Table of Contents

Pictures

Tables

14. Marine Ecology and Nature Conservation

14.1 Introduction

14.1.1 This chapter of the Preliminary Environmental Information (PEI) Report identifies the potential impacts to marine ecology and nature conservation that are to be considered as part of the Environmental Impact Assessment (EIA) of the Proposed Development.

14.1.2 The Site is located predominately on the southern bank of the River Tees at the mouth of the estuary although several of the industrial connection corridors (i.e. Natural Gas connection and the CO_2 Gathering Network) will be located underneath the River Tees onto the northern bank. The Water Connection and CO_2 Export Pipeline also extend across the Coatham Dunes and the coastal foreshore of Coatham Sands down to below the Mean Low Water Springs (MLWS) mark.

14.1.3 A detailed Description of the Existing Environment and The Proposed Development is provided in Chapters 3 and 4 (PEI Report, Volume I), respectively. Construction Programme and Management details can be found in Chapter 5 (PEI Report, Volume I). The main elements of the Proposed Development which are relevant to this chapter broadly include:

- **Construction phase**:
  - Construction of the Water Connections including the Abstraction and Discharge Corridors;
  - Construction of the CO_2 Gathering Network;
  - Construction of the Natural Gas Corridor; and
  - Construction of the on-shore CO_2 Export Pipeline.
- **Operational phase (including maintenance)**:
  - Air emissions;
  - Water abstraction from the River Tees;
  - Treated water discharge to the Tees Bay; and
  - Any routine maintenance.

14.1.4 This chapter sets out a review of the existing marine ecological baseline conditions, potential temporary and permanent impacts of the Proposed Development, and identifies the scope of further work required to assess these impacts. The marine ecological receptors that are considered in this chapter are:

- Designated sites;
- Plankton (phytoplankton and zooplankton);

- Benthic ecology (including Invasive Non-Native Species (INNS));
- Fish and shellfish (including migratory fish species); and
- Marine mammals.

14.1.5 Potential impacts to marine water quality have been considered within Chapter 9: Surface Water, Flood Risk and Water Resources (PEI Report, Volume I) whilst coastal seabirds and associated designated sites are considered in Chapter 15: Ornithology (PEI Report, Volume I).

14.1.6 This chapter is supported by the following technical appendices, provided in PEI Report, Volume III:

- Appendix 14A: Intertidal Benthic Ecology Survey Report
- Appendix 14B: Fisheries and Fish Ecology Baseline Report
- Appendix 14C: Marine Mammal Ecology Baseline Report
- Appendix 14D: Subtidal Benthic Ecology Survey Report
- Appendix 9B: Coastal Modelling Report
- Appendix 15A: Habitats Regulations Assessment Report

14.2 Legislation and Planning Policy Context

14.2.1 This assessment included within this PEI Report has been undertaken within the context of relevant planning policies (both national and local), guidance documents and legislative instruments. A summary of the legislative background and policies relating to marine ecology and nature conservation is provided below.

Legislative Background

14.2.2 The following legislation is considered relevant to the Proposed Development in respect of marine ecology:

- Wildlife and Countryside Act 1981 (as amended by the Countryside and Rights of Way Act 2000);
- Marine and Coastal Access Act 2009;
- Salmon and Freshwater Fisheries Act 1975 (as amended);
- The Eels (England and Wales) Regulations 2009;
- The Conservation of Habitats and Species Regulations 2017;
- The Environmental Permitting (England and Wales) Regulations 2016;
- Conservation of Seals Act 1970;
- The Marine Strategy Regulations 2010;
- The Water Environment (Water Framework Directive (WFD)) (England and Wales) Regulations 2017;

- OSPAR Convention for the Protection of the Environment of the North-East Atlantic 1992;
- The Convention on the Conservation of European Wildlife and Natural Habitats 1979 (the Bern Convention);
- The Natural Environment and Rural Communities Act (NERC Act) 2006; and
- The Convention on Biological Diversity 1992.

National Policy

14.2.3 The key national planning policy related to the Proposed Development in respect of marine ecology includes:

- National Policy Statement for Energy (EN-1) (Department of Energy and Climate Change (DECC), 2011);National Planning Policy Framework (Ministry of Housing, Communities and Local Government, 2019);
- Governments' 25-Year Environmental Plan (HM Government, 2018);
- The UK Marine Policy Statement (HM Government, 2011); and
- UK Biodiversity Action Plan (1994 – 2012) (HM Government, 1994).

14.2.4 The overarching National Policy Statement for Energy (NPS EN-1) (DECC, 2011) sets out national policy for energy infrastructure. Part 5.3 relates to biodiversity and states that where development is subject to EIA, the Environmental Statement (ES) should clearly set out the effects on internationally, nationally and locally designated sites of ecological or geological conservation importance, protected species and habitats and other species identified as being of principal importance for the conservation of biodiversity. It also requires that the applicant shows how the project adheres to the Government's biodiversity strategy which aims to ensure:

- "*A halting, and if possible a reversal, of declines in priority habitats and species, with wild species and habitats as part of healthy, functioning ecosystems; and*
- *The general acceptance of biodiversity's essential role in enhancing the quality of life, with its conservation becoming a natural consideration in all relevant public, private and non-governmental decisions and policies*" (paragraph 5.2.18 of NPS EN-1).

14.2.5 This must be demonstrated through robust application of the mitigation hierarchy and can achieved by the application of appropriate mitigation to ensure that:

- The footprint of construction activities is reduced as far as practicable;
- Construction and operation best practice is adhered to in order to minimise disturbance to marine habitats and species;
- Restoration of habitats is carried out where loss and physical disturbance cannot be avoided; and
- Opportunities are sought to conserve and enhance biodiversity.

14.2.6 Where appropriate mitigation cannot be applied, it would be expected that requirements would be attached to the Development Consent Order (DCO) consent and / or any planning obligations entered into.

14.2.7 Also of relevance to marine ecology is part 5.15 of NPS EN-1 which relates to water quality and resources and requires applicants to consider impacts of the Proposed Development to water bodies and protected areas (e.g. shellfish waters) under the WFD.

14.2.8 Planning policy to support the halting of overall declines in biodiversity is set out in the National Planning Policy Framework (NPPF) (Housing, Communities and Local Government, 2019) and the Governments' 25-Year Environment Plan (HM Government, 2018). Both policy documents also include a commitment to promote opportunities to incorporate biodiversity improvements in order to achieve net gains for biodiversity.

14.2.9 Whilst the NPPF does not directly apply to nationally significant infrastructure projects (NSIPs), such as the Proposed Development, the Secretary of State (SoS) may have regard to policies in the NPPF if the SoS thinks that they are important and relevant. The forthcoming Environment Bill will mandate biodiversity net gain for development (housing and commercial) but this does not currently apply to NSIPs.

14.2.10 The Governments' 25-Year Environment Plan, which aligns with the Clean Growth Strategy, is relevant to the Proposed Development. To fulfil the aims of the 25-Year Environment Plan, Natural England has developed 'Defra Metric 2.0', a tool for measuring and accounting for biodiversity losses and gains resulting from development. The latest version of this tool, which was published in December 2019, includes intertidal habitats[1].

14.2.11 The UK Marine Policy Statement (MPS) provides a framework for preparing marine plans and taking decisions affecting the marine environment. Its focus is on promoting sustainable economic development with respect to the marine environment, ensuring promotion of healthy, functioning marine ecosystems and protecting marine habitats, species and heritage assets. As the North East Inshore Marine Plan is still under development, the MPS remains the relevant policy document - NSIP applications are required to have regard to the MPS.

14.2.12 Once the North East Marine Plan has been formally published, and notification is provided that it is the relevant policy document under Section 59 of the Marine and Coastal Access Act (2009), it will become a formal consideration as part of the NSIP decision process. A draft of the North East Marine Plan was published for consultation in January 2020. The timeframe for adoption of the plan is unknown; the ES for the Proposed Development will demonstrate compliance with the relevant policy document at the time of its publication.

14.2.13 The UK Biodiversity Action Plan (BAP) was published in 1994 and was the UK Government's response to the Convention on Biological Diversity (CBD). Action plans for the most threatened species and habitats were set out to aid

[1] http://publications.naturalengland.org.uk/publication/5850908674228224

recovery, and national reports, produced every three to five years, showed how the UK BAP was contributing to the UK's progress towards the significant reduction of biodiversity loss called for by the CBD. The UK BAP priority list contains 1150 species and 65 habitats requiring special protection.

14.2.14 The 'UK Post-2010 Biodiversity Framework', published in July 2012, succeeds the UK BAP. This is the result of a change in strategic thinking following the publication of the CBD's 'Strategic Plan for Biodiversity 2011–2020' and its 20 'Aichi Biodiversity Targets', agreed at Nagoya, Japan in October 2010, and the launch of the new EU Biodiversity Strategy 2020 in May 2011. The lists of priority species and habitats agreed under UK BAP still form the basis of much biodiversity work in each of the devolved administrations.

Local Policy

14.2.15 The land considered for the Proposed Development is located within the administrative boundaries of Redcar & Cleveland Borough Council (RCBC) and Stockton-on-Tees Borough Council (STBC). Local planning policy relevant to this PEI Chapter is set out in the Redcar & Cleveland Local Plan (adopted in May 2018) (RCBC, 2018) and the Stockton-on-Tees Local Plan (adopted in January 2019) (STBC, 2019).

14.2.16 Policy N1 (Landscape) and N4 (Biodiversity and Geological Conservation) of the Redcar & Cleveland Local Plan relates to the protection of the marine environment and important sites for biodiversity including Special Protection Areas (SPAs)/Ramsar, European Marine Sites, Sites of Special Scientific Interest (SSSI) and local nature reserves (RCBC, 2018). Similar themes are covered by the Stockton-on-Tees Local Plan Policy ENV5 which aims to preserve, protect and enhance ecological networks, biodiversity and geodiversity (STBC, 2019).

14.2.17 Both local plans make specific mention of the then proposed extension of the Teesmouth and Cleveland Coast SPA into the marine environment to protect breeding colonies of common tern (*Sterna hirundo*) and avocet (*Recurvirostra* spp.) as well as non-breeding waterbirds. The policies outlined above provide the necessary safeguards to protect both designated and proposed nature conservation sites.

14.2.18 The Tees Valley Biodiversity Action Plan (BAP) covers the local authority areas of Hartlepool, Stockton, Middlesbrough and Redcar and Cleveland. Darlington is currently being incorporated into the plan.

14.2.19 Local Priority Species for the Tees Valley which are relevant to the assessment of marine ecology include salmon (*Salmo salar*), sea trout (*Salmo trutta*), European eel (*Anguilla anguilla*) river lamprey (*Lampetra fluviatilis*) and sea lamprey (*Petromyzon marinus*).

14.2.20 Local Priority Habitats for the Tees Valley which are relevant to the assessment of marine ecology (with some overlap with terrestrial and aquatic ecology) include maritime cliffs and slopes, mudflats and saltmarsh, sand dunes, saline lagoons.

14.2.21 The cornerstone of the Tees Valley BAP is a series of habitat and species action plans for locally identified priority habitats and species (Tees Valley Nature Partnership, 2012). As the Tees is recognised as one of the main salmon rivers in England and Wales, there is currently a Salmon Action Plan enforced by the Environment Agency (EA) (Environment Agency, 2009a).

14.2.22 The actions of high priority within the Salmon Action Plan include:

- To improve water quality in the lower river and estuary;
- Free fish passage past the Tees Barrage;
- To improve evaluation of compliance against spawning targets;
- Maintain liaison with developers to ensure impacts of new developments are minimised; and
- Promote new regional byelaws relating to fishing near obstructions.

14.3 Assessment Methodology and Significance Criteria

Use of the Rochdale Envelope

14.3.1 In accordance with the Planning Inspectorate (PINS) Advice Note 9 (PINS, 2018), the ES will present a robust yet reasonable “worst case” assessment of the potential impacts of the Proposed Development on marine ecology, using the “Rochdale Envelope” where a degree of flexibility needs to be maintained for certain aspects of the design. For instance, the assessment of underwater noise impacts will consider those activities which may be necessary as part of the Proposed Development and which are likely to give rise to the greatest noise levels.

14.3.2 The exact nature of the Proposed Development and the scope of the necessary construction works is dependent in some cases, on the condition of existing infrastructure. Investigations into the feasibility of using the existing infrastructure are ongoing and so for the purpose of this PEI Report, the worst-case scenario has been assumed. These assumptions are shown in Table 14-1 alongside the preferred scenarios for the works. Further information can be found in Chapter 5: Construction Programme and Management (PEI Report, Volume I).

Table 14-1: Preferred and Worst-Case Construction Scenarios

Construction element	Preferred scenario	Worst-case scenario
Natural Gas Connection Corridor – River Tees crossing	'No dig' construction e.g. trenchless technologies	Same as preferred scenario
Water Connection – Abstraction Corridor and Discharge Corridor	Connection to Northumbrian Water's industrial water supply and sewerage network	Wastewater for cooling and other industrial processes will be abstracted from the River Tees and discharged to the Tees Bay following treatment on-site
Water connection – abstraction point	Use of existing intake infrastructure with minor refurbishment which will include installation of screening to comply with the Eel Regulations 2009	Extensive refurbishment and / or replacement of intake infrastructure to include: The installation of a cofferdam within the River Tees using vibro-piling Dredging Construction / alteration works to install new intake infrastructure Installation of screening system(s) The removal of a cofferdam
Water connection – discharge point	Use of existing outfall with minor maintenance and refurbishment works	Emplacement of a new outfall head to include: Dredging Placement of outfall head to include a short campaign of either piling or pin drilling to secure the structure Backfill of the dredged pocket around the outfall head The positioning of rock armouring / scour protection around the outfall head 'Full' refurbishment or replacement of treated water outfall tunnel to include: Open-cut trench through the most substantial area of dune complex at the South Gare Pre-works bathymetry and/or magnetometer surveys Dredging of a pipeline trench Placement of pipeline tunnel sections within the trench Backfill of the dredged trench Final assembly, pipeline jointing, connections, fabrication and ancillary commissioning works to connect to outfall head Both activities would require the presence of vessels such as dredger(s), work boat(s) and/or barge(s) to support the refurbishment process
CO_2 Gathering Network	'No dig' construction using e.g. using trenchless technologies	Same as preferred scenario
CO_2 Export Pipeline	Construction from the compression site to below MLWS using trenchless technologies	Open-cut method through the dune complex at Coatham Dunes whilst the section which transects the foreshore at Coatham Sands will be constructed using trenchless technologies

Assessment Methodology

14.3.3 The approach to the assessment for marine ecology will follow the general process outlined in Chapter 2: Assessment Methodology (PEI Report, Volume I). Potential impacts will be assessed against the baseline condition.

14.3.4 The impact significance will be based on assessing the impact magnitude (i.e. the deviation from the baseline condition) and the sensitivity and value (which is synonymous with 'importance') of the receptor. Temporary, permanent, direct and indirect impacts will be considered during the construction, operation and decommissioning phases of the Proposed Development, and any mitigation measures necessary will be identified.

14.3.5 The assessment will be completed in accordance with the Charted Institute of Ecology and Environmental Management's (CIEEM) Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine (CEEM, 2018).

14.3.6 The aims of the ecological impact assessment (EcIA) are to:

- Identify important ecological features (e.g. designated sites, habitats or species) which may be impacted by the Proposed Development;
- Provide a robust assessment of the likely ecological impacts and resultant effects of the Proposed Development, which may be beneficial (i.e. positive) or adverse (i.e. negative);
- Facilitate determination of the consequences of the Proposed Development in terms of national, regional and local policies relevant to nature conservation and biodiversity, where the level of detail provided is proportionate to the scale of the development and the complexity of its potential impacts;
- Identify appropriate mitigation to reduce the impact; and
- Set out the steps to be taken to adhere to legal requirements relating to the relevant ecological features concerned.

14.3.7 In accordance with CIEEM (2018) guidance, not all habitats and species which have the potential to occur in the Zone of Influence (ZoI) of the Proposed Development will be considered within the EcIA. Rather, focus will be placed on those features considered to be 'important' – determining importance is discussed in further detail below. To ensure compliance with National and European policy, consideration will still be given to biodiversity in its entirety and the need to achieve no net loss and enhancement of biodiversity.

14.3.8 The importance of an ecological feature or receptor is defined according to the following factors determined within a specific geographical context (e.g. international/, national, regional or local):

- Conservation or legal status;
- Quality or health;
- Extent; and

- Rarity or endemism.

14.3.9 Table 14-2 shows how the importance of a particular ecological feature or receptor is classified according to these factors.

14.3.10 In line with the CIEEM guidelines, the terminology used within the EcIA draws a clear distinction between the terms ‘impact’ and ‘effect’. For the purposes of the EcIA, these terms are defined as follows:

- impact – actions resulting in changes to an ecological feature; for example, underwater sound disturbance leading to displacement of hearing sensitive species; and
- effect – outcome resulting from an impact, acting upon the conservation status or structure and function of an ecological feature; for example, displacement of individuals and loss of important foraging or breeding grounds leading to effects on the reproduction and survival of the local population.

Table 14-2: Importance Criteria for Marine Ecology Features / Receptors

Importance	Description*
Very High	Designated sites and qualifying / supporting features of international importance. Species which are legally protected and / or in significant decline (i.e. classified as ‘endangered’ or ‘critically endangered’ according to the IUCN Red List[2]). High quality examples of rare habitats which are threatened throughout their range.
High	Designated sites and qualifying / supporting features of national conservational importance. Priority habitats and species or those considered to be of principal importance for the conservation of biodiversity in England and those species considered vulnerable to decline (i.e. classified as ‘vulnerable’ or ‘near threatened’ according to the IUCN Red List). High quality examples of uncommon habitats which are vulnerable throughout their range.
Medium	Habitats and species of regional or local importance. Those species considered to be of ‘least concern’ (according to the IUCN Red List). Poor quality examples of rare or uncommon habitats which are threatened or vulnerable throughout their range.
Low	Habitats and species of low conservation importance, such as those generally abundant and widespread around the UK with no specific local value.

*Should there be any overlap in the description of a particular feature / receptor, the worst-case importance criteria shall be adopted.

[2] https://www.iucnredlist.org/

14.3.11 To determine the likely significance of impact, the following parameters may be used:

- Impact type - direct or indirect, positive or negative, temporary or permanent;
- Magnitude of impact – the ‘amount’ or intensity of an impact. This may sometimes be synonymous with ‘extent’ (see below) for certain receptors, such as habitats loss. For mortality it may be the number of individuals killed;
- Spatial extent of impact – the area over which the impact will occur; and
- Temporal nature of impact – timing, frequency and duration.

14.3.12 The assessment shall also give regard to the sensitivity of an ecological feature to an impact which is determined by its:

- Adaptability i.e. the capacity, or lack thereof, of a feature to avoid or adapt to a change; and
- Tolerance / resilience i.e. capacity, or lack thereof, of a feature to accommodate temporary or permanent change or recover to pre-existing state following exposure to a change;

14.3.13 By combining the characteristics of a potential impact with the importance and sensitivity of ecological features or receptors, a measure of the significance of effects on marine ecology can be derived.

Significance Criteria

14.3.14 For each marine ecological receptor only those characteristics relevant to understanding the ecological effect and determining the significance are described. The determination of the significance of effects has been made based on the predicted effect to:

- Designated sites – i.e. the conservation objectives for the site and / or its interest / qualifying features;
- Ecosystems / biodiversity – resulting in a change in ecosystem structure and / or function;
- Habitats – i.e. extent, distribution, structure, function as well as its and associated species, and its conservation status within a given geographical area; and
- Species – i.e. abundance, distribution (including spawning, foraging and nursery habitats) and its conservation status within a given geographical area or at a particularly sensitive time (e.g. spawning season).

14.3.15 Conclusions on the significance of effects will be assessed as being either:

- Not Significant – no effect to one or more of the features described above; or
- Significant – one or more features described above are affected.

14.3.16 A matrix approach for determining significance of effects on marine ecological receptors has not been used as this does not accord with the 2018 CIEEM guidance. However, in order to provide consistency, the assessment conclusions presented within this chapter have been translated into the significance terminology used within the wider PEI Report (see Chapter 2: Assessment Methodology, PEI Report, Volume I). See Table 14-3 below.

Table 14-3: Description of Significance Terminology Used within this PEI Chapter

Classification of effect based on CIEEM guidance	Terminology used elsewhere in the PEI Report	Description in accordance with CIEEM guidance
Significant (beneficial)	Major beneficial	Beneficial effect on designated sites, ecosystems, habitat and species at the international level
	Moderate beneficial	Beneficial effect on designated sites, ecosystems, habitat and species at the national or regional level
Non-significant	Minor beneficial	Beneficial effect on designated sites, ecosystems, habitat and species at a local level
	Negligible	No effect on designated sites, ecosystems, habitat and species
	Minor adverse	Adverse effect on designated sites, ecosystems, habitat and species at the local level
Significant (adverse)	Moderate adverse	Adverse effect on designated sites, ecosystems, habitat and species at the national or regional level
	Major adverse	Adverse effect on designated sites, ecosystems, habitat and species at the international level

Consultation

14.3.17 An EIA Scoping Opinion was received from the Planning Inspectorate in April 2019 (Appendix 1B: PEI Report, Volume III). Table 14-4 provides an account of how comments raised by stakeholders in the Scoping Opinion in relation to marine ecology have been considered and actioned where appropriate.

