REPORT

Port of Leith – Outer Berth

Environmental Impact Assessment Report

Client: Forth Ports Limited

Reference: PC2045-RHD-ZZ-XX-RP-EV-0007

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Acronyms

Acronyms	Acronyms Description
AL	Action Levels
AON	Apparently Occupied Nests
BAP	Biodiversity Action Plan
BoCC5	Birds of Conservation Concern 5
BTO	British Trust for Ornithology
CAR	Controlled Activities Regulations 2011
CD	Chart Datum
CEC	City of Edinburgh Council
CEMP	Construction Environmental Management Plan
CES	Coastal East Scotland
CGNS	Celtic and Greater North Seas
CIA	Cumulative Impact Assessment
CIEEM	Chartered Institute of Ecology and Environmental Management
DAERA	Department for Agriculture the Environment and Rural Affairs
DBT	Dibutyltin
EA	Environment Agency
EIA	Environmental Impact Assessment
EMODnet	European Marine Observation and Data Network
EPS	European Protected Species
EQS	Environmental Quality Standard
ES	East Scotland
FCS	Favourable Conservation Status
FeAST	Marine Scotland’s Feature Activity Sensitivity Tool
GEART	Guidelines for the Environmental Assessment of Road Traffic
GEN	General Planning Principles
GGP	Guidance for Pollution Prevention
HGV	Heavy Goods Vehicle
HRA	Habitats Regulations Appraisal
ICES	International Council for the Exploration of the Sea
ICZM	Integrated Coastal Zone Management

Acronyms	Acronyms Description
IEMA	Institute of Environmental Management & Assessment
ISQG	Canadian Interim Sediment Quality Guidelines
JNCC	Joint Nature Conservation Committee
LDP	Local Development Plan
MarESA	Marine Evidence based Sensitivity Assessment
MarLIN	Marine Life Information Network
MF	Moray Firth
MHWS	Mean High Water Springs
MPS	Marine Policy Statement
MS	Marine Scotland
MU	Management Unit
MWRs	Marine Works (EIA) (Scotland) Regulations 2017, as amended
NIEA	Northern Ireland Environment Agency
NMP	National Marine Plan
NMPi	Marine Scotland's National Marine Planning interactive
NRW	Natural Resources Wales
NS	North Sea
OWF	Offshore Wind Farm
PAC	Pre-Application Consultation
PAH	Polycyclic Aromatic Hydrocarbon
PAN	Planning Advice Note
PCB	Polychlorinated Biphenyls
PEL	Probable Effect Level
PMF	Priority Marine Feature
PPG	Pollution Prevention Guidance
PSA	Particle Size Analysis
SAC	Special Areas of Conservation
SCANS	Small Cetaceans in the European Atlantic and North Sea
SDP	Strategic Development Plan
SEPA	Scottish Environment Protection Agency
SPA	Special Protection Area
SSC	Suspended Sediment Concentration

Acronyms	Acronyms Description
TBT	Tributyltin
TCPRs	Town and Country Planning (EIA) (Scotland) Regulations 2017
TEL	Threshold Effect Level
THC	Total hydrocarbons
TTS	Temporary Threshold Shift
VPs	Vantage Points
WeBS	Wetland Bird Survey
WFD	Water Framework Directive
ZOI	Zone of Influence

1 Introduction

1.1 Background

Offshore wind is a key growth industry for Scotland, and a key component for reaching Scotland's target to reduce greenhouse gas emissions by 75% by 2030 and being net-zero by 2045[1]. The ScotWind process will mean more wind farm projects in the future, and a part of that process includes the commitment to at least 25% of the Offshore Wind Farm (OWF) industry being local[2]. To be able to achieve this, additional suitable port capacity is required in Scotland. To date, there has been limited local content in relation to the currently installed / being installed capacity. An increase in suitable port capacity will facilitate increased local content. Given the proximity of the Port of Leith to either consented or planned developments, it has been identified that Leith should be a strategic location for the offshore wind supply chain in the future. Further information on this need is provided in **Section 1.3**.

The lock gates at the Port of Leith currently restrict access for vessels with a beam (width) of over 30m. Forth Ports Limited is therefore proposing to improve the berth seaward of the entrance to lock; to support vessels associated with the offshore renewables industry which cannot currently transit the lock entrance (see **Figure 1-1**). The development of the outer berth at Port of Leith (the 'proposed development') would (see also **Figure 1-1**):

- Improve a 125m section of existing berth (Area 1);
- Provide an area of hardstanding to be used for loading/unloading (Area 2);
- Provide a laydown area for the storage and transhipment of components for the offshore renewables industry (Area 3); and,
- Include capital dredging to enlarge the existing berth pocket (Area 4).

1.2 Requirement for Environmental Impact Assessment

The following Environmental Impact Assessment (EIA) regulations apply to the proposed development:

1. Marine Works (EIA) (Scotland) Regulations 2017 (as amended) (the MWRs); and,
2. Town and Country Planning (EIA) (Scotland) Regulations 2017 (as amended) (TCPRs).

The proposed development falls under Schedule 2 10(g) of the above regulations, as:

- Construction of harbours and port installations, including fishing harbours (unless included in schedule 1)

Thus, an EIA Screening Report (**Appendix 1-1**) was submitted to both the City of Edinburgh Council (CEC) and Marine Scotland (MS) along with requests for Screening Opinions on 20th September 2021 and 9th November 2021, respectively. CEC's Screening Opinion was received on 14th October 2021 (**Appendix 1-2**), which determined that the proposed development was not EIA development in accordance with the TCPRs and Circular 1/2017. Subsequent to this, MS provided their Screening Opinion on 18th January 2022 (**Appendix 1-3**), which determined the proposed development to be EIA development under the MWRs.

[1] https://www.gov.scot/policies/climate-change/reducing-emissions/
[2] https://www.crownestatescotland.com/resources/documents/supply-chain-development-statement-summary-1

Legend:

- Red line boundary
- 1 - New Berth
- 2 - Hardstanding Area
- 3 - Berth Pocket
- 4 - Laydown area for OWF support

Client: Forth Ports Limited

Project: Port of Leith - Outer Berth

Title: Port of Leith Outer Berth Development

Figure: 1.1

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As the proposed development was determined to be EIA development by MS, an EIA is required to support the Marine Licence application under the MWRs. Further details on the requirement for EIA can be seen in **Section 5.2**.

1.3 Description of Study Area

The study area considered in this EIA Report is the Zone of Influence (ZOI) over which direct and indirect potential impacts of the proposed development may occur. In terms of the proposed development, this was determined by the ZOI for potential impacts to ornithology (**Chapter 11 Ornithology**), which radiates 5km from the proposed development site. The existing baseline within the ZOI, in terms of relevant receptors, is described in the relevant sections of this report.

1.4 Production of the EIA Report

This document constitutes the EIA Report for the proposed development and presents the findings of the EIA process. It has been prepared in accordance with the MWRs to support an application for the required Marine Licence.

The MWRs require an EIA Report to be prepared by competent persons. This report has been compiled by Royal HaskoningDHV, a company which is a corporate member of the Institute of Environmental Management & Assessment (IEMA) (number 0001189) and also a Corporate Registered Assessor for EIA under IEMA's voluntary EIA Quality Mark scheme, through which EIA activity is independently reviewed, on an annual basis, to ensure it delivers excellence in areas including EIA management, team capabilities, regulatory compliance, content, presentation, and improving practice.

1.5 Structure of this Report

Following this introductory chapter, **Chapter 2** provides the need for the proposed development and potential benefits from the development.

Chapter 3 provides details of the proposed development and the alternatives considered.

Chapter 4 outlines the relevant legislation and policy taken into consideration when undertaking the EIA.

Chapter 5 describes the approach taken in producing the EIA, including the Cumulative Impact Assessment (CIA).

Chapter 6 outlines the consultation undertaken in relation to the proposed development.

Chapters 7 to 12 set out the environmental assessment of the proposed development. These sections describe the baseline environment for each of the environmental topics considered. Potential impacts that could arise during the proposed development are identified and, where appropriate, mitigation measures are defined. The predicted residual impacts (i.e., those potential impacts remaining, assuming the recommended mitigation measures are implemented) are also set out in each chapter.

Chapter 13 presents the CIA.

Chapter 14 presents a summary of the potential impacts and mitigation measures.

Chapter 15 lists the references cited within this EIA report.

2 Need for the Proposed Development

The proposed development is a key component in Scotland's economic recovery and energy transition plans, and in the achievement of Scotland's net zero carbon emissions targets. It represents a £50m private sector investment that will see the creation of a bespoke, riverside marine berth capable of accommodating the world's largest offshore wind installation vessels. This will be supplemented by the upgrading of a cargo handling site to accommodate lay down, assembly and supply chain opportunities.

Renewable energy is critical to the decarbonisation effort to achieve net zero greenhouse gas emissions; however, it also has a significant role to play in safeguarding energy security, which has been highly exposed due to the recent events in Eastern Europe, causing the supply crunch in oil market fuelling further exacerbating the volatility of energy prices. The 2020 Sectoral Marine Plan for Scotland[3] highlights that growth of the renewable energy sector in Scotland will be an essential feature of its future clean energy system and a potential key driver of economic growth and ports are identifies as vital infrastructure to support the offshore wind projects.

In response to this, the Edinburgh Waterfront has been designated as a 'National Development' under the draft Fourth National Planning Framework[4] for the provision of services, including port use, to support offshore energy production. NPF4 specifically supports "new and/or upgraded green and blue infrastructure" and "new and/or upgraded port facilities for vessel berthing and related landside activities including for lay-down, and marine sector services". The proposed development has been identified as contributing to this National Development by supporting the manufacture, assembly, storage and distribution and shipment of off-shore renewable structures[5].

Further evidence for the need for the proposed development, a recent report to the Scottish Offshore Wind Energy Council[6] highlighted a need for between 100 and 200Ha of space suitable for marshalling/assembly facilities in Scotland to deliver the current ScotWind proposals and between 175 and 300Ha to support deployment beyond the current ScotWind leasing round. Leith and Dundee are deemed suitable to support North Sea Leasing Zones due to proximity and existing capacity for marshalling and assembly as well as future expansion opportunities, addressing significant port capacity shortfall. **The proposed development would provide 16Ha of space suitable to support the offshore renewables industry.**

In summary, the proposed development would:

- Make a major contribution to Scotland achieving its 70% reduction by 2030 and 2045 net zero targets, as defined in the Climate Change (Scotland) Act 2009 (as amended) and Climate Change (Emissions Reduction Targets) (Scotland) Act 2019;
- Secure the Firth of Forth as the driver for Scotland's green energy transition as envisaged in Scotland's National Marine Plan 2015 and adopted in the 2020 Sectoral Marine Plan for Scotland to support and facilitate growth of offshore wind renewable energy;
- Support Forth Ports' planned bid to the Scottish Government for Firth of Forth Greenport, encompassing the Port of Leith, which aims to fuel economic growth and Covid recovery in designated areas by developing freeports with lower tax levies, less regulations and allocation of government funds;

[3] *2020 Sectoral Marine Plan for Scotland (offshorewindscotland.org.uk)*
[4] *https://www.transformingplanning.scot/national-planning-framework/national-developments/what-are-national-developments/*
[5] *Annex B: Suggestions Contributing to the Proposed National Developments (in whole or in part) - Scotland 2045 - fourth National Planning Framework - draft - national developments: assessment report - gov.scot (www.gov.scot)*
[6] *SOWEC, 2021. Scottish Offshore Wind Strategic Investment Assessment - An Independent report to the Scottish Offshore Wind Energy Council, August 2021*

- Help spearhead Edinburgh’s and Scotland’s Covid 19 recovery plan in-line with the green recovery policy including the Covid Recovery Strategy 2021; and,
- Support up to 1,000 high quality, long term direct jobs and about 2,000 indirect jobs.

3 Description of the Proposed Development

3.1 The Proposed Development

The proposed development would (see also **Figure 1-1**):

- Improve a 125m section of existing berth (Area 1);
- Provide an area of hardstanding to be used for loading/unloading (Area 2);
- Provide a laydown area for the storage and transhipment of components for the offshore renewables industry (Area 3); and,
- Include capital dredging to enlarge the existing berth pocket (Area 4).

3.2 Construction Phase

3.2.1 Outer Berth

The improved berth would be constructed seaward of the existing concrete lead-in jetty as a suspended deck, approximately 125m long, 35m in width, with a 10m run off apron landside (shown as Area 1 on **Figure 1-1**). A plan and cross-section of the improvement works to the outer berth are provided as **Figure 3-1** and **Figure 3-2**.

3.2.1.1 Enabling Works

Prior to the piles being delivered, a site clearance and initial dredge would be undertaken. A barge would be mobilised to remove the existing walkways and existing piles from the dolphins (see **Figure 3-3**). Given the existing piles are socketed it would be difficult to extract them and therefore they would be cut off at bed level. The pile would be suspended by a sling during this process and lifted out after it has been cut.

The initial dredging works are required to remove the overburden prior to the piles being installed. This would be undertaken using two excavators, one on the existing breakwater and the second on a barge. The material would be re-used on site, loaded onto barges and taken to the offsite disposal site (Narrow Deep B Spoil Disposal Ground) or disposed of on land, as appropriate. Volume of material to be dredged according to soil type can be seen in **Table 3-1**.

Table 3-1 Soil type and volume of material to be dredged as part of the pre-works for the development of the outer berth

Soil Type	Volume (m^3)
Soft material (clay/silt/sand)	8,755
Glacial Till	28,825
Mudstone	1,250
Rock	8,150
Total	**47,000**

3.2.1.2 Placement of Rock Armour

Once the excavators have removed the overburden material, they would place the first layer of the rock armour providing protection to the breakwater. The rock would be stored in the inner harbour and moved out to the excavators in 300t loads. When the piling works are complete, a second layer of rock armour would be placed using the excavators.

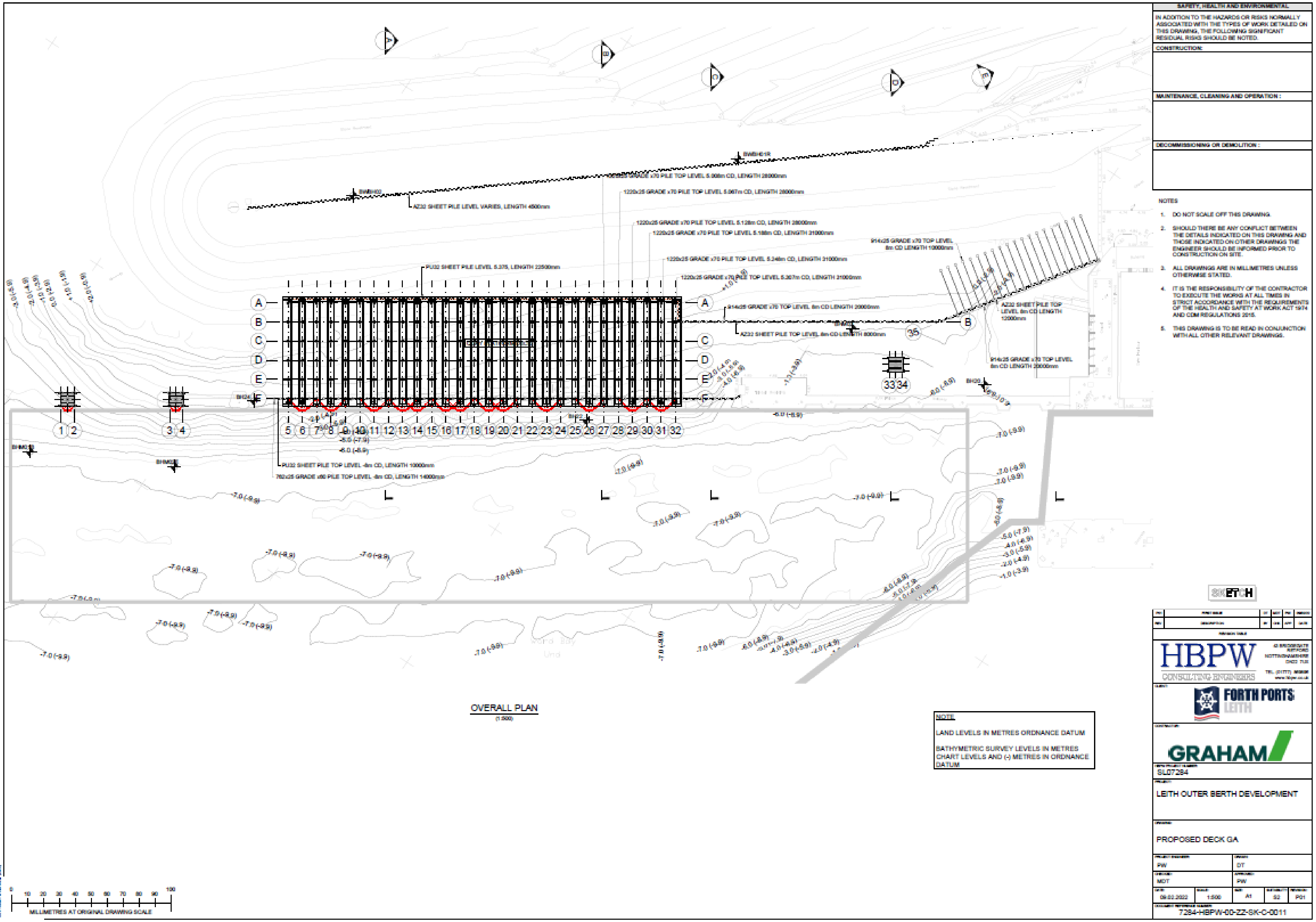


Figure 3-1 *Plan view of the pile layout of the outer berth*

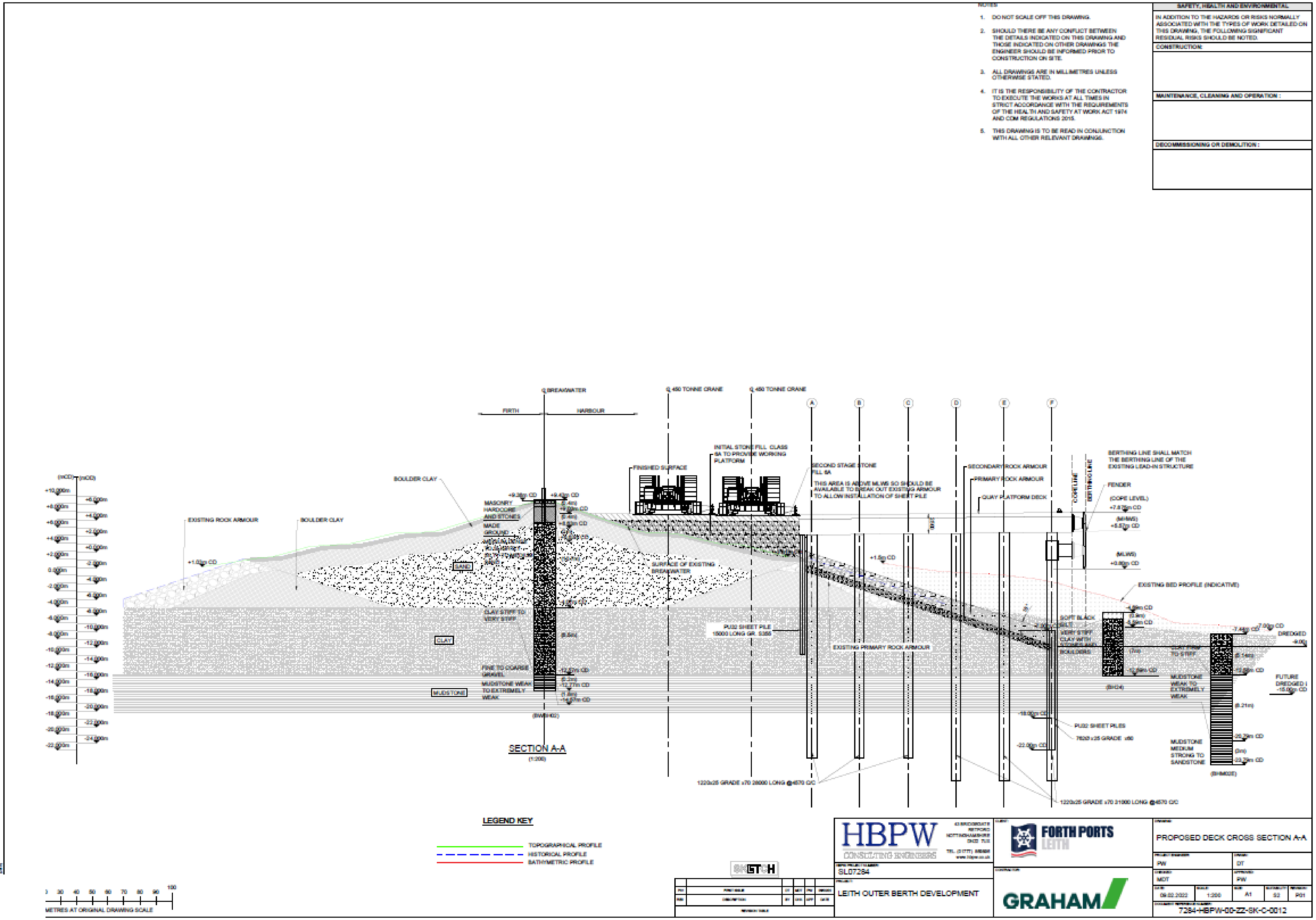


Figure 3-2 *A typical cross section of outer berth and landward area*

Figure 3-3 Removal of existing infrastructure

3.2.1.3 Piling and Area of Hardstanding

Piling platforms would be created on the breakwater to enable the crane to hold the piling hammer (see **Figure 3-4**). Up to 168 tubular piles (6 rows of 28 piles) of approximately 1.2m diameter. In addition, a front row of smaller piles (39 piles of approximately 0.8m diameter) would be installed connected with sheet piles. To support the tubular piles and landward development, sheet piles would also be installed. A plan of the piles is provided as **Figure 3-1**. A 450t crane would install the back row (Row B) of piles, while a 250t crane would install the sheet piles using a hydraulic hammer. When the sheet piles have been completed, the second stage of the piling platform would be created to allow the crane to reach the remaining piles. Row B would be installed first, followed by Rows C to F working from west to east. Fifty percent of the piles in Rows D, E and F may need drilling, using a drill top rig mounted on the 250t crane.

Precast beams would be cast in the hinterland area before placing onto the piles by the 450t crane, followed by the installation of the omni planks and the pouring of the concrete deck, in-situ (see **Figure 3.5**). When the concrete has set, the quay furniture would be installed, including the fenders and bollards. The pavement behind the quay structure would also be installed along with the sheet piles for the floodwall. A typical cross-section of the deck is provided in **Figure 3-2**.

3.2.2 Laydown Area

By the time construction of the laydown area commences (Area 3 on **Figure 1-1**) the pipe coating and storage yard will have been removed. There are a number of bunds on the site which would be modified and excavators and dumpers would be used to move material around site and a compaction roller would be used to compact the fill material prior to placing the wearing course.

Drainage infrastructure and lighting would be installed, including new storm water drainage outfalls that would discharge surface water run-off into the sea following suitable treatment, as per the current situation.

All lighting would be directed downwards to minimise any spill and use minimum lux levels as required for health and safety purposes.

Figure 3-4 Installation of the piles

Figure 3-5 Placement of the precast beams, omni planks and pouring of the concrete deck

3.2.3 Berth Pocket

The existing berth pocket (Area 4 on **Figure 1-1**) would be enlarged by dredging to -9m Chart Datum (CD) (-9.3m CD including a 0.3m over dredge allowance) and be approximately 300m long by 60m wide. Much of the berth pocket area is within the Approach Channel to the Port of Leith, which undergoes regular maintenance dredging to -7m CD. Dredging would be undertaken using a backhoe dredger supported by a barge to take the dredged arisings to the offshore disposal site (Narrow Deep B Spoil Disposal Ground). The volume of material to be dredged according to soil type can be seen in **Table 3-2**.

Table 3-2 Soil type and volume of material to be dredged to enlarge the existing berth pocket

Soil Type	Volume (m^3)
Soft material (clay/silt/sand)	7,358
Glacial Till	27,506
Mudstone	19,136
Total	**54,000**

3.2.4 Delivery of Materials

The majority of the earthwork materials, steel tubular piles, steel sheet piles, fenders and bollards required for construction would be delivered to site by the sea. Material required for raising levels of the hinterland and the wearing course would be imported from local quarries and enter the port via the road network. This equates to approximately 35,000m^3 of material which equates to 4,400 Heavy Goods Vehicle (HGV) movements.

These deliveries would be programmed to occur over around 50 days, resulting in up to 88 HGV deliveries per day, or 176 two-way daily HGV movements. It is noteworthy however, the previous pipe coating facility located on the site of the proposed development has cease operations and therefore the ‘net’ increase in HGV traffic would be significantly less than 176 two-way HGV movements.

3.2.5 Outline Construction Programme

Mobilisation would occur as soon as the consents are in place, within construction expected to take around 15 months. A high-level construction sequence, and indicative timings, is provided below. These activities would not necessarily be carried out consecutively and may be undertaken partially or wholly in parallel:

- Demolition of existing dolphins and associated walkways, and excavation of overburden - four months;
- Installation of primary rock armour, before driving of piles – one month;
- Piling works for the improved quay – five and a half months;
- Installation of secondary rock armour, following driving of piles – three months;
- Installation of precast deck panels and concrete - six months;
- Installation of fender sleeves and fenders – three months;
- Installation of bollards and ladders – one month;
- Dredging – four months;
- Hardstanding to rear of jetty and landward side – two months;
- Rear Wave Wall – four months;
- Drainage system, lighting, and services - four months; and
- Inspection, snagging and demobilisation – four months.

3.3 Operational Phase

3.3.1 Outer Berth

The primary use of the improved outer berth would be for the offshore renewables industry, providing facilities for the transhipment and storage of components such as all wind turbine generator (WTGs) parts associated with a wind farm project (including the blades, towers and nacelles) as well as foundations (such as pin piles, jackets and floating foundations) **(Figure 3-6)**. The berth could also be used for other tidal energy projects and the decommissioning of redundant oil and gas structures where vessels cannot transit the existing lock entrance.

Offshore renewable energy components would be delivered to the Port of Leith from various locations across the UK, Europe, and other international locations. Loading/unloading, using mobile cranes, is expected to take up to 24 hours; whilst a vessel is berthed, during which the entrance to the Port of Leith would be restricted. It is therefore in the interest of the port to ensure the berth is occupied for the minimum time possible. Overall lock and berth utilisation would be controlled by the port, as is the case today.

Figure 3-6 Example loading of offshore renewables vessel when berthed and laydown area

As with the current operations at the port, the outer berth would be operational 24 hours a day, seven days a week, and be available for use by the port's customers. Use of the proposed development by the offshore renewables industry, i.e., those vessels which cannot transit the lock gates due to the beam restrictions, is expected to be relatively infrequent as these vessels would only use the facility during the construction phase of an offshore renewable project.

For illustrative purposes, an offshore wind farm comprising the installation of 100 turbines to pre-installed foundations would be expected to require 25 round trips of the installation vessel from the port to the project site over a period of six to 12 months, i.e., on an average, 2 to 4 times per month

The number of vessels currently using the port is, on average, 1,150 per year. Given this, and the fact that vessels would no longer access the port for the decommissioned Shawcor facility, the overall change in vessel numbers using the port would be negligible and not likely to be significant. Facilities will be provided for the future provision of shore power; this would reduce the need for vessels to be 'idling' at the berth with engines running, therefore reducing noise and emissions to air.

3.3.2 Laydown Area

The type of components that may be stored within the laydown area include those that are required for offshore wind farms (such as foundations, towers, nacelles, blades, tidal turbines) as well as other components related to the offshore renewable industry.

3.3.3 Maintenance Dredging

The requirement for maintenance dredging during the operation of the proposed development has been predicted using the MIKE3-Mud Transport (MT) model (see **Section 7.7.2.2**). The model predicts an increase of around 22% on the annual average dredged volume from the Approach Channel, with most of this arising from the enlarged berth pocket. Based upon a current average maintenance dredge volume of 19,197m^3 (**Table 7-8**), this would equate to a predicted increase of approximately 4,225m^3.

The marine licence application being made for the proposed development will not include for this maintenance dredging; this will likely form a variation to Forth Ports existing maintenance dredge licence. Consequently, maintenance dredging is not assessed within this EIA Report.

3.4 Consideration of Alternatives

3.4.1 Do-Nothing Scenario

The do-nothing scenario would mean that the sole use of the outer berth at Leith would be the same as the current operations. The potential of the Port of Leith would not be realised, thereby hindering:

- Scotland achieving it 2045 net zero targets;
- Scotland's green energy transition; and,
- Scotland's Covid 19 recovery plan.

In addition, the significant economic and employment benefits associated with the proposed redevelopment would not be realised. Consequently, the do-nothing scenario has been discounted.

3.4.2 Design

Several alternatives were considered at design stage for the proposed development as described below.

Quay platform vs quay wall

A quay platform has been preferred over a quay wall. As seen in the below annotated sketches, a quay platform is an elevated deck that is extended over the shore towards the sea. It has the same level as the ground level on the landside. Since the platform is supported by piles, it allows free circulation of water underneath and keeps the habitat, over which the platform extends, intact (**Figure 3-7**). A quay wall is an enclosed structure with structural walls on three sides and backfilled to match the ground level on the landside (**Figure 3-8**). This can significantly affect the existing hydrodynamic regime and the habitat within the reclaimed area would be lost.

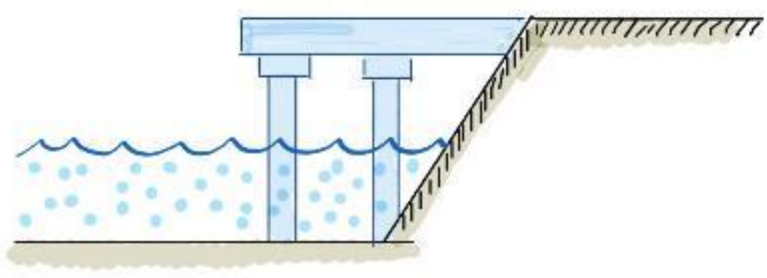


Figure 3-7 A typical section for an elevated Quay Platform

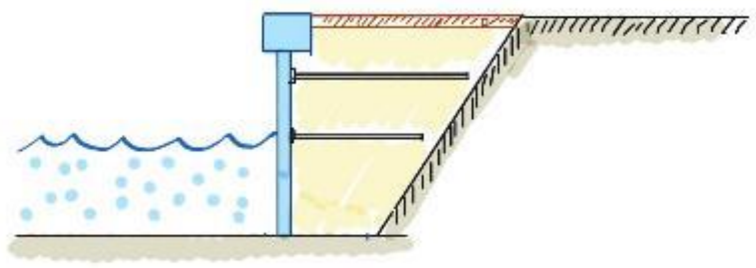


Figure 3-8 A typical section for a Quay Wall

Since the improved berth would be located near the existing lock structure, the discharge of water from the lock culvert would be less impacted with a quay platform compared to a quay wall. A quay platform would also require significantly less fill material than a quay wall, hence it will significantly reduce the transportation requirement of this material.

The improved berth would be located at the tip of the Leith breakwater and construction works would be subject to weather and tidal conditions. The construction activities for a quay platform would be less impacted by adverse weather and tidal conditions, given the installation of sheet piles to stabilise the ground, in comparison to building several quay walls.

Steel encased concrete piles vs reinforced concrete piles
Steel encasements have been proposed to be used. These would be protected by paint and/ cathodic protection against corrosion impact of sea water, which might not be the case should reinforced concrete piles be used.

Sheet pile wall vs retaining wall
Sheet pile walls have been proposed to be installed. This type of structure is widely used in the structural design works to stabilise the ground beneath the quay platform. In comparison to a retaining wall or a slurry wall, they can be embedded into soil and no excavation will be required. Moreover, sheet pile walls are designed to integrate and link with the steel driven piles and creating a continuous structural wall acting as a single unit. In addition, construction of a retaining wall in the marine environment would have required additional engineering solutions, which would have increased costs and construction time.

Use of rock armour protection rather than concrete slabs
Embedded sheet piles and driven steel piles will be protected by rock armour which is easy to maintain and can be replenished depending on weather and tide related erosion. Rock is a natural material and is more durable than concrete.

3.4.3 Site Layout

The proposed development seeks to utilise areas of existing development. As an alternative, the landside elements of the proposed development could be located elsewhere which could result in acquiring new land in greenfield locations, resulting in significant environmental impacts.

3.5 Embedded Mitigation

In addition to the measures set out in the following chapters to avoid or mitigate any adverse effects that could arise as a result of the proposed development, Forth Ports Limited is committed to the use of best practice techniques and due diligence regarding construction projects. A CEMP would be developed following the standard best practice measures. In view of the above and the commitment to the CEMP, the risk of accidental leaks and spills would be reduced as far as possible and therefore has not considered further.

4 Relevant Legislation

This section of the EIA Report provides details on the overarching legislative framework for the proposed works. Additional legislation specific to an environmental topic is described in the relevant chapters.

4.1 Enabling Legislation

4.1.1 Marine Scotland Act 2010

Part 4 of the Marine Scotland Act 2010 provides a framework for the marine licensing system for those ‘licensable marine activities’ undertaken within Scottish waters below Mean High Water Springs (MHWS). The Scottish Ministers are the licensing authority for most matters in Scottish inshore and offshore waters with Marine Scotland’s Licensing Operations Team responsible for issuing licences on their behalf.

4.2 EIA Legislation

The two regulations that apply to the proposed development are MWRs and TCPRs. For the purposes of this report, these regulations are termed the ‘EIA Regulations’. The EIA Regulations contain two Schedules that identify projects that are considered as EIA development and whether an EIA is mandatory as follows:

- Schedule 1: development of this type requires that an EIA is undertaken; and,
- Schedule 2: development of this type ***may*** require that an EIA is undertaken depending on the scale of the development, its characteristics, and the sensitivity of the environment in which the development will take place.

It has been concluded that the proposed development is not a Schedule 1 development under the EIA Regulations, and falls under Schedule 2, 10(g). The reasons for this are outlined in more detail as follows.

Paragraph 8 of Schedule 1 of the EIA Regulations states:

> *(1) Inland waterways and ports for inland-waterway traffic which permit the passage of vessels of over 1,350 tonnes.*
> *(2) Trading ports, piers for loading and unloading connected to land and outside ports (excluding ferry piers) which can take vessels of over 1,350 tonnes.*

Paragraph 21 of the MRWs and Paragraph 24 of the TCPRs of Schedule 1 states:

> *Any change to or extension of projects listed in this schedule where such a change or extension in itself meets the thresholds, if any, or description of projects set out in this schedule.*

Paragraphs 21 and 24 of the MRWs and TCPRs respectively, as outlined above, are to be read in conjunction with paragraphs 8(1) and 8(2). The proposed development does not fall under paragraphs 8(1) and 8(2) of Schedule 1; 8(1) does not apply as the development is not for an “inland waterway” or a “port for inland waterway traffic”, and 8(2) is aimed at the provision of new “ports” or “piers” with potential to take large vessels. That is not the case regarding the proposed development at the Port of Leith. The reference to piers (paragraph 8(2)) is not relevant as it refers to piers outside of, i.e., not part of an existing port. The proposed development is wholly within Forth Ports’ existing harbour area. It is also within the confines of the existing Port of Leith, both operationally and from a land ownership perspective. The proposed works at the Port of Leith are concerned with the alteration or improvement of existing infrastructure at a port, which already provides for vessels of over 1,350 tonnes. The works are not to form a new port which can take vessels of over 1,350 tonnes, or to increase the capacity of a port such that in future it can take vessels of over 1,350 tonnes. As such, paragraphs 21 and 24 of the MRWs and TCPRs respectively are not considered relevant as these relate only to changes or extensions to the type of projects listed in schedule 1 which itself does not apply to the proposed works.

The proposed development is however considered to be a Schedule 2 development, falling under Schedule 2 10(g) of the MWRs as:

> *construction of harbours and port installations, including fishing harbours (unless included in schedule 1)*

Schedule 3 of the EIA Regulations sets out the criteria that should be considered for deciding whether a Schedule 2 project should be screened as an EIA development. Taking those criteria into account, screening opinions were sought from MS under the MWRs and the CEC under the TCPRs, as described in **Section 1.2**.

CEC has determined that EIA is not required for the proposed development in accordance with the TCPRs, while MS considered that an EIA is required to be carried out for this development under the MWRs 2017.

4.3 Other Relevant Legislation and Policy

Overarching legislation and policies that are relevant to the proposed development or the EIA study are mentioned in the following sub-sections. Details of topic specific legislations, policies and guidance are provided in the relevant chapters.

4.3.1 Marine Licensing (Pre-application Consultation) (Scotland) Regulations 2013

Section 23 of the Marine (Scotland) Act 2010 provides a requirement of a pre application consultation. The process and approach to the pre-consultation is detailed in The Marine Licensing (Pre-application Consultation) (Scotland) Regulations 2013.

According to Section 4(d) of The Marine Licensing (Pre-Application Consultation) (Scotland) Regulations 2013, a development requires pre-application consultation when:

> *the construction of any works (with the exception of a renewable energy structure) within the Scottish marine area either in or over the sea or on or under the seabed, but only where the total area in which such works are to be located exceeds 1000 square metres in extent*.

As such, the proposed development required pre-application consultation and a PAC report, detailing the approach and its outcomes, has been submitted in support of the marine licence application.

4.3.2 Conservation (Natural Habitats, &c.) Regulations 1994, as amended

In Scotland, the Habitats Directive is translated into specific legal obligations by the Conservation (Natural Habitats, &c.) Regulations 1994, as amended. These regulations (hereafter the 'Habitats Regulations') transpose the Habitats and Birds Directives into Scottish legislation.

The Habitats Regulations place an obligation on 'competent authorities' to carry out an appropriate assessment of any proposal likely to affect a designated site, to seek advice from NatureScot and not to approve an application that would have an adverse effect on a designated site unless certain conditions are met (where there are no alternative solutions, the plan or project can only proceed if there are imperative reasons of over-riding public interest and if the necessary compensatory measures can be secured).

A shadow Habitats Regulations Appraisal (HRA) has been undertaken and submitted to MS in support of the Marine Licence application.

4.3.3 UK Marine Policy Statement 2011

The UK Marine Policy Statement (MPS) sets out a framework for preparing Marine Plans and taking decisions affecting the marine environment[7]. It aims to achieve a shared vision by the UK Administrations of having 'clean, healthy, safe, productive and biologically diverse oceans and seas. The Marine Statement sets out the following high level marine objectives:

- Promote sustainable economic development;
- Enable the UK's to move towards a low-carbon economy, in order to mitigate the causes of climate change and ocean acidification and adapt to their effects;
- Ensure a sustainable marine environment which promotes healthy, functioning marine ecosystems and protects marine habitats, species, and our heritage assets; and,
- Contribute to the societal benefits of the marine area, including the sustainable use of marine resources to address local social and economic issues.

It also sets out the framework for environmental, social and economic considerations that need to be taken into account in marine planning, considering:

- Marine ecology and biodiversity;
- Air quality;
- Noise;
- Ecological and chemical water quality and resources;
- Seascape;
- Historic environment;
- Climate change adaptation and mitigation; and,
- Coastal change and flooding particularly.

The MPS identifies 'Ports and shipping' and 'Energy production and infrastructure development' as key activities taking place within the marine environment, and that they are essential contributors to the economic and social well-being of the UK. Securing the UK's energy objectives and providing key transport infrastructure between land and sea, while protecting the environment, is defined as a priority for marine planning. The proposed development is aligned with these objectives.

4.3.4 Scotland National Marine Plan

Scotland's National Marine Plan (NMP) was published by the Scottish Government in March 2015. The plan covers the management of both Scottish inshore waters (out to 12 nautical miles) and offshore waters (12 to 200 nautical miles), setting out the Scottish Government's policies for the sustainable development of Scotland's seas (MSD, 2015).

[7] *UK Marine Policy Statement 2010. https://www.gov.uk/government/publications/uk-marine-policy-statement*

The plan promotes an ecosystem-based approach, putting the marine environment at the heart of the planning process to promote ecosystem health, resilience to human induced change and the ability to support sustainable development and use. It adopts the guiding principles of sustainable development, which also ensures that any individual policy, plan, or activity is carried out within environmental limits.

Chapter 4 of the NMP sets out the General Planning Principles necessary to achieve sustainable development. Those relevant to the proposed development, along with details of how the proposed development supports these, can be seen in **Table 4-1**.

Table 4-1 NMP's general planning principles relevant to the proposed development

General Planning Principle	Policy Context	How does the Proposed Development comply with the Policy?
GEN 1 General Planning Principle	There is a presumption in favour of sustainable development and use of marine environment when consistent with the policies and objectives of this plan.	The proposed development would support renewable energy projects. It would have a significant beneficial impact on the local and regional socio-economy, through the provision of significant numbers of well-paid permanent jobs and career opportunities, as well as indirect employment opportunities.
GEN 5 Climate Change	Marine planners and decision makers must act in the way best calculated to mitigate, and adapt to, climate change.	See **Chapter 2 Need for the Proposed Development**.
GEN 7 Landscape/ Seascape	Marine planners and decision makers should ensure that development and use of the marine environment take seascape, landscape, and visual impacts into account.	The proposed development is located within an operational port and would not result in a significant effect on the local landscape/seascape character or visual setting. This was confirmed by the CEC's Screening Opinion (see **Appendix 1-2**).
GEN 8 Coastal Processes and Flooding	Developments and activities in the marine environment should be resilient to coastal change and flooding, and not have unacceptable adverse impact on coastal processes or contribute to coastal flooding.	The proposed development would have a negligible, not significant in EIA terms, effect on coastal processes, as explained in **Chapter 7 Coastal Processes**.
GEN 9 Natural Heritage	Development and use of the marine environment must: (a) Comply with legal requirements for protected areas and protected species. (b) Not result in significant impact on the national status of Priority Marine Features. (c) Protect and, where appropriate, enhance the health of the marine area.	The proposed development would have minor to negligible, not significant in EIA terms, impacts on natural heritage. See Chapters 9 to 12.
GEN 10 Invasive Non-Native Species	Opportunities to reduce the introduction of invasive non-native species to a minimum or proactively improve the practice of existing activity should be taken when decisions are being made.	The proposed development is located within an operational port and would follow best practices to avoid the introduction or spread of invasive non-native species as carried out currently.
GEN 11 Marine Litter	Developers, users, and those accessing the marine environment must take measures to address marine litter where appropriate. Reduction of litter must be taken into account by decision makers.	The proposed development is located within an operational port and would follow best practices to manage marine litter as carried out currently.

General Planning Principle	Policy Context	How does the Proposed Development comply with the Policy?
GEN 12 Water Quality and Resource	Developments and activities should not result in a deterioration of the quality of waters to which the Water Framework Directive, Marine Strategy Framework Directive or other related Directives apply.	The proposed development would have minor adverse, not significant in EIA terms, impacts on water quality as explained in **Chapter 8 Marine Water and Sediment Quality**.
GEN 13 Noise	Development and use in the marine environment should avoid significant adverse effects of man-made noise.	With adherence to standard best practice measures, the proposed development would not result in significant adverse noise impacts to the marine environment during construction. See Chapters 10 to 12. No significant noise impacts would occur during operation.
GEN 14 Air Quality	Development and use of the marine environment should not result in the deterioration of air quality and should not breach any statutory air quality limits.	The proposed development would not result in a deterioration in air quality. Refer to section 4.8 of the **Appendix 1-1**.
GEN 21 Cumulative Impacts	Cumulative impacts affecting the ecosystem of the marine plan area should be addressed in decision making and plan implementation.	A CIA is provided in **Chapter 13 Cumulative Impact Assessment**.

5 EIA Methodology

5.1 Introduction

This section sets out the approach for the assessment of potential impacts which has been adopted within this EIA Report. In summary, this section presents:

- The EIA process followed for the proposed development;
- The approach adopted to define the baseline environment (specific details are provided for each environmental topic considered in the relevant chapter);
- The generic approach taken to assess potential impacts, including the evaluation of significance (where a different approach has been adopted for a specific topic, this is set out in the relevant chapter);
- The generic approach taken to the derivation of mitigation measures and the assessment of residual impacts; and,
- The approach taken to the assessment of potential cumulative impacts.

5.2 EIA Guidance

This EIA has been undertaken in accordance with the requirements of the MWRs and has considered key legislation, guidance, and advice, including but not limited to the following:

- Chartered Institute of Ecology and Environmental Management (CIEEM) "*Guidelines for Ecological Impact Assessment in the UK and Ireland*" (2018); and,
- IEMA "*Guidelines for Environmental Impact Assessment*" (2017).

It is noted that this list of guidance is not exhaustive, and the relevant guidance adopted for the assessment of each environmental parameter is described in the relevant topic chapter.

5.2.1 The EIA Process

In accordance with the Schedule 4 of the EIA Regulations, the EIA Report should include such information as is reasonably required to assess the likely significant environmental effects of the proposed development and which the applicant can reasonably be required to compile, including:

- a description of the proposed development comprising information on its site, design, size, and other relevant features of the development;
- a description of the likely significant effects of the proposed development on the environment;
- a description of any features of the proposed development, or measures envisaged to avoid, prevent, or reduce and, if possible, offset likely significant adverse effects on the environment;
- a description of the reasonable alternatives studied by the developer, which are relevant to the proposed development and its specific characteristics, and an indication of the main reasons for the option chosen, considering the environmental effects of the development on the environment; and,
- a non-technical summary of the above.

EIA is a process that systematically examines and assesses the potential impacts of a project on the environment. The process is outlined in **Table 5.1**.

Table 5-1 The EIA process

Stage	Task	Aim / objective	Work / output (examples)
Screening report	Screening	To formally confirm route for EIA and lead responsible authority.	Appropriate level of information on proposals and approach.
Scoping study (optional)	Scoping	To identify the potentially significant direct and indirect impacts of the proposed scheme.	Preliminary consultation with key consultees. Targets for specialist studies (e.g., bird survey).
EIA	Consultation	Consult with statutory and non-statutory organisations and individuals with an interest in the area and the proposed scheme.	Local knowledge and information.
	Primary data collection	To characterise the existing environment.	Background data including existing literature and specialist studies.
	Specialist studies	To further investigate those environmental parameters which may be subject to potentially significant effects.	Specialist reports.
	Impact assessment	To evaluate the existing environment, in terms of sensitivity. To evaluate and predict the impact (i.e., magnitude) on the existing environment. To assess the significance of the predicted impacts.	Series of significant adverse and beneficial impacts.
	Mitigation measures	To identify appropriate and practicable mitigation measures and enhancement measures.	The provision of solutions to minimise adverse impacts as far as possible. Feedback into the design process, as applicable.
	EIA Report	Production of the EIA Report in accordance with EIA guidance.	EIA Report.

The approach adopted for this EIA is summarised in the following sections. It should be noted that these stages are not consecutive and overlap. For example, iterative design changes may be made considering emerging findings of the EIA process to prevent or reduce the significance of a potential impact.

5.3 Screening

As described in **Sections 1.2** and **4.2** the proposed development falls under Schedule 2 10(g) of the MWRs, as:

- Construction of harbours and port installations, including fishing harbours (unless included in schedule 1)

Thus, an EIA Screening Report (**Appendix 1-1**) was submitted to both the CEC and MS along with requests for Screening Opinions on 20th September 2021 and 9th November 2021, respectively. CEC's Screening Opinion was received on 14th October 2021 (**Appendix 1-2**), which determined that the proposed development was not EIA development in accordance with the TCPRs and Circular 1/2017 for the following reasons:

- The proposal relates to uses that are of a similar nature to operations already undertaken within the wider area. Vessels of a similar size are already accepted within the dock. It also includes the removal existing facility that creates noise and air emissions.
- The screening request indicates that there will be some effects from the construction stage, but these will be short term.
- To the south and east of the site there are identified Air Quality Management Area areas but the continued use of the dock for appropriate uses would not warrant an EIA with the proposals including the loss of an existing industrial use and proposed materials associated with this development indicated to be transported by sea.
- In terms of noise, the area already accepts ships and operates as a port.
- The Habitats Regulations Appraisal submitted to accompany the screening request indicates that Appropriate Assessment will be undertaken and agreed with NatureScot and mitigation measures put in place if required.
- The Martello Tower is a Scheduled Monument, but its location is already surrounded by existing industrial style uses.
- Visual impacts will be temporary in nature.

MS provided their Screening Opinion on 18th January 2022 (**Appendix 1-3**). Consultation undertaken to inform MS's Screening Opinion **(Appendix 1-3**) also either expressed no opinion on the need for EIA or determined the proposed development to not be EIA development with the exception of NatureScot, who considered that the proposed development had the potential to result in significant impacts specifically to:

- several European sites (Special Areas of Conservation (SACs) and Special Protection Areas (SPAs)); and,
- European Protected Species (EPS) that are not specifically protected by relevant European sites, for example otter, minke whale or harbour porpoise.

NatureScot recommended that an EIA should be undertaken that focuses on the above receptors and, for this reason, MS determined that the proposed development was EIA development under the MWRs. Consequently, an EIA is required to support the Marine Licence application under the MWRs.

5.4 Scoping

The scope of this EIA has been informed by the EIA screening exercise and discussions with key stakeholders, including MS and NatureScot.

The topics to be considered by the EIA are those identified in MS's Screening Opinion and the same as those that are the focus of the HRA. Discussions with NatureScot have confirmed the topics to be assessed and scope of work required to inform the HRA (see **Section 6.2.2**) and therefore these discussions have been used to confirm the scope of the EIA. The following topics have been scoped into this EIA:

- Coastal processes
- Marine water and sediment quality

- Marine and coastal ecology
- Fish and shellfish ecology
- Ornithology
- Marine mammals
- Cumulative Impacts

The assessments have been informed by the following surveys and investigations, as agreed with NatureScot:

- Hydrodynamic, sediment dispersion and sedimentation numerical modelling
- Sediment sampling and analyses
- Desk based benthic ecology assessment
- Bird surveys, comprising:
  - Twice-monthly estuarine bird counts within the impounded dock system and nearby coastal / offshore locations between March 2021 and March 2022.
  - Twice monthly tern colony counts during May to July 2021 (inclusive), denoting the number of apparently occupied nests (AON) at Imperial Dock Lock Leith SPA; and,
  - Twice monthly tern flight behaviour surveys during May to July 2021 (inclusive).
- Airborne noise modelling
- Underwater noise modelling

Applying the analysis in the EIA Screening Report (**Appendix 1-1**) and conclusions in the Screening Opinions (**Appendices 1-2** and **1-3**) the following topics have been scoped out of the EIA:

- Ground conditions
- Water resources and flood risk
- Traffic and transport*
- Noise and vibration – human receptors
- Air quality
- Terrestrial ecology
- Commercial fisheries
- Commercial and recreational navigation
- Infrastructure and other users
- Archaeology and cultural heritage
- Landscape and visual impact
- Tourism and recreation
- Waste
- Accidents and disasters
- Climate change
- Socio-economics

* The EIA screening exercise was based on the majority of materials being delivered by sea; however, subsequent to this, it has been identified that some of the fill material would be imported by road from local quarries. Whilst the selection of local quarries has not been finalised, it would be anticipated that all deliveries would arrive/leave the Port of Leith on the A199 towards the A1.

Department for Transport Traffic Count data (2019[8]) highlights that south of the Port of Leith, the A199 typically carries in the region on 22,000 vehicles per day of which approximately 1,000 are HGVs. A peak increase traffic movements of 176 per day would therefore equate to a change in total traffic less than 1% and approximately 18% in HGVs.

The Guidelines for the Environmental Assessment of Road Traffic (GEART) (published in January 1993 by the Institute of Environmental Assessment) are guidelines for the assessment of the environmental impacts of road traffic associated with new developments, irrespective of whether the developments are subject to formal EIAs. GEART suggests application of the following rules to as a screening process to delimit the scale and extent of the assessment required:

- Rule 1: Include highway links where traffic flows are predicted to increase by more than 30% (or where the number of HGVs is predicted to increase by more than 30%); and,
- Rule 2: Include any specifically sensitive areas where traffic flows are predicted to increase by 10% or more (or where the number of HGVs is predicted to increase by 10% or more).

The A199 comprises of a main A road serving the existing port and industrial areas of Edinburgh and would therefore be considered to be of low sensitivity to the expected increases in traffic. Therefore, noting that the forecast peak changes in total and HGV are less than 30% and temporal, traffic and transport are not considered to be significant and therefore traffic and transport effects remain scoped out of the EIA.

5.5 EIA Report

5.5.1 Baseline Environment

The term 'baseline environment' is used to describe the nature, scale, condition, and other relevant information to provide a detailed description of a given environmental receptor that falls within the scope of the EIA report. Within this report, the description of the baseline environment consists of the following aspects:

- the spatial location and extent of the environmental features or receptors;
- a description of the environmental features or receptors and their character;
- the context of the environmental features or receptors in terms of rarity, function, and population at the local, regional and national level;
- the sensitivity of the environmental features or receptors in relation to physical, chemical or biological changes; and,
- the value of the environmental features or receptors (e.g. designated status).

5.5.2 Impact Identification

Where appropriate, the assessment has used the conceptual 'source-pathway-receptor' model. The model identifies potential impacts resulting from the proposed activities on the environment and sensitive receptors within it. This process provides an easy-to-follow assessment route between impact sources and potentially sensitive receptors ensuring a transparent impact assessment. The aspects of this model are defined as follows:

- Source - the origin of a potential impact (i.e., an activity such as earthworks and a resultant effect e.g. contaminated run-off from the site);

[8] *https://roadtraffic.dft.gov.uk/manualcountpoints/50939*

- Pathway - the means by which the effect of the activity could impact a receptor (e.g. for the example above, changes to the water quality in the watercourses affected); and,
- Receptor - the element of the receiving environment that is impacted (this could either be a component of the physical, ecological or human environment such as water quality, e.g. for the above example, species living on or in the watercourses affected).

Where a different approach has been necessary to reflect the specific assessment requirements of a particular topic, this is described in the corresponding technical chapter.

5.5.3 Significance of the Impact

5.5.3.1 Determining Receptor Value and Sensitivity

The characterisation of the existing environment helps to determine the receptor sensitivity in order to assess the potential impacts upon it.

Receptor value considers whether, for example, the receptor is rare, has protected or threatened status, has importance at a local, regional, national or international scale and, in the case of biological receptors, whether the receptor has a key role in the ecosystem function.

The ability of a receptor to adapt to change, tolerate, and/or recover from potential impacts is key to assessing its sensitivity to the impact under consideration. For ecological receptors, tolerance could relate to short term changes in the physical environment; for human environment receptors, tolerance could relate to impacts upon community. The time required for recovery is an important consideration in determining receptor sensitivity.

The overall receptor sensitivity is determined by considering a combination of value, adaptability, tolerance and recoverability. This is achieved through applying known research and information on the status and sensitivity of the feature under consideration coupled with professional judgement and past experience.

Expert judgement is particularly important when determining the sensitivity of receptors. For example, an Annex II species (under the Habitats Directive) would have a high inherent value, but may be tolerant to an impact or have high recoverability. In this case, sensitivity should reflect the ecological robustness of the species and not necessarily default to its protected status. Example definitions of the different sensitivity levels for a generic receptor are given in **Table 5-2**.

Table 5-2 Example definitions of different sensitivity levels for a generic receptor

Sensitivity	Definition
High	Individual receptor has very limited or no capacity to avoid, adapt to, accommodate or recover from the anticipated impact.
Medium	Individual receptor has limited capacity to avoid, adapt to, accommodate or recover from the anticipated impact.
Low	Individual receptor has some capacity to accommodate, adapt or recover from the anticipated impact.
Negligible	Individual receptor is generally can accommodate or recover from the anticipated impact.

The definitions of sensitivity given within each chapter are relevant to that particular EIA topic and are clearly defined by the assessor within the context of that assessment.

In addition, for some assessments the value of a receptor may also be an element to add to the assessment where relevant, for instance if a receptor is designated or has economic value. Example definitions of the value levels for a generic receptor are given in **Table 5-3**.

Table 5-3 Example definitions of the value levels for a generic receptor

Value	Definition
High	Internationally / nationally important (for example internationally or nationally protected site).
Medium	Regionally important / regionally protected site.
Low	Locally important.
Negligible	Not considered to be important (for example common or widespread).

The terms 'high value' and 'high sensitivity' are not necessarily linked within a particular impact and it is important not to inflate impact significance specifically because a feature is 'valued'. For example, a receptor could be of high value (e.g. an Annex I habitat) but have a low or negligible physical / ecological sensitivity to an effect.

5.5.3.2 Determining Magnitude of Effect

In order to predict the level and significance of an impact, it is necessary to establish the magnitude of effect, as well as the probability of an impact occurring through consideration of:

- Scale or spatial extent (small scale to large scale or a few individuals to most of the population);
- Duration (short term to long term);
- Likelihood of impact occurring;
- Frequency; and,
- Nature of change relative to the pre-impact condition of the existing environment.

5.5.3.3 Evaluation of Significance

Subsequent to establishing the sensitivity of the receptor and the magnitude of effect, the impact significance is predicted by using quantitative or qualitative criteria, as appropriate, to ensure a robust assessment. The matrix presented in **Table 5-4** has been used to provide transparency to the assessment process; however, it should be stressed that the assessments are based on the application of expert judgement.

Table 5-4 Impact assessment matrix

		Negative magnitude				Beneficial magnitude			
		High	Medium	Low	Negligible	Negligible	Low	Medium	High
Sensitivity	High	Major	Major	Moderate	Minor	Minor	Moderate	Major	Major
	Medium	Major	Moderate	Minor	Minor	Minor	Minor	Moderate	Major
	Low	Moderate	Minor	Minor	Negligible	Negligible	Minor	Minor	Moderate
	Negligible	Minor	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Minor

Table 5-4 provides an indication of the significance levels used in the assessment process for the majority of parameters. Any exceptions to these definitions are due to the application of best practice methodologies for a particular topic, as described above.

Descriptions of the approach to impact assessment and the interpretation of significance levels are provided within the relevant chapters of this EIA. This approach ensures that the definition of impacts is transparent and specific to each topic under consideration. Example definitions of the significance levels for a generic receptor are given in **Table 5-5**.

Table 5-5 Example impact significance definitions

Value	Definition
Major	Fundamental, permanent / irreversible changes, over the whole receptor, and / or fundamental alteration to key characteristics or features of the particular receptor's character or distinctiveness. May include change to key environmental characteristics which are well in excess of the natural range of variability, and likely to occur some distance away from the development area.
Moderate	Considerable, permanent / irreversible changes, over the majority of the receptor, and / or discernible alteration to key characteristics or features of the particular receptor's character or distinctiveness. May include change to key environmental characteristics which are in excess of the natural range of variability but may be largely restricted to the development area. Change occurs throughout the associated project development phase.
Minor	Discernible, temporary (throughout project duration) change, over a minority of the receptor, and / or limited but discernible alteration to key characteristics or features of the particular receptor's character or distinctiveness. May include change to key environmental characteristics which are similar to, but occasionally in excess of, the natural range of variability. Change occurs intermittently during associated project development phase and is likely to be restricted to the development area.
Negligible	Discernible, temporary (for part of the project duration) change, or barely discernible change for any length of time, over a small area of the receptor, and/or slight alteration to key characteristics or features of the particular receptor's character or distinctiveness.

For the purposes of EIA, major and moderate impacts are deemed to be 'significant', whilst minor and negligible impacts are considered 'not significant'.

For each topic within the EIA, best practice methodology (based on the latest available guidance) has been followed, which may augment the assessment framework presented above. In all cases the specific approach taken to assess impacts is described within each technical chapter.

5.5.4 Mitigation

Where the assessment identifies that an aspect of the development is likely to give rise to significant environmental impacts, mitigation measures have been proposed and discussed with the relevant authorities in order to avoid, prevent or reduce impacts to acceptable levels.

For the purposes of the EIA, two types of mitigation are defined:

- Embedded mitigation: consisting of mitigation measures that are identified and adopted as part of the evolution of the project design, and form part of the project design that is assessed in the EIA; and,
- Additional mitigation: consisting of mitigation measures that are identified during the EIA process specifically to reduce or eliminate any predicted significant impacts.

5.5.5 Residual Impacts

Following initial assessment, if the impact does not require additional mitigation (or none is possible) the residual impact will remain the same. However, if additional mitigation measures are identified, impacts are re-assessed, and all residual impacts clearly described.

5.5.6 Assumptions and Limitations

The EIA process requires an EIA Report to provide an indication of any difficulties (technical deficiencies or lack of expertise) encountered during the assessment process. Any such assumptions or limitations are identified within the relevant topic chapter, where appropriate.

5.6 Cumulative Impact Assessment

5.6.1 Impact Inter-relationships

This EIA Report has given due consideration to the potential for different residual impacts to have a combined impact on key sensitive receptors. The objective is to identify where the accumulation of impacts on a single receptor, and the relationship between those impacts, potentially gives rise to a need for additional mitigation. Inter-relationships have been assessed within the relevant sections of the topic chapters of the EIA Report.

5.6.2 Cumulative Impacts

In line with IEMA's Guidelines for EIA (2017), cumulative impacts are defined as:

"…the impacts on the environment which result from incremental impacts of the action when added to other past, present and reasonably foreseeable future actions …"

There is no legislation that outlines how CIA should be undertaken; however, the EIA and Habitats Regulations require the consideration of direct impacts and any indirect, secondary and cumulative effects of a project. Guidance on CIA is provided in a number of good practice documents (e.g. the European Commission, 1999). This guidance is not prescriptive, but rather suggests various approaches which may be used, depending on their suitability to the project (for example the use of matrices, expert opinion, consultation, spatial analysis and carrying capacity analysis).

