

The Lighthouse Green Fuels Order

Application Reference: EN0110025

Applicant: LGF Projects Limited

Appendix 12A: Coastal and Estuary Processes

Document Reference: 6.3.18

Revision: 00

APFP Reg. 5(2)(a) and EIA Reg. 14

Document Information

Document Title	Appendix 12A: Coastal and Estuary Processes
Document Ref	6.3.18
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Revision record

00	Purpose	DCO Application Submission
	Date	September 2026

Information classification

Information Classification	Date	Reason
Public	September 2026	Proprietary information which will have no impact on the company if disclosed publicly

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Abbreviations

Acronym	In Full / Term
ADCP	Acoustic Doppler Current Profiler
ASU	Air Separation Unit
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CD	Chart Datum
CHP	Combined Heat and Power
CO ₂	Carbon dioxide
cSAC	Candidate Special Area of Conservation
CTD	Conductivity, Temperature and Depth
DCO	Development Consent Order
EA	Environment Agency
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
ES	Environmental Statement
HRA	Habitat Regulations Assessment
HW	High Water
km	kilometre
LGF	Lighthouse Green Fuels
LiDAR	Light Detection and Ranging
MCAA	Marine and Coastal Access Act 2009
MMO	Marine Management Organisation
mODN	Metres Ordnance Datum Newlyn
MPS	Marine Policy Statement
MT	Mud Transport
MW	Megawatts
MWe	Megawatts electrical
NGCT	Northern Gateway Connection Terminal
NPSP	National Planning Policy Statement for Ports
NSIP	Nationally Significant Infrastructure Project
PDT	PD Teesport Ltd
PEIR	Preliminary Environmental Impact Report
PINS	Planning Inspectorate
PSA	Particle Size Analysis
pSPA	Potential Special Protection Area
RCBC	Redcar and Cleveland Borough Council

SAF	Sustainable Aviation Fuel
SBQ	South Bank Quay
SLR	Sea Level Rise
SoS	Secretary of State
SSC	Suspended Sediment Concentration
STBC	Stockton-on-Tees Borough Council
UKCP	UK Climate Projections
WFD	Water Framework Directive

1 Introduction

- 1.1.1 This report provides an assessment of the potential impacts of the Proposed Development on the Coastal and Estuarine Processes of the Tees Estuary. These processes comprise the physical and hydrodynamic mechanisms that govern the movement of water and sediment within the estuary (water levels, flows and waves).
- 1.1.2 The following have been considered as part of the assessment:
- hydrodynamics;
 - sediments and sediment transport pathways; and
 - plume dispersion.
- 1.1.3 The findings from this report also inform the assessment within the following Environmental Statement (ES) chapters:
- **Chapter 11: Freshwater and Marine Ecology (ES Volume I, Application Document Ref. 6.1);**
 - **Chapter 12: Water Environment (ES Volume I, Application Document Ref. 6.1); and**
 - **Chapter 20: Marine Navigation (ES Volume I, Application Document Ref. 6.1).**

2 Consultation

- 2.1.1 The Environmental Impact Assessment (EIA) Scoping Report [Ref 1] for the Proposed Development was published in September 2025 followed by the Preliminary Environmental Impact Report (PEIR) in Lighthouse Green Fuels [Ref 2]. The PEIR was published on 02 December 2025 for formal (statutory) consultation on the Proposed Development in December 2025.
- 2.1.2 These documents did not have specific consideration of Coastal and Estuarine Processes, but consideration of some of the potential effects were discussed in PEIR Chapter 12: Water Environment, Chapter 21: Geology and Soils and Chapter 11: Freshwater and Marine Ecology.
- 2.1.3 Table 2.1 sets out responses to relevant comments provided during scoping and statutory consultation. Comments from Navigator Terminals are separately addressed in Appendix 20A: Navigation Risk Assessment.

Table 2.1 Consultation comments from the PEIR and Scoping report

Consultee	Reference, date	Summary of response	How have comments been addressed in this report
MMO	Statutory consultation DCO/2025/00012 January 2026 (PEIR)	Whilst some of the potential impacts have been discussed in Chapter 11 in relation to benthic ecology, the MMO consider that a chapter on Marine Physical Processes would have been beneficial. Information on impacts to hydrodynamics and geomorphological features is limited. The MMO do not consider that impacts associated with marine physical processes have been adequately captured. The following is recommended to be considered further: - How construction of the new quay/infrastructure will impact estuarine flow, and if estuarine flow is impacted, whether salinity/nutrient levels in the water will be impacted. - The impact of the project on sediment pathways. The construction of the new quay could act as a barrier to sediment pathways. Changes to fluvial flow may also impact sediment pathways further downstream. - Suspended sediment and impacts on ecological receptors and contaminant levels.	This report has been produced to consider the impacts of the Proposed Development on hydrodynamics and geomorphological features. The assessment is supported by a suite of numerical modelling studies, details of which are provided in Annex 1 and Annex 2. Section 8: Assessment supported by hydrodynamic modelling to assess the impact on estuarine flow. The effects on salinity/nutrient levels is considered in Chapter 12: Water Environment (ES Volume I, Application Document Ref. 6.1). Section 8: Assessment supported by sediment transport modelling used in to assess the impact on sediment pathways. Section 8: Assessment of the potential dredge plume supported by numerical modelling to assess the impact of suspended sediments. The effect on ecological receptors is assessed in Chapter 11: Freshwater and Marine Ecology (ES Volume I, Application Document Ref. 6.1).
PD Teesport Ltd (PDT)	Scoping Opinion consultation, October 2025	PDT considers that the ES should assess impacts arising from the following matters: Works in, on and under the River Tees, especially any works that may affect navigation, those which may	This report assesses the potential impacts on hydrodynamic and sediment transport processes as a result of the works on or in the River Tees.

Consultee	Reference, date	Summary of response	How have comments been addressed in this report
		change the riverbed or the ability to dredge the riverbed from time to time in accordance with PDT's statutory duties and any works in relation to pipelines or conduits crossing beneath the river and associated riverside portals.	Section 8: Hydrodynamic modelling used to assess the impact of the Proposed Development on estuarine flow. Section 8: The potential plume arising from the capital dredging has been modelled using particle tracking model and sediment transport modelling has assessed the impact of the Proposed Development on sediment pathways. The potential effects on navigation are assessed in Chapter 20: Marine Navigation (ES Volume I, Application Document Ref. 6.1).

3 Legislation, policy and guidance

- 3.1.1 The legislation, policy and guidance relevant to coastal and estuarine processes assessment and details of how their requirements will be met are presented in Table 3.1.

Table 3.1 Relevant legislation, policy and guidance regarding coastal and estuarine processes assessment

Legislation	Consideration within the Environmental Statement
The Marine and Coastal Access Act 2009 (MCAA) [Ref 5]	
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 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 is provided in the ES including characterisation of the coastal and estuarine processes baseline (Section 6 of this report) and an impact assessment has been undertaken (Section 8 of this report).
The Planning Act 2008 (PA 2008) [Ref 6]	
Whilst the MCAA regulates marine licensing for works at sea, section 149A of the PA 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 is provided in the ES including characterisation of the physical processes baseline (Section 6) and an impact assessment has been undertaken (Section 8).
The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 [Ref 7]	
The Water Framework Directive (WFD) (2000/60/EEC) is transposed into UK law through the Water Environment (Water Framework Directive) (England and Wales)	The WFD surface water bodies are described in Chapter 12: Water Environment (ES Volume I, Application Document Ref. 6.1). A WFD Compliance Assessment has been prepared to support the DCO application (Document Ref. 3.1). This includes consideration of the potential

Regulations 2017, known as the Water Framework Regulations¹. In terms of water and sediment quality, “<i>Good ecological status/potential</i>” has regard to physico-chemical quality elements, and specific pollutants. The Good ecological status/potential assessment also considers biological and hydromorphological elements. “<i>Good chemical status</i>” has regard to a series of priority substances and priority hazardous substances.	risks for several key receptors, including hydromorphology. The WFD Compliance Assessment has been informed by the outcomes of the physical processes assessment reported within this report.
The Conservation of Habitats and Species Regulations 2017 [Ref 8]	
The Habitats Directive (92/43/EEC) and Birds Directive (2009/147/EC) are transposed into UK law through The Conservation of Habitats and Species Regulations 2017 as amended, known as the “Habitats Regulations”². 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 Special Areas of Conservation (SACs) (classified under the Habitats Directive) and Special Protection Areas (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 6 of this report characterises the baseline for physical processes. An impact assessment is provided in Section 8 of this report, which has informed the preliminary assessment of impacts on protected habitats and species presented in Chapter 11: Freshwater and Marine Ecology (ES Volume I, Application Document Ref. 6.1). In particular, information is provided with respect to the following potential impact pathways: • physical damage through disturbance and/or smothering of supporting habitats and associated prey resources for interest features; • physical damage through alterations in physical processes of supporting habitat for interest features; and • non-toxic contamination through elevated Suspended Sediment Concentration (SSC) resulting in impacts on interest features, or their prey resources. A Habitats Regulations Assessment (HRA) is provided as part of the DCO (Application Document Ref. 5.11).

¹ 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.

² 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.

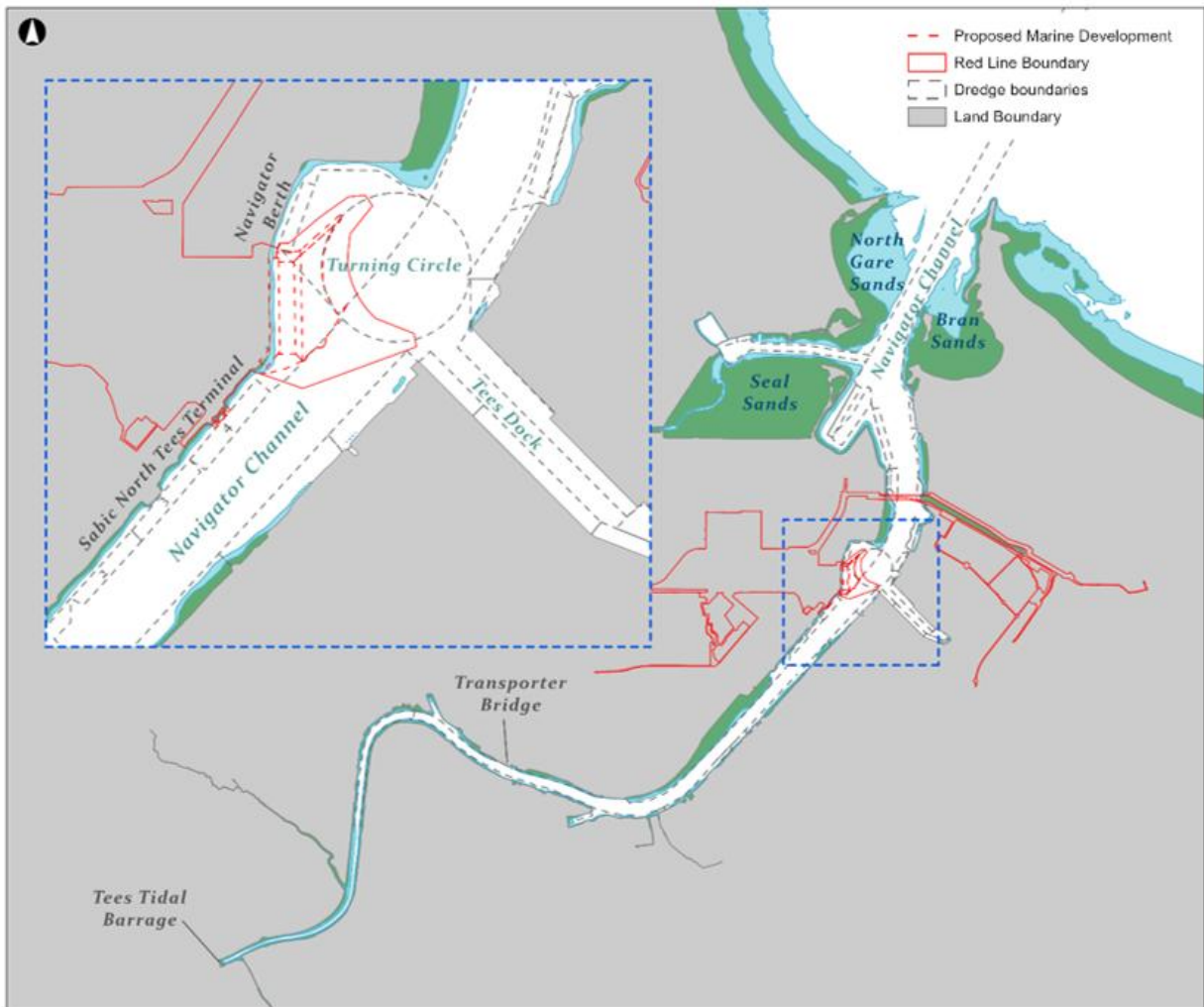
Policy	Consideration within the Environmental Statement
National Planning Policy Statement for Ports (NPSP) [Ref 9]	
The NPSP provides the policy framework for nationally significant infrastructure projects involving new port development. In order to meet the requirements of the Government's policies on sustainable development, the NPSP requires that new port infrastructure should also, amongst other things, assess the impact on coastal processes, be adapted and resilient to the impacts of climate change and provide high standards of protection for the natural environment. It also advises in Paragraph 4.108 that applicants should assess the impact of the proposed project on coastal processes and geomorphology, including by taking account of potential impacts from climate change. If the development has an impact on coastal processes, the applicant must demonstrate how the impacts will be managed to minimise adverse impacts on other parts of the coast. Paragraph 4.108 of the NPSP advises that applicants also assess the vulnerability of the Proposed Development to coastal change in the context of climate change during the project's operational life and any decommissioning period. Paragraph 4.113 states that the decision-maker should be satisfied that the Proposed Development will be resilient to coastal change, taking account of climate change, during the project's operational life and any de-commissioning period.	This document provides the assessment of the impact of the Proposed Development on coastal and estuarine processes.
UK Marine Policy Statement (MPS) [Ref 10]	
The 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 consenting development in the UK marine areas. Section 2.6.8 of the MPS is relevant to the Physical Processes assessment. In particular, paragraph 2.6.8.4 states, amongst other things, that - "<i>Marine plan</i>	This document provides the assessment of the impact of the Proposed Development on coastal and estuarine processes. Mitigation has been considered in Section 8.4.2 and 8.5 of this report and at present no mitigation is anticipated to be required.

