Immingham Green Energy Terminal

TR030008

Volume 6

6.2 Environmental Statement

Chapter 9: Nature Conservation (Marine Ecology)

Planning Act 2008

Regulation 5(2)(a)

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 (as amended)

September 2023

Infrastructure Planning

Planning Act 2008

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Immingham Green Energy Terminal

Development Consent Order 2023

6.2 Environmental Statement

Chapter 9: Nature Conservation (Marine Ecology)

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9. Nature Conservation (Marine Ecology)

9.1 Introduction

9.1.1 This chapter of the Environmental Statement ("ES") presents the findings of the assessment of the likely significant effects of the Project on Marine Ecology. This chapter sets out the assessment methodology used, the datasets used to inform the assessment, an outline of baseline conditions, and sets out the likely significant effects the Project will have on marine ecology receptors.

9.1.2 The following receptors have been considered as part of the assessment:

a. Nature conservation designations and protected species.

b. Benthic habitats and species.

c. Fish.

d. Marine mammals.

9.1.3 There are no classified commercial shellfish (bivalve) beds in the Humber Estuary (Ref 9-1) and the areas around the Project and possible disposal sites do not support other commercial shellfisheries (such as crab/lobsters using creels or the collection of whelks). On this basis, commercial shellfisheries have, therefore, been scoped out of the assessment. Relevant fauna which are considered shellfish species (such as cockles or clams), however, are considered within the benthic habitats and species assessment.

9.1.4 Phytoplankton has also been scoped out of the assessment as while phytoplankton can be sensitive to changes in water quality, the predicted magnitude of potential changes in suspended sediments and contamination levels in the water column (as summarised in **Chapter 16: Physical Processes** and **Chapter 17: Marine Water and Sediment Quality**, respectively **[TR030008/APP/6.2]**) are not considered to be at a level which would cause lethal or sub-lethal effects in plankton. On this basis, phytoplankton has been scoped out of the assessment.

9.1.5 There may be interrelationships related to the potential effects on Marine Ecology and other disciplines. Therefore, also refer to the following chapters **[TR030008/APP/6.2]**:

a. **Chapter 6: Air Quality**

b. **Chapter 10: Ornithology**

c. **Chapter 16: Physical Processes**

d. **Chapter 17: Marine Water and Sediment Quality**

9.1.6 Relevant aspects of the nature conservation and marine ecology assessment presented in this chapter have informed the Water Framework Directive ("WFD") Assessment, presented in **Appendix 18.A [TR030008/APP/6.4]** and also the **Shadow Habitats Regulations Assessment** ("HRA") **[TR030008/APP/7.6]**.

9.1.7 This chapter is also supported by the following figures and appendices:

a. **Figure 9.1:** Project specific subtidal benthic sampling stations **[TR030008/APP/6.3]**

b. **Figure 9.2:** Internationally and nationally designated conservation sites **[TR030008/APP/6.3]**

c. **Figure 9.3:** Spawning and nursery grounds of commercial fish species **[TR030008/APP/6.3]**

d. **Figure 9.4:** TrAC fish monitoring stations in the vicinity of the Project [**TR030008/APP/6.3]**

e. **Figure 9.5:** Annual grey seal pup counts at Donna Nook (Source: Ref 9-64) **[TR030008/APP/6.3]**

f. **Figure 9.6:** Aerial counts of grey seals at Donna Nook (Source: Ref 9-64) **[TR030008/APP/6.3]**;

g. **Figure 9.7:** Harbour porpoise sightings in the Humber Estuary since 2000 (Source: Ref 9-30) **[TR030008/APP/6.3]**

h. **Appendix 9.A:** Benthic Survey Report **[TR030008/APP/6.4]**

i. **Appendix 9.B:** Underwater Noise Assessment **[TR030008/APP/6.4]**

9.2 Consultation and Engagement

9.2.1 A scoping exercise was undertaken in August 2022 to establish the form and nature of the Marine Ecology assessment, and the approach and methods to be followed. The Scoping Report (**Appendix 1.A [TR030008/APP/6.4]**) records the findings of the scoping exercise and details the technical guidance, standards, best practice and criteria being applied in the assessment to identify and evaluate the likely significant effects of the Project on Marine Ecology. A Scoping Opinion (**Appendix 1.B [TR030008/APP/6.4]**) was adopted by the Secretary of State on 10 October 2022.

9.2.2 Statutory Consultation took place between 9 January and 20 February 2023 in accordance with the Planning Act 2008 ('2008 Act'). The Applicant prepared a Preliminary Environmental Information Report ("PEI Report"), which was publicised at the consultation stage.

9.2.3 As a result of consideration of the responses to the first Statutory Consultation, the developing environmental assessments and through ongoing design-development and assessment, a series of changes within the Project were identified. A second Statutory Consultation took place between 24 May and 20 July 2023 in accordance with the 2008 Act and a PEI Report Addendum was publicised to support the second Statutory consultation.

9.2.4 The consultation undertaken with statutory consultees to inform this chapter, including a summary of comments raised via the formal Scoping Opinion **(Appendix 1.B [TR030008/APP/6.4])** and in response to the formal consultation and other pre-application engagement is summarised in **Table 9-1**. The full responses to consultation comments are included within the **Consultation Report [TR030008/APP/5.1].**

Table 9-1: Consultation summary table

Reference/date	Consultee	Summary of Response	How comments have been addressed in this chapter
Scoping Report August 2022	Environment Agency	Paragraph 8.2 makes no mention of pelagic ecology, in particular phytoplankton communities – these should be considered (even if they are scoped out) as there is a pathway for impact on this ecological element for example, as a result of sediment resuspension, contaminant release, changes to hydromorphology (these are highlighted in the physical processes and water quality sections). Neither is there any explicit mention of saltmarsh baseline data (although saltmarshes are discussed in the 'current baseline' sections). The Environment Agency holds saltmarsh data for the Humber Transitional waterbodies. We recommend the Applicant search on the Environment Agency's Ecology and Fish data explorer to see if additional data are available at https://environment.data.gov.uk/ecology/explorer/ We are satisfied with the survey rationale outlined in section 8.3.	Scoping opinion noted. Phytoplankton has been scoped out of the assessment as while phytoplankton can be sensitive to changes in water quality, the predicted magnitude of potential changes in suspended sediments and contamination levels in the water column (as summarised in **Chapter 16**: **Physical Processes** and **Chapter 17: Marine Water and Sediment Quality [TR030008/APP/6.2],** respectively) are not considered to be at a level which would cause lethal or sub-lethal effects in plankton. On this basis, phytoplankton has been scoped out of the assessment. Further baseline saltmarsh data has been provided in **Section 9.6.**
Scoping Report August 2022	Planning Inspectorate	The Scoping Report states that there are no classified commercial shellfish (bivalve) beds in the Humber Estuary and the areas around the Proposed Development and dredged sediment disposal sites do not support other commercial shellfisheries (such as crab/ lobsters using creels or the collection of whelks) and therefore seeks to scope out impacts on commercial shellfisheries. The Inspectorate agrees	Scoping opinion noted.

Reference/date	Consultee	Summary of Response	How comments have been addressed in this chapter
		that this matter can be scoped out of the assessment on this basis.	
Scoping Report August 2022		The Scoping Report states that the amount of sediment that settles out of suspension back onto the seabed as result of piling is expected to be negligible and benthic habitats and species are not expected to be sensitive to this level of change. The Inspectorate agrees that this impact pathway is not likely to have a significant effect and can be scoped out.	Scoping opinion noted.
Scoping Report August 2022		The Scoping Report states that the pile structures have the potential to result in changes to hydrodynamic and sedimentary processes but such effects are anticipated to be negligible and highly localised (which would be confirmed by the physical processes assessment) and marine habitats and species are not expected to be sensitive to this level of change. The Inspectorate does not agree that this matter should be scoped out of the assessment as there is insufficient evidence that changes to hydrodynamic and sedimentary processes would not have any adverse significant effects	Scoping opinion noted. The assessment has confirmed that the effects of changes to hydrodynamic and sedimentary processes are highly localised (see **Chapter 16**: **Physical Processes [TR030008/APP/6.2]**) This pathway is considered in **Section 9.8**.
Scoping Report August 2022		The Scoping Report states that the expected negligible, highly localised and temporary changes in suspended sediment levels (and related changes in sediment bound contaminants and dissolved oxygen) associated with bed disturbance during piling is considered unlikely to produce adverse effects in any marine species. The Inspectorate agrees that this	Scoping opinion noted.

Reference/date	Consultee	Summary of Response	How comments have been addressed in this chapter
		impact pathway is not likely to have significant adverse effects on marine species.	
Scoping Report August 2022		The Scoping Report proposes to scope impacts on fish from the capital dredge and disposal on the basis that the scale of the predicted changes are unlikely to cause anything more than negligible changes to fish habitats (feeding, spawning and nursery areas). The Inspectorate does not agree that this matter should be scoped out as changes in water and sediment quality during capital dredging and dredge disposal have been scoped into the assessment and there is insufficient evidence in the Scoping Report to demonstrate that changes to hydrodynamic and sedimentary processes would not have any adverse significant effects on fish habitats.	Scoping opinion noted. Direct effects of the capital dredge and disposal on fish habitats are assessed in **Section 9.8.** Indirect effects due to hydrodynamic and sedimentary processes have been screened out as the predicted changes are not expected to modify existing subtidal habitat types found in the area. Indirect effects on fish habitats (feeding, spawning and nursery areas) are, therefore, considered to be negligible. Further information and justification on this is provided in **Table 9-17.**
Scoping Report August 2022		The Scoping Report proposes to scope out an assessment of impacts on marine mammals as a result of changes to marine mammal foraging habitat and prey resources on the basis that the footprint of the Project only covers a highly localised area that constitutes a negligible fraction of the known ranges of local marine mammal populations. Given the limited scale of the area affected, the Inspectorate agrees that this matter can be scoped out of the assessment.	Scoping opinion noted.
Scoping Report August 2022		The Scoping Report proposes to scope out the potential for disturbance to hauled out seals on the basis of the distance between breeding populations and haul out sites to the proposed works (i.e. the closest haul out site is observed to be on the north	Scoping opinion noted.

Reference/date	Consultee	Summary of Response	How comments have been addressed in this chapter
		bank of the Humber Estuary, 3-4km from the dredge disposal sites and 4km from the DCO boundary). Given the large distances involved, the Inspectorate agrees that this matter should be scoped out of the assessment.	
Scoping Report August 2022		Impacts from vessels involved in construction and dredging activity are proposed to be scoped out on the basis that they would mainly be stationary or travelling at low speeds, making the risk of collision low. The Inspectorate agrees that this matter can be scoped out of the assessment on the basis that the collision risk is low and is not likely to have any adverse significant effects on marine mammals.	Scoping opinion noted.
Scoping Report August 2022		The Scoping Report proposes to scope out water quality impacts arguing that (1) the changes in suspended sediment levels would be localised, temporary and unlikely to result in adverse effects on marine mammals; (2) they are adapted to highly turbid conditions, and (3) contamination levels would be unlikely to produce lethal effects in these highly mobile species. In the absence of further data regarding sediment contamination levels and the potential water quality effect of the capital dredge, the Inspectorate is unable to scope this matter out of the assessment.	Scoping opinion noted. A more detailed rationale for scoping out water quality effects on marine mammals has been provided in **Table 9-17**.
Scoping Report August 2022		The Scoping Report proposes to scope out the potential for visual disturbance to hauled out seals because of the distance between breeding populations and haul out sites to the proposed	Scoping opinion noted.

Reference/date	Consultee	Summary of Response	How comments have been addressed in this chapter
		works. The Inspectorate agrees that this matter can be scoped out of the assessment on this basis.	
Scoping Report August 2022		The Scoping Report proposes to scope out this matter owing to the existing heavy shipping traffic and anticipated slow speeds of operational vessels (including maintenance dredging/ dredge disposal). The Inspectorate agrees that this matter can be scoped out of the assessment on the basis that the collision risk is low and is not likely to have any adverse significant effects on marine mammals.	Scoping opinion noted.
Scoping Report August 2022		In addition to the Humber Estuary European sites, the Proposed Development may also impact on the Greater Wash SPA and this should be considered within the ES.	Noted. The Special Protection Area ("SPA") is considered **Chapter 10: Ornithology [TR030008/APP/6.2]** of the ES.
Scoping Report August 2022		In addition to the assessment of the direct loss of intertidal and subtidal habitats and species as a result of the piles, the ES should also assess the potential for direct changes to benthic habitats and species underneath the raised pier structures, to determine their effect on the ecological function of the mudflats beneath.	Scoping opinion noted. Direct changes to benthic habitats and species underneath the raised pier structures have been scoped in and assessed in the operational phase (as the built infrastructure has the potential to result in this pathway).
Scoping Report August 2022		The impact of sediment resuspension and hydro-morphological changes on pelagic ecology receptors such as phytoplankton should be considered in the assessment of effects, unless otherwise robustly justified and agreed with relevant consultation bodies.	Phytoplankton has been scoped out of the assessment as while phytoplankton can be sensitive to changes in water quality, the predicted magnitude of potential changes in suspended sediments and contamination levels in the water column (as summarised in **Chapter 16: Physical Processes** and **Chapter 17: Marine Water and Sediment Quality [TR030008/APP/6.2]** respectively) are not considered to be at

Reference/date	Consultee	Summary of Response	How comments have been addressed in this chapter
			a level which would cause lethal or sub-lethal effects in plankton.
Scoping Report August 2022	Natural England	The development site is within or may impact on the following European/internationally designated nature conservation site(s): •Humber Estuary Special Area of Conservation (SAC); •Humber Estuary Special Protection Area (SPA); •Humber Estuary Ramsar site. •Greater Wash Special Protection Area (SPA) Natural England broadly agrees with this section of the Scoping Report which detail the potential impact pathways on the designated sites during both construction and operation phases of the proposed development.	Scoping opinion noted.
Scoping Report August 2022		In addition, in the benthic habitats and species sections [with reference to Paragraph 8.4.4 (a) of the Scoping Report], we advise that direct changes to benthic habitats and species underneath the raised pier structures should also be assessed, to determine if it could affect the ecological function of the mudflats beneath. Natural England do not concur with the conclusion [with reference to Paragraph 8.4.4 (b) of the Scoping Report that Indirect changes to seabed habitats and species as a result of changes to hydrodynamic and sedimentary processes due to the capital dredge and disposal should be scoped out for fish] when 'Changes in water and sediment quality during	Direct changes to benthic habitats and species underneath the raised pier structures have been scoped in and assessed in the operational phase (as the built infrastructure has the potential to cause effects for this pathway). An assessment of effects for this pathway is provided in **Section 9.8**. The predicted changes in hydrodynamic and sedimentary processes are very small. Based on modelling results (see **Chapter 16**; **Physical Processes [TR030008/APP/6.2]**) and an understanding of the baseline conditions for fish it is very unlikely there would be any potential for effects on fish habitats (feeding, spawning and nursery areas) (see **Table 9-17**).

Reference/date	Consultee	Summary of Response	How comments have been addressed in this chapter
		capital dredging and dredge disposal' have been scoped in. We would seek further clarification on this.	
Scoping Report August 2022		Impacts that maintenance dredging will have refer to notified feature having no sensitivity due 'to the scale of changes in SSC anticipated during capital dredging' [with reference to Paragraph 8.4.6 (a) (iii)]. These are two very different impacts therefore Natural England advise further consideration is given to the impacts of maintenance dredging will have on water quality.	The potential for impacts on water quality to affect marine mammals during capital dredging and disposal have been considered (see **Table 9-17**). The predicted changes in water quality during the capital dredge and disposal are negligible. Given that the maintenance dredging will be on a much smaller scale than capital dredging there are no anticipated effects.
Scoping Report August 2022		Natural England welcome the commitment to determine mitigation measure through the statutory consultation process.	Scoping opinion noted.
Statutory Consultation (PEIR) January – February 2023	Natural England	**Chapter 9: Nature Conservation (Marine Ecology) Marine ecology related comments in Chapter 2: The Project** Natural England notes the change in design plans to include two berths on the jetty instead of a single berth as stated in Chapter 2: The Project (paragraph 2.4.38). However, we consider that the creation of another berth may have additional impacts and should be assessed. Natural England welcomes the inclusion of the impact of maintenance dredging on the marine environment in the Environmental Statement as stated in Chapter 2: The Project (paragraph 2.4.5f). We note that the capital dredge methodology has not yet been finalised for this project (paragraph 2.6.4). We also note that the exact the marine construction	Noted. **Chapter 2: The Project [TR030008/APP/6.2]** of the ES provides a full description of the Project. Only a single berth is now proposed. The remainder of this comment has been noted.

Reference/date	Consultee	Summary of Response	How comments have been addressed in this chapter
		methodology and sequencing for the marine works is still being developed (paragraph 2.6.6). Therefore, the comments below are on the basis of current available information and may be subject to change as more details on the project are provided.	
Statutory Consultation (PEIR) January – February 2023	Natural England	<u>Assessment of impacts on benthic habitats and species</u> At this time, Natural England have not fully considered the potential impacts on benthic habitats and species, and we will provide detailed comments on the ES. However, we have some initial comments below.	Noted.
Statutory Consultation (PEIR) January – February 2023	Natural England	<u>Potential effects from permanent direct loss of intertidal and subtidal habitat during construction and operation phases</u> Natural England notes that the proposed development will result in loss of 0.017 ha of intertidal habitat as a result of the proposed jetty piles. In addition, it is noted that piling activities will result in a direct loss of 0.035 ha of subtidal habitat. Natural England advises that the assessment considers the potential for adverse effects as a result of loss of both intertidal and subtidal habitat. This should include the combined loss of SAC habitat (i.e., Estuaries and Mudflats and sandflats not covered by seawater at low tide) as well as the loss of supporting habitat for SPA bird species. Natural England considers that any credible risk of a measurable loss of marine or terrestrial habitat, no	Habitat loss values have been updated to reflect the latest scheme design. The assessment has considered the potential for adverse effects as a result of loss of both intertidal and subtidal SAC habitat **(Section 9.8** of this chapter**)** and supporting habitat for SPA bird species (Section 10.8 of **Chapter 10: Ornithology [TR030008/APP/6.2]**). Noted. Loss of marine and terrestrial from within a European site has been screened-in for further assessment in the Appropriate Assessment as part of the **Shadow HRA [TR030008/APP/7.6]).**

Reference/date	Consultee	Summary of Response	How comments have been addressed in this chapter
		matter how small, from within a European site is a 'likely significant effect' and the full significance of its impact on site integrity should be screened-in and further tested by an Appropriate Assessment. It is Natural England's advice that a lasting and irreparable loss of European Site habitat will prevent a conclusion of no adverse effect on site integrity being reached, unless an Appropriate Assessment can clearly demonstrate it is ecologically inconsequential. Furthermore, the appropriate assessment should be made in view of the European sites' conservation objectives, which provides a list of attributes contributing to site integrity that can provide a checklist for the assessment process, the detailed supplementary advice and advice on operations should also inform the conclusion.	The Information to support the Appropriate Assessment in the **Shadow HRA [TR030008/APP/7.6])** has been prepared in view of the European sites conservation objectives which has been used as a basis for the assessment. The supplementary advice and advice on operations has also been used to inform the conclusion.
Statutory Consultation (PEIR) January – February 2023	Natural England	Potential effects from capital and maintenance dredging and disposal of dredged material to sea during construction and operation phases. During the construction phase, potential changes to benthic habitats and species as a result of the proposed capital dredge have been scoped in, on the basis that dredging could result in changes in species' abundance and distribution through damage, mortality or relocation to a disposal site. It is not clear why the same impact pathway has been scoped out for the proposed maintenance dredging. In addition, Table 9.12 acknowledges that the predicted impacts on benthic ecology receptors as a result of maintenance dredging could be equivalent	Noted. Changes to benthic habitats and species as a result of removal of sediment during maintenance dredging have been scoped into the assessment. Noted. Changes to benthic habitats and species as a result of removal of sediment during maintenance dredging has been scoped into the assessment. This has considered the expected frequency of maintenance dredging to better understand potential recoverability.

Reference/date	Consultee	Summary of Response	How comments have been addressed in this chapter
		to the predicted impacts as a result of the capital dredge regime. We consider that changes in species' abundance and distribution are also possible during the maintenance dredging through the same mechanisms identified for the capital dredge. In addition, paragraph 9.7.25 states that the infaunal community could re-establish themselves in less than 1-2 years, however it is unclear whether the benthic community in the area of seabed requiring periodic maintenance dredging would have the ability to recover as the frequency of this dredging activity has not been provided. In addition, we also consider that the statement "Subtidal habitats in areas around the Port of Immingham are considered to be typically of limited ecological value" is not a suitable justification for scoping out the impact of maintenance dredging regarding changes to benthic habitats and species. Subtidal muddy sand, which primarily constitutes the project area, is a sub-type of the Annex I notified feature "H1110 Sandbanks which are slightly covered by sea water all the time" and is part of the Humber Estuary SAC. Therefore, this should be scoped into the assessment.	The assessment has considered the subtidal habitat in the dredge footprint as a component of the 'Estuaries' feature rather than 'Sandbanks which are slightly covered by sea water all the time' as the project specific benthic grab samples recorded mud sediment types (mud or sandy mud) rather than being characterised by predominantly sand sediment fractions.
Statutory Consultation (PEIR) January – February 2023	Natural England	Natural England notes that a maintenance dredging protocol has not been referred to within the PEIR. Natural England continues to support the production (including reviews) of Maintenance Dredge Protocols (MDP) as industry best practice, providing a foundation for consistent and informed decision making by all competent authorities. The MDP provides a strategic approach to considering the	Noted. The Maintenance Dredge Protocols ("MDP") for the Humber Estuary (Ref 9-139) has been considered as a basis for the assessment for maintenance dredging.

Reference/date	Consultee	Summary of Response	How comments have been addressed in this chapter
		impacts of maintenance dredge activity within a defined port or estuary and can support demonstration of compliance with The Conservation of Habitats and Species Regulations 2017 as amended (The Habitats Regulations). It also negates the need to produce an environmental assessment for individual consent applications, thereby providing efficiencies through the consenting process. This enables a clear baseline and audit trail for compliance with the Habitats Regulations to support dredging activities (and any potential marine licence applications as required) for all statutory harbour authorities in the area.	
Statutory Consultation (PEIR) January – February 2023	Natural England	We note that ABP will be undertaking site-specific sediment sampling to establish the likelihood of remobilisation of contaminated sediment. We acknowledge that the assumptions within the PEIR are based upon previous surveys undertaken at the Immingham site which were found to be low. However, until the survey data confirms this, this impact pathway cannot be ruled out. As a result, therefore NE cannot agree with the conclusion reached in paragraph 9.7.54 as the sampling results will inform the assessment.	Noted. The assessment has been based on the project-specific sediment contamination survey results.
Statutory Consultation (PEIR) January – February 2023	Natural England	<u>Assessment of impacts on Sea and River Lamprey (migratory fish) during the construction phase</u> The following advice is provided on the assumption that the underwater noise modelling used in the assessment in Appendix 9B is correct and we defer to Cefas advice as to the accuracy of the modelling.	Noted.

Reference/date	Consultee	Summary of Response	How comments have been addressed in this chapter
		NE note in paragraph 9.8.1, that there are a number of mitigation measures being considered for fish and marine mammals including "the use of soft start procedures, the use of vibro piling where possible with seasonal/night time piling restrictions specifically for migratory fish species and JNCC piling protocols for marine mammals" it also states that these mitigation measures would be further developed, if required, through ongoing engagement with statutory authorities as part of the statutory consultation process and taking into account the final scheme design information and latest understanding of potential effects. We agree that the mitigation set out would be effective in reducing impacts to migratory fish and should be considered within the assessment. The outcome of the HRA will identify the mitigation required. We welcome the commitment to engage with Natural England to further develop mitigation measures considering the final design and understanding of potential effects.	Noted. Mitigation requirements **(Section 9.9**) for fish have been developed as part of the assessment process (including the Shadow HRA **[TR030008/APP/7.6]**) and through engagement with statutory authorities.
Statutory Consultation (PEIR) January – February 2023	Natural England	<u>Assessment of impacts on marine mammals during construction and operation phases</u> As above, the following advice is provided on the assumption that the modelling used in the underwater noise assessment in Appendix 9B is correct and we defer to Cefas advice as to the accuracy of the modelling. NE broadly agrees with the scope of the assessment during the construction phase of the project.	Noted.

Reference/date	Consultee	Summary of Response	How comments have been addressed in this chapter
		Nonetheless, we advise that the assessment should reflect the key impact parameters including hammer energy, pile diameter, timing, and duration. An assessment based on these parameters should present the ranges/zones of injury and disturbance to marine mammals. The number of animals predicted to be within the impact zones should be determined and presented as a proportion of the relevant reference population (e.g., Management Unit population for EIA purposes). Note that we consider it likely that marine mammals could be within the construction impact zones, based on their highly mobile nature and the evidence presented by the Application such as the sightings of harbour porpoise approximately 2km from the project area and grey seals are regularly recorded foraging in the Immingham area. Once the risk of exposure is identified, appropriate mitigation should be considered. The outcome of the HRA will identify the mitigation required. We welcome the commitment to engage with Natural England to further develop mitigation measures considering the final design and understanding of potential effects.	The assessment has been based on the results of the underwater noise modelling and has taken into account factors such as marine piling method, pile diameter, duration. Mitigation has been developed based on an understanding of the population ecology of the marine mammal species in the area. Where possible a broad estimation of the number of animals predicted to be within the potential zone of effect of marine piling has been determined and presented as a proportion of the relevant reference population (e.g., Management Unit population). Mitigation requirements for marine mammals have been developed as part of the assessment process (including the **Shadow HRA [TR030008/APP/7.6]**) and through engagement with statutory authorities.
Pre-application meeting, 23 November 2022.	Natural England	The meeting provided an update of the IGET project, a summary of the future site-specific surveys and a high-level discussion of potential effects.	This chapter (**[TR030008/APP/6.2]**) and the **Shadow HRA**(**[TR030008/APP/7.6]**) have been completed taking on board consultee comments from the meeting.
Pre-application meeting, 11 January 2023	Natural England	The meeting provided a further update of the Project as well as a discussion on potential effects, HRA, stakeholder engagement and project programme.	This chapter and the **Shadow HRA** (**[TR030008/APP/7.6]**) have been completed taking on board consultee comments from the meeting.

Reference/date	Consultee	Summary of Response	How comments have been addressed in this chapter
Statutory Consultation (PEIR) January – February 2023	Environment Agency	Chapter 9 of the PEI Report provides detailed background/baseline information for fish. The entrainment and/or removal of fish and fish eggs during dredging activities have been scoped into Table 9.11. This has then been ruled out for needing further assessment in the section 9.7.78. However, this fails to consider the potential impacts of dredging on fish (entrainment and/or removal of fish) such as juvenile eel and lamprey living in sediments, which are unlikely to be able to escape the works. Measures may therefore be needed to minimise the impacts of dredging operations on fish and should be scoped into further assessment unless suitable justification is provided.	Section 9.7.78 of the PEI Report did not rule out the potential for entrainment and/or removal of fish which was considered as part of the 'Direct loss or changes to fish populations and habitat as a direct result of dredging and dredge disposal' and has been considered as part of the assessment **(Section 9.8)**.
Statutory Consultation (PEIR) January – February 2023	Lincolnshire Wildlife Trust	Given the extent of dredging and marine construction described in the PEI Report, it is prudent that the Applicant properly evaluates potential impacts on features within the Humber Estuary. This would require, current, site-specific data on distributions of species of interest in the local and surrounding areas. While the Applicant has provided several sources to help establish a baseline, LWT would argue that several of these datasets are not current (older than five years) or are too far to be relevant to the local area in question (questionable data sources listed below). While these datasets may be used to help establish a historic baseline and understanding for expected species, LWT does not feel that these datasets alone are sufficient to determine an ecological baseline or to directly inform potential impacts and mitigation for the proposed project.	With respect to benthic data, project specific benthic data (grab samples) were collected from within and near the potential development footprint in 2022. All the faunal samples collected over the survey area were very impoverished in nature with commonly occurring species recorded and assemblages similar to recent previous samples collected nearby for the proposed Immingham Eastern Ro-Ro Terminal (“IERRT”) project in 2021 (<0.5-1km away). Based on an understanding of the subtidal ecology of the local area more generally, the samples are considered representative of the impoverished subtidal communities found in this section of the Humber Estuary which are subject to physical disturbance as a result of strong tidal currents and sediment movement. On this basis there is considered to be no requirement for the collection of any additional benthic samples. With respect to fish data, it is acknowledged that some of the data sources are more than five years old, and while relatively

Reference/date	Consultee	Summary of Response	How comments have been addressed in this chapter
		Therefore, these historic datasets would need to be supplemented with more current, site-specific data. Benthic datasets older than five years: · Able Marine Energy Park Benthic Surveys (2015 and 2016) · Humber Estuary SAC Intertidal Sediment Survey (2014) · South Humber Channel Marine Studies (2010) · HU056 Disposal Site Monitoring (2017) · Clay Huts Disposal Benthic Monitoring (2008) Fish datasets older than five years: · South Humber Channel Marine Studies (2010) · EA TraC Fish Monitoring (2017) · EA Review of fish population data (2013 – used for fish species records presented in Tables 9.7 and 9.8) · Ref 9-28 – Spawning and nursery grounds (2012 – used for fish species records presented in Tables 9.7 and 9.8)	near to the development footprint, do not directly overlap. However, given the wide variety of surveys and studies undertaken on fish in the region as well as the mobile nature of fish, the surveys are considered broadly representative of the fish assemblage that could be present within the dredge footprint and surrounding local area. Furthermore, based on an understanding of potential impacts it is diadromous migratory fish (which would not be targeted by fish survey methods in the development footprint) rather than other fish species which are considered most likely to be sensitive to potential impacts. On this basis, site-specific data fish data is not considered to be needed to inform the assessment.
Statutory Consultation (PEIR) January – February 2023	Lincolnshire Wildlife Trust	The dynamic and localised nature of benthic ecology necessitates comprehensive, localised data to properly establish a baseline for ecological assessment. Furthermore, data outside the proposed Site Boundary would likely be required given the type of sediment and extent of dredging and pile-driving that are proposed for this project. LWT recognizes that current data from grab samples have been provided in Appendix 9.A; however we would argue that this level of data is insufficient (Sample size of eight taken during a single day of sampling) to establish a clear understanding of the local and	Project specific benthic data (grab samples) were collected from within and near the potential development footprint in 2022. The scale of the sampling was considered comparable to those undertaken for other recent developments and proportionate based on an understanding of the subtidal assemblages known to occur in the local area. All the faunal samples collected over the survey area were very impoverished in nature with commonly occurring species recorded and assemblages similar to recent previous samples collected nearby for the proposed IERRT project in 2021 (<0.5-1km away). Based on an understanding of the subtidal ecology of the local area more generally, the samples are considered

Reference/date	Consultee	Summary of Response	How comments have been addressed in this chapter
		surrounding benthic habitat that is likely to be impacted by such an extensive level of construction and dredging. Therefore, LWT would recommend that further surveys be undertaken prior to approval of dredging and construction.	representative of the impoverished subtidal communities found in this section of the Humber Estuary which are subject to physical disturbance as a result of strong tidal currents and sediment movement. On this basis there is no requirement for the collection of any additional benthic samples.
Statutory Consultation (PEIR) January – February 2023	Lincolnshire Wildlife Trust	LWT appreciates the Underwater Noise report provided in Appendix 9.B. However, we believe that this exercise did not go far enough to properly assess potential risk or impacts to marine fauna. Currently, the assessment only provides noise propagation models for construction/dredging, known hearing sensitivities and responses of marine fauna, and characterisations of proposed development activities. We believe that this exercise could have been improved by modelling species distributions based on current data in conjunction with noise propagation models based on the location and time of year of the construction phase. This type of investigation might be used to quantify potential risk to sensitive species based on the anticipated timing of construction and predicted habitat use, and therefore would be a valuable tool for avoiding/mitigating impacts (e.g. timing construction based on anticipated risk and interaction with sensitive species)	The underwater noise assessment is based on the worst case assumption that any sensitive marine species that are known to occur in the study area (i.e. the Humber Estuary) have the potential to overlap with the underwater noise generated by the proposed development activities. It takes account of the published evidence on marine species' temporal and spatial distribution that is reviewed in this chapter to identify the key species that require to be assessed but it does not attempt to quantify the risk through modelling which is likely to have inherent uncertainties associated with it and potential to misrepresent or underestimate the effects. Furthermore, this approach was not identified as a requirement at the scoping stage of the Project.
Statutory Consultation (PEIR) January – February 2023	Lincolnshire Wildlife Trust	LWT recognizes that marine works (capital dredging and piles) have been scoped in and we will be monitoring further assessments of pile-driving impacts, capital dredging impacts and dredge disposal. We have provided details above that will facilitate assessments of dredging and construction	The scope of dredging requirements has changed since the PEI Report. The need for future maintenance dredging within the new berth pocket is expected to be very limited (if required at all). Further information on maintenance dredging has been provided in **Section 9.8**. The assessment considers the impact on habitats of maintenance dredging during the operational

Reference/date	Consultee	Summary of Response	How comments have been addressed in this chapter
		impacts. However, we do not agree with the scoping out of maintenance dredging in the operational phase. While the Applicant has claimed that 'the predicted impacts on benthic habitats and species as a result of maintenance dredging are considered to be equivalent or lower than capital dredge and comparable to the existing maintenance dredge regime', it is currently unclear how this proposed maintenance would contribute to cumulative impacts of ongoing works within the Humber Estuary. Therefore, we recommend that maintenance dredging is scoped into further assessment, and that both capital dredging and maintenance dredging are included in future cumulative impact assessments.	phase. Cumulative effects of dredging are considered (**Chapter 25**: **Cumulative and In-Combination Effects of the ES [TR030008/APP/6.2**]).
Statutory Consultation (PEIR) January – February 2023	Marine Management Organisation	While the introduction and spread of invasive non-native species (INNS) will be addressed under the CEMP for the project, the MMO consider the piles that provide support for the jetty and approach trestle to provide suitable structure for the settlement of INNS, such as the leathery sea squirt, *Styela clava,* which has been recorded in the area, and for others yet to be identified. The MMO consider that the impacts of INNS that may recruit on infrastructure should be considered further and included in any monitoring assessment following construction.	Noted. Consideration of the potential for non-natives to colonise piles and other structures has been included within the ES (operational phase, **Section 9.8**).
Statutory Consultation (PEIR) January – February 2023	Marine Management Organisation	For the purpose of the Environmental Statement (ES) it is not appropriate to quantify habitat loss for fish receptors as a percentage of total available habitat. Fish do not use habitat uniformly and may use discrete locations for feeding and spawning activities which will vary from year to year and	The assessment in the ES provides further detail on the individual receptors sensitivities to suspended sediment concentrations ("SSC") and also considers the temporal aspect in terms of how often particularly high background SSC occurs and the timing of this and the spatial aspect and characteristics of the plume in relation to swimming behaviour. Further

Reference/date	Consultee	Summary of Response	How comments have been addressed in this chapter
		season to season. At this stage, the MMO does not support the preliminary assessment conclusion that impacts from changes in water and sediment quality as a result of dredging are not significant for fish. The justification for this conclusion is based on the following; fish receptors in the Humber Estuary are anticipated to be well adapted to living in an area with variable and typically high SSC; fish are expected to move to avoid areas of adverse conditions; plumes resulting from dredging and dredge disposal are expected to be localised and short lived due to strong hydrodynamic conditions in the area. Regarding salmonids and other migratory fish, the PEI Report acknowledges that these species can be sensitive to elevated SSC, however it is assumed that they would be able to avoid the sediment plumes. However, the assessment has not considered the effect of high background levels on SSC in-combination with elevated SSC as a result of capital dredging, which would result in SSCs and reduced water quality that exceed background levels.	information is provided on feeding and spawning habitats for sensitive receptors (**Section 9.6**).
Statutory Consultation (PEIR) January – February 2023	Marine Management Organisation	Furthermore, the timing of dredging (and piling) activity has not been discussed in the context of the migratory seasons of diadromous fish. Avoidance of an impacted area by migratory species may not always be possible for some species, particularly those in their juvenile stages or using selective tidal stream transport to move up/downstream from their natal grounds and especially when dredging is proposed on a 24/7 basis. In addition, avoidance of an impacted area can lead to additional stressors such as increased expenditure of energy and	Further information on migration periods of key species and timing of dredging and marine piling operations has been provided alongside more detail on the temporal and spatial characteristics of the dredge plume and on the zone of influence from underwater noise from marine piling (**Section 9.8**).

Reference/date	Consultee	Summary of Response	How comments have been addressed in this chapter
		increased respiration which may reduce overall levels of fitness at crucial life stages. The MMO recommend that the final assessment for changes in water and sediment quality in the ES provides consideration of the above comments, particularly in respect of the timing of dredging activity in relation to the timing of the migratory period of fish in the Humber.	
Statutory Consultation (PEIR) January – February 2023	Marine Management Organisation	Changes to fish populations and habitat due to maintenance dredging and disposal has been scoped out of the ES as the impacts are anticipated to be equivalent to or lower than the capital dredging and comparable to or lower than existing maintenance dredging regime. The maintenance dredge footprint and proposed disposal site are considered unlikely to provide important nursery or spawning functions for fish species as a result of the disturbed nature of these habitats. Whilst the MMO generally agree with this assessment, the scope of the maintenance dredging is yet to be fully determined in the PEI Report, and therefore it is difficult to fully assess the potential impacts. If this is to be equivalent to the planned capital dredging (as stated in the report), then this should be taken forward for further assessment in the upcoming ES.	Further information on maintenance dredging has been provided in **Section 9.8** including an assessment of potential effects relating to this pathway. The need for future maintenance dredging within the new berth pocket is expected to be very limited (if required at all).
Statutory Consultation (PEIR) January – February 2023	Marine Management Organisation	Changes in water and sediment quality due to maintenance dredging and disposal has been scoped out of the ES as changes in water quality are expected to be lower than for capital dredging and similar to existing maintenance dredging. Whilst the MMO generally agree with this assessment, the	Further information on maintenance dredging has been provided in **Section 9.8** including an assessment of potential effects relating to this pathway. The need for future maintenance dredging within the new berth pocket is expected to be very limited (if required at all).

Reference/date	Consultee	Summary of Response	How comments have been addressed in this chapter
		scale of the maintenance dredging is yet to be clearly stated, but will be set out in the upcoming ES. If the scale of maintenance dredging is to be potentially similar in scale to the capital dredging this should also be taken forward for further assessment within the ES and should be properly characterized and quantified before it can be excluded.	
Statutory Consultation (PEIR) January – February 2023	Marine Management Organisation	Underwater noise due to maintenance dredge and dredge disposal has been scoped out of the assessment on the basis that under the worst-case scenarios the impact of underwater noise due to dredging activities on fish receptors will be insignificant. The MMO disagree with this statement. Firstly, the underwater noise assessment states that dredging could cause moderate behavioural impacts on all types of fish receptors (physostomous and physoclistous) at the intermediate distances (i.e. hundreds of metres from the source). This might seem insignificant in the contact of the Humber Estuary, however there may be potential for cumulative impacts with other activities. Secondly, if the impacts of underwater noise due to maintenance dredging are anticipated to be similar to capital dredging activities, this should also be taken forward for assessment within the ES.	Further information on maintenance dredging has been provided in **Section 9.8** including an assessment of potential effects relating to this pathway. The need for future maintenance dredging within the new berth pocket is expected to be very limited (if required at all).
Statutory Consultation (PEIR) January – February 2023	Marine Management Organisation	The impact of lighting due to vessel operations has been scoped out of the assessment as impacts are expected to be small and localised within the context of the Humber Estuary. The MMO agree with the assessment, however, recommend that where practicable, and safe to do so, lighting should be	Lighting design will be optimised to avoid any unnecessary light-spill on the water or foreshore habitats **(Section 9.8**).

