BP Exploration Operating Company Ltd

Northern Endurance Partnership

Scoping Report for Offshore Environmental Impact Assessment

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1. INTRODUCTION

Carbon capture and storage (CCS) refers to a set of processes that capture carbon dioxide (CO_2) from waste gases produced at industrial facilities and permanently store it in offshore geological storage sites (Tiley, 2020)[1]. CCS is proven technology and is already in use around the world.

The Northern Endurance Partnership (NEP) of bp Exploration Operating Company Limited (bp), Eni UK Limited, Equinor New Energy Limited, National Grid Carbon Limited, Shell U.K. Limited and Total Gas & Power Chartering Limited was formed to develop offshore CO_2 transport and storage infrastructure in the UK Southern North Sea (SNS). bp, as operator, is responsible for developing, installing and operating the infrastructure on behalf of the other companies in NEP. This infrastructure will serve the proposed Net Zero Teesside (NZT)[2] and Zero Carbon Humber (ZCH)[3] projects that aim to decarbonise industrial clusters in Teesside and Humberside and deliver the UK's first zero-carbon industrial cluster – collectively termed the East Coast Cluster.

An offshore Environmental Impact Assessment (EIA) is being conducted in support of NEP's development of offshore CO_2 transport and storage infrastructure. This report informs the public scoping exercise which gathers the views of stakeholders and the public and is an essential part of the EIA process. The comments raised from this scoping exercise will inform the EIA process, to be summarised in an Environmental Statement (ES) report for submission to the regulator (Department for Business, Energy & Industrial Strategy Offshore Petroleum Regulator for Environment & Decommissioning, BEIS OPRED[4]) in Q1/Q2 2022.

The objective of this report is to provide an overview of the offshore elements of NEP ('the Development', as explained further in Section 1.1) and to identify the potential environmental and social impacts to be considered as part of the EIA process. The specific objectives of the scoping study, summarised in this report are to:

- Provide an overview of the proposed Development;
- Provide an overview of the existing environment in the proposed Development area utilising environmental data collected to date for the proposed Development area;
- Identify key potential issues to be assessed within the EIA process;
- Outline the supporting studies that will be required to provide data for more detailed assessment of the potential key issues; and
- Facilitate dialogue with stakeholders regarding the key potential issues, potential mitigation and environmental data sources.

[1] *CCS is a subset of Carbon capture utilisation and storage (CCUS) in which CO_2 captured from industrial processes can alternatively be used in the production of chemicals, minerals, plastics and synthetic fuels (Tiley, 2020).*
[2] *https://www.netzeroteesside.co.uk/*
[3] *https://www.zerocarbonhumber.co.uk/*
[4] *https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1005109/The_Offshore_Oil_and_Gas_Exploration_Production_Unloading_and_Storage_Environmental_Impact_Assessment_Regulations_2020_-_A_Guide_July_2021.pdf*

1.1 Background to the Development

In the UK, the Government has a legally binding target to achieve net zero in terms of greenhouse gas emissions by 2050[5]. The UK needs to use every possible technology to green the economy and decarbonise industry. CCS has been identified as essential in reaching the net-zero emissions target as part of a suite of abatement strategies to reduce greenhouse gas emissions[6]. Indeed, the UK Government is targeting the capture of 10 million tonnes (Mt) of carbon dioxide a year by 2030 – the equivalent of 4 million cars' worth of annual emissions (HM Government, 2020).

To achieve net zero, industrial emissions will need to reduce by at least two thirds by 2035 and at least 90% by 2050. The UK Government is committed to investing up to £1 billion to support the establishment of CCS in four industrial clusters in areas such as the North East, the Humber, North West, Scotland and Wales (HM Government, 2021). CCS infrastructure is needed to decarbonise the industrial heartlands of Teesside and the Humber which together account for nearly half of carbon emissions from UK industrial clusters.

The proposed East Coast Cluster development (Figure 1-1) consists of a diverse mix of low-carbon projects including industrial carbon capture, low-carbon hydrogen production, negative emissions power, and power with carbon capture. All these technologies are essential for the UK to meet its net zero targets. The Cluster consists of the following three primary components, of which the offshore element of the NEP project is the subject of this report:

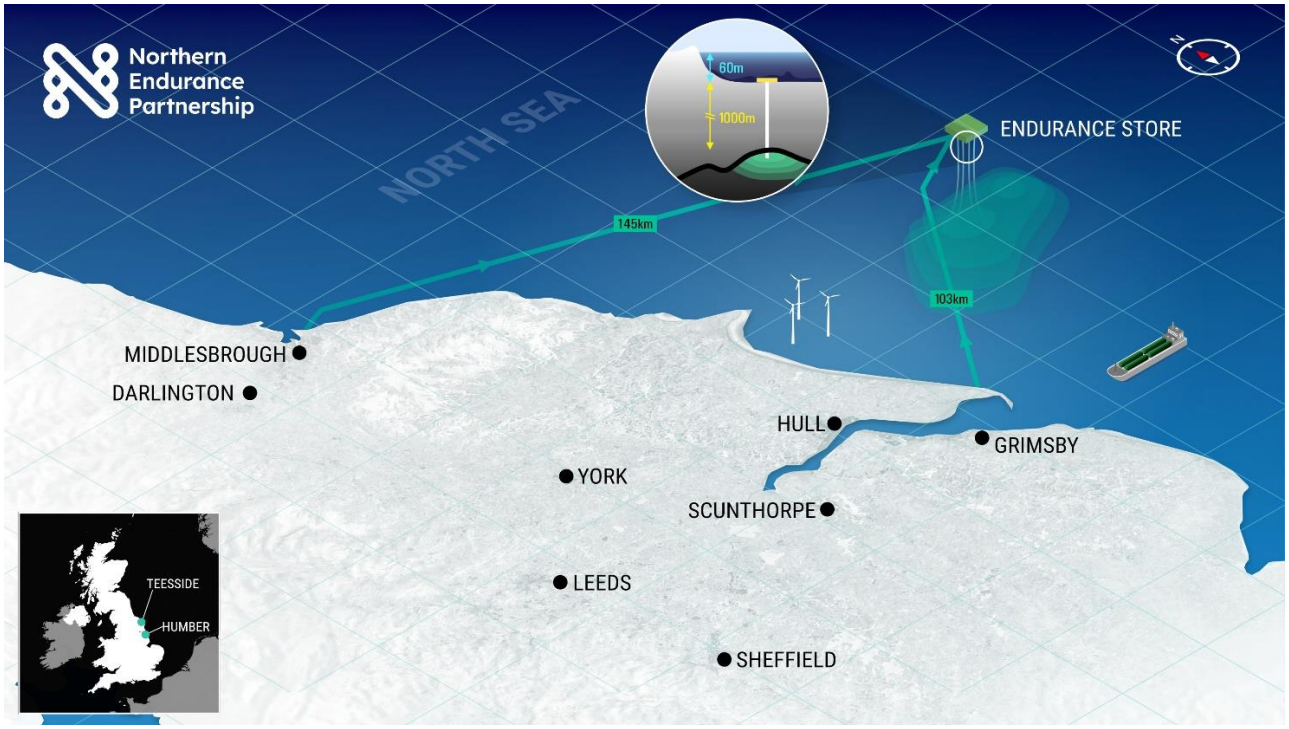

Figure 1-1 - Overview of the East Coast Cluster

[5] *Climate Change Act 2008 (as amended)*

[6] *"Net Zero The UK's contribution to stopping global warming", a report documenting the findings of The Committee on Climate Change (CCC), an independent statutory body established under the Climate Change Act 2008 (CCC, 2019)*

1. Net Zero Teesside[7] is a CCUS project, based in Teesside in the North East of England. Proposals for NZT include the Net Zero Teesside Power Station (NZT Power) which will potentially be the world's first commercial scale gas fired power station with CCUS. NZT Power will provide dispatchable low carbon power which will enable and compliment increasing renewable energy deployment by providing low carbon power to back up intermittent forms of renewable energy such as wind and solar. NZT Power is a joint venture between bp, Eni, Equinor and Total with bp leading as operator.

A CO_2 gathering network, CO_2 compression and the onshore section of a CO_2 export pipeline on Teesside will enable the capture, transportation and storage of CO_2 from NZT Power and a range of carbon intensive businesses which could include BOC, H2 Teesside, CF Fertilizers, TV ERF, 8Rivers, Suez and Kellas.

NZT could help protect up to 70% of existing jobs in heavy industry on Teesside, and enable many thousands of new, high quality opportunities. NZT aims to capture and store up to 10 million tonnes of CO_2 emissions each year, equivalent to the emissions associated with the annual energy use of up to 3 million homes in the UK.

An application was made in July 2021 to the Secretary of State (SoS) for Business, Energy and Industrial Strategy (BEIS) for a Development Consent Order (DCO[8]) to authorise this Nationally Significant Infrastructure Project (NSIP), pursuant to the Planning Act 2008. This application has now been accepted for examination.

2. Zero Carbon Humber[7] is leading companies and organisations in a plan to decarbonise the UK's largest emitting industrial region.

ZCH includes ABP, British Steel, Centrica Storage, Drax, Equinor, Mitsubishi Power, National Grid, px Group, SSE Theral, Triton Power, Uniper and University of Sheffield Advanced Manufacturing Centre (AMRC).

The ZCH Partnership have a shared ambition to make the Humber industrial region net zero by 2040 through low carbon hydrogen, carbon capture and carbon removal technology, enabled by shared regional pipelines for hydrogen and carbon emissions and the common offshore NEP infrastructure.

With its first projects aiming to start up in the mid-2020s, ZCH aims to capture at least 17 million tonnes of CO_2 emissions per year and supply up to 10 gigawatts of hydrogen in industry and power projects across the Humber by the mid-2030s. This could reduce the UK's annual emissions by 15% and safeguard 55,000 existing jobs in the region, whilst creating thousands of new science, technology, engineering and maths roles and developing skills, apprenticeships and educational opportunities in the area.

It is planned that a DCO application for Humber Low Carbon Pipelines will be made by National Grid Ventures (NGV) in Q3 2022 to the SoS for BEIS, to authorise this NSIP, pursuant to the Planning Act 2008.

3. Northern Endurance Partnership will route CO_2 from the industrial clusters NZT and ZCH, to the offshore geological storage site, the Endurance Store located approximately 63 km from the nearest coastline in the SNS, (Figure 1-1). The project objective is to deliver technical and commercial solutions required to implement innovative

[7] https://eastcoastcluster.co.uk/
[8] https://infrastructure.planninginspectorate.gov.uk/application-process/the-process/

First-of-a-Kind (FOAK) offshore low-carbon CCS infrastructure in the UK. This includes CO_2 pipelines connecting from Humber and Teesside compression/pumping systems to a common subsea manifold and well injection site at the Endurance Store, i.e. transporting and storing CO_2 emissions from both onshore clusters (Figure 1-2). The Endurance carbon storage licence, awarded by the Oil and Gas Authority (OGA), is held by National Grid (33%), bp (33%) and Equinor (33%).

The Endurance Store was selected following evaluation of two offshore CO_2 stores in the SNS: 'Endurance Store', a saline aquifer formation structural trap, and 'Hewett', a depleted gas field. The storage capacity requirement was for either store to accept 6+ Mtpa CO_2 continuously for 25 years. Endurance was selected as the primary store for the project as:

- The storage capacity of the Endurance Store is 3 to 4 times greater than that of Hewett;
- The development base cost is estimated to be 30 to 50% less than Hewett; and
- CO_2 injection into a saline aquifer is a worldwide proven concept, whilst no benchmarking is currently available for injection in a depleted gas field.

The EIA will consider potential impacts associated with activity to the seaward side of the Mean Low Water Springs (MLWS). Any infrastructure and associated potential impacts landward of MLWS will be subject to the respective DCO processes for NZT and ZCH (Humber Low Carbon Pipelines Project).

The East Coast Cluster aims to remove 50% of the UK's industrial cluster CO_2 emissions, ensuring the UK's leadership in the energy transition and the emerging global low-carbon and hydrogen market and playing a major role in levelling up across the country. The NEP Development is critical to delivery of the wider East Coast Cluster development.

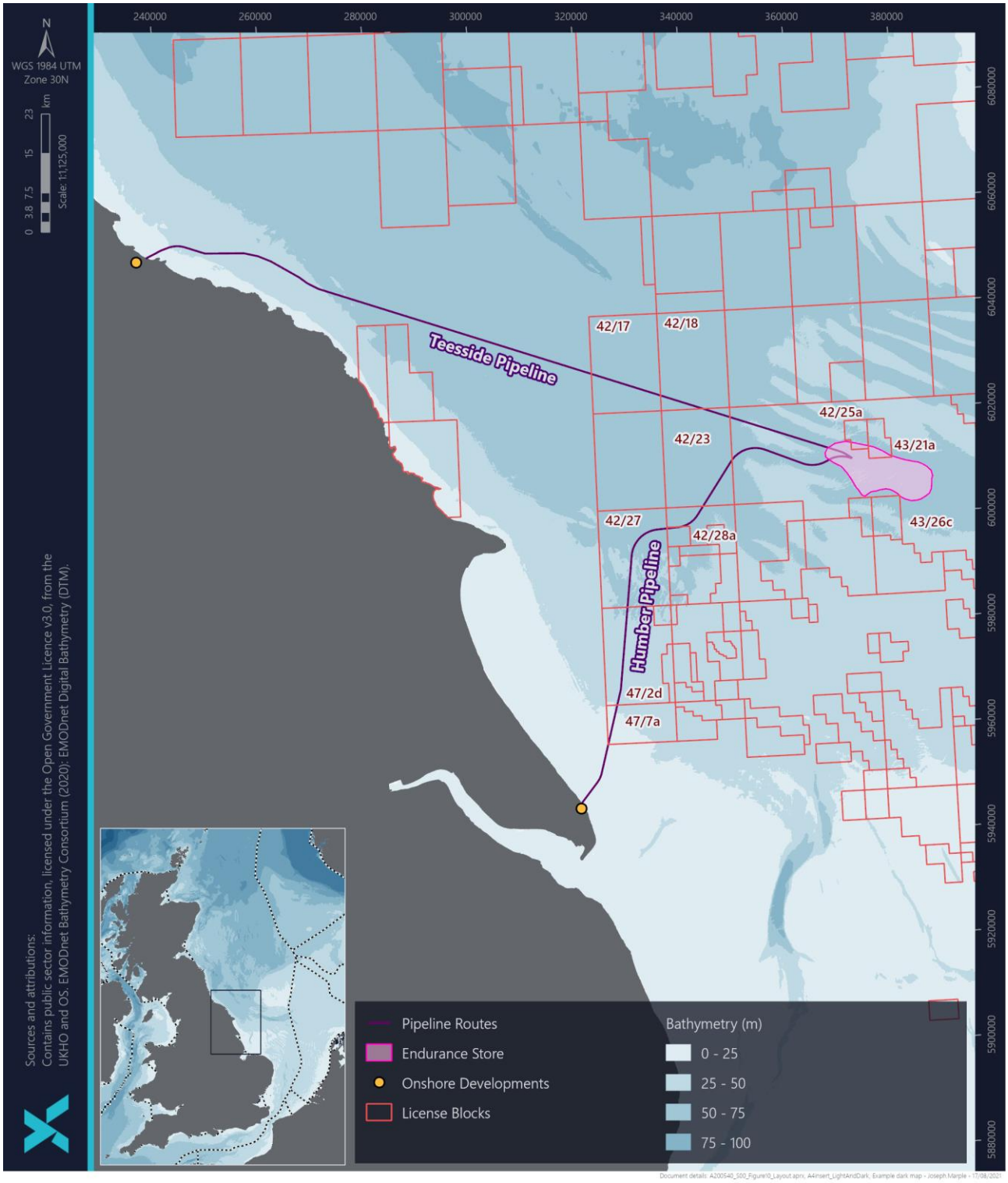

Figure 1-2 - Overview of Development area showing the Endurance Store and the Teesside and Humber Pipelines

2. LEGISLATIVE AND POLICY FRAMEWORK

The UK Government supports CCUS, considering it likely to be essential in tackling climate change, meeting the ambitions of the United Nations Framework Convention on Climate Change (UNFCCC) Paris Agreement and the UK net zero target (Tiley, 2020):

- Clean Growth Strategy: The Clean Growth Strategy[9] was announced by the UK Government in October 2017, setting out a strategy to deliver increased economic growth while cutting greenhouse gas emissions. Commitments were made to demonstrate international leadership in CCUS, by collaborating with global partners and investing in leading edge CCUS and industrial innovation to drive down costs (BEIS, 2017).
- Net Zero Target: In July 2019, the UK Government amended the Climate Change Act to commit the UK to a legally binding target of net zero emissions by 2050 whereby any emissions would be balanced by schemes to offset an equivalent amount of greenhouse gases from the atmosphere, such as using technology like CCUS[10].
- Ten Point Plan for a Green Revolution: In November 2020 the UK Government published the Ten Point Plan for a Green Revolution which included an ambition to establish CCUS in at least two industrial clusters by mid 2020s and aim for four of these sites by 2030, capturing up to 10 million tonnes per annum of CO_2[11].

The Crown Estate (TCE) holds the seabed rights for CO_2 transportation and storage within the United Kingdom's Exclusive Economic Zone, excluding Scotland. TCE is able to grant rights to developers for pipelines, injection wells, platforms and manifolds, storage sites and other offshore facilities to deliver a CCUS project.

The Endurance Store is regulated under a CO_2 appraisal and storage licence from the OGA, the licensing and permitting authority for offshore CO_2 storage.

OPRED regulates the environmental aspects of offshore CCUS with statutory advisors including the Marine Management Organisation (MMO), the Joint Nature Conservation Committee (JNCC), Natural England (NE) and the National Federation of Fishermen's Organisation (NFFO).

The key piece of environmental legislation for the Development is The Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020, with associated guidance[12]. These regulations mandate the undertaking of an EIA and the production of an ES for certain types of offshore developments, including activities related to the geological storage of CO_2, as per the Energy Act 2008. The ES is the means whereby the Secretary of State is assured that the environmental implications of the proposed Development have been properly considered and, subject to all other requirements being satisfied, the Secretary of State can agree that consent for the project can be granted by the OGA via a Storage Permit.

