REPORT

Port of Dundee Capital Dredge and Quay Improvement Works

Shadow Habitats Regulations Appraisal

Client:	Port of Dundee Limited
Reference:	PC6550-RHD-XX-XX-RP-EV-0010
Status:	Final/02
Date:	7 July 2025

Haskoning
Enhancing Society Together

FORTH PORTS SCOTLAND

HASKONING UK LTD.

Honeycomb
Edmund Street
Liverpool
L3 9NG
United Kingdom
Water & Maritime
VAT registration number: 792428892

Phone: +44 151 2362944
Email: info@uk.haskoning.com
Website: haskoning.com

Document title:	Port of Dundee Capital Dredge and Quay Improvement Works
Subtitle:	Shadow Habitats Regulations Appraisal
Reference:	PC6550-RHD-XX-XX-RP-EV-0010
Your reference	N/A
Status:	Final/02
Date:	7 July 2025
Project name:	Port of Dundee
Project number:	PC6550
Author(s):	Rachel Greaves
Drafted by:	EF, RG, BH, SB, EM
Checked by:	EF, EB, AS, LG, PP
Date:	1 July 2025
Approved by:	JG
Date:	7 July 2025
Classification:	Project related

Table of Contents

Table of Tables

Table of Figures

Appendices

Acronyms

Acronym	Definition
BTO	British Trust for Ornithology
cSAC	Candidate Special Area of Conservation
CEDA	Central Dredging Association
CES	Coastal East Scotland
CD	Chart Datum
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
EMODnet	European Marine Observation and Data Network
GNS	Great North Sea
GPP	Guidance for Pollution Prevention
GPS	Global Positioning System
HRA	Habitats Regulations Appraisal
IAMMWG	Inter-Agency Marine Mammal Working Group
IROPI	Imperative Reasons of Overriding Public Interest
JNCC	Joint Nature Conservation Committee
LSE	Likely Significant Effect
MarLIN	The Marine Life Information Network
MD-LOT	Marine Directorate – Licensing Operations Team
MMO	Marine Mammal Observer
MU	Management Unit
NMFS	National Marine Fisheries Service
OFFSABC	Outer Firth of Forth and St Andrew's Bay Complex
PCW	Prince Charles Wharf
PCWE	Prince Charles Wharf Extension
PMF	Priority Marine Feature
pSAC	Possible Special Area of Conservation
pSPA	Potential Special Protection Area
PTS	Permanent Threshold Shift
RMS	Root Mean Square
RS	Resting Site
RSPB	Royal Society for the Protection of Birds
SAC	Special Area of Conservation

Acronym	Definition
SCANS	Small Cetaceans in the European Atlantic and North Sea
SCOS	Special Committee on Seals
SEL	Sound Exposure Level
SEL_{cum}	Sound Exposure Level, cumulative
SEL_{SS}	Sound Exposure Level, single strike
sHRA	Shadow HRA
SMRU	Sea Mammal Research Unit
Scottish Natural Heritage	SNH
SPA	Special Protected Area
SPL	Sound Pressure Level
SPL_{peak}	Sound Pressure Level Peak
SSC	Suspended Sediment Concentration
SSSI	Site of Special Scientific Interest
TSHD	Trailer Suction Hopper Dredger
TTS	Temporary Threshold Shift
UK	United Kingdom
WeBS	Wetland Bird Survey
WODA	World Organization of Dredging Associations
WTG	Wind Turbine Generator

1 Introduction

1.1 Project background and need

One of the primary uses for the Port of Dundee is to service and support the offshore renewables industry. The port already provides facilities for the transhipment and storage of components, such as wind turbine generators (WTGs) and other component parts associated with wind farm projects. Due to the increasing size of the components and vessels used by the offshore renewables industry, the Port of Dundee Limited is proposing to undertake a suite of works at the Port of Dundee and Lady Shoal approach channel in order to accommodate the increasing needs of the offshore renewables industry.

The suite of works that comprise the Proposed Scheme includes (see **Figures 1-1** to **1-3**):

- Capital dredging works to:
    - Deepen the approaches to DunEco Quay and Prince Charles' Wharf (PCW) to -6.0m Chart Datum (CD) and -6.5m CD, respectively;
    - Widen the PCW berth pocket to 70m and deepen to -9m CD, extend eastwards by approximately 200m to a depth of -10m CD (called the Prince Charles Wharf Extension (PCWE)); and
    - Deepen a section of the Lady Shoal Approach channel to -6.5m CD.
- Improvement works to the PCW.

It is anticipated that approximately 220,000m^3 of material would be removed, approximately 490,000m^3 including a 0.5m over-dredge allowance, from within the dredge footprints within the dredge areas. Disposal would be at the existing Middle Bank disposal site, as confirmed by the Best Practicable Environmental Option (BPEO) assessment submitted in support of the marine licence application (ref: PC6550-RHD-XX-XX-RP-EV-0061).

For further information on the Proposed Scheme see **Section 2**.

1.2 Purpose of this report

This report documents Stages 1 and 2 of the Habitats Regulations Appraisal (HRA) process. The aim of Stage 1 is to determine whether or not a plan or project is likely to have a significant effect (Likely Significant Effect (LSE)) on the qualifying features and Conservation Objectives of a European (Special Area of Conservation (SAC) and Special Protection Area (SPA)) or Ramsar site, either alone or in-combination with other plans and projects. Where it is considered that there is no potential for LSE, the site (or relevant interest feature) is 'screened out' from further consideration in the HRA process. Where the potential for LSE cannot be discounted, it is 'screened in' for Appropriate Assessment. Stage 2 comprises the provision of sufficient evidence to allow an Appropriate Assessment of the Proposed Scheme to be carried out by the competent authority (in this instance the Marine Directorate). The Appropriate Assessment is a determination of whether the Proposed Scheme may, even with mitigation measures in place, result in an adverse effect on site integrity.

340000 345000 350000

735000 730000 725000

N

MIDDLE BANK (TAY)

0 2 4 km

Legend:

- Prince Charles Wharf Approach Channel Dredge Area
- DunEco Quay Approach Channel Dredge Area
- Proposed Extension to PCW Berth Pocket
- Existing PCW Berth Pocket
- Lady Shoal Approach Channel Dredge Area
- Quay Improvement Works
- Disposal Site

Client:	Project:
Port of Dundee Limited	Port of Dundee Capital Dredge and Quay Improvement Works

Title:

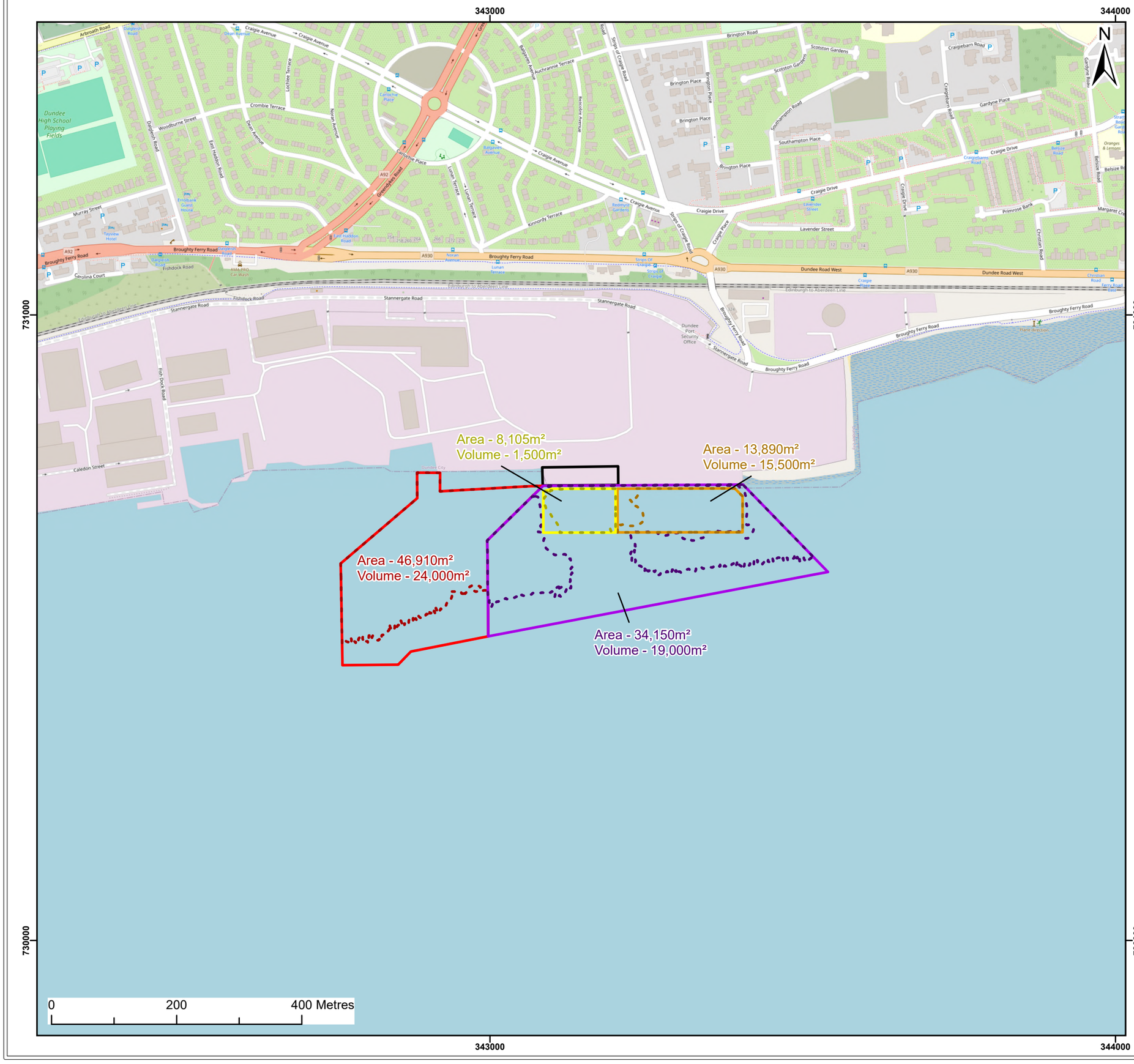
Location Plan showing the Proposed Scheme

Figure:	Drawing No:
1-1	PC6550-RHD-XX-ZZ-D-EV-0064

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
P01	10/07/2025	JH	JG	A3	1:50,000

Co-ordinate system: British National Grid

Haskoning
Enhancing Society Together



Legend:

- Remedial Quay Works

DunEco Quay Approach Channel

- Dredge Area
- Dredge Footprint

Prince Charles Wharf Approach Channel

- Dredge Area
- Dredge Footprint

Proposed Extension to PCW Berth Pocket

- Dredge Area
- Dredge Footprint

Existing PCW Berth Pocket

- Dredge Area
- Dredge Footprint

Client:	Project:
Port of Dundee Limited	Port of Dundee Capital Dredge and Quay Improvement Works

Title:

Proposed Works at the Port of Dundee

Figure:	Drawing No:
1-2	PC6550-RHD-XX-ZZ-DR-Z-0002

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
P02	10/06/2025	JH	RG	A3	1:6,000
P01	10/12/2024	GC	RG	A3	1:6,000

Co-ordinate system: British National Grid

Haskoning
Enhancing Society Together

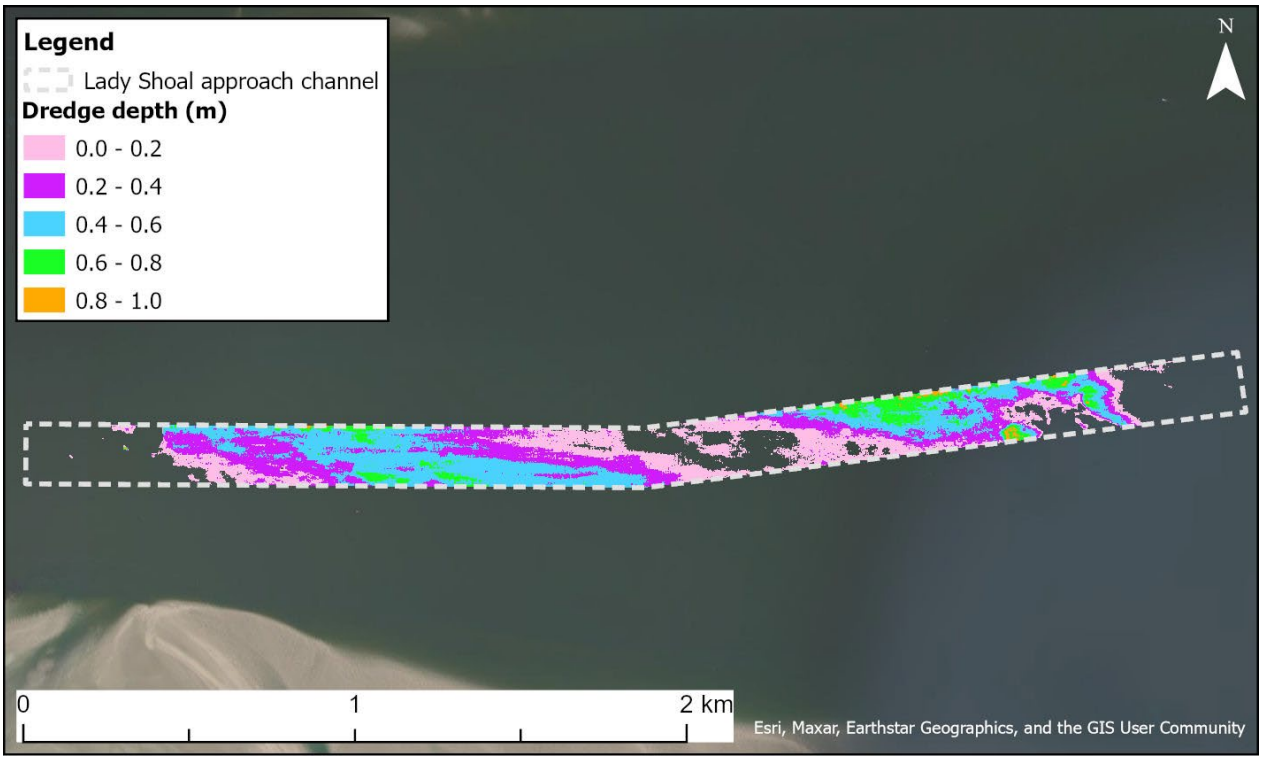


Figure 1-3 Lady Shoal approach channel dredge area (white dashed line) and footprint (by dredge depth)

1.3 Structure of this report

This shadow HRA (sHRA) report is structured as follows:

Chapter 1 provides an introduction to the Proposed Scheme, the requirement for HRA and describes changes to the Proposed Scheme since HRA screening.

Chapter 2 provides a description for the Proposed Scheme, including information on the construction methodology, an overview of the operational phase.

Chapter 3 provides an overview of the legislation of relevance to the Proposed Scheme and this sHRA.

Chapter 4 presents the findings of the Stage One: Screening for LSE of this sHRA.

Chapters 5 to **7** provides the Information for Appropriate Assessment.

Chapter 8 summarises the conclusions of this sHRA.

Chapter 9 provides a list of references used in the compiling of this sHRA

Appendices

Appendix 4-1 Port of Dundee Project Introduction
Appendix 4-2 Port of Dundee HRA Screening Report
Appendix 4-3 NatureScot's Comments on HRA Screening Report
Appendix 4-4 Underwater Noise Modelling
Appendix 4-5 Species Specific Distribution Maps

Appendix 4-6 Otter Survey Target Notes
Appendix 5-1 Benthic Survey Report

2 Description of the Proposed Scheme

2.1 Construction Phase

2.1.1 Capital dredging

The capital dredging works would be carried out as follows:

- Deepen the approach to DunEco Quay to -6m CD (red outline on **Figure 1-2**);
- Deepen the approach to the PCW to -6.5mCD (purple outline on **Figure 1-2**);
- Widen the PCW berth pocket to 70m and deepen to -9m CD (orange outline on **Figure 1-2**);
- Extend the berth pocket 200m to the east along the PCWE and deepen to -10m CD (**Figure 1-2**); and
- Deepen a section of the Lady Shoal Approach channel to -6.5m CD (see **Figure 1-3**).

All dredging at the Port of Dundee, with the exception of a very small area in the south-west corner of the dredge footprint, is within the Port of Dundee Limited's licenced maintenance dredge area. The proposed dredging would generate approximately 60,000m^3 of material (105,000m^3 with an over-dredge allowance of 0.5m). The dredge depth would be between approximately 0.5m to 1m, and up to 2.5m within the berth pocket extension area. The dredge depth in the Lady Shoal Approach channel would mostly be less than 1m and would generate approximately 160,000m^3 of material (385,000m^3 with an over-dredge allowance of 0.5m). The actual dredging works would take place within the dredge footprints within the dredge areas, as shown on **Figure 1-2** and **Figure 1-3**.

Total volume of dredged material would be approximately 220,000m^3 (490,000m^3 with an over-dredge allowance of 0.5m), from within the dredge footprints within the dredge areas. All dredging would be undertaken by back-hoe dredger, with the material being disposed of at the existing licenced Middle Bank disposal site (see **Figure 1-1**) using hopper barges. A summary of the proposed dredging can be seen in **Table 2-1**.

Table 2-1 Details of proposed dredge footprints

Dredge location	Approximate area within dredge footprint (m^2)	Volume (m^3) (without over-dredge allowance)	Volume (m^3) (with 0.5m over-dredge allowance)
Approach to DunEco Quay	46,810	24,000	45,750
Approach to PCW	34,150	19,000	35,700
PCW berth pocket	8,105	1,500	1,800
PCWE berth pocket	13,890	15,500	21,750
Lady Shoal approach channel	458,500	160,000	385,000
Total	**561,455**	**220,000**	**490,000**

2.1.2 Improvement works to the PCW

New piles would be installed along a 106m the sea facing front of the existing PCW to reinforce the quay structure, consisting of 48 main piles, infilled with sheet-piles (see **Figure 2-1** and **Figure 2-2** with new piles shown in red). Piling would undertaken using a combination of vibro- and impact-piling.

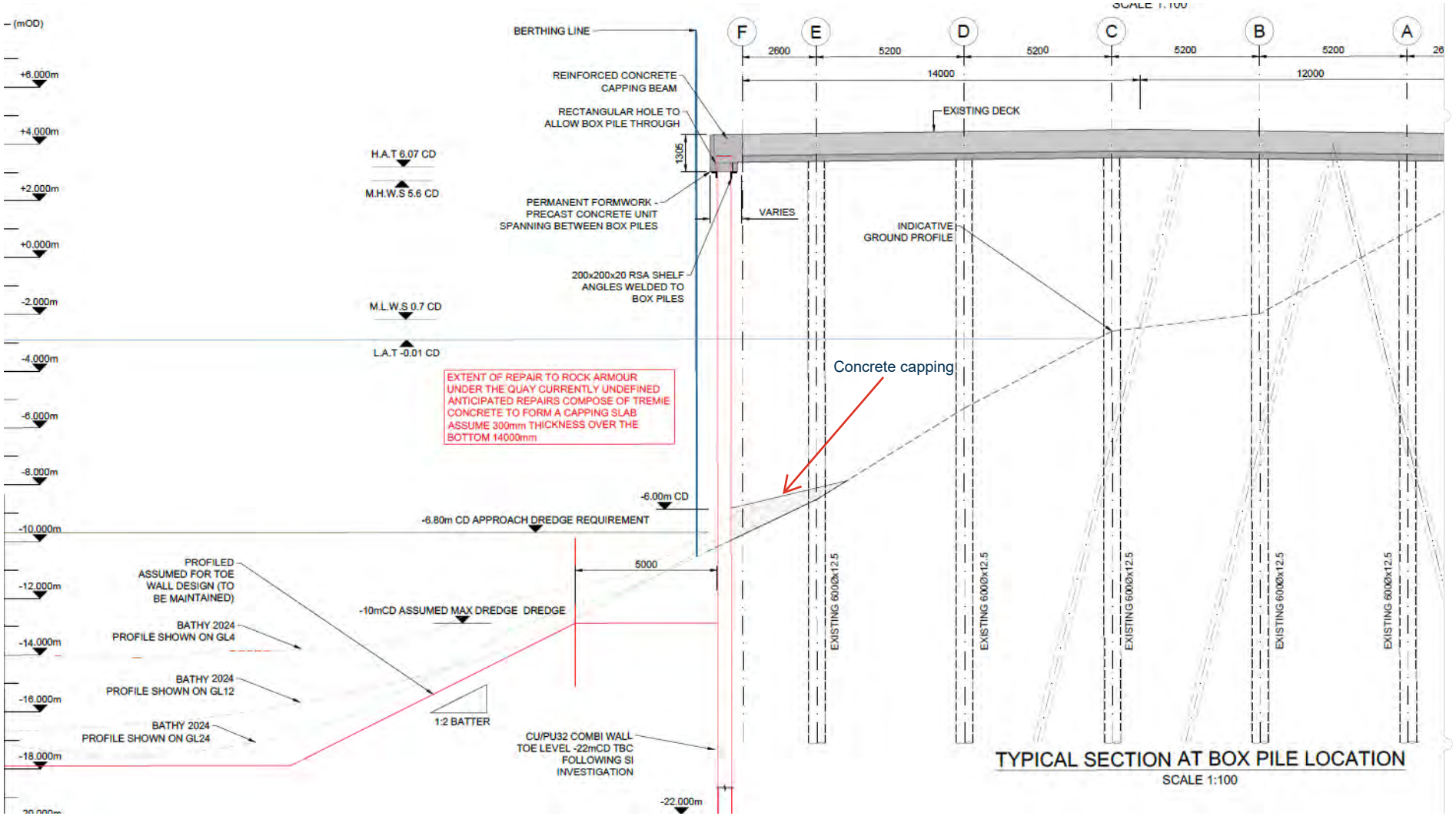


Figure 2-1 Typical cross section of the improvement works to the PCW (proposed new pile shown in red)

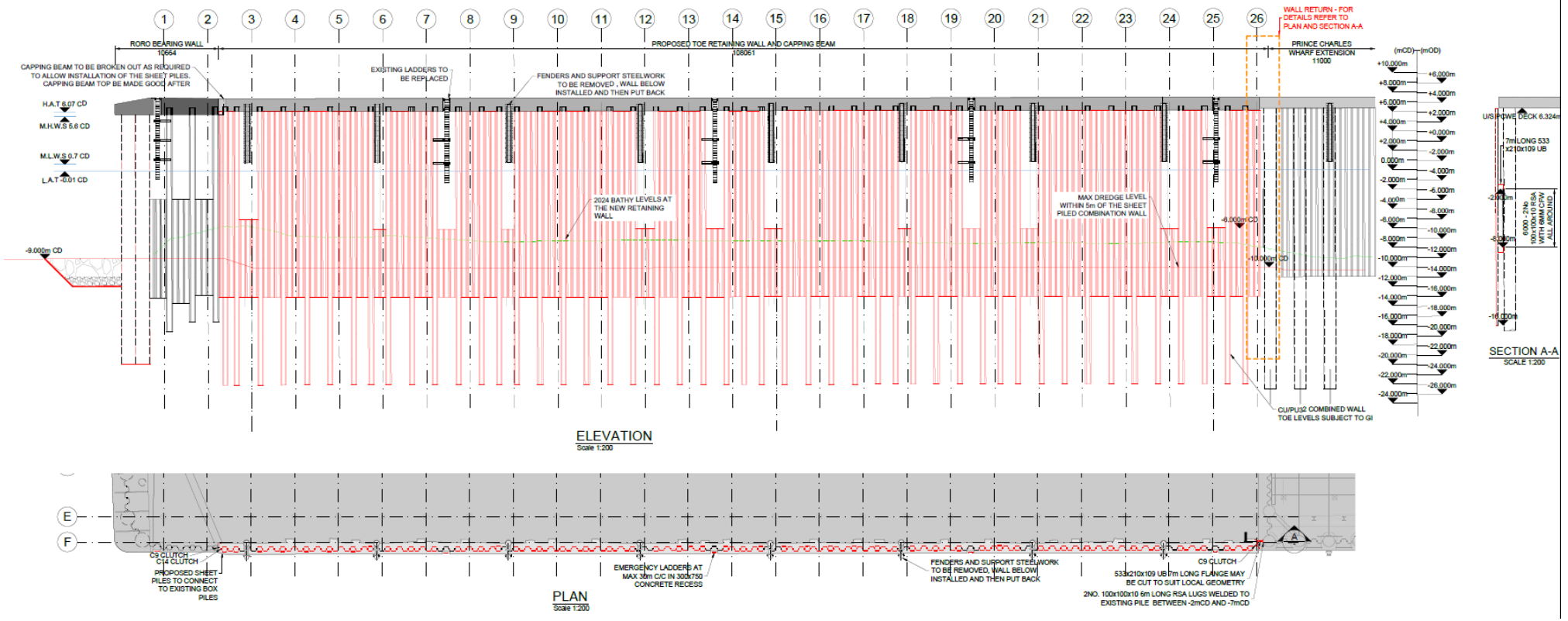


Figure 2-2 Improvement works to the PCW, elevation (top) and plan view (bottom) (proposed works are shown in red)

Localised excavation around the base of the existing quay wall may be required to remove any obstructions, using either land-based long reach excavators or dredging equipment, as appropriate, backfilling as required to maintain to a level in front of the wall of -10m CD. There is potential for concrete capping at the toe of the rock armour below the PCW where it meets the new wall of up to 300mm, which would not extend past the existing extent of rock armour (**Figure 2-1**).

A new beam will be installed at the head of the piles to facilitate the pile being tied into the existing PCW deck. Existing fenders would be cut off at existing pile locations, retained and welded back on following installation of wall. Existing ladders would be replaced (**Figure 2-2**).