<i>authorities should be satisfied that activities and developments will themselves be resilient to risks of coastal change and flooding and will not have an unacceptable impact on coastal change...".</i> In addition, paragraph 2.6.8.6 notes that the impacts of climate change throughout the operational life of a development should be taken into account in assessments, and that any geomorphological changes that an activity or development has on coastal processes, including sediment movement, should be minimised and mitigated.	
UK Marine Strategy [Ref 11]	
The aim of the UK Marine Strategy is to protect the UK's marine environment. The Strategy sets out a comprehensive framework for assessing, monitoring, and taking action to achieve the UK's shared vision for clean, healthy, safe, productive, and biologically diverse seas. It aims to achieve good environmental status of marine waters by 2020 (followed by a six-year review) and then to protect the resource base upon which marine-related economic and social activities depend. The Strategy constitutes a vital environmental component of future maritime policy, designed to achieve the full economic potential of oceans and seas in harmony with the marine environment. The UK Marine Strategy applies to the landward boundary of coastal waters as defined under the WFD (i.e., from mean high water springs (MHWS)) to the outer limit of the UK Exclusive Economic Zone (EEZ), as well as the area of UK continental shelf beyond the EEZ. Government reporting against the Strategy is a cyclical process, and the most recent assessments and Marine Strategy documents were updated in 2019.	The anticipated pressures exerted on the marine environment by the Proposed Development are of sufficiently small magnitude, in the context of UK Marine Regions, that they are unlikely to be of significance. The Strategy is, therefore, not considered further in this assessment.
North East Inshore and North East Offshore Marine Plans [Ref 13]	
The North East Inshore and North East Offshore marine plans were published in June 2021 by the Department for Environment, Food and Rural Affairs. The relevant policies for the Proposed Development are as follows: NE-CO-1 Proposals that optimise the use of space and incorporate opportunities for	The impact assessment in Section 8 of this report assesses how the Proposed Development (construction and operation) impacts the neighbouring berth pockets and navigational channels.

co-existence and cooperation with existing activities will be supported. Proposals that may have significant adverse impacts on or displace, existing activities must demonstrate that they will, in order of preference: a) avoid, b) minimise or c) mitigate. NE-DD-1 In areas of authorised dredging activity, including those subject to navigational dredging, proposals for other activities will not be supported unless they are compatible with the dredging activity.	
Guidance	Consideration within the Environmental Statement
PINS: Advice on the Water Framework Directive [Ref 12]	
The Advice explains the information that the Inspectorate considers an applicant must provide with their Nationally Significant Infrastructure Project (NSIP) application in order to clearly demonstrate that the WFD and the Water Environment (WFD) (England and Wales) Regulations 2017 have been appropriately considered. The Advice also refers to Environment Agency (EA) guidance on Water Framework Directive assessment: estuarine and coastal waters, in terms of the WFD process and the information required. Furthermore, the Advice describes the relevant bodies to be consulted in the pre-application process, and the presentation of information.	The WFD Compliance Assessment for the Proposed Development (Application Document Ref. 5.10) contains the information specified in this guidance as appropriate. The WFD Compliance Assessment has been informed by the outcomes of this physical processes assessment.

4 Definition of the study area

- 4.1.1 The study area for this assessment is the area over which potential direct and indirect impacts of the Proposed Development on coastal and estuary processes are predicted to occur during the construction and operational phases.
- 4.1.2 The direct impacts on physical processes are those confined to the areas within the footprint of the Proposed Development (dredged berth pocket and reclaimed land).
- 4.1.3 Indirect impacts are those that may arise due to wider changes in the estuary flow and sedimentary regime and any associated change to the estuary morphology as a result of the Proposed Development.
- 4.1.4 Consequently, the study area shown in Inset 4.1 for the coastal and estuarine processes report comprises of:
- the Proposed Development site;
 - existing jetties and berths across the near-field and the central part of the Tees Estuary;
 - the existing navigational turning circle and channel; and
 - the wider estuary, between the Tees Tidal Barrage and Teesmouth (including Seal Sands, North Gare Sands and Bran Sands).



Inset 4.1 Regional setting within the Tees Estuary

Note: This figure shows a superseded Site boundary (shown in red) which was used to support discussions with stakeholders while developing this appendix. The final Site boundary has subsequently been refined and reduced in extent. The figure is retained for illustrative purposes and does not materially affect the findings of this appendix

5 Assessment methodology

- 5.1.1 This section describes the data sources used to inform the Coastal and Estuarine Processes assessment, the methodology applied to determine the significance of identified impacts, and the key assumptions and limitations that have been adopted through the report.
- 5.1.2 The assessment of the changes in coastal and estuary processes has utilised numerical (computer) models, which have been created to replicate the flow (hydrodynamic) and sediment transport regimes in the estuary under baseline conditions. A particle tracking module has also been applied, driven by the flow model, to predict the dispersion and fate of sediments released from capital dredging associated with the Proposed Development. Details of the numerical models are provided in Annex 1 and Annex 2.
- 5.1.3 Due to the location of the study area within Teesport there is anticipated to be a minimal wave regime experienced at the Proposed Development defined in Inset 4.1 (see Section 6.7.4 for further details). The impacts of the Proposed Development on the existing wave regime are therefore not considered to be significant and have not been assessed within this report.

5.2 Data and information sources

- 5.2.1 Current baseline conditions have been determined by a desk-based review of available information, supported by numerical modelling of flows and sediment transport (Annex 1). The hydrodynamic surveys used to inform the numerical modelling are as follows:
- April 2005: Acoustic Doppler Current Profiler (ADCP) and Conductivity, Temperature and Depth (CTD) survey campaign, data presented in HR Wallingford (2006) report to support Northern Gateway Connection Terminal (NGCT) EIA; and
 - July 2020: ADCP and CTD survey campaign undertaken by Partrac, data presented in RHDHV (now known as Haskoning) (2020a) report to support South Bank Quay (SBQ) development EIA.
- 5.2.2 The bathymetric surveys used to inform the numerical modelling are as follows:
- ABPmer bathymetric surveys collected on behalf of the EA in 2023 (ABPmer, 2023);
 - EA Light Detection and Ranging (LiDAR) data (from 2019 and 2021);
 - PDT surveys (from 2014 – 2025); and

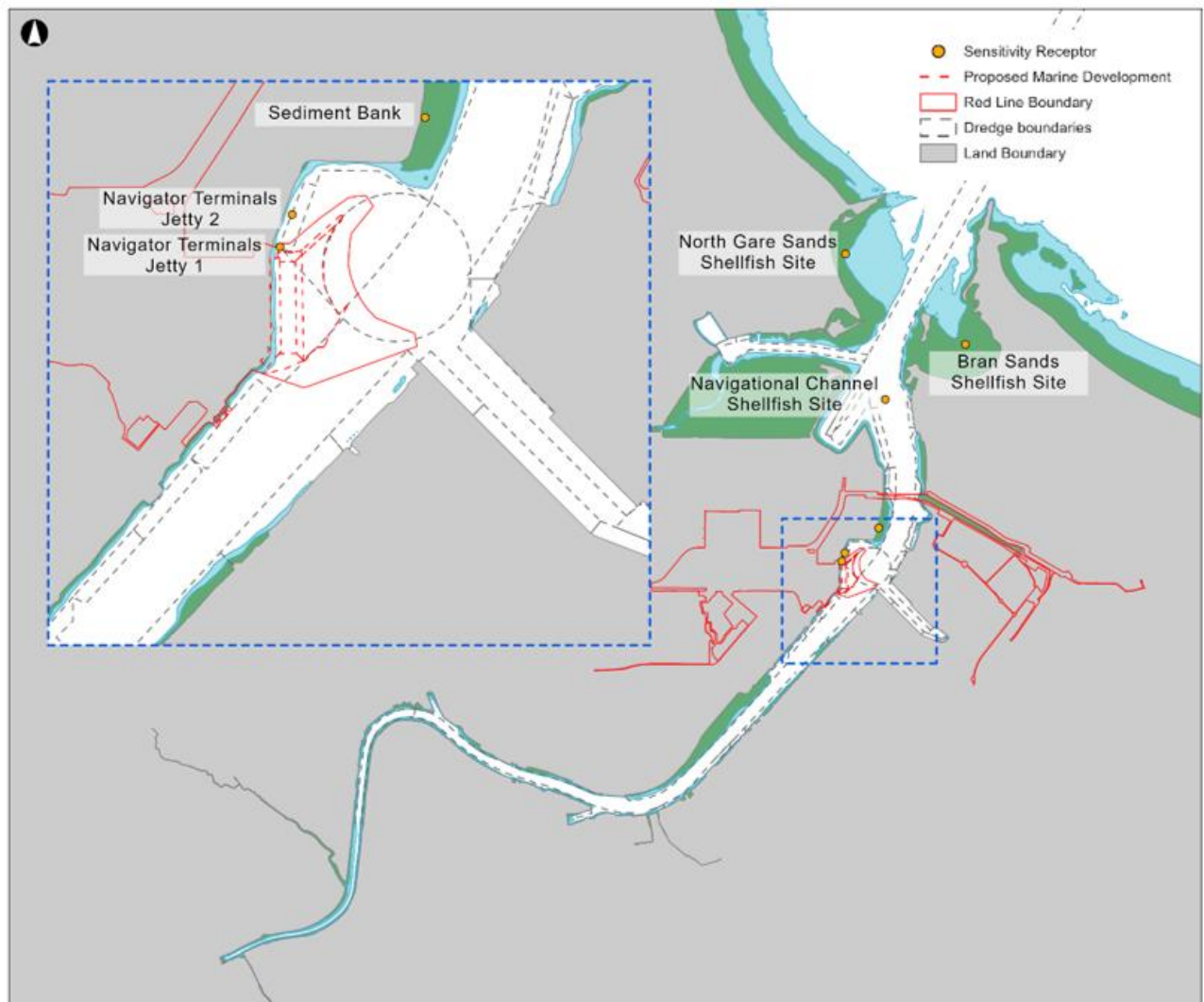
- Bathymetric survey data sourced from UK Hydrographic Office (UKHO) Admiralty Marine Data Portal (from 1988-2018).
- 5.2.3 The main desk-based sources of information that have been reviewed to inform the current baseline description within the vicinity of the Proposed Development include:
- ABPmer (2002), Tees Entrance Channel Study Part 1. A conceptual Model of Estuary processes in the Tees Estuary;
 - RHDHV (2020a) SBQ EIA;
 - UKHOe Admiralty Tide Tables (UKHO, 2025);
 - EA Coastal Flood Boundary Conditions for the UK: Update 2018 (EA, 2018);
 - Centre for Environment, Fisheries and Aquaculture Science (Cefas) WaveNet (2026) Tyne/Tees Buoy;
 - National River Flow Archive (2026);
 - Site-specific marine sediment samples collected within the Tees Estuary for particle size analysis (PSA) as part of PD Teesport Ltd marine licence agreement;
 - RHDHV (2020b) NGCT EIA update/extension; and
 - HR Wallingford (2006) NGCT EIA, Modelling Report.
- 5.3 **Determining magnitude of impact**
- 5.3.1 The approaches adopted for the assessment of the impacts on coastal and estuarine processes are based on the methods laid out in **Chapter 2: Assessment Methodology (ES Volume I, Application Document Ref. 6.1)**.
- 5.3.2 The Proposed Development has the potential to result in changes to hydrodynamic and sedimentary processes.
- 5.3.3 Coastal and estuary processes are generally defined as pathways, with the potential to subsequently result in associated effects on receptors. For example, 'changes' in the transport and deposition of sediment ('pathway') may 'impact' on the structure and function of marine habitats and their associated species ('receptor' within **Chapter 11: Freshwater and Marine Ecology (ES Volume I, Application Document Ref. 6.1)**).

- 5.3.4 A number of potentially sensitive features of interest have been identified, as described below. Consequently, this report assesses a Magnitude of Impact for each of the identified pathways and potentially sensitive features of interest but does not subsequently assess a significance of effect. Where relevant, the assessment of Magnitude of Impact covers the study area as well as the identified specific features of interest (see below).

5.4 Features of interest for assessment

- 5.4.1 This report has identified several Coastal and Estuary Process features of interest, which are potentially sensitive to the Proposed Development. Whilst not specifically designated features (and, hence, not defined as EIA Receptors), the identified features of interest have been assessed within this report and the magnitude of impact (for each pathway) has been considered. These features of interest, locations shown in
- 5.4.2 Inset 5.1, are outlined as follows:
- *Navigator Terminals Jetty 1*: less than 30m upstream from Proposed Development (sensitive to changes in hydrodynamics, siltation from construction dredge or operational changes to sediment transport pathways);
 - *Navigator Terminals Jetty 2*: approximately 150m upstream from Proposed Development (sensitive to changes in hydrodynamics, siltation from construction dredge or operational changes to sediment transport pathways);
 - *Unnamed Sediment Bank*: approximately 620m upstream from the Proposed Development on the north bank of the Tees adjacent to Navigator Terminals Seal Sands (of interest to feeding birds; sensitive to changes to hydrodynamics and associated potential erosion as a result of changes to sediment transport pathways);
 - *Navigational Channel Shellfish Site*: approximately 2.4km upstream from the Proposed Development (sensitive to changes in hydrodynamics, siltation from construction dredge or operational changes to sediment transport pathways);
 - *North Gare Sands Shellfish Site*: approximately 4.5km upstream from the Proposed Development (sensitive to changes in hydrodynamics, siltation from construction dredge or operational changes to sediment transport pathways); and
 - *Bran Sands Shellfish Site*: approximately 4.5km upstream from the Proposed Development (sensitive to changes in hydrodynamics,

siltation from construction dredge or operational changes to sediment transport pathways).



Inset 5.1 Sensitive features of interest assessed within the coastal and estuarine processes ES chapter

Note: This figure shows a superseded Site boundary (shown in red) which was used to support discussions with stakeholders while developing this appendix. The final Site boundary has subsequently been refined and reduced in extent. The figure is retained for illustrative purposes and does not materially affect the findings of this appendix

5.5 Assumptions and limitations

- 5.5.1 The information presented in this assessment reflects the proposed parameters and design considerations for the Proposed Development, as described in **Chapter 4: Proposed Development (ES Volume I, Application Document Ref. 6.1)**.

- 5.5.2 The dredged materials will be disposed of offshore by deposit at a disposal site carrying reference TY150– "Tees Bay C" if acceptable to the MMO. Otherwise, dredged material may be disposed of at an alternative offshore site to be agreed with the MMO or onshore permitted landfill site. Off-shore disposal of dredged materials is not assessed.
- 5.5.3 This assessment has been undertaken based on the following assumptions,
- dredging is required to remove up to a maximum of 800,000m³ of material;
 - capital dredging works are to be carried out 24/7;
 - a backhoe dredger is solely used to excavate the dredged material at a rate of 600m³/hour using a 20m³ bucket (120 second bucket cycle time); and
 - self-propelled hopper barges with 1,500 m³ capacity are used to transport the excavated material from the site to the dumping ground.
- 5.5.4 To examine the hydrodynamic and mud transport regime under the baseline (present-day) conditions and how it may be affected by the Proposed Development, three model scenarios have been examined. These cover three river discharge scenarios at the Tees Barrage, determined from river gauge data (as described in Section 6.5). The scenarios are defined as:
- low flow: the combined 95%ile exceedance average daily flow rate of 3.39m³/s;
 - mean flow: the annual mean average daily flow rate of 23.14m³/s; and
 - high flow: the combined 10%ile exceedance average daily flow rate of 52.79m³/s.
- 5.5.5 The assessment within this chapter has been undertaken considering the anticipated worst-case scenario in respect of physical processes interest features across the study area.
- 5.5.6 This assessment presents only the mean flow scenario, unless either the low or high flow scenario has a notable difference on the outcome of the assessment. Specific assumptions associated methodology and all scenario results for the assessment is provided in Annex 1.

