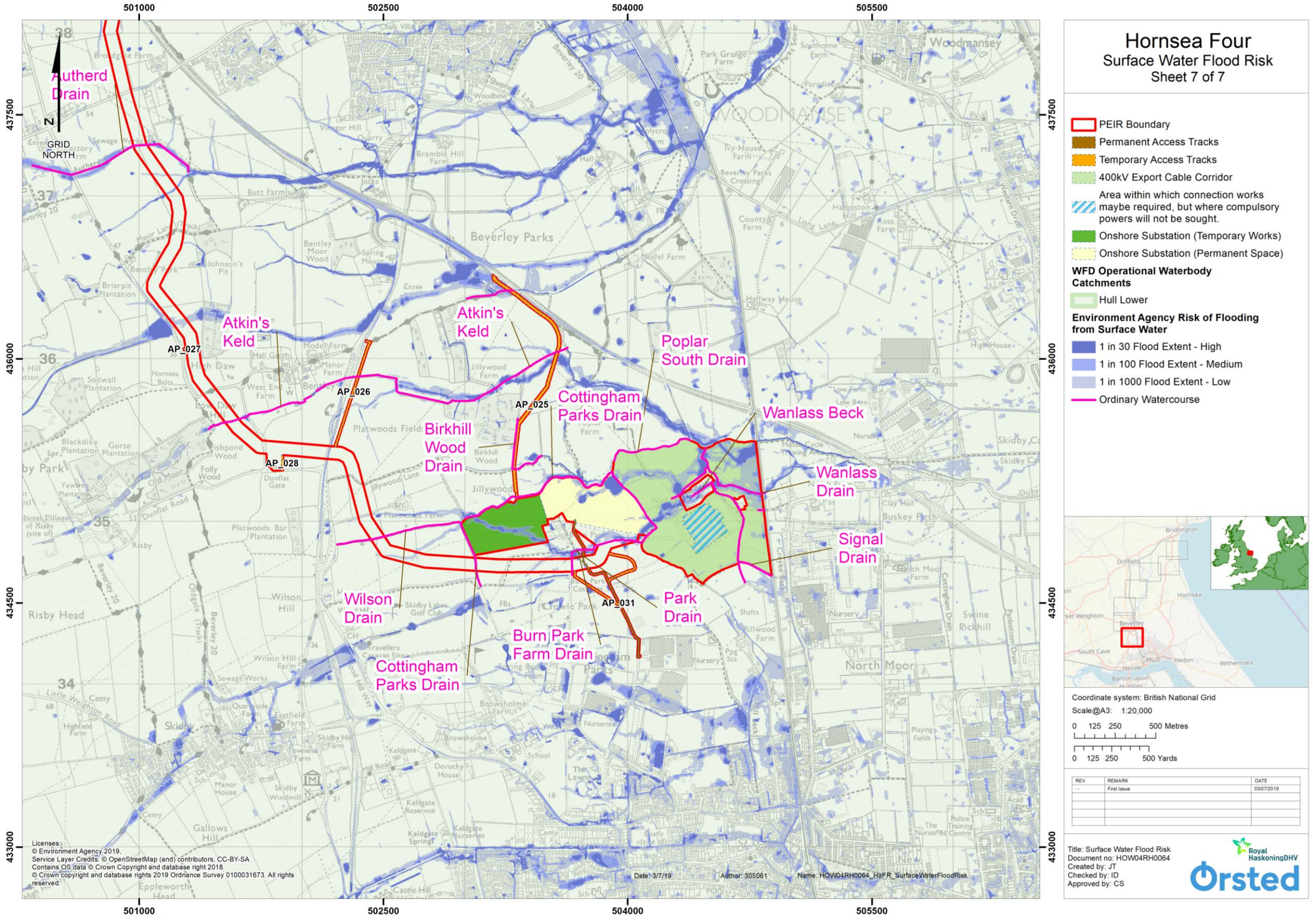


Figure 16: Surface Water Flood Risk Sheet 7 of 7 (Not to Scale).