2.1.3 Outline construction programme

The proposed improvement works to the PCW would take up to two months to complete, within which piling works would take approximately 35 days. The proposed dredging and disposal activities would take up to seven weeks to complete. The proposed works are planned to commence in December 2025.

2.2 Description of the Operational Phase

The Proposed Scheme would not change the number or type of vessels berthing at the Port of Dundee, rather it will ensure that the Port can continue to accommodate the vessels being used by the offshore renewables industry and components used in the construction of offshore wind farms. The Proposed Scheme would not result in any changes to the existing operations being carried out at the Port.

The proposed deepening works would not change the maintenance dredge requirement at the Port of Dundee, nor would dredging be required to maintain the deepened Lady Shoal approach channel dredge area (see Section 7.6.1.2 of Environmental Impact Assessment Report (EIAR) for further details).

In light of the above, with the exception of any changes to estuarine processes as a result of the Proposed Scheme there are no effects during the operational phase.

3 Habitats Regulations Appraisal

3.1 Legislation

The HRA process affords protection to those sites designated under the European Council Directive 2009/147/EC on the conservation of wild birds (the 'Birds Directive') and Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora (the 'Habitats Directive'). The UK also has to meet its obligations under relevant international agreements such as the Ramsar Convention. The UK exited the EU on 31 January 2020; however, the application of the HRA process remains largely unchanged due to the introduction of the EU Exit Regulations 2019.

3.2 International Legislation

3.2.1.1 EU Habitats Directive

The Habitats Directive provides a framework for the conservation and management of natural habitats, wild fauna (except birds) and flora in Europe. Its aim is to maintain or restore natural habitats and wild species at a favourable conservation status. The relevant provisions of the Directive are the identification and classification of SAC in Article 4, and procedures for the protection of SACs and SPAs in Article 6. SACs are identified based on the presence of natural habitat types listed in Annex I and populations of the species listed in Annex II. The Directive requires national Governments to establish SACs and to have in place mechanisms to protect and manage them.

3.2.1.2 EU Birds Directive

The Birds Directive provides a framework for the conservation and management of wild birds in Europe. The relevant provisions of the Birds Directive are the identification and classification of SPAs for rare or vulnerable species listed in Annex I of the Directive and for all regularly occurring migratory species (required by Article 4). The Directive requires national Governments to establish SPAs and to have in place mechanisms to protect and manage them. The SPA protection procedures originally set out in Article 4 of the Birds Directive have been replaced by the Article 6 provisions of the Habitats Directive.

3.2.1.3 Ramsar Convention

The Convention on Wetlands of International Importance especially as Waterfowl Habitat, as amended in 1982 and 1987 (the 'Ramsar Convention') is an international treaty for the conservation and sustainable use of wetlands of international importance. Ramsar site selection has had an emphasis on wetlands of importance to waterbirds, however non-bird features are increasingly taken into account, both in the selection of new sites and when reviewing existing sites. The UK government and the devolved administrations have issued policy statements relating to Ramsar sites which extend to them the same protection at a policy level as SACs and SPAs. Ramsar sites are therefore included in the HRA process.

3.2.2 Scottish HRA Legislation

3.2.2.1 Conservation (Natural Habitats, &c.) Regulations 1994

In Scotland, the Habitats Directive and Birds Directive is transposed into Scottish national legislation by the Conservation (Natural Habitats, &c.) Regulations 1994, as amended (hereafter the 'Habitats Regulations'). The Habitats Regulations place an obligation on a competent authority (for marine licensing matters, this refers to the Marine Directorate) to carry out an appropriate assessment of any proposal likely to affect a designated site. When undertaking appropriate assessment, the competent authority must seek advice from

NatureScot (as the appropriate nature conservation body) and cannot approve any application that would have an adverse effect on the integrity of a designated site unless certain conditions are met (i.e. that alternative solutions have been exhausted, that compensatory measures can be secured and that the proposal is necessary for imperative reasons of overriding public interest).

3.3 HRA Process

The HRA process helps meet the requirements of Article 6(3) of the Habitats Directive and Regulation 48(1) of the Habitats Regulations, which state that any plan or project, which is not directly connected with or necessary to the management of a designated site and is likely to have a significant effect on such a site (either alone or in combination with other plans or projects), will be subject to an appropriate assessment of its implications for the site in view of its conservation objectives.

In accordance with the Habitats Regulations, Appropriate Assessment is required for any plan or project, not connected with the management of a site within the NSN, which is likely to have a significant effect on the site, either alone, or in-combination with other plans and projects.

According to the Waddenzee judgement (Judgement of 7.9.2004 – Case C-127/02), an appropriate assessment is required if LSE cannot be excluded on the basis of objective information. The Sweetman Opinion (Opinion of Advocate General 22.10.2012 – Case C-258/11) states that the question is simply whether the plan or project concerned is capable of having an effect.

3.3.1 Stages of HRA

The HRA process (in its entirety) follows a staged approach, as detailed in NatureScot (then Scottish Natural Heritage; 'SNH') Natura Casework Guidance (SNH, 2014).

1. What is the plan or project: to establish whether there is sufficient information on the plan or project (location, extent, timings).

2. Is the plan or project directly connected with or necessary to site management for nature conservation: works which are clearly necessary to the management of the site, or that provide value to the site are not required to undertake further assessment.

3. Is the plan or project likely to have a significant effect: The process of identifying potentially relevant designated sites, and whether the Proposed Scheme is likely to have a significant effect on the qualifying features of the site, either alone or in-combination with other plans and projects. If it is concluded at this stage that there is no potential for LSE, there is no requirement to carry out subsequent stages of the HRA.

4. Undertake an Appropriate Assessment: Where an LSE for a designated site(s) cannot be ruled out, either alone or in-combination with other plans and projects, assessment of the potential effects on the integrity of the site(s), again either alone or in-combination with other plans and projects, in view of its qualifying features and conservation objectives is required. Where an adverse effect on integrity cannot be excluded, an assessment of mitigation options is carried out and mitigation measures (where available) are proposed to address the effects. If, after taking account of mitigation, an adverse effect on integrity cannot be excluded, the HRA must progress to Stages Three and Four.

5. Can it be ascertained that the plan or project will not adversely affect site integrity: the appropriate authority must decide if the plan or project in question will or will not adversely affect the integrity of the site(s).

6. Are there Alternative Solutions: Identifying and examining alternative ways of achieving the objectives of the project to establish whether there are solutions that would avoid or have a lesser effect on the site(s).

7. Would a priority habitat or species be adversely affected: priority habitats and species are afforded a greater level of protection under the Regulations, this stage determines whether Stage Eight or Stage Nine should be undertaken.

8. Are there Imperative Reasons of Overriding Public Interest (IROPI) (non-priority habitats and/or species): Where no alternative solution exists, the next stage of the process is to assess whether the development is necessary for IROPI and, if so, the identification of compensatory measures needed to maintain the overall coherence of the designated site network.

9. Are there IROPI (priority habitats and/or species): as above, for priority habitats and/or species, where there are exceptional health, safety, or environmental benefits, or other reasons for IROPI.

3.3.2 Types of designated sites included in HRA

The classes of designations considered by HRA are:

- Ramsar sites;
- SPAs and potential SPAs (pSPAs); and
- SACs, possible SACs (pSACs) and candidate SACs (cSACs).

4 Screening for LSE

4.1 Consultation with NatureScot

4.1.1 Early engagement with NatureScot

Initial contact was made with NatureScot via email on 12 September 2024, supported by a project briefing note which included an outline of the Proposed Scheme (as it was understood at the time, though it has now since evolved and no longer includes a rock mattress), and specifications of surveys proposed to be undertaken. This was followed by a meeting on 24 September 2024. Following the meeting, NatureScot provided comments on 15 October, as provided in **Appendix 4-1** and summarised below:

- potential impacts that should be considered on designated sites and their qualifying interests;
- confirmation and comments on the survey specifications as set out in the provided project briefing note for marine mammals, benthic habitats and ornithology, namely that in addition to those surveys proposed, an overwintering bird survey should be undertaken to include the marine area in front of the Port of Dundee. Suggested methodology for bird surveys were included in these comments and was used to undertake overwintering bird surveys between October 2024 and April 2025;
- comments to be considered in the specification for the benthic ecology survey; and
- details of whether maintenance dredging of the Lady Shoal approach channel would be required to be provided.

4.1.2 HRA Screening Report

A HRA Screening Report (**Appendix 4-2**) was issued to NatureScot for comment in January 2025, presenting Stage One of the HRA process and the proposed approach to providing the required information to inform an Appropriate Assessment. NatureScot's comments were received on 27 February 2025 as provided in **Appendix 4-3** and summarised below:

- **Outer Firth of Forth and St Andrews Bay Complex (OFFSABC) SPA** – NatureScot advised that potential impacts to the breeding seabird assemblage of the OFFSABC SPA should be screened in on the basis of herring gull and guillemot recorded in baseline surveys. NatureScot provisionally agreed with the other species screened in/out for the OFFSABC SPA; however, that this should be verified against the additional survey requested previously. NatureScot agreed with the approach to the in-combination screening assessment. NatureScot advised that the impact pathways considered were relevant; however, that clarity is required as to potential impacts from the storage and assembly of offshore wind turbines. Further clarity on whether maintenance dredging will be required in the Lady Shoal approach channel is also required.
- **Firth of Tay and Eden Estuary SPA** – NatureScot provisionally agreed with the species screened in/out of the appropriate assessment for the Firth of Tay and Eden Estuary SPA; however, this should be verified against the additional survey requested previously. Comments on potential impact pathways from the storage and assembly of offshore wind turbines and potential impacts during the operational phase for the OFFSABC SPA also apply to the Firth of Tay and Eden Estuary SPA.
- **River Tay SAC** – NatureScot agreed with the screening in of Atlantic salmon, river and sea lamprey. NatureScot disagreed with the screening out of otter and advised that an otter survey should be carried out.
- **Firth of Tay and Eden Estuary SAC** – NatureScot agreed with the impact pathways identified; however, disagreed with the conclusion of no LSE on mudflats and sandflats not covered at low tide.
- **Moray Firth SAC** – NatureScot agreed with screening in bottlenose dolphin.

- **Isle of May SAC and Berwickshire & North Northumberland Coast SAC** – NatureScot agreed with screening out these designated sites.

4.2 Changes to the Proposed Scheme since Screening for LSE

The HRA Screening Report that was issued to NatureScot was based on a previous iteration of the Proposed Scheme, which included extending the laydown area at the port and further landside improvements to the PCW. The previous iteration of the Proposed Scheme was determined to not be EIA development under the Town and Country Planning (EIA) (Scotland) Regulations 2017 (as amended) (see Section 1.2 of the EIAR for further details). Furthermore, a sHRA undertaken on the landside elements confirmed that they would not result in an adverse effect on the integrity on relevant European or Ramsar sites.

As such, the landside elements, i.e. the extension to the laydown area and landside improvements to the PCW, could be carried out under the Port of Dundee Limited's Permitted Development Rights and have therefore been progressed separately. Any in-combination effects with the landside works and the Proposed Scheme have been considered as part of the in-combination assessments presented in this report.

Since the HRA Screening Report was submitted, it has been confirmed that the proposed deepening works would not change the maintenance dredge requirement at the Port of Dundee, nor would dredging be required to maintain the deepened Lady Shoal approach channel dredge area (see Section 7.6.1.2 of EIAR for further details).

4.3 Further information to inform Screening for LSE

Since the production of the HRA Screening Report, the following information became available and used to inform Screening for LSE:

- 2024/2025 overwintering bird survey at the Port of Dundee;
- Otter survey undertaken between March and May 2025;
- Underwater noise modelling of the proposed piling and dredging works;
- British Trust for Ornithology (BTO) Wetland Bird Survey (WeBS) data[1]; and
- eBird data[2].

Given the changes to the Proposed Scheme, availability of additional information, and NatureScot's comments on the HRA Screening Report, a further screening for LSE has been undertaken on the following:

- the direct impact of underwater noise on marine mammals (bottlenose dolphin (Moray Firth SAC) and harbour seal (Firth of Tay and Eden Estuary SAC)) (**Section 4.4**);
- potential impacts of the Proposed Scheme on ornithology (SPAs and Ramsar sites) (**Section 4.6**); and
- potential impacts of the Proposed Scheme on otter (River Tay SAC) (**Section 4.7**).

[1] *Waterbirds in the UK 2023/24: The Wetland Bird Survey and Goose & Swan Monitoring Programme. BTO/RSPB/JNCC/NatureScot. Thetford. app.bto.org/webs-reporting/ Contains WeBS data from Waterbirds in the UK 2023/24© copyright and database right 2025. WeBS is a partnership jointly funded by the BTO, RSPB and JNCC, with fieldwork conducted by volunteers.*

[2] *eBird (Cornell Lab of Ornithology, Ithaca NY, USA) <https://ebird.org>*

4.4 Revised Screening for LSE: Direct impact of underwater noise on marine mammals

Underwater noise modelling (see **Appendix 4-4**) was undertaken on following construction activities of relevance to the Proposed Scheme:

- Impact piling;
- Vibro piling; and
- Dredging.

Impact piling has long been established as a source of high-level underwater impulsive noise (Nedwell *et al*., 2003; 2007; Thomsen *et al*., 2006). If a marine mammal is in very close proximity to the piling, the high peak pressure sound levels have the potential to cause physical injury, with a severe injury having the potential to lead to death. High exposure levels from underwater noise sources (such as impact piling) can cause auditory injury or hearing impairment, through permanent loss of hearing sensitivity, or Permanent Threshold Shift (PTS) or from a temporary loss in hearing sensitivity, or Temporary Threshold Shift (TTS). The potential for auditory injury is not just related to the level of the underwater sound and its frequency relative to the hearing bandwidth of the animal but is also influenced by the duration of exposure. The level of impact on an individual is related to the Sound Exposure Level (SEL) that an individual receives.

PTS can occur instantaneously from acute exposure to high noise levels, such as single strike (SEL_{ss}) of the maximum hammer energy during piling. PTS can also occur as a result of prolonged exposure to increased noise levels, such as during the duration of pile installation (SEL_{cum}), or on reoccurrences of TTS.

All species of cetaceans rely on sonar for navigation, finding prey and communication; they are therefore highly sensitive to permanent hearing damage (Southall *et al*., 2007). Pinnipeds use sound both in air and water for social and reproductive interactions (Southall *et al*., 2007), but not for finding prey. Therefore, Thompson *et al*. (2012) suggest damage to hearing in pinnipeds may not be as sensitive as it could be in cetaceans. The effect would be permanent and marine mammals within the potential impact area are considered to have very limited capacity to avoid such effects, and unable to recover. Underwater noise has the potential to impact cetaceans if the sound levels are greater than thresholds for the species (Southall *et al*., 2019) as presented in **Table 4-1**.

Table 4-1 Cetacean threshold and criteria for underwater noise (from Southall et al., 2019)

Species Hearing Group	Unweighted SPL_{peak} (dB re 1 µPa)		Weighted SEL_{cum} (dB re 1 µPa2s)			
	Impulsive		Impulsive		Non-impulsive	
	PTS	TTS	PTS	TTS	PTS	TTS
Dolphin species High-frequency cetaceans	230	224	185	170	198	178
Seal species phocids in water	218	212	185	170	201	181

4.4.1 Potential for PTS onset during impact piling

The underwater noise modelling results for the potential for PTS in bottlenose dolphin and harbour seal are presented in **Table 4-2**, which identifies that it is unlikely that impulsive noise would exceed the PTS threshold for these species at any range from the piling activities.

Table 4-2 Impact ranges and areas for the risk of PTS from impact piling

Potential impact	Receptor	Impact range	Impact area
PTS without mitigation – Impact Piling	Bottlenose dolphin	No Exceedance	No Exceedance
	Harbour seal	No Exceedance	No Exceedance

4.4.2 Potential for TTS onset during impact piling

The underwater noise modelling results for the potential for TTS in bottlenose dolphin and harbour seal are presented in **Table 4-3**, and which identifies that it is unlikely that impulsive noise would exceed the TTS threshold for these species at any range from the piling activities.

Table 4-3 Impact ranges and areas for the risk of TTS from impact piling

Potential impact	Receptor	Impact range	Impact area
TTS without mitigation – Impact Piling	Bottlenose dolphin	No Exceedance	No Exceedance
	Harbour seal	No Exceedance	No Exceedance

4.4.3 Potential for PTS onset during dredging activities

The underwater noise modelling results for non-impulsive criteria have shown that it is unlikely that dredging activities would exceed the PTS threshold at any range for bottlenose dolphin and harbour seal.

4.4.4 Screening for LSE

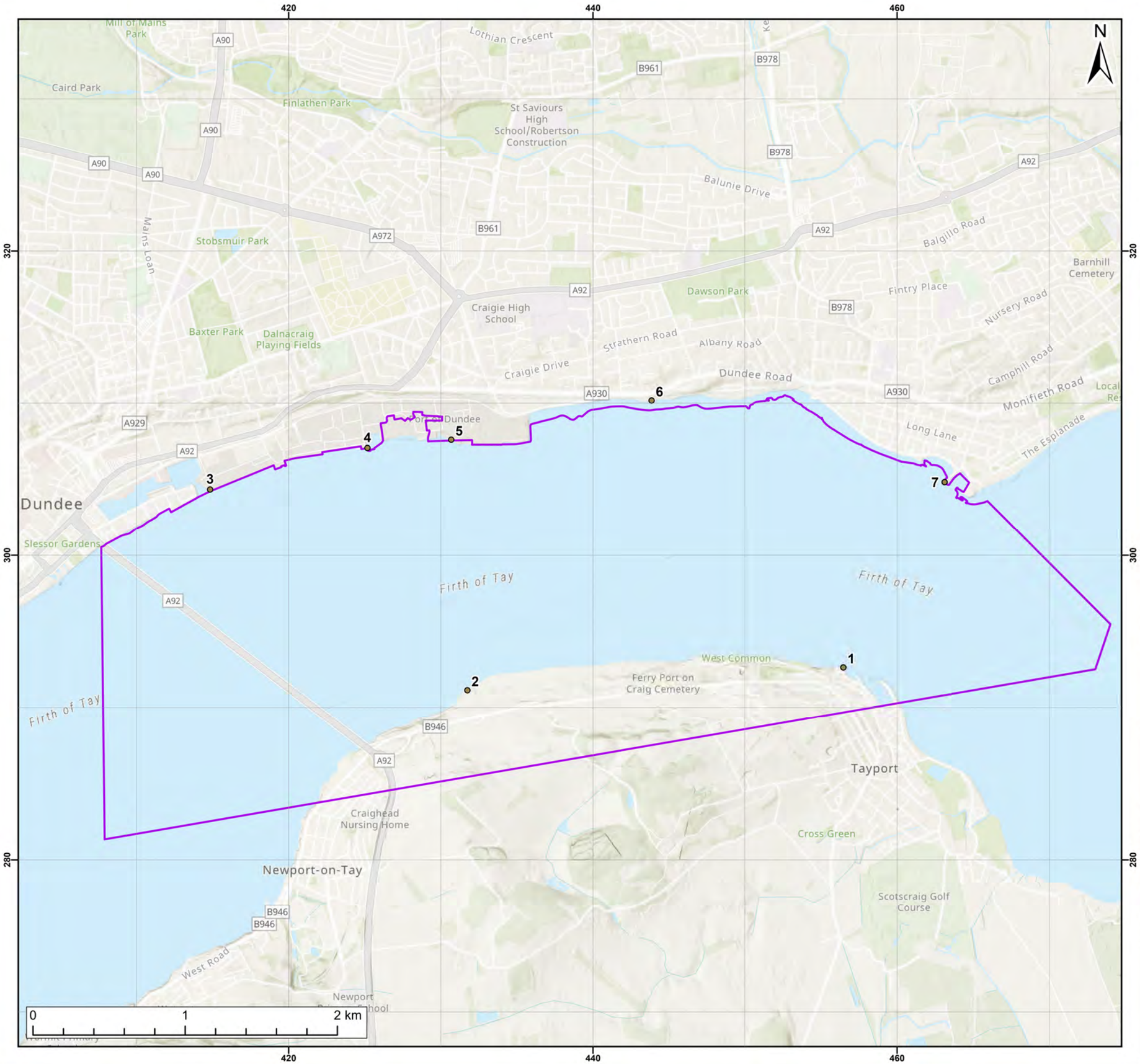
Based on the above, it is considered that there is no potential for LSE as a result of physiological effects to bottlenose dolphin (Moray Firth SAC) and harbour seal (Firth of Tay and Eden Estuary SAC) from the proposed piling and dredging activities. As such this impact has been screened out of the HRA.

4.5 Revised Screening for LSE: Potential impacts of the of the Proposed Scheme on ornithology

4.5.1 Ornithology Survey (2024/25) Results

The overwintering bird survey was carried out between October 2024 and April 2025, inclusive, with the survey area shown in **Figure 4-1**. The survey area included an area of the Port, extending approximately 2km upstream and downstream, and across the Firth of Tay. The area was defined using points on both banks of the Tay, ensuring consistent boundaries for recording bird activity. The eastward extent was marked from Craighead to Discovery Point, and the westward extent from Broughty Ferry piers to Pile lighthouse.

Survey visits were conducted once per month, with counts timed to coincide with low tide at dawn or dusk. This timing was chosen because geese are most likely to use the site for roosting when there is exposed sand or mud. Two 3-hour watches per month were conducted from two vantage points, scheduled on the same day with a half-hour break in between. A total of 42 hours of observations were completed from October to April.



Legend:

- Survey Area
- Vantage Point

Client:	Project:
Port of Dundee Limited	Port of Dundee Capital Dredge and Quay Improvement Works

Title:

Survey Area for Overwintering Birds 2024/2025

Figure:	Drawing No:
4-1	PC6550-RHD-XX-XX-D-EV-0059

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
01	03/07/2025	JH	RG	A3	1:25,000

Co-ordinate system: British National Grid

Haskoning
Enhancing Society Together

During the survey visits, 11 species of relevance to surrounding SPAs and Ramsar site were recorded (**Table 4-4**). Of these species, black-headed gull and herring gull were the most abundant, with peak counts of 70 and 25, respectively; both were observed flying, roosting and loafing in the survey area.

Table 4-4 Overwintering bird survey results 2024 / 2025

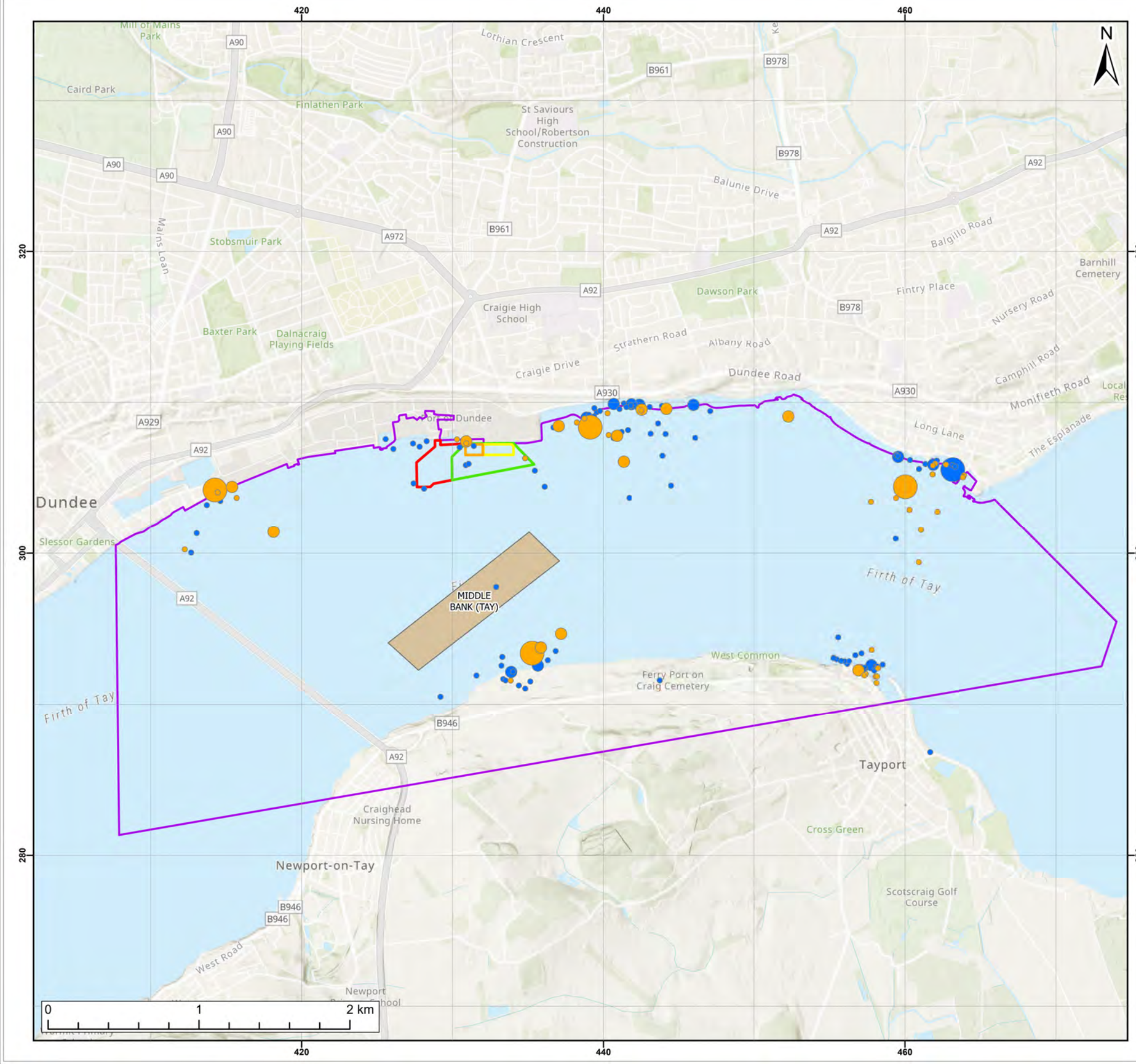
Species	Location	Activity	Peak Number Observed
Black-headed gull	1km east of the Proposed Development	Flying, foraging	70
Cormorant	Survey area, shoreline to the boundary of the Proposed Development, 1km east	Roosting, foraging	4
Herring gull	Survey area, shoreline to the west of PCW	Flying, roosting, loafing	25
Common gull	East and southeast of the Proposed Development, estuary between Tayport and Broughty Ferry Salt Dog Marine	Roosting, in flight	5
Eider	1km east of the Proposed Development, Tayport, Broughty Ferry	Roosting, foraging	7
Great black-backed gull	Broughty Ferry Salt Dog Marine	Roosting	3
Guillemot	East of the Proposed Development, estuary between Tayport and Broughty Ferry Salt Dog Marine	Foraging	7
Oystercatcher	1km west and east of the Proposed Development	Roosting, foraging	20
Redshank	Proposed Development, Tayport	Roosting	3
Red-breasted merganser	Shoreline 1km east of the Proposed Development	Foraging	3

The distribution of all birds recorded during the survey can be seen in **Figure 4-2**, species specific distribution maps can be found in **Appendix 4-4**.