Reference/date	Consultee	Summary of Response	How comments have been addressed in this chapter
		directed to best avoid unnecessary light-spill on the water.	
Statutory Consultation (PEIR) January – February 2023	Marine Management Organisation	The report makes a brief reference to the potential limitations of the fisheries surveys data used to inform the assessment. For the ES, the MMO would expect to see limitations such as differing gear selectivity and timings of the surveys explored in more depth in the 'Limitations and Assumptions' section 9.4.3-9.4.6 in Chapter 9 of the PEI Report.	Potential limitations of the fisheries surveys data used to inform the assessment has been included in the Limitations and Assumptions section of this chapter (**Section 9.4**).
Statutory Consultation (PEIR) January – February 2023	Marine Management Organisation	The MMO support the proposal to use soft-start procedures on commencement of piling. Soft-start procedures, in accordance with JNCC guidelines (Ref 9-18) should be adopted as part of the developers' 'best practice' mitigation. This will enable fish to distance themselves from the source of impact as the sound source gradually increases. However, whilst soft-start measures may allow resident species to leave the area of greatest disturbance (and thereby potentially reducing the total number of dangerous exposures in terms of auditory damage), such measures may not necessarily be appropriate (or of benefit) for migratory species, when the primary concerns is that underwater noise may create a temporary acoustic barrier in the river, impeding travel/migration.	Noted. Suitable mitigation for migratory fish has been developed further in consultation with the Marine Management Organisation ("MMO") and based on underwater noise modelling and further assessment work.
Statutory Consultation (PEIR) January – February 2023	Marine Management Organisation	The MMO appreciate and welcome the suggestion of temporal/seasonal piling restrictions specifically for migratory fish receptors, though no details of these restrictions have been submitted at this point. As mentioned above, the exact dates when piling and	Noted. Suitable mitigation for migratory fish has been developed further in consultation with the MMO and based on underwater noise modelling and further assessment work.

Reference/date	Consultee	Summary of Response	How comments have been addressed in this chapter
		dredging activities are to take place have not been stated so it is not possible to determine whether seasonal/temporal restrictions will be required for piling or dredging. The requirement for seasonal/temporal mitigation should be determined on the basis of the outcomes of the final EIA and will be subject to the timing of construction activities.	
Statutory Consultation (PEIR) January – February 2023	Marine Management Organisation	It should be noted that as piling will only occur during daylight hours (7 am to 7 pm) a night-time piling restriction is only likely to be of benefit to those species with nocturnal habitats such as European eel. Whilst a night-time restriction on piling will provide a 12-hour period of quiet 'down-time' for all fish receptors, the proposal to carryout dredging on a 24/7 basis will result in increased noise, increased SSC and reduced water quality, and thus potential impacts to fish receptors during hours of darkness are still a concern.	Noted. Suitable mitigation for migratory fish has been developed further in consultation with the MMO and based on underwater noise modelling and further assessment work with respect to marine piling. The maximum impact marine piling scenario is for three tubular piles to be installed each day using up to two marine piling rigs pile driving at any one time, involving approximately 270 minutes of impact marine piling per day and 60 minutes of vibro marine piling per day in a 12-hour shift. There will, therefore, be significant periods over a 24-hour period when fish will not be disturbed by any marine piling noise. The actual proportion of impact marine piling is estimated to be at worst around 23% (based on 270 minutes of impact marine piling and 60 minutes of vibro marine piling each working day) over any given construction week.
Statutory Consultation (PEIR) January – February 2023	Marine Management Organisation	The information regarding shellfisheries is detailed, relevant and extensive, both in respect of the baseline and the impact assessments conducted. The MMO have identified no significant gaps in respect to shellfisheries.	Noted

Reference/date	Consultee	Summary of Response	How comments have been addressed in this chapter
Statutory Consultation (PEIR) January – February 2023	Marine Management Organisation	The MMO note that underwater noise arising from vessel operations maintenance dredge and dredge disposal (during the operational phase) has been scoped out for all marine receptors. Provided that the worst-case dredging assumptions have been considered, then the MMO have no major objections to the scoping out (of a more detailed assessment) of maintenance dredging during the operational phase. Nevertheless, it will still be important to consider any overlap of maintenance dredging operations with key migratory or spawning periods	Further information on maintenance dredging has been provided in **Section 9.8** including an assessment of potential effects relating to this pathway. The need for future maintenance dredging within the new berth pocket is expected to be very limited (if required at all).
Statutory Consultation (PEIR) January – February 2023	Marine Management Organisation	Mitigation measures included in the report are the standard measures expected for this type of development. The MMO recommend that soft start procedures are adopted for all percussive piling. Soft start may help to reduce the total number of dangerous exposures in terms of auditory injury. The MMO also support the use of vibro piling where possible. Furthermore, it will be important to identify any overlap of construction works with key migratory and spawning periods. Some seasonal or night time restrictions may be necessary to protect sensitive receptors.	Noted. Suitable mitigation for migratory fish has been developed further in consultation with the MMO and based on underwater noise modelling and further assessment work.
Pre-application meeting, 28 April 2023	MMO and Cefas	The meeting provided an update on the Project and focused on discussing comments received from the MMO and Cefas on the PEIR with respect to potential effects on migratory fish species.	The scope of the environmental assessments has been completed taking on board consultee comments from this meeting.
Second Statutory	Natural England	**Internationally and nationally designated sites**	A **Shadow HRA** has been produced **[TR030008/APP/7.6]** which considers potential effects on the Humber Estuary SAC,

Reference/date	Consultee	Summary of Response	How comments have been addressed in this chapter
Consultation May 2023 – July 2023		Natural England notes there have been no amendments to the PEIR Appendix 9C which was provided in the first S42 consultation. The application site is in close proximity to European designated sites (also referred to as Habitat sites), and therefore has the potential to affect their interest features. European sites are afforded protection under the Conservation of Habitats and Species Regulations 2017, as amended (the 'Habitats Regulations'). The application site is within and adjacent to the Humber Estuary Special Area of Conservation (SAC) and Special Protection Area (SPA) which are European sites. The site is also listed as Humber Estuary Ramsar site and notified at a national level as Humber Estuary Site of Special Scientific Interest (SSSI). Our advice regarding the potential impacts upon the Humber Estuary SSSI coincides with our advice regarding potential impacts upon the Humber Estuary SAC/SPA/Ramsar as detailed above. Natural England notes that the application site is in close proximity to the Humber Estuary SSSI and North Killingholme Haven Pits SSSI. Based on the plans submitted, Natural England considers that the proposed development could have potential significant effects on the interest features for which the sites have been notified. The consultation documents provide some screening information for the Habitats Regulations Assessment (Shadow HRA). It is Natural England's advice that the proposal is not directly connected with or	SPA and Ramsar site. Where Likely Significant Effects ("LSEs") were identified at the screening stage of HRA, the relevant impact pathways were taken forward to stage 2 Appropriate Assessment. Marine ecology features of Humber Estuary SSSI are considered in **Section 9.8** and ornithology features of the SSSI in Section 10.8 of **Chapter 10: Ornithology [TR030008/APP/6.2]**. Potential effects on the North Killingholme Haven Pits SSSI are considered in Section 10.8 of **Chapter 10: Ornithology [TR030008/APP/6.2].**

Reference/date	Consultee	Summary of Response	How comments have been addressed in this chapter
		necessary for the management of the European site. You should therefore determine whether the proposal is likely to have a significant effect on any European site, proceeding to the Appropriate Assessment stage where significant effects cannot be ruled out.	
Second Statutory Consultation May 2023 – July 2023	Marine Management Organisation	1. Benthic Ecology 1.1. The MMO does not have any concerns relating to benthic ecology arising from the proposed changes to the project as outlined in the PEIR addendum. We agree with the overall conclusions that there will be no changes to the likely significant effects presented in the PEIR for benthic ecology. The MMO notes that the only significant change to the assessment will be in relation to the reduced number and footprint of the piles which is unlikely to result in new or different pathways to impact on benthic receptors. The MMO does not consider the decrease in the number of proposed berths (from two to one) and the change in the marine site boundary to require additional assessment to that of the first PEIR. 1.2. While the introduction and spread of invasive non-native species (INNS) will be addressed under the Construction Environmental Management Plan (CEMP) for the project, the MMO, in consultation with Cefas, consider that the piles which provide support for the jetty would be a suitable structure for the settlement of INNS, such as the leathery sea squirt, Styela clava which has been recorded in the area, and for others yet to be identified. However, the	Noted. Consideration of the potential for non-natives to colonise piles and other structures has been included within the ES (operational phase, **Section 9.8**).

Reference/date	Consultee	Summary of Response	How comments have been addressed in this chapter
		MMO recommend that the impacts of INNS that may recruit on infrastructure are considered further and included in any monitoring assessment following construction.	
Second Statutory Consultation May 2023 – July 2023	Marine Management Organisation	3. Fisheries 3.1. The description of the proposed changes to the project generally appear to indicate a reduction in the scale of the project, mainly due to the removal of one of the berths. However, specific details about the reduced width of the jetty are not provided in the report and it is unclear whether the area and volume of material to be removed during capital dredging have changed. Given the reduced scale of the IGET, it would be reasonable to assume that the footprint of the works will be smaller, and that the volume and area of dredging would not increase as a result of the proposed changes. On this basis, the MMO would not expect the likelihood or significance of impacts to fish species to increase as a result of the design changes. 3.2. Nonetheless, the MMO's advice provided at PEIR stage raised a number issues which highlighted concerns with the robustness of the preliminary environmental impact assessment in respect of fisheries, in particular the impacts to fish arising from capital dredging and underwater noise and vibration from piling. Assuming that piling and dredging are still required to construct the IGET project, the EIA should be revisited based on the revised project design, taking into account our	The assessment provided in **Section 9.8** considers both potential effects from dredging and marine piling based on the revised Project design, taking into account our comments raised during the initial consultation on 16 February 2023.

Reference/date	Consultee	Summary of Response	How comments have been addressed in this chapter
		comments raised during the initial consultation on 16 February 2023.	
Second Statutory Consultation May 2023 – July 2023	Marine Management Organisation	4. Shellfisheries 4.1. The MMO has no additional comments to make regarding potential impacts to Shellfisheries as a consequence of this PEIR addendum.	Noted.
		5.1. In the PEIR addendum there are two proposed changes to the project related to the marine environment. Firstly, the site boundary has been amended in response to the design evolution of the project. The MMO agrees that the reduction of the marine area being used for construction of the green energy terminal should reduce the potential for adverse sound and vibration impacts, but this will be confirmed after the completion of noise modelling for the full environmental impact assessment (EIA). 5.2. Secondly, marine design changes to the green energy terminal include that the jetty will now be reduced from a double to a single berth. Table 7.2 Implications of the proposal changes by topic, details that the potential for vibration effects to the existing jetty to the West is reduced or removed given the revision to the marine works. The MMO considers that piling will be the significant source of underwater noise at the site. The original PEIR outlined several mitigation measures including soft start procedures, the use of vibro piling where possible with seasonal/ night-time piling restrictions	Noted. All comments received from the MMO have been addressed and the updated scheme design has been assessed within this chapter and the underwater noise assessment (**Appendix 9.B [TR030008/APP/6.4]**). The change in marine design will involve the installation of approximately 393 steel tubular piles of varying sizes to support the approach jetty and jetty head. Further details are provided in **Chapter 2: The Project [TR030008/APP/6.2]** and summarised in the underwater noise assessment (**Appendix 9.B [TR030008/APP/6.4]**). Further consideration has been given to the timing of the proposed activities in relation to key migratory or spawning periods. It is not, however, possible to confirm the exact timing and programme for the marine piling and dredging at this stage and the assessment has, therefore, been undertaken on the basis that the works could be undertaken at any time of year. Marine piling restrictions to avoid sensitive periods for migratory fish have been discussed with the MMO and Cefas and are set out in **Section 9.9** of this chapter.

Reference/date	Consultee	Summary of Response	How comments have been addressed in this chapter
		specifically for migratory fish species and JNCC marine piling protocols for marine mammals. Given the marine design changes outlined in the addendum, we request that the applicant address whether the change in marine design to a single berth also decreases the number of piles planned (in the original PEIR 380 tubular piles were included), or if the same number of piles and piling schedule is planned. 5.3. Furthermore, in previous advice dated 16 February 2023, several comments were raised regarding underwater noise modelling. Subsequently, the MMO, in consultation with Cefas, look forward to reviewing the noise modelling performed in the environmental impact assessment for the updated marine design. 5.4. Previous advice also emphasised that the applicants should review whether the timing of planned dredging and piling operations overlaps any key feeding or spawning periods. The MMO appreciate that the report highlights that during the environmental statement, the mitigation measures associated with the development will be presented. 5.5. Underwater noise is expected to be produced during dredging and piling operations at the site. Overall, the MMO agrees with the conclusions reached in the PEIR addendum that given the limited extent of the changes, no new significant effects are identified due to Underwater Noise. Furthermore, the proposed changes do not alter the conclusions with respect to significant effects identified in the first	

Reference/date	Consultee	Summary of Response	How comments have been addressed in this chapter
		statutory consultation. To minimise the potential effects of underwater noise on migratory fishes and marine mammals, the MMO advise appropriate literature is continued to be reviewed (Popper et al., 2014), (National Marine Fisheries Service, 2018) and consider the timing of the proposed activities in relation to key migratory or spawning periods for marine life.	
Second Statutory Consultation May 2023 – July 2023	Lincolnshire Wildlife Trust	LWT is pleased to see that the level of dredging required for the Project has now reduced with the decision to implement one berth instead of two. However, the details of dredging works remain vague at this time, and LWT will continue to monitor this as more information is given. Our concerns regarding capital dredging and maintenance dredging were not addressed in the updated documents for this Second Statutory Consultation. Therefore, we have included our previously stated views in an appendix (Appendix A) to this letter.	Capital dredging is assessed in **Section 9.8**. The need for future maintenance dredging within the new berth pocket is expected to be very limited (if required at all). Further information on maintenance dredging has been provided in **Section 9.8**. The assessment considers the impact on habitats of maintenance dredging during the operational phase. Cumulative effects of dredging are considered (**Chapter 25: Cumulative and In-Combination Effects** of the ES **[TR030008/APP/6.2]**).
Pre-application meeting, 01 August 2023.	Natural England	The meeting provided a further update of the Project as well as a discussion on potential effects, HRA, stakeholder engagement and project programme.	This chapter and the **Shadow HRA** (**[TR030008/APP/7.6]**) have been completed taking on board consultee comments from the meeting.

9.2.5 Having regard to the information presented within the Scoping Report (**Appendix 1.A [TR030008/APP/6.4]**), the Planning Inspectorate's Scoping Opinion (**Appendix 1.B [TR030008/APP/6.4]**) has also confirmed the Applicant's view that significant effects on: phytoplankton; commercial shellfisheries; sediment deposition impacts of marine piling to benthic habitats and species; water quality effects due to marine piling on marine species, impacts to marine mammals as a result of changes to foraging habitat and prey resource; disturbance to hauled out seals; collision risk to marine mammals from vessels involved in construction and dredging are unlikely. Accordingly, these matters have remained scoped out of consideration in the ES.

9.3 Legislation, Policy and Guidance

9.3.1 **Table 9-2** presents the legislation, policy and guidance relevant to the Marine Ecology assessment and details how their requirements will be met.

Table 9-2: Relevant legislation, policy and guidance regarding Marine Ecology

Legislation / Policy / Guidance	Consideration within the ES
Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora ('The Habitats Directive') (Ref 9-3)	
The Habitats Directive (92/43/EEC) is intended to help maintain biodiversity throughout the EU Member States by defining a common framework for the conservation of wild plants, animals and habitats of community interest. It established a network of Special Areas of Conservation ("SAC") designated by Member States to conserve habitats and species (listed in Annexes I and II).	The Humber Estuary SAC and features are described in **Section 9.6**. Consideration of impacts on SAC habitats and species is provided in **Section 9.8.** A **Shadow HRA** has been produced **[TR030008/APP/7.6].**
Council Directive 2009/147/EC on the conservation of wild birds ('The Birds Directive') (Ref 9-4)	
Directive 2009/147/EC on the conservation of wild birds is known as the 'Birds Directive'. It creates a comprehensive scheme of protection for all wild bird species. The Directive recognises that habitat loss and degradation are the most serious threats to the conservation of wild birds. It, therefore, places great emphasis on the protection of habitats for endangered as well as migratory species (listed in Annex I), especially through the establishment of a coherent network of Special Protection Areas ("SPA"s) comprising all the most suitable territories for these species.	The Humber Estuary SPA and qualifying features are described in **Chapter 10: Ornithology**. Consideration of impacts on coastal waterbirds which are features of these sites are outlined in Section 10.8 of that chapter. A **Shadow HRA** has been produced **[TR030008/APP/7.6].**
The Water Framework Directive 2000/60/EEC (Ref 9-5)	
The Water Framework Directive (2000/60/EEC) ("WFD") establishes a framework for the	The Project (and associated disposal sites) is located within the Humber Lower water body (ID: GB530402609201) (further described in **Chapter 17: Marine Water and Sediment Quality**

Legislation / Policy / Guidance	Consideration within the ES
management and protection of Europe's water resources. The overall objectives of the WFD are to achieve "good ecological and good chemical status" in all inland and coastal waters by 2021 unless alternative objectives are set or there are grounds for time limited derogation. For example, where pressures preclude the achievement of good status (e.g. navigation, coastal defence) in heavily modified water bodies ("HMWB"s), the WFD provides that an alternative objective of "good ecological potential" is set.	**[TR030008/APP/6.2]**. A WFD compliance assessment has been prepared to support the DCO application which includes consideration of several key biological receptors, specifically habitats, fish, protected areas and invasive non-native species ("INNS"). The WFD compliance assessment has derived information provided both in this chapter and other chapters within the ES.
Conservation of Habitats and Species Regulations 2017 as amended ('The Habitats Regulations') (Ref 9-6)	
The Habitats Directive and Birds Directive are transposed into UK law through the Conservation of Habitats and Species Regulations 2017 as amended, known as the "Habitats Regulations"[1]. The Habitats Regulations provide for the designation and protection of 'European sites', the protection of 'European protected species' and the adaptation of planning and other controls for the protection of European Sites. The Regulations also require the compilation and maintenance of a register of European sites, to include SACs (classified under the Habitats Directive) and SPAs (classified under the Birds Directive). These sites form the Natura 2000 network. These regulations also apply to Ramsar sites (designated under the 1971 Ramsar Convention for their internationally important wetlands), candidate SACs ("cSAC"), potential Special Protection Areas ("pSPA"), and proposed and existing European offshore marine sites.	**Section 9.6** identifies protected habitats and species. A Consideration of impacts on these receptors is provided in **Section 9.8**. A **Shadow HRA** has been produced **[TR030008/APP/7.6].**This report will inform the consultation process and will aid the Competent Authority[2] in determining whether the Project has the potential for a LSE on the interest features and/or supporting habitat of a European/Ramsar site either alone or in-combination with other plans, projects and activities and, if so, will inform the requirement to undertake an Appropriate Assessment ("AA") of the implications of the proposals in light of the site's conservation objectives and provide information to support the AA undertaken.
The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 (Ref 9-7)	
The Water Framework Directive (2000/60/EEC) is transposed into UK law through the Water Environment (Water Framework Directive) (England	The Project (and associated disposal sites) is located within the Humber Lower water body (ID: GB530402609201) (further described in **Chapter 17: Marine Water and Sediment Quality [TR030008/APP/6.2]**. A WFD compliance

1 Following the UK leaving the EU, the Conservation of Habitats and Species Regulations 2017 have been modified by the Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019.

2 The Secretary of State is the Competent Authority for the HRA under the UK Habitats Regulations for this Application.

Legislation / Policy / Guidance	Consideration within the ES
and Wales) Regulations 2017 as amended, known as the Water Framework Regulations[3].	assessment will be prepared to support the Development Consent Order ("DCO") application which includes consideration of several key biological receptors, specifically habitats, fish, protected areas and INNS. The WFD compliance assessment will draw on information provided both in this chapter and other chapters within the ES.
Marine and Coastal Access Act 2009 ("MCAA") (Ref 9-8)	
The MCAA provides the legal mechanism to help ensure clean, healthy, safe, productive, and biologically diverse oceans and seas by putting in place a new system for improved management and protection of the marine and coastal environment. The MCAA established the Marine Management Organisation ("MMO") as the organisation responsible for marine planning and licensing. The Project will require a Marine Licence for the elements of the works below Mean High Water Springs including dredging, disposal and placing or removing objects on or from the seabed. For NSIPs, the Development Consent Order (DCO) where granted may include provision deeming a marine licence to have been issued under Part 4 of the Marine and Coastal Access Act 2009. The MMO is responsible for enforcing, post-consent monitoring, varying, suspending, and revoking any deemed marine licence(s) as part of the DCO.	Information relevant to the marine licensing process has been provided including characterisation of the baseline for key marine ecology receptors (nature conservation sites, protected habitats and species, fish and marine mammals) (**Section 9.6**) and an assessment of impacts (**Section 9.8**). With respect to Marine Conservation Zones ("MCZ"), the Holderness Inshore MCZ is the nearest MCZ to the Project (located approximately 20 km away). This is considered to be beyond the zone of potential effects of the Project and as a consequence, a MCZ Assessment is not considered to be required.
The Planning Act 2008 (PA2008) (Ref 9-9)	
Whilst the MCAA regulates marine licensing for works at sea, section 149A of the Planning Act 2008 enables an applicant for a DCO to include within the Order a Marine Licence which is deemed to be granted under the provisions of the MCAA.	Information relevant to the marine licensing process has been provided including characterisation of the baseline for key marine ecology receptors (nature conservation sites, protected habitats and species, fish and marine mammals) (**Section 9.6**) and a assessment of impacts (**Section 9.8**).
The Wildlife and Countryside Act 1981 ("WCA") (Ref 9-10)	
The WCA is the principal mechanism for the legislative protection of wildlife in Great Britain. The WCA is the means by which the Convention on the Conservation of European Wildlife and Natural Habitats (the Bern Convention), the Convention on	**Section 9.4** identifies habitats and species which are protected under the WCA. Consideration of impacts on these receptors is provided in **Section 9.8**.

[3] Following the UK leaving the EU, the main provisions of the WFD have been retained in English law through The Floods and Water (Amendment etc.) (EU Exit) Regulations 2019.

Legislation / Policy / Guidance	Consideration within the ES
the Conservation of Migratory Species of Wild Animals (Bonn Convention), the Birds Directive (79/409/EEC) and the Natural Habitats and Wild Fauna and Flora Directive (92/43/FFC) are implemented in Great Britain. The WCA applies to the terrestrial environment and inshore waters (0 to 12 nautical miles) and concerns the protection of wild animals and the designation of protected areas, including SSSIs.	
The Countryside and Rights of Way Act 2000 ("CroW Act") (Ref 9-11)	
The CroW applies to England and Wales only. Part III of the CroW Act deals specifically with wildlife protection and nature conservation. The CroW Act places a duty on the Government to have regard for the conservation of biodiversity and maintain lists of species and habitats for which conservation steps **should** be taken or promoted, in accordance with the Convention on Biological Diversity. Schedule 9 of the CroW Act amends the SSSI provisions of the WCA, including increased powers for the protection and management of SSSIs. The provisions extend powers for entering into management agreements; place a duty on public bodies to further the conservation and enhancement of SSSIs; increase penalties on conviction where the provisions are breached; and include an offence whereby third parties can be convicted for damaging SSSIs.	**Section 9.6** identifies habitats and species for which SSSIs have been designated. Consideration of impacts on these receptors is provided in **Section 9.8**.
Natural Environment and Rural Communities Act 2006 ("NERC Act") (Ref 9-12)	
The NERC Act came into force in October 2006. In addition to establishing Natural England ("NE") as the body responsible for conserving, enhancing, and managing England's natural environment, the Act also made amendments to both the Wildlife and Countryside Act 1981 and the CroW Act 2000. For example, it extended the CroW Act's biodiversity duty to public bodies and statutory undertakers,and altered enforcement powers in connection with wildlife prosecution. In addition to this, the NERC Act contains a number of additional measures designed to help streamline delivery and simplify the legislative framework, such as changes to the remit and constitution of the Joint Nature Conservation Committee ("JNCC"), reconstitution of the Inland Waterways Amenity Advisory Council, and improving the governance arrangements for the National Parks.	**Section 9.6** identifies habitats and species for which are protected under the NERC Act (priority species and habitats of principal importance). Consideration of impacts on these receptors is provided in **Section 9.8**.

Legislation / Policy / Guidance	Consideration within the ES
Section 41 of the NERC Act requires the SoS to publish a list of habitats and species which are of principal importance for the conservation of biodiversity in England. The list has been drawn up in consultation with NE, as required by the NERC Act.	
The Eels (England and Wales) Regulations (2009) (Ref 9-13)	
The Eels (England and Wales) Regulations 2009 implement Council Regulation (EC) No 1100/2007 of the Council of the European Union, establishing measures for the recovery of the stock of European eel. This includes the requirement to notify the Environment Agency of the construction, alteration or maintenance of any structure likely to affect the passage of eels and where any such structure exists, the requirement to construct and operate an eel pass to allow the free passage of eels.	**Section 9.6** provides background information on European eel in the vicinity of the Project and outlines their ecology and distribution. Consideration of impacts on European eel is provided in **Section 9.8.**
National Policy Statement for Ports (Ref 9-14)	
The National Policy Statement for Ports ("NPSfP") provides the framework for decisions on proposals for new harbour facility developments that constitute an NSIP. This policy requires that in order to meet the requirements of the Government's policies on sustainable development, new port infrastructure **should** also, amongst other things, preserve, protect and where possible improve marine and terrestrial biodiversity, be adapted to the impacts of climate change and provide high standards of protection for the natural environment. As highlighted in paragraphs 5.1.4 and 5.1.5 of the NPSfP, where the development is subject to EIA, the applicant **should** ensure that the ES clearly sets out any effects on internationally, nationally and locally designated sites of ecological or geological conservation importance, on protected species and on habitats and other species identified as being of principal importance for the conservation of biodiversity. As highlighted in paragraphs 5.1.8 and 5.1.9 of the NPSfP, developments **should** aim to avoid significant harm to biodiversity and geological conservation interests, including through mitigation and consideration of reasonable alternatives. They **should** also ensure that appropriate weight is attached to designated sites of international, national and local importance.	Consideration of impacts on species and habitats including those which are features of internationally, nationally and locally designated sites of ecological importance are presented in **Section 9.8.** Where appropriate, mitigation has been included and this is outlined in **Section 9.9**.

Legislation / Policy / Guidance	Consideration within the ES
UK Marine Policy Statement (Ref 9-15)	
The UK Marine Policy Statement ("MPS") is the framework for preparing marine plans and taking decisions affecting the marine environment. The MPS also sets out the general environmental, social and economic considerations that need to be taken into account in marine planning and provides guidance on the pressures and impacts that decision makers need to consider when planning for and permitting development in the UK marine areas. Paragraphs 3.1.7 and 3.1.8 of the MPS are relevant to the ecology assessment of the Project which, amongst other things, state that: "Marine plan authorities and decision makers **should** take account of how developments will impact on the aim to halt biodiversity loss and the legal obligations relating to all MPAs, their conservation objectives, and their management arrangements…" Marine plan authorities and decision-makers **should** take account of the regime for MPAs and comply with obligations imposed in respect of them. This includes the obligation to ensure that the exercise of certain functions contribute to, or at least do not hinder, the achievement of the objectives of an MCZ. This would also include the obligations in relevant legislation relating to SSSIs and sites designated under the Birds and Habitats Directives.	Consideration of impacts on species and habitats including those which are features of MPAs are presented in **Section 9.8**.
East Inshore and East Offshore Marine Plans (Ref 9-16)	
The East Inshore and East Offshore Marine Plans, which are collectively referred to as 'the East Marine Plans', were formally adopted on 2 April 2014. There are five policies within the East Marine Plans specifically related to nature conservation and marine ecology.	Provides general guidance. See considerations of specific policies below.
Policy ECO1 - Cumulative impacts affecting the ecosystem of the East marine plans and adjacent areas (marine, terrestrial) **should** be addressed in decision-making and plan implementation:	Information on the cumulative and in-combination effects assessment for the Project are included in **Chapter 25: Cumulative and In-Combination Effects [TR030008/APP/6.2]** of this ES.
Policy BIO1 - Appropriate weight **should** be attached to biodiversity, reflecting the need to protect biodiversity as a whole, taking account of the best available evidence on those habitats and species that are protected or of conservation	Consideration of impacts to habitats and species that are protected or of conservation concern is presented in **Section 9.8**.

Legislation / Policy / Guidance	Consideration within the ES
concern in the East Marine Plans and adjacent areas (marine, terrestrial).	
Policy BIO2 - Where appropriate, proposals for development **should** incorporate features that enhance biodiversity and geological interests.	Consideration of design, mitigation and enhancement measures is outlined in **Section 9.7 and Section 9.9**.
Policy MPA1 - Any impacts on the overall MPA network must be taken into account in strategic level measures and assessments, with due regard given to any current agreed advice on an ecologically coherent network:	Consideration of impacts habitats and species that are features of MPAs is presented in **Section 9.8**. A **Shadow HRA** has been produced **[TR030008/APP/7.6]**. MCZs are considered in **Section 9.8**.
Policy FISH2 - Proposals **should** demonstrate, in order of preference: a) that they will not have an adverse impact upon spawning and nursery areas and any associated habitat, b) how, if there are adverse impacts upon the spawning and nursery areas and any associated habitat, they will minimise them, c) how, if the adverse impacts cannot be minimised they will be mitigated, and d) the case for proceeding with their proposals if it is not possible to minimise or mitigate the adverse impacts	**Section 9.6** provides background information on fish spawning and nursery areas in the vicinity of the Project. A preliminary consideration of impacts on fish is provided in **Section 9.8**.
North East Lincolnshire Local Plan 2013 to 2032 (Ref 9-17)	
The North-East Lincolnshire Local Plan was adopted in 2018 and covers the period 2013 to 2032. Policy 7 of the plan highlights that for operational port areas “proposals for port related use will be supported and, where appropriate, approved by the Council if the submitted scheme accords with the development plan as a whole and subject to the ability to satisfy the requirements of the Habitats Regulations.” In addition, Policy 41 of the plan states that: “*The Council will have regard to biodiversity and geodiversity when considering development proposals, seeking specifically to:* *A. establish and secure appropriate management of long-term mitigation areas within the Estuary Employment Zone, managed specifically to protect the integrity of the internationally important biodiversity sites (see Policy 9 ‘Habitat Mitigation - South Humber Bank’);* *B. designate Local Wildlife Sites (“LWS”s) and Local Geological Sites (LGSs) in recognition of particular wildlife and geological value;* *C. protect manage and enhance international, national and local sites of biological and geological*	Consideration of impacts on marine species and habitats and designated sites are presented in **Section 9.8**. A **Shadow HRA** has been produced **[TR030008/APP/7.6].** This policy is considered for terrestrial ecology in **Chapter 8: Terrestrial Ecology [TR030008/APP/6.2].**

Legislation / Policy / Guidance	Consideration within the ES
conservation importance, having regard to the hierarchy of designated sites, and the need for appropriate buffer zones; *D. localize the loss of biodiversity features, or where loss is unavoidable and justified ensure appropriate mitigation and compensation measures are provided;* *E. create opportunities to retain, protect, restore and enhance features of biodiversity value, including priority habitats and species; and,* *F. take opportunities to retain, protect and restore the connectivity between components of the Borough's ecological network.* Any development which would, either individually or cumulatively, result in significant harm to biodiversity which cannot be avoided, adequately mitigated or as a last resort compensated for, will be refused".	

9.4 Assessment Methodology

9.4.1 To facilitate the impact assessment process and ensure consistency in the approach to assessing a standard assessment methodology will be applied to determine the significance of effects within this chapter**.** This methodology has been developed from a range of sources, including relevant Environmental Impact Assessment ("EIA") Regulations, the EIA Directive (2014/52/EU), statutory and non-statutory guidance, consultations and professional project experience. The assessment also follows the principles of relevant guidance, including Institute of Environmental Management and Assessment ("IEMA") guidelines, and the latest Chartered Institute of Ecology and Environmental Management ("CIEEM") guidelines for ecological impact assessment in the UK and Ireland (which combine advice for terrestrial, freshwater and coastal environments) (Ref 9-2). The methodology adopted is considered to be 'best practice'.

9.4.2 The environmental issues are divided into distinct 'receiving environments' or 'receptors'. The effect of the proposed development on each of these has been assessed by describing in turn:

a. The baseline environmental conditions of each receiving environment.

b. The 'impact pathways' by which the receptors could be affected.

c. The significance of the effect occurring as a result of the impact.

d. The measures to mitigate for significant adverse effects where these are predicted.

9.4.3 In accordance with CIEEM (Ref 9-2), an impact is defined as an action resulting in changes to an ecological feature (e.g., construction activities resulting in the direct loss of benthic habitat) and an effect is the outcome to an ecological feature from an impact (e.g. the effects on fish from the loss of benthic habitat).

Magnitude of impacts

9.4.4 The first stage in the assessment process involves understanding the impact magnitude which is determined by predicting the scale of any potential change in baseline conditions.

9.4.5 Magnitude of change needs to be considered in spatial and temporal terms (including duration, frequency and seasonality), and against background environmental conditions in a study area. The assessment of magnitude should also be carried out taking account of any embedded and standard design mitigation.

9.4.6 The following criteria have been used to assess the magnitude of impact:

a. Negligible: Changes that are barely discernible from existing baseline conditions.

b. Small: Relatively localised changes that are often temporary in nature and/or a receptor has limited exposure to change.

c. Medium: Receptors are subject to changes that occur over a large spatial area, but the effects are considered temporary.

d. Large: Receptors are subject to changes over a large spatial area with effects that are considered permanent/long-term duration.

9.4.7 Once a magnitude has been assessed, this is then considered in terms of the probability of occurrence (i.e. likelihood that the impact will occur) to derive an overall level of exposure to change.

Sensitivity of receptors

9.4.8 Sensitivity can be described as the intolerance of a habitat, community or individual of a species to an environmental change and essentially considers the response characteristic of the feature. The sensitivity of a marine habitat or species is considered to be a product of the following (Ref 9-140):

a. The likelihood of damage (termed intolerance or resistance) due to a pressure. This could include behavioural effects, physiological damage or even mortality of individuals or populations.

b. The rate of (or time taken for) recovery (termed recoverability, or resilience) of marine species once the pressure has abated or been removed.

9.4.9 The following criteria have been used to assess sensitivity:

a. **Low**: Pressures in which the likelihood of damage to individuals or populations is low with recoverability expected to occur over short timescales.

b. **Moderate**: Pressures in which damage to individuals or populations could occur but recoverability is expected to occur over short to moderate timescales.

c. **High**: Pressures in which damage to individuals or populations is highly likely with either no recoverability or recoverability expected to occur over longer timescales.

9.4.10 **Table 9-3** summarises the sensitivity level that has been assigned to different receptors considered in this assessment based on consideration of the criteria highlighted above. Further rationale for the sensitivity levels that have been assigned are included for each pathway in the impact assessment.

Table 9-3: Assessed sensitivity of marine ecology receptors.

Receptor	Sensitivity
Benthic, habitats and species	The benthic habitats and species in the dredge footprint and disposal sites are considered to have a **high** sensitivity to habitat loss, a **low** sensitivity to habitat change (due to relatively high recoverability), a **low** to **moderate** sensitivity to non-native species introductions and a **low** sensitivity to water quality and underwater noise on the scale predicted.
Intertidal and coastal terrestrial habitats	The intertidal and coastal terrestrial habitats within the zone of influence are considered to have a **high** sensitivity to changes in air quality due to high background levels of some pollutants.
Fish	Fish species in the study area are considered to have a **low** sensitivity to marine habitat change on the scale predicted for the Project (due to the high mobility of the species). They are considered to have a **low to moderate sensitivity** to water quality and underwater noise (depending on the species and activity).
Marine mammals	Marine mammals are generally considered to have a **low** sensitivity to changes in water quality and marine habitat change / loss on the scale predicted for the Project (due to the high mobility of the species). The species in the study area are considered to have a **moderate** sensitivity to the anticipated level of underwater noise generated by the Project from marine piling and a low sensitivity to noise due to dredging activities.

Receptor importance

9.4.11 In considering the magnitude of impacts and sensitivity of the receptor, it is also necessary to identify whether an ecological feature is ‘important’. As such, where possible, habitats, species and their populations have been valued on the basis of a combination of their conservation status, rarity and ecological/socioeconomic value using contextual information - where it exists.

9.4.12 The CIEEM (Ref 9-2) guidelines recognise that determining ecological importance is a complex process, which is a matter of professional judgement guided by the importance and relevance of a number of factors. These include designation and legislative protection as well as biodiversity value and secondary / supporting value (e.g. where habitats may function as a buffer or resource associated with an adjacent designated area).

9.4.13 The importance of each ecological receptor has been determined, based on the following criteria:

a. **Low**: The receptor is neither protected nor designated and is considered to be of low to moderate biodiversity or supporting value.

b. **Moderate** Statutory protection/designation is afforded to a receptor, but it is considered to be of low to moderate biodiversity/supporting value or the receptor does not receive statutory protection but is considered to be of high biodiversity or supporting value.

c. **High**: Statutory protection/designation is afforded to a receptor and the receptor is considered to be of high biodiversity or supporting value.

9.4.14 The importance of a receptor has also been considered with regard to the marine geographic frame of reference defined below as recommended in the CIEEM (Ref 9-2) guidelines:

a. International and European

b. National

c. Regional (Humber Estuary)

d. Local (Port of Immingham area)

9.4.15 **Table 9-4** summarises the importance level that has been assigned to the different receptors that have, to date, been assessed based on the criteria highlighted above.

Table 9-4: Assessment of the importance of marine ecology receptors

Receptor	Importance
Benthic habitats and species	**Low to high** (local to international) importance: Intertidal habitats in the study area are considered to be of **high** importance due to their designated status (as a qualifying feature of the Humber Estuary SAC and Sites of Special Scientific Interest (SSSI), NERC listed habitat and as supporting habitat of the Humber Estuary SPA, as well as the functional importance they provide in terms of benthic prey resources for intertidal birds. The disposal sites identified for the disposal of the dredged arisings are considered to be of **moderate** importance due to their typically impoverished nature and low ecological value albeit characteristic of the *Sandbanks which are slightly covered by sea water all the time* qualifying feature of the Humber Estuary SAC. The importance of other subtidal habitats in the vicinity of the proposed development is also considered to be **moderate.** This is because subtidal species in the area are considered to be commonly occurring and of low conservation concern with the habitats not characteristic of any of the qualifying

Receptor	Importance
	features of overlapping designated sites although it is noted that subtidal habitats form a component of the 'Estuaries' feature of the SAC.
Intertidal and coastal terrestrial habitats	Intertidal and coastal terrestrial habitats in the study area are considered to be of **high** importance due to their designated status (as a qualifying feature of the Humber Estuary SAC, SSSI, NERC listed habitat and as supporting habitat of the Humber Estuary SPA.
Fish	**Low to high** (local to international) importance: Some species are commonly occurring and not protected - these are considered to be of low importance such as sand gobies *Pomatoschistus minutus* or mullet species. Other species which are commercially important species (e.g., whiting *Merlangius merlangus*, Dover sole *Solea solea* and plaice *Pleuronectes platessa*) are considered to be of **moderate** importance. Species such as diadromous migratory species (European eel *Anguilla anguilla*, Atlantic salmon *Salmo salar*, sea trout *Salmo trutta*, sea lamprey *Petromyzon marinus*, river lamprey *Lampetra fluviatilis*, twaite shad *Alosa fallax*, allis shad *Alosa alosa*, European smelt *Osmerus eperlanus*) are considered to be of **high** importance.
Marine mammals	**High** (international) importance: All species are of conservation interest and protected.