4.7 Onshore Substation (OnSS) and 400 kV onshore ECC area

4.7.1 Overview of Proposed Activities

4.7.1.1 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 400kV onshore ECC area can be found in **Volume 1, Chapter 4: Project Description**.

4.7.1.2 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
- **Section 4.10**: 400 kV onshore ECC area.

4.7.1.3 The permanent OnSS is also expected to have permanent operation and maintenance access from the South (Cottingham) using Park Lane Road. Flood risk associated with this access route is discussed in **Section 4.9**.

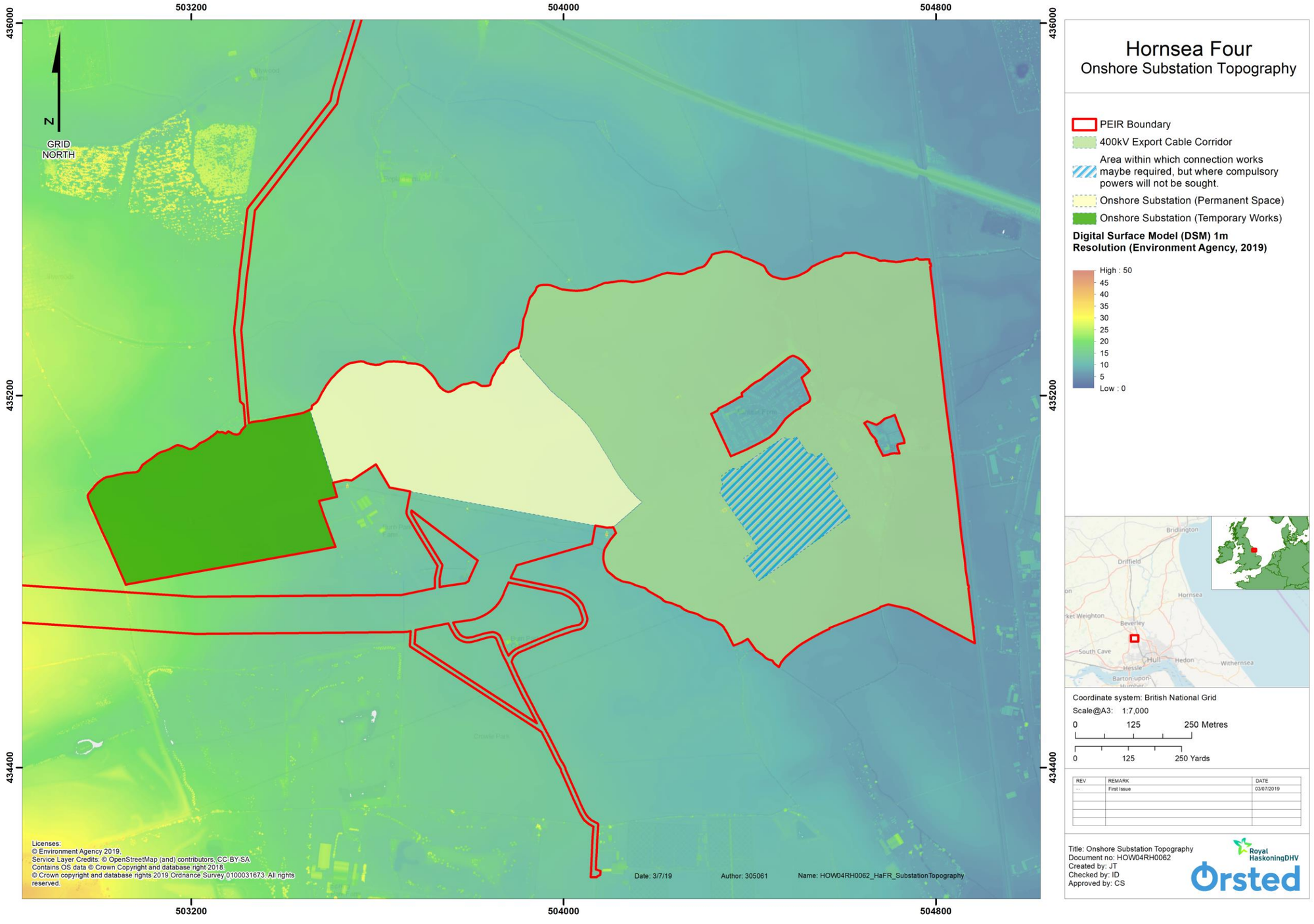


Figure 17: Onshore Substation Topography (Not to Scale).