[9] https://www.gov.uk/government/publications/clean-growth-strategy
[10] https://www.gov.uk/government/news/uk-becomes-first-major-economy-to-pass-net-zero-emissions-law
[11] https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution
[12] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1005109/The_Offshore_Oil_and_Gas_Exploration_Production_Unloading_and_Storage_Environmental_Impact_Assessment_Regulations_2020_-_A_Guide_July_2021.pdf

The relevant Marine Plan for the Development is the North East Marine Plan (DEFRA, 2021), encompassing the North East Inshore Marine Plan and the North East Offshore Marine Plan. The Marine Plan aims to enhance and protect the marine environment and achieve sustainable economic growth, whilst respecting local communities both within and adjacent to the marine plan areas. Policies of the North East Marine Plan include support for proposals associated with the deployment of low carbon infrastructure for industrial clusters. The ES will present the key principles of the Marine Plan policies relevant to the Development, and alignment of the Development with these policies.

The EIA will take account of recommendations arising from the Strategic Environmental Assessments (SEAs) undertaken by OGA, i.e. the existing Offshore Energy Strategic Environmental Assessment (OESEA3) and OESEA4 (publication anticipated in 2021).

There is also a requirement to consider the potential impacts on the integrity of protected habitats[13]. Special Areas of Conservation (SACs)and Special Protection Areas (SPAs) are protected areas in the UK and form part of the UK's national site network. The sites are designated under the Conservation of Habitats and Species Regulations 2017 (as amended) within 12 nm and under the Conservation of Offshore Marine Habitats and Species Regulations 2017 (as amended) outwith 12 nm. OPRED is the Competent Authority for the Habitats Regulations Assessment (HRA) process, with the advice of relevant Statutory Nature Conservation Agencies. bp will present all the necessary information to support the HRA process in the ES, such that the Competent Authority will have sufficient information to undertake an Appropriate Assessment, if required (i.e. if approval of the Development was considered likely to result in a significant effect on a protected area). Whilst HRA focuses on SACs, SPAs and Ramsar sites, bp will also present sufficient information within the ES to assess the potential for impact on all other relevant marine protected areas (for example, Marine Conservation Zones).

The Energy Act 2008 (Consequential Modifications) (Offshore Environmental Protection) Order 2010 applies the provisions of the following regulations to offshore CCUS activities:

- The Offshore Petroleum Activities (Conservation of Habitat) Regulations 2001;
- The Offshore Marine Conservation (Natural Habitats, & c.) Regulations 2007;
- The Offshore Chemicals Regulations 2002;
- The Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005;
- The Offshore Installations (Emergency Pollution Control) Regulations 2002; and
- The REACH Enforcement Regulations 2008.

This results in a number of key environmental approvals required for the Development, including:

- Oil Pollution Emergency Plans (drilling);
- Permits for chemical use and discharge (drilling and pipeline).
- Pipeline Works Authorisation (PWA) and associated environmental screening directions (PLA MAT); and
- Deposit of Materials Consent (DepCon).

A full list of applicable legislation and approvals will be included in the ES.

[13] https://jncc.gov.uk/

3. STRATEGY AND SCOPE

During the impact assessment process, the potential environmental and social impacts associated with the Development will be identified and evaluated. Mitigation measures will be identified and designed to control activities to reduce any potentially significant, adverse impacts identified to an acceptable level. The full impact assessment will consider the full life of the Development from installation through to decommissioning and be presented in the ES for submission to the regulator.

3.1 Stakeholder Consultation

bp recognises the benefits of public stakeholder consultation to capture relevant concerns regarding a particular project and address these, where appropriate, in the impact assessment. As such, consultation will be ongoing through the project design, impact assessment and the life of the Development.

Stakeholder engagement for the Development to date has provided initial information on the Development and its technical aspects to the offshore regulator and statutory consultees. A summary of the stakeholder meetings which have been held is included within Table 3-1.

Table 3-1 - Summary of stakeholder meetings held to date

MEETING DATE	STAKEHOLDERS	PURPOSE
6th March 2020	OPRED	Provide project overview
23rd March 2020	OPRED JNCC Natural England	Discuss 2020 Survey Activity
20th August 2020	OPRED	Discuss 2020 Survey Activity
15th December 2020	OPRED	Scoping discussion
12th January 2021	OPRED	Discuss environmental survey plan Introduce EIA schedule
2nd March 2021	OPRED	Technical discussion of project environmental aspects
10th March 2021	OPRED Natural England JNCC	Provide project overview Introduce EIA schedule Technical discussion of project environmental aspects
16th March 2021	NFFO	Discuss 2021 Survey Activity
22nd March 2021	OPRED CEFAS	Provide project overview Introduce EIA schedule Technical discussion of project environmental aspects

MEETING DATE	STAKEHOLDERS	PURPOSE
31st March 2021	JNCC Natural England	Discuss Autonomous Survey Vessel Surveys with deployment of Sub-Bottom Profiler
6th April 2021	OPRED	Technical discussion of project environmental aspects
14th April 2021	OPRED OGA	Technical discussion of project environmental aspects
20th April 2021	OPRED CEFAS	Technical discussion of project environmental aspects
19th May 2021	Yorkshire Marine Nature Partnership (YMNP)	Provide CCS and Project overview
25th May 2021	OPRED Natural England	Discuss Humber Pipeline Routing Options
7th June 2021	YMNP	Provide CCS and Project overview
4th August 2021	Natural England	Discuss 2021 Nearshore Survey Scope

3.2 The EIA Process

The EIA process that this report forms part of will achieve the following:

- Characterise the environmental and social baseline;
- Identify the Development's components (and alternatives), associated activities and aspects, and assess potential impacts;
- Identify and address, where appropriate, stakeholder and public concerns regarding the proposed development;
- Identify design solutions and management control measures that will reduce potential negative environmental and social impacts identified;
- Identify potential residual impacts and their significance; and
- Identify, assess and (f required) mitigate potential cumulative, in-combination and transboundary impacts.

The ES will contain the information as required by Schedule 6 of The Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020.

3.3 The EIA Scope

The EIA will cover all installation, commissioning, operational, maintenance and decommissioning activities of the Development over which bp has operational control. These include:

- Installation and commissioning of the CO_2 gas export pipelines from ZCH and NZT to the Endurance Store;
- Installation of seabed infrastructure including manifolds and infield pipelines;
- Drilling of wells into the Endurance Store;
- All operational and maintenance activities occurring within the Development area, including storage and well monitoring activities
- Decommissioning of the Development (including the pipelines and wells).

3.4 Exclusions from the EIA

Activities excluded from the scope of this offshore EIA include:

- Activity landward of the MLWS including on the beach. This is addressed via the DCO applications for NZT and for ZCH (Humber Low Carbon Pipelines project with NGV as promoter). At both Teesside and Humberside, the sections of the respective pipeline between Mean High Water Spring (MHWS) and MLWS is anticipated to require either a standalone Marine Licence Application or a licence 'deemed' within the body of the DCO i.e. a Deemed Marine Licence (DML). Note that potential cumulative and in-combination impacts of the Development with activity landward of the MLWS will be considered in this ES;
- Pre-construction, maintenance and transport of infrastructure required for the project but outside the Development area (e.g. at ports, pipeline fabrication yards) where bp does not have operational control; and
- Further activities that might be undertaken, for which the Development could act as an enabler.

4. DEVELOPMENT DESCRIPTION

4.1 Overview

The proposed Development, which forms the offshore part of the wider East Coast Cluster development (Section 1.1), comprises the following activities:

- Installation, connection to seabed infrastructure and commissioning of two CO_2 export pipelines;
- Installation of seabed infrastructure including manifolds and infield pipelines;
- Drilling of five CO_2 injector wells and one Endurance Store monitoring well;
- Operation and maintenance of seabed infrastructure and pipelines; and
- Monitoring and management of the storage reservoir.

The Development is FOAK for this type of infrastructure project in the UK. Consequently, at this early stage a degree of flexibility in the design and configuration of infrastructure is required. Future definition of the preferred methodology and contractor(s) will be available when further studies have been carried out, and more detailed information produced to inform the design

In order to ensure a robust assessment of the likely significance of the environmental effects of the Development therefore, the EIA will assess the maximum (or where relevant, minimum) parameters for the elements where flexibility needs to be retained due to stage of design. Where this approach is applied to specific aspects of the EIA, this will be confirmed within the relevant chapters of the submitted ES. As such, the ES should represent a realistic worst-case assessment of the potential impacts of the Development identified at its current stage of design. Detailed design after this point is not expected to result in greater significance of impacts than those presented in the ES.

4.2 Pipelines and Seabed Infrastructure

The dehydrated and compressed CO_2 will be transported offshore via two new 28", concrete-coated CO_2 export pipelines that will direct the dense phase fluid to the Endurance Store, these pipelines are referred to as the Teesside Pipeline and the Humber Pipeline. The Teesside Pipeline will be approximately 145 km in length and the Humber Pipeline approximately 103 km in length.

The proposed pipeline routes and landfall locations are shown in Figure 1-1 and Figure 5-4. The preferred location for the Humber Pipeline landfall is at Easington on the East Yorkshire coast and this scoping report is prepared on that basis. Due to ongoing consideration of the relative preferences for the onshore route and the cumulative and in-combination impacts of the onshore and offshore projects, alternative landfall locations are being evaluated. Should one of these options be selected, additional scoping, environmental baseline surveys and assessment work would be required.

The trenchless landfall solution of Horizonal Directional Drilling (HDD) will be utilised at the Teesside Pipeline landfall. At the Humber Pipeline landfall, trenchless landfall solutions of HDD or micro-tunnelling are proposed as the base case for the pipelines, with the detail to be developed during further project design. In both solutions, a tunnel is drilled between a nearshore and onshore location, sufficiently deep below the sediment surface to prevent

disturbance. In an HDD solution, the pipe is then fed in directly whereas in a micro-tunnelling solution, the tunnel is first lined with a concrete sleeve and then pipe is introduced. Consideration of alternatives for the Humber Pipeline landfall is ongoing, including evaluation of the option to use a cofferdam in the intertidal region. The landfall solutions will be described in more detail in the ES and a reasonable worst-case environmental impact assessment conducted. Landfall design will be informed by the solutions and mitigations adopted for existing pipelines, particularly at the Humber location.

During subsequent project phases, the requirements for measures to ensure pipeline protection and stability will be assessed with the aim of minimising the length of pre-dredging required. It is likely that the pipelines will be surface-laid on the seabed with some sections, particularly nearshore, requiring installation into pre-dredged trenches that will subsequently be backfilled.

An electric power and fibre-optic communications control cable will be installed from NZT to the seabed infrastructure at the Endurance Store. A Subsea Isolation Valve[14] (SSIV) may be installed with each pipeline approximately 5 km from the shoreline. An additional electrical power and communications cable would be laid to connect each of the SSIVs to the respective shore facilities.

The new pipelines will cross over existing infrastructure on the seabed, including other pipelines. The crossings will be protected - as is routine - by concrete mattresses or rock, with rock also being used to provide support where freespans (unsupported sections of pipe due to uneven seabed) are identified following pipe-lay.

At the Endurance Store, the electrically powered, seabed facilities consist of two manifolds[15] (Figure 4-1):

- A crossover co-mingling manifold to combine the flows from the Teesside and Humber Pipelines and distribute it for injection into three wells at the Endurance Store; and
- A 4-slot injection manifold at the Endurance Store connected to the other two injection wells, with the potential to support a further 2 injection wells.

The 8" carbon steel, infield pipelines which run between the two manifolds and from the manifolds to the injection wells will each be a maximum 5 km in length. Power and communications are provided from the manifolds to each of the six wells, including the Endurance Store monitoring well at which pressures and temperatures will be monitored. All installed structures will be designed to be fishing friendly. There will be no permanent structures above sea level associated with the Development at the Endurance Store area.

[14] *A valve that will close and isolate a particular pipeline or process in an emergency.*
[15] *Arrangement of piping and/or valves designed to combine, distribute, control, and often monitor fluid flow.*

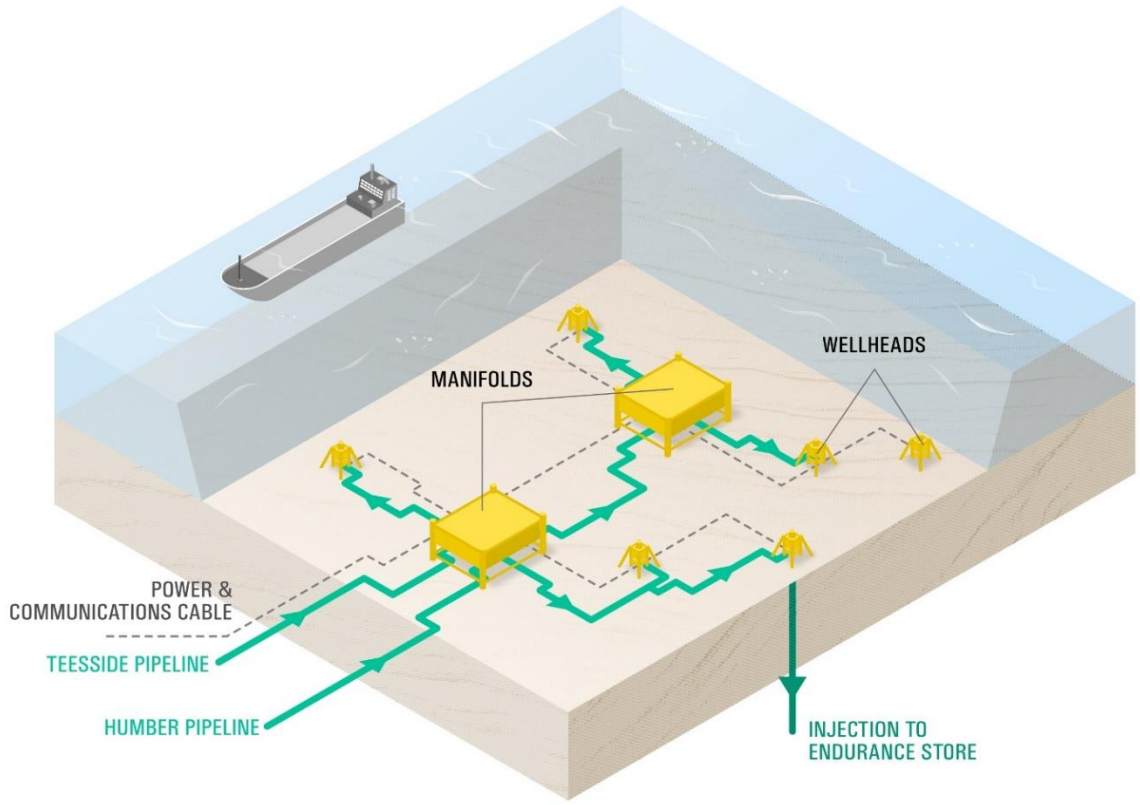

Figure 4-1 - Schematic of the seabed infrastructure at the Endurance Store area (not to scale)

4.3 Wells Programme

The storage site is in the Endurance underground aquifer beneath the SNS, located approximately 145 km to the east southeast of Teesside and 63 km from the nearest coastline. Referred to as the Endurance Store, this is the UK's largest and most well-understood saline aquifer for carbon storage.

4.3.1 Endurance Store

The Endurance Store is a large anticline, meaning it is an arch shaped convex formation. The crest of the dome is located at a depth of approximately 1,020 m below the seabed surface. The structure is formed above a salt pillow, approximately 25 km long by 8 km wide, oriented northwest to southeast (bp, 2021a). The Store contains highly saline water (approximately 250,000 mg/kg) (bp, 2021b). The CO_2 will be injected into the Triassic-age (approximately 250 to 200 million years ago) Bunter Sandstone Formation within the structural closure of the Endurance anticline.

Primary 'seal' layers are formed of Röt Clay and Röt Halite. These layers, which overlay the Bunter Sandstone formation, enclose the Store and provide the properties required for storage of CO_2. The Röt Clay is the lowermost seal, comprised of approximately 10 m of mudstone, followed by approximately 100 m of Röt Halite (bp, 2021a). Well bore core measurements from the Endurance Store noted the change in porosity and permeability between the

Bunter Sandstone which is the main geological feature of the aquifer in which the CO_2 will be stored, relative to the tight sealing properties of the overlying Röt Clay and the impermeable Röt Halite layers (bp, 2021a).

Studies have demonstrated that the Store and associated overburden (the material above the Store) has:

- Excellent trapping mechanism: the rock architecture of the Store and overlying material provides storage security;
- Seal competence: the impermeable overburden provides storage security, primarily consisting of sealing lithologies such as clay, shales, anhydrites and halite (the minerally occurring form of sodium chloride, or table salt).
- Significant store capacity of about 450 Mt CO_2 due to the size of the Bunter Sandstone 'dome-like' structure; and
- Injectivity: the structure contains pore spaces between sand grains that are filled with saltwater. These pores are large enough (porosity) and connected enough (suitable rock permeability) to allow CO_2 to move through and be stored.

In addition to CO_2 dissolution into formation water[16], geochemical processes operating over hundreds of years on the stored CO_2 further increase storage security: with time, CO_2 can precipitate in mineral form and/or be held by, for example, clay minerals.

The Bunter Outcrop, approximately 20 km east of where CO_2 injection will occur, is an expanse of up to 1.6 km^2 of bedrock exposed to the seabed. At this location, the Bunter Sandstone Formation has been folded up in geological timescales to occur (outcrop) at the seabed due to an underlying geological intrusion (Figure 4-2). The Bunter Outcrop feature has the same geological properties as the rest of the aquifer (bp, 2021a).