4.5.2 Desk-based study for Lady Shoal approach channel dredge area

eBird is a biodiversity science project in which bird sightings are contributed by users while birding recreationally worldwide. eBird is managed by the Cornell Lab of Ornithology. eBird data documents bird distribution, abundance, habitat use, and trends through checklist data collected within a simple, scientific framework[3]. eBird data from 2015 – June 2025 from the eBird 'Hotspots' Broughty Ferry Mudflats and Tayport Promenade combined, were used to inform the desk study. These locations are the nearest eBird locations to the Lady Shoal Approach Channel dredge area. Whilst they are land-based sites, largely overlooking the nearshore marine waters and tidal flats, they provide an indication of the birds that would be present. Occurrence and count data from all types of checklist visit methodology (Complete Checklist (reporting all species identified), Incomplete List (select subset of species according to notability, etc.), Historical, Incidental) were considered.

[3] *eBird (Cornell Lab of Ornithology, Ithaca NY, USA) <https://ebird.org>*



Legend:

- Survey Area
- Quay Improvement Works
- DunEco Quay Approach Channel Dredge Area
- Prince Charles Wharf Approach Channel Dredge Area
- Proposed Extension to PCW Berth Pocket
- Existing PCW Berth Pocket
- Disposal Site

Loafing Bird
- 1-5
- 6-20
- 21-70

Foraging Bird
- 1-5
- 6-20
- 21-70

Client:	Project:
Port of Dundee Limited	Port of Dundee Capital Dredge and Quay Improvement Works

Title:

Distribution map of all birds recorded during overwintering bird survey, October 2024 - April 2025

Figure: 4-2	Drawing No: PC6550-RHD-XX-XX-D-EV-0060

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
01	03/07/2025	JH	RG	A3	1:25,000

Co-ordinate system: British National Grid

Haskoning
Enhancing Society Together

The data, as presented in eBird's Bar Charts feature, illustrated each species' reporting rate as a percentage of Complete Checklists submitted for each of 48 approximate 'weeks' (quarter-months) in the calendar year, here aggregated for period 2015 to June 2025. The mean number of Complete Checklists underlying the data for each of the 48 weeks was 3.0, with only four weeks with zero Complete Checklists, and a maximum weekly sample size of nine. The Line Graphs feature was used to access the weekly High Count data throughout the calendar year for each species. This illustrated further occurrences of the species (e.g. as captured in Incidental observations) and seasonal variation in their abundance.

Population data for estuarine birds is collected on an on-going basis by the BTO Wetland Bird Survey[4] (WeBS). The WeBS scheme monitors the numbers and distribution of non-breeding waterbirds (ducks, swans, geese, grebes, divers, waders, herons, rails, cormorants, gulls and terns) in the UK. Reference populations have been developed based on the citation SPA population of each species (qualifying feature or named assemblage component). WeBS five-year average data (the mean of the validated annual peak counts of each species in the five 'WeBS years' (July to following June) 2019/20 to 2023/24) for the Tay Estuary (which covers Newburgh to the opening of the Firth into St Andrews Bay (**Figure 4-3**)) from the WeBS Online Report was used as the reference population for non-named SPA waterbird assemblage species where there is no SPA citation population given.

For Arctic tern and common tern, there is no cited populations in the SPAs being screened, however the OFFSABC SPA is considered to support foraging individuals from the Forth Islands SPA breeding population, therefore, this SPA population has been used a reference population for these species.

The desk-based baseline marine ornithology assessment for the area surrounding the Lady Shoal Approach Channel is summarised in **Table 4-5**.

Figure 4-3 WeBS count area for the Tay Estuary (Location Code: 85971)

[4] *Waterbirds in the UK 2023/24: The Wetland Bird Survey and Goose & Swan Monitoring Programme. BTO/RSPB/JNCC/NatureScot. Thetford. app.bto.org/webs-reporting/ Contains Wetland Bird Survey (WeBS) data from Waterbirds in the UK 2023/24 © copyright and database right 2025. WeBS is a partnership jointly funded by the BTO, RSPB and JNCC, with fieldwork conducted by volunteers.*

Table 4-5 Baseline marine ornithology (SPA feature and assemblage species) in the Tay Estuary

Species	Seasonal (/Monthly) Occurrence (eBird Broughty Ferry Mudflats, Tayport Promenade data, 2015-25)	SPA or Reference Population	Individuals recorded as % of SPA or Ref Population (%)
Firth of Tay and Eden Estuary SPA (UK9004121) and Ramsar site (UK13018)			
Bar-tailed godwit	This species only uses intertidal or terrestrial habitats and has no potential to occur in the Lady Shoal dredge area.	-	-
Little tern	The species was not recorded.	-	-
Marsh harrier	The species was not recorded.	-	-
Redshank	This species only uses intertidal or terrestrial habitats and has no potential to occur in the Lady Shoal dredge area.	-	-
Greylag goose	Three eBird records in past ten years in August to December, with a high count of two.	1,200 individuals	<1
Pink-footed goose	This species largely uses terrestrial habitats and has no potential to occur in the Lady Shoal dredge area.	-	-
Velvet scoter	Two eBird records in past ten years, in July and December with a high count of 30.	730 individuals	4
Cormorant	Recorded all year round (weekly high counts typically 5 to 30 individuals).	230 individuals	12
Shelduck	Recorded all year round, with highest counts (10-30 individuals) mainly from February to June.	1,200 individuals	3
Eider	Recorded all year round, up to 2,000 individuals recorded (especially between November and April but also in June and August possibly due to migratory passage).	13,800 individuals	10
Common scoter	The species was not recorded.	-	-
Black-tailed godwit	This species only uses intertidal or terrestrial habitats and has no potential to occur in the Lady Shoal dredge area.	-	-
Goldeneye	Recorded in small numbers (fewer than 15 individuals) November to March.	230 individuals	7
Red-breasted merganser	Recorded from July to March (weekly high counts of 10 to 100 individuals).	470 individuals	25
Goosander	Recorded March to December (with peak in abundance in June to August – 40 to 200 individuals).	220 individuals	90
Oystercatcher	This species only uses intertidal or terrestrial habitats and has no potential to occur in the Lady Shoal dredge area.	-	-
Grey plover	This species only uses intertidal or terrestrial habitats and has no potential to occur in the Lady Shoal dredge area.	-	-
Sanderling	This species only uses intertidal or terrestrial habitats and has no potential to occur in the Lady Shoal dredge area.	-	-

Species	Seasonal (/Monthly) Occurrence (eBird Broughty Ferry Mudflats, Tayport Promenade data, 2015-25)	SPA or Reference Population	Individuals recorded as % of SPA or Ref Population (%)
Dunlin	This species only uses intertidal or terrestrial habitats and has no potential to occur in the Lady Shoal dredge area.	-	-
Long-tailed duck	Scarce, one eBird record in past ten years, in December.	560 individuals	<1
Red-necked grebe[1]	Scarce, one eBird record in past ten years, in September.	BTO WeBS Tay Estuary mean peak count 2019/20 to 2023/24: 0	n/a
Great crested grebe[1]	Recorded infrequently from January to March (1 to 2 individuals).	BTO WeBS Tay Estuary mean peak count 2019/20 to 2023/24: 1	n/a
Black-throated diver[1]	Scarce, four eBird records in past ten years, in November to March.	BTO WeBS Tay Estuary mean peak count 2019/20 to 2023/24: 0	n/a
Great northern diver[1]	Scarce, one eBird record in past ten years, in March.	BTO WeBS Tay Estuary mean peak count 2019/20 to 2023/24: 0	n/a
OFFSABC SPA (UK9020316)			
Red-throated diver	Scarce, two eBird records in past ten years, in October and December.	851 individuals	<1
Slavonian grebe	The species was not recorded.	-	-
Little gull	Recorded infrequently or sporadically from January to August (1 to 10 individuals).	126 individuals	8
Common tern	Recorded infrequently June to September in small numbers (3 to 5 individuals).	334 pairs (based on Forth Islands SPA breeding population)	<1
Arctic tern	Three eBird records in past ten years, in May to August with a high count of three.	540 pairs (based on Forth Islands SPA breeding population)	<1
Eider	Recorded all year round, with up to 2,000 individuals recorded (especially between November and April but also in June and August possibly due to migratory passage).	21,546 individuals	10
Shag	Recorded infrequently in small numbers (typically fewer than 10 individuals) from August to April.	2,426 individuals	<1
Gannet	Four eBird records in past ten years, from July to October with a high count of four.	10,945 individuals	<1
Long-tailed duck	One eBird record in past ten years, in December, with a high count of four.	1,948 individuals	<1
Common scoter	The species was not recorded.	-	-
Velvet scoter	Two eBird records in past ten years, in July and December with a high count of 30.	775 individuals	3

Species	Seasonal (/Monthly) Occurrence (eBird Broughty Ferry Mudflats, Tayport Promenade data, 2015-25)	SPA or Reference Population	Individuals recorded as % of SPA or Ref Population (%)
Goldeneye	Recorded in small numbers (fewer than 15 individuals) November to March.	589 individuals	3
Red-breasted merganser	Recorded from July to March (weekly high counts of 10 to 100 individuals).	431 individuals	25
Black-headed gull	Recorded all year round, with peak abundance (100 to 1,000 individuals) from July to February.	26,835 individuals	4
Common gull	Recorded all year round (typically 10 to 100 individuals).	14,647 individuals	<1
Herring gull	Recorded all year round (weekly high counts typically 100 to 400 individuals).	3,044 individuals (breeding) 12,313 (non-breeding)	4
Guillemot	Recorded from July to March in small numbers (typically fewer than 10 individuals).	28,123 individuals	<1
Kittiwake	One eBird record in past ten years, in July with a high count of one.	12,020 individuals (breeding 3,191 (non-breeding)	<1
Razorbill	Recorded infrequently from August to March in small numbers (typically fewer than five individuals).	5,481 individuals	<1
Puffin	The species was not recorded.	-	-
Manx shearwater	The species was not recorded.	-	-
Notes – 1. Species is not a named assemblage component but is a species vulnerable to disturbance and displacement by vessel traffic			

4.5.3 Results of Screening the proposed works at the Port of Dundee

The results of the HRA screening for LSE alone of the proposed works at the Port of Dundee on the Firth of Tay and Eden Estuary SPA and Ramsar site and OFFSABC SPA are presented in **Table 4-6** and **Table 4-6** respectively.

Table 4-6 Results of HRA screening alone of the proposed works at the Port of Dundee on the Firth of Tay and Eden Estuary SPA and Ramsar site

Qualifying features	LSE (yes/no)	Justification
Bar-tailed godwit	No	The species was not recorded during either the 2023/2024 or 2024/2025 surveys.
Little tern	No	The species was not recorded during either the 2023/2024 or 2024/2025 surveys.
Marsh harrier	No	The species was not recorded during either the 2023/2024 or 2024/2025 surveys.
Redshank	No	Redshank were only observed flying over the survey area (2024/25 survey).
Greylag goose	No	Greylag geese were only observed flying high over the survey area in September 2023; none were record during the 2024/25 survey.
Pink-footed goose	No	Pink-footed geese were only observed flying high over the survey area in December 2023; none were recorded during the 2024/25 survey.

Qualifying features	LSE (yes/no)	Justification
Non-breeding waterfowl assemblage	No	No component species of the qualifying assemblage was present in numbers representing more than 1% of the SPA population therefore it can be considered the site is not of value to these species.

Table 4-7 Results of HRA screening alone of the proposed works at the Port of Dundee on the OFFSABC SPA

Qualifying features	LSE (yes/no)	Justification
Arctic Tern	No	The species was not recorded during the surveys.
Common tern	No	The species was not recorded during the surveys.
Eider	No	A peak of seven eider were recorded during the 2024/25 survey, which represents 0.03% of the SPA population of 21,546). Given this is less than 1% of the cited population, no LSE has been concluded.
Gannet	No	The species was not recorded during the surveys.
Little Gull	No	The species was not recorded during the surveys.
Red-throated diver	No	A peak of two red-throated diver was recorded during the 2023/24 survey, which represents 0.002% of the SPA population of 851). Given this is less than 1% of the cited population, no LSE has been concluded.
Shag (breeding)	No	The species was not recorded within the survey area in the breeding season.
Slavonian grebe	No	The species was not recorded during the surveys.
Waterfowl assemblage	No	No component specie of the qualifying assemblage was present in numbers representing more than 1% of the SPA population.
Seabird assemblage, breeding	No	No assemblage species were recorded in breeding season during the surveys.
Seabird assemblage, non-breeding	No	No component species of the qualifying assemblage was present in numbers representing more than 1% of the SPA population.

4.5.4 Results of screening the deepening of the Lady Shoal approach channel

The results of the HRA screening for LSE alone of the proposed deepening of the Lady Shoal approach channel on the Firth of Tay and Eden Estuary SPA and Ramsar site and OFFSABC SPA are presented in **Table 4-8** and **Table 4-9** respectively.

Table 4-8 Results of HRA screening alone of the proposed deepening of the Lady Shoal approach channel on the Firth of Tay and Eden Estuary SPA and Ramsar site

Qualifying features	LSE (yes/no)	Justification
Bar-tailed godwit Redshank Pink-footed goose	No	The species only uses intertidal or terrestrial habitats so has no potential to occur in the Lady Shoal dredge area.
Little tern Marsh harrier	No	The species was not recorded.
Greylag goose	No	The species was scarcely recorded (<1% of the reference population).
Non-breeding waterfowl assemblage	No	Some component species were recorded in numbers of more than 1% of their respective SPA population. Pre-application advice received from NatureScot on the 15th of October 2024 (**Appendix 4-1**) acknowledged that the Lady Shoal area is a very busy channel for vessels (1,928 vessel movements in 2023), and the additional presence of three vessels would be temporary (up to seven weeks). Any individuals utilising the

Qualifying features	LSE (yes/no)	Justification
		area can be assumed to be acclimated to vessel presence. Potential impacts on benthic habitats, and fish and shellfish (prey resource) are presented in Chapters 9 and 10 of the accompanying EIAR, respectively, and concluded no significant impacts; therefore, there would be no LSE on this feature.

Table 4-9 Results of HRA screening alone of the proposed deepening of the Lady Shoal approach channel on the OFFSABC SPA

Qualifying features	LSE (yes/no)	Justification
Arctic Tern Common tern Eider Little Gull Shag (breeding) Waterfowl assemblage Seabird assemblage, breeding Seabird assemblage, non-breeding	No	Some component species recorded in numbers of more than 1% of their respective SPA population. Pre-application advice received from NatureScot on the 15th of October 2024 (**Appendix 4-1**) acknowledged that the Lady Shoal area is a very busy channel for vessels (1,928 vessel movements in 2023), and the additional presence of three vessels would be temporary (up to seven weeks). Any individuals utilising the area can be assumed to be acclimated to vessel presence. Potential impacts on benthic habitats, and fish and shellfish (prey resource) are presented in Chapters 9 and 10 of the accompanying EIAR, respectively, and concluded no significant impacts; therefore, there would be no LSE on this feature.
Gannet Red-throated diver	No	The species was scarcely recorded (<1% of the reference population).
Slavonian grebe	No	The species was not recorded.

4.5.4.1 LSE Screening for in-combination effects

As no LSEs have been identified to qualifying features of the Firth of Tay and Eden Estuary SPA and Ramsar site nor the OFFSABC SPA, there can be no in-combination LSEs with any other plans or projects.

4.6 Screening for LSE: River Tay SAC - Otter

In response to NatureScot's comment on the HRA Screening Report (see **Section 4.2**) regarding the potential for LSE on otter as a feature of the River Tay SAC, an otter survey was undertaken at the Port of Dundee on 31st March 2025. During the survey, four potential otter resting sites (RS 1-4) were identified (**Figure 4-4**). To determine the activity status of these sites, camera monitoring was subsequently carried out between 7th April and 5th May 2025.

4.6.1 Methodology

4.6.1.1 Field Survey

All areas of suitable otter habitat within the 200m Study Area were surveyed (**Figure 4-4**). A comprehensive search for characteristic signs of the presence of otters (including resting sites, spraint, footprints and slides) was made.

Resting sites were categorised as either 'holts' or 'couches'. The term holt is applied to an otter resting site which is located within an enclosed cavity, where the back of the structure cannot be seen and the presence of an animal at the time of the survey cannot be ruled out. Couches are features that can be viewed fully, are usually above ground features where otters can lie up or groom, often within long grass, reeds etc.; however, for the purposes of this report, couch has also been used for above ground resting sites within rock armour for example.

342500 343000 343500

N

RS3

RS4

0 0.25 0.5 km

Legend:

- Potential Holt
- Couch / Potential Holt
- Proposed Scheme Area
- 200m Study area
- No access

Client:	Project:
Port of Dundee Limited	Port of Dundee Capital Dredge and Quay Improvement Works

Title:

Otter Study Area and Results

Figure: 4-4 | DrawingNo: PC6550-RHD-XX-XX-D-EV-0051

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
P01	05/06/2025	JH	RG	A3	1:5,000

Co-ordinate system: British National Grid

Haskoning
Enhancing Society Together

Where a potential resting site was found, presence of supporting field sign had to be present in association with the feature in order to suggest it was being used by otters for shelter. This was particularly pertinent for this site due to the main resting site habitat being long sections of rubble piles and rock armour creating a labyrinth of holes and crevices that may harbour resting sites. In order to narrow this down, professional judgement was used where spraint was present in the locality of suitable entrances together with pathways to them, although the latter was often absent due to the nature of the habitat; therefore, all resting sites have been labelled 'potential' and camera monitoring of the features has been completed to confirm resting sites' status (see **Sections 4.7.1.2** and **4.7.2.3**).

4.6.1.2 Camera Monitoring

Camera monitoring was undertaken at four potential resting sites (RS1 – RS4) identified during the initial survey for a period of 28 days which was considered a sufficient time period in order to confirm the activity status. The cameras were installed on the 7th April and uplifted on the 5th May with an interim visit on the 18th April to check the cameras, change SD cards and batteries.

The results confirmed RS3 as a non-breeding holt, with a single otter observed resting diurnally at the location. Several additional single otter passes were also documented throughout the monitoring timeframe. Since this survey was undertaken, the boundary of the laydown area has been moved to be sited more than 30m from RS3.

4.6.2 Results

4.6.2.1 Habitats

The initial field survey was undertaken on the 31st March 2025 during warm, sunny weather conditions and with no rainfall in the days leading up to the survey.

Areas of suitable resting site habitat within the Study Area comprised the shoreline of the River Tay alongside the port where the banks consisted of rubble piles / rock armour above the high tide line, particularly where set into neighbouring earth banks and scrub. This was mainly along the bank of the River Tay adjacent to the western development area and the bank in the eastern region of the Study Area. The River Tay itself offers a good foraging and commuting resource.

The remaining areas along the shoreline within the Study Area were considered unsuitable for otters, being quayside or dock areas built from vertical sections of sheet piling or concrete, straight into the water, with no ledges or features suitable for use as resting sites. Some areas of the sheet piling had degraded with holes and cavities but were wet and silty and flooded at high tide. In addition, such areas were busy with port activities such as boat traffic creating disturbance and the water quality appeared to be poor and turbid.

No suitable otter habitat was considered to be present outwith the shoreline within the Study Area with most areas being hardstanding, some brownfield areas with demolished buildings, storage areas and the operational port. The A930 main road and railway passes through the northern section of the Study Area. No further watercourses or waterbodies were noted within the Study Area or surrounding areas. The nearest marked watercourse on the OS map for the area was the Dighty Burn at Broughty Ferry, a tributary of the River Tay approximately 8km to the east of the Site. A burn and small waterbody west of the airfield was noted on the OS map around 8km to the west of the site along the coast. All areas to the north were Dundee City and heavily built up.

Freshwater is essential to coastal otters to wash fur free of salt to maintain insulation so the lack of freshwater waterbodies in the vicinity of the Study Area may lessen the suitability of the resting sites to be used for breeding females and may be more suitable for otters sheltering whilst foraging in the area. However, otters are known to travel long distances, with females ranging to around 20km and males much larger distances, so the watercourses described above are within this range (Harris and Yalden, 2008). The disturbed location of the site does suggest less of likelihood for breeding with breeding females favouring undisturbed areas (Liles G., 2003)).

4.6.2.2 Resting sites

Otter survey Target Notes are provided in **Appendix 4-6**. One potential couch/holt and three potential holts were found as a result of the survey. RS1 – RS3 were potential holts located within rubble piles embedded into earth banks and scrub adjacent to the western development area. All had spraint associated with possible entrances into the bank behind. The remaining resting site was a possible couch (RS4) found within the top of the rock armour in the eastern region of the Study Area where a pile of recent and old spraint was found on top of a large flat boulder. The spraint pile may also be a marker for a holt that may lie within the network rocks that lies beneath and cannot be fully viewed.

4.6.2.3 Camera monitoring

Of the four resting sites subject to camera monitoring, RS3 was confirmed as a non-breeding holt and RS4 a non-breeding couch / potential holt. RS1 was confirmed as not being currently used as a resting site as only two otter passes were recorded over the monitoring period and no entries/exits from the feature observed. RS2 was not a resting site and being used by common rat (*Rattus norvegicus*).

The footage of RS3 showed a single otter emerging from one of the previously identified entrances in the rubble pile at dusk on the 27th April at 20:44 and with dry fur, confirming diurnal resting at the feature. Further footage showed a possible entry from a single adult otter into a previously unidentified entrance in the feature at dawn on the 26th April at 05:19, but only a tail can be seen as it is obscured by the rubble. If this was an entry, it is likely connected under the rubble pile to the aforementioned entrance. Timings of both pieces of footage further support diurnal resting at RS3. Nine further otter passes were noted over the 28 days with single otters visiting the area through the night to spraint and scent mark. The infrequent use of the feature with one, potentially two, entries into RS3 over the 28 day monitoring period by single otters, with no cubs observed, confirms the resting site to be non-breeding.

RS4 footage showed one entry by a single otter into the rock armour above the couch on the 18th April at 21:38. Ten further otter passes were noted over the 28 days with single otters mainly commuting along the shoreline overnight, sprainting and scent marking on occasion. As for RS3 above, due to the infrequency of use of the resting site, RS4 can also be confirmed as a nonbreeding resting site. Due to the complexity of the rock armour around the couch, to which the extents cannot be fully seen, the feature may also be a holt.

Other mammal species noted on the footage were common rat, rabbit (*Oryctolagus cuniculus*), fox (*Vulpes vulpes*), wood mouse (*Apodemus sylvaticus*), grey squirrel (*Sciurus carolinensis*), domestic cats (*Felis catus*) and a beaver (*Castor fiber*) was noted on one occasion passing by RS4.

4.6.3 Results of screening for LSE

4.6.3.1 Screening for LSE - Alone

Table 4-10 provides the results of the Screening for LSE alone as a result of the Proposed Scheme on otter feature of the River Tay SAC.

Table 4-10 Results of HRA Screening Alone – River Tay SAC otter qualifying feature

Qualifying Feature	LSE (yes/no)	Justification
Otter	Yes	Resting sites identified in proximity to the Proposed Scheme.

4.6.3.2 Screening for LSE - In-combination

Potential in-combination effects could arise with the proposed laydown extension and landside improvements to the PCW.

4.7 Conclusions of Further Screening for LSE

Compared to the conclusions of the HRA Screening Report in **Appendix 4-2**, the differences are as follows:

- All LSEs to SPAs and Ramsar sites have been screened out of the HRA;
- Direct impact of underwater noise on bottlenose dolphin and harbour seal has been screened out; and
- Otter, as a feature of the River Tay SAC, has been screened into the HRA.

Table 4-11 summarises the sites and features where a LSE has been concluded and therefore have been taken forward to the Appropriate Assessment. The locations of the designated sites are shown on **Figure 4-5** and **Figure 4-6**. All other conclusions of the HRA Screening Report (**Appendix 4-2**) remain valid.