Significance criteria

9.4.16 Determination of the significance of the predicted ecological effects is based on professional judgement having regard to the positive (beneficial) or negative (adverse) nature of a potential impact.

9.4.17 In summary, to assess the significance of effects, the magnitude of the impact pathway and the probability of it occurring is evaluated to understand the exposure to change. This is then assessed against the sensitivity of a receptor/ feature to understand its vulnerability. Finally, this is considered in the context of the importance of a receptor/feature to generate a level of significance for effects resulting from each impact pathway.

9.4.18 The CIEEM (Ref 9-2) guidelines state that an effect should be determined as being significant when it "*either supports or undermines biodiversity conservation objectives for important ecological* features". It relates to the weight that should be afforded to effects when decisions are made, and to the consequences, in terms of legislation, policy and/or development control. A significant adverse effect on a feature of importance (as defined in **Table 9-4**) would, therefore, be likely to generate the need for development control mechanisms, such as DCO Protective Provisions or Requirements.

9.4.19 Whilst this assessment adopts an Ecological Impact Assessment ("EcIA") approach and, therefore, expresses the significance of ecological effects with reference to a geographic frame of reference (as advocated in the CIEEM Guidelines), significance is also expressed using a generic EIA significance criteria. The generic criteria used throughout this report is based on an expression of severity, to describe the significance of environmental impacts. For ease of reference, **Table 9-5** provides a means of relating the two approaches

and is provided in order to allow the EcIA to be integrated into the wider EIA framework without compromising the CIEEM best practice approach.

9.4.20 To ensure transparency in the impact assessment, it is important to make clear the evidence-based or value-based judgments used at each stage of the assessment and how they have been attributed to a level of significance. This is presented in the impact assessment for each impact pathway.

9.4.21 Following the significance assessment, a confidence assessment was undertaken which recognises the degree of interpretation and professional judgement applied. This is presented in the summary table contained within the conclusions section of this chapter (**Section 9.11**). Confidence was assessed on a scale incorporating three values: low, medium and high.

9.4.22 As shown in **Table 9-5**, effects that are identified as being moderate or major adverse/beneficial are classified as significant effects and those as minor or insignificant as not significant.

Table 9-5: Significance Criteria

Significance Level		Criteria	CIEEM Geographical Criteria
Significant	Major	These effects are likely to be important considerations at a local or district scale but, if adverse, are potential concerns to the project and may become key factors in the decision-making process.	Ecological impacts assessed as being significant at the regional scale and that have triggered a response in development control terms are considered to represent impacts that overall, within this assessment, are of major significance.
	Moderate	These effects, if adverse, while important at a local scale, are not likely to be key decision-making issues. Nevertheless, the cumulative effect of such issues may lead to an increase in the overall effects on a particular area or on a particular resource.	Ecological impacts assessed as being significant at the county/metropolitan scale, and that have triggered a response in development control terms, will be considered to represent impacts that overall, within this assessment, are of moderate significance.
Not significant	Minor	These effects may be raised as local issues but are unlikely to be of importance in the decision-making process. Nevertheless, they are of relevance in enhancing the subsequent design of the project and consideration of mitigation or compensation measures.	Ecological impacts assessed as being significant at the local scale, and that have triggered a response in development control terms, will be considered to represent impacts that overall, within this assessment, are of minor significance.

Significance Level		Criteria	CIEEM Geographical Criteria
	Insignificant	No effect or an effect which is beneath the level of perception, within normal bounds of variation or within the margin of forecasting error.	Ecological impacts that have been assessed as not being significant at any geographic level.

Impact assessment guidance tables

9.4.23 The matrices in **Table 9-6** to **Table 9-8** have been used to help assess significance.

9.4.24 **Table 9-6** has been used as a means of generating an estimate of exposure to change. Once a magnitude has been assessed, this has been combined with the probability of occurrence to arrive at an exposure score which can then be used for the next step of the assessment, which is detailed in **Table 9-7**. For example, an impact pathway with a medium magnitude of change and a high probability of occurrence would result in a medium exposure to change.

Table 9-6: Exposure to change, combining magnitude and probability of change

Probability of Occurrence	Magnitude of Change			
	Large	Medium	Small	Negligible
High	High	Medium	Low	Negligible
Medium	Medium	Medium/Low	Low /Negligible	Negligible
Low	Low	Low /Negligible	Negligible	Negligible
Negligible	Negligible	Negligible	Negligible	Negligible

9.4.25 **Table 9-7** has then been used to score the vulnerability of the features/receptors of interest based on the sensitivity of those features and their exposure to a given change.

Table 9-7: Estimation of vulnerability based on sensitivity and exposure to change

Sensitivity of Feature (Table 9-3)	Exposure to change (Table 9-6)			
	High	Medium	Low	Negligible
High	High	High	Moderate	None
Moderate	High	Moderate	Low	None
Low	Moderate	Low	Low	None

Sensitivity of Feature (Table 9-3)	Exposure to change (Table 9-6)			
	High	Medium	Low	Negligible
None	None	None	None	None

9.4.26 The vulnerability has then been combined with the importance of the feature of interest using **Table 9-8** to generate an initial level of significance. For example, if a high vulnerability is assessed against a feature of low importance, the level of significance of the effect is assessed as minor.

Table 9-8: Estimation of significance based on vulnerability and importance

Importance of Receptor (Table 9-4)	Vulnerability of Feature to Impact (Table 9-7)			
	High	Moderate	Low	None
High	Major	Moderate	Minor	Insignificant
Moderate	Moderate	Moderate/Minor	Minor/Insignificant	Insignificant
Low	Minor	Minor/Insignificant	Insignificant	Insignificant
None	Insignificant	Insignificant	Insignificant	Insignificant

Significance criteria impact management (mitigation)

9.4.27 Impacts that are found to be significant in the process, (i.e., **moderate** and/or **major adverse**) may require mitigation measures to reduce residual impacts, as far as possible, to environmentally acceptable levels. Within the assessment procedure the use of mitigation measures will alter the risk of exposure and, hence, will require significance to be re-assessed and thus the residual impact (i.e., with mitigation) identified.

9.4.28 Mitigation measures considered throughout the EIA process can take three forms (as summarised in (see **Chapter 5: EIA Approach [TR030008/APP/6.2]**)) (Ref 9-141):

a. *Embedded mitigation measures:* modifications to the location, design or operation of a development that are an inherent part of the Project and do not require additional action to be taken.

b. *Standard mitigation measures:* measures comprising management activities and techniques, which would be implemented during construction of the Project to limit impacts through adherence to good site practice and achieving legal compliance. These measures for the construction phase are set out in the Outline Construction Environmental Management Plan ("CEMP") **[TR030008/APP/6.5]**.

c. *Additional mitigation measures:* these comprise measures over and above any embedded and standard mitigation measures, for which the EIA has

identified a requirement to further reduce likely significant environmental effects.

9.4.29 In addition, it is appropriate to adopt a mitigation hierarchy which, from the CIEEM (Ref 9-2) guidance on ecological impact assessment specifically, can be summarised as follows:

a. In the first instance, seek to adopt options that avoid harm.

b. Identify ways to minimise adverse effects that cannot be completely avoided through mitigation.

c. Provide compensation where there are significant residual adverse effects despite the mitigation proposed.

d. Provide net benefits (for biodiversity) above requirements for avoidance, mitigation or compensation.

9.4.30 In some instances, a decision may need to be taken despite residual uncertainty about the effects. In such cases, adaptive management, linked to a bespoke monitoring programme, is a well-established and recommended way of ensuring that any negative impacts or effects are addressed in the course of the development and during the subsequent operational phase.

Limitations and Assumptions

9.4.31 This assessment has been undertaken based on the following assumptions:

a. The Project design and project methodology, as detailed in **Chapter 2: The Project** and **Chapter 3: Need and Alternatives** of the ES **[TR030008/APP/6.2]**.

b. The baseline (**Section 9.6**) used to inform the fish assessment is based on fish survey data from nearby to the Project. While these surveys do not overlap specifically with the Project, they are considered broadly representative of the fish assemblage that could be present within the dredge footprint and surrounding local area. This is because the surveys have used a variety of techniques to target different habitats within both the intertidal and subtidal. The Transitional and Coastal Waters ("TrAC") surveys are also relatively contemporary and cover a range of seasons.

c. The underwater noise assessment assumes that up to three tubular piles to be installed each day using up to two marine piling rigs pile driving concurrently as a worst case;

d. The underwater noise assessment assumes that the dredging and vessel activity will take place continuously (24/7) during construction and as such, provides a precautionary assessment (noting that capital dredging is programmed for 12 days).

e. Future maintenance dredging within the new berth pocket is expected to be very limited (if required at all) as summarised in the physical processes assessment (**Chapter 16: Physical Processes** of the ES **[TR030008/APP/6.2])**.

f. The underwater noise assessment assumes that marine mammals will evade the noise source.

9.4.32 Whilst these are assumptions, the assessment within this ES has been undertaken considering the anticipated worst-case scenario in respect of marine ecology receptors at the dredge, marine piling and disposal locations.

9.5 Study Area

9.5.1 The study area for this assessment is the area over which potential direct and indirect effects of the Project are predicted to occur during the construction and operational periods. The direct effects on nature conservation and marine ecology receptors are those that occur within the footprint of the Project, such as the direct disturbance to benthic habitats and associated species as a result of construction. Indirect effects are those that may arise outside this footprint, such as the potential underwater noise effects on fish during construction.

9.5.2 The study area for the nature conservation and marine ecology topic is focused on the Port of Immingham and proposed disposal sites with data for the wider Humber Estuary region presented where relevant to provide contextual information and to ensure the area of potential effects (e.g., noise disturbance) are fully considered.

9.6 Baseline Conditions

Current Baseline

Data and information sources

9.6.1 Current baseline conditions have been determined by a desk-based review of available information. A project-specific subtidal benthic survey has also been undertaken to characterise seabed habitats and species within and near to the proposed dredge footprint.

9.6.2 The main desk-based sources of information that have been reviewed to inform the current baseline description within the vicinity of the Project include:

Nature conservation sites

a. Natura 2000 standard data forms or information sheets for each designation: Information on the species and habitats listed in the original citations (Ref 9-38; Ref 9-39; Ref 9-40; Ref 9-41).

b. Multi-Agency Geographic Information for the Countryside (“MAGIC”) Interactive Map (Ref 9-19): Information on the boundaries of designated sites.

c. Natural England Conservation Advice for Marine Protected Areas: Humber Estuary SAC (Ref 9-20) and Humber Estuary SPA (Ref 9-21).

Benthic habitats and species

d. Recent Port of Immingham Benthic Surveys between the Immingham Oil Terminal and Eastern Jetty. This included ten intertidal stations sampled in September 2021 using a 0.01m² hand-held core and ten subtidal stations that were sampled in September 2021 using a 0.1m² Day Grab. In addition, six stations were sampled at dredge disposal sites HU060 and HU056 in September 2021 using a 0.1m² Day Grab (four within each of the disposal sites and two nearby to each of the disposal sites).

e. Able Marine Energy Park Benthic Surveys: The results of intertidal benthic surveys (undertaken in 2015 and 2016) using a 0.01m² core sample and a subtidal survey in 2016 using a 0.1m² Day Grab in the North Killingholme area (Ref 9-22).

f. Humber Estuary SAC Intertidal Sediment Survey: Ecological survey work undertaken in 2014 to monitor and assess the intertidal mudflat and sandflat communities of the Humber Estuary (Ref 9-44).

g. Immingham Outer Harbour Benthic Surveys: Intertidal sampling at 14 stations (using a Day Grab (0.06m²) or Van Veen Grab (0.03m²) and subtidal sampling at 17 stations in the Port of Immingham area in 2009 (Ref 9-23).

h. South Humber Channel Marine Studies: Benthic sampling in the intertidal (using a 0.01m² core from 36 stations) and subtidal (0.1m² Hamon grab from 30 stations) between the Humber Sea Terminal and Immingham Port undertaken in 2010 (Ref 9-24).

i. HU056 Disposal Site Monitoring: Benthic invertebrate samples collected at five sites within the disposal sites and at six locations nearby (triplicate samples at all locations) in 2017 (Ref 9-25).

j. Clay Huts Disposal Site Benthic Monitoring: Benthic invertebrate samples collected from four stations in 2008 from within and near to the Clay Huts disposal sites (Ref 9-23).

Fish

k. South Humber Channel Marine Studies: Fish surveys in the intertidal (four double-ended fyke nets) and subtidal (eight beam trawls) between the Humber Sea Terminal and Port of Immingham undertaken in 2010 (Ref 9-24). These sites are located approximately 3 to 4km from the Project.

l. Review of fish population data in the Humber Estuary: A review of available data to describe the fish populations in the Humber Estuary (Ref 9-57).

m. The Humber Regional Environmental Characterisation (“REC”): Fish ecology information provided in the Marine Aggregate Levy Sustainability Fund (Ref 9-26).

n. Environment Agency TraC Fish Monitoring: The results of the most recently available WFD fish monitoring for the nearest sites to the Project (seine netting/bream trawls at Foulholme Sands and otter trawls at Burcom). The Foulholme Sands surveys were undertaken twice a year in the spring and autumn with the Burcom surveys annually in the early winter. These sites are located approximately 3-5km from the Project with data available up to 2017 for Foulholme Sands and 2019 for Burcom (Ref 9-27).

o. Cefas Spawning and Nursery Grounds of Selected Fish Species in UK waters: Distribution maps of the main spawning and nursery grounds for 14 commercially important species (cod, haddock, whiting, saithe, Norway pout, blue whiting, mackerel, herring, sprat, sandeels, plaice, lemon sole, sole and Norway lobster) (Ref 9-28).

p. Fish Atlas of the Celtic Sea, North Sea, and Baltic Sea: The study provides an overview of information collected from internationally coordinated and national surveys and presents data and information on the recent distribution and biology of demersal and small pelagic fish in these ecoregions (Ref 9-29).

Marine mammals

q. Donna Nook Seal Counts: The latest pup counts available from the Lincolnshire Wildlife Trust for winter 2021/22 and 2020/21.

r. Sea Watch Foundation Review of Marine Mammals in the Humber Estuary Region: Information on cetacean status and distribution in the area derived from survey data and the national sightings database maintained by the Sea Watch Foundation with sightings data from 2000 onwards analysed (Ref 9-30).

s. Records of marine mammal sightings from the Lincolnshire Environmental Records Centre (Ref 9-31) and National Biodiversity Network (Ref 9-32).

t. Distribution maps of cetacean and seabird populations in the North-East Atlantic: Distribution maps of cetaceans and seabirds based on survey data in the North-East Atlantic between 1980 and 2018 collated and standardised (Ref 9-33).

u. At-sea Distribution Data for Grey and Harbour Seals: The latest habitat-based predictions of at-sea distribution for grey and harbour seals in the British Isles (including the Humber Estuary region) estimated using data from animal-borne telemetry tags by the Sea Mammal Research Unit (“SMRU”) (Ref 9-34).

v. Donna Nook Telemetry Data; The results of the tagging of 11 grey seals from the Donna Nook colony to understand the movements of grey seals in the region (Ref 9-35).

w. Special Committee on Seals (“SCOS”) Annual Report: Information on the status of seals around the UK coast is reported annually by the SMRU advised SCOS (Ref 9-36).

x. The Identification of Discrete and Persistent Areas of Relatively High Harbour Porpoise Density in the Wider UK Marine Area: The report presents the results of 18 years of survey data in the Joint Cetacean Protocol ("JCP"), undertaken to inform the identification of discrete and persistent areas of relatively high harbour porpoise density in the UK marine area (Ref 9-37).

y. Small Cetaceans in European Atlantic Waters and the North Sea ("SCANS") III Data: Cetacean surveys to estimate the abundance of cetacean species in shelf and oceanic waters of the European Atlantic undertaken in 2016. Teams of observers searched along 60,000 km of transect line, recording thousands of groups of cetaceans from 19 different species. The survey (SCANS-III) is the third in a series that began in 1994 (SCANS) and continued in 2005 (SCANS-II) (Ref 9-37).

z. Inter-Agency Marine Mammal Working Group ("IAMMWG") Management Units Abundance Estimates: In 2015, the IAMMWG defined Management Units ("MUs") for the seven most common cetacean species found in UK waters: harbour porpoise, bottlenose dolphin, short-beaked common dolphin, white-beaked dolphin, Atlantic white-sided dolphin, Risso's dolphin and minke whale. Updated abundance estimates for these species and their MUs have been obtained from (SCANS)-III' (Ref 9-135).

9.6.3 Site specific surveys that have been undertaken to underpin the assessments include:

a. **Subtidal benthic sampling:** Eight subtidal stations were sampled in July 2022 (using a 0.1 m² Day Grab) within and near to the Project footprint. The location of the survey stations is shown in **Figure 9.1 [TR030008/APP/6.3].** All the samples collected were analysed for macrofaunal analysis (faunal composition, abundance and biomass), Particle Size Analysis ("PSA") and Total Organic Carbon ("TOC"). The methods and results of these surveys are included in **Appendix 9.A [TR030008/APP/6.4]** and summarised in **Section 9.6** of this chapter.

Nature conservation sites and protected species

Designated sites

9.6.4 The Project falls within the boundaries of the Humber Estuary SAC, SPA and Ramsar site (collectively forming the Humber European Marine Site ("EMS"); **Figure 9.2 [TR030008/APP/6.3]**). For the Humber Estuary SAC, the primary reason for designation is the presence of two broad scale habitats, 1130 Estuaries and 1140 Mudflats and sandflats not covered by seawater at low tide (Ref 9-38). These broad scale habitats support other more specific habitats which are qualifying features but not a primary reason for designation. These are:

a. 1110 Sandbanks which are slightly covered by sea water all the time.

b. 1150 Coastal lagoons (identified as a priority feature).

c. 1310 *Salicornia* and other annuals colonizing mud and sand.

d. 1330 Atlantic salt meadows (Glauco-Puccinellietalia maritimae).

e. 2110 Embryonic shifting dunes.

f. 2120 Shifting dunes along the shoreline with *Ammophila arenaria* ('white dunes').

g. 2130 Fixed coastal dunes with herbaceous vegetation ('grey dunes') (identified as a priority feature).

h. 2160 Dunes with *Hippopha rhamnoides*.

9.6.5 Alongside the habitats for which the SAC is designated, there are also three mobile species listed on Annex II of the EU Habitats Directive (92/43/EEC) (the Natural Habitats and Wild Fauna and Flora Directive) included in the designation (Ref 9-38), namely:

a. 1095 Sea lamprey (*Petromyzon marinus)*.

b. 1099 River lamprey (*Lampetra fluviatilis)*.

c. 1364 Grey seal (*Halichoerus grypus*).

9.6.6 Qualifying features of the Humber Estuary SPA and Humber Estuary Ramsar site are shown in **Table 9-9** and **Table 9-10** respectively.

Table 9-9: Qualifying features of the Humber Estuary SPA (Ref 9-39)

Internationally Important Populations	
Internationally Important Populations of Regularly Occurring Annex 1 Species	
Breeding Species Population	
Bittern *Botaurus stellaris*	2 calling males (10.5 % of the GB population)
Marsh Harrier *Circus aeruginosus*	10 breeding females (6.3 % of the GB population)
Avocet *Recurvirostra avosetta*	64 pairs (8.6 % of the GB population)
Little Tern *Sternula albifrons*	51 pairs (2.1 % of the GB population)
Wintering Species Population	
Bittern	4 (4.0 % of the GB population)
Hen harrier *Circus cyaneus*	8 (1.1 % of the GB population)
Bar-tailed Godwit *Limosa lapponica*	2,752 (4.4 % of the GB population)
Golden Plover *Pluvialis apricaria*	30,709 (12.3 % of the GB population)
Avocet *Recurvirostra avosetta*	54 (1.7 % of the GB population)
On passage Species population	
Ruff *Calidris pugnax*	128 (1.4 % of the GB population)

Internationally Important Populations	
Internationally Important Populations of Regularly Occurring Migratory Species	
Wintering Species Population	
Teal† *Anas crecca*	2,322 (<1 % of the population)
Wigeon† *Mareca penelope*	5,044 (<1 % of the population)
Mallard† *Anas platyrhynchos*	2,456 (<1 % of the population)
Turnstone† *Arenaria interpres*	629 (<1 % of the population)
Common Pochard† *Aythya ferina*	719 (<1 % of the population)
Greater Scaup† *Aythya marila*	127 (<1 % of the population)
Brent Goose† *Branta bernicla*	2,098 (<1 % of the population)
Goldeneye† *Bucephala clangula*	467 (<1 % of the population)
Sanderling† *Calidris alba*	486 (<1 % of the population)
Dunlin *Calidris alpina*	22,222 (1.7 % of the Northern Siberia/Europe/Western Africa population)
Red Knot *Calidris canutus*	28,165 (6.3 % of the North-eastern Canada/Greenland/Iceland/North-western Europe population)
Ringed Plover† *Charadrius hiaticula*	403 (<1 % of the population)
Oystercatcher† *Haematopus ostralegus*	3503 (<1 % of the population)
Black-tailed Godwit *Limosa*	1,113 (3.2 % of the Icelandic Breeding population)
Curlew† *Numenius arquata*	3,253 (<1 % of the population)
Grey Plover† *Pluvialis squatarola*	1,704 (<1 % of the population)
Shelduck *Tadorna tadorna*	4,464 (1.5 % of the North-western Europe population)
Redshank *Tringa totanus*	4,632 (3.6 % of the Eastern Atlantic Wintering population)
Northern Lapwing† *Vanellus vanellus*	22,765 (<1 % of population)
On passage Species Population	
Sanderling†	818 (<1 % of the population)
Dunlin	20,269 (1.5 % of the Northern Siberia/Europe/Western Africa population)

Internationally Important Populations	
Red Knot	18,500 (4.1 % of the North-eastern Canada/Greenland/Iceland/North-western Europe population)
Ringed Plover†	1,766 (<1 % of the population)
Black-tailed Godwit	915 (2.6 % of the Icelandic Breeding population)
Whimbrel† *Numenius phaeopus*	113 (<1 % of the population
Grey Plover†	1,590 (<1 % of the population)
Greenshank† *Tringa nebularia*	77 (<1 % of the population)
Redshank	7,462 (5.7 % of the Eastern Atlantic Wintering population)
Internationally Important Assemblage of Waterfowl	
Waterfowl assemblage	153,934 waterfowl
†Species with this symbol do not represent a population that is > 1 % of the international threshold but are included in the waterfowl assemblage.	

Table 9-10: Qualifying marine features of the Humber Estuary Ramsar Site (Ref 9-40)

Ramsar Criterion	
Criterion 1 – natural wetland habitats that are of international importance	
The site is a representative example of a near-natural estuary with the following component habitats: dune systems and humid dune slacks, estuarine waters, intertidal mud and sand flats, saltmarshes, and coastal brackish/saline lagoons.	
Criterion 3 – supports populations of plants and/or animal species of international importance	
The Humber Estuary Ramsar site supports a breeding colony of grey seals *Halichoerus grypus* at Donna Nook. It is the second largest grey seal colony in England and the furthest south regular breeding site on the east coast.	
Criterion 5 – Bird Assemblages of International Importance	
Wintering waterfowl	153,934 waterfowl (5-year peak mean 1998/99-2002/3)
Criterion 6 – Bird Species/Populations Occurring at Levels of International Importance	
Species	Spring/Autumn Population (5-year peak mean 1996-2000)

Ramsar Criterion	
Golden Plover	17,996 (2.2 % of the Iceland & Faroes/East Atlantic population)
Red Knot	18,500 (4.1 % of the West & Southern African wintering population)
Dunlin	20,269 (1.5 % of the West Siberia/West Europe population)
Black-tailed Godwit	915 (2.6 % of the Iceland/West Europe population)
Redshank	7,462 (5.7 % of the population)
Species	Wintering Population (5-year peak mean 1996/7-2000/1)
Shelduck	4,464 (1.5 % of the North-western Europe Population)
Golden Plover	30,709 (3.8 % of the Iceland & Faroes/East Atlantic population)
Red Knot	28,165 (4.1 % of the West & Southern African wintering population)
Dunlin	22,222 (1.7 % of the West Siberia/West Europe population)
Black-tailed Godwit	1,113 (3.2 % of the Iceland/West Europe population)
Bar-tailed Godwit	2,752 (2.3 % of the West Paleartic population)
Criterion 8 – Internationally important source of food for fishes, spawning grounds, nursery and/or migration path	
The Humber Estuary acts as an important migration route for both river lamprey *Lampetra fluviatilis* and sea lamprey *Petromyzon marinus* between coastal waters and their spawning areas.	

9.6.7 The Greater Wash SPA is designated for a range of seabird and diving bird species and is located approximately 20km from the Project. Qualifying features of this site is shown in **Table 9-11**.

Table 9-11: Qualifying marine features of the Greater Wash SPA (Ref 9-41)

Internationally Important Populations	
Internationally Important Populations of Regularly Occurring Annex 1 Species	
Breeding Species Population	
Little Tern *Sternula albifrons*	798 pairs (42% of GB breeding population)
Common Tern *Sterna hirundo*	510 pairs (5.1% of GB breeding population)
Sandwich Tern *Sterna sandvicensis*	852 pairs (35% of GB breeding population)
Wintering Species Population	
Little Gull *Hydrocoloeus minutus*	1,255 (no current GB population estimate)
Red-throated Diver *Gavia stellata*	1,407 (8.3% of GB non-breeding population)
Internationally Important Populations of Regularly Occurring Migratory Species	
Common Scoter *Melanitta nigra*	3,449 (0.6% of biogeographic population)

9.6.8 The Humber Estuary Site of Special Scientific Interest ("SSSI") overlaps part of the Project site. This is designated for its nationally important habitat assemblage (intertidal mudflats and sandflats, and coastal saltmarsh) geological interest, importance to breeding, wintering and passage birds, breeding grey seal and the presence of river and sea lamprey.

9.6.9 North Killingholme Haven Pits SSSI is located approximately 5km away from the Project. This site comprises saline lagoon habitats and supports important populations of waders including Black-tailed Godwits and Redshank. The Lagoons SSSI is located approximately 20km from the Project and supports a variety of coastal habitats (such as saline lagoons and sand dunes) as well as a population of breeding Little Terns.

9.6.10 The Holderness Inshore MCZ is the nearest MCZ to the Project (located approximately 20km away). The site is designated for intertidal sand and muddy sand as well as a variety of subtidal rock and sedimentary habitats.

9.6.11 The nearest Local Nature Reserve ("LNR") is Cleethorpes Sands LNR (located approximately 13km south east of the Project) which supports a variety of intertidal and coastal habitats.

Protected species

9.6.12 The Wildlife and Countryside Act 1981 (as amended) ("WCA") protects various animals, plants, habitats in the UK. Relevant protected WCA species recorded in the Humber Estuary region include:

a. The tentacled lagoon worm *Alkmaria romijni*.

b. The lagoon sand shrimp *Gammarus insensibilis*.

c. Twaite shad *Alosa fallax* and allis shad *Alosa alosa*.

d. Cetacean (whale and dolphin) species.

e. All bird species.

9.6.13 Marine species are also protected from being killed, injured or disturbed both inside and outside designated sites under the provisions of the Habitats Directive. Of relevance to the Humber Estuary are:

a. Common seal *Phoca vitulina* and grey seal *Halichoerus grypus* (listed in Annex II and V).

b. Bottlenose dolphin *Tursiops truncatus* and harbour porpoise *Phocoena phocoena* (listed in Annex II and IV).

c. Sea lamprey *Petromyzon marinus* (listed in Annex II) and river lamprey (listed in Annex II and V).

d. Twaite shad *A. fallax* and allis shad *A. alosa* (listed in Annex II and V).

e. Atlantic salmon *Salmo salar* (listed in Annex II and V).

9.6.14 Seals are also protected under the Conservation of Seals Act 1970.

9.6.15 In addition, some marine fauna and habitats are listed as priority species and habitats of principle importance in England, as required under Section 41 of the NERC Act 2006. Species of principal importance which are of relevance to the Humber Estuary include various species of waterbird, commercial fish (such as cod *Gadus morhua* and herring *Clupea harengus*), migratory fish (such as lampreys, European smelt *Osmerus eperlanus*, Atlantic salmon and European eel *Anguilla anguilla*).

9.6.16 Habitats of principle importance which are of relevance to the Humber Estuary include intertidal mudflats, coastal saltmarsh, saline lagoons and sand dunes. Based on the current geographic extent and location of habitats of principal importance under Section 41 of the NERC Act 2006 that are publicly available on the MAGIC website (Ref 9-19), the proximity of these coastal and intertidal habitats to the Project are described below:

a. Mudflats: The intertidal habitat directly overlaps the footprint of the Project.

b. Coastal saltmarsh: The nearest saltmarsh habitat is located over 3km to the northwest of the Project.

c. Coastal sand dunes: The nearest coastal sand dunes within the Humber SAC are located more than 12km southwest of the Project at Cleethorpes.

d. Saline lagoons: The nearest coastal lagoon habitat within the Humber Estuary is located approximately 5km from the Project at Killingholme.

9.6.17 European eels are also afforded protection as part of the Eels (England and Wales) Regulations 2009 (Ref 9-13). The regulations which apply to all freshwater and estuarine waters of England and Wales give powers to statutory bodies to implement measures for the recovery of European eel stocks including improving access, habitat quality and easing fishing pressure.

Benthic habitats and species

Humber Estuary overview

9.6.18 The Humber Estuary supports a wide variety of marine habitats including intertidal mudflats and sandflats, intertidal seagrass beds, coastal lagoons, saltmarsh, reedbeds, subtidal sandbanks and mixed sediment habitats (Ref 9-42; Ref 9-43; Ref 9-44).

9.6.19 The intertidal area of the Humber Estuary is extensive, covering approximately 10,000 ha, of which more than 90 % is mudflat and sandflat (Ref 9-45). The largest areas of mudflat occur in the outer Humber Estuary at Spurn Bight and Pyewipe, at Foul Holme and Skitter Sand in the mid Humber Estuary and across most of the Estuary width in the inner estuary above the Humber Bridge. This habitat changes from moderately exposed sandy shores at the mouth of the Humber Estuary to sheltered muddy shores within the main body of the Estuary and up into the tidal rivers. The mid and upper Humber Estuary is characterised by fringing reedbeds *Phragmites australis* on the upper shore while saltmarshes are present along the north bank and on the Lincolnshire coast east of Cleethorpes (Ref 9-45; Ref 9-20; Ref 9-21; Ref 9-44).

9.6.20 The subtidal area of the Humber Estuary is approximately 16,800 ha in extent (Ref 9-45). The subtidal environment of the Humber Estuary is highly dynamic and varies according to the composition of the bottom sediments, salinity, sediment load and turbidity and dissolved oxygen. Many of these factors vary with the season or state of the tide. Subtidal sand (including muddy sand) is the predominant subtidal sediment type in the Humber Estuary. The high mobility of sediments and high turbidity means that this habitat is typically relatively impoverished with a limited fauna characterised by very low densities of opportunistic species and species adapted to these conditions (Ref 9-20; Ref 9-21; Ref 9-45).

9.6.21 Invasive marine species known to occur in the Humber Estuary region include slipper limpet *Crepidula fornicata*, Chinese mitten crab *Eriocheir sinensis*, Pacific oyster *Magallana gigas* and acorn barnacle *Austrominius modestus* (Ref 9-43; Ref 9-24; **Appendix 9.A [TR030008/APP/6.4]**).

Intertidal habitats and species in the Port of Immingham area

9.6.22 Intertidal benthic surveys undertaken in the Port of Immingham area in 2021 recorded sandy mud habitat with the number of taxa found in the samples ranging from four to 15. The number of individuals was also highly variable and ranged from 1,100 organisms per m² to 40,600 organisms per m². The samples were predominantly characterised by nematodes, the oligochaetes *Tubificoides benedii* and Enchytraeidae spp., the mud shrimp *Corophium volutator*, the mudsnail *Peringia ulvae*, Baltic tellin *Limecola balthica* as well as the polychaetes *Hediste diversicolor* and *Pygospio elegans* recorded in the samples. These species dominated the assemblage and contributed almost entirely to the total abundances of organisms recorded at most of the sites surveyed.

9.6.23 The assemblage recorded was considered typical of the community recorded on mudflats in the nearby area (Ref 9-23; Ref 9-24; Ref 9-22). For example, intertidal surveys at North Killingholme (located approximately 3km from the Project) in 2015 and 2016 also recorded a benthic assemblage characterised by species such as *Corophium volutator, Tubificoides benedii, Pygospio elegans, Hediste diversicolor, Limicola balthica* and nematodes with a broadly similar total number of individuals in the samples (up to around 50,000 organisms per m²) (Ref 9-22).

9.6.24 Many of the species recorded in the samples are considered prey species for coastal waterbirds such as polychaetes, Baltic tellin *Limecola balthica*, mudsnail *Peringia* spp. and mudshrimp *Corophium* spp. (Ref 9-55; Ref 9-56).

Project specific subtidal benthic surveys

9.6.25 In order to characterise the subtidal benthic communities present in the vicinity of the Project, subtidal sampling was undertaken in July 2022.

9.6.26 At each station, a sample was analysed for macrofaunal analysis (faunal composition, abundance and biomass), PSA and TOC.

9.6.27 The results of these project specific benthic surveys are summarised below in **Table 9-12** with the methods and results described in more detail in **Appendix 9.A [TR030008/APP/6.4]**.

9.6.28 The sediment from samples collected from the area consisted of mud and sandy mud. The TOC in the samples ranged between approximately 3 % and 6 %.

9.6.29 The samples collected were highly impoverished with the number of taxa found in the samples ranging from one (Station 3) to eight (Station 1), and the number of individuals from 10 organisms per m² (Station 3) to 190 organisms per m² (Station 1). The range in total species biomass in the samples was between <1 and 1.8 grams per m².

9.6.30 The faunal samples were characterised by low numbers of species (occurring in low abundances) including polychaetes (such *Nephtys* spp, *Streblospio shrubsolii* and *Scoloplos armiger*), nematodes, oligochaetes *Tubificoides* spp and crustacean *Diastylis rathkei*. All the species recorded from the samples in this area were considered commonly occurring in the region and not protected.

9.6.31 The faunal assemblage recorded is considered characteristic of subtidal habitats in this section of the Humber Estuary. For example, subtidal benthic surveys undertaken in the Immingham area in 2009, 2010, 2016 and 2021 predominantly recorded mud or muddy sand habitat which was generally impoverished (with a low number of taxa occurring at the majority of sites). The most commonly recorded infaunal species (generally recorded in low abundances) were the polychaetes *Capitella capitata*, *Streblospio shrubsolii, ,Pygospio elegans, Polydora cornuta*, oligochaetes *Tubificoides* spp., mud shrimp *Corophium volutator*, and nematodes (Ref 9-23; Ref 9-24; Ref 9-22).

Subtidal habitats and species at the disposal site

9.6.32 Dredge material will be deposited at either the Clay Huts disposal site (HU060) or Holme Channel disposal site (HU056).

9.6.33 Benthic surveys undertaken in 2021 within and near to Clay Huts disposal site (HU060) recorded predominantly sand habitat with the samples characterised by a wide range of species but typically in low abundances including nematodes, barnacle *Amphibalanus improvises*, polychaetes (such as *Pygospio elegans* and *Arenicola* spp.) and the amphipod *Corophium volutator*. Benthic sampling at the Holme Channel disposal site (HU056) recorded sand, gravelly sand and sandy gravel habitat with a highly impoverished assemblage characterised by low abundances of a few species (the amphipod *Corophium volutator*, mysid shrimp *Gastrosaccus spinifer*, bryozoan *Electra monostachys* and springtails *Collembola* spp.) (Ref 9-23).

Table 9-12: Subtidal benthic survey results

Station	Sediment Type	TOC (%)	No. of Taxa (per m²)	No. of Individuals (per m²)	Total Biomass (g per m²)	Key Characterising Species (Number per m² Shown in Brackets)
1	Mud	6.45	8	190	0.02	*Tubificoides swirencoides* (60) *Nephtys* spp (40) *Diastylis rathkei* (20) Nematoda (20) *Streblospio shrubsolii* (20) *Corophium volutator* (10) *Macoma balthica* (10) *Nephtys hombergii* (10)
2	Mud	6.34	2	30	0.05	Nematoda (20) *Diastylis rathkei* (10)
3	Mud	5.37	1	10	<0.01	*Streblospio shrubsolii* (10)
4	Sandy Mud	4.38	2	120	0.06	*Nepthys* spp (110) *Diastylis rathkei* (10)

Station	Sediment Type	TOC (%)	No. of Taxa (per m²)	No. of Individuals (per m²)	Total Biomass (g per m²)	Key Characterising Species (Number per m² Shown in Brackets)
5	Sandy Mud	3.07	2	70	0.03	*Nepthys* spp (60) *Scoloplos armiger* (10)
6	Sandy Mud	3.77	5	100	1.79	*Nepthys* spp (60) *Arenicola marina* (10) *Austrominius modestus* (10) *Scoloplos armiger* (10)
7	Sandy Mud	4.50	3	80	0.11	*Nepthys* spp (40) *Diastylis rathkei* (20) Nematoda (20)
8	Sandy Mud	3.67	4	110	0.03	*Nepthys* spp (80) *Mytilus edulis* (10) Nematoda (10) *Tubificoides swirencoides* (10)

Fish

Humber Estuary overview

9.6.34 The Humber Estuary contains a varied fish fauna, totalling over 80 species with the majority common to most UK estuaries. The Humber Estuary fish assemblage comprises resident, nursery, seasonal and migratory species, typical of estuarine fish communities (Ref 9-57; Ref 9-58).

9.6.35 In general, the abundance and diversity of fish increases towards the mouth of the estuary. The outer reaches are characterised by a community dominated by inshore marine species such as whiting *Merlangius merlangus*, cod *Gadus morhua*, plaice *Pleuronectes platessa* and Dover sole *Solea solea*. The middle and upper reaches of the estuary support more euryhaline species including flounder *Platichthys flesus*, European eel *Anguilla anguilla*, gobies and sprat *Sprattus sprattus* (Ref 9-59; Ref 9-58).

9.6.36 The Humber Estuary supports a fish assemblage typical of other estuaries in north western Europe. However, a higher fish diversity than recorded in other estuaries in the UK has been found which may be due to the large catchment area and high fluvial flow allowing freshwater taxa to actively or passively occur in greater numbers into this estuary (Ref 9-60).

9.6.37 The baseline review presented in this chapter has primarily focused on key species which are of either commercial and/ or conservation importance. The functional guilds for estuarine fish used in Ref 9-57 which were based on published guild definitions (Ref 9-61; Ref 9-62) have been used to help summarise the life history and ecology of fish species occurring in the Humber Estuary, as follows:

a. Diadromous species (“D”): Species using estuaries as pathways of migration (for reproduction) between freshwater and the sea; migration from freshwater to sea water to breed (catadromous species, e.g. eel), and in the opposite direction (anadromous species, e.g., salmonids and lampreys).

b. Marine migrant species (“MM”): Marine species that spawn at sea and regularly enter estuaries in large numbers, thus having a temporary residence in the estuarine habitat; they usually are highly euryhaline species, able to move throughout the full length of the estuary, and spending much of their life within estuaries, using these habitats as nursery grounds or visiting them regularly at sub-adult and adult life stages.

c. Estuarine resident species (“ES”): Species that are able to reproduce and complete their life cycle in the estuary; as such they are highly euryhaline species, able to move throughout the full length of the estuary.

d. Marine straggler species (“MS”); Marine species usually associated with coastal marine waters but entering estuaries accidentally in low numbers. These are predominantly stenohaline species, occurring most frequently in the lower sections of the estuary.

e. Freshwater species (“F”): Species of freshwater origin that regularly or accidentally enter estuaries, in moderate to low numbers, moving varying distances down the estuary but often restricted to low-salinity, upper reaches of estuaries and to periods of freshwater flooding.

9.6.38 Table **9-13** provides a summary of species that have been recorded in the Humber Estuary (based on Ref 9-57) with further information on key species within each ecological guild provided below.