[16] *Formation water is water that occurs naturally within the pores of rocks.*

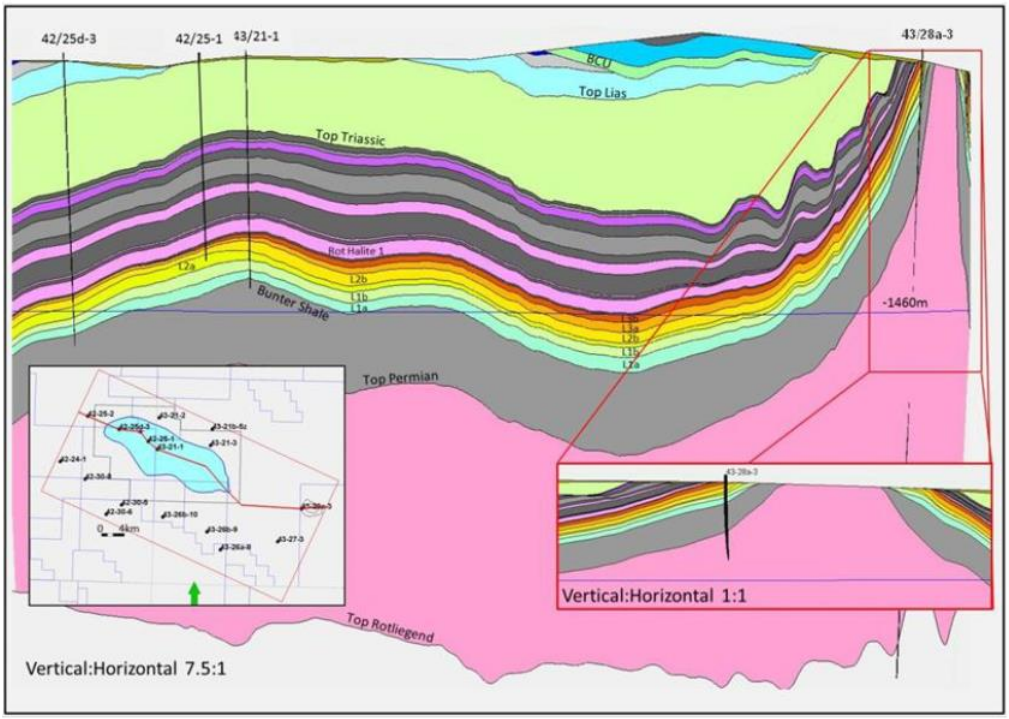

Figure 4-2 - Cross-section through Endurance structure showing Bunter Sandstone Formation occurring at the seabed (©National Grid Carbon Ltd 2021)

4.3.2 Wells

Drilling of the wells into the Endurance Store is expected to commence in 2025 and will be developed in one stage. Five CO_2 injector wells are planned and will be connected to the injection manifold, with up to two wells connected per manifold slot (Section 4.2). The wells will be drilled from a jackup rig due to the water depth of approximately 60 m. One monitoring well will be drilled to monitor the Endurance Store. Each well will have a wellhead and control module (tree) for CO_2 injection, control and well monitoring, within a fishing friendly integrated frame.

Drilling fluids are used to assist in maintaining the drilled hole and to transport the cutting materials out of the hole as drilling progresses from wider diameter to smaller diameter sections of the well. Water based mud (WBM) drilling fluids will be used for the initial sections of each well, the mud and associated cuttings will be discharged at the seabed. WBM drilling fluids contain bentonite and barite, both of which are included on the OSPAR List of Substances Used and Discharged Offshore and which are considered to Pose Little or No Risk to the Environment (PLONOR) (OSPAR, 2019). To reduce the likelihood of the drilling equipment getting stuck and to provide sufficient lubrication between the equipment and the borehole, lower sections of each well will be drilled using synthetic based mud (SBM) drilling fluids. SBM and associated cuttings will be returned to the jackup rig for recycling and disposal onshore.

4.4 Operation

During operations, it is likely that water washing of each well borehole will be required on an annual basis to avoid loss of CO_2 injectivity. No planned discharges to sea will occur during water washing because the wash will be going into the Store with no return. A measurement, monitoring and verification (MMV) plan for the Endurance Store will be developed and agreed with the OGA as part of the storage permitting process. It is anticipated that the MMV plan will include periodic seismic surveys of the Store coupled with continuous well data monitoring to show where CO_2 moves within the formation and inform where CO_2 is injected (Figure 4-3).

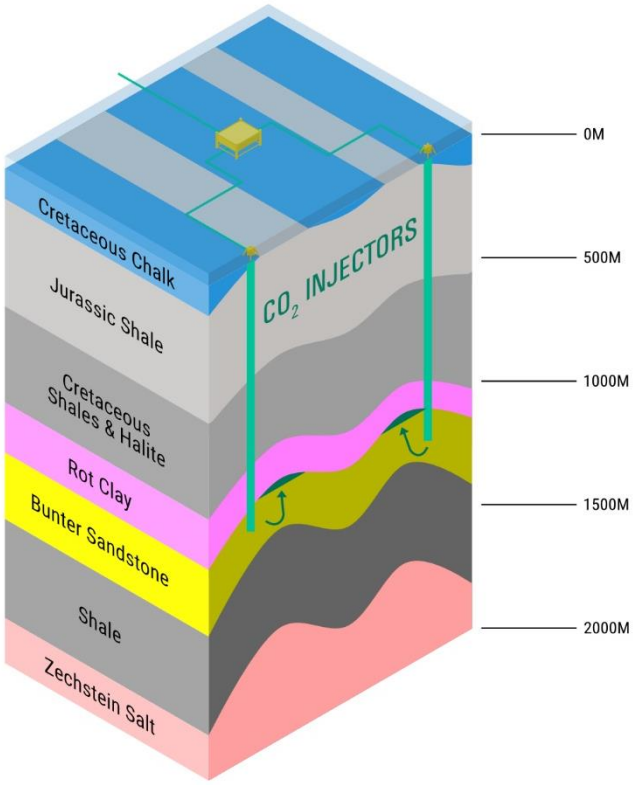

Figure 4-3 - Schematic of CO_2 injection into the Endurance Store

Due to temperatures and depth pressures in the Endurance Store, CO_2 will be in dense phase[17] form. There is the potential for a connection between the aquifer and the seabed. During the operational phase of the Development, it is anticipated that injection into the Store will indirectly displace formation water from the upper 300 m of the Bunter Sandstone Formation into the sea at the Bunter Outcrop location (Section 4.3.1). Assessment of formation water displacement, which is expected to occur from the shallow depths of the outcrop (up to 300 m below seabed), is discussed further in Section 6.3.

[17] *Dense phase means the CO_2 demonstrates properties of both liquid and gas. The dense phase has a viscosity similar to that of a gas, but a density closer to that of a liquid.*

4.5 Development Schedule

bp expects to submit the ES in Q1/Q2 2022 with a view to obtaining approval for the Development in 2023. Based on current schedule estimates, bp expects installation of the pipelines and seabed infrastructure (including manifolds) to commence in 2024 with drilling of the wells into the Endurance Store expected to commence in 2025. First CO_2 injection is anticipated in 2026.

5. ENVIRONMENT DESCRIPTION

The available environmental baseline information is presented in summary here, to inform the high-level review of potential environmental issues provided in Chapter 6. Site specific surveys were undertaken in October – November 2020, covering the Endurance Store and the Bunter Outcrop areas (Gardline 2021a, 2021b) (Figure 5-1). The following site-specific surveys are being undertaken this year and will provide more detailed environmental baseline data to inform the EIA (see Section 7 for further information):

- Teesside and Humber Pipeline corridors – Autonomous Surface Vehicle;
- Teesside and Humber Pipeline corridors and Endurance Store area – survey vessel; and
- Nearshore pipeline route survey using Autonomous Surface Vehicle and survey vessel.

Where site specific data is not currently available, particularly for the Humber Pipeline route, information to inform this study has been drawn from publicly available information sources and the baseline data used to support the Tolmount to Easington Pipeline Offshore Environmental Statement (Premier Oil, 2018). The Tolmount to Easington Pipeline runs within 10 km of the proposed Humber Pipeline from onshore until the Tolmount field, i.e. approximately half the length of the Humber Pipeline.

As part of the ongoing EIA process, the outcome of which will be summarised in the future ES, a review of any newly available regional and local-scale data will be undertaken to enable update of the existing baseline environment description prior to submission. This baseline will focus on providing data relevant to the local environment within which the various components of the Development will be sited.

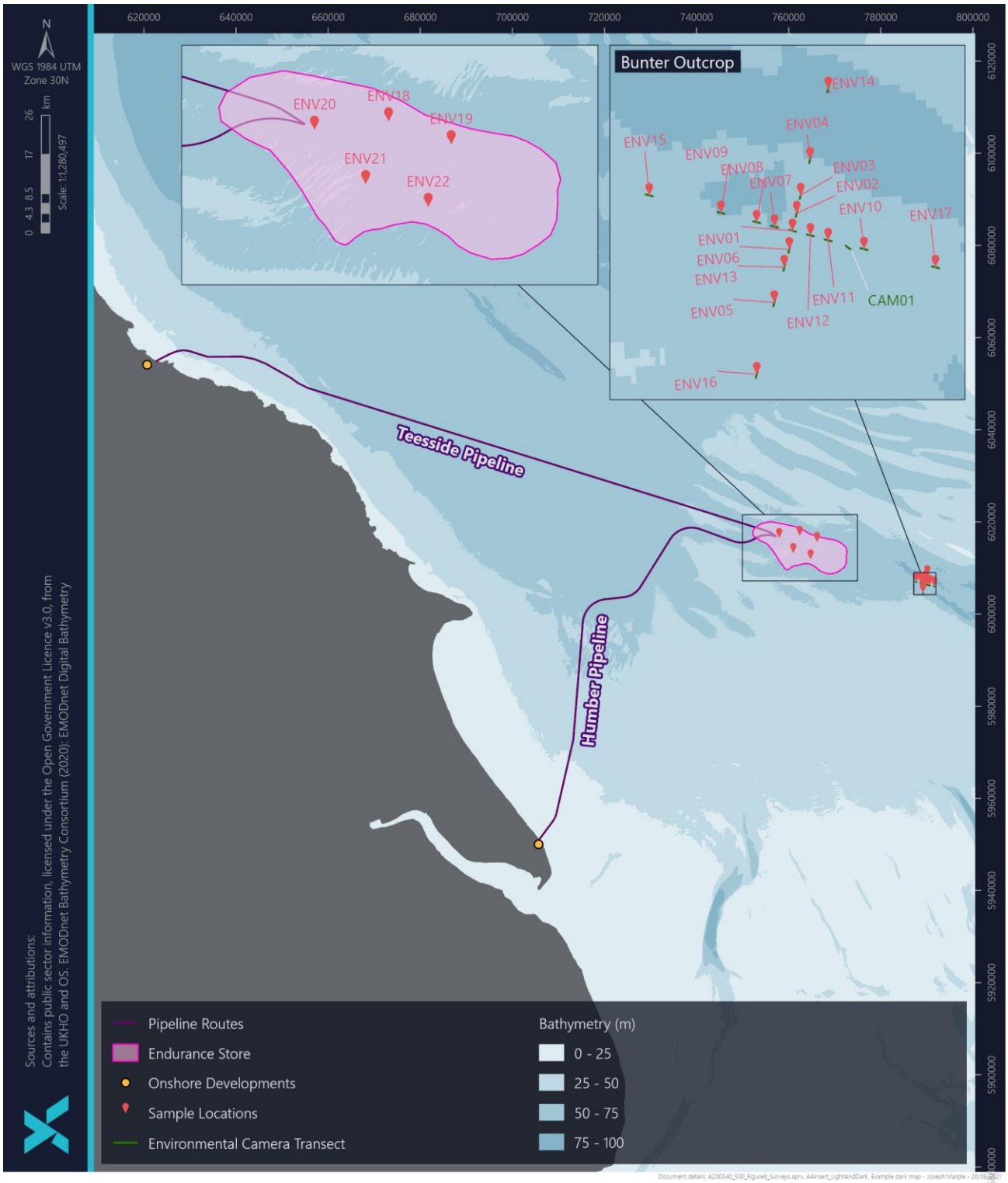

Figure 5-1 - Survey locations at the Endurance Store and Bunter Outcrop

5.1 Physical Environment

5.1.1 Weather and Sea Conditions

The east coast of the UK is relatively sheltered compared to the west. Mean wind speed at the coast is 5-8 m/s during winter and 4-5 m/s during summer (DECC, 2016). Offshore, in Regional Sea 2 where the Endurance Store and Bunter Outcrop are located, winds are predominantly from the south and northwest. Wind speed is most commonly between 1-11 m/s in summer. In winter there is an increased probability of high winds. In January wind speed exceed 14 m/s 20% of the time, while in July these speeds occur only 2-4% of the time (DECC, 2016).

This region of the North Sea is dynamic, characterised by shallow, well-mixed waters, which undergo large seasonal temperature variations. The SNS receives significant freshwater input from the surrounding land masses, making it less saline than other parts of the North Sea and subject to nutrient-rich inputs (DECC, 2009; 2011). Currents in the North Sea circulate in an anti-clockwise direction, driven by inflows from the North Atlantic which travel down the east coast of the UK, and from the English Channel, with outflow northwards along the Norwegian coast.

5.1.1.1 Endurance Store area

A preliminary assessment of metocean conditions for the Endurance Store area and Teesside Pipeline route was undertaken in 2020[18]. Winds occur from all directions but winds from the southwest and west predominate. The maximum annual wind speed is up to 25 m/s. The majority of waves come from the north and reach a maximum significant height of 7 m. The most frequently occurring waves are between 0.5 m and 1 m in height, followed by slightly larger waves between 1 m and 1.5 m in height (Figure 5-2; bp, 2020).

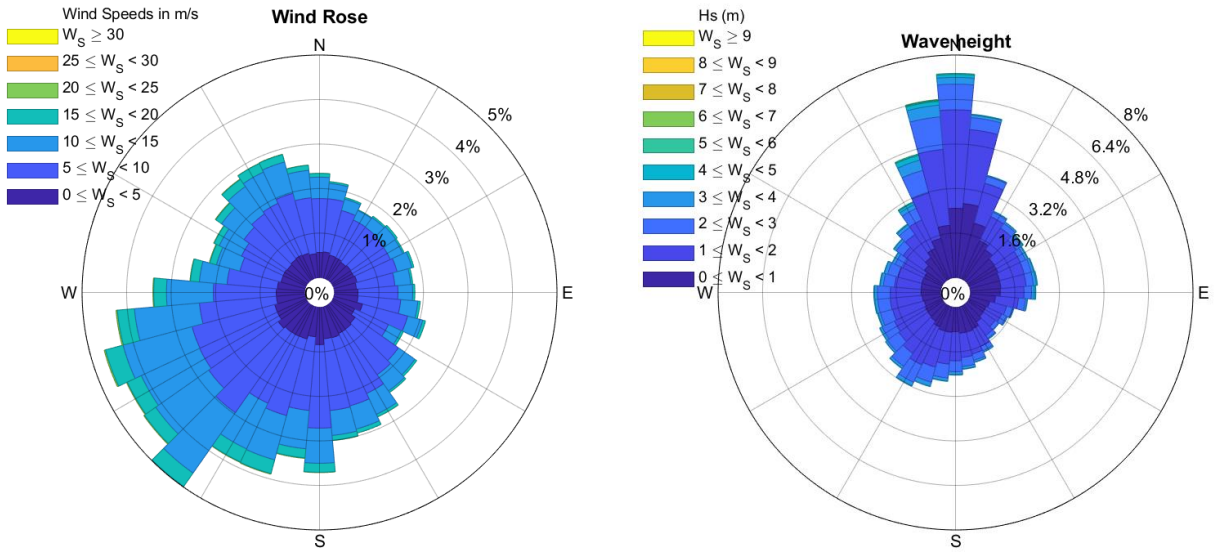

Figure 5-2 - Mean wind direction and speed and mean significant wave height and direction (coming from) at the Endurance Store area (bp, 2020)

[18] *Assessment of metocean conditions for the Humber Pipeline route is still to be completed.*

5.1.1.2 Teesside Pipeline

Modelled surface currents along the Teesside Pipeline route increase with distance from shore. In terms of frequency of occurrence, currents at the shore are most likely to be between 0.1 and 0.4 m/s, compared to nearer the Store where speeds of 0.3-0.5 m/s are most likely (bp, 2020).

Near-bed current directions are predominantly southeast and northwest along the pipeline route.

Modelled sea-surface temperatures along the pipeline route range from 16.4 to 17.6 °C and near-bed temperatures range between 16.5 to 18.1 °C (bp, 2020).

5.1.1.3 Humber Pipeline

No metocean modelling has been undertaken to date for the Humber Pipeline route, therefore data from the Tolmount to Easington pipeline ES is used as a proxy.

Maximum spring and neap tidal currents of 1.3 m/s and 0.6 m/s respectively occur towards the coast, with maximum tidal current speeds occurring on the flood tide. At Spurn Head, less than 10 km south of the Humber Pipeline landfall location, the mean range of the spring tide is 5.7 m and the mean neap tidal range is 2.8 m. Tidal currents in the region are generally quite uniform, except further north where tidal streams run off prominent headlands like Flamborough Head, giving rise to turbulence and eddies on both sides of the headland (Premier Oil, 2018 and references therein).

The mean wave field from 2008 to 2016, measured at the Hornsea wave buoy situated 5 km off Hornsea and located approximately 10 km from the Humber Pipeline, for the months of January, April, July and October showed the most frequent wave direction in all months is north-northeast, followed by northeast then east-northeast in all months but July. The mean significant wave height in the vicinity of the Harbour Energy Humber Gathering System (HGS) Tolmount Normally Unmanned Installation (NUI) platform is 1.49 m, ranging from an average of 1 m in the summer to over 1.9 m in the winter (Premier Oil, 2018 and references therein).

5.1.2 Bathymetry

5.1.2.1 Endurance Store area

Across the Endurance Store area, water depth varies from 40.1 m lowest astronomical tide (LAT) to 63.8 m LAT in a depression to the north (Gardline, 2021a). The seabed in the area is mostly flat (gradients of less than 1°), with the exception of prominent sandwaves which are abundant across the site.

The seabed topography is highly irregular across the Bunter Outcrop with water depth varying between 47.8 m LAT atop a ridge in the southwest, and 86.8 m LAT within a large depression in the northeast (Gardline, 2021a).

Within the centre of the Bunter Outcrop lies a section of exposed sandstone bedrock which stands up to 15 m above the surrounding seabed comprising multiple outcrops between 0.05 to 2.5 km in length. Seabed gradients across the area surveyed were generally less than 3°, although localised gradients up to 20° were observed around the central outcrop of bedrock (Gardline, 2021a).

5.1.2.2 Teesside and Humber Pipeline

A site specific geophysical and benthic survey of the pipeline routes is being undertaken in 2021 to inform project design and the EIA.

Water depth in the SNS is particularly shallow, with water depths mostly less than 50 m (DECC, 2009). Water depths generally reduce towards land, albeit with minor undulations (Figure 1-2).

Under the English Marine Plans, each Marine Plan area is apportioned into Marine Character Areas (MCAs). Within the North East Marine plan, MCA 24 for the Breagh Oil and Gas Field, within which much of the Teesside Pipeline is located, describes an undulating marine plain approximately 50 to 70 m in depth, deeper in the north (MMO, 2018).

Studies for the Tolmount to Easington Pipeline identified megaripples in sandier sediments which were absent closer to shore. Orientation of the megaripples was northeast to southwest, wavelength ranged from 2 m to 20 m and amplitude ranged from <0.2 m to 0.5 m. Ridges were identified approaching the inshore region, often associated with escarpments and orientated in the same direction. The slopes of the ridges were steeper on the south-west faces, and the heights ranged from 0.5 m to 3 m above the surrounding seabed (Horizon Geosciences, 2018) (Premier, 2018).