6 Baseline description

6.1 Overview

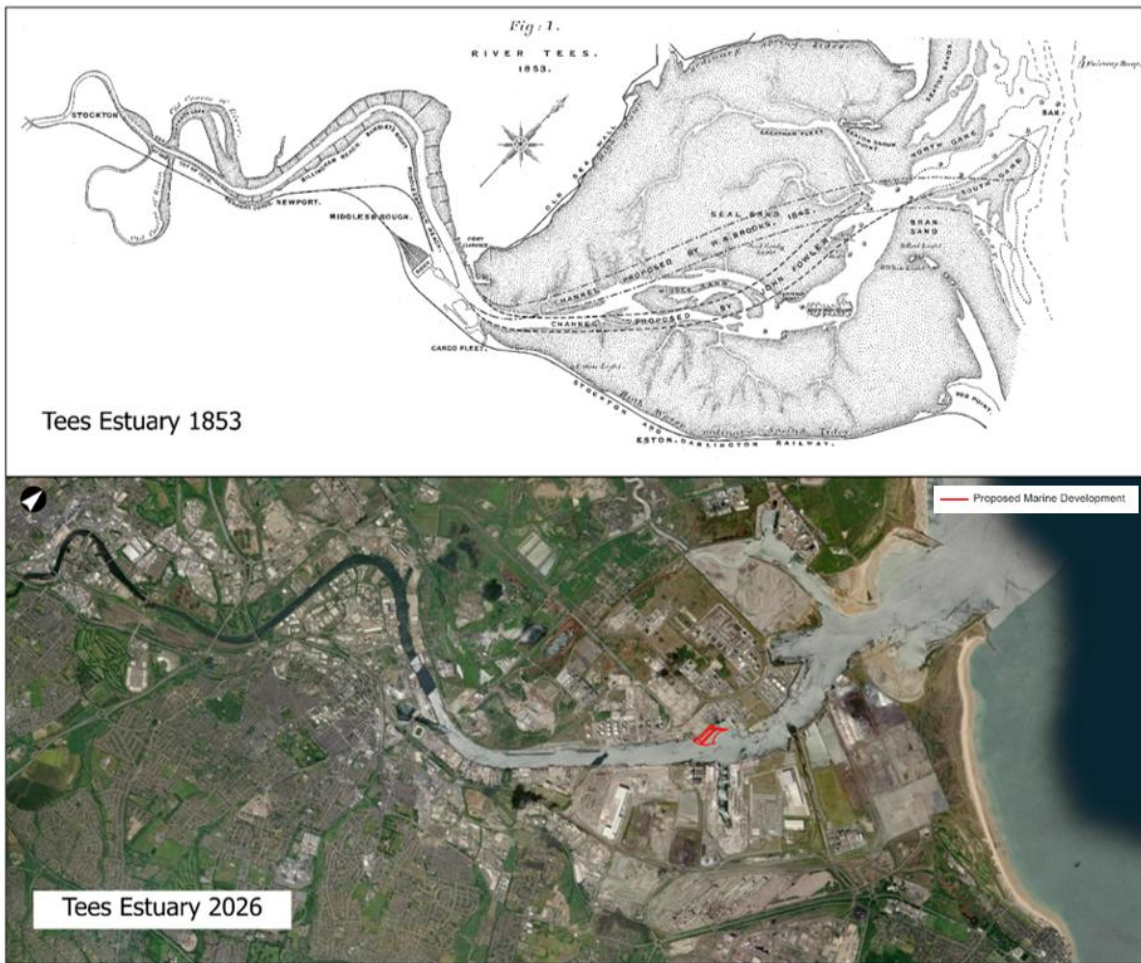
- 6.1.1 The following sections provide an overview of the existing (baseline) conditions across the study area, including geomorphology, hydrodynamics (tides and waves) and sediments.

6.2 Geomorphology

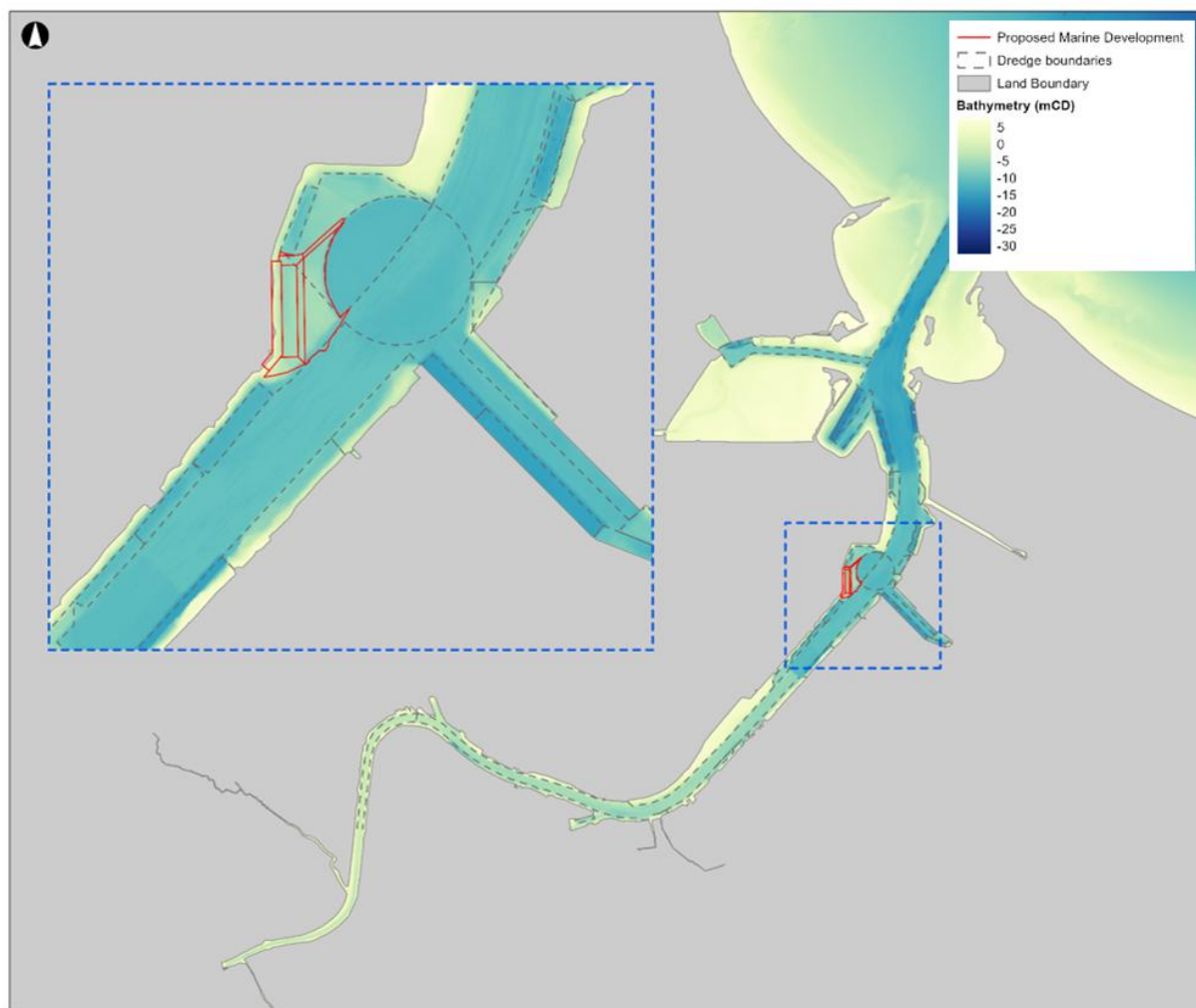
- 6.2.1 The morphology of the coast in the vicinity of the entrance to the Tees estuary is constrained by a resistant Permian Magnesian Limestone outcrop at The Headland in Hartlepool to the north of the estuary, and a resistant outcrop of sandstone and shale of the Jurassic Redcar Mudstone outcrop at Coatham Rocks to the south, in Redcar. Between these outcrops the coastline consists largely of clay and sand and other quaternary deposits (up to 30m thick) with limited rock outcrops (except at Long Scar off Hartlepool) (ABPmer, 2002).
- 6.2.2 In the last 115,000 years the relative sea level has changed by over 100m, at times above or below the present sea level. These changes are the result of Holocene glaciation and deglaciation, post-glacial rebound and barystatic sea level change. By comparison, the contemporary rates of change are low; between 1895 and 1982 sea level rise was approximately 2mm/yr (ABPmer, 2002).
- 6.2.3 Prior to the mid-19th century, the mouth of the Tees was an open estuarine environment with tidal flats and migrating channels of the main River Tees and tributaries (Inset 6.1). Since this period, industrial expansion has led to narrowing and canalisation of the river upstream of the estuary entrance. Significant areas of land have been reclaimed for industrial use over this period, as can be seen by comparing the past and present extents of the Tees Estuary illustrated in Inset 6.1.

6.3 Bathymetry

- 6.3.1 The River Tees Entrance comprises a deep, dredged navigational channel (-14.1m below Chart Datum (CD)) surrounded by shallower inter- and sub-tidal North Gare and Bran Sands. By the site of the Proposed Development, the depth of the navigational channel is -10.4mCD, having shallowed further down-estuary. The Turning circle (which overlaps the navigational channel) has a deeper depth of -11mCD. The general bathymetry of the Tees is displayed in Inset 6.2.



Inset 6.1 Comparison between the Tees Estuary morphology in 1853 (Fowler, 1876) and present day satellite imagery



Inset 6.2 Bathymetry of the Tees Estuary

6.4 Tides and water levels

6.4.1 The Tees Estuary is a macro-tidal, moderate-sized estuary and has a spring tidal range of 4.6m and neap tidal range of 2.3m. Adjacent to the outer coastline, between Hartlepool and Redcar, flows on the flood and ebb tide run to the south and north, respectively. Table 6.1 shows the characteristic water levels at the entrance to the River Tees in metres relative to Ordnance Datum Newlyn (mODN).

Table 6.1 Astronomical tidal water levels within the Tees Estuary

Tidal level	Acronym	Tees entrance (mODN)	Middlesbrough (dock entrance) (mODN)
Highest Astronomical tide	HAT	3.25	3.25
Mean High Water Springs	MHWS	2.65	2.75
Mean High Water Neaps	MHWN	1.45	1.65
Mean Sea Level	MSL	0.30	-
Mean Low Water Neaps	MLWN	-0.85	-0.75

Tidal level	Acronym	Tees entrance (mODN)	Middlesbrough (dock entrance) (mODN)
Mean Low Water Springs	MLWS	-1.95	-2.05
Lowest Astronomical Tide	LAT	-2.85	-3.15
Astronomic Tidal Range		6.10	6.40
Mean Spring Range		4.60	4.80
Mean Neap Range		2.30	2.40

Source: UK Hydrographic Office (2026)

6.4.2 The extreme return period for nearshore water level conditions (tide and surge) at the entrance to the Tees Estuary is presented in Table 6.2, based on the EA's Coastal Flood Boundary Dataset [Ref 3]. The maximum water level currently recorded at Tees Dock (the closet tide gauge to the Proposed Development) occurred on 05 December 2013 at 16:45 hours with a level of 4.09mODN compared to the predicted 2.84mODN; therefore, the meteorological surge effect during the recorded event was 1.25 m.

Table 6.2 Extreme water levels – Outer Tees

Return period (years)	Outer Tees Estuary (mODN)
HAT (Tees Entrance)	3.25
t1	3.36
t2	3.44
t10	3.65
t20	3.74
t50	3.87
t75	3.92
t100	3.97
t1000	4.32

Source: UKHO (2026), Environment Agency (2018)

6.5 Fluvial flow regime

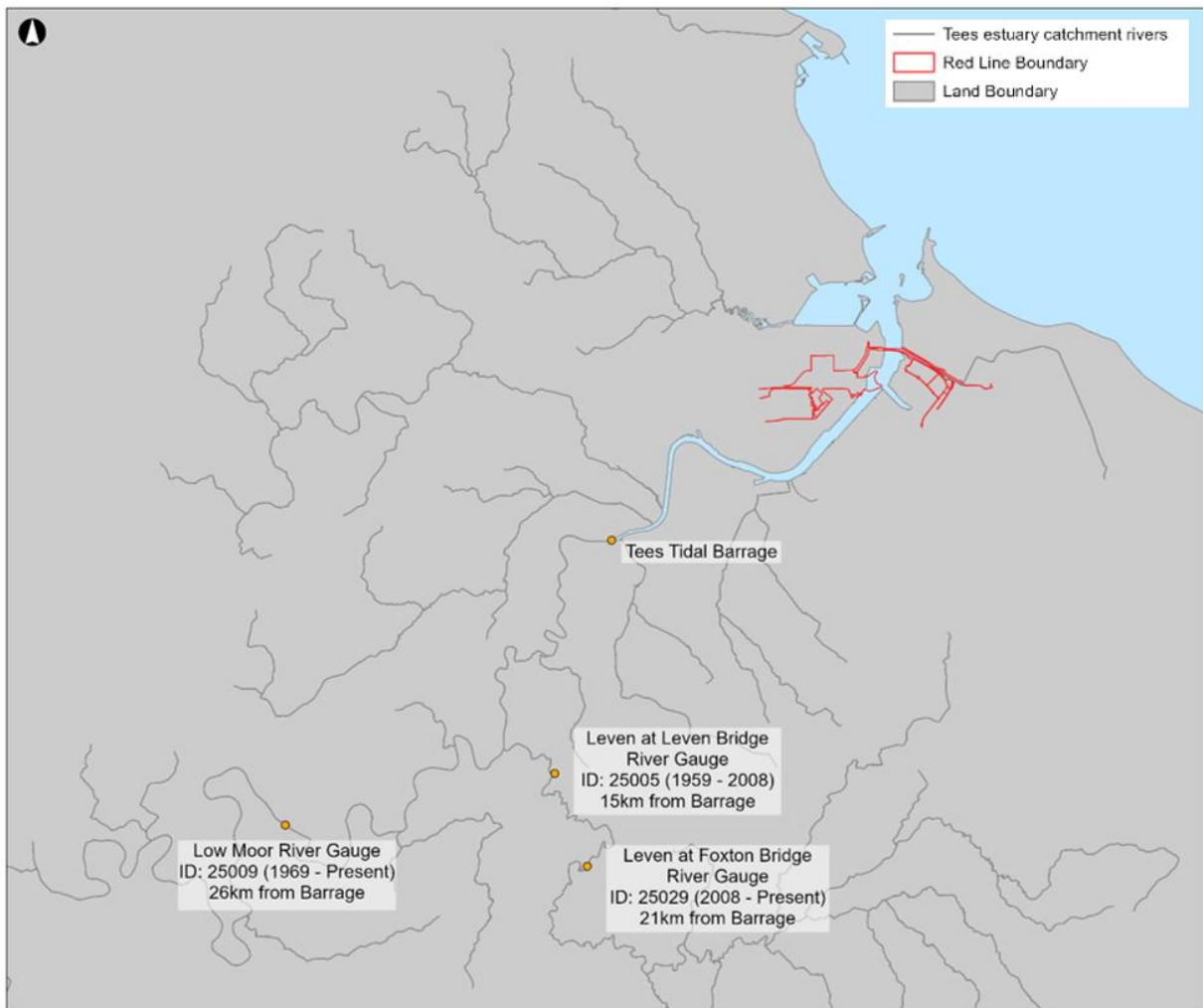
6.5.1 The source of the River Tees is located 160km inland from the Tees estuary entrance at Cross Fell on the Pennines. The main fluvial input into the estuary is recorded at Low Moor with a secondary input further downstream at the River Leven. The flow values at Low Moor and Leven from the National River Flow Archive [Ref 23] are shown in Table 6.3, with the locations of the river gauging stations (and distance from the tidal barrage) displayed in Inset 6.3.