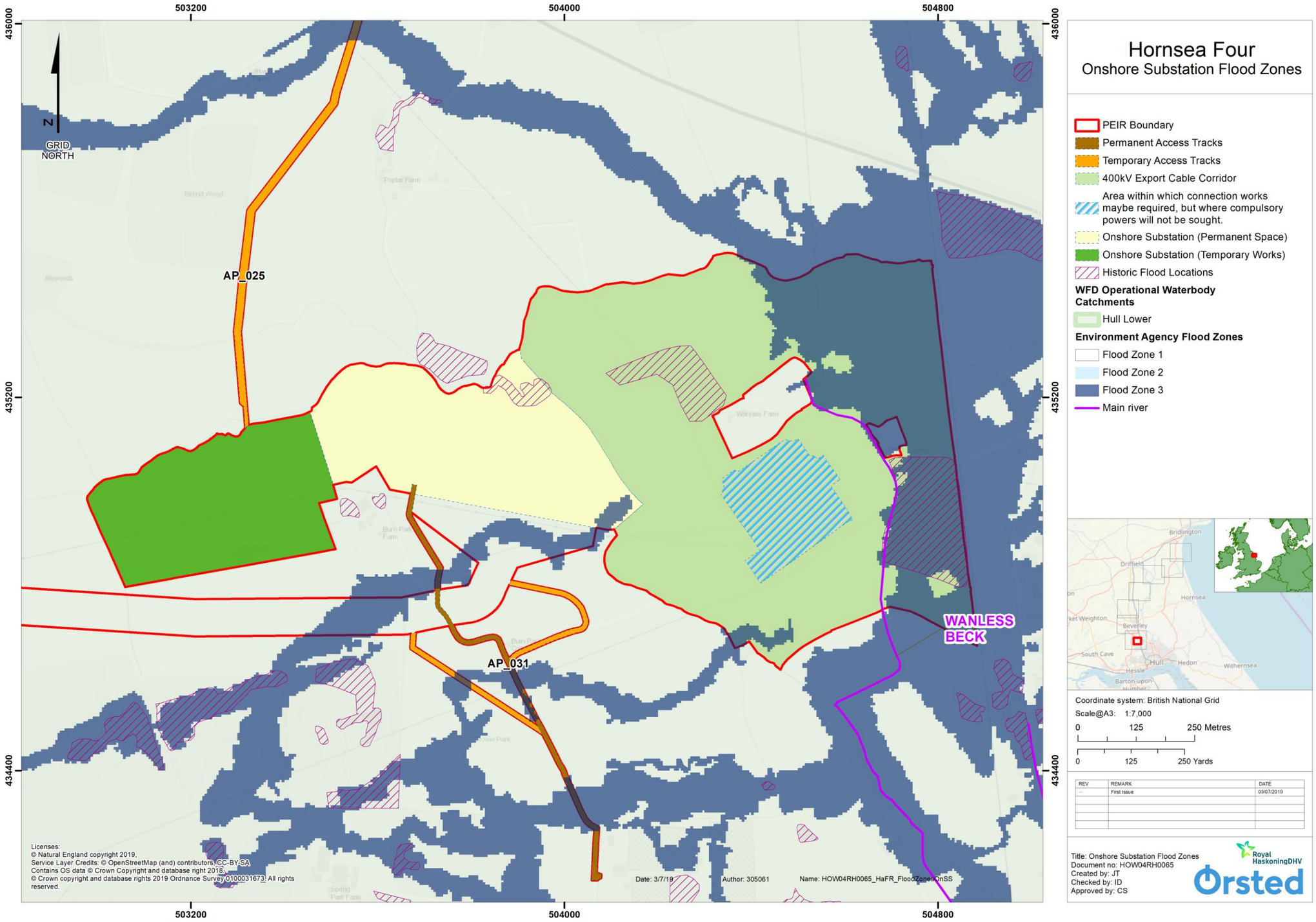


Figure 18: OnSS Flood Zones (Not to Scale).

