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13 FISH AND FISHERIES

13.1 Introduction

As well as the terrestrial environment, the proposed scheme will occupy subtidal and intertidal areas of the Tees estuary that may provide suitable habitat for finfish and shellfish species of commercial and ecological importance. This section assesses the potential impacts on these receptors, as well as the fishing industry that is reliant on such resources.

A desk-based assessment has been undertaken based on the most recent data sources available in the Tees estuary; the data available from other recent projects in the Tees is considered to negate any requirement for a site-specific fish survey in order to complete the assessment.

The potential impacts on fish and other marine species and habitats from the offshore disposal of dredged sediments are assessed in **Sections 26**. Potential cumulative impacts are addressed in **Section 27**.

Given that fish provide an importance prey source for marine mammals and seabirds, this chapter should also be read in conjunction with **Section 10** and **Section 12**, respectively.

Potential impacts on fish resources and fisheries activities that are assessed in this section of the EIA Report are broadly separated into the following:

- impacts on marine water quality;
- noise-related injury or disturbance to fish stocks;
- direct impacts on supporting habitat for fish stocks; and,
- obstructions to fishing activity within the Tees.

13.2 Policy and consultation

13.2.1 North East Inshore and Offshore Marine Plan

Full details of the draft North East Inshore and Offshore Marine Plan are provided in **Section 4.9**. **Table 13.1** signposts relevant objectives and policies within the draft Marine Plan when considering the potential effects of the proposed scheme on fish resources and fishing activities.

As set out in the draft Marine Plan, spatial planning within inshore and offshore plan areas *"seeks to support access to fishing activities and ensures considerations are made of the impacts upon fisheries from other marine activities. Proposals will identify potential significant adverse impacts on access to fishing activities. Significant adverse impacts on access includes the loss of access resulting from a proposal that blocks transit routes to and from an area, and also the loss of access to the area where the proposal is located."*

Table 13.1 Marine plan policies relevant to fish and fisheries

Marine Policy Statement / Marine Plan Objectives	***- There is equitable access for those who want to use and enjoy the coast, seas and their wide range of resources and assets;*** ***- The marine environment and its resources are used to maximise sustainable activity, prosperity and opportunities for all, now and in the future.***	
Marine plan policies relevant to this section		**Where addressed in this section**
NE-FISH-2	*Proposals that may have significant adverse impacts on access for fishing activities, must demonstrate that they will, in order of preference:* *a) Avoid;*	Impacts on access to fishing activities are addressed in **Section 13.5.6**.

	b) Minimise; *c) Mitigate significant adverse impacts;* *d) If it is not possible to mitigate the significant adverse impacts, proposals should state the case for proceeding.*	
Marine Policy Statement / Marine Plan Objectives	***- Biodiversity is protected, conserved and, where appropriate, recovered, and loss has been halted;*** ***- Healthy marine and coastal habitats occur across their natural range and are able to support strong, biodiverse communities and the functioning of healthy, resilient and adaptable ecosystems.***	
Marine policies relevant to this section		**Where addressed in this section**
NE-FISH-3	*If proposals cannot enhance essential fish habitat, they must demonstrate that they will, in order of preference:* *d) Avoid;* *e) Minimise;* *f) Mitigate significant adverse impact on essential fish habitat, including spawning, nursery and feeding grounds, and migration routes.*	Defined spawning / nursery grounds are listed in **Section 13.4.1.6**. Impacts on fish supporting habitat are addressed in **Section 13.5** and **13.6**.
NE-BIO-1	*Proposals that may have significant adverse impacts on the distribution of…priority species must demonstrate that they will, in order of preference:* *e) Avoid;* *f) Minimise;* *g) Mitigate;* *h) Compensate for significant adverse impacts.*	Priority species are listed in **Section 13.4.1.4**. Impacts on fish, including priority species, are addressed in **Sections 13.5** and **13.6**.
NE-BIO-2	*Proposals that may cause significant adverse impacts on native species or habitat adaptation or connectivity, or native species migration must demonstrate that they will, in order of preference:* *e) Avoid;* *f) Minimise;* *g) Mitigate significant adverse impacts;* *h) Compensate for significant adverse impacts.*	Migratory species are described in **Section 13.4.1.2**. Impacts on migratory species are addressed in **Sections 13.5** and **13.6**

13.2.2 Consultation

Site-specific comments relevant to fish and fisheries that were received during the EIA scoping process are detailed in **Table 13.2**. This table also signposts to the relevant section of this EIA Report where the comment has been addressed.

Table 13.2 Relevant site-specific comments received from stakeholders during the scoping process

Consultee	Comment	Response / section of the EIA Report where the comment is addressed
Environment Agency	The creation of a wharf involves a substantial amount of piling. The noise from piling, particularly impact piling may impact severely on fish migration. Salmon, sea trout, eel, lamprey and possibly smelt all frequent this area of the Tees on their upstream migrations. Some restrictions on piling activity should be expected in order to reduce the impact on protected migratory fish species such as Atlantic Salmon. We have noted that report states that as the piling would occur on land that the noise would be reduced, the EA are still concerned there would be a risk to fish. This would not be the case if the applicant were to provide noise/vibration assessment survey which demonstrated that this would not be the case.	Following receipt of this comment, Subacoustech were commissioned to undertake a review of potential underwater noise impacts as a result of piling activities associated with the construction of the new quay (on land (**Appendix 8**)). The output from the review has been incorporated into the assessment of impacts from piling noises in **Section 13.5.4**.

Consultee	Comment	Response / section of the EIA Report where the comment is addressed
	Extensive dredging activity is planned for this area of the River Tees, and the effects of deepening this large section of the Tees estuary on intertidal mixing will be uncertain. In order to protect vulnerable fish species such as European Eel, Atlantic Salmon and Lamprey, it is likely that dredging activity will need to take into account the protection of these species during critical migration periods. This would entail limiting dredging activity to certain times of the year and/or providing suitable monitoring and mitigation such as stop start thresholds for parameters such as suspended sediment and dissolved oxygen levels.	Changes to marine water quality as a result of the dredging have been considered in **Section 7**, and the assessment of consequent impacts on migratory fish is presented in **Section 13.5.1**.
	The structure itself [i.e. the existing timber and concrete wharf] will likely be used by numerous species as a shelter, including for juvenile fish. EA survey data will not cover this location due to its inaccessibility, so we advise that this is included into any monitoring survey design being carried out.	A survey underneath the structure is proposed and results will be provided following completion. However, due to the time frames involved, the results are not available at the time of assessment. Correspondence with the Environment Agency in September 2020 (**Appendix 3)** indicated that, in lieu of survey results, the assessment should be based on an assumption that the structure will have habitat value for sheltering fish. This has been carried forward into the assessment in **Section 13.5.5**.

13.3 Methodology

13.3.1 Study area

For this section of the EIA Report, the study area comprises the likely maximum extent over which potentially significant environmental impacts of the proposed scheme may occur. In this instance, this has been informed by the hydrodynamic and sedimentary plume modelling undertaken, as well as the understanding of underwater noise levels arising from construction works such as piling and dredging. This section excludes consideration of potential impacts to the fisheries interests of the Tees Bay C offshore disposal site; such impacts are considered in **Section 26**.

13.3.2 Methodology used to describe the existing environment

This section of the EIA Report has been informed through a desk-based assessment. The desk-based assessment has included a review of the following:

- Existing data on fisheries resources in the Tees estuary and surrounding marine environment collated for other developments in the area, specifically the benthic trawl surveys undertaken for the NGCT scheme (2019) (Royal HaskoningDHV, 2020), the Hartlepool Approach Channel deepening (2018) (Royal HaskoningDHV, 2018), the consented Anglo American Harbour Facilities scheme (2014) (Royal HaskoningDHV, 2015) and the Dogger Bank Teesside A and Sofia project (2012/13) (Forewind, 2014) (see **Section 13.4.1.1**);
- Readily available resources on UK fisheries interests, specifically the Environment Agency's Tees Barrage fish counter, information on spawning and nursery grounds from Ellis *et al.*, 2010, and the International Union for Conservation of Nature(IUCN) Red List of Threatened Species;

- UK sea fisheries statistics from the period 2014/15 to 2018/19, detailing the value and tonnage of landings from the coastal region in which the Tees estuary lies (see **Section 13.4.1.3**);
- A review undertaken by Subacoustech (2020) on the risk of underwater noise impacts from land-based piling works (see **Section 13.5.4** and **Appendix 8**), plus threshold underwater noise criteria provided by Popper *et al.* (2014); and
- The Marine Life Network (MarLIN) sensitivity assessment for UK marine life.

13.3.3 Methodology for assessment of potential impacts

The methodology used to assess potential environmental impacts on fish and fisheries interests follows that described in **Section 5** of this report.

Professional judgement has been used to determine potential environmental impacts which could arise during the construction and operational phases of the proposed scheme, based on our existing knowledge of the sensitivity of the Tees estuary.

Cross reference to the findings of the hydrodynamic and sedimentary regime assessment (**Section 6**), the marine water quality assessment (**Section 7**) and the assessment on marine benthic ecology receptors (**Section 9**) has been made when assessing potential impacts to marine ecological receptors.

13.4 Existing environment

13.4.1 Fish and shellfish

13.4.1.1 Review of existing studies within the Tees estuary and adjacent marine areas

The lower Tees estuary provides both intertidal and subtidal habitat for a number of benthic-feeding marine fishes, some of which are estuary-dependent (such as flounder *Platichthys flesus*) and some temporary residents (such as plaice *Pleuronectes platessa*) which use the estuary as a nursery ground. Herring *Clupea harengus*, sprat *Sprattus sprattus*, cod *Gadus morhua*, spurdog *Squalus acanthias*, anglerfish *Lophius piscatorius*, whiting *Merlangius merlangus*, lemon sole *Microstomus kitt* and nephrops *Nephrops norvegicus* have all been documented within the estuary and adjacent marine area (Royal HaskoningDHV, 2015 and 2020).