Table 14-4: Key Issues Raised in Relation to Marine Ecology During EIA Scoping

Key issue raised (by whom, ID/page no., theme)	Response to issue raised and action taken where appropriate
Secretary of State (SoS) Scoping Opinion, 4.6.3, Study area: The Inspectorate considers that a study area of 15 km should be applied to assess impacts from emissions to air on statutory designated ecological sites as per EA/Defra guidance.	A Study Area of 15 km has been applied to the assessment of impacts from emissions to air on statutory designated sites. All potential impact pathways to marine ecological receptors have been identified in this chapter along with justification of the proposed Study Area.
SoS Scoping Opinion, 4.6.5, Baseline Surveys: It is unclear whether the Extended Phase 1 Habitat Surveys covered the entirety of the application site or just the Main Site.	Extended Phase I surveys have been carried out across the full extent of the Site. In November 2019, a dedicated Phase I and Phase II intertidal benthic survey was undertaken to characterise the ecological baseline within the proposed Site boundary. Further information (including the Study Area) can be found in Appendix 14A: Intertidal Benthic Ecology Survey Report, PEI Report, Volume III.
SoS Scoping Opinion, 4.6.6, Marine Ecology: The scope of baseline ecological surveys does not include surveys for benthic species, marine mammals, shellfish, fish or eels. However, potential impacts to aquatic habitats and water quality in the River Tees/North Sea are identified. The ES should explain the baseline conditions in respect to marine ecology and effort should be made to agree the sufficiency and location of any baseline surveys with relevant consultation bodies. The ES should also identify potential impacts to marine ecology and assess any likely significant effects, as well as describe any measures proposed to mitigate such impacts. Finally, the ES should include confirmation of how any such measures are secured.	Since submission of the Scoping Opinion work has been ongoing to characterise the marine ecology baseline. This has culminated in the production of four appendices covering intertidal benthic ecology (Appendix 14A: Intertidal Benthic Ecology Survey Report), subtidal benthic ecology (Appendix 14D: Subtidal Benthic Ecology), fisheries and fish ecology (Appendix 14B: Fisheries and Fish Ecology Baseline), and marine mammals (Appendix 14C: Marine Mammal Ecology Baseline). These appendices can be found in PEI Report, Volume III although a summary of the findings can be found in Section 14.4 of this PEI chapter. Baseline surveys have been completed for intertidal and subtidal benthic ecology. Characterisation of baseline conditions for all remaining marine ecological receptors has drawn upon desk-based literature and publicly available data sets. This approach to baseline characterisation was communicated to the MMO during a stakeholder meeting held on 26th September 2019. All potential impacts to marine ecology which are outlined within Section 14.6 of this PEI chapter will be assessed in the ES. Where mitigation is required, these measures will be described and secured within the appropriate control documents.
SoS Scoping Opinion, 4.6.7, Guidance: The ecology assessments within the ES should be undertaken with the most up-to-date version of the CIEEM guidelines.	As outlined above, the EcIA will be completed in accordance with the latest CIEEM Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine (CIEEM, 2018).

Key issue raised (by whom, ID/page no., theme)	Response to issue raised and action taken where appropriate
SoS Scoping Opinion, 4.6.11, Habitat gain/loss: The ES should identify and quantify all temporary and permanent habitat gains and losses by type (including any functionally linked land).	All temporary and permanent gains and losses of intertidal and subtidal marine habitats will be quantified within the ES according to the lowest (i.e. most detailed) possible EUNIS habitat classification level (EEA, 2012).
SoS Scoping Opinion, 4.6.12, Invasive species: Surveys should be undertaken to identify the presence of any invasive species on the application site and any necessary eradication/control measures detailed in the ES.	The presence of any INNS has been recorded during the characterisation of baseline conditions and is summarised in Section 14.4 below with further information provided within the supporting appendices (see PEI Report, Volume III).
EA, pg. 72, 25-Year Environment Plan: Developments should be looking to enhancement of the environment and not just to mitigate. The level of mitigation/compensation for nationally designated sites should be based on the ecological potential of the sites and not on the current ecological value.	This comment is acknowledged. Opportunities for ecological enhancement of the marine environment will be explored within the ES where practicable. Engagement with Natural England is ongoing to discuss this in further detail.
EA, pg. 72, Designated sites and habitats: Consideration must be made to all designated sites or locally non-statutory sites which fall within the boundary. This includes the Teesmouth National Nature Reserve (NNR).	Teesmouth NNR includes important intertidal mudflat habitats at Seal Sands and tidal lagoon habitat. Thus, this designated site has been considered in this PEI chapter and will be considered further in the ES.
EA, pg. 73, Biodiversity and Environmental Opportunities: Opportunities to delivery environmental enhancement and net gain in collaboration with organisations such as the Tees Estuary Partnership and should be sought to mitigate or compensate for impacts to habitats and species.	This comment is acknowledged. Opportunities to deliver marine ecological enhancement and net gain are currently being reviewed and will be discussed with stakeholders in due course.
EA, pg. 73, Estuarine and Coastal Environment: We recommend that the development proposal incorporates as best available practice Estuary Edges habitat designs on any existing or newly constructed structures that intersect the inter tidal zone. The 'IMMERSE' project funded through EU Interreg is currently piloting implementation of such measures in the Tees estuary through the Tees Rivers Trust.	This comment is acknowledged. Should a requirement for marine or coastal habitat creation be identified, efforts will be made to incorporate best available practice habitat design where practicable.
EA, pg. 74, No net loss of intertidal habitat: The EA is committed to no net loss of intertidal and subtidal habitat. When encroachment is shown in plans for any new works, considerable justification for this, together with details of mitigation and compensation would need to be included.	This comment is acknowledged. Details of mitigation measures relevant to the assessment of effect to intertidal and subtidal habitats are provided in Sections 14.5 and 14.7 of this PEI chapter. Further information will be provided within the ES as appropriate.
EA, pg. 74, Fish and eels: The DCO application must take protected fish species and eels into consideration, as the development will have impacts on the River Tees, which contains protected fish species, including Salmon, Sea trout, Eel and Lamprey. Eels are specifically	All potential impacts to migratory fish species including salmon, sea trout, eel and lamprey will be considered within the ES and the necessary mitigation agreed with the EA. An overview of the likely impacts and effects to migratory fish species can be found in Section 14.6 of this PEI

Key issue raised (by whom, ID/page no., theme)	Response to issue raised and action taken where appropriate
covered within the Eel (England and Wales) Regulations 2009. Activities that are likely to affect fish migration need to be fully considered for their potential impacts, and necessary mitigation measures agreed with the EA to prevent damage to any protected species.	chapter with information about relevant mitigation provided in Sections 14.5 and 14.7.
EA, pg. 74, Entrainment: All endeavours should be taken to avoid entrainment. The abstraction should comply with screening guidance in relation to the eel regulations.	The cooling technology for the Proposed Development will be a hybrid system, representing a combination of both wet and dry cooling. Abstraction volumes associated with this method are significantly lower than other forms of cooling (e.g. wet cooling) and thus, entrainment risk is reduced. The intake screening will be upgraded to achieve compliance with the Eel Regulations 2009. A reduction in screening mesh size will further reduce entrainment.
EA, pg. 75, Piling restrictions: Temporal restrictions may be imposed on any works taking place in the Tees Estuary or coastal waterbodies that could impact the passage of migratory fish.	Potential temporal restrictions to piling are acknowledged. Any licensing / supporting requirements including mitigation measures intended to reduce impacts on migratory fish passage will be discussed and agreed with the EA. Engagement with the MMO is ongoing regarding the scope and content of any future marine licence, including potential seasonality controls.
EA, pg. 75, Dredging: Any dredging works carried out between March and November, in any given year will require a silt mitigation plan and/or appropriate water quality monitoring programme must be implemented in accordance with a scheme agreed with the EA.	Should dredging works be required as part of the Proposed Development, licensing / supporting requirements including appropriate mitigation will be discussed and agreed with the EA and the MMO as the body responsible for issuing a marine licence for dredging works.
EA, pg. 75, INNS: INNS must be included in future ecological assessments and considered within the DCO application, so an informed decision can be made regarding any mitigation for potential adverse effects.	Marine INNS have been considered as part of the baseline characterisation detailed within this PEI chapter and supporting appendices. Potential impacts of the Proposed Development on the introduction and spread of INNS have been considered within Section 14.6 of this PEI chapter and will be assessed further within the ES.
Marine Management Organisation (MMO), pg. 100, Planning policy: It should be noted that, while the Project includes the potential for works below MHWS [Mean High Water Springs], consideration must be given to any relevant marine plans.	The Site falls within the North East Inshore Plan area. As this plan is still under development, the MPS remains the relevant policy document. Regard has been given to the MPS within this PEI chapter and will remain applicable to the ES providing the North East Inshore Plan is not published in the interim. As above, a watching brief will be maintained in relation to the draft North East Inshore Plan ahead of DCO submission.
MMO, pg. 100, Potential significant environmental issues: While a wide range of	Since submission of the Scoping Opinion work has been ongoing to characterise the marine

Key issue raised (by whom, ID/page no., theme)	**Response to issue raised and action taken where appropriate**
potential impacts pertaining to marine ecology have been scoped in, very little information has been provided with regards to the baseline features or specific potential impacts. The MMO would expect this to be presented in detail during the EIA process.	ecological baseline. This information can be found in Section 14.4 of this PEI chapter and the supporting appendices (see PEI Report, Volume III). All potential impacts to marine ecology which are outlined within Section 14.6 of this PEI chapter will be assessed in the ES.
MMO, pg. 100, Potential significant environmental issues: Should works be required within intertidal or estuarine areas of the River Tees and/or North Sea, then the EIA should provide a characterisation of fish ecology by identifying the fish species and habitats within the Study Area which may be subject to the impacts of activities.	A detailed characterisation of fish ecology relevant to the Proposed Development can be found in Appendix 14B: Fisheries and Fish Ecology Baseline, PEI Report, Volume III, with a summary of this information presented in Section 14.4 of this PEI chapter.
MMO, pg. 101, Potential significant environmental issues: The report appears to lack any reference to or consideration of potential impacts to local fisheries – and marine ecology – arising from the use of seawater as a means to cool the CCGT.	Your comment is acknowledged. Consideration of potential impacts to marine ecology forms the focus of this PEI chapter and supporting appendices. Consideration of potential impacts to local fisheries can be found in Chapter 20: Socio-economics and Tourism (PEI Report, Volume I).
MMO, pg. 101, Potential significant environmental issues: At this stage Project details are limited, for example it is currently unknown if existing infrastructure and/or tunnels can be used or if new infrastructure and/or tunnels will be required. As such, it is impossible to understand potential impacts to fisheries and/or other marine users. The MMO would expect that, moving forward, potential impacts on local fisheries and other marine users are considered during the EIA process.	Detailed information related to application of the Rochdale Envelope and reasonably worst-case can be found in Chapter 4: Proposed Development (PEI Report, Volume I) and Chapter 5: Construction Programme and Management (PEI Report, Volume I), with a summary presented in Section 14.2 of this PEI chapter. This forms the basis of the assessments presented in Section 14.6 of this PEI chapter; further information on impacts to local fisheries and other marine users can be found in Chapter 20: Socio-economics and Tourism (PEI Report, Volume I).

14.3.18 On 26th September 2019, a meeting was held with the MMO in order to demonstrate the progress which had been made with respect to marine matters since the Scoping Opinion was received in April 2019. During this meeting, the MMO was presented with further information about the Proposed Development and the marine scope including the ecological baseline, stakeholder engagement and consenting. Details on how marine matters would be considered within the developing PEI were also discussed.

14.3.19 A further engagement meeting was held with the MMO on the 13th February 2020 where additional progress on the Proposed Development and scope of marine assessment was presented. During this meeting, the MMO was also presented with information on how key marine topics were being addressed; this included aspects of thermal modelling, sedimentology and dredging and disposal activities.

14.4 Baseline Conditions

14.4.1 The marine ecological baseline relevant to the Proposed Development is summarised below. Further findings of the desk and field-based studies, including evaluation of the relative conservation value of identified ecological features is provided within the technical appendices listed in paragraph 14.1.6 – these can be found in PEI Report, Volume III.

Designated Sites

14.4.2 The Site is situated within the Teesmouth and Cleveland Coast Special Protected Area SPA/Ramsar site and the Teesmouth and Cleveland Coast Site of Special Scientific Interest (SSSI). These sites are designated for the protection of breeding / non-breeding bird species and other important waterfowl species associated with the site and include a range of coastal habitats (sandflats and mudflats, rocky shore, saltmarsh, freshwater marsh and sand dunes) within and around the Tees Estuary.

14.4.3 As of January 2020, the proposed extension to the existing Teesmouth and Cleveland Coast SPA and Ramsar site has been formally adopted and is intended to protect important marine foraging areas for breeding terns as well as intertidal areas and estuarine waters used by wintering birds. Intertidal areas are known to support benthic invertebrate communities which provide an important food resource for the majority of bird species found to occur in the area (Natural England, 2018).

14.4.4 The Teesmouth and Cleveland Coast SSSI encompasses a number of previously designated SSSI sites, including the Seal Sands SSSI which is located 2.9 km to the west of the proposed Site boundary and supports a breeding population of harbour seal (*Phoca vitulina*). The area is also used as a haul-out site by grey seal (*Halichoerus grypus*) (INCA, 2019).

14.4.5 Whilst direct and indirect effects to coastal seabirds and associated designated sites (e.g. the Teesmouth and Cleveland Coast SPA/ Ramsar) will be covered in Chapter 15: Ornithology (PEI Report, Volume I), consideration has been given to the Teesmouth and Cleveland Coast SSSI within this chapter owing to the importance of supporting coastal and marine habitats for seals.

14.4.6 The Site does not overlap with any other European Sites or Marine Conservation Zones (MCZs) designated for marine species and habitats.

14.4.7 The nearest SACs designated for marine mammal species are located between 86 km and 211 km from the Site. The only SAC for which there is considered to be a pathway for impact is the Southern North Sea SAC which is designated for harbour porpoise – further information can be found in paragraph 14.4.54 below.

14.4.8 Runswick Bay is the nearest MCZ, located over 20 km to the southeast of the Site. This site is designated for a range of intertidal and subtidal habitats as well as the ocean quahog (*Arctica islandica*), a species of edible clam (Defra, 2016). There is considered to be no pathway for impact to this site and it has therefore, been scoped out from requiring assessment within Section 14.6 of this PEI Report.

Plankton

14.4.9 Plankton includes a diverse array of small organisms including plants (known as "phytoplankton") and animals (known as "zooplankton") which live predominantly in the upper portion of the water column and are unable to swim independently of water currents. Also included are bacteria, algae and the early life stages of a range of species. Plankton provide a crucial food source to other animals and whilst generally microscopic in size, they include a wide range of organisms including jellyfish.

14.4.10 Since 2003, the EA has been sampling phytoplankton on a monthly basis at six sites within the lower portion of the Tees (downstream of the Tees Barrage). The most coastal site (The Gares) is located at the mouth of the estuary (Environment Agency, 2019a).

14.4.11 The most recent six-years of data (2012 – 2017 and 2019) has shown that peak phytoplankton abundance typically occurs between April and July, peaking in June (at approximately 4.5 million cells L^{-1}). The lowest abundances were observed during the winter months (December to January: <941,805 cells L^{-1}). Inter-annual variability in phytoplankton abundance since 2012 has ranged from an average of 101,778 cells L^{-1} (2012) to 2.6 million cells L^{-1} (2013 and 2019).

14.4.12 The composition of the phytoplankton community recorded in the Tees represents that found typically in UK estuaries. The most abundant taxa were diatoms followed by cyanophytes, euglenophytes and microflagellates. Combined these taxonomic groups represented 99% of the annual average abundance of phytoplankton.

14.4.13 No protected phytoplankton species or INNS were identified during the EA surveys, but five taxa known to cause harmful algal blooms in UK coastal waters were recorded. These included: *Alexandrium* spp., *Karenia mikimotoi*, *Dinophysis acuminata*, *Dinophysis acuta*, and *Pseudo-nitzschia* spp. which are all known to cause shellfish poisoning (Defra, 2008). In addition, several taxa known to cause mortality in fish due to physical damage were also recorded; these included *Gymnodinium* spp., *Dictyocha speculum*, *Chaetoceros spp. and K. mikimotoi* (Defra, 2008; ICES, 2018).

14.4.14 The EA survey data for the Tees Estuary suggests that *Alexandrium* spp., *K. mikimotoi* and *Dinophysis* spp. are the only phytoplankton taxa which are known to occur in potentially harmful abundances. No formal monitoring of harmful algal blooms is carried out within the lower Tees estuary or coastal water bodies (Environment Agency, 2019b). The Tees WFD water body, which covers the lower reaches of the estuary, is classified as having 'Good' phytoplankton status despite Seal Sands being recognised as a sensitive eutrophic area (Environment Agency, 2019b; 2019c).

14.4.15 Zooplankton communities in the North Sea are dominated in terms of biomass and productivity by copepods, particularly *Calanus spp. including C. finmarchicus* and *C. helgolandicus* (DECC, 2009). Other important taxa include *Acartia* spp., *Temora longicornis* and *Oithona* spp. The larger zooplankton, known as megaplankton, includes euphausiids (krill), thaliacea (salps and doliolids), siphonophores and medusae (jellyfish). Decapod larvae is also an important component of the zooplankton assemblage. Zooplankton species richness is generally higher in the northern North Sea than in the southern North Sea, with northern communities also displaying greater seasonal variability (Lindley and Batten 2002).

14.4.16 Observed changes in the biogeographic distribution of many zooplankton species (e.g. the northward expansion of warm water species and a northward retreat of cold-water species) are likely to be due to variations in the hydro-climatic conditions (i.e. increased sea temperatures). The extent of the northward shift in plankton distribution over the past 40 years has equated to about 10° latitude and appears to have accelerated since 2000 (EEA, Several INNS (including the cladoceran *Penilia avirostris* and the copepod, *Pseudodiaptomus marinus*) are known to have been introduced to the North Sea due to human activities and have responded to favourable conditions (Johns, unpublished cited in DECC, 2009; Edwards *et al*., 2014).

Benthic Ecology

14.4.17 In October 2019, a Phase I and II intertidal benthic survey was undertaken in order to characterise the intertidal habitats and species present within the vicinity of the Site. A grab survey was also completed in December 2019 to characterise subtidal habitats and communities.

14.4.18 During these surveys, three replicate core and grab samples were taken from 10 intertidal and 23 subtidal stations, respectively. Taxonomic analysis was undertaken by a NMBAQC (North Atlantic Marine Biological Analytical Quality Control) participating laboratory. All surveys and sample analysis were carried out in accordance with relevant best practice guidance (Davies *et al*., 2001).

14.4.19 Sediment samples collected from the 10 intertidal stations and 10 of the 23 subtidal stations were also analysed for abiotic indicators including organic matter, Particle Size Distribution (PSD), heavy and trace metals, and other contaminants (organotins, hydrocarbons and polychlorinated biphenyls and organochlorine pesticides). Laboratory analysis was carried out in accordance with the MMO's requirements for Marine Licensing (MMO, 2018).

14.4.20 The Study Area and sampling locations for the benthic surveys are shown in Figure 14-1 in Appendix 14A: Intertidal Benthic Ecology Survey Report (PEI Report, Volume III). The extent of the Study Area was determined based upon project design information available at the time, relevant guidance and an understanding of the extent of likely impacts of the Proposed Development. The indicative sampling locations were also discussed during pre-application engagement with the MMO.

14.4.21 The following subsections provide an overview of the project-specific survey data as well as the published information which has been used to characterise baseline conditions for benthic ecology within the Study Area.

Further information can be found in Appendix 14A: Intertidal Benthic Ecology Survey Report and 14D: Subtidal Benthic Ecology provided in PEI Report, Volume III.

Intertidal Benthic Ecology

14.4.22 Results of the Phase I and macrofaunal sampling showed that the Study Area could be divided into four geographically distinct areas based on the dominant habitats and species present. These included Coatham Sands, South Gare Breakwater, Paddy's Hole and Bran Sands.

14.4.23 Coatham Sands is a 4 km expanse of exposed intertidal sandflats running from Redcar to South Gare breakwater. Benthic ecology was found to be sparse with infaunal communities exhibiting low abundance and diversity, being characterised predominately by species associated with mobile sands. The dominant biotope in the area was 'barren or amphipod-dominated mobile sand shores' (EUNIS A2.22) which qualifies as an Annex I habitat type (mudflats and sandflats not covered by seawater at low tide).

14.4.24 South Gare breakwater is an area of coastal protection made of rock armour which is located to the north of Coatham Sands. Paddy's hole is an artificial bay built into the western side of South Gare breakwater which functions as a harbour for inshore fishing vessels. The dominant biotopes found on South Gare breakwater and at Paddy's hole were '*Semibalanus balanoides* on exposed to moderately exposed or vertical sheltered eulittoral rock' (EUNIS A1.113) and '*Fucus vesiculosus* on variable salinity mid eulittoral boulders and stable mixed substrata' (EUNIS A1.323), respectively. Although habitats in both areas were considered representative of Annex I rocky reef (with the latter also being representative of UK BAP Priority estuarine rocky habitat), they were not considered to represent high quality naturally occurring examples.