5.1.3 Seabed Sediments and Features

The benthic environment in the SNS is largely sedimentary, consisting mostly of sand or muddy sand with significant areas of coarse sediment and occasional outcropping bedrock closer to shore (DECC, 2009; JNCC, 2010a). Seabed features in the SNS include active sandbanks and sandwaves (DTI, 2001), which are maintained by the tidal and the current regime described in Section 5.1.1. Examples of such features include the North Norfolk sandbanks, active systems that are thought to be progressively elongating in a northeasterly direction and which are maintained and developed by sediment transported offshore, and the less active Dogger Bank, a large sublittoral sandbank formed by glacial processes before being submerged through sea level rise (DECC, 2009).

5.1.3.1 Endurance Store area

Surveys of the Endurance Store area indicate the sediment consists of predominantly loose to medium dense sand. Coarser sediment lies in the troughs between sandwaves (Gardline, 2021a). The uppermost sedimentary unit within the Endurance Store area becomes more gravelly at the base where it sits atop older deposits.

Surface sediments were found to be homogenous in comparison to those at the Bunter Outcrop where sand waves occurred. Mean particle diameter varied from 270 µm (ENV21) to 419 µm (ENV22) (see Figure 5-1 for sampling locations). Under the Wentworth (1922) classification system, all samples were considered medium sand. Fines content ranged from 0% to 7.6% across samples with gravel contributing between 0.3% to 9.9% (Gardline, 2021a).

A number of boulders and debris items populate the seabed and magnetic anomalies indicated the presence of well 43/21-1 or 42/25-1, both of which had previously been drilled for exploration (1970 and 1990 respectively) but have been plugged[19] in line with OGA requirements and are no longer in use (Gardline, 2021a).

Some sandwaves are observed, being oriented northeast to southwest with heights of up to 8 m and local gradients of up to 11°. Megaripples superimposed on the sandwaves are typically less than 0.5 m in height and are absent from within the troughs between sandwaves (Gardline, 2021a).

Surveys at the Bunter Outcrop indicate that the sediment is predominantly medium to coarse silty sand with areas of coarser gravelly sands, additionally characterised by sandwaves, particularly in the south of the survey area. The sediment layer was at its thickest in the centre of the survey area among the sandstone outcrops. This

[19] *Made incapable of flowing*

uppermost sediment layer had, in places, a depth of up to 18 m below the seabed. Sediment was between 1 and 8 m thick in the north of the site but present as only a thin veneer in the south (Gardline, 2021a). Sandwaves are oriented in a north-south direction and are up to 3 m in height with gradients up to 7°. Megaripples were superimposed on the sandwaves and rarely exceeded 0.5 m in height (Gardline, 2021a).

The presence of sandwaves and megaripple at the Endurance Store area and the Bunter Outcrop are indicative of active sediment transport mechanisms which are described further in Section 5.1.4.1

As part of the survey, particle size analysis (PSA) identified varied grain sizes and contribution of fines (particles of a size less than 63 µm) and gravel (greater than 2 mm) across the site. Mean particle diameter across the Bunter Outcrop area varies from 164 µm (ENV09) to 604 µm (ENV06) (see Figure 5-1 for sampling locations).

The survey identified three distinct sediment groups at the Bunter Outcrop (Gardline, 2021a):

- Moderately well/moderately sorted medium sand. These stations had low fines content (less than 2%) and negligible gravel content (less than 1%), therefore were largely sand.
- Increased fines content (6% to 23%) but low gravel content (less than 3%). These sediments were considered poorly sorted and were classed under the Folk (1954) classification as sand, muddy sand or slightly gravelly muddy sand.
- Poorly sorted gravelly muddy sand under the Folk classification, with fine 11% to 17% and gravel 7% to 19%. All but one station was classed as medium sand; ENV13 was considered coarse sand.

Boulders were identified at numerous points across the Bunter Outcrop area (Gardline, 2021a).

5.1.3.2 Teesside and Humber Pipelines

Data from the EUSeaMap (EMODnet, 2019) indicates that the majority of the offshore sections of both pipeline routes are characterised by sandy and coarse sediments. Notably, small areas of faunal communities on deep low energy circalittoral rock (A4.33) are present along the Teesside Pipeline route. Similarly, British Geological Survey data indicate a progression from sandy mud, gravelly sand, sandy gravel, muddy sandy gravel along the majority of both pipeline routes (NMPi, 2021)

Surveys conducted to support the nearby Tolmount to Easington Pipeline ES reported that the seabed along the majority of the proposed Tolmount pipeline route was found to comprise a thin veneer of sand and gravel, interpreted to be Holocene deposits overlying the Bolders Bank Formation. The seabed in the nearshore survey area was generally irregular, with a rough texture; interpreted as outcropping of the Bolders Bank formation at the seabed surface (Premier Oil, 2018).

Boulders were the most common seabed feature, occurring either on the seabed or partially buried throughout much of the survey corridor. Boulders were observed to be sparse offshore, becoming numerous in the 20 km region approaching landfall (Premier Oil, 2018)

The biotope classifications across the Development area will be confirmed through site-specific surveys (Section 7).

5.1.4 Sediment Transport

5.1.4.1 Endurance Store area

Studies completed across the wider SNS region indicate a north to northwest directed sediment transport pathway across the offshore locations covered by the Endurance Store are. Conversely along the coast and nearshore areas, there is southerly directed sediment transport pathway (HR Wallingford, 2002). More detailed modelling of the influence of tidal residual flow associated with contributions from waves, indicated a much more complex and dynamic sediment transport pattern.

The seabed across the Endurance Store area comprises sandwave and megaripple features, with heights of up to 8 m and gradients that would indicate active movement of these features (Gardline, 2021a). With the orientation of these sandwave features varying between north – south and northeast – southwest across the store area (Section 5.1.2.1) further highlights the dynamic and variable patterns of sediment movement across this offshore location.

5.1.4.2 Teesside Pipeline

The Teesside Pipeline landfall is located within the Coastal Cell 1, part of a region-wide coastal monitoring programme which collates information on coastal change and which extends between St Abb's Head, Scotland and Flamborough Head. The coastline and nearshore seabed along this coastal cell are predominantly controlled by the underlying geological structure, which creates a series of typically sandy bays between harder rock headlands. Sediment transport processes along the frontage are through longshore transport processes in the nearshore, with cross-shore sediment movement particularly in relation to seasonal environmental patterns. Where individual bays exist, longshore transport is generally well-confined within these along the coastal cell frontage (Scarborough Borough Council, 2014).

Elsewhere along the more open coast that characterises the Teesside Pipeline landfall, sediment transport is predominantly to the south, where drift rates are relatively low and temporary drift reversals can occur along frontages under short-duration storm events from different directions. Sediment transport is also strongly influenced by changes in orientation of the shore profile and the angle of the shore relative to the approach directions that characterise the nearshore wave climate. There are complex physical process effects in the lee of major headlands (e.g. Hartlepool Headland, Scarborough Castle Headland) and significant shore-perpendicular structures (e.g. North and South Gare Breakwaters, Whitby Harbour Piers) which have localised effects on sediment transport directions and rates. Cross-shore sediment exchange is also of great importance to the frontage along the coastal cell, with many beaches experiencing significant onshore-offshore transport during storm events. During periods of energetic storm events, material is being drawn down the beach to the lower foreshore and nearshore zone, where it can become entrained by tidal currents and advected along the coast, generally in a southerly direction in line with the dominant sediment transport direction (Scarborough Borough Council, 2014).

In general, beach sediment slowly and progressively returns to the upper foreshore as conditions become calmer, leading to beach recovery. Therefore, it is wave-generated forces that dominate longshore transport in this region, with tidal currents having little effect in the mobilisation of sediments. Generally, sediment volumes involved in such short-term cross-shore transport can be greater – in many cases orders of magnitude greater – than the net alongshore sediment transport potential. It is likely that during storms sediment is removed from the beaches as a cross-shore process and then transported alongshore (predominantly to the south) in the shallow nearshore zone.

After the stormier wave climate has passed, the sediment then progressively returns to the beaches as a cross-shore process (either within the same bay or further south along the coast after bypassing a headland) during calmer wave conditions (Scarborough Borough Council, 2014).

5.1.4.3 Humber Pipeline

The Humber Pipeline landfall is located within Coastal Cell 2, which extends between Flamborough Head to Gibraltar Point at the mouth of The Wash. The Holderness coast is one of Europe's fastest eroding coastlines, receding landwards at a rate of between 1.5 and 2 m/year (ERYC, 2017). Persistent wave and tidal energy from the North Sea drives the erosion of both the soft glacially deposited boulder clay cliffs backing the beach, and the cohesive shore platform (clay substrate) and overlying beach sediments on the foreshore.

Cliff erosion produces up to 1,000,000 m^3 of sediment annually, while erosion of the clay foreshore produces up to a further 2,000,000 m^3 per year, meaning annual sediment production totals up to 3,000,000 m^3 (ERYC, 2017). Once the eroded cliff and beach sediments are entrained by the sea, they are transported by a combination of wave and tidal forces. In the nearshore, the dominant northeasterly wave propagation direction drives transport, moving sediment to the south. In offshore locations, tidal currents dominate, with the flood-ebb inequality likewise producing a net movement to the south in line with the tidal residual in this part of the SNS (Premier Oil, 2018).

A comprehensive study of the sediment transport of the SNS was undertaken, including numerical modelling and field campaigns to better characterise offshore sediment transport for regions such as the Holderness coast (Wallingford *et al.*, 2002). The study produced estimates of sediment transport volumes and major transport pathways. The sediment transport process along this frontage is a cycle of cliff erosion providing sediment inputs into the beach and nearshore zone, which are gradually transported to the south and offshore over a period of time. The potential longshore sediment transport rate for sand was calculated at between 200,000 and 350,000 m^3/year. Transport rates are highest during major storm events, and within about 2 km of the shore (HR Wallingford *et al.*, 2002). The same process of changing beach-nearshore cross-shore profiles associated with stormier energetic conditions and calmer seasonal variations is also prevalent along the coastal frontage (Premier Oil, 2018).

5.1.5 Coastal Properties

5.1.5.1 Teesside Pipeline

The coastal properties along Coastal Cell 1 comprise a series of geologically controlled embayments with sections of open coast. In proximity to the Teesside Pipeline landfall at Coatham Sands, long term trends in the beach profile show that along the upper beach, dunes systems are prevalent, much of which are stable or even accreting seawards (Natural England, 2018a). Accretion is particularly prominent in the west of the Coatham area (Redcar and Cleveland Council, 2021). Overall, beach levels at Coatham Sands remain high in 2021 compared to the range recorded in previous surveys (Redcar and Cleveland Council, 2021). The dunes at Coatham have been influenced by historic slag deposition from local industrial works (Scarborough Borough Council, 2018).

Currently, the Shoreline Management Plan (SMP) covering Coatham Sands proposes no active intervention (NAI) as part of future management. At Coatham East, hold the line (HTL) defence is proposed at the Redcar frontage. This may lead to losses of sand at the foreshore which may in turn have a possible ecological consequence on the terrestrial coastal habitats and species (Scarborough Borough Council, 2017).

5.1.5.2 Humber Pipeline

Based on the SMP for the Coastal Cell 2 (Humber Estuary Coastal Authorities Group, 2010), the coastal properties along Cell 2 comprise five main components, which include:

- Chalk cliffs (Flamborough Head to Sewerby);
- Holderness cliffs (Sewerby to Kilnsea);
- Spurn Head;
- Outer Humber; and
- Lincolnshire coast (Donna Nook to Gibraltar Point).

The Humber landfall intersects with the Holderness Cliffs and is in proximity to Spurn Head. Based on the SMP for this stretch of coast, the level of coastal defence and intervention is variable according to the level and type of local land use and coastal processes exhibited in the area. The cliffs along the Holderness coastline are actively eroding with cliff collapse and recession frequently recorded. These 'soft' cliffs are eroding rapidly at approximately 1.8 m per year; a process which has been ongoing since the end of the last ice age. This erosion occurs through repeated landslide activity (Humber Estuary Coastal Authorities Group, 2010). The rapid erosion is attributed to wave activity coming from the northeast, which is also the direction of the longest fetch; this combined with the geology of the cliffs is responsible for the differential rate of erosion along the Holderness coast, in comparison to the harder chalk headland of Flamborough Head to the north (Curriculum Press, 2003). The cliffs primarily comprise of mud at up to 67%, and are a main source of suspended sediment regionally. As discussed in Section 5.1.4.3, this sediment is transported south by longshore drift (Humber Estuary Coastal Authorities Group, 2010; Tappin *et al.*, 2011). While finer sediments are likely to travel down to the Lincolnshire coast, larger sediment sizes, such as gravels, are unlikely to cross the Humber mouth. At certain locations along the coastline coastal defences protect the cliffs, such as at Easington (Humber Estuary Coastal Authorities Group, 2010). There is a HTL for current defences along the Cell 2 frontage, while a NAI occurs everywhere else, with the exception of Spurn Head, which has managed realignment (MA) in the short-term and MA/NAI in the medium to long-term. In proximity to the Humber landfall at Easington, there is a HTL in place. However, this is due to be reviewed in 2025 (Humber Estuary Coastal Authorities Group, 2010).

5.1.6 Water Quality

5.1.6.1 Endurance Store area

Survey and analysis of water quality at the Endurance Store area was completed as part of the integrated site survey. The work included analyses of total organic compounds (TOC), total inorganic carbon (TIC), nutrients, suspended solids, total hydrocarbons (THC), poly aromatic hydrocarbons (PAH), phenols and metals (Gardline, 2021a). A summary of the results for each are presented below:

- TOC, TIC, Nutrients and Suspended solids: Concentrations of TOC, nitrate and total suspended solids (TSS) were generally below their respective limit of detection (LOD). The few exceptions were at low levels.
- THC, PAH and phenols: Concentrations of THC were generally below 6.4 μgL^{-1}, with a few exceptions. All concentrations of PAHs and 16 priority concentrations were below the LOD at <1 μgL^{-1} for each target compound, indicating PAH levels were negligible. All phenols were below their respective LOD.

- Metals: Concentrations of most of the tested metals were below their respective LOD. This included mercury (Hg), nickel (Ni), tin (Sn), aluminium (Al), beryllium (Be), copper (Cu), iron (Fe), lead (Pb) and zinc (Zn). Levels of arsenic (As), barium (Ba), cadmium (Cd), chromium (Cr), cobalt (Co), lithium (Li), magnesium (Mg), manganese (Mn), selenium (Se), strontium (Sr) and vanadium (V) were all detected, although these were at low levels.

5.1.6.2 Teesside Pipeline

The Teesside Pipeline passes through the Tees Coastal water body (GB650301500005), designated under the Water Framework Directive (WFD), and approximately extends from Hartlepool in the north to Runswick Bay in the south and out to 3 nm offshore (approximately 5.6 km). Tees Coastal is classified as being a heavily modified water body (HMWB), since it supports coastal protection, flood protection and navigation, ports and harbours. The water body has a 'Moderate' overall status with a 'Good' performance against chemical standards but a 'Moderate' status against ecological standards (Environment Agency, 2021a). The water body aims to achieve a target status of 'Good' by 2027. The water body is not monitored for harmful algae and it does not have a phytoplankton classification. There are no WFD mitigation measures currently in place for the Tees Coastal water body (Environment Agency, 2021a).

Protected sites along the coast of this Tees waterbody have variable conditions that are reflected across the range of water-dependent protected sites within the Northumbria river basin district. There are no designated shellfish waters (under the WFD) along the Teesside coast (MagicMap, 2021). No Nitrate Vulnerable Zones (NVZs) are located along the Teeside coast, although these occur much further inland.

5.1.6.3 Humber Pipeline

The Humber Pipeline runs through the Yorkshire South Coastal WFD water body (GB640402491000) prior to landfall. The water body runs from Flamborough Head in the north to Spurn Point in the south. Yorkshire South is also considered an HMWB, since it supports coastal protection, flood protection and navigation, ports and harbours. It is currently classified as having a 'Moderate' overall status with a 'Good' performance against chemical standards but a 'Moderate' status against ecological standards (Environment Agency, 2021a). The target water body status aimed for in 2027 is 'Good'. The water quality phytoplankton and harmful algae classification is 'High', but the water body is not monitored so there is no known history of harmful algae. There are no WFD mitigation measures currently in place (Environment Agency, 2021a). Just under half of the water-dependent protected areas within the Humber river basin district are considered to be in an unfavourable declining condition, some of which may apply to coastal sites (Environment Agency, 2015b). The Humber river basin district is much smaller than that of the Northumbria basin, where the Teesside Pipeline landfall is located, and proportionately less of the area is in unfavourable declining (or worse) condition. There are no WFD designated shellfish waters along the Humber coast (MagicMap, 2021). NVZs are located along the full length of the Holderness coast and are present along almost the whole extent of the Humber and inland along the Rivers Trent and Ouse (Environment Agency, 2021b).

5.2 Biological Environment

5.2.1 Plankton

Phytoplankton abundance in the SNS fluctuates less than in the Central North Sea (CNS) and Northern North Sea (NNS). The influences of coastal water (refer to Section 5.1.5) are particularly marked in Regional Sea 2 where the Development is located, resulting in turbid water and a characteristic phytoplankton composition (DECC, 2016).

As described in the SEA3 report (DECC, 2016), due to the dynamic environment, with considerable tidal mixing and eutrophication there is relatively little stratification throughout the year and constant replenishment of nutrients, so opportunistic organisms such as diatoms are particularly successful (Margalef 1973, cited in Leterme *et al.* 2006). Diatoms comprise a greater proportion of the phytoplankton community than dinoflagellates from November to May, when mixing is at its greatest (McQuatters-Gollop *et al.* 2007). The phytoplankton community is dominated by the dinoflagellate genus Ceratium, along with higher numbers of the diatom Chaetoceros, than are typically found in the NNS. Harmful Algal Blooms (HABs) caused by *Noctiluca* spp. are often observed in the region (DECC, 2016).

The zooplankton community in the region comprises *C. helgolandicus* and *C. finmarchicus* as well as *Paracalanus* spp., *Pseudocalanus* spp., *Acartia* spp., *Temora* spp. and cladocerans such as *Evadne* spp. Commonly seen jellyfish in the region include *A. aurita* and *Chrysaora hysoscella* (Pikesley *et al.* 2014). There has been a marked decrease in copepod abundance in the SNS in recent years (Edwards *et al.* 2013), possibly linked to the North Atlantic Oscillation (NAO) index, which has a significant impact in the SNS, where the interface between the atmosphere and the sea is most pronounced (Harris *et al.* 2013).