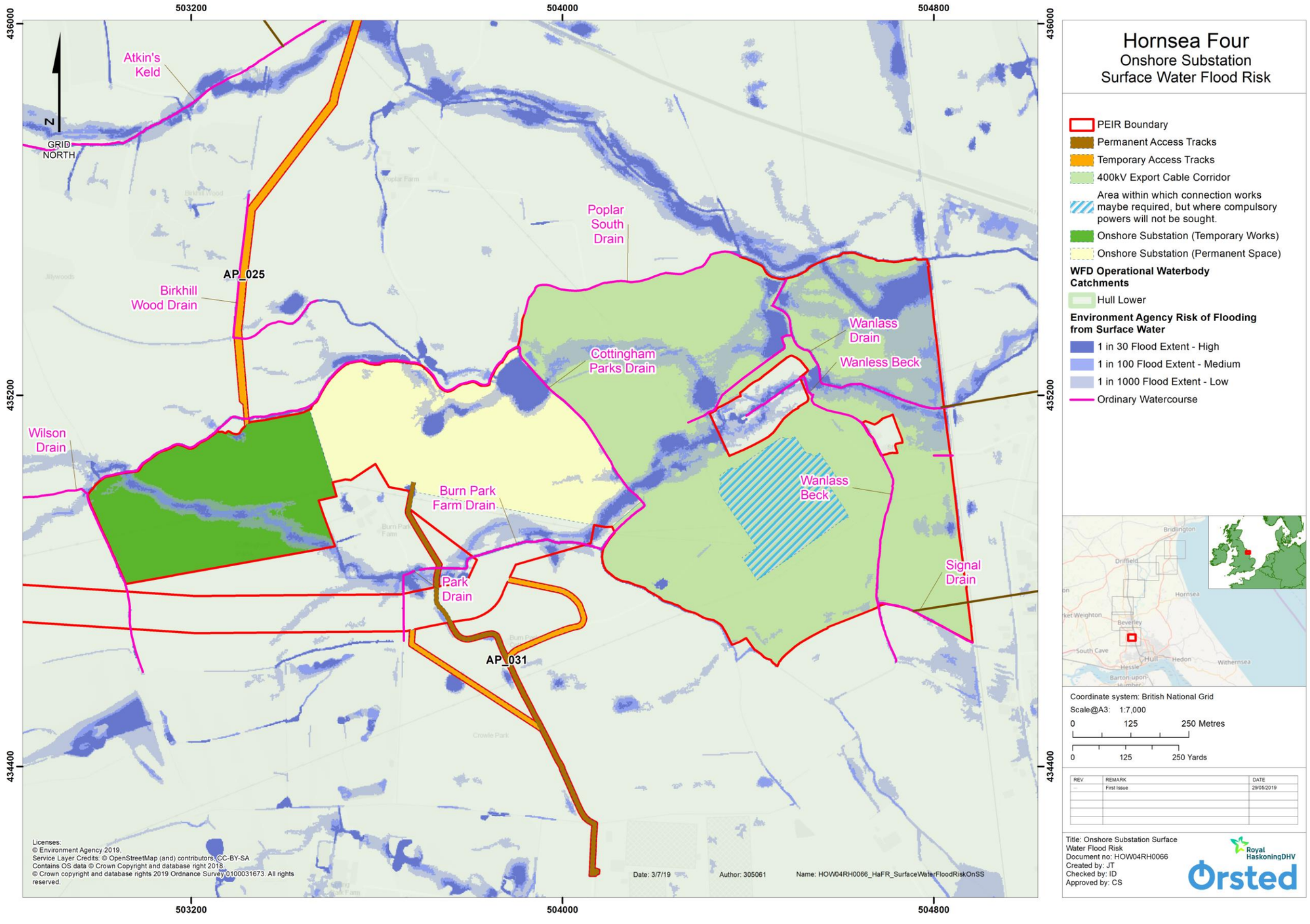


Figure 19: OnSS Surface Water Flood Risk (Not to Scale).

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 Product 4 data provided by the Environment Agency 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.

4.8.6.2 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 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 25,000m^3. The Environment Agency Flood Risk from Reservoirs map shows the site is not at risk of reservoir flooding (EA, 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 (Co19). Furthermore, the risk will be removed entirely following completion of construction, with the site being returned to its previous state.

4.9 Permanent OnSS area

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 Land in the centre 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 site, associated with an Ordinary Watercourse known as Cottingham Parks Drain (identified in the LLFA dataset as UFRN ARF258).

4.9.2.2 This FRA notes that following construction of the permanent OnSS, the risk from fluvial flooding will be addressed as the key infrastructure is proposed to be located within Flood Zone 1.

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**).

4.9.4 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.

4.9.6.2 The Level 1 SFRA (ERYC, 2010) identifies that a large proportion of the ERYC 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 site, 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 site. However, this risk 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 site area both during construction and once operational.

4.9.7 Flooding from Surface Water

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

4.9.7.2 The Permanent OnSS site has a flow route running along the southern boundary of the site, identified as being at 'High' risk of flooding. There is also an area to the north-east of the OnSS site which is at 'High' risk as well as an area in the centre of the permanent OnSS site (**Figure 19**).

4.9.7.3 There is one permanent access track serving the OnSS, running north from Park Lane. From Park Lane the permanent access track will follow an existing access track to Burn Park Farm, for a short distance, before heading north over agricultural land (**Figure 19**). The permanent access track crosses over the Burn Park Farm Drain 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 it passes over the existing watercourse. Therefore, this FRA suggests that any improvement works to the route should be designed to retain sufficient floodplain capacity and / or flow conveyance (Co184).