14.4.25 Bran Sands is located to the west of Coatham Sands within the mouth of the Tees Estuary. This site was characterised by homogenous intertidal muddy sandflats, typified by the biotope '*Cerastoderma edule* and polychaetes in littoral muddy sand' (EUNIS A2.242). This area was found to support more complex and diverse benthic communities than the other areas sampled with species such as the common cockle (*Cerastoderma edule*) and the lugworm (*Arenicola marina*) visibly present. Infaunal communities also exhibited higher abundances, biomass, species richness and diversity compared to Coatham Sands, although the difference in the abundance and biomass of infaunal communities within these two areas were not found to be statistically significant.

14.4.26 Small but statistically significant differences in the abundance and biomass of intertidal infauna were found across the survey area as a whole. Overall, communities were characterised by relatively low abundance, biomass, species richness and diversity. No protected species were identified during the intertidal survey. The only INNS recorded was the seaweed wakame (*Undaria pinnatifida*).

14.4.27 The results of the 2019 intertidal survey correspond with results of the pre-construction intertidal surveys undertaken for Teesside Offshore Windfarm in

2009 (Lancaster *et al*., 2011) and the Marine Nature Conservation Review (MNCR) Newbiggin to Saltburn survey which was undertaken in 1993.

14.4.28 Despite the industrialised nature of the surrounding area, chemical analysis of intertidal sediments within the Study Area showed no evidence of contaminant levels which would be expected to cause harm to benthic habitats and species.

Subtidal Benthic Ecology

14.4.29 Three biotopes where recorded across the 23 subtidal sampling stations. These were found to represent three spatially discrete areas characterised by varying macrofaunal assemblages, substrata and exposure conditions. See Figure D14-10 in Appendix 14D: Subtidal Benthic Ecology (PEI Report, Volume III) for the location of the sampling stations and biotopes.

14.4.30 Stations sampled on the south bank of the River Tees within the mouth of the estuary were characterised by the biotope '*Nephtys hombergii* and *Macoma balthica* in infralittoral sandy mud' (A5.331). Here, conditions were found to be relatively sheltered with weak tidal streams (>1 knot) which enable the build-up of muds which providing optimum habitat for the polychaete worm taxa *Nephtys* sp., in particular *Nephtys hombergii*.

14.4.31 Sampling stations out in the Tees Bay were classified as either '*Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand' (A5.233) or '*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand' (A5.242). The former biotope was found in the shallow inshore area which is characterised by moderate to high exposure and sediments possessing a low clay/silt content. The latter biotope characterised stations which were located, in most cases, in slightly deeper waters and were less exposed and exhibited a higher percentage of silt/clay.

14.4.32 Stations 6, 7, and 8 corresponded to those sampled in 2010 as part of a benthic survey undertaken for the Teesside OWF development (Entec UK Limited, 2011) and so the biotope classifications can be compared. Biotope classifications remained consistent at stations 7 and 8. However, at station 6 an increase in mud content within sediments had led to a shift in biotope from 'infralittoral mobile clean sand with sparse fauna' (A5.231) recorded in 2010 to '*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand'. Given the anticipated mobility of sediment in this area, as a result of the varying levels of exposure along this coast, this change is not unexpected.

14.4.33 Two of the biotopes identified (A5.233 and A5.242) qualify as habitats of principal importance being listed under Section 41 of the Natural Environment and Rural Communities (NERC) Act 2006 and belong to the UK BAP priority habitat type, 'subtidal sands and gravels'. These are also representative of the Annex I habitat 'sandbanks slightly covered by sea water all the time'. However, these habitats are not a qualifying feature of any nearby designated site. No individuals of *Sabellaria spinulosa* or reef structures were recorded at any of the subtidal benthic stations sampled in 2019.

14.4.34 Samples analysed for sediment chemistry found elevated levels of both trace metals and Polycyclic Aromatic Hydrocarbons at stations 1 and 2, in the estuary. There was little evidence to suggest the presence of wider sediment contamination within the Study Area.

14.4.35 In accordance with the Cefas guidelines for the disposal of dredged material, the localised contamination of sediments around the intake would be unlikely to prohibit disposal if dredged. In addition, a comparison to biological thresholds (CCME, 1999; Long *et al*., 1995) found that contamination levels were unlikely to significantly affect the benthic ecology (see Appendix 14D: Subtidal Benthic Ecology (PEI Report, Volume III) for further information). These elevated contaminants reflect the history and nature of the subtidal Study Area as a highly industrial region, with a broad variety of industries, including steelmaking and chemical manufacture, utilising land and resources within close proximity to the marine environment.

14.4.36 Despite there being evidence of localised contamination, the ecological status of macrobenthic infaunal invertebrate assemblages at station 2 and 5 were both ‘High’, and at station 1 the status was ‘Good’. Communities classified as ‘High’ were generally characterised by the presence of disturbance sensitive taxa and levels of diversity and abundance associated with undisturbed conditions (Phillips *et al*., 2014). Those assigned as having a ‘Good’ IQI status represents habitats which are only slightly disturbed.

14.4.37 No species afforded conservation protection were recorded during the subtidal benthic grab surveys. Furthermore, no INNS were recorded in any of the samples.

Fish and Shellfish

14.4.38 Based on the location of the Site the Study Area for the fisheries and fish ecology baseline has been defined as the area comprising the River Tees, the Tees estuary, and the wider coastal area up to and including the Greater North Sea out to a distance of 10 km offshore from the indicative Site boundary. The Study Area falls within the MMO North East Inshore Marine Plan area and the International Council for the Exploration of the Sea (ICES) rectangle 38E8. The Study Area is within the district of the North Eastern Inshore Fisheries and Conservation Authority (NEIFCA). See Figure 14B-1: Study area for the fisheries and fish ecology baseline in Appendix 14B: Fisheries and Fish Ecology Baseline (PEI Report, Volume III) for the location of the fisheries and fish ecology Study Area.

14.4.39 The Tees river and estuary is an important water body for diadromous fish species which make seasonal migrations between the sea and riverine environment. Salmon, sea trout, European eel, river lamprey and sea lamprey are all known to be present and have been identified as Local Priority Species within the Tees Valley BAP.

14.4.40 The River Tees is designated as one of the 64 main salmon rivers in England and Wales. There is currently a Salmon Action Plan in force which aims to manage the performance of salmon stocks within the River Tees against conservation limits (CL) (Cefas *et al*., 2019). The River Tees has been subject to historic pollution and is therefore recovering but it does support a small and increasing salmon and sea trout rod river fishery (Environment Agency, 2009a). The River Tees is not achieving its current CL which has been identified as an annual production of 14.9 million eggs[3]. Whilst this is expected for a river in the recovery phase, it is projected that in 2021, the Tees will remain at risk of not complying with salmon management objectives reported by ICES (Environment Agency, 2018).

14.4.41 The key migratory period for salmon and sea trout includes much of the spring, summer and autumn months with smolts migrating downstream in spring and early summer and adults returning to upstream habitats between June to August or October to December, respectively (Thorstad *et al*., 2012; Cowx and Fraser, 2003). Spring and autumn are key periods for migrating European eel and sea lamprey (Chadwick *et al*., 2007; Righton *et al*., 2016; Laughton and Burns, 2003) whilst river lamprey exhibit a protracted migratory period extending from mid-summer (July) through to the end of autumn (December) (Natural England, 2010).

14.4.42 Estuarine and marine fish communities within the vicinity of the Site represent a mixed demersal and pelagic fish assemblage typical of the central North Sea (Environment Agency, 2019d). Within the lower reaches of the River Tees and coastal waters, species such as sprat (*Sprattus sprattus*), herring (*Clupea harengus*), plaice (*Pleuronectes platessa*) and lesser sandeel (*Ammodytes tobianus*) are most prevalent. Assemblages offshore are characterised by herring, Atlantic mackerel (*Scomber scombrus*), horse mackerel (*Trachurus trachurus*), cod (*Gadus morhua*), whiting (*Merlangius merlangus*), haddock (*Melanogrammus aeglefinus*), plaice, and dab (*Limanda limanda*) (Teal, 2011; Callaway *et al*., 2002).

14.4.43 Common shellfish species within inshore waters include edible crab (*Cancer pagurus*), European lobster (*Homarus gammarus*) and velvet swimming crab (*Necora puber*) whilst the Dublin Bay prawn, *Nephrops norvegicus* commonly occurs offshore (Entec UK Limited, 2011). There are no designated shellfish waters within the vicinity of the Site, with the nearest one located at Holy Island of the Northumberland coast over 120 km away.

14.4.44 Fisheries sensitivity maps (Coull *et al*., 1998; Ellis *et al*., 2012) indicate that the Site is located within the nursery grounds of the following species: herring, sprat, cod, whiting, plaice, *Nephrops*, lemon sole (*Microstomus kitt*) and spurdog (*Squalus acanthias*). The Proposed Development is also found within the spawning area of lemon sole and *Nephrops*.

14.4.45 Within ICES rectangle 38E8, demersal otter trawling, and seine netting are the most prevalent fishing methods, targeting predominately *Nephrops* and whiting (MMO, 2018). Potting and trapping for lobster, edible crab, velvet swimming crab, *Nephrops* and cod also commonly occurs.

14.4.46 Further information related to the fisheries and fish ecology baseline can be found in Appendix 14B: Fisheries and Fish Ecology Baseline provided in PEI Report, Volume III.

[3] This is the target number of eggs deposited during spawning to ensure the status of the population remains favourable.

Marine Mammals

14.4.47 The ZoI of potential effects to marine mammals from the Proposed Development is predicted to occur predominately within the immediate vicinity of the Site. This Study Area encompasses the lower reaches of the Tees River and the coastal waters around the entrance to the estuary and to the south, between South Gare and around Coatham Rocks. However, recognising the highly mobile and transient nature of marine mammals and the potential implications of local impacts on wider populations, the Study Area also includes the Greater North Sea Ecoregion (North Sea, English Channel, Skagerrak and Kattegat) but with a focus on the ICES Division IVb. This extent also takes into consideration (where available) species-specific Management Units published by the Inter Agency Marine Mammal Working Group (IAMMWG) (IAMMWG, 2015). See Figure 14C-1: Immediate and wider Study Area for the marine mammal baseline in Appendix 14C: Marine Mammal Ecology Baseline (PEI Report, Volume III) for the location of the marine mammal Study Area.

14.4.48 Within the Greater North Sea Ecoregion, four cetacean species occur regularly or are resident including harbour porpoise (*Phocoena phocoena*), minke whale (*Baleanoptera acutorostrata*), bottlenose dolphin (*Tursiops truncates)* and white-beaked dolphin (*Lagenorhynchus albirostris*) (ICES, 2019). Two seal species live and breed in UK waters: grey seal and harbour (or common) seal (SCOS, 2018).

14.4.49 The North Sea and coastal waters around the Site are known to be important for harbour porpoise whilst comparatively, of low or very low importance for species such as white-beaked dolphin and bottlenose dolphin, respectively (Hammond *et al*., 2017). Although minke whale are not thought to occur in shallow coastal waters within the immediate vicinity of the Site, the northern North Sea is of importance for this species. All four cetacean species are recognised as being of ‘favourable’ conservation status (Joint Nature Conservation Council (JNCC), 2019) and of ‘least concern’ globally (IUCN, 2019).

14.4.50 The immediate area around the Site is of local importance for harbour seal due to the presence of a breeding colony at Seal Sands. This area is also a haul-out site for grey seal. Surveys carried out by the Industry Nature Conservation Association (INCA) in 2019 observed a record number of harbour seal pups and adults in Teesmouth. However, whilst no pup deaths were recorded during the INCA monitoring period (i.e. when pups are dependent on their mother), unrecorded levels of mortality were observed by the British Divers Marine Life Rescue in the succeeding months (INCA, 2019). Most deaths were linked to an unknown infection.

14.4.51 Seal Sands typically supports 100 – 140 harbour seals and 40 grey seals during the summer period (INCA, 2019). The mean number of grey seals recorded by INCA across all sampling months was lower in 2019 compared to previous years (e.g. 2014, 2016 and 2017) although remained high compared to pre-2010 counts (INCA, 2019).

14.4.52 Further haul-out sites are located at Greatham Creek and Bailey Bridge approximately 1.6 km and 0.9 km away from the proposed Site boundary, respectively. These sites are predominately used by harbour seals for breeding and moulting. An average of 18 harbour seals have been observed at Greatham Creek in August between 2010 and 2019, whilst the mean abundance observed at Bailey Bridge in 2019 was less than six individuals (INCA, 2019). Grey seals are also known to haul out at Greatham Creek on occasion but again in low abundance (typically less than 10 individuals). Grey seals were not observed hauling out at Bailey Bridge during the 2019 survey (INCA, 2019).

14.4.53 Tagging and observational studies have shown that, despite a local presence, the coastal waters around the Site (i.e. within ~50 km) are not heavily used by either seal species (Russell *et al*., 2017). Whilst grey seal is considered to be of 'favourable' conservation status in the UK, harbour seal is 'unfavourable – inadequate' (JNCC, 2019). However, globally both species are considered to be of 'least concern' (IUCN, 2019).

14.4.54 As outlined in paragraph 14.4.6, the Site and immediate Study Area (i.e. within a few kilometres from the indicative Site boundary) does not overlap with any European Sites or MCZs designated for marine species, including marine mammals. However, four SACs located in the wider North Sea (between 86 km and 211 km from the Site) are designated for marine mammal species including grey seal (Berwickshire and Northumberland SAC and Humber Estuary), harbour seal (The Wash and North Norfolk Coast) and harbour porpoise (Southern North Sea SAC).

14.4.55 Recognising the importance of the Study Area for harbour porpoise and the potential connectivity to the Southern North Sea SAC, this designated site has been considered within the assessment presented in Section 14.6 of this PEI chapter.

14.4.56 Tagging and observational studies have shown little interaction between harbour seal which occur in the Teesmouth and SAC populations within the wider North Sea. Furthermore, although interactions between major grey seal colonies are known, individuals have been observed to migrate offshore (>50 km) well beyond the ZoI of the Proposed Development (Russell *et al*., 2019). Thus, all the sites listed in paragraph 14.4.54 which are designated for seals have been scoped out from the assessment presented in Section 14.6 of this PEI chapter.

14.4.57 Further information related to the marine mammal baseline can be found in Appendix 14C: Marine Mammal Ecology Baseline provided in PEI Report, Volume III.

Summary of Receptors

14.4.58 In accordance with the methodology outlined in Section 14.3, Table 14-5 summarises the receptors relevant to the assessment of marine ecology for the Proposed Development and their ecological importance.

Table 14-5: Summary of the Importance of Marine Ecological Receptors

Receptor group	Description	Importance rating
Designated Sites	Teesmouth and Cleveland Coast SPA / Ramsar / SSSI and Southern North Sea SAC	Very High
Plankton	Phytoplankton and Zooplankton	Low
Intertidal habitats and communities	Includes sand and mudflats and rocky shore*	Medium
Subtidal habitats and communities	Includes all subtidal habitats and non-commercial invertebrate species	Medium
Fish and shellfish	Migratory fish species (including Atlantic salmon, European eel, sea trout and lamprey)	Very High
	Commercial fish and shellfish species	High
	General fish and shellfish	Low
Marine mammals	Cetaceans and pinnipeds	Very High

* Other coastal habitats including reedbeds, coastal marsh, saline lagoons, sand dune and maritime cliffs and slopes are covered by terrestrial and aquatic ecology (Chapter 12 and 13, respectively).

Baseline Evolution

14.4.59 The Tees river and estuary has had a long industrial and urbanised history during which time disturbance to the marine environment has been high. Historically, human activities have led to range of impacts including increased water pollution and reduced access to upstream environments which have resulted in several well documented ecological effects including a decline in the abundance of migratory fish species and seals within the Tees Estuary (Cefas *et al*., 2019; INCA, 2019).

14.4.60 In recent years, conservation and management efforts have seen an improvement in environment conditions and a recovery in species populations. Trends for several species such as harbour seal are generally increasing (INCA, 2019), whilst for others such as Atlantic salmon, populations remain at risk (Cefas *et al*., 2019). Future management measures (e.g. continued improvements in water quality, removal of instream barriers and the installation of fish passes and screening at intakes) can be expected to facilitate improvements in species populations although it is not possible to quantify the future benefits of such measures.

14.4.61 Other factors which pose a risk to marine ecological receptors include the prevalence of disease and climate change. Outbreaks of phocine distemper virus can lead to mass mortality of seals. In 2019, unprecedented levels of seal pup mortality were observed in the Study Area and although no specific cause was identified, individuals displayed similar symptoms which indicated some type of infection (INCA, 2019).

14.4.62 Future UK Climate Projections 2018 (UKCP18) from the Met Office for the Stockton-on-Tees area (The Met Office, 2019), based on a 1981 – 2000 baseline[4], uses a range of possible scenarios, classified as Representative Concentration Pathways (RCPs), to inform different future emission trends. RCP 8.5 has been used for the purposes of this assessment as a worst-case scenario.

14.4.63 Based on RCP 8.5, there is a 50% probability that sea levels will have risen 8 cm by 2022 (i.e. commencement of construction) and 11 cm by 2026 (i.e. commencement of operation). By 2051 (i.e. the end of the Proposed Developments operational lifespan) this may increase further to 26 cm above 1981 – 2000 baseline.

14.4.64 Sea temperature change projections are more variable and less specific to the Teesside region. Under RCP 8.5 a rise in global sea surface temperatures of 1.5°C by 2050 is predicted, increasing to a 3.2°C rise by 2100 relative to 1870 – 1899 temperatures. In UK waters, mean annual sea temperatures have risen by 0.8°C since 1870 and have continued to show consistent warming trends since the 1970s onwards (Genner *et al*., 2017).

14.4.65 Changes in sea level can lead to shifts in the abundance, extent and distribution of habitats and species. Increased sea temperatures can also lead to changes in species abundance and distribution as well as life history processes including growth and reproduction.

14.4.66 Based on the climate change predictions outlined above, and the characteristics of the coastal environment within the vicinity of the Site (i.e. relatively low lying), there is potential for the extent and distribution of habitats to change up until commencement of operation in 2026. For example, an 11 cm increase in sea level in 2026 would subject the area to coastal squeeze resulting in a loss of mudflat and sandflat habitats, a landward shift in the distribution of intertidal habitats and an extension of subtidal habitats. As a consequence, functional habitats for fish and shellfish may expand and seals may be vulnerable to a loss of suitable haul-out areas within Seal Sands and the wider Tees Estuary.

14.4.67 The predicted increase in sea temperature is unlikely to result in detectable shifts in the abundance, distribution and life history characteristics of species (e.g. infaunal species, fish, shellfish and marine mammals) within the vicinity of the Site prior to approximate commencement of operation of the Proposed Development (2026). However, unpredictable changes to seal populations due to, for example, a sudden outbreak of disease during this time cannot be ruled out.

14.4.68 Further changes may be observed during the operational lifetime of the Proposed Development (25 – 30 years) which may affect baseline conditions at the point of decommissioning. Prior to decommissioning, a Decommissioning Environment Management Plan (DEMP) will be developed and agreed with the Environment Agency and other stakeholders. This shall

[4] This baseline has been selected as it provides projections for 20-year time periods (e.g. 2020 – 2039).

consider in detail all potential environmental risks of the Site and would be expected to consider baseline conditions at that time.

14.5 Development Design and Impact Avoidance

14.5.1 The design process for the Proposed Development has included consideration of ecological constraints and has incorporated, where possible, measures to reduce the potential for adverse ecological effects, in accordance with the mitigation hierarchy and relevant planning policy.

14.5.2 The measures identified and adopted include those that are inherent to the design of the Proposed Development, and those that can realistically be expected to be applied as part of environmental best practice, or as a result of legislative requirements.

14.5.3 A Construction Environmental Management Plan (CEMP) and Site Waste Management Plan (SWMP) shall be prepared and implemented by the Contractor(s). These documents are intended to secure all good practice and mitigation measures to be executed during the construction phase in order to control and minimise impacts on the environment.

14.5.4 The following measures are specifically intended to avoid and / or reduce impacts to marine ecology and relevant designated sites during the construction and operational phases of the Proposed Development. The measures proposed have taken into the considered the worst-case scenarios presented in Table 14-1.

To Avoid and / or Reduce Direct Loss and Physical Disturbance to Marine Ecology

14.5.5 The design of the Proposed Development includes wet / dry (hybrid) cooling. This will have the benefit of minimising the abstraction and discharge of cooling water and associated effects to marine ecology (i.e. entrapment of organisms and thermal / chemical effects of cooling water discharge).

14.5.6 Re-use, replacement or upgrade of the existing water connection infrastructure from the former Redcar Steelworks shall be carried out where practicable to minimise land-take and the subsequent loss of benthic habitats and species, as well as to reduce disturbance to other marine ecological receptors.

14.5.7 Upgrade works to the abstraction point (i.e. intake) shall include installation of new screens to minimise entrapment risk to European eel and ensure compliance with the Eels (England and Wales) Regulations 2009.

14.5.8 If required, ‘no dig’ construction using trenchless technologies shall be used to install the Natural Gas Connection and CO_2 Gathering Network pipelines across the River Tees in order to minimise disturbance to riverine habitats and species;

14.5.9 Trenchless technologies would be used where possible to install the CO_2 Export Pipeline and Discharge Corridor across the foreshore to minimise disturbance to benthic habitats and species;

14.5.10 Cofferdam installation and removal at the abstraction point will be programmed to avoid the main migratory period for salmonids, European eel and lamprey.

14.5.11 Pre-construction sediment contamination testing shall be carried out in consultation with the MMO to identify whether there is potential for direct effects to marine water quality (and therefore subsequent indirect effects to marine ecology) and to allow opportunity to avoid or mitigate any adverse impacts.