6.5.2 These flows are restricted within the estuary by the tidal barrage, located 16.5km up estuary from the Tees entrance. The barrage, constructed in 1995, has prevented the continuous fluvial input into the Tees due to its facility to control freshwater discharge into the estuary. This has limited the fluvial flow input to the surface layers of the water column and has resulted in a more strongly stratified, salt-wedge estuary (as opposed to a more mixed estuary prior to barrage construction).

Table 6.3 Flow data from the Leven and Tees (These combine to provide discharge at the Tees Tidal Barrage)

	Station ID: 25005 Leven at Leven Bridge	Station ID: 25029 Leven at Foxton Bridge (replaced Leven Bridge in 2008)	Station ID: 25009 Tees at Low Moor	Estimated combined flow at Tees Barrage
Period of record:	1959 - 2008	2007 - 2024	1969 - 2024	
Percent complete:	>99 %	>99 %	99 %	
Base flow index:	0.42	0.43	0.39	
Mean flow:	1.892 m³/s	2.040 m³/s	21.105 m³/s	23.14 m³/s
95% Exceedance (Q95):	0.249 m³/s	0.261 m³/s	3.13 m³/s	3.39 m³/s
70% Exceedance (Q70):	0.517 m³/s	0.533 m³/s	6.23 m³/s	6.76 m³/s
50% Exceedance (Q50):	0.873 m³/s	0.906 m³/s	11.2 m³/s	12.1 m³/s
10% Exceedance (Q10):	4.248 m³/s	4.620 m³/s	48.1 m³/s	52.72 m³/s
5% Exceedance (Q5):	6.78 m³/s	7.59 m³/s	69.8 m³/s	77.39 m³/s

Source: National River Flow Archive (2026)



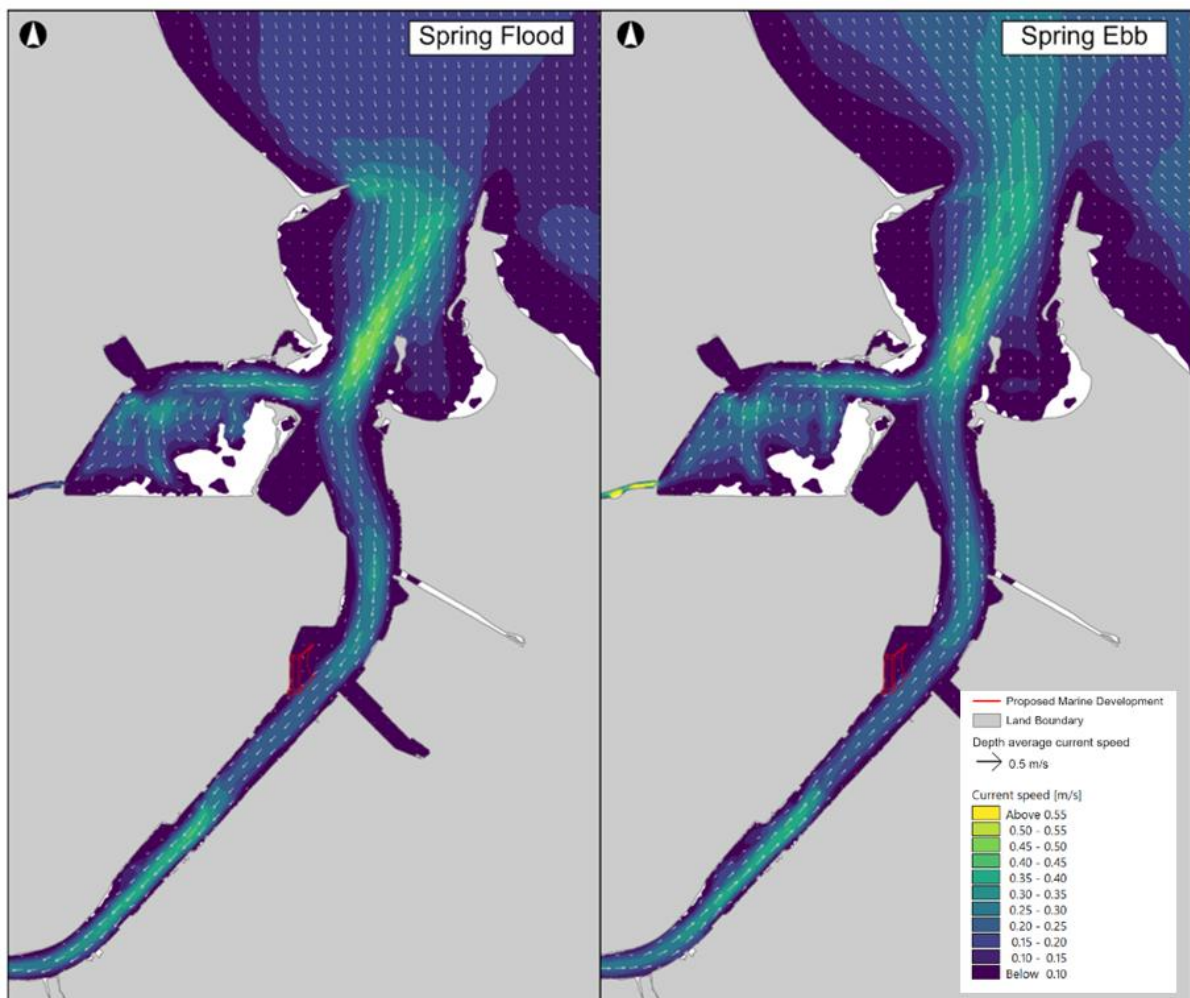
Inset 6.3 Locations of the river gauges inputting into the Tees Estuary with the distance from the Tees Tidal Barrage

Note: This figure shows a superseded Site boundary (shown in red) which was used to support discussions with stakeholders while developing this appendix. The final Site boundary has subsequently been refined and reduced in extent. The figure is retained for illustrative purposes and does not materially affect the findings of this appendix

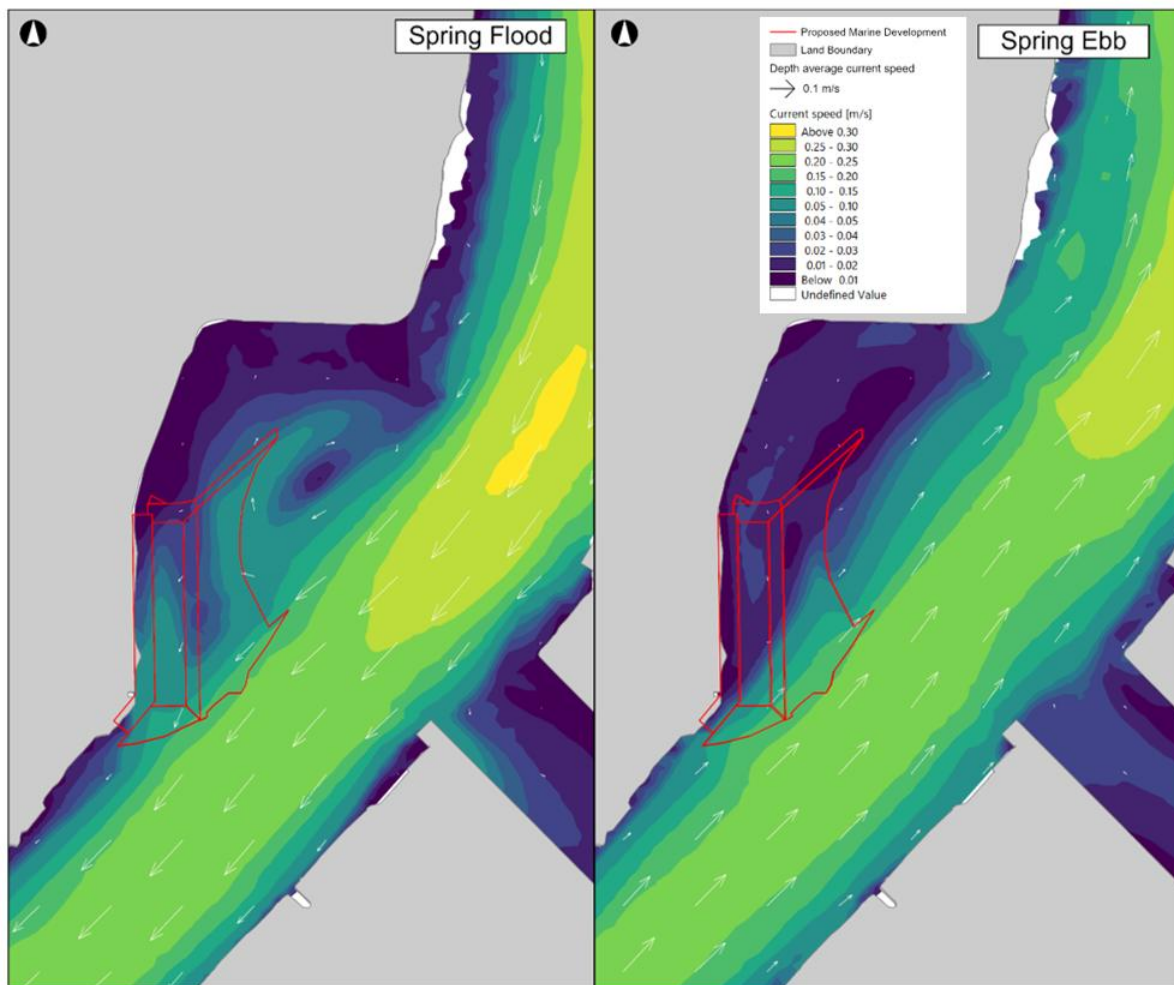
6.6 Tidal flow regime

- 6.6.1 Flow speed data produced by the fully calibrated baseline model is presented for the Spring Tide peak flood and ebb periods in Inset 6.4 (see Annex 1 for more detail on model setup, calibration and baseline flows). The baseline model shows that the flows are highest in the inner Tees estuary navigational channel between North Gare Sands and Bran Sands, speeds here can reach up to 0.5m/s. Up estuary at the Proposed Development flows are slower, with speeds having a maximum of 0.3m/s in the navigational channel and <0.1m/s within the Proposed Development.

- 6.6.2 The current direction generally aligns with the orientation of the estuary throughout a tidal cycle, with flows branching at the entrance to Greatham Creek. Near the Proposed Development, an eddy structure forms under all scenarios on the flood tide, shown in Inset 6.5 for the mean flow scenario. On the ebb tide this structure does not form, which is likely a result of the ebb flow characteristics in relation to the local estuary morphology.
- 6.6.3 The neap tides have the same flow structure as the spring tides presented, but with the current speeds having approximately half the magnitude across the estuary.



Inset 6.4 Depth-average flow regime on a flood (left) and ebb (right) spring tide under a mean flow scenario

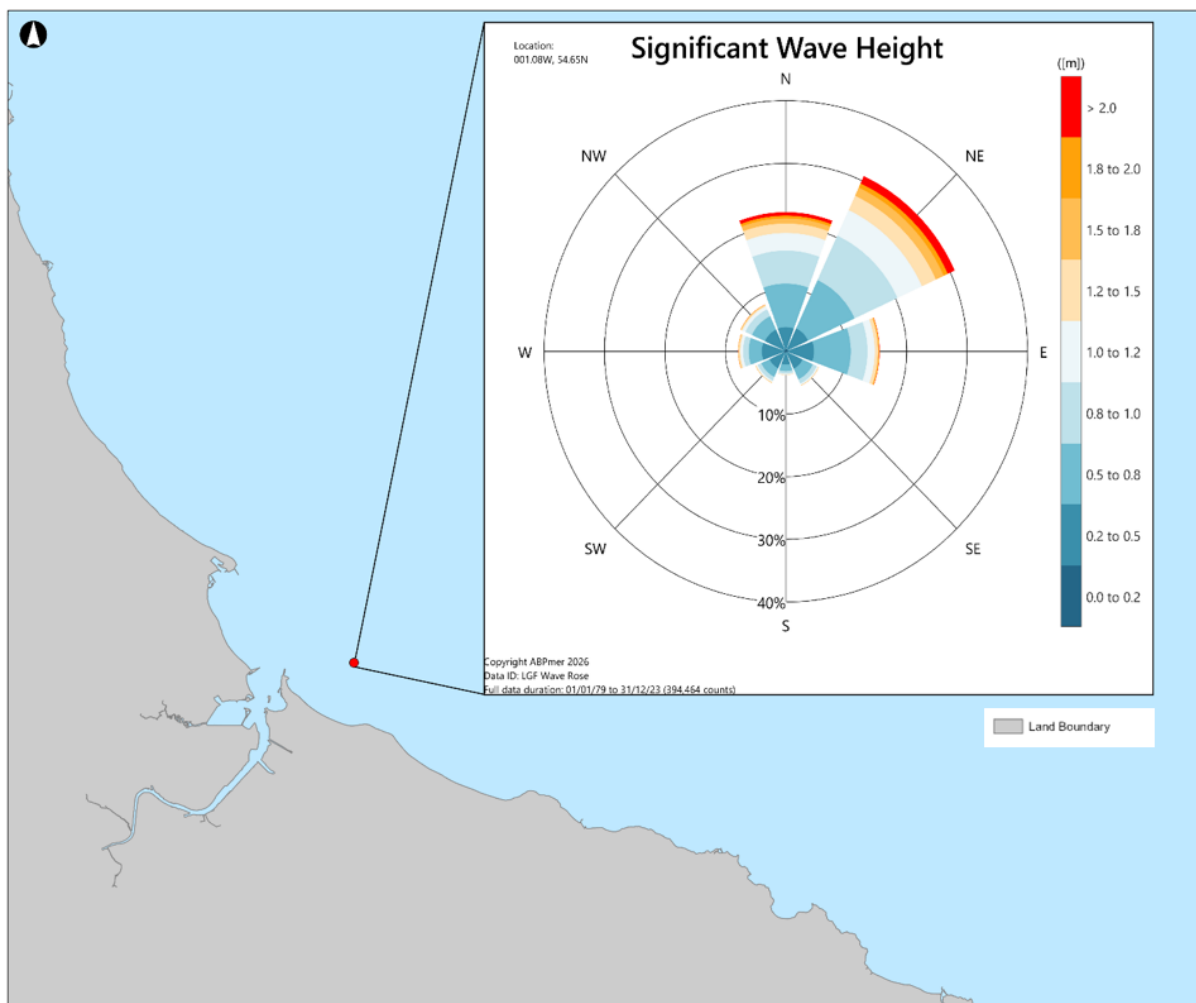


Inset 6.5 Depth-average flow regime at the Proposed Development on a flood (left) and ebb (right) spring tide under a mean flow scenario

6.7 Wave regime

- 6.7.1 The characteristic wave patterns along the outer open coastline between Hartlepool and Redcar are shown in Inset 6.6. The wave rose characteristics are the average condition from the 44-year SEASTATES hindcast record between 1979 and 2025 [Ref 24]. The wave rose shows that waves along this section of coastline are predominantly from a northerly direction, with the highest waves generally coming from a north easterly direction.
- 6.7.2 A previous wave study undertaken by ABPmer within the Seal Sands/Greatham area of the Tees Estuary [Ref 25]. This showed that waves with a mean wave direction of between 352.5° and 37.5° account for approximately 30% of the total wave distribution. The highest waves offshore (a maximum recorded 8.7m) occur in the sector 22.5° to 37.5° (from).