4.9.7.4 Further information related to flood risk issues along the permanent access route, variations in ground levels and existing flow paths will be obtained as part of the pre-construction survey (Co14). This will inform the development of appropriate mitigation measures to limit any restriction in flow.

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 site 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 (EA, 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 site area.

4.9.10.2 The main risks to the permanent OnSS area are the Flood Zone 3 extent at the southern corner of the site and the surface water flow route and associated areas of 'High' flood risk.

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). As stated in Commitment 19 (**Volume 4, Annex 5.2: Commitments Register**), the drainage system will be designed so that the existing run-off rates to the surrounding water environment are maintained at pre-development rates. The detailed design of the surface water drainage scheme will be based on a series of infiltration/soakaway tests carried out on site and the attenuation volumes outlined in supporting FRAs. The tests will be undertaken prior to construction and in accordance with the BRE Digest 365 Guidelines. The strategy will ensure that the current mean annual run-off rates at the substation are maintained at a rate to be agreed with the Environment Agency and are monitored to ensure that the agreed rate of discharge is maintained.

4.10 400 kV onshore ECC area

4.10.1 Historic Flooding

4.10.1.1 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 400kV onshore ECC area in two locations (**Figure 18**):

- Historic surface water flooding in June 2007 along the eastern boundary of the 400 kV onshore ECC area adjacent the railway line, appears to be associated with an Ordinary Watercourse (identified in the LLFA dataset as UFRN AFT682) (**Figure 18**); and

- Historic surface water flooding in June 2007 affected land in the centre of the 400 kV onshore ECC area. This appears to be associated with an Ordinary Watercourse (identified in the LLFA dataset as UFRN AFU031) (**Figure 18**).