Summary of 2019 benthic trawls within the lowers Tees estuary

As part of a benthic ecological survey undertaken in the lower Tees Estuary in March 2019 for the NGCT project (Royal HaskoningDHV, 2020), 16 benthic trawls were undertaken within and downstream of the Tees Dock turning circle. While benthic trawls are limited in the data they can provide (for example, pelagic or semi-pelagic species are likely to be under-represented in benthic trawls, and they only provide a 'snapshot' of the species present), they do provide some information on the demersal species likely to be present within the lower Tees.

A total of 18 finfish taxa were recorded from the 2019 benthic trawls, the most abundant of which was plaice (433 individuals across the 16 trawls). Other abundant taxa included commercial species, such as dab *Limanda limanda* (168 individuals), whiting (45 individuals) and flounder (40 individuals), plus non-commercial species such as *Pomatoschistus* gobies (96 individuals). Despite being a benthic trawl, herring and sprat (both pelagic species) were also recorded. A full list of the finfish species recorded in the 2019 benthic trawls is presented in **Table 13.3Table**. Commercially targeted shellfish species recorded included one common lobster *Homarus gammarus*, 24 pink shrimps *Pandalus montagui* and various crab species.

Royal HaskoningDHV

Of the species recorded during the trawls, plaice, whiting, cod and herring are listed as species of principal importance for conservation in England under Section 41 of the Natural Environment and Rural Communities (NERC) Act 2006 (see **Section 13.4.1.4**).

Table 13.3 Finfish species recorded during 16 benthic trawls undertaken in Tees Estuary, March 2019 (Royal HaskoningDHV, 2020)

Species	Abundance (no. of individuals)	Species	Abundance (no. of individuals)
Plaice *Pleuronectes platessa*	433	Poor-cod *Trisopterus minutus*	3
Dab *Limanda limanda*	168	Lesser weever *Echiichthys vipera*	2
Pomatoschistus spp. gobies	96	Herring *Clupea harengus*	1
Whiting *Merlangius merlangus*	45	American plaice *Hippoglossoides platessoides*	1
Flounder *Platichthys flesus*	40	Saithe *Pollachius virens*	1
Pogge *Agonus cataphractus*	27	Sprat *Sprattus sprattus*	1
Cod *Gadus morhua*	16	Common dragonet *Callionymus lyra*	1
Fivebeard rockling *Ciliata mustela*	6	Butterfish *Pholis gunnellus*	1
Bull rout *Myoxocephalus scorpius*	3		

Summary of 2014 epibenthic beam trawl survey in the lower Tees estuary

Epibenthic beam trawl surveys were undertaken in the Tees in July 2014 within and downstream of the Tees Dock turning circle, to inform the EIA undertaken for the consented Anglo American Harbour facilities (Royal HaskoningDHV, 2015). A total of 13 finfish and two commercial shellfish species were recovered from ten trawls. The most abundant finfish species recorded was cod (83 individuals), with relatively low abundance of all other species. A full list of the finfish species caught in the 2014 trawls is presented in **Table 13.4**. Commercial shellfish recovered included *c.*7,500 brown shrimp *Crangon* spp. and *c.*150 pink shrimp.

Of the species recorded during the trawls, plaice, whiting, cod and herring are listed as species of principal importance for conservation in England under Section 41 of the NERC Act 2006 and sand goby *Pomatoschistus minutus* is listed for protection in Appendix III to the Bern Convention (see **Section 13.4.1.4**).

Table 13.4 Finfish species recorded during 10 epibenthic trawls undertaken in the Tees estuary, July 2014 (Royal HaskoningDHV, 2015)

Species	Abundance (no. of individuals)	Species	Abundance (no. of individuals)
Cod *Gadus morhua*	83	Flounder *Platichthys flesus*	3
Pogge *Agonus cataphractus*	20	Fivebeard rockling *Ciliata mustela*	2
Plaice *Pleuronectes platessa*	18	Poor-cod *Trisopterus minutus*	2
Pollock *Pollachius pollachius*	12	Common dragonet *Callionymus lyra*	1
Dab *Limanda limanda*	10	Butterfish *Pholis gunnellus*	1
Sand goby *Pomatoschistus minutus*	4	Bull rout *Myoxocephalus scorpius*	1
Whiting *Merlangius merlangus*	3		

Summary of 2018 benthic trawls for the Hartlepool Approach Channel project

A benthic ecological survey undertaken in October 2018 in the Hartlepool Approach Channel (Royal HaskoningDHV, 2018), approximately 5km north of the Tees estuary mouth, included three beam trawls, which offer some further information on the demersal species that may be present in the marine area in and around the Tees estuary.

Five species of fish were identified from the trawls, including commercial flatfish such as juvenile plaice (the most abundant fish species recorded), dab and sole *Solea solea*, plus common goby *Pomatoschistus microps* and pogge *Agonus cataphractus*. Plaice catches made up 71% of the total flatfish haul during the trawls. Commercial shellfish recorded included brown shrimp and harbour crab *Liocarcinus depurator*.

Of the species recorded during the beam trawls, plaice and sole are both listed as species of principal importance for conservation in England under Section 41 of the NERC Act 2006, and common goby is listed for protection in Appendix III to the Bern Convention (see **Section 13.4.1.4**).

The species recorded during the 2018 trawls were reported to be typical of North Sea inshore assemblages inhabiting soft sediment environments.

Summary of 2012 and 2013 fish surveys in the Dogger Bank Teesside A & Sofia export cable corridor

A number of fish surveys were undertaken in 2012/13 within the export cable corridor for the Dogger Bank Teesside A / Sofia offshore wind farms, which makes landfall near to Redcar (*c.* 8km from the mouth of the Tees) (Forewind, 2014). Surveys undertaken within (or partly within) the export cable corridor included an adult and juvenile fish characterisation trawl surveys, shellfish (potting) survey and trammel net survey (Forewind, 2014).

Otter trawl surveys, undertaken in April 2012, July/August 2012 and September/October 2012, confirmed that significant numbers of grey gurnard *Eutrigla gurnardus* and whiting were present within and around the export cable corridor. Dab and sand goby were the dominant species caught in beam trawl surveys over the same period. Whiting, haddock *Melanogrammus aeglefinus*, dab, plaice and grey gurnard were the dominant species recorded from additional otter trawls in April 2013, undertaken at the inshore end of the export cable corridor (i.e. in Tees Bay, near to the landfall at Redcar).

Trammel nets were deployed close to the shore in Tees Bay in September 2013 and April 2013, and estuarine species caught included edible crab *Cancer pagurus*, dab, cod, small-spotted catshark *Scyliorhinus canicula*, thornback ray *Raja clavata*, spotted ray *Raja montagui* and lesser sandeel *Ammodytes tobianus*. Edible crab was the most abundant shellfish species caught during inshore shellfish surveys undertaken over two four-day periods in September 2012 and April 2013, with moderate numbers of lobster and velvet swimming crab *Necora puber.*

13.4.1.2 Migratory fish in the Tees

As outlined in the MMO Scoping Opinion EIA/2019/00017, key migratory fish species that have been recorded in the Tees estuary include salmon *Salmo salar*, brown trout *Salmar trutta*, European eel *Anguilla anguilla*, sea lamprey *Petramyzon marinus* and river lamprey *Lampetra fluviatilis*. Salmonid numbers recorded in the Tees have increased in recent years, and the Tees is recognised as an important migration route for salmon. All of these species are listed under Section 41 of the NERC Act 2006, with salmon, sea lamprey and river lamprey afforded additional protection as Annex II species in the EU Habitats Directive (see **Section 13.4.1.4**).

River and sea lamprey are anadramous ‘jawless’ fish species, which grow to maturity in estuarine areas and migrate upstream to spawn. Both species have been recorded within the Tees estuary, and sea lampreys have been observed at the Tees Barrage at Stockton, approximately 9km upstream of the proposed scheme footprint. The 2018 Tees fish survey, undertaken by the Environment Agency as a seine sweep near the Tees Barrage, included catches of European eels, a catadramous species that migrate to marine areas from freshwater environments to spawn.

The Environment Agency installed an electronic fish counter at the Tees Barrage in 2011, which monitors the upstream migration of salmonids (salmon and brown trout) through the fish pass. The stacked chart shown in **Figure 13.1** presents count data from the counter since the beginning of 2012 (the first full year of operation) until June 2020 and illustrates the seasonal nature of migration movements in the Tees. The season for adult salmonids migrating upstream to spawn generally commences in April, peaks in the summer months, notably July and August, and finishes around November. The peak number of upstream migrations counted in a given month was 735 in August 2012. Downstream smolt migration is not recorded by the electronic counters, but the seasonality of this is temperature-dependent and in other rivers in the northeast, such as the Tyne, smolt migration tends to peak in May (Environment Agency, 2019).