With respect to 'past' projects, a useful ground rule in CIA is that the environmental impacts of schemes that have been completed should be included within the environmental baseline; as such, these impacts will be accounted in the EIA process and, generally, can be excluded from the scope of CIA. However, the environmental impacts of recently completed projects may not be fully manifested and, therefore, the potential impacts of such projects should be taken into account in the CIA.

6 Consultation

6.1 Introduction

The following sections outlines the EIA consultation that has been undertaken with CEC, MS and other key stakeholders.

6.2 Stakeholder Consultation

6.2.1 Early Stakeholder Consultation

Consultation with key stakeholders was undertaken early on in the consenting process. Stakeholders were divided into two groups as presented in **Table 6-1**.

Table 6-1 Stakeholder groups

Regulators and Statutory Authorities	Key Stakeholders
• MS • CEC • NatureScot • Historic Environment Scotland • RSPB • SEPA	• Crown Estate Scotland • Maritime and Coastguard Agency • Northern Lighthouse Board • Royal Forth Yacht Club • Scottish Wildlife Trust • Transport Scotland • Inshore fisheries and coastal communities • Forth District Salmon Fishery Board • Whale and Dolphin Conservation • Scottish Fishermen's Federation

A presentation was given to the Regulators and Statutory Authorities on 9th June 2021 (see **Appendix 6-1**). The purpose of the presentation was to introduce the proposed development and to seek early input on:

- Environmental sensitivities;
- Potential environmental issues; and,
- Consenting approach.

A note was issued to Key Stakeholders on 1st June 2021 to provide an introduction to the proposed development, and included (see **Appendix 6-2**):

- a description of the proposed development;
- an overview of the potential environmental constraints and opportunities that have been identified;
- the key pieces of legislation relevant to the proposed development; and,
- consultation objectives.

Key Stakeholders were asked to provide their views on the proposed development and in particular:

- Key environmental constraints and opportunities;
- Potential issues (relating to the environmental impacts, or otherwise) that should be considered through the consenting process; and,
- Any information that would benefit the consenting process.

All responses received from the key stakeholders are presented in **Table 6-2**.

Table 6-2 Key Stakeholder responses during early consultation exercise

Key Stakeholder	Response
Crown Estate Scotland	The Crown Estate Scotland have no objection to this proposal and, based upon the information provided, that their interests will only be affected if any of the dredge material is placed on seabed under their management. A system is in place to handle such activity so this should not present any difficulties should the need arise.
Maritime and Coastguard Agency	The MCA has an interest in the works associated with the marine environment, and the potential impact on the safety of navigation, access to ports, harbours and marinas and any impact on our search and rescue obligations. We note that the new berth falls within the jurisdiction of a Statutory Harbour Authority (SHA) – Forth Ports Ltd, who have the responsibility for the safety of navigation during construction, and the ongoing safe operation of the berth. The MCA would expect any works in the marine environment to be subject to the appropriate consents under the Marine (Scotland) Act 2010 (or Marine and Coastal Access Act 2009 where appropriate) before carrying out any marine licensable activities. The MCA is a statutory consultee to Marine Scotland under the marine licensing regime. We would expect a Navigation Risk Assessment, relative to the scale of the works, to consider the impact of the works on shipping and navigation, agreed with the SHA. To address the ongoing safe operation of the marine interface for this project, we would point the developers in the direction of the Port Marine Safety Code (PMSC) and its Guide to Good Practice. They will need to liaise and consult with the SHA and develop a robust Safety Management System (SMS) for the project under this code. We note Leith Port has declared its compliance with the Port Marine Safety Code. The SHA may also wish to consider its existing powers/byelaws in relations to the new berth/port activities and whether any changes are required through a Harbour Revision Order.
Northern Lighthouse Board	At this time, Northern Lighthouse Board have no objection to the proposed works, and would respond as such to any formal Marine Scotland licensing consultation. Northern Lighthouse Board would however, request ongoing engagement with Forth Ports or their designated contractor, with regard to Aid to Navigation provision across both the construction and operational phase of the project.
Royal Forth Yacht Club	From the environmental point of view, of course we are aware of the SPA protecting a population of Terns and other seabirds at the location. Within the context of Granton and Wardie Bay, our waters are increasingly being used for recreation by private boats, water users and swimmers and the wildlife within cannot be undervalued. A guarantee that water quality would not be adversely affected would be important to our members and our business. It is noted that the information provided does state that all filtered drainage would go out to sea. Thorough proposals to mitigate against potential harm would be of vital importance to the success of this development. In all other regards, we do not foresee an impact on us at Granton Harbour.

Details of topic specific consultation that has been undertaken is descried in the relevant chapter.

6.2.2 Consultation with NatureScot

Consultation with NatureScot was undertaken to confirm the approach to the bird surveys and overall approach to the HRA.

6.2.2.1 Bird Surveys

A bird survey specification report was issued to NatureScot on 13th April 2021 (see **Appendix 6-3**). NatureScot's response was received on 28th April 2021 as provided below.

Summary
The surveys planned are suitable for establishing a baseline against which to assess the effect of the proposed development.

Estuarine bird surveys
The vantage point (VP) surveys appear to follow standard protocols, and the tern surveys will use methods developed in the seabird monitoring handbook. We note that the survey area extends 2km either side, and out into the Firth of Forth, from the point of noise generation from piling. The surveys therefore cover all the area where significant response to noise would be expected.

The methodology does not appear to encompass the effects of night-time working under lights, and nor are any dredging effects which may include noise and possibly increased water turbidity. This may be because these effects are expected to be much more local to the worksite?

The plan discusses 'bird redistribution' within the survey area. If there is no other suitable roost location within 2km when a preferred roost site is disturbed, birds may have to move a greater distance to find a roost. Without identifying all roost sites and feeding sites within a much larger area it is probably not possible to state that all likely redistribution areas have been covered. However, we do note that the likely disturbance areas are covered which is the key aspect of the study.

One final point is that 2km range is likely to be the limit that birds can be identified from a VP location even with the aid of modern optics. The plan does not acknowledge this, and it is only likely to be a factor in the offshore water bird counts. There is no obvious remedy so we do not propose a change to the protocols, but acknowledge that a species such as Slavonian Grebe will not be reliably detected at 2km range. A shift offshore from 1km to 2km would affect counts within the zone.

Breeding Tern counts
Forth Ports should be able to supply you with a history of breeding success from Imperial Dock Lock, Leith SPA, as they have worked in collaboration with Lothians Ringing Group here for many years. We encourage you to liaise with that group to ensure you both get the data you need whilst minimising disturbance to the breeding birds.

Common tern flight behaviour
Only the tern flight line surveys do not have a generally established protocol, but will follow methods used for a previous study in the area, and so should be compatible with some already collected information.

6.2.2.2 Approach to the HRA

A note setting out the approach to the HRA was issued to NatureScot on 31st January 2022 (see **Appendix 6-4**). NatureScot confirmed on 4th March 2022 that the approach to the HRA appeared comprehensive and had taken on board earlier discussions.

6.3 Statutory Consultation

6.3.1 EIA Screening Opinion

Details of the screening process that has been undertaken on the proposed development can be found in **Section 1.2** and **4.2**.

6.3.2 PAC Event

According to Regulation 4(d) of The Marine Licensing (Pre-Application Consultation) (Scotland) Regulations 2013, the proposed development requires pre-application consultation (PAC).

As part of complying with the pre-application requirements, the PAC event was advertised in two newspapers, namely Edinburgh Evening News and The Gazette, on 13th and 14th December 2021, respectively. Due to the COVID-19 pandemic and the physical distancing guidance that has been put in place by the Scottish Government, the PAC Regulations were amended by The Marine Works and Marine Licensing (Miscellaneous Temporary Modifications) (Coronavirus) (Scotland) Regulations 2020 ("the Amending Regulations"), which became effective on 20th May 2020, meaning that the PAC event had to be held online. Thus, the event was scheduled for 25th January 2022 at 7:00 pm on Microsoft Teams. In support of the PAC Event, information on the proposed development was made available online from the 17th January 2022. No members of the local community or stakeholders registered for the event. A PAC report has been provided in support of the Marine Licence application.

6.3.3 Planned Consultation

Consultation will continue to be undertaken with both the public and stakeholders as part of the statutory Marine Licencing process.

7 Coastal Processes

7.1 Introduction

This chapter describes the existing environment in relation to hydrodynamics, wave climate and sediment transport, and details the assessment of the potential effects during the construction and operational phases of the proposed development.

7.2 Legislation, Policy and Guidance

The following key pieces of policy are relevant to this chapter.

7.2.1 Marine Policy Statement

Marine plan authorities should not consider development which may affect areas at high risk and probability of coastal change unless the impacts upon it can be managed. Marine plan authorities should seek to minimise and mitigate any geomorphological changes that an activity or development will have on coastal processes, including sediment movement.

7.2.2 Scotland's National Marine Plan

General Planning Policy GEN 8 Coastal Processes and Flooding of Scotland's NMP states that 'developments and activities in the marine environment should be resilient to coastal change and flooding, and not have unacceptable adverse impact on coastal processes or contribute to coastal flooding'. GEN 5 Climate change is also relevant and states that 'marine planners and decision makers must act in the way best calculated to mitigate, and adapt to, climate change'.

7.3 Consultation

The approach to the numerical modelling was agreed with NatureScot (see **Section 6.2.2**).

7.4 Assessment Methodology

7.4.1 Impact Assessment Methodology

Consideration of the potential effects of the proposed development on the coastal processes was carried out over the following spatial scales:

- near-field: the area within the immediate vicinity (tens or hundreds of metres) of the proposed development; and,
- far-field: the wider area that might also be affected indirectly by the proposed development (e.g. due to disruption of waves, tidal currents or sediment pathways).

Two phases of development have been considered, in conjunction with the present-day baseline. These are:

- construction phase; and,
- operational phase.

The assessment covers changes to coastal processes which in themselves are not impacts to which significance can be ascribed. Rather, these changes (such as a change in the wave climate, the tidal regime or a change in suspended sediment concentrations) represent effects which may manifest themselves as impacts upon other receptors, most notably marine water and sediment quality, marine ecology and fish and shellfish resource (e.g. in terms of increased suspended sediment concentrations and/or erosion or smothering of habitats on the sea bed). In this case, whilst the magnitude of effect can be determined, the sensitivity of the receptors and the significance of impacts on them is assessed within the relevant chapters of this EIA Report pertaining to those receptors.

7.4.2 Numerical Modelling

To support the assessment of potential effects, numerical modelling of tidal currents and suspended sediment transport changes caused by the construction and operation of the proposed development have been completed. Simulations were run for the baseline condition and after implementation of the proposed development. These models represent recognised good practice for informing environmental appraisals and are required as the greatest risk concerns morphological changes to the wider seabed, nearshore areas, and beaches caused by changes to physical processes. Outputs from the modelling are presented to inform the EIA process and aid interpretation of the potential effects. The numerical models used to predict changes in tidal currents and suspended sediment transport conditions are listed in **Table 7-1**.

Table 7-1 Numerical models used to inform the assessment process

Modelled parameter	Model
Tidal currents	MIKE21-FMHD and MIKE3-HD
Sediment plume dispersion	MIKE3-MT

7.4.3 Transboundary Impact Assessment

Transboundary impacts are assessed through consideration of the extent of influence of changes or effects and their potential to impact upon coastal processes receptor groups that are located within neighbouring EU member states. Given the distance of the port from international boundaries in the North Sea, it is concluded that transboundary impacts on coastal processes would not occur.

7.5 Baseline Environment

This section provides an overview of the existing hydrodynamics, wave climate and sediment transport environment. The approach taken has been to review existing relevant data and reports for the Port of Leith and surrounding area, to formulate an understanding of the baseline physical and sedimentary environments using expert-based assessment and judgement.

7.5.1 Bathymetry

The UK Hydrographic Office Admiralty Chart 735 (**Figure 7-1**) shows the approach to the Port of Leith inner harbour from the North Sea through the Firth of Forth.

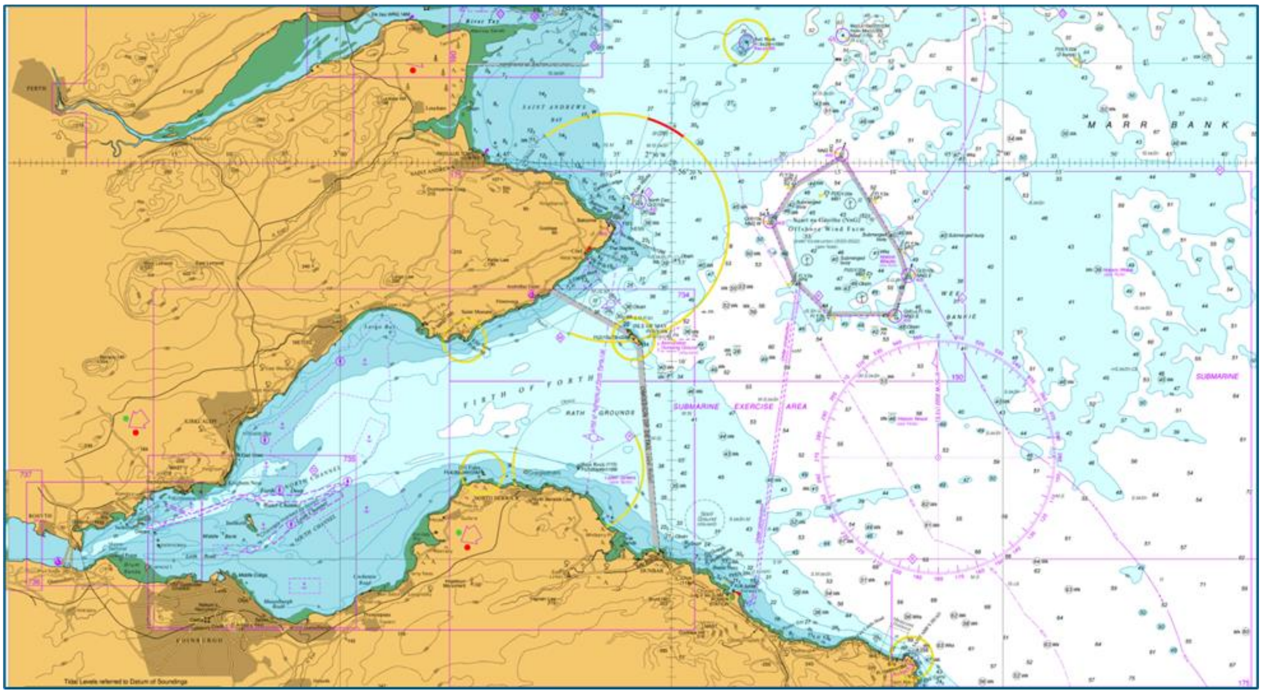


Figure 7-1 Extract from Admiralty Chart 735 Firth of Forth Approaches To Leith (Copyright UKHO)

FugroEMU (2013a) completed a bathymetric survey of the area surrounding the Port of Leith between 19th November and 19th December 2012 (**Figure 7-2**). All measured depths were converted to Ordnance Datum Newlyn (ODN) and indicate that seabed elevations ranged from 2.7m ODN to -20.3m ODN. From the outer berth for about 2km into the Firth of Forth, the bathymetry gradually deepens from about -5m ODN to about -18m ODN. Further offshore the seabed then rises to about -9m ODN before starting to deepen again. The Approach Channel to the outer berth is a straight-edged, maintained channel with depths of about -10m ODN. The bathymetric contours to the west of the outer berth and Approach Channel are smoother than those to the east implying sedimentary cover to the west and more exposed bedrock and harder substrate to the east. Indeed, three areas of rocky seabed extend out from the coast to the east of the Port of Leith.

7.5.2 Astronomical Water Levels

The tide levels for Port of Leith are regular and semi diurnal, with predicted spring and neap tide ranges of 4.83m and 2.37m, respectively. The Admiralty Tide Tables (2022) outline the principal reference tide levels, as set out in **Table 7-2**. The relationship between is CD and ODN is that CD is -2.90m ODN.

Table 7-2 Tide levels (Admiralty Tide Tables, 2022)

Reference Tide	Abbreviation	Tide level (m CD)
Highest Astronomic Tide	HAT	+6.27
Mean High Water Spring	MHWS	+5.61
Mean High Water Neap	MHWN	+4.38
Mean Sea Level	MSL	+3.195
Mean Low Water Neap	MLWN	+2.01
Mean Low Water Spring	MLWS	+0.78
Lowest Astronomic Tide	LAT	-0.08

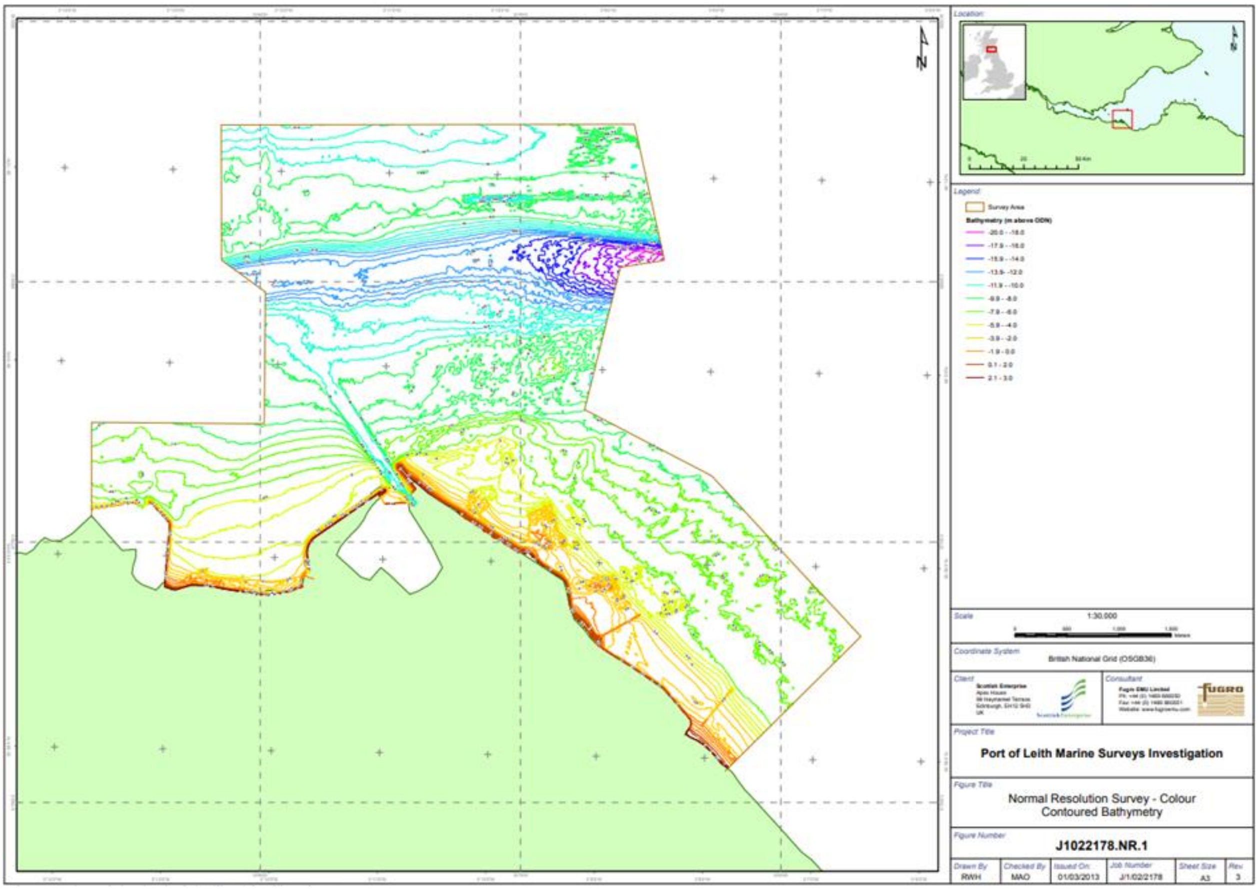


Figure 7-2 Bathymetry adjacent to the outer berth in late 2012 (FugroEMU, 2013a)

The flood tide duration is slightly longer than the ebb tide duration, with an average flood time of 6 hours 28 minutes whereas the average ebb time is around 5 hours 56 minutes.

7.5.3 Storm Surge

The Port of Leith is potentially susceptible to storm surges because of meteorological conditions such as low barometric pressure and strong winds. Water levels at the proposed development site could become elevated above those of the predicted astronomical tide.

7.5.4 Tidal Currents

The nearest Admiralty tidal stream data are located in South Channel some distance away from the Port of Leith. Here, tidal streams run approximately parallel to the coast and are east to west (into the Firth of Forth) during the flood tide and west to east (out of the Firth of Forth) during the ebb tide (British Geological Survey, 1986). The Admiralty tidal stream data indicates that the tidal velocities vary between 0.1 and 0.6m/s during spring tides and 0.1 to 0.3m/s during neap tides. This indicates the tidal currents are relatively mild in South Channel (but sufficient to transport and erode fine sediment) and weaker in the nearshore zone closer to the Port of Leith. FugroEMU (2013a) deployed four acoustic current profilers offshore from the Port of Leith for 30 days at the end of 2012/early 2013 to capture data on current speed and direction (**Figure 7-3**).

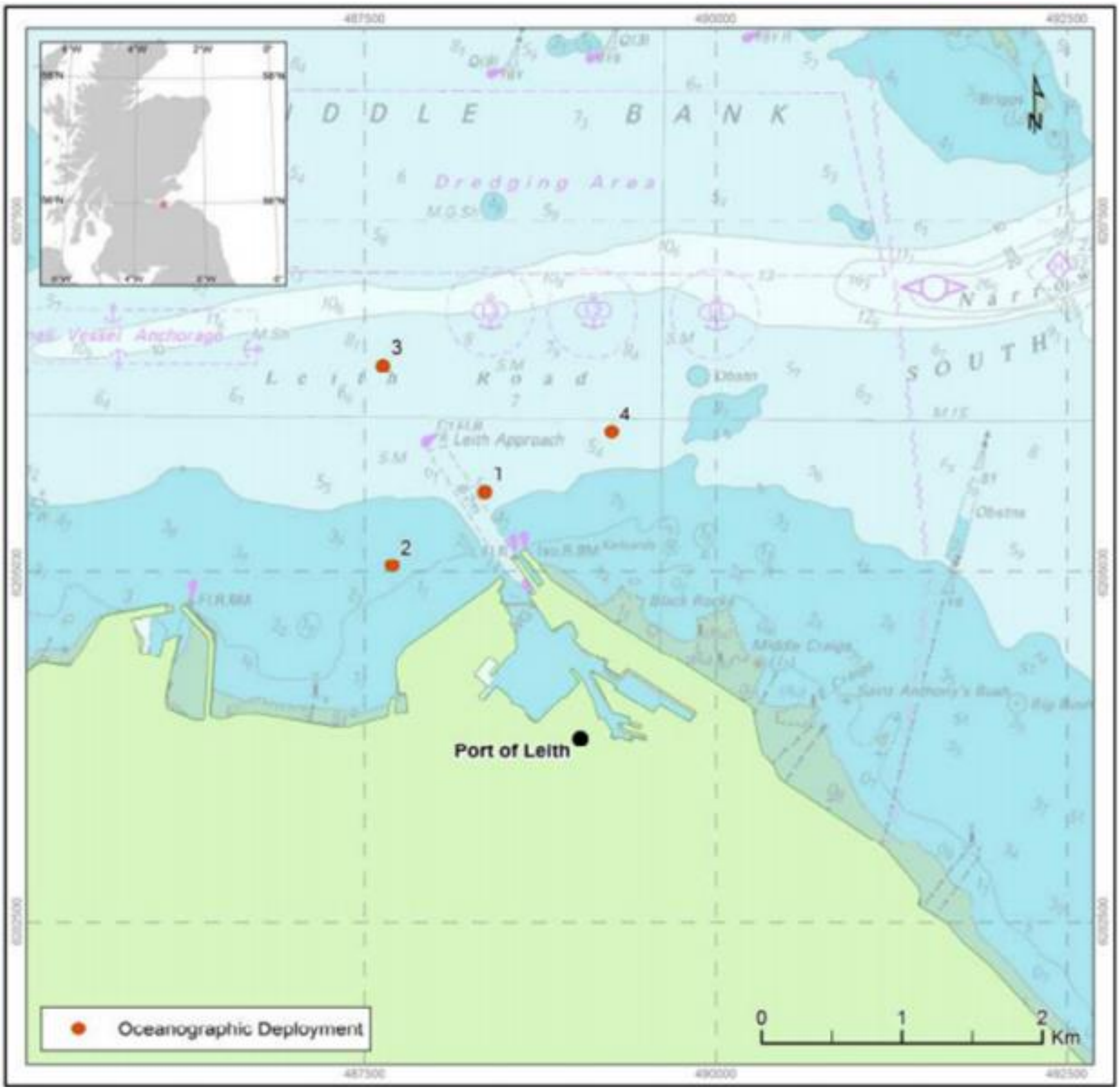


Figure 7-3 *Locations of acoustic current profiler deployments in 2012 (FugroEMU, 2013a)*

They showed that the tidal current floods in a west-southwest direction and ebbs in an east-northeast direction; however, the current speed and direction can be disturbed by non-tidal river discharge when the current direction on much of the flood tide remains easterly (i.e., out of the Firth of Forth). The maximum recorded tidal current speed was 1.27m/s near the water surface at Site 1. Maximum near-bed tidal current speeds (potential driver of bedload sediment transport) reached 0.57m/s at Site 1 and 0.41m/s at Site 2. The statistics at Sites 1 and 2, closest to the outer berth, are presented in **Table 7-3** and **Table 7-4**.

Table 7-3 Current statistics for Site 1 (FugroEMU, 2013a)

Statistic	Depth-averaged	Surface (0-0.5m)	Mid (5.0-5.5m)	Near-bed (1.0-1.5m)
Maximum tidal current speed	0.70	1.27	0.71	0.57
Mean spring tide speed (m/s)	0.47	0.63	0.50	0.34
Mean neap tide speed (m/s)	0.25	0.40	0.25	0.18
Flood direction (°N)	246	247	248	240
Ebb direction (°N)	66	67	68	60

Table 7-4 Current statistics for Site 2 (FugroEMU, 2013b)

Statistic	Depth-averaged	Surface (0-0.5m)	Mid (5.0-5.5m)	Near-bed (1.0-1.5m)
Maximum tidal current speed	0.49	0.72	0.46	0.41
Mean spring tide speed (m/s)	0.32	0.36	0.31	0.24
Mean neap tide speed (m/s)	0.17	0.22	0.15	0.13
Flood direction (°N)	255	265	251	245
Ebb direction (°N)	75	85	71	65

Arup (2007) indicated that an eddy forms in the Approach Channel at the end of the eastern breakwater, which peaks a couple of hours after high water and a couple of hours after low water. Measurements taken by the Port of Leith in July 1999 indicate a maximum current of 0.44m/s on the spring tide and 0.41m/s on the neap tide. The direction of these currents depends on location. About 100m from the end of the eastern breakwater the current flows 10°N and 190°N depending on the state of the tide, and at 300m from the end of the breakwater, the current flows approximately 310-320°N and 110-130°N depending on the state of the tide.

The tidal current velocities experienced under existing baseline conditions have been modelled using DHI's MIKE21-Flexible Mesh (FM) Hydrodynamic Module (HD) to gain an understanding of the likely changes in spatial variation of peak flood and ebb tidal currents during a typical 30-day spring and neap tide cycle. **Figure 7-4** and **Figure 7-5** show the spatial variation of the peak flood tidal currents for the existing baseline, and **Figure 7-6** and **Figure 7-7** shows the model results for the peak ebb tidal currents.

The tidal modelling results clearly show that an eddy feature is formed just upstream and downstream of the eastern breakwater on the flood and ebb tide respectively. The modelling also confirms that the current velocities are relatively weak in the lee of the eastern breakwater with speeds less than 0.2m/s.

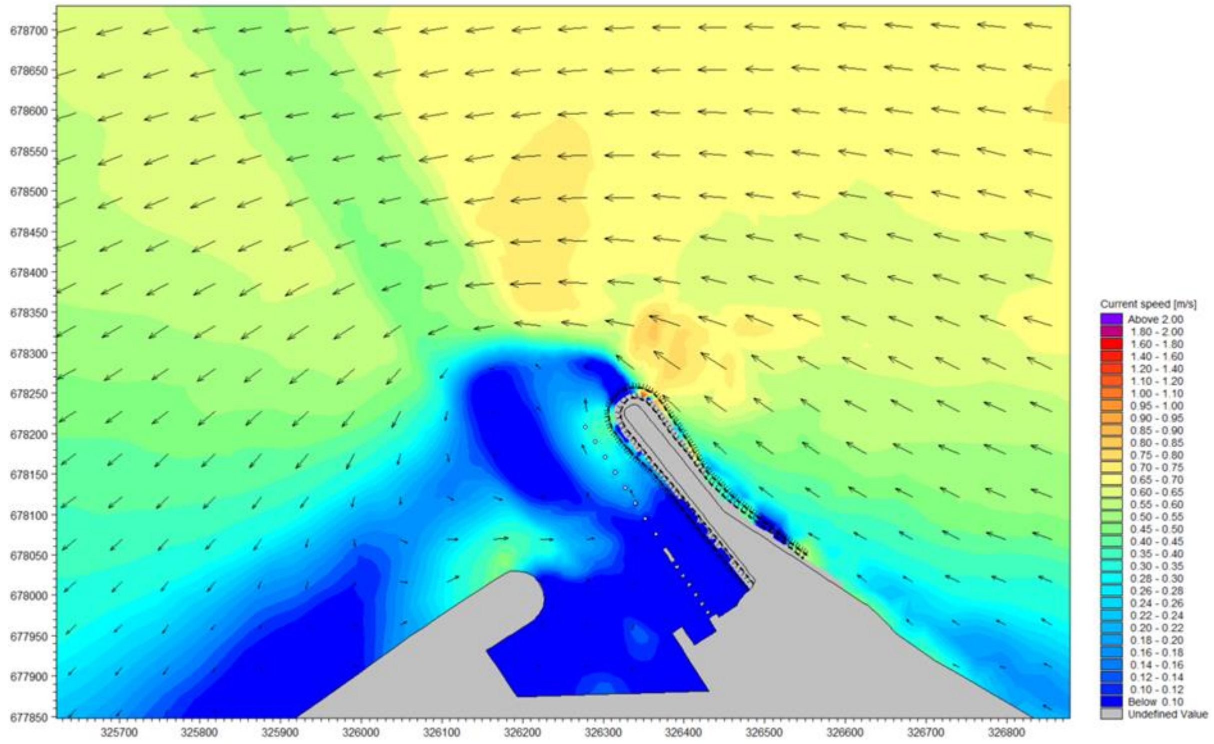


Figure 7-4 *Spatial variation of peak flood currents during spring tide – existing baseline*

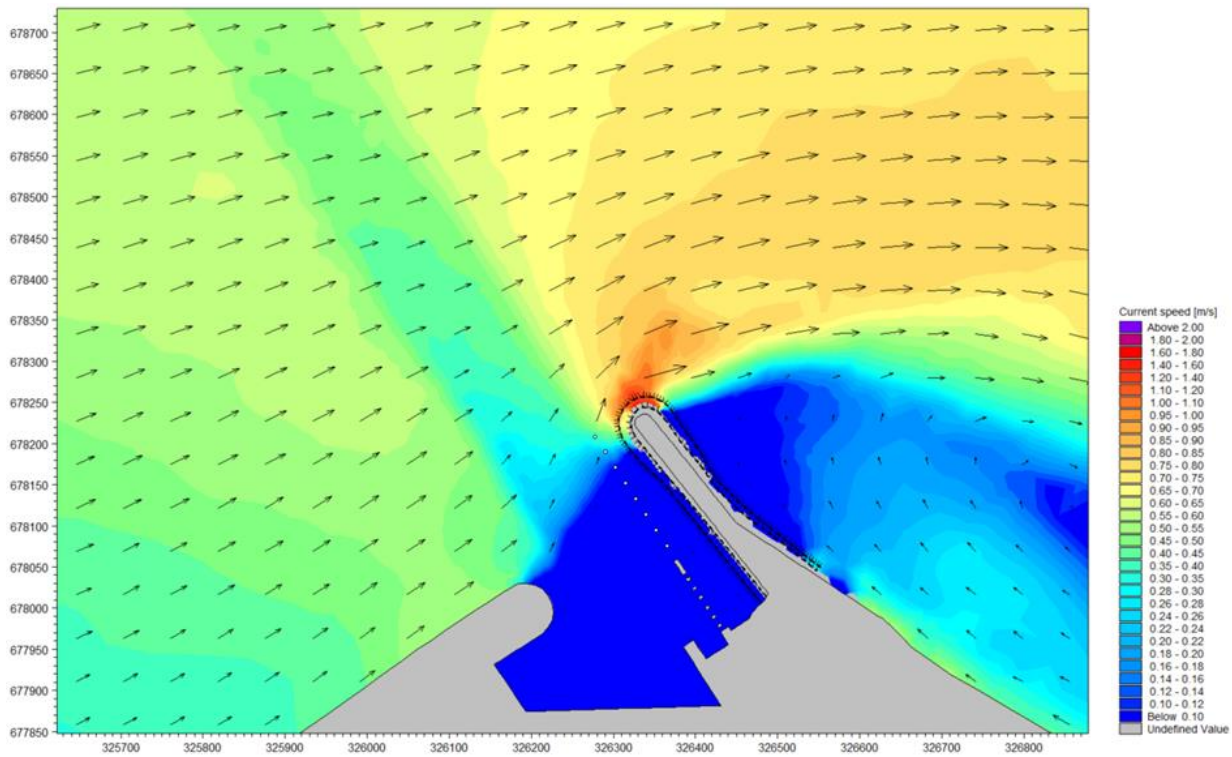


Figure 7-5 *Spatial variation of peak ebb currents during spring tide – existing baseline*

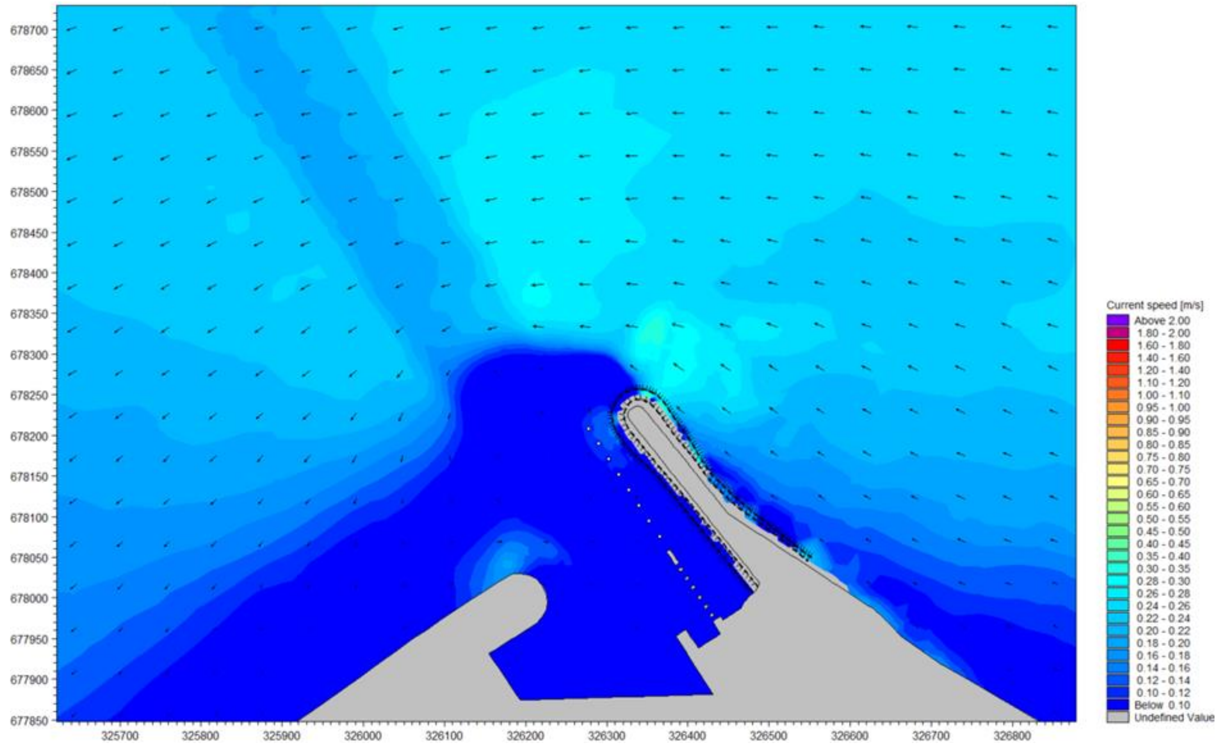


Figure 7-6 Spatial variation of peak flood currents during neap tide - existing baseline

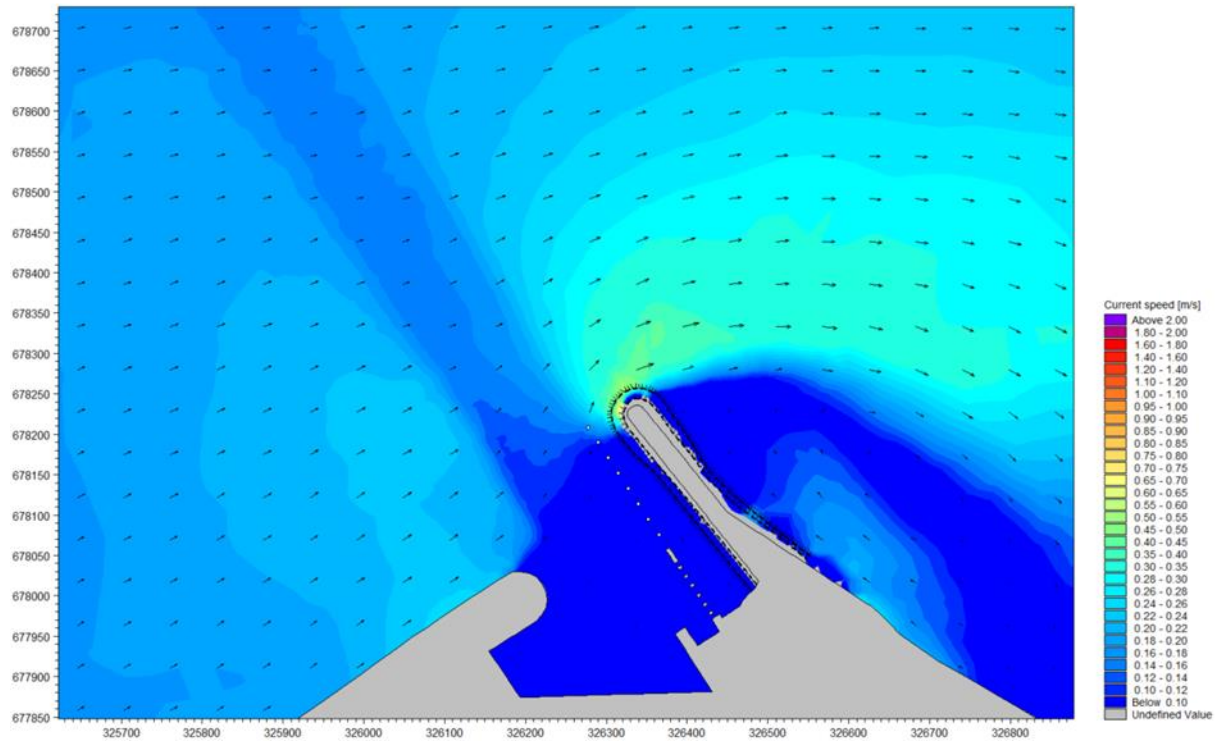


Figure 7-7 Spatial variation of peak ebb currents during neap tide - existing baseline

7.5.5 Bed Shear Stress

The tidal current velocities generate shear stresses on the seabed which, if sufficiently large in magnitude, can cause the erosion, transport and deposition of sediment. The MIKE21-FM HD model has been used to understand the likely changes in spatial variation of peak bed shear stresses during a typical 30-day spring and neap tide cycle. **Figure 7-8** and **Figure 7-9** show the spatial variation of the peak flood tidal currents for the existing baseline and **Figure 7-10** and **Figure 7-11** shows the model results for the peak ebb tidal currents. Peak bed shear stresses appear to lie just off the breakwater head, with very low bed shear stresses to the sheltered west of the breakwater within the harbour basin.

Note that the legend in these plots has been selected to mimic the critical thresholds for motion of different sediment grain sizes, as presented in **Table 7-5**. For example, in the lightest blue areas (bed shear stress below 0.18NN/m^2) any sediments with a mean grain size above 0.2mm would not be mobilised.

Table 7-5 Critical bed shear stress thresholds for motion of different sediment grain sizes

D_{50} (mm)	Critical Bed Shear Stress (N/m^2)	D_{50} (mm)	Critical Bed Shear Stress (N/m^2)
0.2	0.18	7	6.09
0.5	0.27	8	7.06
1	0.5	9	8.01
2	1.23	10	9
3	2.1	20	18
4	3.09	50	45
5	4.09	100	89
6	5.1		

7.5.6 Freshwater Input

The Water of Leith is the main river flowing roughly from the centre of Edinburgh. It flows into the Port of Leith where it eventually flows into the North Sea via the Firth of Forth. The influence of this freshwater source on a day-to-day basis has no discernible impact upon the hydrodynamics of the proposed development site; however, under high rainfall events, water levels inside the inner harbour rise and the Port of Leith manage this increase by allowing water to discharge into the Firth of Forth via a culvert on the northern side of the lock.

7.5.7 Wave Climate

The predominant waves approach the Port of Leith region from the east to east-northeast sector (from the North Sea). These waves drive longshore sediment transport to the west. The waves are composed of two distinct components (HR Wallingford, 2007). These are short period waves, generated by winds blowing across the Firth of Forth, and longer period swell waves, generated further offshore modified (reduced) by the sheltering effects of the adjacent coast and refraction as they propagate through the Firth of Forth.

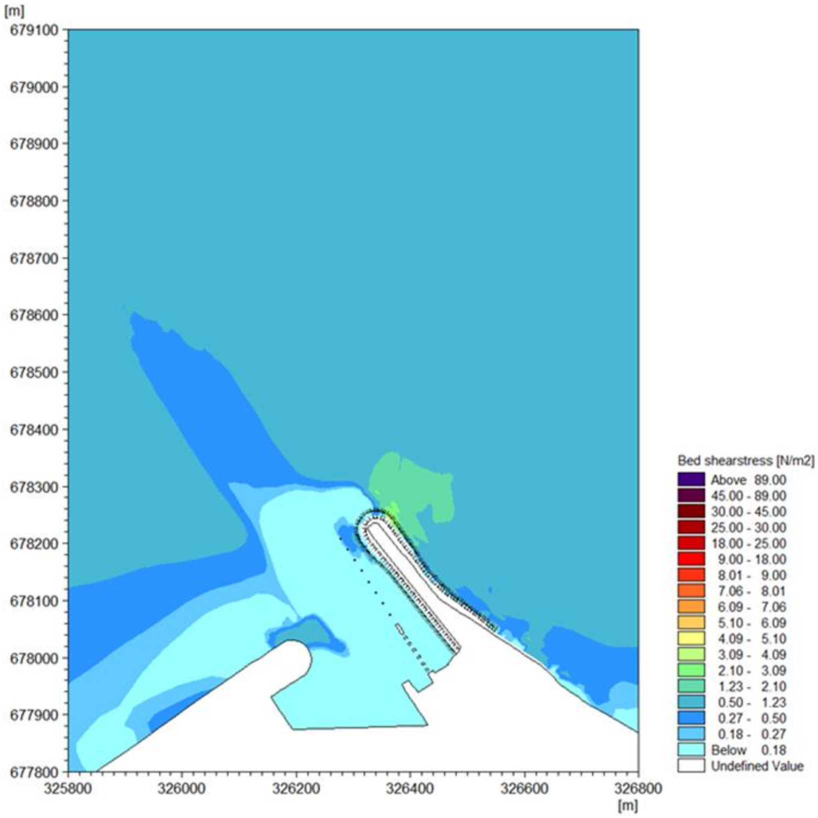


Figure 7-8 *Spatial variation of bed shear stress during peak flood currents during spring tide – existing baseline*

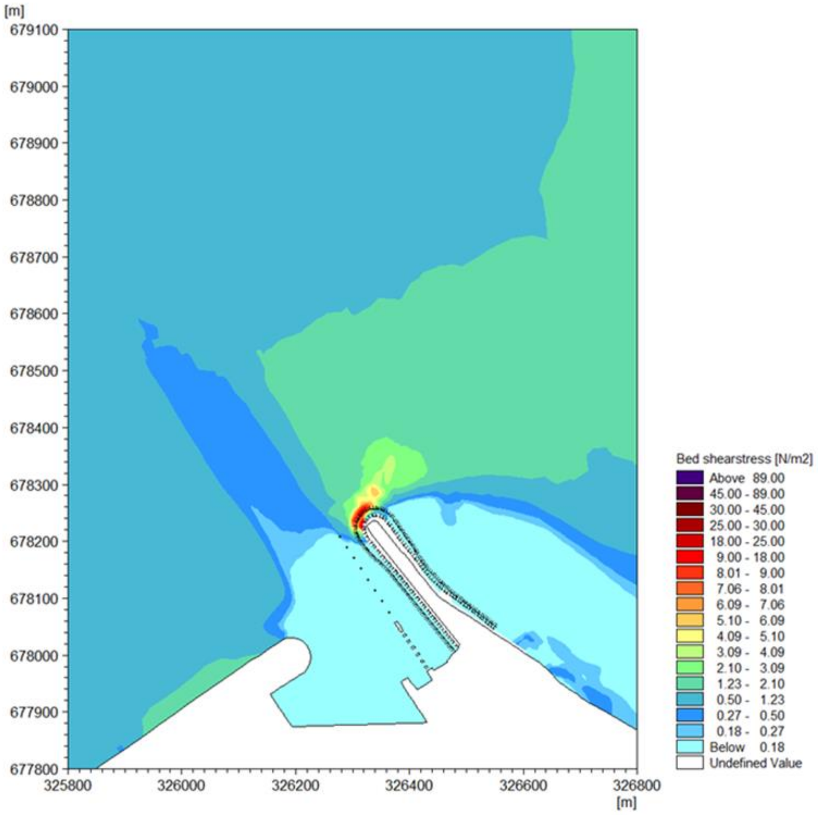


Figure 7-9 *Spatial variation of bed shear stress during peak ebb currents during spring tide – existing baseline*

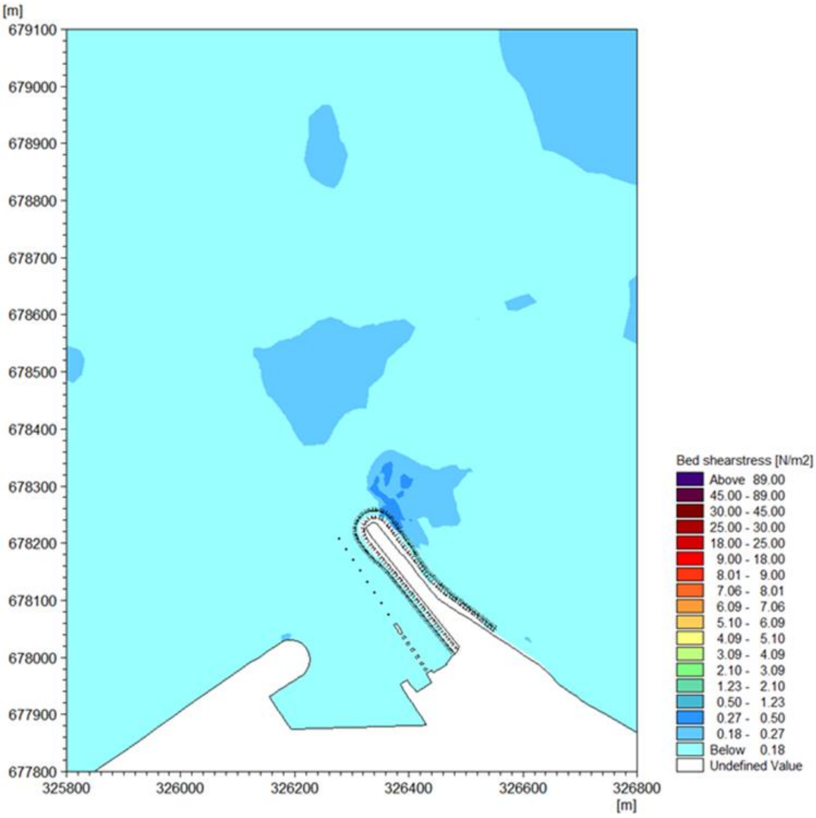


Figure 7-10 *Spatial variation of bed shear stress during peak flood currents during neap tide – existing baseline*

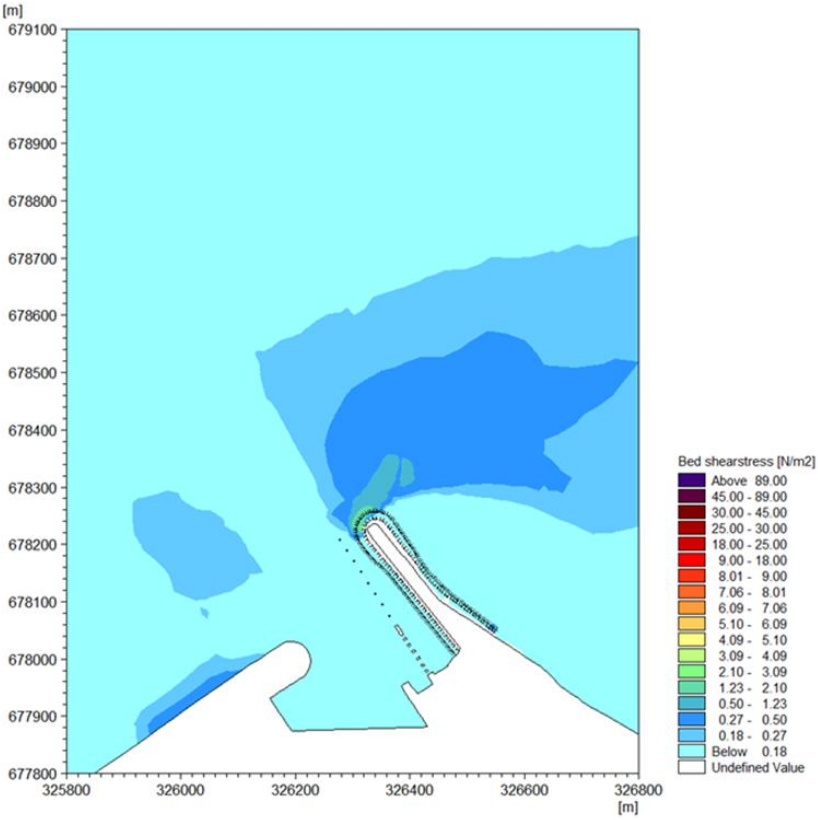


Figure 7-11 *Spatial variation of bed shear stress during peak ebb currents during neap tide – existing baseline*

HR Wallingford (2004) used hindcast wave data between 1987 and 2002 and showed that the largest incident wave conditions caused by wind are from the 45-75°N offshore sector, which has long fetch lengths and one of the strongest wind speed sectors. For a one-summer (April to September) return period, the maximum significant wave height from this sector is 1.7m. The sectors either side (15-45°N and 75-105°N) have maximum significant wave heights of 1.3m and 1.4m, respectively. Swell waves approaching the proposed development site from the 30-120°N sectors have significant wave heights of 0.6-0.9m for the one-summer return period. The combination of wind-wave and swell waves from the northeast results in maximum significant wave heights of 1.5-1.8m for the one-summer return period. Waves from the west have shorter fetches but higher wind speeds resulting in maximum significant wave heights of 1.3m for the one-summer return period. Waves from the north have a maximum significant wave height of 1.0m for the one-summer return period.

Using an extended hindcast dataset (1987-2006), HR Wallingford (2007) showed that the nearshore wave conditions are relatively benign with fewer than 0.1% of significant wave heights predicted to be greater than 2m. The larger waves (significant wave heights greater than 1.2m) had peak periods less than seven seconds. Longer period waves do penetrate the site, with peak periods as high as 17 seconds, but the longest waves (periods greater than 12 seconds) tend to be associated with relatively small waves (significant wave heights less than 0.6m).

Wave data was collected at Site 3 (**Figure 7-3**) by FugroEMU (2013a) to assist in the quality control of turbidity data. General statements on wave conditions were provided. Maximum significant wave heights during calm conditions were less than 0.5m. Three periods of elevated wave heights were recorded, during which significant wave heights increased to up to 1m with maximums between 1.25m and 2.9m.

7.5.8 Sedimentary Processes

There are three potential sources of sediment which may influence the sedimentary processes at the Port of Leith. These are:

- Nearshore sediment source within the Firth of Forth;
- Coastal sediments; and,
- Seabed sediments within the immediate vicinity of the proposed development (i.e. Approach Channel).

7.5.8.1 Potential Nearshore Sediment Sources

FugroEMU (2013c) completed a grab sample survey in the nearshore area around the Port of Leith between the 17th and 20th November 2012 and on 29th November 2012 (**Figure 7-12**). All but three sites were sampled for particle size distribution.

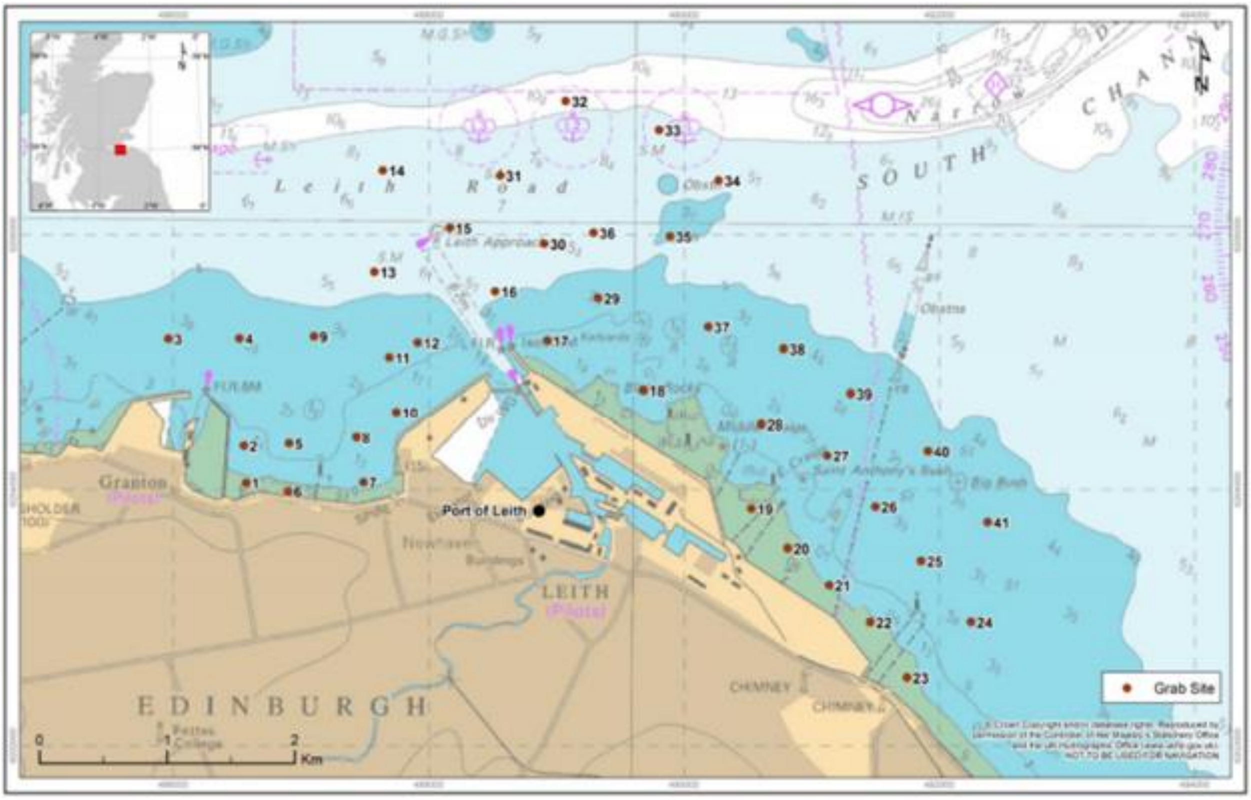


Figure 7-12 Location of grab samples recovered by FugroEMU (2013c) in November 2012

The particle size distributions can be divided into three distinct areas (**Figure 7-13**). West of the outer berth (outside the entrance of Granton Harbour to the entrance channel of the Port of Leith), the dominant sediment is silt (less than 63 microns) with subordinate very fine to fine sand and gravel. To the east of the outer berth (offshore from the Port of Leith between the entrance channel and Black Rocks), silt is still dominant, but the percentage of gravel increases relative to sand. East of the Black Rocks, very fine to fine sand is dominant with subordinate gravel. The predominant samples to the west of the outer berth contain 0-6% gravel, 16-41% sand and 59-80% mud. The predominant samples to the east of the outer berth are variable containing 1-77% gravel, 19-98% sand and 1-48% mud.

Fugro (2013b) completed 45 boreholes to the north-northwest of the eastern breakwater (**Figure 7-14**). The general geological succession comprised bedrock of interbedded mudstone, siltstone and sandstone overlain by sandy gravelly clay with gravel bands (till) overlain by recent clay/silt/sand/gravel. Particle size analyses were undertaken on 255 sediment samples recovered from the boreholes. Particle size data from the top 1m of the eight samples closest to the eastern breakwater (BH01, 02, 03, 04, 05, 15, 16, and 25) are presented here (**Table 7-6**). The predominant lithology is sand with subordinate mud and gravel. The percentage of sand typically ranges from 32% to 94% with 1-38% mud and 5-51% gravel.