Table 4-11 Summary of screening for LSE alone

Designated Site	Site features
Firth of Tay and Eden Estuary SAC	• Estuaries • Sandbanks which are slightly covered by sea water all the time (i.e. subtidal sandbanks) • Mudflats and sandflats not covered by seawater at low tide (i.e. intertidal mudflats and sandflats) • Harbour seal (indirect impacts only)
Moray Firth SAC	• Bottlenose dolphin (indirect impacts only)
River Tay SAC	• Atlantic salmon • Sea lamprey • River lamprey • Otter

Projects with the potential for in-combination are those located within 5km of the Proposed Scheme, as beyond this distance it would not be expected that there is the potential for combined disturbance to individuals affected by the Proposed Scheme and other projects. This 5km screening distance has been used for benthic features, transitional fish and otter. For seals, projects are considered if they are located within the Firth of Tay, and for bottlenose dolphin, due to the SAC they are associated with being within the Moray Firth, the Firth of Forth, as well as off the east coast of Scotland, between the Proposed Scheme and the inner Moray Firth. In-combination screening for LSE with other plans and projects has been updated to take account of the further screening for LSE alone, as presented in **Table 4-12**.

Table 4-12 Summary of screening for LSE in-combination with other plans and projects

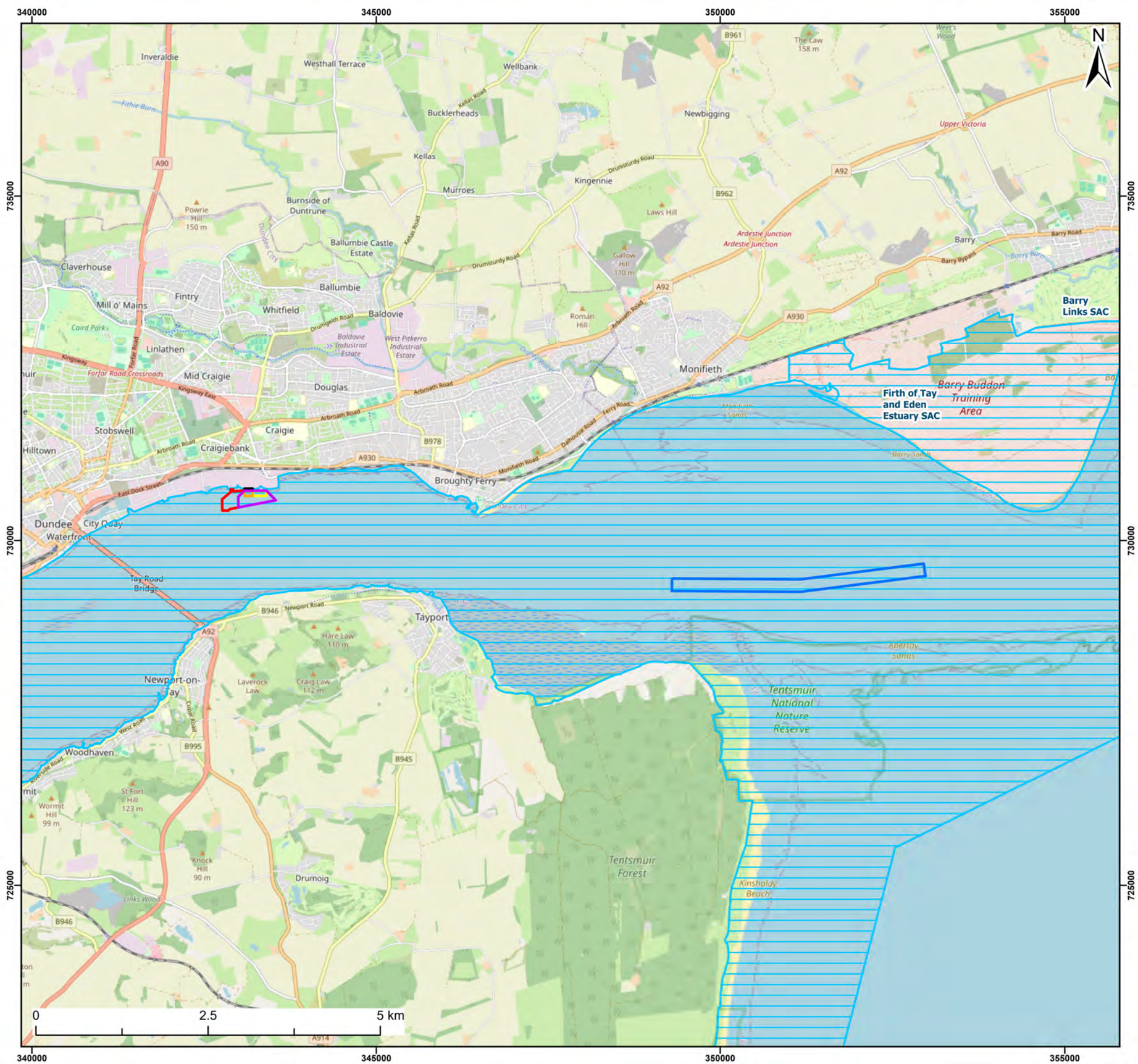
Project	Designated site	Features screened in	Potential for in combination effects
Port of Dundee Landside Works	Firth of Tay and Eden Estuary SAC	• Estuaries • Sandbanks which are slightly covered by sea water all the time (i.e. subtidal sandbanks) • Mudflats and sandflats not covered by seawater at low tide (i.e. intertidal mudflats and sandflats)	No – there are no impact pathways from this project to the marine environment.
		• Harbour seal	No – there are no impact pathways from this project to the marine environment.
	Moray Firth SAC	• Bottlenose dolphin	No – there are no impact pathways from this project to the marine environment.
	River Tay SAC	• Atlantic salmon • Sea lamprey • River lamprey • Otter	**Yes for otter only – there are no impact pathways from this project to the marine environment.**
Seagreen OWF operation and maintenance	Firth of Tay and Eden Estuary SAC	• Estuaries • Sandbanks which are slightly covered by sea water all the time (i.e. subtidal sandbanks) • Mudflats and sandflats not covered by seawater at low tide (i.e. intertidal mudflats and sandflats)	No – Not within 5km of the Proposed Scheme.
		• Harbour seal	**Yes – Within area used by the harbour seal population of the Firth of Tay and Eden Estuary SAC**.
	Moray Firth SAC	• Bottlenose dolphin	**Yes – Within area used by the bottlenose dolphin population of the Moray Firth SAC**.
	River Tay SAC	• Atlantic salmon • Sea lamprey • River lamprey • Otter	No – Not within 5km of the Proposed Scheme.

Project	Designated site	Features screened in	Potential for in combination effects
Berwick Bank geophysical survey	Firth of Tay and Eden Estuary SAC	• Estuaries • Sandbanks which are slightly covered by sea water all the time (i.e. subtidal sandbanks) • Mudflats and sandflats not covered by seawater at low tide (i.e. intertidal mudflats and sandflats)	No – Not within 5km of the Proposed Scheme.
		• Harbour seal	No – Not within the Firth of Tay study area.
	Moray Firth SAC	• Bottlenose dolphin	**Yes – Within area used by the bottlenose dolphin population of the Moray Firth SAC**.
	River Tay SAC	• Atlantic salmon • Sea lamprey • River lamprey • Otter	No – Not within 5km of the Proposed Scheme.
Inch Cape OWF - Landfall	Firth of Tay and Eden Estuary SAC	• Estuaries • Sandbanks which are slightly covered by sea water all the time (i.e. subtidal sandbanks) • Mudflats and sandflats not covered by seawater at low tide (i.e. intertidal mudflats and sandflats)	No – Not within 5km of the Proposed Scheme.
		• Harbour seal	No – No effect on receptor.
	Moray Firth SAC	• Bottlenose dolphin	No – No effect on receptor.
	River Tay SAC	• Atlantic salmon • Sea lamprey • River lamprey • Otter	No – Not within 5km of the Proposed Scheme.
Eastern Green Link	Firth of Tay and Eden Estuary SAC	• Estuaries • Sandbanks which are slightly covered by sea water all the time (i.e. subtidal sandbanks) • Mudflats and sandflats not covered by seawater at low tide (i.e. intertidal mudflats and sandflats)	No – Not within 5km of the Proposed Scheme.
		• Harbour seal	No – Not within the Firth of Tay study area.

Project	Designated site	Features screened in	Potential for in combination effects
	Moray Firth SAC	• Bottlenose dolphin	**Yes – within area used by the bottlenose dolphin population of the Moray Firth SAC**.
	River Tay SAC	• Atlantic salmon • Sea lamprey • River lamprey • Otter	No – Not within 5km of the Proposed Scheme.
Leith Outer Berth Development	Firth of Tay and Eden Estuary SAC	• Estuaries • Sandbanks which are slightly covered by sea water all the time (i.e. subtidal sandbanks) • Mudflats and sandflats not covered by seawater at low tide (i.e. intertidal mudflats and sandflats)	No – Leith Outer Berth development has been completed.
		• Harbour seal	
	Moray Firth SAC	• Bottlenose dolphin	
	River Tay SAC	• Atlantic salmon • Sea lamprey • River lamprey • Otter	
Eastern Green Link 2	Firth of Tay and Eden Estuary SAC	• Estuaries • Sandbanks which are slightly covered by sea water all the time (i.e. subtidal sandbanks) • Mudflats and sandflats not covered by seawater at low tide (i.e. intertidal mudflats and sandflats)	No – Not within 5km of the Proposed Scheme.
		• Harbour seal	No – Not within the Firth of Tay study area.
	Moray Firth SAC	• Bottlenose dolphin	**Yes – within area used by the bottlenose dolphin population of the Moray Firth SAC**.
	River Tay SAC	• Atlantic salmon • Sea lamprey • River lamprey • Otter	No – Not within 5km of the Proposed Scheme.
		• Estuaries	No – Not within 5km of the Proposed Scheme.

Project	Designated site	Features screened in	Potential for in combination effects
North Sea Renewables Grid Geophysical Surveys	Firth of Tay and Eden Estuary SAC	• Sandbanks which are slightly covered by sea water all the time (i.e. subtidal sandbanks) • Mudflats and sandflats not covered by seawater at low tide (i.e. intertidal mudflats and sandflats)	
		• Harbour seal	No – not within the Firth of Tay study area.
	Moray Firth SAC	• Bottlenose dolphin	**Yes – within area used by the bottlenose dolphin population of the Moray Firth SAC**.
	River Tay SAC	• Atlantic salmon • Sea lamprey • River lamprey • Otter	No – Not within 5km of the Proposed Scheme.
Moray West OWF operation and maintenance	Firth of Tay and Eden Estuary SAC	• Estuaries • Sandbanks which are slightly covered by sea water all the time (i.e. subtidal sandbanks) • Mudflats and sandflats not covered by seawater at low tide (i.e. intertidal mudflats and sandflats)	No – Not within 5km of the Proposed Scheme.
		• Harbour seal	No – Not within the Firth of Tay study area.
	Moray Firth SAC	• Bottlenose dolphin	**Yes – Within area used by the bottlenose dolphin population of the Moray Firth SAC**.
	River Tay SAC	• Atlantic salmon • Sea lamprey • River lamprey • Otter	No – Not within 5km of the Proposed Scheme.
Beatrice	Firth of Tay and Eden Estuary SAC	• Estuaries • Sandbanks which are slightly covered by sea water all the time (i.e. subtidal sandbanks) • Mudflats and sandflats not covered by seawater at low tide (i.e. intertidal mudflats and sandflats)	No – Not within 5km of the Proposed Scheme.
		• Harbour seal	No – not within the Firth of Tay study area.

Project	Designated site	Features screened in	Potential for in combination effects
	Moray Firth SAC	• Bottlenose dolphin	No – While this is within the study area for the dolphin population, the noise and disturbance levels were not considered to have a cumulative effect and were therefore screened out.
	River Tay SAC	• Atlantic salmon • Sea lamprey • River lamprey • Otter	No – Not within 5km of the Proposed Scheme.
Neart na Gaoithe O&M	Firth of Tay SAC	• Estuaries • Sandbanks which are slightly covered by sea water all the time (i.e. subtidal sandbanks) • Mudflats and sandflats not covered by seawater at low tide (i.e. intertidal mudflats and sandflats)	No – Not within 5km of the Proposed Scheme.
		• Harbour seal	**Yes – Within area used by the harbour seal population of the Firth of Tay and Eden Estuary SAC**.
	Moray Firth SAC	• Bottlenose dolphin	**Yes – Within area used by the bottlenose dolphin population of the Moray Firth SAC**.
	River Tay SAC	• Atlantic salmon • Sea lamprey • River lamprey • Otter	No – Not within 5km of the Proposed Scheme.



Legend:

- Prince Charles Wharf Approach Channel Dredge Area
- DunEco Quay Approach Channel Dredge Area
- Proposed Extension to PCW Berth Pocket
- Existing PCW Berth Pocket
- Lady Shoal Approach Channel Dredge Area
- Quay Improvement Works
- Special Areas of Conservation (SAC)

Client:	Project:
Port of Dundee Limited	Port of Dundee Capital Dredge and Quay Improvement Works

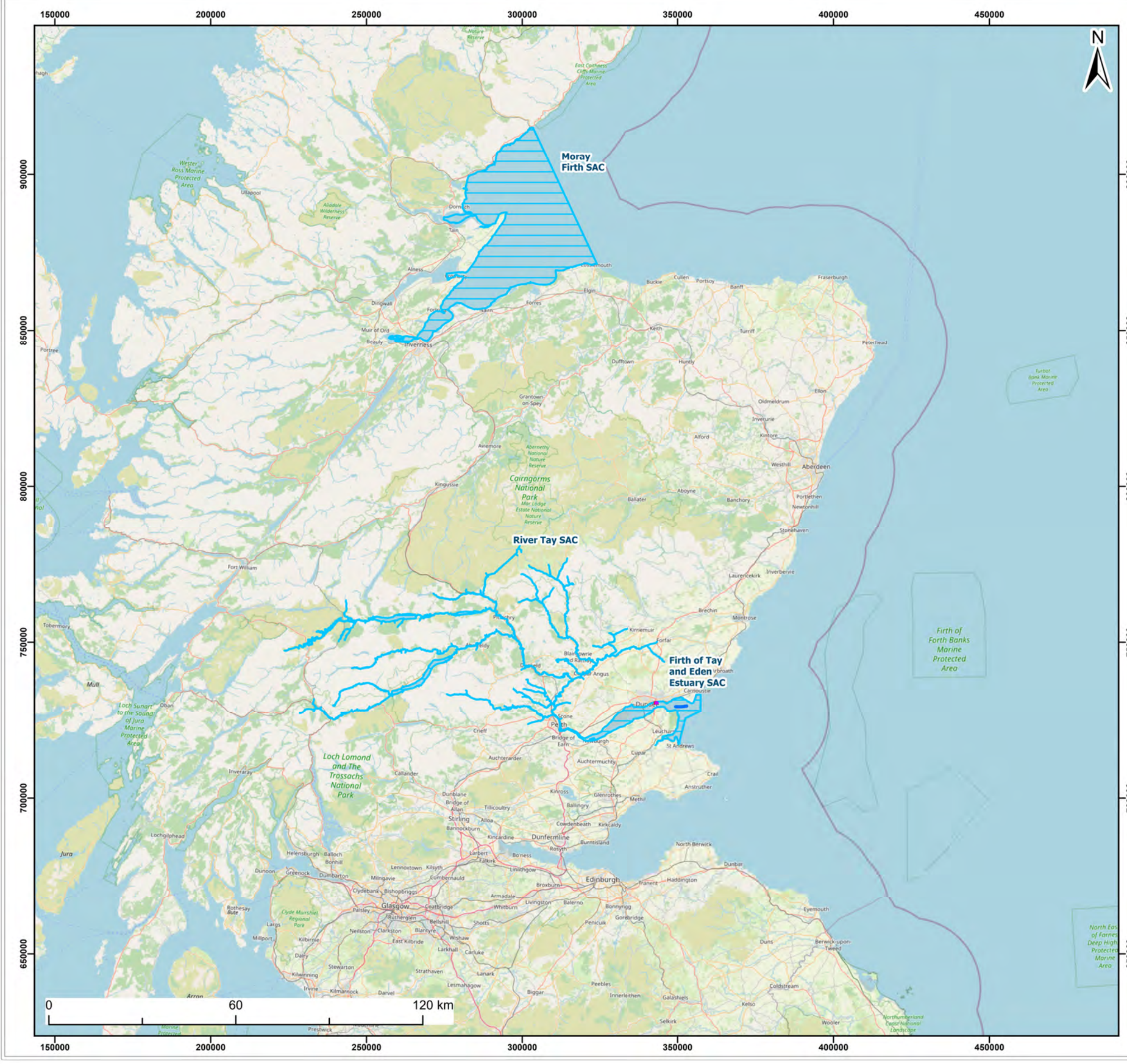
Title: Designated Sites within 5km of the Proposed Development at the Port of Dundee

Figure: 4-5 | Drawing No: PC6550-RHD-XX-ZZ-DR-Z-0020

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
P02	10/06/2025	JH	RG	A3	1:55,000
P01	10/12/2024	GC	RG	A3	1:55,000

Co-ordinate system: British National Grid

Haskoning
Enhancing Society Together



Legend:

- Prince Charles Wharf Approach Channel Dredge Area
- DunEco Quay Approach Channel Dredge Area
- Proposed Extension to PCW Berth Pocket
- Existing PCW Berth Pocket
- Lady Shoal Approach Channel Dredge Area
- Quay Improvement Works
- Special Areas of Conservation (SAC)

Client: Port of Dundee Limited

Project: Port of Dundee Capital Dredge and Quay Improvement Works

Title: Designated Sites at 80km of the Proposed Development at the Port of Dundee

Figure: 4-6

Drawing No: PC6550-RHD-XX-ZZ-DR-Z-0021

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
P02	29/05/2025	JH	RG	A3	1:1,200,000
P01	10/12/2024	GC	RG	A3	1:1,200,000

Co-ordinate system: British National Grid

Haskoning
Enhancing Society Together

5 Information for Appropriate Assessment: Firth of Tay and Eden Estuary SAC

This chapter provides information to determine whether the potential effects of the Proposed Scheme would have an adverse effect on the integrity of the Firth of Tay and Eden Estuary SAC.

5.1 Features Screened in

Features screened into the Appropriate Assessment include (see **Section 4.7**):

- Estuaries;
- Sandbanks which are slightly covered by sea water at all time (i.e. subtidal sandbanks);
- Mudflats and sandflats not covered by seawater at low tide (i.e. intertidal mudflats and sandflats); and
- Harbour seal.

5.2 Description of Designation

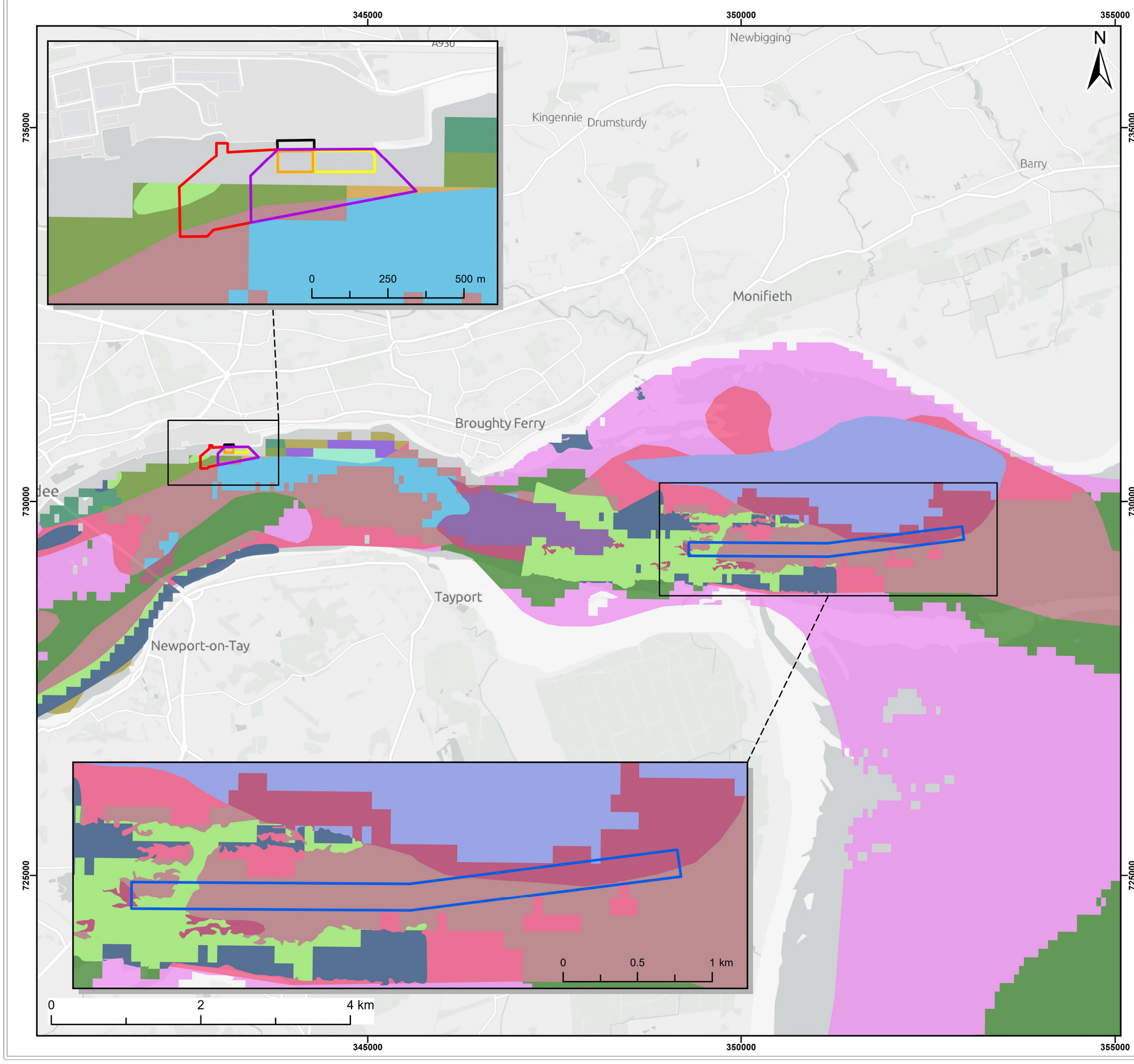
The Firth of Tay and Eden Estuary SAC is approximately 15,442 hectares, covering the full extent of the Tay and Eden estuaries, and includes a variety of habitats such as marine areas, sea inlets, tidal rivers, estuaries, mudflats, sandflats, salt marshes, coastal sand dunes, and inland water bodies. The Tay is the least-modified of the large east coast estuaries in Scotland, while the Eden estuary represents a smaller 'pocket' estuary. The inner parts of the estuaries are largely sheltered from wave action, while outer areas, particularly of the Tay, are more exposed to stronger tidal streams, giving rise to a complex pattern of erosion and deposition of the sandbanks at the mouth of the Firth.

The qualifying benthic features for the Firth of Tay and Eden Estuary SAC are estuaries, intertidal mudflats and sandflats, and subtidal sandbanks. Both seagrass *Zostera* sp. beds and blue mussel *Mytilus edulis* beds form part of the intertidal mudflats and sandflats feature and are referenced within the Conservation and Management Advice for the SAC (NatureScot, 2024). The largest known subtidal blue mussel beds are in the Firth of Tay (>4 million m^2, Bates *et al*, 2004).

The sediments within the SAC support biotopes that reflect the gradients of exposure and salinity and are typical of estuaries on the east coast of the UK. The abundance, distribution and composition of the associated plant and animal communities are ecologically representative of northern North Sea estuaries.

European Marine Observation and Data Network (EMODnet) broad-scale seabed habitat mapping suggests that the seabed within the Port dredge areas comprise circalittoral mixed sediment with several patches of infralittoral rock and biogenic reef (i.e. blue mussel beds). In the outer Tay, around the vicinity of the Lady Shoal approach channel dredge area, EMODnet broad-scale seabed habitat mapping suggests the area is dominated by coarser sediments, infralittoral rock and biogenic reef (i.e. blue mussel *Mytilus edulis* beds) (**Figure 5-1**).

With regards to intertidal mudflats and sandflats, the inner Tay has extensive sediment flats, in places over 3km wide, made up of fine silty sands and mud with marshes at or above high water level. The Abertay Sands at the mouth of the Tay Estuary consist of extensive, shifting sands and coarse sediments approximately 6km in length. These, together with Tentsmuir Sands, are integral components of the dynamic sand bar and dune system that stretches from the Tay south to the mouth of the Eden Estuary. The entire Eden Estuary, apart from the main river channel, is exposed at low water (NatureScot, 2024).



Legend:

- Prince Charles Wharf Approach Channel Dredge Area
- DunEco Quay Approach Channel Dredge Area
- Remedial Quay Works
- Proposed Extension to PCW Berth Pocket
- Existing PCW Berth Pocket
- Lady Shoal Approach Channel Dredge Area

EUSeaMap (2023) Habitat Types (EUNIS, 2019)

- MB222
- MB2223
- MB32
- MB42
- MB52
- MB62
- MC223
- MC2235
- MC32
- MC42
- MC52
- MC62
- MD22
- MD32
- MD42
- MD52
- MD62

Client: Port of Dundee Limited	Project: Port of Dundee Capital Dredge and Quay Improvement Works

Title:

Distribution of broadscale habitats in Firth of Tay (EUSeaMap, 2023)

Figure: 5-1 | Drawing No: PC6550-RHD-XX-XX-D-EV-0056

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
P01	03/07/2025	JH	RG	A3	1:50,000

Co-ordinate system: British National Grid

Haskoning
Enhancing Society Together

Many shores in the outer Tay and in the Eden support sparse beds of the eelgrass *Nanozostera noltei* (previously referred to as *Zostera noltei*) (Bates *et al*., 2004). Sparse beds of eelgrass *Z. angustifolia* can also be found to some extent in both estuaries. In the Tay Estuary on the western side of Monifieth Sands, there are patches of the eelgrass, *N. noltei* (with overall coverage of approximately 5–10%) in an upper shore band off Broughty Ferry. *N. noltei* is also found in shallow pools on the midshore. At Tayport Beach *N. noltei* is widely distributed reaching 40% coverage in a small area near the top of the shore on the eastern side. In the Eden Estuary, a century ago *Zostera* spp. were reported to cover vast areas of the estuary but have now almost disappeared. During the 2003 survey of the Eden Estuary (Bates *et al*., 2004) one small stand with *Zostera* sp. was recorded just east of Martin's Point. Several beds of Zostera are known to persist in the estuary, mainly on open mudflats on the north side of the estuary, and to shallow drainage channels on the south side (NatureScot, 2024).