14.5.12 All project vessels shall adhere to the International Convention for the Control and Management of Ships' Ballast Water and Sediments with the aim of preventing the spread of marine INNS [5].

14.5.13 All project vessels shall adhere to the International Maritime Organisation (IMO) Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species (Biofouling Guidelines)[5].

To Avoid and / or Reduce Underwater Sound and Visual Disturbance

14.5.14 The standard JNCC mitigation measures for explosives and geophysical surveys (JNCC, 2010; JNCC, 2017) shall be adopted during construction of the Proposed Development as appropriate;

14.5.15 Construction working hours will generally be Monday to Friday 07:00 to 19:00 and Saturday 07:00 to 13:00 thereby offering marine ecological receptors respite from any disturbance.

14.5.16 Activities that generate impulsive underwater sound within the marine environment (i.e. piling) shall not be undertaken at night.

14.5.17 Construction and operational lighting will be arranged so that glare and light spill outside the construction site is minimised to avoid impacts to sensitive ecological features.

14.5.18 An Indicative Lighting Strategy for both the construction and operational phases of the Proposed Development shall be prepared for the ES to support the DCO application.

To Avoid and / or Reduce Changes to Marine Water Quality

Construction Phase

14.5.19 Within the CEMP will be a Water Management Plan (WMP) that sets out the principles that will be adhered to by the Contractor(s) in order to manage the risk of water pollution. These overriding principles include:

- All works subject to any form of permission from a regulatory agency will be undertaken by the Contractor(s) conforming to all conditions of that permission;

[5] http://www.imo.org/en/OurWork/Environment/Biofouling/Pages/default.aspx

- Contractor(s) shall adhere to relevant guidance including the latest Pollution Prevention Guidance[6] as well as other relevant good practice guidance intended to protect the water environment (see Section 9.5 in Chapter 9: Surface Water, Flood Risk and Water Resources (PEI Report, Volume I) for further information); and
- The Contractor(s) shall ensure all relevant staff receive adequate training in environmental awareness, pollution prevention and pollution response protocols.

14.5.20 The outline WMP will also describe in greater detail the range of measures that could be adopted by the Contractor(s) when undertaking the works in accordance with these environmental protection principles. These measures broadly focus on:

- Managing the risk of construction site runoff or dewatering containing high levels of fine sediment or contaminants;
- Implementing measures to control the storage, handling and disposal of potentially polluting substances during construction;
- Managing activities adjacent to and within waterbodies (both freshwater, estuarine and marine) to avoid, minimise and reduce water pollution, unacceptable physical damage, potential ecological impacts, and disruption to third parties; and
- Ensuring there is adequate emergency response equipment, training and planning for all possible incidents.

14.5.21 Specific mitigation measures related to the management of construction site runoff, spillage risk and the dispersion of suspended sediments is outlined in Section 9.4 of Chapter 9: Surface Water, Flood Risk and Water Resources (PEI Report, Volume I). Briefly, these include measures such as:

- Use of a cofferdam at the abstraction point to minimise the dispersion of suspended sediment and any sediment-bound contaminants;
- Implementation of a temporary drainage system during the construction phase to prevent contaminated surface water run-off from entering the marine environment;
- Safe and secure storage of flammable/ toxic/ corrosive materials within bunded and fenced off areas;
- All refuelling, oiling and greasing to take place above drip trays or on an impermeable surface;
- Provision of wash down facilities for vehicles and equipment.
- Preparation of a Pollution Prevention Plan to be included alongside the CEMP; and

[6] http://www.netregs.org.uk/environmental-topics/pollution-prevention-guidelines-ppgs-and-replacement-series/guidance-for-pollution-prevention-gpps-full-list/

- Water quality monitoring of potentially impacted watercourses will be undertaken to ensure that pollution events can be detected against baseline conditions and can be dealt with effectively.

14.5.22 All Project vessels shall comply with the International Regulations for Preventing Collisions at Sea (1972) and regulations relating to International Convention for the Prevention of Pollution from Ships (the MARPOL Convention 73/78)[7] with the aim of preventing and minimising pollution from ships. Most critically, all vessels shall have a contingency plan for marine oil pollution (Shipboard Oil Pollution Emergency Plan).

14.5.23 Should any preparatory dredging be required, material shall be disposed of at a licenced marine site. This site is yet to be formally identified but several options, in close proximity to the Site, are available; this includes the existing Teesside A (TY 160) and Teesside C (TY 150) which are known to regularly receive material similar to that which is likely at the proposed dredge locations. Disposal of dredged material would be undertaken in accordance with a deemed Marine Licence from the MMO and following chemical testing.

Operational Phase

14.5.24 A formal drainage strategy will be developed for the operational phase of the Proposed Development. This will include a suitable surface water drainage network (i.e. compliant Sustainable Drainage System (SuDS)) which will capture surface water run-off for processing on site before being discharged to the Tees Bay via the treated water outfall.

14.5.25 A Surface Water Maintenance and Management Plan shall also be developed detailing information relating to access and maintenance of the different SuDS and surface water features proposed on the Site.

14.5.26 A site Emergency Response Plan shall be produced for the operational phase to deal with emergency situations involving loss of containment of any hazardous substances. Key actions which shall be included within this plan are outlined in Section 9.5 of Chapter 9: Surface Water, Flood Risk and Water Resources (PEI Report, Volume I).

14.5.27 Sampling of treated water shall be undertaken prior to discharge to ensure compliance with Environmental Permitting requirements during the construction and operational phases of the Proposed Development. The frequency of sampling shall be agreed with the permitting authority.

Decommissioning Phase

14.5.28 A DEMP will be produced and agreed with the relevant statutory consultees as part of the Environmental Permitting and site surrender process. The DEMP will consider in detail all potential environmental risks on the Site and contain guidance on how these risks can be removed or mitigated. Decommissioning activities will be conducted in accordance with the appropriate guidance and legislation at the time of the Proposed Developments closure.

[7] http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-(MARPOL).aspx

14.6 Likely Impacts and Effects

14.6.1 This section describes the impacts and potential effects of construction and operation of the Proposed Development on marine ecological receptors in the absence of any mitigation, over and above that which is inherent to the design and good practice (as described in Section 14.5).

14.6.2 To enable a focussed impact assessment, a scoping exercise has been undertaken to identify the potential impacts of construction and operation that are likely to result in adverse or beneficial effects on marine ecology and which require further impact assessment below.

14.6.3 The following activities are considered unlikely to result in any impact to marine ecology and have therefore been scoped out from requiring further consideration within Section 14.6 of this PEI chapter and the ES.

- Either existing infrastructure or a 'no dig' construction method using trenchless technologies shall be used to construct the gas connection and CO_2 Gathering Network cross the River Tees. There is no pathway for impact to marine ecological receptors from either of these options as the works would be underground with breakout points above MLWS.
- The quality of any effluent discharged to the marine environment will comply with the Environmental Permit for operational activities.
- During the operational phase, domestic and sanitary waste from the Proposed Development will be piped off-site to a local Northumbrian Water treatment plant where it will be adequately treated before being discharged. As outlined in Chapter 9: Surface Water, Flood Risk and Water Resources (PEI Report, Volume I), the impact to WFD water bodies is predicted to be not significant and thus, there is considered to be no pathway for impact to marine ecological receptors.
- In light of the mitigation proposed (summarised in paragraphs 14.5.24 to 14.5.27 but described in full within Chapter 9: Surface Water, Flood Risk and Water Resources (PEI Report, Volume I)), the risk of impacts to WFD water bodies from routine surface water run-off and accidental spillages during the operational phase are predicted to be negligible. Thus, there is considered to be no pathway for impact to marine ecological receptors.

Construction Phase

14.6.4 The following sections consider the way in which construction of the Proposed Development has the potential to impact marine ecological receptors.

Direct Loss and Physical Disturbance to Habitat and Species Under the Footprint of the Marine Construction Works

14.6.5 Several construction activities have the potential to result in the direct loss and physical disturbance of marine habitats and species. These include:

- Installation of the temporary cofferdam within the River Tees;

- Dewatering from behind the temporary cofferdams;
- Construction and installation of the intake infrastructure (including screens);
- Preparatory dredging to:
  - Facilitate access to the intake:
  - Create a pocket for emplacement of the outfall head; and
  - Dig out the trench for the outfall pipeline.
- The installation of rock armouring / scour protection around the outfall head;
- Creation of breakout points within the foreshore if using trenchless technologies of the CO_2 Export Pipeline; and
- Anchoring, grounding or positioning of work boat(s) and /or barge(s) on the seabed to support the refurbishment works.

14.6.6 The majority of these activities are expected to have a temporary impact, each lasting for only a short duration of the construction phase and are only expected to occur once during the construction phase. The only exceptions are the construction and installation of intake infrastructure, emplacement of the outfall head and installation of the associated rock armouring / scour protection which would all result in a permanent impact.

14.6.7 The footprint of the temporary and permanent marine construction works is still to be established pending detailed design of the Proposed Development. This information will be included within the ES.

14.6.8 Construction of the Proposed Development also presents opportunities for marine habitat gains which would arise due to substrate changes and the addition of rock armour around the outfall head. This could potentially have the capacity to function as an artificial rocky reef providing new colonisation opportunities for species dependant on hard substrate. Beneficial effects to benthic ecology, mobile invertebrates and fish are considered in further detail below. However, the introduction of hard artificial substrates in areas otherwise characterised by sandy mobile substrates also has the potential to facilitate the establishment and spread of INNS leading to adverse effects to marine ecology – this is discussed in paragraph 14.6.138.

Intertidal and Subtidal Benthic Ecology

14.6.9 Intertidal and subtidal habitats and their associated infaunal and epifaunal communities will be directly lost under the footprint of the marine construction activities. This would lead to fragmentation of habitats and a loss of ecosystem services provide by these habitats.

14.6.10 Any habitat can be regarded as intolerant of permanent loss. However, soft sediment habitats such as those which characterise much of footprint of the marine construction works are, according to the Marine Life Information Network's (MarLIN) Marine Evidence Based Sensitivity Assessment (MARESA)[8], known to be highly resilient to direct physical disturbance

[8] https://www.marlin.ac.uk/

arising from substrate loss (e.g. from dredging) and penetration (e.g. from anchoring or grounding of vessels). Overall, intertidal and subtidal benthic ecology would have medium sensitivity to direct loss and physical disturbance.

14.6.11 Although the exact extent of temporary and permanent habitat loss is still be established, based on the current Project Description, there is predicted to be no permanent loss of rocky shore, sandflat and mudflat within the intertidal zone. These habitats are examples of Annex I habitat and known to provide foraging habitat to qualifying features of the Teesmouth and Cleveland Coast SPA / Ramsar / SSSI. However, permanent habitat loss within the subtidal zone may occur underneath the outfall head and any associated rock armouring / scour protection. This would affect subtidal sandflats which are representative of Annex I habitat and are also afforded national conservation protection.

14.6.12 Temporary loss and physical disturbance of intertidal habitats and subtidal habitats considered to be representative of Annex I habitats would occur during the construction phase. However, the spatial extent of impact would be small and highly localised to the marine construction works. Furthermore, recovery would be expected to occur over reasonable timescales (i.e. <5 years) within this area following completion of construction as the habitats known to be present are well adapted to regular natural disturbance from for example, storm events.

14.6.13 The exact volume of rock armouring required for protection of the outfall is currently unknown but as a worst-case it is expected to be around 250 m^3. This presents a significant surface area for colonisation by flora (e.g. algae) and fauna (e.g. barnacles, tube worms, sea squirts and soft corals such as *Alcyonium digitatum*). Following placement and during the remaining construction phase and into the operational phase, a succession in the benthic communities associated with this structure is likely to be observed, transitioning from early colonisers (e.g. diatoms, filamentous algae and barnacles) to a climax community. In terms of biomass, this newly available food resource can be expected to offset to some extent the loss of infauna habitats (Langhamer, 2012).

14.6.14 Whilst construction of the Proposed Development can be expected to alter the extent, distribution and structure of intertidal and subtidal habitats and communities under the footprint of the marine works, these adverse effects are only predicted to occur at the local level. In the context of the availability of similar habitat across broader geographical scales, the effect of direct loss and physical disturbance to intertidal and subtidal habitats and communities under the footprint of the marine construction works is predicted to be **Not Significant**.

14.6.15 In accordance with National policy drivers, the ES will include a formal Biodiversity Assessment which will be undertaken using Natural England's 'Defra Metric 2.0' tool[1] to examine biodiversity losses and gains in relation to intertidal habitats. A less prescriptive assessment will also be undertaken for subtidal habitats using the most relevant and up-to-date guidance. This information shall be used to inform the requirement for additional mitigation, enhancement or compensatory measures in relation to the loss of marine biodiversity as a consequence of the Proposed Development.

Fish and Shellfish

14.6.16 Fish and shellfish may be affected by the direct loss and physical disturbance of functional habitats (i.e. those used for spawning or as nursery grounds) under the footprint of the temporary or permanent marine construction works, with less mobile or benthic life stages (e.g. eggs and larvae) and species (e.g. shellfish) potentially vulnerable to mortality. Fish and shellfish may also be vulnerable to direct mortality from dewatering activities if individuals become trapped inside the temporary cofferdam and are unable to escape.

14.6.17 Migratory fish species are not considered to have any functional associations with benthic habitats under the footprint of the marine construction works due to their life history strategies and transient presence. Therefore, potential effects from the direct loss and physical disturbance of habitats are not considered for this receptor group.

14.6.18 Migratory fish species are also unlikely to be directly affected by dewatering activities as they are generally highly mobile and sensitive to other sources of disturbance such as underwater sound generated by the construction activities (see paragraph 14.6.54 onwards for an assessment of this impact) which is likely to deter them from the area prior to completion of construction of the cofferdam. However, should they become entrapped and require removal, migratory fish are considered to have a low sensitivity to physical handling.

14.6.19 As outlined in paragraph 14.5.10, installation or removal of the temporary cofferdam shall not take place between 1st March and 30th November to avoid the main migratory period for salmonids, European eel and lamprey. Taking into consideration this mitigation, the magnitude of impact to migratory fish as a consequence of dewatering activities is predicted to be negligible and thus, any effect is predicted to be **Not Significant**.

14.6.20 The area under the footprint of the marine construction works is not considered to provide particularly important functional habitat for most fish and shellfish. The only exception is sandeel (*Ammodytes* spp.) as there is evidence to suggest that this species utilises inshore areas as a nursery ground (see Appendix 14B: Fisheries and Fish Ecology (PEI Report, Volume III)). This species exhibits a degree of site fidelity and is therefore likely to be more vulnerable to habitat disturbance than other fish species.

14.6.21 Nonetheless, the majority of species and life stages known to be present in the area are mobile and would be able to move away from the area of disturbance. Owing to the prevalence of the same or similar habitats within the area, fish and shellfish are expected to be relatively tolerant of displacement. Recovery of species populations and habitat function under the footprint of the temporary marine construction works would also be expected. This includes the recolonisation of suitable sediments by sandeels following completion of the works. Overall, the sensitivity of fish and shellfish to direct loss and physical disturbance is considered to be low.

14.6.22 Notwithstanding the potential adverse effects of discharge effluents (see assessment of effects for the operational phase), the addition of hard artificial substrate around the outfall head may also provide alternative refuge for fish (e.g. rocky reef dwelling taxa such as Gobiidae, wrasse and juvenile sand smelt) and shellfish (e.g. lobster and crab) as well as provide food resources once benthic communities have become established on these structures.

14.6.23 Fish and shellfish (excluding migratory fish) may be vulnerable to mortality due to dewatering activities. Those species that are sensitive to physical handling by dewatering pumps (e.g. clupeids and sand smelt) are considered to be most at risk. However, displacement of some species due to other sources of disturbance due to construction of the Proposed Development such as underwater sound is likely to occur, reducing the likelihood of individuals becoming trapped behind the cofferdam.

14.6.24 Overall, although there is potential for some direct loss and physical disturbance to fish and shellfish (excluding migratory fish) within the footprint of the marine construction works, given the localised and temporary nature of the impact, there is unlikely to be any discernible effect to functional habitats or species populations. Thus, the effect of direct loss and physical disturbance to fish and shellfish (excluding migratory fish) under the under the footprint of the marine construction works is predicted to be **Not Significant**.

14.6.25 Nonetheless, as additional mitigation, it is proposed that fish-friendly pumps are used for dewatering activities.

Marine Mammals and Designated Sites

14.6.26 Based on the outcome of the assessment of direct effects to benthic ecology and fish and shellfish, any indirect effect from a loss of food resources to marine mammals including, harbour seal which is a feature of the Teesmouth and Cleveland Coast SSSI, is predicted to be **Not Significant**.

Physical Disturbance to Benthic Habitats and Species from Increased Suspended Sediment Concentrations (I.E. Turbidity) and Deposition

14.6.27 The construction activities listed in paragraph 14.6.5 as well as the activities listed below all have the potential to increase suspended sediment concentrations (SSC) (i.e. turbidity) and create a sediment plume within the marine environment:

- Discharge of surface water run-off to the Tees Estuary or Tees Bay; and
- Disposal of dredged material within the marine environment.

14.6.28 This in turn can cause increased deposition as suspended sediments settle out. Both increased turbidity and deposition can cause physical disturbance to benthic habitats and species with potential for indirect effects to higher trophic levels. The release and re-deposition of sediment-bound contaminants also has the potential to effect benthic habitats and species through toxicity.

14.6.29 Several of the mitigation measures outlined in Section 14.5 are designed to avoid or reduce impacts to marine ecological receptors from SSC, deposition and the release of sediment-bound contaminants. These include:

- Use of a cofferdam at the abstraction point to minimise the dispersion of suspended sediment and any sediment-bound contaminants;
- Pre-construction sediment testing to identify any contamination and allow opportunity to implement further mitigation to avoid or reduce the potential for adverse impacts to the environment; and
- Implementation of the temporary drainage system which will be subject to frequent sampling of SSC to ensure compliance with Environmental Permitting requirements for discharge to the marine environment.

14.6.30 Considering the design mitigation outlined above and in Section 14.5, the spatial extent of impact due to dredging is predicted to be very small. All other sources of increased SSC and deposition (i.e. from surface water run-off, dewatering and the installation of the outfall pipeline and head), are also expected to generate a small, temporary or intermittent SSC plume which would be rapidly dispersed by hydrodynamic conditions.

14.6.31 In light of this, the release of suspended sediment and subsequent deposition is not expected to significantly alter the geomorphology or structure of substrates such that there is likely to be indirect effects to marine ecology.

14.6.32 The results of sediment quality analysis of samples collected from the expected footprint of the dredging works suggest that sediment contamination is likely to be low and highly localised to the intake. Any contaminated sediments which are disturbed during the construction phase would be expected to disperse and settle out over a wide area and thus, the potential for impact to marine ecological receptors would be limited. The overall significance of effects to marine ecological receptors is assessed in the following sections.

14.6.33 It is assumed that any dredged material from the Site shall be disposed of locally at a licensed marine disposal site. Given the low predicted volume of dredged material requiring disposal and the highly dispersive nature of hydrodynamic conditions within the North Sea there is unlikely to be any impact to benthic habitats and species as a result of this activity. Alongside regular disposals from PD Teesport dredging operations, detailed dispersion modelling has been undertaken for existing consented infrastructure projects seeking to dispose of material at these sites including York Potash (Royal HaskoningDHV UK Ltd., 2015). The results from this modelling exercise support this prediction. Nonetheless, a formal project-specific assessment of effect will be made within the ES.

14.6.34 The results of any additional sediment sampling carried out to support Marine Licensing shall be reported in the ES and used to further inform the assessment of effects to marine ecology.

Subtidal Habitats and Communities

14.6.35 Epifaunal abundance within the ZoI for turbidity and sediment deposition effects is thought to be low. The subtidal habitats and communities known to be present around the intake are considered to have a medium sensitivity to smothering and scouring effects (Ashley and Budd, 2007) whilst subtidal habitats out in the Tees Bay exhibit low sensitivity (Tilin and Rayment, 2016; Tilin and Garrard, 2019).

14.6.36 Taking into consideration the design mitigation, the resultant nature of potential impacts to sediment habitats and communities from increased turbidity and deposition (i.e. small in extent, temporary and localised) and the low to medium sensitivity of subtidal habitats and species to increased turbidity and smothering, the effect of construction of the Proposed Development is predicted to be **Not Significant**.

Fish and Shellfish

14.6.37 Mobile species or life stages would be expected to move away from unfavourable conditions and would be capable of returning to an area once adverse conditions had abated. Although demersal life stages are less able to adapt to adverse levels of turbidity and deposition, many are known to be reasonably tolerant of smothering (Kiørbe *et al*., 1981). Overall, the sensitivity of fish and shellfish to increased SSC and deposition is considered to be low.

14.6.38 The area within the predicted ZoI is not considered to provide particularly important functional habitat for most fish and shellfish (with the exception of sandeel which are known to utilise the area as a nursery ground) nor do migratory fish species utilise these areas for any specific purpose. Given the predicted extent and duration of impacts to turbidity, the suspended sediment plume is also unlikely to present a barrier to migratory fish species.

14.6.39 Sandeel are adapted to live in highly dynamic environments characterised by mobile sediments and variable turbidity and so there is considered limited potential for physiological damage (e.g. disruption to feeding or respiratory) or mortality of adult, juvenile or larval sandeel. Although sandeel do exhibit site fidelity, this species is considered adaptable and physiologically capable of relocating to alternative adjacent habitat temporarily and recolonising suitable sediments following completion of the works. Water currents would also be expected to disperse SSC and remove overlying deposited sediments. Thus, the risk of displacement and physiological damage or mortality of demersal species (such as sandeel) and life stages is considered to be low.