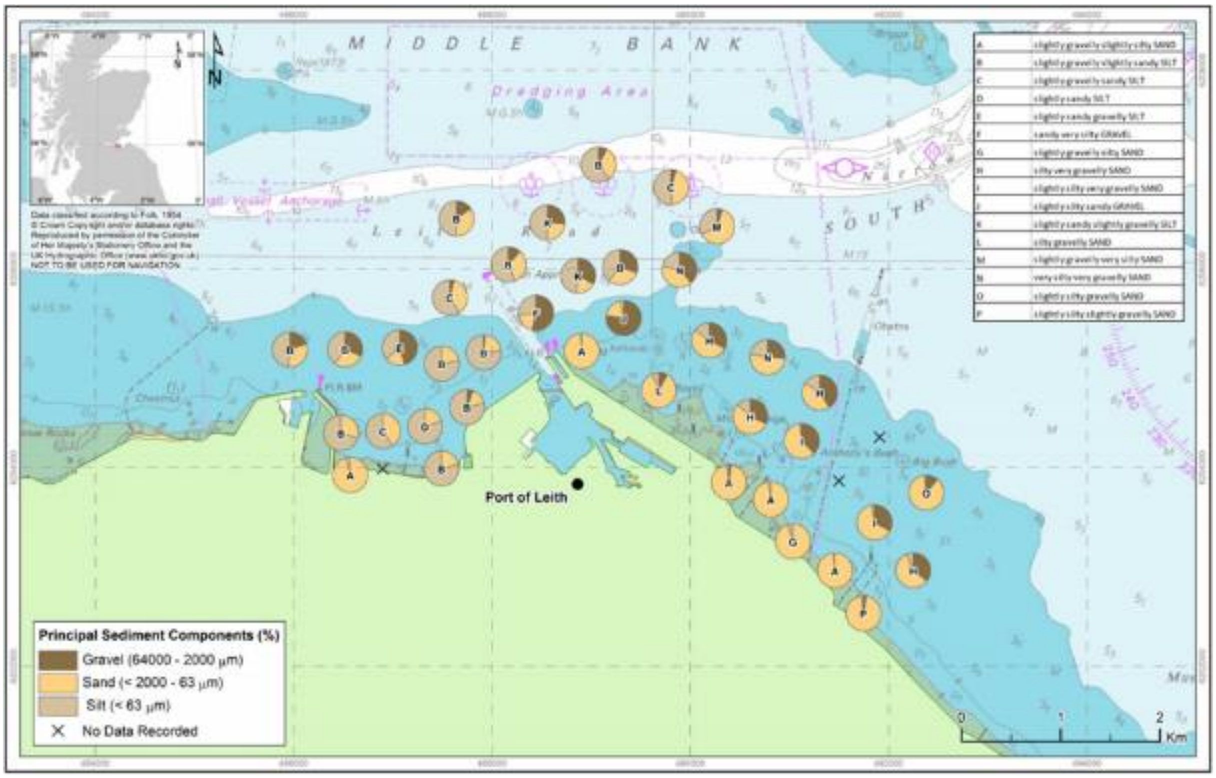


Figure 7-13 *Sediment classifications at each of the grab samples recovered by FugroEMU (2013c) in November 2012*

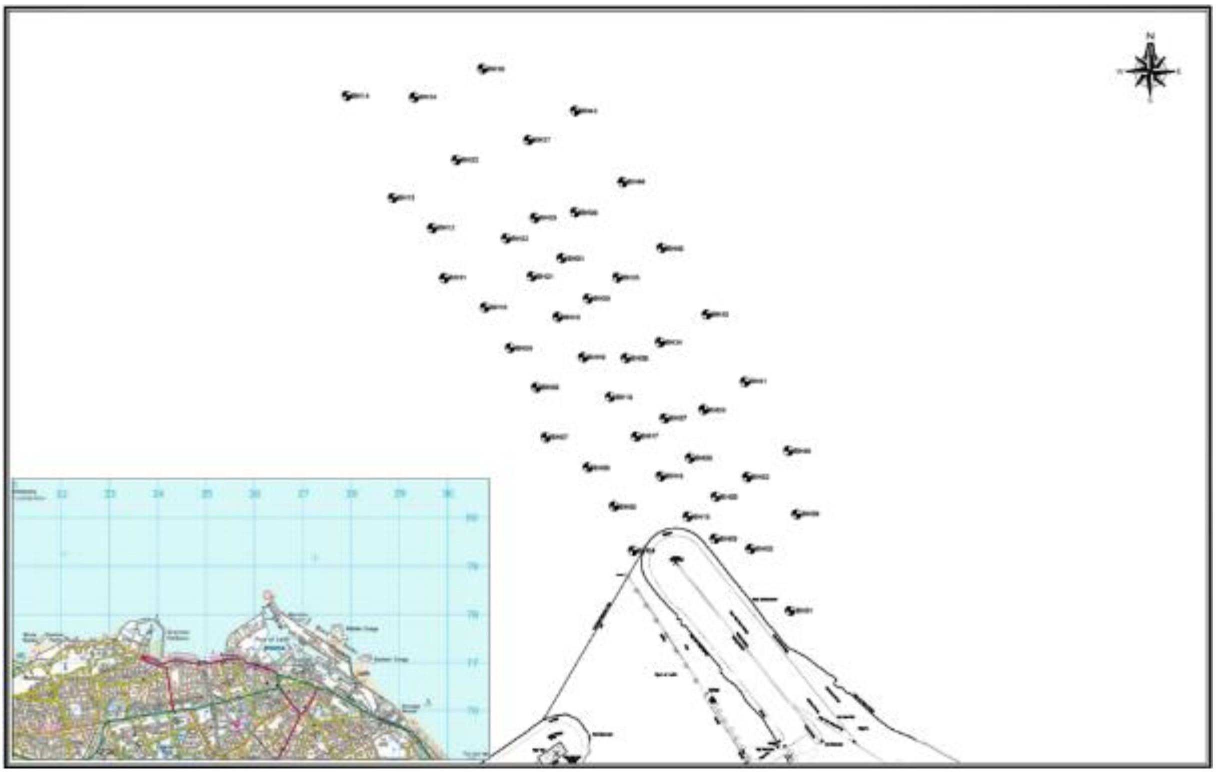


Figure 7-14 *Location of boreholes recovered by Fugro (2013b)*

Table 7-6 Sediment classifications at each of the borehole samples close to the eastern breakwater recovered by Fugro (2013b)

Borehole	Depth	%mud	%sand	%gravel	%cobbles
01	0.0	1	70	28	1
02	0.0	2	47	51	0
03	0.5	1	94	5	0
04	0.0	7	81	12	0
04	0.5	24	32	34	10
05	0.0	38	46	16	0
05	0.6	12	65	23	0
15	0.0	6	66	28	0
16	0.0	32	35	26	7
25	0.5	6	71	23	0
25	1.0	25	44	29	2

7.5.8.2 Potential Coastal Sediment Sources

HR Wallingford (2004) described the coastal geomorphology along Leith Sands; the 2km of coast stretching southeast from the eastern breakwater of the Port of Leith. The eastern breakwater is fronted by a beach composed of medium to coarse sand (**Figure 7-15**) comprising a mixture of natural beach sand and a large proportion which appears to have originated from the degraded building material that has been tipped further southeast along the coast (**Figure 7-16**). This material has been continually eroding into a small scarp but has provided some benefit as a sea defence. Below this slope the foreshore is covered with rubble eroded from the tipped material. Along most of Leith Sands where there is tipped building material, the amount of sand on the upper foreshore is small. Most of the beach is composed of concrete, rock or brick rubble enabling an artificially steep slope to be maintained (**Figure 7-17**). **Figure 7-17** also shows local accretion of the foreshore in the shelter of the Middle Craigs Rocks which act as a submerged offshore breakwater.

Further east, the seawall turns south for about 0.5km before turning back to its orientation. This frontage is occupied by the East Sands of Leith. At the south of the southerly oriented coast, the seawall temporarily ends and there is a short stretch of approximately 100m with no sea defence and a small coarse sand beach. Erosion of this beach in the past has been mitigated by the disposal of sand and concrete from a cement mixing plant on the site. East from the small beach, the coast is defended by a steep seawall with a narrow foreshore before the beach widens further east into the nourished and groyned Portobello Beach.

West of Port of Leith to Granton Harbour there is very little sand on the foreshore (**Figure 7-18**). West from Granton Harbour there is also very little foreshore sand until the vast sand flats of Drum Sands.

Figure 7-15 Leith Sands beach immediately southeast of the eastern breakwater (HR Wallingford, 2004)

Figure 7-16 Eroding tipped building waste along Leith Sands (HR Wallingford, 2004)

Figure 7-17 *Steep slope formed by building waste and local accretion of foreshore in the lee of Middle Craigs Rocks*

Figure 7-18 *Coast to the west of the Port of Leith*

7.5.8.3 Seabed Sediments in the Approach Channel

According to HR Wallingford (2004), dredging records show that the sediment trapped in the Approach Channel is silty sand. No particle size data were available for sediments in the outer berth. An assessment of the amount of annual dredging that has occurred historically in the Approach Channel to the Port of Leith, where this material was dredged and why it occurs at these locations has been undertaken.

7.5.8.4 Historical Dredging Volumes

The Port of Leith is licensed to dispose 250,000m^3 of dredged sediment annually in Narrow Deep within South Channel. Between 2001 and 2017, the recorded volumes were the combined dredging of the Approach Channel and within the dock (**Table 7-7**), whereas between 2018 and 2021 the volumes are for the Approach Channel only (**Table 7-8**). Most of the deposition within the dock was derived from supply from the Water of Leith, whereas the sediment removed from the Approach Channel was supplied by marine/coastal sediment transport.

The annual combined volumes (2001 to 2017) range from 0 to 65,719m^3 with an average of 19,608m^3. The annual volumes dredged from the Approach Channel (2018 to 2020) range from 6,780m^3 to 28,342m^3 with an average of 19,197m^3. These volumes suggest that most of the sediment is removed from the Approach Channel with very small volumes from the dock area. Hence, the longer-term average volume of maintenance dredging from the Approach Channel has been about 20,000m^3/year. This dredging rate can be used as a proxy for the rate of sediment transport into the Approach Channel.

Table 7-7 Annual maintenance dredge volumes from the Approach Channel and dock combined (data from Forth Ports)

Year	Volume (m^3)	Year	Volume (m^3)
2001	65,719	2010	23,574
2002	23,820	2011	21,597
2003	21,689	2012	0
2004	10,162	2013	0
2005	0	2014	25,930
2006	14,096	2015	18,966
2007	3,173	2016	47,957
2008	28,412	2017	0
2009	28,241		
Average 2001-2017		**19,608**	

Table 7-8 Annual maintenance dredge volumes from the Approach Channel (data from Forth Ports)

Year	Volume (m^3)
2018	22,468
2019	6,780
2020	28,342
2021	8,523
Average 2018-2020	**19,197**

7.5.8.5 Predominant Deposition Location in the Approach Channel

Figure 7-19 shows the change in depth between January 2019 and pre-dredge December 2020 (top) and post-dredge December 2020 (bottom). A comparison of the two images serves as a proxy for where sediment accumulates in the Approach Channel and shows that most deposition occurs in the inner Approach Channel and in the outer berth. This is supported by HR Wallingford (2004) who indicated that deposition occurs mainly in the landward 250m of the Approach Channel with limited deposition in the remaining two thirds.

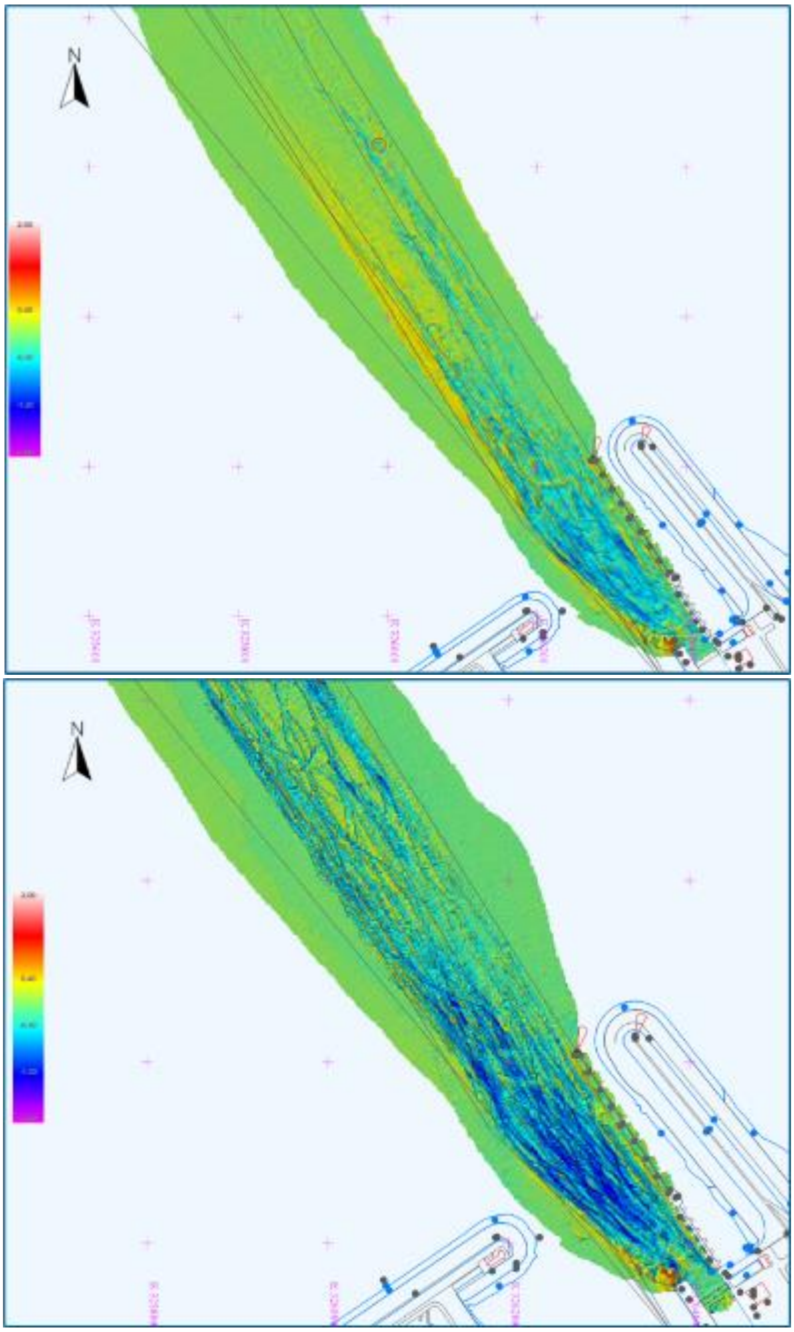


Figure 7-19 Comparison of 2019 routine survey bathymetry with 2020 pre-dredge bathymetry (top) and 2020 post-dredge bathymetry (bottom)

7.5.8.6 Deposition Mechanism

The predominance of silty sand in the Approach Channel (HR Wallingford, 2004) suggests that the deposition mechanism could be a combination of deposition from suspension in the water column and deposition by sediment transport processes along the bed.

7.5.8.7 Sediment Transport Mechanisms

Sediment transport is a crucial link in the interaction between coastal morphological evolution and waves, currents and tides. Sedimentation is related to convergence of sediment transport and erosion to divergence of sediment transport. Sediment transport takes place in several ways:

- Suspended load transport;
- Bedload transport; and,
- Fluid mud motion.

Suspended load transport is the transport of sedimentary particles that are suspended in the fluid whilst bedload transport is the transport of sedimentary particles that are rolling or leaping along the seabed. Fluid mud transport is the motion of a fluid mud layer along the seabed.

Given the type of sediment present within the local coastal environment, sediment transport due to bed load and suspended sediments are the dominant sediment transport mechanism for the accumulation of sediment found at the Port of Leith.

Bedload Sediment Transport

Ramsay and Brampton (2000) indicated that longshore transport of sediment is dominated by wave action from the North Sea which results in a net westerly movement of sediment along the southern coast of the Firth of Forth (**Figure 7-20**). The net rate of longshore sediment transport at and adjacent to the Port of Leith is low (Ramsay and Brampton, 2000; HR Wallingford, 2004). This is because along Leith Sands the coast is oriented approximately perpendicular to the predominant wave approach direction.

Sand has accreted along the outer face of the eastern breakwater since it was constructed. It is possible that some of the nourished sand from Portobello Beach is transported west along the coast to the Leith Sands frontage. A small volume of the bedload sediment from Leith Sands is transported around the end of the eastern breakwater and deposited in the Approach Channel (HR Wallingford, 2004); however, the limited volume suggests that there is not a large flux of wave-driven bedload sediment in a westerly direction across the port entrance (Sinclair Knight Merz, 2012). There will also be reversals of transport due to locally generated waves from the west.

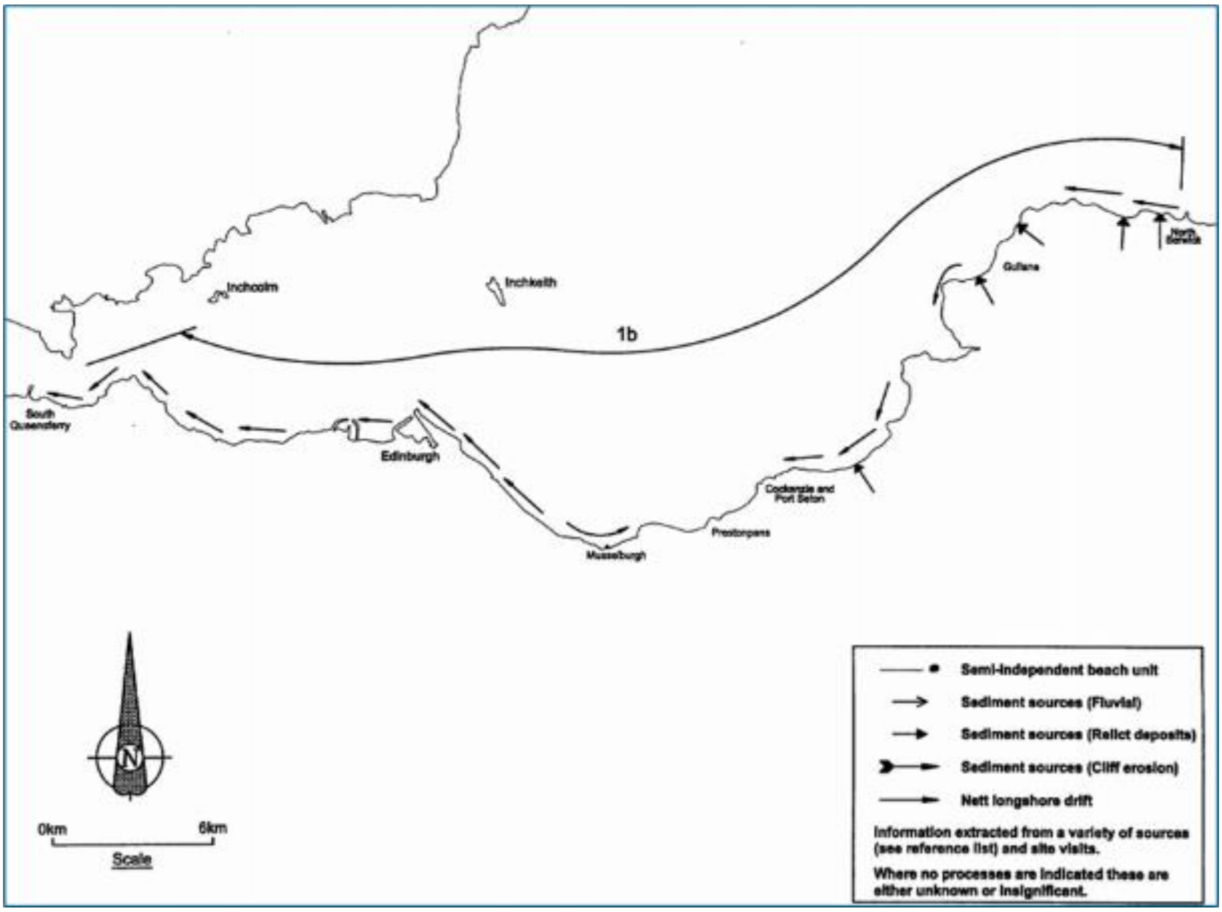


Figure 7-20 Net longshore sediment transport directions along the south shore of the Firth of Forth (Ramsay and Brampton, 2000)

Suspended Sediment Transport

FugroEMU (2013b) deployed four optical backscatter sensors offshore from the outer berth (at the same locations as the acoustic current profilers (**Figure 7-3**) to capture data on suspended sediment concentrations. Wave data was also collected at Site 3 to assist in the quality control of turbidity time series data. During calm wave conditions, near-bed suspended sediment concentrations of 10-50mg/l was recorded (**Figure 7-21**). This period was characterised by maximum wave heights less than 0.5m (at Site 3). During the first period of elevated wave heights, near-bed suspended sediment concentrations increased to approximately 1,300mg/l, 1,100mg/l, 600mg/l and 200mg/l at Sites 1, 2, 3 and 4, respectively.

During the second period of high waves, the suspended sediment concentrations reached approximately 1,000mg/l at Sites 1, 2 and 3 whilst at Site 4 the concentration peaked at around 700mg/l. During the third period, suspended sediment concentrations peaked at 500mg/l at Sites 1, 2 and 4, and 200mg/l at Site 3.

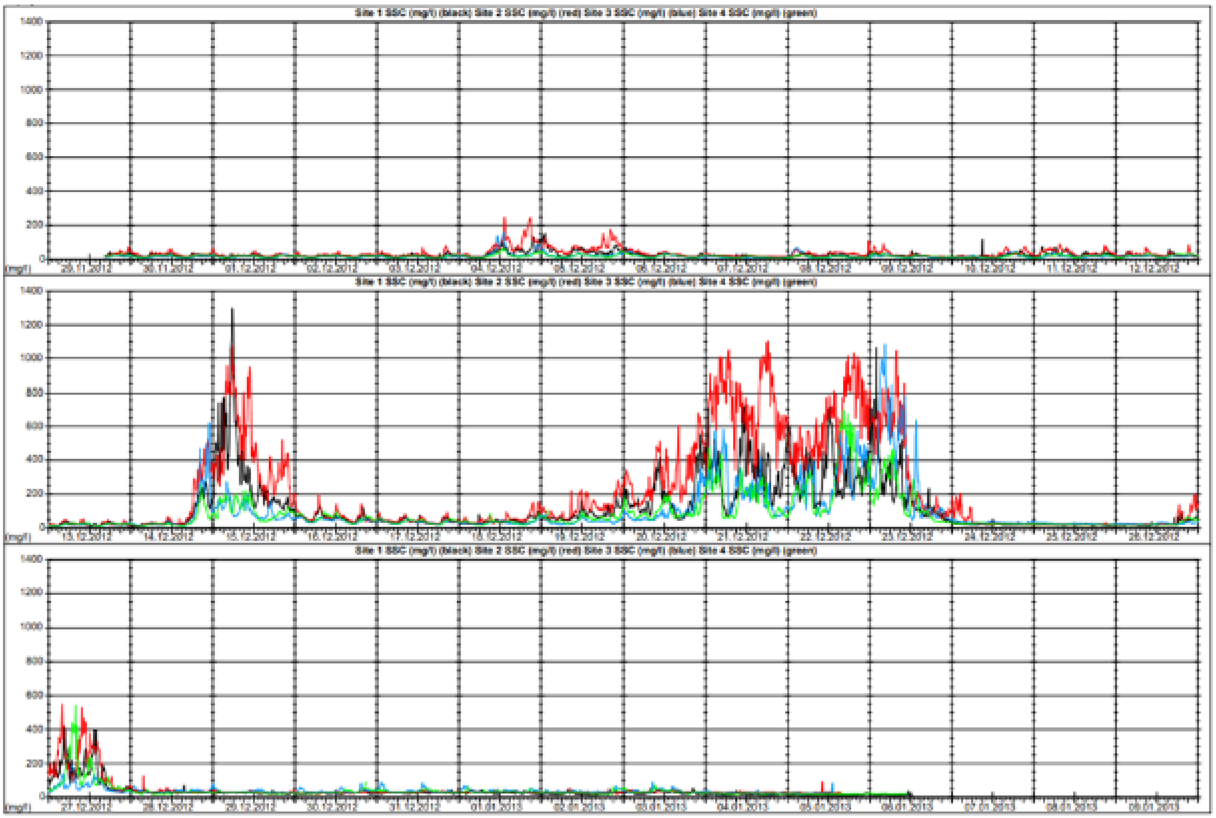


Figure 7-21 Suspended sediment concentrations at Sites 1 (black), 2 (red), 3 (blue) and 4 (green) between 29th November 2012 and 6th January 2013 (FugroEMU, 2013b)

The data shows that re-suspension of sediment from the seabed resulting in very high suspended sediment concentrations above ambient conditions is caused by increased wave heights. After the sediment is elevated into the water column by this process, it is transported past the eastern breakwater by tidal currents on the flood tide and by wave induced flows (typically during easterly weather (HR Wallingford, 2004)). On the flood tide it is likely that a large-scale eddy forms in the lee of the eastern breakwater (Arup, 2007) that traps some of the suspended sediment that bypasses the eastern breakwater allowing it to settle and deposit in the inner Approach Channel and outer berth (ERM, 2021).

7.6 Prediction of Potential Effects during Construction

7.6.1 Changes in Sea-bed Level due to Dredging

The increased suspended sediment concentrations created by the proposed dredging works associated with the outer berth will have the potential to deposit sediment and raise the seabed elevation in the vicinity of the proposed development and disposal site.

Figure 7-22 shows the predicted changes in seabed elevation at the proposed development site, which indicates that the largest change in seabed elevation would occur as a small patch in the vicinity of the proposed development. The magnitude of the predicted seabed increase is up to 0.23m. Generally, along the sheltered side of the eastern breakwater the predicted seabed increase is up to 0.10m but within the enlarged pocket berth and within the existing Approach Channel, deposition of between 0.01 and 0.03m is predicted; however, with progression away from the proposed development the amount of deposition reduces considerably and seabed depositions reduce to less than 0.005m (5mm), which is deemed negligible. Given that the Approach Channel will continue to be dredged along with the enlarged berth pocket until the required depths are achieved, it is expected that sediment accretion of this amount would not persist.

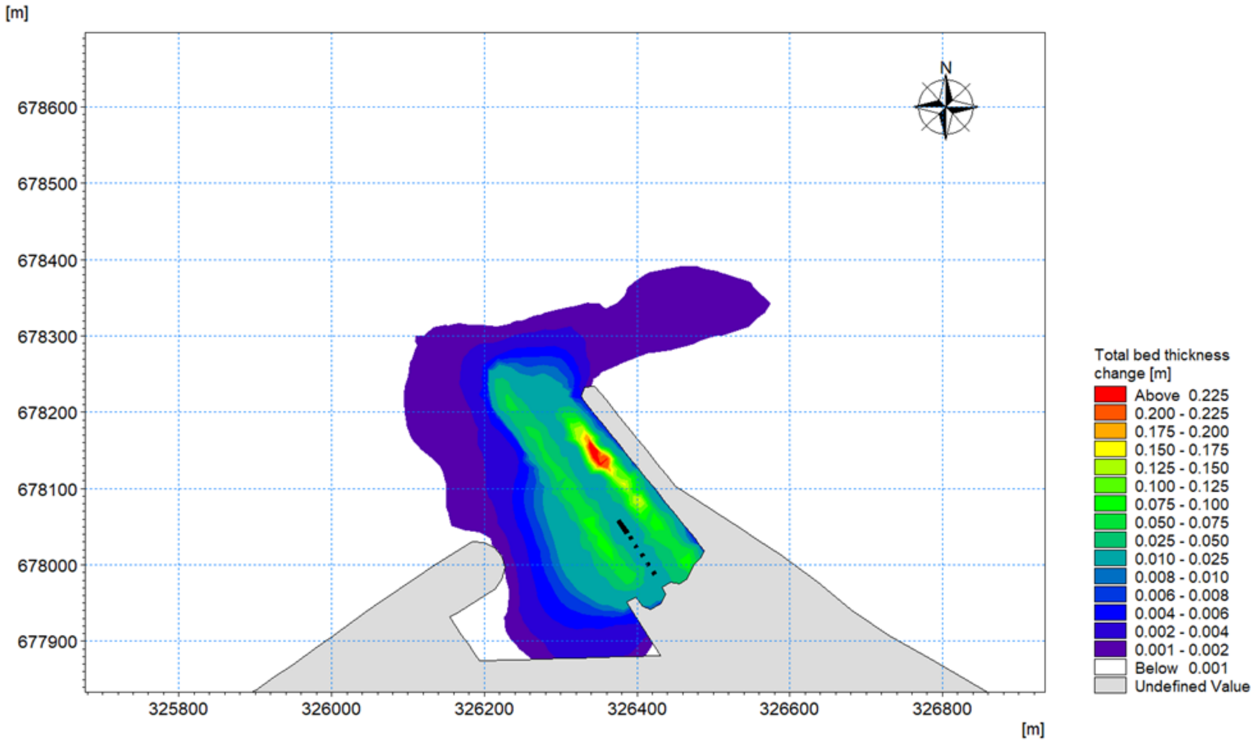


Figure 7-22 Predicted changes in seabed elevation due to deposition from the plume caused by dredging

Assessment of effect

The changes in seabed levels due to dredging would have the magnitudes of effect shown in **Table 7-9**.

Table 7-9 Magnitude of effect on sea-bed level changes due to deposition of the plume as following dredging

Location	Scale	Duration	Frequency	Reversibility	Magnitude of Effect
Near-field	Small	Short	Construction only	Reversible	Low
Far-field	N/A	N/A	N/A	N/A	No Impact

7.6.2 Changes in Sea-bed level due to Deposition of the Sediment Plume at Narrow Deep Disposal Site

Figure 7-23 shows the predicted changes in seabed elevation at Narrow Deep disposal site due to the deposition of the sediment plume. The results show that any predicted increase in bed thickness is confined predominantly to within the boundary of the disposal site and outside this region the amount of increase in seabed level is relatively small at less than 0.005m (5mm).

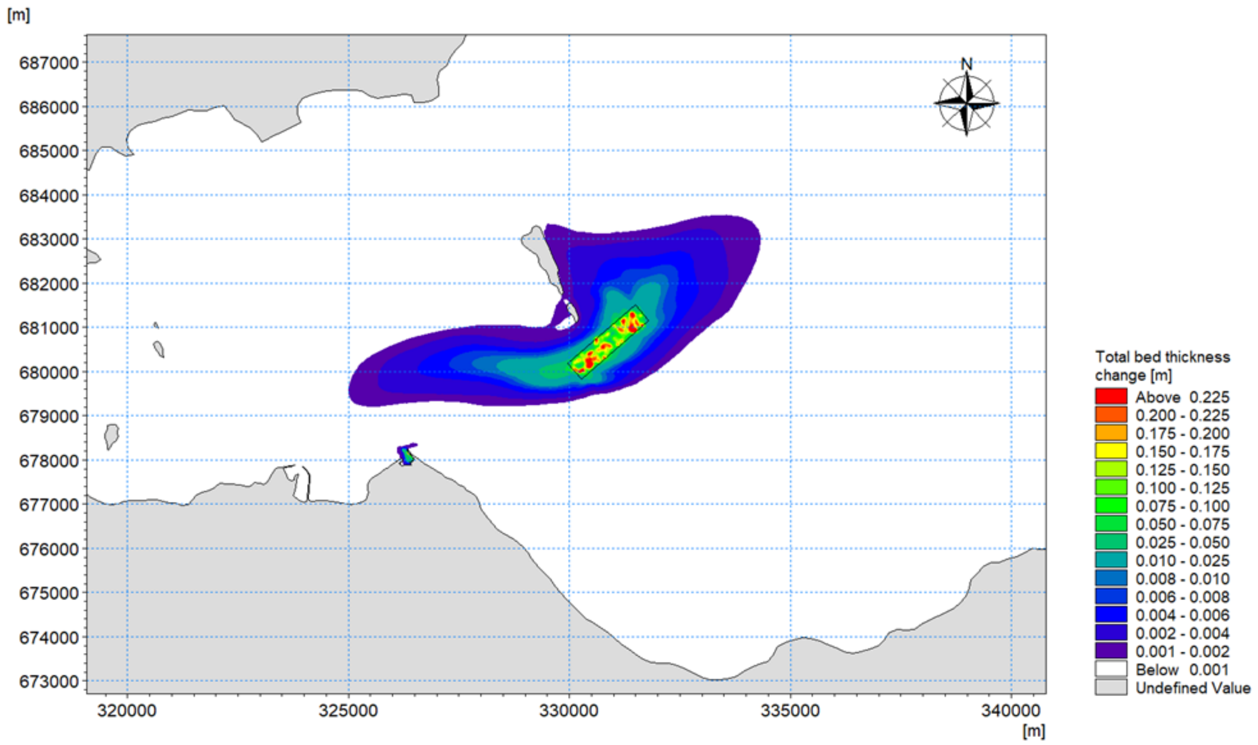


Figure 7-23 Predicted changes in seabed elevation due to deposition from the plume created by disposal of dredged sediments

Assessment of effect

The changes in seabed levels due to disposal of sediments would have the magnitudes of effect shown in **Table 7-10**.

Table 7-10 Magnitude of effect on sea-bed level changes due to deposition of the plume following disposal of the dredged material

Location	Scale	Duration	Frequency	Reversibility	Magnitude of Effect
Within disposal site	Small	Short	Construction	Reversible	Low
Outside Disposal site	Negligible	Short	Construction	Reversible	Negligible

7.7 Prediction of Potential Effects during Operation

7.7.1 Changes to the Tidal Current Regime due to the Presence of the Outer Berth and Enlarged Berth Pocket

The presence of the proposed development has the potential to alter the baseline tidal regime, particularly tidal currents and associated bed shear stresses. Any changes in the tidal regime may have the potential to contribute to changes in seabed morphology due to alteration of sediment transport patterns.

The tidal current velocities have been modelled to represent the improved outer berth and enlarged berth pocket. Results have been presented for peak flood and peak ebb flows on spring tides in **Figure 7-24** and **Figure 7-25**, and for peak flood and peak ebb flows on neap tides in **Figure 7-26** and **Figure 7-27**. The results clearly show that the eddy feature, seen just upstream and downstream of the eastern breakwater on the flood and ebb tide respectively in baseline conditions, remains unaffected by the proposed development.

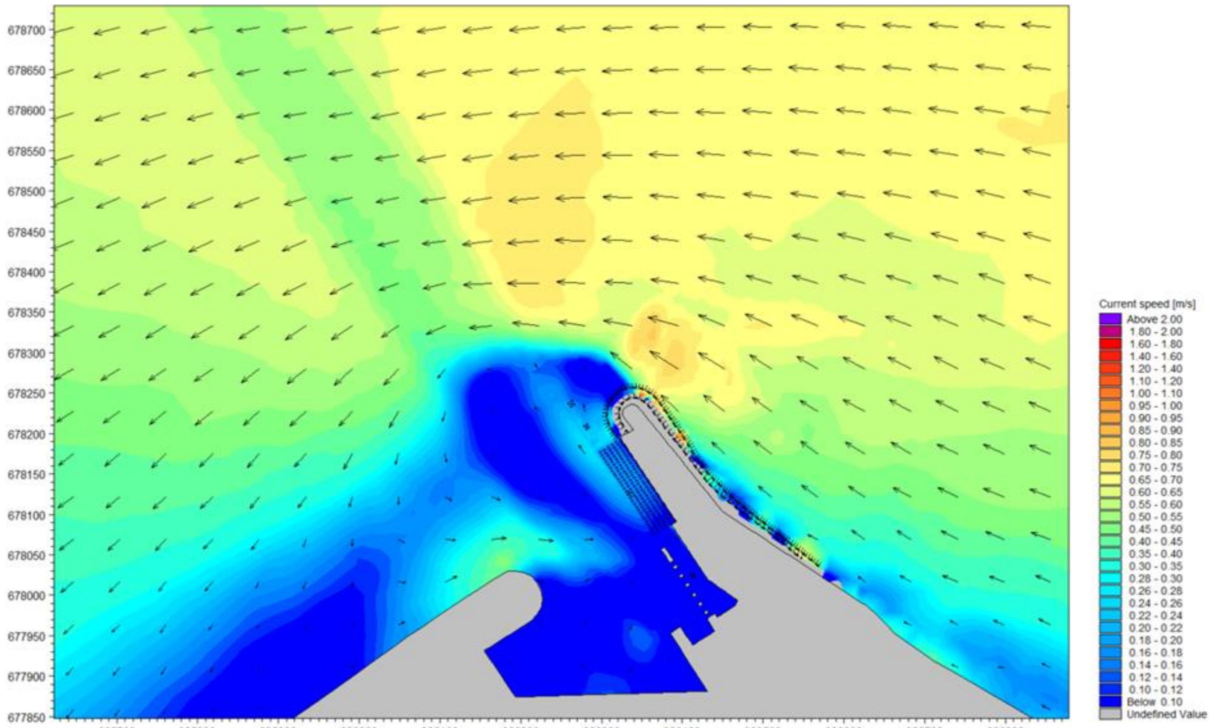


Figure 7-24 Spatial variation of peak flood currents during spring tide – with proposed development

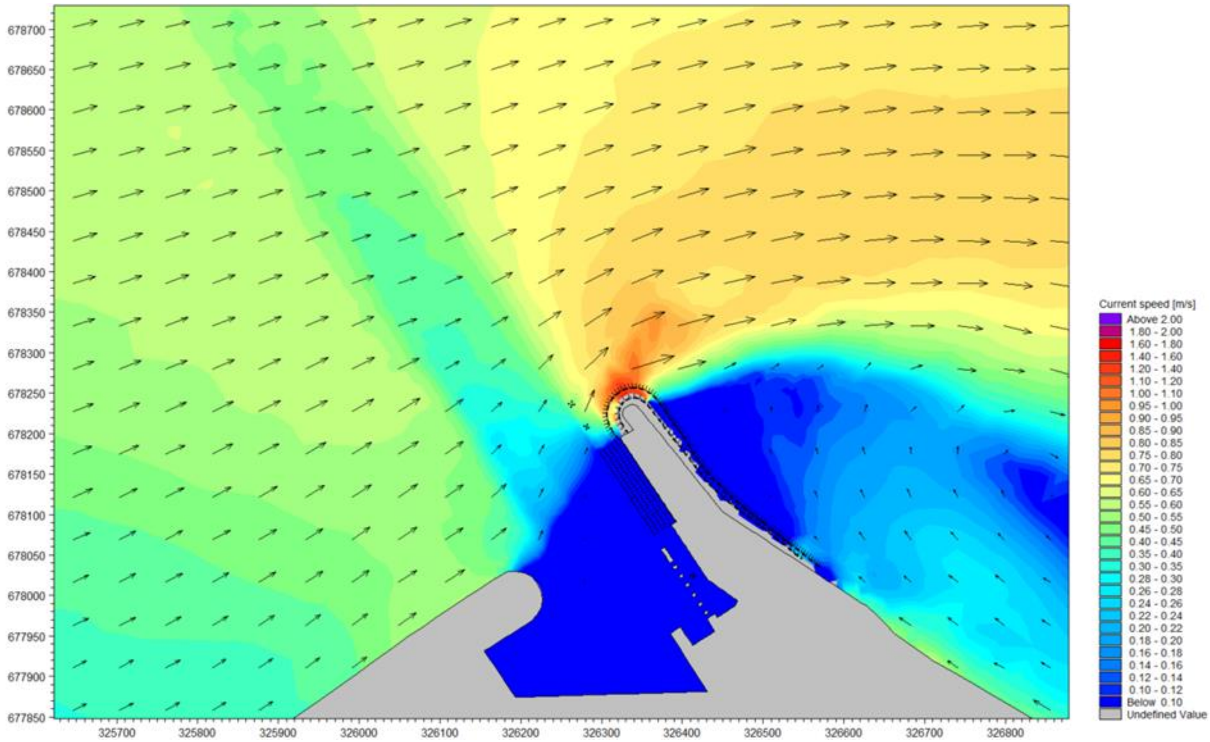


Figure 7-25 Spatial variation of peak ebb currents during spring tide – with proposed development

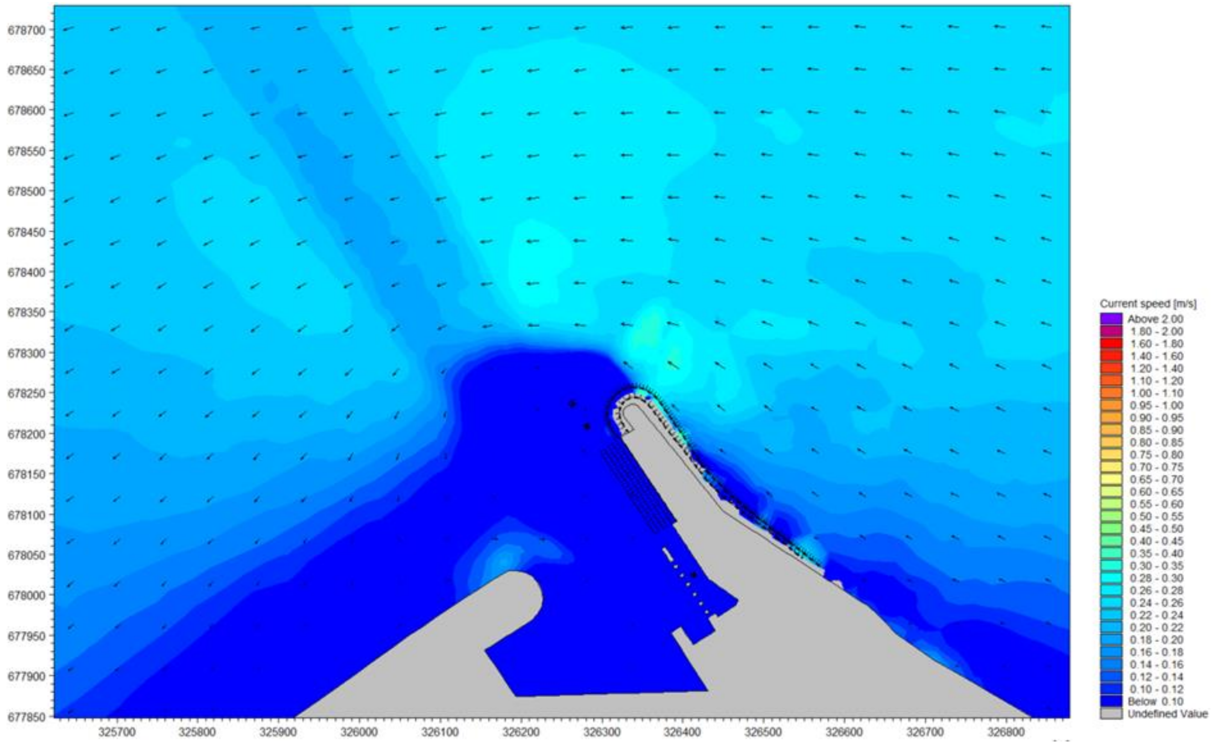


Figure 7-26 *Spatial variation of peak flood currents during neap tide – with proposed development*

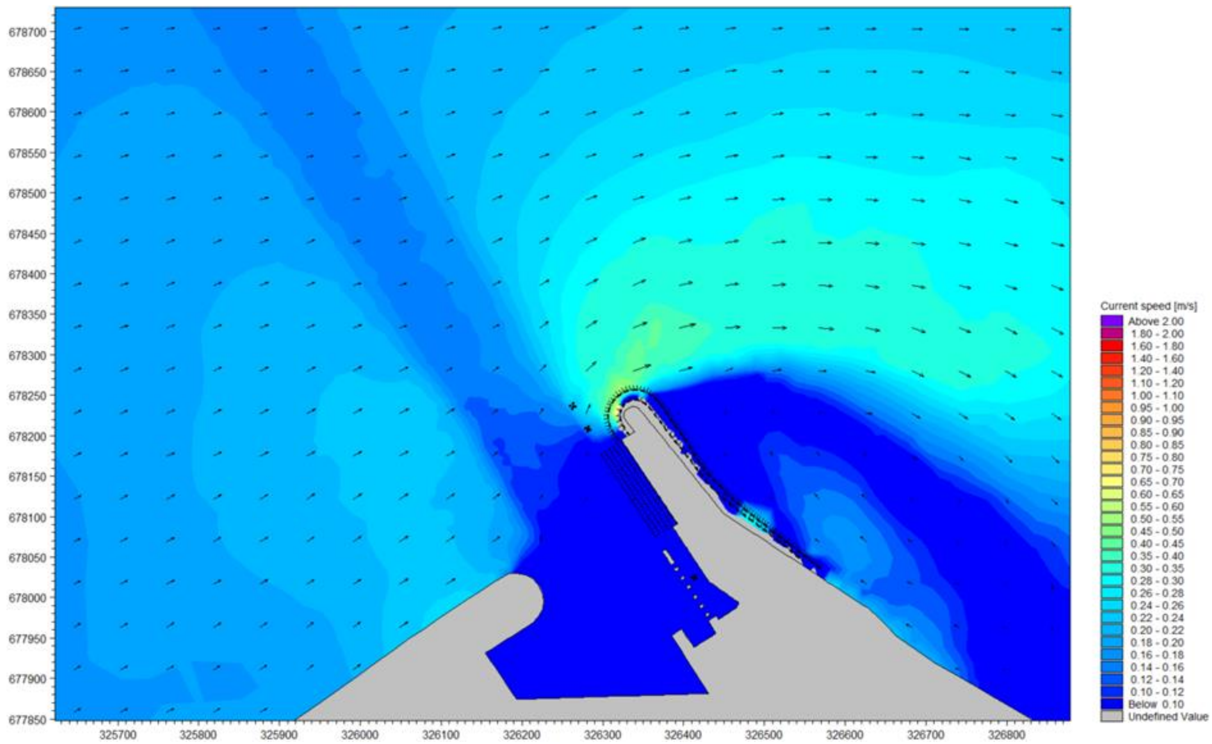


Figure 7-27 *Spatial variation of peak ebb currents during neap tide – with proposed development*

Difference plots have been produced to understand the change in tidal current velocities at key stages within the tidal cycle that would occur between the baseline and with proposed development scenarios. **Figure 7-28** and **Figure 7-29** show the current velocity changes due to the proposed development (relative to baseline conditions) at peak flood and peak ebb on a spring tide.

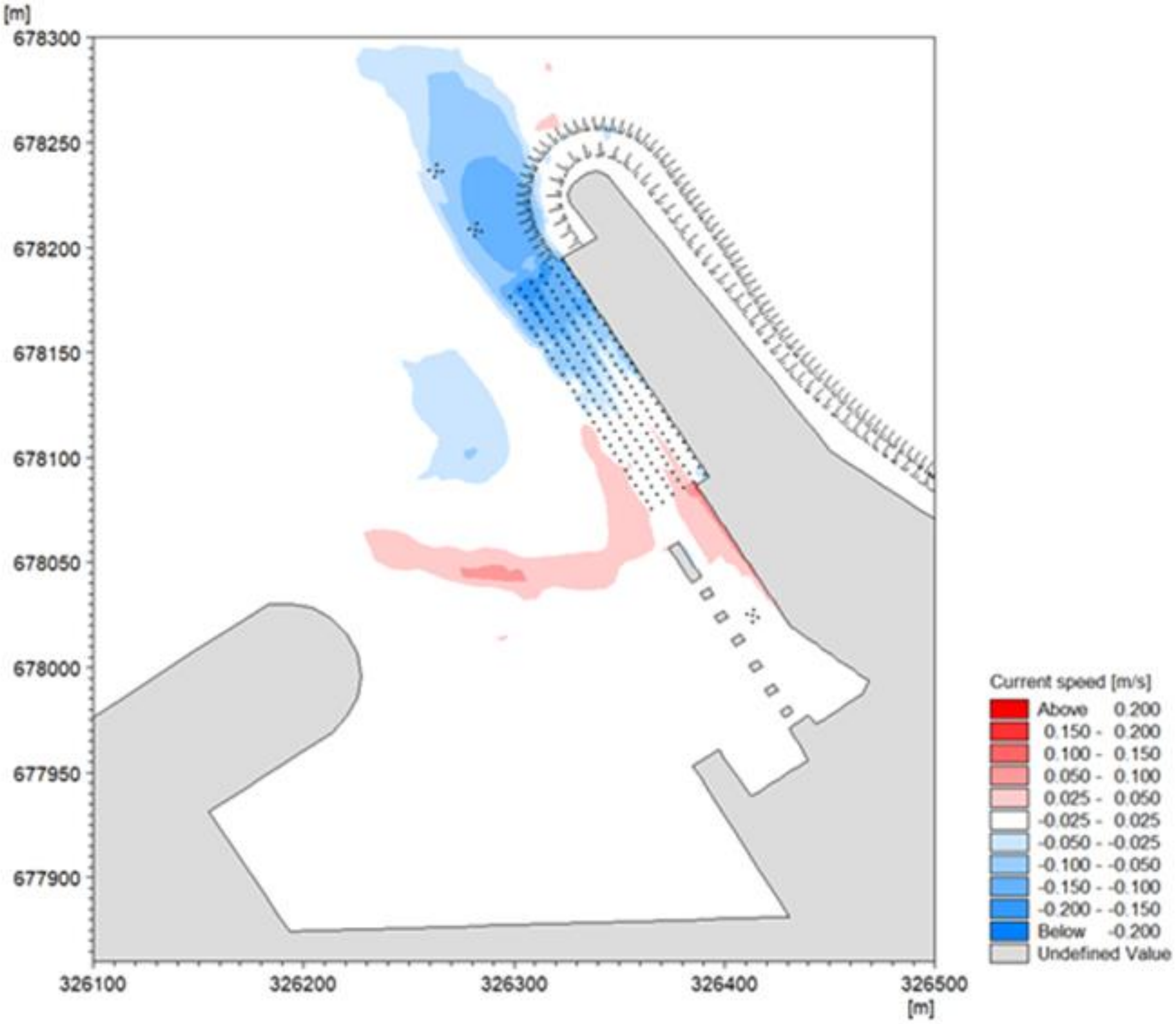


Figure 7-28 Changes in current speed at peak flood during a spring tide

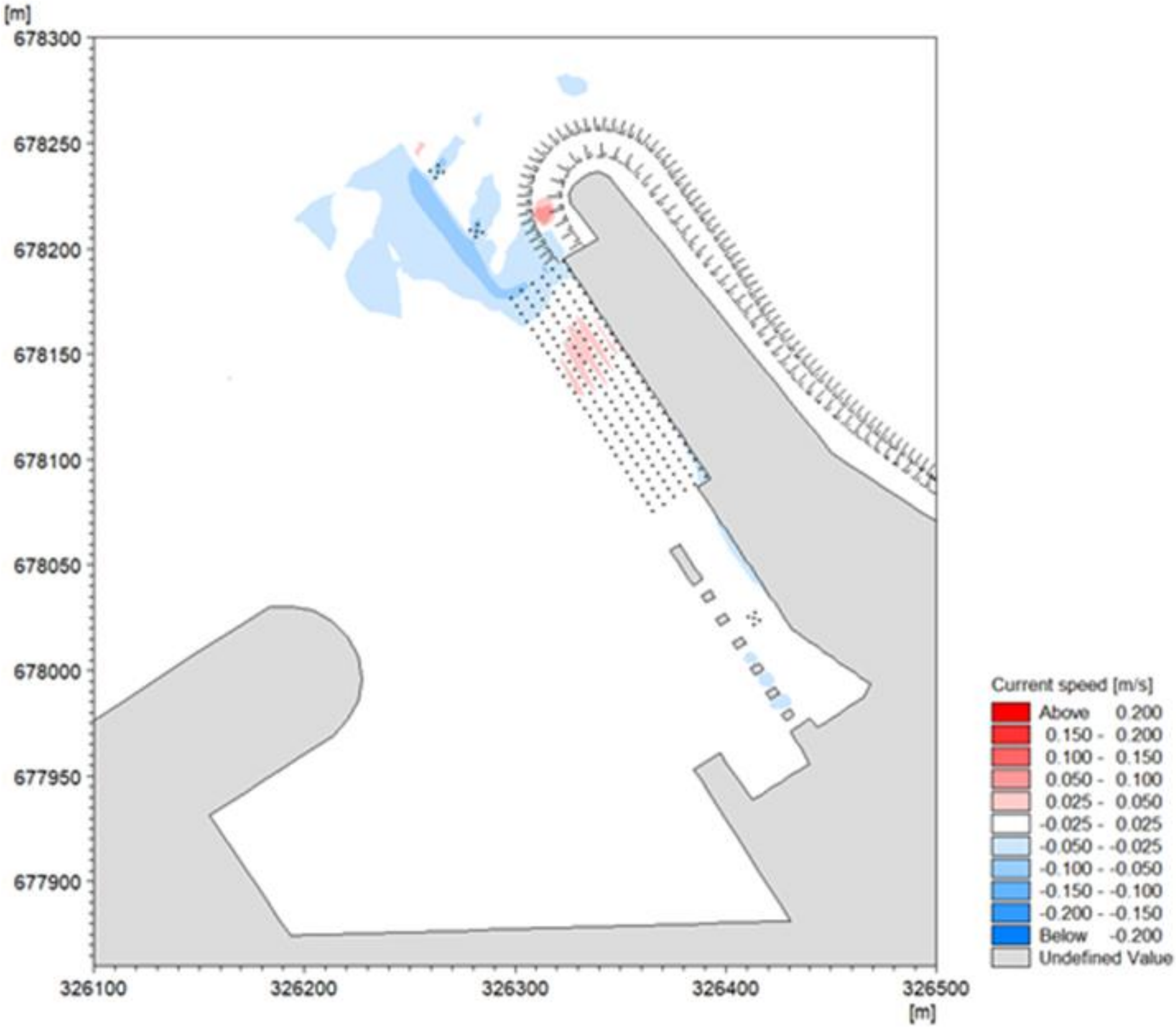


Figure 7-29 Changes in current speed at peak ebb during a spring tide

The results show that changes to current velocities are predicted along the full length of the eastern breakwater and extend slightly (approximately 50m) off the end of the eastern breakwater head during the flood tide period. During the ebb tide period, the changes are less and mainly focussed around the improved outer berth and eastern breakwater head. There are no other changes within the wider model extent.

On the peak flood tide, the current velocity is predicted to reduce by up to 0.15 – 0.2m/s on the western side of the eastern breakwater head. Under the improved outer berth, the current velocities continue to be reduced by a slightly less amount (0.1m/s). Towards the landward end of the improved outer berth the current velocity is predicted to increase slightly when compared to the baseline situation and this also extends perpendicularly across the Approach Channel. The magnitude of this increase is predicted to be less than 0.1m/s.

Assessment of effect

Changes to tidal currents due to the presence of the improved outer berth and enlarged berth pocket would have the magnitudes of effect described in **Table 7-11**.

Table 7-11 Magnitude of effect on tidal currents due to the presence of the improved outer berth and enlarged berth pocket

Location	Scale	Duration	Frequency	Reversibility	Magnitude of Effect
Near-field	Small	Ongoing	Continuous	Reversible	Low
Far-field	N/A	N/A	N/A	N/A	No Impact

7.7.2 Changes to Sediment Transport and Erosion/accretion Patterns

7.7.2.1 Bedload Sediment Transport and Associated Erosion/accretion Patterns

The tidal current velocities generate bed shear stresses which, if sufficiently large in magnitude, can cause the erosion, transport and deposition of sediment along the seabed. The bed shear stresses have been modelled to represent the enlarged berth pocket and improved outer berth. The results are presented in **Figure 7-30** and **Figure 7-31** for bed shear stresses at times of peak flood and peak ebb flows on spring tides respectively, and in **Figure 7-32** and **Figure 7-33** for bed shear stresses at times of peak flood and peak ebb flows on neap tides respectively. Note that the legend in these plots has been selected to mimic the critical thresholds for motion of different sediment grain sizes, as presented in the earlier **Table 7-5**.

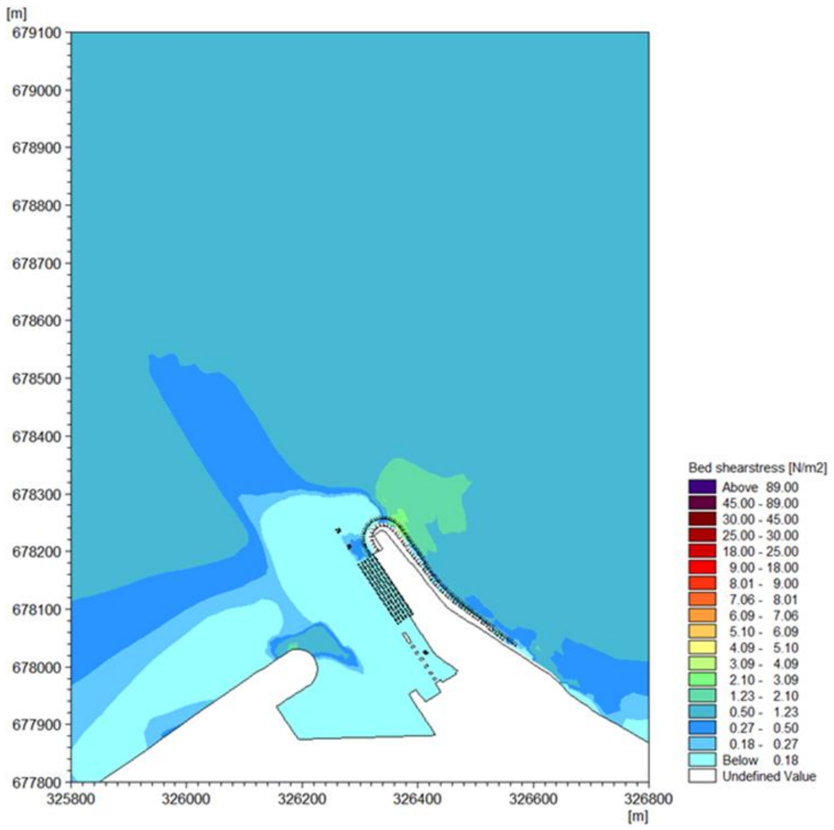


Figure 7-30 Spatial variation of bed shear stress during peak flood currents during spring tide – with proposed development

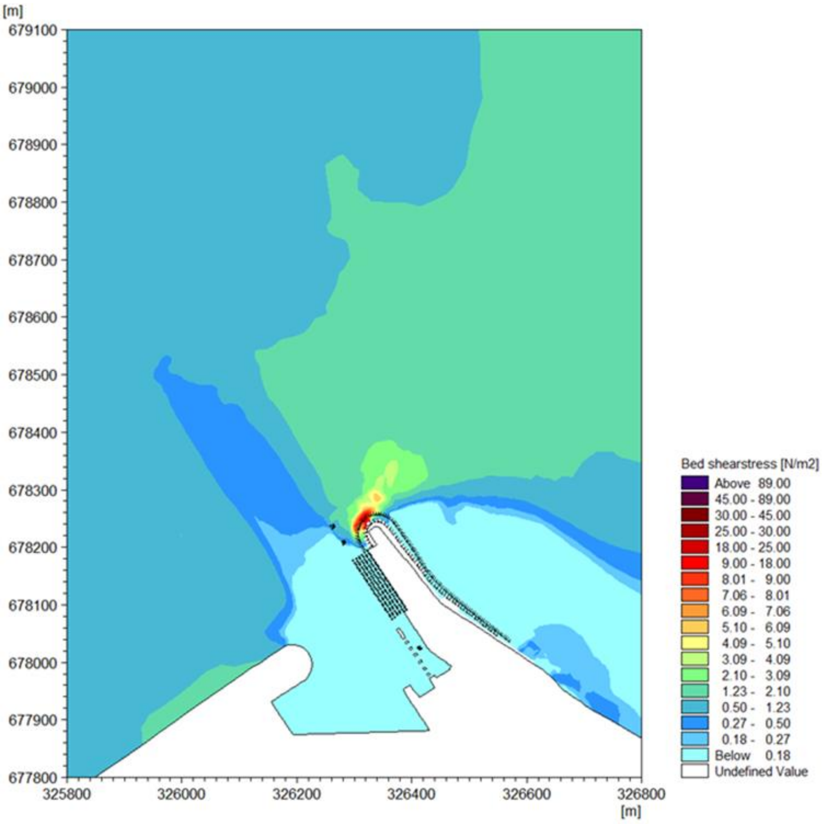


Figure 7-31 *Spatial variation of bed shear stress during peak ebb currents during spring tide – with proposed development*

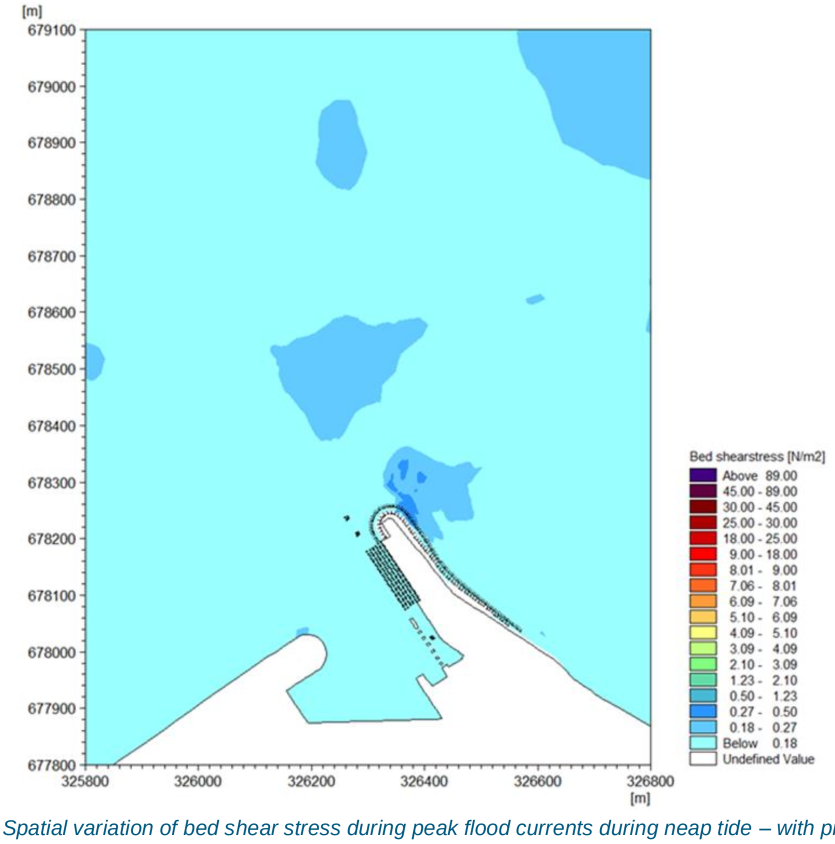


Figure 7-32 *Spatial variation of bed shear stress during peak flood currents during neap tide – with proposed development*

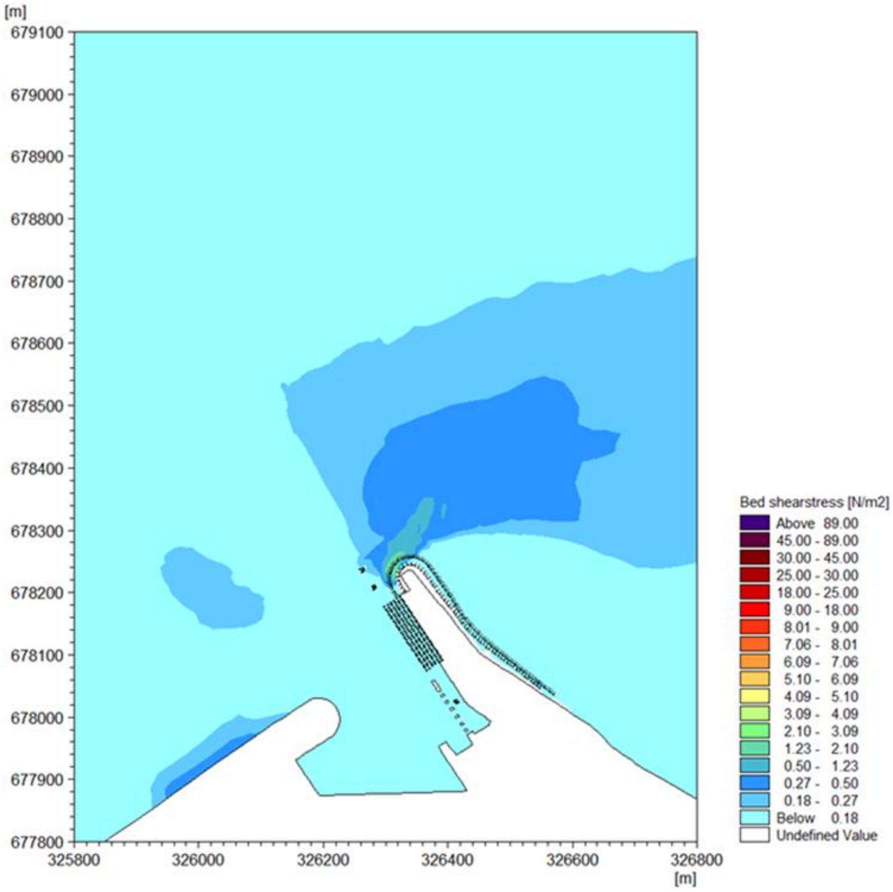


Figure 7-33 Spatial variation of bed shear stress during peak ebb currents during neap tide – with proposed development

Difference plots have been produced to understand the change in bed shear stresses at key stages within the tidal cycle that would occur between the baseline and with proposed development scenarios. **Figure 7-34** and **Figure 7-35** show the bed shear stress changes due to the proposed development (relative to baseline conditions) at peak flood and peak ebb on a spring tide respectively.