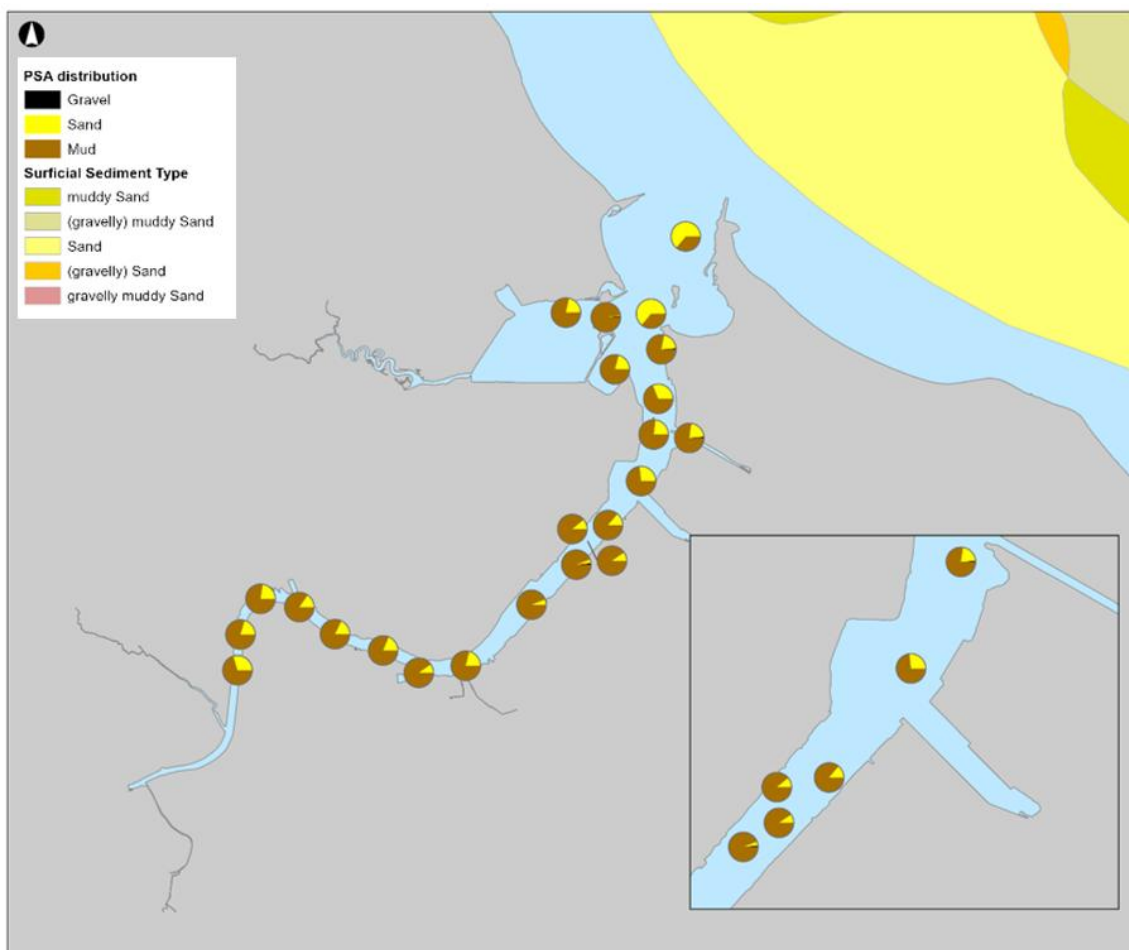
- 6.7.3 Waves up to $H_s=5\text{m}$ are observed to originate from easterly directions and whilst these are significant, the geometry of the shoreline and Tees Harbour in relation to these easterly wave events will shelter the entrance to the Tees from any extreme easterly waves. In addition, the geometry of the Tees harbour is unlikely to allow propagation of these waves into the harbour. It is likely that the effect of waves on other hydrodynamic and sedimentary processes will be minimal, with only locally generated wind waves present, developed over the limited fetch length.
- 6.7.4 Waves at the Proposed Development tend to be less than 0.5m and are the remnants of swell wave energy or are wake/wash features generated by passing/berthing vessels.



Inset 6.6 Long-term average wave rose of significant wave height near the entrance to the Tees Estuary

6.8 Surface sediments

- 6.8.1 Due to the geomorphological processes that have occurred in the formation of the Tees Estuary, bed sediments found across the study area tend to be either sandy or silty in nature, as shown in Inset 6.7. This figure shows the particle size analysis (PSA) results of sediment samples taken in 2024 [Ref 26].
- 6.8.2 At the entrance to the estuary, specifically North Gare Sands and Bran Sands, surface sediments have a higher proportion of sandy material. This is the result of the entrance acting as a sink for material due to the sheltering effect of the North and South Gare breakwaters [Ref 15].
- 6.8.3 Further up estuary, silty sediments are more dominant, particularly in the navigational channel where the riverine silts tend to accumulate. At the Proposed Development, the nearest sediment sample composition is approximately 75% silt and 25% sand with no gravel present.



Inset 6.7 Surface sediment composition within the Tees Estuary and immediate offshore area

6.9 Sediment transport

Suspended load transport

- 6.9.1 Suspended sediment concentrations (SSC) within the Tees Estuary are generally low. Around Tees Dock, SSCs are in the order of around 20mg/l, with short term peaks of 40-80mg/l. Closer to the tidal barrage, further up the estuary, concentrations can increase but are predominantly still around 30mg/l, with the highest concentrations in the lower layers of the water column [Ref 18].

Bedload transport

- 6.9.2 Flow speeds within the estuary are generally low and often insufficient to re-erode sediments once they have been deposited. An exception to this is on the larger (spring) tides and when assisted by wave disturbance (which is generally limited to the outer parts of the system, around the mouth of the estuary) [Ref 27].
- 6.9.3 Deposition (evidenced by the higher maintenance dredge commitments [Ref 26] is greater towards the entrance of the Tees Estuary. Here, sand accumulates within 2km of the estuary entrance having been transported in from offshore up to 2km.
- 6.9.4 Further up-estuary siltation reduces in the mid reaches and then increases from the Transporter Bridge to the Tees Barrage. At the Proposed Development, it is estimated from dredging records that (averaged over the total estuary reach area) accretion equates to approximately 0.025m/year.

7 Future baseline

- 7.1.1 Guidance for the implications of climate change and future sea level rise (SLR) is provided by the UK Climate Projections 2018 (UKCP18) [Ref 4]. For the coastal cell nearest the entrance to the Tees Estuary, the UKCP18 guidance indicates that future sea levels could increase by 0.15m to 0.9m by 2100 (under a range of emission scenarios and probabilities). The SLR guidance values, at the 70 and 95 percentile probabilities and using the RCP8.5 scenario, is provided in Table 7.1. Consequently, flood risk is likely to continue to increase in the Tees Estuary with or without the implementation of the Proposed Development.
- 7.1.2 A rise in sea level may allow larger waves, and therefore more wave energy, to propagate further in the Tees Estuary under certain conditions. This may result in an increase in local rates or patterns of erosion. Although, the morphology of the Tees Estuary is heavily modified with large areas of reclaimed land (Section 6.2) so is unlikely to have considerable change.

Table 7.1 UKCP18 RCP8.5 sea level rise scenario (relative to 2026 base year)

Year	UKCP18 RCP8.5 projected sea level rise (m)	
	70%ile	95%ile
2026	-	-
2040	0.08	0.11
2060	0.24	0.31
2080	0.44	0.58
2100	0.66	0.90

8 Impact assessment

- 8.1.1 When considering the Coastal and Estuary Processes as pathways, the magnitude of impact has been determined. For the coastal and estuarine interest features (Section 5.4), a specific magnitude of impact has also been provided.

8.2 Construction phase impacts

- 8.2.1 This section documents the assessment of the potential impacts of the construction phase of the Proposed Development.
- 8.2.2 The following impact pathways have been scoped into the assessment during the constructional phase:
- plume impacts from the capital dredging (Details of the numerical modelling are provided within the modelling report in Annex 1);
 - i. increased SSC and potential sedimentation over the extent of the disturbance plume because of the capital dredging works; and
 - ii. changes in seabed bathymetry and composition because of deposition of dredged material within the area of the respective plumes.
 - changes in hydrodynamic regime from temporary construction infrastructure and vessels (Details of the numerical modelling are provided within the modelling report in Annex 1).
 - changes in hydrodynamic regime from potential temporary bund required to support the construction (Details of the numerical modelling are provided within the modelling report in Annex 2).
- 8.2.3 The assessment has used numerical modelling to predict the potential impacts of the Proposed Development on the estuary. The models have been run for a Baseline Scenario without the Proposed Development and with the Proposed Development activities represented.

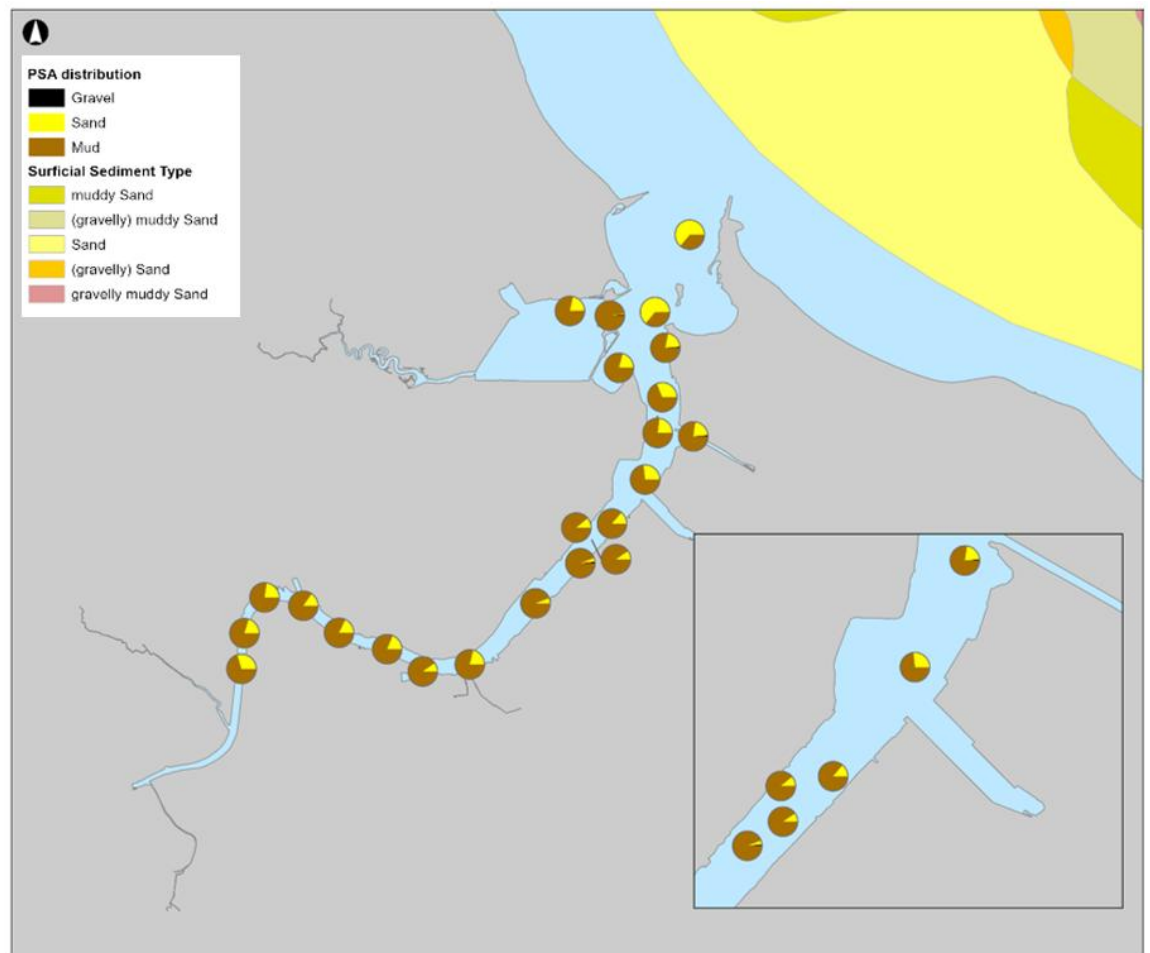
Plume impacts from the capital dredging

- 8.2.4 The sediment plume model scenario is considered a 'worst-case' scenario in terms of potential impacts on sediment plumes from construction activity as follows based on previous experience and the design parameters set out below:
- dredging works are to be carried out 24/7;
 - a backhoe dredger is solely used to excavate the dredged material at a rate of 600m³/hour using a 20m³ bucket (120 second bucket cycle);

- self-Propelled Hopper Barges with 1,500m³ capacity are used to transport the excavated material from the site to the dumping ground (with sufficient barges available to allow for continuous dredging); and
- dredging is required to remove up to 800,000m³ of material.

8.2.5 In addition, the following details have also been assumed in respect of the plume assessment, based on an understanding of the method and equipment to be used:

- characteristic sediment distribution is informed by the surface sediment samples (Inset 6.7



), with a mean grain diameter of 20µm; and

- inputs to the plume modelling from the dredge are applied at the bed, surface and through the water column, arising from bucket lowering, bed ripping, water column wash and slewing (breaking the water surface).