4.10.1.2 Overall review of the historic flooding data suggests that the 400 kV onshore ECC 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 onshore ECC area intersects two Flood Zone 3 extents (**Figure 18**):

- A large proportion of the 400 kV onshore ECC site running approximately 800 m adjacent to the railway line on the eastern boundary of the site, associated with the Wanless Beck Main River; and

- 130 m at the south of the 400 kV onshore ECC, 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 through the 400 kV onshore ECC (**Figure 18**). This Main River is the Wanless Beck, which runs south immediately to the east of the Creyke Beck substation.

4.10.3.2 This FRA suggests that the 400kV onshore ECC infrastructure should be sequentially located to avoid the Flood Zone 3 extent on the eastern side of the area when connecting to the Creyke Beck NGET substation.

4.10.4 Flooding from IDB maintained watercourses

4.10.4.1 There are no IDB maintained watercourses within the 400 kV onshore ECC 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 onshore ECC 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 onshore ECC area is located over bedrock designated as a Principal Aquifer. Principal Aquifers are usually considered to provide a high level of water storage.

4.10.6.2 The Level 1 SFRA (ERYC, 2010) identifies that a large proportion of the ERYC 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 onshore ECC 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 400kV onshore ECC area.

4.10.6.4 The effect the 400kV onshore ECC 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. 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 1.2m below ground (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 (Co19).

4.10.6.5 Based on the above information there is likely to be a groundwater flood risk to the 400kV onshore ECC 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 an appropriate CoCP (Co124), so as to 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 400kV onshore ECC area is at 'Very Low' risk of surface water flooding (Figure 19).

4.10.7.2 The 400kV onshore ECC 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. There are also three areas towards the north of this site that are at 'High' risk from surface water flooding.

4.10.8 Flooding from Sewers

4.10.8.1 No DG5 (sewer flood record) information has been obtained to support this FRA. The 400kV onshore ECC 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 400kV onshore ECC area. Therefore, there is no risk of flooding from reservoirs, canals or other artificial sources to the 400kV onshore ECC area.

4.10.10 Summary of Flooding Sources to the 400kV onshore ECC area

4.10.10.1 Overall, the 400kV onshore ECC 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 400kV onshore ECC area, this will be managed once operational as it will be located within sealed ducts.

4.10.10.2 The Wanless Beck Main River and associated Flood Zone 3 extents show parts of the 400kV onshore ECC area are at high risk of fluvial flooding. There are also a number of locations shown to be at 'High' flood risk associated with surface water.

4.10.10.3 Based on the current proposed location of the permanent OnSS site and the existing location of the Creyke Beck NGET substation, it is unlikely that large areas of this section of cable would pass through Flood Zone 3, any remaining surface water flood risk could 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.

4.11 Summary of Flood Risk to Hornsea Four

4.11.1.1 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.

4.11.1.2 Part of the 400kV onshore ECC area is located in Flood Zone 3. Based on the current proposed location of the permanent OnSS site and the existing location of the Creyke Beck substation, it is unlikely that a large area of this section of cable would pass through Flood Zone 3 (**Figure 18**).

4.11.1.3 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.

4.11.1.4 The risk of surface water flooding is identified as predominantly 'Very Low', with small isolated small are 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 mitigated, with all infrastructure located below ground.

4.11.1.5 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 and identification of appropriate access / egress route as stated in **Volume F2, Chapter 6: Outline Onshore Infrastructure Drainage Strategy** (Co19) (**Figure 19**).

4.11.1.6 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.

4.11.1.7 There is no risk of flooding from the sea.

4.11.1.8 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) will be incorporated into the design.

4.11.1.9 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.

4.12 Consideration of the Sequential and Exception Test

4.12.1.1 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.