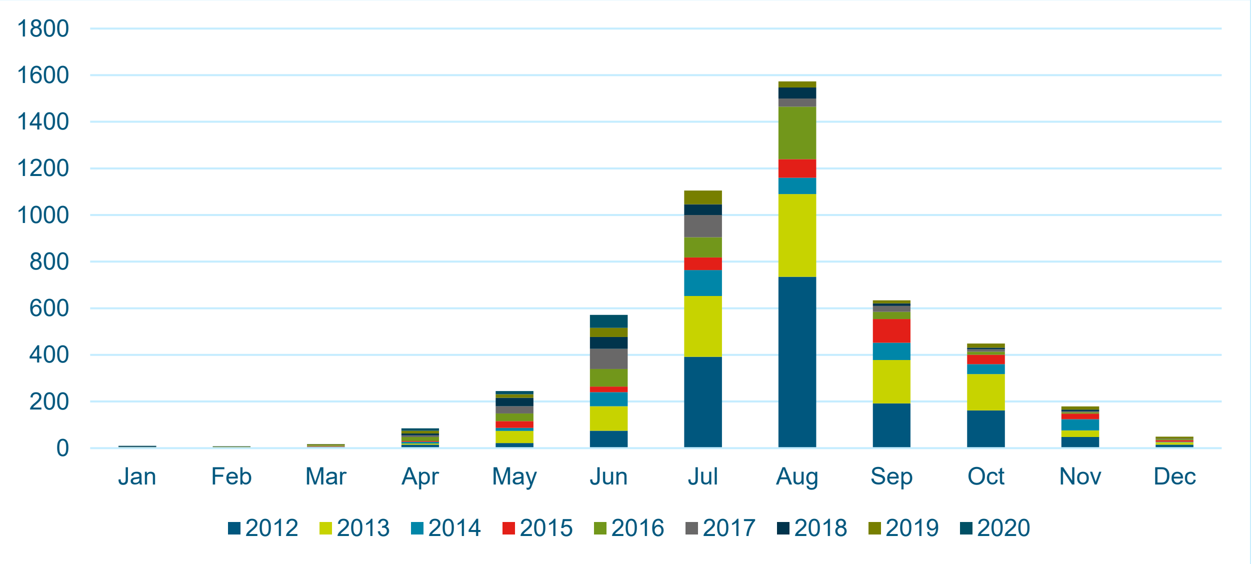


Figure 13.1 Stacked bar chart showing monthly counts of salmonids (sea salmon and brown trout) on upstream migration through the Tees Barrage fish pass (data from Environment Agency electronic fish counter)

13.4.1.3 Commercial species

As well as the site-specific studies outlined above, commercial landings data from the International Council for the Exploration of the Sea (ICES) provides an indication of the commercially targeted fish and shellfish species that may be present in the lower Tees estuary and Tees Bay. ICES statistical rectangle 38E8 encompasses the east coast from Marske-by-the-Sea (*c.*10 km south along the coastline from the mouth of the Tees) to Tynemouth and includes the Tees Estuary and Tees Bay. **Table 13.5** lists the species for which there have been significant (greater than 1 tonne) landings from ICES rectangle 38E8.

Table 13.5 Commercial fish species with significant landings from ICES rectangle 38E8 (ICES, 2020)

Species	ICES total annual landings FROM 38E8 (metric tonnes)					
	2014	2015	2016	2017	2018	Total 2014-18
Blonde ray *Raja brachyura*	0	1	1	0	0	2
Brill *Scophthalmus rhombus*	4	8	8	4	2	26
Cod *Gadus morhua*	88	123	35	21	16	283

Species	ICES total annual landings FROM 38E8 (metric tonnes)					
	2014	2015	2016	2017	2018	Total 2014-18
Crab – edible crab *Cancer pagurus*	161	135	128	114	155	693
Crab – velvet swimming crab *Necora puber*	8	7	3	3	4	25
Cuckoo ray *Leucoraja naevus*	2	0	0	0	0	2
Dab *Limanda limanda*	1	0	0	0	2	3
Gurnard – grey gurnard *Eutrigla gurnardus*	2	8	8	2	0	20
Gurnard – red gurnard *Chelidonichthys cuculus*	7	32	20	10	1	70
Haddock *Melanogrammus aeglefinus*	14	22	20	12	8	76
Hake *Merluccius merluccius*	3	2	1	0	0	6
Halibut *Hippoglossus hippoglossus*	1	2	3	3	3	12
Herring *Clupea harengus*	1	1	1	1	1	5
Lemon sole *Microstomus kitt*	26	35	16	9	4	90
Ling *Molva molva*	2	2	2	1	0	7
Lobster *Homarus gammarus*	80	74	81	89	94	418
Mackerel *Scomber scombrus*	20	33	16	14	10	93
Monkfish / anglerfish *Lophius piscatorius*	23	41	15	10	5	94
Mullet – red mullet *Mullus surmuletus*	0	2	1	0	0	3
Nephrops *Nephrops norvegicus*	427	262	442	330	378	1,839
Plaice *Pleuronectes platessa*	33	55	23	14	6	131
Scallops	36	3	5	4	3	51
Sea trout *Salmo trutta*	1	0	0	0	0	1
Sole *Solea solea*	11	15	7	4	2	39
Spotted ray *Raja montagui*	1	1	1	0	0	3
Squid *Loligo* spp.	12	9	14	11	1	47
Thornback ray *Raja clavata*	1	4	5	2	1	13
Turbot *Scophthalmus maximus*	14	19	11	8	5	57
Whelk *Buccinum undatum*	0	0	0	5	0	5
Whiting *Merlangius merlangus*	295	339	267	154	108	1,163
Witch *Glyptocephalus cynoglossus*	1	1	1	0	0	3

13.4.1.4 Conservation interests

There are 22 fish species on the OSPAR List of Threatened and / or Declining Species, of which 19 are present in OSPAR Region II (Greater North Sea). The OSPAR list is designed to identify species that require protection and guides the OSPAR Commission in setting priorities for future conservation and protection of marine biodiversity. Additionally, the statutory list of species of principal importance for the purpose of conserving biodiversity in England (issued in accordance with Section 41 of the NERC Act 2006) contains a number of bony, cartilaginous and jawless fish species. This list is derived from the UK Biodiversity Action Plan (BAP) list of Priority Species.

Royal HaskoningDHV

Some migratory diadromous fish species are afforded additional protection since they are listed in Annex II to the EU Habitats Directive. These are species requiring consideration during the designation of Natura 2000 sites across Europe, and sites designated as being important for such species must be managed in accordance with the ecological needs of the species. The nearest SAC for which Atlantic salmon is a qualifying feature is the River Tweed SAC, which joins with the Tweed Estuary SAC at Berwick-upon-Tweed, Northumberland. The nearest SACs in which river and sea lamprey are qualifying features are the Tweed Estuary SAC and the Humber Estuary SAC, which meets the coast near Grimsby, Northeast Lincolnshire. The Tweed Estuary and the Humber Estuary are both over 100km from the Tees Estuary and Tees Bay C. Given the scale of the proposed scheme and the separation distance, there is no pathway for effect on either of these SACs and they are not considered further in this assessment (nor are they considered in the HRA (**Section 29**).

Table 13.6 lists those species recorded in the studies described above that are recognised as species of conservation interest.

Table 13.6 Conservation status of species recorded in the Tees Estuary and marine areas around Tees Bay

Species	Conservation status				
	OSPAR	NERC S41	IUCN Red list*	Bern Convention	Habitats Directive Annex II
European eel *Anguilla anguilla*	✓	✓	CR		
Salmon *Salmo salar*	✓	✓	LC	✓	✓
Sea trout *Salmo trutta*		✓	LC		
Sea lamprey *Petromyzon marinus*	✓	✓	LC	✓	✓
River lamprey *Lampetra fluviatilis*	✓	✓	LC	✓	✓
Blonde ray *Raja brachyura*	✓		NT		
Spotted ray *Raja montagui*	✓		LC		
Thornback ray *Raja clavata*	✓		NT		
Lesser sandeel *Ammodytes tobianus*		✓	-		
Common goby *Pomatoschistus microps*			LC	✓	
Sand goby *Pomatoschistus minutus*			LC	✓	
Herring *Clupea harengus*		✓	LC		
Cod *Gadus morhua*	✓	✓	VU		
Whiting *Merlangius merlangus*		✓	LC		
Plaice *Pleuronectes platessa*		✓	LC		
Mackerel *Scomber scombrus*		✓	LC		
Sole *Solea solea*		✓	-		
Hake *Merluccius merluccius*		✓	LC		
Halibut *Hippoglossus hippoglossus*		✓	EN		
Monkfish / Anglerfish *Lophius piscatorius*		✓	LC		
Ling *Molva molva*		✓	LC		

*CR = critically endangered, EN = endangered, VU = vulnerable, NT = near threatened, LC = least concern

13.4.1.5 Ecological resources

A Departmental Brief from Natural England on the extension of Teesmouth and Cleveland Coast SPA (Natural England, 2018) states that prey items of foraging seabirds such as terns include sandeels, clupeids (i.e. herring *Clupea harengus* and sprat *Sprattus sprattus*) and zooplankton.

Herring are widely distributed throughout the northwest and northeast Atlantic, with adults generally restricted within the 100m depth contour. As well as evidence from ICES landings data that herring are present within the wider area around the Tees (ICES rectangle 38E8), evidence from site-specific surveys outlined in **Section 13.4.1.1** indicate that herring (and sprat) are present within the Tees and adjacent marine and coastal areas. There are defined nursery grounds for juvenile herring in rectangle 38E8 (see **Section 13.4.1.6**), and juveniles remain within the nursery grounds for up to two years before recruiting into adult fish stocks. Herring spawning grounds were defined by Coull *et al.* (1998), with the nearest located approximately 5km from the mouth of the Tees. Spawning grounds are determined by the substrate available, since herring require coarse gravel and stony substrate to which they attach their eggs.