8.2.6 Based on these assumptions, the assessment considers continuous dredging (of the full dredge volume) at the Site.

Increased SSC and potential sedimentation over the extent of the disturbance plume because of the capital dredging works

- 8.2.7 The predicted spatial extent of the dredge plume over four tidal stages of a mean spring tide (peak ebb, low water, peak flood and high water) is shown in Inset 8.1. This shows the depth-averaged extent of suspended sediments (excess concentration, above background) due to dredging under the mean flow scenario. From these plots it can be seen that at any given point in time, the plume (at excess SSC greater than 10mg/l) tends to be relatively small through the tidal cycle and, depending on tidal state, may split into two distinct areas. The spring high water (HW) has the largest down estuary extent, 2.9km from the Proposed Development, while the spring low water (LW) has the largest up estuary extent, 0.9km from Proposed Development.
- 8.2.8 The statistical maximum extent of SSC is displayed in Inset 8.2, this is modelled under low flow conditions and is the worst-case scenario (against the mean and high flows also modelled). Note that the concentrations presented in Inset 8.2 are an amalgamation of the maximum SSC across all modelled timesteps and it does not display the predicted plume at any specific point in time.
- 8.2.9 The maximum extent of the suspended sediment plume extends approximately 1.5km down-estuary and 3.1km up-estuary at concentrations of between 10mg/l and 20mg/l. As expected, the highest suspended concentrations are at the modelled backhoe dredger location (where peak excess SSC values are more than 800mg/l). However, within 500m of the dredger location, this predicted excess SSC has reduced to less than 50mg/l.
- 8.2.10 The timeseries presented in Inset 8.3 shows the SSC from a day before to a day after the cessation of dredging at the three nearest interest feature locations (Navigator Terminals Jetty 1, 2 and Sediment Bank). The plot shows that once dredge operations have ceased, the plume disperses completely (at these locations) within 1 day.

Changes in seabed bathymetry and composition because of deposition of dredged material within the area of the respective plumes

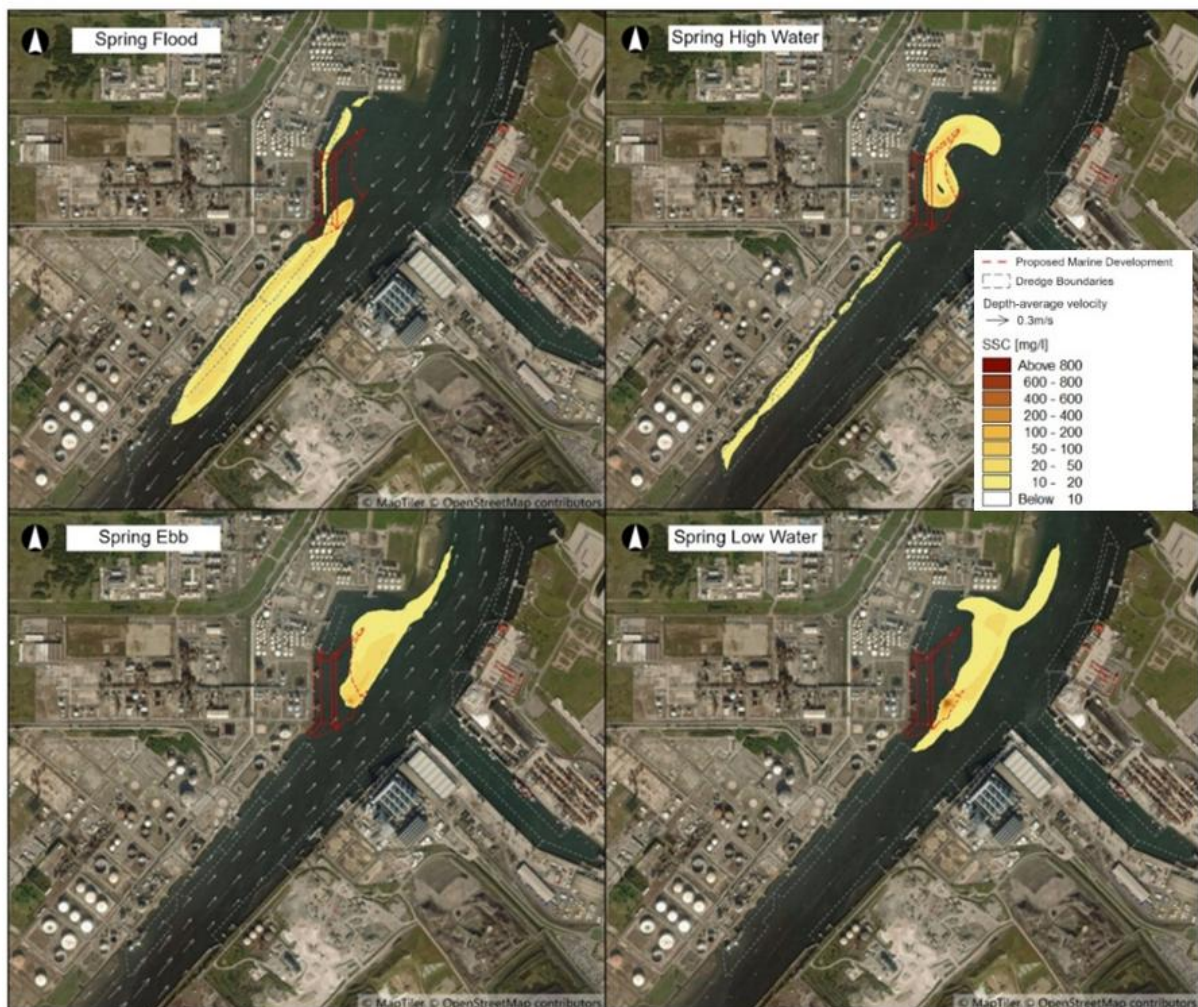
- 8.2.11 The statistical maximum change in predicted bed thickness under low fluvial flow conditions is displayed in Inset 8.4. These values represent the worst-case scenario in which once material settles it cannot be resuspended (no erosion forces are in effect). It should also be noted that any material settling within the Proposed Development will be re-dredged as part of the capital dredge campaign.

- 8.2.12 The settled sediments are predicted to extend with the plume, around 2km down-estuary and 4km up estuary, at thicknesses of between 1mm and 2mm. Closer to the development, if fully dredged, sediment from the dredge plume is predicted to settle with thicknesses of up to 190mm within the neighbouring Sabic North Tees Terminal Jetties 2, 3 and 4, southwest of the Proposed Development.
- 8.2.13 At the identified interest features, the Navigator Terminals Jetty 1 and 2 are modelled to have the highest excess material settling (as a result of the capital dredge works), up to 56mm and 16mm respectively. This is reduced to amounts of less than 3mm at sediment bank and less than 2.5mm at the Navigational Channel shellfish site. North Gare and Bran Sands interest feature sites have less than 0.1 mm of sediments settling within them. The sediment settling in these areas as a result of the dredge will also have a similar composition to that already present with the estuary already having high silt compositions throughout.

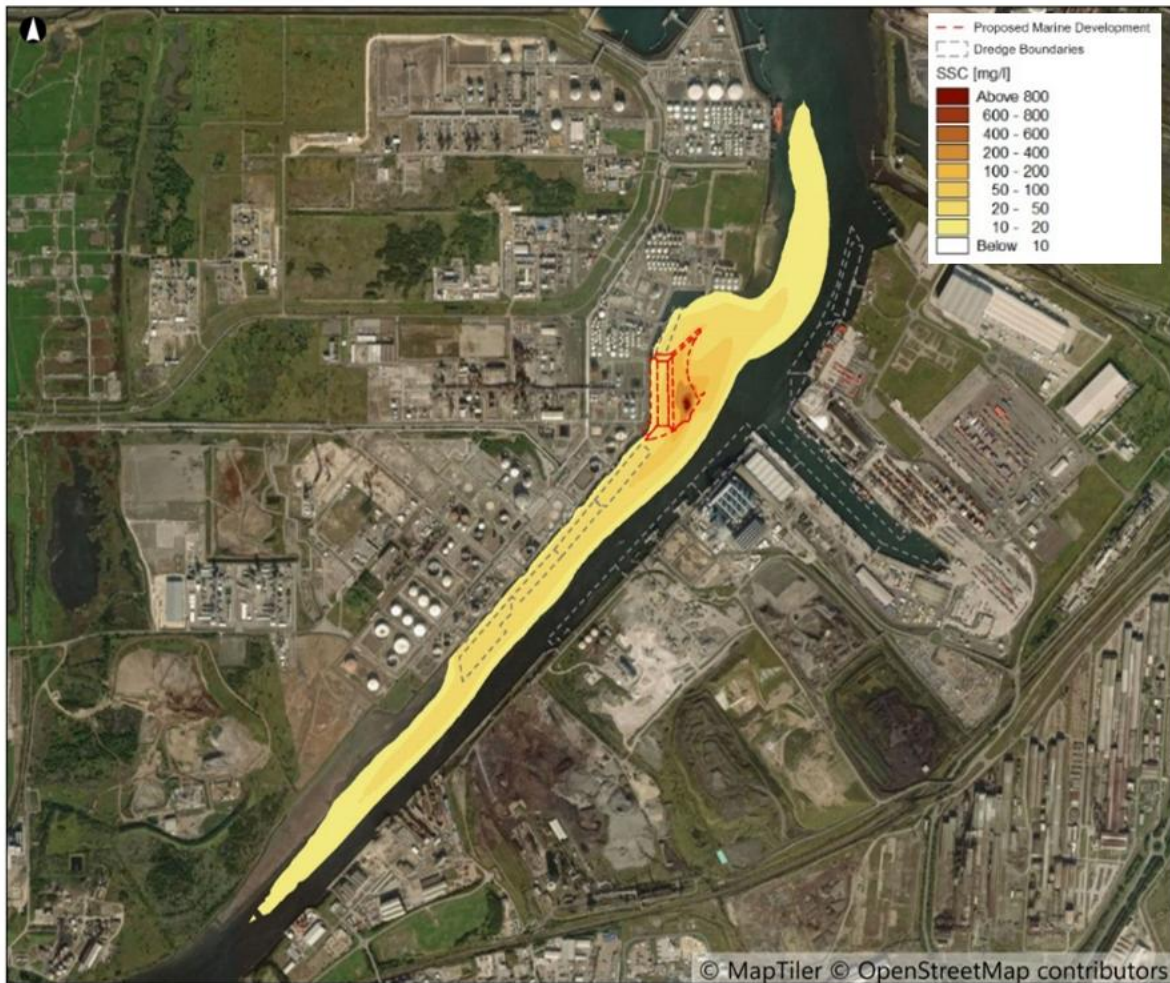
Assessment of impact

- 8.2.14 Material released during the proposed capital dredging campaign will be dispersed throughout the water column and will be dispersed up or down the estuary through the tide. SSC values centred at the dredger will be relatively high but are expected to return to natural background levels within a short distance of the dredging activity. The suspended sediment concentrations produced by the dredge plume are likely to be typically similar to those arising from the existing maintenance dredging activity occurring within the main navigational channel, adjacent berths and turning circle.
- 8.2.15 The settling sediment thickness resulting from the dredge plume is less than 50mm away from maintained berth pockets so overall changes to bathymetry will be negligible (other than in the berths, which may require some additional maintenance dredging following completion of the capital dredge campaign) and material type will not change (based on similar PSA results across the dredge area and the wider extent of the Tees Estuary).
- 8.2.16 For both SSC and sedimentation associated with the dredge plume on coastal and estuary processes, the magnitude of impact is assessed as **Low** in the vicinity of the dredge works and **Very Low** across the wider estuary area.

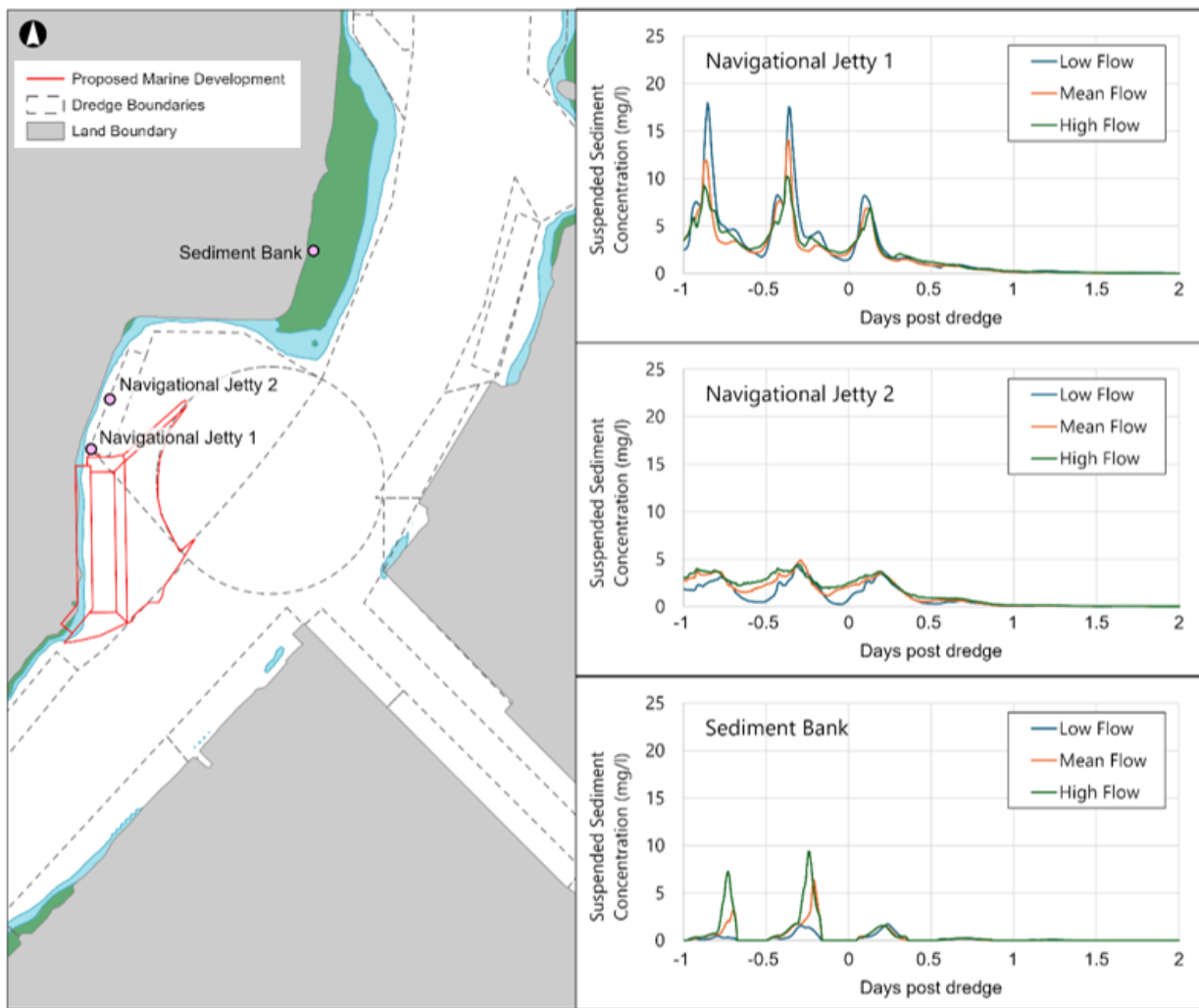
- 8.2.17 The identified coastal process features of interest of Navigator Berths (1 & 2) and the Shellfish Sites (at Navigator Channel, North Gare, and Bran Sands) are all sensitive to changes in sedimentation as a result of the capital dredge plume. Consequently, the magnitude of impact for each of these has been assessed
- 8.2.18 For the Navigator 1 & 2 berths, their proximity to the capital dredge works for the Proposed Development results in an assessed magnitude of impact of **Low**.
- 8.2.19 For each of the three shellfish sites, their distance from the capital dredge works, and the assessed extent of the resultant plume, result in an assessed magnitude of impact of **Very Low**.