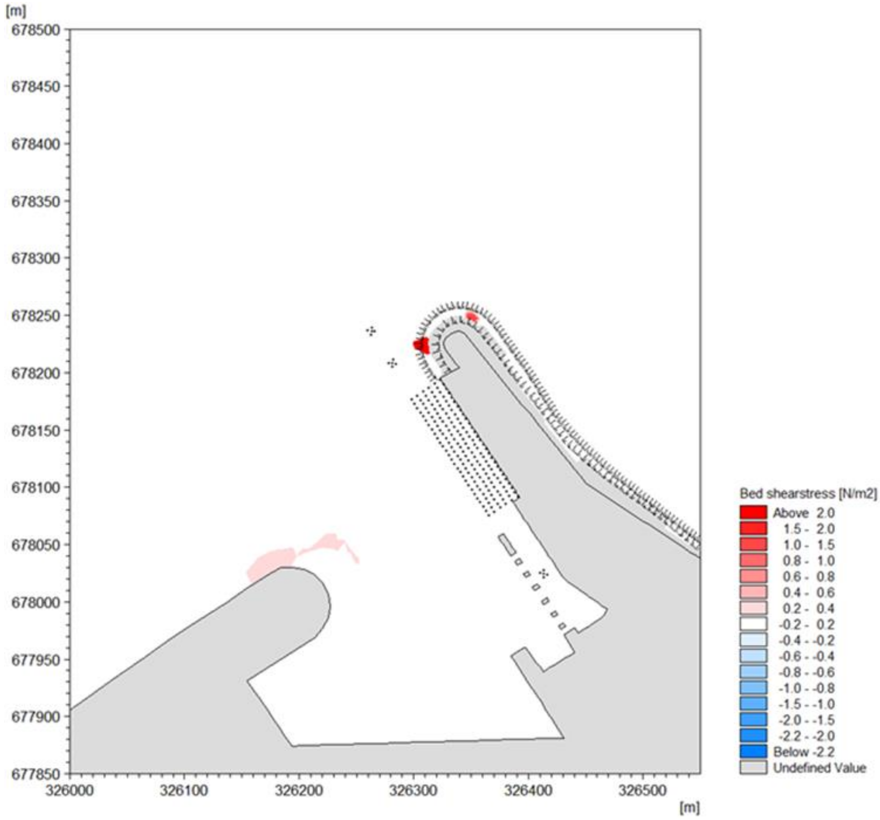


Figure 7-34 Changes in bed shear stress at peak flood during a spring tide

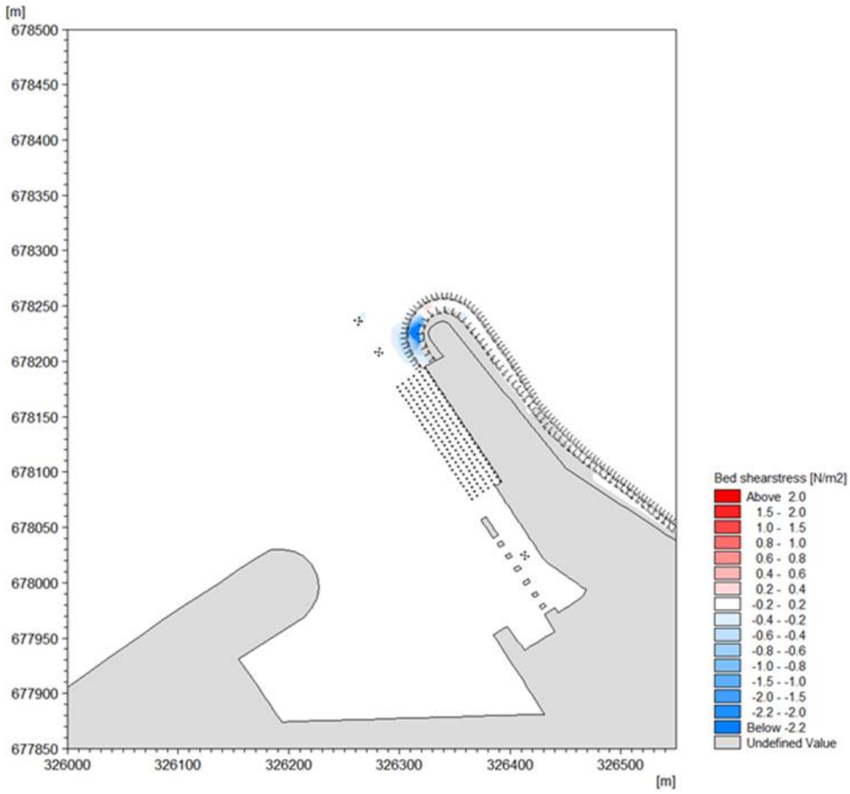


Figure 7-35 Changes in bed shear stress at peak ebb during a spring tide

The results show that changes to bed shear stresses are predicted to be very localised and small in magnitude. There is therefore unlikely to be a discernible effect on bedload sediment transport.

7.7.2.2 Suspended Sediment Transport and Associated Erosion/accretion Patterns

The MIKE3-Mud Transport (MT) model was used to predict the deposition of suspended sediment over a 98-day period, commensurate with the available survey data, for the baseline and the improved outer berth and enlarged berth pocket scenarios. The locations of the channel sections used in the model are shown in **Figure 7-36**. The results, shown in **Figure 7-37**, indicate that sediment is predominantly deposited in the 'inner' and southern part of the 'entrance' channel sections, with far less in the northern part of the 'entrance' and 'outer' channel sections.

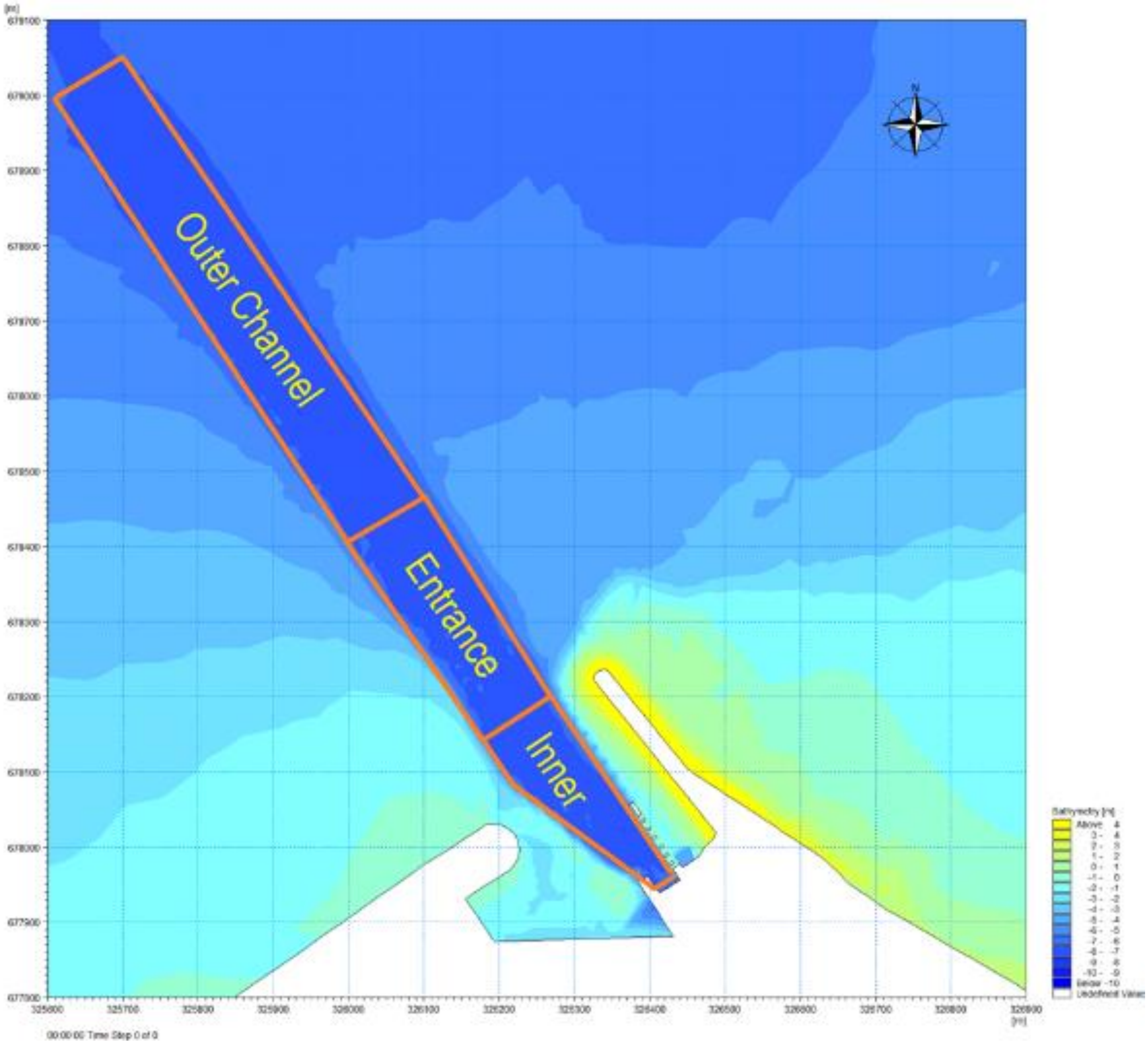


Figure 7-36 Location of Approach Channel sections

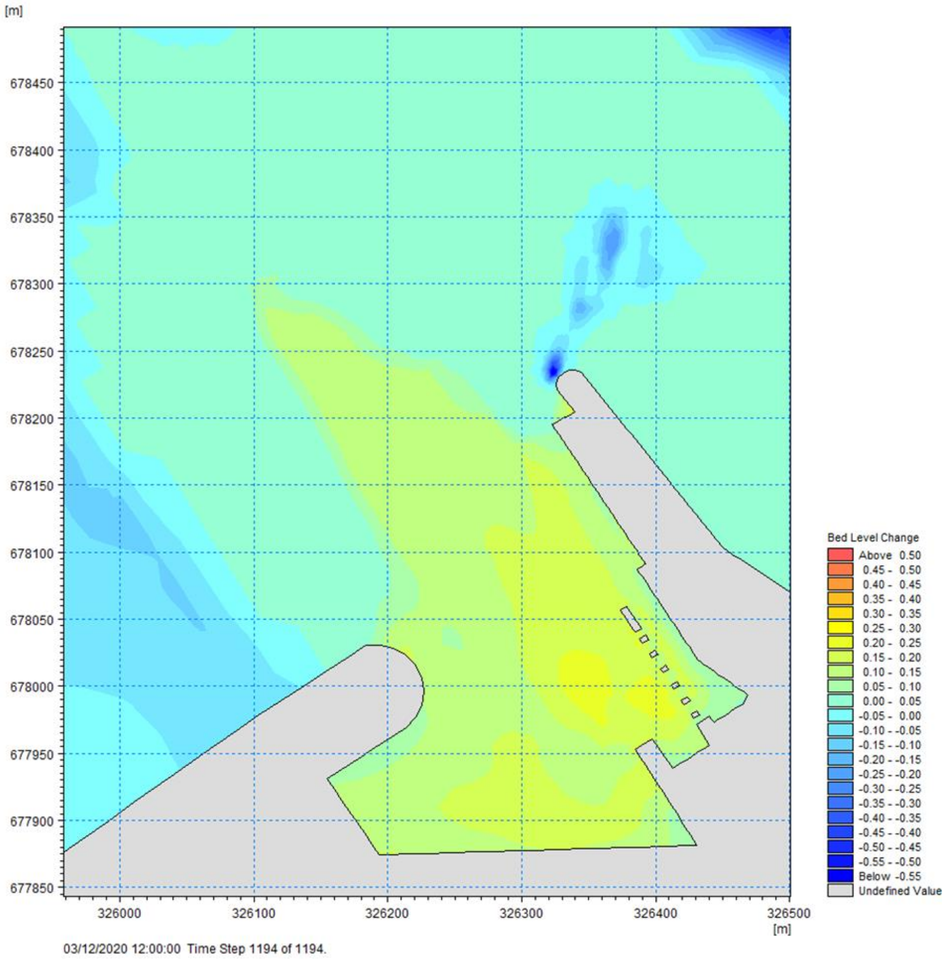


Figure 7-37 Predicted bed level change after 98-day model simulation

The model predicts approximately a 33% increase in deposition of sediment within the 'inner' channel section with the proposed development represented compared to the baseline conditions, reducing to around 20% in the 'entrance' channel section and no change in the 'outer' channel section. Deposition is predominantly focused in areas of the enlarged berth pocket. This result is to be expected, given that the changes in tidal current velocities are so low in magnitude and local in extent.

As a result, future maintenance dredging requirement is predicted to increase by around 22% on the annual average dredged volume from the channel as a whole, with most of this arising from the 'inner' section.

Assessment of effect

Changes to sediment transport and erosion/accretion patterns due to the presence of the improved outer berth and enlarged berth pocket would have the magnitudes of effect described in **Table 7-12**. This considers potential effects to both bedload and suspended sediment transport.

Table 7-12 Magnitude of effect on sediment transport and erosion/deposition due to the presence of the improved outer berth and enlarged berth pocket

Location	Scale	Duration	Frequency	Reversibility	Magnitude of Effect
Near-field	Small	Ongoing	Continuous	Reversible	Low
Far-field	N/A	N/A	N/A	N/A	No Impact

7.8 Summary

A summary of potential effects to coastal processes are listed in **Table 7-13**. Negligible and minor adverse impacts are not significant in EIA terms.

Table 7-13 Summary of potential effects to coastal processes

Potential Impact	Receptor	Value/ Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
Construction						
Changes in sea-bed level due to capital dredging of the berth pocket associated with the outer berth	Seabed	Negligible	Low (near-field) No impact (far-field)	Negligible (near-field) No impact (far-field)	None	Negligible (near-field) No impact (far-field)
Changes in sea-bed level due to disposal of dredge arisings at Narrow Deep within South Channel	Seabed	Negligible	Low (near-field), Negligible (far-field)	Negligible (near-field) Negligible (far-field)	None	Negligible (near-field) Negligible (far-field)
Operation						
Changes to the tidal current regime due to the presence of the outer berth and associated berth pocket	Tidal regime	Negligible	Low (near-field) No impact (far-field)	Negligible (near-field), No impact (far-field)	None	Negligible (near-field), No impact (far-field)
Changes to sediment transport and erosion/accretion patterns due to the presence of the outer berth and associated berth pocket	Sediment transport pathways	Negligible	Low (near-field) No impact (far-field)	Negligible (near-field), No impact (far-field)	None	Negligible (near-field), No impact (far-field)

8 Marine Water and Sediment Quality

8.1 Introduction

This chapter of the EIA Report considers the potential impacts of the proposed development on marine water and sediment quality. It describes the methods used to assess potential effects and the baseline conditions currently existing within the study area. The mitigation measures required to prevent, reduce or off-set any significant adverse impacts are presented together with the likely residual impacts after these measures have been adopted.

This chapter is supported by the following chapters from this EIA Report:

- **Chapter 7 Coastal Processes**

8.2 Legislation, Policy and Guidance

8.2.1 Legislation

Table 8-1 outlines legislation relevant to marine water and sediment quality.

Table 8-1 Summary of the key legislation relevant to marine water and sediment quality

Legislation	Relevance
Water Environment and Water Services Scotland) Act 2003 (WEWS Act)	This act came into being from the Water Framework Directive 2000/60/EC in Scotland. It commits Scotland to achieve good status of all water bodies by 2015 with the final deadline for meeting objectives being 2027. River basins comprise all transitional waters (estuaries) and coastal waters extending to 3 nautical miles (nm) seaward from the territorial baseline. Any proposed development within 3nm must have regard to the requirements of the WFD to ensure that all transitional and coastal water bodies achieve 'Good Ecological Status' and that there is no deterioration in status. This in an overarching act which makes provisions for regulations on controlled activities and protected areas such as shellfish and bathing waters.
Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended)	The Controlled Activities Regulations 2011 (CARs) (and its amendments in 2013 and 2017) apply regulatory controls over activities which may affect Scotland's water environment. The regulations cover rivers, lochs, transitional waters (estuaries), coastal waters, groundwater, and groundwater dependent wetlands. All activities with potential to affect the water environment require to be authorised under the CAR. The level of authorisation required is dependent on the anticipated environmental risk posed by the activity to be carried out and a licence is required to be obtained.
Water Environment (Shellfish Water Protected Areas: Environmental Objectives etc.) (Scotland) Regulations 2013	The Shellfish Waters Directive was repealed in 2013 and was replaced by this legislation in 2013. The objectives of this regulation are to prevent the deterioration of water quality within a shellfish water protected area and protect and improve each protected area to achieve good water quality by 2015. To help achieve this these regulations also put in place a monitoring and measures programmes for each shellfish water.
Bathing Waters (Scotland) Amendment Regulations 2012	Previously designated under the Bathing Water Directive (76/160/EEC), these waters are now covered by the revised Bathing Water Directive (2006/7/EC) and are protected areas under WFD. This directive is transposed into Scottish law through the Bathing Waters (Scotland) Amendment Regulations 2012.

8.2.2 Policy and Plans

The following sections cover the main planning policy and guidance relevant to marine water and sediment quality.

8.2.2.1 Scotland's National Marine Plan

GEN 12 Water Quality and Resource of Scotland's NMP states:

Developments and activities should not result in a deterioration of the quality of waters to which the Water Framework Directive, Marine Strategy Framework Directive or other related Directives apply.

8.2.2.2 MARPOL Convention

The MARPOL Convention is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. It is a combination of two treaties adopted in 1973 and 1978 respectively and updated by amendments through the years. The Convention covers all the technical aspects of pollution from ships, except the disposal of waste into the sea by dumping, and applies to ships of all types, although it does not apply to pollution arising out of the exploration and exploitation of sea-bed mineral resources.

8.2.2.3 Marine Scotland Action Levels for the disposal of dredged material

The context of the contaminants found within sediments is established through the use of recognised guidelines and Action Levels (AL), in this case the MS's ALs (**Table 8-2**).

Table 8-2 Marine Scotland's Action levels

Contaminant	AL1 mg/kg dry weight (ppm)	AL2 mg/kg dry weight (ppm)
Arsenic (As)	20	70
Cadmium (Cd)	0.4	4
Chromium (Cr)	50	370
Copper (Cu)	30	300
Mercury (Hg)	0.25	1.5
Nickel (Ni)	30	150
Lead (Pb)	50	400
Zinc (Zn)	130	600
Tributyltin (TBT)	0.1	0.5
Polychlorinated Biphenyls (PCB)*	0.02	0.18
Polyaromatic Hydrocarbons (PAH)		
Acenaphthene	0.1	None
Acenaphthylene	0.1	
Anthracene	0.1	
Fluorene	0.1	
Naphthalene	0.1	
Phenanthrene	0.1	
Benzo[a]anthracene	0.1	
Benzo[b]fluoranthene	0.1	
Benzo[k]fluoranthene	0.1	

Contaminant	AL1 mg/kg dry weight (ppm)	AL2 mg/kg dry weight (ppm)
Benzo[a]pyrene	0.1	
Benzo[g,h,i]perylene	0.1	
Dibenzo[a,h]anthracene	0.01	
Chrysene	0.1	
Fluoranthene	0.1	
Pyrene	0.1	
Indeno(1,2,3cd)pyrene	0.1	
Total hydrocarbons	100	

*International Council for the Exploration of the Sea (ICES) 7 - a sum of PCB 28, 52, 101, 118, 138, 153, 180

The majority of the material assessed against these standards arises from dredging and disposal activities as part of MS's marine licensing process for disposal of material to sea, but they are also considered a good way of undertaking an initial risk assessment with respect to determining risks to water quality from marine activities like dredging and disposal as part of EIA.

8.2.3 Best Practice and Guidance

This impact assessment takes account of the following guidance:

- IEMA, EIA Guidance;
- Scottish Environment Protection Agency (SEPA) (2017) Land Use Planning System; and,
- SEPA Guidance Note 13.

8.3 Consultation

A sediment sampling plan request was made to MS on 30th July 2021 to seek their approval on the suggested sediment sampling locations and analysis. The agreed sediment sampling plan and MS's approval can be seen in **Appendix 8-1**.

Advice received during the EIA screening process has also been taken into account in undertaking the assessments presented in this chapter.

8.4 Assessment Methodology

8.4.1 Baseline Environment

8.4.1.1 Data Sources – Desk Study

Desk-based sources consulted included:

- SEPA's website and tools including the Water Environment Hub- https://www.sepa.org.uk/datavisualisation/water-environment-hub/;
- Scotland's Environment Web – Map - https://map.environment.gov.scot/sewebmap/; and,
- Scotland Government website - https://www.gov.scot/policies/water/protected-waters/.
- Best Practicable Environmental Option Report for Port of Leith Maintenance Dredge Disposal: Marine Licence Application (ERM, 2021)

8.4.1.2 Data Sources – Site Specific Surveys

A site-specific survey was undertaken between 16th and 18th October 2021 during which sediment samples were taken for the following chemical and physical analysis:

- Trace metals (As, Cd, Cr, Cu, Hg, Ni, Pb and Zn;
- Organotins (Tributyltin (TBT) and dibutyltin (DBT));
- PAHs;
- PCBs; and,
- Particle Size Analysis (PSA).

Samples were analysed by SOCOTECC. The results were received in November 2021 and are presented in **Section 8.5.5.2**.

8.4.2 Study Area

The study area for this topic comprises the likely maximum extent over which potentially significant environmental impacts of the proposed development may occur. This was informed by sediment dispersion modelling of the dredging and disposal activities, and has been based on the maximum predicted extent over which effects of the sediment plume are predicted to occur.

8.4.3 Impact Assessment Methodology

General methodology for EIA is discussed in **Chapter 5.5.** The following sections describe the methodology used to assess the potential impacts of the proposed development on marine water quality, taking into account sediment quality, in more detail.

8.4.3.1 Sensitivity

The definition of sensitivity of the receptor for impact assessment is the same as that defined in **Section 5.5.4**, and depends on a combination of value, adaptability, tolerance, and recoverability.

The composite criterion for sensitivity used for water quality combines value (a measure of the receptors importance) with sensitivity. In some instances, the inherent value of a receptor is recognised by means of designation (such as a bathing or shellfish water) and the 'value' element of the composite criterion recognises and gives weight in the assessment to that designation.

8.4.3.2 Magnitude

The magnitude of the effects has been assessed according to the impact extent, duration, reversibility, timing (critical seasons) and frequency. Where effects are anticipated to occur, their magnitude has been determined as per the criteria stated in **Table 8-3**.

Table 8-3 Definitions of magnitude levels

Magnitude	Definition
High	Major or long-term change (over more than one year) to one or more water quality parameter.
Medium	Noticeable or medium-term change (over a full season) to one or more water quality parameter, for example, one Bathing Water season (one summer)
Low	Small or short-term change (over a matter of days or weeks, or less than one spring tide cycle) to one or more water quality parameter.
Negligible	No detectable change to water quality or change is within natural variation.

8.5 Baseline Environment

8.5.1 WFD Waterbody Classification

The proposed development is within the Kinghorn to Leith Docks coastal water body (ID: 200041), which has an overall status of Good, a chemical status of Pass and an ecological status of Good[9]. The water body is expected to maintain this status in 2021 and 2027. Full classification details of this waterbody are provided in **Table 8-4.**

Table 8-4 2012 Classification status of Kinghorn to Leith Docks coastal water body (ID: 200041)

Parameter	Status	Confidence of Class
Overall Status	*Good*	*High*
Macro-invertebrates	*Good*	*High*
Alien species	*High*	*Low*
Morphology	*Good*	*Medium*
Specific pollutants	*Pass*	*High*
Macroalgae	*Good*	*High*
Dissolved Inorganic Nitrogen	*High*	*Medium*
Dissolved Oxygen	*High*	*High*

8.5.2 Bathing Water

Water quality is also monitored at Bathing Waters designated through the Bathing Water Directive (2006/7/EC) enacted in Scotland by the Bathing Waters (Scotland) Regulations 2008 (as amended[10]) The bathing season runs between the 1st of June and the 15th of September during which SEPA undertakes water quality monitoring. There are no Bathing Waters within the study area.

8.5.3 Shellfish Waters

There are no Shellfish Waters within the Firth of Forth under The Water Environment (Shellfish Water Protected Areas: Designation) (Scotland) Order 2013[11].

8.5.4 Suspended Sediment Concentration

FugroEMU (2013a) deployed four optical backscatter sensors offshore from the outer berth (at the same locations as the acoustic current profilers, (**Figure 7-3**) to capture data on suspended sediment concentrations. Wave data was also collected at Site 3 to assist in the quality control of the turbidity time series data. During calm wave conditions near-bed suspended sediment concentrations of 10-50mg/l was recorded (**Figure 8-1**). This period was characterised by maximum wave heights less than 0.5m (at Site 3). During the first period of elevated wave heights, near-bed suspended sediment concentrations increased to approximately 1,300mg/l, 1,100mg/l, 600mg/l and 200mg/l at Sites 1, 2, 3 and 4, respectively. During the second period of high waves, the suspended sediment concentrations reached approximately 1,000mg/l at Sites 1, 2 and 3 whilst at Site 4 the concentration peaked at around 700mg/l. During the third period suspended sediment concentrations peaked at 500mg/l at Sites 1, 2 and 4, and 200mg/l at Site 3.

[9] *https://www.sepa.org.uk/data-visualisation/water-environment-hub/*
[10] *https://www.legislation.gov.uk/ssi/2008/170/contents/made*
[11] *http://apps.sepa.org.uk/shellfish/pdf/47.pdf*

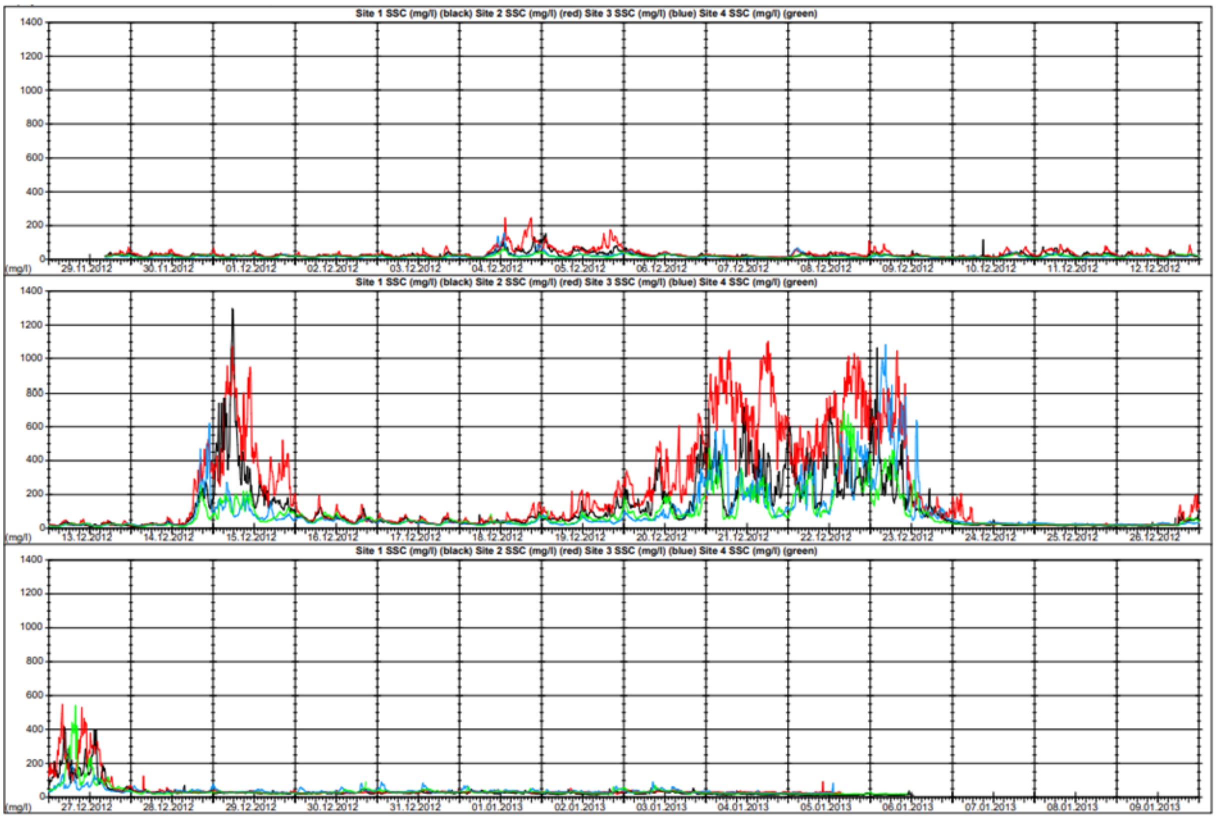


Figure 8-1 Suspended sediment concentrations at Sites 1 (black), 2 (red), 3 (blue) and 4 (green) between 29th November 2012 and 6th January 2013 (FugroEMU, 2013a)

The data shows that re-suspension of sediment from the seabed resulting in very high suspended sediment concentrations above ambient conditions is caused by increased wave heights. After the sediment is elevated into the water column by this process, it is transported past the eastern breakwater by tidal currents on the flood tide and by wave induced flows (typically during easterly weather, HR Wallingford, 2004). On the flood tide it is likely that a large-scale eddy forms in the lee of the eastern breakwater (Arup, 2007) that traps some of the suspended sediment that bypasses the eastern breakwater allowing it to settle and deposit in the inner Approach Channel and outer berth (ERM, 2021).

8.5.5 Sediment Quality

8.5.5.1 Sediment data 1993 – 2020

ERM's Best Practicable Environmental Option Report (ERM, 2021) presents data on sediment quality from 1990 and 2020. Whilst average concentrations of metals were below AL1 (**Table 8-5**), concentrations did to exceed AL1 for all metals except As. The mean concentration for mercury was found to be above AL2 in 1990, 2003 and 2004, while the mean concentrations of zinc were above AL2 in 1994. Mean concentrations of lead were above AL1 in 2003 with the upper end of the range being above AL2. Since 2005, all mean concentrations of metals have been below AL2 but recent samples in 2020 for copper were above AL2.

Table 8-5 Metal Concentrations from Leith (mg/kg Dry Wt) 1990-2000 (ERM, 2021)

Concentration	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
Mean	13.1	1.1	61.4	71.1	1.2	39.8	134.5	261.3
Range	4.6-21.6	0.0-3.9	14.1-105	12.8-362	0.2-4.4	13.0-74.8	29.0-787.0	62.6-687.0

The mean concentration of TBT was reported to be 0.2475mg/kg between 2017 and 2020. Concentrations of ICES 7 PCBs found to vary between 0.0221 and 0.1597mg/kg between 2017 and 2020. Mean concentrations of PCBs are above AL1 (0.02mg/kg), with a peak in 2003 but none of the samples exceeded AL2. A comparison of mean concentrations of PAHs from samples collected between 2003 and 2020 showed that PAH concentrations for the majority of individual PAHs were above AL1. For most of the individual PAHs, there were higher concentrations in the 2020 samples compared to previous years. Metals and ICES 7 PCB congeners concentrations recorded from the Narrow Deep disposal site have been shown to exceed AL1 (**Table 8-6**) (ERM, 2021).

Table 8-6 Concentration of Metals and PCBs (mg/ kg) from Narrow Deep disposal ground (ERM 2021)

Site Name/Date	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn	Sum ICES 7 PCBs
Narrow Deep 2011	9.5	0.2	42.9	21.6	0.49	22.9	53.4	109.4	0.008 (n=3)
(n=6)									
Narrow Deep 2015	11.7	0.2	63.8	24.6	0.6	30.0	58.4	105.9	0.03 (n=3)
(n=4)									

8.5.5.2 2021 Sediment data

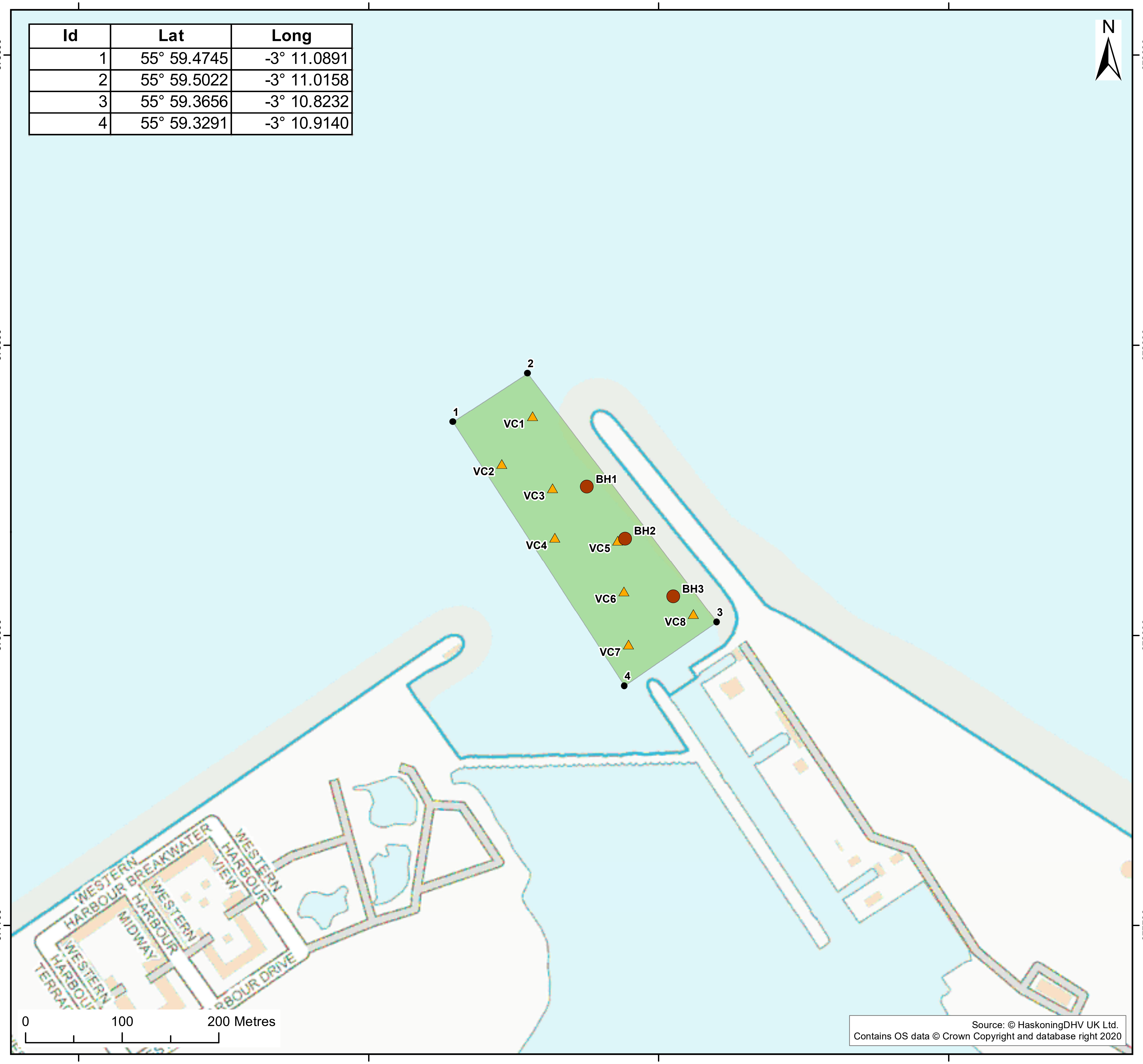
Eight vibrocores were collected from within the proposed dredging area (berth pocket and pre-works area) were collected (**Figure 8-2**). Cores were vibrated through the soft-surface sediments until refusal. Sediment samples were then taken from the surface, mid and bottom of the cores and sent to SOCOTEC for chemical and physical analysis. Results of the sediment analyses are presented in **Tables 8-7** to **8-11**.

Particle Size Analysis

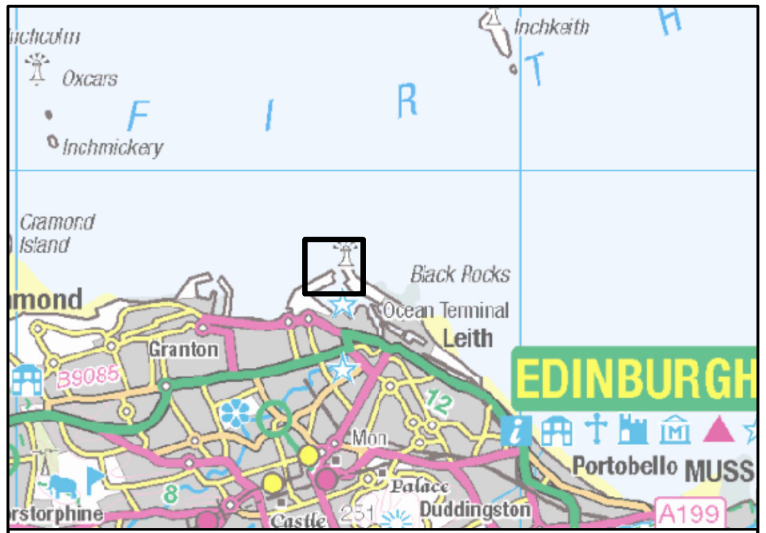
PSA results show that the sediment present within dredge footprint is comprised of mixed sediments with the majority comprising of sand and silt (**Table 8-7**).

Table 8-7 PSA of vibrocore samples

Sample ID	Sample Depth (m)	Gravel (%)	Sand (%)	Silt (%)
VC01	0.00	4.5	38.8	56.6
VC01	1.55	0.0	19.4	80.6
VC01	2.30	12.0	32.1	55.9
VC02	0.00	0.0	21.9	78.1
VC02	0.50	26.3	30.8	42.9
VC03	0.00	0.0	23.4	76.6
VC03	0.50	23.0	22.6	54.4
VC04	0.00	17.6	27.9	54.5
VC04	0.30	22.0	15.9	62.2
VC05	0.00	1.0	27.3	71.8
VC05	1.5	0.0	20.4	79.6
VC05	2.9	28.8	14.9	56.3
VC06	0.00	0.0	19.3	80.7
VC06	0.24	36.3	18.2	45.5
VC07	0.00	3.8	20.6	75.6
VC07	0.50	0.0	21.6	78.4
VC08	0.00	25.3	39.2	35.4
VC08	0.50	16.2	50.7	33.1



Id	Lat	Long
1	55° 59.4745	-3° 11.0891
2	55° 59.5022	-3° 11.0158
3	55° 59.3656	-3° 10.8232
4	55° 59.3291	-3° 10.9140



Legend:

Area of dredge

Sampling Locations

Marine borehole

Vibrocore

Client:	Project:
Forth Ports Limited	Port of Leith - Outer Berth

Title: Vibrocore Locations

Figure: 8.2 | Drawing No: PC2045-RHD-ZZ-ZZ-DR-EV-0003

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
05	20/07/2021	JT	GS	A3	1:4,000
04	05/07/2021	JT	GS	A3	1:4,000

Co-ordinate system: British National Grid

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Metals and Organotins

Concentrations of seven metals, Cd, Cr, Cu, Hg, Ni, Pb and Zn were found at levels marginally exceeding AL1 (**Table 8-8**). Only two samples exceeded AL2, the mid-core sample taken from VC01 contained elevated levels of cadmium and mercury, while elevated levels of mercury were found in the mid-core sample of VC05.

There were no exceedances of AL1 for organotins.

Table 8-8 Metal results (mg/kg) compared to MS's ALs (AL1 exceedance in blue; AL2 exceedances in yellow)

Sample ID	Sample Depth (m)	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn	DBT	TBT
VC01	0	13.6	3.0	70.0	63.6	1.2	37.0	109.0	181.0	0.0143	0.0127
VC01	1.55	15.5	4.4	88.0	103.0	1.7	35.1	156.0	243.0	<0.005	<0.005
VC01	2.3	4.1	0.4	38.9	33.0	0.1	50.5	22.5	87.3	<0.005	<0.005
VC02	0	13.9	0.5	52.2	36.2	0.7	33.3	66.9	124.0	0.0135	<0.005
VC02	0.5	0.9	0.1	7.7	8.4	0.0	11.4	13.0	22.1	<0.005	<0.005
VC03	0	13.7	0.4	54.3	36.1	0.7	36.0	69.5	129.0	<0.005	<0.005
VC03	0.5	4.8	0.3	35.3	29.2	0.1	55.4	19.8	81.1	<0.005	<0.005
VC04	0	15.8	2.8	77.2	70.4	1.3	39.0	117.0	195.0	<0.005	<0.005
VC04	0.3	4.5	0.5	36.8	33.5	0.1	52.9	24.6	88.2	<0.005	<0.005
VC05	0	12.9	2.5	74.5	64.2	1.1	39.6	108.0	178.0	0.0134	0.0161
VC05	1.5	16.4	3.1	67.1	111.0	2.1	38.6	190.0	272.0	<0.005	<0.005
VC05	2.9	5.3	0.5	31.3	31.8	0.2	39.5	23.8	86.5	<0.005	<0.005
VC06	0	15.4	0.3	51.4	32.2	0.6	33.1	63.8	126.0	<0.005	<0.005
VC06	0.24	3.9	0.3	36.5	33.1	0.1	50.8	18.1	80.3	<0.005	<0.005
VC07	0	7.1	0.3	41.2	30.2	0.2	44.8	30.0	88.3	<0.005	<0.005
VC07	0.5	5.1	0.4	32.1	29.8	0.1	45.9	17.9	108.0	<0.005	<0.005
VC08	0	5.5	0.3	22.7	24.0	0.3	19.5	37.4	230.0	0.00601	0.0157
VC08	0.5	8.1	0.2	26.7	13.8	0.0	24.6	13.5	60.5	<0.005	<0.005

Total Hydrocarbons and Polyaromatic Hydrocarbons

Levels of all PAHs were found to be above AL1 for most of the samples (**Table 8-9**). There is no AL2 for PAHs.

Polychlorinated Biphenyls

Levels of the sum total of ICES 7 PCB congeners were found to be higher than AL1 in samples taken at the surface at VC01, VC02, VC04, VC05, and VC08 (**Table 8-10**). AL2 was exceeded in samples taken from the mid-core sample at VC01 and VC05.

Table 8-9 PAH results (mg/kg) compared to MS's ALs (AL1 exceedance in blue)

Sample ID	Sample Depth (m)	Acenaphthene	Acenaphthylene	Anthracene	Benzo (a) anthracene	Benzo (a) pyrene	Benzo (b) fluoranthene	Benzo(ghi) perylene	Benzo(k) fluoranthene	Chrysene	Dibenzo (ah) anthracene	Fluoranthene	Fluorene	Indeno (1,2,3-c,d) pyrene	Naphthalene	Phenanthrene	Pyrene
VC01	0	0.3460	0.0754	0.7870	1.4000	1.3300	1.3200	1.1100	0.6260	1.4900	0.1710	2.8800	0.4070	0.9530	0.4350	1.9900	3.0700
VC01	1.55	0.8010	0.2430	1.5600	3.5800	5.0300	4.5900	4.0000	2.3000	3.9200	0.5420	6.5200	0.9100	3.6400	1.1200	4.2100	6.7400
VC01	2.3	0.0179	0.0094	0.0226	0.0509	0.0606	0.1050	0.1710	0.0164	0.1510	0.0194	0.0840	0.0850	0.0446	0.1400	0.3820	0.1190
VC02	0	0.0812	0.0487	0.3070	0.5950	0.5930	0.6060	0.5470	0.2800	0.6060	0.0811	1.2300	0.1320	0.4830	0.2530	0.7270	1.3100
VC02	0.5	0.0157	0.0077	0.0221	0.0421	0.0463	0.0919	0.1350	0.0211	0.1330	0.0132	0.0811	0.0856	0.0343	0.0981	0.3670	0.1170
VC03	0	0.0598	0.0411	0.2230	0.4560	0.4840	0.5310	0.4980	0.2520	0.4890	0.0944	0.8000	0.1160	0.4330	0.2460	0.5410	0.9190
VC03	0.5	0.0215	0.0098	0.0315	0.0649	0.0775	0.1140	0.1800	0.0329	0.1690	0.0180	0.1040	0.0862	0.0562	0.1060	0.3860	0.1560
VC04	0	0.0633	0.0360	0.2030	0.3880	0.4010	0.4340	0.3850	0.1650	0.4170	0.0750	0.7320	0.1140	0.3490	0.1850	0.4380	0.8260
VC04	0.3	0.0212	0.0092	0.0261	0.0472	0.0525	0.0788	0.1450	0.0201	0.1280	0.0139	0.0856	0.0886	0.0378	0.1090	0.3080	0.1230
VC05	0	0.1740	0.0925	1.0500	2.9600	2.0300	2.1400	1.1000	1.3300	3.1200	0.2630	5.6100	0.2850	1.0800	0.3690	2.1400	5.4600
VC05	1.5	0.3220	0.1100	0.7690	1.2500	1.2100	1.1600	0.9600	0.6700	1.4400	0.1490	2.6300	0.4680	0.8050	0.5570	1.8000	2.7000
VC05	2.9	0.0162	0.0068	0.0241	0.0447	0.0499	0.0695	0.1250	0.0169	0.1080	0.0143	0.0730	0.0665	0.0323	0.0739	0.2610	0.1040
VC06	0	0.0570	0.0344	0.2180	0.4620	0.4980	0.5370	0.4900	0.2740	0.4870	0.0722	0.8410	0.0943	0.4300	0.2050	0.5750	0.9730
VC06	0.24	0.0232	0.0260	0.0964	0.2050	0.2170	0.2290	0.2150	0.1150	0.2170	0.0304	0.3630	0.0456	0.1830	0.1040	0.2390	0.4380
VC07	0	0.0616	0.0364	0.1640	0.2870	0.3150	0.3840	0.4340	0.1490	0.4540	0.0567	0.5710	0.1900	0.2530	0.2770	0.7050	0.7350
VC07	0.5	0.0093	0.0061	0.0323	0.0520	0.0571	0.0612	0.0564	0.0336	0.0618	0.0111	0.1220	0.0160	0.0470	0.0431	0.0930	0.1300
VC08	0	0.0024	<0.001	0.0039	0.0086	0.0100	0.0161	0.0233	0.0027	0.0162	0.0021	0.0143	0.0076	0.0072	0.0123	0.0390	0.0187
VC08	0.5	0.1360	0.0374	0.2170	0.4950	0.4570	0.4890	0.3620	0.2390	0.5510	0.0896	1.0300	0.1790	0.3420	0.3650	0.7380	0.8790

Table 8-10 ICES 7 PCB congeners results (mg/kg) compared to MS's ALs (AL1 exceedance in blue; AL2 exceedances in yellow)

Sample ID	Sample Depth (m)	Sum of ICES 7 PCB congeners
VC01	0	0.12372
VC01	1.55	0.2392
VC01	2.3	0.004
VC02	0	0.02476
VC02	0.5	0.00077
VC03	0	0.01641
VC03	0.5	0.00075
VC04	0	0.1014
VC04	0.3	0.00207
VC05	0	0.06273
VC05	1.5	0.3393
VC05	2.9	0.00366
VC06	0	0.01199
VC06	0.24	0.00057
VC07	0	0.00293
VC07	0.5	0.0006
VC08	0	0.06234
VC08	0.5	0.00115

Average for the Total Dredge Area

Given the small number of exceedances of AL2, averages across the dredge area, taken from the MS reporting spreadsheet, have been presented to provide a more representative assessment of risk to the marine environment (**Table 8-11**). When averaged, only two metals (Cd and Hg) were found to exceed the AL1 and these exceedances are only marginal. Whilst most of the PAHs exceed AL1, levels are generally under 0.5mg/kg; the exceptions being pyrene and fluoranthene. Average levels of ICES PCBs also exceed AL1 but do not approach the AL2 concentration.

Table 8-11 All parameters averaged over total dredge area (AL1 exceedance in blue)

Parameters	Unit	Average value
Total Solids	%	63.1
Gravel	%	12.0
Sand	%	25.8
Silt	%	62.1
As	mg/kg	5.7
Cd	mg/kg	0.66
Cr	mg/kg	30.1
Cu	mg/kg	27.7

Parameters	Unit	Average value
Hg	mg/kg	0.32
Ni	mg/kg	27.2
Pb	mg/kg	36.1
Zn	mg/kg	85.4
DBT	mg/kg	0.005
TBT	mg/kg	0.006
Acenaphthene	mg/kg	0.0611
Acenaphthylene	mg/kg	0.0232
Anthracene	mg/kg	0.1550
Benzo (a) anthracene	mg/kg	0.3340
Benzo(a)pyrene	mg/kg	0.3450
Benzo(b)fluoranthene	mg/kg	0.3500
Benzo(ghi)perylene	mg/kg	0.3010
Benzo(k)fluoranthene	mg/kg	0.1750
Chrysene	mg/kg	0.3850
Dibenzo (ah)anthracene	mg/kg	0.0473
Fluoranthene	mg/kg	0.6420
Fluorene	mg/kg	0.0982
Indeno (1,2,3-c,d) pyrene	mg/kg	0.2460
Naphthalene	mg/kg	0.1380
Phenanthrene	mg/kg	0.4580
Pyrene	mg/kg	0.6700
Sum of ICES 7 PCB congeners	mg/kg	0.0307

Given there is no AL2 for individual PAHs, an indication of potential toxicity of the levels recorded can be provided by applying the Canadian Interim Sediment Quality Guidelines (ISQG). The ISQGs were developed by the Canadian Council of Ministers of the Environment for evaluating the potential for adverse biological effects in aquatic systems (CCME, 1999). They have been derived from available toxicological information, reflecting the relationships between sediment concentrations of chemicals and any adverse biological effects resulting from exposure to these chemicals. They are not statutory standards; however, in the absence of suitable alternatives, these guidelines can provide an indication of whether there is likely to be a toxicological effect.

ISQGs comprise two assessment levels. The lower level is referred to as the Threshold Effects Level (TEL) and represents a concentration below which adverse biological effects are expected to occur only rarely (for example in some sensitive species). The higher level, the Probable Effect Level (PEL), defines a concentration above which adverse effects may be expected in a wider range of organisms. The three ranges of chemical concentrations (<TEL, between TEL and PEL, and >PEL) indicate those concentrations that are rarely, occasionally and frequently associated with adverse biological effects, respectively. **Table 8-12** presents the 2021 sediment data, comparing these to the Canadian ISQGs, showing that most of the PAHs are exceeding TEL but well below the PEL.

Table 8-12 2021 data and comparison to the Canadian ISQGs (µg/kg (TEL exceedance in blue)

Substance	ISQG/TEL	PEL	Incidence (%ISQG)	Incidence (ISQG<%<PEL)	Incidence (%³PEL)	Average value 2021 data
Acenaphthene	6.71	88.9	8	29	57	61.1
Acenaphthylene	5.87	128	7	14	51	23.2
Anthracene	46.9	245	9	20	75	155
Benz(a)anthracene	74.8	693	9	16	78	334
Benzo(a)pyrene	88.8	763	8	22	71	345
Chrysene	108	846	9	19	72	385
Dibenz(a,h)anthracene	6.22	135	16	12	65	47.3
Fluoranthene	113	1,494	10	20	80	642
Fluorene	21.2	144	12	20	70	98.2
Naphthalene	34.6	391	3	19	71	138
Phenanthrene	86.7	544	8	23	78	458
Pyrene	153	1,398	7	19	83	670

8.6 Potential Impacts during Construction

Potential impacts to marine water and sediment quality during construction phase of the proposed development include:

- Increase in SSC due to dredging and disposal; and,
- Potential release of contamination during dredging and disposal.

8.6.1 Increase in SSC due to Dredging

An increase in SSC during the dredging activity for the proposed development could lead to a potential reduction in water clarity and therefore quality. As detailed in **Tables 3.1** and **3.2**, around 85% of the material to be dredged would be non-erodible i.e., consist of Glacial Till, Mudstone and rock.

To assess the potential effects of dredging on SSC, sediment dispersion modelling using MIKE MT was carried out at both the dredging and disposal locations. The dispersion modelling modelled the worst-case scenario i.e., it was assumed that all the top soft silty material would be dredged continuously prior to hard material at the rate of 1000m^3/day within a period of approximately three weeks. In reality, dredging would be undertaken over a longer timeframe and comprise both dispersible and non-dispersible material, meaning the actual increase in SSCs would be lower.

Predicted maximum SSCs were extracted at the surface (**Figure 8-3**), mid-depth (**Figure 8-4**) and seabed (**Figure 8-11**). The figures show that the extent of the plume is predicted to be localised to within 100m of, and contained by, the eastern breakwater, with comparable SSCs throughout the water depth (i.e., there is minimal difference between concentrations at the surface, mid-depth and at the seabed).

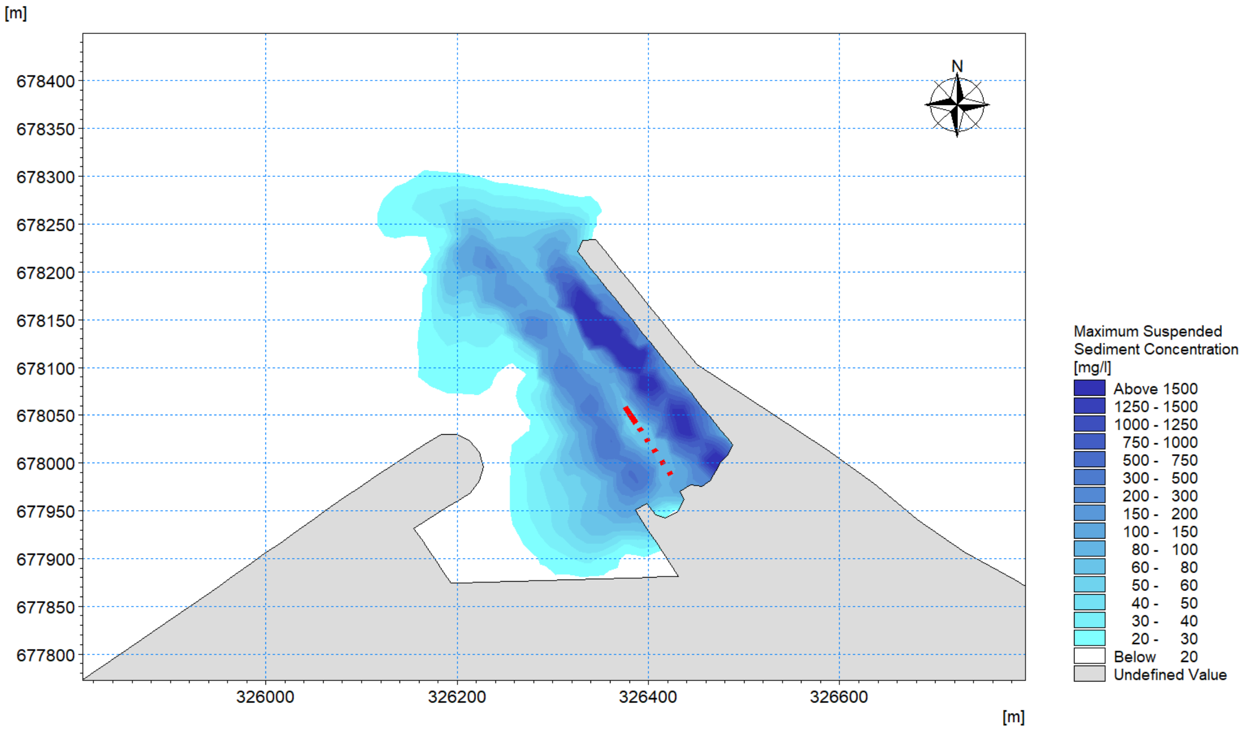


Figure 8-3 Maximum sediment concentration at dredging site - at surface

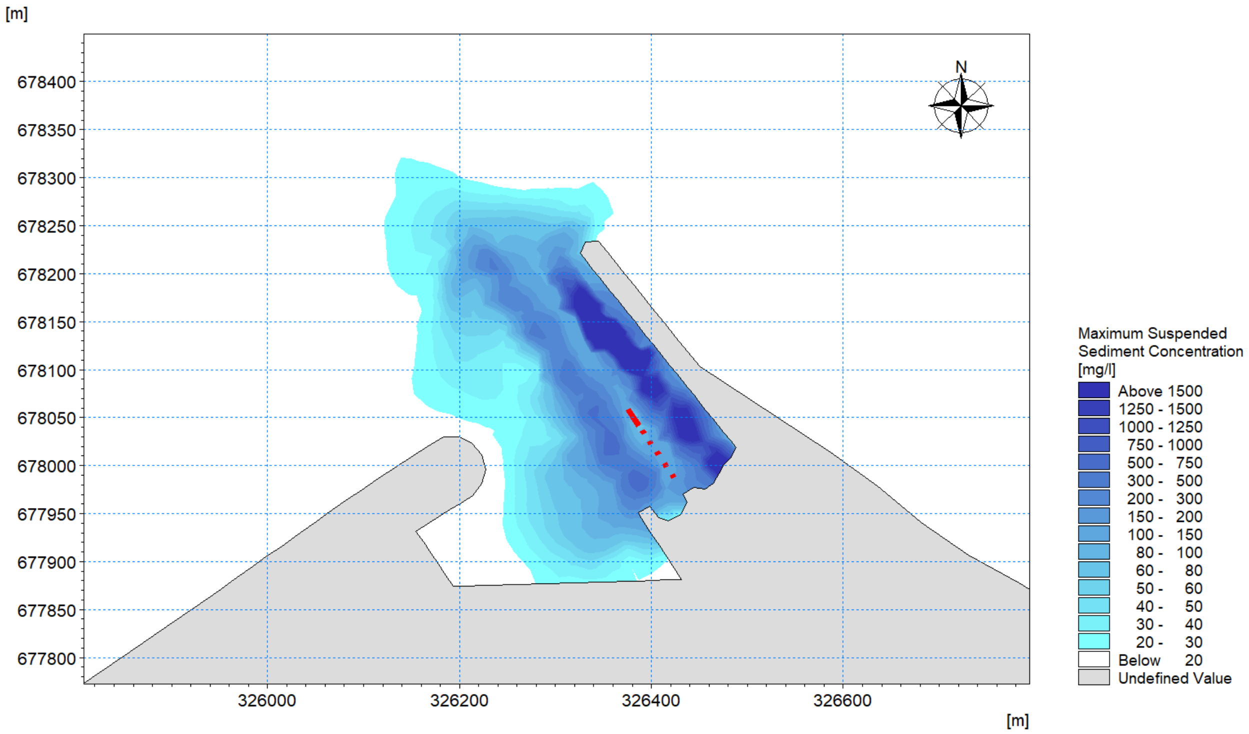


Figure 8-4 Maximum sediment concentration at dredging site - at mid-depth

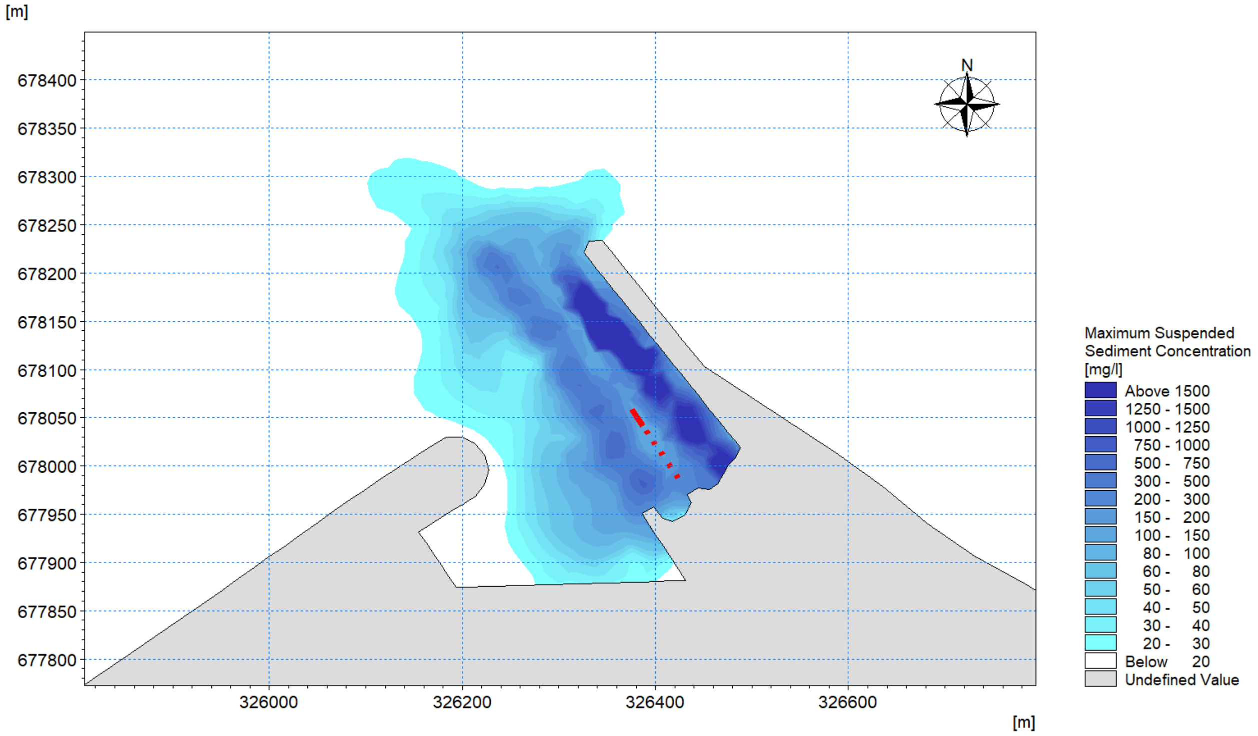


Figure 8-5 Maximum sediment concentration at dredging site - at seabed

To indicate the time over which peaks in SSC are predicted, timeseries plots have been extracted at the locations shown in **Figure 8-6**, to present SSC at two locations, LHA and LHB (**Figure 8-7** and **Figure 8-8**, respectively). These plots show that SSCs are predicted to be below 10mg/l for most of the dredging period. Results also indicate that peaks in SSC disperse to background levels within 1.5 hours.