Sandeels were not recorded from the Tees estuary during the site-specific surveys summarised in **Section 13.4.1.1**. The nearest defined sandeel spawning / nursery grounds are ICES rectangle 39E8 and the eastern half of ICES rectangle 38E9, approximately 40km from the mouth of the Tees. However, a sandeel was recorded in trammel net surveys of inshore areas within the Dogger Bank A & Sofia OWF export cable corridor, near to Redcar, and ESs for consented projects within the Tees estuary (e.g. Royal HaskoningDHV, 2015) indicate that sandeels are abundant in the marine area adjacent to the estuary.

13.4.1.6 Spawning and nursery grounds

An evidence-based study of the potential spawning and nursery grounds of 40 fish species considered to be of conservation importance was undertaken by Cefas (Ellis *et al.*, 2010), which formed an update to an earlier study by Coull *et al.* (1998). Spawning and nursery ground distribution information from Ellis *et al.* (2010) was derived from juvenile fish data recorded during UK groundfish beam trawl surveys.

Where confidence in the juvenile fish data from Ellis *et al.* (2010) allowed, the spatial extent of spawning and nursery areas was defined at a resolution of half an ICES statistical rectangle. The Tees Estuary is situated within the eastern half of ICES rectangle 38E8. Defined spawning / nursery areas that may include the Tees Estuary and may overlap with the proposed scheme and / or disposal site are summarised in **Table 13.7**.

Table 13.7 Defined spawning and / or nursery areas that overlap with the proposed scheme and / or Tees Bay C disposal site

Species	General description	Defined spawning area?	Defined nursery area?
Whiting	Whiting is a marine species that utilises estuarine habitats and other coastal waters as nursery grounds.	No	High intensity[1,2]
Spurdog	Spurdog is a fully marine species that is recorded occasionally in estuaries, though not typically occurring water <10m deep. Locations and temporal stability of specific parturition grounds are not well established.	No	Low intensity[1]
Plaice	Plaice is a marine species that utilises estuarine habitats and coastal zones as nursery grounds.	Low intensity[1,2]	Low intensity[1,2]
Herring	Herring is a marine species that utilises estuarine habitats as nursery grounds. Defined herring spawning grounds are sites of suitable spawning substrate and known active or historic spawning.	No	High intensity[1,2]

Species	General description	Defined spawning area?	Defined nursery area?
Cod	Cod is a marine species that utilises estuarine habitats and other coastal waters as nursery grounds.	No	High intensity[1,2]
Anglerfish / monkfish	Anglerfish is a fully marine species that is recorded only very occasionally in estuaries. Juveniles may occur in coastal waters, although adults tend to occur further offshore.	No	Low intensity[1]
Lemon Sole		Yes (unspecified intensity)[2]	Yes (unspecified intensity)[2]
Nephrops		Yes (unspecified intensity)[2]	Yes (unspecified intensity)[2]

[1]Defined in Ellis *et al.* (2010); [2]Defined in Coull *et al.* (1998).

As shown in **Table 13.7**, the Tees estuary and adjacent coastal/marine areas may be used as nursery grounds by a number of species and may be used as a spawning habitat by plaice, lemon sole and *nephrops*. It should be noted, though, that the species listed in the table all have extensive nursery and spawning grounds which encompass much of the central North Sea.

There are extensive herring spawning grounds (defined by Coull *et al*., 1998) at Flamborough, which extend north along the Yorkshire coastal waters, though at the nearest point the defined spawning grounds lie at least 5km from the mouth of the Tees estuary.

The list of species in **Table 13.7** is not an exhaustive list; these are simply the species for which defined spawning or nursery areas have been mapped. It is possible that other species may use the Tees estuary and adjacent coastal areas as spawning and / or nursery grounds, but there is insufficient data for defining the extent of such grounds. As an example, during 2018 benthic trawl surveys of Hartlepool Channel (Royal HaskoningDHV, 2018), all dab recovered were smaller than length at first maturity and an assemblage of pogge and common goby was composed of a mixture of both juvenile and mature individuals.

13.4.2 Commercial and recreational fisheries

Marine fisheries (including estuarine fisheries) in the Tees estuary and Tees Bay, out to a distance of 6nm from the shore, fall within the remit of the North East Inshore Fisheries and Conservation Authority (NEIFCA), although the Environment Agency has responsibility for the management of fisheries for migratory species, namely salmon, sea trout and eels.

13.4.2.1 Fisheries byelaws

Under NEIFCA byelaws, the following spatial restrictions apply to fisheries within the Tees estuary and adjacent marine area:

- Byelaw III – Trawling: Prohibition: Exceptions – prohibits trawling activity within the Tees estuary upstream of an invisible line drawn between the seaward extremities of the North Gare and South Gare breakwaters;
- Byelaw IV – Seine Net, Draw Net or 'Snurrevad': Prohibition Of – prohibits use of seine netting or similar gear within the Tees estuary and adjacent marine areas;
- Byelaw XXVIII – Crustacea Conservation Byelaw – only vessels 10m or under in length can deploy potting gear within the Tees Estuary (unless a legacy vessel existing prior to the byelaw implementation); and,
- Byelaw XXIII – Method and Area of Fishing (Scallop Dredges) Byelaw 2015 – prohibits any scallop dredge activity within the Tees Estuary and any marine area within 3nm of the coast.

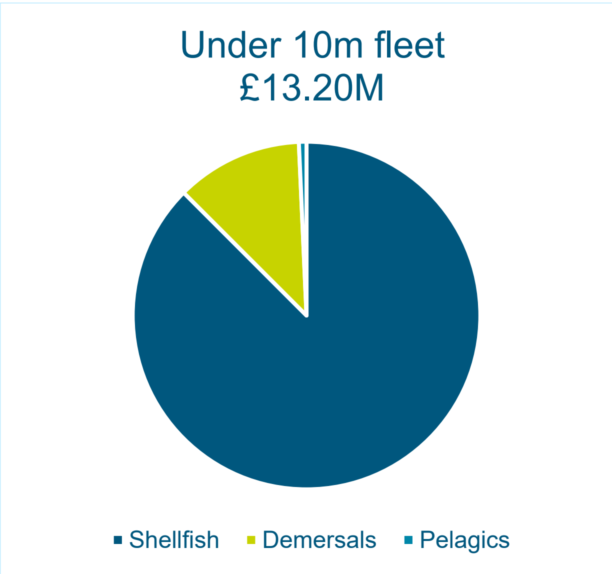
Royal HaskoningDHV

13.4.2.2 Commercial fishing activity

Vessels fishing within marine areas adjacent to the mouth of the Tees largely operate out of fishing ports at Redcar, Hartlepool, South Gare (Paddy's Hole) and further afield. Annual landings data for vessels operating in the ICES statistical rectangle 38E8 are available from ICES (MMO, 2020), up to the year 2019. This data is based on reported landings, which is mandatory for larger fishing vessels (above 10m) but is not for vessels under 10m in length, therefore landings from the under-10m fleet may be understated.

As illustrated in **Figure 13.2**, landings by both the under-10m fleet and the over-10m fleet are dominated by landings of shellfish and, to a lesser extent, demersal finfish species. Over the period 2014 to 2018, it is evident that in rectangle 38E8 the fleet of smaller vessels (i.e. 10m or under) are the main operators. Over the period 2015 to 2019, the key shellfish species landed by small vessel operators were lobster (which made up 48% of the shellfish landings, by value) and nephrops (which made up 41% of the shellfish landings, by value).

Consultation with the NEIFCA as part of other EIAs recently undertaken in the Tees estuary indicated that the majority of commercial fishing activity takes place outside the estuary, though there are limited seasonal fisheries for lobster and velvet swimming crab within the estuary during the summer months, undertaken by vessels under 10m in length. As outlined in **Section 13.4.2.1**, trawling, scallop dredging and netting gear are prohibited within the Tees estuary. There is some bait digging activity in intertidal mud and sandflat areas, targeting lugworm, ragworm and peeler crabs.



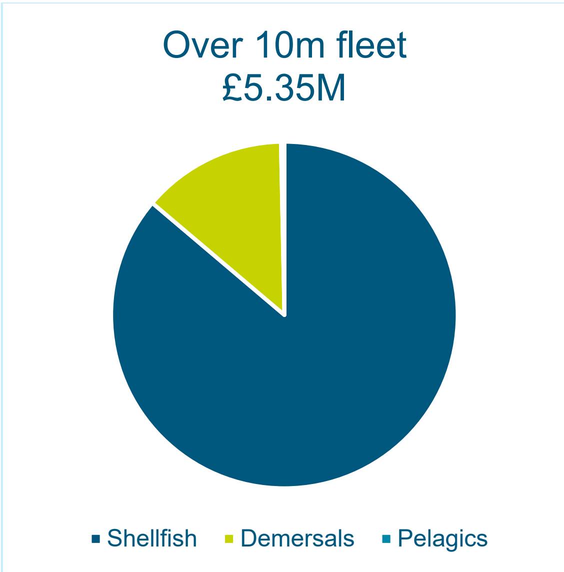


Figure 13.2 Landings from ICES rectangle 38E8 during the period 2015 to 2019 (data source: MMO, 2020)

13.5 Potential impacts during the construction phase

13.5.1 Changes in marine water quality due to dredging activity

During capital dredging, approximately 1.8Mm^3 of sediment (including approximately 1.27Mm^3 of soft material) will be removed by TSHD and backhoe dredger, which will result in a temporary increase in SSC within the water column. Under a worst-case scenario whereby the proposed scheme is implemented in full in one phase, the capital dredge campaign is anticipated to continue for approximately four months. Full details of the increase in SSC, including the visual output of sediment plume modelling for the capital dredging, is provided in **Section 6**. The peak suspended sediment concentration within the Tees during the dredging campaign is predicted to be around 85 mg/l, although this is very limited in extent and would only occur for a very limited amount of time (approximately one hour).