Beds of blue mussel are common in the subtidal waters within the Tay Estuary and on intertidal banks in the main channels of both the Firth of Tay and the Eden Estuary. Areas of dense mussel bed are reported to occur on both northern and southern margins of the middle Tay, beneath the railway bridge and within the channel where it shallows at Lady Shoal (Bates *et al*., 2004). Within the Eden Estuary, mussel reefs are confined to the intertidal muddy areas, namely on the shores of the outer Tay (Tayport Beach and Monifieth Sands) and the Eden Estuary (NatureScot, 2024).

Subtidal sandbanks in the Firth of Tay and Eden Estuary SAC are primarily located in the channel in the upper Firth of Tay and in the central section of the firth between Invergowrie and Broughty Ferry. At the southeastern end of the Firth of Tay are the sandbanks in the Tayport - Tentsmuir Coast Site of Special Scientific Interest (SSSI). The outer sandflats provide for a nationally important pupping and moulting haul-out for harbour seals and grey seals also use the area as a summer haul-out, but not for breeding or moulting (NatureScot, 2010). Sandbanks are usually mobile and are influenced by water movements therefore natural change in the extent and distribution of this feature is expected (NatureScot, 2024).

The Firth of Tay and Eden Estuary SAC supports a nationally important breeding colony of harbour seal *Phoca vitulina*, which form part of the east coast population of seals that typically utilise sandbanks. Harbour seal haul-out on land to rest, breed, and moult, with the core pupping period being between June and July. Harbour seal generally take foraging trips of between 30km and 50km; however, movements vary among individuals and foraging trips of up to 273km have been reported (Carter *et al.,* 2022). The nearest seal haul-out site is located in the Tayport - Tentsmuir Coast SSSI.

Tagging studies of harbour seal within UK waters have been undertaken since 2001, with a total of 420 individuals tracked within Scottish waters. These studies show that there is connectivity with the Proposed Scheme and the Firth of Tay and Eden Estuary SAC, with individuals travelling from the SAC through the Firth of Forth (**Figure 5-2**; Carter *et al*., 2020; 2022).

The latest harbour seal count (from 2023) in the Firth of Tay and Eden Estuary SAC was 55 (Special Committee on Seals, SCOS, 2024), and the population in this site has been in decline since the 2000s; the 1990 to 2002 count within the SAC was 641 (Hague *et al.,* 2020). The count of harbour seal within the SAC has been stable, at between 29 and 60, since 2013 (**Figure 5-3**; SCOS, 2020). To generate a SAC population estimate of this SAC, the count has been corrected to take account of those not available to count during the surveys (a correction of 0.72; Lonergan *et al.,* 2013). This results in a total SAC population estimate of 76 for which the potential for effect has been assessed (SCOS, 2024).

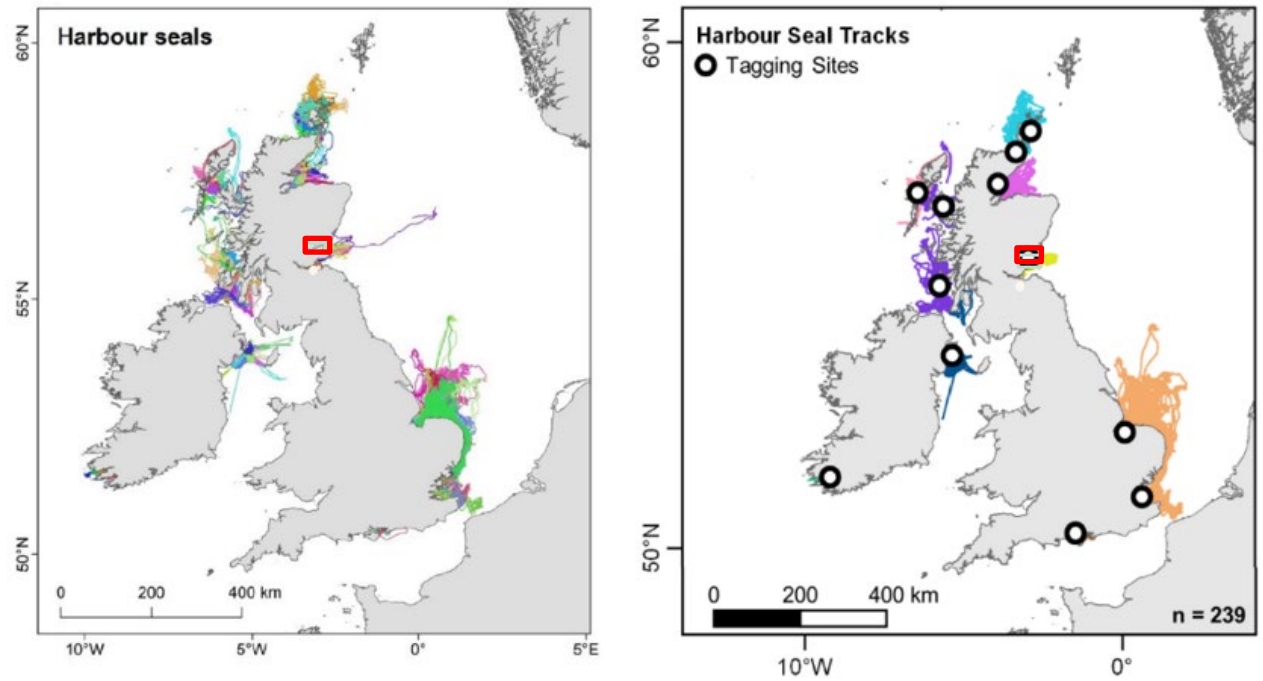


Figure 5-2 Harbour seal tagging studies; Left = harbour seal (n=114) tracking data combined from SMRU, University of Aberdeen and University College Cork, coloured by individual (Carter et al., 2020); Right = tracking data for harbour seal (n=239), cleaned to remove erroneous locations, trips between locations, and locations in breeding season (Carter et al., 2022). [Approximate location of the Firth of Tay and Eden Estuary SAC shown by the red square, and approximate location of the Proposed Scheme shown by the red rectangle].

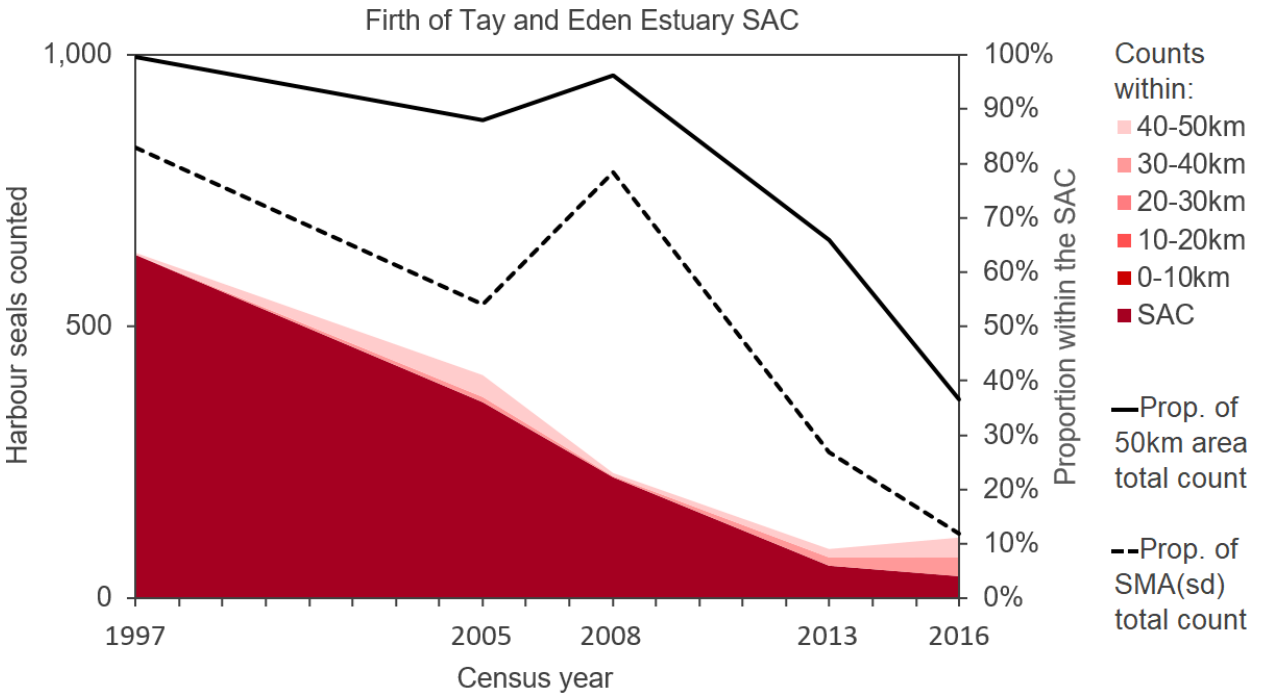


Figure 5-3 Harbour seal counts in the Firth of Tay and Eden Estuary SAC, and up to 50km from the SAC. The dotted black line shows the SAC count as a proportion of the total count for East Scotland MU (SCOS, 2020).

While there is some connectivity of individuals from the Firth of Tay and Eden Estuary SAC within the wider area, this SAC population is the most isolated harbour seal SAC population in Scotland, with the majority of individuals staying within close proximity of the SAC. Only a small proportion of the wider East Scotland population are associated with haul-out sites within the Firth of Tay and Eden Estuary SAC (**Figure 5-3**; SCOS, 2020).

Harbour seal are likely present in lower numbers around the Proposed Scheme (SCOS, 2022; Carter *et al.,* 2022). For harbour seal associated with the Firth of Tay and Eden Estuary SAC, the mean predicted density for each grid square that overlaps with the Proposed Scheme is 0.02563km^2, a relative density of very low when compared to the overall distributions of harbour seal (Carter *et al*., 2022). This density and reference population of 76 will be used for the assessing the potential impacts to harbour seal associated with the Firth of Tay and Eden Estuary SAC.

Harbour seal take a wide variety of prey including sandeels, gadoids., herring *Clupea harengus* and sprat *Sprattus sprattus*, flatfish and cephalopods. Diet varies seasonally and regionally, prey diversity and diet quality also showed some regional and seasonal variation (SCOS, 2022). It is estimated harbour seals eat 3-5kg per adult seal per day depending on the prey species (SCOS, 2022).

The range of foraging trips varies depending on the surrounding marine habitat (e.g. 25km on the west of Scotland (Cunningham *et al.,* 2009), and 30km-45km in the Moray Firth (Tollit *et al.,* 1998; Thompson and Miller 1990). Telemetry studies indicate that the tracks of tagged harbour seals have a more coastal distribution and do not travel far from haul-outs.

5.2.1 Conservation Objectives

The Firth of Tay and Eden Estuary SAC Conservation Objectives for benthic ecology are:

- To ensure that the qualifying features of Firth of Tay and Eden Estuary SAC are in favourable condition and make an appropriate contribution to achieving Favourable Conservation Status.
- To ensure that the integrity of Firth of Tay and Eden Estuary SAC is maintained in the context of environmental changes by meeting objectives for each qualifying feature:
    - Extent and distribution of the habitat within the site.
    - Structure and function of the habitat and the supporting environment on which it relies.
    - Distribution and viability of typical species of the habitat.

The features ‘Intertidal mudflats and sandflats’ and ‘Subtidal sandbanks’ are in favourable condition. The habitat ‘Estuaries’ has not been assessed Further details on the conservation objectives for each feature can be found in the Conservation and Management Advice for the SAC (NatureScot, 2024).

The Firth of Tay and Eden Estuary SAC Conservation Objectives for harbour seal are:

- To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained, and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features; and
- To ensure for the qualifying species that the following are maintained in the long term:
    - Population of the species as a viable component of the site;
    - Distribution of the species within site;
    - Distribution and extent of habitats supporting the species;
    - Structure, function and supporting processes of habitats supporting the species; and
    - No significant disturbance of the species.

Harbour seal within the Firth of Tay and Eden Estuary SAC are in unfavourable condition.

5.3 Data Sources

The following project specific information on benthic ecology were used to inform the baseline review and assessment of effects:

- A site-specific benthic ecology survey undertaken between 4th and 7th November 2024 during which Drop Down Video (DDV) was used for feature identification and benthic grabs for faunal analysis (**Appendix 5-1**);
- Acoustic data collected in April/May 2025 used to create benthic habitat maps;
- Underwater noise modelling (**Appendix 4-3**); and
- Sediment sample analysis of material to be dredged and disposed of (see Chapter 8 of the accompanying EIAR).

A number of publicly available datasets and information on benthic ecology in the area were also used, as follows:

- Firth of Tay and Eden Estuary Conservation and Management Advice (NatureScot, 2024);
- The Marine Life Information Network (MarLIN);
- Defra's MaGiC map;
- EMODnet habitat mapping; and
- Scottish Natural Heritage's (SNH) (now NatureScot) HRA on the Firth of Forth: A Guide for developers and regulators (SNH, 2016).

Additionally, a number of data sets have been used to inform the baseline for harbour seals. These are listed in **Table 5-1**.

Table 5-1 Data sources

Data	Year	Coverage	Notes
Scientific Advice on Matters Related to the Management of Seal Populations: 2024 (SCOS, 2024)	2024	UK Waters	Provides information on seal populations for the proposed offshore development area and the area around.
Habitat-based predictions of at-sea distribution for grey and harbour seals in the British Isles (Carter *et al.*, 2022)	1991-2019	British Isles	Provides information on abundance and absolute density estimates (i.e. number of seals) for seal species.
Seal telemetry data (e.g. Sharples *et al.*, 2008; Russell and McConnell, 2014; Russell, 2016a)	1988-2010; 2015	North Sea	Provides information on relative density (i.e. percentage of at-sea population) for seal species.

5.4 Overview of Effect Pathways Screened In

As described in the HRA Screening Report (**Appendix 4-2**) and supplemented by **Section 4**, the potential impacts on benthic features and harbour seal of the Firth of Tay and Eden Estuary SAC are:

- Direct loss of benthic habitat as a result of the proposed dredging;
- Increases in SSC and smothering of benthic habitats as a result of the proposed dredging and disposal;
- Release of sediment bound contaminants as a result of the proposed dredging affecting benthic habitats;
- Accidental leaks and spillages affecting benthic habitats;
- Disturbance from underwater noise from piling and dredging activity affecting harbour seals;
- Disturbance of Seals at Haul-Out Sites; and
- Indirect effects due to changes in water quality and prey resource affecting harbour seal.

In their consultation response to the HRA Screening Report, NatureScot requested that consideration also be given to the effects on blue mussel beds from underwater noise produced by piling; therefore this has also been assessed.

5.5 Potential Effects of the Proposed Scheme Alone

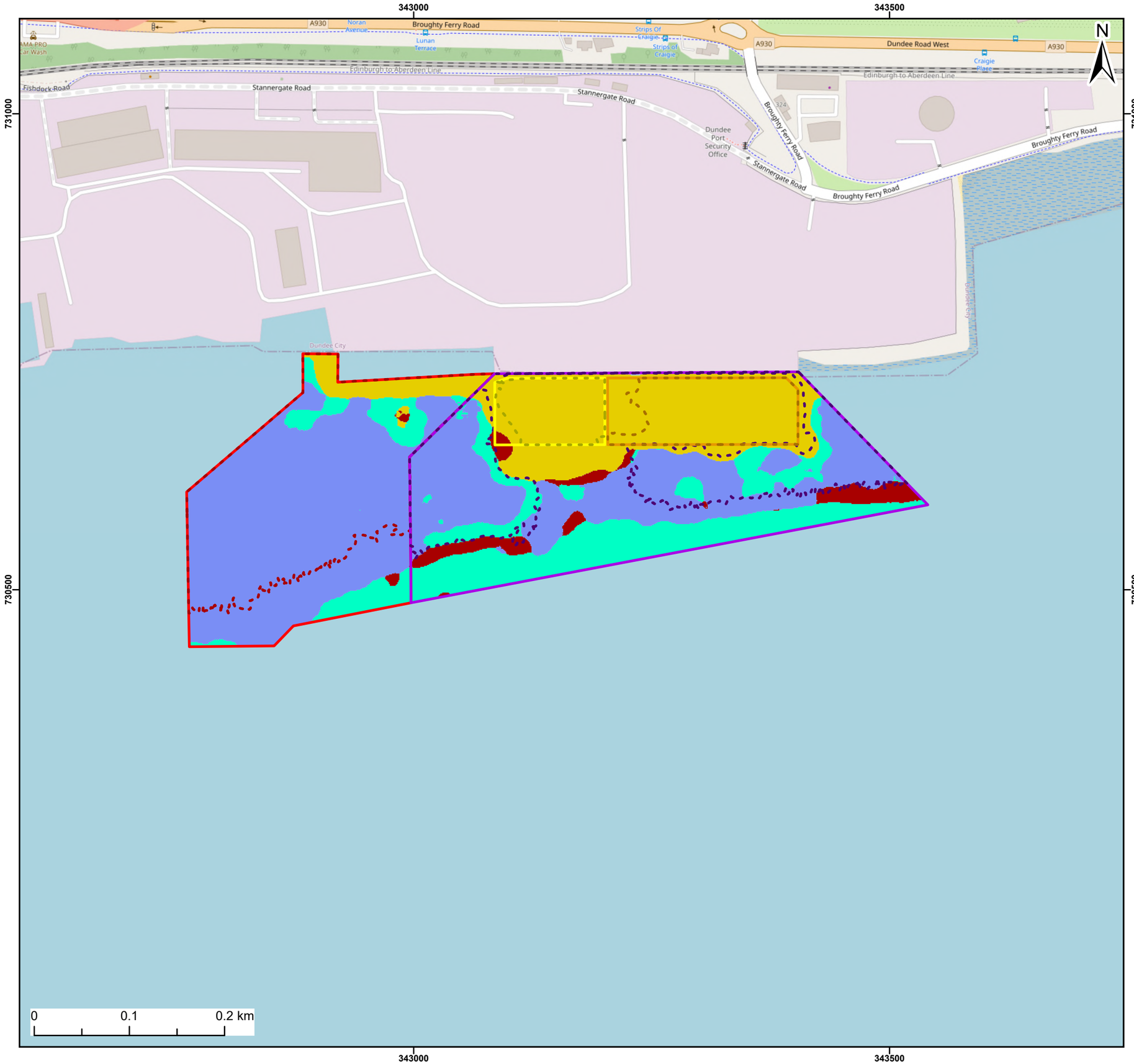
5.5.1 Direct loss of benthic habitat as a result of the proposed dredging

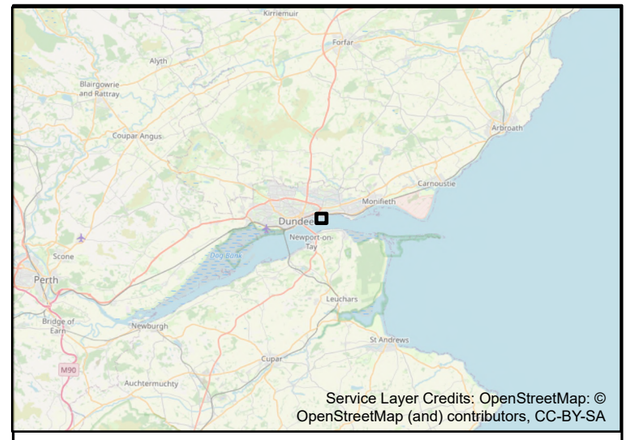
Benthic surveys undertaken in November 2024 identified the habitat within the Port of Dundee dredge area to be coarse sediments and circalittoral mixed sediments (see Figure 4 in **Appendix 5-1**). Habitats within the Lady Shoal approach channel dredge area were identified as predominantly circalittoral coarse sediments (see Figures 4 to 7 in **Appendix 5-1**).

The priority marine feature (PMF) 'Blue mussel beds' was identified within 30 images along three transects: TR002, TR003 and TR015 (Figure 8 and Figure 10 in **Appendix 5-1**). Transects TR002 and TR003 were located along the seaward extent of the Port of Dundee dredge area and TR015 to the south of the Lady Shoal approach channel dredge area. 'Blue mussel beds' were assigned to EUNIS biotope MC2235 'Mytilus edulis beds on sublittoral sediment'.

Acoustic data, gathered in April / May 2025, has been used in conjunction with the survey data to produce benthic habitat maps (see **Figure 5-4** and **Figure 5-5**). These maps were developed by Envision Ltd. using habitat modelling software, which used the benthic sample data as 'training sites' to model the distribution of biological habitat classes identified. These training sites were then superimposed on the layers of acoustic data to identify corresponding statistical signatures in the acoustic data, and thus develop a habitat map of the dredge area. The habitat maps broadly align with the EUSeaMap data.

There are areas of seabed within the dredge areas that are already below the required dredged depth. As such, these areas would not be dredged and the habitats present would remain. The actual area of dredging (the dredge footprint) can be seen on **Figure 5-4** and **Figure 5-5**, and which has been used to calculate the area of habitats that would be lost as a result of the proposed dredging, as presented in **Table 5-2**.





Legend:

Proposed Extension to PCW Berth Pocket
- Dredge Area
- Dredge Footprint

Existing PCW Berth Pocket
- Dredge Area
- Dredge Footprint

Prince Charles Wharf Approach Channel
- Dredge Area
- Dredge Footprint

DunEco Quay Approach Channel
- Dredge Area
- Dredge Footprint

Eunis Habitat (2022)
- MB5/MC5 - (Infralittoral/Circalittoral sand (Dredged Area)
- MC2235 - Mytilus edulis beds on Atlantic circalittoral sediment
- MC32 - Atlantic circalittoral coarse sediment
- MC42 - Atlantic circalittoral mixed sediment

Client:	Project:
Port of Dundee Limited	Port of Dundee Laydown Area and Quay Improvement Works

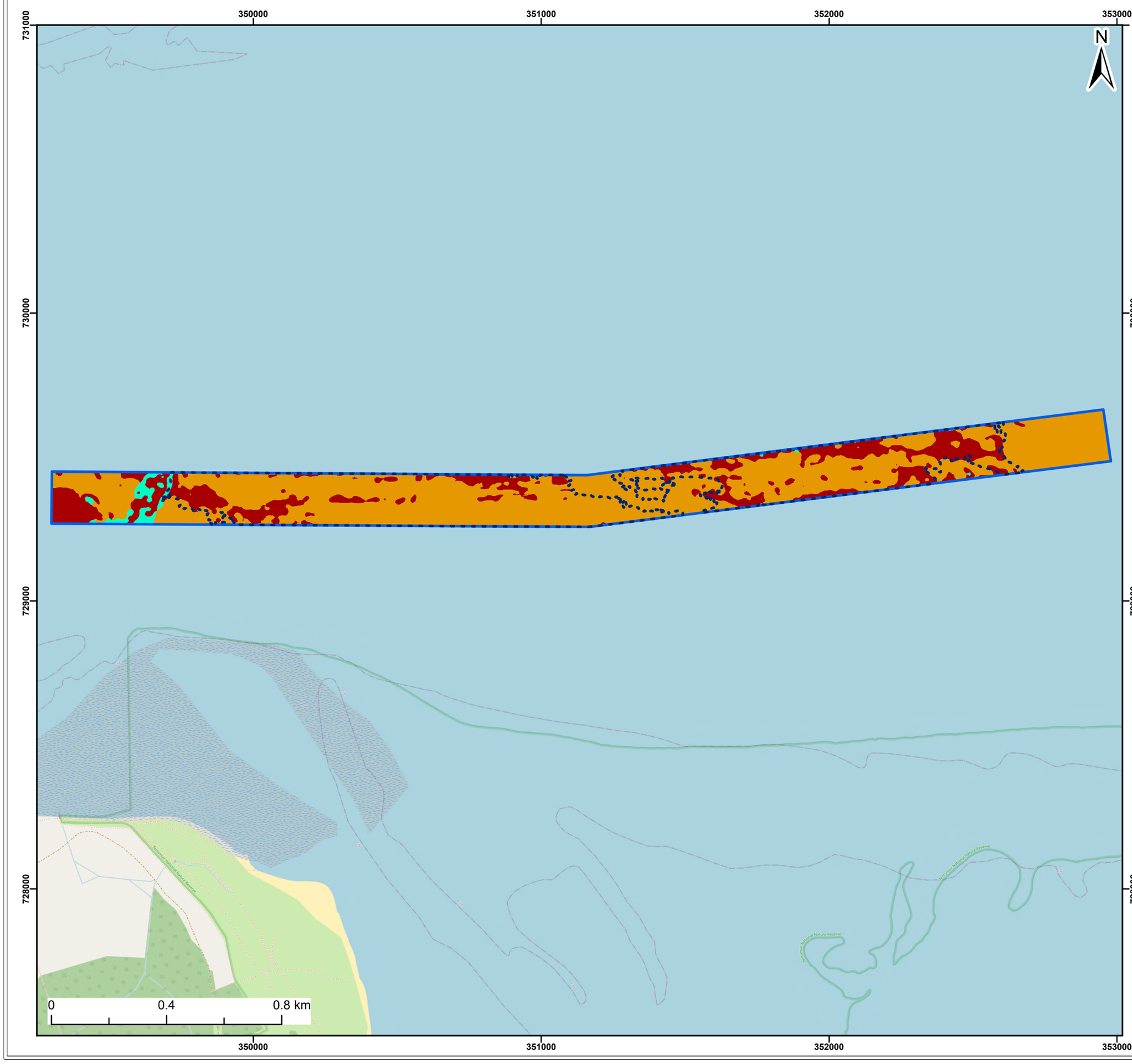
Title: Benthic survey habitat map of Port of Dundee

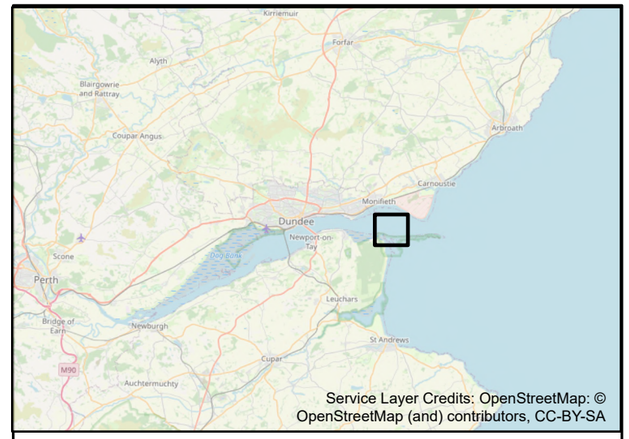
Figure:	Drawing No:
5-5	PC6550-RHD-XX-XX-D-EV-0071

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
P01	18/08/2025	JH	RF	A3	1:4,000

Co-ordinate system: British National Grid

Haskoning
Enhancing Society Together





Legend:

Lady Shoal Approach Channel

- Dredge Area
- Dredge Footprint

Eunis Habitat (2022)

- MC2235 - Mytilus edulis beds on Atlantic circalittoral sediment
- MC32 - Atlantic circalittoral coarse sediment
- MC3211 - Pomatoceros triqueter with barnacles and bryozoan crusts on Atlantic circalittoral unstable cobbles and pebbles

Client:	Project:
Port of Dundee Limited	Port of Dundee Laydown Area and Quay Improvement Works

Title:

Benthic survey habitat map of Lady Shoal Approach Channel

Figure:	Drawing No:
5-6	PC6550-RHD-XX-XX-D-EV-0072

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
P01	18/08/2025	JH	RF	A3	1:13,000

Co-ordinate system: British National Grid

Haskoning
Enhancing Society Together

Table 5-2 Areas of habitat within the Port of Dundee and Lady Shoal Approach Channel dredge footprints

Habitat	Total Area of Habitat within Dredge Footprint (m^2)
Port of Dundee	
MB5/MC5 – Infralittoral / Circalittoral sand	25,754
MC2235 – Mytilus edulis beds on Atlantic circalittoral sediment	10,681
MC32 – Atlantic circalittoral coarse sediment	439
MC42 – Atlantic circalittoral mixed sediment	57,273
Lady Shoal Approach Channel	
MC2235 – *Mytilus edulis* beds on Atlantic circalittoral sediment	1,361
MC32 – Atlantic circalittoral coarse sediment	123,714
MC3211 – *Pomatoceros triqueter* with barnacles and bryozoan crusts on Atlantic circalittoral unstable cobles and pebbles	332,617

57,712m^2 of Atlantic circalittoral coarse and mixed sediment habitats are present within the Port of Dundee dredge footprint, with 25,724m^2 of sand habitat predicted closer to the port. Small areas of blue mussel bed are predicted throughout the dredge footprint (totalling 10,681m^2).