14.6.40 Taking into consideration the design mitigation, the resultant nature of potential impacts to fish and shellfish from increased turbidity and deposition (i.e. small in extent, temporary and short-term) and the low sensitivity of fish and shellfish to increased turbidity and smothering, the effect of construction of the Proposed Development is predicted to be **Not Significant**.

Marine Mammals and Designated Sites

14.6.41 Based on the results of the sediment dispersion modelling, construction of the Proposed Development is not predicted to have any direct effect on marine mammals.

14.6.42 Based on the outcome of the assessment of direct effects to benthic ecology and fish and shellfish, any indirect effect from a loss of food resources to marine mammals, including harbour seal which is a feature of the Teesmouth and Cleveland Coast SSSI, is predicted to be **Not Significant**.

Indirect Effects to Marine Ecology from Changes in Marine Water Quality (Excluding Turbidity)

14.6.43 Discharges into the marine environment from land drainage and marine vessels, accidental spillages of fuel, oils and chemicals, and deposition of air pollutants during the construction phase has the potential to alter water quality in terms of physico-chemical, biological and chemical parameters with indirect effects to marine ecology.

14.6.44 As demonstrated by the air quality modelling results presented in Chapter 8: Air Quality (PEI Report, Volume I), the release of air pollutants produced by land-based construction machinery and vehicles during the construction is predicted to have a negligible effect on air quality. As such, there is considered to be no pathway for impact to marine ecology.

14.6.45 As outlined in Section 14.5, several design and good practice mitigation measures are intended to avoid and reduce the risk of pollution entering the marine environment. This includes installation of a temporary drainage system manage surface water run-off. It is not currently known where the temporary drainage system would discharge to, but it is assumed that this may be via the existing outfall. All discharges to the marine environment during the construction phase are expected to comply with the relevant Environmental Permitting requirements and will be subject to routine water quality monitoring.

14.6.46 Other measures such as production of a CEMP and SWMP as well adherence to the relevant Pollution Prevention Guidelines and the International Regulations for Preventing Collisions at Sea (1972) and regulations relating to International Convention for the Prevention of Pollution from Ships (the MARPOL Convention 73/78), are also expected to significantly reduce the risk of accidental spillages of fuel, oils and chemicals.

14.6.47 The direct effects to marine water quality have been considered in Chapter 9: Surface Water, Flood Risk and Water Resources (PEI Report, Volume I). Notwithstanding the mitigation outlined above and in Section 14.5, this assessment concluded a moderate significant adverse effect to the Tees Bay and Tees Estuary waterbodies from changes in surface water quality during the construction phase. In accordance with the topic-specific assessment methodology outlined in Chapter 9: Surface Water, Flood Risk and Water Resources, this conclusion reflects a potential measurable change in the quality or vulnerability of an attribute of the Tees Bay or Tees Estuary waterbodies, both of which are considered to be of very high importance.

14.6.48 Considering the design and good practice mitigation outlined above and in Section 14.5, any indirect effects to intertidal and subtidal habitats and species from changes in marine water quality would be expected to be highly localised, temporary and short-term.

14.6.49 Given the highly dynamic nature of the Tees Bay and Tees Estuary waterbodies, any pollutants or contaminants would be rapidly dispersed and diluted. In light of this and the rapid turnover of marine plankton communities, effects to this receptor are predicted to be negligible.

14.6.50 Mobile receptors such as some fish species and life stages (including migratory species) and marine mammals would also be able to move away from adverse water quality conditions and so effects to these receptors would be limited. However, there remains potential for indirect effects to intertidal and subtidal habitats and species including less mobile life stages of fish (e.g. demersal eggs and larvae).

14.6.51 Considering the nature of the impact, it is unlikely that there would be any discernible effect to the abundance, distribution or functioning of habitats and species populations beyond the local level. Thus, indirect effects to marine ecology receptors from changes in marine water quality (excluding turbidity) during construction of the Proposed Development are predicted to be **Not Significant**.

14.6.52 More detailed information regarding the description of the Proposed Development and the design mitigation (e.g. temporary drainage system) will be made available for consideration within the ES. However, this shall be expected to adhere to the environmental management principles detailed in Chapter 5: Construction Programme and Management (PEI Report, Volume I) and summarised in paragraphs 14.5.19 and 14.5.20.

14.6.53 Consultation with the Environment Agency is also scheduled to be undertaken in 2020 and is expected to include discussions regarding requirements for chemical discharge modelling. If deemed necessary, this work will be completed prior to, and in sufficient time to inform the environmental assessments presented within the ES.

Changes in Underwater Soundscape

14.6.54 The following construction activities associated with the Proposed Development will create underwater sound and vibration within the marine environment which has the potential to impact fish and marine mammals:

- Vibro-piling of the temporary cofferdam at the intake;
- Drilling of the pin piles for installation of the outfall head;
- Dredging;
- Trenching for pipeline emplacement;
- Rock placement on the seabed;
- Marine vessel movements;
- Geophysical surveys; and

- Unexploded ordnance (UXO) detonation (if required).

14.6.55 There has been very little research into the impact of underwater sound on marine invertebrates (including shellfish) which are believed to be sensitive to particle motion rather than to sound pressure (Popper and Hawkins, 2018). At present there are no published sensitivity thresholds for this receptor group. As such, the assessment of underwater sound effects has focussed on impacts to fish and marine mammals for which there is recognised to be an important and often significant interaction.

14.6.56 Sound can be either impulsive in nature, such as that created by sonar sources or continuous such as from vessel movements and dredging. For underwater sound impact assessments, the metrics are sound pressure level (SPL) and sound exposure levels (SEL). The SPL is a measure of the amplitude or intensity of a sound and, for impulsive sound sources, is typically measured as a peak or rms (root-mean-square) value. In contrast, the SEL is a time-integrated measurement of the sound energy, which takes account of the level of sound as well as the duration over which the sound is present in the acoustic environment.

Underwater Sound Modelling Approach

14.6.57 To determine whether the construction activities are likely to generate sound propagation which may exceed the thresholds of marine ecological receptors, a simplified geometric spreading model has been used. This takes into account the maximum sound source level (SSL) and the transmission loss (TL) to calculate the received level (RL) of sound at a particular receptor:

$$RL = SSL - TL$$

14.6.58 The SSLs used within the assessment are summarised in Table 14-6. Generally, the source level is calculated by measuring the SPL in the acoustic far-field of the source, in a specified direction, and propagating the value back to the reference distance of 1 m from the acoustic centre of the source using an appropriate propagation model. This can lead to sound levels in the ‘near field’/close proximity to source being under or over-estimated (Farcas *et al*., 2016).

14.6.59 The propagation of underwater sound (i.e. the TL) is modelled using the standard acoustic geometric spreading formula (Xavier, 2002) given below:

$$TL = A \log (r) + B r + C$$

Where:

TL is the transmission loss at a distance r from the source.

A is the wave mode coefficient. For spherical waves A = 20, and cylindrical waves A = 10

B is an attenuation factor that is dependent on water depth and sea bottom conditions.

C is a fixed attenuation due to acoustic screening. In open water this will be 0.

14.6.60 In a free acoustic field without any reflecting boundaries, such as in deep mid-ocean water, the sound will decrease by 20 log (r) (i.e. spherical spreading) as the energy is dispersed over a large area in all directions. In shallow water the bottom and water surface will reflect the sound, causing interferences and the transmission loss will be better described by 10 log (r) (cylindrical spreading). Given the shallow water depths within the vicinity of the Site (i.e. <200 m) (Illingworth and Rodkin Inc, 2016) and the nature of the sound sources which are typically broad frequency, cylindrical spreading (i.e. A=10) has been assumed for most construction activities.

14.6.61 The sound propagation for UXO explosions (if required) has been calculated using the following semi-empirical formula originating from the Kirkwood-Bethe propagation theory, presented by Soloway and Dahl (2014).

$$P_{peak} = 52.4 \times 10^{6} \left(\frac{R}{W^{\frac{1}{3}}} \right)^{-1.13}$$

Where:

R is the measurement distance, and W the charge weight in kg TNT.

14.6.62 For UXO explosions two TNT equivalent charge weights have been modelled – 100 kg which is based on a “typical” ex-WWII North Sea air-dropped ordnance, and a more conservative charge weight of 55 kg.

14.6.63 As outlined below, this modelling approach has several key limitations and is therefore only intended to provide a preliminary assessment of underwater sound impacts to marine ecological receptors. More comprehensive range-dependant transmission loss modelling which addresses these limitations shall be undertaken once further design and construction information is available for the Proposed Development and will be used to inform a more robust assessment within the ES.

Table 14-6: Sound Source Levels Assumed within the Geometric Spreading Model

Construction activity	Sound type	Sound Source Level, dB rms re. 1µPa-m	Wave mode coefficient, A	Reference
Vibratory sheet piling	Non impulsive	181 (peak) 165 (rms) 165 (SEL)	10	California Department of Transport (2007)
Drilling of pin piles	Non impulsive	165 (rms)	10	Washington State Department of Transportation (2007)
Dredging / trenching	Non impulsive	178 (rms)	10	Greene (1987) in Genesis (2011)
Vessel movements – assumed small (<50 m) and medium (50 – 100 m) vessels as worst-case	Non impulsive	160 – 180 dB (rms)	10	Genesis (2011) Richardson *et al*. (1995) OSPAR Commission (2009)
Swathe or multi-beam echo sounder	Impulsive	232 (rms) 235 (peak)	15	Genesis (2011)
Side scan sonar	Impulsive	220 – 226 (rms) 223 – 229 (peak)	15	Genesis (2011)
Ultra-Short Base Line (USBL)	Impulsive	204 (rms) 207 (peak)	15	Applied Acoustics Engineering Ltd. (nd.)
UXO explosions – assumed 55 kg and 100 kg charge weight as worst-case	Impulsive	289 (peak)	10	Soloway and Dahl (2014)

14.6.64 The principle limitation of using the spreading law model, as undertaken here, is that it does not account for the main mechanism for sound propagation in shallow water, the repeated reflection and scattering from the sea surface and seafloor boundaries. These are particularly important in topographically complex river and estuarine environments, yet the modelling can only assume a free acoustic field. For example, the spreading propagation cannot take into account any potential acoustic shielding which may occur between the source and receiver (e.g. land masses) which could possibly limit sound transmission to sensitive sites such as Seal Sands. In addition, transmission losses due to scattering and diffraction are also not included within the model predictions, nor is the effect of the ambient underwater sound environment (i.e. baseline conditions).

14.6.65 Furthermore, propagation loss calculated on the basis of the spreading law model underestimates sound exposure close to the source, which is the region where sound levels are highest (and risk of injury and disturbance is greatest) and overestimates sound levels further from the source, giving the potentially misleading impression that a larger area would be affected

(Farcas *et al*., 2016). Geometric spreading propagation modelling also overestimates sound exposure because it assumes both a stationary receptor and a stationary sound source. Whilst the sound source may be derived from a fixed location, some sound sources (e.g. vessel sounds and acoustic surveys) and most marine ecological receptors will be highly mobile. Most individual animals such as fish and marine mammals are unlikely to remain in the same location for very long and in the presence of obtrusive underwater sound there is a high likelihood that they will move away, reducing the sound energy experienced with distance.

14.6.66 The consideration of UXO disposal operations will be largely hypothetical during the earlier stages of consenting for the Proposed Development. This is because the exact location, nature and disposal requirements of a UXO or UXOs is unknown and cannot be ascertained prior to DCO submission. For this reason, the Marine Licence will include draft conditions to require the detailed consideration of UXO disposal activities, and any required mitigation measures, at the time of a UXO anomaly being discovered. This is a typical approach for UK coastal infrastructure projects; the application of this approach to the Proposed Development has been discussed with the MMO.

Fish and Shellfish

14.6.67 Underwater sound can cause a variety of effects to fish. In extreme cases, where fish are in close proximity, very high sound pressure levels associated with impulsive sources such as UXO detonations can cause physical injury including rupturing of the swim bladders and subsequent death and effect such as haemorrhaging, embolism and bulging eyes may also occur. The extent of this type of injury is related to sound intensity (the sound pressure level) (Halvorsen *et al*., 2012) and rapid rise time of the impulse creating a shock wave. A range of other physiological effects such as physical damage to the auditory system structures (i.e. inner ear/sensory hair cells and otoliths) may also occur (Nedwell *et al*., 2006). Temporary threshold shift (TTS) is a common auditory impact representing an elevation in hearing threshold (i.e. a non-permanent reduction in hearing sensitivity). Behavioural effects are also of significant concern, particularly during fish migratory periods when underwater sound may form a barrier to movement.

14.6.68 The potential impacts of sound on fish is, to a large extent, determined by the physiology of fish, particularly the presence or absence of a swim bladder and the potential for the swim bladder to improve the hearing sensitivity and range of hearing (Popper *et al*., 2014). These morphological features have been used to develop categories of fish depending on how they might be affected by sounds and these are used when assessing impacts. Fish have been grouped into the following three categories of hearing sensitivity to underwater sound as described below:

- **High hearing sensitivity fish** – species in which hearing involves a swim bladder or other gas volume (e.g. Atlantic cod, herring and relatives). These species are susceptible to barotrauma and detect sound pressure as well as particle motion.
- **Medium hearing sensitivity fish** – species with swim bladders in which hearing does not involve the swim bladder or other gas volume (e.g.

Atlantic salmon, sea trout and European eel). These species are susceptible to barotrauma although hearing only involves particle motion, not sound pressure.

- **Low hearing sensitivity fish** – species with no swim bladder or other gas chamber (e.g. dab and other flatfish and elasmobranchs) are less susceptible to barotrauma detecting particle motion rather than sound pressure.

14.6.69 Several fish species with medium to high hearing sensitivity (e.g. Atlantic salmon, cod, herring, European eel and sea trout) known to be present in the River Tees are UK BAP priority species and / or species of principal importance. During the spring, summer and autumn months, there is potential for migratory fish species to pass by the Site.

Fish Sensitivity Thresholds

14.6.70 Popper et al. (2014) provide the most up-to-date acoustic sensitivity thresholds for the fish groups identified above. These criteria in relation to impulsive sound sources such UXO detonation are shown in Table 14-7 whilst the criteria for non-impulsive (i.e. continuous) sound sources is shown in Table 14-8.

14.6.71 For impulsive sound sources, the injury thresholds are expressed as dual criteria including a single strike peak sound pressure level (SPL) and cumulative sound exposure level (SEL). The impact zone and assessment of effects to fish and other marine species is based on the criteria which generates the largest estimated distance.

14.6.72 Where a quantitative threshold is not available, due to a lack of scientific information, qualitative impact criteria are provided in terms of relative risk (high, moderate, low) given for fish at three distances from the source defined in relative terms as near (N), intermediate (I), and far (F); “near” is considered to be in the tens of metres from the source, “intermediate” in the hundreds of metres, and “far” in the thousands of metres.

14.6.73 With regards to UXO detonation, Popper *et al*. (2014) provides guidance for the effect of vibration (rather than sound) on eggs and larvae. However, due to the unknown nature of UXO detonations and associated seabed conditions that would be required in order to predict vibration transmission, this has not been assessed further.

Table 14-7: Fish Sensitivity Thresholds for Fish for Impulsive Sound Sources - UXO Detonation

Sensitivity group	Mortality / mortal injury	Recoverable injury	TTS	Behaviour
Low sensitivity fish	229 - 234 dB peak	(N) High (I) Low (F) Low	(N) High (I) Moderate (F) Low	(N) High (I) Moderate (F) Low
Medium sensitivity fish	229 - 234 dB peak	(N) High (I) High (F) Low	(N) High (I) Moderate (F) Low	(N) High (I) High (F) Low
High sensitivity fish	229 - 234 dB peak	(N) High (I) High (F) Low	(N) High (I) High (F) Low	(N) High (I) High (F) Low
Eggs and larvae	>13 mm s −1 peak velocity	(N) High (I) Low (F) Low	((N) High (I) Low (F) Low	(N) High (I) Low (F) Low

Source: Popper et al. (2014)

Table 14-8: Fish Sensitivity Thresholds for Non-Impulsive Sound Sources

Sensitivity group	Mortality / mortal injury	Recoverable injury	Temporary Threshold Shift (TTS)	Behaviour
Low sensitivity fish	(N) Low (I) Low (F) Low	N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Moderate (F) Low
Medium sensitivity fish	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Moderate (F) Low
High sensitivity fish	(N) Low (I) Low (F) Low	170 dB SPL_{rms} (unweighted) re. 1μPa, for 48 hours	158 dB SPL_{rms} (unweighted) re. 1μPa, for 12 hours	(N) High (I) Moderate (F) Low
Eggs and larvae	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Moderate (F) Low

Source: Popper et al. (2014)

Modelling Results and Assessment for Fish – Impulsive Sound Sources

14.6.74 The results of the underwater sound modelling have been compared to the sensitivity thresholds for fish to show the estimated distances (i.e. impact zones) at which the different ecological effects may occur as a result of impulsive sound sources (Table 14-9). Note that the predictions have only been provided where a sensitivity threshold has been quantified. Alternatively, an assessment has been made using the qualitative criteria provided.

14.6.75 For UXO detonations using a TNT equivalent charge weight of 100 kg, the geometric spreading model predicts that mortality of fish may occur up to 473 m from the detonation (Table 14-9). An almost 50% reduction in charge weight would reduce the worst-case impact zone to 388 m. However, sub-lethal effects (i.e. recoverable injury, TTS and behavioural disturbance) could occur at greater distances.

Table 14-9: Fish Impact Zones for UXO Explosions

Receptor	Effect	Threshold level (impulsive sound source)	55 kg charge weight	100 kg charge weight
All fish (irrespective of sensitivity)	Mortality and potential mortal injury	234 dB peak (unweighted) re. 1μPa	233 m	284 m
		229 dB peak (unweighted) re. 1μPa	388 m	473 m

14.6.76 UXO detonations, if required, would only be expected to occur in the Tees Bay. As outlined in paragraph 14.5.15, standard JNCC mitigation measures for using explosives shall be applied in the event that a UXO detonation is required during the construction phase (JNCC, 2010). This shall include the use of 'soft-start' which would involve detonation of a sequence of smaller chargers to deter fish beyond the potential range of injury prior to the UXO detonation. Whilst this would mean fish would be displaced from the area, this effect would be temporary with fish able to return to the area following completion of the works.

14.6.77 Considering the good practice and design mitigation proposed, the potential for lethal effects to fish is considered to be low. Given the short-term and infrequent nature of UXO detonations, effects to fish would be localised and temporary. As such, there is unlikely to be any discernible effect on species populations either via changes in the local distribution, abundance or conservation status of species. Thus, effects to fish and shellfish from UXO detonation during the construction phase are predicted to be **Not Significant**.

Modelling Results and Assessment for Fish – Non-Impulsive Sound Sources

14.6.78 Table 14-10 presents the predicted impact zones for non-impulsive sound sources based on the sensitivity thresholds presented in Table 14-8. Note that the predictions have only been provided where a quantitative sound threshold is available.

Table 14-10: Fish Impact Zones for Non-Impulsive Sound Sources

Construction activity	High sensitivity fish	
	Recoverable injury 170 dB SPL_{rms} (unweighted) re. 1μPa, for 48 hours	TTS 150 dB SPL_{rms} (unweighted) re. 1μPa, for 12 hours
Vibratory sheet piling	<10 m	32 m
Drilling of pin piles	<10 m	<10 m
Dredging/ cable trenching	10 m	1000 m
Marine vessel movements	<10 m	631 m

14.6.79 The results of the geometric spreading model show that for all construction activities which generate a non-impulsive (i.e. continuous) sound source, recoverable injury of highly sensitive fish species is only predicted to occur if individuals were to remain within 10 m from the sound source for a period of 48 hours. The impact zone for TTS varies depending on the activity being undertaken and ranges from <10 m for drilling activities to 1000 m for dredging / cable trenching providing that individuals remain within the impact zones for a period of 12 hours.

14.6.80 Considering the construction working hours outlined in paragraphs 14.5.15 and 14.5.16, none of the construction activities outlined in Table 14-10 are expected to occur for longer than 12 hours and in many cases are unlikely to occur continuously for more than a few hours. Also, the fish with high hearing sensitivity are pelagic species, highly mobile and free-ranging and so unlikely to remain within the impact zone. Thus, no injurious impacts in fish, from any vessel movements are anticipated.

14.6.81 Based on the sensitivity thresholds outlined in Table 14-8, the potential for mortality or mortal injury, even in high sensitivity fish, is considered to be low even in the near-field (i.e. tens of metres from the sound source). However, there is a high and moderate risk of behavioural disturbance within the near- and intermediate-field (i.e. hundreds of metres from the sound source).

14.6.82 Overall, behavioural disturbance to fish from continuous sound sources would be localised, short-term and intermittent. A degree of habituation would also be expected, particularly given the area is already characterised by a reasonably high level of marine traffic transiting to and from the port facilities within the Tees Estuary. Thus, effects to fish and shellfish from construction activities which generate a non-impulsive (i.e. continuous) sound source are predicted to be **Not Significant**.