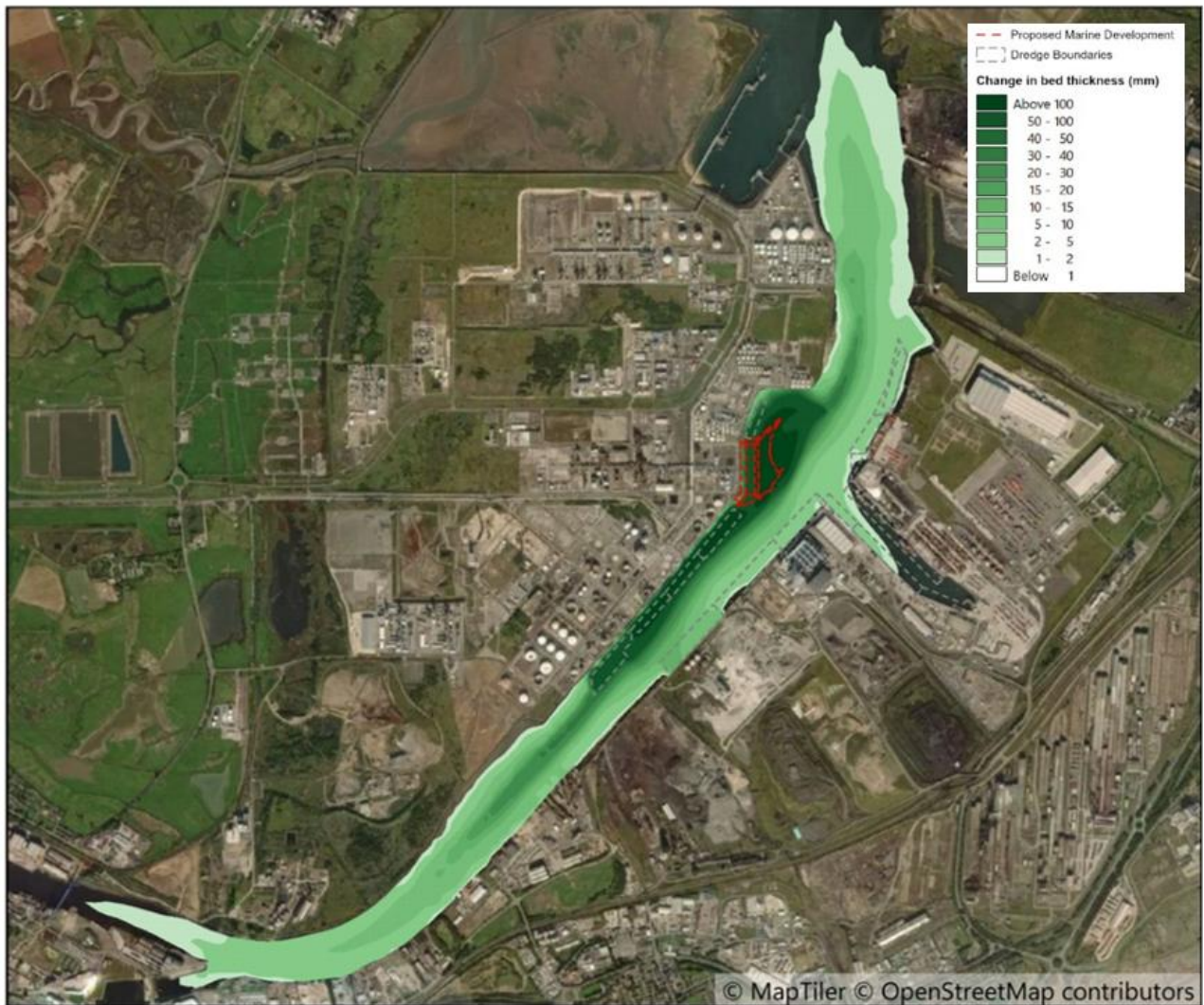
Inset 8.1 SSC during dredging works over four periods of a spring tide (under a mean fluvial discharge rate)



Inset 8.2 Statistical maximum extent of suspended sediment concentration under low fluvial flow conditions



Inset 8.3 Timeseries of SSC concentrations near the Proposed Development a day before and two days after the cessation of dredging activities



Inset 8.4 Statistical maximum extent of changes to bed thickness (under low fluvial flow conditions)

Changes in hydrodynamic regime from construction infrastructure and vessels

- 8.2.20 As described in **Chapter 5: Construction Programme and Management (ES Volume I, Application Document Ref. 6.1)**, the approach to be taken for the construction of the quay will be for construction using land-based plant and equipment, together with quasi-stationary floating and jack-up barges.

- 8.2.21 Therefore, the only vessels associated with the construction phase are the dredgers and barges for the capital works and jack-up barges that remain effectively stationary while works are undertaken. The material is expected to be dredged using a backhoe dredger and loaded into a hopper for subsequent disposal. Whilst the final dredging plant specification will be determined by the appointed specialist contractor, the backhoe dredging method involves a largely stationary dredger excavating a defined area before incrementally repositioning across the dredge footprint until the required material has been removed.
- 8.2.22 As a result, vessel movements during construction of the quay will be relatively infrequent and largely restricted to repositioning within the dredge area, rather than occurring continuously throughout the dredging campaign minimising the potential for impacts on local flow conditions in neighbouring berth pockets.

Assessment of impact

- 8.2.23 There is predicted to be a generally limited temporal change in the local flow regime from the construction vessel movements (with infrequent movements across the berth pocket). As a result, it is unlikely that there would be any notable change on local flows across the adjacent berth pockets and, by association, no likely change on local accretion or erosion processes.
- 8.2.24 Changes to the hydrodynamic regime result in a potential impact on a 'pathway' (rather than an identified 'receptor/interest feature' within this report); consequently, an assessment is made of the magnitude of impact (following the approach described in Section 5.3), but an assessment of significance of effect is not undertaken. As a result of the small, predicted changes and the limited spatial and temporal extent, the overall magnitude of impact is assessed as **Low** in the vicinity of the Proposed Development and **Very Low** across the wider estuary.
- 8.2.25 The identified coastal process features of interest of Navigator Berths (1 & 2), Sediment Bank and the Shellfish Sites (at Navigational Channel, North Gare, and Bran Sands) are all potentially sensitive to changes in hydrodynamics as a result of construction infrastructure and vessels. Consequently, the magnitude of impact for each of these has been assessed
- 8.2.26 For the Navigator 1 & 2 berths, their proximity to the construction works for the Proposed Development result in an assessed magnitude of impact of **Low**.

8.2.27 For the Sediment Bank site, the distance from construction works for the Proposed Development result in an assessed magnitude of impact of **Very Low**.

8.2.28 For each of the three shellfish sites, their distance from the construction works, result in an assessed magnitude of impact of **Very Low** (effectively 'no impact').

Changes in hydrodynamic processes resulting from the temporary bund

8.2.29 The implementation of a temporary bund may be required during the construction phase of the Proposed Development. The bund has a crest level of +3.65mODN, extends 10m the front crane pile centre and has a (V:H) 1:4 slope. A steeper slope may be considered, however a 1:4 slope represents an anticipated worst-case footprint.

8.2.30 To examine how the hydrodynamic regime will be affected under the during construction layout the model has been run for three model scenarios representing low, mean and high river flows) that were examined for the baseline case.

Assessment of impact

8.2.31 The release of fines into the water column as a result of the construction and removal of the bund may have detrimental effect on the water column. However, it is assumed that fines will be removed from the granular material in the material sourcing and construction and removal will have limited spatial and temporal extent, therefore the plume dispersion impact is assessed as **Very Low** in the vicinity of the Proposed Development and across the wider estuary and does not require plume modelling.

8.2.32 The predicted impacts on hydrodynamics within the Proposed Development are generally small in magnitude and limited in extent.

- on the spring ebb tide, flow speeds decrease near to the implemented bund by up to 0.1m/s;
- on the flood tide, flow speeds decrease by more than 0.1m/s near the crest of the bund wall. At the base of the bund, flow speeds increase on the mean and high flow scenarios by a maximum of 0.05m/s; and
- the two nearest receptors (Navigator Terminal Jetty 1 and 2) show a reduction in current speed by up to 0.07m/s. There is no impact to other receptors.

- 8.2.33 The predicted changes to flows and associated bed shear stresses are small in magnitude (one order of magnitude less than the baseline values without the temporary bund) and limited in spatial extent. Therefore the overall magnitude of impact is assessed as **Low** in the vicinity of the Proposed Development and **Very Low** across the wider estuary.

8.3 Operational phase impacts

- 8.3.1 This section contains an assessment of the potential impacts of the operational phase of the Proposed Development. Numerical modelling is based on a scenario with all elements of infrastructure in place including the berth and is considered a worst-case scenario in terms of potential impacts on hydrodynamics.
- 8.3.2 The following impact pathways have been scoped into the assessment during the operational phase (Details of the numerical modelling are provided within the modelling report in Annex 1):
- changes to hydrodynamic processes resulting from the Proposed Development; and
 - changes to local and regional sediment transport resulting from of the Proposed Development.

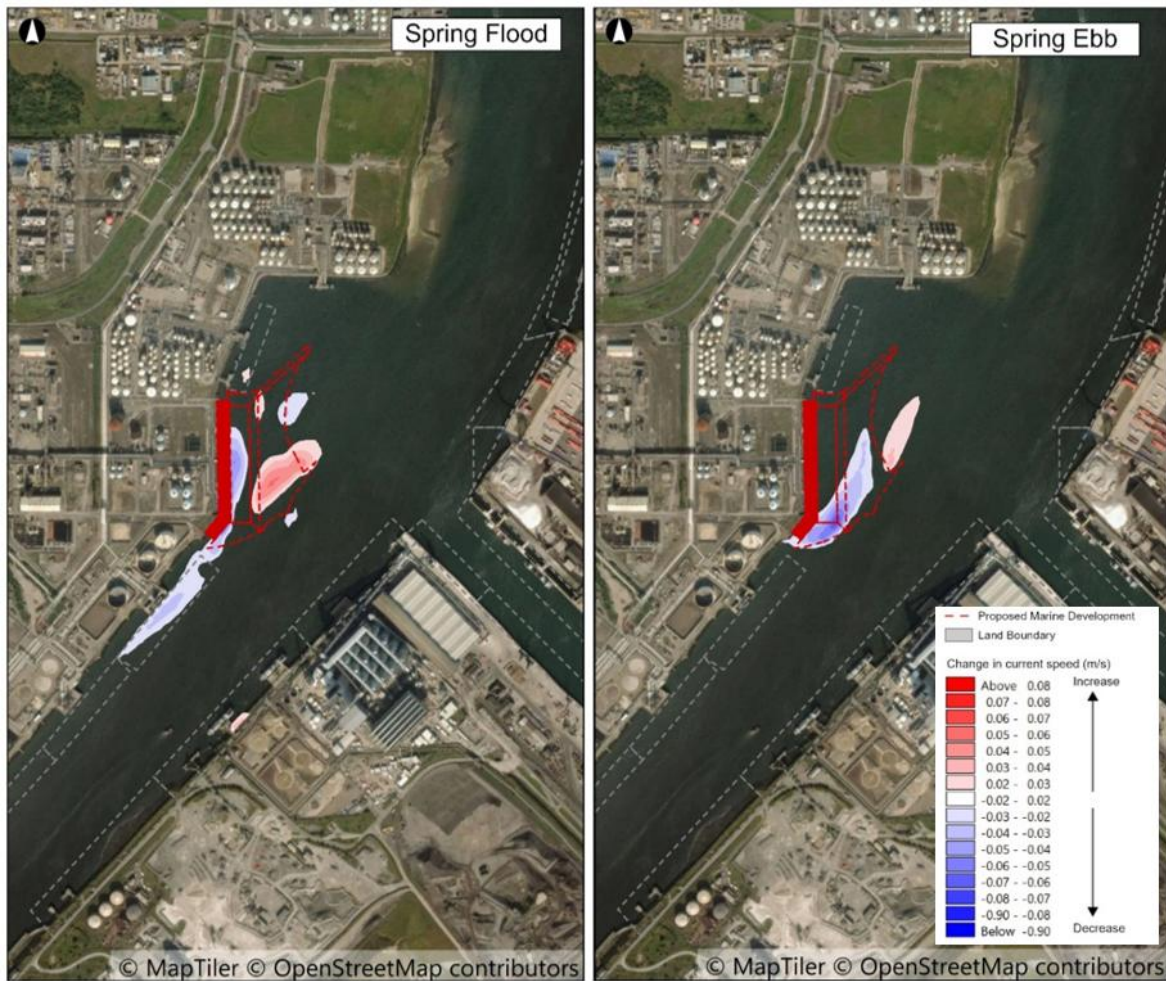
Changes to hydrodynamic processes resulting from the Proposed Development

- 8.3.3 Flow speeds as a result of the deepening from the Proposed Development are compared to the baseline for the spring flood and ebb (under a mean fluvial flow input condition) in Inset 8.5. Results from the hydrodynamic modelling show that the Proposed Development causes generally small impacts to the flow regime, confined predominantly to the vicinity of the development.
- 8.3.4 On both the peak flood and the peak ebb, current speeds tend to increase along the southern edge of the proposed capital dredge and across parts of the navigational channel turning circle; the peak difference in flow speed is approximately 0.06m/s. Current speeds also tend to decrease within the Proposed Developments berth pocket, particularly on the south-eastern side where it is closest to the main navigational channel; within this area, the predicted reduction in flow speed is around -0.06m/s.

- 8.3.5 The spatial variation in the current speed changes varies with the tide. On the flood tide, changes tend to be orientated up-estuary with the current speed decreases extending out of the Proposed Development and into Jetty 4 of Sabic North Tees Terminal (owned by Navigator) at -0.04m/s. On the ebb, this reduction is orientated upstream within the dredge footprint of the Proposed Development. There is predicted to be negligible change to flow speeds within the adjacent Navigator 1 and 2 berths.