Habitats throughout the Lady Shoal approach channel dredge footprint are predominantly *Pomatoceros triqueter* with barnacles and bryozoan crusts on Atlantic circalittoral unstable cobles and pebbles sediment (332,617m^2) and Atlantic circalittoral coarse sediment (123,714m^2). Small areas of blue mussel beds (totalling 1,361m^2) are located throughout the eastern extent of the dredge footprint.

No areas of subtidal sandbank were identified within the proposed dredge areas, and as such there would be no direct loss of this SAC qualifying feature. The footprint of the Proposed Scheme does not encompass any intertidal areas and changes in estuarine processes are not predicted to extend to the intertidal zone (see Chapter 7 of the accompanying EIAR). As such, there would be no direct or indirect loss of the SAC qualifying feature (i.e. mudflats and sandflats not covered by seawater at low tide).

Estuaries, as a qualifying feature, are defined as a habitat complex comprising an interdependent mosaic of subtidal and intertidal habitats, which are closely associated with surrounding terrestrial habitats. The majority of the habitats within the dredge areas have low to medium sensitivity to habitat loss (removal of substrate) according to the MarLIN sensitivity review (Tillin *et al*., 2024). Furthermore, the dominant habitat types are widespread throughout the estuary. The species of the communities found in the dredge areas are mainly species that are opportunistic settlers, capable of relatively rapid recolonisation provided that suitable substrate is available. While the dredging would result in minor local movement of sediments within the Firth of Tay, this is a dynamic system and there would be no adverse effect on the overall extent or function of habitats within the wider Firth of Tay.

Whilst there would be some loss of subtidal habitats within the estuary, as presented in **Table 5-2**, in the context of the wider Firth of Tay, these areas are considered negligible. Modelling undertaken on the Proposed Scheme has predicted no/negligible changes in estuarine processes within the areas to be dredged and therefore dredging to maintain the deepened areas will not be required (see Chapter 7 of the accompanying EIAR for further details). As such, it is considered that any habitats affected would recover based on natural processes.

The Conservation and Management Advice for the SAC (NatureScot, 2024) notes that any loss in extent or distribution of blue mussel beds within the site has the potential to cause a long-term or permanent reduction

in the extent of the habitat and/or change the local distribution on a continuing basis; however, the advice goes on to state that key factors influencing the recovery of their extent and distribution are suitable habitat, sufficient adults to provide a substrate for settlement and protection of juveniles and a supply of larvae from within/outwith the site.

As detailed in **Section 5.2**, there is an estimated area of >4 million m^2 of blue mussel beds in the Firth of Tay (Bates *et al*, 2004). Between the Lady Shoal approach channel and the Port of Dundee, the combined area of mussel beds that would be lost equates to 12,042m^2, representing approximately 0.3% of the estimated area of blue mussel beds in the Firth of Tay.

The PSA of sediment samples collected from the proposed dredge footprints shows that sediment composition does not vary significantly with depth (see Chapter 7 of the accompanying EIAR). In addition, the proposed dredge depth at the location of the existing mussel beds is less than 1m, meaning a phase shift in community structure would not occur. As such, and as no future maintenance dredging would be required, affected mussel beds would recover based on natural processes.

Taking into consideration the small extent of mussel bed that would be lost, temporary nature of the proposed dredging activity and the opportunity for recovery post-dredging due to the availability of suitable habitat and adjacent blue mussel beds, it is considered that there will be **no adverse effect on the integrity of the benthic features of the Firth of Tay and Eden Estuary SAC from the loss of benthic habitats**.

5.5.2 Increases in SSC and smothering of benthic habitats as a result of the proposed dredging and disposal

Dredging and disposal activities would lead to the dispersal of sediments within the SAC, resulting in changes in suspended solids within the water column and deposition of those sediments potentially causing smothering. Disposal would take place at an existing designated disposal site, meaning the benthic communities in and around the disposal site will be tolerant to the effects of sediment disposal.

Turbidity was measured at Port of Dundee and Lady Shoal approach channel between 23rd January 2025 and 25th February 2025. The minimum SSC measured was 5mg/l, with most values between 10mg/l and 100mg/l. The highest recorded SSC was 551mg/l at the Port and 339mg/l at the Lady Shoal approach channel (see Chapter 7 of the accompanying EIAR for further details).

The effects of the dredging and disposal activities have been predicted using plume dispersal modelling, as presented in Chapter 7 of the accompanying EIAR**.** When dredging, maximum SSC was predicted near the seabed, and lowest at near the sea surface. At the Port of Dundee, maximum SSC near the seabed was predicted to reach up to 2,000 mg/l and last for around 30 minutes. Maximum SSC near the seabed at Lady Shoal was predicted to reach up to 1,000 mg/l, with timeframes ranging from 30 minutes to 5 hours. Maximum SSCs near the seabed at the disposal site was predicted to reach up to 2,000 mg/l, lasting for around 30 minutes.

The Firth of Tay and Eden Estuary is characterised by powerful tidal currents and a high suspended sediment load (NatureScot, 2024) and therefore the habitats and species within the estuary will be adapted to withstand high SSC. The MarLIN sensitivity review for the communities identified by the benthic surveys considers these communities as not being sensitive to increased suspended sediment and any impact will be negligible. Additionally, although peaks in SSC are high during the dredging and disposal, those peaks are short-lived and levels quickly return to ambient levels and as such are unlikely to result in any impacts on the intertidal seagrass beds in the Tay Estuary.

With regards to deposition, the modelling predicted that, even for the worst case scenario, deposition of sediments was primarily restricted to within the dredge areas and disposal site. At the Port of Dundee and Lady Shoal approach channel, the model predicted that sediment deposition would remain below 0.1m. At the disposal site, the modelling predicted that sediment was deposited in patchy areas, extending slightly outside of the disposal site. Inside the Disposal site area, patches of deposition remained below 0.4m. Outside the Disposal site area, the few deposition patches remained below 0.3m.

Sediment deposition is highly localised to the dredge areas and in the vicinity of the disposal site and would therefore not impact the intertidal habitats or subtidal sandbank features of the SAC. Blue mussel beds in and around the dredge and disposal sites may experience some limited sedimentation; however, Last *et al.* (2011) as cited on MarLIN found that individual mussels were able to survive burial in depths of 2, 5, and 7cm for over 32 days. *Mytilus* spp. populations are considered to have a strong ability to recover from environmental disturbance (Holt *et al*., 1998; Seed & Suchaneck, 1992, cited on MarLIN). Additionally, MarLIN sensitivity assessment of blue mussel beds on sublittoral sediment to smothering and siltation rate changes states: *"Overburden by 5cm of fine material in a single incident is unlikely to result in significant mortality in blue mussel beds before sediments are removed by current and wave action"*. The sensitivity review goes on to say: "*Overburden by 30cm of fine material in a single incident could result in significant mortality in blue mussel beds…Mortality will be limited, and possibly avoided, where the smothering sediment is removed due to wave action or tidal streams*" (Tillin *et al*., 2024). Beyond the disposal site, deposition is unlikely to reach depths or remain in place long enough to have significant effects on blue mussels.

In light of the above there will be **no adverse effect on the integrity of the benthic features of the Firth of Tay and Eden Estuary SAC** due to the dredging and disposal activities.

5.5.3 Release of sediment bound contaminants as a result of the proposed dredging affecting benthic habitats

Changes in water quality can occur as a result of contaminants being mobilised into the water column as a result of seabed disturbance. Sediment samples collected across the dredge areas were analysed for contaminants and compared to the Marine Directorate's Action Levels. On average, the levels of contaminants are mostly below AL1 and therefore considered suitable for offshore disposal (see Chapter 8 of the accompanying EIAR).

Furthermore, the dredged sediment would be disposed to an active disposal site, designated for the disposal of dredged material. The sediment plume modelling shows that the sediment, and any associated contaminants, would mostly be deposited within the bounds of the disposal site (see Chapter 7 of the accompanying EIAR).

As there are no predicted effects on benthic communities, there will be **no adverse effect on the integrity of benthic features of the Firth of Tay and Eden Estuary SAC** as a result of the release of sediment bound contaminants.

5.5.4 Accidental leaks and spillages affecting benthic habitats

During the proposed works, there is a risk of accidental spills or leaks into the marine environment from the following sources:

- Oils and fuels stored on site;
- Construction and refuelling machinery or site vehicles/vessels; and

- Concrete and cement in construction works.

The effect of a potential spill and leak incidence would be dependent on the scale and nature of the incident. The following pollution prevention guidelines are relevant to the Proposed Scheme and will be adhered to:

- Guidance for Pollution Prevention (GPP) 1: Understanding your environmental responsibilities - good environmental practices;
- GPP 5: Works and maintenance in or near water;
- PPG 6: Working at construction and demolition sites;
- PPG 7: Safe storage - The safe operation of refuelling facilities;
- GPP 8: Safe storage and disposal of used oils;
- GPP 13: Vehicle washing and cleaning (April 2017);
- GPP 21: Pollution incident response planning; and
- GPP 22: Dealing with spills.

As a result of the adherence to the above pollution prevention guidelines, the risk of a spill or leak occurring is low, and should one occur appropriate measures will be in place to manage it. As such there will be **no adverse effect on the integrity of benthic features of the Firth of Tay and Eden Estuary SAC** as a result of accidental leaks and spillages.

5.5.5 Underwater noise during piling affecting blue mussels

The effects of underwater noise on blue mussels are not as well studied as impacts on marine mammals or fish. Studies of the effects of vessel noise have shown DNA changes, reduced feeding rate, reduced oxygen consumption, increased valve gape (Wale *et al*., 2019) and increased settlement of larvae (Jolivet *et al.,* 2016); however, these studies are based on laboratory conditions using playback of continuous low frequency sound. One of the researchers stated: "*Given the wide distribution of mussels in areas where they may be exposed to noise, the impact of noise does not appear to be fatal or immediately dangerous for mussels*" (Wale *et al*. 2019).

A field study on the impact of pile driving within 15m of blue mussels in a dock environment, reported an increased filtration rate in blue mussels during piling activity compared to those in ambient conditions. The field study went on to conclude that in a situation where food resources are limited, this may have a detrimental effect (Spiga *et al*., 2016).

Piling works related to the Proposed Scheme are anticipated to last for up to 35 days and would not be continuous. Given this, the fact that the closest mussels are over 35m from the proposed piling works and that food resources in the Tay are very unlikely to be limited, there will be **no adverse effect on the benthic features of the Firth Tay and Eden Estuary SAC** as a result of underwater noise on blue mussels.

5.5.6 Potential for disturbance from piling activities affecting harbour seal

Whilst there is the potential for a displacement response by harbour seal as a result of underwear noise generated by the proposed piling activities, it is expected that they would quickly return once the activity has been completed, and therefore any effects would be both localised and temporary. The area surrounding the Port of Dundee is already a busy marine area, and any seals in the vicinity of the Proposed Scheme would be used to a noisy environment.

Taking the above into account, there will be **no adverse effect on the integrity of harbour seal, as a feature of the Firth of Tay and Eden Estuary SAC,** due to underwater noise effects from piling works.

5.5.7 Potential for disturbance from dredging activities and vessels affecting harbour seal

Sound sources included for dredging include the dragging of equipment on the seabed, as well as sound sources from the vessel such as inboard pump, thrusters, propeller and engine noise (Central Dredging Association (CEDA), 2011; World Organization of Dredging Associations (WODA), 2013). Noise measurements indicate that the most intense sound emissions from dredgers are typically low frequencies, up to and including 1kHz (Robinson *et al*., 2011). Underwater noise from dredging is comparable to those for a cargo ship travelling at modest speed (between 8 and 16 knots) (Theobald *et al.,* 2011). As noted in **Section 5.5.6**, the area surrounding the Port of Dundee is a busy marine area and any seals present in the area would be used to increased levels of underwater noise. Given the busy nature of the area, any potential for disturbance from the dredging activities and vessels would be localised and unlikely to cause any significant disturbance to harbour seal in the area.

Table 5-2 presents the assessment for any potential disturbance from dredging activities including vessels noise using a 2km disturbance range**.** It shows that less than one individual (0.4) could be disturbed, with up to 0.3% of the Firth of Tay and Eden Estuary SAC population affected.

Table 5-3 Impact ranges and areas, and maximum number of individuals (and % of reference population) that could be at risk of disturbance from dredging activities and vessels using a 2km disturbance range

Activity	Impact range (and area)	Maximum number of individuals (% of reference population)
Dredging activity and vessels	2km (12.57km^2)	0.4 (0.3% of the SAC)

Taking into account the above, there will be **no adverse effect on the integrity of harbour seal, as a feature of the Firth of Tay and Eden Estuary SAC**, due to disturbance from dredging activities and vessels.

5.5.8 Disturbance of seals at haul-out sites

Seals at haul-outs vary in their reaction to construction disturbance depending on disturbance type (vessel noise/presence, piling etc,) and proximity to the sites. The deepening of a section of the Lady Shoal approach channel is approximately 340m from the nearest seal haul-out located in the Tayport - Tentsmuir Coast SSSI.

The most common disturbance effects at haul out sites include increased vigilance and 'flushing' behaviour, which can be energetically taxing especially if pups are present or during moulting season when seals tend to spend more time on land (Machernis *et al.,* 2018). A study was carried out by Sea Mammal Research Unit (SMRU) (Paterson *et al.,* 2015) using a series of controlled disturbance tests at harbour seal haul-out sites, consisting of regular (every three days) disturbance through direct approaches by vessel and effectively 'chasing' the seals into the water. The seal behaviour was recorded via GPS tags and found that even intense levels of disturbance did not cause seals to abandon their haul-out sites more than would be considered normal (for example seals travelling between sites) and the seals were found to haul-out at nearby sites or to undertake a foraging trip in response to the disturbance (but would later return).

Further studies on the effects of vessel disturbance on harbour seals when they are hauled out, suggest that even with repeated disturbance events that are severe enough to cause individuals to flee into the water, the likelihood of harbour seals moving to a different haul-out site would not increase. Furthermore, this appeared to have little effect on their movements and foraging behaviour (Paterson *et al.* 2019). In areas

of high vessel traffic, there can be habituation effects and disturbance behaviours are generally reduced over time (Strong *et al.,* 2010).

It is expected that if there is any disturbance to seals at haul-out sites from dredging activities it is a short-term effect. For example, a 2019 study on harbour seals in Scotland found that 30 minutes after a disturbance event, seals return to 52% pre-disturbance levels at haul-out sites and 94% pre-disturbance levels four hours after a disturbance event (Paterson *et al.,* 2019).

A study of the reactions of harbour seal from cruise ships found that, if a cruise ship (which are larger and nosier than the dredging vessels and activities) was less than 100m from a harbour seal haul-out site, individuals were 25 times more likely to flee into the water than if the cruise ship was at a distance of 500m from the haul-out site (Jansen *et al.,* 2010). At distances of less than 100m, 89% of individuals would flee into the water, at 300m this would fall to 44% of individuals, and at 500m, only 6% of individuals would flee into the water (Jansen *et al.,* 2010). Beyond 600m, there was no discernible effect on the behaviour of harbour seal.

Due to the distance from the haul-outs in the SAC, the short duration of the effects and recoverability or habituation due to high levels of vessel traffic in the area there will be **no adverse effect on the integrity of harbour seal, as a feature of the Firth of Tay and Eden Estuary SAC**, due to disturbance of seals at haul-out sites from dredging activities and vessels.

5.5.9 Potential for indirect effects as a result of changes to water quality and prey resource on harbour seal

The potential indirect effects to harbour seal can result from changes in water quality (from an increase in SSC, the release of contaminated sediments during dredging and disposal, and accidental spillages and leaks) and from changes in prey resource.

An increase in SSC during dredging and disposal activities could lead to a reduction in water clarity and therefore quality. Modelling results predict the increase in SSC to be localised and temporary. Dredging would be non-continuous and SSC levels would dissipate to within background levels between dredging activities.

As described in **Section 5.5.3**, the sediment to be dredged is considered suitable for disposal at sea. With adherence to the mitigation measures stated in **Section 5.5.4**, the risk of an accidental spillage or leak is low, and should one occur appropriate measures will be in place to manage it.

A detailed assessment of potential impacts on fish and shellfish as a result of the Proposed Scheme is presented in Chapter 10 of the accompanying EIAR. The assessment concluded that potential impacts on fish and shellfish would be minor adverse to negligible, which is not significant.

Taking the above into account, there will be **no adverse effect on the integrity of harbour seal, as a designated feature of the Firth of Tay and Eden Estuary SAC**, due to changes in water quality and prey resource**.**

5.6 Potential effects of the Proposed Scheme In-Combination with other Plans and Projects

As presented in **Table 5-3**, there is no potential for in-combination effects on benthic features as there are no other projects within 5km of the Proposed Scheme. It has therefore been concluded that there will be **no**

adverse effect on the benthic features of the Tay and Eden Estuaries SAC, as a result of in-combination effects.

Regarding harbour seal, there is the potential for in-combination effects to arise from disturbance from dredging and vessels. For operation and maintenance activities at Seagreen offshore windfarm, a 4km disturbance area was applied resulting in a potential effect area of 50.27km^2. A 2km disturbance range (effect area of 12.57km^2) has been used for the potential disturbance of activities as a result of the Proposed Scheme. The in-combination assessment is presented in **Table 5-3**.

Table 5-3 shows that 2.6% of the Firth of Tay Eden Estuary SAC population of harbour seal could be disturbed from activities with other projects and the Proposed Scheme. In reality however it is very unlikely that all project activities would occur at the same time.

It has therefore been concluded that there would be **no adverse effect on the integrity of harbour seal, as a designated feature of the Firth of Tay and Eden Estuary SAC**, due to in-combination effects from dredging and vessel disturbance.

Table 5-4 In-combination assessment of vessel disturbance for harbour seal as feature of the Firth of Tay and Eden Estuary SAC

Project	Harbour seal density (/km^2)	Effect area (km^2)	Maximum number of individuals potentially disturbed
Proposed Scheme	0.02563	12.57	0.3
Seagreen OWF Operations & Maintenance	0.02563	50.27	1.3
Neart na Gaoithe O&M	0.02563	50.27	1.3
Total number of harbour seal			**3.0**
Percentage of SAC MU			**3.8%**

6 Information for Appropriate Assessment: Moray Firth SAC

This chapter provides information to determine whether the potential effects of the Proposed Scheme would have an adverse effect on the integrity of the Moray Firth SAC.

6.1 Features Screened in

As the Moray Firth SAC is located approximately 138km from the Proposed Scheme, only bottlenose dolphin was screened in for further assessment (see **Section 4.7**).

6.2 Description of Designation

The Moray Firth SAC, in north-east Scotland, supports the only known resident population of bottlenose dolphin in the North Sea. The Moray Firth is approximately 138km from Port of Dundee. Individuals are present all year round and, while they range widely in the Moray Firth, they appear to favour particular areas. The bottlenose dolphin is a wide-ranging species and occurs across the continental shelf. Historically, very few sightings of bottlenose dolphin were recorded further south on the east coast of the UK; however, in recent years an increase in bottlenose dolphins in the north-east of England have been reported (Aynsley, 2017), with one individual from the Moray Firth population being recorded as far south as The Netherlands (Cheney *et al*. 2024).

The Moray Firth SAC is in the SCANS block CS-K (**Figure 6-1**). For the entire SCANS-IV survey area, bottlenose dolphin abundance in the summer of 2022 was estimated to be 80,809, with an overall estimated density of 0.0551/km^2 (CV = 0.194; 95% Confidence Limit (CL) = 52,711 – 117,736) (Gilles *et al.,* 2023). The SCANS-IV survey did not identify any bottlenose dolphins within survey block NS-D, where the Proposed Scheme is located; however, the SCANS-III survey did identified bottlenose dolphin in survey block R (renamed block NS-D for the SCANS-IV survey). Abundance estimates for bottlenose dolphin were 1,924 bottlenose dolphin (95% CI = 0 - 5,048) and a density estimate of 0.0298 bottlenose dolphin/km^2 (CV = 0.861) (Hammond *et al.,* 2021).

The Moray Firth SAC consists of a resident population of bottlenose dolphin, with an estimated 226 individuals (95% CI: 214 – 239; Cheney *et al*. 2024). The most recent study from Cheney *et al*. (2024) on the Moray Firth SAC bottlenose dolphin population noted a decline in dolphins using the SAC from the previous six years. Although the population has been using the Moray Firth SAC less, as noted above, the population within the east coast of Scotland appears to be steady and slightly increasing. Bottlenose dolphins have been recorded approximately 480km outside of what would be considered their 'normal' home range (Cheney *et al*. 2024), with one individual from the Moray Firth population being recorded as far south and east as the Netherlands (Hoekendijk *et al*., 2021). Whilst bottlenose dolphin presence has been increasing in north-east England in recent years, they appear to still be a coastal population at present (Hacket, 2022).

A recent study published in 2024 by Cheney *et al.,* (2024) provided results from a mark-recapture study of the Moray Firth SAC bottlenose dolphin population between 2017 and 2022. The results highlighted that the total abundance of bottlenose dolphin in 2022 was 94 within the SAC and 245 on the east coast of Scotland. The weighted mean estimate of the number of bottlenose dolphin in the east coast from 2020 to 2022 was 226 (95% CI: 214-239). This number has therefore been used in this assessment.

Bottlenose dolphin are opportunistic feeders and consume a wide variety of fish and invertebrate species. Benthic and pelagic fish (both solitary and schooling species), as well as octopus and other cephalopods, have all been recorded in the diet of bottlenose dolphin (Santos *et al.,* 2001; Santos *et al.,* 2004; Reid *et al.,*

2003). Analysis of the stomach contents of ten bottlenose dolphin in Scottish waters, from 1990 to 1999, revealed that the main prey were cod (29.6% by weight), saithe *Pollachius virens* (23.6% by weight), and whiting (23.4% by weight), although other species including salmon (5.8% by weight), haddock (5.4% by weight) and cephalopods (2.5% by weight) were also identified in lower number (Santos *et al.,* 2001).