Table 9-13: Fish recorded in the Humber Estuary, grouped by ecological guilds.

Ecological guild	Species name	Common name	Ecological guild	Species name	Common name
Diadromous (D)	*Alosa alosa*	Allis shad	Marine stragglers (MS)	*Hyperoplus immaculatus*	Greater sandeel
	Alosa fallax	Twaite shad		*Hyperoplus lanceolatus*	Great sandeel
	Osmerus eperlanus	Smelt		*Callionymus lyra*	Dragonet
	Lampetra fluviatilis	River lamprey		*Taurulus bubalis*	Long-spined sea scorpion
	Petromyzon marinus	Sea lamprey		*Pollachius virens*	Coley / Saithe / Coalfish
	Salmo salar	Atlantic salmon		*Trisopterus minutus*	Poor cod
	Salmo trutta	Brown / sea trout		*Melanogrammus aeglefinus*	Haddock
	Gasterosteus aculeatus	3-spined stickleback		*Crystallogobius linearis*	Crystal goby
	Liza ramada	Thinlip mullet		*Pomatoschistus lozanoi*	Lozano's goby
	Anguilla	European eel		*Liparis montagui*	Montagu's seasnail
Marine migrants (MM)	*Atherina presbyter*	Sand smelt		*Gaidropsarus mediterraneus*	Shore rockling
	Clupea harengus	Atlantic herring		*Mullus surmuletus*	Striped red mullet
	Sprattus sprattus	Sprat		*Glyptocephalus cynoglossus*	Witch flounder
	Cyclopterus lumpus	Lumpsucker		*Microstomus kitt*	Lemon Sole

Ecological guild	Species name	Common name	Ecological guild	Species name	Common name
	Gadus morhua	Atlantic cod		*Scomber scombrus*	Mackerel
	Merlangius merlangus	Whiting		*Scophthalmus rhombus*	Brill
	Pollachius	Pollack		*Scyliorhinus* sp.	Spotted dogfish
	Trisopterus luscus	Pouting / Bib		*Buglossidium luteum*	Solenette
	Ciliata mustela	5-bearded rockling		*Entelurus aequoreus*	Snake pipefish
	Dicentrarchus labrax	Sea bass		*Echiichthys vipera*	Lesser weever
	Chelon labrosus	Thick lipped grey mullet		*Chelidonichthys cuculus*	Red gurnard
	Liza aurata	Golden grey and	Freshwater species (F)	*Cobitis taenia*	Spined loach
	Limanda limanda	Dab		*Abramis brama*	Common bream
	Platichthys flesus	Flounder		*Alburnus alburnus*	Common bleak
	Pleuronectes platessa	Plaice		*Blicca bjoerkna*	Silver bream
	Scophthalmus maximus	Turbot		*Carassius auratus*	Goldfish
	Solea solea	Dover sole		*Rutilus rutilus*	Roach
	Chelidonichthys lucernus	Tub gurnard		*Scardinius erythrophthalmus*	Rudd
	Eutrigla gurnardus	Grey gurnard		*Squalius cephalus*	Chub

Ecological guild	Species name	Common name	Ecological guild	Species name	Common name
Estuarine residents (ES)	*Agonus cataphractus*	Hooknose / Pogge		*Tinca tinca*	Tench
	Ammodytes tobianus	Lesser sandeel		*Gobio gobio*	Gudgeon
	Myoxocephalus scorpius	Shorthorn sculpin		*Leuciscus cephalus*	Chub
	Raniceps raninus	Tadpole-fish		*Leuciscus leuciscus*	Dace
	Aphia minuta	Transparent goby		*Rutilus x Alburnus alburnus*	Roach x Common bleak hybrid
	Pomatoschistus microps	Common goby		*Scardinius erythrophthalmus x Abramis brama*	Rudd x Common bream hybrid
	Pomatoschistus minutus	Sand goby		*Esox lucius*	Pike
	Liparis liparis,	Sea-snail		*Pungitius pungitius*	10-spined stickleback
	Pholis gunnellus	Rock gunnel		*Perca fluviatilis*	Perch
	Syngnathus acus	Greater pipefish		*Gymnocephalus cernuus*	Ruffe
	Syngnathus rostellatus	Lesser (Nillsons) pipefish			
	Zoarces viviparus	Viviparous blenny			

Source: Ref 9-57.

Marine migrant species

9.6.39 With respect to demersal fish considered to be marine migrant species, the Humber Estuary is considered to be an important nursery ground for several commercially important gadoids including whiting *Merlangius merlangus* and cod *Gadus morhua* (**Figure 9.3 [TR030008/APP/6.3]**). These species are typically the most abundant gadoids occurring in the Humber Estuary (Ref 9-28; Ref 9-57). Further information on the ecology of these species is provided in **Table 9-14**. Other gadoids commonly occurring include pouting *Trisopterus luscus* and pollack *Pollachius pollachius*.

9.6.40 A range of flatfish species are commonly recorded in the Humber Estuary region with flounder *Platichthys flesus* considered to be the most commonly occurring species. Nursery grounds for the commercially important Dover sole *Solea solea* and plaice *Pleuronectes platessa* occur in the region with these species also commonly occurring. Spawning grounds for Dover sole also occur in the region (**Table 9-14** and **Figure 9.3 [TR030008/APP/6.3]**). In addition, dab *Limanda limanda* and turbot *Scophthalmus maximus* are also recorded.

9.6.41 With respect to pelagic marine migrant species (free-swimming fish that inhabit the mid-water column), the clupeids sprat *Sprattus sprattus* and herring *Clupea harengus* are the most commonly occurring species. The Humber Estuary is considered to be nursery ground for herring (**Figure 9.3 [TR030008/APP/6.3]**). These pelagic species tend to have little association with the seabed and as a result are often distributed over widespread and indistinct grounds, often forming large shoals. Sea bass *Dicentrarchus labrax* is also frequently recorded in the Humber Estuary. Further information on the ecology of these species is provided in **Table 9-14**.

Table 9-14: Background information on the most commonly recorded marine migrant species occurring in the Humber Estuary

Species	Ecology
Whiting	In the Humber Estuary, whiting is recorded throughout most of the year with the highest abundances typically occurring in autumn. Most individuals recorded are juveniles, suggesting the Humber Estuary is predominantly used as a nursery ground.
Cod	In the Humber Estuary, the species occurs throughout most of the year but at lower frequency in the spring and summer. Cod is rarely recorded in intertidal and shallow subtidal habitats within the Humber Estuary. Most individuals recorded are juveniles, suggesting the Humber Estuary is predominantly used as a nursery ground. Spawning occurs offshore between January and April, peaking during February, with spawning grounds in the North Sea usually located in the pelagic zone at depths between 20 m and 100 m.

Species	Ecology
Flounder	Flounder occurs year-round in the Humber Estuary but with higher abundance typically recorded in late spring and summer. This species occurs in inshore waters to depths of 50 m and commonly reported using estuarine systems as nurseries. In the North Sea, the species generally spawn in spring in deeper marine waters, and larvae and early juveniles use selective tidal transport to migrate upstream to estuaries and rivers hence it may be regarded as semi-catadromous.
Dover sole	In the Humber Estuary, sole is recorded throughout most of the year with juvenile sole generally appearing in the Humber Estuary during the late spring and summer, after larvae and juveniles are transported here from adjacent coastal spawning areas by tidal currents. In the North Sea, the species generally reproduces in spring (March to late June, with a peak in April) in coastal waters, with spawning areas along the East coast of England from the Humber Estuary down to the Norfolk coast. In the North Sea, the nurseries are in shallow (< a few metres deep) sandy or muddy bottoms.
Plaice	Plaice occur throughout most of the year in the Humber Estuary with juveniles mainly recorded, suggesting the Humber Estuary is predominantly used as a nursery ground. Plaice spawn between January and April (with peak densities on spawning grounds in May). Spawning grounds in the UK are generally located at between 20m and 40m water depth with spawning grounds for plaice occurring in the marine areas near the mouth of the Humber Estuary. Plaice is a marine flatfish that uses estuarine habitats as nursery grounds. Plaice live mostly on sandy bottoms, although it can also be found on gravel and mud and on sandy patches in rocky areas, habitats and coastal zones as nursery grounds.
Dab	Dab occurring in the Humber Estuary are mainly juveniles, which suggests the estuary is predominantly used as a nursery ground. Dab spawn from January to June in the North Sea) with adults migrating to deeper waters between May and September.
Herring and sprat	Both sprat and herring occur in the Humber Estuary throughout most of the year but with a lower frequency in the spring and higher frequency in autumn (herring) and winter (sprat). Most individuals of both species recorded are juveniles or young individuals. Sprat is very abundant in the shallow coastal and estuarine areas of the North Sea in winter before spawning offshore between May and August in the North Sea. Herring spawn in shoals on coarse sand, gravel, shells and small stones in shallow water between 15 to 40m depth. Herring are demersal spawners, depositing their sticky eggs on coarse sand, gravel, small stones and rock. Young herring spend some time in the inshore areas before migrating offshore to join the adult population. Stocks that spawn in spring tend to use inshore spawning grounds whilst autumn and winter spawners tend to move offshore using the edges of ocean banks (e.g. around the Dogger Bank and off the Northumberland and Yorkshire coasts).
Sea bass	The occurrence of the sea bass in the Humber Estuary is typically sporadic. Data suggests that the estuary is predominantly used by juvenile/young stages, although the typically low frequency and abundance of the species suggest that the Humber Estuary is not an important nursery ground for sea bass.

Source: Ref 9-57; Ref 9-26; Ref 9-28; Ref 9-29.

Estuarine resident fishes

9.6.42 The sand goby *Pomatoschistus minutus* is the most frequently recorded goby species in the Humber Estuary, with common goby *P. microps* and the transparent goby *Aphia minuta* also occurring.

9.6.43 Sand gobies are frequently encountered in all areas of the estuary, but mainly in shallow intertidal areas in sandy and muddy habitats. Spawning occurs in shallow waters over an extended period, mostly during the spring and summer (sand goby spawn in summer while common goby spawn after their first winter between February and September, depending on the latitude), with multiple batches of eggs laid during this season (batch spawner).

9.6.44 Other estuarine resident species occurring in the Humber Estuary include lesser sandeel *Ammodytes tobianus*, hooknose *Agonus cataprachus*, tadpole fish *Raniceps raninus*, sea snail *Liparis liparis*, rock gunnel *Pholis gunnellus,* pipefish (greater pipefish *Sygnathus acus* and lesser pipefish *S. rostellatus*), and the viviparous blenny *Zoarces viviparus*.

Marine stragglers and freshwater species

9.6.45 Marine stragglers occur relatively infrequently with species recorded including the lesser weever *Echiichthys vipera* and dragonet *Callionymus lyra*.

9.6.46 The most commonly recorded freshwater species recorded in the Humber Estuary are roach *Rutilus rutilus* and common bream *Abramis brama* with other freshwater species recorded including and silver bream *Blicca bjoerkna* and rudd *Scardinius erythrophthalmus.* These species are typically recorded in the upper and mid sections of the Humber Estuary.

Diadromous migratory fish

9.6.47 Diadromous migratory fish (species migrating between freshwater and seawater) which occur in the Humber Estuary include salmonids (Atlantic salmon *Salmo salar* and sea trout *Salmo trutta*), lampreys (river lamprey *Lampretra fluviatilis* and sea lamprey *Petromyzon marinus*), European eel *Anguilla anguilla*, shads (allis shad *Alosa alosa* and twaite shad *Alosa fallax*) and European smelt *Osmerus eperlanus*. Of these species, European eel, European smelt and river lamprey have been the species most commonly recorded in sampling in the Humber Estuary (Ref 9-57). These species are all afforded protection under various legislation as described above.

9.6.48 Further information on the ecology and migration of these species is provided in **Table 9-15**.

Table 9-15: Background information on the ecology and distribution of diadromous migratory fish

Species	Ecology
European eel	European eel is a catadromous species which migrates to the marine environment (Sargasso Sea) to spawn. The larvae (leptocephali) then drift in the Gulf Stream and then North Atlantic Drift current for two to three years across the Atlantic Ocean to Europe and metamorphose into juveniles (elvers). The eels usually migrate into freshwater where they remain for many years. However, not all eels migrate into freshwater and some, predominantly males, remain in inshore coastal areas. The adults, commonly referred to as 'silver eels' during the spawning migration, leave river systems to return to the Sargasso Sea. The European Eel is widely distributed in the Humber catchment, although it is absent from the upper reaches of some rivers. In the Humber catchment, glass eels/elvers generally immigrate in spring and early summer, whereas the majority of silver eel emigrate in late summer and autumn. Eels are typically present in the Humber Estuary in the spring and summer. There is evidence that glass eels migrate upstream using 'Selective Tidal Stream Transport' whereby individuals with low locomotive capability, such as glass eels, move into the water column during flood tides to move up estuaries toward freshwater, typically remaining on or in the bottom substrate on ebb tides to avoid currents. Glass eel behaviour can be influenced by light levels, and although glass eels do migrate during the day there is an increase in activity during the night time, particularly in the first hours of darkness, when they also distribute closer to the surface. Some research suggests an increased abundance in glass eel catches during the new moon phase, but not the full moon, despite the fact that the tidal amplitude during both periods is similar. This could potentially be explained by the influence of light intensity on migration patterns. This effect of the lunar cycle and hence moonlight intensity is modulated by cloud cover and turbidity; therefore, one consequence is the fact that any lunar effect is not usually observed in highly turbid estuaries (Ref 9-127).
European smelt	The European smelt is a small anadromous species, widely distributed throughout the Atlantic and European waters, that migrates from estuaries and coastal waters into the lower reaches of rivers to spawn in early spring. Data suggests that the highest densities of smelt in the Humber Estuary occur in the spring and summer. The spawning migration starts in September to October, when mature fishes aggregate in estuaries to overwinter. Upriver migration starts in March to April when temperatures rise above 4 to 6°C and during rainy and stormy weather. Adult smelt generally enter the tidal Trent and Ouse from the Humber Estuary in early March and presumably return to the estuary after spawning.
River and sea lamprey	The river lamprey and the sea lamprey are both anadromous species, spawning in freshwater but completing part of their lifecycle in estuaries or at sea. The sea lamprey adult growth phase is short and lasts around two years. In this time, the species is parasitic, feeding on a variety of marine and anadromous fishes, including shad and salmon as well as herring, cod, haddock and basking sharks *Cetorhinus maximus.* Unlike sea lamprey, the growth phase of river lamprey is primarily restricted to estuaries. River lamprey have been frequently recorded in the Humber Estuary, with the Ouse catchment believed to support one of the

Species	Ecology
	most important river lamprey populations in the UK. In the Humber basin, river lamprey mainly enters the rivers from the estuary in autumn and then spawn in April. Sea lamprey spawning is almost entirely restricted to the Ouse catchment, principally the Rivers Ouse, Swale, Ure and Wharfe. The spawning migration of sea lamprey usually takes place in April and May when the adults start to migrate back into freshwater. The upstream migration of river lamprey takes place almost exclusively at night, with adults being sedentary and resting under rocks and riverbanks during the day.
Shads	The twaite and allis shad are anadromous species. Mature allis shad, having spent most of their lives in the sea stop feeding and move into the estuaries of large rivers, migrating into freshwater during late spring (April to June). Adult twaite shad stop feeding at sea and gather in the estuaries of suitable rivers in early summer (April and May), moving upstream to spawn from mid-May to mid-July. Within the Humber Estuary, most records of allis shad were juveniles while twaite shad adults.
Atlantic salmon and sea trout	Atlantic salmon and sea trout are anadromous species which migrate to freshwaters to spawn, whilst spending much of their life in the marine environment. They spawn in upper reaches of rivers, where they live for one to three years before migrating to sea as smolts. Atlantic salmon and sea trout smolts move out of the rivers and migrate downstream to the sea in spring, with the main movements occurring between April and June. At sea, salmon grow rapidly and after one to three years return to their natal river to spawn. The majority of adult salmon return to their natal rivers in autumn, although a small proportion returns in the spring and summer. In the Humbler catchment, Atlantic salmon has been mainly recorded from the upper reaches of the Ouse with brown/sea trout widespread in the upper reaches of the Humber catchment. In the Humber Estuary, most Atlantic salmon and sea trout have been recorded in the spring months between April and June and have been of smolt size.

Sources, Ref 9-57 Ref 9-127; Ref 9-127; Ref 9-128.

9.6.49 In summary**,** existing data suggests that the Humber Estuary supports a wide range of fish species including commonly occurring estuarine species and migratory species including diadromous fish. The Humber Estuary is also considered an important nursery ground for a range of commercially important fish species.

Immingham area

9.6.50 Fish data collected as part of intertidal fyke net and subtidal beam trawl surveys undertaken in May/June 2010 at sites located approximately 3 to 4km from the Project (between the Humber Sea Terminal and the Port of Immingham) has also been reviewed; despite the vintage of these data, they provide an indication of species which may be present (Ref 9-24)[4].

[4] A fyke net is a type of fish trap. It consists of long cylindrical netting bag usually with several netting cones fitted inside the netting cylinder to make entry easy and exit difficult. This fishing methods typically target demersal fish species.

9.6.51 The intertidal sampling (fyke netting) catch was dominated by flatfish species (flounder and sole) which consisted of 1+group flounder (born the year before) and mostly 0+ group sole, which suggested the area is used as a flatfish nursery. Single individuals of pollock, five-bearded rockling *Ciliata Mustela* and sand goby were also recorded (due to the small size of sand goby, this fish is normally misrepresented in fyke net catches).

9.6.52 Sand gobies and sole were the most abundant species recorded in the subtidal sampling (beam trawls) with other species recorded in lower abundances including whiting, five-bearded rockling and river lamprey. Sole caught in the subtidal survey were significantly larger than the specimens from the fyke nets. This is consistent with earlier research by Cefas that analysed annual 2m beam trawl and 1.5m push net survey data from the period 1981 to1995 and found that 0-group sole were highest in the 2m to 5.9m depth band (Ref 9-63).

9.6.53 The results of the most recently available Environment Agency TraC fish monitoring for the sites nearest the Project (seine netting/beam trawls at Foulholme Sands and otter trawls at Burcom) are summarised in **Table 9-16**. Beach seine netting targets both demersal and pelagic species occurring in shallow inshore locations. Beam and otter trawls target demersal species[5]. The Foulholme Sands surveys were undertaken twice a year in the spring and autumn with the Burcom surveys annually in the early winter. These monitoring sites are located approximately 3km to 5km from the Project and are shown in **Figure 9.4 [TR030008/APP/6.3]**. Data was available up to 2017 for Foulholme Sands and up to 2019 for Burcom (Ref 9-27).

Table 9-16: The total number of fish caught in fish surveys undertaken at Burcom and Foulhome Sands between 2013 and 2019

Species	Burcom Otter Trawl*	Foulhome Sands Beam Trawl**	Foulhome Sands Seine Net***
3-spined stickleback	-	1	41
5-bearded rockling	7	-	1
Bullrout / Short-spined sea scorpion	6	-	-
Cod	150	-	-
Common goby	7	-	8
Dab	48	-	
Dover sole	515	38	125
Dragonet	-	1	-

[5] These bottom trawls would only accidentally capture pelagic species (such as sprat or sea bass).

Species	Burcom Otter Trawl*	Foulhome Sands Beam Trawl**	Foulhome Sands Seine Net***
Flounder	81	48	63
Herring	14	4	205
Hooknose / Pogge	7	4	-
Lesser (Nillsons) pipefish	-	53	222
Lesser sandeel	-	1	-
Lesser weever	-	-	1
Plaice	4	114	1303
River lamprey	1	-	-
Sand goby	1220	21	752
Sea bass	-	1	35
Sea-snail	21	-	
Smelt	3	-	74
Sprat	9	-	20
Thin lipped grey mullet	-	-	9
Thornback ray/Roker	2		-
Turbot	-	-	4
Viviparous blenny	1	-	6
Whiting	164	10	45

* Surveys undertaken between 2013 and 2019.

** Surveys undertaken between 2014 and 2017.

*** Surveys undertaken between 2013 and 2017.

9.6.54 In summary, the most abundant species recorded in the surveys summarised in **Table 9-16** were sand gobies, the flatfish species plaice and Dover sole, the pelagic species herring and the gadoids whiting and cod. Other commonly occurring species recorded included the diadromous European smelt, flounder, 3-spined stickleback, dab and sprat. The results are consistent with data for the wider Humber Estuary region (described above) which suggests that these species are some of the most commonly occurring species in the region. In

addition, of note was a single individual River lamprey recorded in the Burcom Otter Trawl.

9.6.55 While these surveys do not overlap specifically with the Project, they are considered broadly representative of the fish assemblage that could be present within the dredge footprint and surrounding local area. This is because the surveys have used a variety of techniques to target different habitats within both the intertidal and subtidal. The TrAC surveys are also relatively contemporary and cover a range of seasons.

Marine mammals

Humber Estuary overview

Seals

9.6.56 The most commonly occurring marine mammals recorded in the Humber Estuary region are seals with populations of both grey seal *Halichoerus grypus* and common (harbour) seal *Phoca vitulina* occurring. Further information about the abundance and distribution of these species is provided below followed by a description of cetacean (whale, dolphin and porpoise) species occurring in the region.

9.6.57 The intertidal area at Donna Nook is the main haul out site in the region and is an important breeding ground for grey seals. This colony is located over 25km from the Project at the mouth of the Humber Estuary. In 2019, there were an estimated 67,789 grey seal pups born in Britain (Ref 9-64) with approximately 3% of the pup production occurring at Donna Nook. Breeding occurs once a year between October and December and the vast majority of seals in this colony breed at Donna Nook, with a few seals breeding on Skidbrooke Ridge, south of Donna Nook. Peak grey seal pup numbers in winter 2021/22 and 2020/21 at Donna Nook consisted of two, 122 and 2,214 seals respectively with numbers having increased substantially in recent years from under 100 pups born annually in the 1980s (see **Figure 9.5 [TR030008/APP/6.3]**).

9.6.58 The intertidal mudflats also provide an important habitat throughout the year for grey seals to haul out or rest, particularly during the spring when all grey seals (except young born the previous year) are moulting. Aerial seal counts undertaken in August 2021 recorded 3,897 grey seals hauled out at Donna Nook. Total numbers at this colony have increased from the low hundreds recorded in the late 1990s and early 2000s to counts over 4000-6,000 seals in more recent years (Ref 9-64) (see **Figure 9.6 [TR030008/APP/6.3]).**

9.6.59 Grey seals can undertake wide ranging seasonal movements over several thousand kilometres (Ref 9-65; Ref 9-34; Ref 9-35). However, while grey seals may range widely between haul out sites, tracking has shown that most foraging probably occurs within 100km of a haul-out site (Ref 9-36). Seals tagged at Donna Nook were recorded undertaking wide ranging movements in the outer Humber Estuary and approaches as well as more widely in the North Sea (Ref 9-35). This is reflected in high predicted at-sea densities of grey seals in the approaches to the Humber Estuary (Ref 9-34).

9.6.60 The Humber Estuary region also supports a small population of common seal. As for the grey seal, Donna Nook is also the key haul out site for common seals. A total of 122 common seals were recorded as part of annual aerial monitoring in the region in August 2021. Since the 1990s numbers have generally fluctuated between 100 and 400 counts annually in the region (Ref 9-36). Common seals typically forage within 40 km to 50 km of haul out sites (Ref 9-36).

Cetaceans

9.6.61 While over ten species of cetacean have been recorded in the southern and central North Sea, only harbour porpoise *Phocoena phocoena* is considered as regularly occurring throughout most of the year (Ref 9-30; Ref 9-66; Ref 9-33). In 2021, an abundance of 53,485 harbour porpoises was estimated for the southern North Sea region based on (SCANS) III data (Ref 9-37), with 159,632 harbour porpoise estimated for the UK portion of the North Sea harbour porpoise MU (Ref 9-135).

9.6.62 Near to the Humber Estuary, high densities of harbour porpoise have been recorded offshore from the Lincolnshire coast and the Holderness Coast (Ref 9-37; Ref 9-46). Harbour porpoise are also frequently recorded foraging in the Humber Estuary region with over 2,000 sightings since 2000 (Ref 9-30; Ref 9-32; Ref 9-31). Peak sightings and numbers occur in August, September and October. Although porpoises in the North Sea can give birth in any month of the year, breeding is typically seasonal with most births in June or July and a peak in mating in August (Ref 9-30).

9.6.63 Other cetacean species recorded in the Humber Estuary region more rarely include bottlenose dolphin *Tursiops truncatus*, common dolphin *Delphinus delphis*, white-beaked dolphin *Lagenorhynchus albirostris* killer whale *Orcinus orca* and minke whale *Balaenoptera acutorostrata* (Ref 9-30); Ref 9-31).

Immingham area

9.6.64 Marine mammal survey data or sighting records for the Immingham area are limited. However, given that seals (particularly grey seals) are regularly recorded foraging in the Humber Estuary, this species would be expected to occur relatively frequently in this area. For example, approximately ten to 15 grey seals were observed hauling out on mudflat at Sunk Island (on the north bank of the Humber Estuary) during recent benthic surveys as detailed in Ref 9-47. This haul out site is located approximately 4km northeast from the Project and around 3 - 4km from the dredge disposal sites (including transit routes). No seal haul out sites are known to occur nearer to the Project.

9.6.65 Harbour porpoises have also been regularly recorded foraging in this section of the Humber Estuary (Ref 9-30) (see **Figure 9.7 [TR030008/APP/6.3]**). This includes observations of a harbour porpoise foraging approximately 1-2km from the Project in the mid channel, offshore from Immingham during recent benthic surveys as detailed in Ref 9-47.

Future Baseline

9.6.66 In the absence of the Project, the current marine coastal processes would remain the same as described in the physical processes assessment (**Chapter 16: Physical Processes** of the ES **[TR030008/APP/6.2]**).

9.6.67 Marine species are likely to become increasingly vulnerable to anthropogenic pressures in the future due to the predicted effects of climate change and ocean acidification in combination with more local pressures. The 2020 Marine Climate Change Impact Partnership report card (Ref 9-48) highlighted the following changes to marine ecology receptors could potentially occur during the operational phase of the Project as a result of climate change:

a. Sea-level rise could result in deeper waters and larger waves reaching saltmarsh and other intertidal habitats, causing erosion at the seaward edge.

b. Changes in patterns of rainfall or temperature changing vegetation composition of coastal saltmarsh communities.

c. Marine communities around the UK altering as ocean acidification increases.

d. Changing sea temperatures resulting in range shifts for both benthic species and mobile species (such as fish, marine mammals). This could result in a decline of some cold-water species around certain parts of the UK and an increase in the prevalence of non-native species.

e. Changing temperatures affecting spawning in some marine species as well as the timings of migrations.

f. Coastal waterbirds showing north-easterly shifts in the winter distributions in Europe.

g. Changes in prey distribution and availability, resulting in range shifts in some regional populations of marine mammals, fish and seabirds.

9.6.68 Data suggests that ecological changes linked to climate change (such as range shifts) are already occurring although there is currently a high degree of uncertainty with respect to predicting the magnitude of potential effects in the future.

9.7 Development Design and Impact Avoidance

Embedded Mitigation Measures

9.7.1 The Project has been designed, as far as possible, to avoid and minimise impacts and effects to marine ecology through the process of design development, and by embedding mitigation measures into the design, such as minimising the dredge requirements as far as possible and lighting design will be optimised to avoid any unnecessary light-spill on the water or foreshore habitats.

Standard Mitigation Measures

9.7.2 A number of measures will be undertaken to manage commonly occurring environmental effects. Although these are not likely to alter the assessment conclusions, they are considered to be standard good practice. These are as follows:

a. Even disposal deposition of dredged material: Targeting disposal loads in the central/deeper area of the disposal sites to reduce depth reductions. This will minimise the initial reduction in water depth and any environmental changes at the disposal sites.

b. Following biosecurity management procedures: Biosecurity control measures during construction will be included within the **Outline CEMP [TR030008/APP/6.5]** and existing biosecurity management procedures will be followed during operation.

c. Adhering to environmental management best practice: The potential risk from accidents and spillages/leaks during construction will be avoided or minimised by ensuring that the construction methods, proposed design and the contractual arrangements follow pollution prevention legislation and environmental management best practice.

9.8 Assessment of Likely Impacts and Effects

9.8.1 The assessment has identified potential likely significant effects on marine ecology receptors as a result of the construction and subsequent operation of the Project.

9.8.2 The physical processes assessment (**Chapter 16: Physical Processes [TR030008/APP/6.2]**), water and sediment quality assessment (**Chapter 17: Marine Water and Sediment Quality [TR030008/APP/6.2]**) and underwater noise assessment (**Appendix 9.B [TR030008/APP/6.4])** have informed the outcomes of the marine ecology assessment.

9.8.3 Potential impacts on features of internationally designated sites (SACs, SPAs and Ramsar sites) have been assessed within the **Shadow HRA [TR030008/APP/7.6].**

9.8.4 With respect to marine ecology features of Humber Estuary SSSI, potential impacts on the following features were considered in the ES and **Shadow HRA [TR030008/APP/7.6]**:

a. Estuary (with its component habitats of intertidal mudflats and sandflats and coastal saltmarsh).

b. Fish and marine mammals (grey seal, river lamprey, sea lamprey).

9.8.5 All other habitat features of the SSSI are not considered to be in the zone of influence of potential effects. Coastal waterbird features of Humber Estuary SSSI are discussed in more detail in **Chapter 10: Ornithology** of the ES **[TR030008/APP/6.2].**

9.8.6 The nearest MCZ (Holderness Inshore) is located approximately 20km from the Project and does not overlap with the zone of influence. Furthermore, there are no mobile Features of Conservation Importance ("FOCI") that could overlap with any of the marine effects resulting from the Project. Overall, therefore, there is considered to be no potential for direct or indirect impacts on FOCI at this site. On this basis an MCZ Assessment is not considered to be required.

9.8.7 Cumulative impacts on marine ecology receptors that could arise as a result of other coastal and marine developments and activities in the Humber Estuary combined with the Project are considered as necessary as part of the cumulative impacts and in-combination effects assessment (**Chapter 25: Cumulative and In-Combination Effects** of the ES **[TR030008/APP/6.2]**).

Construction

9.8.8 This section provides an assessment of the potential impacts to marine ecology receptors as a result of the construction phase of the Project. Potential effects during the construction phase that are considered relevant are reviewed in **Table 9-17.** It should be noted that **Table 9-17** includes the rationale for the scoping in or out of individual pathways for further assessment.

Table 9-17: Potential effects during construction scoped in / out of further detailed assessment

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in assessment?	Justification
Benthic habitats and species	Direct loss of intertidal and subtidal habitats and species as a result of the piles	Marine piling	Yes	Marine piling would result in the small loss of subtidal and intertidal habitat. This impact pathway has, therefore, been scoped into the assessment.
	Direct changes to benthic habitats and species as result of seabed removal during dredging	Capital dredge	Yes	Capital dredging causes the direct physical removal of marine sediments from the dredge footprint, resulting in the modification of existing marine habitats. The impacts to benthic fauna associated with the dredged material include changes to abundance and distribution through damage, mortality or relocation to a disposal site. This impact pathway has, therefore, been scoped into the assessment.
		Dredge disposal	N/A	This pathway relates to changes in habitat resulting directly from seabed removal and is, therefore, not considered relevant to the dredge disposal activity. Potential effects resulting from sediment deposition at the disposal site are discussed later in the table below.
	Direct changes to benthic habitats and species as a result of sediment deposition	Marine piling	No	Marine piling has the potential to result in the localised resuspension of sediment as a result of seabed disturbance. Sediment that settles out of suspension back onto the seabed as result of marine piling is expected to be negligible and benthic habitats and species are not expected to be sensitive to this level of change. This impact pathway has, therefore, been scoped out of the assessment.

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in assessment?	Justification
		Capital dredge	Yes	Capital dredging has the potential to result in localised physical disturbance and smothering of seabed habitats and species (where the sediment settles out of suspension back onto the seabed). This impact pathway has, therefore, been scoped into the assessment.
		Dredge disposal	Yes	Dredge disposal will result in the deposition of sediments which has the potential to cause physical disturbance and smothering of seabed habitats. This impact pathway has, therefore, been scoped into the assessment.
	Indirect loss or change to seabed habitats and species as a result of changes to hydrodynamic and sedimentary processes	Marine works (jetty structure and capital dredging)	Yes	The jetty structure and capital dredge have the potential to result in changes to hydrodynamic and sedimentary processes (e.g. flow rates, accretion and erosion patterns). Marine invertebrates inhabiting sand and mud habitat show different tolerance ranges to physiological stresses caused by tidal exposure and tidal elevation and, therefore, hydrodynamic and bathymetric changes caused by the dredging could affect the quality of marine habitats and change the distribution of marine species. This impact pathway has, therefore, been scoped into the assessment.
		Dredge disposal	Yes	The disposal of dredged material at the marine disposal site has the potential to result in changes to hydrodynamic and sedimentary processes (e.g. water levels, flow rates, changes to tidal prism, accretion and erosion patterns). Marine invertebrates inhabiting sand and mud habitat show different tolerance ranges to physiological stresses caused by tidal

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in assessment?	Justification
				exposure and tidal elevation and, therefore, hydrodynamic and bathymetric changes caused by the disposal could affect the quality of marine habitats and change the distribution of marine species. This impact pathway has, therefore, been scoped into the assessment.
	Changes in water and sediment quality	Marine piling	No	The negligible, highly localised and temporary changes in suspended sediment levels (and related changes in sediment bound contaminants and dissolved oxygen) associated with bed disturbance during marine piling is considered unlikely to produce adverse effects in any species. The potential for accidental spillages will also be negligible during construction through following established industry guidance and protocols. This impact pathway has, therefore, been scoped out of the assessment.
		Capital dredge	Yes	Changes in water quality during capital dredging could impact benthic habitats and species through an increase in suspended sediment concentrations (“SSC”) and the release toxic contaminants bound in sediments. This impact pathway has, therefore, been scoped into the assessment.
		Dredge disposal	Yes	Changes in water quality could occur during dredged material disposal through the deposition of material causing elevated SSC and contaminant levels. This could potentially impact on benthic habitats and species. This impact pathway has, therefore, been scoped into the assessment.
		Surface water drainage	No	Standard measures to control surface water run-off during construction are embedded within the Project design for legislative compliance, and therefore it is very unlikely that

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in assessment?	Justification
				contaminated run-off would enter the Humber Estuary. This impact pathway has, therefore, been scoped out of the assessment.
	Underwater noise	Marine piling	Yes	Underwater noise generated by marine piling has the potential to affect benthic species. This will require further assessment and has, therefore, been scoped in.
		Capital dredge	Yes	Underwater noise generated by dredging has the potential to affect benthic species. This will require further assessment and has, therefore, been scoped in.
		Dredge disposal	Yes	Underwater noise generated by the movement of the dredger to and from the disposal site has the potential to affect benthic species if this disposal option is adopted. This will require further assessment and has, therefore, been scoped in.
	The potential introduction and spread of non-native species	Construction of marine infrastructure	Yes	Non-native species have the potential to be transported into the local area as a result of construction activity. This impact pathway has, therefore, been scoped into the assessment.
		Capital dredge	Yes	Non-native species have the potential to be transported into the local area on the hulls of dredging vessels. Non-native invasive species also have the potential to be transported via vessel ballast water. This impact pathway has, therefore, been scoped into the assessment.
		Dredge disposal	Yes	Non-native species have the potential to be transported into the local area on the hulls of dredging vessels. Non-native invasive species also have the potential to be transported via

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in assessment?	Justification
				vessel ballast water. This impact pathway has, therefore, been scoped into the assessment.
	Damage to sensitive habitats as a result of changes in air quality.	Road traffic emissions	No	There are no designated nature conservation receptors within 200m of a road that exceeds the Institute of Air Quality Management ("IAQM") and Environmental Protection UK ("EPUK") screening guidance on local roads (see **Chapter 6: Air Quality** of the ES **[TR030008/APP/6.2]**), below which a road traffic impact is unlikely to contribute to a significant effect on local air quality. There are also no roads that exceed the National Highways DMRB screening criteria on the Strategic Road Network (see **Chapter 6: Air Quality** of the ES **[TR030008/APP/6.2]**). This impact pathway has, therefore, been scoped out of the assessment.
		Construction vessel emissions	No	The assessment has considered a scenario of peak construction vessel operation (see **Chapter 6: Air Quality** of the ES **[TR030008/APP/6.2]**)**.** Given the limited number of construction vessel emissions sources, the frequency of operation and distance between source and sensitive receptors (over 3km away from the nearest saltmarsh habitat), it is considered highly unlikely that this source could contribute to a significant effect on local air quality. Although there are areas of designated habitat within the Humber Estuary SAC/SPA/Ramsar/SSSI that are nearer to the source of vessel emissions, these are intertidal mudflats and subtidal estuarine habitats that do not support any rooted plants that could be sensitive to vessel emissions. While intertidal mudflats can be sensitive to nutrients in some circumstances, where they cause excessive macroalgal (seaweed) growth, the APIS notes that even for saltmarsh *'Overall N deposition*

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in assessment?	Justification
				[from atmosphere] is likely to be of low importance for these systems as the inputs are probably significantly below the large nutrient loadings from river and tidal inputs'. It is also considered that the Humber Estuary is likely to be at relatively low risk of smothering from macroalgae, given the role of high sediment load in limiting sunlight penetration and strong wave action in breaking up macroalgae mats. This impact pathway has, therefore, been scoped out of the assessment.
Fish	Direct loss or changes to fish populations and habitat	Marine piling	No	There is the potential for impacts to fish as a result of habitat loss due to installation of piles and the footprint of the Project. However, the direct footprint of the marine piling only covers a highly localised area with the mobile nature of fish allowing them to utilise nearby areas. This impact pathway has, therefore, been scoped out of the assessment.
		Capital dredge	Yes	Backhoe dredging can directly remove fish and fish eggs in the bucket. In addition, capital dredging has the potential to result in seabed disturbance and smothering of seabed habitats and species. These changes have the potential to impact on fish species through potential changes in prey resources and the quality of foraging, nursery and spawning habitats. This impact pathway has, therefore, been scoped into the assessment.
		Dredge disposal	Yes	Disposal at the marine disposal site will result in the deposition of sediments which has the potential to cause physical disturbance and smothering of seabed habitats. These changes have the potential to impact on fish species through potential changes in prey resources and the quality of

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in assessment?	Justification
				foraging, nursery and spawning habitats. This impact pathway has, therefore, been scoped into the assessment.
	Indirect changes to seabed habitats for fish	Marine piling	No	Marine piling has the potential to result in changes to hydrodynamic and sedimentary processes (e.g. water levels, flow rates, changes to tidal prism, accretion and erosion patterns). However, such effects will be negligible and highly localised and will cause no direct changes to fish habitat. This impact pathway has, therefore, been scoped out of the assessment.
		Capital dredge	No	The capital dredge has the potential to result in changes to hydrodynamic and sedimentary processes (e.g. water levels, flow rates, changes to tidal prism, accretion and erosion patterns). However, as described in more detail in **Chapter 16: Physical Processes** of the ES **[TR030008/APP/6.2]**), negligible changes in estuary processes are predicted. The predicted changes are not expected to modify existing subtidal habitat types found in the area. Indirect effects on fish habitats (feeding, spawning and nursery areas) are, therefore, considered to be negligible. On this basis, this pathway has been scoped out of the assessment.
		Dredge disposal	No	Dredge disposal has the potential to result in changes to hydrodynamic and sedimentary processes (e.g. water levels, flow rates, changes to tidal prism, accretion and erosion patterns). However, as described in more detail in **Chapter 16: Physical Processes** of the ES **[TR030008/APP/6.2]**), only minor changes in flow rates and subtidal seabed morphology are predicted which are not expected to modify existing subtidal habitat types found in the area (i.e. mobile

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in assessment?	Justification
				sand habitats characterised by an impoverished infaunal assemblage). Given the offshore location of the disposal site, no changes in wave regime are predicted. Indirect effects on fish habitats (feeding, spawning and nursery areas) are, therefore, considered to be negligible. On this basis, this pathway has been scoped out of the assessment.
	Changes in water and sediment quality	Marine piling	No	The expected highly localised and temporary changes in suspended sediment levels and related changes in sediment bound contaminants and dissolved oxygen associated with bed disturbance during marine piling are considered highly unlikely to produce adverse effects in any fish species. The potential for accidental spillages will also be negligible during construction through following established industry guidance and protocols. This impact pathway has, therefore, been scoped out of the assessment.
		Capital dredge	Yes	Changes in water quality during capital dredging could impact fish species through an increase in SSC and the release of toxic contaminants bound in sediments. This impact pathway has, therefore, been scoped into the assessment.
		Dredge disposal	Yes	Changes in water quality could occur during dredged material disposal through the deposition of material causing elevated SSC and contaminant levels. This could potentially impact on fish species. This impact pathway has, therefore, been scoped into the assessment.
	Underwater noise	Marine piling	Yes	During marine piling, there is the potential for noise disturbance to fish. Percussive (impact) and vibro marine piling will produce underwater noise above background

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in assessment?	Justification
				conditions and at a level that may cause a risk of injury and behavioural changes to fish in the vicinity of the Project. This impact pathway has, therefore, been scoped into the assessment.
		Capital dredge	Yes	Elevated underwater noise and vibration levels caused by the action of the dredger could potentially affect fish. This impact pathway has, therefore, been scoped into the assessment.
		Dredge disposal	Yes	Underwater noise and vibration levels caused by the movement of the dredger to and from the disposal site could potentially affect fish. This impact pathway has, therefore, been scoped into the assessment.
Marine mammals	Direct loss or changes in marine mammal foraging habitat	Construction (marine piling, capital dredge and dredge disposal)	No	There is the potential for impacts to marine mammals as a result of changes to marine mammal foraging habitat and prey resources. However, the footprint of the Project only covers a highly localised area that constitutes a negligible fraction of the known ranges of local marine mammal populations. This impact pathway has, therefore, been scoped out of the assessment.
	Changes in water and sediment quality	Marine piling	No	The negligible, highly localised and temporary changes in suspended sediment levels and related changes in sediment bound contaminants and dissolved oxygen associated with bed disturbance during marine piling, is considered highly unlikely to produce adverse effects in any marine mammal species. The potential for accidental spillages will also be negligible during construction through following established industry guidance and protocols. This impact pathway has, therefore, been scoped out of the assessment.