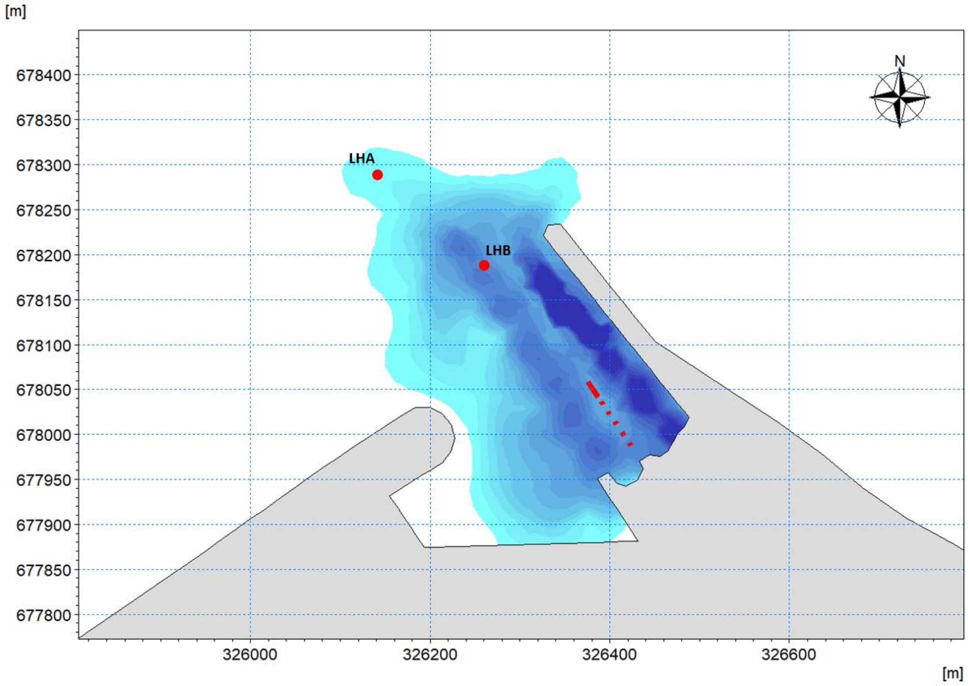


Figure 8-6 Location of extraction of SSC timeseries at dredging location

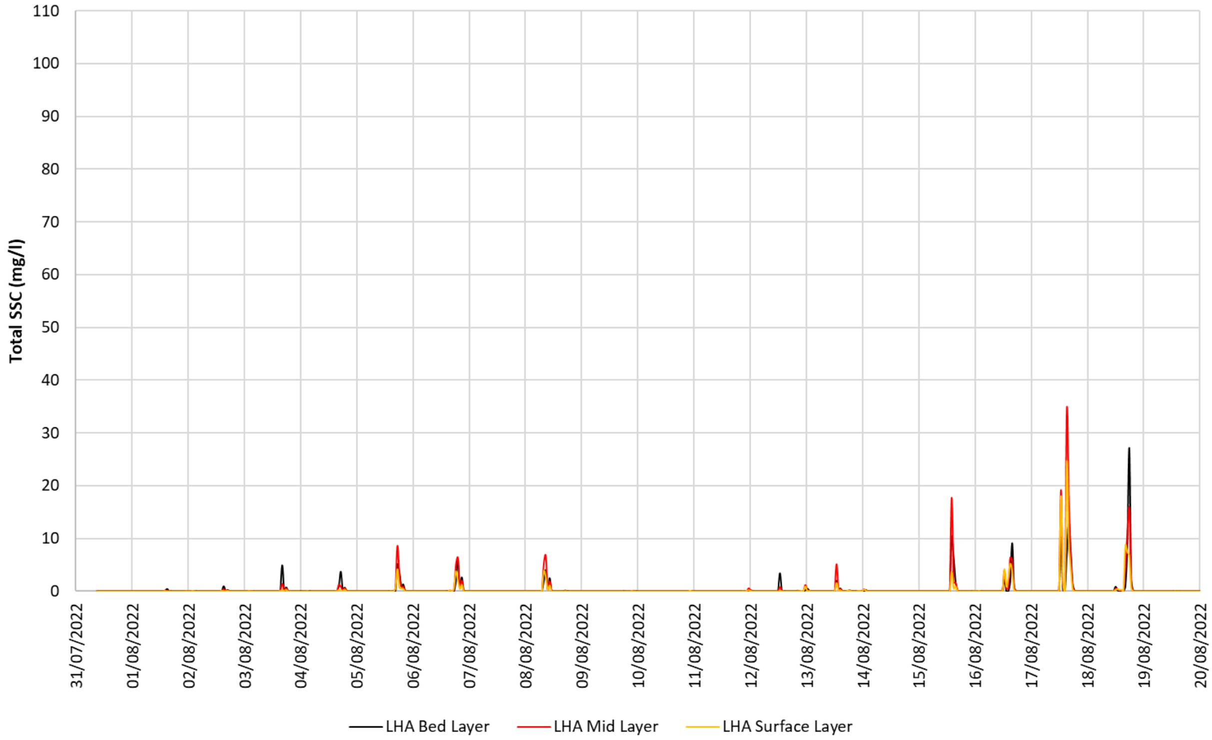


Figure 8-7 *Predicted SSC at Leith harbour at location LHA*

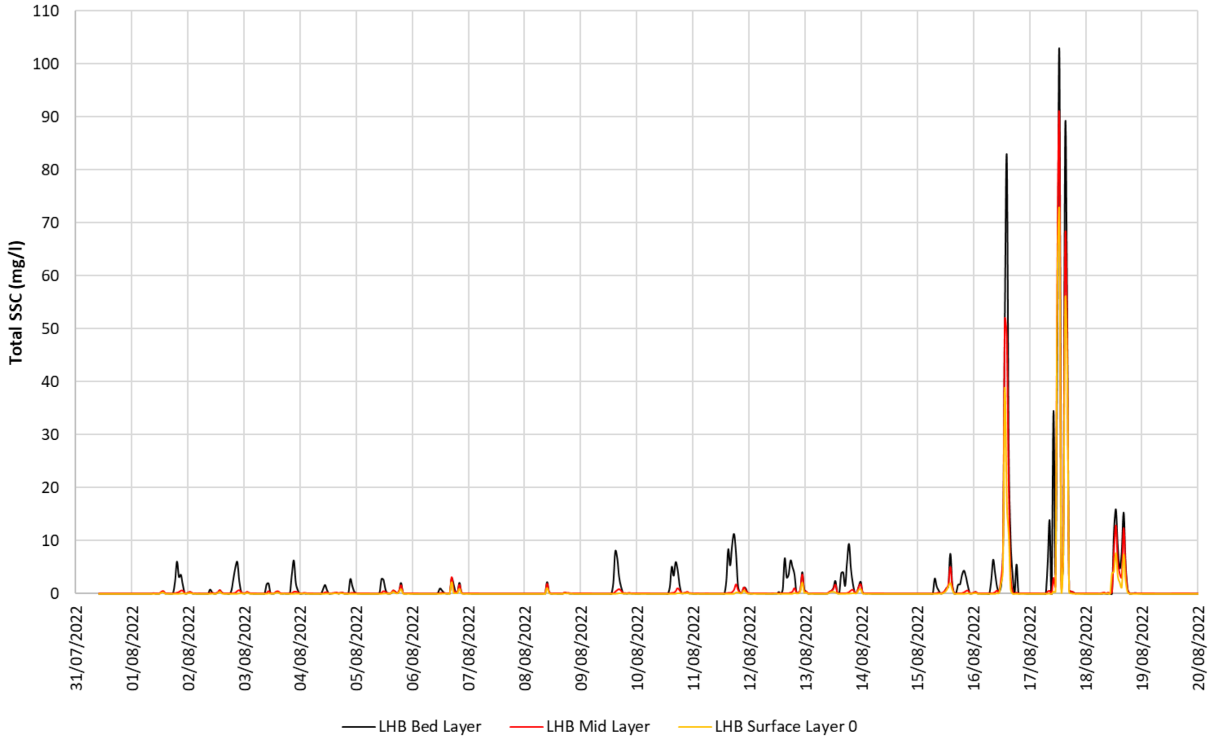


Figure 8-8 *Predicted SSC at Leith harbour at location LHB*

The results show that the magnitude of effect of dredging on SSCs is low, reversible and short-term. The receptor sensitivity is also considered to be low given the open nature of the water, absence of shellfish and bathing areas. Consequently, the potential impact is assessed as being of **minor adverse significance**.

Mitigation measures and residual impact

No mitigation measures are considered necessary. The residual impact would be of **minor adverse significance, which is not significant in EIA terms**.

8.6.2 Increase in SSC during Disposal

Once the material is dredged from the harbour area, it would be taken to Narrow Deep disposal site, which is around 5 – 7km from the dredging works.

Predicted maximum SSCs were extracted at the surface (**Figure 8-9**), mid depth (**Figure 8-10**) and seabed (**Figure 8-11**). These figures show that the majority of the material would rapidly descend to the seabed following discharge from the barge. Some dispersion of fine material would take place, extending 3km along the seabed toward east and west of the disposal location. As stated earlier, the modelling represents the worst-case scenario and the actual increase in SSCs would be lower.

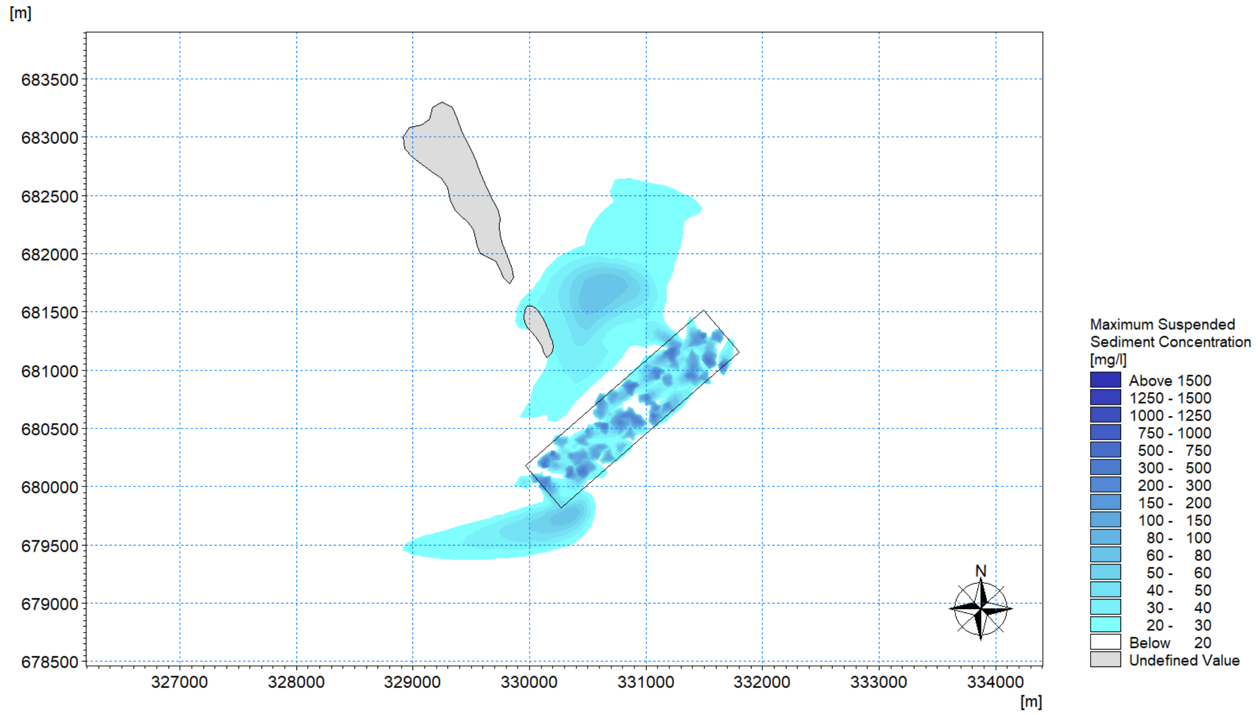


Figure 8-9 Maximum sediment concentration at disposal site - at surface

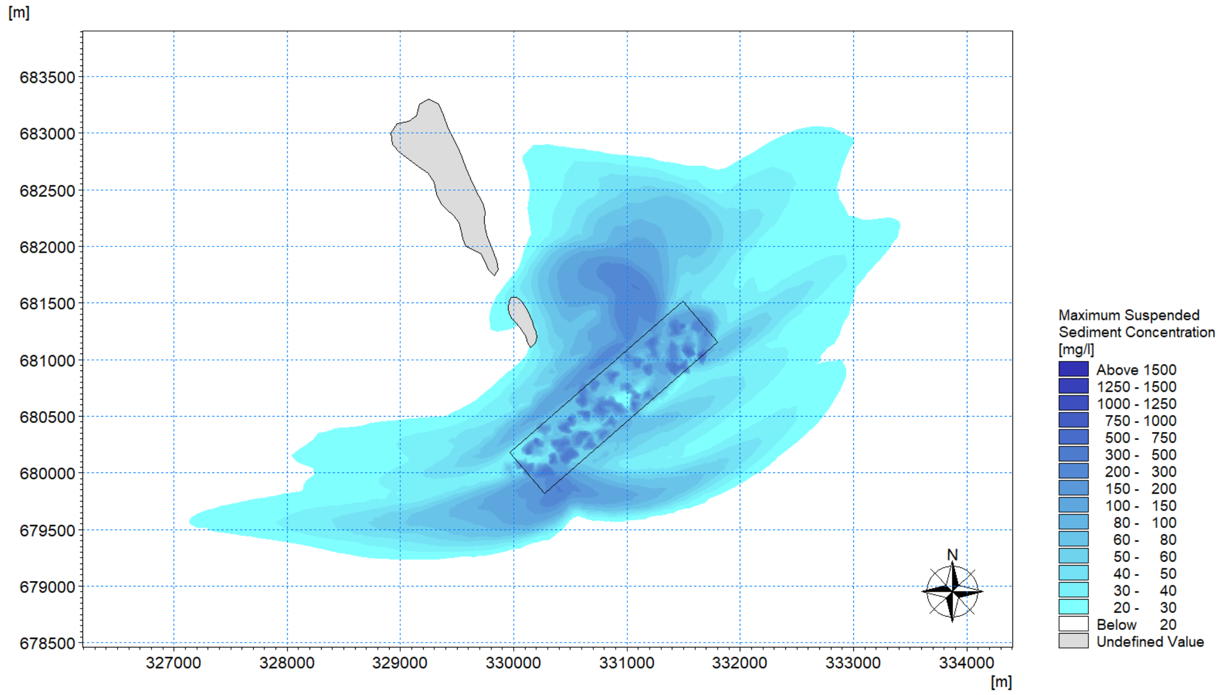


Figure 8-10 Maximum sediment concentration at disposal site - at mid-depth

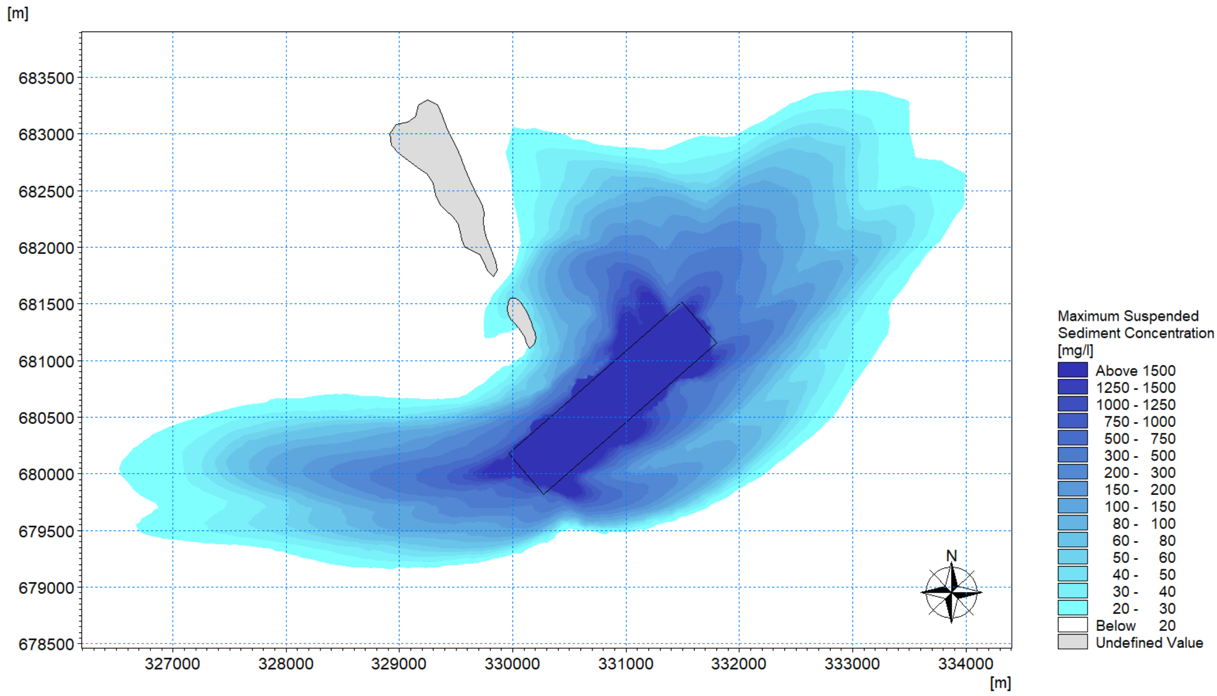


Figure 8-11 Maximum sediment concentration at disposal site - at seabed

Timeseries plots of predicted maximum SSCs at the two locations shown in **Figure 8-12** an be seen in **Figure 8-13 and Figure 8-14**. The plots show that peak SSCs occur up to 150mg/l but are short-lived and only experienced at the seabed. Much lower concentrations are predicted at the surface and mid-depth. All peaks are predicted to occur for a matter of hours.

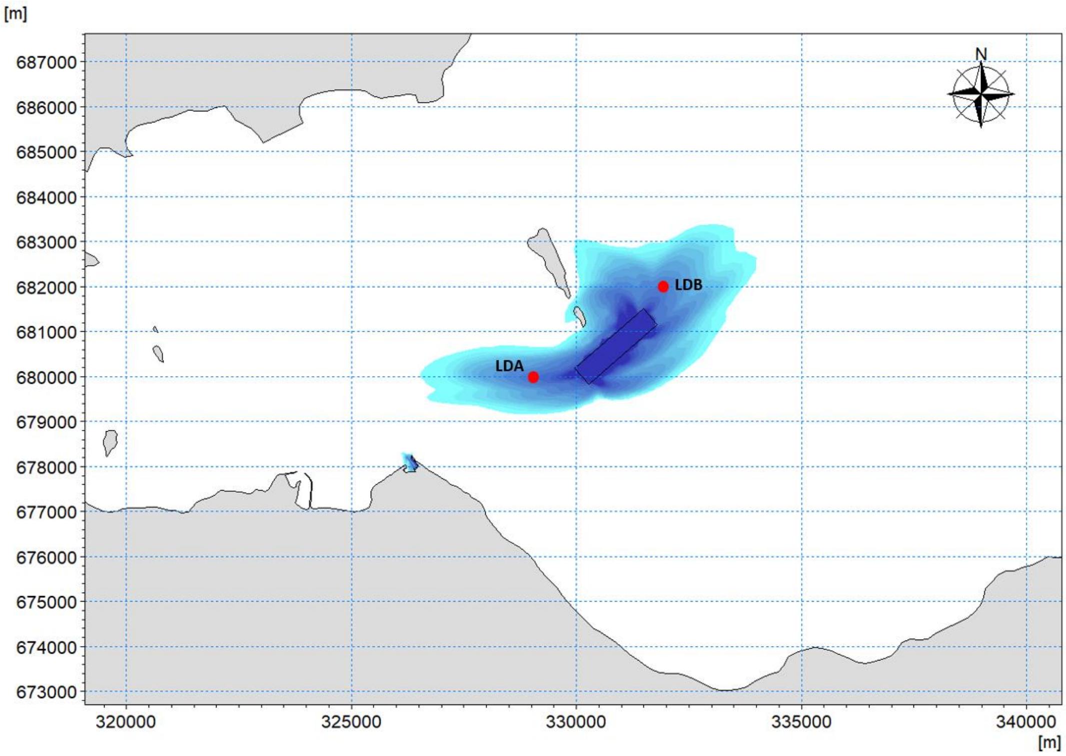


Figure 8-12 Location of extraction of SSC timeseries at disposal site

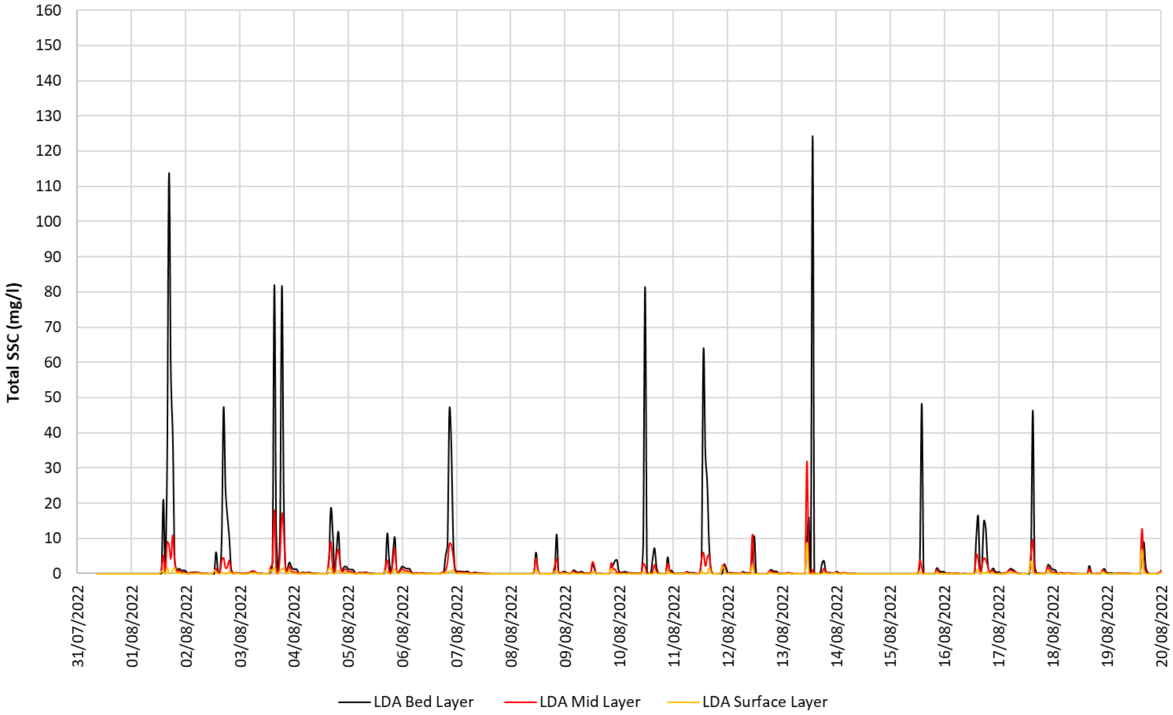


Figure 8-13 Predicted maximum SSCs at disposal site at location LDA

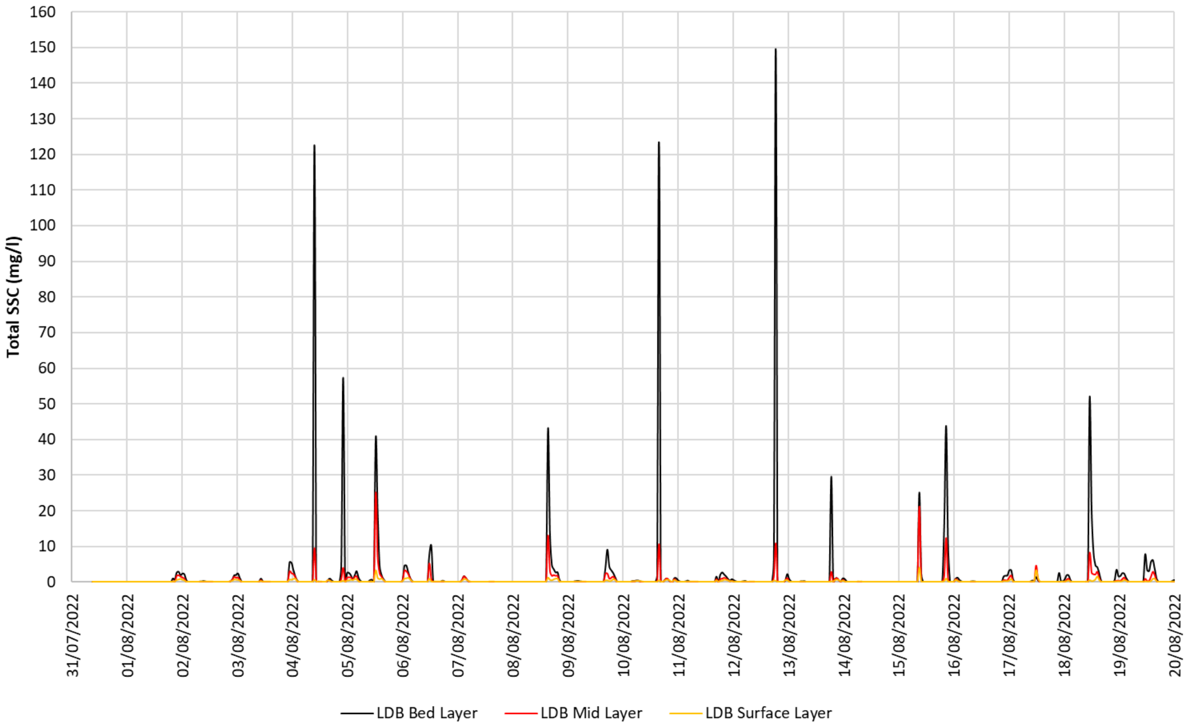


Figure 8-14 Predicted maximum SSCs at disposal site at location LDB

In reality, the period between these peaks is likely to be extended given the more realistic scenario of dredging both hard and soft material at the same time thus limiting the amount of soft material during each disposal event.

Considering the background SSCs in Firth of Forth (between 50 and 1,200mg/l (FugroEMU, 2013b), as shown in **Figure 8-1,** and the short duration of the peaks, the impact magnitude is assessed to be low on the water quality, reversible and short-term. There are no water quality sensitive receptors within the study area. Consequently, the potential impact is assessed as being of **minor adverse significance**.

Mitigation measures and residual impact

No mitigation measures are considered necessary. The residual impact would be of **minor adverse significance, which is not significant in EIA terms**.

8.6.3 Deterioration in Water Quality due to Release of Sediment-bound Contaminants

Dredging and disposal activities have the potential to adversely impact water quality due to the potential release of contaminants adsorbed to sediment particles; however, it should be noted that the majority of the material to be dredged for this project is Glacial till and mudstone which does not contain anthropogenic derived contaminants.

Sediment samples indicate that the remaining soft material component when averaged, does not contain significantly elevated concentrations of contaminants. There are a number of contaminants, which when averaged, still exceed AL1 but none exceed AL2. (**Section 8.5.5.2**). These results are in line with the historic data collected between 1993 – 2020 where a few metals and most of PAHs were found to be above AL1 within Port of Leith and Narrow Deep disposal ground (**Section 8.5.5.1**).

Relevant to the assessment of potential risk to the marine environment associated with contaminant release are the results of dispersion modelling, which predict that the sediment plume would remain localised to the dredging location and peaks in SSCs would only be short-term returning to baseline within a matter of hours. At the disposal site, the plume extent is predicted to be larger but restricted to the seabed. Peaks in SSC are also predicted to be short term and return to baseline within a matter of hours. Therefore, if any contamination is released during dredging or disposal, dispersion is likely to dilute any release quickly and a return to baseline conditions would be expected within hours. Plume predictions are also likely to be exaggerated given that the dredging and disposal activity is likely to require dredge and disposal of soft and hard material rather than all the soft material in one event.

Given the above, the reversibility of the impact, the magnitude of effect is also assessed to be low. Therefore, the impact is of **minor adverse significance**.

Mitigation measures and residual impact
No mitigation is required to reduce the impact significance. The residual impact is **minor adverse significance, which is not significant in EIA terms**.

8.7 Potential Impacts During Operation

No impacts to marine water and sediment quality would occur during the operational phase.

8.8 Summary

Table 8-13 summarises the significance of the potential impacts to marine water and sediment quality assessed in this chapter. Negligible and minor adverse impacts are not significant in EIA terms.

Table 8-13 Potential Impacts Identified for marine water and sediment quality

Potential Impact	Sensitivity	Magnitude	Significance	Mitigation Measures	Residual Impact
During Construction					
Increase in SSC due to dredging	Low	Low	Minor adverse	None Required	Minor adverse
Increase in SSC due to disposal	Low	Low	Minor adverse	None Required	Minor adverse
Deterioration in water quality due to release of sediment-bound contaminants	Low	Low	Minor adverse	None Required	Minor adverse

9 Marine and Coastal Ecology

9.1 Introduction

This chapter of the EIA Report considers the potential impacts of the proposed development on marine ecology and how this could affect priority habitats and/or protected/notable species. It describes the methods used to assess potential effects and the baseline conditions currently existing within the study area. The mitigation measures required to prevent, reduce or off-set any significant adverse impacts are presented together with the likely residual impacts after these measures have been adopted.

This chapter is informed by the following chapters from this EIA Report:

- **Chapter 7 Coastal Processes**
- **Chapter 8 Marine Water and Sediment Quality**

An assessment on fish and shellfish ecology, ornithology and marine mammals can be found in Chapters 10, 11 and 12 of this EIA Report respectively.

9.2 Legislation, Policy and Guidance

9.2.1 Legislation

The following legislation is relevant to marine ecology:

- Conservation (Natural Habitats, &c.) Regulations 1994, as amended ('the Habitats Regulations').
- Nature Conservation (Scotland) Act 2004 (as amended).
- Wildlife and Countryside Act 1981 (as amended) (includes amendments made via the Wildlife and Natural Environment (Scotland) Act 2011).

9.2.2 Policy

9.2.2.1 Scotland's National Marine Plan

Within Scotland's NMP are a set of Good Environmental Status (GES) indicators that must be met. Within these, of relevance to the proposed development, are:

- "Biological diversity is maintained and recovered where appropriate. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions (GES 1).
- All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity (GES 4)",

9.2.2.2 Edinburgh Biodiversity Action Plan

The UK generated the UK Biodiversity Action Plan (BAP) in response to the Convention on Biological Diversity from the Rio summit in 1992. Local BAPs were adopted at the county level to generate action on the ground and help meet UK targets.

The fifth edition of the Edinburgh BAP (covering 2019-2021) is the most recent BAP in and around the city. Amongst other aims and actions, the Edinburgh BAP sets out the importance of ensuring protected and priority species are reflected in plans, policies, strategies, projects and other activities, as appropriate.

9.2.3 Best Practice and Guidance

The impact assessment adheres to the following guidance and standards:

- CIEEM (2018) Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine
- CIEEM Guidelines for Ecological Report Writing (2nd Edition, December 2017)
- Environmental Impact Assessment Handbook (SNH, 2018)
- British Standard 42020:2013 –Biodiversity. Code of Practice for planning and development (British Standard, 2013)
- CIRIA Guidance note C692 Environmental Good Practice on Site Guide (3rd edition) (CIRIA, 2010)
- Joint Nature Conservation Committee Marine Monitoring Handbook (2001)
- Planning Advice Note 1/2013: Environmental Impact Assessment (Scottish Government, 2013)
- Scottish Biodiversity List (Biodiversity Scotland, undated)
- Planning Advice Note (PAN) 60 (Planning for Natural Heritage) (Scottish Government, 2000)
- Scottish Natura Heritage website: guidance on protected species (https://www.nature.scot/professional-advice/safeguarding-protected-areas-and-species/protected-species) (SNH, 2019)
- GB Non-native Species Secretariat (2015) Species Information

9.3 Consultation

Advice received during the EIA screening process has been taken into account in undertaking the assessment presented in this chapter. The approach to the assessment was also agreed with NatureScot when confirming the approach to the HRA (see **Section 6.2.2**).

9.4 Assessment Methodology

9.4.1 Study Area

The study area for marine ecology comprises the likely maximum extent over which potentially significant environmental impacts of the proposed development may occur. This has been informed by the sediment dispersion modelling carried out on the dredging and disposal activities and is based on the maximum predicted extent over which effects are predicted to occur (see **Chapter 7 Coastal Processes**).

9.4.2 Baseline Environment

The assessment of marine ecology has been informed through a desk-based review of available information, including:

- EUSeaMap 2021. An online mapping resource that is hosted by the European Marine Observation and Data Network (EMODnet). This provides broadscale habitat maps as well as more specific habitat maps on a broad, medium and fine scale, obtained from surveys. The maps can predict seabed-habitat types by combining measurements, such as water depth and light levels amongst others, using statistical analysis and Geographical Information System modelling (EMODnet, 2022).
- A site-specific survey was undertaken between 16th and 18th October 2021 during which sediment samples were taken for chemical and physical analysis.
- NBN Atlas. An online database, part of the National Biodiversity Network, that records biological sightings around the UK.
- Marine Life Information Network (MarLIN).

9.4.3 Impact Assessment Methodology

The methodology used to assess the potential environmental impacts associated with the proposed development is provided in **Section 5.5**. Professional judgement has been used to determine potential environmental impacts which could arise during the construction and operational phases of the proposed development.

9.4.3.1 Sensitivity

The sensitivities of marine species and habitats have been developed using a four-point scale (high, medium, low or negligible) and the definitions of the sensitivity levels used in this assessment are provided in **Table 9-1** below. This scale has been developed with reference to the MarLIN Marine Evidence based Sensitivity Assessment (MarESA), (Tyler-Walters, 2018). The sensitivity of a receptor is dependent upon its adaptability (the degree to which a receptor can avoid or adapt to an effect), tolerance (the ability of a receptor to absorb stress or disturbance without changing character) and recoverability (the temporal scale and extent to which a receptor will recover following an effect).

In conjunction with MarESA, Marine Scotland's Feature Activity Sensitivity Tool (FeAST) has been used in assessment of sensitivity of protected features. FeAST has developed a sensitivity matrix of marine habitats and species to pressures taking place in the marine environment.

Table 9-1 Definitions of Sensitivity Levels for Marine Ecology

Sensitivity	Definition
High	Individual receptor (species or habitat) has very limited or no capacity to accommodate, adapt or recover from the anticipated impact (e.g., receptor is killed/destroyed or damaged with recovery greater than 10 years).
Medium	Individual receptor (species or habitat) has limited capacity to accommodate, adapt or recover from the anticipated impact (e.g., killed/destroyed with recovery in 1to 10 years or damaged with recovery in 5 to 10 years).
Low	Individual receptor (species or habitat) has some tolerance to accommodate, adapt or recover from the anticipated impact (e.g., killed/destroyed with recovery with 1 year or damaged with recovery in 1 to 5 years)
Negligible	Individual receptor (species or habitat) is generally tolerant to and can accommodate or recover from the anticipated impact.

9.4.3.2 Nature conservation value

Nature conservation value (also referred to in the CIEEM guidelines as nature conservation importance) is a measure of the conservation value of a species potentially affected by the proposed development and has been used as an adjusting factor in determining the overall receptor sensitivity. The 'value' of a receptor has been used, as described in **Table 9-2**.

Table 9-2 Definitions of nature conservation Value for Marine Ecology receptors

Value	Definition
High	Nationally important / rare with limited potential for offsetting / compensation. Habitats (and species) protected under international law (e.g. Annex I habitats within a SAC boundary)
Medium	Regionally important / rare with limited potential for offsetting / compensation. Habitats / species protected under Scottish law and / or a focus of Scottish conservation efforts (e.g. Annex I habitats not within an SAC boundary; Priority Marine Features (PMFs), species on the Scottish Biodiversity List). Species/habitat that may be rare or threatened in the UK.
Low	Locally important / rare. Species for which targeted conservation work in the Edinburgh region is undertaken in line with the Edinburgh Biodiversity Action Plan. Habitats or species that provide prey items for other species of conservation value
Negligible	Habitats and species which are not protected under conservation legislation and are not considered to be particularly important or rare.

It should be noted that high value and high sensitivity are not necessarily linked within a particular impact. A receptor could be of high value (e.g. an Annex 1 habitat) but have a low or negligible physical/ecological sensitivity to an effect – it is important not to inflate impact significance just because a feature is ‘valued’. This is where the narrative behind the assessment is important; the value can be used where relevant as a modifier for the sensitivity assigned to the receptor.

9.4.3.3 Magnitude

Definitions of the magnitude levels are given in **Table 9-3**

Table 9-3 Definitions of Magnitude levels for Marine Ecology

Magnitude	Definition
High	Fundamental, permanent / irreversible changes, over the whole receptor, and / or fundamental alteration to key characteristics or features of the particular receptors character or distinctiveness.
Medium	Considerable, permanent / irreversible changes, over the majority of the receptor, and / or discernible alteration to key characteristics or features of the particular receptors character or distinctiveness.
Low	Discernible, temporary (throughout project duration) change, over a minority of the receptor, and / or limited but discernible alteration to key characteristics or features of the particular receptors character or distinctiveness.
Negligible	Discernible, temporary (for part of the project duration) change, or barely discernible change for any length of time, over a small area of the receptor, and/or slight alteration to key characteristics or features of the particular receptors character or distinctiveness.

9.5 Baseline Environment

9.5.1 Designated Sites for Nature Conservation

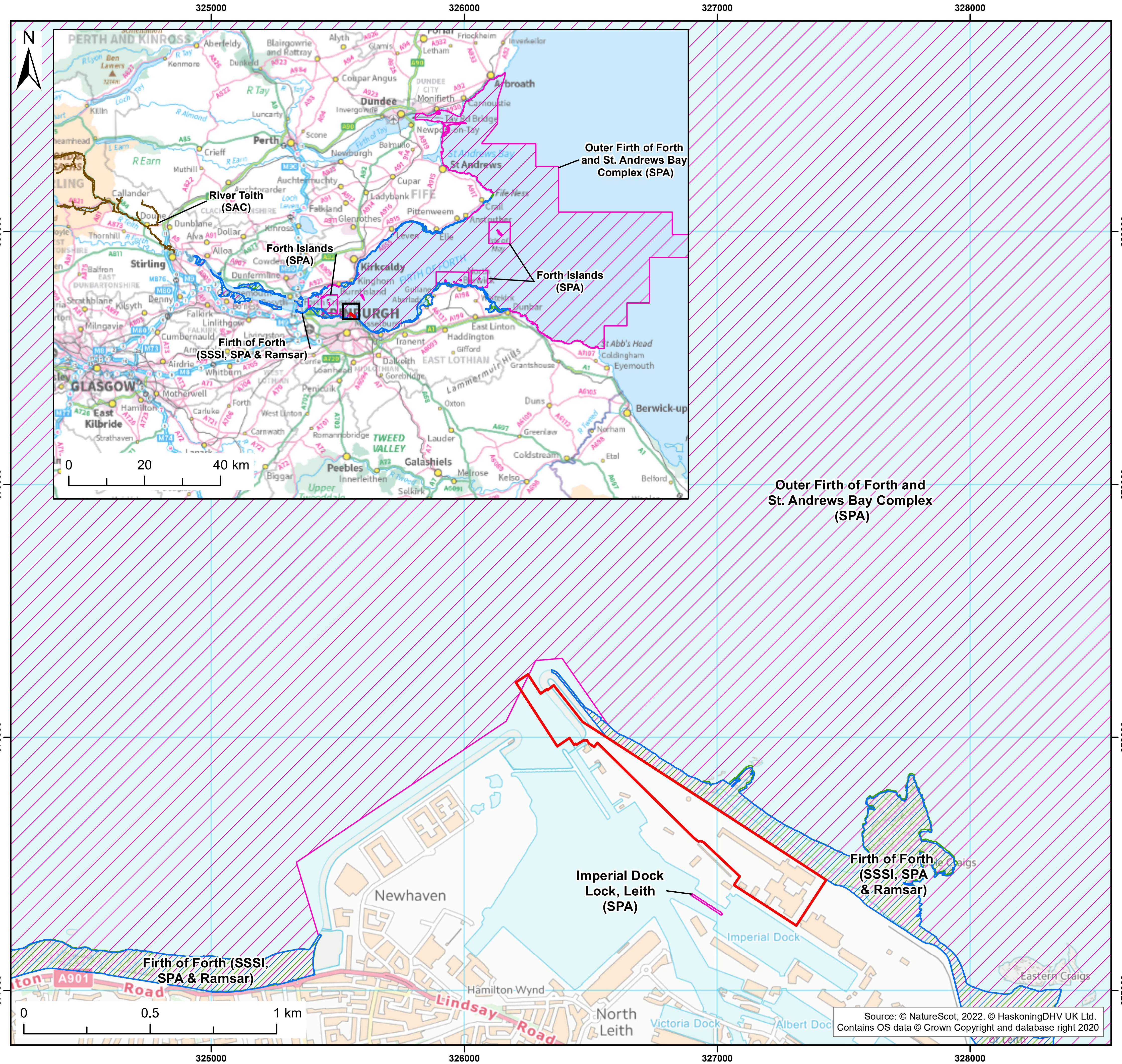
The following designated sites are present within the study area see also (**Figure 9-1**):

- Outer Firth of Forth and St Andrews Bay Complex (OFFSABC) Special Protection Area (SPA) - 0km from the proposed development.
- Firth of Forth Site of Special scientific Interest (SSSI), SPA and Ramsar site - 0km from the proposed development.
- Imperial Dock Lock, Leith SPA - Less than 1km from the proposed development.

In addition, the following designated sites for nature conservation have interest features that have the potential to be present in the study area:

- Forth Islands SPA - Approximately 4km from the proposed development.
- River Teith Special Area of Conservation (SAC) - Approximately 49km from the proposed development, screened in for long-ranging or migratory species only.
- Isle of May SAC - Approximately 43km from the proposed development, screened in for long-ranging or migratory species only.
- Firth of Tay and Eden Estuary SAC - Approximately 64km from the proposed development, screened in for long-ranging or migratory species only.
- Berwickshire and North Northumberland Coast SAC - Approximately 63km from the proposed development, screened in for long-ranging or migratory species only.
- Moray Firth SAC - Approximately 300km from the proposed development, screened in for long-ranging or migratory species only.

SACs, SPAs and Ramsar sites have been considered by a Habitats Regulations Appraisal (HRA) submitted in support of the marine licence application, with their fish, ornithological and marine mammal features assessed in Chapters 10, 11 and 12 respectively.



Legend:

- Red Line Boundary
- Site of Special Scientific Interest (SSSI)
- Special Protection Area (SPA)
- Special Area of Conservation (SAC)
- Ramsar

Client: Forth Ports Limited

Project: Port of Leith - Outer Berth

Title: Conservation Designations

Figure: 9.1

Drawing No: PC2045-RHD-ZZ-ZZ-DR-EV-0048

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
02	01/04/2022	JR	RP	A3	1:15,000
01	25/03/2022	FC	KF	A3	1:15,000

Co-ordinate system: British National Grid

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Whilst the proposed development does not directly impact on the Firth of Forth SSSI, this site is located directly adjacent, covering the intertidal area to the east (see **Figure 9-1**). The site covers approximately 7,425ha and is designated for its variety of geological and geomorphological features, coastal and terrestrial habitats, vascular plants, invertebrates, breeding, passage and wintering birds. Potential impacts to ornithological features are assessed in **Chapter 11 Ornithology**. No other potential impacts to this site have been identified.

9.5.2 Marine Ecology

Broadscale seabed habitat mapping is available in the Firth of Forth from the EUSeaMap (2021) project, the newest release of the EMODnet broadscale habitat map for Europe[12]. The seabed within the footprint of the proposed development, and within the area likely to be affected by increased levels of sediment deposition as indicated in **Figure 7-22**, is mainly comprised of moderate energy Atlantic infralittoral mixed sediments (EUNIS 2019 habitat description code: MB42), with deeper areas in the Approach Channel to the port containing moderate energy Atlantic circalittoral mixed sediment (MC42). The latter is the primary habitat in deeper waters at a distance of *c.*1km offshore from the outer berth (i.e. outside of the affected area during dredging activity). Towards the centre of the main Forth channel, there are extensive areas of finer sediment, principally moderate energy Atlantic circalittoral mud (MC62). Adjacent to the shoreline to the east of the proposed development are a series of rocky outcrops known as the Middle Craigs and Eastern Craigs, which are comprised of moderate energy Atlantic infralittoral rock (MB12) and are algal covered at lower elevations. Previous studies have highlighted how, in areas surrounding the Port of Leith, faunal assemblages of generally higher diversity are on rocky seabeds and lower diversity in littoral sediments (e.g. Bennett and McLeod, 1998).

The benthic macrofaunal communities in proximity to Narrow Deep spoil disposal ground are expected to be typical for estuarine conditions and not considered to be of high conservation significance due to the wide distribution, low diversity and lack of any rare or notable species (Elliot and Kingston, 1987). Narrow Deep is an existing licenced spoil disposal ground therefore benthic communities within the site and surrounding areas have been impacted by ongoing spoil deposition activities that have occurred there over more than 50 years. Seabed habitat mapping from the EUSeaMap project indicates that the seabed in the spoil ground and in areas likely to be affected by sediment deposition during disposal (as indicated in **Figure 7-23**) is area is generally characterised by low to moderate energy Atlantic circalittoral mud (MC62) and infralittoral mud (MB42) (hence is likely to be prone to natural periodic disturbance). In the context of the wider area, low to moderate energy circalittoral mud is by far the most prevalent habitat type across the entirety of the mid- to outer Firth of Forth.

Benthic species in the vicinity of the Port of Leith are common to the area and include the bivalve *Abra alba* (White Furrow shell) and common mussel *Mytilus edulis* (Jacobs Arup, 2009; Forth Properties Ltd, 2007). Limpets and periwinkles have also been reported to inhabit the study area (Jacobs Arup, 2009; Forth Properties Ltd, 2007).

9.5.2.1 Priority Marine Features

Although not necessarily afforded protection by legislation or other designations, Scottish Ministers adopted a list of PMFs that are considered to be marine nature conservation priorities in Scottish waters. In producing the list, species on existing conservation schedules were assessed against criteria that considered i) whether the species occurs in significant numbers in Scotland’s seas; ii) whether the species is under threat or in decline; and iii) the functional role that the species plays.

[12] https://emodnet.ec.europa.eu/en/euseamap-2021-emodnet-broad-scale-seabed-habitat-map-europe

Distribution of intertidal / subtidal PMFs in Scottish waters is presented through Marine Scotland's National Marine Planning Interactive (NMPi) tool. According to the tool, very few habitat PMFs are recorded within the outer Firth of Forth and none are within the ZOI.

9.5.3 Coastal Ecology

9.5.3.1 Coastal habitats

The port itself is characterised by an impounded dock system with surrounding quays / docksides and is non-tidal. Quayside habitats comprise no more than areas of hardstanding with buildings, with scattered ruderal vegetation in areas.

To the west of the port, coastal habitats include a man-made promenade and breakwater with amenity grassland, sea walls and revetment which extend through the supralittoral and littoral range, a fishing port / marina area with quaysides, and brownfield areas of ruderal vegetation / grassland near to the West Breakwater. These habitats are all typical of an urban coastline and would be insensitive to the effects of the proposed development.

9.5.3.2 European Protected Species

Otters *Lutra lutra*

As an EPS, otters are fully protected from deliberate or reckless injury or disturbance under the Habitats Regulations. The species is also a key focus of conservation work in Edinburgh under the local Biodiversity Action Plan. NBN Atlas records indicate that otters are increasingly present within urban / suburban areas of Edinburgh, with almost 150 sightings within 5km of the Port of Leith recorded in the NBN database, up to and including 2021. The majority are associated with individuals known to frequent Dunsapie Loch and Duddingston Loch, *c.*3km from the proposed development and separated from the development by urban (residential, commercial and industrial) landscape, with other well-publicised sightings in the Union Canal. Other records (12 in total) were around the Waters of Leith (the waterway that drains into the impounded dock system), although only one record (from 2015) was within 2km of the Port of Leith (in an urban environment at a distance of *c.*1.4km from the proposed development).

During the 2021/22 baseline estuarine bird surveys (see **Chapter 11**), which involved a total of 25 site visits to the impounded dock system and a stretch of coastline 2km west and east of the Outer Berth (each over two days, hence a total of 50 days on site), a single otter was recorded on one occasion (2 May 2021). This individual was recorded in the Waters of Leith, at a busy commercial location where the waterway enters the Inner Harbour (just south of the Victoria Swing Bridge, *c.*500m from the southernmost point of the proposed development).

The baseline information indicates that otters are present in the Waters of Leith and are regularly sited in suburban / urban environments there and elsewhere in Edinburgh, but there is no evidence of use of habitat within the port itself, nor the coastline to the west and east.

9.5.3.3 Other coastal / terrestrial EPS

NBN Atlas records indicate that other coastal / terrestrial EPS recorded within 2km of the proposed development comprise water vole *Arvicola ammphibius* (one individual, 2020) and bat species (namely common and Soprano pipistrelle *Pipistrellus pipistreelus* and *P. pygmaeus* (nine records). The impounded dock system, surrounding quaysides and coastline are not appropriate habitat for water vole. Similarly, the port estate (and associated structures therein) are unlikely to hold any potential for bat roosting or significant activity. As such, these species have not been considered in this assessment.

9.6 Potential Impacts During Construction

Potential impacts on marine benthic ecology during construction include:

- Direct loss of benthic habitats within the footprint of the proposed development.
- Smothering of benthic habitats as a result of the proposed dredging and disposal activities.
- Release of contaminants during dredging and disposal.
- Disturbance to otters, and reduced availability of prey resources for this EPS.

9.6.1 Direct Loss of Benthic Habitats within the Footprint of the Proposed Development

The majority of the benthic habitats within the footprint of the proposed development are within the existing Approach Channel to the Port of Leith, which is regularly dredged. Consequently, the species present will be tolerant to dredging related impacts. Dredging within the berth pocket area will deepen the pocket by up to 2m, which is not considered sufficient to result in a change of the benthic communities present.

A section of the intertidal/subtidal rock armour along the western side of the eastern breakwater would be removed; however, once piling has been completed, a new rock revetment would be placed that would effectively replace what was lost. Recolonisation is expected to eventually result in benthic communities of similar diversity and composition as those present on the artificial habitat that is currently present.

In light of the above, the magnitude of the potential impact and sensitivity of the habitats are considered to be low. These habitats are also considered to be of low value, being common along the coastline. A potential impact of **minor adverse significance** has therefore been predicted.

Mitigation measures and residual impact
No mitigation is required and as such the residual impact is of **minor adverse significance, which is not significant in EIA terms**.

9.6.2 Smothering of Benthic Habitats as a Result of Dredging and Disposal Activities

The increased SSCs created by the proposed dredging works associated with the Outer Berth will have the potential to deposit sediment and raise the seabed elevation in the vicinity of the proposed development and disposal site.

As discussed in **Section 7.6.1**, sediment deposition within the enlarged pocket berth and the existing Approach Channel is predicted to be between 0.01 and 0.03m; however, with progression away from the proposed development the amount of deposition reduces considerably, and seabed depositions reduce to less than 0.005m (5mm). The benthic communities surrounding the proposed development are already tolerant to this level of disturbance, given the existing level of maintenance dredging that takes place in the Approach Channel.

The predicted changes in seabed elevation at Narrow Deep disposal site due to the disposal of the dredged material show that any predicted increase in bed thickness is confined predominantly to within the boundary of the disposal site and outside this region the amount of increase in seabed level is relatively small at less than 0.005m (5mm) (see **Section 7.6.2** for further details). As for the benthic communities surrounding the proposed development, benthic communities surrounding the disposal site will be tolerant to this level of deposition.

Given the worst-case scenario modelled, the level of deposition is conservative. This and the redistribution of deposited sediment that would occur, means that actual deposition levels will be lower than that considered here. As such, the magnitude is considered to be negligible and the sensitivity and value of the benthic habitats low. A potential impact of **negligible significance** has therefore been predicted.

Mitigation measures and residual impact
No mitigation is required and as such the residual impact is of **negligible significance, which is not significant in EIA terms**.

9.6.3 Release of Contaminants During Dredging and Disposal

The potential effect of the release of contaminants during dredging and disposal on marine water and sediment is discussed in **Section 8.6.3**, with a minor adverse impact predicted. Given this, the localised and low levels of deposition predicted, the magnitude of the potential impact is low. The sensitivity and value of the benthic habitats are also low and therefore a potential impact of minor adverse significance is has been predicted.

Mitigation measures and residual impact
No mitigation is required and as such the residual impact is of **minor adverse significance, which is not significant in EIA terms**.

9.6.4 Potential Impacts on Otters

As noted in **Section 9.5.3.2**, it is evident that otters regularly use the Waters of Leith in and around urban Edinburgh. Potential impacts on this species from the proposed development could potentially arise due to the effects of noise / visual disturbance during construction works, or from changes in availability of prey resources.

While otters are an EPS and a focus of conservation management on both a national and local scale (and hence are of high conservation value), any otters that frequent the lower reaches of the Waters of Leith are clearly tolerant of ongoing anthropogenic activity, given that habitat there is representative of an urban (residential, commercial and industrial) environment. Based on the frequency of sightings reported in the NBN Atlas, and a general understanding of the ecology of urban otters in Edinburgh, it appears that areas upstream (i.e. more than 2km from the Port of Leith) are favoured and would provide suitable alternative habitat to downstream areas that are in close proximity to the port. Given the above, the sensitivity of this feature is considered to be medium, as a worst case.

There is no evidence to suggest significant use of habitat within the impounded dock system or the coastline immediately adjacent to the works by otters. In terms of noise disturbance, this infers that those areas in close proximity to 'noisy' works (i.e. noise emissions that are considered to be additional to the typical noises associated with a busy working port, notably piling) are of low importance to the Edinburgh otter population. At a distance of more than 2km upstream, such noises would likely be indistinguishable from typical urban noises that form the baseline environment. In terms of impacts on prey resources within the Waters of Leith, the dam / lock gates that separate the impounded dock system from the marine environment would prevent any significant impacts from underwater noise and suspended sediment increases. In all cases, impacts would be temporary and short-term (noise from piling would last *c.*5.5 months, sediment disturbance during dredging would last *c.*4 months).

Given the above, the magnitude of impacts on otters would be very low, and the overall significance would hence be of **minor adverse significance**.

Mitigation measures and residual impact

No mitigation is required and as such the residual impact is of **minor adverse significance, which is not significant in EIA terms**.

9.7 Potential Impacts During Operation

Potential impacts during the operational phase on benthic habitats can arise through changes in erosion and accretion patterns. Changes in erosion and accretion patterns are discussed in **Section 7.7.2.2**, which concludes that changes to bed shear stresses are predicted to be very localised and small in magnitude. As such, there it is unlikely that there would be any discernible effect on bedload sediment transport and **no impact** on benthic habitats.

9.8 Summary

Table 9-4 summarises the potential impacts to marine and coastal ecology assessed in this chapter. Negligible and minor adverse impacts are not significant in EIA terms.

Table 9-4 Summary of potential impacts to marine and coastal ecology

Potential Impact	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
Construction					
Direct loss of benthic habitats within the footprint of the proposed development	Low	Low	Minor Adverse	None required	Minor Adverse
Smothering of benthic habitats as a result of the proposed dredging and disposal activities	Low	Negligible	Negligible	None required	Negligible
Release of contaminants during dredging and disposal	Low	Low	Minor Adverse	None required	Minor Adverse
Impacts on otter due to disturbance and change in availability of prey resource	Medium	Very low	Minor adverse	None required	Minor adverse
Operation					
Changes in erosion and accretion patterns	Low	Low	No Impact	None required	No Impact

10 Fish and Shellfish Ecology

10.1 Introduction

This chapter of the EIA Report considers the potential impacts of the proposed development on migratory and estuarine fish populations in the Firth of Forth.

It provides a summary of the baseline conditions of the proposed development site and surrounding environs, based on publicly available information. This is followed by identification of the potential impacts of the proposed development during the construction and operational phases, and an assessment of the magnitude and significance of the effects on fish receptors as a consequence of these impacts. The mitigation measures required to prevent, reduce or off-set any significant adverse effects are presented together with the likely residual effects after such measures have been adopted.

This chapter is supported by the following technical appendices:

- **Appendix 10-1** – Subacoustech Environmental Report No. P303R0102: Underwater noise propagation modelling for construction works at Port of Leith, Scotland, which provides details of underwater noise modelling methodology and output.
- **Appendix 10-2** – Marine Mammal and Fish Technical Report for Underwater Noise Impacts, which provides an assessment of the impacts of underwater noise on fish species based on underwater noise modelling presented in **Appendix 10-1**.

10.2 Legislation, Policy and Guidance

10.2.1 Legislation

10.2.1.1 Conservation (Natural Habitats, &c.) Regulations 1994 (as amended) ('the Habitats Regulations')

The Habitats Regulations transpose Council Directive 92/43/EEC ('the Habitats Directive') into Scottish national law. The Regulations require competent authorities to consider or review planning permission, applied for or granted, affecting nature conservation designations within the UK's National Site Network – including SACs designated for migratory fish species – and, subject to certain exceptions, restrict or revoke permission where the integrity of the site would be adversely affected. Details on the sites within the National Site Network that have migratory fish interest and may be affected by the proposed development are provided in **Section 11.5.1**. A HRA, undertaken in accordance with the Habitats Regulations, has also been undertaken for the proposed development and provided in support of the marine licence application.

10.2.2 Policy and plans

10.2.2.1 Scotland's National Marine Plan

General policy 'GEN 9: Natural Heritage' of the Scotland's NMP focuses on the achievement of the objective 'living within environmental limits' by ensuring that development and use of the marine environment must, *inter alia*:

- Comply with legal requirements for protected areas and species; and,
- Protect and, where appropriate, enhance the health of the marine area.

In adherence to this policy, marine planners and other decision makers should act in the way best calculated to further the achievement of sustainable development, including the protection of the health of the marine area. The Strategy for Marine Nature Conservation in Scotland's Seas sets out aims and objectives to achieve this. The Strategy outlines a three-pillar approach to conservation:

- Site protection: plans or projects may only be approved if they will not have a significant effect on the site integrity of SACs (and SPA, Ramsar Sites and SSSIs).
- Species protection: if there is evidence to suggest that a protected species may be affected by a proposed development, the protection afforded by legislation must be factored into the planning and design of the development and impacts fully considered.
- Wider seas measures: consideration must be given to PMFs in marine planning, including fishes listed as Priority Marine Species.

10.2.2.2 Edinburgh Biodiversity Action Plan

The UK generated the UK BAP in response to the Convention on Biological Diversity from the Rio summit in 1992. Local BAPs were adopted at the county level to generate action on the ground and help meet UK targets.

The fifth edition of the Edinburgh BAP (covering 2019-2021) is the most recent BAP in and around the city. Amongst other aims and actions, the Edinburgh BAP sets out the importance of ensuring protected and priority species (including PMF fish species) are reflected in plans, policies, strategies, projects and other activities, as appropriate.

10.3 Consultation

Advice received during the EIA screening process has been taken into account in undertaking the assessment presented in this chapter. The approach to the assessment was also agreed with NatureScot when confirming the approach to the HRA (see **Section 6.2.2**).

10.4 Assessment Methodology

10.4.1 Study area

For the purpose of assessment on fish and shellfish, the study area comprises the likely maximum extent over which potentially significant environmental impacts of the proposed development may occur. This has been informed by the sediment dispersion modelling of the dredging and disposal activities and is based on the maximum predicted extent over which effects are predicted to occur (**Section 8.6.1**). The study area also takes into account the extent to which underwater noise may lead to physiological effects on fish species (see **Appendix 10-1**).

10.4.2 Data sources

Sources of data that have been used in providing the required evidence for the assessment include:

- Scottish Natural Heritage's (now NatureScot) *HRA on the Firth of Forth: A Guide for developers and regulators* (SNH, 2016);
- Underwater noise modelling of the proposed development, undertaken by Subacoustech (see **Appendix 10-1** for full details of modelling methodology and outputs);
- Sediment dispersion modelling (as described in **Section 8.6.1** and subsequently deposited onto the seabed (as described in **Section 7.6.1** and **7.6.2**); and,
- Sediment sample analysis of dredged material, as described in **Section 8.5.5.2**.

10.4.3 Assessment methodology

For the purposes of the assessment of potential impacts on fish and shellfish receptors, the methodology used is as per the general approach set out in in **Section 5.5**.