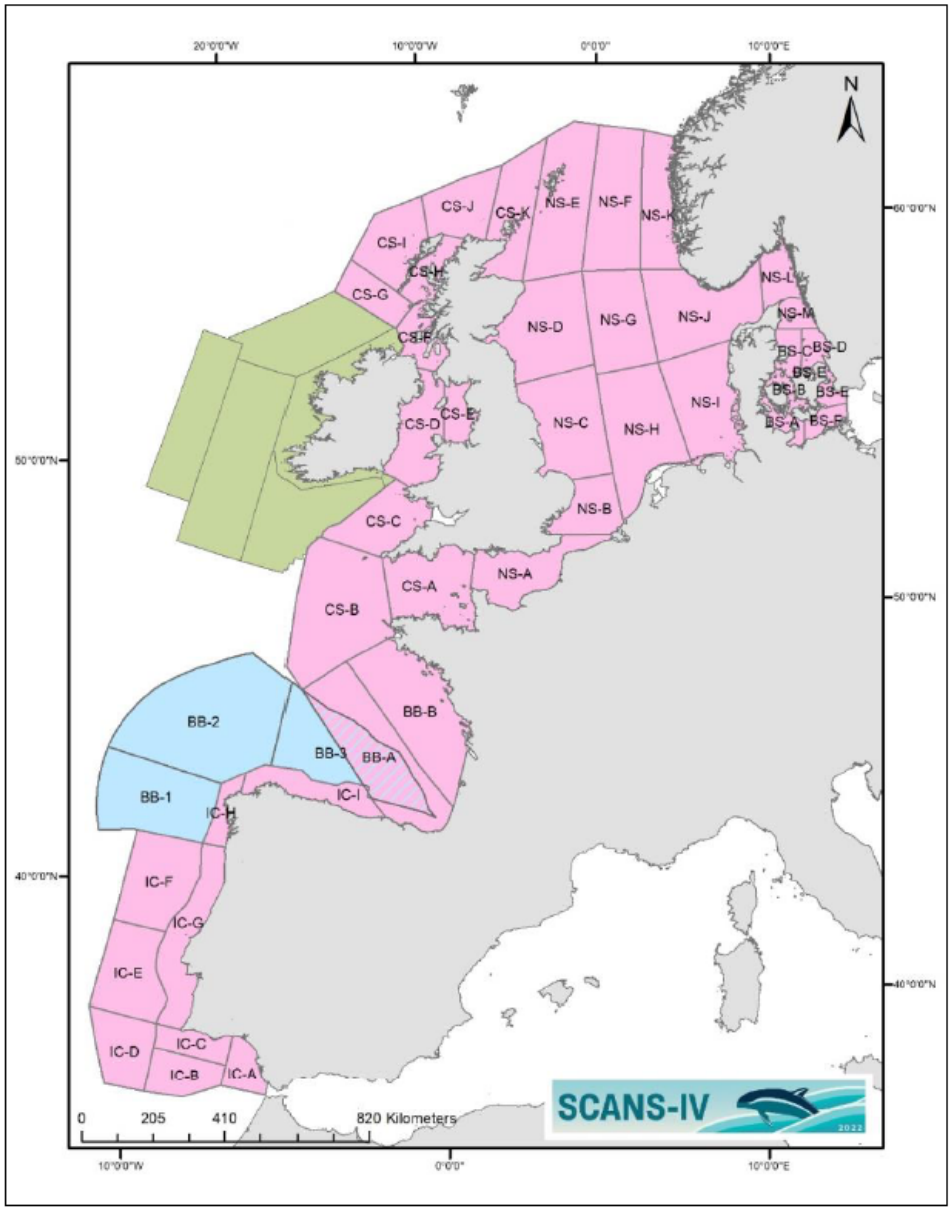


Figure 6-1 Area covered by SCANS-IV and adjacent surveys. SCANS-IV pink lettered blocks were surveyed by air; blue numbered blocks were surveyed by ship. Blocks coloured green were surveyed by the Irish ObSERVE project. (Giles et al., 2023).

6.2.1 Conservation Objectives

The Moray Firth SAC Conservation Objectives for bottlenose dolphin are:

- To ensure that the qualifying features of Moray Firth SAC are in favourable condition and make an appropriate contribution to achieving Favourable Conservation Status.

- To ensure that the integrity of Moray Firth SAC is maintained or restored in the context of environmental changes by meeting the following objectives for each qualifying feature:
    - The population of bottlenose dolphin is a viable component of the site;
    - The distribution of bottlenose dolphin throughout the site is maintained by avoiding significant disturbance; and
    - The supporting habitats and processes relevant to bottlenose dolphin and the availability of prey for bottlenose dolphin are maintained.

Bottlenose dolphin within the Moray Firth SAC are currently in favourable condition.

6.3 Data Sources

The following project specific information on was used to inform the baseline review and assessment of effects:

- Underwater noise modelling (See **Appendix 5-2**); and
- Sediment sample analysis of material to be dredged and disposed of (see Chapter 8 of the accompanying EIAR).

Additionally, a number of data sets have been used to inform the baseline for bottlenose dolphin. These are listed in **Table 6-1.**

Table 6-1 Data sources

Data	Year	Coverage	Notes
Small Cetaceans in the European Atlantic and North Sea (SCANS-IV) data (Gilles *et al.*, 2023)	Summer 2022	North Sea and European Atlantic waters	Provides information including abundance and density estimates of cetaceans in European Atlantic waters in summer 2022, including the proposed offshore development area.
Distribution and abundance maps for cetacean species around Europe (Waggitt *et al.*, 2019)	1980-2018	North-east Atlantic	Provides information on harbour porpoise in the North Sea area.
Management Units (MUs) for cetaceans in UK waters (Inter-Agency Marine Mammal Working Group (IAMMWG), 2023)	2023	UK waters	Provides information on cetacean MUs for the proposed offshore development area.
Abundance estimation and movements of bottlenose dolphin along the east coast of Scotland (Arso Civil *et al.,* 2021)	2009-2019	East coast, Scotland	Provides abundance estimates for bottlenose dolphin on the east coast.
Site Condition Monitoring of bottlenose dolphins within the Moray Firth Special Area of Conservation (Cheney *et al.,* 2024)	2017-2022	Moray Firth SAC	Provides information on the population abundance of Bottlenose Dolphins in the Moray First SAC between 2017-2022.

6.4 Overview of Effect Pathways Screened In

As described in the HRA Screening Report (**Appendix 4-2**) and supplemented by **Section 4**, the potential impacts on bottlenose dolphin of the Moray Firth SAC are:

- Disturbance from underwater noise piling and dredging activities affecting bottlenose dolphin; and
- Indirect effects due to changes in water quality and prey resource affecting bottlenose dolphin.

6.5 Potential Effects of the Proposed Scheme Alone

6.5.1 Potential for disturbance from piling activities

There is the potential for a displacement response from the area for as a result of piling activities; however, there is little information on behavioural response of bottlenose dolphin. During the installation of Moray East offshore wind farm, it was found that piling had no impact on the presence of dolphins (Fernandez-Betelu *et al.,* 2021). Although Graham *et al*. (2017) found dolphins to move away from impulsive noise sources such as piling during offshore wind construction.

The area surrounding the Port of Dundee is already a busy marine area, and any bottlenose dolphins in the vicinity of the Proposed Scheme would be used to increased levels of marine traffic and a noisy environment. Whilst there is the potential for a displacement response by bottlenose dolphin as a result of underwater noise generated by the proposed piling activities, it is expected that they would quickly return once the activity has been completed, and therefore any effects would be both localised and temporary.

Taking the above into account, there will be **no adverse effect on the integrity bottlenose dolphin, as a feature of the Moray Firth SAC**, due to disturbance from piling activities.

6.5.2 Potential for disturbance from dredging activities and vessels

As noted in **Section 6.5.2**, the area surrounding the Port of Dundee is a busy marine area and any bottlenose dolphin present in the area would be used to increased levels of underwater noise. Given the busy nature of the area, any potential for disturbance from the dredging activities and vessels would be localised and unlikely to cause any significant disturbance to bottlenose dolphin in the area.

Table 6-2 presents the assessment for any potential disturbance from dredging activities and vessels using a 2km disturbance range. It shows that less than one individual (0.3) could be disturbed from dredging activity with up to 0.16% of the Coastal East Scotland (CES) population affected.

Table 6-2 Impact ranges and areas, and maximum number of individuals (and % of reference population) that could be at risk of disturbance from dredging activities and vessels using a 2km disturbance range

Activity	Impact range (and area)	Maximum number of individuals (% of reference population)
Dredging activity and vessels	2km (12.57km^2)	0.3 (0.16% of CES MU)

Taking into account the above, there will be **no adverse effect on the integrity of bottlenose dolphin, as a feature of the Firth of Tay and Eden Estuary SAC**, due to disturbance from dredging activities and vessels.

6.5.3 Potential for indirect effects as a result of changes to water quality and prey resource

The potential indirect effects to bottlenose dolphin can result from changes in water quality (from an increase in SSC, the release of contaminated sediments during dredging and disposal, and accidental spillages and leaks) and from changes in prey resource.

Marine mammals often inhabit turbid environments and cetaceans utilise sonar to sense the environment around them and there is little evidence that turbidity affects cetaceans directly (Todd *et al*., 2014). Pinnipeds

are not known to produce sonar for prey detection purposes; however, it is likely that other senses are used instead of, or in combination with, vision.

As described in **Section 5.5.3**, the sediment to be dredged is considered suitable for disposal at sea. With adherence to the mitigation measures stated in **Section 5.5.4**, the risk of an accidental spillage or leak is low, and should one occur appropriate measures will be in place to manage it.

A detailed assessment of potential impacts on fish and shellfish as a result of the Proposed Scheme is presented in Chapter 10 of the accompanying EIAR. The assessment concluded that potential impacts on fish and shellfish would be minor adverse to negligible, which is not significant.

Taking the above into account, there will be **no adverse effect on the integrity of bottlenose dolphin, as a designated feature of the Moray Firth SAC**, due to changes in water quality and prey resource**.**

6.6 Potential effects of the Proposed Scheme In-Combination with other Plans and Projects

Potential in-combination effects have been assessed in **Table 6-3**, using the same approach as that undertaken for the Firth of Tay and Eden Estuary SAC in **Section 5.6**. In addition to the assessment in **Section 5.6;** there are more projects in closer vicinity to Moray Firth SAC. Such as operation and maintenance activities at Moray West OWF, additional geophysical surveys at North Sea Renewables and Berwick Bank OWF. The activities at Eastern Green link and Eastern Green Link 2 have been grouped together,

Table 6-3 In-combination assessment for bottlenose dolphin at the Moray Firth SAC

Project	Bottlenose dolphin density (/km^2)	Effect area (km^2)	Maximum number of individuals potentially disturbed
Proposed Scheme	0.0298	12.57	0.4
Seagreen operations & maintenance	0.0298	50.27	1.5
Eastern Green link and Eastern Green Link 2	0.0037	50.27	0.2
North Sea Renewables Grid geophysical surveys	0.0298	78.54	2.3
Berwick Bank geophysical surveys	0.0298	78.54	2.3
Moray West O&M	0.0037	50.27	0.2
Neart na Gaoithe O&M	0.0298	50.27	0.2
Total number of Bottlenose dolphin			**7.0**
Percentage of SAC MU			**3.0%**

Table 6-3 shows that 3.0% of the Moray Firth SAC population of bottlenose dolphin could be disturbed from activities from other projects with the Proposed Scheme. In reality however it is very unlikely that all project activities would occur at the same time. In addition, the assessment is precautionary as some of the other projects are quite far away from the Moray Firth SAC, where any effects would more likely impact on the Great North Sea population rather than the Moray Firth CES population. The CES population is very coastal and on average remain within 2km of the coast (Quick *et al.,* 2014).

It has therefore been concluded that there would be **no adverse effect on the integrity of bottlenose dolphin, as a feature of the Moray Firth SAC**, due to in-combination effects from dredging and vessel disturbance.

7 Information for Appropriate Assessment: River Tay SAC

This chapter provides information to determine whether the potential effects of the Proposed Scheme would have an adverse effect on the integrity of the River Tay SAC.

7.1 Features Screened In

Features screened into the Appropriate Assessment include (see **Section 4.7**):

- Atlantic salmon;
- River lamprey;
- Sea lamprey; and
- Otter.

7.2 Description of Designation

The River Tay is Scotland's longest river that starts on Ben Lui in Argyll and Bute and makes its way eastward through the Grampian mountains towards Perth where it enters the Firth of Tay. The SAC is designated for transitional fish species: Atlantic salmon, sea lamprey and river lamprey. The presence of these species attributes to the river's high water quality and necessary habitats to support their life cycles. Although lampreys are present as qualifying Annex II species, they are not the primary reason for site selection. The river is thought to support one of the most important sea lamprey populations in Scotland (NatureScot, 2020).

The otter population of the River Tay are wide-ranging and highly mobile. The population at the River Tay SAC is reliant on suitable habitat in the surrounding countryside. The home range of an otter will vary depending on their sex, habitat quality and food availability. At this SAC, some otters that have parts of their territories within the designated area may also feed in coastal waters that lie out with the boundary of the SAC. In coastal areas, otter densities may be as high as 0.5 - 0.7 animals/km (NatureScot, 2020). Males living in rivers and streams can have a mean linear range size of around 40km, though have been known to range as far as 80km, and females living in the same habitat can have a linear home range of 20km. The feature is in favourable maintained condition.

7.2.1 Conservation Objectives

The River Tay SAC Conservation Objectives for transitional fish are to:

- Maintain the population of Atlantic salmon, including range of genetic types, as a viable component of the site;
- Maintain the distribution of Atlantic salmon throughout the site;
- Maintain the habitats supporting Atlantic salmon within the site and availability of food;
- Maintain the population of the lamprey species as viable components of the site;
- Maintain the distribution of the lamprey species throughout the site; and
- Maintain the habitats supporting the lamprey species' within the site, and availability of food.

Conservation Objectives for the River Tay SAC in relation to otters are (NatureScot, 2020):

- To ensure that the qualifying features of River Tay SAC are in favourable condition and make an appropriate contribution to achieving favourable conservation status;

- Maintain the population of otter as a viable component of the site;
- Maintain the distribution of otter throughout the site; and,
- Maintain the habitats supporting otter within the site and availability of food.

7.3 Data Sources

A number of publicly available datasets and information on transitional fish in the area were used and included in the baseline review and assessment of effect. These are listed below:

- River Tay Special Area of Conservation Advice Package (NatureScot, 2020);
- SNH's (now NatureScot) Habitats Regulations Appraisal (HRA) on the Firth of Forth: A Guide for developers and regulators (SNH, 2016);
- Underwater noise modelling (**Appendix 5-2**);
- Sediment sample analysis of material to be dredged and disposed of (see Chapter 8 of the accompanying EIAR); and
- Otter survey (**Section 4.6**).

7.4 Overview of Effect Pathways Screened in

As described in the HRA Screening Report (**Appendix 4-2**) and supplemented by **Section 4**, the potential impacts on transitional fish and otter of the River Tay SAC are:

- Potential impacts on transitional fish:
    - Generation of underwater noise from piling operations and dredging activity, which could result in physiological and / or behavioural responses, or may form a 'barrier' to migration routes;
    - Changes in water quality, such as increased suspended sediment, which may have physiological effects or may form a barrier to migration; and
    - Changes in habitat quality, such as increased sedimentation or loss of habitat.
- Potential impacts on Otter
    - disturbance and mortality as a result of the proposed works.

7.5 Potential Effects of the Proposed Scheme Alone

7.5.1 Underwater noise effects during piling affecting transitional fish

As stated in **Chapter 2**, there is the potential for both impact-piling and vibro-piling to be used to install the piles. Underwater noise modelling, undertaken for the Proposed Scheme (**Appendix 5-2**), predicted that impact-piling has a greater potential to impact transitional fish than vibro-piling, and therefore impact-piling has been assessed as the worst-case.

Noise produced from dredging activities was also modelled. The model confirmed that that noise levels from shipping and continuous sounds would not affect any fish species; therefore, underwater noise from dredging activities and vessels has therefore not been considered further.

Fish have a wide range of auditory capabilities depending on the species, mostly in the frequency 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 piling and dredging is expected to fall within the hearing ranges of transitional fish species from the River Tay SAC (Popper, 2003).

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 (Popper and Hastings, 2009). The impacts can be summarised into four broad categories (Popper *et al*., 2014):

1. **Mortality and mortal injury** – immediate or delayed death.
2. **Recoverable injury** – injuries, including hair cell damage, minor internal or external hematoma, etc. None of these injuries are likely to result in mortality.
3. **TTS** – short or long term changes in hearing sensitivity that may or may not reduce fitness. TTS is defined as any change in hearing of 6dB or greater that persists. This level is selected since levels less than 6 dB are generally difficult to differentiate. It is also the view of Popper et al., (2014)that anything less than 6dB will not result in a significant effect from the standpoint of hearing.
4. **Masking / behavioural effects** – impairment of hearing sensitivity by greater than 6dB, including all components of the auditory scene, in the presence of noise. Behavioural effects include a substantial change in behaviour for the animals exposed to a sound. This may include long-term changes in behaviour and distribution, such as moving from preferred sites for feeding and reproduction, or alteration of migration patterns. This behavioural criterion does not include effects on single animals, or where animals become habituated to the stimulus, or small changes in behaviour such as a startle response or small movements.

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).

The swim bladder of Atlantic salmon *Salmo salar* does not aid in hearing and this species can be regarded as a hearing generalist (Popper *et al*., 2014). Studies by Hawkins and Johnstone (1978) found salmon show low sensitivity to noise. Their ability to respond to noise is regarded as poor with a narrow frequency span and a limited ability to discriminate between different noises. Nedwell *et al.* (2006), concluded for salmon and brown trout, no obvious signs of trauma could be attributed to sound exposure from vibro- and impact-piling associated with these fish species which were caged between 30m – 400m from the source of noise.

Sea lamprey *Petromyzon marinus* and river lamprey *Lampetra fluviatilis* are fish without a swim bladder and are considered to have a low sensitivity to noise (Popper *et al*., 2014).

Overall, sea and river lamprey, and Atlantic salmon are considered to be members of Hearing Group One and Two respectively, as defined by Popper *et al*. (2014), and therefore have low sensitivity to noise (Popper *et al*., 2014).

Behavioural responses to underwater noise disturbance have the potential to occur anywhere within the zone of audibility and may include evasive actions or other altered behaviour due to masking of ambient background sounds. Masking effects can be significant if an anthropogenic sound prevents fish from responding to biologically relevant sounds. Of particular relevance for transitional fish species is the risk of underwater noise forming a 'barrier' to movement along migratory routes, potentially preventing upstream or downstream movement thus affecting productivity / spawning success.

It should be noted that all piling would be subjected to the Joint Nature Conservation Committee (JNCC) soft-start protocol to reduce risk to sensitive marine receptors (JNCC, 2010), meaning that piling energy would be gradually ramped up from commencement over a period of at least 20 minutes, to allow for receptors within injurious range to move away from the source. This has been taken into account in the assessment that follows.

For fish, the largest recoverable injury ranges (203dB SEL_{cum} threshold) are predicted out to a maximum of 10m when considering a stationary animal, which reduces to less than 10m for fleeing animal calculations. Maximum TTS impact ranges (186dB SEL_{cum} threshold) are predicted out to 80m for stationary animals, and these ranges also reduce to less than 10m when considering fleeing animals (see **Appendix 5-2**).

Salmon and / or lamprey species within 10m of the piling source would be exposed to injurious noise levels from a single strike of an impact pile; however, this would be mitigated with the soft start procedure allowing any individuals to move to a safe area. There is a potential for TTS in all species at a distance of up to 80m from the piling source. Since only mobile adults/pre-adults are likely to be present within the estuary, with an ability to move away from the piling, there is little to no risk of mortality, recoverable injury or TTS onset.

In terms of the potential effects of underwater noise on migration activity, at the location where the piling would take place, the estuary is approximately 1.5km wide, which is greater than the maximum impact range predicted by the model. In terms of behavioural effects, Popper *et al*. (2014) provides a qualitative description of relative sensitivity of fish and indicates that far-field behavioural responses (i.e. more than 1km from the source) would be of low magnitude for Atlantic salmon and lamprey species. As such, based on the modelled maximum impact range, it can be concluded that the respective ranges for potential injury, TTS and significant behavioural modification would not sufficiently extend into the migratory route to interfere with migration; therefore, there is no potential for a 'barrier' effect from noise produced by the proposed piling and migration is expected to continue unimpeded. Any individuals that may move along the southern edge of the Firth of Tay (and hence may encounter noise levels capable of preventing onwards movement (bearing in mind that there remains a lack of evidence for the potential of piling noise to cause a barrier to movement for these species) would be able to simply move further out into the river channel to circumnavigate through unaffected waters.

As such, it is concluded that the effects of underwater noise on migrating sea lamprey, river lamprey and Atlantic salmon would not have an adverse effect on the integrity of the River Tay SAC.

7.5.2 Changes in water quality affecting transitional fish

Dredging would result in a temporary increase in SSC in the water column that 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*., 2007). 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. Disturbance of sediment may also risk the release of sediment-bound contaminants into the water column, which again may have physiological effects (depending on concentration). As with underwater noise, adverse water quality effects (i.e. increases in SSC or contaminant release) could act as a barrier to migratory movements in transitional fish.

The Firth of Tay and Eden Estuary is characterised by powerful tidal currents which generate high suspended sediment load (Bates *et al.*, 2004). Turbidity has been measured near to the Port of Dundee and Lady Shoal approach channel. At both locations, the minimum suspended sediment concentration measured was 5mg/l, with most values within the time series between 10mg/l and 100mg/l. The highest observed SSCs were 551mg/l near the Port and 339mg/l near the Lady Shoal approach channel.

Predicted changes to SSC as a result of the proposed dredging and disposal are described in Chapter 7 of the accompanying EIAR. The extent of the sediment plume predicted near to the sea bed is shown on **Figure 7-1**, which shows that significant increase in SSC during dredging and disposal would be localised to the immediate vicinity of the dredge footprint and disposal site. At a distance of 500m to the west and 1.3km to the east from the disposal, maximum SSC increases are predicted to be less than 300mg/l, which

is within the natural variations for the Tay. SSC increases at the disposal site are predicted to last up to 30 minutes before returning to ambient. The Firth of Tay at the location of the Proposed Scheme is approximately 1.5km wide, hence there would be no significant obstruction or 'barrier effect' to migrating lamprey and Atlantic salmon.

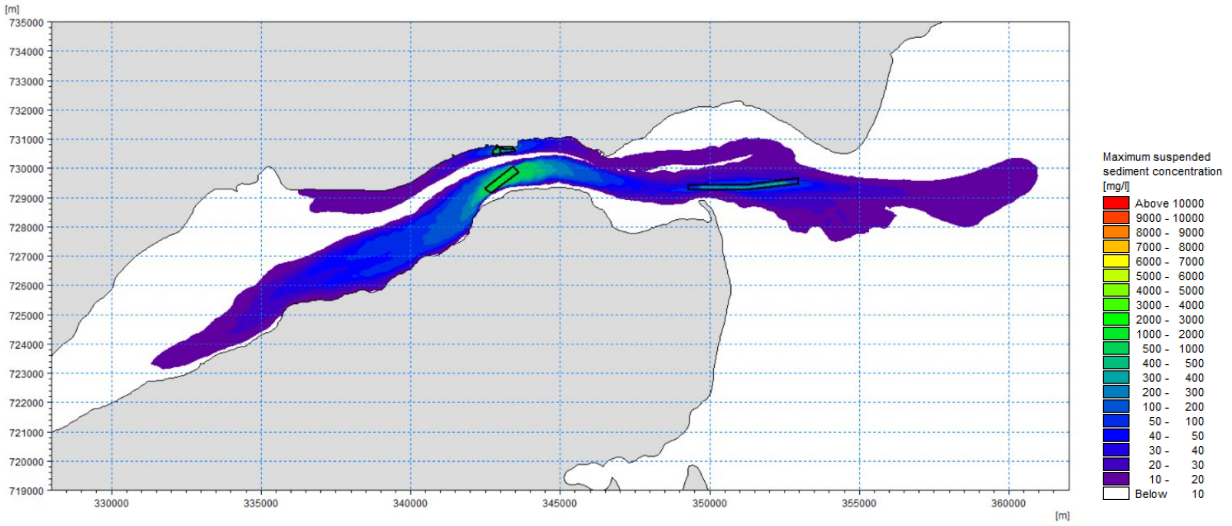


Figure 7-1 Predicted maximum suspended sediment concentrations near the bed of the Firth of Tay during the worst-case dredging at the Port of Dundee and Lady Shoal approach channel, and disposal at Middle Deep disposal site

As described in **Section 5.5.3**, the sediment to be dredged is considered suitable for disposal at sea. With adherence to the mitigation measures stated in **Section 5.5.4**, the risk of an accidental spillage or leak is low, and should one occur appropriate measures will be in place to manage it.

Taking the above into account, there would be **no adverse effect on sea lamprey, river lamprey and Atlantic salmon, as features of the River Tay SAC**, due to changes in water quality.

7.5.3 Changes in habitat availability affecting transitional fish

In terms of physical loss of habitat used by fish, this would constitute the approaches to DunEco Quay and PCW, and at the Lady Shoal approach channel dredge area. In addition, the suspension and deposition of sediment as a result of the dredge / disposal activities may lead to 'loss' or change in the composition of supporting habitat for fish species. As these areas are within the Firth of Tay, transitional fish use the area to transit to and from their spawning and nursery grounds. As such, the Proposed Scheme would have no effect on the spawning and nursery habitat of Atlantic salmon, and river and sea lamprey. The assessment of the Proposed Scheme on benthic habitats can be seen in Chapter 8 of the accompanying EIAR. The assessment concluded minor to negligible impacts on benthic habitats, which are not significant.