4.13 Vulnerability Classification

4.13.1.1 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.

4.14 Application of the Sequential Test and Exception Test

4.14.1.1 The Hornsea Four PEIR boundary is 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 8).

Table 8: 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	X	Exception test required	✓	✓
3b	Exception test required	X	X	X	✓

4.14.1.2 The parts of the Hornsea Four PEIR boundary 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.

4.14.1.3 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.

4.14.1.4 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 mitigated as the transition joint bays, cables and link boxes will be wholly located underground (Co25 and Co28), with the latter sealed through a watertight manhole cover with no interaction with the above ground Flood Zones.

4.14.1.5 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 Burn Park Farm Drain where it will be within the Flood Zone 3 extent.

4.14.1.6 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. The permanent access route follows a private access track from Park Lane to Burn Park Farm before crossing agricultural land. The permanent access route will be built to include mitigation measures to retain sufficient floodplain capacity and / or flow conveyance, as far as possible (Co184).

4.14.1.7 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.

5 Climate Change

5.1.1.1 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.

5.1.1.2 Current guidance on climate change allowances (Environment Agency, 2019), states 'Essential Infrastructure' developments within Flood Zone 3 should use the 'Upper End' climate change allowance and 'Essential Infrastructure' within Flood Zone 2 should consider the 'Higher Central' and 'Upper End' allowances when considering impacts on fluvial flood risk due to climate change. If a site is located within Flood Zone 1 then guidance states that the 'Central' allowance should be used for 'Essential Infrastructure'.

5.1.1.3 The Hornsea Four PEIR boundary is located within the Humber river basin. Assuming construction commences in 2023, the peak river flow climate change allowance would comprise an additional 20% or 30% in Flood Zone 2 and an additional 30% in Flood Zone 3

assuming 35 years of operation. In Flood Zone 1 the peak river flow climate change allowance would comprise an additional 15% assuming 35 years of operation, as shown in Table 9.

Table 9: 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%

5.1.1.4 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. As the permanent substation site is predominantly located within Flood Zone 1, it is recommended that a climate change allowance equivalent to a 20% increase in peak river flows be considered.

5.1.1.5 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.

5.1.1.6 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. Therefore, the effects of climate change from fluvial sources will not impact the Hornsea Four onshore infrastructure.

5.1.1.7 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).

5.1.1.8 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 (Co14).

6 Surface Water Drainage

6.1 Onshore Infrastructure Pre-Construction Work

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

6.1.1.2 A Construction Surface Water and Drainage Strategy will be developed as part of the DCO application, agreed with regulators 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). This will assess the current and proposed runoff rates, volume of storage required and the proposed approach for discharge of water from the site.

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

6.2 Landfall and onshore ECC Surface Water Drainage

6.2.1.1 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 should ground reinstatement not be carefully managed.

6.2.1.2 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 and Co28).

6.2.1.3 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, it will be necessary to ensure that flow along the watercourse is maintained and there is no increase in flood risk as a result of the temporary works. 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 Internal Drainage Board. 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).

6.2.1.4 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.

6.2.1.5 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 (Co19). 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.

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

6.3 Onshore ECC Post-Construction

6.3.1.1 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 (Co19). 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).

6.3.1.2 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 detailed in the Outline Onshore Infrastructure Drainage Strategy (**Volume F2, Chapter 2**).

6.4 Onshore Substation (OnSS) Surface Water Drainage

6.4.1.1 Surface water drainage requirements will be dictated by the final Surface Water and Drainage Strategy 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.

6.4.1.2 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.

6.4.1.3 The OnSS drainage strategy will be developed according to the principles of the SuDS discharge hierarchy. 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.

6.4.1.4 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, which will be based on the Outline Infrastructure Drainage Strategy (**Volume F2, Chapter 6**, Co19) (post Development Consent Order (DCO) consent). Attenuation ponds 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.