As detailed in the water quality assessment in **Section 7**, sediment quality testing from 2019 indicates that it is very unlikely that disturbance of sediment during the dredging would result in exceedances of EQSs, therefore the risk of physiological effects on fish from contaminant release is considered to be very low. Furthermore, **Section 7** indicates that long-term effects on DO concentrations within the Tees are unlikely, and any effect would be temporary and reversible. As such, this assessment focuses on potential effects from an increase in SSC.

An increase in SSC in the water column may lead to physiological effects in finfish, including, *inter alia*, impaired swimming ability, immunosuppression (i.e. increased susceptibility to disease) and reduced rates of growth and larval development (Robertson *et al.*, 2006). Particles in the water column may increase the risk of asphyxiation due to inhibition of gaseous exchanges at the gill lamellae or blockage of the opercular cavity. Increased SSC can also result in decreased foraging efficiency and a reduction in the ability to detect and evade predators.

In shellfish resources, increased SSC can affect an organism's filter-feeding mechanisms and its ability to respire and excrete. Behavioural and biological responses to an increase in SSC will increase energetic costs and may cause metabolic stress and, potentially, mortality. The likelihood of mortality increases with longer levels of exposure (John *et al.*, 2000), and other effects may include reduced growth rates, reduced feeding efficiency and weakened shells.

Generally speaking, estuarine fish and shellfish have a degree of resilience to relatively large changes in SSC due to the natural fluctuations associated with tidal activity, discharge from the river during high rainfall and increased wave action during storms. Sensitivity of lobsters and velvet swimming crabs (the species of highest commercial interest within the Tees estuary, see **Section 13.4.2**) to increased SSC is low, according to the MarLIN sensitivity scoring index. Mobile species (including most adult finfish) are generally able to detect early onset of increased SSC and relocate away from the affected area. Some juveniles and larvae finfish, however, may be more susceptible due to the fact that their sensory systems may be less developed, and they are less likely to relocate from affected areas. Similarly, juvenile and larval shellfish are more sensitive than adults as they have more limited mobility and hence are less capable of avoiding affected areas (Appleby and Scarratt, 1989). However, given that maintenance dredging is regularly undertaken with the Tees by PDT (almost daily maintenance dredging all year round), it can be reasonably assumed that resident individuals within the affected area would likely be relatively tolerant / acclimatised to the disturbances associated with dredging activity.

It is important to note that migratory species move upstream and downstream within the Tees (see **Section 13.4.1.2**), including both adult fish and juveniles / smolts. During the peak migratory season, when a sediment plume creating a 'barrier' effect could cause a significant disruption to the annual migration pattern, such species are considered to be more sensitive than resident species. For the purpose of this assessment it is assumed that the programme for the capital dredging in the proposed scheme may coincide with peak migration periods, and the sensitivity of receptors is considered to be high.

As outlined in **Section 6**, background SSC within the Tees channel measured during the 2020 met ocean survey was generally very low (0.0 to 8.5 mg/l), though it should be noted that the survey was undertaken during a period of very hot and dry weather. Modelling of the sediment plume during capital dredging indicates that an increase in SSC up to 350mg/l is predicted, although this only affects the direct vicinity of the dredging activity and falls below 50mg/l a short distance from the area being dredged. Concentrations of suspended sediments are predicted to decrease significantly with increased distance from the dredging vessel, both laterally and along the line of the vessel. The periphery of the plume (10 to 20 mg/l) extends no more than a few hundred metres from the dredging source.

The cross section of the river channel affected by the plume is particularly relevant when considering migrating fish; if areas remain relatively unaffected then migration would be able to continue. With respect to the proposed dredging, significant elevations in SSC are predicted to occur in the immediate vicinity of the dredger and along the streamline and, for the most part, are expected to be restricted to a relatively narrow plume along the axis of the river.

However, when considering the worst-case scenario (i.e. maximum enhanced SSCs) from the four modelled dredging phases set out in **Section 6**, the maximum area affected by increased SSC includes the entire width of the Tees (see **Figure 6.49**), meaning that there is the potential for a cross-sectional area of the river to be influenced. This is a highly conservative scenario; the maximum enhanced SSC plots indicate the maximum area affected but it is important to note that not all areas would be affected at any one time and it is very unlikely that entire cross sections of the river would be significantly affected for any protracted period. However, while unlikely, it has to be taken into account that sediment plumes encompassing the entire cross section of the river for any significant length of time, may result in significant impacts on migratory fish movement in the estuary, particularly in juvenile (smolt) stages. With the dredging lasting for approximately five months, the worst-case situation would be that this period covers a significant proportion of the peak migratory window, hence the magnitude of the impact is considered to be high.

With this in mind, there is predicted to be a **moderate adverse** impact on fish populations within the estuary, particularly when considering migratory species that may be prevented from undertaking their migratory journeys throughout the dredging campaign.

Mitigation and residual impact

The following mitigation measure is proposed to reduce the potential for impacts on migratory fish from changes to marine water quality:

- Limiting both the TSHD and BHD to working within one side of the river at a time. Operations will therefore be undertaken in long strips along the axis of the estuary rather than dredging across the width of the river. This is to reduce both the extent and impact of the dredged plume, as any plume generated by operations is predicted to remain on the same side of the river as the dredging operation, as with other capital dredge operations in the Tees (e.g. Royal HaskoningDHV, 2020).

With the implementation of the above mitigation measure, water quality will only be impacted on one side of the river at a time and, should dredging be undertaken during the months when migratory fish are present in the river, one side of the river will remain relatively unaffected. This area will form a passage through which migratory fish will be able to move past the dredging activity (and for resident species to relocate to largely undisturbed areas), thus reducing the magnitude of the impact.

Mitigation of the plume effects by reducing the size of the TSHD, and thus reducing the rate of overflow, is not viable since the size of dredger has to be sufficient to carry a large enough drag head and to have sufficient propulsion power to undertake the required dredging operation.

With the implementation of the above measure, the residual impact is considered to be **minor adverse** to both resident and migratory fish.

13.5.2 Entrainment of fish and fish eggs by dredging gear

Use of dredging apparatus, particularly TSHD dredge heads, could potentially lead to the entrainment of fish/shellfish, fish eggs and benthic food resources on which some fish/shellfish species rely. Potential effects from direct uptake during dredging include physical injury, mortality and displacement. The potential for entrainment is greater for demersal species, such as flatfish, than pelagic or semi-pelagic species. From the studies described in **Section 13.4.1**, it is evident that demersal species are likely to be present within the lower Tees estuary, including the footprint of the proposed dredge, with plaice and dab notably abundant in the 2018 and 2019 benthic trawl surveys (Royal HaskoningDHV, 2018 and 2020).

Physical disturbance to the riverbed and noise/visual disturbance within close proximity to the dredging activity would likely result in an avoidance reaction by mobile individuals (i.e. adult and juvenile fish, crustaceans), with the presence of the dredge head likely resulting in them temporarily relocating away from the immediate area, thereby avoiding direct uptake. Given their ability to relocate away from the source of entrainment, adult/juvenile finfish and mobile shellfish likely to be present in the Tees are considered to have low sensitivity to such impacts.

Eggs of benthic fish species that remain in close contact with the seabed, whether by adhering directly to the substrate or by other means, are likely to be sensitive to entrainment from dredging activities on that substrate. As detailed in **Section 13.4.1.6**, defined spawning grounds that may incorporate the lower Tees estuary include those for plaice and lemon sole (Coull *et al.*, 1998; Ellis *et al.*, 2010), though eggs of both of these species develop in the water column and are less sensitive to being entrained by dredge gear operating at the seabed. Regardless, regular maintenance dredging undertaken within the proposed dredge footprint almost daily across the whole year suggests that the riverbed is likely to be characterised by regular disturbance events, making it unsuitable for spawning activity by any fish/shellfish species and reducing the risk of direct uptake of eggs during the capital dredge.

In the event that some level of entrainment of fish/shellfish eggs does occur, it would be of low magnitude since it would be limited to those present within the dredge footprint (an area of ~350,000m^2). Given that the defined spawning areas are delineated at a resolution of half an ICES rectangle (Ellis *et al.*, 2010), the overall defined extent of spawning areas is generally very large. As such, localised effects on fish eggs would be of low magnitude when considered in the context of the defined populations in the Tees estuary and beyond. The impact is therefore predicted to be of **negligible** significance.

A loss of benthic food resources for fish/shellfish by entrainment is encompassed within the overall effects of dredging on benthic habitat and food resources, assessed in **Section 13.5.5**.

Mitigation and residual impact
No mitigation measures are required. The residual impact would remain of **negligible** significance.

13.5.3 Underwater noise during dredging

Sources of underwater noise when using a TSHD (the worst-case scenario in terms of noise emissions from the dredging options) include movement of the drag head on the seabed, material suctioned through the underwater pipe and vessel sources such as the inboard pump, thrusters, propeller and engine noise (CEDA, 2011; WODA, 2013). Noise measurements indicate that the most intense sound emissions from TSHD dredgers are typically low frequencies, up to and including 1kHz (Robinson *et al.,* 2011). Underwater noise from a TSHD is comparable to those for a cargo ship travelling at modest speed (between 8 and 16 knots) (Theobald *et al.,* 2011). Although backhoe dredging will also be employed during the capital dredging, underwater noise associated with this method is generally considered to be lower than for TSHD (as demonstrated later in this section, the zone of influence from BHD is considerably less than it is for TSHD).