Taking the above into account, there would be **no adverse effect on sea lamprey, river lamprey and Atlantic salmon, as features of the River Tay SAC**, due to changes in habitat availability.

7.5.4 Disturbance and mortality to otter

Potential impacts to otter include disturbance to resting places, or holts, due to dredging and pilling activities. Piling, in particular, can generate airborne noise and vibration, which may disturb otters using nearby areas, especially if undertaken close to potential resting or foraging habitat. These effects may reduce habitat

connectivity and increase competition among otters for limited resources, potentially reducing their overall fitness.

Given the existing level of usage of the area surrounding the recorded holts, it can be assumed that otters using the area are habituated to the existing operations of the Port. In addition, the recorded holts are approximately 250m for RS3 and 230m for RS4 from the proposed piling works. To minimise disturbance from the construction activities a lighting strategy will be put in place, which includes:

- Avoid artificial lighting on or near the water, especially white or blue-spectrum lights;
- Use directional lighting (using fittings such as hoods, cowls or shields) to direct light downwards wherever possible and avoid unnecessary light spill;
- LED luminaires should be used where possible due to their sharp cut-off, lower intensity, good colour rendition and dimming capability;
- Adopt a warm white spectrum (ideally <2700 Kelvin, max 4000 Kelvin) to reduce the blue light component;
- Position lighting to avoid illumination of suitable foraging and commuting habitat within and adjacent to the Site; and
- Restrict lighting times where practicable (e.g. switch off between 23.00 and 05.00) to maintain dark periods.

Taking the above into account, there would be **no adverse effect on otter, as a feature of the River Tay SAC**, due to disturbance and mortality.

7.6 Potential effects of the Proposed Scheme In-Combination with other Plans and Projects

As presented in **Table 5-3**, there is no potential for in-combination effects for transitional fish.

The proposed improvements to the PCW as part of the Proposed Scheme has the potential to result in cumulative impacts with the proposed extension to the laydown area and landside improvements to PCW at the Port of Dundee. Both projects have proposed mitigation measures to avoid and minimise potential impacts to otter, including the implementation of a sensitive lighting strategy. In addition, the extension of the laydown area and landside improvements to PCW project will adhere to the following good practice measures:

- Cover / fence-off any excavations, or provide escape ramps at the end of the working day to avoid animals becoming trapped (if an animal does become trapped, advice would be sought immediately from NatureScot);
- Cap any temporarily exposed pipe systems out of work hours;
- Sensitive lighting scheme; and
- Avoid unnecessary disturbance to habitats by minimising the extent of ground clearance, as far as possible.

It has therefore been concluded that there would be **no adverse effect on the integrity of Atlantic salmon, sea lamprey, river lamprey or otter, as a features of the River Tay SAC**, due to in-combination effects with other plans and projects.

8 Conclusions

The Stage One (screening) assessment concluded that, during the construction phase of the Proposed Scheme, LSE could not be excluded for designated features of the following sites:

- Transitional fish species and otter of the River Tay SAC;
- All features of the Firth of Tay and Eden Estuary SAC; and
- Bottlenose dolphin feature of the Moray Firth SAC.

The Proposed Scheme would not change the number or type of vessels berthing at the Port of Dundee, nor would not result in any changes to the existing operations being carried out at the Port. The proposed deepening works would not change the maintenance dredge requirement at the Port of Dundee, nor would dredging be required to maintain the deepened Lady Shoal approach channel dredge area. As such, the operational phase does not have the potential to cause LSE to any of the qualifying features of the above sites with respect to their Conservation Objectives, and no operational mitigation measures are necessary.

The information provided to inform the Appropriate Assessment has concluded that there would be no adverse effect on the integrity of the sites listed above during the construction phase of the Proposed Scheme, with construction phase potential impacts being mitigated for where required.

9 References

Arso Civil, M., Quick, N., Mews, S., Hague, E., Cheney, B. J., Thompson, P.M. and Hammond, P.S. (2021). Improving understanding of bottlenose dolphin movements along the east coast of Scotland. Available at: https://group.vattenfall.com/uk/contentassets/c65a13553f864f599431d69c8c6a57b4/bottlenose-dolphin-monitoring---final-report-2021.pdf

Aynsley, C.L., (2017). Bottlenose dolphins (*Tursiops truncatus*) in north-east England: A preliminary investigation into a population beyond the southern extreme of its range. MSc Thesis, Newcastle University.

Bates, C. R., Moore, C. G., Malthus, T., Mair, J. M. and Karpouzli, E. (2004). Broad scale mapping of habitats in the Firth of Tay and Eden Estuary, Scotland. Scottish Natural Heritage Commissioned Report No. 007 (ROAME No. F01AA401D).

Benhemma-Le Gall, A., Graham, I.M., Merchant, N.D. and Thompson, P.M. (2021). Broad-Scale Responses of Harbor Porpoises to Pile-Driving and Vessel Activities During Offshore Windfarm Construction. Front. Mar. Sci. 8:664724. doi: 10.3389/fmars.2021.664724.

Brandt, M.J., Dragon, C.A., Diederichs, A., Bellmann, M.A., Wahl, V., Piper, W., Nabe-Nielsen, J. and Nehls G. (2018). Disturbance of harbour porpoises during construction of the first seven offshore wind farms in Germany. Marine Ecology Progress Series, 596: 213-232.

Calbrade, N.A., Birtles, G.A., Woodward, I.D., Feather, A., Hiza, B., Caulfield, E., Balmer, D.E., Peck, K., Wotton, S.R., Shaw, J.M., and Frost, T.M. (2025). Waterbirds in the UK 2023/24: The Wetland Bird Survey and Goose & Swan Monitoring Programme. BTO/RSPB/JNCC/NatureScot. Thetford.

Carter, M.I., Boehme, L., Duck, C.D., Grecian, J., Hastie, G.D., McConnell, B.J., Miller, D.L., Morris, C., Moss, S., Thompson, D. and Thompson, P. (2020). Habitat-based predictions of at-sea distribution for grey and harbour seals in the British Isles. Available at: https://research-repository.st-andrews.ac.uk/bitstream/handle/10023/21558/Carter2020_Report_BEIS.pdf?sequence=1&isAllowed=y

Carter, M.I., Boehme, L., Cronin, M.A., Duck, C.D., Grecian, W.J., Hastie, G.D., Jessopp, M., Matthiopoulos, J., McConnell, B.J., Miller, D.L. and Morris, C.D. (2022). Sympatric Seals, Satellite Tracking and Protected Areas: Habitat-Based Distribution Estimates for Conservation and Management. Available at: https://www.researchgate.net/profile/Matt-Carter-2/publication/361420073_Sympatric_Seals_Satellite_Tracking_and_Protected_Areas_Habitat-Based_Distribution_Estimates_for_Conservation_and_Management/links/62b0801289e4f1160c8d1956/Sympatric-Seals-Satellite-Tracking-and-Protected-Areas-Habitat-Based-Distribution-Estimates-for-Conservation-and-Management.pdf

Cates, K. & Acevedo-Gutierrez, A. (2017). Harbor Seal (Phoca vitulina) Tolerance to Vessels Under Different Levels of Boat Traffic Kelly Cates and Alejandro Acevedo-Gutiérrez Aquatic Mammals 2017, 43(2), 193-200, DOI 10.1578/AM.43.2.2017.193.

Central Dredging Association (CEDA) (2011). Underwater sound in relation to dredging. Position Paper - 7 November 2011. Available at URL: http://www.dredging.org/documents/ceda/downloads/2011-11_ceda_positionpaper_underwatersound.pdf (Accessed on 22/01/2015)

Challis, A., Wilson, M.W., Eaton, M.A., Stevenson, A., Stirling-Aird, P., Thornton, M. and Wilkinson, N.I. (2022) Scottish Raptor Monitoring Scheme Report 2020. BTO Scotland, Stirling.

Cheney, B.J., Arso Civil, M., Hammond, P.S. and Thompson, P.M. (2024). Site Condition Monitoring of bottlenose dolphins within the Moray Firth Special Area of Conservation 2017-2022. NatureScot Research Report 1360.

Cook, A.S.C.P. and Burton, N.H.K, 2010. A Review of the Potential Impacts of Marine Aggregate Extraction on Seabirds. Marine Environment Protection Fund Project 09/P130. British Trust for Ornithology, Thetford, February 2010

Cunningham, L., Baxter, J.M., Boyd., I.L., Duck, C.D., Lonergan, M., Moss, S.E. and McConnell, B. (2009). 'Harbour seal movements and haul-out patterns: implications for monitoring and management'. Aquatic Conservation: Marine and Freshwater Ecosystems, 19 398-407.

Ellison WT, Southall BL, Clark CW, Frankel AS. (2012). A new context-based approach to assess marine mammal behavioral responses to anthropogenic sounds. Conserv Biol 26:21–28

Fernandez-Betelu, O., Graham, I.M., Brookes, K.L., Cheney, B.J., Barton, T.R. and Thompson, P.M.. (2021). Far-field effects of impulsive noise on coastal bottlenose dolphins. Frontiers in Marine Science, 8, p.664230.

Fliessbach, K. L., Borkenhagen, K., Guse, N., Markones, N., Schwemmer, P., & Garthe, S. (2019). A ship traffic disturbance vulnerability index for Northwest European seabirds as a tool for marine spatial planning. Frontiers in Marine Science, 6, 192.

Gilles, A, Authier, M, Ramirez-Martinez, NC, Araújo, H, Blanchard, A, Carlström, J, Eira, C, Dorémus, G, Fernández-Maldonado, C, Geelhoed, SCV, Kyhn, L, Laran, S, Nachtsheim, D, Panigada, S, Pigeault, R, Sequeira, M, Sveegaard, S, Taylor, NL, Owen, K, Saavedra, C, Vázquez-Bonales, JA, Unger, B, Hammond, PS. (2023). Review of Management Unit boundaries for cetaceans in UK waters (2023). Available at: https://dce.au.dk/fileadmin/dce.au.dk/Udgivelser/Eksterne_udgivelser/20230928_SCANS-IV_Report_FINAL.pdf.

Gomez C, Lawson JW, Wright AJ, Buren AD, Tollit D, Lesage V. (2016). A systematic review on the behavioural responses of wild marine mammals to noise: The disparity between science and policy. Can J Zool 94(12):801–819.

Graham, I.M., Pirotta, E., Merchant, N.D., Farcas, A., Barton, T.R., Cheney, B., Hastie, G.D. and Thompson, P.M., (2017). Responses of bottlenose dolphins and harbor porpoises to impact and vibration piling noise during harbor construction. *Ecosphere*, *8*(5), p.e01793.

Hackett, K. (2022). Movement and ecology of bottlenose dolphin (Tursiops truncates) along the North East coast of the UK. *Bangor University* Hammond, P.S., Bearzi, G., Bjørge, A., Forney, K., Karczmarski, L., Kasuya, T., Perrin, W.F., Scott, M.D., Wang, J.Y., Wells, R.S. & Wilson, B. (2008). Delphinus delphis. The IUCN Red List of Threatened Species 2008: e.T6336A12649851.

Hague, E.L., Sinclair, R.R. and Sparling, C.E., (2020). Regional baselines for marine mammal knowledge across the North Sea and Atlantic areas of Scottish waters. Scottish Marine and Freshwater Science.

Harris S and Yalden D.W. (Eds.) (2008). Mammals of the British Isles: Handbook, 4th Edition. The Mammal Society.

Hammond, P. S., Lacey, C., Gilles, A., Viquerat, S., Börjesson, P., Herr, H., Macleod, K., Ridoux, V., Santos, M. B., Scheidat, M., Teilmann, J., Vingada, J., and Øien, N. (2021). Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys. Available at: https://scans3.wp.st-andrews.ac.uk/files/2021/06/SCANS-III_design_based_estimates_final_report_ revised_June_2021.pdf

Hawkins, A.D. and Johnstone, A.D. (1978). 'The hearing of the Atlantic salmon, *salmo salar*', Journal of Fish Biology, 13(6), pp. 655–673. doi:10.1111/j.1095-8649.1978.tb03480.x

Hoekendijk, J.P., Leopold, M.F. and Cheney, B.J. (2021). Bottlenose dolphins in the Netherlands come from two sides: across the North Sea and through the English Channel. Journal of the Marine Biological Association of the United Kingdom, 101(5), pp.853-859.

IAMMWG, (2023). Review of Management Unit boundaries for cetaceans in UK waters. Available at: https://data.jncc.gov.uk/data/b48b8332-349f-4358-b080-b4506384f4f7/jncc-report-734.pdf

Jansen, J.K., Boveng, P.L., Dahle, S.P. and Bengston, J.L. (2010). Reaction of harbor seals to cruise ships. Journal of Wildlife Management,74,1186–1194. https://doi.org/10.1111/j.1937-2817.2010.tb01239.x

Jennings, G., (2012). The ecology of an urban colony of common terns Sterna hirundo in Leith Docks,Scotland. PhD thesis, University of Glasgow. [Online]: http://theses.gla.ac.uk/3910/. Accessed November2021.

JNCC. (2007). *Ramsar Information Sheet: Firth of Tay & Eden Estuary*. Version 3.0. Peterborough: JNCC. Available at: [URL] (Accessed: 20 February 2025).

Jolivet, A., Tremblay, R., Olivier, F. (2016) Validation of trophic and anthropic underwater noise as settlement trigger in blue mussels. *Sci Rep* **6**, 33829

Liles G (2003). Otter Breeding Sites. Conservation and Management. Conserving Natura 2000 Rivers Conservation Techniques Series No. 5. English Nature, Peterborough.

Machernis, A. F., Powell, J. R., Engleby, L., & Spradlin, T. R. (2018). An updated literature review examining the impacts of tourism on marine mammals over the last fifteen years (2000-2015) to inform research and management programs.

McQueen, A.D., Suedel, B.C., de Jong, C. and Thomsen, F., (2020). Ecological risk assessment of underwater sounds from dredging operations. *Integrated environmental assessment and management*, *16*(4), pp.481-493.

National Marine Fisheries Service, (2018). 2018 Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts.

NatureScot (2010) Citation Tayport – Tentsmuir Coast Site of Special Scientific Interest. Fife. Site code: 1523. Available at: https://www.nature.scot/sites/default/files/site-special-scientific-interest/1523/sssi-citation.pdf

NatureScot (2020) River Tay Special Area of Conservation (SAC) Advice to developers when considering new projects which could affect the River Tay Special Area of Conservation.

NatureScot (2024) Firth of Tay and Eden Estuary SAC Conservation and Management Advice.

Nedwell, J., Turnpenny, A., Lovell, J,M., and Edwards, B. (2006) An investigation into the effects of underwater piling noise on salmonids. Available at: https://www.researchgate.net/publication/6658690_An_investigation_into_the_effects_of_underwater_piling_noise_on_salmonids

Paterson, W., Russell, D. J. F, Wu, M., McConnell, B. J. and Thompson, D. (2015). Harbour seal haul-out monitoring, Sound of Islay. Scottish Natural Heritage Commissioned Report No. 894.

Paterson, W.D., Russell, D.J.F., Wu, Gi-Mick, McConnell, B.J., Currie, J., McCafferty, D. and Thompson, D. (2019). Post-disturbance haul-out behaviour of harbour seals. Aquatic Conservation: Marine and Freshwater Ecosystems. Doi: 10.1002/aqc.3092.

Popper, A.N. (2003). Effects of anthropogenic sounds on fishes. Fisheries, 28 (10), 24-31.

Popper, A.N. Hawkins, A.D., Fay, R.R., Mann, D.A., Bartol, S., Carlson, T.J., Coombs, S., Ellison, W.T., Gentry, R.L., Halvorsen, M.B., Løkkeborg, S., Rogers, P.H., Southall, B.L., Zeddies, D.G., and Tavolga, W.N. (2014). Sound Exposure Guidelines for Fishes and Sea Turtles. Springer Briefs in Oceanography ASA S3/SC1.4 TR-2014, Springer.

Popper, A.N., and Hastings, M.C. (2009). The effects of anthropogenic sources of sound on fishes. Journal of Fish Biology 75, 455-489.

Quick, N.J., Arso Civil, M., Cheney, B., Islas Villanueva, V., Janik, V., Thompson, P. and Hammond, P.S., 2014. The east coast of Scotland bottlenose dolphin population: Improving understanding of ecology outside the Moray Firth SAC. Ransijn, J.M., Booth, C. and Smout, S.C. (2019). A calorific map of harbour porpoise prey in the North Sea. JNCC Report No. 633. JNCC, Peterborough, ISSN 0963 8091.

Reid, J.B, Evans, P.G.H. and Northridge, S.P. (2003). Atlas of cetacean Distribution in North west European waters. JNCC, Peterborough.

Robertson, M. J., Scruton, D. A., and Clarke, K. D., (2007). Seasonal Effects of Suspended Sediment on the Behavior of Juvenile Atlantic Salmon, Transactions of the American Fisheries Society, 136:3, 822-828, DOI: 10.1577/T06-164.1

Robinson S. P., Theobald P.D., Hayman G.,Wang L. S., Lepper P. A., Humphrey V., and Mumford, S. (2011). Measurement of underwater noise arising from marine aggregate dredging operations. Marine Aggregate Levy Sustainability Fund MEPF report 09/P108.

Russell, D.J., McClintock, B.T., Matthiopoulos, J., Thompson, P.M., Thompson, D., Hammond, P.S., Jones, E.L., MacKenzie, M.L., Moss, S. and McConnell, B.J., (2015). Intrinsic and extrinsic drivers of activity budgets in sympatric grey and harbour seals. Oikos, 124(11), pp.1462-1472.

Russell, D.J.F. and McConnell, B.J. (2014). Seal at-sea distribution, movements and behavior. Report to DECC. URN: 14D/085. March 2014 (final revision). Sea Mammal Research Unit, St. Andrews, UK.

Santos, M.B., Pierce, G.J., Learmonth, J.A., Reid, R.J., Ross, H.M., Patterson, I.A.P., Reid, D.G. and Beare, D. (2004). Variability in the diet of harbor porpoises (Phocoena phocoena) in Scottish waters 1992–2003. Marine Mammal Science, 20(1), pp.1-27.

Santos, M.B., Pierce, G.J., Reid, R.J., Patterson, I.A.P., Ross, H.M. and Mente, E., (2001). Stomach contents of bottlenose dolphins (Tursiops truncatus) in Scottish waters. Marine Biological Association of the United Kingdom. Journal of the Marine Biological Association of the United Kingdom, 81(5), p.873.

SCOS, (2020). Scientific Advice on Matters Related to the Management of Seal Populations: 2020. Available at: http://www.smru.st-andrews.ac.uk/research-policy/scos/

SCOS, (2022). Scientific Advice on Matters Related to the Management of Seal Populations: 2020. Available at: http://www.smru.st-andrews.ac.uk/files/2021/06/SCOS-2020.pdf

SCOS, (2024). Scientific Advice on Matters Related to the Management of Seal Populations: 2024. Available at: https://biology.st-andrews.ac.uk/smru/wp-content/uploads/sites/12/2025/05/SCOS-2024.pdf

SNH, (2014). Natura Casework Guidance: How to consider plans and projects affecting Special Areas of Conservation (SACs) and Special Protection Areas (SPAs). Available from: https://www.nature.scot/sites/default/files/2018-05/Guidance%20-

%20Natura%20Casework%20Guidance%20-%20How%20to%20consider%20plans%20and%20projects%20affecting%20Special%20Areas%20of%20Conservation%20%28SACs%29%20and%20Special%20Protection%20Areas%20%28SPAs%29.pdf

SNH, (2016). Habitats Regulations Appraisal on the Firth of Forth: A Guide for Developers and Regulators. Inverness, May 2016. Available from: https://www.nature.scot/sites/default/files/2019-07/Habitats%20Regulations%20Appraisal%20%28HRA%29%20on%20the%20Firth%20of%20Forth%20-%20A%20Guide%20for%20developers%20and%20regulators_1.pdf

SNH, (2018a). Citation for Special Protection Area (SPA): Firth Of Tay And Eden Estuary (UK9004121)

SNH, (2018b). Citation for Special Protection Area Firth of Forth.

Southall, B.L., Bowles, A.E., Ellison, W.T., Finneran, J.J., Gentry, R.L., Greene Jr., C.R., Kastak, D., Ketten, D.R., Miller, J.H., Nachtigall, P.E., Richardson, W.J., Thomas, J.A., and Tyack, P.L. (2007). Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. Aquatic Mammals, 33 (4), pp. 411-509.

Southall, B.L., Finneran, J.J., Reichmuth, C., Nachtigall, P.E., Ketten, D.R., Bowles, A.E., Ellison, W.T., Nowacek, D.P. and Tyack, P.L., (2019). Marine mammal noise exposure criteria: updated scientific recommendations for residual hearing effects.

Southall, B.L., Nowacek, D.P., Bowles, A.E., Senigaglia, V., Bejder, L. and Tyack, P.L., (2021). Marine mammal noise exposure criteria: assessing the severity of marine mammal behavioral responses to human noise. *Aquatic Mammals*, *47*(5), pp.421-464.

Spiga, I., Caldwell, G.S. and Bruintjes, R. (2016). Influence of Pile Driving on the Clearance Rate of the Blue Mussel, *Mytilis edulis* (L.). Proceedings of Meetings on Acoustics 27: 040005.

Strong, P. and Morris, S.R. (2010), “Grey seal (*Halichoerus grypus*) disturbance, ecotourism and the Pembrokeshire Marine Code around Ramsey Island”, *Journal of Ecotourism*, Vol. 9 No. 2, pp. 117–132, doi: 10.1080/14724040903019869.

Theobald, P.D., Robinson, S.P., Lepper, P.A., Hayman, G., Humphrey, V.F., Wang, L. and Mumford, S.E. (2011). The measurement of underwater noise radiated by dredging vessels during aggregate extraction operations. 4th International Conference and Exhibition on Underwater Acoustic Measurements: Technologies & Results.

Thompson, P.M., Hastie G. D., Nedwell, J., Barham, R., Brookes, K., Cordes, L., Bailey, H. and McLean, N. (2012). Framework for assessing the impacts of pile-driving noise from offshore windfarm construction on the Moray Firth harbour seal population. Seal assessment Framework Technical Summary, 6th June 2012

Thompson, P.M. and Miller, D., (1990). ‘Summer foraging activity and movements of radio-tagged common seals (Phoca vitulina. L.) in the Moray Firth, Scotland’. Journal of applied Ecology, pp.492-501.

Thomsen, F., Lüdemann, K., Kafemann, R. and Piper, W. (2006). Effects of offshore windfarm noise on marine mammals and fish, on behalf of COWRIE Ltd.

Tillin, H.M., Mainwaring, K., Tyler-Walters, H., Williams, E. & Watson, A. (2024). *Mytilus edulis* beds on sublittoral sediment. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology

and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 02-07-2025]. Available from: https://marlin.ac.uk/habitat/detail/36

Todd, V.L.G., Todd, I.B., Gardiner, J.C., Morrin, E.C.N., MacPherson, N.A., DiMarzio, N.A. and Thomsen, F. (2014). A review of impacts of marine dredging activities on marine mammals. – ICES Journal of Marine Science, doi: 10.1093/icesjms/fsu187.

Tollit, D.J., Black, A.D., Thompson, P.M., Mackay, A., Corpe, H.M., Wilson, B., Parijs, S.M., Grellier, K. and Parlane, S. (1998). 'Variations in harbour seal Phoca vitulina diet and dive-depths in relation to foraging habitat'. Journal of Zoology, 244(2), pp.209-222.

Waggit, J. J., Evans, P. G. H., Andrade, J., Banks, A. N., Boisseau, O., Bolton, M., Bradbury, G., Brereton, T., Camphuysen, C. J., Durinck, J., Felce, T., Fijn, R.C., Garcia-Baron, I., Garthe, S., Geelhoed, S. C. V., Gilles, A., Goodall, M., Haelters, J., Hamilton, S., Hartny-Mills, L., Hodgins, N., James, K., Jessopp, M., Kavanagh, A. S., Leopold, M., Lohrengel, K., Louzao, M., Markones, N., Martínez-Cedeira, J., Cadhla, O. Ó ., Perry, S. L., Pierce, G. J., Ridoux, V., Robinson, K. P., Begoña Santos, M., Saavedra, C., Skov, H., Stienen, E. W. M., Sveegaard, S., Thompson, P., Vanarmen, N., Wall, D., Webb, A., Wilson, J., Wanless, S. and Hiddink, J. G. (2019). Distribution maps of cetacean and seabird populations in the North-East Atlantic. Available at: https://besjournals.onlinelibrary.wiley.com/doi/epdf/10.1111/1365-2664.13525.

Wale, M.A., Briers, R.A, Hartl, M.G.J., Bryson, D., Diele, K. (2019) From DNA to ecological performance: Effects of anthropogenic noise on a reef-building mussel. Sci Total Environ. 2019 Nov 1;689:126-132. doi: 10.1016/j.scitotenv.2019.06.380. Epub 2019 Jun 24. PMID: 31271981.

WODA (2013). Technical Guidance on: Underwater Sound in Relation to Dredging. World Organisation of Dredging Associations.

Appendix 4-1 Port of Dundee Project Introduction
Appendix 4-2 Port of Dundee HRA Screening Report
Appendix 4-3 NatureScot's Comments on HRA Screening Report
Appendix 4-4 Underwater Noise Modelling
Appendix 4-5 Species Specific Distribution Maps
Appendix 4-6 Otter Survey Target Notes
Appendix 5-1 Benthic Survey Report