Marine Mammals and Designated Sites

14.6.83 Sound from anthropogenic activities can negatively impact marine mammals as it influences their ability to echolocate, communicate and some sound sources can cause physical harm including trauma to auditory apparatus. Sound can also cause certain cetacean species to change their behaviour and can result in increased alertness, modification of vocalisations, interruption or cessation of feeding or social interactions, alteration of movement or diving behaviour, and temporary or permanent habitat abandonment. Only in severe cases, such as sound caused by explosions or some military type sonar, are animal responses likely to include panic, flight, stampede, or disorientation which could lead to stranding, which could sometimes result in indirect injury or death.

14.6.84 Cetaceans produce and receive sound over a great range of frequencies for use in communication, orientation, predator avoidance and foraging (Tyack, 1998). As sound production in marine mammals is integral to a range of important behaviours, any interference with these communicative functions has the potential for adverse effects.

14.6.85 Seals (and other pinnipeds) also produce a diversity of sounds, though generally over a lower and more restricted bandwidth (generally from 100 Hz to several tens of kHz) than cetaceans. Their sounds are used primarily for social and reproductive interaction, both in water and air (Southall *et al*., 2007).

14.6.86 To reflect the different hearing sensitivities of marine mammal species, marine mammals have been classified into functional hearing groups as discussed below (Southall *et al*., 2007; NMFS, 2018). There is the potential for species in each of the following categories to be present in the vicinity of the Site:

- **Low frequency cetaceans -** baleen whales including the minke whale;
- **Mid frequency cetaceans -** the toothed whales and dolphins including the bottlenose dolphin;
- **High frequency cetaceans** – including harbour porpoise; and
- **Pinnipeds (phocids)** – earless or 'true' seals including harbour and grey seal.

14.6.87 Anthropogenic sound may have a diverse range of effects on marine receptors from injury to minor behavioural responses. The potential impacts on marine mammals are generally split into the following levels:

- **Effects on hearing** - a consequence of damage to the inner ear of marine mammals, the organ system most directly sensitive to sound exposure and, thus, the most susceptible to sound-derived damage (Southall *et al*., 2007). Hearing loss or a shift in hearing thresholds can be permanent or temporary:
  - **Permanent Threshold Shift (PTS)** - is a permanent elevation in hearing threshold (i.e., an unrecoverable reduction in hearing sensitivity). PTS can occur from a variety of causes, but it is most often the result of intense and/or repeated noise exposures; and
  - **Temporary Threshold Shift (TTS**) - is a recoverable elevation in hearing threshold (i.e., a non-permanent reduction in hearing sensitivity) most commonly resulting from long-term noise exposure not high enough to cause PTS.
- **Behavioural responses** – are highly variable and context-specific ranging from increased alertness, altering vocal behaviour, interruption to feeding or social interaction, alteration of movement or diving behaviour, temporary or permanent habitat abandonment. In severe cases, such as sound from explosions or military sonar, panic, flight, stampede, or stranding, sometimes resulting in indirect injury or death could occur. Minor or temporary behavioural responses are often simply evidence that an animal has heard a sound;
- **Masking** – anthropogenic underwater sound may partially or entirely reduce the audibility of signals of interest such as those used for communication and prey detection; and
- **Detection** – the limit of hearing. Marine mammals generally have high sensitivity to sound pressure (low detection thresholds) and can hear across a broad range of bandwidths.

Marine Mammal Sensitivity Thresholds

14.6.88 There is no evidence in the literature to suggest physical injury is likely to occur as a result of sound from impulsive sound sources but other injurious auditory impacts, such as PTS and TTS, as well as behavioural responses, are possible. The level of auditory impact will depend on the SSL generated, the sound propagation characteristics of the area, duration of the sound generating construction activities and the distance of the marine mammal receptor to the sound source. Whereas behavioural responses are often more variable and context specific.

14.6.89 Table 14-11 and Table 14-12 present the sensitivity threshold criteria for marine mammal groups, defined on the basis of their hearing sensitivity, to impulsive and non-impulsive sound sources, respectively. The thresholds cover the onset of TTS and PTS based on guidance from the National Marine Fisheries Service (NMFS) (2018).

Table 14-11: Marine Mammal Sensitivity Thresholds for Impulsive Sound Sources

Marine mammal hearing group	PTS		TTS	
	SPL*	SEL*	SPL*	SEL*
Low frequency cetaceans	219	183	213	168
Medium frequency cetaceans	230	185	224	170
High frequency cetaceans	202	155	196	140
Pinnipeds	218	185	212	170

*Units as follows: SPL dBpeak (unweighted) re. 1μPa and SEL dB SELcum (M-weighted) re. 1μPa²s
Source: NMFS (2018)

Table 14-12: Marine Mammal Sensitivity Thresholds for Non-Impulsive Sound Sources

Marine mammal hearing group	PTS (multiple pulses)	TTS (multiple pulses)
	SEL*	SEL*
Low frequency cetaceans	199	179
Medium frequency cetaceans	198	178
High frequency cetaceans	173	153
Pinnipeds	201	181

*Units as follows: SPL dBpeak (unweighted) re. 1μPa and SEL dB SELcum (M-weighted) re. 1μPa²s
Source: NMFS (2018))

Modelling Results and Assessment for Marine Mammals – Impulsive Sound Sources

14.6.90 The results of the simplified underwater sound modelling have been compared to the sensitivity thresholds for marine mammals to calculate the estimated distances (i.e. impact zones) at which received sound levels decreased to below the threshold values associated with the different ecological effects for impulsive sound sources (Table 14-13 and Table 14-14).

14.6.91 The results of the simplified underwater sound modelling predicts relatively small impact distances for sonar sound sources related to geophysical surveys, although for high frequency cetaceans, the potential impact zone is estimated to extend up to 5.7 km from the sound source for TTS and 3 km for PTS (Table 14-13).

14.6.92 Southall *et al*. (2007) suggests the onset of significant behavioural disturbance occurs at the lowest level of sound exposure that has a measurable transient impact on hearing, which is TTS. Thus, whilst the TTS threshold is not considered to be a behavioural impact *per se*, this auditory impact can be used as a proxy behavioural threshold. However, it should be noted that behavioural responses are extremely variable and context specific and therefore using a single threshold value is highly limited and conservative. The results are therefore used to help inform the overall assessment of behavioural response rather than being adopted as a definitive indicator of an effect occurring based on the sound level alone.

Table 14-13: Marine Mammal Impact Zones for Impulsive Sound Sources – Geophysical Survey Elements

Marine mammal hearing group	Threshold level	Swathe or multi-beam echo sounder		Side scan sonar		USBL	
		PTS	TTS	PTS	TTS	PTS	TTS
Low frequency cetaceans	SPL SEL (1-hr exposure)	<10 m 240 m	<10 m 620 m	<10 m 70 m	<10 m 270 m	<10 m 90 m	<10 m 650 m
Medium frequency cetaceans	SPL SEL (1-hr exposure)	<10 m 750 m	<10 m 1.3 km	<10 m 410 m	<10 m 780 m	<10 m 180 m	<10 m 1.0 km
High frequency cetaceans	SPL SEL (1-hr exposure)	<10 m 1.9 km	20 m 2.5 km	<10 m 1.2 km	<10 m 1.6 km	<10 m 3 km	<10 m 5.7 km
Pinnipeds	SPL SEL (1-hr exposure)	<10 m 370 m	<10 m 800 m	<10 m 130 m	<10 m 380 m	<10 m 120 m	<10 m 800 m

The distances at which SELcum threshold criteria for marine mammals are met have included consideration of marine mammal auditory weighting functions ('M-weighting') the broadband weighting factor adjustments as set out in Appendix D of NMFS (2018).

14.6.93 Baseline information suggests that harbour porpoise can be expected to occur from time to time within the Tees Bay but are unlikely to venture into the estuary. Other cetaceans, including bottlenose and white-beaked dolphin and minke whale may be present further offshore on occasion but only in low numbers (see Appendix 14C: Marine Mammal Ecology Baseline, PEI Report, Volume III for further information). Given the presence of a seal colony at Seal Sands, harbour and grey seals would be expected to occur frequently within the impact zones for geophysical survey activities. On this basis, some permanent or temporary injury to the hearing of both pinnipeds and cetaceans could occur and, assuming that the TTS threshold is indicative of a behavioural response, significant behavioural disturbance is also likely to occur.

14.6.94 Installation or removal of the cofferdam at the intake shall be undertaken outside of the breeding and moulting season for harbour seal, which extends from June through to early September (see paragraph 14.5.10). Furthermore, as outlined in Section 14.5, the standard JNCC mitigation for geophysical surveys (JNCC, 2017) shall be adopted for the Proposed Development as good practice mitigation. This would include measures such as a marine mammal observation zone for visual monitoring, passive acoustic monitoring and a soft-start approach which would increase sound levels gradually, allowing any marine mammals in the area opportunity to move away.

14.6.95 These measures aim to reduce the risk of permanent or temporary injury to hearing and severe behavioural impacts, particularly panic type reactions. They are most effective for the near-field effects, which are greater and possibly underestimated by the geometric spreading modelling (see paragraph 14.6.65 for further information). Far-field effects (e.g. behavioural disturbance), whilst harder to mitigate, are considered to be overestimated by the modelling approach. These results should therefore be interpreted cautiously.

14.6.96 There remains a risk that marine mammals could become displaced during any geophysical surveys. Geophysical surveys would be expected to take no more than approximately 10 days and during this time, behavioural effects would be intermittent and short-term.

14.6.97 Based on the information and mitigation outlined above, the risk of physiological impact to cetaceans is considered to be very low. Given the temporal nature of underwater sound impacts geophysical surveys (i.e. short-term and intermittent) and the resilience of cetaceans to temporary displacement, this construction activity is not predicted to affect the abundance and distribution of harbour porpoise within the wider North Sea, nor is it predicted to have any effect on the conservative status of the Southern North Sea SAC population. Thus, effects to this species and other less sensitive cetaceans from underwater sound generated by geophysical surveys during the construction phase are predicted to be **Not Significant**.

14.6.98 Given the short-term and intermittent nature of geophysical surveys, temporary displacement of pinnipeds (harbour and grey seal) is not predicted to affect the abundance and distribution of species within the Seal Sands area or within the wider North East Seal Management Unit (i.e. at the regional scale). Thus, effects to pinnipeds and the Teesmouth and Cleveland Coast SSSI (with respect to harbour seal) from underwater sound generated from geophysical surveys during the construction phase are predicted to be **Not Significant**.

14.6.99 Should detonation of UXOs be necessary, the geometric spreading model predicts that TTS (and behavioural disturbance) in cetaceans and pinnipeds could occur up to >10 km and 2.7 km away, respectively, depending on species sensitivities and the TNT equivalent charge weight used (Table 14-14). For PTS, the worst-case impact zone for cetaceans and pinnipeds is 7.4 km and 1.5 km, respectively. This assessment has been made using the sensitivity thresholds outlined in Table 14-11.

Table 14-14: Marine Mammal Impact Zones* For Impulsive Sound Sources – UXO Explosions

Marine mammal hearing group	55 kg charge weight		100 kg charge weight	
	PTS	TTS	PTS	TTS
Low frequency cetaceans	1.1 km	2.0 km	1.3 km	2.4 km
Medium frequency cetaceans	350 m	645 m	427 m	787 m
High frequency cetaceans	6.1 km	>10 km	7.4 km	>10 km
Pinnipeds	1.2 km	2.2 km	1.5 km	2.7 km

* Potential impact zones determined on the basis of SPL to reflect only 1 pulse per explosion

14.6.100 As outlined in paragraph 14.5.14, the standard JNCC mitigation for explosions (JNCC, 2010) shall be adopted for the Proposed Development as good practice mitigation. Crucially, this shall include the use of 'soft-start' or acoustic deterrent devices to reduce the risk of physiological impacts (i.e. TTS and PTS) and severe behavioural impacts although displacement would occur over potentially considerable distances.

14.6.101 The requirement for UXO detonation remains uncertain although given the small predicted extent of the marine construction works associated with the Proposed Development, the overall number is likely to be low. As such, the temporal nature of impact to marine mammals would be infrequent and extremely short-term with individuals capable of returning to the area following completion of the works.

14.6.102 On this basis, effects to cetaceans including harbour porpoise which is a qualifying feature of the Southern North Sea SAC located approximately 102 km away from the Site from underwater sound generated by UXO detonations during the construction phase are predicted to be **Not Significant**.

14.6.103 Considering the potential proximity of UXO detonations to the seal haul-out site at Seal Sands, effects to pinnipeds including harbour seal which is a qualifying feature of the Teesmouth and Cleveland Coast SSSI, from underwater sound generated by UXO generated by UXO detonations during the construction phase are predicted to be **Significant**.

14.6.104 To reduce the likelihood of impact it is proposed as additional mitigation that UXO detonations should be carried out outside of the sensitive breeding and moulting season for harbour seals (June to early September). Abatement measures such as implementation of acoustic barrier technologies, deflagration and the use of acoustic deterrent devices shall also be investigated and incorporated into the Proposed Development where practicable.

14.6.105 With consideration of these additional mitigation measures (predominately temporal restrictions on UXO detonations), the effects to pinnipeds from underwater sound generated by UXO detonations during the construction phase are predicted to be **Not Significant**.

14.6.106 As noted in paragraph 14.6.63, the underwater sound assessment presented in this PEI chapter is based on a preliminary modelling assessment. A more comprehensive modelling exercise shall be undertaken and reported within the ES with the aim of improving confidence in the assessment.

Modelling Results and Assessment for Marine Mammals – Non-Impulsive (I.E Continuous) Sound Sources

14.6.107 Table 14-15 presents the estimated distances (i.e. impact zones) at which PTS and TTS may occur in marine mammals as a result of cumulative exposure to non-impulsive (i.e. continuous) sound sources for a period of 1-hour. For the purpose of this assessment, the TTS impact zones have been used as a de facto behavioural threshold (see paragraph 14.6.92 for further information).

14.6.108 For vibro-piling and drilling, PTS in all marine mammals is predicted to occur within 571 m from the sound source. Larger impact zones are predicted for dredging / cable laying and general marine vessel movements; for high frequency cetaceans (e.g. harbour porpoise), PTS is predicted to occur at distances >10 km, whilst for all other marine mammal hearing groups, the impact zone is predicted to be no more than 57 m.

14.6.109 The estimated impact distance for TTS is within 2.6 km for low frequency cetaceans whereas for medium and high frequency cetaceans, as well as pinnipeds, TTS is predicted to occur at distances >10 km. Whilst the far field impacts are expected to be over-estimated by the use of geometric sound propagation calculations, the results do show there is a risk of TTS occurring for most marine mammals that remain in the vicinity of dredging / cable lay activities and marine vessels for longer than an hour.

Table 14-15: Marine Mammal Impact Zones[*] for Non-Impulsive Sound Sources (1-hour Exposure)

Marine mammal hearing group	Vibratory sheet piling		Drilling of pin piles		Dredging/ cable trenching		Marine vessel movements	
	PTS	TTS	PTS	TTS	PTS	TTS	PTS	TTS
Low frequency cetaceans	14 m	1.4 km	<10 m	143 m	29 m	2.9 km	45 m	4.5 km
Medium frequency cetaceans	<10 m	37 m	< 10 m	180 m	36 m	3.6 km	57 m	5.7 km
High frequency cetaceans	25 m	2.6 km	571 m	>10 km	>10 km	>10 km	>10 km	>10 km
Pinnipeds	<10 m	672 m	<10 m	90 m	18 km	1.8 km	29 m	2.9 km

[*] The distances at which SELcum threshold criteria for marine mammals are met have included consideration of marine mammal auditory weighting functions (‘M-weighting’) the broadband weighting factor adjustments as set out in Appendix D of NMFS (2018).

14.6.110 In practice, marine construction activities which generate non-impulsive sound sources would not be expected to operate continuously for a 1-hour period and so the impact zones presented can be regarded as precautionary. Marine mammals are highly mobile, and whilst many dolphin species are known to bow-ride fast moving vessels this is normally for short-periods only (i.e. <1-hour). Most cetaceans would be expected to move away from sources of underwater noise disturbance and so the potential for PTS is considered to be low. Nonetheless, there remains significant potential for individuals very close to the sound source to be subject to TTS and behavioural disturbance, with the magnitude of effects diminishing with distance.

14.6.111 TTS and behavioural disturbance effects are predicted to be temporary, short-term and intermittent. A degree of habituation would also be expected, particularly given the area is already characterised by a reasonably high level of marine traffic transiting to and from the port facilities within the Tees Estuary. In light of this, there is considered to be limited potential for detectable changes in the abundance, distribution and conservation status of marine mammals. Thus, effects to marine mammals and relevant designated sites (e.g. harbour seal – Teesmouth and Cleveland Coast SSSI and harbour porpoise – Southern North Sea SAC), from underwater sound generated by non-impulsive sound sources during the construction phase are predicted to be **Not Significant**.

14.6.112 Nonetheless, idling of marine vessels and equipment during the construction phase should be kept to a minimum.

Changes in the Airborne Soundscape During Construction

14.6.113 Marine and land-based construction activities associated with the Proposed Development will create airborne sound which has the potential to disturb pinnipeds (i.e. seals) that have surfaced or have hauled out. Disturbance effects might include cessation of feeding, resting, travelling and / or socialising, with possible long-term effects of repeated disturbance resulting in permanent displacement and / or a decline in fitness and productivity (e.g. moulting or breeding success).

14.6.114 There is a haul-out site for grey seals and breeding harbour seals at Seal Sands which is located approximately 0.6 km from the proposed Site boundary. Further haul-out sites are located at Greatham Creek and Bailey Bridge approximately 1.6 km and 0.9 km away from the proposed Site boundary, respectively. Seal Sands supports the greatest number of seals followed by Greatham and Bailey Bridge. On Seal Sands, the majority of harbour seals and grey seals are known to haul out at Sites A and D, respectively (Picture 14-1).

Picture 14-1 Location of Haul Out Sites on Seal Sands (Source: INCA, 2019)

14.6.115 As outlined in Chapter 11: Noise and Vibration (PEI Report, Volume I), ambient sound measurements were made at the Seal Sands industrial area in December 2019 during the daytime. The L_{Aeq} measured 68 dB whilst the representative $L_{A90,15min}$ and highest $L_{Amax,15\ min}$ measured 56 dB and 83 dB, respectively. The major source of sound at this location was industry but there was also a significant contribution from the unnamed road through the Seal Sands industrial estate. The monitoring site (E4 – see Figure 11-1 in PEI Report, Volume II) is located approximately 1.2 km away from where seals are known to haul out and is therefore expected to overestimate baseline conditions within the immediate vicinity of hauled out individuals.

14.6.116 Indicative predictions of construction sound levels have been made to determine the impacts of construction activities on sensitive human and ecological receptors. The free-field (A-weighted) sound level at a particular receptor for each construction activity has been predicted assuming a 12-hour working day. Further details on the construction sound prediction methodology can be found in Chapter 11: Noise and Vibration (PEI Report, Volume I).

14.6.117 During the construction phase, the activity which is predicted to generate the highest sound impacts for seals hauled out at Seal Sands is vibro-piling for installation of the temporary cofferdam which shall encompass the abstraction point within the River Tees. In practice, installation or removal of the cofferdam at the intake shall be undertaken outside of the breeding and moulting season for harbour seal, which extends from June through to early September (see paragraph 14.5.10) and so, this activity will not disturb seals either surfaced or hauled out during this period. Nonetheless, this activity has been considered as a worst-case for the construction phase and may impact seals either surfaced or hauled out during the remainder of the year.

14.6.118 Vibro-piling of the temporary cofferdam is predicted to generate sound levels at the nearest part of the Seal Sands mudflat to the sound source (i.e. located ~0.75 km away from the cofferdam to the east of Site D in Picture 14-1) and the area most commonly used by harbour seals (i.e. Site A in Picture 14-1 located ~1.6 km away) of 51 and 44 L_{Aeq}, respectively.

14.6.119 The sound exposure level thresholds for the onset of TTS and PTS in phocids (such as harbour and grey seals) are 134 and 154 dB re (20 µPa) in air (Southall *et al*., 2019). These sound exposure level thresholds use a weighting specific to the phocid seal group (Southall *et al*., 2019) which differs slightly from the A-weighting that has been applied within the model and is typically used for human receptors. These weightings reflect variations in peak sensitivity of the two receptor groups, which occurs around 10 kHz for marine species and around 1 – 4 kHz for humans (i.e. marine species are more sensitive to high frequency sound than humans).

14.6.120 Construction activities would be expected to be dominated by low- or mid-frequency sound. Furthermore, there is also likely to be less propagation of high frequency sound (compared to mid- or low-frequency sound) due to ground absorption and dispersion. Thus, in the absence of high frequency sound it is considered reasonable to assume for the purpose of this PEI Report that the predicted human A-weighted sound pressure levels are equivalent (and a likely worst-case) to phocid-weighted sound pressure levels. However, to permit a comparison between the predicted levels expressed as an L_{Aeq}, and the TTS and PTS thresholds which are expressed as sound exposure levels (Table 14-16), the former have been reported as 12-hour unweighted sound pressure levels then converted to an SEL and as a worst case, are compared to the thresholds for phocid seals.

14.6.121 The predicted unweighted sound exposure level at the nearest part of the Seal Sands mudflat to the abstraction point is predicted to be 99 dB which is considerably less than the 134 dB and 154 dB onset threshold for TTS and PTS given by Southall *et al*. (2019). The unweighted sound exposure level is even lower (92 dB) at Site A (see Picture 14-1), the area most commonly used by harbour seals.