6.4.1.5 Drainage systems installed for the OnSS. will include suitably sized attenuation ponds / tank(s). 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. The exact position will be confirmed during detailed design, post-consent.

6.4.1.6 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.

6.4.1.7 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.

7 Flood Risk Management and Mitigation Measures

7.1.1.1 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.

7.2 Design Mitigation

7.2.1.1 The Hornsea Four PEIR boundary is primarily located outside of Flood Zones 2 and 3 wherever possible, in areas at low risk of flooding from fluvial or tidal sources.

7.2.1.2 At landfall, where the works have the potential to affect the tidal / coastal flood risk, the techniques to carry out the works broadly fall in to two categories; open cut installation or trenchless techniques (i.e. HDD). The preference for the project is to carry out the landfall works using HDD. However, as described in **Volume 1, Chapter 4: Project Description** no

geophysical / geotechnical information, of sufficient spatial resolution is currently available to confirm the feasibility of HDD at landfall.

7.2.1.3 Should it be necessary to adopt open cut installation, a number of design principles have been identified including the use of cofferdams and / or dewatering to ensure that the potential risk associated with tidal / coastal flooding will be mitigated.

7.2.1.4 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.

7.2.1.5 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 (Co19).

7.2.1.6 Temporary access tracks are primarily located where there is an existing natural track or access route, where this has been possible (**Volume 1, Chapter 3**). 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).

7.2.1.7 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).

7.2.1.8 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. There is the potential for surface water flooding to affect the permanent OnSS site. 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 run-off 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).

7.2.1.9 Existing land drains both along the onshore ECC and at the OnSS will need to be reinstated (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).

7.3 Flood Warning and Evacuation Plan

7.3.1.1 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.

7.3.1.2 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.

7.3.1.3 All personnel using the access routes should be made aware of those access routes which are 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.

7.3.1.4 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.

7.3.1.5 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.

7.3.1.6 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. A flood warning can then be issued when necessary to allow work to stop, especially in areas in close proximity to key watercourses. The site cleared of all personnel in this instance.

7.4 Access and Egress

7.4.1.1 The OnSS 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.

7.4.1.2 Flood risk associated with temporary access routes during construction have been identified in **paragraph 4.3.5**. The short duration of construction will mitigate any long-term risks and the development of Flood Warning and Evacuation Plans (**Section 7.3**) will reduce the risk during construction to an acceptable level using flood forecasting methods.

7.4.1.3 The one proposed permanent access route, to the north of Park Lane crosses 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).

7.4.1.4 Although the permanent access route is shown to be at surface water flood risk and crosses small areas of Flood Zone 3 the wider area surrounding the OnSS primarily comprises Flood Zone 1. Therefore, access and egress from the OnSS can be maintained via footpaths and farmland to the wider area for the efficient evacuation of personnel. In addition, once operational the use 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 route or utilising farmland within Flood Zone 1, prior to flooding occurring.

7.5 Flood risk during Decommissioning

7.5.1.1 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 pollution prevention, and the avoidance of ground disturbance, as well as being in line with the latest relevant available guidance (Co127).

7.5.2 Landfall

7.5.2.1 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.

7.5.2.2 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.

7.5.3 Onshore ECC

7.5.3.1 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.

7.5.3.2 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.

7.5.4 OnSS

7.5.4.1 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.

8 Conclusions

8.1.1.1 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 if installed using trenchless technologies, such as HDD. Design principles e.g. dewatering and / or cofferdams are proposed, should there be a need to adopt open cut installation, to ensure that there is no increase in flood risk during the construction works. The landfall logistics compound is temporary in nature and therefore would not be subject to the managed coastal retreat proposed for this area.

8.1.1.2 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 **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.

8.1.1.3 The OnSS is primarily located within Flood Zone 1, at low risk of flooding from fluvial sources. The OnSS is also located primarily within areas of very low and low surface water flood risk. An area of high surface water flood risk is located to the north-east of the OnSS.

8.1.1.4 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)).

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

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