Fish have a wide range of auditory capabilities, mostly in the range of 30Hz to 1kHz, and detect sound through mechanosensory organs including the otolithic organs and (for detecting nearby sounds) a lateral line system. As such, underwater sound arising from the dredging is expected to fall within the hearing ranges of fish species present in the Tees (Popper *et al*., 2003). This could be a particular issue for migratory species, such as salmonids and eels, which must pass along the length of the Tees to access upstream or downstream spawning grounds.

The extent to which underwater sound might cause an adverse impact on fish is dependent on the sound energy level, sound frequency, duration and / or repetition of the sound wave (Hastings and Popper, 2005). The impacts can be summarised into three broad categories:

- Physical trauma / mortality;
- Auditory damage (temporary or permanent threshold shift); and,
- Disturbance (i.e. behaviour modification, masking of background noise).

The presence of a gas-filled swim bladder (or other gas chamber) increases the risk of sound pressure-related injury (i.e. barotrauma), since the involuntary movement of the swim bladder caused by sudden pressure changes (notably from impulsive noises) can cause damage to it and surrounding organs. As such, fish with swim bladders are more sensitive to exposure to sound pressure (i.e. more likely to be physically harmed) than those without a swim bladder (Popper *et al.*, 2014). Given that barotrauma can lead directly or indirectly to mortality, impulsive anthropogenic sounds at a level capable of causing such injuries pose the most severe risk to fish.

Disturbance effects may occur anywhere within the zone of audibility and may include evasive actions or other altered behaviour, and masking of ambient background sounds. Masking effects can be significant if an anthropogenic sound prevents fish from responding to biologically relevant sounds. Importantly for migratory species, evasive responses to increased noise levels could result in ‘barrier’ effects that prevent migration up- and downstream.

Some fish, such as clupeids and cod, can detect sounds over a broader frequency range and at greater distances than other species due to their ability to detect sound pressure due to them having swim bladders close to the otolithic organs (i.e. the swim bladders are ‘involved in hearing’) (Popper *et al.* 2003). Those species are likely to modify their behaviour in response to sound exposure over a greater distance than those lacking swim bladders, or those with swim bladders not involved in hearing. They would also be more affected by the masking of ambient sounds.

Popper *et al.* (2014) provides information on the relative risk of the effects of continuous sounds sources, such as those produced by operational dredging vessels, to fish, as presented in **Table 13.8**. Given a lack of information, quantitative thresholds are only available for auditory damage in fish with a swim bladder involved in hearing (i.e. the most sensitive species). Salmon and trout, the most sensitive to noise of the migratory species, fall into the category of species with ‘swim bladders not involved in hearing’.

Table 13.8 Relative risk of auditory impacts from continuous sound emissions at near-, intermediate- and far-field locations (Popper et al., 2014)

	Mortality and potential mortal injury	Impairment			Behaviour
		Recoverable injury	TTS	Masking	
No swim bladder	N: Low I: Low F: Low	N: Low I: Low F: Low	N: Moderate I: Low F: Low	N: High I: High F: Moderate	N: Moderate I: Moderate F: Low
Swim bladder not involved in hearing	N: Low I: Low F: Low	N: Low I: Low F: Low	N: Moderate I: Low F: Low	N: High I: High F: Moderate	N: Moderate I: Moderate F: Low
Swim bladder involved in hearing	N: Low I: Low F: Low	170 dB rms for 48 hrs	158 dB rms for 12 hrs	N: High I: High F: High	N: High I: Moderate F: Low
Eggs and larvae	N: Low I: Low F: Low	N: Low I: Low F: Low	N: Low I: Low F: Low	N: High I: Moderate F: Low	N: Moderate I: Moderate F: Low

N = near-field (tens of metres); I = intermediate-field (hundreds of metres); F = far-field (thousands of metres)

Based on the range of species present in the Tees estuary, as described in **Section 13.4.1**, the sensitivity of receptors varies, though for the purpose of this assessment a conservative estimate of high sensitivity (taking into account receptors particularly sensitive to sound pressure level changes, such as clupeids) has been applied. There is little evidence on the sensitivity of marine invertebrates (including shellfish) to anthropogenic noise but the suggestion is that sensitivity is low (Hawkins and Popper, 2012). Where applicable, particular focus in the assessment is placed on migratory species and how their migration activities may be impacted.

Temporary or permanent physical effects on fish

For the purposes of this assessment, the risk that noise from dredging activities could result in mortality or potential mortal injury is not considered to be an issue, given that there is no direct evidence of such noise resulting in mortal injury (Popper *et al.*, 2014). More relevant is the risk of recoverable injury and / or TTS. As indicated in **Table 13.8**, sound emissions greater than 158 dB rms for 12 hours mark the threshold at which TTS may be elicited, and 170 dB rms for 48 hours marks the point at which recoverable physical injury may be experienced by the most sensitive species.

A detailed underwater noise survey and modelling exercise was undertaken in 2014 to inform the EIA for the Anglo American Harbour Facilities (Royal HaskoningDHV, 2014). The findings of the modelling exercise provide useful context for the proposed scheme since a number of the input parameters used in the 2014 study are applicable, specifically:

- Source noise levels from a TSHD were used in the underwater noise assessment to represent a worst-case scenario (this form of dredging forms the worst-case scenario for the proposed scheme);
- The footprint of the Anglo American Harbour Facilities is approximately 600m downstream from the Tees Dock turning circle and the dredge footprint for the proposed scheme.
- The bathymetry and substrate in the proposed dredging location is broadly similar to that in the area modelled.

The 2014 modelling results, presented in **Table 13.9**, provide a summary of the estimated ranges out to which certain unweighted RMS SPLs were expected to occur from both backhoe and TSHD dredging.

Table 13.9 Summary of the modelled ranges for unweighted RMS SPLs in 10dB increments for dredging activities in the Tees (Royal HaskoningDHV, 2014)

Unweighted RMS SPLs	Backhoe dredging			TSHD		
	Max. range	Min. range	Mean	Max. range	Min. range	Mean
160 dB re 1 µPa	<5m	<5m	<5m	20m	20m	20m
150 dB re 1 µPa	10m	10m	10m	95m	75m	88m
140 dB re 1 µPa	30m	25m	28m	475m	335m	423m
130 dB re 1 µPa	105m	65m	92m	2,140m	485m*	1,310m
120 dB re 1 µPa	480m	275m	400m	2,460m	485m*	1,700m
110 dB re 1 µPa	1,860m	485m*	1,090m	2,920m	485m*	1,860m

**minimum range was limited by the width of the river*

Modelled ranges for backhoe dredging are notably less than they are for TSHD. For the most sensitive species (i.e. those with swim bladders involved in hearing), the unweighted SPLs outlined above only exceed the quantitative threshold for TTS (see **Table 13.8**) at a very short range (less than 88m from source when considering use of TSHD, and 5 to 10m from source when undertaking backhoe dredging). This is also based on the assumption that exposure is continuous for a period 12 hours, whereas in reality there will be breaks in dredging activity during the dredge/disposal cycles, plus it is highly unlikely that fish would remain within the injurious range (especially high value receptors such as migrating salmonids and eels).

Given the above, the risk and magnitude of recoverable injury or temporary auditory impairment is considered to be very low, and the significance of the impact is **negligible**.

Noise-related barrier effects on migrating species

When assessing the potential disturbance impact of noise on fish populations (whether by eliciting a behavioural response or by masking background sounds), it is important to consider the nature of the baseline sounds in the local environment and assess impacts in this context.

Underwater noise measurements were recorded in the River Tees, including the area of the proposed capital dredging, during an underwater noise survey conducted by Subacoustech in 2014 (Royal HaskoningDHV, 2014). The 2014 measurements indicated that background noise levels are typically in the region of 103 to 115 dB re 1µPa SPL_{RMS} along the centre of the river, which is considered to be relatively high for a wide, slow-moving river and is influenced by constant sources of shipping, engine and generator noise audible along the entire length of the channel. With passing heavy vessels, measurements were typically seen to increase to between 130 and 150 dB SPL_{RMS}.

Given the background noise levels in the river, it can be assumed that underwater noise above ~115dB re 1uPa SPL_{RMS} will be audible to fish, and **Table 13.9** indicates that noise levels of at least 130-140 dB SPL_{RMS} will be present across the entire width of the river during use of TSHD. As such, the underwater noise levels expected during TSHD use are likely to fall within the range experienced with passing vessels, although it will be sustained for as long as dredging is ongoing (a period of approximately four months). Noise levels from backhoe dredging are considerably lower, and only significantly exceed background levels within a short distance (<100m) of the source.

While effects on resident fish species may include some temporary behavioural alterations and masking, resident species are likely to have a level of acclimatisation to fluctuating noise levels caused by passing vessels and almost daily maintenance dredging, and they would also be able to temporarily move to nearby, less affected areas within the river while dredging is ongoing. Potential impacts for migratory species are considered to be more severe, since there is a risk of barrier effects that could prevent migration up- or downstream, particularly if dredging is undertaken during key migratory periods (see **Section 13.4.1.2**). Given that significantly elevated noise levels produced during backhoe dredging are not expected to extend across the entire width of the river (and would therefore be less likely to form a complete barrier effect for migrating fish), this assessment is based on the use of TSHD.

The TSHD campaign is predicted to last for approximately four weeks. While dredge/disposal cycles will run continuously during this period, each cycle time is estimated to last 175 to 190 minutes, of which only 60 to 75 minutes will be spent loading, with 115 minutes spent discharging and commuting to and from the disposal site.