10.4.4 Species considered in the underwater noise assessment

Standard control measures, such as the use of soft-start protocols during piling (JNCC, 2010), would be in place to prevent mortality of resident fish species. As such, resident fish species within the estuary would not be significantly affected by underwater noise during construction of the proposed development, hence are not considered in this assessment.

Migratory species, including SAC features (lamprey species and Atlantic salmon), have been considered in the underwater noise assessment since there is risk, if coinciding with migratory periods, of causing an impediment (or 'barrier effects') to migration. As such, the assessment that follows specifically focuses on the following migratory species that are known to be present in the Firth of Forth:

- Sea and river lamprey;
- Atlantic salmon;
- Sea trout;
- Smelt; and,
- European eel.

10.5 Baseline Environment

10.5.1 Migratory fish associated with River Teith SAC

The NatureScot guidance document (*HRA on the Firth of Forth – A Guide for Developers and Regulators*; SNH, 2016) states there is the potential for connectivity with the River Teith SAC due to the migration routes of Atlantic salmon *Salmo salar*, sea lamprey *Petromyzon marinus* and river lamprey *Lampetra fluviatilis*. These species are known to occur within the wider Forth Estuary during parts of their life cycle.

The River Teith SAC is approximately 49km from the proposed development (**Figure 9-1**) and is the most significant tributary of the River Forth. The importance of this SAC is heightened as it supports populations of all three UK lamprey species (including brook lamprey *Lampetra planeri*; however, this is a non-migratory freshwater fish and therefore not considered in this assessment).

10.5.1.1 Sea lamprey

Mature sea lamprey migrate to the River Teith SAC and freshwater reaches of the Forth every year to spawn. Spawning in the Teith and Forth usually occurs in late May or June, when the water temperature reaches at least 15°C (SNH, 2016), and mature sea lamprey start to migrate through the Firth of Forth as early as April. Adults die after spawning. Juvenile lamprey settle in silt beds within the SAC for up to five years, before pre-adult lamprey migrate downstream to the open sea, typically between October and December, during hours of darkness (SNH, 2016). Sea lamprey will spend up to two years feeding at sea and reaching sexual maturation before migrating back to the SAC (SNH, 2016).

10.5.1.2 River lamprey

As with sea lamprey, river lamprey live in freshwater as juveniles, before migrating out to estuarine or coastal areas for maturation. Mature river lamprey adults return to the SAC every year from October to December, ready for spawning when water reaches temperatures of 10-11°C, typically late March to May. Juveniles disperse into silt beds and remain in the SAC for three to five years, before migrating, during darkness, to the Firth of Forth and other coastal or estuarine areas where they will spend up to two years feeding and reaching maturation.

10.5.1.3 Atlantic salmon

Atlantic salmon within the Firth of Forth have a complex life cycle, which begins and ends in freshwater spawning grounds in the catchments of the rivers Forth, Teith, and Allan (SNH, 2016). Atlantic salmon typically spend four years as juveniles in freshwater, before migrating downstream and out to sea. They would then spend up to four years at sea, before migrating back to their spawning grounds as mature adults. Juvenile smolt migrate from freshwater to sea from March to May, and adults can migrate back to freshwater at any time of the year. Peak spawning occurs between November and December, but can extend from October to late February (SNH, 2016).

10.5.2 Other migratory fish

European eel *Anguilla anguilla* moves from freshwater to the sea to spawn, passes through the Firth of Forth on its way to spawning grounds in the sea (Malcolm *et al.,* 2010). Once they have arrived in European waters from the spawning grounds in the Sargasso sea, juvenile 'glass' eels move between marine and riverine waters during development. Once mature, eels from riverine or marine waters in Europe return to Sargasso spawning grounds.

Young 'glass' eels generally arrive in Scottish marine waters from September to December but remain in coastal waters until April or May when river temperatures are sufficiently warm. Mature adult eels undergo an 'autumn' migration, but individuals may begin to leave rivers at almost any point of the year; in Scotland peak counts tend to be between August and October (Malcolm *et al.*, 2010). As such, it is likely that key migratory periods in the Firth of Forth would be April to May (juvenile migration upstream) and August to October (adult downstream migration).

Data collected at the Longannet power station further upstream (SKM, 2011) shows that as well as eel and the SAC features listed above, other migratory fish that travel through the Firth of Forth, including European smelt *Osmerus eperlanus*, which migrates upstream during spring to spawn (Maitland and Lyle, 1996) and sea trout *Salmo trutta*, which migrate upstream as juveniles to overwinter and as adults to spawn (Malcolm *et al*., 2010).

Twaite shad *Allosa falax* and allis shad *A. alosa*, which are both classified as rare species in Appendix III of the Bern Convention and Annexes II and V of the Habitats Directive, are occasionally recorded in the Forth but are not regular[13] and are not features of any nearby SAC.

10.5.3 Resident estuarine fish and shellfish

The Firth of Forth supports a diverse range of fish species, and encompasses several areas reported to be spawning and nursery grounds for species, including herring *Clupea harengus,* cod *Gadus morhua,* whiting *Merlangius merlangus,* plaice *Pleuronectes platessa*, sprat *Sprattus*, and lemon sole *Microstomus kitt* (Ellis *et al*., 2012; Coull *et al.,* 1998). An abundance of other species are also known to be present in the wider area, including mackerel *Scomber scombrus*, blue whiting *Micromesistius poutassou* and ling *Molva molva* (Ellis *et al*., 2012; Coull *et al.,* 1998).

Several other fish species are known to be present within the Firth of Forth, including flounder *Pleuronectus flesus*, lesser sandeel *Ammodytes tobianus*, , common goby *Pomatoschistus microps*, and small spotted catshark *Scyliorhinus canicular*(Forth Properties Ltd, 2007; Jennings *et al*., 2012).

[13] *https://forthriverstrust.org/rivers-wildlife/learn/wildlife/marine/twaite-shad/*

A range of shellfish species may be found in the vicinity of the proposed development, including brown shrimp *Crangon crangon,* which have been recorded throughout the Firth of Forth, while the pink shrimp *Pandalus montagui* occurred in the lower reaches of the estuary (Jayamanne, 1995). Razor shells *Ensis spp*. have been recorded in the inshore areas (Robson, 1997). Other shellfish species found in southeast Scotland that may be found in the Firth of Forth include European lobster *Hommarus Gammarus*, edible crab *Cancer pagurus*, velvet swimming crab *Necora puber*; king scallop *Pecten maximus*, Norway lobster *Nephrops norvegicus*, and the squid *Loligo forbesi* (Beard and McGregor, 2004; Robson, 1997).

10.5.4 Conservation interest

There are 22 fish species on the OSPAR List of Threatened and / or Declining Species, of which 19 are present in OSPAR Region II (Greater North Sea). The OSPAR list is designed to identify species that require protection and guides the OSPAR Commission in setting priorities for future conservation and protection of marine biodiversity. The list includes migratory species found regularly in the Firth of Forth (see **Sections 10.5.1** and **10.5.2**), namely Atlantic salmon, sea lamprey and European eel, plus resident fish species that are associated with estuarine environments around the east Scotland coast such as cod, spotted ray *Raja montagui*, thornback ray *R. clavata* and spurdog *Squalus acanthias*.

Although not necessarily afforded protection by legislation or other designations, Scottish Ministers adopted a list of PMFs that are considered to be marine nature conservation priorities in Scottish waters. In producing the list, species on existing conservation schedules were assessed against criteria that considered i) whether the species occurs in significant numbers in Scotland's seas; ii) whether the species is under threat or in decline; and iii) the functional role that the species plays. The list of PMFs includes a number of fish species that are understood to be potentially present in the estuary, as listed in **Table 10-1**.

Table 10-1 Fish Priority Marine Species that are likely to be present in the outer Firth of Forth

Common Name	Scientific Name
Anglerfish	*Lophius piscatorius*
Herring	*Clupea harengus*
Mackerel	*Scomber scombrus*
Salmon	*Salmo salar*
Cod	*Gadus morhua*
Eel	*Anguilla anguilla*
River lamprey	*Lampetra fluviatilis*
Ling	*Molva molva*
Saithe	*Pollachius virens*
Sandeels	*Ammodytes tobianus*
Sand goby	*Pomatoschistus minutus*
Sea lamprey	*Petromyzon marinus*
Sea trout	*Salmo trutta*
Smelt	*Osmerus eperlanus*
Whiting	*Merlangius merlangus*

The list of PMFs includes the migratory diadromous fish species referred to in **Section 10.5.1** as features of the River Teith SAC (i.e. river lamprey, sea lamprey and Atlantic salmon). Also included are other migratory species known to be present in the Firth of Forth, including smelt, trout and European eel, plus a number of species that are reported to have spawning and / or nursery grounds in the Firth of Forth.

10.6 Potential Impacts During Construction

10.6.1 Underwater noise

Details of elements of the proposed development that may act as a source of underwater noise are presented in **Appendices 10.1** and **10.2**. Notably, such sources would constitute:

- Piling of tubular and sheet piles, with a duration of approximately 5.5 months, with up to three piles installed per day (an average of less than 2) at a rate of two hours per pile; and,
- Dredging using a backhoe dredger for preparatory works and to deepen the outer berth pocket, with a duration of around four months.

Use of construction vessels during the construction phase would not form a significant increase in vessel activity in and around a busy working port and would not form a significant source of underwater noise disturbance.

The significance of an impact on migratory fish would be dependent on the time of year that works are undertaken; outside the migratory period, impacts are less likely to be significant than if undertaken during peak migration periods. Whilst the actual timing has yet to be determined, this assessment is based on a worst case scenario that the above works would coincide with the peak migration season for at least one of the species screened in for assessment.

Fish have a wide range of auditory capabilities, mostly in the range of 30Hz to 1kHz, and detect sound through mechanosensory organs including the otolithic organs and (for detecting nearby sounds) a lateral line system. As such, underwater sound arising from the piling and dredging is expected to fall within the hearing ranges of transitional fish species from the River Teith 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 three broad categories:

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

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 standard 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. The assessment that follows is based on the underwater noise modelling described in **Appendix 10-1**[14].

10.6.1.1 Sensitivity of species screened in for assessment

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

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. Some fish can detect sounds over a broader frequency range and at greater distances than other species due to their ability to detect sound pressure due to them having swim bladders close to the otolithic organs (i.e. the swim bladders are 'involved in hearing') (Popper *et al.* 2003). Those species are likely to modify their behaviour in response to sound exposure over a greater distance than those lacking swim bladders, or those with swim bladders not involved in hearing.

Compared to other teleost fish, salmonids (such as Atlantic salmon and sea trout) are particularly sound insensitive and lack specialist hearing mechanisms (Chapman and Hawkins, 1973; Hawkins and Johnstone, 1978). Studies on both species (e.g. Nedwell *et al*., 2003; Harding *et al.,* 2016), indicate little behavioural response to exposure to underwater noise from piling sources. While unlikely to display behavioural responses, salmonids do have a swim bladder hence may be susceptible to the adverse injurious effects of pressure changes. This is similarly true for smelt. As such, Atlantic salmon, sea trout and smelt are considered to have a **medium** sensitivity.

European eels also have a swim bladder that is not associated with hearing mechanisms; this species displays rapid behavioural recovery from anthropogenic disturbance (Bruintjes *et al*., 2016). Although previously considered to have a low sensitivity to hearing, a review by Popper and Fay (2011) indicated that this species is able to respond to sound pressure at high frequency. European eel is therefore considered to have a **medium** sensitivity.

Lamprey species are non-teleosts and do not possess a swim bladder. Although studies have indicated that there may be behavioural response to low frequency sounds (Mickle *et al.*, 2018), they are considered to have **low** sensitivity. Particle motion (vibration) effects are considered to be potentially more important to low sensitivity demersal fish, however, there is presently limited publicly available information on this issue.

10.6.1.2 Magnitude of effect

An underwater noise assessment has been undertaken for fish within the Firth of Forth based on noise modelling of both impulsive (i.e. tubular and sheet piling) and continuous (i.e. dredging) noise sources, using recognised noise threshold criteria set by Popper *et al.* (2014). The assessment is provided as **Appendix 10.2** to this HRA and is summarised here.

[14] *As a worst-case scenario, the underwater noise modelling modelled the use of a suction dredger, as this produces the highest sound levels. The modelling was also based on the assumption that all tubular piling would be installed by impact piling; however, there could be the requirement to drill piles that cannot be driven to the required depth. As drilling piles generates less noise than impact piling, the modelling has been based on the worst case scenario. Only the larger diameter piles have been included in the model as the worst case.*

While lamprey, salmonids, smelt and European eel within 50m of the piling source would be exposed to injurious noise levels from a single strike of a tubular pile, the soft start procedure would allow any individuals within this range to move to a less affected area. For cumulative exposure to repeated strikes over a working day (i.e. up to six hours), lamprey species (which lack a swim bladder) would be at risk of injury (mortal or recoverable) if stationary within 100m of the piling source throughout that period. Salmon, trout, smelt and European eel (which have a swim bladder not involved in hearing) would be at risk of injury if stationary within 190m of the piling source. There is a potential for temporary threshold shift (TTS) in all species (for up to six hours a day) at a distance of up to 1.2km from the piling source, again assuming a stationary animal. Since only mobile adults / pre-adults are likely to be present within the marine environment in the Firth of Forth, there is little to no risk of mortality, recoverable injury or significant TTS onset.

In terms of the effects on migration activity, the key migratory route is considered to be in and out of the mouth of the Firth of Forth. In the outer estuary, at the location where the piling would take place, the estuary is approximately 8km wide, which is considerably greater than the maximum impact range predicted in the modelling. 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 in fish without swim bladders and those with swim bladders that aren't involved in hearing mechanics. 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 extend significantly into the main migratory routes. Migrating individuals would not be exposed to a 'barrier' effect from considerable noise levels extending across an entire cross section of the river channel, hence migration could continue relatively unimpeded. Any individuals that may migrate along the southern edge of the Firth of Forth (and hence may encounter noise levels capable of preventing onwards movement) would be able to simply move further out into the river channel to circumnavigate through unaffected waters. Given the duration of the piling works, around 5.5 months, no more than one migration season (either upstream or downstream) is likely to be affected.

Underwater noise modelling was also undertaken for dredging, which indicated that fish would have to remain stationary for 12 hours within a range of 50m from the dredger in order to experience either recoverable injury or TTS. The impacted zone is hence considerable smaller than that predicted from piling activity and again would have no significant effect on the capability of transitional fish species, namely lamprey, salmonids, smelt and European eel, to navigate along the estuary during migration.

Based on the above, the magnitude of the impact is assessed to be **very low**, even if the piling coincides with the migration season for one or more of the species considered. As such, the overall significance of the effect on migrating fish is **minor adverse significance** for species with a swim bladder (salmonids, smelt and European eel) and **negligible significance** for species that lack a swim bladder (lamprey).

Mitigation measures and residual impact

Soft start procedures as per JNCC protocol (JNCC, 2010) would be adhered to for all within water piling activities. With this mitigation in place, the residual impact is predicted to remain of **minor adverse significance, which is not significant in EIA terms,** for salmonids, smelt and European eel, and **negligible significance, which is not significant in EIA terms,** for species that lack a lamprey.

10.6.2 Changes in water quality

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

10.6.2.1 Sensitivity of species screened in for assessment

Generally speaking, fish present in estuarine waters are anticipated to have a degree of resilience to relatively large changes in SSC due to the natural fluctuations in such environments associated with tidal activity, discharge from the river during high rainfall and increased wave action during storms. Mobile species (which, by definition, would include migratory species) are generally able to detect early onset of increased SSC and relocate away from the affected area. Nevertheless, a sediment plume creating a 'barrier' effect could cause a significant disruption to the annual migration pattern, hence such species are considered to be more sensitive than resident species. For the purpose of this assessment, it has been assumed that the programme for the dredging and / or disposal may coincide with peak migration periods, and the sensitivity of receptors, as a worst case, is considered to be **high**.

10.6.2.2 Magnitude of effect

Total dredging for the proposed development would be approximately 101,000m^3 of material; around 85% of this material would be non-erodible (i.e. glacial till, mudstone and rock). Only around 16,000m^3 of soft sediment containing fines would be dredged.

The extent of the sediment plume predicted from the proposed dredging (and subsequent disposal) is described in detail in **Chapter 8 Marine Water and Sediment Quality**. **Figure 8-3** to **Figure 8-5** presents modelled sediment plumes at different layers (surface, mid-depth and seabed), indicating the predicted maximum SSC during dredging activity. **Figure 8-9** to **Figure 8-11** presents the same during disposal at the licensed disposal site (Narrow Deep B Spoil Disposal Ground) in the Firth of Forth. Following each disposal event, SSC was predicted to disperse to baseline levels within 1.5 hours. Increases in SSC would only be experienced during the dredging and disposal campaign, hence would not affect more than one migration period for a given species.

The sediment dispersion modelling predicted that significant increases in SSC during dredging would be confined to the immediate vicinity of the dredge footprint. At a distance of more than *c.*100m from the dredging source, maximum SSC increases would be less than 20mg/l, which is irrelevant in the context of a dynamic estuarine system such as that present in the Firth of Forth. As noted, the Firth of Forth at the location of the proposed development is approximately 8km wide, hence there would be no significant obstruction or 'barrier effect' to migrating lamprey, salmonids, smelt or European eels.

Any trace contaminants disturbed during dredging would be bound to fine sediment particles hence would only be present within the sediment plume. Chemical analysis of the dredge material has been undertaken and is reported in **Section 8.5.5**. The analyses indicate that contaminant levels within the sediment are suitable for offshore disposal (as determined through comparison against Cefas action levels) and therefore would not pose a significant risk to fish.

The offshore disposal site (Narrow Deep B Spoil Disposal Ground) is a licensed site which has been used in the past for disposal of fine sediments and is located where the estuary widens (the estuary is over 12km wide at this location). Significant increase in SSC (ranging from 200mg/l to c.1,500mg/l at the point of release) would be confined within the footprint and immediate vicinity of the disposal site, with lower magnitude increases (i.e. 20 mg/l to 200mg/l) possible at distances of up to c.2km north and c.500m south of the site. Such increases are within the natural variation typically characteristic of a dynamic estuarine environment. The sediment plumes from the modelling output represent the maximum area affected over the course of the disposal campaign; it is important to note that it is highly unlikely that the entire plume would be present at any single time.

Again, given the availability of unaffected waters within the main migratory path through to the River Teith, and the fact that increases in SSC outside of the disposal site are likely to be relatively minor and in line with natural variation in a dynamic estuarine environment (and would return to baseline quickly), there would be no risk of 'barrier effect' to migrating fish, and the magnitude of effect is considered to be **very low**. As such, the overall significance of the effect on migrating fish is assessed to be **minor adverse significant**.

Mitigation measures and residual impact
No mitigation is required and as such the residual impact is of **minor adverse significance, which is not significant in EIA terms**.

10.6.3 Changes in habitat availability

In terms of physical loss of habitat used by fish, this would constitute a small area of *c.*1.8ha subtidal habitat where the existing berth pocket at the entrance to the Port would be enlarged and deepened during the dredging component of the proposed development (i.e. Area 4 in **Figure 1-1**).

The area of subtidal habitat (1.8ha) physically lost as a result of the dredging is infinitesimal in the context of available subtidal habitat within the wider Firth of Forth. Furthermore, the majority of this area is within the existing Approach Channel that is regularly dredged. The impact of habitat loss at this scale would therefore have no measurable effect on fish and shellfish species.

In addition to physical loss of habitat, suspension and transportation of fine sediment during dredge / disposal activities would result in subsequent deposition as sediment settles back out of the water column. Significant levels of sediment deposition on benthic habitat may lead to 'loss' or change in the composition of supporting habitat. As explained in **Section 9.6.3**, the potential impact to benthic habitats is considered to be negligible.

As such, the significance of the effect on fish and shellfish would be **minor adverse significance**, at worst.

Mitigation measures and residual impact
No mitigation is required and as such the residual impact is of **minor adverse significance, which is not significant in EIA terms**.

10.7 Potential Impacts During Operation

There would not be any significant change, through operation, compared to the existing activity levels (for example, in terms of vessel traffic in and out of the busy port); therefore, there would not be any potential to impact fish and shellfish ecology during the operational phase.

10.8 Summary of potential impacts on fish and shellfish ecology

Table 10-2 summarises the significance of the potential impacts on fish and shellfish receptors assessed in this chapter. Negligible and minor adverse impacts are not significant in EIA terms.

Table 10-2 Summary of potential impacts to fish and shellfish ecology

Effect	Receptor	Magnitude	Impact significance	Mitigation proposed	Residual impact
Construction phase					
Underwater noise	Migratory fish (salmon, trout, European eel)	Low	Minor adverse	Soft start procedures as per JNCC protocol (JNCC, 2010).	Minor adverse
	Migratory fish (sea lamprey and river lamprey)	Low	Negligible		Negligible
Changes in water quality	All fish	Low	Minor adverse	None required.	Minor adverse
Changes in habitat availability	All fish and shellfish	Low	Minor adverse	None required.	Minor adverse

11 Ornithology

11.1 Introduction

This chapter of the EIA Report considers the potential impacts of the proposed development on estuarine bird populations in the Firth of Forth.

It provides a summary of the ornithology baseline conditions of the proposed development site and surrounding environs, based on project specific baseline surveys and publicly available information. This is followed by identification of the potential impacts of the proposed development on ornithological receptors during the construction and operational phases, and an assessment of the magnitude and significance of the effects as a consequence of these impacts. The mitigation measures required to prevent, reduce or off-set any significant adverse effects are presented together with the likely residual effects after such measures have been adopted.

This chapter is supported by the following technical appendix:

- **Appendix 11-1** – Port of Leith Bird Surveys 2021/22: Survey Report, which provides species-specific information on the distribution and abundance of estuarine bird species in the port and surrounding environs.

11.2 Legislation, Policy and Guidance

11.2.1 Legislation

11.2.1.1 Council Directive 2009/147/EC on the Conservation of Wild Birds ('the Birds Directive')

The Birds Directive, first passed in 1979 (79/409/EEC) and codified in 2009, provides a 'General System of Protection' for all species of naturally-occurring wild birds in the UK. The Directive provisions the identification and classification of SPAs for significant populations of rare or vulnerable species (listed in Annex I of the Directive) and regularly occurring migratory species (required by Article 4 of the Directive). Article 5 of the Directive establishes a general scheme of protection for all wild birds.

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 and are transposed into Scottish law by the Conservation (Natural Habitats, &c.) Regulations 1994 and Section 1 of the Wildlife and Countryside Act 1981 (see below).

11.2.1.2 Conservation (Natural Habitats, &c.) Regulations 1994 (as amended) ('the Habitats Regulations')

The Habitats Regulations transpose Council Directive 92/43/EEC ('the Habitats Directive') into Scottish national law. The Regulations require competent authorities to consider or review planning permission, applied for or granted, affecting nature conservation designations within the UK's National Site Network – including SPAs and (as a matter of policy) Ramsar Sites – and, subject to certain exceptions, restrict or revoke permission where the integrity of the site would be adversely affected. Details on the sites within the National Site Network that have ornithological interest and may be affected by the proposed development are provided in **Section 11.5.1**.

11.2.1.3 Wildlife and Countryside Act 1981 (as amended) (includes amendments made via the Wildlife and Natural Environment (Scotland) Act 2011)

This Act codifies the Birds Directive into UK law and is the principal mechanism for statutory protection of wildlife in the UK. Section 1 of the Act provides protection for all species of wild birds and their nests. With exception to species listed in Schedule 2 of the Act, and with additional penalties for species listed in Schedule 1, Section 1 of the Act makes it an offence to intentionally or recklessly:

- kill, injure, or take any wild bird;
- take, damage or destroy the nest of any wild bird while that nest is in use or being built;
- take or destroy an egg of any wild bird;
- disturb any wild bird listed in Schedule 1 whilst it is building a nest or is in, on or near a nest containing eggs or young; and,
- disturb the dependent young of any wild bird listed in Schedule 1.

The Act also makes provision for the notification and confirmation of SSSIs.

11.2.1.4 Nature Conservation (Scotland) Act 2004

The Nature Conservation (Scotland) Act 2004 places duties on public bodies to further the conservation of biodiversity, increases protection for SSSIs (above that set out in the Wildlife and Countryside Act 1981), amends legislation on Nature Conservation Orders, provides for Land Management Orders for SSSIs and associated land and strengthens wildlife enforcement legislation (to include ‘reckless’ acts).

11.2.2 Policies and Plans

11.2.2.1 Scotland’s National Marine Plan

General policy ‘GEN 9: Natural Heritage’ of the Scotland’s NMP focuses on the achievement of the objective ‘living within environmental limits’ by ensuring that development and use of the marine environment must, *inter alia*:

- Comply with legal requirements for protected areas and species; and,
- Protect and, where appropriate, enhance the health of the marine area.

In adherence to this policy, marine planners and other decision makers should act in the way best calculated to further the achievement of sustainable development, including the protection of the health of the marine area. The Strategy for Marine Nature Conservation in Scotland’s Seas sets out aims and objectives to achieve this. The Strategy outlines a three-pillar approach to conservation:

- Site protection: plans or projects may only be approved if they will not have a significant effect on the site integrity of SPAs (and SAC), Ramsar Sites and SSSIs.
- Species protection: if there is evidence to suggest that a protected species may be affected by a proposed development, the protection afforded by legislation (such as the Wildlife and Countryside Act 1981) must be factored into the planning and design of the development and impacts fully considered.
- Wider seas measures: consideration must be given to Priority Marine Features in marine planning (though this does not include wild birds species).

11.2.2.2 Edinburgh Biodiversity Action Plan

The UK generated the UK BAP in response to the Convention on Biological Diversity from the Rio summit in 1992. Local BAPs were adopted at the county level to generate action on the ground and help meet UK targets. The fifth edition of the Edinburgh BAP (covering 2019-2021) is the most recent BAP in and around the city. Amongst other aims and actions, the Edinburgh BAP sets out the continued role of decision makers and statutory / non-statutory advisors in providing advice on all casework and licences affecting the Firth of Forth SPA and other protected sites in order to develop green and blue networks.

11.2.3 Best Practice and Guidance

The impact assessment has been based upon the guidance provided in the CIEEM (2018) *Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine.*

11.3 Consultation

11.3.1 Screening Opinion

In their advice to Marine Scotland with regard to EIA screening, NatureScot outlined the fact that the EIA should have focus on the potential ornithological impacts that may arise due to effects on Firth of Forth SPA / Ramsar Site and other SPAs within the zone of influence of the proposed development (**Appendix 1-3**).

11.3.2 Consultation with NatureScot regarding Surveys

Prior to commencement of the baseline bird surveys of the Port and surrounding area, the scope and methodology for the surveys, including the study area, was agreed with NatureScot on the understanding that the surveys would provide sufficient baseline information to inform this EIA and the corresponding HRA (see **Section 6.2.2**).

11.4 Assessment Methodology

11.4.1 Baseline Data Sources

Project-specific baseline bird surveys (detailed in **Appendix 11-1**) have been used to describe the baseline ornithological environment within the ornithological study area (described in **Section 11.4.2**) and inform the subsequent assessment on ornithological receptors. Other sources of data that were used in describing the baseline include:

- SPA site citations for Forth Islands SPA (NatureScot, 2018a), Firth of Forth SPA (NatureScot, 2018b), Outer Firth of Forth and St Andrew's Bay Complex (OFFSABC) SPA (NatureScot, 2020) and Imperial Dock Lock, Leith SPA (SNH, 2004);
- Ramsar Site Information Sheet for Firth of Forth Ramsar Site (JNCC, 2005);
- NatureScot's '*SiteLink*' Protected Areas portal[15];
- Marine Scotland's National Marine Planning interactive (NMPi) tool[16];
- British Trust for Ornithology (BTO) Wetland Bird Survey (WeBS) core count data for sectors 83440 (Water of Leith – Ocean Drive Bridge to Western Harbour) and 83441 (Seafield to Eastern Breakwater), 2018/19 to 2019/20;
- JNCC's Seabird Monitoring Programme (JNCC, 2022), a collaborative database of seabird breeding activity which includes nest counts at the Imperial Dock Lock, Leith SPA;
- Scottish Natural Heritage's (now NatureScot) *Habitats Regulations Appraisal (HRA) on the Firth of Forth: A Guide for developers and regulators* (SNH, 2016); and,
- Birds of Conservation Concern 5 (BoCC5) (Stanbury *et al*., 2021).

[15] https://sitelink.nature.scot/home
[16] https://marinescotland.atkinsgeospatial.com/nmpi/

11.4.2 Baseline Bird Survey Methods

11.4.2.1 Survey Objectives

Baseline ornithology at the Port of Leith has been characterised through estuarine bird surveys of the port and surrounding marine and coastal areas. There were three elements to the surveys:

- Twice-monthly estuarine bird counts within the impounded dock system and nearby coastal / offshore locations;
- Twice-monthly common tern colony counts, undertaken from May to July 2021 (inclusive), denoting the number of Apparently Occupied Nests (AON) at Imperial Dock Lock, Leith SPA; and,
- Twice-monthly common tern flight behaviour surveys at the SPA colony, which were undertaken from May to July 2021 (inclusive).

The objective of the baseline estuarine bird survey was to provide baseline information on the number and distribution of coastal and marine bird species that use the Port of Leith and adjacent coastal, nearshore and offshore areas. The objective of the tern survey was to determine the level and nature of activity at the SPA colony during the breeding season.

11.4.2.2 Survey Fieldwork Methodology

The full methodology for the surveys is described in **Appendix 11.1**. As noted in **Section 11.3.2**, the scope and methodology for the surveys, including the study area, was agreed with NatureScot with the aim of providing sufficient baseline information to inform the assessment.

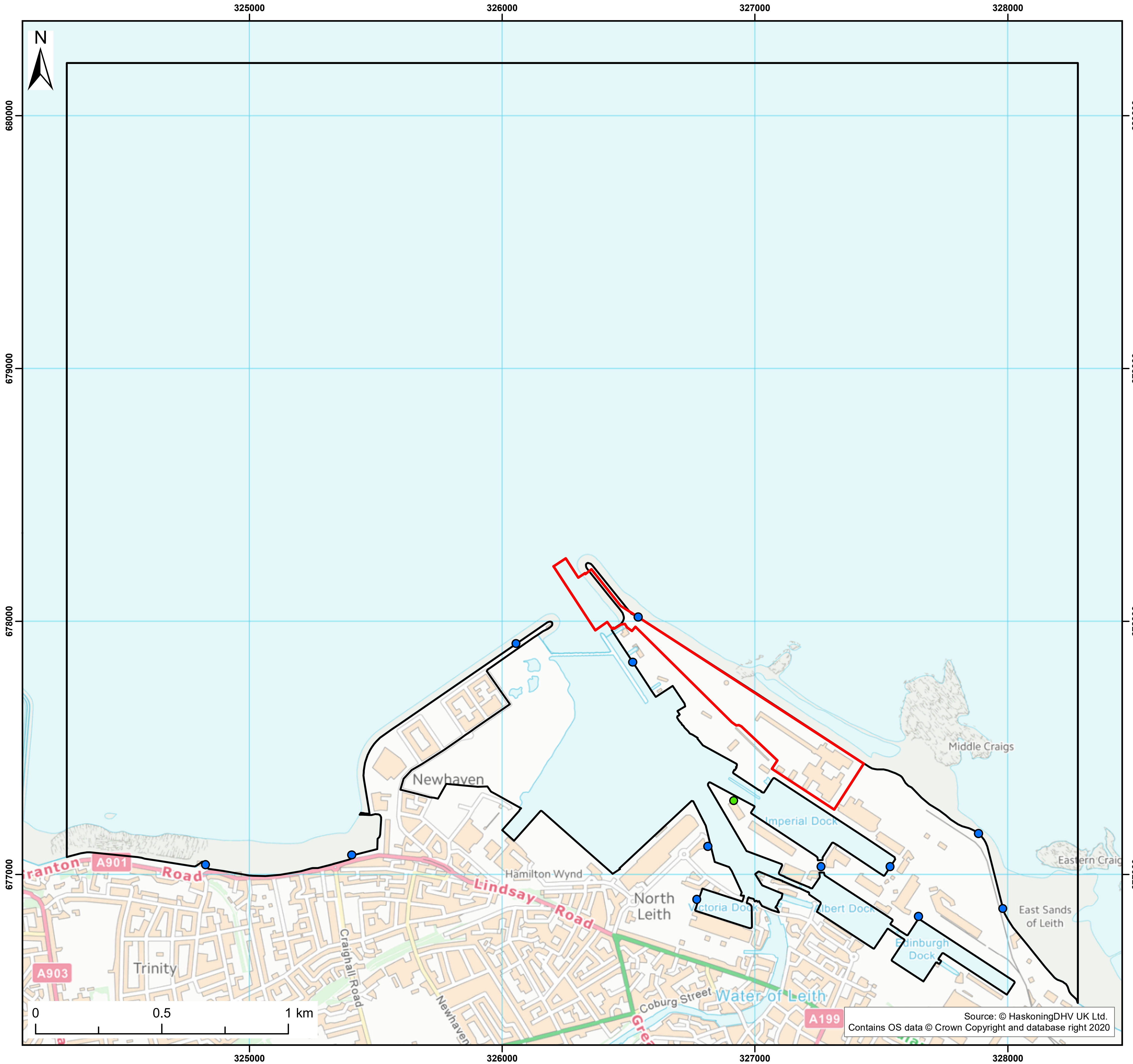
The ornithological study area, presented in **Figure 11-1**, extends 2km to the east and west of proposed development and 2km offshore. The study area was identified to include areas from which estuarine birds may be disturbed due to construction works during the proposed development, plus adjacent areas where disturbed birds may relocate.

Two survey visits were scheduled each month, from March 2021 to February 2022 inclusive, with both low tide (+/- 3 hrs) and high tide (+/- 3 hrs) counts undertaken during each visit. In addition, Forth Ports Limited commissioned an additional single survey in March 2022 which, although above and beyond the scope agreed with NatureScot, provides data from a full, continuous overwintering season (classed as October to March, inclusive).

Count methods were based on the BTO WeBS core (high tide) and low tide count methodology (Bibby *et al.*, 2000). Birds were viewed with the assistance of binoculars and a spotting scope from strategically positioned Vantage Points (VPs), shown in **Figure 11-1**, which together gave a sufficient view over the entire study area. During each count, estuarine birds within the study area were counted from each VP and their positions and behaviour marked on field maps using standard BTO two-letter codes.

Tern colony counts were undertaken from a VP overlooking the colony using the Census Method One ('Count of Apparently Incubating Adults') for tern species, taken from JNCC's *Seabird Monitoring Handbook* (Walsh *et al.*, 1995).

A generally established protocol for tern flight surveys was not available at the time of undertaking; however, it was agreed with NatureScot that a methodology employed for common tern flight surveys undertaken at the Port in 2008-10 (Jennings, 2012) was appropriate. The study area was divided into four sectors and the surveyor undertook 20-minute counts (per sector), twice per month, of common tern flights heading both towards (inbound) and away from (outbound) the colony. Flight heights were recorded in the categories 0-5m, 5-10m, 10-20m and 20m+.



Legend:

- Red Line Boundary
- Survey Area
- Estuarine Bird Survey VP
- Tern Colony Survey VP

Client:	Project:
Forth Ports Limited	Port of Leith - Outer Berth

Title:

2021/22 Estuarine Bird Survey Area

Figure: 11.1 | Drawing No: PC2045-RHD-ZZ-ZZ-DR-EV-0016

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
01	03/03/2022	FC	BH	A3	1:15,000

Co-ordinate system: British National Grid

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11.4.3 Assessing noise disturbance levels

The assessment of effects on ornithological receptors includes consideration of the impacts of noise during the construction phase of the proposed development. A distinction has been made between ‘continuous’ noise levels (L_{Aeq}) and maximum (impulsive) noise levels (L_{Amax}) when considering noise disturbance effects on birds. Impulsive noises are the most likely to cause disturbance reactions in birds, particularly ‘irregular’ impulsive noises (for example, impact piling or explosion) (Cutts *et al.,* 2009 and 2013). The most likely cause of disturbance to birds using the study area would be impulsive noise from impact pile driving; construction-specific impulsive noise impacts are therefore the focus of the assessment. Sources of non-impulsive noise (e.g. noise associated with machinery, plant and vessel use), and even occasional ‘irregular’ impulsive noises caused by e.g. dropped items, would be synonymous with existing general port activity and would not represent a significant departure from baseline noise.

The L_{Amax} noise level predictions presented in this chapter have been undertaken using a 3-D model of the site and surroundings, created in 3-D noise modelling software SoundPLAN (v8.2). The software implements a range of accepted prediction methodologies. It includes topographical data, the height and location of nearby buildings and acoustic absorption characteristics of the ground. All predictions are at 1.5m above ground level.

The baseline L_{Amax} noise levels have been based on measured noise level data taken from the Western Harbour Development Noise Impact Assessment – Rev 00 by New Acoustics (Feb 2019). Measurements of a “Large crane moving large pieces of broken ship @ 30m” were used to determine the octave band sound power levels of this activity in terms of the L_{Aeq}. The applicable L_{Amax} was identified based on the difference between the L_{Aeq} and the L_{Amax} observed in the measured levels for loading large pipes onto lorries via mobile forklift, as reported in the Aberdeen Harbour Expansion Project Appendix 20-D Operational Noise Level Calculations (November 2015). The sound has been assumed to be emitted by a point source at 2m above ground level. The prediction methodology used is that specified in ISO 9613-2:1996 ‘Acoustics — Attenuation of sound during propagation outdoors — Part 2: General method of calculation’.

The L_{Amax} noise levels likely to be emitted by a tubular impact piling have been based on noise level data taken from the Federal Highway Administration Highway Construction Noise Handbook. The sound has been assumed to be emitted by a point source at 10m above sea level. The predictions have been undertaken in octave bands based on a typical L_{max} frequency spectrum for hydraulic impact piling, taken from the SoundPLAN library which specifies the data source as Taschenbuch der Technischen Akustik, 1994. The prediction methodology used is that specified in British Standard 5228-1+A1:2014 ‘Code of practice for noise and vibration control on construction and open sites – Part 1: Noise’.

BS5228-1 states that *‘at distances over 300m noise predictions have to be treated with caution…because of the increasing importance of meteorological effects*’. However, it should be noted that the above method provides a conservative prediction of L_{Amax} levels; in reality, levels may be as much as 10 dB lower than estimated, hence the predicted levels are likely to account for any meteorological variation. The 3-D model set up is focused on the port estate and the eastern half of the ornithological study area, as this is where topographical and building height data was available. Offshore noise level predictions are limited due to the variable influence of external factors (e.g. meteorology and sea state). Nevertheless, given that the key ornithological sensitivities (outlined later in this chapter) are all within the port itself, or along the shoreline to the east, this model set up is appropriate.

11.4.4 Impact Assessment methodology

11.4.4.1 Sensitivity of ornithological receptors

For ornithological receptors, sensitivity is dependent on the factors set out in **Section 5.5** (i.e. it based on the tolerance, adaptability and recoverability of the receptor). **Table 5-2**, which defines sensitivity levels for a generic receptor, is applicable for ornithological receptors.

In considering ornithological sensitivity, it is important to note that sensitivity is a characteristic of the receptor population, not individual birds that make up that population. Receptor populations that are of high conservation value are likely to have higher sensitivity (due to lower tolerance and recoverability) than those that are of lower conservation value.

Assigning nature conservation value to ornithological receptors

Nature conservation value (also referred to in the CIEEM guidelines as nature conservation importance) is a measure of the conservation value of a species potentially affected by the proposed development and has been used as an adjusting factor in determining the overall receptor sensitivity. The nature conservation value of ornithology receptors is defined as per the criteria set out in **Table 11-1**. Species on the BoCC5 red list (Stanbury *et al.,* 2021) are considered to have the greatest value, as these are species that, on a national or even international scale, have shown declining population and distribution trends. Species that are recognised as features of conservation interest through the provision of enhanced legal protection are also considered to be of comparatively high value.

Table 11-1 Definitions of nature conservation value for ornithological receptors

Value	Definition
High	• Species listed in the BoCC5 red list (Stanbury *et al*., 2021).
Medium	• Species listed in the BoCC5 amber or green list (Stanbury *et al*., 2021) that qualify as SPA features listed in one or more of the following: • Annex I of the Birds Directive; and, • Schedule 1 to the Wildlife and Countryside Act 1981.
Low	• All other SPA features and / or BoCC5 amber list species.
Very low	• All other species.

11.4.4.2 Assigning spatial magnitude to impacts on receptor populations

Determination of spatial magnitude requires that a species receptor population is appropriately defined (CIEEM, 2018). For the purpose of this assessment, regional populations across the Firth of Forth are considered to be appropriate receptor populations.

For waterbird species, regional receptor populations used are one or both of the following:

- The latest WeBS five-year mean peak counts (2015/16 to 2019/20) from the 'Forth Estuary' site; and,
- SPA populations as per the relevant citations (NatureScot, 2018a, 2018b and 2020) or the abundance figures presented in NatureScot's (then Scottish Natural Heritage) *Habitats Regulations Appraisal (HRA) on the Firth of Forth: A Guide for developers and regulators* (SNH, 2016).

WeBS data tend not to include counts (or have only partial counts) of seabirds (including gulls and terns), hence for these species the reference SPA populations are herein applied as the regional receptor populations.

Spatial magnitude is considered in terms of the proportion of the receptor population that may be affected by a given impact and is classified into the four categories defined in **Table 11-2**. In some instances, mitigating circumstances (such as the seasonality of peak counts, or the documented distribution of a given species within the Firth of Forth) have been used in concluding the spatial magnitude of an effect.

Table 11-2 Definitions of spatial magnitude of impacts on ornithological receptor populations

Impact magnitude	Definition
High	Effect may lead to a major reduction in the abundance and status of the receptor population (i.e. >20% of the population is affected).
Medium	Effect may lead to a moderate reduction in the abundance and status of the receptor population (i.e. 5-20% of the population is affected).
Low	Effect may lead to a small but discernible reduction in the abundance and status of the receptor population (i.e. 1-5% of the population is affected).
Negligible	Effect would lead to no or indiscernible reduction in the abundance and status of the receptor population (i.e. less than 1% of the population is affected).

11.4.4.3 Assigning temporal magnitude

Temporal magnitude has been categorised according to whether a given impact is judged to be short term, medium term or long term, and whether it is considered to be temporary (reversible) or permanent (irreversible). For ornithology receptors the following definitions have been used to guide the categorisation of temporal magnitude:

- Short term: effects which occur for <1 year over a maximum of one breeding and / or non-breeding season;
- Medium term: effects which occur over 1 to 5 years; and,
- Long term: effects which occur for >5 years.

11.4.4.4 Impact significance

Following determination of receptor sensitivity / value and the magnitude of a given effect, the significance of the impact (and residual impact if mitigation measures are to be implemented) has been determined as outlined in **Section 5.5.3.3**.

11.5 Baseline Environment

11.5.1 Designated Sites

The proposed development and wider Port area overlaps with, or is in close proximity to, a number of nature conservation designations of ornithological interest, as shown in **Figure 9-1**.

The Imperial Dock Lock, Leith SPA (UK9004451) is located within the impounded dock system, *c.*100m from the laydown area element of the proposed development. It is part of the UK site network, protected for the purpose of nature conservation under the Habitats Regulations and designated due to a nationally important population of breeding common tern on the dockside.

In addition, the proposed development is located adjacent to the Firth of Forth SPA (UK9004411) and Ramsar Site (UK13017) and partially overlaps the Outer Firth of Forth and St Andrews Bay Complex (OFFSABC) SPA (UK9020316). The Firth of Forth SPA, underpinned in coastal areas by the Firth of Forth SSSI and covering an area of *c.*6,320ha (of which 95.4% is marine), was designated in 2010 to protect coastal / intertidal foraging / roosting grounds of non-breeding waterbirds. The OFFSABC SPA, covering an area of *c.*272,000ha across the Firths of Forth and Tay, is a marine protected area designated in 2020 to protect the marine areas used by non-breeding waterbirds and both breeding and non-breeding seabirds.

The proposed development is also approximately 3.5km, at the nearest point, from the Forth Islands SPA (UK9004171), a breeding seabird colony SPA. This SPA is designated for the breeding populations of seabirds on the islands of Inchmickery, Isle of May, Fidra, The Lamb, Craigleith, Long Craig and Bass Rock.

Details of the qualifying features of the above sites are described in **Table 11-3**.

Table 11-3 Qualifying ornithological features of nature conservation designations

Designation	Features
Imperial Dock Lock, Leith SPA (Scottish Natural Heritage, 2004)	**The site qualifies under Article 4.1 of the Wild Birds Directive** as it is used regularly by 1% or more of the GB populations of the following species listed in Annex I in any seaso*n:* • Breeding common tern *Sterna hirundo*.
Forth Islands SPA (NatureScot, 2018a)	**The site qualifies under Article 4.1 of the Wild Birds Directive** as it is used regularly by 1% or more of the GB populations of the following species listed in Annex I: • Breeding Sandwich tern *Sterna sandvicensis*, roseate tern *Sterna dougallii*, common tern and Arctic tern *Sterna paradisaea*. **The site qualifies under Article 4.2 of the Wild Birds Directive** as it is used regularly by 1% or more of the biogeographical populations of the following migratory species: • Breeding lesser black-backed gull *Larus fuscus*, puffin *Fratercula arctica*, gannet *Morus bassanus* and shag *Phalacrocorax aristotelis*. **The site qualifies under Article 4.2** as it is used regularly by more than 20,000 seabirds in the breeding season. The main components of the assemblage include the species listed above, plus nationally important populations of kittiwake *Rissa tridactyla*, herring gull *Larus argentatus*, guillemot *Uria aalge*, razorbill *Alca torda* and cormorant *Phalacrocorax carbo*.
Firth of Forth SPA (NatureScot, 2018b)	**The site qualifies under Article 4.1 of the Wild Birds Directive** as it is used regularly by 1% or more of the Great Britain populations of the following species listed in Annex I in any season: • Non-breeding red throated diver *Gavia stellata*, Slavonian grebe *Podiceps 119enelop*, golden plover *Pluvialis apricaria* and bar-tailed godwit *Limosa lapponica;* and, • Passage Sandwich tern. **The site qualifies under Article 4.2 of the Wild Birds Directive** as it is used regularly by 1% or more of the biogeographical populations of the following migratory species (other than those listed in Annex I)*:* • Non-breeding pink-footed goose *119enelo brachyrhynchus*, shelduck *Tadorna tadorna*, knot *Calidris canutus*, redshank *Tringa 119enelop* and turnstone *Arenaria interpres.* **The site qualifies under Article 4.2** as it used regularly by 95,000 waterbirds in the non-breeding season. The main components of the assemblage include the species listed above, plus nationally important populations of: great crested grebe *Podiceps cristatus*, cormorant*,* mallard *Anas platyrhynchos*, wigeon *Anas 119enelope*, scaup *Aythya marila*, eider *Somateria mollissima*, common scoter *Melanitta nigra*, velvet scoter *Melanitta fusca*, long-tailed duck *Clangula hyemalis*, goldeneye *Bucephala clangula*, red-breasted merganser *Mergus serrator*, oystercatcher *Haematopus ostralegus*, ringed plover *Charadrius hiaticula*, grey plover *Pluvialis squatarola*, lapwing *Vanellus vanellus*, dunlin *Calidris alpina alpina* and curlew *Numenius arquata*.
Firth of Forth Ramsar Site	**The site qualifies under Ramsar Criterion 4** by supporting the following waterbird species at a critical stage in their life cycles: • Scaup, great crested grebe, cormorant, curlew, eider, long-tailed duck, common scoter, velvet scoter, red-breasted merganser, oystercatcher, ringed plover, grey plover and dunlin. **The site qualifies under Ramsar Criterion 5** by regularly supporting waterbirds in numbers of 20,000 individuals or more.

Designation	Features
	The site qualifies under Ramsar Criterion 6 by regularly supporting 1% or more of the individuals in a population of waterbirds: • Slavonian grebe, pink-footed goose, shelduck, knot, redshank, turnstone, goldeneye, bar-tailed godwit and Sandwich tern.
OFFSABC SPA (NatureScot, 2020)	**The site qualifies under Article 4.1 of the Wild Birds Directive** as *it is used regularly by 1% or more of the Great Britain populations of the following species listed in Annex I in any season:* • Non-breeding red throated diver, Slavonian grebe and little gull *Hydrocoloeus minutus*; and, • Breeding common tern and Arctic tern. **The site qualifies under Article 4.2 of the Wild Birds Directive** *as it is used regularly by 1% or more of the biogeographical populations of the following migratory species (other than those listed in Annex I):* • Non-breeding eider; and • Breeding shag and gannet. **The site qualifies under Article 4.2** as it used regularly by more than 20,000 waterbirds in the non-breeding season. The main components of the assemblage include nationally important populations of common scoter, velvet scoter, long-tailed duck, goldeneye and red-breasted merganser. **The site qualifies under Article 4.2** as it used regularly by more than 20,000 seabirds in the non-breeding season. The main components of the assemblage include nationally important populations of black-headed gull *Chroicocephalus ridibundus*, common gull *Larus canus*, herring gull, kittiwake, guillemot and razorbill. **The site qualifies under Article 4.2** as it used regularly by more than 20,000 seabirds in the breeding season. The main components of the assemblage include nationally important populations of Manx shearwater *Puffinus puffinus*, herring gull, kittiwake, puffin and guillemot.

11.6 Baseline Estuarine Bird Survey

11.6.1.1 Survey Overview

The 2021/22 baseline estuarine bird survey showed that the study area supports a fairly wide variety of estuarine birdlife throughout the year, with the habitats present in the study area providing opportunities for foraging and resting (i.e. loafing and / or roosting). The variety, abundance and seasonal occurrence of all the bird species seen were in line with expectations based on published literature and experience. A brief summary of the survey results is provided here, with a full survey report provided as **Appendix 11-1**.

Over the course of the 24 survey visits, a total of 43 estuarine bird species were recorded interacting directly with the study area (i.e. they used the study area for foraging / roosting / loafing, as opposed to commuting through the study area without stopping). Species recorded included:

- 18 seabird species (i.e. gulls, terns, auks, skuas, gannet, cormorants, fulmar and divers);
- 14 waterfowl species (i.e. ducks and swans plus – for the purpose of this summary – grebes and herons); and,
- 11 wader species.

Table 11-4 presents the peak high tide and low tide counts of estuarine species recorded across the whole of the study area. **Appendix 11-1** provides further detail on the distribution of counts in different parts of the study area.

Table 11-4 Low tide and high tide peak counts during the 2021/22 baseline estuarine bird survey

Species[1]		Low tide (+/- 3 hr.)		High tide (+/- 3 hr.)	
		Peak count	Month	Peak count	Month
Seabirds					
Common tern	*Sterna hirundo*	839	Aug.	c.2,000	May
Black-headed gull	*Chroicocephalus ridibundus*	1,177	Nov.	1,534	Nov.
Herring gull	*Larus argentatus*	1,303	Sep.	1,108	Sep.
Guillemot	*Uria aalge*	995	Sep.	826	Sep.
Lesser black-backed gull	*Larus fuscus*	523	Sep.	441	Aug.
Razorbill	*Alca torda*	200	Aug.	209	Aug.
Cormorant	*Phalacrocorax carbo*	141	Sep.	139	Sep.
Sandwich tern	*Sterna sandvicensis*	69	Sep.	84	Aug.
Great black-backed gull	*Larus marinus*	72	Dec.	70	Dec.
Kittiwake	*Rissa tridactyla*	52	Sep.	57	Sep.
Shag	*Phalacrocorax aristotelis*	53	Sep.	28	Sep.
Gannet	*Morus bassanus*	48	Sep.	6	Apr.
Common gull	*Larus canus*	27	Apr.	8	Sep.
Puffin	*Fratercula arctica*	3	May	3	Jul.
Fulmar	*Fulmarus glacialis*	3	Jan.	3	Apr.
Red-throated diver	*Gavia stellata*	2	May	2	Nov.
Roseate tern	*Sterna dougallii*	0	-	1	May
Arctic skua	*Stercorarius parasiticus*	1	Oct.	0	-
Waterfowl					
Eider	*Somateria mollissima*	651	Jun.	976	Aug.
Goldeneye	*Bucephala clangula*	268	Jan.	413	Jan.
Mallard	*Anas platyrhynchos*	81	Nov.	71	Oct.
Red-breasted merganser	*Mergus serrator*	38	Mar.	17	Mar.
Velvet scoter	*Melanitta fusca*	27	Mar.	10	Mar.
Common scoter	*Melanitta nigra*	22	Aug.	0	-
Mute swan	*Cygnus olor*	8	Dec.; Jan.	17	Jan.
Goosander	*Mergus merganser*	12	Sep.	10	Sep.
Shelduck	*Tadorna tadorna*	3	May	4	Feb.
Teal	*Anas crecca*	3	Dec.	2	Jan.
Grey heron	*Ardea cinerea*	3	Oct.	2	Nov.; Dec.
Great crested grebe	*Podiceps cristatus*	2	May	2	Jan.
Surf scoter	*Melanitta perspicallata*	0	-	1	Apr.
Long-tailed duck	*Clangula hyemalis*	1	Jan.	0	-

Species[1]		Low tide (+/- 3 hr.)		High tide (+/- 3 hr.)	
		Peak count	Month	Peak count	Month
Waders					
Oystercatcher	*Haematopus ostralegus*	284	Mar.	289	Nov.
Dunlin	*Calidris alpina*	270	Nov.	136	Nov.
Redshank	*Tringa totanus*	146	Dec.	192	Nov.
Knot	*Calidris canutus*	48	Mar.	47	Dec.
Turnstone	*Arenaria interpres*	26	Dec.	43	Jan.
Ringed plover	*Charadrius hiaticula*	24	Sep.	35	Sep.
Bar-tailed godwit	*Limosa lapponica*	13	Jan.	27	Apr.
Curlew	*Numenius arquata*	12	Jul.	10	Apr.
Sanderling	*Calidris alba*	2	Jul.	10	Dec.
Purple sandpiper	*Calidris maritima*	2	Mar.	4	Mar.
Common sandpiper	*Actitis hypoleucos*	2	Jul.	2	Jul.
[1]Species in bold are qualifying SPA / Ramsar Site / SSSI features or are features of qualifying assemblages					

The most numerous species recorded was common tern, which is unsurprising given the presence of the active breeding colony within the study area at Imperial Dock Lock, Leith SPA. Other abundant species recorded included gull species (notably black-headed gull and herring gull), eider and, during the post-migration breeding period, auks (particularly guillemot). Oystercatcher was the most abundant wader species recorded in the study area.

Most species of seabird were recorded offshore or nearshore; however, some of the more frequent species – particularly common tern, black-headed gull, herring gull and lesser black-backed gull – were recorded loafing or roosting in large numbers at the shore and / or within the Port estate itself. Small numbers of auks were recorded loafing in the impounded dock system, though most were recorded offshore.

Waterfowl were recorded across the study area, with most sea ducks (e.g. scoters, sawbills and long-tailed ducks) generally recorded in nearshore or offshore areas and mallards, teal and mute swans recorded in the impounded dock system or on the three small scrapes to the west of the Port (near to the West Breakwater lighthouse). Eider and goldeneye were recorded both in marine areas and within the dock system, particularly the latter which was present within the dock system in relatively large numbers during winter months.

Wading birds were generally recorded along the beach to the east of the port, with smaller numbers using the foreshore in the west of the study area.

Of the species recorded in the study area, 32 are species for which regional numbers (i.e. the wider Firth of Forth populations) are nationally or internationally important and hence are features of the nature conservation designations outlined in **Section 11.5.1**. A full, detailed account for all SPA / Ramsar Site / SSSI features, including distribution maps for features present in notable numbers, is provided in **Appendix 11.1**. Non-SPA species were generally only present in low numbers.

11.6.1.2 Habitats Observed during Baseline Surveys

From an ornithological perspective, the study area provides a range of habitats of value to estuarine bird species. In the western part of the study area (i.e. around Newhaven foreshore and along the West Breakwater), potential habitats that may be utilised by estuarine birds include:

- A man-made promenade and breakwater, with amenity grassland;
- Seawall and revetment, with algal growth at lower elevations;
- Newhaven harbour, a fishing port / marina with quaysides;
- A brownfield area of ruderal vegetation / grassland, with scrub in places and an area of demolition, to the west of the Western Harbour;
- A brownfield area with three small scrapes to the west of the Port Entrance Basin, earmarked for residential development; and,
- Intertidal soft sediment (sand and mud), with intertidal rocky outcrops (some of which are algal-covered) and rock pools.

In the eastern part of the study area (i.e. the coastline along the north / east side of the Port, towards Portobello), potential habitats include:

- Intertidal soft sediment (sand and mud) with intertidal rocky outcrops (some of which are algal-covered and some of which are partly exposed even at high tide) and rock pools;
- Sandy beach;
- A man-made East Breakwater; and,
- Hardstanding at the Port boundary at the crest of the beach.

Within the Port estate and impounded dock system, potential habitats include:

- Quaysides, docks and laydown areas;
- Port buildings; and,
- Saltwater impounded docks, with throughput from the Water of Leith.

In addition, the offshore part of the study area provides shallow subtidal estuarine areas for foraging and / or loafing, with deeper areas within the maintained approaches to the port.

11.6.1.3 Regional Context of Numbers Recorded in the Baseline Survey

Table 11-5 indicates the relative importance of the study area in the context of regional reference populations. The table excludes species that were present in numbers of no regional importance (i.e. species that were present in numbers that represented less than 1% of regional totals and are deemed to be of local importance only).

The importance of the study area (in a regional context) is categorised as ‘low’ if the peak count during the survey represents between 1% and 5% of the reference population, ‘moderate’ if it represents between 5% and 20% of the regional population and ‘high’ if it represents more than 20%. In some instances, mitigating circumstances (such as the seasonality of peak counts, or the documented distribution of a given species within the Firth of Forth) has been used in concluding the level of regional importance (see species-specific accounts in **Appendix 11-1**).

For waterfowl and wader species, regional reference populations comprise one or both of the following:

- The latest WeBS five-year mean peaks from the 'Forth Estuary' site; and,
- SPA populations as per the relevant citations (NatureScot, 2018a, 2018b and 2020) or the abundance figures presented in NatureScot's (then Scottish Natural Heritage) *Habitats Regulations Appraisal (HRA) on the Firth of Forth: A Guide for developers and regulators* (SNH, 2016).

WeBS data tend not to include counts (or have only partial counts) of seabirds (including gulls and terns), hence for these species the reference SPA populations have been applied as the regional receptor populations. **Table 11-5** provides a summary of the general distribution and behaviour of each species. Full species-specific accounts are presented in **Appendix 11-1**.

Table 11-5 Relative importance of study area in the context of regional estuarine bird populations in the Firth of Forth

Species	Abundance (min to max.)	Main distribution and behaviour when present	Seasons present in notable numbers	Importance in regional context (see Appendix 11.1)
Seabirds				
Black-headed gull	1 – 1,534	Loafing / roosting across the study area, including Port areas. Foraging concentrated around East Sands of Leith.	All year	Low
Cormorant	8 – 141	Loafing / roosting mainly in coastal habitat along the eastern shoreline. Low intensity foraging activity.	All year (highest numbers during post-breeding migration (Aug. to Sep.))	Moderate
Herring gull	302 – 1,303	Loafing / roosting across the study area, including Port areas. Foraging concentrated around East Sands of Leith and offshore.	All year *	Low
Lesser black-backed gull	0 – 441	Loafing / roosting across the study area, including Port areas. Foraging concentrated around East Sands of Leith.	Mar. to Oct. (highest numbers during post-breeding migration (Aug. to Sep.))	Low
Sandwich tern	0 – 84	Loafing / roosting at East Sands of Leith and the Newhaven foreshore. Low intensity foraging activity offshore.	Post-breeding migration (Aug. to Sep.)	Low
Shag (non-breeding)	0 – 53	Loafing / roosting mainly in coastal habitat along the eastern shoreline. Low intensity foraging activity across the marine area.	Post-breeding migration (Sep. to Oct.)	Low
Waterfowl				
Eider	21 – 976	Loafing / roosting activity across the study area, particularly around East Breakwater and the eastern shoreline. Foraging activity focused offshore.	Highest numbers during breeding season (Jun. to Sep.), with moderate numbers also present in Mar.	Moderate
Goldeneye	0 – 413	Loafing / roosting activity off the Newhaven waterfront and within the impounded dock system. Foraging activity mainly off the Newhaven waterfront.	Winter (Nov. to Feb.)	Moderate to high

Species	Abundance (min to max.)	Main distribution and behaviour when present	Seasons present in notable numbers	Importance in regional context (see Appendix 11.1)
Mallard	9 – 81	Loafing / roosting within the impounded dock system, plus associated with three small scrapes near West Breakwater.	All year	Low
Red-breasted merganser	0 – 38	Loafing and foraging activity concentrated both nearshore and offshore towards the west and east boundaries of the study area.	Non-breeding season (Oct. to Apr.)	Moderate
Waders				
Bar-tailed godwit	0 – 27	Loafing and foraging at East Sands of Leith.	Spring passage (Apr.)	Low
Dunlin	0 – 270	Loafing and foraging at East Sands of Leith.	Autumn passage (Nov.)	Low
Oystercatcher	74 – 289	Resting and foraging mainly in coastal habitat along the eastern shoreline, particularly at East Sands of Leith.	All year (highest numbers Jul. to Mar.)	Low
Redshank	0 – 192	Resting and foraging mainly in coastal habitat along the eastern shoreline, particularly at East Sands of Leith.	Passage and wintering season (Sep. to Apr.)	Low
Ringed plover	0 – 35	Resting and foraging mainly in coastal habitat along the eastern shoreline, particularly near to East Breakwater.	All year	Low to moderate
Turnstone	0 – 41	Resting and foraging mainly in coastal habitat along the eastern shoreline, particularly at East Sands of Leith.	Passage and wintering season (Oct. to Jan.)	Low to moderate

Most of the species presented in **Table 11-5** are of low (or low to moderate) regional importance; however, the following species were concluded to be present in numbers of moderate (or higher) regional importance:

- **Cormorant** The peak count of 141 individuals represented 20.7% of the Firth of Forth SPA non-breeding season reference population (682 individuals; NatureScot, 2018b) and 27.0% of the WeBS five-year mean peak in the Forth Estuary (522 individuals); however, monthly peaks in August and September – when migrating birds from outside the region are likely to be present – were significantly higher than all other counts. During winter and return migration seasons (December to May), monthly peaks where of low regional importance. This species is widespread and common throughout the Firth of Forth (SNH, 2016).
- **Eider** The peak count of 976 individuals represented 10.4% of the Firth of Forth SPA population (9,400 individuals; NatureScot, 2018b) and 19.5% of the WeBS five-year mean peak in the Forth Estuary (5,018 individuals). Outside of the breeding period (June to September) and the March migration period, peak counts did not exceed 5% of reference populations and were of low regional importance. This species is widespread and common through the outer Firth of Forth (SNH, 2016).
- **Goldeneye** The peak count of 413 individuals represented 13.7% of the Firth of Forth SPA reference population (3,004 individuals; NatureScot, 2018b) and 26.2% of the WeBS 5-year mean peak in the Forth Estuary site (1,577 individuals; 2015/16 to 2019/20) and was present in numbers of moderate to high regional importance throughout the wintering period (November to February). This species was absent from the study area during the period March to October, inclusive.
- **Red-breasted merganser** The peak count of 38 individuals represented 5.7% of the Firth of Forth SPA reference population (670 individuals; SNH, 2016) and 12.8% of the WeBS 5-year mean peak

in the Forth Estuary site (296 individuals; 2015/16 to 2019/20). Numbers only exceeded 5% of the reference populations in January and March, and this species was absent from May to September, inclusive.