14.6.122 Even when summing the measured ambient sound levels with the predicted levels at Seal Sands due to vibro-piling of the temporary cofferdam (see paragraph 14.6.115), there is predicted to be no exceedance of TTS and PTS thresholds. Thus, it is considered unlikely that seals hauled out at Seal Sands would be vulnerable to auditory damage due to changes in the airborne soundscape during construction as a result of sheet vibro-piling at the abstraction point. Using the TTS threshold as a proxy behavioural threshold, the risk of behavioural disturbance is also considered to be negligible.

Table 14-16 Predicted Airborne Sound Levels at Seal Sands from Sheet Piling at the Abstraction Point

Location	Distance to cofferdam (m)	Predicted free-field sound level for sheet piling for cofferdam installation (unweighted) $L_{eq,12h}$	Sound exposure level (unweighted)
Nearest part of the mudflat	750	53	99
Site most commonly used by harbour seals (i.e. Site A)	1600	46	92

14.6.123 Seals which surface in close proximity to the abstraction point whilst vibratory sheet piling is in progress are likely to be more vulnerable to auditory damage and behavioural disturbance. However, in practice piling would not be expected to operate continuously during the working day and would be likely to be less than a 1-hour period. Seals are also highly mobile and so individuals would be expected to move away from airborne sound disturbance although a degree of habituation would also be expected given the industrialised nature of the estuary.

14.6.124 In light of this and given that installation or removal of the cofferdam at the intake shall be undertaken outside of the breeding and moulting season for harbour seal (June through to early July) , there is considered to be limited potential for detectable changes in the behaviour, abundance, distribution and conservation status of harbour and grey seals as a consequence of changes to the airborne soundscape during construction. Thus, effects to seals and relevant designated sites (e.g. harbour seal – Teesmouth and Cleveland Coast SSSI) are predicted to be **Not Significant**.

14.6.125 Further work will be undertaken for the ES to enable a direct comparison between the model outputs and the threshold criteria presented by Southall *et al*. (2019). Furthermore, concurrent construction activities shall be modelled where possible to provide a cumulative assessment of the potential changes to the airborne soundscape during construction and the subsequent impact on seals.

Changes in Visual Stimuli (Including Artificial Light)

14.6.126 Land and marine-based construction activities could result in changes in visual stimuli (including artificial light) leading to avoidance behaviour in marine organisms which could affect breeding or foraging activities, with potential for wider implications for populations.

14.6.127 It can often be very difficult to separate out the relative contribution of different stimuli causing disturbance to marine organisms. However, for larger taxa which occur in shallow or surface waters (e.g. fish and marine mammals) and those that migrate onto land (e.g. seals hauled out), changes in visual cues (particularly light) are known to strongly influence behaviour.

14.6.128 As design mitigation, it is proposed that construction and operational lighting will be arranged so that glare and light spill into the marine environment is minimised. This measure will apply to land-based lighting as well as lighting on marine vessels operating in the adjacent coastal environment. A Lighting Strategy for both the construction phase of the Proposed Development will also be prepared for the ES to support the DCO application.

Fish and Shellfish

14.6.129 Fish species are photoreceptive, with key activity rhythms and behavioural patterns (e.g. feeding) stimulated by light. Daytime feeders are generally attracted to light whilst nocturnal species (e.g. carnivores) exhibit strong avoidance of light (Marchesan *et al*., 2005). Shellfish typically exhibit higher activity levels in the hours of darkness (Robson *et al*., 2010).

14.6.130 Given the design mitigation outlined above, any changes in visual stimuli to fish and shellfish would be highly localised to the construction works or Site and therefore the spatial extent of any disturbance would be small. The majority of lighting, plant and personnel would also be mobile and so any effect would be temporary, short-term and intermittent.

14.6.131 It is likely that other sources of disturbance (e.g. changes in the underwater soundscape) would deter fish from the vicinity of marine construction works thereby reducing the likelihood of visual disturbance. Any avoidance or attraction of fish to the construction activities within or adjacent to the marine environment is unlikely to affect the integrity of populations given the availability of alternative habitats elsewhere in Tees Estuary and Bay. Thus, effects to fish and shellfish from changes in visual stimuli during the construction phase are predicted to be **Not Significant**.

Marine Mammals and Designated Sites

14.6.132 Seals which have surfaced or hauled-out could be affected by changes to visual stimuli causing individuals to stop resting, feeding, travelling and / or socialising, with possible long-term effects of repeated disturbance resulting in permanent displacement and / or a decline in fitness and productivity.

14.6.133 In general, shipping traffic more than 1,500 m away from a haul-out site is not thought to evoke any reaction. However, between 900 m and 1,500 m, grey seals could be expected to detect the presence of vessels; and at closer than 900 m, a flight reaction may occur (Scottish Executive, 2007). Studies of harbour seals have shown a flight response to boats occurs at a distance of around 500 m (Anderson *et al*., 2012).

14.6.134 The width of the Tees between the abstraction point and the spit of land which encompasses Seal Sands is approximately 800 m. The topography of the spit means that direct line of sight to the haul-out site from the Main Site is extremely limited and so construction works on the south side of the river are not predicted to cause any visual disturbance to seals hauled out at Seal Sands.

14.6.135 The Tees Estuary is a highly industrialised area with regular marine vessel traffic. Furthermore, the area is frequently visited by members of the public to watch the wildlife (i.e. seals and birds) within the area. It can therefore be expected that seals and other marine mammals which occupy the estuary and surrounding area would be habituated to anthropogenic sources of visual stimuli.

14.6.136 Considering this and the temporary, localised and intermittent nature of any changes in visual stimuli arising as a consequence of construction of the Proposed Development, effects to marine mammals, including harbour seal which is a feature of the Teesmouth and Cleveland Coast SSSI, is predicted to be **Not Significant**.

Introduction and Spread of Invasive Non-Native Species

14.6.137 INNS have the potential to out-compete native species with possible detrimental impacts to native habitats via species loss, modifications to ecosystems and the introduction of disease and pathogens leading to mortality.

14.6.138 Marine plant and vessels required for construction of the Proposed Development represents the most likely pathway for the introduction of INNS, either from biofouling or from the discharge of ballast water and bilge water. However, INNS may also be introduced via construction materials (e.g. placement of rock armouring required around CW outfall head). The introduction of hard artificial structures also has the potential to facilitate the colonisation of INNS as these are known to disproportionately favour non-native species compared to naturally occurring hard-bottom species due to the absence of competition and predation (Witt *et al.,* 2012). New substrates or structures can also serve as 'stepping stones' in otherwise unhospitable areas, which can assist with the expansion of species distributions (Mineur *et al*., 2012).

14.6.139 Considering the good practice mitigation measures outlined in paragraphs 14.5.12 and 14.5.13, the risk of introduction and spread of INNS through ballast water exchange and biofouling would be reduced and therefore the probability of transmission is low. Given the relatively small volume of rock armouring which would be required to protect the treated water outfall head, the risk of INNS transmission on this material is also low.

14.6.140 The prevalence of existing INNS within the vicinity of the Site is limited and none appear to be detrimental to native species habitats, diversity or ecosystem functioning (see Section 14.4). Given the limited extent of loss and physical disturbance to habitats and species, and volume of artificial substrate added during construction, the risk of existing or new INNS becoming established or proliferating to an extent that would cause ecological harm is considered to be very low. Thus, the effects to marine ecological receptors are predicted to be **Not Significant**.

14.6.141 Additional information regarding marine vessel movements and the volume of rock armouring which will be required during construction will be provided in the ES. This information will be used to further inform the assessment of INNS risk to marine ecological receptors.

Collisions Between Project Vessels and Marine Mammals

14.6.142 Moving marine vessels and plant have the potential to collide with marine mammals. This may result in the physical injury, such as propeller injuries, and in the worst case, mortality (Pace *et al*., 2006; Dolman *et al*., 2006).

14.6.143 Should refurbishment and / or upgrade of the Cooling Water System (CWS) be required in addition to construction of the CO_2 Export Pipeline, there is potential for several marine vessels to be transiting and operating within the mouth of the Tees Estuary and within the wider Tees Bay. The exact number and types of vessels required is not currently known although these can be expected to include flat-bottom workboats and barges, shallow-hull trenching vessels, jack-up barges, and Rigid Inflatable Boats (IRIBs). The frequency of vessel movements and the level of marine traffic is also yet to be determined but as a worst-case scenario it is assumed that vessels may be operating at the same time.

14.6.144 Marine mammals are considered to be fast swimming, agile species, with fast reflexes and good sensory capabilities (Hoelzel, 2002). However, individuals can become distracted by activities such as foraging and social interactions, and therefore may not perceive the threat of an approaching vessel (Wilson *et al*., 2007). Locally resident species such as harbour and grey seals, which use haul sites within the Tees Estuary, are likely to be habituated to marine vessel movements although juvenile seal pups which are inexperienced in the water and more inquisitive species such as the bottlenose dolphin would be expected to be vulnerable.

14.6.145 Marine mammals possess a thick subdermal layer of blubber which provides a level of protection to their vital organs meaning they are reasonably resilient to minor strikes and collisions (Wilson *et al*., 2007). However, a direct strike from a sharp object such as rotating propeller blades has potential to cause lethal injury to marine mammals and several cases of seal injuries thought to be caused by propellers and thrusters (for dynamic positioning of vessels) have been recorded in recent years (Bexton *et al*., 2012).

14.6.146 The most lethal and serious injuries to marine mammals are believed to be caused by large ships, typically 80 m and longer as well as vessels travelling faster than 14 knots (Laist *et al*., 2001).

14.6.147 The majority of vessels potentially required for construction of the Proposed Development will be <80 m in length, slow moving (i.e. operational speeds of <14 knots) and will be stationary for long periods of time within discrete work areas (i.e. proximity to the intake, treated water outfall and on-shore CO_2 Export Pipeline location). Other vessels, such as shallow-hulled trenching vessels and flat-bottomed work boats, have a shallow draught and will be operating close inshore which means the potential for collision with marine mammals would be limited.

14.6.148 RIBs or similar vessels have the capacity to travel at high speeds although the number required during construction is expected to be limited. Furthermore, their movements would generally be limited to within the immediate vicinity of the Site and speeds within the Tees Estuary would be limited by restrictions imposed by the local port authority.

14.6.149 With the exception of harbour and grey seals, the abundance of marine mammals within the immediate vicinity of the Site is predicted to be low. Given the likely occurrence of other disturbance effects (e.g. underwater sound disturbance), displacement of individuals is also probable.

14.6.150 Overall, the likelihood of marine vessels colliding with marine mammals is predicted to be low but a small risk to juvenile seal pups is considered to remain. Any effect would occur at the local level with no impact to wider species populations or the conservation status of species at the management unit level). As such, effects to marine mammals including harbour seal, which is a feature of the Teesmouth and Cleveland Coast SSSI, is predicted to be **Not Significant**.

14.6.151 Additional information regarding the type, number and activity of marine vessels required for construction of the Proposed Development will be included within the ES. This additional information will be used to further inform the assessment of collision risk to marine mammals.

Operational Phase

Entrapment of Marine Organisms Within the Cooling Water System

14.6.152 During operation, there may be a requirement to abstract water from the River Tees for cooling and other industrial processes. In this case, biota such as fish and invertebrates would be at risk of being drawn into the CWS. Fish and invertebrates small enough to pass through the intake screens would be entrained through the entire CWS and discharged to the marine environment via the outfall located in the Tees Bay. Conversely, organisms which are too large to pass through screens are at risk of becoming impinged on the intake screens.

14.6.153 Plankton including ichthyoplankton (fish eggs and larvae), phytoplankton and zooplankton are most at risk of being entrained as not only are they small enough to pass through the screens, but they are also unable to swim against the intake currents. Once within the CWS, planktonic organisms are exposed to a range of stressors, including pressure and temperature differentials, mechanical effect and abrasion and hydraulic shear stress which can lead to mortality. For the purpose of this assessment 100% mortality of the entrained fraction has been assumed.

14.6.154 The majority of biota which become impinged will not be able to move away from the intake screens and will thus, be vulnerable to physical injury and subject to mechanical effects (i.e. abrasion) causing fatal injuries, and predation. For the purpose of this assessment 100% mortality of the impinged fraction has been assumed. The susceptibility of biota to impingement depends on several factors including the abstraction volume, water temperatures, the life stage of the organism, species-specific hearing ability and swimming ability.

14.6.155 The mortality of marine species due to 'entrapment' (i.e. entrainment and impingement effects combined) could lead to reduced productivity with the wider marine environment with potential for indirect effects to higher trophic levels (i.e. predatory fish, marine mammals and birds) from a loss of prey resource.

14.6.156 As outlined in Section 14.5, several mitigation measures have been incorporated into the design of the Proposed Development to minimise the risk of entrapment. Most critically, is the use of wet / dry (hybrid) cooling for the condensation of steam exiting the steam turbine which significantly reduces water demand for cooling purposes. Based on current design information, the worst-case abstraction rate for each CCGT unit[9] is predicted to be 0.61 m^3/s (i.e. a total worst-case abstraction rate of 1.83 m^3/s). This is considerably lower than that of the former Redcar Power Station (which was licenced to abstract at a rate of 8.3 m^3/s) and many other current-generation coastal energy stations (designed to abstract at a rate of up to c.130 m^3/s).

14.6.157 Minimising the volume of seawater abstracted from the River Tees reduces the risk of entrainment. Lower abstraction rates (in combination with other intake design parameters) can also reduce approach velocities and therefore impingement risk, enabling organisms which possess good swimming ability, and which are able to perceive the threat posed by intake, opportunity to swim away.

Plankton (Phytoplankton and Zooplankton)

14.6.158 Even with consideration of the design mitigation, plankton would remain at risk of entrainment. For the purpose of assessment, 100% mortality of entrained organisms is assumed and so the sensitivity of this receptor group is considered to be high.

14.6.159 Mortality of plankton has the potential to reduce primary and secondary production in the immediate vicinity of the outfall in the Tees Bay. Effects would be continuous and long-term. However, given the low predicted abstraction volumes, the magnitude of impact is predicted to be small and replenishment from the wider area is likely. Thus, there is unlikely to be any discernible impact to plankton communities and food web dynamics at the regional level.

14.6.160 Given the low importance of plankton and the predicted spatial extent of impact, effects to phytoplankton and zooplankton communities from entrainment during the operational phase are predicted to be **Not Significant**.

Fish and Shellfish

14.6.161 As outlined in Section 14.5, any upgrade works to the intake will include installation of new screens which shall be compliant with the Eels (England and Wales) Regulations 2009. This measure aims to minimise the

[9] Based on base load operation during winter (extreme) conditions. There will be three CCGT units in total.

entrapment risk to European eel although it would also afford benefits to other fish species and life stages.

14.6.162 In light of the mitigation measures proposed, the magnitude of impact to migratory fish is predicted to be negligible. Entrapment is therefore unlikely to have any discernible impact on populations at the local level or across wider geographical scales and thus, effects to migratory fish are predicted to be **Not Significant**.

14.6.163 Other species of fish and invertebrate (including those of conservation and/or commercial importance) are likely to remain at risk of impingement. Juveniles and invertebrates such as crabs, shrimp, prawns and molluscs would be most at risk owing to their reduced swimming ability. Despite the mitigation measures proposed, ichthyoplankton (excluding early life stages of migratory fish) will also remain at risk of entrainment.

14.6.164 Although entrapment would have a continuous and permanent adverse effect during the operational phase, many species are considered to be reasonably tolerant to mortality at the population level owing to their life history characteristics. For example, most invertebrates and many fish species (e.g. sprat and sand smelt) are short-lived, exhibit little or no parental care of their young and are highly fecund. This strategy means species are adapted to accommodate extremely high rates of natural mortality (i.e. 50% to 90%) (Houde, 2002).

14.6.165 The magnitude of impact and severity of effects from entrapment will largely depend on the final design of the CWS operations (including the screening and mitigation arrangement) as this will influence the vulnerability and survival of species. However, given the low predicted abstraction rate and the expected low approach velocities, the overall magnitude of impact is predicted to be small. Whilst there may be some localised changes to the abundance and distribution of species within the vicinity of the intake and outfall, effects are unlikely to be discernible at the population level which for many species is defined at regional level. Thus, effects to fish and shellfish (excluding migratory fish), due to entrapment are predicted to be **Not Significant**.

14.6.166 Should abstraction from the River Tees be required, a detailed Best Available Technique (BAT) assessment will be undertaken to determine the level of protection required for the intake screens under the BAT principles, and the most effective screening option in terms of cost and environmental protection. This assessment will be carried out in consultation with the relevant stakeholders and shall consider best practice guidance for eel screening (Environment Agency, 2015) as well as guidance for other sensitive species or life stages (i.e. salmonid smolts and lamprey) known to be present in the River Tees (Environment Agency, 2009b).

14.6.167 If required, the outcome of the BAT assessment will be used in-combination with more detailed design information to further inform the assessment of entrapment effects presented within the ES.

Marine Mammals and Designated Sites

14.6.168 Based on the outcome of the assessment of direct entrapment effects to benthic ecology and fish and shellfish, any indirect effect from a loss of food resources to marine mammals including harbour seal which is a feature of the Teesmouth and Cleveland Coast SSSI is predicted to be **Not Significant**.

Thermal Effects from Treated Water Discharge

14.6.169 The discharge of thermal effluent from CWS operations can influence a variety of marine organisms including plankton, benthic habitats and species as well as fish, shellfish and INNS. Long-term effects can include changes in biological processes (e.g. growth, spawning, etc.), mortality, displacement and changes in species' community composition and distribution.

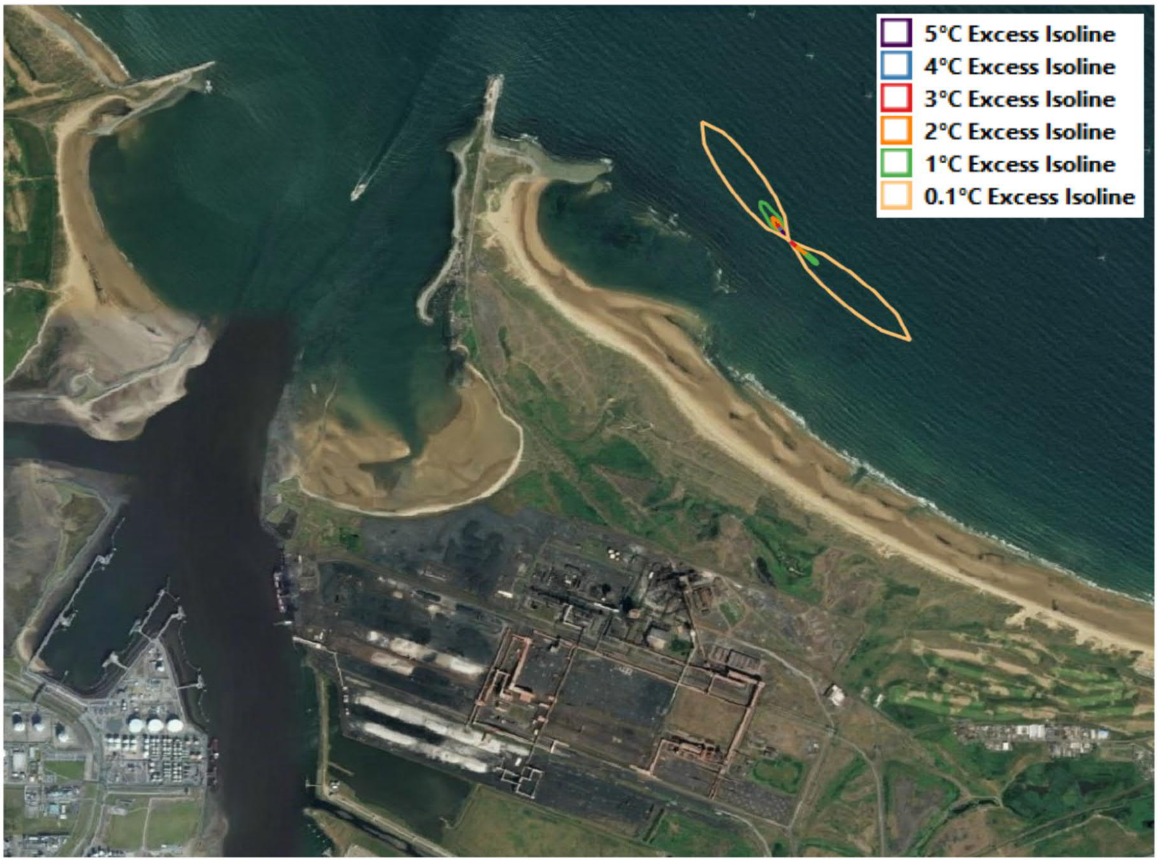
14.6.170 Marine mammals can be indirectly affected by shifts in the distribution of food resources if for example, prey species are attracted or deterred by the warmer waters around the treated water outfall. The thermal front of the treated water discharge plume can also act as barrier to fish migration.

14.6.171 Preliminary near-field modelling of CWS operations has been undertaken to determine the characteristics of the resultant thermal discharge plume under baseline hydrodynamic conditions (see Appendix 9B: Coastal Modelling Report, PEI Report, Volume III). The unbounded CORMIX model assumed a temperature excess of 15°C, a flow rate of 1.37 m^3/s and a density of 1,018 and 1,020 kg/m^3 to represent summer and winter conditions, respectively. Average summer and winter wind speed values of 4.08 and 5.32 m/s respectively were assumed based on data collected in 2015 – 2019 from Durham Tees Valley Airport.