As described in Popper *et al*. (2014), fish with swim bladders not involved in hearing (which includes migratory species such as salmon and trout) are considered to be moderately sensitive to the risk of behavioural impacts at both near-field and intermediate-field locations with regard to continuous noise sources (see **Table 13.8**). With this as a proxy, for the purpose of this assessment the sensitivity of the main receptors (i.e. migratory species) is considered to be medium.

Outside the migratory period, there would be a negligible impact on fish movement up- and downstream since noise emissions would not affect a significant number of migrating fish. If the TSHD campaign is undertaken during the key months of July and August (when salmonid migration is at a peak), the magnitude of the impact would be medium since, whilst being undertaken at a critical time of the year, it should be recognised that the noise levels produced would fall within the range experienced at the site as a matter of course when vessels pass on a day-to-day basis. Furthermore, noise levels associated with the capital dredging would likely be very similar to the almost-daily maintenance dredging activities undertaken in the channel; it should be noted that the baseline migration trends are in the face of this regular maintenance activity.

Given that the TSHD campaign would only last approximately four weeks, the duration of the impact is not expected to encompass the entire migratory season and normal migratory patterns would be expected to recommence once the dredging campaign has ceased. Furthermore, the noise levels at the site will abate for the majority of each dredge/disposal cycle while the TSHD vessel transports material to and from the disposal site, meaning that there are windows in which normal migratory patterns can occur even during the dredging campaign. As such, the significance of a potential barrier effects on migratory species caused by noise from TSHD is considered to be **minor adverse**.

Mitigation and residual impact

Use of dredging vessels are imperative for the proposed scheme. While use of smaller dredger heads may slightly reduce noise levels, they would continue for a longer period so are not considered to be a suitable measure. Applying the measure set out in **Section 13.5.1** (dredging along the axis of the river, rather than across the river) will help to ensure that noise levels at the opposite side of the river from the dredger remain as low as possible over a dredge/disposal cycle, but as stated above the elevated noise levels will be detectable across the entire width of the river. As such, the residual effect will remain **minor adverse**.

13.5.4 Underwater noise from land-based piling activities

While piling works are to be undertaken on land at least 20m from the river edge, consultation with the Environment Agency (see **Section 13.2.1**) has raised the issue of noise emissions from the landside piling propagating into the water column and potentially affecting migratory fish during upstream migration. Experience of piling in the Tees estuary suggests that impact pile driving is envisaged to take approximately 10 minutes per pile, with one pile driven per day at a rig and four rigs in use. As such, there could be up to 40 minutes of impact pile driving activity per day.

Popper *et al.* (2014) provides information on the relative risk of the effects of impulsive (percussive) piling driving sounds sources, presented in **Table 13.10**. As outlined in **Section 13.5.3**, salmon and trout, the most sensitive to noise of the migratory species, fall into the category of species with 'swim bladders not involved in hearing'.

Table 13.10 Summary of the qualitative effects on fish from impulsive pile driving sources (Popper* et al.*, 2014)

	Mortality and potential mortal injury	Impairment			Behaviour
		Recoverable injury	TTS	Masking	
No swim bladder	>219 dB SEL_{cum} or >213 dB peak	>216 dB SEL_{cum} or >213 dB peak	>>186 dB SEL_{cum}	N: Moderate I: Low F: Low	N: High I: Moderate F: Low
Swim bladder not involved in hearing	>210 dB SEL_{cum} or >207 dB peak	>203 dB SEL_{cum} or >207 dB peak	>186 dB SEL_{cum}	N: Moderate I: Moderate F: Low	N: High I: Moderate F: Low
Swim bladder involved in hearing	>207 dB SEL_{cum} or >207 dB peak	>203 dB SEL_{cum} or >207 dB peak	186 dB SEL_{cum}	N: High I: High F: Moderate	N: High I: High F: Moderate
Eggs and larvae	N: Low I: Low F: Low	N: Low I: Low F: Low	N: Low I: Low F: Low	N: High I: Moderate F: Low	N: Moderate I: Moderate F: Low

N = near-field (tens of metres); I = intermediate-field (hundreds of metres); F = far-field (thousands of metres)

Additionally, Woodbury and Stadler (2008) and, more recently, Caltrans (2015) referenced a noise threshold of 150 dB 1 µPa SPL (RMS assumed) for eliciting a behavioural response in fish. Although Popper and Hawkins (2019) state concerns with this figure, including that the basis for it is unknown, or exactly what behaviour it relates to, in the absence of any alternative numerical criteria for behavioural effects, the noise levels produced by piling have been compared to this below.

Sound propagates most efficiently via a single, uninterrupted medium. Where it must pass through multiple media (i.e. mixed sand/silt and water), then the transmission of noise is reduced. In the proposed piling activities, vibration will be transferred from the pile and hammer and distributed into the substrate, and out into the river. Situations involving ground-borne noise transmission are complex due to the variety and layers of media. The calculation of how, and how much, noise is transmitted is much more difficult than a simple calculation of transmission directly through air or water, and it varies depending on the ground type present, and is most accurately identified by direct measurement. When it comes to predicting the noise level, the detail of analysis in calculation should be commensurate with the level of risk, and this relates to the level of noise present at source (i.e. the noise-generating activity) and the sensitivity of the receptor.

Subacoustech (2020) reviewed the risk of transmission of underwater noise into the river from the piling activities and the potential impacts on migratory fish (**Appendix 8**). Based on prior underwater noise surveys of land-based piling in other locations, Subacoustech considered a likely minimum loss of 5dB between the working area and the river. Applying this to typical piling underwater noise levels, the conservative noise level predictions in the Tees from piling, as used in the review, are set out in **Table 13.11** below.

Table 13.11 Predictions of underwater noise levels during percussive piling in the River Tees (Subacoustech, 2020)

Range	SPL_{Peak}	SPL_{RMS}	SEL_{ss}
100m	186	169	163
200m	175	158	152
300m	170	153	147
400m	167	151	144

For the cumulative exposure calculations, an assumption has been used that the receptor remains in the middle of the river closest to the piling for 10 minutes, considered to be a reasonable estimate for the length of time that impact pile driving could take per pile. A stationary animal calculation has been used. This is a worst-case assumption as the receptors are migratory and expected to be highly mobile, therefore are unlikely to remain static in the water near to the noise source (they would likely move away in the event of a noise that would be considered disturbing or hazardous).

The maximum noise level predicted from percussive piling is 159 dB SEL_{ss} in the centre of the river channel, at 150m directly opposite the piling. Based on the above assumption, this is equivalent to 185 dB SEL_{cum}. This is under the quantitative threshold for TTS set out by Popper *et al.* (2014), and itself is expected to be a significant over-estimation of the actual noise exposure to an individual, therefore there is no risk of injury or TTS to even the most sensitive species of fish.

Noise-related barrier effects on migrating species during piling

The predicted level of 158 dB SPL_{RMS} at a distance of 200m is somewhat higher than the background noise levels in the Tees described in **Section 13.5.3**. Based on the predicted piling noise levels at the greatest distance (i.e. 151 dB SPL_{RMS} at 400 m), the noise level at the furthest 'line of sight' of the piling (around Middlesbrough Dock) using a reasonable estimation for noise attenuation in the water, the noise level would drop to 139 dB SPL_{RMS} (Subacoustech, 2020). This is still likely to be audible to fish, including migratory species.

The noise level predicted at the opposite side of the river (~300 m), 153 dB SPL_{RMS}, is slightly over the behavioural reaction threshold of 150 dB SPL_{RMS}. As this threshold is only for a "behavioural reaction" rather than the somewhat stronger response of aversive behaviour that would lead to an effective barrier in the river, and the relative insensitivity of the fish under consideration, it is thought that the noise from piling on land is unlikely to impede their passage during piling (noting that caution such be used in the generalisation of the behavioural reaction threshold (Popper *et al.*, 2019).

It is important to note that any motorised vessel present in the river will produce noise levels considerably in excess of background noise and of similar order (or greater) than the noise level produced during piling for much of the affected area. As stated in **Section 13.5.3**, the migratory species present in the Tees are expected to have some level of tolerance to periodic increases in noise levels. Furthermore, underwater noise emissions associated with the impact pile driving are expected over an approximate period of 40 minutes in a single day. Outside the key migration period there would be no effect on migration; however, even if piling takes place during the peak months of July and August the magnitude of the impact would be low since movement of fish along the river would be unimpeded for the majority of the time. The impact of underwater noise of piling activities is therefore considered to have a **negligible** impact on migration up- and downstream.

Mitigation and residual impact

No mitigation measures are required. The residual impact remains **negligible**.

13.5.5 Direct loss/alteration of habitat and food resources

As outlined in **Section 13.2.2**, in lieu of survey data under the existing timber and concrete wharf at the time of writing, the assumption has been made that the structure is likely to provide sheltering habitat for juvenile fish. Removal of the wharf would result in a permanent loss of such habitat. Additionally, capital dredging and excavation of the subtidal and intertidal will result in temporary or permanent loss or alteration of habitat that could potentially be used for foraging and/or shelter by both adult and juvenile fish and shellfish. Full details of the anticipated changes in the intertidal and subtidal benthic environments are described in **Section 9**.