5.2.2 Benthos

The biotope classifications and presence of sensitive or protected features across the Development area will be confirmed through site-specific surveys. These are yet to be conducted for the pipeline routes (Section 7) and therefore Section 5.5.2.2 relies on EUSeaMap (2019) and data from the Tolmount to Easington Pipeline ES (Premier Oil, 2018)[20].

5.2.2.1 Endurance Store area

Fauna abundance and diversity across the Endurance Store area (example image, Figure 5-3) was relatively low, consisting mainly of Annelida (Polychaeta); Arthropoda (Paguridae); Echinodermata (Asteroidea); Mollusca (Pectinidae), Chordata (Callionymidae, Pleuronectiformes) and Porifera (Gardline, 2021a). *Sabellaria spinulosa* are protected as 'biogenic reefs' under Annex I of the Habitats Directive[21]. The *S. spinulosa* observed showed no resemblance to biogenic reef and it was concluded that the seabed was unlikely to support the 'sea pen and burrowing megafauna communities' habitat. Sponges (Porifera) did not constitute a significant sponge aggregation. *Arctica islandica* is a long-lived bivalve mollusc which has a very slow growth rate. It is featured on the OSPAR (2008) list of threatened and/or declining species. However, it is commonly found throughout much of the North Sea. Possible *A. islandica* were identified at one location within the Endurance Store area.

At the Bunter Outcrop locations (example image, Figure 5-3) where the seabed was sandy and homogenous, observed numbers of fauna were relatively low. Comparatively, where the seabed consisted of gravelly sand with cobbles and boulders were characterised by higher faunal density, notably Hydrozoa and *Alyonium digitatum* (Gardline, 2021a). Small, isolated patches of possible *Sabellaria sp*. tubes were observed on still images but these were considered unlikely to resemble *S. spinulosa* reef. Burrows were frequently observed at the Bunter Outcrop but it was determined that the seabed was unlikely to support the 'sea pen and burrowing megafauna communities' habitat (Gardline, 2021b). Sponges were observed at some of the survey sample locations but it is unlikely that a

[20] *UKBenthos has not been updated for recent pipelines into Easington.*
[21] *The UK legislation transposing the EU Habitats Directive has been changed so that it continued to operate effectively from 1 January 2021. The changes were made by the Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019.*

significant sponge aggregation habitat is present at the Bunter Outcrop (Gardline, 2021b). Possible *A. islandica* were identified at one location within the Bunter Outcrop area.

ENV10 sample station at the Bunter Outcrop

ENV21 sample station at the Endurance Store area

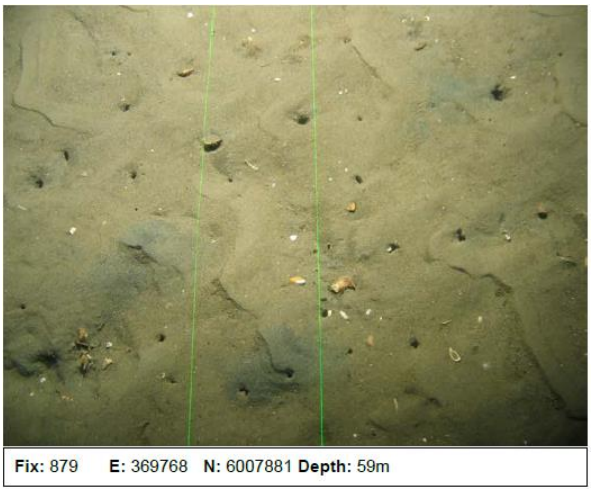

Figure 5-3 - Images of the seabed at the Bunter Outcrop and Endurance Store

5.2.2.2 Teesside and Humber Pipelines

Data from EUSeaMap (2019) indicates that the majority of the offshore sections of both pipeline routes are characterised by the 'deep circalittoral sand' biotope (A5.27), progressing into 'deep circalittoral coarse sediment' (A5.15) and 'circalittoral coarse sediment' (A5.14) towards the shore. Small areas of 'mixed sediment' are present along, or in close proximity to both routes, with an increase in sandy sediment types on approach to the Teesside Pipeline landfall location. Notably, small areas of 'faunal communities on deep low energy circalittoral rock' (A4.33) are infrequently present along the Teesside Pipeline route.

The Tolmount pipeline site specific surveys reported offshore sediments predominantly comprising megarippled gravelly sands, corresponding to the EUNIS biotope complex 'circalittoral coarse sediment' (A5.14). These areas generally supported a sparse scour tolerant epifauna including brittle starts, anemones, occasional encrusting and short turf-forming species such as serpulid polychaetes, barnacles, bryozoans, hydroids, and more mobile forms e.g. common starfish, small crabs and fish. One area along the Tomount pipeline route ~25 km offshore supported a significant presence of the Ross worm *Sabellaria spinulosa*, such that it was considered to be EUNIS habitat A5.611 '*Sabellaria spinulosa* on stable circalittoral mixed sediment'. Reefs formed from *S. spinulosa* are protected as 'biogenic reefs' under Annex I of the Habitats Directive, however no stations were interpreted to support medium quality reef, or better, overall. Furthermore, 3 areas showing medium resemblance to stony reef, a habitat listed as a potential driver for the creation of SACs under Annex I of the Habitats Directive, qualified as stony reef as defined by European Commission (2013) (Premier Oil, 2018). These areas were distributed along the Tolmount pipeline route.

5.2.3 Fish

5.2.3.1 Endurance Store area

A number of commercially important fish species occur in the vicinity of the Endurance Store area which is located in a nursery area for herring *Clupea harengus*, lemon sole *Microstomus kitt*, sandeel *Ammodytes marinus*, sprat *Sprattus sprattus*, anglerfish *Lophius piscatorius*, blue whiting *Micromesistius poutassou*, mackerel *Scomber scombrus*, European hake *Merluccius merluccius*, and spurdog *Squalus acanthias*. In addition, the Endurance Store is located in high intensity nursery areas for cod *Gadus morhua* and whiting *Merlangius merlangus* (Coull *et al.*, 1998; Ellis *et al.*, 2012).

Of the species which may be present in the Store area, cod and spurdog are on the OSPAR (2008) List of Threatened and/or Declining Species and Habitats. Spurdog is additionally globally classed as vulnerable under the IUCN Red list.

Spawning grounds are generally regarded as having higher sensitivity than nursery areas. The Endurance Store is located within spawning grounds for the following species: cod, lemon sole, sprat and whiting. The Endurance Store area also overlaps a high intensity spawning location for plaice *Pleuronectes platessa* and sandeel. Peak spawning for plaice occurs from January to February. For cod, peak spawning is between February and March and peak spawning for sprat is from May to June (Coull *et al.*, 1998; Ellis *et al.*, 2012). Although there is fish spawning and nursery activity in the vicinity at certain times of the year, the spawning and nursery areas are part of larger offshore areas. Spawning locations may vary spatially and temporally from year to year (Cefas, 2001, Coull *et al.*, 1998, Ellis *et al.*, 2012).

A review of available data on juvenile fish was undertaken by Aires *et al.* (2014), taking into account the findings of Ellis *et al.* (2012) and Coull *et al.* (1998) together with findings from the National and International Bottom Trawl Surveys, the Beam Trawl Survey, International Herring Larval Surveys and other standalone surveys. The findings summarise the probability of aggregations of group 0 fish (those in the first year of their lives) around the UKCS. Within the Store area and surroundings, there is a low probability of juvenile plaice, sole, whiting, haddock, cod, sprat, herring, hake, angler fish, mackerel, horse mackerel, Norway pout and blue whiting (Aires *et al.*, 2014).

Individuals of sandeels (*Ammodytes* sp.) were identified within sediment samples taken at the Bunter Outcrop. Sandeel species are listed as Features of Conservation Importance (FOCI) in relation to the UK's Marine Conservation Zone (MCZ) network.

The basking shark *Cetorhinus maximus* is classed as vulnerable on the IUCN Red list and is protected under the Wildlife and Countryside Act 1981 (as amended). Basking sharks are seasonal visitors to British waters and are predominantly sighted off the west coast of the UK (Basking Shark Trust, 2021). The Store area is considered to be of low importance for basking sharks.

5.2.3.2 Teesside Pipeline

Along the Teesside Pipeline, the species using the area as nursery grounds and for spawning are much the same as for the Endurance Store area with a few exceptions. European hake are exclusively found further offshore therefore, while they are found at the Endurance Store area, they are not noted as using the area along the Teesside Pipeline for spawning or as nursery grounds (Coull *et al.*, 1998; Ellis *et al.*, 2012). Additional to the other species present at the Endurance Store area, *Nephrops*, plaice and ling *Molva molva* may be present at points along the Teesside Pipeline using the area as nursery grounds. *Nephrops* also use the area for spawning grounds

further north, overlapping with the Teesside Pipeline close to landfall (Coull *et al.*, 1998; Ellis *et al.*, 2012). *Nephrops* spawn all year round but peak between April and June (Coull *et al.*, 1998).

5.2.3.3 Humber Pipeline

The same species are present along the Humber Pipeline as at the Endurance Store area with the exception again of European hake. Common to both pipelines (and absent from the Endurance Store area) plaice use the area along the pipeline route for nursery grounds, (Coull *et al.*, 1998; Ellis *et al.*, 2012). With regards to species which may use the area for spawning, sole *Solea solea* are unique to the Humber Pipeline. They are recorded as being present along the coast south of Flamborough and peak spawning effort occurs in April (Coull *et al.*, 1998; Ellis *et al.*, 2012).

The Humber Pipeline landfall at Easington is located approximately 3 km from the Humber Estuary SAC which is noted for the presence of river lamprey *Lampetra fluviatilis* and sea lamprey *Petromyzon marinus* which breed in the River Derwent, a tributary of the River Ouse, which flows into the Humber Estuary.

5.2.4 Marine Reptiles

Of the seven species of marine turtle which occur globally, five have been recorded in UK waters. The majority of records in UK waters are for leatherback turtle *Dermochelys coriacea* (DECC, 2016). Most sightings occur around the west and south coasts of Ireland, southwest England, northwest Wales and the Irish Sea (National Biodiversity Network Atlas, 2021; Reeds, 2004). The British Isles and Republic of Ireland Marine Turtle Strandings and Sightings Report (Penrose *et al.*, 2021) indicates there was a single sighting or stranding event between 2010 and 2020 along the English east coast, approximately 40 km south of Teesside. It is therefore considered unlikely that turtles will be observed in the vicinity of the Development. No other species of marine reptile are recorded in the North Sea.

5.2.5 Birds

Of the seabird species which breed regularly in Britain and Ireland, fulmar *Fulmar glacialis*, cormorant *Phalacrocorax carbo*, shag *Phalacrocorax aristotelis*, gannet *Morus bassanus*, three species of auk, six species of gull and five species of tern breed around the North Sea coast of England (DTI, 2001). Seabird colonies support nationally and internationally important populations at the Farne Islands, Coquet Island, the coastline from Scremerston near Berwick-Upon-Tweed in the north to Blyth in the south and at Flamborough Head and Bempton Cliffs.

According to the seabird density maps provided in Kober *et al.* (2010), the following species have been found in the Development area at relatively high densities: northern fulmar (breeding: March to July, and wintering (August to February); northern gannet (wintering: October to April); pomarine skua *Stercorarius pomarinus* (March to June and August to November); Arctic skua *Stercorarius parasiticus* (breeding: May to August; moulting: September to November); great skua *Stercorarius skua* (wintering: September to April); black-legged kittiwake *Rissa tridactyla* (wintering: October to April); little gull *Hydrocoloeus minutus* (breeding: May to June, additionally August to November); great black-backed gull *Larus marinus* (breeding: April to August, and wintering: September to March); common gull (breeding: May to August); herring gull *Larus argentatus* (wintering: September to March); glaucous gull (wintering: October to March); common tern (breeding: May to September); common guillemot *Uria aalge* (August to September; wintering: October to April); razorbill *Alca torda* (breeding: May to June; wintering: October to April); little auk (wintering: November to March); and Atlantic puffin *Fratercula arctica* (wintering: August to March).

Across all species, there appears to be a relative hotspot associated with breeding activity offshore at the Endurance Store area. Summer activity also peaks in the south of the Endurance Store area with bird density reaching up to 171 individuals/km^2. In both summer and winter, increased densities appear along the coast just north of Teesside (Kober *et al.*, 2010).

Additionally, the Red-throated diver *Gavia stellata* can be present all year round in the SNS (Skov et al., 1995) but is typically most abundant between October and March (Stone et al., 1995; Lawson et al., 2016). Common scoter *Melanitta nigra* is typically most abundant in the Greater Wash between October and March (Lawson et al., 2016) although low densities can occur between July and September in the SNS (Stone et al., 1995). Sandwich tern *Thalasseus sandvicensis* is generally present in the SNS between April and August (Stone et al., 1995). Common tern *Sterna hirundo* is typically present in the SNS between April and September (Stone et al., 1995). Little tern *Sternula albifrons* is most observed between April and June with fewer observation between July and October (Stone et al., 1995). Red knot *Calidris canutus* has peak density during winter and the Common redshank *Tringa tetanus* during migration in spring and autumn (JNCC, 2008).

Study work (Section 7) will be conducted as part of the EIA to provide more detailed site-specific characterisation of ornithological conditions in the Development area, including the protected status of individual species and their relation to protected sites.

5.2.6 Marine Mammals

5.2.6.1 Pinnipeds

Both grey seal *Halichoerus grypus* and harbour seal *Phoca vitulina* are resident in UK waters and are found on the east coast of England. Out to 12 nm, grey and harbour seals are protected under The Conservation of Seals Act 1970, the Wildlife and Countryside Act 1981 and the Conservation of Habitats and Species Regulations 2017. Beyond 12 nm they are protected under the Conservation of Offshore Marine Habitats and Species Regulations 2017. Both species feed both inshore and offshore depending on the distribution of their prey, which varies seasonally and annually. Both species tend to be concentrated close to shore, particularly during the pupping and moulting season.

Foraging density maps published by the Sea Mammal Research Unit (SMRU), report the presence of harbour seals at the Endurance Store area to be 5.15 individuals per 25 km^2 square (Russel *et al.*, 2017). The most recent seal data considers 0-0.001% of the wider at-sea harbour seal population to be within the Development area at any one time, based on known haul out locations (Carter *et al.*, 2020).

Approximately 38% of the world's grey seal population breeds in the UK, however the majority of these breed in Scotland; approximately 0.6% of the UK population lives and breeds along the English coast between Newcastle and Great Yarmouth. Donna Nook, Blakeney Point and Horsey are the three best established breeding colonies on the east coast of England. Donna Nook, a well-established breeding colony, is located approximately 17 km south of the Easington terminal. The site is a National Nature Reserve covering approximately 10 km of coastline. Pupping for the east coast population occurs between early November and mid-December (SCOS, 2016).

Most grey seals forage within 100 km of haul out sites, although they are capable of travelling many hundreds of kilometres. Distribution data on grey seals suggests it is likely for grey seals to be present in the Development area. Grey seal density maps published by the SMRU report the presence of grey seals at the Endurance Store area to be 0.04 individuals per 25 km^2. At other locations in the Development area, the seal density was as high as 101-200 individuals per 25 km^2 square (Russel *et al.*, 2017); mostly associated with the coast. Recent data

considers that 0.06-0.08% of the grey seal at-sea population could be in the Development area at any given time (Carter *et al.*, 2020).

5.2.6.2 Cetaceans

A total of 19 species of cetacean have been recorded in UK waters (Reid *et al.*, 2003). Cetaceans regularly recorded in the North Sea include the harbour porpoise *Phocoena phocoena*, bottlenose dolphin *Tursiops truncatus*, minke whale *Balaenoptera acutorostrata*, killer whale *Orcinus orca*, Atlantic white-sided dolphin *Lagenorhynchus acutus* and white-beaked dolphin *Lagenorhynchus albirostris*. Rarer species include fin whale *Balaenoptera physalus*, long-finned pilot whale *Globicephala melas*, Risso's dolphin *Grampus griseus* and the short beaked common dolphin *Delphinus delphis* (Reid *et al.*, 2003). Typically, the SNS has a lower density of cetaceans than the NNS and CNS.

In the Development area, bottlenose dolphin, harbour porpoise, white-sided dolphin, pilot whale, minke whale, white-beaked dolphin, bottlenose dolphin and common dolphin have all been observed, with densities peaking in February-March for harbour porpoise and white-beaked dolphin and also in summer (June-August) for bottlenose dolphin and white-beaked dolphin (Reid *et al.*, 2003)

Harbour porpoise are the most abundant cetacean species in the Development area (ca. 53,500 individuals), followed by minke whale (ca. 600 individuals) and white beaked dolphin (ca. 150 individuals) (Hammond *et al.* 2021).

During initial geophysical surveys at the Endurance Store area, a single pod of unidentified dolphin species (of ca. seven individuals) was observed over a 27 day period (Gardline, 2020).

Based on the available information, the Development area is considered to host a number of species which will belong to wider ranging populations, with no elevated importance for feeding, breeding, nursery or migrating cetaceans.

5.3 Conservation

Offshore conservation interests focus around those sites designated under national UK law. The Endurance Store area and Teesside and Humber Pipelines intersect with a number of protected sites. Designated sites proximal to the Development are shown in Figure 5-4. Table 5-1 lists the sites which directly intersect with the Development and provides a detailed description of the site and the Conservation Objectives associated with the qualifying features of the site.

Table 5-1 - Designated sites which intersect with the Development

QUALIFYING FEATURES AND DEVELOPMENT INTERSECT	CONSERVATION OBJECTIVES
Southern North Sea SAC	
• Habitat for harbour porpoise during both the summer and winter months (JNCC, 2019).	To ensure that the integrity of the site is maintained and that it makes the best possible contribution to maintaining Favourable Conservation Status (FCS) for harbour porpoise in UK waters.