14.6.172 To represent ambient conditions, a mean spring tidal range (approximately 4.6 m) was isolated in the model output as this represented the greatest tidal excursion. The implications of seasonal (i.e. summer versus winter) conditions, tidal variations (i.e. flood versus ebb), and wind speed were explored through a series of sensitivity tests. Wind direction was considered to be sufficiently consistent at a value of 230 °N to be applied to all model runs. The outfall pipe was assumed to measure 0.8 m in diameter and located 1 m above the seabed with the outlet orientated in the vertical plane (i.e. pointing upwards).

14.6.173 The results of the sensitivity tests showed that seasonal variations were negligible with the plume extending very slightly further in summer compared with winter for a spring flood tide. As would be expected, the plume retained its excess temperature more under ebb conditions than flood conditions but only out to a distance of 300 m, at which point the model runs converged. Summer winds of 4.08 m/s had a negligible impact on the extent of the thermal plume although significantly higher winds of 15 m/s were found to facilitate greater mixing and a more rapid reduction in excess temperature.

14.6.174 Picture 14-2 presents the extent of the excess temperatures isolines from +0.1 °C to +5°C under mean spring tidal conditions. This information is also shown in Table 14-17. These modelling results have been considered in relation to the potential impacts on water quality and the Tees Coastal waterbody in Chapter 9: Surface Water, Flood Risk and Water Resources of this PEI Report (PEI Report, Volume I).



Picture 14-2: CORMIX Excess Temperature Isolines (°C) Under Mean Spring, Peak Flood (Southeast) and Ebb (North West) Tidal States

14.6.175 There are no legal standards for limits on thermal discharges into coastal water bodies. The most recent guidance available was developed by the British Energy Estuarine & Marine Studies Expert Panel who produced a report: *Thermal standards for Cooling Water from new build nuclear power stations*, which summarises existing temperature standards and provides evidence on the effects of thermal discharges (BEEMS, 2011). This work was expanded by Wither *et al*. (2012) in a review of the thermal tolerances of fish and marine biota and recommended thresholds in relation to WFD status boundaries (i.e. high, good, moderate, poor and bad, where the aim is for all water bodies to achieve good).

14.6.176 The normative boundary definitions (as an annual 98 percentile) proposed by BEEMS (2011) include a +2°C temperature uplift for a WFD classification of High / Good and +3°C uplift for all subsequent classifications (Good /Moderate, Moderate / Poor and Poor / Bad). Based on the +2°C and +3°C temperature boundaries, the modelling results predict a maximum extent of 1,673 m^2 and 71 m^2, respectively. Thus, under spring conditions, the likely extent of thermal plume would be very localised with a 2°C temperature excess extending no more than 107 m on the flood tide and 140 m during the ebb tide. These distances are further reduced when considering a 3°C temperature excess (see Table 14-17).

Table 14-17: Excess Temperature Isoline Extents from the Outfall for a Mean Spring Tide Under Peak Flood and Peak Ebb Conditions

Excess temperature isoline (°C)	Peak flood tide		Peak ebb tide	
	Isoline extent from outfall (m)	Area of excess temperature (m^2)	Isoline extent from outfall (m)	Area of excess temperature (m^2)
5.0	1.6	32	61.3	2
4.0	6.6	49	79.4	3
3.0	44.7	71	97.6	21
2.0	106.5	1,673	140.0	76
1.0	179.3	7,500	235.4	1,455
0.1	754.2	81,256	718.1	74,758

Source: see Appendix 9B: Coastal Modelling Report (PEI Report, Volume III)).

14.6.177 The following assessments consider the locations of the +2°C and +3°C temperature boundaries as well as other receptor-specific thresholds where available.

Plankton

14.6.178 Plankton have limited motility and their distribution is governed by external factors including the hydrodynamic regime and degree of vertical mixing within the water column. Primary production can be enhanced by increased water temperatures although localised effects are usually hard to detect in coastal waters owing to the patchiness of plankton concentrations.

14.6.179 Given the highly limited predicted extent of the thermal plume and the apparent degree of mixing, it is unlikely that the planktonic community would be exposed to a temperature increase that would affect their metabolic rate or productivity, even within the immediate vicinity of the treated water outfall. Any effect is therefore unlikely to impact the wider abundance and diversity of plankton communities. The magnitude of impact to plankton from thermal discharge as a result of CWS operations is predicted to be negligible and the effects **Not Significant**.

Intertidal Habitats and Communities

14.6.180 Intertidal habitats and species are naturally exposed to a greater degree of thermal stress than subtidal species, as they are periodically exposed to elevated temperature and desiccation when exposed during low tide. For example, during summer low tides, Spencer (1970) in Withers *et al*. (2012) found that temperatures on uncovered sandflats in Milford Haven ranged from 15°C to 26°C during September 1966 whereas ambient water temperature remained around 16.5°C.

14.6.181 The intertidal area within the vicinity of the CWS outfall is known to support a low abundance and diversity of macrofauna with few species of macroalgae present (see Appendix 14A: Intertidal Benthic Ecology Survey Report, PEI Report, Volume III). Based on the MarLIN MarESA[8], all intertidal habitats and associated communities within the footprint of the thermal plume are considered to be highly resistant and resilient to local temperature increases.

14.6.182 Based on the results of the thermal dispersion modelling, there is predicted to be limited interaction between the thermal plume and intertidal habitats and so the magnitude of impact is predicted to be small and highly localised. Thus, effects to intertidal habitats and species are predicted to be **Not Significant**.

Subtidal Habitats and Communities

14.6.183 Subtidal organisms are naturally less adapted to wide fluctuations or increases in temperature than those in intertidal communities, and as a result are possibly more susceptible to the effects of thermal stress.

14.6.184 As shown in Table 14-17, the extent of the thermal plume within the water column will be highly localised, even when considering a small temperature uplift of 1°C which is predicted to extend approximately 179 m and 235 m for a mean spring tide under peak flood and ebb conditions, respectively. Thermal effluent generated by the Proposed Development will be naturally buoyant (due to lower salinity and the lower density of warmer water) and therefore the footprint of the thermal plume on the seabed will likely be further reduced.

14.6.185 The dominant habitat which is expected to be present within the vicinity of the treated effluent outfall is '*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand'. According to MarESA, this habitat has a low sensitivity to local temperature increases, which for the purpose of this assessment was considered to be a 2°C increase for one year (Tilin and Rayment, 2016). As such, they are considered to be reasonably tolerant of a chronic 2°C uplift although some sub-lethal effects such as changes to the timing of gametogenesis and spawning may occur at higher temperature increases (i.e. within tens of metres of the outfall).

14.6.186 Given the results of the thermal dispersion modelling and the sensitivity of species known to be present, discharge of thermal effluents during operations of the Proposed Development is not predicted to have any discernible impact on the subtidal habitats and the abundance, distribution and diversity of associated species beyond the immediate vicinity of the outfall. The magnitude of impact is therefore predicted to be small and highly localised and thus the effects to subtidal habitats and species are predicted to be **Not Significant**.

Invasive Non-Native Species

14.6.187 During baseline surveys, wakame (*Undaria pinnatifida*) was reported as the only INNS currently known to be present and growing within the Study Area. This intertidal macroalgae is a species of kelp which originates from Japan. Due to its rapid growth rate, it is known to outcompete native species within rocky reef habitats (GB NNSS, nd.).

14.6.188 The growth of wakame is stimulated by reduced rather than increased temperatures with persistent colder conditions below 15°C promoting recruitment and growth (Thornber *et al*., 2004). Thus, CWS operations are not predicted to exacerbate growth of this species within the vicinity of the Proposed Development.

14.6.189 It is possible that some INNS which are present in the surrounding waters, that are adapted to warmer water, could become established in the vicinity of the treated water outfall during operation. The baseline for non-native species will continue to evolve during the construction phase and therefore it is not possible to accurately predict the species that could become established.

14.6.190 Overall, the risk that thermal discharge from the Proposed Development could facilitate introduction and spread of INNS during operation is considered to be low. The effect on native habitats and species from the establishment of non-natives linked to the thermal plume is therefore predicted to be **Not Significant**.

Fish and Shellfish

14.6.191 Depending on the species, increases in sea temperature may have a positive, negative or neutral effect on fish and shellfish. Effects are likely to include thermal avoidance or attraction, changes in growth rate or the modification of community structure.

14.6.192 As shown in Table 14-17, the extent of the thermal plume is considered to be highly localised. Considering this and the predicted temperature increase, the exposure of fish and shellfish (namely demersal life stages and species such as sandeels) to the thermal plume is unlikely to result in changes to communities in terms of abundance and diversity. The thermal plume is also not predicted to affect the reproductive success of fish species of conservation and / or commercial importance nor would it represent a barrier to migratory species.

14.6.193 Thus, the magnitude of impact is predicted to be negligible and the effect on fish and shellfish from thermal discharge is predicted to be **Not Significant**.

Marine Mammals and Designated Sites

14.6.194 Marine mammals are physiologically adapted to regulate their body temperature. Although the increase in water temperature in the vicinity of the discharge may be noticeable to those marine mammals known to occupy inshore areas (e.g. seals), this would be within the natural temperature range that would be experienced by these species (e.g. when diving and moving between coastal and estuarine waters or, in the case of seals, when hauling-out). Thus, direct effects to marine mammals from the discharge of thermal effluent, including harbour seal which is a feature of the Teesmouth and Cleveland Coast SSSI, is predicted to be **Not Significant**.

14.6.195 Based on the outcome of the assessment of direct effects to benthic ecology and fish and shellfish, any indirect effect from a loss of food resources to marine mammals, including harbour seal which is a feature of the Teesmouth and Cleveland Coast SSSI, is predicted to be **Not Significant**.

Chemical Effects from Wastewater Discharge

14.6.196 During operation, there is potential for wastewater to be discharged to the Tees Bay which may result in changes to marine water quality, leading to indirect effects to marine ecology.

14.6.197 Whilst an initial Option Appraisal has been undertaken to explore on-site wastewater treatment (should wastewater disposal via Northumbrian Water's wastewater treatment facilities and outfall not be possible) (Wood, 2019), this aspect of the Proposed Development is yet to be subject to a Front End Engineering Design (FEED). Therefore, for the purpose of this assessment the preferred wastewater treatment design identified within the Options Appraisal has been assumed. This concept design is outlined below.

14.6.198 The wastewater generated during operation of the Proposed Development is expected be made up of predominately treated water used within the cooling water system, with some demineralised water which has been utilised in the steam cycle. Other sources will include surface water run-off from the Site and wastewater generated from amine solution and boiler feed water make-up as well as intermittent sources including turbine washes, utility stations and fire systems usage. The principle source of chemical contaminants would be from the direct contact cooler blowdown which will comprise water primarily containing dissolved CO_2 and elevated concentrations of ammonia. In all other cases, chemical concentrations are expected to be below consent limits or will be collected and disposed of off-site.

14.6.199 It is proposed that water from the direct contact cooler blowdown will be sent to an on-site effluent treatment plant where it will be subject to biological treatment. The treated process effluent will then be transferred along with other process water streams to an outfall retention pond before being discharged to the Tees Bay.

14.6.200 The proposed wastewater treatment system is designed to achieve compliance with Environmental Permitting Requirements. However, regular sampling of the treated wastewater prior to discharge will be carried out to monitor compliance. The retention pond will also be designed with sufficient capacity to hold treated effluent for approximately eight hours should any quality issues be identified, thereby further reducing the risk of non-compliance.

14.6.201 Given the information presented above, the low predicted rate of treated effluent which will be discharged to the Tees Bay (i.e. a total worst-case abstraction rate of 1.83 m3/s) and the open nature of the coastline where hydrodynamic conditions are expected to facilitate rapid dispersion, the potential for adverse effects to marine water quality is considered to be low. As such, the assessment in Chapter 9: Surface Water, Flood Risk and Water Resources (PEI Report, Volume I) has concluded a minor adverse non-significant effect to marine water quality.

14.6.202 Whilst the impact would be permanent, a localised deterioration in marine water quality within the vicinity of the outfall is not predicted to result in any detectable effects to marine species or habitats, nor to biodiversity or the conservation objectives for any marine species or designated site. As such, the effects to marine ecological receptors from wastewater discharge are predicted to be **Not Significant**.

14.6.203 This conclusion is based on the current preferred design for the on-site wastewater treatment facilities. It is expected that further design details regarding wastewater treatment will be made available following FEED and consultation with the regulator, permitting a more robust assessment of effects to marine ecological receptors within the ES.

Effects to Intertidal Habitats and Species (Including Fish) From the Deposition of Airborne Pollutants

14.6.204 Deposition of air pollutants released from point source emissions can be deposited into the marine environment either by wet or dry deposition processes. Deposition of air pollutants, particularly nitrogen and sulphur compounds can cause direct disturbance to marine habitats and species through acidification.

14.6.205 The air quality assessment (see Chapter 8: Air Quality, PEI Report, Volume I) has identified a potential air quality impact on coastal habitats including sand dune and saltmarsh habitat for which the Teesmouth and Cleveland Coast Ramsar and SSSI and the Teesmouth NNR are designated and which support the interest features of the SPA. A formal assessment of effects to these habitats and designated sites has been made in Chapter 12: Terrestrial Ecology and Nature Conservation (PEI Report, Volume I). This assessment concluded a significant (major adverse) effect to sand dune and saltmarsh habitats. Consequently, there is considered potential for the deposition of air pollutants to effect other intertidal habitats (e.g. mudflats) and species, as well as fish species which may depend on these for specific functions (e.g. nursery grounds).

14.6.206 The project design and air quality assessment for the operational phase are still under development and therefore the current findings should be regarded as provisional. In light of this and the paucity of scientific information related to the potential impacts of air pollutant deposition on marine ecology, it is not considered possible to make a formal assessment of the significance of effects to this receptor group at this time.

14.6.207 Additional work will be undertaken prior to submission of the ES to further advance and scrutinise the air quality assessment in relation to developments in the project design. If necessary, consultation will also be undertaken with the relevant stakeholders and technical specialists to develop an appropriate evidence base regarding the potential effects of air pollutant deposition on marine ecology. This information along with the final outcome of the air quality assessment for the operational phase will be used to provide a more reliable and robust assessment of effects to marine ecology within the ES.

Changes in the Airborne Soundscape During Commissioning and Operation

14.6.208 As outlined in paragraph 14.6.113, a change in the airborne soundscape has the potential to disturb pinnipeds (i.e. seals) that have surfaced or have hauled out.

14.6.209 As part of routine testing and maintenance of the CO_2 pipeline, there will be a requirement to occasionally undertake manual CO_2 venting. This is predicted to produce the highest sound levels at Seal Sands of any activity associated with the commissioning and operational phases of the Proposed Development and is therefore considered to be representative of worst-case for the assessment of effects to seals from changes in airborne sound.

14.6.210 Sound data from similar pipeline projects has been used in order to calculate the sound levels associated with CO_2 venting. For the calculations it has been assumed that a five-minute vent will be required. For this activity, only A-weighted sound levels (being the most appropriate model for human, and therefore mammal, hearing) are available. Further details on the prediction methodology can be found in Chapter 11: Noise and Vibration (PEI Report, Volume I).

14.6.211 The A-weighted sound exposure level at the nearest part of the mudflats to the sound source is predicted to be 104 dB re $(20\ \mu Pa)^2s$ (Table 14-18), which is considerably less than the 134 dB and 154 dB re $(20\ \mu Pa)^2s$ onset threshold for TTS and PTS, respectively which uses phocid-specific weightings (Southall *et al*., 2019). As the predicted A-weighted sound exposure level is 30 dB less than the onset threshold for TTS, and given that the two weightings are relatively similar (see paragraph 14.6.119), it is considered with a high level of confidence that the sound pressure levels produced by CO_2 venting will not exceed the onset threshold for TTS and PTS given in Southall *et al*. (2019), even when taking into account baseline conditions.

14.6.212 Thus, it is considered very unlikely that seals hauled out at Seal Sands would be vulnerable to auditory damage due to changes in the airborne soundscape during commissioning and operation as a result of CO_2 venting. Using the TTS threshold as a proxy behavioural threshold, the risk of behavioural disturbance is also considered to be negligible.

Table 14-18 Predicted Airborne Sound Levels at Seal Sands for CO_2 Venting

Location	Distance to the nearest CO_2 vent (m)	Predicted free-field sound level for CO_2 Venting (A-weighted) $L_{Aeq,5\ min}$	Sound exposure level (A-weighted)
Nearest part of the mudflat	1100	79	104
Site most commonly used by harbour seals (i.e. Site A)	1500	77	102

14.6.213 Whilst the exact frequency of CO_2 venting is yet to be determined, this is expected to be an occasional and short-term activity (i.e. lasting minutes). It is therefore considered highly unlikely that seals would be surfaced when this activity is undertaken and in sufficient proximity to result in auditory damage. Behavioural disturbance may occur at greater distances although this effect would be short-term and reversible.

14.6.214 In light of this, there is considered to be limited potential for detectable changes in the abundance, distribution and conservation status of harbour and grey seals as a consequence of changes to the airborne soundscape during commissioning and operation. Thus, effects to seals and relevant designated sites (e.g. harbour seal – Teesmouth and Cleveland Coast SSSI) are predicted to be **Not Significant**.

14.6.215 As outlined in paragraph 14.6.125, further work shall be undertaken for the ES to model concurrent activities where possible, in order to provide a cumulative assessment of the potential changes to the airborne soundscape and the subsequent impact on seals during commissioning and operation of the Proposed Development.

14.7 Mitigation and Enhancement Measures

14.7.1 The only significant adverse impact to marine ecology predicted for the construction phase relates to effects on pinnipeds (i.e. seals) and the Teesmouth and Cleveland Coast SSSI from underwater sound disturbance potentially generated by UXO detonations.

14.7.2 No significant adverse impacts to marine ecology during the operational phase are predicted to occur..

14.7.3 The following additional mitigation and enhancement measures have been proposed with the aim of further reducing the magnitude and likelihood of both significant and non-significant effects to marine ecology.

Fish-Friendly Pumps

14.7.4 To minimise the direct loss of marine fish, a fish-friendly pump maybe considered for use by the contractor for dewatering inside the temporary cofferdam. This would reduce the likelihood of direct loss (i.e. mortality) of marine fish (and possibly other organisms) enclosed inside the cofferdam.

Biodiversity Enhancement

14.7.5 Based on the assessment of worse case (i.e. full refurbishment of the existing intake and outfall structures), there is considered a potential requirement for biodiversity enhancement measures to offset loss of marine biodiversity under the footprint of any permanent structures within the intertidal and subtidal zone.

14.7.6 The requirement for biodiversity enhancement is dependent on the final design of the Proposed Development and the outcome of a formal Biodiversity Assessment which will be undertaken within the ES, if required.

14.7.7 Should biodiversity enhancement be required, the details of the enhancement measures shall be discussed and agreed with the relevant stakeholders and secured within the Draft DCO application.

Underwater Sound Mitigation Measures

14.7.8 A comprehensive range-dependant transmission loss modelling exercise will be undertaken and assessed within the ES to provide a more robust indication of likely significant effects to marine ecology. The outcome of this assessment will inform the need for additional mitigation (discussed below) which would be secured within the DCO submission.

14.7.9 To minimise the potential for auditory and behavioural disturbance to seals and particularly the harbour seal which is a qualifying feature of the Teesmouth and Cleveland Coast SSSI, noise abatement will be considered if UXO detonations are required, which may include not carrying out detonations during the sensitive breeding and moulting seasons.

14.7.10 To minimise the potential auditory and behavioural disturbance to marine mammals and fish from marine vessel movement and equipment operation, it is proposed that idling of vessels and plant is kept to a minimum during the construction phase.

14.8 Limitations or Difficulties

14.8.1 Any limitations to the collection of field survey data or gathering of based information are identified in the relevant technical appendices.

14.8.2 Project design and construction information was under development at the time of writing this preliminary EcIA. Therefore, a reasonably set of worst-case assumptions have been identified and assessed within this PEI chapter (see Section 14.2) using Rochdale Envelope principles. Whilst there is considered to be sufficient information made available at this stage to enable consultees to make an informed view of the likely significant environmental effects of the Proposed Development, it is recognised that further modelling and assessment work is required prior to submission of the ES.

14.8.3 One limitation which is recognised within the assessment of likely impacts and effects relates to changes in underwater soundscape during the construction phase. The current assessment relies on a simplified geometric spreading underwater acoustic model which does not account for the physical footprint of the river / estuary environment and is known to underestimate sound exposure close to the source and overestimate sound levels further away. Additional design information will enable a more comprehensive underwater acoustic modelling exercise to be undertaken and is considered necessary to inform the assessment of effects presented in the ES.

14.8.4 There are also limitations with the approach taken to assessing the effects of changes in the airborne soundscape on seals during the construction, commissioning and operational phases of the Proposed Development. The current assessment only considers the worst-case activity for each phase of as the programme of works has not yet been fully developed for the Proposed Development. However, a cumulative modelling assessment which considers concurrent activities within each project phase shall be undertaken for the ES to permit a more robust assessment of airborne sound disturbance effects to seals.

14.8.5 As the description of the Proposed Development evolves and further information about construction methodologies become available, all the assessments presented within this PEI chapter will be re-examined and updated as appropriate. Ongoing engagement with the relevant stakeholders regarding the progress of these assessments will continue to take place up to submission of the DCO application.

14.9 Residual Effects or Conclusions

14.9.1 Having taken into account the design, good practice and additional information described in the preceding sections, this PEI has concluded no significant adverse effects to marine ecology from construction or operation of the Proposed Development.

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