Additionally, although not included in the above table, common tern numbers in the study area were of high regional importance due to the presence of the active breeding colony within the port at Imperial Dock Lock, Leith SPA. Further details on this species are provided in **Section 11.6.3**. A summary of key ornithology habitats indicated by the baseline survey (and other baseline data from the following sections) is provided in **Section 11.6.5**.

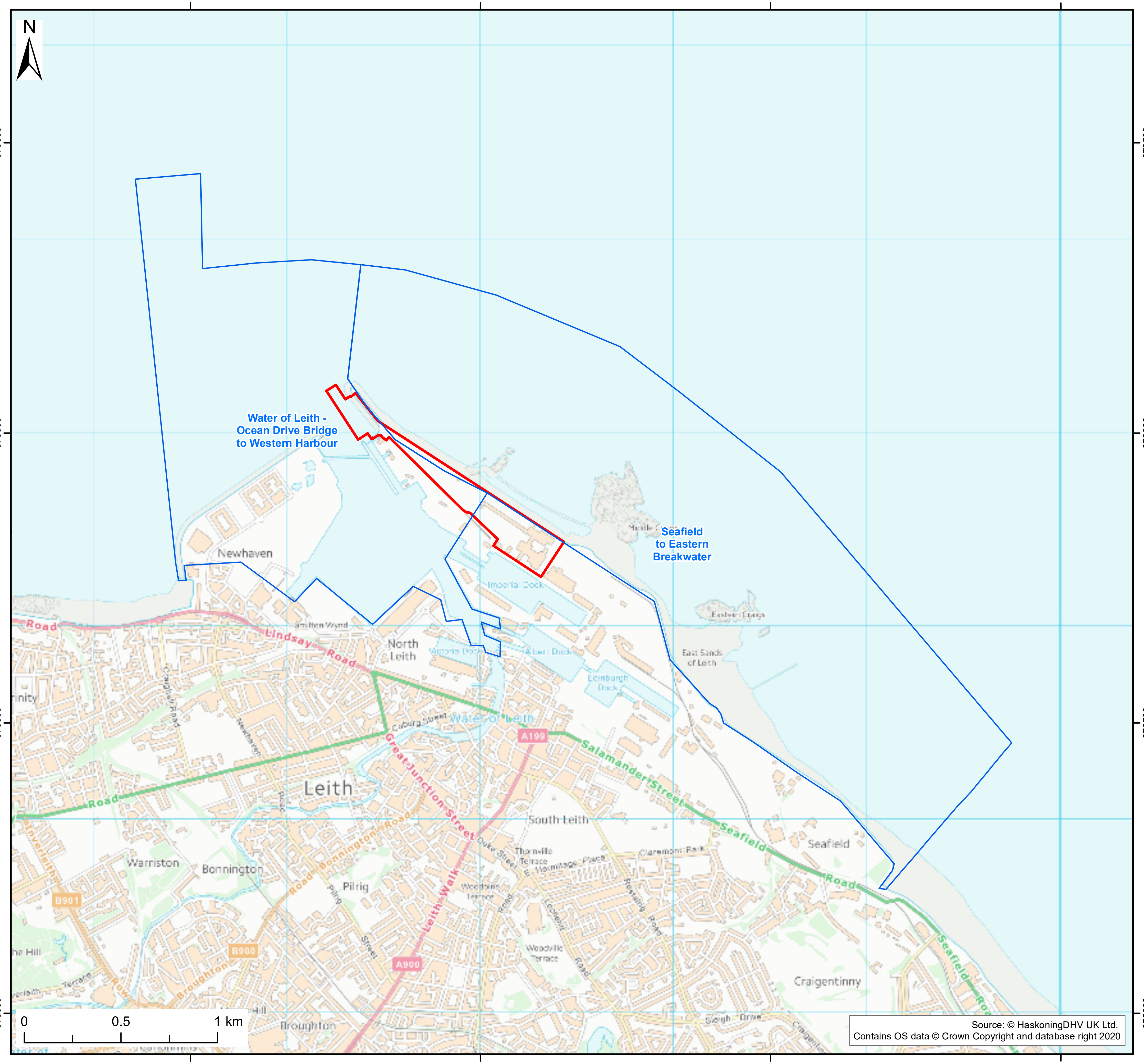
11.6.2 Other Available Baseline Estuarine Bird Data

WeBS core count data for estuarine birds in and around the proposed development site is available for the following sectors, both of which overlap with the proposed development (see **Figure 11-2**):

- Water of Leith – Ocean Drive Bridge to Western Harbour (83440), overlapping with and extending to the west of the development area; and,
- Seafield to Eastern Breakwater (83441), overlapping with and extending to the east of the development area.

The core count data for these sectors is presented in **Table 11-6** and **Table** 11-7. Data is only available for the years 2018/19 and 2019/20. The tables present peak monthly counts (i.e. the peak numbers of a given species recorded in a given month during the 2018/19 to 2019/20 period).

A total of 41 species were recorded across the two WeBS sectors. Species that were present in the WeBS data but were not recorded using the study area during the baseline estuarine bird survey included Arctic tern, golden plover *Pluvialis apricaria*, Mediterranean gull *Ichthyaetus melanocephalus*, pink-footed goose *126enelo brachyrhynchus*, snipe *Gallinago gallinago*, spotted redshank *Tringa erythropus*, tufted duck *Aythya fuligula*, whimbrel *Numenius phaeopus* and wigeon *Anas 126enelope*. Most were recorded in very low numbers, except for pink-footed goose, the peak count of which was 150 individuals during the autumn passage period.



Legend:

Red Line Boundary

WeBS Sectors

Client: Forth Ports Limited	Project: Port of Leith - Outer Berth

Title: WeBS Core Count Sectors

Figure: 11.2 | Drawing No: PC2045-RHD-ZZ-ZZ-DR-EV-0018

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
01	03/03/2022	FC	BH	A3	1:20,000

Co-ordinate system: British National Grid

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Table 11-6 WeBS monthly peaks of SPA qualifying species at Water of Leith – Ocean Drive to Western Harbour (2018/19 to 2019/20). Dark blue shading indicates the highest monthly peak

Species	J	F	M	A	M	J	J	A	S	O	N	D
Arctic tern	0	0	0	0	0	0	0	1	0	0	0	0
Black-headed gull	3,000	101	4	0	0	0	7	27	48	93	158	171
Common gull	0	0	0	0	0	0	0	0	20	0	0	0
Common scoter	0	0	0	3	0	0	0	0	0	0	0	0
Common tern	0	0	0	0	63	200	120	1	0	0	0	0
Common sandpiper	0	0	0	0	0	0	2	0	0	0	0	0
Cormorant	3	0	1	7	2	2	6	4	11	13	8	9
Curlew	0	0	0	0	0	0	0	1	0	1	1	0
Eider	32	50	106	107	48	220	19	12	12	4	55	29
Goldeneye	504	0	37	0	0	0	0	0	0	0	0	408
Goosander	0	0	0	0	0	0	0	0	0	0	0	6
Great black-backed gull	7	0	1	0	0	1	2	0	2	1	8	5
Grey heron	0	0	0	0	0	0	7	3	0	4	3	0
Herring gull	500	62	103	83	27	160	81	68	114	104	109	228
Mallard	8	27	25	3	3	14	10	30	46	9	14	24
Mute swan	2	4	5	3	8	2	13	13	5	6	2	2
Lesser black-backed gull	0	0	20	10	15	31	32	56	140	9	9	11
Oystercatcher	1	3	0	0	0	2	0	4	4	16	4	12
Red-breasted merganser	0	0	0	0	0	0	1	0	0	2	10	1
Redshank	0	1	0	0	0	0	0	0	0	0	0	0
Sandwich tern	0	0	0	0	0	0	2	125	9	0	0	0
Shag	1	0	0	0	0	0	3	0	1	2	0	0
Tufted duck	0	0	0	2	0	0	0	0	0	0	0	0

Table 11-7 WeBS monthly peaks of SPA qualifying species at Seafield to Eastern Breakwater (2018/19 to 2019/20). Dark blue shading indicates overall peak counts

Species	J	F	M	A	M	J	J	A	S	O	N	D
Arctic tern	0	0	0	0	0	0	0	1	0	0	0	0
Bar-tailed godwit	0	4	2	0	0	0	9	0	1	5	2	0
Common sandpiper	0	0	0	3	0	0	0	2	0	0	0	0
Common scoter	0	0	0	0	6	0	0	0	0	8	0	1
Common tern	0	0	0	0	0	0	0	0	2	1	0	0
Cormorant	11	4	9	3	7	12	26	13	50	41	17	3
Curlew	6	14	9	8	4	1	19	28	30	27	15	6
Eider	133	57	265	141	205	660	391	426	713	112	40	78
Goldeneye	46	71	2	0	0	0	0	0	0	0	11	114

Species	J	F	M	A	M	J	J	A	S	O	N	D
Golden plover	0	0	0	0	0	0	0	1	0	0	0	0
Goosander	0	0	0	0	0	0	0	0	6	3	0	0
Great crested grebe	2	1	0	0	0	0	0	0	0	0	1	0
Grey heron	0	1	0	0	0	0	0	1	1	0	0	0
Kittiwake	0	0	0	55	1	0	0	0	0	0	0	0
Knot	0	0	0	0	0	0	1	0	0	0	0	0
Mallard	0	5	34	11	13	13	0	5	0	0	16	0
Mediterranean gull	2	0	0	0	0	0	1	2	0	0	0	0
Mute swan	0	1	4	1	3	0	0	0	0	0	0	4
Long-tailed duck	0	3	0	0	0	0	0	0	0	0	0	0
Oystercatcher	270	140	105	121	91	39	68	161	165	252	193	70
Pink-footed goose	0	0	0	0	0	0	0	0	60	150	0	0
Purple sandpiper	7	11	10	15	1	0	0	0	0	1	3	0
Red-breasted merganser	17	26	13	6	0	0	0	0	4	18	10	26
Red-throated diver	3	0	0	3	0	1	0	0	0	2	7	0
Redshank	120	160	122	143	0	0	48	29	6	63	33	140
Ringed plover	73	43	34	24	14	4	42	55	8	37	77	37
Sandwich tern	0	0	0	4	0	0	0	0	12	15	2	0
Shag	7	16	13	19	3	10	2	1	23	34	18	6
Shelduck	1	3	3	2	2	0	0	0	0	0	0	0
Snipe	1	0	0	0	0	0	0	0	0	0	0	0
Spotted redshank	0	0	0	0	0	0	1	0	0	0	0	0
Teal	0	0	0	0	0	0	0	0	3	0	0	0
Tufted duck	0	0	0	0	0	1	0	0	0	0	0	0
Turnstone	35	66	33	27	3	5	3	29	36	25	33	31
Whimbrel	0	0	0	0	0	0	1	0	0	0	0	0
Wigeon	0	0	0	0	0	0	1	0	0	0	0	0
Velvet scoter	6	0	0	5	0	0	0	0	0	0	2	0

For many of the species of conservation interest (i.e. SPA / Ramsar Site / SSSI features, or named assemblage components), peak counts from the WeBS data were lower than the peak counts recorded during the baseline estuary bird survey (noting that the study area for the latter extended further west along the Newhaven foreshore). For those species, the conclusions of **Appendix 11-1** (and summarised in **Section 11.6**) regarding the importance of the study area in a regional context are considered to be sufficiently precautionary.

For the SPA / Ramsar Site / SSSI features presented in **Table 11-8**, peak counts recorded during the two years of WeBS survey data exceed the peak counts recorded during the baseline surveys. **Table 11-8** examines the WeBS peak counts for these species in a regional context to determine whether the importance of the site is higher than that recorded in **Appendix 11-1**.

Table 11-8 Peak WeBS counts (2018/19 to 2019/20) in the context of regional populations

Species	Reference population	Sector 83440		Sector 83441	
		Peak count as a % of ref. pop.	Importance in regional context	Peak count as a % of ref. pop.	Importance in regional context
Seabirds					
Arctic tern	1,784[1]	0.1	None	0.1	None
	1,080[2]	0.1		0.1	
Black-headed gull	26,835[1]	11.2	Low*	Unavailable	N/A
Red-throated diver	851[1]	0.0	None	0.8	Low
	90[2]	0.0		7.7	
Sandwich tern	1,617[3]	7.7	Moderate	0.9	None
Waterfowl					
Goldeneye	3,004[3]	16.8	High	3.8	Moderate
	1,577[4]	32.0		7.2	
Long-tailed duck	1,948[1]	0.0	None	0.2	None
	1,045[3]	0.0		0.3	
Pink-footed goose	10,852[3]	0.0	None	1.4	Low
	17,544[4]	0.0		0.9	
Wigeon	2,139[3]	0.0	None	<0.1	None
	2,570[4]	0.0		<0.1	
Waders					
Golden plover	2,949[3]	0.0	None	<0.1	None
	1,261[4]	0.0		0.1	
Ringed plover	328[3]	0.0	None	23.4	High
	310[4]	0.0		24.8	
Turnstone	860[3]	0.0	None	7.7	Moderate
	680[4]	0.0		9.7	

[1]SPA citation population for OFFSABC SPA (NatureScot, 2020);
[2]SPA citation population for Forth Islands SPA (NatureScot, 2018a and SNH, 2016);
[3]SPA citation population for Firth of Forth SPA (NatureScot, 2018b and SNH, 2016);
[4]WeBS five-year mean peak for the Forth Estuary, 2015/16 to 2019/20 (Frost *et al.*, 2021).
*Importance has been determined as low because, although the peak count accounts for more than 5% of the reference population, black-headed gull is widespread and numerous throughout the Firth of Forth (SNH, 2016) and therefore it is unlikely that the study area would have any particular importance in the context of the wider area.

In general, the information set out in **Table 11-8** does not change the conclusions regarding regional importance set out in **Appendix 11-1**.

11.6.3 Common Tern Ecology in the Study Area

A brief summary of the tern survey is provided here, with a full survey report provided in **Appendix 11-1**.

11.6.3.1 Common Tern Abundance and Apparently Occupied Nest counts

In the 2021 terns survey, common terns were first recorded on the site in May. The peak number of AONs in the colony was 264, recorded at the end of May. The number of AONs decreased through June and July, with approximately 14 AONs remaining during a colony count in mid-July. Good numbers of chicks were observed throughout. The peak count of 264 AON is in keeping with the most recent Seabird Monitoring Programme record of 246 AON in 2019 (JNCC, 2022), which was lower than previous counts of 514 AON in 2018, 985 AON in 2017, 719 AON in 2016 and 636 AON in 2015. A well-documented desertion of the nest (attributed to mink predation) was recorded in 2019 with no breeding success; there have been similar years with breeding failure, such as in 2002 and 2009 (SNH, 2016).

Following completion of the dedicated colony counts, common tern individuals continued to be recorded as part of the baseline estuarine bird survey. While a peak count of 2,000 individuals was recorded at the height of the breeding period at the end of May, a count of 839 roosting / loafing birds were still present in the port at the beginning of August (no AONs were present by this point). By September, very few birds remained in the study area and the species was absent from October onwards.

During the 2021/22 baseline estuarine bird surveys, an offshore count of 17 individuals was the highest count of foraging birds in the study area (there was no foraging activity recorded within the dock system itself), indicating that most birds from the colony appeared to commute outside the study area to forage. This point was also noted in a study of foraging ecology of terns at the colony by Jennings (2012).

A distribution map of common tern sightings through the estuarine bird survey period is presented in **Appendix 11-1**, which indicates areas of usage within the port. In general, during the breeding season (i.e. May to July) birds were only recorded at or very close to the colony at Imperial Dock. In August (i.e. within the post-breeding period), reasonably large groups of terns were recorded loafing / roosting elsewhere in the port, including near to the East Breakwater and on the western wall of the entrance lock. The study of the colony during the period 2008-10 by Jennings (2012) indicated that other important areas of usage by common terns within the port include the land stage and oil jetty just northwest of the colony, the quayside adjacent to the dry dock immediately north of the colony, and the old West Pier structure near to the entrance of the Albert Dock Basin (see **Figure 11-3**).

11.6.3.2 Flight Behaviour

The direction of each individual ‘flyover’ by common terns accessing or leaving the colony during the flight behaviour surveys in 2021 were attributed to one of four sectors providing access to the open sea, as shown in **Figure 11-4.** Heights of individual flights were also recorded, in categories of <5m, 5-10m, 10-20m and 20m+.

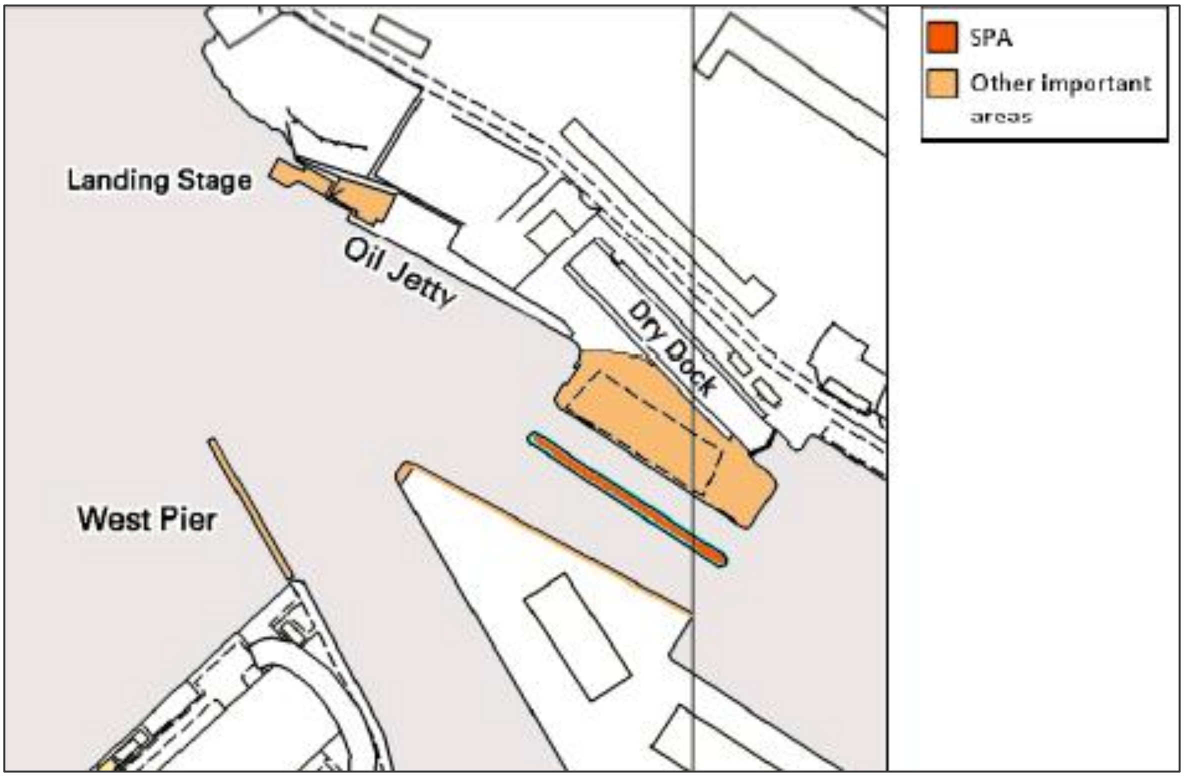


Figure 11-3 Areas used by adult and juvenile common terns (taken from Jennings, 2012)

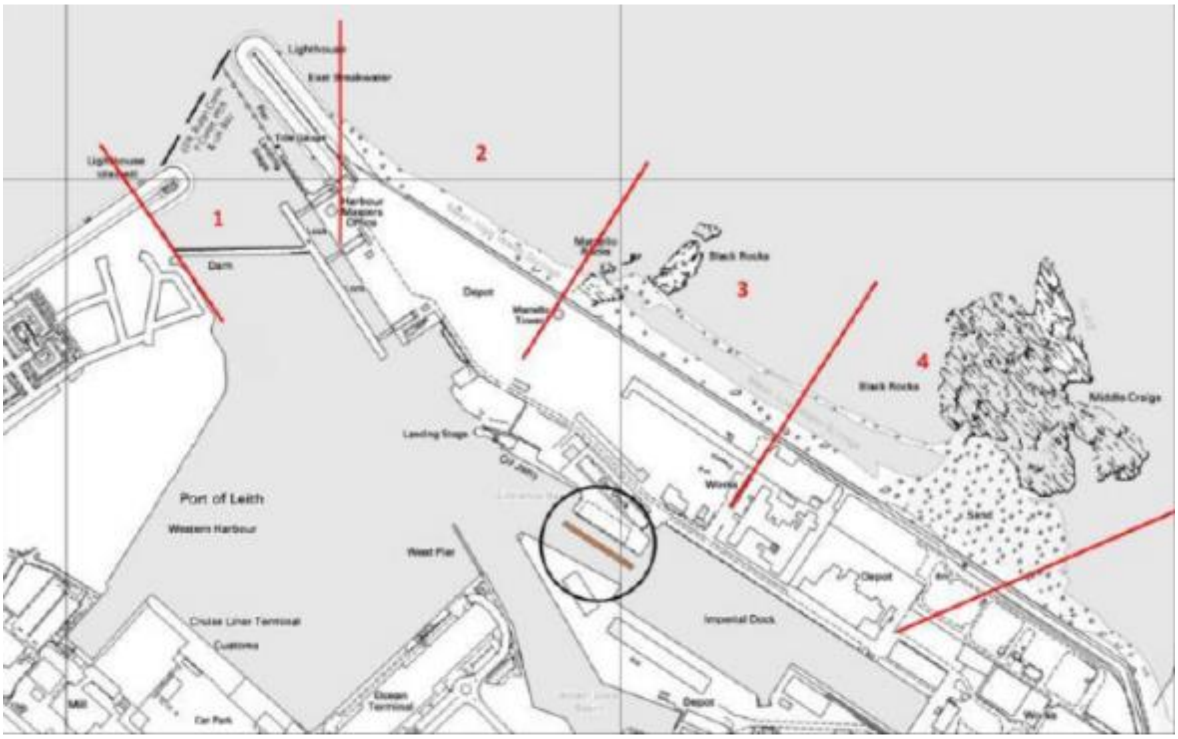


Figure 11-4 Common tern flight survey sectors at Port of Leith (taken from Jennings, 2012)

The highest peak flight rates were recorded in Sector 3, which offers the shortest route to sea (and also coincides with the location of the proposed laydown area), with around 75-85% of flights in this sector split evenly between the 10-20m and 20m+ categories during each count. Sector 1 (i.e. through the mouth of the port) was the second busiest flight sector, again mostly at heights of 10-20m and 20m+.

In all sectors, peak flight rates were generally recorded during the second June visit or the two July visits, correlating with periods when chick feeding requirements are likely to be greatest. During the second June survey, it was reported by the surveyor that c.70% of all inbound terns were carrying fish.

The flight survey methodology was based on similar surveys undertaken annually in the port from 2008 to 2010, inclusive (Jennings, 2012). Key findings of the 2008-10 study were as follows:

- Greater numbers of flights were recorded during the chick-rearing periods than during incubation (i.e. later in the season);
- Sector 3 was by far the most frequently used, followed by Sector 1; and,
- The most frequent flight height category was 10-20m, with the least frequent being 0-5m.

It is evident that the outcome of the 2021 survey is complemented by the findings of the earlier surveys and is therefore likely to be representative of the typical situation during the breeding season at the colony. In general, therefore, it appears that the majority of terns from the colony take the shortest route to and from the sea, across the port estate, at heights exceeding 10m in altitude.

11.6.4 Conservation Status of Estuarine Birds Present

Table 11-9 presents the nature conservation status of all species that were recorded – either during the baseline estuarine bird survey or in WeBS counts at sectors 83440 and 83441 – in numbers of regional importance (i.e. more than 1% of the respective reference populations). In accordance with the definitions set out in **Table 11-1** in **Section 11.4.4**, the nature conservation value of each species has also been listed.

Table 11-9 Conservation status of relevant estuarine bird species

Species	BoCC5	SPA feature	Schedule 1	Annex I	Nature conservation value
Bar-tailed godwit	Amber	Firth of Forth	×	✓	Medium
Black-headed gull	Amber	OFFSABC	×	×	Low
Cormorant	Green	Firth of Forth; Forth Islands	×	×	Low
Common tern	Amber	Imperial Dock Lock, Leith; Forth Islands; OFFSABC	×	✓	Medium
Dunlin	Red	Firth of Forth	×	×	High
Eider	Amber	Firth of Forth; OFFSABC	×	×	Low
Goldeneye	Red	Firth of Forth	×	×	High
Herring gull	Red	Forth Islands; OFFSABC	×	×	High
Lesser black-backed gull	Amber	Forth Islands	×	×	Low
Mallard	Amber	Firth of Forth	×	×	Low
Oystercatcher	Amber	Firth of Forth	×	×	Low
Red-breasted merganser	Amber	Firth of Forth; OFFSABC	×	×	Low
Red-throated diver	Green	Firth of Forth; OFFSABC	✓	✓	Medium

Species	BoCC5	SPA feature	Schedule 1	Annex I	Nature conservation value
Redshank	Amber	Firth of Forth	×	×	Low
Ringed plover	Red	Firth of Forth	×	×	High
Sandwich tern	Amber	Firth of Forth; Forth Islands	×	✓	Medium
Shag	Red	Forth Islands; OFFSABC	×	×	High
Turnstone	Amber	Firth of Forth	×	×	Low

11.6.5 Summary of Key Sensitivities Identified from Baseline Information

While all of the species present in numbers of regional note are of medium or high conservation interest (see **Table 11-9**), the baseline information provided by the 2021/22 baseline estuarine bird surveys (**Section 11.6**), tern-specific surveys (**Section 11.6.3**) and supplementary WeBS data (**Section 11.6.2**) has indicated the following key habitats / sensitivities within the study area:

- The quayside at the Imperial Dock Lock, Leith SPA hosts a large number of nesting common terns during the breeding season (May to July). Post-breeding (August), terns from the colony were also observed used other quayside areas within the Port for loafing / roosting, including the Imperial Dock quayside and the western wall of the entrance lock to the port. Dockside areas, particularly around Imperial Dock, supported large numbers of roosting / loafing gulls throughout the year.
- Intertidal habitats in the eastern half of the study area, namely the East Sands of Leith and adjacent rocky outcrops (Eastern Craigs and Middle Craigs) were the most regularly used habitats by estuarine birds, including waders such as oystercatcher, dunlin, turnstone, redshank and bar-tailed godwit and other waterbirds / seabirds, such as roosting Sandwich terns, eider, shag and cormorant.
- The foreshore adjacent to the East Breakwater appeared to be the favoured foraging / roosting habitat for non-breeding ringed plover. Large eider roosts / loafing areas were also regularly recorded at this location, although comparably-sized groups of roosting / loafing eider were also recorded in the impounded dock system (particularly Imperial Dock) and at the East Sands of Leith.
- The sheltered waters available both within the impounded dock system (notably Western Harbour and Imperial Dock) and in the embayment in the western half of the study area supported overwintering goldeneye in numbers of high regional importance (November to February).

The above have been identified as key sensitivities based on the fact that one or more SPA / Ramsar Site features, numbers of which may be of regional importance, appeared to show preference for those habitats for roosting and / or foraging during the baseline bird surveys (see distribution maps in **Appendix 11-1**).

11.6.6 Baseline Sources of Ornithological Disturbance

During the baseline estuarine bird survey, the surveyor recorded instances of human activity resulting in disturbance to birds using the study area. Full details are provided in **Appendix 11-1**; however, a summary is provided below.

There is public access to the Newhaven foreshore and the West Breakwater, in the western half of the study area, hence there was regular disturbance from walkers / dogs, anglers, swimmers and other recreational users. The most common source of disturbance in this sector was the presence of walkers / dog walkers along the foreshore and breakwater, which was recorded on most survey visits.

There was less recorded disturbance in the eastern half of the study area, due to limited public access along the shorefront. However, at the far east end of the study area, near to Portobello, there was regular disturbance from walkers / dog walkers.

Within the Port estate and impounded dock system there was regular recorded activity by vehicles (including heavy goods vehicles) and dock workers, as well as vessel movements within and into / out of the Port. Generally, such activities did not result in anything other than a 'low' level of disturbance to the birds present.

The presence of vessels in nearshore and offshore areas across the study area was also regularly recorded. While much of this was port-associated traffic, there was also regular presence of non-motorised and motorised vessels (including active fishing vessels) from Newhaven and Granton Harbours. Vessel activity was concentrated offshore, although there was regular nearshore activity by sailing vessels and kayaks at Newhaven.

11.7 Potential Impacts During Construction

11.7.1 Species Considered in the Construction-phase Assessment

For the purpose of this assessment, receptor populations of the species listed in **Table 11-10** have been considered. All other species have been 'scoped out' and have not been subject to further assessment, as, on the basis of expert judgement, there would be no more than a negligible magnitude of impact on these species.

Table 11-10 Species screened in for consideration in for detailed impact assessment

Species	Nature conservation value	Importance of study area in a regional context
Seabirds		
Black-headed gull	Low	Low
Common tern	Medium	High
Cormorant	Low	Moderate
Herring gull	High	Low
Lesser black-backed gull	Low	Low
Sandwich tern	Medium	Moderate
Shag	High	Low
Waterfowl		
Eider	Low	Moderate
Goldeneye	High	High
Mallard	Low	Low
Red-breasted merganser	Low	Moderate
Red-throated diver	Medium	Low
Waders		
Bar-tailed godwit	Medium	Low
Dunlin	High	Low
Oystercatcher	Low	Low
Redshank	Low	Low

Species	Nature conservation value	Importance of study area in a regional context
Seabirds		
Ringed plover	High	High
Turnstone	Low	Moderate

The species listed in the table are all species for which the port and surrounding environs has more than negligible importance in the context of the regional population, based on peak counts from the baseline bird survey (**Section 11.6**) and / or local WeBS data (**Section 11.6.2**).

While the above species have been considered in the assessment that follows, particular focus has been placed on the key sensitivities in the study area identified from the baseline data for the reasons set out in **Section 11.6.5**, namely:

- Common terns from the colony at Imperial Dock Lock, Leith SPA;
- Wintering goldeneye within the port and adjacent waters; and,
- Non-breeding ringed plover on the beach to the west of the East Breakwater.

11.7.2 Disturbance

The construction phase has the potential to cause acoustic and visual disturbance effects to bird populations within, or in close proximity to, the footprint of the proposed development. Estuarine birds can respond to disturbance, both visual and acoustic, in a number of ways. Disturbance may cause birds to move away from an area to another site, in which case the consequence is essentially the same as habitat loss. Disturbance may also cause birds to temporarily interrupt their normal activity leading to, for example, reduced feeding rates or productivity, or increased energy expenditure through movement away from sources of disturbance. In these ways and others, disturbance effects have potential to reduce individuals' fitness and could ultimately lead to an increase in mortality.

Some bird species may habituate to disturbance; indeed, given that it is a busy working port environment, it is considered likely that many of the birds using the port and adjacent habitats would already have a degree of habituation to anthropogenic activity, and this is taken into account in the assessment that follows.

Sources of visual disturbance related to the construction (e.g. the presence of machinery, plant, workers and vehicles on the quayside, vessels at the entrance to the port and the use of construction lighting in working areas) would be synonymous with existing day-to-day port activity (as noted during the 2021/22 surveys, see **Section 11.6.5**). Birds that routinely use habitats in, or in close proximity to, the port are expected to have a high degree of tolerance and habituation to such sources of disturbance, hence would not be significantly impacted. By the very nature of the works, birds that are typically found in areas relatively unexposed to day-to-day port activity (e.g. more distant locations such as the shoreline at Newhaven, the East Sands of Leith, and offshore areas) would not be exposed to the visual disturbances associated with the construction phase of the proposed development, since these would be confined to the port. Even individuals that regularly use 'less exposed' environments within the study area are likely to have some degree of resilience and habituation to anthropogenic activity, given the level of activity that is regular present across the wider study area (e.g. from walkers, dogs, anglers, boats, etc.; see **Section 11.6.5**).

In terms of noise disturbance, the most likely cause of disturbance to birds using the study area during the construction phase is likely to arise as impulsive noise from impact pile driving, as described in **Section 11.4.3**, although this would be persistent during operational hours and would be classed as a 'regular' (as opposed to periodic or 'irregular') noise source. The assessment of disturbance-related effects on ornithological receptor populations, presented below, focuses specifically on the potential impacts that may arise from noise disturbance during piling activity.

11.7.2.1 Temporal Magnitude of Piling-associated Noise Effects

As reported in **Section 3.2.1.4**, a total of 168 relatively small-diameter (1.22m) tubular piles will be driven into place using a hydraulic hammer, along with sheet piles adjacent to the back row of tubular piles. Some of the piles may eventually require drilling; however, for the purpose of precautionary assessment it is assumed that all piles would be installed by percussive means. It is anticipated that piling would be undertaken over a period of approximately 160 days (i.e. around 5.5 months). Each pile would take around 2hrs to drive to the correct depth at a strike rate of *c.*45 per minute, with a maximum of three piles installed per day (an average of less than two per day). Hence, it is anticipated that there would be up to six hours of piling in a given day, but on average less than four hours. For each pile, energy will be gradually increased from *c.*20% to 100% over the first twenty minutes, in accordance with standard JNCC protocol for 'soft starts' (JNCC, 2010).

It is to be expected that, following completion of the piling works, any noise-related disturbance effects on birds within range would cease; as such, the temporal magnitude of noise disturbance effects is considered to be short term, and would overlap with no more than one breeding season and / or one non-breeding season. Furthermore, daily piling-associated noise disturbances would be periodic, lasting no more than six hours per day.

11.7.2.2 Spatial Magnitude of Piling-associated Noise Effects

Much of the work undertaken on bird response to noise disturbance in the UK has focused on wintering estuarine birds (e.g. Cutts *et al*., 2009 and 2013; Wright *et al*., 2010). These studies tend to suggest that bird response to noise disturbance is likely to be minor at levels of 60dB(A) or lower (note that (A) refers to A-weighting, which approximates the frequency response of the human ear).

Wright *et al.* (2010) investigated the effects of impulsive noise on an assemblage of estuarine birds (including waders and gulls) and identified ranges in noise which caused behavioural responses (based on a measured L_{Aeq}). These are:

- No observable behavioural response: 54.9 to 71.5 dB(A);
- Non-flight behavioural response: 62.4 to 79.1 dB(A);
- Flight with return: 62.4 to 73.9 dB(A); and,
- Flight with all birds abandoning the site: 67.9 to 81.1 dB(A).

The likelihood of birds flying away and abandoning the area was low (less than 10%) at levels of around 60dB(A) increasing to almost 30% at levels of 70dB(A) and close to 100% at levels of 80dB(A). Less severe responses, which may include flight with return to the area, are most likely between around 65dB(A) and 75 dB(A).

Similarly, Cutts *et al.* (2009; 2013) compiled classifications for construction noise disturbance to wintering waterbirds as follows:

- Noise below 50 dB(A): low;
- Regular noise 50-70 dB: moderate to low;
- Irregular noise 50-70 dB: moderate;
- Regular piling noise (below 70dB): moderate; and,
- Noise above 70 dB: high to moderate.

In this classification, low response was defined as ‘no effect’, moderate response was defined as ‘head-turning, scanning, reduced feeding or movement to nearby areas’ and high response was defined as ‘preparing to fly, flight or abandonment of the area’. Cutts *et al.* (2009) does note that ‘data availability is poor for differing noise sources, receptors and times of year’, so this caveat should be recognised when applying the conclusions of the study.

Noise modelling undertaken for the proposed piling, an L_{Amax} noise contour plot for which is presented in **Figure 11-5**, indicates that noise emissions in the immediate vicinity of the piling may be over 90dB L_{Amax} and reduces with increased distance from the source.

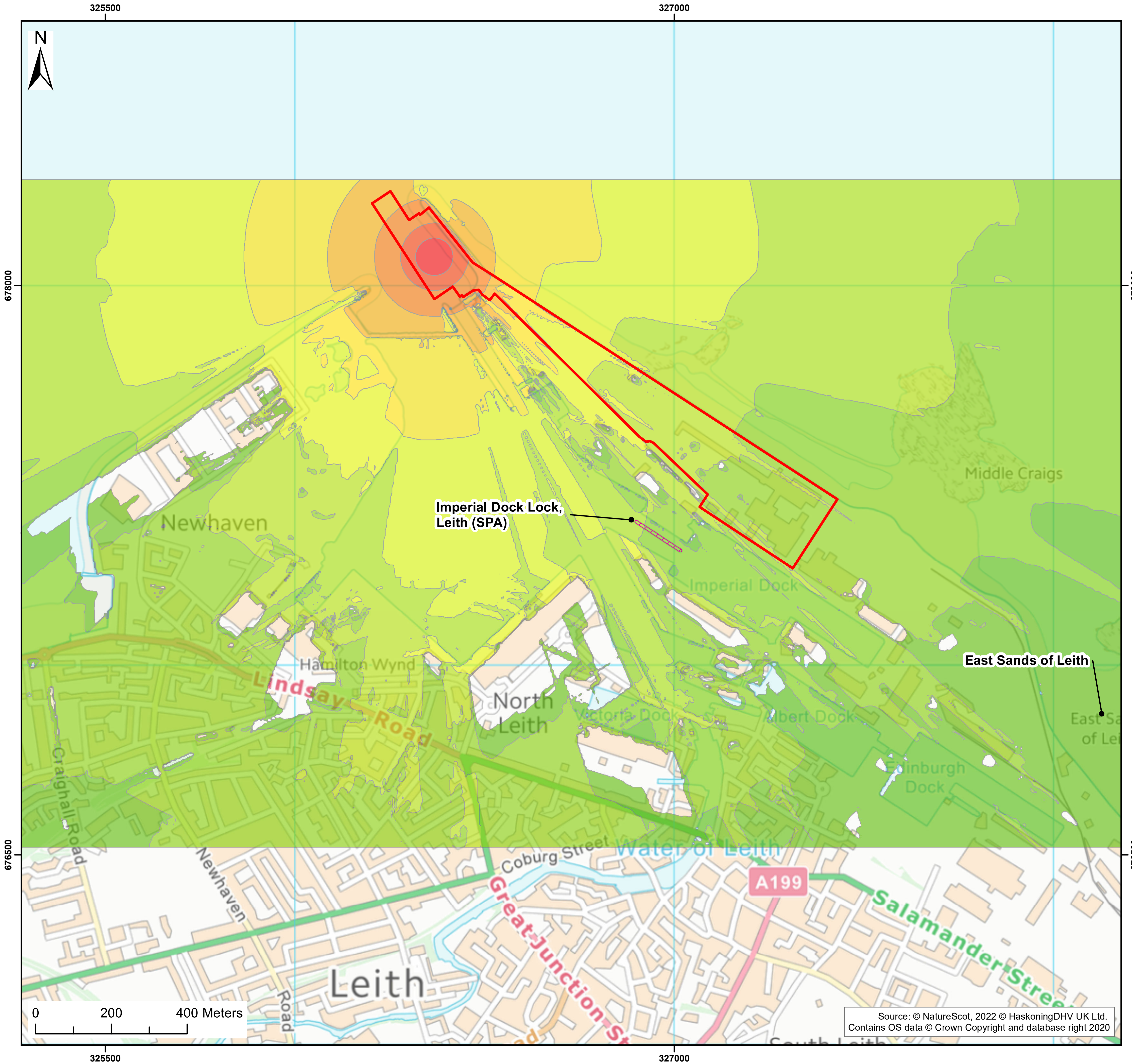
Based on the noise levels predicted in **Figure 11-5**¸ noise levels close to the source of the proposed piling activities are considered likely to elicit high to moderate responses, such that waterbirds present may exhibit behavioural responses such as flight with return or temporary abandonment of the site. Where noise levels from the piling attenuate to around 60 to 70dB, the noise disturbance stimuli is considered to be moderate and responses are most likely to range from head turning and scanning to temporary flight with return. At 60dB, the noise disturbance stimuli is considered to be low and little to no response would be expected.

In terms of the area likely to experience noise levels likely to elicit high to moderate levels of disturbance (i.e. above 70dB), affected habitats would include a stretch of the coastline extending *c.*1.2km south east of the piling source that would encompass the foreshore and beach adjacent to the East Breakwater and part of the port estate, where waterbirds – notably ringed plover, cormorant and eider, were recorded during baseline surveys (see **Appendix 11-1** for further details on distribution). While a stretch of the coastline south west of the piling source, encompassing the West Breakwater and adjacent promenade, would be exposed to similar noise levels, bird use of this area is limited (see **Appendix 11-1**). The key habitats at East Sands of Leith, Middle Craigs and Eastern Craigs are predicted to experience noise levels that correlate with low to moderate levels of disturbance (i.e. less than 70Db L_{Amax}).

For most of the species screened in, the importance of the study area in a regional context is low to moderate. On a precautionary assumption that there may be potential disturbance to a significant proportion of the birds within the study area during piling activity, the spatial magnitude of the effect on regional receptor populations would correspondingly be low to medium. This is considered to be an adequately conservative assessment of spatial magnitude based on the fact that several species favour habitats at East Sands of Leith and Eastern Craigs (see **Appendix 11-1** for further details on distribution), where noise levels are likely to be low enough that significant responses would not be expected.

Given that the temporal magnitude of the would be short-term, the overall magnitude of effect on such species is considered to be **low**.

For common tern, ringed plover and goldeneye, the importance of the study area in a regional context has been assessed as high and hence the spatial magnitude of effect on regional receptor populations of these species would be high. Again, this is a precautionary assessment based on noise levels likely to elicit moderate or high to moderate responses affecting a significant proportion of the population within the study area. Given the piling works would be short-term, the overall magnitude of effect for these species is considered to be **medium**.



Legend:

- Red Line Boundary
- Imperial Dock Lock SPA

Noise level Lr24hr in dB(A)

- <= 60
- 61 - 65
- 66 - 70
- 71 - 75
- 76 - 80
- 81 - 85
- 86 - 90
- 91 - 95
- 96 - 100
- > 100

Client:	Project:
Forth Ports Limited	Port of Leith - Outer Berth

Title:

Piling LAmax Noise Levels

Figure: 11.5 | Drawing No: PC2045-RHD-ZZ-ZZ-DR-EV-0046

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
01	21/03/2022	JR	BH	A3	1:10,000

Co-ordinate system: British National Grid

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11.7.2.3 Sensitivity of Receptor Populations and Assessment of Impact Significance

The sensitivities of estuarine bird species to the potential impact of noise disturbance will depend on the timing of the piling works relative to the period when birds numbers are at their highest. For common terns, the baseline data indicates this is likely to be during the breeding / post-breeding season (May to August). For the other species screened in for assessment, the baseline data indicates it is likely to be during the wintering and passage season (generally late August to March). For the purposes of assessment, and on a precautionary basis, it has been assumed that the piling works may take place during either of these periods.

Soft-start piling protocols set out by JNCC (JNCC, 2010) would be applied (i.e. low power start increased over a period of at least 20 minutes) will be employed at the onset of each pile installation. This is likely to increase the ability of birds to habituate to the predicted noise levels and has been taken into account when assessing sensitivity.

It is important to note that the works are being undertaken within a busy working port environment, hence the sensitivities of all species present in the study area have been assessed in light of the fact that they have clearly adapted to tolerate the day-to-day disturbances that such environs would present. In other words, all are likely to be habituated, to some degree, to the presence of anthropogenic activity. Once piling activity has ceased, it is expected that baseline levels of disturbance would be restored even during other stages of construction – since the presence of plant, vessels, workers and vehicles on the port estate is in line with the types of activity that would be regularly expected.

Disturbance to common terns at the breeding colony

Noise disturbance resulting from construction activities during the breeding season has the potential to cause common terns nesting within the port to experience reduced breeding success or even colony abandonment. Reduced breeding success may arise as a consequence of birds flying up and leaving nests / chicks unattended for longer periods in response to disturbance stimuli, increasing risk of predation (e.g. from gulls) and / or chilling of eggs and chicks (Burger, 1998; Medeiros *et al*., 2007). Breeding failure could lead to colony abandonment.

The studies on waterbirds by Cutts *et al.* (2009; 2013) and Wright *et al.* (2010) can only be regarded as providing general context to assessment regarding common terns since they apply to different species during the non-breeding season, when behavioural responses may differ. A study of more direct relevance was undertaken on breeding crested terns in Australia (Cabot and Nisbet, 2013), where the effects of recorded aircraft noise were documented on an unhabituated colony. Low level responses to noise (e.g. increased alertness) were recorded at noise levels exceeding 65 to 70dB(A). Higher level responses, such as fly ups or escape behaviour, were only recorded at exposure to noise levels of 90 to 95dB(A), and, even then, fewer than 20% of birds displayed such responses.

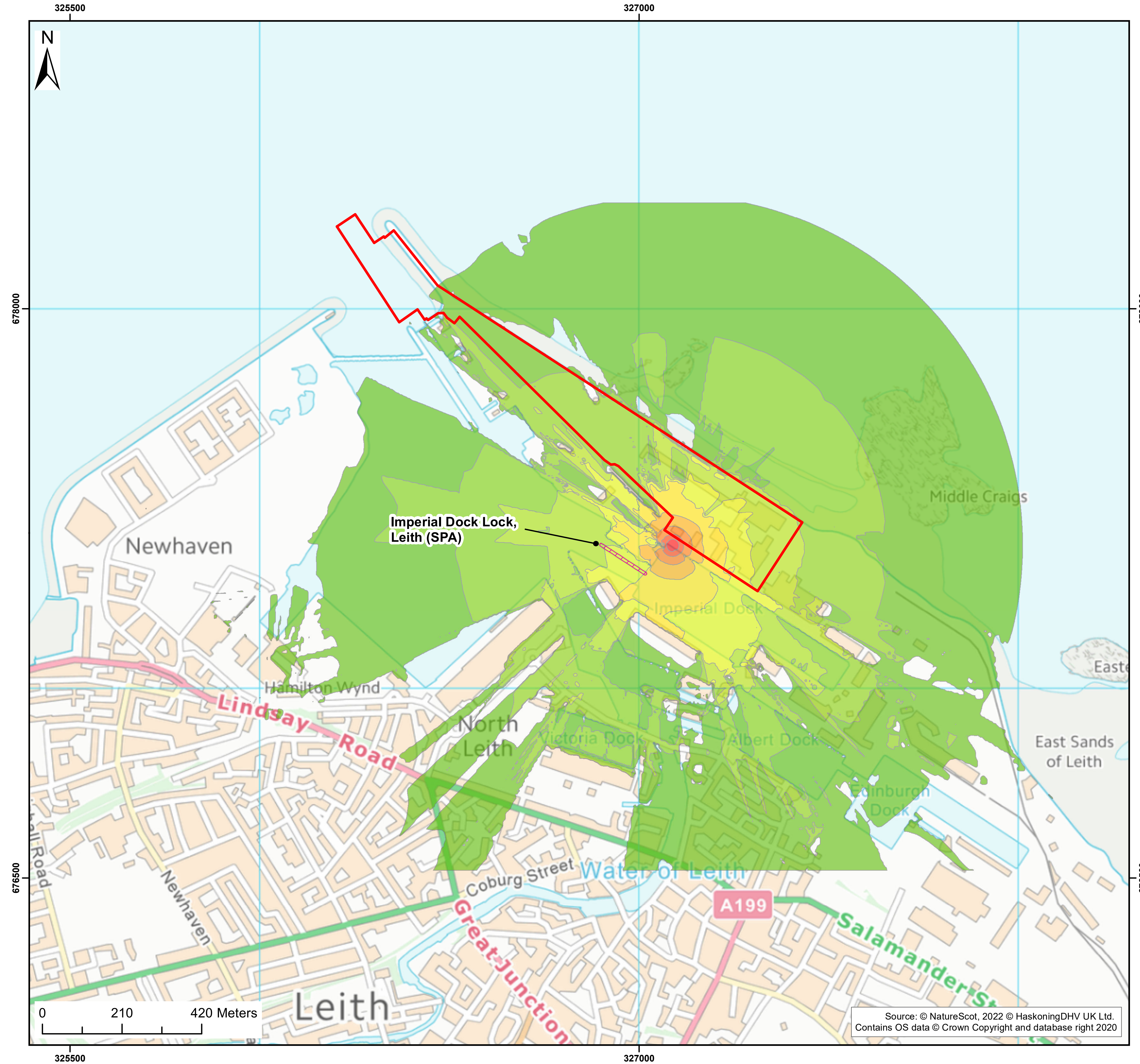
The breeding colony at Imperial Dock Lock is approximately 900m from the piling location. The predicted L_{Amax} from the proposed piling works is between 67 and 71dB at the SPA. At such noise levels, tern responses might typically include increased alertness or short-lived fly ups or ‘dreads’ (whereby a significant proportion of the colony takes flight silently and flies low before returning) but are unlikely to include responses at the upper end of the scale, such as ‘escape’ behaviour leading to temporary or prolonged abandonment (Cabot and Nisbet, 2013). Evidence to support this hypothesis is described below.

There are a number of examples where substantial common tern colonies breed in situations where there is a high potential for noise (and visual) disturbance. This applies to the colony at Imperial Dock; another large colony at Shotton Steelworks in Deeside, North Wales, is a further example. The colony at Imperial Dock Lock occurs in a location where vessels of 30m to 190m length pass within a matter of metres of the colony, along with accompanying irregular bursts of loud noise from ship horns and nearby gantry crane activity (Jennings, 2012). Other activity close to the colony includes movements of lorries, vans, cars and workers on foot.

A study of responses to disturbance by the colony was undertaken by Jennings (2012), which found that noise impacts (classed as sudden 'irregular' loud nearby noises, mostly from ship horns) resulted in some form of response approximately 70% of the time, most often in the form of short fly-ups or dreads, with large numbers of birds reacting. Given the consistency of these responses, it is reasonable to expect that, as a worst case, the onset of construction noise may elicit similar fly ups, involving a short time away from nests. Such short-term absences during fly ups are highly unlikely to result in chilling of eggs or chicks. Losses of eggs or chicks to opportunistic predators (e.g. gulls) could potentially occur during short absences, but the frequency with which fly ups were recorded by Jennings (2012) and the short duration of such responses suggests that any additional losses from an increase in fly ups would be small. Rapid habituation at the colony has been recorded; on one occasion a ship in Imperial Dock sounded its horn three times in close succession – the first caused most of the colony to react, with the severity of the response reduced on the second, and no visible response to the third (Jennings, 2012). Noise levels from nearby ship horns are likely to be considerably louder than the predicted noise levels at the colony from the proposed piling activity. This suggests that, in the event of a fly up response from piling commencement, there would be rapid resettling as the birds become habituated.

The baseline L_{Amax} estimated at the colony is presented in **Figure 11-6**, which is based on the use of a large crane moving pieces of broken ship, the source of the highest L_{Amax} levels in the vicinity of the colony. Such activity periodically occurs at the two cranes near to the dry dock, just north of the colony. At the SPA, baseline L_{Amax} levels are in the range of 75-80 dB (i.e. higher than the predicted levels from the piling shown in **Figure 11-5**). This indicates that, firstly, common terns in the colony are likely to be reasonably habituated to maximum impulsive noise levels within and above the predicted L_{Amax} range and, secondly, piling noise levels at the colony would be lower than those that are periodically experienced during existing port operations.

Historically (and typical of tern species), common tern numbers at Imperial Dock, Lock Leith SPA have fluctuated in terms of abundance. There have been years where terns have failed to establish a nesting colony at the site, or have established a colony and subsequently deserted the site (NatureScot have noted that recent abandonments were related to predator (mink) activity). As has been evidenced in the 2021/22 survey period, the site was used successfully by significant numbers of terns for nesting despite preceding years experiencing well-publicised breeding failure. Similarly, SNH (2016) indicates that years with failed breeding at Imperial Dock Lock were followed by years with high breeding (for example, zero breeding pairs counts in 2002 and 2009 were followed by counts of almost 1,000 breeding pairs in 2003 and 2010). While there is no evidence to suggest that the proposed works would cause colony breeding failure or abandonment, this historical data does highlight the resilience of the colony and its ability to recover successfully and rapidly.



Legend:

Red Line Boundary

Imperial Dock Lock SPA

Noise level Lr24hr in dB(A)

<= 60	96 - 100
61 - 65	> 100
66 - 70	
71 - 75	
76 - 80	
81 - 85	
86 - 90	
91 - 95	

Client:	Project:
Forth Ports Limited	Port of Leith - Outer Berth

Title:

Baseline Operational LAmax Noise Levels at Imperial Dock Lock

Figure: 11.6	Drawing No: PC2045-RHD-ZZ-ZZ-DR-EV-0047

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
01	21/03/2022	JR	BH	A3	1:10,000

Co-ordinate system: British National Grid

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The above evidence indicates that common terns at the Imperial Dock colony have a high degree of tolerance and recoverability when it comes to human-related disturbance within the port, and would become habituated to regular piling activity even if it coincided with the breeding period. Evidence of ongoing breeding activity within the active port area alongside baseline noise disturbances understood to be of similar or higher intensity indicates that the overall sensitivity of this species to the predicted noise levels at the colony would be **low.**

Given that the magnitude of effect on the receptor common tern population would be medium, the significance of the impact would be **minor adverse significance, which is not significant in EIA terms**.

Disturbance to common terns during the post-breeding season

During the post-breeding season, particularly in August, relatively large groups of common tern from the colony are still present in the port, but are not confined to the site of the colony itself. The 2021/22 baseline estuarine bird survey recorded groups of loafing / roosting individuals on the western wall of the entrance lock as well as at the East Breakwater, both of which are within close proximity to the piling works and may be exposed to maximum noise levels exceeding 80dB L_{Amax}.

Other areas of use by common terns, including juvenile birds, were identified by Jennings (2012) in the port (see **Figure 11-3** in **Section 11.6.3**). The landing stage and west pier, both to the west of Imperial Dock Lock, would experience maximum noise levels of 70 to 80 dB L_{Amax}. The quaysides to the north and south of the SPA would generally experience similar noise levels to those experienced at the SPA itself (i.e. 65 to 70dB L_{Amax}.

Given that a number of these potential roosting locations would be subject to noise levels above 70dB, there is a risk of a moderate to high level disturbance responses, ranging from temporary fly ups with return, to escape behaviour with a consequent need to find alternative roosting / loafing locations.

As noted above, evidence indicates that common terns at the Imperial Dock colony have a high degree of tolerance and recoverability when it comes to human-related disturbance within the port and would become habituated to regular piling activity, even if it coincided with the post-breeding period. Furthermore, there is evidence from Jennings (2012) that alternative roosting / loafing locations have been utilised historically within the port, including in locations unlikely to be exposed to noise levels exceeding 70dB during the piling works, therefore a level of adaptability is predicted. Nevertheless, it is apparent from the baseline information that important roosting locations may be affected therefore, on balance, it is considered that the sensitivity of post-breeding roosting / loafing flocks to noise effects would be **medium**.

Given that the magnitude of effect on the receptor common tern population would be medium, the significance of the impact would be **moderate adverse significance, which is significant in EIA terms**.

Effects of noise on foraging common terns

Although common tern is the only species known to regularly breed in significant numbers in and around the port (and hence is the only species constrained in its foraging ability by a need to return to nest), the 2021/22 baseline survey indicated that common terns generally did not actively forage within the nearshore waters around the port, nor within the impounded dock system itself. A peak foraging count of just 17 individuals represented less than 1% of the overall peak count of birds present. This was also noted during foraging ecology surveys undertaken by Jennings (2012). Most birds, therefore, are likely to forage outside the study area before returning to the colony. Common terns have a mean-maximum foraging range of 17.6km (standard deviation of 9.1km), with a maximum flight range from the Imperial Dock Lock colony of *c.*21km (Wilson *et al*., 2014; Woodward *et al.*, 2019).

The evidence considered above suggests that noise levels below 70dB will usually only elicit low to moderate responses. Noise levels in tern flight Sector 3 (i.e. the shortest and most regularly used flight route for birds accessing and leaving the colony; see **Section 11.6.3**) and Sector 4 are predicted to be around 65 to 75 dB, which is in keeping with the baseline L_{Amax} noise levels and the predicted noise levels expected at the colony itself.

Broad-based and qualitative consideration has been given to seabird responses to disturbances in offshore environments when commuting or foraging (Garthe and Hüppop, 2004; Furness *et al*., 2013). These two studies scored bird responses to ship and aircraft traffic at sea on a five-point scale, ranging from 1 ('hardly any escape / avoidance behaviour and / or none / very low fleeing distance') to 5 ('strong escape / avoidance behaviour and / or large fleeing distance'). Common tern was scored at two. Although not directly applicable, given that these were studies of birds at sea and based on different noise sources, it underlines the relative tolerance of this species to anthropogenic disturbance when commuting.

In terms of effects of underwater noise, diving terns are not likely to be present in significant numbers within the study area and are therefore unlikely to be affected by either injurious underwater noise levels or from reduced foraging ability. As standard practice, soft-start procedures defined by JNCC protocol (i.e. 10% starting energy ramped up over 20 minutes; JNCC, 2010) will be employed which further reduces the risk of injurious effects of underwater noise on diving terns. Potential indirect effects arising from displacement of prey species due to underwater noise are addressed in **Section 11.7.4**.

Based on the evidence above, the sensitivity of foraging terns to this effect is considered to be **low**, and the significance of the impact would be **minor adverse significance, which is not significant in EIA terms**.

Disturbance to other seabirds

Other seabirds that have been screened in for assessment (black-headed gull, herring gull, lesser black-backed gull, Sandwich tern, cormorant and shag) are generally present at the site in highest numbers during passage periods, when regional populations are supplemented by migrating birds. While foraging activity was recorded for these species during the 2021/22 baseline estuarine bird survey, these species predominantly forage at sea and would have no restriction on use of alternative marine areas unaffected by increased noise levels both within the study area and in other local areas in the Firth of Forth. Evidence from the baseline surveys indicates that intertidal foraging by gulls is focused at the East Sands of Leith, over 1.5km from the piling, where predicted maximum noise levels would be comparatively low (less than 65dB L_{Amax}; see **Figure 11-5**). As such, foraging activity is unlikely to be significantly affected and this section focuses on roosting or loafing seabirds.

In the baseline surveys and supplementary data, gull species are amongst the most abundant seabird species present in the study area, and the distribution maps in **Appendix 11-1** indicate that they were widely distributed throughout the study area. This includes areas of the port within close proximity to the piling works (such as the East Breakwater and quayside / docks near to the entrance lock) where predicted noise levels would exceed 70dB L_{Amax}, though there was no evidence that such areas are preferentially used. There was significant usage of other areas of the port, including Imperial Dock where the contour plot shown in **Figure 11-6** indicates baseline maximum noise levels are comparable to the predicted noise levels from the proposed piling (see **Figure 11-5**), as well as more distant habitats such as the East Sands of Leith where noise levels are predicted to be low.

Black-headed gull, herring gull and lesser black-backed gull are species that often associate with (or are seen alongside) anthropogenic activities that may form sources of significant noise, such as port activities (as is the case here) and landfill activities. Birds present in the Port of Leith are already exposed to the reasonably high levels of background noise expected in a working port environment, as described already in this section. As such it is expected that there would be a high degree of tolerance to anthropogenic disturbance, including noise associated with piling activities. A study of pile driving impacts during offshore wind farm construction in the Netherlands indicated that there was little, if any, effect of pile driving on the presence of gulls (Leopold and Camphuysen, 2009).