QUALIFYING FEATURES AND DEVELOPMENT INTERSECT	CONSERVATION OBJECTIVES
• The Endurance Store area is located within the summer habitat for the species. • The Humber Pipeline also passes through an area of winter habitat prior to landfall.	In the context of natural change, this will be achieved by ensuring that: 1. Harbour porpoise is a viable component of the site; 2. There is no significant disturbance of the species; and 3. The condition of supporting habitats and processes, and the availability of prey is maintained.
Teesmouth and Cleveland Coast SPA	
• Significant areas of intertidal sand and mudflat, saltmarsh and freshwater grazing marsh, saline lagoon, sand dune, shingle, rocky shore and shallow coastal waters. • Designated for the following: breeding little tern, passage Sandwich tern, wintering red knot and passage common redshank. (Natural England, 2020). • The Teesside Pipeline intersects the site.	The site objectives are to ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that it contributes to achieving the aims of the Wild Birds Directive[22], by maintaining or restoring: • the extent and distribution of the habitats of the qualifying features; • the structure and function of the habitats of the qualifying features; • the supporting processes on which the habitats of the qualifying features rely; • the populations of each of the qualifying features; and • the distribution of qualifying features within the site.
Greater Wash SPA	
• The site qualifies for designation by regularly supporting nationally important populations of red-throated diver, little gull, sandwich tern, common tern and little tern, as well as an internationally important population of the migratory common scoter (JNCC, 2020a).	The site objectives are to ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the aims of the Wild Birds Directive[22], by maintaining or restoring: • the extent and distribution of the habitats of the qualifying features; • the structure and function of the habitats of the qualifying features; • the supporting processes on which the habitats of the qualifying features rely; • the populations of each of the qualifying features; and

[22] *The legislation transposing the EU Wild Birds Directive has been changed so that it continued to operate effectively from 1 January 2021. The changes were made by the Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019.*

QUALIFYING FEATURES AND DEVELOPMENT INTERSECT	CONSERVATION OBJECTIVES
• The Humber Pipeline intersects this site.	• the distribution of qualifying features within the site (Natural England, 2019).
Holderness Offshore MCZ	
• The site is designated for Subtidal coarse sediment; Subtidal mixed sediments; Subtidal sand; North Sea glacial tunnel valleys; and Ocean quahog (JNCC, 2020b). • The Humber Pipeline intersects this site.	The Conservation Objective for the Holderness Offshore MCZ is that the protected features: • so far as already in favourable condition, remain in such condition; and • so far as not already in favourable condition, be brought into such condition, and remain in such condition. With respect to Subtidal coarse sediment, Subtidal sand and Subtidal mixed sediments within the Zone, this means that: • its extent is stable or increasing; and • its structures and functions, its quality, and the composition of its characteristic biological communities (which includes a reference to the diversity and abundance of species forming part of or inhabiting that habitat) are such as to ensure that it remains in a condition which is healthy and not deteriorating. With respect to the Ocean quahog *Arctica islandica* within the Zone, this means that the quality and quantity of its habitat and the composition of its population in terms of number, age and sex ratio are such as to ensure that the population is maintained in numbers which enable it to thrive. With respect to the North Sea glacial tunnel valleys within the Zone, this means that: • its extent, component elements and integrity are maintained; • its structure and functioning are unimpaired; and • its surface remains sufficiently unobscured for the purposes of determining whether the conditions in paragraphs (i) and (ii) are satisfied (JNCC, 2021).
Holderness Inshore MCZ	
• The site is designated for Intertidal sand and muddy sand; Moderate energy and High energy circalittoral rock; Subtidal coarse sediment;	The (draft) Conservation Objective for the Holderness Inshore MCZ is that the protected features: • Are maintained in favourable condition if they are already in favourable condition; and

QUALIFYING FEATURES AND DEVELOPMENT INTERSECT	CONSERVATION OBJECTIVES
Subtidal mixed sediments; Subtidal sand and Subtidal mud (Defra, 2016). • The Humber Pipeline intersects this site.	• Be brought into favourable condition if they are not already in favourable condition. For each protected feature, favourable condition means that, within a zone: • Its extent is stable or increasing; and • Its structure and functions, its quality, and the composition of its characteristic biological communities (including diversity and abundance of species forming part or inhabiting the habitat) are sufficient to ensure that its condition remains healthy and does not deteriorate. Any temporary deterioration in condition is to be disregarded if the habitat is sufficiently healthy and resilient to enable its recovery. For the geological feature within the Zone (Spurn, subtidal) favourable condition means: • It's extent, component element and overall integrity are maintained; and • It's structure and functioning are unimpaired. • The feature remains unobscured so its condition may be determined (Natural England, 2018c).

Furthermore, the following marine sites are located within 50 km of the Development but do not intersect directly with any proposed Development infrastructure:

- Humber Estuary SPA (3 km south-southeast of the Humber Pipeline at Easington);
- Humber Estuary SAC (4 km south-southwest of the Humber Pipeline at Easington);
- Northumbria Coast SPA (15 km north-northwest of the Teesside Pipeline);
- Flamborough Head SAC (19 km west-northwest of the Humber Pipeline);
- Dogger Bank SAC (21 km north-northeast of the Endurance Store);
- Flamborough Head and Filey Coast SPA (22 km west-northwest of the Humber Pipeline); and
- Inner Dowsing, Race Bank and North Ridge SAC (45 km east-southeast of the Humber Pipeline).

In addition to sites of conservation importance, numerous species found in the offshore area are listed as species of conservation importance. These species have been highlighted as required in the previous sections.

Ramsar sites are wetlands of international importance designated under the Ramsar Convention:

- Teesmouth and Cleveland Coast Ramsar site (situated onshore of the Teesside Pipeline landfall location). The site includes a range of coastal habitats, including sand-flats and mud-flats, rocky shore, saltmarsh, freshwater marsh and sand dunes which are situated in and around an estuary which has been considerably modified by human activities. The Teesmouth and Cleveland Coast site is designated for assemblages of international importance and the presence of populations of common redshank *Tringa*

totanus totanus (representing an average of 0.7% of the British population) and wintering red knot *Calidris canutus islandica* (representing an average of 0.9% of the British population; JNCC, 2008a).

- Humber Estuary Ramsar site (approximately 3 km south of the Humber Pipeline). Being the largest macro-tidal estuary on the British North Sea coast, the Humber Estuary is the site of the single largest input of freshwater from Britain into the North Sea. The inner estuary supports extensive areas of reedbeds and saltmarsh. At other places within the estuary the saltmarsh is backed by sand dunes and marshy slacks. This varied habitat supports internationally important populations of waterfowl in winter and nationally important breeding populations in summer. Species of particular interest, and contributing to the designation of the site are: Eurasian golden plover *Pluvialis apricaria*; red knot; dunlin *Calidris alpina*; black-tailed godwit *Limosa limosa*; common redshank *Tringa totanus*; common shelduck *Tadorna tadorna*; bar-tailed godwit *Limosa lapponica* (JNCC, 2008b).

A number of coastal Sites of Special Scientific Interest (SSSI's) are situated onshore of the landfall locations (Figure 5-4). The Teesside Pipeline landfall is seaward of the Teesmouth and Cleveland SSSI and the Humber Pipeline landfall is seaward of the Dimlington Cliff SSSI, designated for geological features (Natural England, 1990a). The Teesmouth and Cleveland SSSI is designated for both geological and biological features, including sand dune and saltmarshes habitats, breeding harbour seals, breeding bird species and an assemblage of more than 20,000 waterfowl during the non-breeding season (Natural England, 2018b). The Lagoons SSSI, 3 km west southwest of the Humber Pipeline, comprises a variety of coastal habitats including saltmarsh, shingle, sand dune, swamp and most significantly, saline lagoons and pools which represent the only extant example in North Humberside of this nationally rare habitat (Natural England, 1990b).

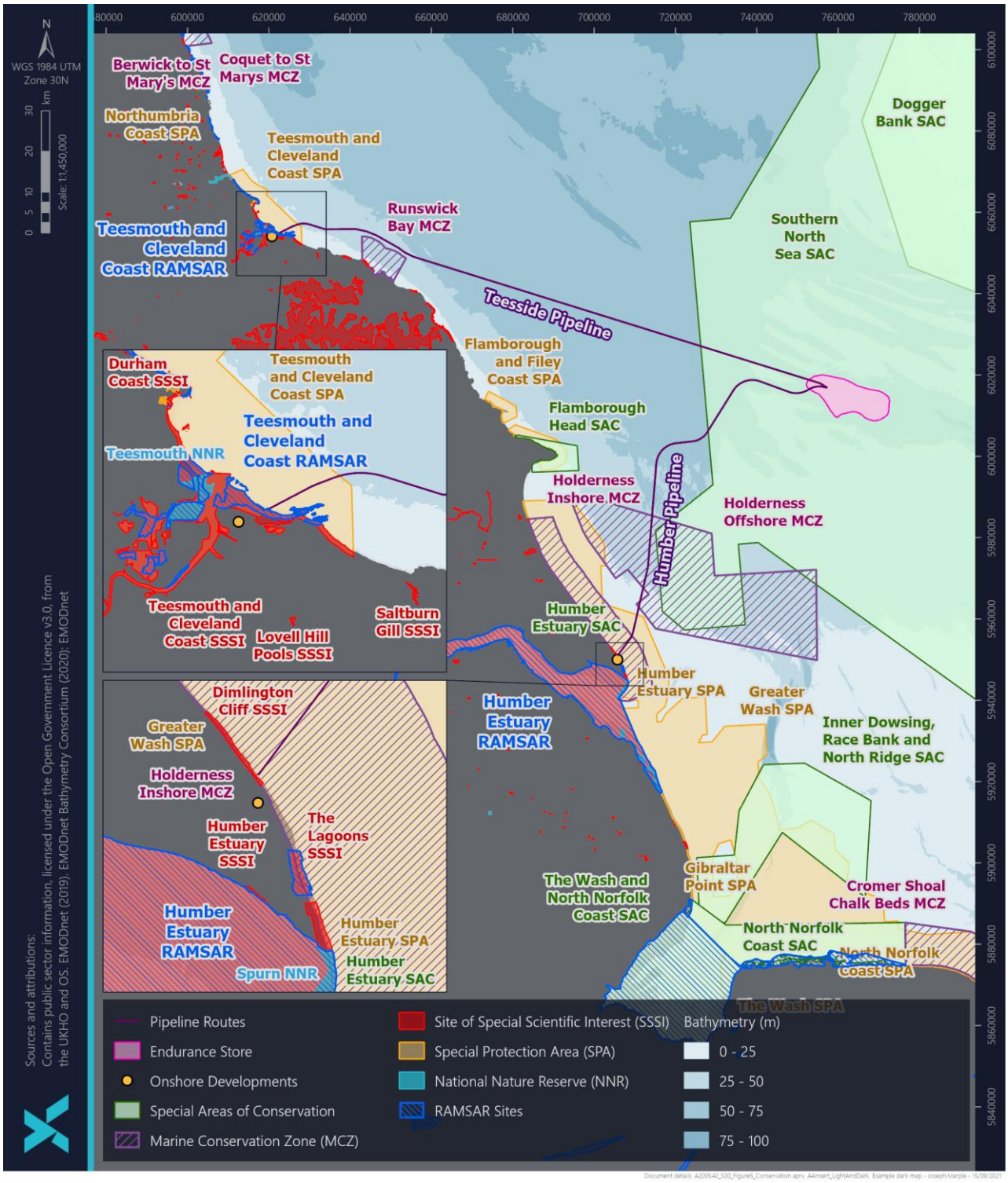

Figure 5-4 - Designated sites in the vicinity of the Development

5.4 Other Sea Users

A broad overview of other sea users in the vicinity of the Development is shown in Figure 5-5.

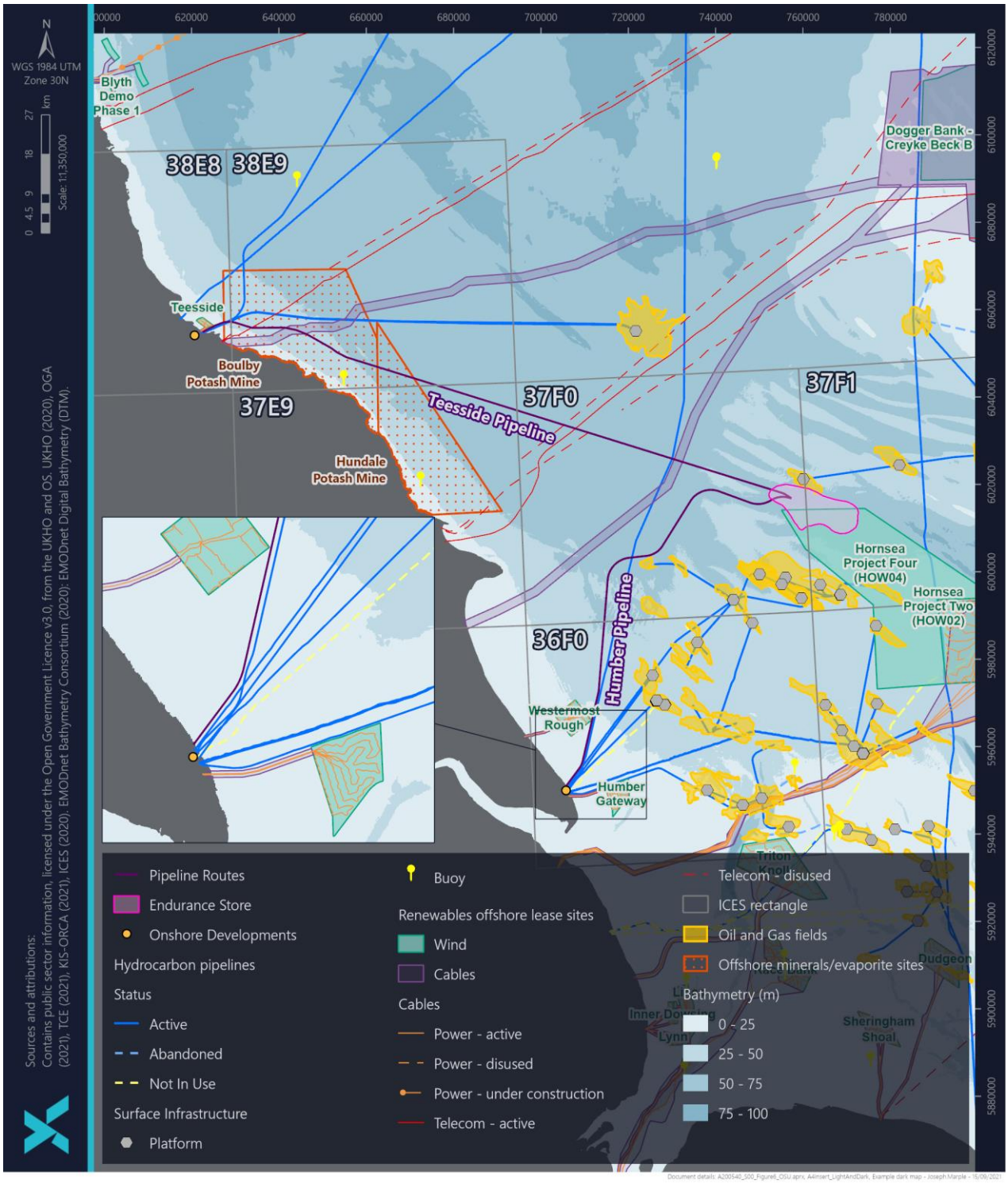

Figure 5-5 - Summary of infrastructure in the region of the Development, including proposed Development and proposed Hornsea 4 wind farm extension. Inset shows infrastructure proximal to the Humber Pipeline landfall.

5.4.1 Commercial Fisheries

The North Sea has important fishing grounds and is fished throughout by both UK and international fishing fleets, targeting demersal, pelagic and shellfish fish stocks.

The seas in the north east Atlantic region have been divided into a series of administrative rectangles by the International Council for the Exploration of the Seas (ICES). These are known as ICES rectangles and measure 30 minutes latitude by 1 degree longitude, which covers approximately 30 square nautical miles and are used as a basis for carrying out statistical analysis of sea areas (MMO, 2020). The Endurance Store is located in rectangles 37F0 and 37F1, most of the Humber Pipeline is located in rectangle 36F0, and the Teesside Pipeline intersects rectangles 37E9, 38E8 and 38E9 in addition to extending almost the length of 37F0 (Figure 5-5).

Shellfish catches dominated the landings value and live-weight tonnage across the Development area between 2015 and 2019, of which crab, lobster and scallops are typically the most valuable species, with some high values assigned to *Nephrops* and plaice in certain areas. In particular, the contribution of shellfish within rectangle 36F0, close to shore through which the Humber pipeline passes, is the highest across the Development area, equating to 99% of the catch every year both in terms of landings weight and value; this catch of predominantly shellfish, was valued at just under £11 million in 2019 (MMO, 2020).

However, pelagic species can form an important portion of the catch, notably contributing 74% to the overall 2017 catch in ICES rectangle 37F0, in which the Endurance Store is located. The demersal catch is consistently low across the Development area (MMO, 2020).

Within the context of the UKCS, the contributions from the nearshore ICES rectangles 37E9, 38E8 and 38E9 (the Teesside pipeline) together comprise approximately 0.79% of the total UK landings liveweight and 2.07% of the value (MMO, 2020). The geographical area covered by the three ICES rectangles is smaller than average considering that the coastline takes up a large part of each rectangle. Although the rectangles produce less catch by weight than the average rectangle, they contribute a higher than average catch value to the annual overall total.

The contributions from the offshore ICES rectangles 37F0 and 37F1 together comprise approximately 0.51% of the total UK landings liveweight and 0.75% of the value corresponding well to the geographical area covered by the two ICES rectangles; 0.8% of the area covered by all ICES rectangles in UK waters. As such, the two rectangles can therefore be considered average across the North Sea in terms of productivity.

Comparatively, rectangle 36F0 alone contributed 0.51% of the UKCS total landings by weight and 1.41% of the annual value (MMO, 2020), making this one of the singularly most productive rectangles in the Development area.

Fishing activity in the Development area occurs throughout the year. The total days spent fishing by UK-registered vessels >10 m in length has remained relatively consistent from year to year across all the ICES rectangles.

Effort is lowest in rectangle 37F1 which is within the offshore Endurance Store area. In many months effort is recorded as 'Disclosive' in this rectangle meaning fewer than five vessels (>10 m length) spent time fishing that month and so detailed records are not published for reasons of commercial confidentiality. Also in the Endurance Store area, effort

in rectangle 37F0 has increased of late, resulting in 2018 and 2019 showing higher annual effort than preceding years (Scottish Government, 2020).

The most common gear types in the Development area close to shore are pots and traps, and gears using hooks. Further offshore, demersal trawls/seines, beam trawls, and dredges dominate. In rectangle 37E9 drift and fixed nets also feature as a gear type used in demersal fisheries, although this method contributes little to overall landings and value. There was one additional instance of drift and fixed nets being used in rectangle 37F0 in 2019 (MMO, 2020).