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in assessment?	Justification
		Capital dredge	No	The plumes resulting from dredging are expected to have a relatively minimal and local effect on SSC in the vicinity of the Project (as described in more detail in **Chapter 16: Physical Processes** of the ES **[TR030008/APP/6.2]**). Marine mammals are well adapted to turbid conditions and, therefore, not sensitive to the scale of changes in SSC predicted during capital dredging (Ref 9-49). Given the limited extent of sediment dispersal significant elevations in water column contamination are unlikely. This will be confirmed following analysis of the uplift in contaminant concentrations in the water column once sediment sampling and analysis has been carried out. In addition, the temporary and localised changes in water column contamination levels are considered unlikely to produce any lethal and sub-lethal effects in these highly mobile species (the concentrations required to produce these effects are generally acquired through long-term, chronic exposure to prey species in which contaminants have bioaccumulated) (Ref 9-49). Furthermore, potential for accidental spillages will also be negligible during all phases through the application of established industry guidance and protocols. The potential for water quality impacts to marine mammals has, therefore, been scoped out of the assessment.
		Dredge disposal	No	The plumes resulting from dredge disposal are expected to have a relatively minimal and local effect on SSC (as described in more detail in **Chapter 16: Physical Processes** of the ES **[TR030008/APP/6.2]**). Marine mammals are well adapted to turbid conditions and, therefore, not sensitive to the scale of changes in SSC predicted during disposal (Ref 9-49). Given the limited extent of sediment dispersal significant

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in assessment?	Justification
				elevations in water column contamination are unlikely. This will be confirmed following analysis of the uplift in contaminant concentrations in the water column once sediment sampling and analysis has been carried out. In addition, the temporary and localised changes in water column contamination levels are considered unlikely to produce any lethal and sub-lethal effects in these highly mobile species (the concentrations required to produce these effects are generally acquired through long-term, chronic exposure to prey species in which contaminants have bioaccumulated) (Ref 9-49). Furthermore, potential for accidental spillages will also be negligible during construction through the application of established industry guidance and protocols. The potential for water quality impacts to marine mammal has therefore been scoped out of the assessment.
	Collision risk	Construction, dredging and dredge disposal	No	Vessels involved in construction and dredging/dredge disposal will be mainly stationary or travelling at low speeds (2-6 knots), making the risk of collision very low. Although all types of vessels may collide with marine mammals, vessels traveling at speeds over 10 knots are considered to have a much higher probability of causing lethal injury (Ref 9-50). Furthermore, the region is already characterised by heavy shipping traffic. The additional movements due to construction activity (including capital dredging) will only constitute a small increase in vessel traffic in the area which will also be temporary in nature. In general, incidents of mortality or injury of marine mammals caused by vessels remain a relatively rare occurrence in UK waters (Ref 9-51; Ref 9-52). For example, out of 144 post mortem examinations carried out on cetaceans in 2018, only

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in assessment?	Justification
				two (1.4 %) were attributed to boat collision with the biggest causes of mortality including starvation and by-catch, although some incidents are likely to remain unreported (Ref 9-52). In addition, marine mammals foraging within the Humber Estuary region will routinely need to avoid collision with vessels and are, therefore, considered adapted to living in an environment with high levels of vessel activity. This impact pathway has, therefore, been scoped out of the assessment.
	Underwater noise	Marine piling	Yes	Percussive (impact) and vibro marine piling will produce underwater noise above background conditions and at a level that may cause a risk of injury and behavioural changes to marine mammals in the vicinity of the Project. This impact pathway has, therefore, been scoped into the assessment.
		Capital dredge	Yes	Elevated noise and vibration levels caused by the action of the dredger could potentially affect marine mammals by inducing adverse behavioural reactions. This impact pathway has, therefore, been scoped into the assessment.
		Dredge disposal	Yes	Elevated noise and vibration levels caused by the movement of the dredger to and from the disposal site could potentially affect marine mammals by inducing adverse behavioural reactions. This impact pathway has, therefore, been scoped into the assessment.
	Visual disturbance of hauled out seals	Construction, dredging and dredge disposal	No	The nearest established breeding colony for grey seals is located over 25km away at Donna Nook. Approximately ten to 15 grey seals were also observed hauling out on mudflat at Sunk Island (on the north bank of the Humber Estuary) during

Receptor	Impact Pathways/ Potential Effects	Project activity	Included in assessment?	Justification
				recent benthic surveys as detailed in Ref 9-47. This haul out site is located approximately 4km north-east from the Project and around 3-4km from the dredge disposal sites (including transit routes). No seal haul out sites are known to occur nearer to the Project. Seals which are hauled out on land, either resting or breeding, are considered particularly sensitive to visual disturbance (Ref 9-67). The level of response of seals is dependent on a range of factors, such as the species at risk, age, weather conditions and the degree of habituation to the disturbance source. Hauled out seals have been recorded becoming alert to powered craft at distances of up to 800 m although seals generally only disperse into the water at distances <150-200 m (Ref 9-68; Ref 9-69; Ref 9-70; Ref 9-71). For example, in a study focusing on a colony of grey seals on the South Devon coast, vessels approaching at distances between 5m and 25m resulted in over 64 % of seals entering the water, but at distances of between 50m and 100m only 1 % entered the water (Ref 9-72). Recent disturbance research has also found no large-scale redistribution of seals after disturbance with most seals returning to the same haul out site within a tidal cycle (Ref 9-73). Based on this evidence, seals hauled out on the intertidal habitats of Sunk Island (located on the opposite bank to the Project) are out of the zone of influence of any potential visual disturbance effects as a result of dredging, dredge disposal or construction activity. The potential for disturbance to hauled out seals has, therefore, been scoped out of the assessment.

Benthic Habitats and Species

9.8.9 This section contains an assessment of the potential impacts to benthic ecology receptors as a result of the construction phase of the Project. The following impact pathways have been assessed:

a. Direct loss of intertidal habitat as a result of the piles.

b. Direct loss of subtidal habitat as a result of the piles.

c. Changes to benthic habitats and species as result of the removal of seabed material during dredging.

d. Changes to benthic habitats and species as a result of sediment deposition during dredging and dredge disposal.

e. Indirect loss or change to seabed habitats and species as a result of changes to hydrodynamic and sedimentary processes during marine works (jetty structure and capital dredging) and dredge disposal.

f. Changes in water and sediment quality during capital dredging and dredge disposal.

g. Underwater noise and vibration on invertebrates during marine piling, capital dredging and dredge disposal.

h. Introduction and spread of non-native species during construction, capital dredging and dredge disposal.

Direct loss of intertidal habitat as a result of the piles

General scientific context

9.8.10 The impact of direct intertidal habitat loss can involve building over marine habitats (such as reclamation) or the permanent physical removal of substratum and associated organisms from the seabed. Direct habitat loss can also occur due to deepening as a result of dredging causing a change from an intertidal to a subtidal environment.

9.8.11 Intertidal habitats are sensitive to physical loss at locations where new structures are introduced onto the seabed (i.e., within the development ‘footprint’ of these structures). The significance of such losses will vary on a site-by-site basis in response to differences in the extent and duration of the losses as well as the relative value of the habitats in question. The value of the habitats is, in turn, reflected by the species that are present and level of statutory and non-statutory protection afforded to them. As any effects are very much dependent upon site specific considerations, a generic scientific review is not appropriate, and the focus of the impact assessment has been based on site-specific considerations.

Project impact assessment

9.8.12 The piles will cause a direct loss of up to 0.00158 ha of intertidal mudflat habitat.

9.8.13 The intertidal habitat loss as a result of the marine piling represents approximately 0.000004 % the Humber Estuary SAC and approximately 0.000017 % of the 'mudflats and sandflats not covered by seawater at low tide' feature of the Humber Estuary SAC[6].

9.8.14 This loss also represents 0.000004 % of the Humber Estuary SPA/Ramsar[7]. When considering this in the context of intertidal area, the area of loss represents approximately 0.000018 % of intertidal foreshore habitats[8] and approximately 0.000025 % of mudflat[9] within the SPA.

9.8.15 This habitat loss is therefore negligible in extent in the context of the Humber Estuary SAC, SPA and Ramsar. The **Shadow HRA [TR030008/APP/7.6]** considers potential effects of this loss on these designated sites in more detail.

9.8.16 The loss of intertidal habitat due to marine piling will be highly localised and considered *de minimis* in extent. The loss is also considered to be a magnitude that will not change the overall structure or functioning of the nearby mudflats within the Port of Immingham area or more widely in the Humber Estuary. Potential effects of direct intertidal habitat loss on coastal waterbirds are considered in **Chapter 10: Ornithology** of the ES **[TR030008/APP/6.2]**.

9.8.17 Based on the evidence provided above, the probability of habitat loss occurring is high and the magnitude of potential impacts is considered to be negligible. Exposure to change is, therefore, negligible. While the sensitivity of species to direct habitat loss, is considered to be high for all benthic habitats and species within the footprint (given the lack of recoverability), vulnerability is assessed as none, given the negligible exposure to change. While the benthic community is common throughout the region, it is noted that the intertidal habitat itself is protected (both as a qualifying feature of the Humber Estuary SAC and a NERC Habitat of Principle Importance) and of functional importance for waterbirds. Notwithstanding that importance is considered to be high, taking all of these factors into account (including magnitude of change and vulnerability to change), the potential effects arising from the direct loss of intertidal are considered to be **insignificant**.

Direct loss of subtidal habitat as a result of the piles

General scientific context

9.8.18 The impact of direct habitat loss can involve building over marine habitats (such as reclamation) or the permanent physical removal of substratum and associated organisms from the seabed. Direct habitat loss can also occur due to deepening as a result of dredging causing a change from an intertidal to a subtidal environment.

[6] Based on the extents given in the Standard Data Form on the JNCC website (Ref 9-38)
[7] Based on the extents given in the Standard Data Form on the JNCC website (Ref 9-39)
[8] OBJ 'Intertidal Substrate Foreshore (England and Scotland)
[9] Based on using mudflat data layer of the Priority Habitat Inventory (England).

9.8.19 Subtidal habitats are sensitive to physical loss at locations where new structures are introduced onto the seabed (i.e., within the development 'footprint' of these structures). The significance of such losses will vary on a site-by-site basis in response to differences in the extent and duration of the losses as well as the relative value of the habitats in question. The value of the habitats is, in turn, reflected by the species that are present and level of statutory and non-statutory protection afforded to them. As any effects are very much dependent upon site specific considerations, a generic scientific review is not appropriate in this case and the focus of the impact assessment is based on site-specific considerations.

Project impact assessment

9.8.20 Marine piling in the subtidal area will result in the direct loss of up to 0.051 ha of seabed habitat. This habitat represents approximately 0.00014 % of the Humber Estuary SAC.

9.8.21 The project-specific subtidal survey (**Section 9.6** and **Appendix 9.A [TR030008/APP/6.4]**) recorded a highly impoverished assemblage characterised polychaetes (such *Nephtys* spp, *Streblospio shrubsolii* and *Scoloplos armiger*), nematodes, oligochaetes *Tubificoides* spp and crustacean *Diastylis rathkei)*.

9.8.22 The loss in subtidal habitat as a result of the piles is considered negligible in the context of extent of the overall amount of similar marine habitats found locally in the Humber Estuary. All the species recorded were considered commonly occurring and not protected. Furthermore, faunal assemblage recorded are also considered characteristic of subtidal habitats found more widely in this section of the Humber Estuary (Ref 9-23; Ref 9-24; Ref 9-22).

9.8.23 Based on the evidence provided above, the probability of habitat loss occurring is high and the magnitude of potential impacts is considered to be negligible. Exposure to change is, therefore, negligible. While the sensitivity of species to direct habitat loss, is considered to be high for all benthic habitats and species within the footprint (given the lack of recoverability), vulnerability is assessed as none given the negligible exposure to change. Importance is considered to be moderate as the subtidal species found in the area are commonly occurring and of low conservation concern although subtidal habitats form a component of the 'Estuaries' feature of the SAC. On this basis, the effect resulting from direct habitat loss on subtidal benthic habitats and species is assessed as **insignificant**.

Direct changes to benthic habitats and species as result of the removal of seabed material during dredging

General scientific context

9.8.24 Dredging causes a direct physical removal of sediments, causing a modification to the existing subtidal and intertidal habitats. The impacts to benthic fauna associated with the dredged material include changes to abundance and distribution through damage, mortality or relocation to a disposal site.

9.8.25 The speed of recovery of the temporarily disturbed areas is dependent on the scale and timing of the disturbance, the life histories of species and the stability and diversity of the benthic community present. For example, while the opportunistic bivalve *Abra* spp. is vulnerable to physical disturbance (due to its fragile shell), the species is considered to have a high recoverability due to a high fecundity and larval dispersal rate (Ref 9-142; Ref 9-74). Furthermore, a regularly disturbed sedimentary habitat with a low diversity benthic assemblage is likely to recover more quickly (i.e., return to its disturbed or 'environmentally-stressed' baseline condition) than a stable habitat with a pre-existing mature and diverse assemblage (Ref 9-143).

9.8.26 In general, where studies have been undertaken to understand the effects of physical disturbance, they have shown recolonisation of deposited sediments by benthic species to be quite rapid (Ref 9-133). Sites are initially colonised by short lived, fast growing, opportunistic species ('r-selected') that are tolerant of high levels of disturbance; infaunal species dominate, particularly polychaetes worms. In time, these are succeeded by longer lived, slower growing species with a lower tolerance for disturbance (Ref 9-144; Ref 9-145). Rates of recovery reported in reviewed literature suggest that a recovery time of six to 24 months is characteristic of many mobile sands and estuarine muds where frequent disturbance of the deposits precludes the establishment of long-lived communities (Ref 9-78; Ref 9-146; Ref 9-133). In contrast, a community of sands and gravels may take two to three years to establish, depending on the proportion of sand and level of environmental disturbance by waves and currents (Ref 9-144; Ref 9-147).

Project impact assessment

9.8.27 The capital dredge will remove approximately 4,000m³ of material over a maximum area of approximately 10,000m² of subtidal habitat. It is expected that the material will be removed with a backhoe dredger.

9.8.28 Following the capital dredge, it is likely that the dredge pocket would provide similar habitat to that under pre-dredge conditions. The baseline benthic surveys predominantly recorded surface sediment within and near to the dredge footprints with a high silt content (i.e., mud and sandy mud) (**Section 9.6** and **Appendix 9.A [TR030008/APP/6.4]**). Sub surface sampling in the capital dredge footprint recorded sediments from most sampling locations dominated by silt material (see **Appendix 2.A [TR030008/APP/6.4]**.

9.8.29 The project-specific subtidal survey (**Section 9.6** and **Appendix 9.A [TR030008/APP/6.4]**) recorded a highly impoverished benthic community which is likely to reflect the existing high levels of physical disturbance in the area due to strong tidal currents and sediment movement.

9.8.30 Samples were characterised by polychaetes (such *Nephtys* spp, *Streblospio shrubsolii* and *Scoloplos armiger*), nematodes, oligochaetes *Tubificoides* spp and crustacean *Diastylis rathkei.* These species are typically fast growing and/or have rapid reproductive rates which allow populations to fully re-establish in typically less than 1-2 years and for some species within a few months (Ref 9-74; Ref 9-75; Ref 9-76). All the species recorded are commonly occurring and not

protected. In addition, the faunal assemblage recorded is considered characteristic of subtidal habitats found more widely in this section of the Humber Estuary (Ref 9-23; Ref 9-24; Ref 9-22).

9.8.31 Based on the evidence provided above in the scientific review and applying the project impact assessment methodology, the magnitude of the change to the subtidal habitats and associated benthic species is considered to be small. Therefore, while the probability of occurrence is high, the overall exposure is assessed as low for subtidal habitats. The sensitivity of subtidal habitats to seabed disturbance within the dredge footprint is considered to be low given the high recoverability rates. Vulnerability is, therefore, assessed as low. While subtidal communities are considered commonly occurring in the region, subtidal habitats form a component of the 'Estuaries' feature of the SAC. Importance is, therefore, considered to be **moderate**. Overall, however, the potential effect is assessed as **insignificant to minor**.

9.8.32 It should be noted that this assessment specifically relates to the effects of the capital dredge. The need for future maintenance dredging within the new berth pocket is expected to be very limited (if required at all). However, as this could cause disturbance to the seabed on a very periodic basis, changes to benthic habitats and species as result of the removal of seabed material during maintenance dredging is considered in the operational section.

Direct changes to benthic habitats and species as a result of sediment deposition during dredging and dredge disposal

General scientific context

9.8.33 Sediments suspended and dispersed during the marine works, dredging and disposal have the potential to resettle over the seabed. This potential blanketing or smothering of benthic species may cause stress, reduced rates of growth or reproduction and in the worst cases the effects may be fatal (Ref 9-148; Ref 9-149).

9.8.34 Habitats within estuarine and coastal environments have highly fluctuating conditions including the resuspension and deposition of sediments on a daily basis (through tidal action), lunar cycles (due to the differing influences of spring and neap tides) and on a seasonal basis (due to storm activity and conditions of extreme waves). Subtidal and intertidal habitats are, therefore, characterised by such perturbations and the biological communities of these environments are well adapted to survival under fluctuating conditions.

9.8.35 If the amount of sediment deposited is too great to allow species to survive burial, then recovery occurs via re-colonisation and/or migration to the new sediment surface (Ref 9-150; Ref 9-151). In general, the rate of recovery is dependent upon just how stable and diverse the assemblage was in the first place. A regularly disturbed sedimentary habitat with a low diversity benthic assemblage is likely to recover more quickly (i.e., return to its disturbed or 'environmentally-stressed' baseline condition) than a stable habitat with a pre-existing mature and diverse assemblage. A study by Bolam *et al.* (Ref 9-152), for instance, concluded that the relatively rapid recovery observed at a location on the Crouch Estuary was due to the opportunistic nature of the invertebrate assemblages and the

dispersive behaviour of the dominant species that were present before the material was deposited. Furthermore, in cases where the quantity and type of sediment deposited does not differ greatly from natural sedimentation, e.g., of similar particle size, the effects are likely to be relatively small as many of the species are capable of migrating up through the deposited sediments (Ref 9-153). Dauvin *et al* (Ref 9-133) undertook an experimental study between 2016 and 2017 to identify changes of the benthos at ten stations on six surveys at a dredge disposal site. The study found that the impact of dredging remains local, and the benthic habitats display a high degree of resilience with rapid recovery of the community after the cessation of disturbance.

9.8.36 The Marine Evidence based Sensitivity Assessment ("MarESA") approach (Ref 9-140found that benthic communities in both sandy and muddy estuarine sediments are typically considered to be tolerant to the deposition of up to 5cm of fine material in a single event with burrowing species considered able to relocate to preferred depths through this level of deposition. Deposition of greater depths of fine sediment could result in some mortality although evidence suggests that some characterising species are likely to be able to reposition. Bivalve and polychaete species have been reported to migrate through depositions of sediment greater than 30cm (Ref 9-74; Ref 9-146; Ref 9-76; Ref 9-75). A previous review by the University of Hull also concluded that benthic invertebrates in sediments are able to adapt and readjust if sediment laid is placed as thin veneers over several days although they can also tolerate moderate amounts (20cm) of material being deposited at one time (Ref 9-154).

Project impact assessment: Capital Dredging

9.8.37 Sediment changes that are predicted to occur as a result of the capital dredge are presented in **Chapter 16: Physical Processes** of the ES **[TR030008/APP/6.2]**. In summary, maximum siltation as a result of the capital dredge within about 500m up and down the estuary from the edge of the dredge pocket is predicted to be around 1mm. Beyond this area, deposition levels are predicted to be negligible. Furthermore, once on the bed, the deposited material will return to the background system i.e. it will be put back into suspension on subsequent peak flood or ebb tides to be further dispersed. The project-specific subtidal survey (**Section 9.6** and **Appendix 9.A [TR030008/APP/6.4]**) recorded highly impoverished assemblage characterised polychaetes (such *Nephtys* spp, *Streblospio shrubsolii* and *Scoloplos armiger*), nematodes, oligochaetes *Tubificoides* spp and crustacean *Diastylis rathkei*. All the species recorded were considered commonly occurring and not protected.

9.8.38 The benthic species occurring within and near to the dredge area typically consist of burrowing infauna (such as polychaetes, oligochaetes or bivalves), which are considered tolerant to some sediment deposition. Based on evidence provided in relevant MarESA assessments, the characterising species recorded in the project-specific subtidal survey (described above) above are considered tolerant to deposition of at least 50mm with many species considered capable of burrowing through much greater levels of sediment deposition. On this basis, the predicted millimetric changes in deposition are, therefore, considered unlikely to cause smothering effects as described above. In addition, the species recorded

in the benthic invertebrate surveys are fast growing and/or have rapid reproductive rates which allow populations to fully re-establish in typically less than one to two years and for some species within a few months (Ref 9-74; Ref 9-75; Ref 9-76).

9.8.39 Deposition of sediment as a result of dredging will be highly localised and similar to background variability. Magnitude of change is, therefore, assessed as negligible. Probability of occurrence is high and thus the overall exposure to change is negligible. Based on the evidence provided above, sensitivity of subtidal habitats within the vicinity of the proposed works to increased smothering is considered to be low given that these species are well adapted to survival under fluctuating sediment conditions and have high recoverability rates. Vulnerability is therefore assessed as none. While subtidal communities are considered commonly occurring in the region, subtidal habitats form a component of the 'Estuaries' feature of the SAC. Importance is, therefore, considered to be **moderate**. The overall potential impact of deposition on benthic features is assessed as **insignificant**.

Project impact assessment: Disposal

9.8.40 The requirement for disposal of dredged material at sea associated with the Project would be fulfilled at licensed disposal sites HU056 and HU060 (see **Chapter 2: The Project** of the ES **[TR030008/APP/6.2]**).

9.8.41 The assessment of the sediment changes that are predicted to occur as a result of the capital dredging disposal is presented in **Chapter 16: Physical Processes** of the ES **[TR030008/APP/6.2]**. In summary, sedimentation resulting from the disposal plume is predicted to be generally in the range of 1 to 2mm at distances of up to around 1km from the disposal sites. Further up and down estuary, maximum sedimentation as a result of the disposal activities is generally predicted to be negligible.

9.8.42 The disposal sites are located in the mid channel and are subject to regular natural physical disturbance (and associated scouring) as a result of very strong tidal flows. This is reflected in a generally impoverished assemblage at both disposal sites. In addition millions of wet tonnes of dredge sediment are disposed of at HU060 annually which will also cause some disturbance due to sediment deposition.

9.8.43 The benthic species recorded within and adjacent to the disposal sites include mobile infauna (such as errant polychaetes e.g., *Arenicola* spp. and amphipods) which are able to burrow through sediment. They are, therefore, considered tolerant to some sediment deposition. In addition, characterising species typically have opportunistic life history strategies, with short life histories (typically two years or less), rapid maturation and the production of large numbers of small propagules which makes them capable of rapid recoverability should mortality as a result of smothering occur (Ref 9-77; Ref 9-74; Ref 9-75; Ref 9-76; Ref 9-78). On this basis, any effects are considered to be temporary and short term.

9.8.44 In summary, deposition in the wider area surrounding the disposal ground is expected to be in the order of millimetres. Sedimentation of this scale is unlikely to result in significant smothering effects to most faunal species with recoverability expected to be high.

9.8.45 The magnitude of the change during disposal is considered to be negligible. Probability of occurrence is high, and the overall exposure is, therefore, negligible. Given that habitats and species within and around the disposal site are well adapted to disturbed conditions with high recoverability rates, sensitivity is considered to be low and thus vulnerability is considered to be none. The benthic habitats and associated species that overlap with the changes brought about during disposal are of low ecological value but characteristic of the 'Sandbanks which are slightly covered by sea water all the time' feature of the Humber Estuary SAC. Therefore, importance is assessed as high. The overall potential impact of deposition on benthic features is assessed as **insignificant.**

Indirect loss or change to seabed habitats and species as a result of changes to hydrodynamic and sedimentary processes

General scientific context

9.8.46 Port or harbour structures (such as piles, breakwaters, coastal defences, jetties or quay walls) can cause changes to hydrodynamics (flow speeds, flow direction, waves, water levels) and seabed morphology Ref 9-155; Ref 9-156; Ref 9-157). Such changes have the potential to affect habitat quality and result in changes to the diversity, abundance and biomass of intertidal and subtidal species.

9.8.47 Dredging can cause direct habitat changes resulting from seabed removal and sediment deposition, as well as indirect habitat changes linked to hydrodynamic and sedimentary processes. Deepening or widening of channels during dredging can change seabed bathymetry and potentially alter flow patterns (speed/ direction), wave exposure and cause tidal amplification (Ref 9-158; Ref 9-159; Ref 9-160).

9.8.48 These hydrodynamic changes can lead to changes in sediment transport and also patterns of emersion/immersion as well as erosion/accretion of marine sedimentary habitats such as mudflats and sandbanks (Ref 9-158; Ref 9-138). For example, Cox *et al.* (Ref 9-160) found that saltmarsh retreat was related to an increase in the tidal prism brought about by dredging operations to maintain or increase the depth of the main navigable channel of the Westerschelde Estuary in the Netherlands. The greater frequency with which the high tides reached the edge of the fringing marshes increased the risk of erosion.

9.8.49 Increased flow rates can also increase scouring and bed disturbance of subtidal habitats which can cause a reduction in diversity and an increase in more opportunistic species. Reductions in water flow could also increase siltation levels which could change the habitat type of a seabed and lead to sedimentation (Ref 9-77). Marine invertebrates inhabiting sand and mud habitat show different tolerance ranges of physiological stresses caused by exposure and tidal elevation. This can lead to zonation (Ref 9-161). Bathymetric changes caused by dredging could, therefore, change the vertical distribution of marine habitats if

post-dredging water depths were outside the range at which specific biotopes exist.

Project impact assessment: Marine works

9.8.50 An assessment of the hydrodynamic and sediment regime changes that are predicted to occur as a result of the marine works are presented in **Chapter 16: Physical Processes** of the ES **[TR030008/APP/6.2]**. It should be noted that predicted changes are primarily as a result of the presence of the jetty with the effects due to the capital dredge having a negligible, localised effect.

9.8.51 Slight increases to local peak ebb current speed landward of the berth pocket are predicted to cause a limited amount of erosion of the bed along part of the lower intertidal (at the elevation of Mean Low Water Springs) beneath the landward ends of the proposed jetty. This will result in a potential indirect loss in intertidal area (up to approximately 0.03ha). The assessment indicates that once the softer upper layer is removed, the harder, more consolidated, underlayer of bed material is unlikely to erode further. This calculation represents a worst-case assessment of potential elevation changes and has been considered on a precautionary basis. The level of predicted change is at the limit of the accuracy of the modelled data and, in real terms, is likely to be immeasurable against the context of natural variability (as a result of storm events, for example).

9.8.52 The intertidal habitat loss represents approximately 0.00008 % the Humber Estuary SAC and approximately 0.00032 % of the 'mudflats and sandflats not covered by seawater at low tide' feature of the Humber Estuary SAC[10].

9.8.53 The predicted intertidal loss also consists of a very narrow strip on the lower shore around the sublittoral fringe and it is considered that this loss in mudflat extent will not change the overall structure or functioning of the nearby mudflats within the Port of Immingham area or more widely in the Humber Estuary.

9.8.54 Based on these factors, the probability of occurrence is considered to be high on a precautionary basis with the magnitude of change from these highly localised and small scale predicted effects due to hydrodynamic and sedimentary processes is considered to be negligible on marine habitats and species. Exposure is consequently assessed as negligible. While the sensitivity of species to direct habitat loss, is considered to be high for all benthic habitats and species within the footprint (given the lack of recoverability), vulnerability is assessed as none, given the negligible exposure to change.

9.8.55 Intertidal habitat is considered to be of high importance (a qualifying feature of the Humber Estuary SAC and a NERC Habitat of Principle Importance) and of functional importance for waterbirds, Notwithstanding that importance is considered to be high, taking all of these factors into account (including a negligible magnitude of change and no vulnerability to change), the potential effects arising from the direct loss of intertidal are considered to be **insignificant**.

[10] Based on the extents given in the Standard Data Form on the JNCC website (Ref 9-38)

Project impact assessment: Disposal

9.8.56 An assessment of the hydrodynamic and sediment regime changes that are predicted to occur as a result of the capital dredging disposal is presented in **Chapter 16: Physical Processes** of the ES **[TR030008/APP/6.2]**.

9.8.57 Local changes to the bathymetry (as a result of material disposal to the bed) within the disposal site will be small in the context of the existing depths. Disposal activity will be targeted to the deeper areas within the Site Boundary, ensuring that bed level changes are not excessive in any one area, thus, minimising the overall change. As a result, associated changes to the local hydrodynamics (and sediment transport pathways) will be negligible.

9.8.58 These changes are unlikely to result in any significant changes to local sediment transport in the region although some localised changes to seabed bathymetry and morphology could occur.

9.8.59 The predicted changes in flow rates and subtidal seabed morphology are not expected to modify existing subtidal habitat types found in the area (i.e. mobile sand habitats characterised by an impoverished infaunal assemblage).

9.8.60 Based on the available information provided above, magnitude of change on marine habitats and species from these highly localised and small scale predicted effects on the hydrodynamic and sedimentary processes is considered to be negligible. Although the probability of occurrence is high the overall exposure is assessed as negligible. The marine habitats which will be potentially affected are considered to be tolerant to the level of change in conditions expected and, therefore, sensitivity is assessed as low, and vulnerability is assessed as none. The benthic habitats and associated species that overlap with the changes brought about during disposal are of low ecological value but considered characteristic of the 'Sandbanks which are slightly covered by sea water all the time' feature of the Humber Estuary SAC. As a consequence, importance is assessed as moderate. The overall impact is, therefore, assessed as **insignificant**.

Changes in water and sediment quality during dredging and dredge disposal

General scientific context

Elevated suspended sediment concentrations

9.8.61 Dredging activities result in the suspension of disturbed sediment (Ref 9-162). Macrofauna living in estuarine systems which are subject to naturally high levels of SSCs are considered well adapted to living in highly turbid conditions. An increased level of suspended sediments may result in an increase in food availability and therefore growth and reproduction for surface deposit feeders (such as certain polychaetes) within estuarine environments that rely on a supply of nutrients at the sediment surface. However, food availability would only increase if the additional suspended sediment contained a significant proportion of organic matter, and the population would only be enhanced if food was previously limiting (Ref 9-146).

9.8.62 Greater energetic costs for benthic species could occur as a result of higher particle loads due to elevated suspended sediments stimulating the secretion of mucus to protect branchial or feeding structures of filter feeding organisms (Ref 9-163). Suspended sediment concentrations have been found to have a negative linear relationship with sub-surface light attenuation. Light availability and water turbidity are principal factors in determining depth range at which kelp and other algae are recorded. In addition, certain mobile epistrate feeders (such as the amphipod *Bathyporeia* spp.) feed on diatoms within the sand grains and an increase in suspended solids that consequently reduced light penetration could alter food supply (Ref 9-78). However, longer-term changes in turbidity levels rather than temporary elevations are likely to be required to elicit any measurable changes in these species.

9.8.63 Elevated suspended sediment levels can also cause increased scouring and damage of epifaunal species due to the potentially abrasive action of the suspended sediment in flowing water.

9.8.64 Increased suspended sediments may favour the development of suspension feeders such as bivalves over other species. However, it should be noted that many benthic invertebrates can switch feeding modes depending on environmental conditions. The negative effects of suspended sediment may be particularly important during larval settlement in spring, with settling stages potentially being more sensitive to effects such as scour. However, this is generally thought to be of less concern where fauna are adapted to naturally high levels of suspended sediments (Ref 9-164).

Dissolved oxygen

9.8.65 The resuspension of sediments containing organic material can cause oxygen depletion within the water column and the subsequent settling of this organic rich sediment can deplete sediment oxygen levels, potentially affecting benthic species. Reductions in dissolved oxygen from suspended sediments as a result of dredging are generally considered to be minimal and short-lived. However, potential effects can be more pronounced if dredging causes the disturbance of high levels of oxygen-depleting substances and nutrients present in some very fine-grained sediment deposits and where a great portion originate from waste water (Ref 9-165).

9.8.66 Oxygen depletion in severe situations can lead to hypoxia with most research on the effects of reductions in dissolved oxygen on benthic fauna during hypoxic conditions. This occurs when oxygen is consumed (e.g., by decomposing organic matter, respiration and oxidation of reduced chemical species) faster than it is replenished (e.g., via air-water oxygen transfer, photosynthesis, and mixing) (Ref 9-166). Coastal and estuarine waters can be particularly susceptible to low oxygen conditions as sediments are organic-rich and impose high sediment oxygen demands. Highly stratified estuaries, in which surface and bottom waters do not mix, are more prone to hypoxia (Ref 9-166). Coastal areas are more likely to experience hypoxia during summer when high temperatures strengthen salinity stratification (Ref 9-167). Severe anoxic events can deplete the benthic invertebrate communities and cause a shift in community composition, through attrition of intolerant species and elevated dominance, as well as reductions in

body size (Ref 9-168). In general, crustaceans and echinoderms are typically more sensitive to hypoxia, with lower oxygen thresholds, than annelids, molluscs and cnidarians (Ref 9-167).

Release of contaminants

9.8.67 Benthic habitats and species are sensitive to toxic contamination (where concentrations of contaminants exceed sensitivity thresholds). Toxic contamination during construction can occur as a result of the release of synthetic contaminants such as fuels and oils or through the resuspension of sediment as a result of the disturbance of the seabed which can lead to the release and mobilisation of sediment-bound contaminants into the water column. These include both toxic contaminants, such as heavy metals, pesticides and hydrocarbons, and non-toxic contaminants, such as nutrients. In particular, there is a risk that any uncontrolled releases of materials or sediments into the water column could make contaminants temporarily available for uptake by marine organisms. Over the longer-term any such releases could also become stored in the surface sediments of benthic habitats for future benthic uptake.

9.8.68 Suspension-feeding organisms may be particularly vulnerable to pollutants in the water column due to their dependence on filtration (Ref 9-78). High levels of chemical contaminants can potentially cause genetic, reproductive and morphological disorders in marine species. Contaminants may also have combined effects. Studies have suggested links between contamination with polycyclic aromatic hydrocarbons (“PAH”s), polychlorinated biphenyl (“PCB”s), amines and metals and a range of disorders (Ref 9-169). Increased incidence of tumours, neoplasia, DNA damage, polyploidy, hypoploidy, hermaphoditism and reduced immune response have all been reported in marine invertebrates in areas of high levels of pollution (Ref 9-170; Ref 9-171; Ref 9-172; Ref 9-173; Ref 9-174; Ref 9-175). Another highly researched pollutant is Tributyltin (“TBT”), which has toxic effects in a wide variety of biota, whereas inorganic tin is less toxic. TBT effects include lethal toxicity and effects on growth, reproduction, physiology, and behaviour. Several of the negative effects are due to interferences with the endocrine function, as occurs in the phenomenon imposex. Imposex is the superimposition of male organs onto females of gastropods, which are normally a dioecious species (Ref 9-176).

9.8.69 Sub-lethal effects of chemical contamination on marine invertebrates can reduce the fitness of individual species. Lethal effects may allow a shift in community composition to one dominated by pollution-tolerant species such as oligochaete worms (Ref 9-177). A reduction in community species richness is associated with elevated levels of pollutants. Contamination with PAHs, for example, leads to high levels of mortality in amphipod and shrimp species, and decreased benthic diversity (Ref 9-178). Similar reductions in diversity are linked with heavy metal contamination (Ref 9-179). Polychaete worms are thought to be quite tolerant of heavy metal contamination, whereas crustaceans and bivalves are considered to be intolerant (Ref 9-180).

Project impact assessment: Capital dredge

Elevated suspended sediment concentrations

9.8.70 The changes in SSC that are predicted to occur as a result of the capital dredge are presented in **Chapter 16: Physical Processes** of the ES **[TR030008/APP/6.2]**. In summary, the increased concentrations arising from the capital dredge will be of a lower magnitude and persist for a shorter distance (and time) than that from disposal activity which is summarised below.

9.8.71 Naturally very high SSC typically occur year-round in the Humber Estuary, particularly during the winter months when storm events disturb the seabed and on spring tides (Ref 9-79; Ref 9-80). The estuarine benthic communities recorded on mudflats and the shallow mud in the region are considered tolerant to this highly turbid environment (Ref 9-74; Ref 9-75; Ref 9-76). The predicted SSCs are within the range that can frequently occur naturally and also as a result of ongoing dredge and disposal activity (**Chapter 16: Physical Processes** of the ES **[TR030008/APP/6.2]**).

9.8.72 In summary, the predicted increases in SSC due to the capital dredging will be localised and temporary based on the Physical Processes assessment (**Chapter 16: Physical Processes** of the ES **[TR030008/APP/6.2]**). Magnitude of change is assessed as negligible and probability of occurrence is high and thus the overall exposure to change is negligible. Based on the evidence provided above, sensitivity of benthic habitats and species within the vicinity of the Project to increases in suspended sediments are considered to be low given that these receptors are well adapted to living in high suspended sediment conditions. Vulnerability is therefore assessed as none. While subtidal benthic communities are considered commonly occurring in the region, subtidal habitats form a component of the 'Estuaries' feature of the SAC. Importance is, therefore, considered to be moderate. The overall effect of suspended sediments on benthic habitats and species is assessed as **insignificant**.