Alteration of subtidal habitat

Although there is potential for subtidal habitat within the Tees to offer feeding opportunities for fish that prey on benthic estuarine flora and fauna, the regular maintenance dredging undertaken by PDT within the river channel leads to a conclusion that the area of subtidal to be affected by the proposed dredging is unlikely to represent an important spawning or feeding site . Regardless, capital dredging activities on existing subtidal habitat would not represent a permanent loss of such habitat, as described in **Section 9.**

The ongoing maintenance dredging suggests that subtidal habitat in the proposed dredge footprint is likely to be characteristic of estuarine habitats influenced by regular disturbance events, and as such is expected to return to a similar condition following completion of capital works. In the short term the subtidal benthic community would be removed from an area of approximately 32.5ha, but, as described in **Section 9**, the majority of benthic species likely to be present (i.e. potential food resources for fish) are typical of the wider estuarine environment. As such, this temporary loss would not represent a significant reduction in available feeding habitat within the lower Tees estuary, and the magnitude of the impact on fish is considered to be low.

It should be noted that approximately 5ha of existing subtidal would see a permanent change due to the placement of a rock blanket in front of the new quay wall. As stated, however, the area affected is typical of the wider subtidal environment and would not represent a significant loss of such habitat. Furthermore, the introduction of hard, complex substrate may offer new opportunities for foraging, shelter and spawning that do not currently exist at the site, which may in turn improve biodiversity of fish and shellfish using the site. The placement of the rock blanket is not, therefore, expected to significantly change the magnitude stated above.

Given the maintenance dredging that occurs, it can be reasonably assumed that fish feeding within the affected subtidal area would likely be relatively tolerant / acclimatised to the disturbances associated with dredging activity. For this reason, the general sensitivity of fish to temporary changes in subtidal habitat in the affected area is considered to be low.

Given the above, alteration of the subtidal habitat as a result of dredging activity is considered to have a **negligible** impact on fish species within the Tees.

As well as the subtidal area affected directly by dredging activity, the increases in SSC anticipated during capital dredging activity will consequently result in an increase in sediment deposition, which has the potential to cause smothering and consequent loss of epibenthic food resources of benthic feeding fish/shellfish. The extent of sediment deposition above baseline levels is detailed in **Section 6**. The maximum sediment deposition, illustrated in **Figure 6.50**, shows that much of the sediment falls to bed within the dredged area, whilst other areas outside the dredge footprint affected are typically less than 5cm. In the small extent of subtidal area outside the dredge footprint that may be affected by a small amount of sediment deposition, it again can be assumed that feeding fish would be accustomed to similar conditions occurring during the regular PDT maintenance works.

Loss of sheltering/nursery habitat for juvenile fish

During excavation of the berth pocket, approximately 2.5ha of intertidal habitat along the south bank of the Tees will be converted to subtidal habitat. Additionally, removal of the existing wharf will remove what is assumed to be a source of shelter for juvenile fish (see **Section 13.2.1**). As described in **Section 13.4.1.6**, Ellis *et al.* (2010) defined nursery grounds for a number of species (including species of conservation importance) that may encompass suitable areas within the Tees estuary. Small and juvenile fish are considered to have high sensitivity to the loss of sheltering habitat, since it can leave them vulnerable to predation.

Walkover surveys at the site in 2020 (see **Section 9**) indicate that the intertidal area beneath and behind the existing wharf structure is relatively poor quality, with artificial debris and low species diversity (mainly dominated by fucoid algae). The intertidal area comprises mud and gravelly sediment with some rocks. While the loss of such habitat is considered to be insignificant (in terms of impact assessment) for the habitats and benthic communities present in the intertidal, it should be noted that even on poor quality intertidal habitat juvenile fish may, to an extent, use algal cover and artificial debris for shelter when immersed However, notable sheltering habitats such as intertidal pools were not recorded in the survey.

The supporting structures from the wharf appeared to support a low diversity of colonising species during the 2020 walkover survey and were dominated by mat-like green algae. These structures are at the subtidal/intertidal boundary and therefore at least some part of the structures are underwater most of the time. Such structures, when colonised by algae and other taxa that afford shelter, can act as aggregating sites for small / juvenile fish, particularly in nursery sites. The wharf itself may offer protection from aerial predators such as terns and other seabirds. In the absence of survey data at the time of writing, this assessment is based on the worst-case assumption that the structure is important for sheltering small and juvenile fish.

While the removal of sheltering structures and the conversion of intertidal areas to subtidal will result in permanent loss of such features, this is partly offset by the fact that the area of such habitat affected is relatively small (~2ha) and there are numerous other intertidal locations and sheltering structures within the Tees estuary that can be used by the wider population. With this in mind, the magnitude of the impact is considered to be medium, and the loss of sheltering habitat is predicted to have a **moderate adverse** impact on small and juvenile fish.

Mitigation and residual impact

Removal of the existing structures and excavation of the intertidal is an intrinsic part of the project design for the proposed scheme, and there is no feasible mitigation measure that can prevent such losses. However, as described in **Section 3**, opportunities for introducing environmental enhancement measures (IECS, 2018 and Naylor *et al*., 2017) include the incorporation of 'verti-pools' in the quay face at different heights within the tidal frame. Such water retentive measures would provide new shelter for small and juvenile fish from larger marine predators as well as aerial predators. Given that these would be specifically designed to offer shelter throughout the tidal range, this would help to offset the loss of the existing structures and reduce the magnitude of the impact. With the adoption of such enhancement measures, the residual impact on sheltering fish would be reduced to **minor adverse**.

13.5.6 Displacement or disturbance of fishing activities

The use of construction vessels within the river channel (e.g. TSHD and backhoe as well as other supporting vessels to be used during demolition and construction) and the construction work in the intertidal could impede access to passing vessels commuting to fishing grounds in the outer estuary or adjacent coastal areas and, in theory, could lead to localised displacement of fishing activities within (or adjacent to) the footprint of the works.

Although most commercial fishing activity takes place outside of the Tees estuary, there are limited seasonal lobster and velvet swimming crab fisheries in the lower estuary during summer month, as described in **Section 13.4.2**. However, areas within and adjacent to the marine footprint of the proposed scheme are those already subject to regular maintenance dredging and/or experience high volume of vessel traffic and would therefore already be unsuitable for potting activity. Bait digging takes place on intertidal mud and sandflats within the Tees estuary, but the area of intertidal that will be lost during the construction of the proposed scheme is small and has restricted public access; furthermore, most bait digging occurs lower in outer estuary and along the adjacent coastline.

Given the above, it is highly unlikely that there would be any significant displacement of fishing activity within the footprint of the works, and even if there was, the number of vessels/fishers affected would be negligible and could easily use other areas within the lower Tees.

In terms of restricting access to passing fishing vessels commuting to fishing grounds downstream or out to sea, the navigational impacts of the proposed scheme during construction works are assessed in detail in **Section 14**). The navigation assessment concludes that potential conflict between construction activities and navigation within the Tees estuary is predicted to be negligible, given that works will be co-ordinated through the Harbour Master.

As such, any impacts on local fishing activities taking place within the Tees estuary or adjacent coastline are predicted to be **negligible**.

Mitigation measures and residual impact

No mitigation measures are required, although as a matter of course PDT will manage any conflicts through coordination via the Harbour Master and use of VTS. Fishing vessel users will be provided with Notices to Mariners informing them of proposed works, allowing them to adjust accordingly. The residual impact would remain **negligible**.

13.6 Potential impacts during the operational phase

13.6.1 Noise disturbance from increased vessel traffic

It is understood that on average, there are between 800 and 950 commercial vessel movements per month (up to 11,400 per year) in the Tees estuary under baseline conditions. This figure does not include non-commercial activity; therefore, the true number of motorised vessel movements is likely to be higher. It is predicted that there would be an additional 390 operational vessel calls per year at the proposed quay.

Given that fish within the Tees are already exposed to a high degree of vessel-associated disturbance (including noise levels elevated above ambient levels), they are considered to be accustomed to such impacts (including hearing sensitive species, such as those with swim bladders). Furthermore, in the context of existing vessel traffic, the predicted operational vessel movements are considered to be of very low magnitude and there would be significant increase on noise levels already experienced. The minor increase in motorised vessel traffic is therefore considered to have a **negligible** impact on fish populations or behaviour.

Mitigation and residual impact

No mitigation measures are required. The residual impact will remain **negligible**.

13.6.2 Impacts from quayside lighting

At present there is no/minimal light source at the site of the proposed new quay and therefore light spill into the channel will be very limited (although lighting is present along all other operational quays along both banks of the river). However, during the operation phase, approximately 18 new lighting towers (each up to 30m in height) will be present on the quayside for safety reasons. Consequently, there is the potential for additional disturbance to fish as result of light spill compared to the present-day scenario.

The reaction of many fish to this type of disturbance is attraction to the light sources. Therefore, there is the potential for some attraction of fish to the operational area, although noise generated from vessels using the quay will counteract this effect to an extent. Overall, it is concluded that the noise and light during the construction phase will result in some highly localised redistribution of fish within the area around the new quay. However, this would not affect the fish populations of the estuary as a whole and, therefore, the impact is predicted to be of **negligible** significance.

Mitigation and residual impact
No mitigation measures are required; however, in accordance with best practice, lighting would be directed away from the estuary where possible in order to minimise light spill into the water column. The residual impact would be **negligible**.

13.6.3 Change in maintenance dredging regime affecting supporting habitats and benthic prey resources

The predicted changes to the rate of infill of the navigation channel as a consequence of the proposed scheme are minimal. It is concluded that the predicted changes are insignificant with respect to potential effects on the existing maintenance dredging strategy, and no changes to the present-day maintenance dredging strategy are necessary. As such, there would be **no additional impact** on supporting benthic habitats and prey resources beyond those already associated with the existing maintenance dredging regime.

Mitigation measures and residual impact
No mitigation measures are required. There would be **no residual impact**.