5.4.2 Offshore Infrastructure

5.4.2.1 Oil and gas infrastructure

The Development is located in an area of past and present oil and gas exploration and production. Accordingly, there are numerous wells, pipelines and platforms in the region. The closest platform is the normally unmanned installation (NUI) Garrow, 2 km north northeast of the Endurance Store and owned and operated by Perenco. There are an additional 16 other platforms located within 40 km of the Endurance Store. Construction and decommissioning of nearby oil and gas installations could potentially increase interactions between the Development and nearby developments due to increased vessel presence and activities in the surrounding waters. The Cavendish surface installation and associated pipelines (approximately 48 km from the Endurance Store) have been approved for decommissioning which is expected to be ongoing until Q4 2023 (INEOS UK SNS Ltd, 2020). The Tolmount NUI platform and associated subsea infrastructure is currently under construction in UKCS Block 42/28d, with first gas scheduled for late 2021 (Harbour Energy, 2021). The associated Tolmount-Easington Pipeline lies within a kilometre of the Humber Pipeline landfall.

The Humber Pipeline will cross the Langeled Pipeline, a 44" gas pipeline. This is the only anticipated pipeline crossing.

As shown in Figure 5-5, the Humber Pipeline landfall at Easington lies close to multiple existing pipelines. Those within a kilometre of the Humber Pipeline landfall at Easington include:

- Cleeton CP to Dimlington, a 36" gas pipeline;
- Rough 47/3B Import/Export, a 36" gas pipeline;
- Easington to Rough 47/3B, a 16" gas pipeline (not in use);
- York Production Pipeline, a 16" gas pipeline; and
- York Methanol Pipeline, a 3" methanol pipeline.

The Teesside Pipeline will cross the following pipelines:

- Everest to Teesside Central Area Transmission System (CATS), a 36" gas pipeline;
- Breagh Pipeline, a 20" gas pipeline;
- Breagh Pipeline, a 3" monoethylene glycol pipeline; and
- Langeled Pipeline.

5.4.2.2 Renewables

There are a number of wind farm licensed areas and wind farm projects under development in the vicinity of the Development. The Endurance Store overlaps with TCE Lease area currently under agreement for the Hornsea Project Four windfarm. The windfarm is currently in the pre-planning application stage and could cover up to 492 km^2 and contain up to 180 wind turbines (Ørsted, 2021a).

Hornsea Project Four will be adjacent to Hornsea Project Two which is currently under construction, targeting the commencement of operations in 2022 (Ørsted, 2021b). The Phase 2 section of Hornsea Project Two is located closest to the Endurance Store at 25 km east-southeast. The Hornsea 1 windfarm is located 41 km east-south east of the Endurance Store. It has been completed, becoming fully operational in 2021. Hornsea 1, Hornsea Project Two and Hornsea Project Four are all operated by Ørsted. No other renewables lease areas, operational or under agreement, are located within 50 km of the Endurance Store.

The Teesside windfarm is located within a kilometre of the Teesside Pipeline at the closest point. It is located close to the coast, just 1.5 km offshore near Redcar in North Yorkshire. The windfarm contains 27 turbines and has been operational since 2014. It has a capacity of 62 MW and is operated by EDF Renewables (EDF Renewables, 2021).

Two windfarms are located in the vicinity of the Humber Pipeline. The Westermost Rough Offshore Wind Farm is situated 8 km off the Yorkshire Coast, north of Hull and is within a kilometre of the Humber Pipeline at the closest point. The windfarm contains 35 turbines of 6 MW capacity, covering a total area of 35 km^2 (Ørsted, 2019). Similarly, the Humber Gateway windfarm is located approximately 8 km from the East Yorkshire coast and 7 km from the Humber Pipeline. The E.ON Energy operated windfarm became fully operational in 2015 and has a capacity of 219 MW (E.ON Energy, 2021). No other renewables lease areas are located within 50 km of the pipeline routes.

5.4.2.3 Cables

The proposed Teesside Pipeline will cross two wind cable lease areas. Both cable lease areas are currently in planning and extend from shore to the proposed windfarms on the Dogger Bank: Teesside A, Teesside B (Sofia), Creyke Beck A and Creyke Beck B. Close to landfall of the Teesside Pipeline, the pipeline will also pass within a kilometre of the Teesside windfarm export cable which is currently in operation. No other renewables cable lease areas come within 50 km of the Teesside Pipeline.

The Teesside Pipeline will cross the fibre optic cable associated with the Breagh field. The pipeline will also cross a number of telecom cables:

- UK-Denmark 4 (BT) disused cable;
- Pangea North (ASN) active cable; and
- TATA North Europe (TATA Communications) active cable.

The UK-Germany (BT) disused cable is located within a kilometre of the Teesside Pipeline.

Being located close to the Humber Gateway, the Humber Pipeline will come within 2 km of the associated Humber Gateway Offshore Transmission Owner (OFTO) cable. It will also pass within 5 km from the Creyke Beck A and B cable lease areas. The Humber Pipeline will pass 6 km from the Westermost Rough OFTO export cable. At present, the Hornsea Project Four proposed export cable corridor reaches landfall south of Bridlington along the Holderness coast. Once installed it will cross the Humber Pipeline approximately halfway along its length.

A further three cables, all under construction, are located within 10 km of the Humber Pipeline, associated with the Hornsea Project Two, Hornsea 1 and Triton Knoll windfarms.

The Humber Pipeline does not come within 20 km of any telecom cables.

5.4.3 Archaeology

There are 15 records on non-dangerous wrecks within 10 km of the Endurance Store (UKHO, 2020). The closest of these are two un-named wrecks, one (ID 6830) located within the Store area, and another (ID 6832) located 0.6 km north northeast. Similarly, there are 77 records located within 5 km of the Teesside Pipeline route, of which 59 are classed as non-dangerous wrecks, 13 are classed as dangerous wrecks, one distributed remains of a wreck, and four classed as a wreck showing any portion of hull or superstructure. There are 52 records of wrecks within 5 km of the Humber Pipeline route, of which 30 are non-dangerous, 21 are classed as dangerous and one wreck is listed as a wreck showing any portion of hull or superstructure.

There are no records of protected wrecks in the vicinity of the Humber Pipeline or the Teesside Pipeline (Historic England, 2021).

The waters off the east coast in this region contain multiple areas of potential unexploded ordnance (UXO) sources. A large offshore WWII British Mine Area extends along much of the UK east coast and both pipeline routes intersect multiple historic UXO source areas including British WWII Military Armament Areas, WWI German Mine Areas and WWI British Mine Areas (Ordtek, 2021). Despite the prevalence of potential UXO source areas, there is only a low (1-5) density of reported munitions encountered in the Development area, largely limited to the coastal waters of both pipeline routes (OSPAR, 2009).

No obstructions with potential to be a wreck or UXO were identified during the site specific surveys at the Endurance Store area. A full archaeological assessment will be undertaken to inform the EIA (Section 7). Review of pipeline geophysical and geotechnical data can be conducted if available within the timeline of the EIA process to confirm the presence of any archaeological sites.

5.4.4 Aggregate and Mineral Extraction

Each year, 15 to 20 million tonnes of marine sand and gravel is extracted from the seabed within English and Welsh waters (The Crown Estate, 2018). Four licenced aggregate extraction sites occur within 20 km to the south of the Humber Pipeline as it comes to shore, but none of these licenced areas lie within 10 km of the Humber Pipeline. The Humber region contains, at present, ten licenced production agreement marine aggregation extraction sites. The licences are for the removal of both sand and gravel, principally for use in the construction industry. TCE reports that the Humber region provides an average of 1.96 million tonnes of aggregate per year, over a ten year period. In 2017, 1.88 million tonnes of aggregate were produced, the majority of which was shipped for use in the Netherlands. (The Crown Estate, 2018). There are no further aggregate extraction areas within 50 km of the Development.

The Teesside Pipeline will pass through areas of seabed leased for the Boulby and Hundale potash mines (Figure 5-5). These are amongst the only potash mines in the UK.

Beyond these, there are no other areas licensed for mineral extraction close to the Development area.

5.4.5 Military Activity

A Military Practice Area (D307) is located approximately 26 km south of the Humber Pipeline landfall on the coast at Donna Nook (DTE, 2021). In addition, special consultation conditions are flagged by the Ministry of Defence (MoD) in relation to some of the Blocks in the vicinity of the Development (Blocks 47/2, 47/7, 42/27, 42/17 and 42/18; OGA, 2019; Figure 1-2). Activity in these blocks or sub-blocks are of concern to the MoD because they lie within training ranges. The following special condition is attached to any Licence covering, wholly or in part, any such block or sub-block: "The MoD must be notified, at least twelve months in advance, of the proposed siting of any installation anywhere within Block(s), whether fixed to the seabed, resting on the seabed or floating, that is intended for drilling for or getting hydrocarbons, or for fluid injection."

5.4.6 Shipping Activity

The average weekly density of vessels in 2015 in the Development area ranged from 5.1 to 250 transits per 4 km^2. Vessel presence is lowest offshore at the Endurance Store area and increases along the export pipelines, particularly the Humber Pipeline. Shipping levels within the Development area are high in all Blocks (42/28, 47/7, 42/23, 42/27, 42/17 and 42/18) with the exception of Block 47/2, in which shipping activity is considered very high (OGA, 2016; Figure 1-2).

The Humber Estuary is a busy shipping area and this area of coastline, from Teesside to Humber is extremely busy with most traffic attributed to cargo vessels and tankers. A distinct increase in local vessel transit density can be attributed to the Westermost Rough windfarm close to the coast. Automatic Identification System (AIS) vessel movement tracks associated with various service craft are also concentrated at certain points throughout the SNS, likely corresponding to other offshore assets, including renewables sites and oil and gas infrastructure. Fishing vessel movement is also pronounced along the coastline, especially south of Flamborough. Passenger vessel routes are evident coming out of the Humber Estuary and travelling south. No passenger vessel routes depart from Teesside, however an apparent route does extend south from Newcastle upon Tyne, which comes close to the Teesside Pipeline and the Endurance Store area.

5.4.7 Recreation and Tourism

A number of recreation and tourist sites and activities occur in the vicinity of the coastal offshore area of the Development. Withernsea beach is located approximately 9 km north of the Humber Pipeline landfall. The bathing waters at Withernsea are also reported as of good standard in the 2019 Bathing Waters Compliance Report (Defra, 2019).

Located in close proximity to the Teesside Pipeline landfall, are the Redcar Coatham, Redcar Lifeboat and Redcar Granville designated bathing waters. Redcar Coatham and Redcar Lifeboat are considered to be of an excellent standard whereas Redcar Granville is considered to be of a good standard (Defra, 2019)

A number of marinas and slipways are located within the Humber Estuary and the Humber Pipeline passes through an area identified by the Royal Yachting Association (RYA) as a general boating area. The Teesside Pipeline also terminates just south of a general boating area which covers much of Teesside. Various places along the Holderness coast are used for surfing, but the nearest noted site is at Withernsea (Magic Seaweed, 2021), to the north of the proposed Humber Pipeline landfall. There are no known designated recreational waters within the Development area.

5.4.8 Coastal Land Use

Land use along the Holderness Natural Character Area (NCA), where landfall of the Humber Pipeline will occur, is mainly agricultural, with more than 90% of the coast undeveloped and over 71,000 ha used for agriculture purposes (Natural England, 2013a). Of this, arable land for cereal production accounts for over half of this agricultural land (38,997 ha). Only 11% of the farm holdings along the Holderness coast manage livestock (Natural England, 2013a).

Land use within the Tees Lowlands NCA, at the Teesside Pipeline landfall, is also predominantly for arable agriculture. In 2009, there were 63,056 ha within the NCA of which 44% is for cereal production (Natural England, 2013b). 11% of the NCA is urban and much of this industrialised conurbation is centred around Middlesbrough which lies at the estuary of the River Tees (Natural England, 2013b), close to the landfall of the Teesside Pipeline.

6. ASSESSMENT OF KEY ENVIRONMENTAL ISSUES

The following sections outline the potential environmental and social issues that may be associated with the proposed Development. During the EIA and preparation of the ES, the potential for the occurrence of the issues and associated level of significance will be assessed and possible mitigation measures identified. The assessment will include the key potential effects associated with both the development of the Endurance Store and the Teesside and Humber Pipelines.

Each section specifically details any elements that are considered very unlikely to result in significant adverse impact. These elements are proposed to be excluded from further assessment in the EIA due to negligible impact.

In addition to the studies undertaken to date, a series of further studies will be initiated to inform the EIA, these are discussed in Section 7.

6.1 Seabed Disturbance

There is potential for disturbance to the seabed which can have consequences to benthos, fish, birds, marine archaeology, coastal processes and offshore and coastal protected sites. Indirect disturbance may occur from sediment plumes.

Disturbance can occur during drilling activities (such as from rig anchoring, discharges such as drilling fluids, drill cuttings and cement, and installation of the wellheads). Disturbance will also result from the trenching, installation, burial and protection of the pipelines, the construction activities associated with pipeline landfall, the installation and commissioning of the subsea infrastructure (manifolds, infield pipelines and SSIVs), as well as from vessel anchoring during all of these operations.

The Humber Pipeline intersects with the Holderness Offshore MCZ, designated for subtidal coarse sediment, subtidal mixed sediments; subtidal sand; North Sea glacial tunnel valleys; and ocean quahog. The pipeline crosses the Holderness Inshore MCZ which is designated for intertidal sand and muddy sand; moderate energy and high energy circalittoral rock; subtidal coarse sediment; subtidal mixed sediments; subtidal sand and subtidal mud. The pipeline also crosses the Greater Wash SPA which contains a range of marine habitats, including intertidal mudflats and sandflats, subtidal sandbanks and biogenic reef that regularly support nationally important populations of red-throated diver, little gull, sandwich tern, common tern and little tern, as well as an internationally important population of the migratory common scoter. The Teesside Pipeline intersects with the Teesmouth and Coastal SPA, containing significant areas of intertidal sand and mudflat, saltmarsh and freshwater grazing marsh, saline lagoon, sand dune, shingle, rocky shore and shallow coastal waters which supports breeding little tern, passage Sandwich tern, wintering red knot and passage common redshank. The EIA will assess the potential for impact on these and proximal sites (Section 5.3), as well as how the Development can be progressed whilst 'least hindering' the conservation objectives of these sites.

A principal method of assessment to be employed is based on examination of the findings of the project specific benthic and geophysical surveys. The findings of the study will be used alongside a desk-based study utilising BGS mapping, borehole logs and regional reports and other relevant data. Data exists on the MarLIN website to allow an assessment of the sensitivities of individual habitats and species to be included as part of impact assessment.

A desk-based assessment of potential impacts on fish will be based on the most recent available data on spawning and nursery grounds and migratory behaviour of sensitive species. Seabed images collected in the area will also be reviewed to determine the suitability of the sediments present as spawning and nursery grounds.

Potential impacts of the Development on ornithological interests will be assessed against the baseline established utilising existing data including, but not limited to, Natural England's Seabird Mapping and Sensitivity Tool (SeaMaST), ornithological datasets from baseline and post-consent monitoring surveys from windfarms in the vicinity of the Development and surveys conducted to inform designations of SPAs.

An archaeological desk-based study will establish a baseline for the area and assess the value and sensitivity of the known and potential heritage assets. Review of pipeline geophysical and geotechnical data can be conducted if available within the timeline of the EIA process to confirm the presence of any archaeological sites. The nature of the marine archaeological resource is such that there is often a high level of uncertainty regarding the presence/absence, distribution, extent and nature of archaeological assets on the seafloor. As such, the precautionary principle is applied to the marine archaeological environment.

Coastal processes within the Development area will be exposed to potential impacts associated with any changes to the character of the seabed that cause changes to water movement and sediment transport in the area of the Development and the wider region. During the impact assessment process, area(s) of assessment will be defined and baseline data collected via a desk-based study. Potential impacts resulting from activity associated with the Development will be identified and an assessment of potential impacts conducted via a conceptual understanding of the coastal processes informed by academic and industry studies. Site-specific modelling work will be conducted to support assessment of cofferdam options, if selected, and assess coastal erosion.

6.2 Underwater Noise

Underwater noise has the potential to be generated during all phases of the Development, from sources such as repeated geophysical/geotechnical surveys to monitor the Endurance Store, installation vessel thrusters, piling, and detonation of unexploded ordnance (UXO) if encountered and required to be removed. The generation of this underwater noise could potentially result in short-term behavioural change, injury or disturbance to marine species.

The Development intersects with the SNS SAC which is a habitat for harbour porpoise during summer and winter months. The EIA will assess the potential for impact on this and proximal sites (Section 5.3), as well as how the Development can be progressed whilst 'least hindering' the conservation objectives of the site.

The assessment of potential effects of underwater noise on marine mammals will involve simulating the source pressure level and frequency ranges of the Development activities, within the conditions of the surrounding environment, to identify how noise will propagate through the water column. Noise modelling will be employed to characterise the received levels for the sensitive marine receptors under consideration in which potentially significant impacts have been identified (i.e. potential for injury or significant disturbance). This modelled data will then be combined with the functional hearing ranges of sensitive marine receptors, as well as the potential auditory thresholds for disturbance and injury (as detailed in Southall *et al.*, 2007; Southall *et al.*, 2019 and NOAA, 2018) to identify the potential disturbance and injury ranges surrounding the Development's activities.

It is proposed that impacts on seabirds from underwater noise are scoped out of this EIA due to the general absence of data on underwater hearing in birds (Popper and Hawkins, 2012) and given that the seabirds in the Development area are not expected to rely heavily on underwater hearing for the majority of their behaviours.

6.3 Discharges to Sea and Formation Water Displacement

Discharges to sea of drill cuttings entrained with drilling fluids (water-based mud cuttings), cement, completion chemicals, pipeline hydrotest water, and small amounts of hydraulic fluids all have the potential to impact the marine environment through pathways such as toxicity, smothering and bioaccumulation.

Methods of assessment include the modelling of drilling discharges to assess the extent of the potential for impact of the mud and cuttings piles on the benthic environment. This enables assessment of the geographical extent of cuttings/mud deposition and estimates of the recovery times of the sediment. Modelling will also be conducted of the discharges associated with pipeline hydrotesting during pipeline commissioning to gain an understanding of chemical concentrations being discharged into the environment and to understand the areas of the marine environment the discharge could interact with.