Dissolved oxygen

9.8.73 With respect to dissolved oxygen, increases in SSC will be brief and localised and there is not expected to be a significant reduction in dissolved oxygen as assessed in the Water and Sediment Quality assessment in **Chapter 17: Marine Water and Sediment Quality** of the ES **[TR030008/APP/6.2]**. The probability of a localised effect is, therefore, medium to high but the magnitude of change is considered to be negligible, leading to a negligible exposure to change. On this basis the impact is assessed as **insignificant**.

Release of contaminants

9.8.74 The potential to impact the marine environment as a result of any sediment-bound contaminants arises primarily when the sediment that is released into the water column disperses and deposits elsewhere. However, it should be noted that the majority of material disturbed during capital dredging works will be lifted from the bed to the hopper/barge, with only a small proportion raised into

suspension and remaining in the water column (i.e., through abrasion pressure from the draghead/bucket).

9.8.75 Sampling and subsequent chemical analysis has been undertaken in accordance with the agreed MMO sample plan. The results of this analysis are summarised in more detail in the Marine Water and Sediment Quality assessment (**Chapter 17: Marine Water and Sediment Quality** of the ES **[TR030008/APP/6.2]**) and show the majority of contaminants in the sediments of the proposed dredge area are at relatively low concentrations, mostly below, or marginally exceeding, Cefas Action Level 1 ("AL1"). There were no exceedances of Action level 2 ("AL2") in any sediment samples analysed.

9.8.76 Based on the chemical analysis, there are low levels of contamination in sediments in the proposed dredge area. Only a small proportion of disturbed material is expected to be raised into suspension and this material will be rapidly dispersed by strong tidal currents in the area. Significant elevations in the water column contamination are, therefore, not anticipated. Based on these factors, the magnitude of change to subtidal habitat and species will be negligible. Subsequently, exposure of benthic habitats and species to potential contaminants is also assessed as negligible. The sensitivity of subtidal habitats and species to contaminants is assessed as low to moderate because, although contaminants can cause toxicity, the concentrations of contaminants required to produce both lethal and sub-lethal effects are generally high (although responses vary considerably between species).

9.8.77 Thus, marine habitats and species are not considered to be vulnerable to water quality changes associated with the scale of the proposed dredge. Vulnerability is, therefore, assessed as none. While subtidal communities are considered commonly occurring in the region, subtidal habitats form a component of the 'Estuaries' feature of the SAC. Importance is, therefore, considered to be moderate. Overall, the potential impact to benthic habitats and species arising as a result of disturbance of contaminated sediments is assessed as **insignificant**.

Project impact assessment: Disposal

Elevated suspended sediment concentrations

9.8.78 The changes in SSC that are predicted to occur as a result of the capital dredge disposal are presented in **Chapter 16: Physical Processes** of the ES **[TR030008/APP/6.2]**. In summary, the dredge disposal is predicted to produce peak SSC of around 600 to 800 mg/l above background at the disposal site, reducing to typically 100 to 200 mg/l within a distance of around 7km from the source. These peak increases are predicted to persist at any given location for a single modelled timestep (ten minutes) before the tidal forcing carries the plume further up or down estuary on the respective flood or ebb tide. SSCs of this magnitude are considered to regularly occur naturally or as a result of ongoing maintenance dredging/disposal. Upstream of Hull and downstream (within the outer estuary), maximum SSC levels are lower; generally, between 20 and 100 mg/l above background, as the tidal excursion from the disposal site limits the extent of the resultant plume. However, in reality due to the existing high SSC that typically occurs in the Humber Estuary, the predicted increase in

concentrations resulting from the disposal is likely to become immeasurable (against background) within approximately 1km of the disposal site. The measurable plume from each disposal operation is also only likely to persist for a single tidal cycle (less than six hours from disposal) as after this time the dispersion under the peak flood or ebb tidal flows means concentrations will have reverted to background levels.

9.8.79 Naturally very high SSCs typically occur year-round in the Humber Estuary, particularly during the winter months when storm events disturb the seabed and on spring tides. The estuarine benthic communities recorded on mudflats and the shallow mud in the region are considered tolerant to this highly turbid environment (Ref 9-74; Ref 9-75; Ref 9-76). The predicted SSCs are within the range that can frequently occur naturally and also as a result of ongoing dredge and disposal activity (**Chapter 16: Physical Processes** of the ES **[TR030008/APP/6.2]**).

9.8.80 The disposal of sediment will temporarily increase SSC, however, due to the strong hydrodynamic conditions in the area, these temporary elevations in SSC are expected to dissipate rapidly to background concentrations. With respect to dissolved oxygen, increases in SSC will be brief and localised and there is not expected to be a significant reduction in dissolved oxygen nor therefore any implications for benthic species and habitats. The magnitude of change is therefore assessed as negligible. Probability of occurrence is high and thus the overall exposure to change is negligible. Sensitivity of benthic features within the disposal ground and surrounding area to increases in suspended sediments are considered to be low given that these species are well adapted to survival in conditions with elevated SSCs. Vulnerability is, therefore, assessed as none. The benthic habitats and associated species that overlap with the changes brought about during disposal are of low ecological value but considered characteristic of the ‘Sandbanks which are slightly covered by sea water all the time’ feature of the Humber Estuary SAC. Therefore, importance is assessed as moderate. The overall impact is, therefore, assessed as **insignificant**.

Release of contaminants

9.8.81 The results of the sediment contamination sampling are summarised above and the Water and Sediment Quality assessment (**Chapter 17: Marine Water and Sediment Quality** of the ES **[TR030008/APP/6.2]**). In summary, low levels of contamination were found in the samples and there is no reason to believe the sediment will be unsuitable for disposal in the marine environment.

9.8.82 During disposal, sediment will be rapidly dispersed in the water column. Therefore, the already low levels of contaminants in the dredged sediments will be dispersed further. The probability of changes in water quality occurring at the disposal site is considered to be low and the overall exposure to change is considered to be negligible. The sensitivity of subtidal habitats and species to contaminants is assessed as low to moderate because, although contaminants can cause toxicity in subtidal communities, the concentrations of contaminants required to produce both lethal and sub-lethal effects are generally high (although responses vary considerably between species). Thus, subtidal habitats and species are not considered to be vulnerable to water quality changes at the

disposal site in the context of the disposal of the dredged arisings. Vulnerability is, therefore, assessed as none. Benthic habitats and species that overlap with the dispersal plume are of low ecological value but considered characteristic of the 'Sandbanks which are slightly covered by sea water all the time' feature of the Humber Estuary SAC. As a consequence, importance is assessed as moderate. The overall impact is, therefore, assessed as **insignificant**.

Underwater noise and vibration effects on invertebrates during marine piling, capital dredging and dredge disposal

General scientific context

9.8.83 Marine invertebrates lack a gas-filled bladder and are thus unable to detect the pressure changes associated with sound waves (Ref 9-81). However, all cephalopods as well as some bivalves, echinoderms, and crustaceans have a sac-like structure called a statocyst which includes a mineralised mass (statolith) and associated sensory hairs. Statocysts develop during the larval stage and may allow an organism to detect the particle motion associated with soundwaves in water to orient itself. In addition to statocysts, cephalopods have epidermal hair cells which help them to detect particle motion in their immediate vicinity, comparable to lateral lines in fish. Similarly, decapods have sensory setae on their body, including on their antennae which may be used to detect low-frequency vibrations. Whole body vibrations due to particle motion have been detected in cuttlefish and scallops, although species names and details of associated behavioural responses are not specified.

9.8.84 Scientific understanding of the potential effects of underwater noise on marine invertebrates is relatively underdeveloped (Ref 9-103). There is limited research to suggest that exposure to near-field low-frequency sound may cause anatomical damage (Ref 9-81). Anecdotal evidence indicates there was pronounced statocyst and organ damage in seven stranded giant squid after nearby seismic surveys (Ref 9-130). Airgun exposure can cause damaged statocysts in rock lobsters up to a year later (Ref 9-82). However, no such effects were detected in other studies (Ref 9-83). The disparate results between studies seem to be due to differences in sound exposure levels and duration, in some cases due to tank interference, although taxa-specific differences in physical vulnerability to acoustic stress cannot be discounted (Ref 9-81).

9.8.85 There is also increasing evidence to suggest that benthic invertebrates behaviourally respond to particle motion (vibration) (Ref 9-84). For example, blue mussels *Mytilus edulis* vary valve gape, oxygen demand and clearance rates (Ref 9-85) and hermit crabs *Pagurus bernhardus* shift their shell and at very high amplitudes, leave their shell, examine it and then return (Ref 9-84). The vibration levels at which these responses were observed generally correspond to levels measured near anthropogenic operations such as pile driving and up to 300m from explosives testing (blasting). A range of behavioural effects have also been recorded in decapod crustaceans, including a change in locomotion activity, reduction in antipredator behaviour and change in foraging habits (Ref 9-86). However, population level and mortality effects are considered unlikely.

Project impact assessment: Marine piling

9.8.86 Based on the evidence provided in the above scientific context review of the potential effects of underwater noise, population level and mortality effects in benthic invertebrates are considered unlikely. The Project will involve the installation of approximately up to 393 steel tubular piles of varying size in the marine environment. Further details are provided in **Chapter 2: The Project [TR030008/APP/6.2]**. The marine piling works will be temporary and are anticipated to be completed within 343 days.

9.8.87 Applying the project impact assessment methodology, the probability of a change in underwater noise and vibration occurring during marine piling is considered to be high. However, the marine piling activities will be temporary, lasting a period of 343 days, with the vibro and percussive (impact) marine piling noise only taking place for up to a maximum of 60 minutes and 270 minutes per day respectively over that period. Based on these factors, magnitude of the change in underwater noise and vibration due to marine piling is considered to be negligible. Population level and mortality effects in benthic invertebrates are considered unlikely but the marine piling may result in short term behavioural responses in some individuals. The sensitivity of the benthic invertebrate species to marine piling is, therefore, considered to be low. While both the subtidal and intertidal benthic communities are considered commonly occurring in the region, subtidal habitats form a component of the 'Estuaries' feature of the SAC. Intertidal habitats are protected (both a qualifying feature of the Humber Estuary SAC and a NERC Habitat of Principle Importance) and of functional importance for waterbirds. Importance is, therefore, considered to range from moderate (for subtidal habitats) to high (for intertidal habitats). On this basis, given that the magnitude of change is negligible and the sensitivity of benthic invertebrates is low, although the importance of benthic habitats ranges from moderate to high, the impact of marine piling noise and vibration on benthic invertebrates is assessed as **insignificant.**

Project impact assessment: Capital dredge and disposal

9.8.88 Based on the above review of the potential effects of underwater noise, population level and mortality effects in benthic invertebrates are considered unlikely. Furthermore, dredging is known to produce lower noise levels than marine piling or blasting and therefore, there is unlikely to be significant effects on benthic invertebrates.

9.8.89 Based on the evidence provided above in the scientific review and applying the project impact assessment methodology, the probability of a change in underwater noise and vibration occurring during dredging and disposal is considered to be high. However, dredging and the movement of vessels associated with disposal activities are known to produce lower noise levels than marine piling. Furthermore, the proposed capital dredge and disposal activities will be short term and temporary, lasting a period of around 12 days in total. Population level and mortality effects in benthic invertebrates is, therefore, considered unlikely and the only effect that could be expected in the vicinity of the dredging would be short term behavioural responses. Based on these factors, the magnitude of the change in underwater noise and vibration due to dredging

and disposal is considered to be negligible. The sensitivity of the benthic invertebrate species to dredging and disposal noise is considered to be low. As noted earlier, however, their overall importance is considered to range from moderate to high. On this basis, the impact of dredging and disposal noise and vibration on benthic invertebrates is assessed as **insignificant**.

The potential introduction and spread of non-native species

General scientific context

9.8.90 Non-native, or invasive, species are described as 'organisms introduced into places outside of their natural range of distribution, where they become established and disperse, generating a negative impact on the local ecosystem and species' (International Union for Conservation of Nature (Ref 9-87). The ecological impacts of such 'biological invasions' are considered to be the second largest threat to biodiversity worldwide, after habitat loss and destruction. In the last few decades marine and freshwater systems have been impacted by invasive species, largely as a result of increased global shipping (Ref 9-88).

9.8.91 The introduction and spread of non-native species can occur either accidentally or by intentional movement of species as a consequence of human activity (Ref 9-89 cited in Ref 9-90). The main pathway for the potential introduction of non-native species is via fouling of vessels' hulls, transport of species in ballast or bilge water and the accidental imports from materials brought into the system during development activities. Pathways involving vessel movements (fouling of hulls and ballast water) have been identified as the highest potential risk routes for the introduction of non-native species (Ref 9-91; Ref 9-84), particularly from different biogeographical regions, which agrees with the fact that areas with a high volume of shipping traffic are hotspots for non-native species in British waters (Ref 9-84).

9.8.92 The fouling of a vessel hull and other below-water surfaces can be reduced through the use of protective coatings. These coatings usually contain a toxic chemical (such as copper) or an irritant (such as pepper) that discourages organisms from attaching. Other coatings, such as those that are silicone-based, provide a surface that is more difficult to adhere to firmly, making cleaning of the hull less laborious. The type and concentration of coatings that can be applied to a boat hull is regulated and can vary between countries. Maintenance of hulls through regular cleaning will minimise the number of fouling organisms present. Hull cleaning can take place on land or in-water. In both cases, care needs to be taken to prevent the organisms and coating particles from being released into the water. By following best management practices, the impact of the cleaning procedure on the environment can be minimised.

9.8.93 Non-native invasive species also have the potential to be transported via ship ballast water. Seawater may be drawn into tanks when the ship is not carrying cargo, for stability, and expelled when it is no longer required. This provides a vector whereby organisms may be transported long distances. In 2004, the International Maritime Organisation ("IMO") adopted the 'International Convention for the Control and Management of Ships' Ballast Water and Sediments', which introduced two performance standards seeking to limit the risk of non-native

invasive species being imported (including distances for ballast water exchange and standards for ballast water treatment). The Convention came into force internationally in September 2017.

9.8.94 The UK is bound by international agreements such as the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention 1979), the Convention on the Conservation of European Wildlife and Natural Habitat (Berne Convention, 1979) and the Habitats and Birds Directives. All of these include provisions requiring measures to prevent the introduction of, or control of, non-native species, especially those that threaten native or protected species (Ref 9-92). Additionally, Section 14(1) of the WCA makes it illegal to release, or allow to escape into the wild, any animal which is not ordinarily resident in Great Britain and is not a regular visitor to Great Britain in a wild state or is listed in Schedule 9 to the WCA.

Project impact assessment

9.8.95 As discussed above, non-native species have the potential to be transported into the study area on ships' hulls during capital dredging and construction activity (such as crane barges used in marine piling). Non-native invasive species also have the potential to be transported via ship ballast water. Seawater may be drawn into the dredger tanks or hopper when the ship is not carrying cargo, for stability, and expelled when it is no longer required. This provides a vector whereby organisms may be transported long distances.

9.8.96 Within England and Wales, best practice guidance has been developed on how to manage marine biosecurity risks at sites and when undertaking activities through the preparation and implementation of biosecurity plans (Ref 9-93).

9.8.97 This guidance will be followed when developing biosecurity control measures to minimise the risk of the introduction and spread of non-native species during construction of the Project. These measures will be included within the **Outline CEMP [TR030008/APP/6.5]**. On this basis, the probability of the introduction and spread of non-native species from the construction phase is considered to be low. However, given that the magnitude of change is unknown, magnitude ranges from negligible to large depending upon the scale and nature of any non-native species introduction, thus the exposure ranges from negligible to low at worst. The sensitivity of all intertidal and subtidal receptors to non-native species introductions is expected to range from low to moderate. Vulnerability is, therefore, considered to be low. In addition, importance is considered to range from high (for intertidal mudflats) to moderate (for subtidal habitats). The overall impact is, therefore, considered to be **insignificant** to **minor adverse.**

Fish

9.8.98 This section contains an assessment of the potential impacts to fish receptors as a result of the construction phase of the Project. An assessment of the following impact pathways has been undertaken:

i. Direct loss or changes to fish populations and habitat as a direct result of dredging and dredge disposal.

j. Changes in water and sediment quality as a result of dredging and dredge disposal.

k. Underwater noise and vibration during marine piling, capital dredging and dredge disposal.

Direct loss or changes to fish populations and habitat as a direct result of dredging and dredge disposal

General scientific context

Indirect effects (food chain)

9.8.99 Seabed sediment removal during dredging has the potential to directly impact demersal fish but, more importantly, could also impact upon the benthic communities that are prey for fish and shellfish, and consequently could alter the distribution and presence of fish species in the region. Fish can have different feeding strategies, for example, some demersal feeders such as cod can show a strong preference for crustacea (Ref 9-181), whereas species such as plaice, dover sole, lemon sole and dab are benthic invertebrate feeders with a strong preference for polychaetes. Other species such as sand eel and whiting are invertebrate and piscivorous feeders. However, a change in dietary composition as a result of dredging is not considered to be damaging to the fish population as the majority of species are likely to switch to alternate prey sources in the event of an impact on their preferred prey, providing sufficient biomass is available to support them (Ref 9-181).

Indirect effects (habitat change)

9.8.100 Should the removal of seabed sediments during dredging lead to habitat loss or change, it could potentially impact on key habitats including feeding, spawning, nursery and overwintering grounds that have an important ecological function (Ref 9-131). Fish species that spawn directly onto the seabed are more sensitive to the effects of seabed removal due to dredging than those that spawn into the water column. For example, herring use coarse sediments as spawning grounds. Herring along with sand eel species which live within the sediment are considered particularly sensitive to habitat change (Ref 9-145).

Direct effects (uptake)

9.8.101 Hydraulic entrainment, through the direct uptake of aquatic organisms by the suction field generated at the draghead or cutterhead during dredging operations has the potential to result in the by-catch of fish eggs, larvae and even mobile juveniles and adults (Ref 9-95).

9.8.102 Limited research has been carried out regarding entrainment rates of fish in marine dredging. Lees *et al*. (Ref 9-182) sampled the outwash from an aggregate dredger in the English Channel and recorded the species. In five x ten minute samples, 22 fish were sampled and a further red gurnard was found from the surface of the hopper cargo. Most fish appeared physically undamaged and would have been washed back to sea, however the scope of the study did not include assessments of their subsequent survival rates. Demersal fish with poorer hearing sensitivity including flatfish and elasmobranchs are considered

more likely to be entrained by the dredger drag head (Ref 9-183; Ref 9-184). Large and active demersal and pelagic juvenile and adult finfish are likely to avoid dredging areas during operations in response to noise levels and increased turbidity (Ref 9-145).

9.8.103 In general, eggs, embryo and larval stages are considered more vulnerable to entrainment than adults. While the entrainment rates are likely to represent a small proportion of total larval production, fish entrained at the egg, embryo and larval stages will experience extremely high mortality rates although mortality rates will vary among fish species and development stages (Ref 9-95).

Project impact assessment: Capital dredge

9.8.104 Habitat change could potentially impact on critical habitats including spawning, nursery and feeding grounds that have an important ecological function for fish. However, the dredge footprint is considered unlikely to provide important nursery or spawning functions for fish species as a result of the existing disturbed nature of this habitat despite known nursery or spawning areas for species such as Dover sole, whiting or cod occurring in the wider Humber Estuary area.

9.8.105 Potential prey items for flatfish and demersal fish such as polychaete worms were recorded during the project specific subtidal surveys (**Appendix 9.A [TR030008/APP/6.4]**) (Ref 9-77). However, most fish species are opportunistic and generalist feeders, which means that they are generally not reliant on a single prey item. Fish are also mobile species and will easily be able to move away from the zone of influence and utilise other nearby areas for foraging. Furthermore, the area of habitat change will only represent a small proportion of the foraging ranges of many fish species (particularly the larger and more commercial species such as whiting, plaice and Dover sole).

9.8.106 During dredging, there is the potential for fish along with roe (eggs) of these species to be removed. The region is known to support Dover sole spawning grounds. Dover sole spawn on a range of substrates in shallow water. However, the dredge footprint and nearby area is already subject to regular natural seabed disturbance due to strong tidal currents. The dredge footprint and nearby area is, therefore, likely to provide disturbed and sub-optimal spawning conditions with more optimal habitat present in the wider region. In addition, the dredge footprint is considered negligible in the context of suitable nursery habitat in the region.

9.8.107 Given the very small dredge footprint in the context of the entire Humber Estuary (and small amount of material that needs to be dredged), the probability that diadromous species such as European eel and lamprey species will be removed into the bucket during backhoe dredging while passing through the estuary on migration is considered to be relatively low.

9.8.108 Based on these factors, magnitude is considered to be small and probability medium. Consequently, the exposure of all fish to direct habitat changes is considered to be negligible to low. The sensitivity of fish to habitat change on the scale predicted is considered to be low, leading to a low vulnerability. Therefore, while the overall importance of certain fish species is high (i.e. for fish species of conservation interest), the impact is assessed as **insignificant** to **minor adverse**.

Project impact assessment: Disposal

9.8.109 The disposal of dredged material at the marine disposal sites will result in the deposition of sediments which has the potential to cause physical disturbance and smothering of seabed habitats.

9.8.110 The disposal grounds are located in a highly dynamic area with the mobile sandbanks subject to regular natural physical disturbance (and associated scouring) as a result of very strong tidal flows and deposition due to regular dredge activity. This is reflected in a highly impoverished assemblage at both disposal sites (characterised by a few opportunistic species in very low numbers). This area is, therefore, likely to provide limited prey resources for fish species. In addition, as described above, benthic infaunal species characterising the disposal site are considered likely to show some tolerance to sediment deposition and also rapid recoverability rates. On this basis, potential effects on prey resources for fish are expected to be of low magnitude and temporary. Fish are also mobile species and will easily be able to move away from the zone of influence and return following the cessation of disposal activity.

9.8.111 The highly disturbed nature of the seabed is also unlikely to provide suitable conditions as a spawning or nursery area for fish.

9.8.112 Based on these factors, magnitude is considered to be small and probability medium. Consequently, the exposure of all fish to direct habitat changes is considered to be negligible to low. The sensitivity of fish to habitat change on the scale predicted is considered to be low, leading to a low vulnerability. Therefore, while the overall importance of certain fish species is high (i.e. for fish species of conservation interest), the impact is assessed as **insignificant** to **minor adverse**.

Changes in water and sediment quality as a result of dredging and dredge disposal

General scientific context

Elevated suspended sediment concentrations

9.8.113 Increased suspended sediments can lead to physiological effects in adult finfish resulting from the abrasion of sediment particles on gill tissues, causing reduced gill function and possible mortality (Ref 9-95; Ref 9-96; Ref 9-134). Such effects on fish are considered to occur at suspended sediment levels of around 10,000 mg/l (Ref 9-185). High SSC levels may impact spawning and nursery grounds through damage to eggs and planktonic larvae, as well as causing abrasion or clogging of the fragile gills of larval and juvenile fish, resulting in mortality or reduced growth rates.

9.8.114 Because turbidity often impairs visual acuity, activities and processes that require vision can be inhibited, leading to behavioural responses. For example, foraging in both planktivorous and piscivorous fish can be negatively affected by suspended sediments. Piscivores are especially sensitive to increasing turbidity because many are visual hunters that detect prey from a distance. An increase in suspended sediment reduces both light and contrast, decreasing encounter distances between predator and prey (Ref 9-95).

9.8.115 Elevated suspended sediments can also influence the movements and migration of fish (Ref 9-134). For example, a range of salmonid species have been observed actively avoiding moving through areas with suspended sediment plumes (Ref 9-95; Ref 9-96). However, such responses can cease if fish become acclimatised. Fish in high latitude coastal areas typically have to contend with variable turbidity and often poor visual conditions, resulting from fluctuations in ambient light levels, suspended sediments and in the light transmission properties of the water (Ref 9-134). For example, concentrations as high as 9,000 mg/l have been recorded in the path of salmon runs in the Usk Estuary (Ref 9-186). Similarly, lamprey and shad species have been known to successfully pass through estuaries with extremely high suspended sediments and, therefore, can be considered tolerant of turbid conditions (Ref 9-187). The mobile nature of fish species generally allows avoidance of areas of adverse conditions which are unlikely to significantly affect a population provided such conditions are temporary.

Organic enrichment and oxygen depletion

9.8.116 The resuspension of sediments containing organic material can cause oxygen depletion within the water column. The subsequent settling of this organic rich sediment can deplete the sediments of oxygen and affect benthic prey items used by fish. The response of fish to low concentrations of dissolved oxygen is determined by a range of factors, including the duration of exposure, water temperature and the presence of other pollutants (Ref 9-95). The duration of any low dissolved oxygen event is a key factor in determining its effect. Most fish would survive an extremely low concentration of dissolved oxygen, such as 2 mg/l, for a few minutes, but a longer exposure would start to have sub-lethal and eventually lethal effects (Ref 9-188).

Release of contaminants

9.8.117 The potential release of contaminants during construction and dredging activities may result in those contaminants becoming available for uptake by any fish in the water column or on surface sediments. There is an indirect risk to some finfish species as sediment-bound contaminants may temporarily bioaccumulate in the tissues of certain fish prey, such as polychaete worms and marine bivalves, and made available for uptake by feeding fish (Ref 9-134).

9.8.118 The influence of contaminated sediments is considered to have a greater impact on fish than elevated SSC with a range of evidence suggesting that direct exposure to contaminants negatively effects fish (Ref 9-95). Hydrophobic contaminants (such as legacy persistent organic pollutants including PCBs and organochlorine pesticides) as well as high-molecular weight polyaromatic and aliphatic hydrocarbons (such as PAHs), are closely associated with organic material in sediments. These contaminants have been linked to a range of potential reproductive impacts on adult fish (e.g. steroidogenesis, vitellogenesis, gamete production or spawning success) as well as lethal and non-lethal developmental (spinal and organ development, growth) impacts on embryos and larvae (Ref 9-189).

9.8.119 Demersal fish species, such as dab and flounder, which remain close to the seabed and feed mainly on benthic organisms, would experience a higher exposure to contaminated sediments than pelagic fish such as herring.

Project impact assessment: Capital dredge

9.8.120 The changes in SSC that could potentially occur as a result of the capital dredge are presented in the Physical Processes assessment (**Chapter 16: Physical Processes** of the ES **[TR030008/APP/6.2]**) and summarised above in the 'Benthic habitats and species' sub-section (**Paragraphs 9.8.70** to **9.8.72**).

9.8.121 As noted in the preceding section, fish within the Humber Estuary are well adapted to living in an area with variable and typically very high suspended sediment loads. Fish feed on a range of food items and, therefore, their sensitivity to a temporary change in the availability of a particular food resource is considered to be low. Their high mobility enables them to move freely to avoid areas of adverse conditions and to use other food sources in the local area.

9.8.122 As highlighted above, salmonids and other migratory fish can be sensitive to elevated SSC. However, Atlantic salmon and sea trout are both known to migrate through estuaries with high SSC to get to spawning areas (including the Humber Estuary which is considered one of the estuaries in the UK with the highest levels of SSCs) (Ref 9-94; Ref 9-95; Ref 9-96; Ref 9-79; Ref 9-80; Ref 9-134). Other migratory species such as lamprey and shad species also pass through estuaries with high suspended sediments. Elevated SSCs due to dredging are expected to be of a magnitude that can occur naturally during migratory periods or as a result of ongoing maintenance dredging/disposal.

9.8.123 Sediment plumes resulting from dredging will be relatively localised (in the context of the entire width of the estuary). It is considered that they will dissipate relatively rapidly and be immeasurable against background levels within a relatively short duration of time (less than a single tidal cycle) as described in more detail in the Physical Processes assessment (**Chapter 16: Physical Processes** of the ES **[TR030008/APP/6.2]**). Therefore, salmonids and other migratory fish will also be able to avoid the temporary sediment plumes. Based on these factors there is considered to be limited potential for migrating fish to be adversely affected by the predicted changes in SSC.

9.8.124 Given that elevated SSCs due to dredge and dredge disposal are considered to be in the range of variability that can occur naturally in the Humber Estuary (which has very high SSCs year-round, particularly during the winter months) as well as due to ongoing maintenance dredging/disposal and that plumes will be temporary in nature, sensitive life stages of fish occurring in the region such as larvae and juvenile fish are considered unlikely to be adversely affected by the dredging.

9.8.125 Whilst, therefore, the probability of a localised and temporary change is high, the magnitude of change will be negligible and consequently exposure to change is assessed as negligible. Sensitivity of fish is assessed as low to moderate and consequently vulnerability is assessed as none. It follows that although the overall importance of certain fish species is high (i.e. for fish species of conservation interest), the impact is assessed as **insignificant**.

9.8.126 With respect to dissolved oxygen, increases in SSC will be brief and localised and there is not expected to be a significant reduction in dissolved oxygen as assessed in the Water and Sediment Quality assessment (**Chapter 17: Marine Water and Sediment Quality** of the ES **[TR030008/APP/6.2]**). The probability of a localised effect is, therefore, medium to high but the magnitude of change is considered to be negligible, leading to a negligible exposure to change. Whilst the sensitivity of fish is considered to be low to moderate and certain species have a high nature conservation importance, the impact is assessed as **insignificant.**

9.8.127 With respect to sediment contamination, generally low levels of contamination were found in the sediment contamination samples as presented in the Water and Sediment Quality assessment (**Chapter 17: Marine Water and Sediment Quality** of the ES **[TR030008/APP/6.2]**).

9.8.128 Based on this sampling data, the overall level of contamination in the proposed dredge area is considered to be low and the sediment plume would be expected to rapidly dissipate by the strong tidal currents in the area. Significant elevations in the concentrations of contaminants within the water column are not anticipated. Based on these factors, therefore, the magnitude of change to fish species is considered to be negligible. Subsequently, exposure of fish species to potential contaminants is assessed as negligible. Given that the sensitivity of fish is considered to be low to moderate and the overall importance is considered to range from low to high, depending on the ecological value and protected status of individual species, the impact is assessed as **insignificant.**

Project impact assessment: Dredge disposal

9.8.129 The changes in SSC that could potentially occur as a result of the disposal activities are presented in the Physical Processes assessment (**Chapter 16: Physical Processes** of the ES **[TR030008/APP/6.2]**) and summarised above in the 'Benthic Habitats and Species' impact assessment sub-section (**Paragraphs 9.8.78** to **9.8.79**).

9.8.130 The disposal of sediment will temporarily increase SSC, however, due to the strong hydrodynamic conditions in the area, these temporary elevations in SSC are expected to rapidly dissipate to background concentrations within a matter of hours and before the next disposal. As highlighted above, migratory species including Atlantic salmon are known to migrate through estuaries with high SSC (including the Humber Estuary which is considered one of the estuaries in the UK with the highest levels of SSC) (Ref 9-79) and the predicted SSC are within the range that can frequently occur naturally during migratory periods and also as a result of ongoing dredge and disposal activity. Sediment plumes resulting from disposal will also be relatively localised in the context of the entire width of the estuary. Therefore, salmonids and other migratory fish would also be able to avoid the temporary sediment plumes.

9.8.131 Based on these factors, the magnitude of change is assessed as negligible and probability of occurrence is high and thus the overall exposure to change is negligible. Therefore, while the sensitivity of fish is low to moderate and certain species have a high nature conservation importance (e.g. migratory Atlantic salmon and lamprey) any impact is assessed as **insignificant**.

9.8.132 With respect to sediment contamination, the results of the sediment contamination sampling are summarised above, and in the Water and Sediment Quality chapter (**Chapter 17: Marine Water and Sediment Quality** of the ES **[TR030008/APP/6.2]**). In summary, generally low levels of contamination were found in the samples and there is no reason to believe the sediment will be unsuitable for disposal in the marine environment.

9.8.133 Based on the results of the sediment sampling survey, the overall level of contamination in the proposed dredge area is considered to be low. During disposal, sediment will be rapidly dispersed in the water column. As a consequence, the already low levels of contaminants in the dredged sediments will be dispersed further. The probability of changes in water quality occurring at the disposal site is considered to be low and the overall exposure to change is considered to be negligible. Whilst, therefore, the sensitivity of fish is low to moderate and certain species have a high nature conservation importance, any impact will be **insignificant**.

Underwater noise and vibration during marine piling, capital dredging and dredge disposal

General scientific context

9.8.134 Elevated underwater noise and vibration levels during construction activities can potentially disturb fish by causing physiological damage and/or inducing adverse behavioural reactions. A detailed underwater noise assessment has been undertaken for the Project (**Appendix 9.B [TR030008/APP/6.4]**) and is briefly summarised in this section.

9.8.135 For most marine piling activities, the main source of noise and vibration relates to where piles are hammered or vibrated into the ground. Percussive marine piling involves hammering the pile into the seabed resulting in an impact blow and high levels of noise. Vibro marine piling produces lower levels of noise as piles are vibrated into the seabed.

9.8.136 The dredging process involves a variety of sound generating activities which can be broadly divided into sediment excavation, transport and placement of the dredged material at the disposal site (Ref 9-97; Ref 9-98; Ref 9-99). For most dredging activities, the main source of sound relates to the vessel engine noise.

9.8.137 There is a wide diversity in hearing structures in fish which leads to different auditory capabilities across species (Ref 9-100). All fish can sense the particle motion[11] component of an acoustic field via the inner ear as a result of whole-body accelerations (Ref 9-101), and noise detection ('hearing') becomes more specialised with the addition of further hearing structures. Particle motion is especially important for locating sound sources through directional hearing (Ref 9-102; Ref 9-103; Ref 9-104). Although many fish are also likely to detect sound pressure[12], particle motion is considered equally or potentially more important (Ref 9-105).

9.8.138 From the few studies of hearing capabilities in fish that have been conducted, it is evident that there are potentially substantial differences in auditory capabilities from one fish species to another (Ref 9-105). Popper *et al* (2014) proposed the following three categories of fish which are described below (Ref 9-102):

l. Fish with a swim bladder or air cavities that aid hearing.

m. Fish with a swim bladder that does not aid hearing.

n. Fish with no swim bladder.

9.8.139 The first category comprises fish that have special structures mechanically linking the swim bladder to the ear. Fish species in the study area that fall within this first category include herring (*Clupea harengus*) and shads.

9.8.140 The second category comprises fish with a swim bladder where the organ does not appear to play a role in hearing. Fish species in the study area that fall within this second category include Atlantic cod (*Gadus morhua*), Atlantic salmon (*Salmo salar*), European eel (*Anguilla anguilla*), European seabass (*Dicentrarchus labrax*), Atlantic mackerel (*Scomber scombrus*), smelt (*Osmerus eperlanus*) and whiting (*Merlangius merlangus*).

9.8.141 The third category comprises fish lacking swim bladders that are sensitive only to sound particle motion and show sensitivity to only a narrow band of frequencies (e.g. flatfishes, sharks, skates and rays). Fish species in the study area that fall within this third category include plaice (*Pleuronectes platessa*), sea lamprey (*Petromyzon marinus*), sole (*Solea solea*) and thornback ray (*Raja clavata*).

Project impact assessment: Marine piling

9.8.142 The distances at which mortality and potential mortal injury, recoverable injury, temporary threshold shift ("TTS") and behavioural effects in fish are predicted to occur as a result of the percussive marine piling and vibro marine piling associated with the development are included in **Appendix 9.B [TR030008/APP/6.4]**.

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11 Particle motion is a back and forth motion of the medium in a particular direction; it is a vector quantity that can only be fully described by specifying both the magnitude and direction of the motion, as well as its magnitude, temporal, and frequency characteristics.

12 Pressure fluctuations in the medium above and below the local hydrostatic pressure; it acts in all directions and is a scalar quantity that can be described in terms of its magnitude and its temporal and frequency characteristics.

9.8.143 The Project will involve the installation of piles of varying sizes. The highest peak noise levels are generally associated with larger-sized piles given the larger surface area of the pile in contact with the water and the larger hammer energy and/or pile driving time involved in driving them. On this project, the largest piles are up to 2.3m in diameter. However, given that only a total of two of these piles will be driven for the Project, they only represent a very small proportion of all the piles (< 1 %). In addition to modelling the propagation of noise associated with these larger 2.3 m diameter piles as a worst case, therefore, the propagation of noise associated with the second largest 1.5m diameter piles, which comprise a more significant proportion of all the piles (45 %), has also been modelled.

9.8.144 The predicted range at which the quantitative instantaneous peak Sound Pressure Level ("SPL") thresholds for pile driving are reached (as defined in Ref 9-102) indicates that for the 2.3m diameter piles, there is a risk of mortality, potential mortal injury or recoverable injury within 80m from the source of impact marine piling in fish with a swim bladder (such as herring, Atlantic salmon and European eel) and within 40m in fish with no swim bladder (such as lamprey and flatfish). For 1.5m diameter piles, there is a risk of mortality, potential mortal injury or recoverable injury within 20m from the source of impact marine piling in fish with a swim bladder (such as herring, Atlantic salmon and European eel) and within 10m in fish with no swim bladder (such as lamprey and flatfish).

9.8.145 The calculator developed by the United States National Marine Fisheries Service ("NMFS") (Ref 9-106) as a tool for assessing the potential effects to fish exposed to elevated levels of underwater sound produced during pile driving was used to calculate the range at which the cumulative Sound Exposure Levels ("SEL") thresholds for pile driving (Ref 9-102) are reached. Based on the assumptions highlighted in **Appendix 9.B [TR030008/APP/6.4]**, for the 2.3m diameter piles, there is predicted to be a risk of mortality and potential mortal injury within 200m from the source of impact marine piling in fish with a swim bladder involved in hearing (such as herring), within 100m from the source in fish with a swim bladder not involved in hearing (such as European eel) and within 40m in fish with no swim bladder (such as sole). For 1.5m diameter piles, there is predicted to be a risk of mortality and potential mortal injury within 60m from the source of impact marine piling in fish with a swim bladder involved in hearing (such as herring), within 40m from the source in fish with a swim bladder not involved in hearing (such as European eel) and within 10m in fish with no swim bladder (such as sole). For the 2.3m diameter piles, the distance at which the received level of impact marine piling noise is within the limits of the recoverable injury threshold is within 300m in fish with a swim bladder and 60m in fish without a swim bladder. For 1.5m diameter piles, the distance at which the received level of noise is within the limits of the recoverable injury threshold is within 100m in fish with a swim bladder and 20m in fish without a swim bladder.

9.8.146 For vibro marine piling of either 2.3m or 1.5m diameter piles, there is predicted to be a risk of mortality and potential mortal injury within 50m from the source in fish with a swim bladder involved in hearing, within 30m from the source in fish with a swim bladder not involved in hearing and within 10m in fish with no swim bladder. The distance at which the received level of noise is within the limits of the recoverable injury threshold is within 80m in fish with a swim bladder and 10m in fish without a swim bladder.

9.8.147 Given the mobility of fish, any individuals that might be present within the localised areas associated with potential mortality/injury during pile driving activities would be expected to easily move away and avoid harm. Furthermore, the area local to the Project is not considered a key foraging, spawning or nursery habitat for fish and, therefore, this localised zone of injury is unlikely to result in any significant effects on fish.

9.8.148 The range at which the Ref 9-102 TTS and Ref 9-107 quantitative instantaneous peak SPL behaviour thresholds for percussive pile driving are reached indicates that there is a risk of a behavioural response in fish within around 2-3km from the source of impact marine piling for 2.3m diameter piles and 1-2 m from the source of impact marine piling 1.5m diameter piles. For the 2.3m diameter piles, TTS and behavioural reactions during impact marine piling are, therefore, anticipated to occur across 87% to 100% width of the Humber Estuary at low water and 59 % to 88 % of the width of the estuary at high water. For the 1.5m diameter piles, TTS and behavioural reactions are anticipated to occur across 43% to 87% of the width of the Humber Estuary at low water and 29% to 59% of the estuary width at high water. Impact marine piling, therefore, has the potential to create a partial to full temporary barrier to fish movements. For vibro marine piling, there is a risk of TTS and behavioural reactions in fish within around 1km from the source which equates to 43% of the width of the Humber Estuary at low water respectively and 29% of the estuary width at high water.