Assessment of impacts

- 8.3.6 The predicted impacts on hydrodynamics within the Proposed Development are generally small in magnitude and limited in extent, mainly constrained to within the proposed berth and changes are of less than ± 0.1 m/s.
- 8.3.7 Changes to the hydrodynamic regime result in a potential impact on a 'pathway' (rather than an identified 'receptor/interest feature' within this report); consequently, an assessment is made of the magnitude of impact (following the approach described in Section 5.3), but an assessment of significance of effect is not undertaken. As a result of the small, predicted changes and the limited spatial extent, the overall magnitude of impact is assessed as **Low** in the vicinity of the Proposed Development and **Very Low** across the wider estuary.
- 8.3.8 The identified coastal process features of interest of Navigator Berths (1 & 2), Sediment Bank and the Shellfish Sites (at Navigator Channel, North Gare, and Bran Sands) are all potentially sensitive to changes in hydrodynamics as a result of the operation phase. Consequently, the magnitude of impact for each of these has been assessed
- 8.3.9 For the Navigator 1 & 2 berths, the outputs from the numerical modelling (as described above) result in an assessed magnitude of impact of **Very Low**.
- 8.3.10 For the Sediment Bank site, the outputs from the numerical modelling (as described above) result in an assessed magnitude of impact of **Very Low** (effectively 'no impact').
- 8.3.11 For each of the three shellfish sites, their distance from the Proposed Development, and the outputs from the numerical modelling (as described above), result in an assessed magnitude of impact of **Very Low** (effectively 'no impact').

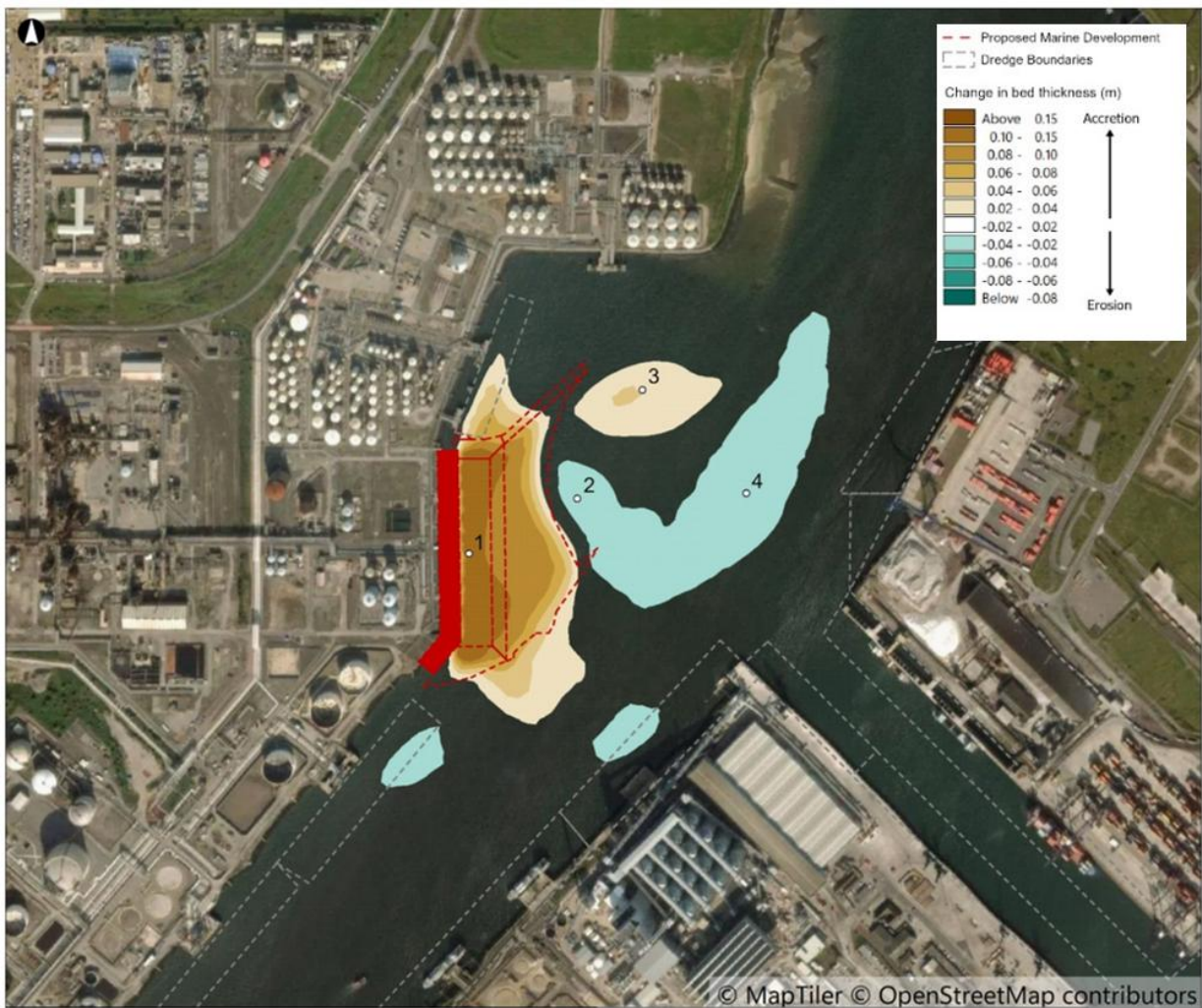


Inset 8.5 Change in current speed due to the Proposed Development on the Spring flood and Ebb tide

Changes to the local sediment transport processes resulting from the proposed development

- 8.3.12 Changes to the local hydrodynamics, as a result of the Proposed Development have the potential to affect local sediment transport (i.e., faster flows may increase erosion of the bed, whilst lower flows may encourage more siltation).
- 8.3.13 To investigate the potential impact of the Proposed Development on sediment transport, the movement of fine-grained material has been investigated using the MIKE Mud Transport (MT) module. The model is driven by the outputs of the hydrodynamic model, described above, and verified against local dredge records and a conceptual understanding of the sediment regime across the wider estuary. The model setup and validation are described in Annex 1.
- 8.3.14 The modelling tool has been applied to model both the existing baseline and the Proposed Development, and the resulting predicted difference in bed thickness over a mean spring-neap cycle has been calculated to assess the impact on sediment transport. For context, this result has then been scaled up to represent a worst-case estimate of potential change over a full year.
- 8.3.15 In Inset 8.6, the spatial plot displays the scaled difference in bed thickness over the course of the year as a result of the implementation of the Proposed Development. The values displayed do not account for any consolidation of the bed material over time, nor the influence of any vessel impacts which may help to mobilise newly deposited material as ships transit through the channel and onto the berths. Additionally, it accounts for one fluvial input condition as a constant through the year, this is representative of a worst-case scenario.
- 8.3.16 Inset 8.6 shows an increase in bed thickness of up to 0.13m (13cm) extends throughout the majority of the new berth pocket over the course of the year. Elsewhere near to the Proposed Development the following changes are modelled to occur:
- at the edge of the turning circle, there is a predicted increase in bed thickness of approximately 0.02m (2cm), resulting in modelled accretion;
 - north of the turning circle, there is a small area of accretion with bed thickness increasing by approximately 0.04m (4cm); and

- south and west of the turning circle erosion is present as there is a predicted reduction in bed thickness of approximately 0.03m (3cm).
- 8.3.17 Given the limited extent of predicted changes in the sediment transport, the impact of the Proposed Development on potential changes to accretion rates has been considered for only the Navigator Terminals Jetty 1 and Navigator Jetty 2 interest features.
- 8.3.18 Within this assessment, the predicted changes to the existing (baseline) mud transport regime have been increased pro-rata based on an approximate definition of likely frequency of each flow event (high, mean or low) over the course of an 'average' year. As described in Section 1.6.9, the low flow represents the combined 95%ile exceedance, and the high flow represents the combined 10%ile exceedance. In increasing the model outputs pro-rata we have assumed low flow conditions occur for 10% of the year (i.e. the modelled 95%ile exceedance low flow is the central estimate of a symmetrical bin corresponding to 10% of time), high flow for 20% (the modelled 10%ile exceedance high flow is the central estimate of a symmetrical bin corresponding to 20% of time) of the year and mean flow for the remaining 70% of the year. This is obviously a simplification, and it should be noted that in years of particularly extreme high or low flow conditions, the resultant impact on accretion and erosion patterns may be significant.
- 8.3.19 Applying the above pro-rated scaling, the predicted impact of the Proposed Development on the Navigator Terminals Berths is an average increase in accretion of around 2-3 cm/yr, with a slightly higher rate in closer proximity to the LGF berth pocket (Jetty 1) and a slightly lower rate further north and in the upper end of the Navigator 1 Berth (Jetty 2).



Inset 8.6 Change in bed thickness due to the Proposed Development on the spring flood and ebb tide

Assessment of impact

- 8.3.20 Hydrodynamic forcing within (and adjacent to) the Proposed Development will only be marginally altered, as described above. Consequently, associated changes in the sediment pathways will also be small. Predicted changes to future sediment transport are small in magnitude and limited in extent to the berth pocket and associated dredge area. Outside of these areas, the Proposed Development has no predicted impact on the baseline sedimentation and erosion rates.
- 8.3.21 As a result, the magnitude and extent of impact is generally small, resulting in an overall **Low** magnitude of impact in the vicinity of the Proposed Development and **Very Low** (effectively 'no impact') across the wider estuary.

- 8.3.22 The identified coastal process features of interest of Navigator Berths (1 & 2), Sediment Bank and the Shellfish Sites (at Navigator Channel, North Gare, and Bran Sands) are all potentially sensitive to changes in sediment transport pathways as a result of the Proposed Development.
- 8.3.23 For the Navigator 1 and 2 berths, their proximity to the Proposed Development, and the outputs from the numerical modelling (as described above) result in an assessed magnitude of impact of **Low**.
- 8.3.24 For the Sediment Bank (just down-estuary of the Proposed Development), the outputs from the numerical modelling (as described above) result in an assessed magnitude of impact of **Very Low**.
- 8.3.25 For each of the three shellfish sites, their distance from the Proposed Development, and the results of the numerical modelling (as described above), result in an assessed magnitude of impact of **Very Low** (effectively 'no impact').

8.4 Decommissioning phase impacts

- 8.4.1 The DCO includes a Requirement to allow for relevant parts such as the marine infrastructure to be decommissioned separately (the undertaker must submit to the relevant planning authority for its approval a decommissioning environmental management plan for that part, as appropriate). This allows for the quay to continue to be used following the eventual decommissioning of the main SAF facility. On this basis, potential impacts on physical processes from decommissioning the marine elements have been scoped out of this assessment.

Mitigation and residual impacts

- 8.4.2 As described above, the impact assessment for Coastal and Estuarine Processes indicates magnitude of impact is generally assessed as **Low** within, and in the vicinity of, the Proposed Development and **Very Low** across the wider study area. As such, no additional mitigation measures are proposed.

8.5 Summary of impacts

- 8.5.1 A summary of the impact pathways that have been assessed, the identified residual impacts and level of confidence is presented in Table 8.1.

Table 8.1 Summary of potential impact, mitigation measures and residual impacts for coastal and estuarine processes

Impact pathway	Assessment of impact	Mitigation measures	Residual impact	Confidence
Construction phase				
Plume impacts from the capital dredging	SSC: <i>General Magnitude of Impact: Low in the vicinity of the dredge works and Very Low across the wider estuary</i> <i>Interest features Magnitude of Impact:</i> Low for the Navigator 1 & 2berths Very Low for the shellfish sites	NA	SSC: <i>General Magnitude of Impact: Low in the vicinity of the dredge works and Very Low across the wider estuary</i> <i>Interest features Magnitude of Impact:</i> Low for the Navigator 1 & 2berths Very Low for the shellfish sites	High
	Sedimentation: <i>General Magnitude of Impact: Low in the vicinity of the dredge works and Very Low across the wider estuary</i> <i>Interest features Magnitude of Impact:</i> Low for the Navigator 1 & 2berths Very Low for the shellfish sites		Sedimentation: <i>General Magnitude of Impact: Low in the vicinity of the dredge works and Very Low across the wider estuary</i> <i>Interest features Magnitude of Impact:</i> Low for the Navigator 1 & 2berths Very Low for the shellfish sites	
Changes in hydrodynamic regime	<i>General Magnitude of Impact: Low in the vicinity of the Proposed</i>	NA	<i>General Magnitude of Impact: Low in the vicinity of the Proposed</i>	High

Impact pathway	Assessment of impact	Mitigation measures	Residual impact	Confidence
from construction infrastructure and vessels	Development and Very Low across the wider estuary <i>Interest features Magnitude of Impact:</i> Low for the Navigator 1 & 2 berths Very Low for the Sediment Bank Very Low for the shellfish sites (no impact)		Development and Very Low across the wider estuary <i>Interest features Magnitude of Impact:</i> Low for the Navigator 1 & 2 berths Very Low for the Sediment Bank Very Low for the shellfish sites (no impact)	
Changes in hydrodynamic regime from temporary bund	<i>General Magnitude of Impact: Low</i> in the vicinity of the Proposed Development and Very Low across the wider estuary <i>Interest features Magnitude of Impact:</i> Very Low for the Navigator 1 & 2 berths Very Low for the Sediment Bank (no impact) Very Low for the shellfish sites (no impact)	NA	<i>General Magnitude of Impact: Low</i> in the vicinity of the Proposed Development and Very Low across the wider estuary <i>Interest features Magnitude of Impact:</i> Very Low for the Navigator 1 & 2 berths Very Low for the Sediment Bank (no impact) Very Low for the shellfish sites (no impact)	High
Operational phase				
Changes to the local hydrodynamic regime from new infrastructure and deepening	<i>General Magnitude of Impact: Low</i> in the vicinity of the Proposed Development and Very Low across the wider estuary	NA	<i>General Magnitude of Impact: Low</i> in the vicinity of the Proposed Development and Very Low across the wider estuary	High

Impact pathway	Assessment of impact	Mitigation measures	Residual impact	Confidence
	<i>Interest features Magnitude of Impact:</i> Low for the Navigator 1 & 2berths Very Low for the Sediment Bank (no impact) Very Low for the shellfish sites (no impact)		<i>Interest features Magnitude of Impact:</i> Low for the Navigator 1 & 2berths Very Low for the Sediment Bank (no impact) Very Low for the shellfish sites (no impact)	
Changes to the local sediment transport processes from new infrastructure and deepening	<i>General Magnitude of Impact: Low</i> in the vicinity of the Proposed Development and Very Low across the wider estuary <i>Interest features Magnitude of Impact:</i> Low for the Navigator 1 & 2 berths Very Low for the Sediment Bank Very Low for the shellfish sites (no impact)	NA	<i>General Magnitude of Impact: Low</i> in the vicinity of the Proposed Development and Very Low across the wider estuary <i>Interest features Magnitude of Impact:</i> Low for the Navigator 1 & 2berths Very Low for the Sediment Bank Very Low for the shellfish sites (no impact)	High

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