Formation water displacement to the water column from the upper 300 m of the Bunter Sandstone formation at the Bunter Outcrop (Section 4.3) will be quantified, and its composition assessed. Modelling will be conducted to assess the potential for impact on the benthic environment and in the water column.

It is considered that the potential effects arising from the following discharges to sea by vessels and the jackup rig are likely to be insignificant. It is therefore proposed that these are scoped out of further assessment in the EIA:

- Routine blackwater production (i.e. sewage), grey water (i.e. from showers and laundry) and food waste (macerated) disposal (from vessels and jackup rig). Existing, effective management controls are in place for such discharges; and
- Routine seawater usage for cooling (e.g. engine cooling). Highly limited temporal and spatial extent of such discharges.

6.4 Atmospheric Emissions

Emissions to the atmosphere from the Development will be associated primarily with fuel combustion by the jackup rig and vessels used during all phases of the Development. These emissions could potentially result in impacts at a local, regional, transboundary and global scale. On a global scale, concern with regard to atmospheric emissions is focused on global climate change. The Intergovernmental Panel on Climate Change (IPCC) in its sixth assessment report states that 'It is unequivocal that human influence has warmed the atmosphere, ocean and land.' The Development is intended to transport and store an average of 4 Mt of CO_2 per year for 25 years, which would otherwise reach the atmosphere and contribute to the increase in atmospheric GHG concentrations.

The method of assessment will consist of a description and quantification of potential emissions based on forecast levels of vessel and rig activity and on emission levels associated with typical vessels and rigs. The assessment will include lifecycle carbon assessment and consideration of potential CO_2 emission reduction options that are relevant to the Development.

6.5 Physical Presence Interactions

The Development has the potential to result in interactions with other sea users and wildlife that utilise the area.

The physical presence of vessels during all phases of the Development could potentially affect wildlife through collision risk. Additionally, airborne noise and lights from vessels required during pipeline installation and the

operations phase (short term and temporary) have the potential to disturb seabirds of international and national interest, including migratory and breeding species that are within the Development area (Section 5.2.5).

Potential disturbance to birds from vessel movements associated with the Development could occur within the Greater Wash SPA, the Teesmouth and Cleveland Coast SPA and within areas of sea that are functionally linked to other SPAs (Section 5.3). The Development intersects with the SNS SAC which is a habitat for harbour porpoise during summer and winter months. The EIA will assess the potential for impact on these and proximal sites (Section 5.3), as well as how the Development can be progressed whilst 'least hindering' the conservation objectives of these sites.

Potential effects on marine mammals and seabirds resulting from, collision risk, displacement or barrier effects, and long-term habitat change are unlikely to require additional modelling data. These will primarily be assessed using the baseline environment data to conduct a desk-based assessment of potential effects, drawing on species specific knowledge on the sensitivities to Development activities. It is proposed that the evidence-base for the impact assessment will utilise industry guidance documents and scientific literature.

The Development has the potential to result in interactions with other sea users including fisheries, military, commercial or wind farm vessels and oil, gas and energy infrastructure. Interactions could result from increased vessel presence during drilling and from installation of the pipelines, by either increasing collision risk and/or through implementation of temporary exclusion zones resulting in loss of access to fishing grounds. The physical presence of infrastructure such as manifolds and pipelines on the seabed have the potential to increase snagging risk and result in loss of access to fishing grounds. To help mitigate the potential impacts of subsea structures on the fishing industry, subsea structures will be 'fishing friendly'.

The proposed Fishing Intensity Study (Section 7) will provide the basis for assessment of potential impact on fisheries; this will be informed by data gathered during consultation with the relevant stakeholders. Limitations in AIS data in terms of the tracking of small vessels, in particular, fishing and recreation data will be overcome by carrying out wider stakeholder consultation.

A Navigational Risk Assessment will be conducted to determine changes in navigational risk resulting from the Development. Risk is systematically evaluated against criteria for frequency and outcome severity and mitigation measures identified and developed to reduce risks where appropriate.

6.6 Accidental Events

Accidental events have the potential to impact the environment. These include hydrocarbon releases from vessel collisions or the jackup rig and CO_2 releases from the pipelines or the Endurance Store and associated infrastructure. The potential impact of an accidental release will be determined by the characteristics of the released material, its trajectory and its proximity to environmental sensitivities.

The ES will contain information to enable the Competent Authority to assess the potential, if required, for hydrocarbon releases to result in likely significant effects on SPAs (in the case of birds) or SACs (in the case of species other than birds and of habitats) and the potential to cause a significant risk to the conservation objectives of other marine protected areas (such as the Holderness Inshore and Offshore Marine Conservation Zones).

The method of assessment in the EIA will consist of the identification of potential accidental events relating to the Development and those (if any) which have the potential to result in a significant impact. The relevant mitigation measures in place to prevent the event occurring will be detailed and modelling conducted to evaluate the fate of the worst-case release scenario. The likelihood of any accidental release having a potential impact on the

environment considers the likelihood of the release occurring against the probability of the release reaching a sensitive area, and the environmental sensitivities present in that area at the time.

It is considered that the potential impacts arising from the accidental deposit of materials on the seabed (e.g. dropped objects and pipelines) are likely to be insignificant given that existing, effective management controls are in place. It is proposed that the accidental deposit of materials on the seabed is scoped out of further assessment in the EIA.

6.7 Waste Generation

Solid waste will be generated during all phases of the Development. Waste will be managed in line with regulatory requirements, such as the Waste Framework Directive. bp's waste duty of care must ensure that the management of waste material complies with all relevant legislation. The bp waste management philosophy incorporates the requirement that waste should be prevented or reduced as far as possible, but where it cannot be prevented, it should be reused and recycled to the extent practicable. Some waste generated may need to be sent to landfill.

It is considered that the potential impacts arising from waste management are likely to be insignificant given that existing, effective management controls are in place. It is proposed that waste management is scoped out of further assessment in the EIA.

6.8 Potential Cumulative, In-combination and Transboundary Impacts

The potential for the Development to act cumulatively or in combination with other offshore, nearshore or onshore projects – including the NZT and ZCH (Humber Low Carbon Pipelines) projects and other relevant partner projects above the MLWS - will require consideration in the EIA. Examples of potential cumulative impacts include disturbance to habitats and species in multiple locations from different projects which could significantly affect the habitat or species as a whole, and disturbance to wildlife through underwater noise from multiple locations/projects excluding animals from a significant proportion of their foraging range. There is also the potential for cumulative interactions with other sea users, including increasing the area within which there is temporary exclusion of fishing activities and increasing the number of vessels and seabed infrastructure within the region thereby increasing navigational risk.

The method of assessment will consist of a desk-based study utilising available consenting documents written for each of the developments, data sources such as the MMO's Marine Information System (MIS) as well as consultation with other developers to understand timelines and potential cumulative interactions. From the overall list of developments and projects identified, relevant ones will be selected and assessed per EIA chapter.

In terms of transboundary impacts, the Endurance Store is located approximately 105 km from the UK/Dutch median line and any possible transboundary impacts (e.g. accidental releases) will be considered by the EIA.

7. SUPPORTING STUDIES

In addition to the studies undertaken to date, bp has identified a series of further studies/reports that will be initiated to inform the EIA:

- 2021 Environmental Baseline Survey of Teesside & Humber Pipeline routing corridors and Endurance Store area including:
    - Unmanned surface vessel conducting multi-beam echo sounder (MBES), side scan sonar (SSS), sub-bottom profiler;
    - Survey vessel conducting magnetometer/SSS with 3 lines, centre line and 25 m either side; grab samples and drop-down camera – adjusting locations dependant on MBES/SSS analysis; grab samples and drop-down camera at the 6 well locations and manifold; sample analysis for macrofauna; provision for camera transects of identified areas of interest; shallow geotechnical survey; and
    - Nearshore pipeline route survey with scopes as above.
- Underwater Sound Modelling: The requirement for underwater sound modelling assessment is made on a case by case basis depending on installation activities (e.g. piling and drilling) and Endurance Store MMV plan activities. Underwater sound impacts will be assessed against relevant criteria for marine mammal species categories (Southall *et al.* 2019 and NOAA 2018) and fish species groups (Popper *et al.* 2014). As per Southall *et al.* (2019) the marine mammal species are categorised into Hearing Groups, dependent on their sensitivity to sound.
- Mud and Cuttings Dispersion Modelling: Modelling of drilling discharges will be carried out to assess the extent of the potential for impact of the mud and cuttings pile on the benthic environment. Modelling would be undertaken using DREAM software.
- Pipeline Hydrotest Modelling: Modelling of pipeline discharges during commissioning will be carried out to gain an understanding of chemical concentrations being discharged into the environment and to understand the areas of the marine environment with which the discharge could interact.
- Formation Water Displacement Study : Modelling will be conducted to assess the potential for impact of the displaced formation water on the benthic environment and in the water column.
- Accidental Release Modelling: Worst-case modelling of a loss of vessel fuel inventory from the jackup rig (stochastic model) with outputs fulfilling the requirements of OPRED's Guidance Notes for Preparing Oil Pollution Emergency Plans for Offshore Oil and Gas Installations and Relevant Oil Handling Facilities, October 2019.
- Assessment of Ornithological Interests: Baseline establishment, against which the impact assessment will be conducted, is to be informed by overviews such as Natural England's Seabird Mapping and Sensitivity Tool (SeaMaST) and ornithological datasets from baseline and post-consent monitoring surveys from windfarms in the vicinity of the Development. Surveys conducted to inform designations of SPAs will also be utilised. The protected status of individual species and their relation to protected sites will be detailed, local seabird vulnerability considered and the sensitivity of individual seabird species to impact mechanisms assessed.

- Coastal Processes: Area(s) of assessment will be defined and baseline data collected. Potential impacts resulting from project activity will be identified and an assessment of impacts conducted via a conceptual understanding of the coastal processes informed by academic and industry studies. Site-specific modelling work will be required to support assessment of the contingency cofferdam option and assess coastal erosion.
- Fisheries Intensity Study: To understand the fishing activity in the Development area, data on landings and activity will be assessed, considering how many fishing vessels use the area, the gears they use, any seasonal patterns, and the value of the area in terms of landings. Consultation will be conducted to obtain fishing data from the MMO, TCE North Eastern Inshore Fisheries and Conservation Authority (NEIFCA) and the Centre for Environment, Fisheries and Aquaculture Science (Cefas). Where relevant, data will be assessed by ICES rectangle/sub-rectangle.
- Archaeological study: A desk-based study will be conducted which utilises existing information to determine the nature, extent and significance of the historic environment resource within the Development area, including prehistoric, maritime and aviation sites. The study will review existing archaeological records and secondary sources and summarise the Historic Seascape Character of the Development area. Review of pipeline geophysical and geotechnical data can be conducted, if available within the timeline of the EIA process, to confirm the presence of any archaeological sites.
- Metocean modelling study to be updated to include metocean conditions for the Humber Pipeline
- Navigational Risk Assessment will be conducted to determine changes in navigational risk resulting from the Development. Risk is systematically evaluated against criteria for frequency and outcome severity and mitigation measures identified and developed to reduce risks where appropriate.

8. RESPONSES AND ENQUIRIES

To respond to this scoping document or to make enquiries please contact:

Email: NEPconsultation@eastcoastcluster.co.uk

Address: BP Exploration Operating Company Limited,
ICBT, Chertsey Road, Sunbury-on-Thames, TW16 7LN, UK

Responses should be made by the 18th October 2021.

Responses will be handled in line with the East Coast Cluster Privacy Policy which can be viewed at https://eastcoastcluster.co.uk/privacy-policy/.

9. REFERENCES

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APPENDIX A ABBREVIATIONS

Abbreviation	
AIS	Automatic Identification System
BEIS	Department for Business, Energy & Industrial Strategy
BGS	British Geological Survey
CATS	Central Area Transmission System
CCC	Committee on Climate Change
CCGT	Combined Cycle Gas Turbine
CCS	Carbon capture and storage
CCU	Carbon capture and utilisation
CCUS	Carbon capture utilisation and storage
CEFAS	Centre for Environment, Fisheries and Aquaculture
CNS	Central North Sea
CO2	Carbon dioxide
DCO	Development Consent Order
DECC	Department of Energy & Climate Change
DEFRA	Department for Environment, Food and Rural Affairs
DepCon	Deposit of Materials Consent
DML	Deemed Marine Licence
DREAM	Dose related Risk and Effect Assessment Model
DTE	Defence Training Estate
DTI	Department of Trade and Industry
EC	European Commission
EIA	Environmental Impact Assessment
ERYC	East Riding of Yorkshire Council
ES	Environmental Statement
EU	European Union
EUNIS	European Nature Information System
FCS	Favourable Conservation Status
FOAK	First-of-a-Kind
FOCI	Features of Conservation Importance
GIS	Geographical Information System
HAB	Harmful Algal Blooms
HDD	Horizontal Directional Drilling
HGS	Humber Gathering System
HMWB	Heavily modified water body

HRA	Habitats Regulations Assessment
HTL	Hold The Line
ICES	International Council for the Exploration of the Seas
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
JNCC	Joint Nature Conservation Committee
LAT	Lowest Astronomical Tide
LOD	Limit of Detection
MBES	Multi Beam Echo Sounder
MCA	Marine Character Area
MCZ	Marine Conservation Zone
MHWS	Mean High Water Springs
MIS	Marine Information System
MLWS	Mean Low Water Springs
MMO	Marine Management Organisation
MMV	Measurement, monitoring and verification
MoD	Ministry of Defence
MPA	Marine Protected Area
MW	Megawatts
NAI	No Active Intervention
NAO	North Atlantic Oscillation
NCA	Natural Character Area
NEIFCA	North Eastern Inshore Fisheries and Conservation Authority
NEP	Northern Endurance Partnership
NFFO	National Federation of Fishermen's Organisation
NGV	National Grid Ventures
NMFS	National Federation of Fishermen's Organisation
NNE	North northeast
NNS	Northern North Sea
NOAA	National Oceanic and Atmospheric Administration
NSIP	Nationally Significant Infrastructure Project
NUI	Normally Unmanned Installation
NVZ	Nitrate Vulnerable Zone
NZT	Net Zero Teesside
OESEA	Offshore Energy Strategic Environmental Assessment
OFTO	Offshore Transmission Owner
OGA	Oil and Gas Authority
OPEP	Oil Pollution Emergency Plan
OPRED	Offshore Petroleum Regulator for Environment & Decommissioning
OSPAR	The Convention for the Protection of the Marine Environment of the North-East Atlantic

PAH	Poly Aromatic Hydrocarbons
PAM	Passive Acoustic Monitoring
Pb	Lead
PLONOR	Pose little or no risk
PSA	Particle Size Analysis
PWA	Pipeline Works Authorisation
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RYA	Royal Yachting Association
SAC	Special Area of Conservation
SBM	Synthetic Based Mud
SCOS	Special Committee on Seals
SEA	Strategic Environmental Assessment
SMP	Shoreline Management Plan
SMRU	Sea Mammal Research Unit
SNS	Southern North Sea
SPA	Special Protected Area
SSIV	Subsea Isolation Valve
SSS	Side-scan Sonar
SSSI	Site of Special Scientific Interest
TCE	The Crown Estate
TOC	Total Organic Carbon
TSS	Total Suspended Solids
UK	United Kingdom
UKCS	United Kingdom Continental Shelf
UKHO	United Kingdom Hydrographic Office
UNFCCC	United Nations Framework Convention on Climate Change
UXO	Unexploded Ordnance
WBM	Water-Based Mud
WFD	Water Framework Directive
YMNP	Yorkshire Marine Nature Partnership
ZCH	Zero Carbon Humber

APPENDIX B DEFINITIONS

Formation Water Displacement	Pressure changes resulting from CO_2 injection into the Endurance Store is anticipated to displace formation water at the Bunter Outcrop.
Bunter Outcrop	Location approximately 20 km from the Endurance Store area where Bunter Sandstone emerges at the seabed.
Carbon Capture and Storage (CCS)	Subset of CCUS in which CO_2 captured from industrial facilities is permanently stored in offshore geological storage sites
Carbon Capture Utilisation and Storage (CCUS)	Set of processes that capture CO_2 from waste gases produced at industrial facilities and either: (i) permanently store it in offshore geological storage sites (Carbon capture and storage or CCS); or (ii) reuse it in industrial processes such as the production of chemicals, minerals, plastics and synthetic fuels (Carbon capture and utilisation or CCU).
CO_2 Export Pipeline	High pressure CO_2 Export Pipeline. Teesside CO_2 Export Pipeline connects NZT to common subsea manifold and well injection site at the Endurance Store Humber CO_2 Export Pipeline connects ZCH to common subsea manifold and well injection site at the Endurance Store Referred to throughout as Teesside Pipeline and Humber Pipeline.
East Coast Cluster	A collaboration between Zero Carbon Humber, Net Zero Teesside, and the Northern Endurance Partnership to enable decarbonisation of the two industrial heartlands; Humber and Teesside.
Endurance Store	Hyper saline aquifer in Bunter Sandstone which is estimated to have the capacity to store approximately 450 Mt CO_2 in liquid form. The structure, which is 25 km long and 8 km wide, is covered by approximately 1,020 m of sealing mudstones and impermeable salts.
Endurance Store area	The environment in the vicinity of the Endurance Store.
Formation Water	Water that occurs naturally within the pores of rocks.
Net Zero Teesside (NZT)	Cluster of industrial, power and hydrogen businesses aiming to decarbonize their operations, by capturing and storing up to 10 million tonnes of CO_2 each year. Businesses include BOC, CF Fertilizers, H2Teesside, Kellas, Suez, TV ERF, 8 Rivers and NZT Power.
Net Zero Teesside Power	Will potentially be the world's first commercial scale gas fired power station with CCS. Net Zero Teesside Power will provide dispatchable low carbon power which will enable and compliment increasing renewable energy deployment by providing low carbon power to back up intermittent forms of renewable energy such as wind and solar.

Northern Endurance Partnership (NEP)	Development consisting of CO_2 Export Pipelines connecting Humber and Teesside CO_2 compression/pumping systems to a common subsea manifold and well injection site at the Endurance Store.
Zero Carbon Humber (ZCH)	ZCH includes ABP, British Steel, Centrica Storage, Drax, Equinor, Mitsubishi Power, National Grid, px Group, SSE Theral, Triton Power, Uniper and University of Sheffield Advanced Manufacturing Centre. The ZCH Partnership aim to make the Humber industrial region net zero by 2040 through low carbon hydrogen, carbon capture and carbon removal technology, enabled by shared regional pipelines for hydrogen and carbon emissions and the common offshore NEP infrastructure.