9.8.149 The scale of the behavioural response is partly dependent on the hearing sensitivity of the species. The key fish in the study area include species across the range of Ref 9-102 fish hearing groups. Fish with a swim bladder involved in hearing (e.g. herring) may exhibit a moderate behavioural reaction within a distance in which a behavioural response is predicted (e.g. a sudden change in swimming direction, speed or depth). Fish with a swim bladder that is not involved in hearing (e.g. European eel) are likely to display a milder behavioural reaction. Fish without a swim bladder (e.g. river lamprey) are likely to show only very subtle changes in behaviour in this zone.

9.8.150 The scale of the behavioural effect is also dependent on the size of fish (which affects maximum swimming speed). Smaller fish, juveniles and fish larvae swim at slower speeds and are likely to move passively with the prevailing current. Larger fish are more likely to actively swim and, therefore, may be able to move out of the behavioural effects zone in less time, although it is recognised that the movement of fish is very complex and not possible to define with a high degree of certainty.

9.8.151 The effects of marine piling noise on fish also need to be considered in terms of the duration of exposure. Marine piling noise will take place over a period of approximately 343 days. However, marine piling will not take place continuously as there will be periods of downtime, pile positioning and set up.

9.8.152 The marine piling works will be undertaken seven days per week. Intended working hours will be from 07:00 to 19:00 in winter months (1 September to 31 March inclusive) and sunrise to sunset in the summer months (1 April to 31 August inclusive). The maximum impact marine piling scenario is for three tubular piles to be installed each day using up to two marine piling rigs pile driving at any one time, involving approximately 270 minutes of impact (percussive) marine piling per day and 60 minutes of vibro marine piling per day in a 12-hour shift. There will, therefore, be significant periods over a 24-hour period when fish will not be disturbed by any marine piling noise. The actual proportion of marine piling is estimated to be at worst around 23% over a 24-hour period (based on 270 minutes of impact marine piling and 60 minutes of vibro marine piling each working day) over any given construction week. In other words, any fish that remain within the predicted behavioural effects zone at the time of marine piling will not be exposed up to 77% of the time over the period of a day.

9.8.153 The marine piling will occur between 07:00 to 19:00 in the winter months and sunrise to sunset in the summer months, which has the potential to disproportionately affect fish that migrate during daylight hours, whilst reducing the potential exposure of fish that predominantly migrate during night time hours (e.g., river lamprey and glass eel).

9.8.154 It is also important to consider the noise from marine piling against existing background or ambient noise conditions. The levels of underwater noise generated by impact marine piling are predicted to reach existing background levels previously measured in the Humber Estuary within around 2 to 3km from the source. The levels of underwater noise generated by vibro marine piling are predicted to reach background levels within around 1km from the source. Furthermore, the wider local area in which the construction will take place already experiences regular vessel operations and ongoing maintenance dredging, and, therefore, fish are likely to be habituated to a certain level of anthropogenic background noise.

9.8.155 Applying the standard impact assessment criteria, the probability of occurrence of underwater noise disturbance during marine piling is high. Given the uncertainty regarding the actual timing and programme for the marine piling, this assessment has been undertaken on the basis that the works could take place at any time of year as a worst case. There is the potential for marine piling to occur during the sensitive migratory periods of fish in the Humber Estuary, including the migratory periods of diadromous fish such as Atlantic salmon, European smelt, European eel, shads and lamprey. Migratory fish moving between the Humber Estuary and the sea could potentially pass near to the proposed marine works (with a risk of injury potentially occurring in very close proximity to the marine piling activity). In addition, a behavioural response (e.g., displacement) or acoustic barrier could occur over the majority of the width of the Humber Estuary at low water and a slightly smaller proportion of the estuary width at high water. Magnitude and

consequently exposure to change is, therefore, considered to be medium for these migratory species.

9.8.156 The sensitivity of Atlantic salmon, sea trout, European smelt, shads and European eel is considered to be moderate with the sensitivity of lamprey species low based on the Popper *et al*. (Ref 9-102) fish noise exposure criteria. All diadromous fish species are considered to have a high importance due to their conservation value and protection. On this basis, whilst only temporary and short term in duration, the effect on Atlantic salmon, sea trout, European smelt, shads, European eel is considered to be **moderate adverse** and the effect to lamprey species **minor adverse**.

9.8.157 In terms of other fish occurring in the Humber Estuary, the effect is considered to be **insignificant to minor adverse**. This is based on these other fish having a range of sensitivities from low to moderate and a low to medium importance in terms of nature conservation status.

Project impact assessment: Capital dredge and dredge disposal

9.8.158 The relative risk and distances at which mortality and potential mortal injury, TTS and behavioural effects in fish are predicted to occur as a result of the dredging and vessel movements associated with the construction and operation of the Project are included in **Appendix 9.B [TR030008/APP/6.4**].

9.8.159 The qualitative guidelines for continuous noise sources (Ref 9-102) consider that the risk of mortality and potential mortal injury in all fish is low in the near, intermediate and far-field. Applying the cumulative SEL thresholds for marine piling (Ref 9-102) on a precautionary basis, indicate that there is a risk of mortality/potential mortal injury within 50m in fish with a swim bladder involved in hearing, within 30m in fish with a swim bladder that is not involved in hearing and 10m for fish with no swim bladder.

9.8.160 According to Ref 9-102, the risk of recoverable injury is also considered low for fish with no swim bladder and fish with a swim bladder that is not involved in hearing. There is a greater risk of recoverable injury in fish where the swim bladder is involved in hearing (e.g. herring) whereby a cumulative noise exposure threshold is recommended (170 dB rms for 48h). The distance at which recoverable injury is predicted in these fish as a result of the dredging and vessel movements is 10m. Applying the cumulative SEL thresholds for marine piling (Ref 9-102) on a precautionary basis, indicate that there is a risk of recoverable injury within 80m in fish with a swim bladder and 20m for fish with no swim bladder.

9.8.161 Ref 9-102 advises that there is a moderate risk of a TTS occurring in the nearfield (i.e. tens of metres from the source) in fish with no swim bladder and fish with a swim bladder that is not involved in hearing and a low risk in the intermediate and far-field. There is a greater risk of TTS in fish where the swim bladder is involved in hearing (e.g. herring) whereby a guideline quantitative threshold is recommended (158 dB rms for 12 h). The distance at which TTS is predicted in these fish as a result of the dredging and vessel movements is 50m. Applying the cumulative SEL thresholds for marine piling (Ref 9-102) on a

precautionary basis, indicate that there is a risk of TTS occurring within 700m in all fish.

9.8.162 Popper *et al.* (2014) (Ref 9-102) guidelines suggest that there is considered to be a high risk of potential behavioural responses occurring in the nearfield (i.e. tens of metres from the source) for fish species with a swim bladder involved in hearing and a moderate risk in other fish species. At intermediate distances (i.e. hundreds of metres from the source), there is considered to be a moderate risk of potential behavioural responses in all fish and in the farfield (i.e. thousands of metres from the source) there is considered to be a low risk of a response in all fish.

9.8.163 Overall, there is generally considered to be a low risk of any injury in fish as a result of the underwater noise generated by dredging and vessel movements although mortality/potential mortal injury or recoverable injury could potentially occur in very close proximity to the dredger, particularly in fish where the swim bladder is involved in hearing (e.g. herring). The level of exposure will depend on the position of the fish with respect to the source, the propagation conditions, and the individual's behaviour over time. However, it is unlikely that a fish would remain in the vicinity of a dredger for extended periods within the distances at which mortality/potential mortal injury or recoverable injury are predicted in fish as a result of the dredging and vessel movements. TTS and behavioural responses are anticipated to be relatively localised in scale and, in the context of the estuary width and the unconstrained nature of the location, fish will be able to move away and avoid the source of the noise as required. Furthermore, the period of capital dredging during construction will be very short term and temporary, lasting a period of approximately 12 days in total.

9.8.164 It is also important to consider the noise from dredging and vessel movements against existing background or ambient noise conditions. The levels of underwater noise generated by dredging and vessel movements are predicted to reach existing background levels previously measured in the Humber Estuary within around 100m from the source. Furthermore, the estuary and location of the proposed works already experiences regular vessel operations and ongoing maintenance dredging, and, therefore, fish are already habituated to a similar level of anthropogenic background noise.

9.8.165 Based on the above considerations, the overall magnitude of the change in underwater noise due to dredging and possible disposal activities is considered to be minor. Probability of occurrence is high and thus the overall exposure to change is low. While sensitivities of fish to underwater noise ranges from low to moderate depending on the Popper *et al.* (Ref 9-102) category within which the fish species falls, vulnerability is assessed as low. The importance of fish ranges from high for fish of high nature conservation status to low for resident fish with no protected status and which are not of commercial value. Overall, therefore, the impact of underwater noise during dredging and disposal activities on fish is considered to be **insignificant** for resident fish and **minor adverse** for fish of high nature conservation status**.**

Marine Mammals

9.8.166 This section contains an assessment of the potential impacts to marine mammal receptors as a result of the construction phase of the Project. The following impact pathway has been assessed:

o. Underwater noise and vibration during marine piling, capital dredging and dredge disposal.

Underwater noise and vibration during marine piling, capital dredging and dredge disposal

General scientific context

9.8.167 Elevated underwater noise and vibration levels during construction activities has the potential to cause physiological damage and induce adverse behavioural reactions. A detailed Underwater Noise assessment has been undertaken for the Project (**Appendix 9.B [TR030008/APP/6.4]**) and is briefly summarised in this section.

9.8.168 For most marine piling activities, the main source of noise and vibration relates to where piles are hammered or vibrated into the ground. Percussive (impact) marine piling involves hammering the pile into the seabed resulting in an impact blow and high levels of noise. Vibro marine piling produces lower levels of noise as piles are vibrated into the seabed.

9.8.169 The dredging process involves a variety of sound generating activities which can be broadly divided into sediment excavation, transport and placement of the dredged material at the disposal site (Ref 9-97; Ref 9-98; Ref 9-99). For most dredging activities, the main source of sound relates to the vessel engine noise.

9.8.170 Marine mammals are particularly sensitive to underwater noise at higher frequencies and generally have a wider range of hearing than other marine fauna, namely fish (i.e. their hearing ability spans a larger range of frequencies). The hearing sensitivity and frequency range of marine mammals varies between different species and is dependent on their physiology.

9.8.171 The National Oceanic and Atmospheric Administration (“NOAA”) (Ref 9-110) provides technical guidance for assessing the effects of underwater anthropogenic (human-made) sound on the hearing of marine mammal species. Specifically, the received levels, or acoustic thresholds, at which individual marine mammals are predicted to experience changes in their hearing sensitivity (either temporary or permanent) for acute, incidental exposure to impulsive and non-impulsive underwater anthropogenic sound sources are provided. These thresholds update and replace the previously proposed criteria in Ref 9-108 for preventing auditory/physiological injuries in marine mammals. Further recommendations have recently been published regarding marine mammal noise exposure by Southall *et al* (Ref 9-109) which complement the NOAA (Ref 9-110) thresholds and also look at a wider range of marine mammal species.

9.8.172 The NOAA (Ref 9-110) and Southall *et al* (Ref 9-109) thresholds are categorised according to marine mammal hearing groups. The key marine mammal species found in the study area for the Project comprise harbour porpoise, common seal and grey seal. According to the NOAA (Ref 9-110), harbour porpoise is categorised as a high-frequency ("HF") cetacean and common and grey seals are categorised as phocid pinniped ("PW") (earless seals or "true seals").

9.8.173 There are no equivalent SPL behavioural response criteria that would represent the sources of underwater noise associated with the Project. Behavioural reactions to acoustic exposure are less predictable and difficult to quantify than effects of noise exposure on hearing or physiology as reactions are highly variable and context specific (Ref 9-108). Instead, a desk-based review of the observations from field studies has been undertaken, as reported in detail in **Appendix 9.B [TR030008/APP/6.4]**.

9.8.174 Field studies have demonstrated behavioural responses of harbour porpoises to anthropogenic noise (Ref 9-111). A number of studies have shown avoidance of pile driving activities during offshore wind farm construction (Ref 9-112; Ref 9-113; Ref 9-114), with the range of measurable responses extending to at least 21km in some cases (Ref 9-115). Seismic surveys have also elicited avoidance behaviour in harbour porpoises, albeit short-term (Ref 9-116), and monitoring of echolocation activity suggests possible negative effects on foraging activity in the vicinity of seismic operations (Ref 9-117). There is a scarcity of studies quantifying behavioural impacts from dredging (Ref 9-118). One investigation showed that harbour porpoises temporarily avoided an area of sand extraction off the Island of Sylt in Germany (Ref 9-119). This study found that, when the dredging vessel was closer than 600m to the porpoise detector location, it took three times longer before a porpoise was again recorded than during times without sand extraction. However, after the ship left the area, the clicks made by harbour porpoise (for echolocation) resumed to the baseline rate (Ref 9-119).

9.8.175 Few studies have documented responses of seals to underwater noise in the field (Ref 9-111). Tracking studies found reactions of the grey seals to pile driving during the construction of windfarms were diverse (Ref 9-120). These included altered surfacing or diving behaviour, and changes in swim direction including swimming away from the source, heading into shore or travelling perpendicular to the incoming sound, or coming to a halt. Also, in some cases no apparent changes in their diving behaviour or movement were observed. Of the different behavioural changes observed a decline in descent speed occurred most frequently, which suggests a transition from foraging (diving to the bottom), to more horizontal movement. These changes in behaviour were on average larger, and occurred more frequently, at smaller distances from the pile driving events, and such changes were statistically significantly different at least up to 36km from the marine piling. In addition to changes in dive behaviour, also changes in movement were recorded. There was evidence that on average grey seals within 33km were more likely to swim away from the pile driving. In some cases, seals exposed to pile-driving at close range, returned to the same area on subsequent trips. This suggests that some seals had an incentive to go to these areas, which was stronger than the deterring effect of the pile-driving.

9.8.176 A telemetry study found no overall significant displacement of common seal during construction of a wind farm in The Wash, south-east England (Ref 9-35). However, during marine piling, seal usage (abundance) was significantly reduced up to 25km from the marine piling activity; within 25km of the centre of the wind farm, there was a 19 to 83% (95% confidence intervals) decrease in usage compared to during breaks in marine piling, equating to a mean estimated displacement of 440 individuals. This amounts to significant displacement starting from predicted received levels of between 166 and 178 dB re 1 µPa (peak-peak). Displacement was limited to marine piling activity; within two hours of cessation of pile driving, seals were distributed as per the non-marine piling scenario.

9.8.177 A playback experiment was conducted on harbour seals in which the recorded sound of an operational wind turbine was projected via a loudspeaker, resulting in modest displacement of seals from the source (median distance was 284 vs 239m during control trials) (Ref 9-121). Two further studies of ringed seals (*Phoca hispida*), which are closely related to both harbour and grey seals, have observed behaviour in response to anthropogenic noise: Animals have been reported swimming away and avoidance within ~150m of a seismic survey(Ref 9-129), while other studies have found no discernible difference in seal densities in response to construction and drilling for an oil pipeline (Ref 9-122).

9.8.178 A number of field observations of harbour porpoise and pinnipeds to multiple pulse sounds have been made and are reviewed by Ref 9-108. The results of these studies are considered too variable and context-specific to allow single disturbance criteria for broad categories of taxa and of sounds to be developed. Another way to evaluate the responses of marine mammals and the likelihood of behavioural responses is by comparing the received sound level against species specific hearing threshold levels. Further information on the dBht metric and its limitations is provided in **Appendix 9.B [TR030008/APP/6.4**].

Project impact assessment: Marine piling

9.8.179 The distances at which permanent threshold shifts (“PTS”), TTS and behavioural effects in marine mammals that occur in the study area are predicted to occur during impact marine piling and vibro marine piling for the Project are included in **Appendix 9.B [TR030008/APP/6.4].**

9.8.180 As discussed above for fish, the Project will involve the installation of piles of varying sizes. The largest piles that will be driven for the Project comprise two 2.3m diameter piles, which represent a very small proportion of all the piles (< 1 %). In addition to modelling the propagation of noise associated with these larger 2.3m diameter piles as a worst case, therefore, the propagation of noise associated with the second largest 1.5m diameter piles, which comprise a more significant proportion of all the piles (45 %), has also been modelled.

9.8.181 The distances at which PTS and TTS in marine mammals are predicted to occur during impact marine piling of 2.3m and 1.5m diameter piles are included in **Table 9-18** and **Table 9-19**.

Table 9-18: Approximate distances (metres) marine mammal response criteria are reached during impact marine piling 2.3m diameter piles

Marine Mammal Hearing Group	PTS		TTS	
	SEL_{cum}	Peak	SEL_{cum}	Peak
Harbour porpoise	3,000	100	20,000	200
Common seal and grey seal	2,000	10	10,000	30

Table 9-19: Approximate distances (metres) marine mammal response criteria are reached during impact marine piling 1.5m diameter piles

Marine Mammal Hearing Group	PTS		TTS	
	SEL_{cum}	Peak	SEL_{cum}	Peak
Harbour porpoise	2,000	40	10,000	90
Common seal and grey seal	800	5	5,000	10

9.8.182 There is predicted to be a risk of instantaneous PTS and TTS in harbour porpoise within approximately 100m and 200m respectively from the source of the percussive marine piling noise of 2.3m diameter piles, and within approximately 40m and 90m respectively from the source of the percussive marine piling noise of 1.5m diameter piles. The risk of instantaneous PTS and TTS in seals is within approximately 10 and 30m respectively from the source of the percussive (impact) marine piling of the 2.3m diameter piles and within approximately 5m and 10m respectively of the 1.5m diameter piles.

9.8.183 If the propagation of underwater noise from impact marine piling were unconstrained by any boundaries, the maximum theoretical distance at which the predicted SEL_{cum} weighted levels of underwater noise during impact marine piling is within the limits of PTS and TTS in harbour porpoise is approximately 3km and 20km respectively for 2.3m diameter piles (**Table 9-18**) and approximately 2km and 10km respectively for 1.5m diameter piles (**Table 9-19**). The maximum distance for PTS and TTS in seals is approximately 2km and 10km respectively for 2.3m diameter piles (**Table 9-18**), and 800m and 5km respectively for 1.5m diameter piles **(Table 9-19**).Assuming a worst case of a lower swimming speed of 1.5m/s for all marine mammal species (including both adults and juveniles), the maximum time that it would take harbour porpoise to leave the centre of the cumulative SEL weighted PTS and TTS injury zones during impact marine piling is estimated to be around 30 minutes and four hours respectively for 2.3m diameter piles and around 20 minutes and 2 hours respectively for 1.5m diameter piles. This is less than 17 % of the time that would be required for an injury to occur and, therefore, assuming harbour porpoise evade the injury effects zone, they are not considered to be at risk of any permanent or temporary injury during impact marine piling. The maximum time that would take seals to leave the PTS and TTS zones is estimated to be 20 minutes and two hours respectively for 2.3m diameter piles and around 9 minutes and one hour respectively for 1.5m

diameter piles. This is less than 9 % of the time that would be required for an injury to occur and, therefore, assuming seals evade the injury effects zone, they are not considered to be at risk of any permanent or temporary injury during impact marine piling.

9.8.184 The distances at which PTS and TTS in marine mammals are predicted to occur during vibro marine piling activities associated with the construction of the proposed development for either 2.3m diameter or 1.5m diameter piles are included in **Table 9-20**.

Table 9-20: Approximate distances (metres) marine mammal response criteria are reached during vibro marine piling

Marine Mammal Hearing Group	PTS	TTS
High-frequency (HF) cetaceans (porpoises, river dolphins)	200	2,000
Phocid pinniped (PW) (true seals)	80	1,000

9.8.185 If the propagation of underwater noise from vibro marine piling were unconstrained by any boundaries, the maximum theoretical distance at which the predicted SEL_{cum} weighted levels of underwater noise during vibro marine piling is within the limits of PTS and TTS in harbour porpoise is 200m and 2km respectively. The maximum distance for PTS and TTS in seals is 80m and 1km respectively.

9.8.186 Assuming a worst case of a lower swimming speed of 1.5m/s for all marine mammal species (including both adults and juveniles), the maximum time that would take harbour porpoise to leave the centre of the cumulative SEL weighted PTS and TTS injury zones during vibro marine piling is estimated to be around two minutes and 30 minutes respectively. This is less than 3% of the time that would be required for an injury to occur and, therefore, assuming harbour porpoise evade the injury effects zone, they are not considered to be at risk of any permanent or temporary injury during vibro marine piling. The maximum time that it would take seals to leave the PTS and TTS zones is estimated to be around one minute and ten minutes respectively. This is less than 1% of the time that would be required for an injury to occur and, therefore, assuming seals evade the injury effects zone, they are not considered to be at risk of any permanent or temporary injury during vibro marine piling.

9.8.187 Impact marine piling is predicted to cause instantaneous injury effects within close proximity to the activity and strong behavioural responses over a wider area although this will be constrained to within the outer section of the Humber Estuary between Hull and Cleethorpes.

9.8.188 The results indicate that if any marine mammals present in the Humber Estuary were to remain stationary within the cumulative SEL distances from the source of marine piling over a 24-hour period, it could result in temporary and/or permanent hearing injury. However, it is considered highly unlikely that any individual marine mammal will stay within this “injury zone” during the marine piling operations.

9.8.189 Any marine mammals present are likely to evade the area. Behavioural responses could include movement away from a sound source, aggressive behaviour related to noise exposure (e.g. tail/flipper slapping, fluke display, abrupt directed movement), visible startle response and brief cessation of reproductive behaviour (Ref 9-108). Mild to moderate behavioural responses of any individuals within these zones could include movement away from a sound source and/or visible startle response (Ref 9-108).

9.8.190 Any evasive response could also lead to the potential temporary avoidance of the outer section of the Humber Estuary between Hull and Cleethorpes. There is therefore considered the potential for the restriction of the movements of marine mammals upstream and downstream (i.e. a barrier to movements). The Humber Estuary upstream of the Project is not known to be used as a breeding site for seals (with the nearest known breeding colony located over 25km away at Donna Nook at the mouth of the estuary). However, as noted in the baseline (**Section 9.6**), seals and harbour porpoise are regularly recorded foraging in the Humber Estuary and have been observed within several kilometres of the Project. While numbers at any given time in the Immingham area will only represent a small proportion of regional populations[13], foraging individuals or small pods (harbour porpoise) in this area are nevertheless expected to occur relatively frequently. Any barrier to movements caused by the noise during marine piling would be temporary with significant periods of a 24-hour period when no marine piling will be undertaken (see below) which will allow the unconstrained movements of marine mammals through the Humber Estuary. Marine mammals are also highly mobile and wide ranging and therefore are likely to be able to exploit other areas for foraging during any marine piling.

9.8.191 The effects of marine piling noise on marine mammals also need to be considered in terms of the duration of exposure. Marine piling noise will take place over a period of approximately 343 days. Marine piling will not take place continuously as there will be periods of downtime, pile positioning and set up.

9.8.192 The piling works will be undertaken seven days per week. Intended working hours will be from 07:00 to 19:00 in winter months (1 September to 31 March inclusive) and sunrise to sunset in the summer months). The maximum impact marine piling scenario is for three tubular piles to be installed each day using up to two marine piling rigs pile driving at any one time, involving approximately 270 minutes of impact marine piling per day and 60 minutes of vibro marine piling per day in a 12 hour shift. There will, therefore, be significant periods over a 24-hour period when marine mammals will not be disturbed by any marine piling noise. The actual proportion of impact marine piling is estimated to be at worst around 23 % over a 24-hour period (based on 270 minutes of impact marine piling and 60 minutes of vibro marine piling each working day) over any given construction week. In other words, any marine mammals that remain within the

[13] The Humber Estuary/Lincolnshire coast region supports thousands of grey seals with counts over 4,000-6,000 seals recorded hauling out and over 2,000 pups born in recent years at Donna Nook. In addition, counts of approximately 100-150 common seals have also been recorded at Donna Nook in recent years. An estimated abundance of over 50,000 harbour porpoises was estimated for the southern North Sea region based on (SCANS) III data (**Section 9.6**).

predicted behavioural effects zone at the time of percussive marine piling will not be exposed up to 77% of the time over the period of a day.

9.8.193 Furthermore, as stated in **Section 9.6**, grey seals can undertake wide ranging seasonal movements over several thousand kilometres (Ref 9-136; Ref 9-132; Ref 9-137). Seals tagged at Donna Nook were recorded undertaking wide ranging movements in the outer Humber Estuary and approaches as well as more widely in the North Sea (Ref 9-137). Therefore, seals are likely to be able to exploit a much wider area for foraging during any marine piling activity.

9.8.194 It is also important to consider the noise from marine piling against existing background or ambient noise conditions. The levels of underwater noise generated by impact marine piling are predicted to reach existing background levels previously measured in the Humber Estuary within around 2 to 3km from the source. The levels of underwater noise generated by vibro marine piling are predicted to reach background levels within around 1 km from the source. Furthermore, the vicinity of the area in which the construction will take place already experiences constant vessel operations and ongoing maintenance dredging, and, therefore, marine mammals are likely to be habituated to a certain level of anthropogenic background noise.

9.8.195 Applying the standard impact assessment criteria in the assessment, the probability of occurrence of underwater noise disturbance during marine piling is high. The magnitude of the change is, however, considered likely to be small to medium, taking account of the scale of change, short term and temporary nature of the marine piling works and highly mobile nature of marine mammals. The sensitivity of marine mammal species to marine piling noise is considered to be moderate[14] . In addition, the importance of marine mammal species is considered to be high given the level of protection that they are afforded. As a consequence, the temporary underwater noise effect on marine mammals during marine piling is assessed as **minor** to **moderate adverse**.

Project impact assessment: Capital dredge and dredge disposal

9.8.196 The distances at which PTS and TTS and behavioural effects in marine mammals that occur in the study area are predicted to occur as a result of the dredging and vessel movements to and from the disposal sites associated with the Project are included in **Appendix 9.B [TR030008/APP/6.4]**.

9.8.197 NOAA's user spreadsheet tool (Ref 9-110) has been used to predict the range at which the weighted cumulative SEL acoustic thresholds (Ref 9-110) for PTS and TTS are reached during the proposed dredging and disposal activity based on the assumptions highlighted in **Appendix 9.B [TR030008/APP/6.4]**.

[14] Moderate sensitivity was assigned on the basis that relatively localised injury effects (and behavioural responses over a wider area) are predicted from the anticipated level of underwater noise generated by the marine piling. However, the zones of potential injury and behavioural responses would be expected to be lower than for other activities such as the percussive marine piling of larger offshore tubular piles, seismic survey or blasting operations.

9.8.198 There is predicted to be no risk of PTS in harbour porpoise and the risk of TTS is limited to within around 40m from the dredging or vessel activity. There is predicted to be no risk of PTS in seals and the risk of TTS is limited to within around 10 m from the source.

9.8.199 Overall, there is not considered to be any risk of injury or significant disturbance to marine mammals from the proposed dredging and vessel activities that are proposed at the Port of Immingham for the Project even if the dredging and vessel movements were to take place continuously 24/7. Furthermore, the period of capital dredging during construction will be very short term and temporary, lasting a period of around 12 days.

9.8.200 The probability of a change in underwater noise occurring during dredging and dredge disposal is high. However, hearing damage is unlikely to occur and the main effect that could be expected in the vicinity of the dredge vessels would be short-term mild behavioural avoidance. Based on these factors, the magnitude of the change due to dredging noise is considered to be negligible and the sensitivity of marine mammals to dredging noise is considered to be low. Taking these factors into account, the overall exposure and vulnerability of marine mammals will be negligible and none respectively. Overall, therefore, the impacts of dredging noise on all marine mammals are considered to be **insignificant.**

Operation

9.8.201 This section contains an assessment of the potential impacts to marine ecology receptors as a result of the operational phase of the Project – those effects being reviewed in **Table 9-21**. This section includes an explanation of the rationale that was adopted for scoping in or out individual pathways for further assessment.

9.8.202 During operation of the Project, maintenance dredging will potentially be required in the same way as currently occurs at the Port of Immingham with the same dredging techniques used. The modelling of the Project (as reported in **Chapter 16: Physical Processes [TR030008/APP/6.2]**) indicates that the berth pocket, once dredged, will remain swept clear of deposited material by the flood and ebb tidal flows (in much the same way the existing Immingham Oil Terminal berths are). Consequently, the need for future maintenance dredging within the new berth pocket is expected to be very limited (if required at all).

9.8.203 Should maintenance dredging be required it is proposed to be incorporated within the maintenance dredge licence for Immingham (L/2014/00429/1) as part of the renewal of the licence at the end of 2025.

9.8.204 If maintenance dredging for the Project is required periodically this will be carried out in line with the existing regime. The frequency and volume of material deposited at the disposal site from each load (for maintenance dredging across the port) will not change compared with current maintenance dredging activities as the same plant and methods are proposed to be used. Furthermore, the volume of material that will need to be maintenance dredged from the berth pocket will be lower than the volumes of capital dredge material. Overall, the changes brought about as a result of the maintenance dredge and disposal of maintenance dredge material during operation will be comparable to that which already arises from the ongoing maintenance of the existing Port of Immingham

berths. Therefore, it is considered that the likely impacts on marine receptors as a result of maintenance dredging will be comparable to the existing maintenance dredge regime. The magnitude of potential impacts is also considered to be lower than the capital dredge. On this basis, potential effects associated with all the maintenance dredging pathways that have been assessed as insignificant are discussed in **Table 9-21** but have been scoped out of a more detailed assessment to avoid unnecessary repetition of text.

Table 9-21: Potential effects during operation scoped in/out of the further detailed assessment undertaken

Receptor	Impact Pathways/Potential Effects	Project activity	Included in more detailed assessment?	Justification
Benthic habitats and species	Direct changes to benthic habitats and species beneath marine infrastructure due to shading	Operation	Yes	Changes in sunlight levels as a result of shading due to marine infrastructure has the potential to cause changes to the benthic community occurring in an area. This impact pathway has, therefore, been scoped into the assessment.
	Changes to benthic habitats and species as result of seabed removal during dredging	Maintenance dredging	Yes	Maintenance dredging causes the direct physical removal of marine sediments from the dredge footprint, resulting in the modification of existing marine habitats. The impacts to benthic fauna associated with the dredged material include changes to abundance and distribution through damage, mortality or relocation to a disposal site. Given that the dredge footprint has not previously been subject to any maintenance dredging, this impact pathway has, therefore, been scoped into the assessment.
		Dredge disposal	N/A	This pathway relates to changes in habitat resulting directly from seabed removal and is, therefore, not considered relevant to the dredge disposal activity. Potential effects resulting from sediment deposition at the disposal site are discussed below.
	Changes to habitats and species as a result of sediment deposition	Maintenance dredging and disposal	No	Maintenance dredge and dredge disposal will result in the deposition of sediments which has the potential to cause physical disturbance and smothering of seabed habitats. As a result of the expected limited maintenance dredging requirements, smaller changes in SSC and sedimentation (within the dredge plumes and at the disposal site) as compared to the capital dredge will occur. Deposition of sediment as a result of dredging will be highly localised

Receptor	Impact Pathways/Potential Effects	Project activity	Included in more detailed assessment?	Justification
				and similar to background variability. The benthic species occurring within and near to the dredge area typically consist of burrowing infauna (such as polychaetes and oligochaetes), which are considered tolerant to some sediment deposition. Based on evidence provided in relevant MarESA assessments, the characterising species recorded in the project-specific subtidal survey (described above) are considered tolerant to deposition of at least 50mm with many species considered capable of burrowing through much greater levels of sediment deposition. The predicted millimetric changes in deposition are, therefore, considered unlikely to cause smothering effects. In addition, the species recorded in the benthic invertebrate surveys are fast growing and/or have rapid reproductive rates which allow populations to typically rapidly recolonise disturbed habitats, many within a few months following the disturbance events (Ref 9-77; Ref 9-74; Ref 9-75; Ref 9-76). The disposal site is located in the mid channel and is subject to regular natural physical disturbance (and associated scouring) as a result of very strong tidal flows. This is reflected in a generally impoverished assemblage at both disposal sites. In addition, millions of wet tonnes of dredge sediment are disposed of at HU060 annually which will also cause some disturbance due to sediment deposition. The benthic species recorded include mobile infauna (such as errant polychaetes e.g. *Arenicola* spp. and amphipods) which are able to burrow through sediment. They are, therefore, considered tolerant to some sediment deposition. In addition, characterising species typically have opportunistic life history strategies, with short life histories (typically two years or less), rapid maturation and the production of large numbers of small propagules which makes them capable of rapid recoverability should mortality as a result of smothering occur (Ref 9-77; Ref 9-74; Ref 9-75; Ref 9-76). On this basis, any effects are

Receptor	Impact Pathways/Potential Effects	Project activity	Included in more detailed assessment?	Justification
				considered to be temporary and short term. Based on the available information provided above, the potential impact has been assessed as **insignificant**.
	Indirect changes to seabed habitats and species as a result of changes to hydrodynamic and sedimentary processes	Maintenance dredging and disposal	No	The predicted physical processes impacts from future maintenance dredging will be similar to that which already arises from the ongoing maintenance of the existing Immingham berths. Maintenance dredging has the potential to result in changes to hydrodynamic and sedimentary processes (e.g. water levels, flow rates, changes to tidal prism, accretion and erosion patterns). However, changes in hydrodynamic and sedimentary processes that are of a negligible magnitude are expected as a result of the expected limited maintenance dredging requirements. Such changes are unlikely to be discernible against natural processes at nearby intertidal habitats. Furthermore, such changes are not expected to modify existing subtidal habitat types found in the area. Based on the available information provided above, the potential impact has been assessed as **insignificant**.
	Changes in water and sediment quality	Maintenance dredge and dredge disposal	No	The need for future maintenance dredging within the new berth pocket is expected to be very limited (if required at all). Consequently, changes in water quality lower than for the capital dredge and at worst similar to existing maintenance dredging is expected. Elevated SSCs due to maintenance dredging and dredge disposal are anticipated to be of a magnitude that can occur naturally or as a result of existing maintenance dredging/disposal and sediment plumes resulting from dredging would also be expected to dissipate relatively rapidly and be immeasurable against background levels within a relatively short duration of time.

Receptor	Impact Pathways/Potential Effects	Project activity	Included in more detailed assessment?	Justification
				Naturally very high SSCs typically occur year-round in the Humber Estuary, particularly during the winter months when storm events disturb the seabed and on spring tides. The estuarine benthic communities recorded in the region are considered tolerant to this highly turbid environment (Ref 9-77; Ref 9-74; Ref 9-75; Ref 9-76). With respect to sediment contamination, the results of the sediment contamination sampling are summarised above, and in the Water and Sediment Quality chapter (**Chapter 17: Marine Water and Sediment Quality** of the ES **[TR030008/APP/6.2]**). In summary, generally low levels of contamination were found in the samples and there is no reason to believe the sediment will be unsuitable for disposal in the marine environment. During maintenance dredging and dredge disposal, sediment will be rapidly dispersed in the water column. Therefore, the already low levels of contaminants in the dredged sediments will be dispersed further. Based on the available information provided above, the potential impact has been assessed as **insignificant**.
		Surface water drainage	No	Standard measures to control surface water run-off during operation are embedded within the Project design for legislative compliance, and therefore there would be no potential for pollution to the Humber Estuary. This impact pathway has, therefore, been scoped out of the assessment.
	Underwater noise	Vessel operations, maintenance dredge and dredge disposal	No	Population level and mortality effects in benthic invertebrates are considered unlikely for marine piling or blasting. Maintenance dredging is known to produce lower noise levels than marine piling or blasting, and, therefore, there is unlikely to be significant effects on benthic

Receptor	Impact Pathways/Potential Effects	Project activity	Included in more detailed assessment?	Justification
				invertebrates and this impact pathway has been scoped out of the assessment.
	Non-native species transfer during vessel operations	Vessel operations	Yes	Non-native species have the potential to be transported into the local area on the hulls of vessels during operation. Non-native invasive species also have the potential to be transported via vessel ballast water. This impact pathway has, therefore, been scoped into the assessment.
	Damage to sensitive habitats as a result of changes in air quality.	Road traffic emissions	No	There are no designated nature conservation receptors within 200m of a road that exceeds the IAQM and EPUK screening guidance on local roads (see **Chapter 6: Air Quality** of the ES **[TR030008/APP/6.2]**), below which a road traffic impact is unlikely to contribute to a significant effect on local air quality. This impact pathway has, therefore, been scoped out of the assessment.
		Marine vessel emissions and landside plant emissions	Yes	Emissions from docked marine vessels and landside plant during operation have been modelled in **Chapter 6: Air Quality** of the ES **[TR030008/APP/6.2]**. The potential for NO_x, NH_3, SO_2 and N deposition to affect designated habitats that are sensitive to these emission sources within the Humber Estuary EMS has been identified, and this impact pathway has, therefore, been scoped into the assessment.
Fish	Changes to fish populations and habitat	Maintenance dredge and dredge disposal	No	As summarised above, impacts on benthic prey and fish receptors as a result of maintenance dredging are anticipated to be lower than the capital dredge and comparable to the existing maintenance dredge regime in the wider area. The maintenance dredge footprint and proposed disposal site are considered unlikely to provide important nursery or spawning functions for fish species as a result of the disturbed nature of these habitats

Receptor	Impact Pathways/Potential Effects	Project activity	Included in more detailed assessment?	Justification
				despite known nursery or spawning areas occurring in the wider Humber Estuary area[15]. Therefore, while during dredging, there is the potential for fish along with roe (eggs) of these species to be removed, sub-optimal spawning conditions are likely to be present with more optimal habitat occurring in the wider Humber Estuary area. In addition, the dredge footprint is considered negligible in extent in the context of suitable spawning habitat in the region. As summarised above, the predicted impacts on benthic habitats and species (and therefore prey for fish receptors) as a result of maintenance dredging are considered to be lower than the capital dredge and comparable to the existing maintenance dredge regime. Most fish species are opportunistic and generalist feeders, which means that they are generally not reliant on a single prey item. Fish are also mobile species and will easily be able to move away from the zone of influence and utilise other nearby areas for foraging. Furthermore, the area of habitat change will only represent a small proportion of the foraging ranges of many fish species (particularly the larger and more commercial species such as whiting, plaice and Dover sole). Based on the available information provided above, the potential impact has been assessed as **insignificant**.
	Changes in water and sediment quality	Maintenance dredge and dredge disposal	No	Changes in water quality are also expected to be lower than for the capital dredge and at worst similar to existing maintenance dredging.

[15] The maintenance dredge footprint and nearby area is already subject to regular natural seabed disturbance due to very strong tidal currents. The disposal ground is located in a highly dynamic area with the mobile sandbanks subject to regular natural physical disturbance (and associated scouring) as a result of very strong tidal flows and deposition due to regular maintenance dredge activity.

Receptor	Impact Pathways/Potential Effects	Project activity	Included in more detailed assessment?	Justification
				Fish within the Humber Estuary are well adapted to living in an area with variable and typically high suspended sediment loads. Fish feed on a range of food items and, therefore, their sensitivity to a temporary change in the availability of a particular food resource is considered to be low. Their high mobility enables them to move freely to avoid areas of adverse conditions and to use other food sources in the local area. With specific respect to migratory fish, salmonids and other migratory fish can be sensitive to elevated suspended sediment concentrations. However, these species are known to migrate through estuaries with high suspended sediment concentrations (including the Humber Estuary). Elevated SSCs due to dredging are anticipated to be of a magnitude that can occur naturally or as a result of ongoing maintenance dredging/disposal. Sediment plumes resulting from dredging and dredge disposal are also expected to dissipate relatively rapidly and be immeasurable against background levels within a relatively short duration of time. Therefore, salmonids and other migratory fish would also be able to avoid the temporary sediment plumes. Based on these factors there is therefore considered limited potential for migrating fish to be adversely affected by the predicted changes in SSC. Given that elevated SSCs due to dredge and dredge disposal are considered to be in the range of variability that can occur naturally in the Humber Estuary (which has very high SSCs year-round, particularly during the winter months) as well as due to existing ongoing maintenance dredging/disposal and that plumes will be temporary in nature, sensitive life stages of fish occurring in the region such as larvae and juvenile fish are considered unlikely to be adversely effected by the dredging.

Receptor	Impact Pathways/Potential Effects	Project activity	Included in more detailed assessment?	Justification
				With respect to sediment contamination, the results of the sediment contamination sampling are summarised above, and in the Water and Sediment Quality chapter (**Chapter 17: Marine Water and Sediment Quality** of the ES **[TR030008/APP/6.2]**). In summary, generally low levels of contamination were found in the samples and there is no reason to believe the sediment will be unsuitable for disposal in the marine environment. Based on the available information provided above, the potential impact has been assessed as **insignificant**.
	Underwater noise	Maintenance dredge and dredge disposal	No	The outcomes of the assessment of underwater noise disturbance from capital dredging activities during construction will be the same for maintenance dredging activities during operation. A worst-case source level for all types of dredgers has been applied to the underwater noise assessment and, therefore, the predicted ranges of effect are applicable to both the maintenance and capital dredging activities. Underwater noise effects on fish during capital dredging were assessed as insignificant for resident fish minor adverse for fish of high nature conservation status. However, the need for future maintenance dredging within the new berth pocket is expected to be very limited (if required at all). On this basis, the magnitude of potential impact during maintenance dredging is considered to be **insignificant** for all fish species. The detailed assessment of the effects of underwater noise from capital dredge activities is the same for maintenance dredging activities and has therefore not been included in this section of the chapter to avoid unnecessary repetition.
	Underwater noise	Vessel operations	No	During the operational phase there is the potential for noise disturbance to fish species as a result of vessel movements. The worst-case source level associated with vessels during operation is the same as for

Receptor	Impact Pathways/Potential Effects	Project activity	Included in more detailed assessment?	Justification
				dredging activity. Only mild behavioural responses for fish species in relative proximity to operational vessels are anticipated with noise levels unlikely to be discernible above ambient levels in the wider Humber Estuary area given the high levels of existing background vessel noise in the area. Furthermore, the additional operational vessel movements resulting from the proposed development will only constitute a small increase in vessel traffic in the area (approximately a 3% increase). This impact pathway has, therefore, been scoped out of the assessment.
	Lighting	Vessel operations	No	The jetty/pier decking will be lit for safety and operational purposes. Lighting design will be optimised to avoid any unnecessary light-spill on the water or foreshore habitats. For any shoaling fish near the surface, the Project will potentially only cause minor changes in behaviour such as increased shoaling in the vicinity of the light source. Such responses could increase the risk of predation but could also have positive effects such as enhancing feeding efficiency. The low levels of lighting would not cause disruption or blocking of migratory routes. The potential effect has been scoped out of more detailed assessment.

Receptor	Impact Pathways/Potential Effects	Project activity	Included in more detailed assessment?	Justification
Marine mammals	Underwater noise	Maintenance dredge and dredge disposal	No	The outcomes of the assessment of underwater noise disturbance from capital dredging activities during construction will be the same for maintenance dredging activities during operation. A worst-case source level for all types of dredgers has been applied to the underwater noise assessment and, therefore, the predicted ranges of effect are applicable to both the maintenance and capital dredging activities. The need for future maintenance dredging within the new berth pocket is expected to be very limited (if required at all). On this basis, the potential effect is, therefore, considered to be **insignificant**. The detailed assessment of the effects of underwater noise from capital dredge activities is the same for maintenance dredging activities and has therefore not been included in this section of the chapter to avoid unnecessary repetition.
	Underwater noise	Vessel operations	No	During the operational phase there is the potential for noise disturbance to marine mammal species as a result of vessel movements. The worst-case source level associated with vessels during operation is the same as for dredging activity. Only mild behavioural responses for marine mammals species in relative proximity to operational vessels are anticipated with noise levels unlikely to be discernible above ambient levels in the wider Humber Estuary area given the high levels of existing background vessel noise in the area. Furthermore, the additional operational vessel movements resulting from the proposed development will only constitute a small increase in vessel traffic in the area (approximately a 3% increase). This impact pathway has, therefore, been scoped out of the assessment.

Receptor	Impact Pathways/Potential Effects	Project activity	Included in more detailed assessment?	Justification
	Visual disturbance of hauled out seals	Vessel operations, maintenance dredge and dredge disposal	No	The nearest established breeding colony for grey seals is located over 25 km away at Donna Nook. Approximately 10 to 15 grey seals were also observed hauling out on mudflat at Sunk Island (on the north bank of the Humber Estuary) during recent benthic surveys as detailed in Ref 9-47. This haul out site is located approximately 4km north-east from the Project. No seal haul out sites are known to occur nearer to the Project. Seals which are hauled out on land, either resting or breeding, are considered particularly sensitive to visual disturbance (Ref 9-67). The level of response of seals is dependent on a range of factors, such as the species at risk, age, weather conditions and the degree of habituation to the disturbance source. Hauled out seals have been recorded becoming alert to powered craft at distances of up to 800m although seals generally only disperse into the water at distances <150-200m (Ref 9-68; Ref 9-69; Ref 9-70; Ref 9-71). For example, in a study focusing on a colony of grey seals on the South Devon coast, vessels approaching at distances between 5m and 25m resulted in over 64 % of seals entering the water, but at distances of between 50m and 100m only 1 % entered the water (Ref 9-72). Recent disturbance research has also found no large-scale redistribution of seals after disturbance with most seals returning to the same haul out site within a tidal cycle (Ref 9-73). Based on this evidence, seals hauled out on the intertidal habitats of Sunk Island (located on the opposite bank to the Project) are out of the zone of influence of any potential visual disturbance effects as a result of maintenance dredging and vessel operations. The potential for disturbance to hauled out seals has, therefore, been scoped out of the assessment.

Receptor	Impact Pathways/Potential Effects	Project activity	Included in more detailed assessment?	Justification
	Collision risk	Vessel operations	No	Vessels using the berths during operation will be typically approaching at slow speeds (2-4 knots) and maintenance dredging/dredge disposal will be mainly stationary or travelling at low speeds (2-6 knots), making the risk of collision very low. Although all types of vessels may collide with marine mammals, vessels traveling at speeds over ten knots are considered to have a much higher probability of causing lethal injury (Ref 9-50). Furthermore, the region is already characterised by heavy shipping traffic. The additional operational vessel movements resulting from the proposed development will only constitute a small increase in vessel traffic in the area (approximately a 3% increase). In general, incidents of mortality or injury of marine mammals caused by vessels remain a relatively rare occurrence in UK waters (Ref 9-51; Ref 9-52). For example, out of 144 post mortem examinations carried out on cetaceans in 2018, only two (1.4 %) were attributed to boat collision with the biggest causes of mortality including starvation and by-catch, although some incidents are likely to remain unreported (Ref 9-52). In addition, marine mammals frequently foraging within the region will routinely need to avoid collision with vessels and are, therefore, considered adapted to living in an environment with high levels of vessel activity. This impact pathway has, therefore, been scoped out of the assessment.

Benthic Habitats and Species

9.8.205 This section contains an assessment of the potential impacts to benthic ecology receptors as a result of the operational phase of the Project. The following impact pathways have been assessed:

a. Changes to benthic habitats and species as result of seabed removal during maintenance dredging.

b. Direct changes to benthic habitats and species beneath marine infrastructure due to shading.

c. Non-native species transfer during vessel operations.

d. Changes in air quality due to marine vessel and landside plant emissions.

Changes to benthic habitats and species as result of seabed removal during maintenance dredging

General scientific context

9.8.206 Scientific evidence on this potential impact pathway has already been provided above in the construction (capital dredge) sub-section of the impact assessment and is, therefore, not repeated here.

Project impact assessment

9.8.207 Maintenance dredging causes the direct physical removal of marine sediments from the dredge footprint, resulting in the modification of existing marine habitats. The impacts to benthic fauna associated with the dredged material include changes to abundance and distribution through damage, mortality or relocation to a disposal site.

9.8.208 As summarised above and in the physical processes assessment (**Chapter 16: Physical Processes** of the ES **[TR030008/APP/6.2]**), maintenance dredging is expected to be very limited (if required at all). As a result, any dredging that is required will only be undertaken very periodically (frequency will be dictated by operational requirements but is anticipated there could be several years or more between maintenance dredge campaigns).

9.8.209 Maintenance dredging will create similar seabed sedimentary conditions to that occurring following capital dredging[16] with the surface layer of the seabed in the dredge footprint expected to be broadly comparable to the existing sediment character (i.e. sediment with a high silt content) following maintenance dredging.

[16] The baseline benthic surveys predominantly recorded surface sediment within and near to the dredge footprints with a high silt content (i.e., mud and sandy mud) (**Section 9.6** and **Appendix 9.A [TR030008/APP/6.4]**). Sub surface sampling in the capital dredge footprint recorded sediments from most sampling locations dominated by silt material (see **Appendix 2.A [TR030008/APP/6.4]**).

9.8.210 On this basis, given the expected frequency of dredging, a comparable macrofaunal community to pre dredge conditions would be expected to occur over much of the maintenance dredging area between maintenance dredging campaigns[17].

9.8.211 Furthermore, the highly impoverished benthic community recorded in the project-specific subtidal survey (**Appendix 9.A [TR030008/APP/6.4]**) (which is likely to reflect the existing high levels of physical disturbance in the area due to strong near bed tidal currents and sediment transport) is considered characteristic of subtidal habitats found more widely in this section of the Humber Estuary (Ref 9-124; Ref 9-23; Ref 9-24; Ref 9-22). All of the species recorded are considered commonly occurring and not protected.

9.8.212 Based on the evidence provided above and applying the project impact assessment methodology, the magnitude of the change to the subtidal habitats and associated benthic species is considered to be small and although the probability of occurrence is high, the overall exposure is assessed as low. The sensitivity of subtidal habitats to seabed disturbance within the dredge footprint is considered to be low given the high recoverability rates. Vulnerability is, therefore, assessed as low. While subtidal benthic communities are considered commonly occurring in the region, subtidal habitats form a component of the 'Estuaries' feature of the SAC. Importance is, therefore, considered to be moderate. Overall, the potential effect is assessed as **insignificant to minor adverse**.

Direct changes to benthic habitats and species beneath marine infrastructure due to shading

General scientific context

9.8.213 Artificial shading such as due to jetty/pier decking has the potential to cause localised changes to the structure and functioning of biological communities in natural ecosystems (Ref 9-124; Ref 9-125; Ref 9-126).

9.8.214 In sedimentary habitats microphytobenthos, macrofauna, sediment erodibility and biogeochemical sediment properties are often found to differ significantly between shaded and unshaded sediments (Ref 9-160; Ref 9-191; Ref 9-126). Microphytobenthos are significant drivers of ecosystem functioning in benthic habitats influencing biogeochemical properties of sediment, food web dynamics (Ref 9-192) and sediment erodibility (Ref 9-193). Heavy shading alters microphytobenthos assemblages causing a variety of responses, including changes in biomass, pigment ratios, species richness and diversity (Ref 9-190; Ref 9-126). These changes can therefore have cascading effects on the sediments they inhabit and associated faunal assemblages (Ref 9-191; Ref 9-

[17] The project-specific subtidal survey (**Appendix 9.A** [**TR030008/APP/6.4**]) recorded a highly impoverished benthic community characterised by polychaetes (such *Nephtys* spp, *Streblospio shrubsolii* and *Scoloplos armiger*), nematodes, oligochaetes *Tubificoides* spp and crustacean *Diastylis rathkei.* These species are typically fast growing and/or have rapid reproductive rates which allow populations to fully re-establish in typically less than 1-2 years and for some species within a few months (Ref 9-74; Ref 9-75; Ref 9-76).

124; Ref 9-126). For example, Tolhurst *et al*. (Ref 9-126) found heavy shading of an intertidal mudflat caused directional responses in sediment properties, in line with a decrease in microphytobenthos, including reductions in chlorophyll *a*, colloidal carbohydrate, erosion threshold and total carbohydrate; and increased erosion rate and water retention. This resulted in significant changes in the faunal assemblage, driven by large decreases in oligochaetes and sabellid polychaetes – likely to be a direct response to the reduction of food; either the amount of microphytobenthos, or perhaps bacteria, or meiofauna (Ref 9-126).

9.8.215 Shading of hard substrates, such as rocky shores and seawalls, can often alleviate stressful conditions associated with temperature and desiccation, caused by emersion during low tide (Ref 9-194). However, this can also cause shifts in the structure and diversity of biological communities, by reducing macroalgae cover (Ref 9-195; Ref 9-194), increasing the abundance of filter feeding invertebrates and mobile consumers (Ref 9-196; Ref 9-194), altering sessile assemblages (Ref 9-197) and influencing larval recruitment (Ref 9-195; Ref 9-125). For example, Pardal-Souza *et al*. (Ref 9-125) found shading to consistently affect the biological community of rocky shores, such that the biomass and cover of macroalgae, and the size of most sedentary grazers, were smaller. Additionally, in the infralittoral fringe there was a shift in dominance from macroalgae to invertebrate filter feeders (Ref 9-125). Larval recruitment was also affected, with oysters and barnacles recruiting more in shaded habitats (Ref 9-125).

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9.8.216 Changes in sunlight levels as a result of shading have the potential to cause changes to the benthic community occurring in an area. In particular, shading can reduce the amount of light available for species that perform photosynthesis such as macroalgae species (seaweeds), macrophytes (such as saltmarsh plants) and microphytobenthos.

9.8.217 The open piled approach jetty could cause some shading to intertidal mudflat habitat. Given that these structures will be located several metres above the seabed, however, some natural light would be expected to reach the mudflat from either side of these structures all times of the day with no habitat permanently shaded. Shading at the level predicted would only be expected to cause negligible changes to the growth rates of macroalgae species (seaweeds) and microphytobenthos occurring on the foreshore. Furthermore, no saltmarsh and only limited macroalgae occurs on mudflats in this area.

9.8.218 Based on the above, the magnitude of the change will be negligible. Whilst the probability of some shading is likely to be high, the overall exposure will be negligible. The sensitivity of benthic habitats and species found in the footprint to the scale of shading effects is considered to be low and thus vulnerability is considered to be none. While both the subtidal and intertidal benthic communities are commonly occurring in the region, intertidal habitats are protected and of functional importance for waterbirds. Importance is therefore considered to range from moderate (for subtidal habitats) to high (for intertidal habitats). Consequently, the overall impact is assessed as **insignificant.**

Non-native species transfer during vessel operations

General scientific context

9.8.219 Scientific evidence on this potential impact pathway has already been provided above in the construction sub-section of the impact assessment and is, therefore, not repeated here (**Paragraphs 9.8.90** to **9.8.94**).

9.8.220 Non-native species have the potential to be transported into the study area on ships' hulls during maintenance dredging and through operational vessels. Non-native invasive species also have the potential to be transported via ship ballast water. Seawater may be drawn into tanks when the ship is not carrying cargo, for stability, and expelled when it is no longer required. This provides a vector whereby organisms may be transported long distances.

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9.8.221 Piles and other artificial structures can provide suitable habitats for non-indigenous marine species and function as corridors for the expansion of these species in terms of range and distribution. However, artificial structures are widespread in the Immingham area with a wide variety of jetty structures, sea walls and sea defences available for species to colonise. On this basis, the presence of new infrastructure as a result of the Project is considered unlikely to significantly increase the rate of spread of non-native species in the area.

9.8.222 In view of current legislation (described in more detail in the assessment of non-native species during construction, **Paragraph 9.8.106**) and the fact that potential biosecurity risks are managed through ABP's existing biosecurity management procedures, the probability of the introduction and spread of non-native species from operational phase is considered to be low. However, given that the magnitude of change is unknown, magnitude ranges from negligible to large depending upon the scale and nature of any non-native species introduction, thus the exposure ranges from negligible to low at worst. The sensitivity of all intertidal and subtidal receptors to non-native species introductions is expected to range from low to moderate. Vulnerability is, therefore, considered to be low. In addition, importance is considered to range from high (for intertidal mudflats) to moderate (for subtidal habitats). The overall impact is, therefore, assessed, as **insignificant** to **minor adverse**.

Changes in air quality due to marine vessel and landside plant emissions

9.8.223 Emissions from docked marine vessels and landside plant during operation have been modelled in **Chapter 6: Air Quality** of the ES **[TR030008/APP/6.2]**. The potential for NOx, NH_3, SO_2 and N deposition to affect designated habitats that are sensitive to these emissions within the Humber Estuary EMS has been identified. The number of vessel calls during operation is anticipated to be 292 each year (average of 0.8 vessels per day); which is very small when considered in context with the baseline vessel movements within the Humber Estuary, which Department for Transport ("DfT") statistics indicate is one of the busiest waterways in the UK serving the main Humber Ports of Hull, Goole, Grimsby and Immingham; analysis of marine traffic presented within Chapter 12 (Marine Transport & Navigation) states that average daily vessel movements in this

section of the Estuary (in the one year period between September 2021 and August 2022) were 78 per day. The majority of the vessels were cargo vessels (c. 47% of movements) followed by tugs (24%), tankers (15%) and passenger vessels (5%).

9.8.224 The assessment of air quality impacts on nature conservation receptors has been informed by modelling presented in **Chapter 6: Air Quality [TR030008/APP/6.2]** and the following sections of that chapter are relevant to the assessment:

a. **Table 6-19** – presents the outcome of air quality modelling on sensitive habitat receptors in the Humber Estuary assuming that all vessels calling at the Project will conform to the MARPOL Tier III NOx emissions standard.

b. **Table 6-20** - presents the outcome of air quality modelling on sensitive habitat receptors in the Humber Estuary assuming that all vessels calling at the Project will conform to the MARPOL Tier II NOx emissions standard.

c. **Figure 6.3 [TR030008/APP/6.3]** showing the locations of the modelled receptor locations within the Humber Estuary designated site.

9.8.225 The modelling and assessment of air quality impacts has been informed by the Critical Loads and Levels for sensitive habitats within the Humber Estuary designated site for NH_3, NO_x, SO_2 and nitrogen deposition, which are published on the UK Air Pollution Information System ("APIS") database. The modelling has also taken into account The International Convention for the Prevention of Pollution from Ships ("MARPOL") standards for marine vessel NOx emissions. MARPOL Tier III is more stringent than MARPOL Tier II; in order to go from the NOx Tier II limits to the NOx Tier III limits, NOx emissions must be cut by about 75%.

9.8.226 While the '1% of the critical level/load' threshold is an important initial assessment threshold, it is not a damage threshold. Moreover, whether the critical level or load will be exceeded by total pollutant concentrations/deposition rates is also important. Modelling presented in **Table 6-19** in **Chapter 6: Air Quality [TR030008/APP/6.2]** demonstrates that with vessels complying with MARPOL Tier III emissions standards, modelled IGET sources account for 1% or less of the Critical Level for annual mean NO_X at all but two receptor locations (O_E1 and O_E2). At these two locations, total NO_X concentrations account for approximately 52% of the Critical Level (i.e. the critical level would not be exceeded). With MARPOL Tier III emissions standards, modelled IGET sources also account for 1% or less of the Critical Levels for SO_2 and NH_3 and of the Critical Load for nitrogen deposition, noting that the IAQM state that the 1% screening criteria should not be used rigidly and not to a numerical precision greater than the expression of the criteria themselves[18].

[18] '*Whilst it is straightforward to generate model results for the PC to any level of precision required, the accuracy of the result is much less certain and it is unwise to place too much emphasis on whether the PC is 0.9% or 1.1%*' (Ref 9-198)

9.8.227 Modelling presented in **Table 6-20** in **Chapter 6: Air Quality [TR030008/APP/6.2]** demonstrates that with vessels complying with MARPOL Tier II emissions standards (i.e. the less stringent standard), modelled IGET sources account for 1% or less of the Critical Level for annual mean NOX at all but three receptor locations (O_E1, O_E2 and O_E3). At these three locations, total NOX concentrations account for approximately 56% of the Critical Level (i.e. the critical level would not be exceeded). With MARPOL Tier II emissions standards, modelled Project sources account for 1% or less of the Critical Levels for SO2 and NH3. Project sources account for 1% or less of the Critical Load for nitrogen deposition at all but two receptors (O_E1 and O_E2), with an impact equivalent to 1.7% and 1.9% of the critical load respectively. At these locations, the Critical Load for nitrogen deposition is already exceeded by the background contribution alone with the Project contribution accounting for just 1.2% of the total nitrogen deposition rate predicted at these locations. Therefore, the impact of the Project on nitrogen deposition under a MARPOL Tier II emissions scenario is greater than 1% of the critical load (being approximately 2% of the critical load) at two receptor locations, and therefore is assessed in further detail below.

9.8.228 At the worst affected nature conservation receptor (O_E12, which relates to saltmarsh habitat on the northern shore of the Estuary) **(Figure 6.3 in [TR030008/APP/6.2]**), the change in annual mean NH_3 and SO_2 can be screened as insignificant in line with Environment Agency guidance as the changes do not exceed 1% of the Critical Levels for NH_3 and SO_2. However, the annual mean NOx concentration and annual N deposition rate cannot be screened as insignificant as it exceeds the 1% screening threshold.

9.8.229 For saltmarsh, APIS provides a Critical Load range of 10 - 20 kg/ha/yr and nitrogen inputs have been experimentally demonstrated to have an effect on overall species composition of saltmarsh. However, the Critical Loads on APIS are relatively generic for each habitat type and cover a wide range of deposition rates. They do not (and are not intended to) take other influences (to which the habitat on a given site may be exposed) into consideration.

9.8.230 Moreover, it is important to note from APIS that the experimental studies which underlie conclusions regarding the sensitivity of saltmarsh have *'… neither used very realistic N doses nor input methods i.e. they have relied on a single large application more representative of agricultural discharge'*, which is far in excess of anything that would be deposited from atmosphere. Therefore, APIS indicates that determining which part of the critical load range to use for saltmarsh requires expert judgment.

9.8.231 Generally, nitrogen inputs from the air are not as important to plants as nitrogen from other sources. Effects of nitrogen deposition from atmosphere are likely to be dominated by much greater impacts from marine or agricultural sources. This is reflected on APIS itself, which states regarding saltmarsh that '*Overall, N deposition [from atmosphere] is likely to be of low importance for these systems as the inputs are probably significantly below the large nutrient loadings from river and tidal inputs*'. Another mitigating factor is that the nature of intertidal saltmarsh in the Humber estuary means that there is daily flushing from tidal

incursion. This is likely to further reduce the role of nitrogen from atmosphere in controlling botanical composition.

9.8.232 The change in threshold values for critical loads in APIS has been informed by recent studies in Ireland and the Netherlands, and a collaboration under the Working Group on Effects ("WGE") of the UNECE Convention on Long-Range Transboundary Air Pollution reported by the German Environment Agency (Ref 1)-. That research has shown that position of the saltmarsh in the tidal profile is relevant to which part of the critical load range is more appropriate. This is because the less the frequency or duration of inundation by seawater, the more important atmosphere becomes as a source of nitrogen. The APIS Site Relevant Critical Load for the Humber Estuary SAC states that the lowest part of the new critical load range for upper saltmarsh (10 kg N/ha/yr) is most appropriate to the *'more densely vegetated upper marsh (e.g. EUNIS class MA223, MA224)'* with the highest part of the range being more appropriate for more frequently inundated marsh. Classes MA223 and MA224 are '*regularly but not daily flooded by seawater'* with a figure cited of 100-200 days/year (Ref 9-202).

9.8.233 There is therefore good reason to conclude that the upper part (20 kg N/ha/yr) of the critical load range is appropriate for the affected areas of saltmarsh. Therefore, the additional predicted contribution from nitrogen emissions from the Project does not result in any exceedance of the Critical Load range for saltmarsh, as the modelled annual mean deposition rate at receptor O_E12 will be 16.0 kg N/ha/yr, which is well below the 20 kg N/ha/yr upper critical load.

9.8.234 Moreover, guidance within the Highways Agency's Design Manual for Roads and Bridges (DMRB) guidance in respect of Air Quality (Ref 9-199), identifies a threshold of 0.4 kg N/ ha/ yr as resulting in 'no significant effect' on all habitats based on Natural England Research Report NECR 210 (Ref 9-200), which collated dose response research and found that the lowest additional nitrogen deposition to reduce species richness in any habitat by one species was 0.4 kg/ N/ ha/ yr. The modelled cumulative Process Contribution from the Project under the worst-case MARPOL Tier II Emissions Standards scenario is 0.2 kg/ N/ ha/ yr and therefore is well under this threshold for effecting a measurable change in vegetated habitat species diversity. Although the emissions to air arising from the Project are mainly from marine vessels, as the pollutants are the same as those assessed for road vehicle engine emissions in the DMRB, it is considered appropriate to apply this threshold in the assessment for the Project.

9.8.235 In addition, Natural England's Supplementary Advice on Conservation Objectives for the Humber Estuary SAC states that the conservation objective for the 'Atlantic salt meadows *Glauco-Puccinellietalia maritimae*' and '*Salicornia* and other annuals colonising mud and sand' habitat features relevant to the assessment of air quality effects is to "*Maintain concentrations and deposition of air pollutants to below the site-relevant Critical Load or Level values given for this feature on the Air Pollution Information System*" (Ref 9-201). As set out above, the Process Contribution from the Project, which results in a mean deposition rate of 16 kg N/ ha/ yr on the nearest saltmarsh habitat does, not result in any exceedances of the Critical Load published on the APIS. Indeed, air quality modelling for this Project forecasts a slight improvement in nitrogen deposition

between the base year and 2036 even when allowing for the Project. Therefore, the Project will not compromise the air quality 'maintain' target for the Humber Estuary SAC.

9.8.236 Intertidal habitats within the Humber Estuary are considered to be of high importance due to their designated status as a qualifying feature of the Humber Estuary SAC/ SSSI, NERC listed habitat and a supporting feature of the Humber Estuary SPA. These habitats are considered to have high sensitivity to changes in air quality due to the existing high background levels of some pollutants. However, as assessed above, the probability of damage occurring due to changes in air quality as a result of the operation of the Project is negligible and the magnitude of impact is also negligible; the vulnerability of these habitats to changes in air quality is therefore none given that no pollutant impacts that would result in damage to designated habitats are predicted. Changes in air quality will not adversely affect designated intertidal or coastal terrestrial habitats within the Humber Estuary, and the effects are therefore assessed as neutral **(insignificant)**.

9.9 Mitigation and Enhancement Measures

Underwater noise and vibration on fish and marine mammals as a result of construction

9.9.1 In order to reduce the level of impact associated with underwater noise and vibration on fish and marine mammals during construction (which is assessed as minor to moderate adverse), the following mitigation measures will be implemented during marine piling.

Soft start

9.9.2 The gradual increase of marine piling power, incrementally, until full operational power is achieved will be used as part of the marine piling methodology. This will give fish and marine mammals the opportunity to move away from the area before the onset of full impact strikes. The duration of the soft start is proposed to be 20 minutes in line with the Joint Nature Conservation Committee ("JNCC") marine piling protocol (Ref 9-18).

Vibro marine piling

9.9.3 Vibro marine piling is proposed to be used where possible (which produces lower peak source noise levels than percussive marine piling) although it is recognised that impact marine piling is anticipated to always be required to reach the design depths. For the purposes of this assessment, the maximum pile driving scenario is assumed as a worst case to involve approximately 60 minutes of vibro -marine piling followed by 270 minutes of impact marine piling per day in a 12 hour shift.

Seasonal marine piling restrictions

9.9.4 During percussive marine piling the following further restrictions are proposed:

a. No percussive marine piling is to take place within the waterbody between 1 April and 31 May inclusive in any calendar year. This will minimise the potential impact on the greatest number of different migratory fish in the Humber Estuary, in accordance with the periods identified in **Table 9-16**, and also the more vulnerable earlier life stages of a number of migratory fish species[19]. This restriction does not apply to percussive marine piling that can be undertaken outside the waterbody at periods of low water[20]; and

b. The duration of percussive marine piling is to be restricted within the waterbody from 1 June to 30 June and 1 August to 31 October inclusive in any year to minimise the impacts on fish migrating through the Humber Estuary during this period such as silver eels, river lamprey and returning adult Atlantic salmon. The maximum amount of percussive marine piling permitted within any four week period must not exceed 140 hours where a single marine piling rig is in operation or a total of 196 hours where two rigs are in operation (it is assumed that up to two marine piling rigs could be pile driving at any one time). The measurement of time during each work-block described above must begin at the start of each timeframe, roll throughout it, then cease at the end, where measurement will begin again at the start of the next timeframe, such process to be repeated until the end of marine piling works. This restriction does not apply to percussive marine piling that can be undertaken outside the waterbody at periods of low water. This approach has been developed in consultation with the MMO and Cefas.

Night time marine piling restriction

9.9.5 The upstream migration of river lamprey takes place almost exclusively at night (Ref 9-57). There is also an increase in glass eel migratory activity during the night time (Ref 9-127). During the periods 1 March to 31 March, 1 June to 30 June and 1 August to 31 October inclusive, piling will be restricted at night. Specifically, no percussive piling will be undertaken from 19:00 to 07:00 in March, September and October and between sunset and sunrise in June and August. Percussive marine piling operations that have already been initiated will, however, be completed where an immediate cessation of the activity would form an unsafe working practice. This restriction does not apply to percussive marine

19 Spring is the peak period when Atlantic salmon and sea trout smolts migrate downstream to the sea and it is also the peak migration period for European eel elvers moving into the estuary. In addition, it is the period when allis shad move into estuaries and when sea lamprey and twaite shad gather in estuaries and move up to spawn. It is also the period when the highest densities of smelt are present in the Humber Estuary.

20 The force generated by marine piling outside the waterbody will be exerted on the ground at that location. The sound waves can travel outwards through the seabed or be reflected from deeper sediments. As these waves propagate, sound will also “leak” upwards contributing to the airborne sound wave. The underwater noise from marine piling outside the waterbody will, therefore, be considerably reduced (and negligible in scale) as a result of absorption of the sound by the ground and air, the interaction with the ground surface (reflection and scattering), and the interaction with and transmission through the ground.

piling that can be undertaken outside the waterbody at periods of low water which will limit the potential effects of underwater marine piling noise on the nocturnal movements of river lamprey and glass eels.

Marine Mammal Observer

9.9.6 In addition, in order to further reduce the significance of the impact to marine mammals the JNCC Statutory Nature Conservation Agency Protocol for Minimising the Risk of Injury to Marine Mammals During Marine piling (Ref 9-18) will be followed during percussive marine piling. The key procedures highlighted in this document include the following:

a. Establishment of a 'mitigation zone' of 500m from the marine piling locations, prior to any percussive marine piling. Within this mitigation zone, observations of marine mammals will be undertaken by a trained member of the construction team using marine mammal identification resources.

b. 30 minutes prior to the commencement of percussive marine piling, a search will be undertaken by the Marine Mammal Observer to determine that no marine mammals are within the mitigation zone. Percussive marine piling activity will not be commenced if marine mammals are detected within the mitigation zone or until 20 minutes after the last visual detection.

c. During percussive marine piling, the Marine Mammal Observer will observe the mitigation zone to determine that no marine mammals are within this area. Construction workers will be alerted if marine mammals are identified, and marine piling will cease whilst any marine mammals are within the mitigation zone. Marine piling can recommence when the marine mammal exits the mitigation zone and there is no further detection after 20 minutes.

d. If there is a pause in percussive marine piling operations for any reason over an agreed period of time, then another search (and soft-start procedures for marine piling) will be repeated before activity recommences. If, however, the mitigation zone has been observed while marine piling has ceased and no marine mammals have entered the zone, marine piling activity can recommence immediately.

9.10 Assessment of Residual Effects

Construction

9.10.1 Without mitigation, the following pathways were assessed as **minor** to **moderate adverse:**

a. Underwater noise and vibration on fish as a result of marine piling.

b. Underwater noise and vibration on marine mammals as a result of marine piling.

9.10.2 With the implementation of appropriate mitigation measures, the residual effects on these receptors are considered **minor** and **not significant**.

9.10.3 All the other potential impacts on nature conservation and marine ecology receptors have been assessed as **insignificant** to **minor adverse** and, therefore, **not significant**.

Operation

9.10.4 All potential impacts on nature conservation and marine ecology receptors during operation have assessed as **insignificant** to **minor adverse** and, therefore, **not significant**.

Decommissioning

9.10.5 The DCO will not make any provision for the decommissioning of the main elements of the marine infrastructure above and below water level. This is because the jetty, jetty head, loading platforms, access ramps and jetty access road would, once constructed, become part of the fabric of the Port estate and would, in simple terms, continue to be maintained so that it can be used for port related activities to meet a long-term need. It is anticipated that plant and equipment on the jetty topside would be decommissioned in parallel with the decommissioning of the related landside elements. On this basis, potential effects on marine ecology receptors from decommissioning have been scoped out.

9.11 Summary of Assessment

9.11.1 A summary of the impact pathways that have been assessed, together with the identified residual impacts and level of confidence is presented in **Table 9-22.**

Table 9-22: Summary of potential impact, mitigation measures and residual adverse effects

Receptor	Impact pathway	Impact Significance	Mitigation Measure	Residual Effect	Confidence
Construction Phase					
Benthic habitats and species	Direct loss of intertidal habitat as a result of the piles	Insignificant	N/A	**Insignificant**	**High:** Baseline conditions and potential impacts on benthic receptors are well understood
	Direct loss of subtidal habitat as a result of the piles	Insignificant	N/A	**Insignificant**	**High:** Baseline conditions and potential impacts on benthic receptors are well understood
	Changes to benthic habitats and species as result of the removal of seabed material during dredging	minor adverse Insignificant	N/A	**Insignificant to minor adverse**	**High:** Baseline conditions and potential impacts on benthic receptors are well understood.
	Changes to habitats and species as a result of sediment deposition during dredging and dredge disposal	Insignificant	Target disposal loads in the central/ deeper area of the disposal sites to reduce depth reductions	**Insignificant**	**Medium:** The assessment is based on site specific data, and conceptual understanding of the study area combined with physical processes modelling. The numerical model is fully calibrated, however, it is recognised that such models represent a number of complex parameters within dynamic environments and as such there will always be a limit to the level of accuracy that can be achieved.

Receptor	Impact pathway	Impact Significance	Mitigation Measure	Residual Effect	Confidence
	Indirect loss or change to seabed habitats and species as a result of changes to hydrodynamic and sedimentary processes during capital dredging and dredge disposal	Insignificant	N/A	**Insignificant**	**Medium:** The assessment is based on site specific data, and conceptual understanding of the study area combined with physical processes modelling. The numerical model is fully calibrated, however, it is recognised that such models represent a number of complex parameters within dynamic environments and as such there will always be a limit to the level of accuracy that can be achieved.
	Changes in water and sediment quality during capital dredging and dredge disposal	Insignificant	N/A	**Insignificant**	**Medium;** The assessment is based on site specific data, and conceptual understanding of the study area combined with physical processes modelling. The numerical model of SSC is fully calibrated, however, it is recognised that such models represent a number of complex parameters within dynamic environments and as such there will always be a limit to the level of accuracy that can be achieved. The potential impacts of water quality on benthic receptors are also well understood, through a large

Receptor	Impact pathway	Impact Significance	Mitigation Measure	Residual Effect	Confidence
					amount of scientific evidence on this subject.
	Underwater noise and vibration effects on invertebrates during marine piling, capital dredging and dredge disposal	Insignificant	N/A	**Insignificant**	**Medium:** Assessment based on available empirical evidence of the behavioural effects of noise on invertebrates.
	Introduction and spread of non-native species	Insignificant to minor adverse	Include biosecurity control measures within the CEMP	**Insignificant to minor adverse**	**Medium:** Scientific understanding of the introduction of non-native species is generally good although some uncertainty still surrounds the level of risk associated with the introduction of species.
Fish	Direct loss or changes to fish populations and habitat as a direct result of dredging and dredge disposal	Insignificant to minor adverse	N/A	**Insignificant to minor adverse**	**Medium:** Potential impacts on fish receptors are generally well understood
	Changes in water and sediment quality as a result of dredging and dredge disposal	Insignificant	N/A	**Insignificant**	**Medium:** The assessment is based on site specific data, and conceptual understanding of the study area combined with physical processes modelling. The numerical model of SSC is fully calibrated, however, it is recognised that such models represent a number of complex

Receptor	Impact pathway	Impact Significance	Mitigation Measure	Residual Effect	Confidence
					parameters within dynamic environments and as such there will always be a limit to the level of accuracy that can be achieved. The potential impacts of water quality on fish are well understood, through a large amount of scientific evidence on this subject.
	Underwater noise disturbance and vibration during marine piling, capital dredging and dredge disposal	Minor to moderate adverse (migratory fish during marine piling) Insignificant to minor adverse (other fish species during marine piling) Insignificant to minor adverse (dredge and dredge disposal)	Apply soft start procedures during marine piling Use vibro marine piling where possible Seasonal marine piling restrictions Night time working restriction	**Insignificant**	**Medium:** The underwater noise model is based on established theoretical parameters but there is limited empirical evidence of the behavioural effects of noise on fish.
Marine mammals	Underwater noise disturbance and vibration during marine piling, capital dredging and dredge disposal	Minor to moderate adverse (marine piling) Insignificant (dredge and dredge disposal)	Apply soft start procedures during marine piling Use vibro marine piling where possible Marine Mammal Observer will follow JNCC protocol to minimise the risk of	**Minor adverse**	**Medium:** The underwater noise model is based on established theoretical parameters but there is relatively limited empirical evidence of the behavioural effects of noise on marine mammals.

Receptor	Impact pathway	Impact Significance	Mitigation Measure	Residual Effect	Confidence
			injury to marine mammals during percussive marine piling		
Operational Phase					
Benthic habitats and species	Changes to benthic habitats and species as result of seabed removal during maintenance dredging	Insignificant to minor	N/A	**Insignificant to minor**	**High:** Baseline conditions and potential impacts on benthic receptors are well understood
	Direct changes to benthic habitats and species beneath marine infrastructure due to shading	Insignificant	N/A	**Insignificant**	**High:** Baseline conditions and potential impacts on benthic receptors are well understood
	Non-native species transfer during vessel operations	Insignificant to minor adverse	N/A	**Insignificant to minor**	**Medium:** Scientific understanding of the introduction of non-native species is generally good although some uncertainty still surrounds the level of risk associated with the introduction of species.
	Damage to sensitive habitats as a result of changes in air quality from marine vessel and landside plant emissions	Insignificant	N/A	**Insignificant**	**High** There will be no exceedances of Critical Loads/ Levels for any pollutant at sensitive habitats within the zone of influence of the Project.

9.12 References

Ref 9-1 Cefas (2021). Shellfish Classification Zones of England and Wales. [Online].

Ref 9-2 Chartered Institute of Ecology and Environmental Management (CIEEM). (2018). Guidelines for Ecological Impact Assessment in the UK and Ireland. [Online]

Ref 9-3 European Commission (1992). Council Directive 92 /43 /EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora.

Ref 9-4 European Commission (2009). Council Directive 2009/147/EC of 30 November 2009 on the conservation of wild birds.

Ref 9-5 European Commission (2000). Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy.

Ref 9-6 The Stationery Office (2017). Statutory Instrument 2017. No. 1012. The Conservation of Habitats and Species Regulations 2017.

Ref 9-7 The Stationery Office (2017). Statutory Instrument 2017 No. 407. The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017.

Ref 9-8 The Stationery Office Limited (2009). Marine and Coastal Access Act 2009.

Ref 9-9 The Stationery Office Limited (2008). Planning Act 2008.

Ref 9-10 The Stationery Office (1981). Wildlife and Countryside Act 1981.

Ref 9-11 The Stationery Office (2000). The Countryside and Rights of Way Act 2000.

Ref 9-12 The Stationery Office (2006). Natural Environment and Rural Communities Act 2006.

Ref 9-13 The Stationery Office Limited (2009). Statutory Instrument 2009. No. 3344. The Eels (England and Wales) Regulations 2009.

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