Even if construction noise were to result in disturbance / displacement of these species, their widespread use of the entire study area (see **Appendix 11-1** for the species-specific accounts), indicates that there would be a high degree of adaptability as they would be able to use alternative, unaffected locations within the study area and beyond. This includes offshore areas, since gulls are equally able to rest on the surface of the sea (and were regularly seen to do so during the 2021/22 surveys). Given this level of adaptability and tolerance, regional gull populations are considered to have a **low** sensitivity to the effect.

Sandwich terns present within the study area during the 2021/22 surveys were predominantly recorded roosting at the East Sands of Leith, in the far east of the study area, with smaller numbers also recorded loafing on the foreshore at Newhaven (see **Appendix 11-1**), both of which are in excess of 2km from the piling location. Predicted noise levels at the East Sands of Leith would be below 65dB (see **Figure 11-5**). The evidence regarding tolerance to anthropogenic disturbance and habituation ability described above for common tern is considered to be applicable also to Sandwich terns (Garthe and Hüppop, 2004; Furness *et al*., 2013; Horizon Nuclear Power, 2018). Passage Sandwich terns are regularly recorded in large roosting flocks at nearby coastal locations on the south coast of the Firth of Forth, notably between Musselburgh and Aberlady Bay (SNH, 2016). The presence of suitable nearby alternative roosting locations means that, in the unlikely event of displacement from roosts at East Sands of Leith, there would be no significant risk to the abundance or wider distribution of the regional population. As such, the regional passage Sandwich tern population is considered to have a **low** sensitivity to the effect.

Cormorant and shag both use the study area for loafing / roosting. The distribution maps in **Appendix 11-1** indicate that the shoreline along the eastern side of the study area is preferentially used by both species. Cormorant and shag are generally considered to be relatively intolerant of anthropogenic activity at sea (Garthe and Hüppop, 2004; Furness *et al*., 2013), hence it is likely that there may be displacement from roosting sites.

The foreshore near to the East Breakwater is a regular roosting / loafing habitat for groups of more than 20 cormorants and it is likely that there would be disruption to these groups during piling activity, since noise levels at this location exceed 70dB and may lead to moderate to high disturbance responses, including temporary abandonment of the roost. However, a significant level of resting behaviour was also recorded in areas further east, notably East Sands of Leith and the Middle and East Craigs, where noise levels are predicted to be considerably lower (60 to 70dB) and disturbance responses are likely to be low to moderate. As such, it is likely that birds would be able to readily adapt by roosting in these alternative locations; given that cormorant is common and widespread in the Firth of Forth (SNH, 2016), it is likely that alternative roost sites elsewhere in the local vicinity could also be utilised. Roosting / loafing cormorants are deemed to have an overall sensitivity of **medium**.

Shag roosting / loafing behaviour was less frequently recorded and appeared to be concentrated around the Middle and Eastern Craigs, where maximum noise levels are predicted to be between 60 and 70dB L_{Amax}, hence are likely to have lower sensitivity.

Given the conclusions set out above, the significance of noise disturbance impacts on regional lesser black-backed gull, herring gull, black-headed gull, Sandwich tern, cormorant and shag populations would be **minor adverse significance, which is not significant in EIA terms**.

Disturbance to non-breeding ringed plover

Ringed plover may be more at risk of adverse effects than the other wader species as the 2021/22 surveys indicate that, when present, this species appeared to favour the beach and intertidal sediment near to the East Breakwater for both foraging and loafing / roosting (see **Appendix 11-1**), between *c.*50m and *c.*300m from the piling location. As noted, this location is likely to be exposed to noise levels in exceedance of 70dB (and at the closest point potentially up to 90dB; see **Figure 11-5**) and therefore, in a general context, may lead to high to moderate disturbance responses in wintering waterbirds (Wright *et al.* 2010; Cutts *et al*., 2009 and 2013).

The Waterbird Disturbance Mitigation Toolkit (Cutts *et al*., 2013) notes that ringed plover are thought to be an 'extremely tolerant species that habituates to anthropogenic activities rapidly'. There is little published evidence with regard to ringed plover reaction to noise but it is considered likely that they would have a high threshold given their general high tolerance, and ringed plovers observed by Cutts *et al.* (2013) did not react to any noise stimuli despite exposure to noise levels up to 88dB from aircraft flying overhead. The Toolkit concludes that a noise level of up to 75dB is considered acceptable at the bird, though L_{Amax} noise levels during piling are likely to exceed 75dB along the foreshore adjacent to the East Breakwater.

Given the generally high level of tolerance in ringed plover to construction-based noise, the sensitivity level of this species is somewhat lessened. It is likely that, while there may be initial disturbance given the noise levels expected at favoured foraging and roosting sites, disturbance responses would ease over time given the species known ability to rapidly habituate to anthropogenic activity. Alternative soft sediment habitat is available at East Sands of Leith, where noise levels would be expected to have little to no effect, hence there is a level of adaptability afforded by the fact that foraging and resting birds could readily redistribute within the study area. Birds that are locally displaced would be able to return to favoured areas following completion of the piling campaign, as well as at times of the day when piling is not being undertaken. With this in mind, the sensitivity of ringed plover to the effects of noise disturbance from the proposed piling is considered to be **low**.

As the overall magnitude of the effect on the regional ringed plover population is also considered to be medium, the overall significance of noise disturbance impacts on the regional population is predicted to be **minor adverse significance, which is not significant in EIA terms**.

Disturbance to wintering goldeneye

It is apparent from the baseline data (see **Sections 11.6** and **11.6.2**) that goldeneye favour sheltered waters in and around the Port during winter months, particularly for loafing. Such areas include the south-western part of the study area (i.e. within the embayment formed by the Newhaven promenade and West Breakwater in the east and Granton Harbour in the west) plus the Western Harbour, Imperial Dock and Albert Dock within the Port itself. Group sizes of up to a few hundred birds were observed in these locations during the 2021/22 surveys, with the largest groups recorded in the embayment and in Imperial Dock.

For the most part, these favoured locations are sufficiently distant or sheltered from the piling activity that they would be exposed to maximum noise levels below 70dB (see **Figure 11-5**), hence only low to moderate disturbance responses would be expected (Cutts *et al*., 2009 and 2013).

There is little to no evidence relating to goldeneye sensitivity and response to disturbance during the wintering period; however, the 2021/22 baseline surveys indicated that large numbers of goldeneye use the impounded dock system itself during winter, particularly Imperial Dock, where baseline noise is characteristic of a working port environment and maximum noise levels from gantry cranes (as well as other sources, such as ship horns) are comparable to the piling activity. Noise modelling at Imperial Dock (where the largest groups of goldeneye were recorded), undertaken for the purpose of assessing impacts on the breeding common terns at Imperial Dock Lock, Leith SPA , indicates that baseline L_{Amax} noise levels at this location during existing port operations can exceed 80dB (see **Figure 11-6**). This indicates that piling L_{Amax} levels at Imperial Dock would be lower than those that are experienced during existing port operations and, consequently, goldeneye using Imperial Dock are likely to be reasonably habituated, or could become reasonably habituated, to impulsive noises within and above the predicted piling L_{Amax} range.

Given the above, there is evidence that – should piling activity be undertaken in winter when goldeneye are present – birds using the Western Harbour (and adjacent dockland areas exposed to noise levels that may lead to displacement effects) would have suitable alternative sheltered habitat available within the study area where noise levels are below 70dB and are unlikely to lead to significant disturbance. Given the duration of the piling, it could only overlap with a maximum of one wintering season. As with ringed plover and other waterbird features, goldeneye that are locally displaced would be able to return to all areas following completion of the piling works, as well as at times of the day when piling is not being undertaken. As such, the sensitivity of goldeneye to this effect is considered to be **low**.

As the overall magnitude of the effect on the regional ringed plover population is also considered to be medium, the overall significance of noise disturbance impacts on the regional population is predicted to be **minor adverse significance, which is not significant in EIA terms**.

Disturbance to other waterbirds

For most of the wading bird species screened in for assessment, the most important location within the study area for both foraging and loafing / roosting activity is the expansive area of soft sediment offered at the East Sands of Leith (see distribution maps in **Appendix 11-1**), over 1.5km from the source of piling noise. At that location, L_{Amax} noise levels are predicted to be around 60 to 65dB(A), hence disturbance responses are likely to be low to moderate, ranging from no visible response to localised redistribution on the foreshore there (Cutts *et al.*, 2009 and 2013). During the 2021/22 surveys, redshank and dunlin numbers were very low elsewhere in the study area and hence the population would be relatively unaffected by piling noise. While oystercatcher and turnstone forage and roost widely in the study area, both displayed a preference for the East Sands of Leith (reasonable numbers of turnstone were also present on the foreshore at Newhaven, also over 1.5km from the piling). This indicates that it is very likely that foraging and resting oystercatchers and turnstone, displaced from areas close to the piling, would readily redistribute locally within the study area. As such, the sensitivity of foraging and roosting / loafing redshank, dunlin, oystercatcher and turnstone is considered to be **low**. For these species, the significance of the impact of noise disturbance would be **minor adverse significance, which is not significant in EIA terms**.

Of the other waterfowl species screened in for assessment, red-breasted merganser and red-throated diver use nearshore and offshore subtidal waters for loafing and / or foraging. During the 2021/22 surveys, there was no evidence of preferential use of marine areas close to the piling (on the contrary, distribution of these species – in particular, red-breasted merganser – was generally concentrated towards the west and east boundaries of the study area i.e. distant from the port entrance). While both species are considered to have a very high sensitivity to marine development (Jarrett *et al.*, 2018), the nature of their use of the study area indicates that they would likely have a high level of adaptability, in that disturbed / displaced birds would be able to readily forage and / or loaf in nearby marine areas (both offshore and alongshore) beyond the range to which noise-related disturbance may occur. As such, sensitivity of both these species to this effect is classed as **low**, and the overall significance of the impact on regional populations would be **minor adverse significance, which is not significant in EIA terms**.

As indicated in the distribution map for eider in **Appendix 11-1**, this species regularly roosts along the East Breakwater in groups of 100 birds or more, most notably on the foreshore adjacent to the seaward side of the breakwater, within *c*.50m and *c*.300m of the piling activity. At this distance, the predicted maximum noise levels (see **Figure 11-5**) would be in excess of 70db L_{Amax} and, at the nearest points, be up to 90dB. As described above, such noise levels would generally be expected to lead to moderate to high levels of disturbance in waterbirds.

There is little published evidence with regard to eider reaction to anthropogenic noise, although Garthe and Hüppop (2004) and Furness *et al*., (2013), on their scale of vulnerability to offshore disturbance from vessels and aircraft, noted a moderate level of sensitivity in eider. A study by Jarrett *et al*. (2018) indicated that eider had a medium sensitivity to marine activity, based on research conducted in the Orkney Islands and the Western Isles of Scotland. The Waterbird Disturbance Mitigation Toolkit (Cutts *et al.*, 2013) focuses on estuarine waterbird populations, but is not specific to eider. Conservative comparisons can be drawn with shelduck, which Cutts *et al.* (2013) consider to be sensitive to both noise and visual disturbance, with aural disturbance from 72dB upward, but is capable of rapidly habituating to anthropogenic noise.

As such, it is to be expected that, particularly at the onset of piling works, there may be a significant level of displacement from eiders roosting / loafing at the East Breakwater and adjacent beach. However, it is clear from the 2021/22 surveys that roosting / loafing eider are not confined to the East Breakwater, with distribution of such activity recorded across the entire study area. Similarly large groups of 100 plus individuals roost / loaf at the East Sands of Leith, Middle Craigs and Eastern Craigs on a regular basis, and large groups of individuals loaf on the water in marine areas both nearshore and offshore.

Notably, large numbers are recorded within the impounded dock system itself – particularly Imperial Dock – where baseline noise is characteristic of a working port environment and maximum noise levels from gantry cranes (as well as other sources such as ship horns) are comparable in nature to the piling activity, indicating that eider within the study area are likely to have a degree of tolerance to anthropogenic activity.

The indication, therefore, is that while individuals using the East Breakwater itself would be sensitive to the effect of noise disturbance during piling, the widespread nature of this species (noted in SNH, 2016) means that the regional population itself would be relatively insensitive and a level of habituation would be expected. Birds displaced from the East Breakwater would be readily able to utilise other marine or shoreline areas for resting within the study area, as well as the wider general locality. There are sheltered areas within the port regularly used by eider, such as Imperial Dock, where predicted piling noise levels are similar to (or even less than) baseline noises from port activity (see **Figure 11-6**). This means that there would be no significant restriction on birds using the sheltered waters within the dock system when required. In terms of recoverability, it is anticipated that, following completion of the piling, noise levels would return to the baseline levels expected in and around a busy port and eider would continue to use the entire study area.

With the above in mind, it is anticipated that eider would have a **medium** sensitivity to noise effects and the significance of the impact of disturbance on the regional population would be **minor adverse significance, which is not significant in EIA terms**.

Mitigation measures and residual impacts

Although in most instances it is anticipated that noise disturbance from the proposed works would not have a significant effect on ornithological receptor populations, a moderate adverse impact (which is significant in terms of the MWRs) has been predicted on the following receptor populations:

- Common terns, specifically post-breeding groups of roosting / loafing common terns that use quaysides within the Port estate.

Impacts on post-breeding common terns have been assessed as moderate adverse given the importance of areas that are likely to be exposed to noise levels that may elicit moderate to high disturbance responses, including potential roosts near to the port entrance lock and East Breakwater, though it is recognised that alternative habitat within lower-affected areas of the port would be available and impacts would be short-term (i.e. over the course of one breeding / post-breeding season).

Nevertheless, a piling shroud is recommended, to be employed during the post-breeding season (i.e. from July to September, inclusive). Measured piling sound levels used in the calculation of source noise levels were provided by the manufacturer of the S-280 Hydrohammer during the construction of berths 201 and 202 at the Port of Southampton. These indicate a piling sound power level of 124 dB L_{WA} with the shroud in place, and L_{Amax} sound levels were a maximum of 11 dB above the measured L_{Aeq}. Using these data, the L_{Amax} sound levels with the shroud in place would be around 7dB lower than predicted using typical (unmitigated) sound emission data.

When considering a reduction of 7dB on the predicted L_{Amax}, the extent to which maximum noise levels may result in high to moderate disturbance in ornithological receptors would be considerably reduced. Although noise levels at the East Breakwater and entrance lock are likely to still exceed 70dB, this mitigation would increase the amount of alternative habitat within the port estate available to post-breeding terns and thereby increase adaptability. A reduction of 7dB would also increase the area in which maximum noise levels from the proposed development would be in keeping with existing baseline maximum noise levels, to which the terns already show some degree of tolerance and habituation.

With this mitigation measure in place, the spatial magnitude of the effect is likely to be reduced (in that a smaller proportion of the regional population would be present within the affected area), and the sensitivity of the above species (in terms of adaptability and tolerance) is also likely to be reduced. As such, the residual significance of the impact on post-breeding common terns is predicted to be **minor adverse significance, which is not significant in EIA terms**.

11.7.3 Change in Prey Availability due to Changes in Water Quality

Dredging and disposal of fine material during the construction phase of the proposed development would result in a temporary increase in SSC. An increase in SSC within the water column may lead to adverse impacts on fish prey resources within the water column, which could lead to behavioural responses, such as temporary displacement of those species from the affected range. This in turn has the potential to affect piscivorous bird species that feed on such resources. Furthermore, high turbidity as a result of increased SSC limits visibility through the water, which may adversely affect the ability of aerial predators to detect prey items in the affected range (Cook and Burton, 2010).

Total dredging for the proposed development would be approximately 101,000 m^3 of material, of which around 85% would be non-erodible (i.e. glacial till, mudstone and rock). Only *c*.16,000m^3 of soft sediment containing fines would be dredged and disposed of.

The extent of the sediment plume predicted from the proposed dredging and disposal, including figures, is described in detail in **Section 8.6**. Significant increases in SSC are only likely within the footprint of the dredge site (i.e. confined solely to the entrance to the port) and the boundaries of the licensed disposal site.

Any trace contaminants disturbed during dredging would be bound to fine sediment particles hence would only be present within the sediment plume. Chemical analysis of the dredge material has been undertaken and is reported in **Section 8.5.5**. The analyses indicate that contaminant levels within the sediment are suitable for offshore disposal (as determined through comparison against Cefas action levels) and therefore would not pose a significant risk to prey resources.

The potential impact of changes in prey availability would depend on the timing of the dredging works relative to the period when birds numbers are at their highest. For common terns, the baseline data indicates this is likely to be during the breeding / post-breeding season (May to August). For the other species screened in for assessment, the baseline data indicates it is likely to be during the wintering and passage season (generally late August to March). For the purposes of assessment, and on a precautionary basis, it has been assumed that the dredging / disposal activity may take place during either of these periods

While all species screened in for assessment have been taken into consideration, effects would likely be most of an issue for breeding birds that are constrained in their foraging areas by requirements to attend a nest. Of the species screened in, this would only apply to common tern.

11.7.3.1 Temporal and Spatial Magnitude of Effect

Dredging activities would be short-term and would overlap with no more than one breeding season and / or one non-breeding season.

The distribution maps presented in **Appendix 11-1** indicate that there is no particular propensity for concentrated foraging activity within the affected range by any piscivorous species (or any other species that forage within the water column); instead, foraging activity was either spread across the marine area or focused to the west and east of the study area and outside the affected range. Furthermore, for most of the species screened in, the importance of the study area in a regional context is low to moderate (see **Table 11-10**). For such species, the spatial magnitude on the regional receptor population could be no more than low to moderate. Given the short-term temporal magnitude, the overall magnitude of effect on most waterbird and seabird species screened in for assessment would be **low**.

Common tern and goldeneye are present across the study area in numbers of high regional importance. As noted in **Section 11.6.3**, common terns generally tend to commute outside the study area to forage, hence the majority of the birds from the Imperial Dock colony would forage in waters unaffected by the sediment plume. Goldeneye were recorded across the site, both to the west and east, but the largest numbers by far were recorded loafing and / or roosting with relatively low numbers recorded foraging (see the species account for goldeneye in **Appendix 11-1** for further detail). Where goldeneye foraging was observed, it was generally centred around the western half of the study area and beyond the extent of the predicted sediment plume. As such, the proportion of common terns and goldeneye foraging within the affected area would be relatively low and hence the spatial magnitude of the effect (with regard to the regional receptor populations) would be reduced.

Given the above, and based on the short-term nature of the effect, the overall magnitude of the effect for common tern and goldeneye is also considered to be **low**.

11.7.3.2 Sensitivity of Receptor Populations and Assessment of Impact Significance

As detailed in **Section 9.6.2** the impact of increased SSC would not have a significant effect on benthic species; therefore, consequent effects on waterbirds feeding on such prey are unlikely. Sensitivity of non-piscivorous species, such as waders and wildfowl that feed on invertebrates or algae, is **negligible**.

For piscivorous (or partly piscivorous) waterbird and seabird species, namely tern species, lesser black-backed and herring gull, cormorant species, diving ducks and red-throated diver, the species-specific distribution maps presented in **Appendix 11-1** do not indicate a foraging reliance on areas within the extent of the predicted sediment plume – indeed, there may be active avoidance of the area affected by the dredge plume given that it coincides with the main access route for vessels into / out of the port. Instead, foraging activity is generally spread across the study area, indicating that it would be possible for those species to forage in alternative areas unaffected by significant increases in suspended sediment and potential displacement of prey resources. Aside from common tern, piscivorous species do not nest in significant numbers in and around the port and are not limited in their ability to forage further afield. As already noted, common terns – despite breeding in the port – generally tend to forage further afield.

Given this adaptability and lack of reliance on specific foraging areas, plus the fact that prey resources are likely to return to affected areas quickly following completion of the dredging, the sensitivity of piscivorous species to this effect is considered to be **low**.

Given the overall magnitude of effect on receptor populations and the sensitivity of bird species to that effect, the significance of the impact is deemed to be **negligible significance, which is not significant in EIA terms,** for wading birds and non-piscivorous waterbirds (including non-breeding ringed plover) present in the intertidal / shallow subtidal and **minor adverse significance, which is not significant in EIA terms,** for piscivorous seabirds and waterbirds that may feed on fish resources within the study area (including common tern and wintering goldeneye).

11.7.4 Change in Prey Availability due to Underwater Noise

Underwater noise from piling and dredging activities during construction may injure, disturb and displace fish prey species of piscivorous (or partly piscivorous) species screened into this assessment, namely tern species, lesser black-backed and herring gull, cormorant species, diving ducks and red-throated diver. If the abundance and / or availability of prey is reduced through displacement or mortality arising from underwater noise, this could adversely affect those species.

11.7.4.1 Temporal and Spatial Magnitude of Effect

Impact piling activities creating impulsive underwater noise are considered to pose the greatest risk to prey fish species, with very limited risk posed by other underwater noise sources such as dredging (see **Section 10.6.1** and the accompanying **Appendix 10-1**). Impact piling would be undertaken over an anticipated period of around 5.5 months, hence the indirect effect on piscivorous birds would be short-term and would overlap with no more than one breeding season and / or one non-breeding season.

Evidence of the effects of underwater noise from the proposed piling on fish is described in **Appendix 10-1** and summarised in **Chapter 10**. High levels of underwater noise can potentially cause injury or death to fish, depending on their hearing sensitivity. Fish species that possess a swim bladder that is anatomically linked with hearing mechanisms are more sensitive than those which do not. However, for all fish species, potential mortal injury could only occur in a very limited range (less than 100m) of the source and a ‘soft start’ to piling, adopted as per JNCC protocol, would allow sensitive fish species within injurious range to move away. As such, mortality rates in fish of all levels of sensitivity are anticipated to be very low. Temporary disturbance to fish is possible across the range to which temporary threshold shift (TTS) may arise. For particularly sensitive species, this is predicted to be a maximum of 1.2km and mean of 710m from source (based on stationary, non-fleeing fish), while for less sensitive species, it would be considerably less (within a few hundred metres). Within this range, there may be small decreases in the abundance of fish species due to displacement, although fish species utilising the area will be somewhat adapted to noise associated with constant vessel access to a busy port area. For this reason, displacement levels are likely to be limited outside of TTS range.

The distribution maps presented in **Appendix 11-1** indicate that there is no particular propensity for concentrated foraging activity within the affected range by any piscivorous species; instead, foraging activity was either spread across the marine area or focused to the west and east of the study area and outside the affected range. Furthermore, for most of the bird species screened into this assessment, the importance of the study area in a regional context is low to moderate (see **Table 11-10**). For such species, the spatial magnitude of the effect on the regional receptor population could be no more than low to moderate. Given the short-term temporal magnitude, the overall magnitude of effect on most piscivorous waterbird and seabird species screened in for assessment would be **low**.

Of the piscivorous (or partly piscivorous) species, only common tern and goldeneye are present across the study area in numbers of high regional importance. As noted in **Section 11.6.3**, common terns generally appear to commute outside the study area to forage, hence the majority of the birds from the Imperial Dock colony would forage in waters where underwater noise would be unlikely to result in any displacement of fish prey. Goldeneye were recorded across the site, both to the west and east, though, as previously noted, the largest numbers by far were recorded loafing and / or roosting, with relatively low numbers recorded foraging. Where goldeneye foraging was observed, it was generally centred around the western part of the study area at the edge of or beyond the TTS range described above. As such, the proportion of common terns and goldeneye foraging within the affected area would be relatively low and hence the spatial magnitude of effect (with regard to the regional receptor populations) would be reduced.

Given the above, and based on the short-term nature of the effect, the overall magnitude of the effect for common tern and goldeneye is also considered to be **low**.

11.7.4.2 Sensitivity of Receptor Populations and Assessment of Impact Significance

For piscivorous bird species, an adverse effect on the receptor population would be most likely during the breeding season, when birds are constrained in their foraging areas by requirements to attend a nest, and to collect food for themselves and growing chicks. However, the only species which breed in considerable numbers within the study area is common tern, which, as already discussed, predominantly commute outside the study area to forage. For other piscivorous species, foraging activity is recorded across the study area with no particular reliance on waters within the affected range, indicating that it would be easily possible for such species to forage in areas unaffected by potential displacement of prey resources. As noted, these other species do not nest in significant numbers in and around the port and are not limited in their ability to forage further afield.

Given this level of adaptability and lack of reliance on the affected areas for foraging, and based on the fact that prey resources are likely to return to affected areas quickly following completion of the piling, the sensitivity of receptor populations of piscivorous species to the effect as described is considered to be **low**.

Given the conclusions regarding the overall magnitude of effect on receptor populations and the sensitivity of receptor populations to that effect, the significance of the impact is deemed to be **minor adverse significance, which is not significant in EIA terms,** for piscivorous seabirds and waterbirds that may feed on fish resources within the study area.

Invertebrate and algal feeding birds, including non-breeding ringed plover and other waterbirds present along the shoreline, would be unaffected by the indirect effects of underwater noise on prey resources.

11.8 Potential Impacts During Operation

11.8.1 Species Considered in the Operation-phase Assessment

No significant increase in vessel-associated disturbance would occur during operation. The laydown area itself would be used for storage and transhipment of OWF components, which, as described in **Section 3.3.2**, would not be a source of significant noise emission due to the use of quiet, modern technology such as self-propelled modular transporters (SMPTs) and would represent a decrease in operational noise from the previous pipe-coating facility. Lighting installed at the site would be directed downwards to minimise any spill and would use minimum lux levels as required for health and safety purposes. These would replace the existing lighting columns that are already in place around the port estate.

As such, significant disturbance effects would generally not be expected for any species. The only potential source of impact would instead be for common terns flying across the port estate when entering or leaving the colony at Imperial Dock Lock, due to the change of use within the proposed laydown area.

11.8.2 Impact of Change-of-use on Common Tern Movements

As noted in **Section 11.6.3**, large numbers of common terns from the Imperial Dock Lock colony regularly fly across the port estate in the vicinity of the proposed new laydown area during the breeding season, corresponding to flight sectors 2 and 3 in **Figure 11-4**. During the 2021 tern flight surveys, 60 to 70% of recorded tern flights passed through those two sectors. There is potential for the change of use (from the pipe-coating plant to the proposed laydown area) to deter flight activity through those sectors (e.g. due to the presence of large OWF components over significant periods of time), implications of which may range from additional energy expenditure to abandonment of the colony.

11.8.2.1 Temporal and Spatial Magnitude of Effect

The storage and transhipment of OWF components within the laydown area would occur throughout the lifetime of the proposed development, hence any effects that this may have on the common tern receptor population would be long-term and would overlap with breeding seasons for an indefinite period.

As discussed, the importance of the study area for common tern in a regional and national context is high (see **Table 11-10**). Given that up to 70% of flights from breeding terns in the colony have been documented in the flight sectors that correspond with the new laydown area, a considerable proportion of the regional population may be affected. As such the spatial magnitude of the effect on the regional receptor population is considered to be high, and, given the long-term temporal magnitude, the overall magnitude of effect on the regional population would be **high**.

11.8.2.2 Sensitivity of Receptor Populations and Assessment of Impact Significance

In terms of the effect that the presence of OWF components may have, flight heights through flight Sectors 2 and 3 (**Figure 11-4**) were mostly recorded in the 10-20m and 20m+ categories (over 75% of all flights) hence would be unaffected by the presence of most components. It is likely that tall components, such as OWF towers and blades (which may be up to 90m in height), would be primarily stored 'laid down', although during mobilisation / transhipment they would be stood erect. While imposing on the landscape when stood erect, it is important to view this in light of the fact that, as described in **Section 11.6.3** and **Appendix 11-1**, common terns preferentially commute through flight Sector 3. When leaving or entering the colony along this flight path, terns pass close to the two tall gantry cranes immediately to the north of the colony, which are over 50m in height when raised, as well as a number of tall lighting columns (see **Plate 11.1** for context). This indicates that terns flying through this sector are habituated to the presence of tall structures near to the flight path and will readily pass close to such structures when commuting back and forth from the colony. The OWF components would not be stored in a way that access is blocked (i.e. there would be space in between individual components for terns to fly through), hence there would be no significant impediment to the flight path and, unlike turbines at sea, components would generally be stationary in the laydown area.

Figure 11-7 View across Imperial Dock Lock towards flight Sector 3, with gantry cranes and lighting columns in the background (photo courtesy of T. Edwards)

It is unlikely that the proportion of flights along other flight paths, such as Sector 1 (the second most used sector in the 2021 surveys), would increase due to individual birds showing less of a preference for Sector 3. However, if this was the case, the additional energy expenditure of a small detour within the port, in the context of the foraging range utilised by common tern (mean maximum flight range of 17.6km +/- 9km; Wilson *et al*., 2014; Woodward *et al*., 2019), would be negligible.

As such, it is highly likely that terns would readily and easily adapt to the change in use of the site. Given that the species already demonstrates a willingness to fly in close proximity to tall quayside structures (and indeed show preference for the flight path that takes them closest to such structures), sensitivity of common terns present at the site to this effect would be **very low** / **negligible**.

Given the conclusions above for receptor sensitivity and the magnitude of effect, the significance of the impact on the regional common tern population would be **minor adverse significance, which is not significant in EIA terms**.

11.9 Summary of Potential Impacts to Ornithology

Table 11-1 summarises the significance of the potential impacts on ornithological receptor populations assessed in this chapter. Negligible and minor adverse impacts are not significant in EIA terms.

Table 11-11 Summary of potential impacts to ornithology

Effect	Receptor	Impact significance	Mitigation proposed	Residual impact
Construction phase				
Noise disturbance from impact piling	Breeding common terns at Imperial Dock Lock	Minor adverse	Soft start procedures as per JNCC protocol (JNCC, 2010).	Minor adverse
	Post-breeding terns within the Port	Moderate adverse	Use of piling shroud to reduce source noise levels. Soft start procedures as per JNCC protocol (JNCC, 2010)	Minor adverse
	Foraging common terns	Minor adverse	Soft start procedures as per JNCC protocol (JNCC, 2010)	Minor adverse
	Other seabirds screened in for assessment	Minor adverse		Minor adverse
	Non-breeding waterbirds screened in for assessment	Minor adverse		Minor adverse
Change in prey availability due to changes in water quality	Piscivorous / partly piscivorous species screened in for assessment	Minor adverse	None required	Minor adverse
	Non-piscivorous species screened in for assessment	Negligible		Negligible
Change in prey availability due to underwater noise	Piscivorous / partly-piscivorous species screened in for assessment	Minor adverse	None required	Minor adverse
	Non-piscivorous species screened in for assessment	Negligible		Negligible
Operational phase				
Impact of change of use on common tern movement	Breeding common terns at Imperial Dock Lock	Minor adverse	None required	Minor adverse

12 Marine Mammals

12.1 Introduction

This chapter of the EIA Report considers the potential impacts of the proposed development with respect to marine mammals. It describes the methods used to assess potential impacts, and the baseline conditions currently existing within the proposed development's footprint and the surrounding area. The mitigation measures required to prevent, reduce or off-set any impacts are presented together with the likely residual impact significance levels after these measures have been adopted.

This chapter is supported by the following chapters and appendices:

- **Chapter 7 Coastal Processes**
- **Chapter 8 Marine Water and Sediment Quality**
- **Chapter 12 Fish and Shellfish Ecology**
- **Appendix 10-1** Underwater Noise Modelling Report
- **Appendix 10-2** Marine Mammal and Fish Technical Report for Underwater Noise Impacts

12.2 Legislation, Policy and Guidance

12.2.1 Legislation

Marine mammal species in the waters surrounding the proposed development are protected by national and international legislation. **Table 12-1** details the legislation and policy relevant to marine mammals for the proposed development.

Table 12-1 International and national legislation relevant to marine mammals

Legislation	Level of protection	Species included	Details
The Berne Convention 1979	International	All cetaceans, grey seal *Halichoerus grypus* and harbour seal *Phoca vitulina*	The Convention conveys special protection to those species that are vulnerable or endangered. Although an international convention, it is implemented within the UK through the Wildlife and Countryside Act 1981.
The Bonn Convention 1979	International	All cetacean species	Protects migratory wild animals across all, or part of their natural range, through international co-operation, and relates particularly to those species in danger of extinction.
Oslo and Paris Convention for the Protection of the Marine Environment 1992	International	Various whale species and harbour porpoise *Phocoena phocoena*	OSPAR has established a list of threatened and/or declining species in the north-east Atlantic. These species have been targeted as part of further work on the conservation and protection of marine biodiversity under Annex V of the OSPAR Convention. The list seeks to complement, but not duplicate, the work under the EC Habitats and Birds Directives and measures under the Berne Convention and the Bonn Convention.
Convention on Biological Diversity 1993	International	All marine mammal species	Requires signatories to identify processes and activities that are likely to have impacts on the conservation and sustainable use of biological diversity, inducing the introduction of appropriate procedures requiring an EIA and mitigation procedures.
Agreement on the Conservation of	International	All cetaceans	ASCOBANS entered into force in 1994 under the auspices of the Convention on Migratory Species (CMS or Bonn Convention), with

Legislation	Level of protection	Species included	Details
Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas, 2008 (ASCOBANS)			additional areas (the north-east Atlantic and Irish Sea) included into the convention in 2008. The aim of the convention is to promote cooperation between parties with a view to maintaining the Favourable Conservation Status (FCS) of small cetaceans throughout the agreement area.
International Convention for the Regulation of Whaling 1956	International	All cetaceans	This convention established the International Whaling Commission who regulate the direct exploitation and conservation of larger whales as a resource, and the impact of human activities on cetaceans.
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) 1973.	International	All cetaceans	Prohibits the international trade in species listed in Appendix 1 (including sperm whales, northern right whales, and baleen whales) and allows for the controlled trade of all other cetacean species.
Marine (Scotland) Act 2010	National	All cetaceans, grey and harbour seal	This Act provides a framework for the sustainable management of Scotland's seas and one of its key aims is to streamline and simplify the licensing and consenting process for marine projects. Under the Marine (Scotland) Act, the Conservation of Seals Act 1970 have been re-enacted, providing designation of specific seal haul-out sites for protections from intentional or reckless harassment. Under Part 6 of the new act, it is an offence to kill, injure or take a seal at any time of year, except to alleviate suffering or where a licence has been issued to do so by Marine Scotland.
The Conservation of Offshore Marine Habitats and Species Regulations 2017	National	All cetaceans	'The Habitats Regulations 2017'. Provisions of The Habitats Regulations are described further in the separate Habitats Regulation Assessment report. It should be noted that the Habitats Regulations apply onshore, within the territorial seas and to marine areas within UK jurisdiction, beyond 12 nautical miles (nm).
Nature Conservation (Scotland) Act 2004	National	All cetaceans, grey and harbour seal	The Nature Conservation (Scotland) Act 2004 sets out a series of measure designed to conserve biodiversity, and to protect and enhance the biological and geological natural heritage. This Act also provides amendments to the Wildlife and Countryside Act 1981 specifically for Scottish waters, adding that it is an offence to disturb cetacean species (either recklessly or intentionally). This Act also enacts requirements under the Bern Convention 1979.
Conservation of Seals Act 1970.	National	Grey and harbour seal	The Marine (Scotland) Act 2010 replaces the Conservation of Seals Act 1970 in Scottish waters. See above for further information.
The Wildlife and Countryside Act 1981 (as amended)	National	All cetaceans	Schedule 5: all cetaceans are fully protected within UK territorial waters. This includes disturbance or harassment of a wild animal (either intentionally or recklessly). Under The Wildlife and Countryside Act (as amended) in Scotland, basking shark are a protected species of fish, and there is a requirement to apply for a basking shark licence for the disturbance or harassment, killing or injury of basking shark (either intentionally or recklessly).
The Countryside and Rights of Way (CroW) Act 2000	National	All cetaceans, grey and harbour seal	Under the CRoW Act 2000, it is an offence to intentionally or recklessly disturb any wild animal included under Schedule 5 of the Wildlife and Countryside Act.

Legislation	Level of protection	Species included	Details
The Protection of Seals (Designation of Haul-Out Sites) (Scotland) Order 2014	National	Grey and harbour seals	This Order designates certain places as seal haul-out sites for the purposes of section 117 of the Marine (Scotland) Act 2010. Harassing a deal (intentionally or recklessly) at a designated haul-out site is an offence under section 117.

12.2.2 Policy and Plans

12.2.2.1 Scotland's National Marine Plan

Within Scotland's NMP are a set of Good Environmental Status (GES) indicators that must be met. Within these, of relevance to marine mammal species are:

- "Biological diversity is maintained and recovered where appropriate. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions (GES 1);
- All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity (GES 4); and,
- Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment (GES 11)".

12.2.2.2 Scottish Priority Marine Features

Scottish Priority Marine Features (PMFs) (SNH, 2014) are habitats and species considered to be marine nature conservation priorities in Scottish waters. The aim of this work is to produce a focussed list of marine habitats and species to help target future conservation work in Scotland. The list includes 13 species of cetacean and both seals species, listed for either offshore waters only, or in both in and offshore waters, as well as basking shark.

12.2.2.3 Protected Species and Marine Wildlife Licence Guidance

All species of cetacean (whale, dolphin and porpoise) occurring in UK waters and otters are listed in Annex IV of the Habitats Directive as European Protected Species (EPS), meaning that they are species of community interest in need of strict protection, as directed by Article 12 of the Directive.

This protection is afforded in Scottish territorial waters (out to 12 nm) under the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended). Regulation 39(1) of these Regulations make it an offence to:

a. Deliberately or recklessly capture, injure or kill a wild animal of an EPS;
b. Deliberately or recklessly:
   i. Harass a wild animal or group of wild animals of an EPS;
   ii. Disturb such an animal while it is occupying a structure or place which it uses for shelter or protection;
   iii. Disturb such an animal while it is rearing or otherwise caring for its young;
   iv. Obstruct access to a breeding site or resting place of such an animal, or otherwise to deny the animal use of the breeding site or resting place;
   v. Disturb such an animal in a manner that is, or in circumstances which are, likely to significantly affect the local distribution or abundance of the species to which it belongs;

vi. Disturb such an animal in a manner that is, or in circumstances which are, likely to impair its ability to survive, breed, or reproduce, or rear or otherwise care for its young; or
vii. Disturb such an animal while it is migrating or hibernating.

Further protection is afforded through an additional disturbance offence given under Regulation 39(2) which states that "it is an offence to deliberately or recklessly disturb any dolphin, porpoise or whale (cetacean)".

12.3 Consultation

Table 12-2 Marine Mammal consultation

Consultee	Date / Document	Comment	Responses / where addressed in the EIA report
Marine Scotland – Licencing Operations Teams	Screening Opinion - 18th January 2022	The site of the Proposed Works also has connectivity to various sites designated for their marine mammal qualifying interests namely the Isle of May and the Berwickshire and North Northumberland Coast SACs designated for their grey seal qualifying interest, the Moray Firth SAC designated for its bottlenose dolphin qualifying interest, and the Firth of Tay and Eden Estuary SAC designated for its harbour seal qualifying interest.	The designated sites are considered with the HRA accompanying shadow HRA report.
		Potential impacts are identified as disturbance due to underwater noise from construction activities and indirect impacts due to changes in water quality and prey availability.	These potential impacts are considered in **Section 12.8**.
		Following the conclusions of the HRA report, the applicant has gone on to conclude within the main EIA screening report that the potentially significant impacts noted above could be managed through a combination of best practice construction methods and standard mitigation measures.	Noted.
		In its advice, NatureScot states that while the scope of the HRA, in terms of the sites and interests covered, appears adequate, and provides information regarding what further work might be needed to undertake a satisfactory appropriate assessment, an assessment has not been carried out, nor is there any indication in regards to many of the impacts identified above, as to what the outcomes of the appropriate assessment might be. As such, NatureScot states that the conclusions of the applicant's EIA screening report are premature and further information and/or assessment is required to satisfactorily determine that there will be no significant impacts as a result of the Proposed Works on marine mammals, ornithology, and fish receptors.	The potential impacts described within the EIA Screening Report are considered fully in **Section 12.8**.
		NatureScot noted that the Proposed Works may have an impact upon EPS which are not necessarily afforded protected by the sensitive sites included in the applicant's HRA such as otters, minke whales and harbour porpoises. NatureScot advised that the impacts outlined in the applicant's HRA were likely to apply to marine EPS as well, and impacts upon these receptors should be considered further.	All relevant marine mammal species are considered fully in this chapter. If required, a EPS Licence, for piling works, will be applied for prior to piling taking place.
NatureScot	Screening Opinion – 15th December 2021	The proposal may also have effects upon EPS that are not specifically protected by relevant European sites, for example otter, minke whale or harbour porpoise. Impacts upon these receptors should be considered through EIA. We advise that	All relevant marine mammal species are considered fully in the following sections.

Consultee	Date / Document	Comment	Responses / where addressed in the EIA report
		assessment, conclusions, and mitigation measures identified in the HRA report are likely to apply to the marine EPS also.	If required, a EPS Licence, for piling works will be applied for prior to piling taking place.
		The HRA screening report scopes in several designated sites and species to be taken forward to appropriate assessment, due to various identified likely significant effects (LSE). It has not indicated its likely conclusion at this stage, outlining what further work is required to inform the appropriate assessment. It does give some indication on likely outcomes for underwater noise disturbance but not other potential impacts.	All relevant marine mammal species are considered fully in the following sections. The potential impacts described within the EIA Screening Report are considered in **Section 12.8**.
		Further to this, we advise that the EIA could be focussed on the above receptors and mirror the work undertaken for the appropriate assessment, as well as including EPS which are outwith the HRA process.	All relevant marine mammal species are considered fully in the following sections. If required, a EPS Licence, for piling works, will be applied for prior to piling taking place.

12.4 Assessment Methodology

12.4.1 Impact Assessment Methodology

The approach to determining the significance of an impact follows a systematic process for all impacts. This involves identifying, qualifying and, where possible, quantifying the sensitivity, value and magnitude of all marine mammal receptors which have been scoped into this assessment. Using this information, a significance of each potential impact has been determined. Each of these steps is set out in the following sections.

The assessments for potential impacts as a result of underwater noise impacts are based on the modelling impact ranges (and areas), which are used to calculate the number of marine mammals potentially at risk (based on the known densities of each relevant marine mammal species in the vicinity of the proposed development), and are then related to the population estimate, using the defined magnitude levels are defined above.

Sensitivity

The sensitivity of a receptor is determined through its ability to accommodate change and on its ability to recover if it is negatively affected. The sensitivity level of marine mammals or basking shark to each type of impact is justified within the impact assessment and is dependent on the following factors:

- Adaptability – The degree to which a receptor can avoid or adapt to an effect;
- Tolerance – The ability of a receptor to accommodate temporary or permanent change without a significant adverse effect;
- Recoverability – The temporal scale over and extent to which a receptor will recover following an effect; and,
- Value – A measure of the receptors importance and rarity (as reflected in the species conservation status and legislative importance).

Table 12-3 defines the levels of sensitivity for marine mammals. The sensitivity to potential impacts of lethality, physical injury, auditory injury or hearing impairment, as well as behavioural disturbance or auditory masking are considered for each species, using available evidence including published data sources.

Table 12-3 Definitions of sensitivity levels for marine mammals

Sensitivity	Definition
High	Individual receptor has very limited capacity to avoid, adapt to, accommodate or recover from the anticipated impact.
Medium	Individual receptor has limited capacity to avoid, adapt to, accommodate or recover from the anticipated impact.
Low	Individual receptor has some tolerance to avoid, adapt to, accommodate or recover from the anticipated impact.
Negligible	Individual receptor is generally tolerant to and can accommodate or recover from the anticipated impact.

Value

In addition, the 'value' of the receptor forms an important element within the assessment, for instance, if the receptor is a protected species. It is important to understand that high value and high sensitivity are not necessarily linked. A receptor could be of high value (e.g. an Annex II species) but have a low or negligible physical/ecological sensitivity to an effect. Similarly, low value does not equate to low sensitivity and is judged on a receptor by receptor basis.

In the case of marine mammals, a large number of species fall within legislative policy; all cetaceans in UK waters are EPS and, therefore, are internationally important. Harbour porpoise, bottlenose dolphin *Tursiops truncatus*, grey seal and harbour seals are Annex II species and also afforded international protection. As such, all species of marine mammals can be considered to be of high value.

The value will be considered, where relevant, as a modifier for the sensitivity assigned to the receptor, based on expert judgement. **Table 12-4** provides definitions for the value afforded to a receptor based on its legislative importance.

Table 12-4 Definitions of value levels for marine mammals

Value	Definition
High	Internationally or nationally important Internationally protected species that are listed as a qualifying interest feature of an internationally protected site (i.e. Annex II protected species designated feature of a European designated site) and protected species (including EPS) that are not qualifying features of a European designated site.
Medium	Regionally important or internationally rare Protected species that are not qualifying features of a European designated site, but are recognised as a BAP priority species either alone or under a grouped action plan, and are listed on the local action plan relating to the marine mammal study area.
Low	Locally important or nationally rare Protected species that are not qualifying features of a European designated site and are occasionally recorded within the study area in low numbers compared to other regions.
Negligible	Not considered to be or particular important or rare Species that are not qualifying features of a European designated site and are never or infrequently recorded within the study area in very low numbers compared to other regions.

It should be noted that high value and high sensitivity are not necessarily linked within a particular impact. A receptor could be of high value (e.g. an Annex 1 habitat) but have a low or negligible physical/ecological sensitivity to an effect – it is important not to inflate impact significance just because a feature is 'valued'. This is where the narrative behind the assessment is important; the value can be used where relevant as a modifier for the sensitivity assigned to the receptor.

Magnitude

The significance of the potential impacts is also based on the intensity or degree of impact to the baseline conditions and is categorised into four levels of magnitude: high; medium; low; or negligible, as defined in **Table 12-5.**

Table 12-5 Definitions of magnitude levels for marine mammals

Magnitude	Definition
High	Permanent irreversible change to exposed receptors or feature(s) of the habitat which are of particular importance to the receptor. Assessment indicates that more than 1% of the reference population are anticipated to be exposed to the effect. OR Long-term effect for 10 years or more, but not permanent (e.g. limited to operational phase of the projects). Assessment indicates that more than 5% of the reference population are anticipated to be exposed to the effect. OR Temporary effect (e.g. limited to the construction phase of development) to the exposed receptors or feature(s) of the habitat which are of particular importance to the receptor. Assessment indicates that more than 10% of the reference population are anticipated to be exposed to the effect.
Medium	Permanent irreversible change to exposed receptors or feature(s) of the habitat of particular importance to the receptor. Assessment indicates that between 0.01% and 1% of the reference population anticipated to be exposed to effect. OR Long-term effect for 10 years or more, but not permanent (e.g. limited to operational phase of the projects). Assessment indicates that between 1% and 5% of the reference population are anticipated to be exposed to the effect. OR Temporary effect (e.g. limited to the construction phase of development) to the exposed receptors or feature(s) of the habitat which are of particular importance to the receptor. Assessment indicates that between 5% and 10% of the reference population anticipated to be exposed to effect.
Low	Permanent irreversible change to exposed receptors or feature(s) of the habitat of particular importance to the receptor. Assessment indicates that between 0.001% and 0.01% of the reference population anticipated to be exposed to effect. OR Long-term effect for 10 years or more, but not permanent (e.g. limited to operational phase of the projects). Assessment indicates that between 0.01% and 1% of the reference population are anticipated to be exposed to the effect. OR Intermittent and temporary effect (e.g. limited to the construction phase of development) to the exposed receptors or feature(s) of the habitat which are of particular importance to the receptor. Assessment indicates that between 1% and 5% of the reference population anticipated to be exposed to effect.
Negligible	Permanent irreversible change to exposed receptors or feature(s) of the habitat of particular importance to the receptor. Assessment indicates that less than 0.001% of the reference population anticipated to be exposed to effect. OR Long-term effect for 10 years or more (but not permanent, e.g. limited to lifetime of the projects). Assessment indicates that less than 0.01% of the reference population are anticipated to be exposed to the effect. OR Intermittent and temporary effect (limited to the construction phase of development or project timeframe) to the exposed receptors or feature(s) of the habitat which are of particular importance to the receptor. Assessment indicates that less than 1% of the reference population anticipated to be exposed to effect.

The thresholds defining each level of magnitude of effect for each impact have been determined using expert judgement, current scientific understanding of marine mammal population biology and JNCC *et al.* (2010) draft guidance on disturbance to EPS species. The magnitude of each effect is calculated or described in a quantitative or qualitative way within the assessment.

The number of animals that can be 'removed' from a population through injury or disturbance varies between species but is largely dependent on the growth rate of the population; populations with low growth rates can sustain the removal of a smaller proportion of the population than one with a larger growth rate. The JNCC *et al.* (2010) draft guidance provides some indication on how many animals may be removed from a population without causing detrimental effects to the population at Favourable Condition Status (FCS). The JNCC *et al.* (2010) draft guidance also provides consideration of permanent displacement and limited consideration of temporary effects. As such this guidance has been considered in defining the thresholds for magnitude of effects.

Temporary effects are considered to be of medium magnitude at greater than 5% of the reference population being affected within one year. JNCC *et al.* (2010) draft guidance considered 4% as the maximum potential growth rate in harbour porpoise, and the 'default' rate for cetaceans. Therefore, beyond natural mortality, up to 4% of the population could theoretically be permanently removed before population growth would be halted. In assigning 5% to a temporary impact in this assessment, consideration is given to uncertainty of the individual consequences of temporary disturbance.

Permanent effects to greater than 1% of the reference population being affected within a single year are considered to be high magnitude in this assessment. This is based on ASCOBANS and Defra advice (Defra, 2003; ASCOBANS, 2015) relating to impacts from fisheries by-catch (i.e. a permanent effect) on harbour porpoise. A threshold of 1.7% of the relevant harbour porpoise population above which a population decline is inevitable has been agreed with Parties to ASCOBANS, with an intermediate precautionary objective of reducing the impact to less than 1% of the population (Defra, 2003; ASCOBANS, 2015).

Impact significance

Following the identification of receptor value and sensitivity and magnitude of the effect, it is possible to determine the significance of the impact. The impact assessment matrix as presented in **Table 5.4** has been used wherever relevant to determine impact significance levels, alongside expert judgement to ensure overall impact significances are realistic and proportional.

12.4.1.1 Conservation Status

When assessing potential impacts consideration is given to the definition of the Conservation Status of a species. There are three parameters that determine when the Conservation Status of a species can be taken as Favourable:

- Population(s) of the species is maintained on a long-term basis;
- The natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future; and,
- The habitat on which the species depends (for feeding, breeding, rearing etc.) is maintained in sufficient size to maintain the population(s) over a period of years/decades.

Member states report back to the EU every six years on the Conservation Status of marine EPS. In the UK, of the common or newly arriving marine mammal species, 11 out of 12 cetacean species have been assessed as having an 'unknown' Conservation Status, and one has not been assessed (based on the 2013-2018 reporting (JNCC, 2019). Some of these species were given a FCS in previous reporting periods, however, the implementation of more robust FCS assessment methodology requires a higher number of UK population estimates over time than are currently available. **Table 12-6** presents the Conservation Status of commonly occurring marine mammal species within UK waters that are of relevance for the proposed development (JNCC, 2019).

There are two species of seals common to UK waters, the grey seal and harbour seal. The current conservation status, as assessed in the 4th UK report on implementation of the Habitats Directive (submitted to the European Commission in 2019), of the grey seal is 'favourable' (JNCC, 2019). The current conservation status, as assessed in the 4th UK report on implementation of the Habitats Directive (submitted to the European Commission in 2012), of the harbour seal is 'unfavourable' for the overall assessment (JNCC, 2019).

Table 12-6 FCS assessment of cetacean species of relevance for the proposed development (JNCC, 2019).

Species	FCS assessment		
	Assessment for range	**Assessment for population level**	**Assessment for supporting habitats**
Harbour porpoise	Favourable	Unknown	Unknown
Bottlenose dolphin	Favourable	Unknown	Unknown
White-beaked dolphin *Lagenorhynchus albirostris*	Favourable	Unknown	Unknown
Minke whale *Balaenoptera acutorostrata*	Favourable	Unknown	Unknown
Humpback whale *Megaptera novaeangliae*	Not assessed		
Sei whale *Balaenoptera borealis*	Not assessed		
Grey seal	Favourable	Favourable	Favourable
Harbour seal	Favourable	Unfavourable - inadequate	Unknown

12.4.2 Transboundary Impact Assessment

There is a significant level of marine development being undertaken or planned by European Union Member States (i.e. Norway, Denmark, Germany Belgium and the Netherlands) in the North Sea. Populations of marine mammals are highly mobile and there is potential for transboundary impacts, especially when considering noise impacts.

Transboundary impacts will be assessed, where possible, in consultation with developers in other Member States to obtain up to date project information to feed into the assessment.

Transboundary impacts will be assessed, as with the other cumulative impacts, for the relevant marine mammal Management units (MUs). The potential for transboundary impacts will be addressed by considering the reference populations and potential linkages to international designated sites as identified through telemetry studies for seals and ranges and movements of cetacean species.

The assessment of the effect on the integrity of the transboundary European sites as a result of impacts on the designated marine mammal populations will be undertaken and presented in the shadow HRA provided in support of the marine licence application.

12.5 Scope

12.5.1 Study Area

The MUs provide an indication of the spatial scales at which effects of plans and projects alone, and cumulatively, need to be assessed for the key cetacean species in UK waters, with consistency across the UK (Inter-Agency Marine Mammal Working Group (IAMMWG), 2021). The study area, MUs and reference populations have been determined based on the most relevant information and scale at which potential impacts from the Project with other plans and projects could occur.

For each species of marine mammal, the following study areas have been defined based on the relevant MUs, current knowledge and understanding of the biology of each species:

- Harbour porpoise: North Sea (NS) MU;
- Bottlenose dolphin: Coastal East Scotland (CES);
- White-beaked dolphin: Celtic and Greater North Seas (CGNS) MU;
- Minke whale: CGNS MU;
- Grey seal: East Scotland (ES) and the Moray Firth (MF); and,
- Harbour seal: ES and the MF.

There is the potential for seals from haul-out sites to move along the coast and offshore to forage in and around the Project areas. Haul-out sites for seal species within the vicinity of the proposed development include:

- Inchkeith, for grey seal, approximately 4.5km from the proposed development.
- Potential harbour and grey seals on the rocky outcrops to the east of the eastern breakwater, with rare sightings of the species within the docks.

12.6 Data Sources

A number of publicly available datasets and information on marine mammal in the area were used in the baseline review and impact assessment. These are listed in **Table 12-7**.

Table 12-7 Marine mammal data sources

Data	Year	Coverage	Notes
Small Cetaceans in the European Atlantic and North Sea (SCANS-III) data (Hammond *et al.*, 2021).	Summer 2016	North Sea and European Atlantic waters	Provides information including abundance and density estimates of cetaceans in European Atlantic waters in summer 2016, 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.
Revised Phase III data analysis of Joint Cetacean Protocol (JCP) data resources (Paxton et al., 2016).	1994-2011	UK Exclusive Economic Zone (EEZ)	Provides information on harbour porpoise in the North Sea area.
The identification of discrete and persistent areas of relatively high harbour porpoise density in the wider UK marine area (Heinänen and Skov, 2015).	1994-2011	UK EEZ	Data was used to determine harbour porpoise SAC sites.
MUs for cetaceans in UK waters (IAMMWG, 2021).	2021	UK waters	Provides information on cetacean MUs for the proposed offshore development area.

Data	Year	Coverage	Notes
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.
Offshore Energy Strategic Environmental Assessment (including relevant appendices and technical reports) (Department of Energy and Climate Change (DECC) (now Department for Business, Energy and Industrial Strategy (BEIS)), 2016).	2016	UK waters	Provides information for the wider North Sea area.
UK seal at sea density estimates and usage maps (Russell *et al.,* 2017).	1988-2016	North Sea	Provides information on species sighted along east coast of England.
Habitat-based predictions of at-sea distribution for grey and harbour seals in the British Isles (Carter *et al.,* 2020).	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.

12.7 Baseline Environment

A number of marine mammal species are found off the east coast of Scotland, and within the Firth of Forth, with the most common being harbour porpoise, white-beaked dolphin, grey seal and harbour seal (Paxton *et al*., 2016; Waggitt *et al*., 2019; Carter *et al*., 2020). Other species include minke whale, with increased presence in the summer periods (DECC, 2016; Paxton *et al*., 2016; Waggitt *et al*., 2019). In addition, in recent years, the population of bottlenose dolphin has been increasing in this area, as the Moray Firth population extends its range south (Civil *et al*., 2018). Less common marine mammal species in this area include sei whale, humpback whale [17], killer whale *Orcinus orca*, Atlantic white-sided dolphin *Lagenorhynchus acutus*, Risso's dolphin *Grampus griseus* and long-finned pilot whales *Globicephala melas* (DECC, 2016; Waggitt *et al*., 2019).

A large-scale survey of the presence and abundance of cetacean species around the north-east Atlantic, undertaken in the summer of 2016 (the Small Cetaceans in the European Atlantic and North Sea (SCANS) III survey; Hammond *et al.,* 2021), indicates harbour porpoise to be the most common cetacean species present in the relevant survey block R. Other cetacean species recorded in survey blocks R include bottlenose dolphin, white-beaked dolphin, white-sided dolphin and minke whale (**Figure 12-1**).

[17] https://www.edinburghlive.co.uk/news/edinburgh-news/incredible-video-captures-huge-humpback-19884228

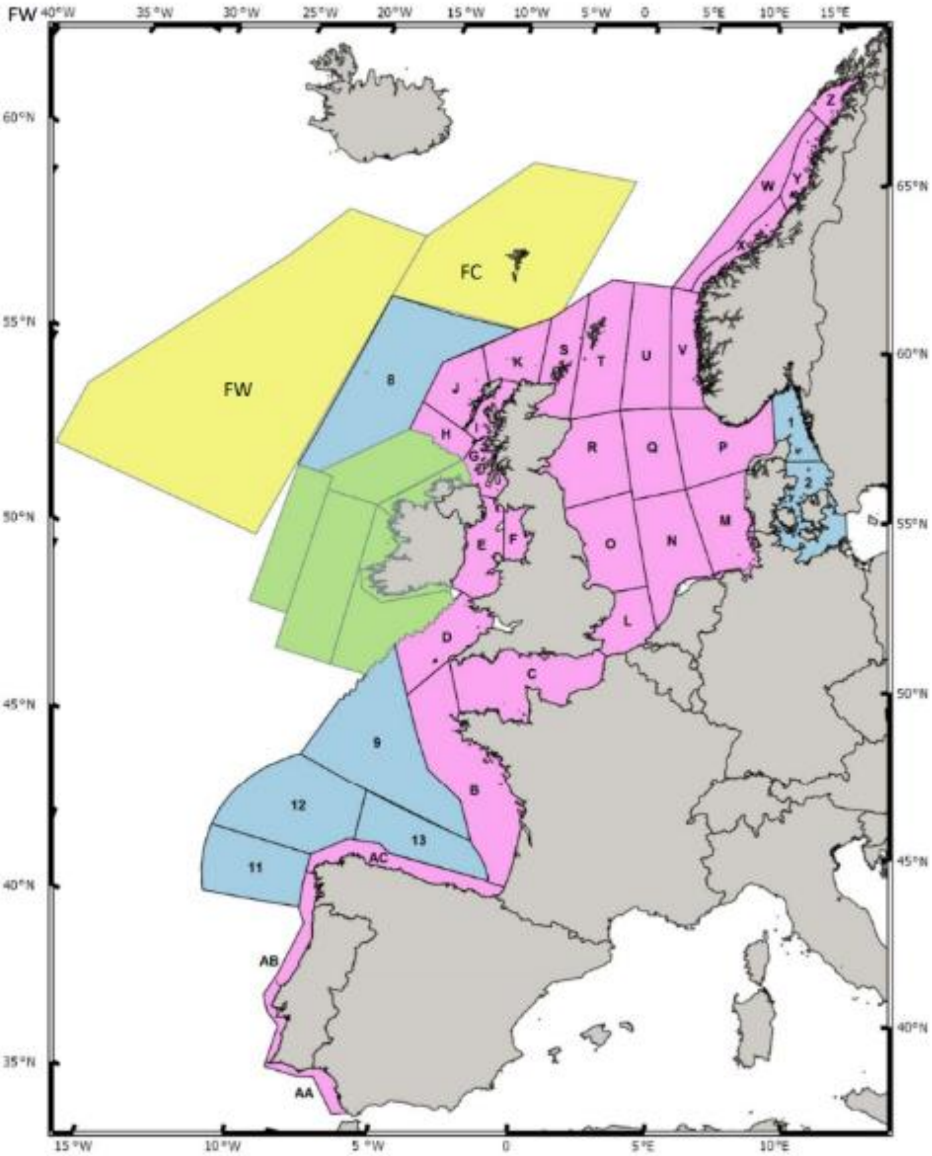

Figure 12-1 Area covered by SCANS-III and adjacent surveys. SCANS-III: pink lettered blocks were surveyed by air; blue numbered blocks were surveyed by ship. Blocks coloured green were surveyed by the Irish ObSERVE project. (Hammond et al., 2021).

Distribution and abundance maps have been developed by Waggitt *et al.* (2019) for cetacean species around Europe. These maps were generated based on a collation of survey effort across the north-east Atlantic between 1980 and 2018, with a total of 1,790,375km of survey effort for cetaceans. All survey data was standardized to generate distribution maps at 10km resolution, with maps generated for each species included for each month of the year. Distribution maps of cetacean species within the north-east Atlantic also indicate that harbour porpoise and white-beaked dolphin are present off north east Scotland in the highest densities, followed by Risso's dolphin, killer whale and minke whale, while bottlenose dolphin[18], short-beaked common dolphin and Atlantic white-sided dolphin are present but in lower densities (**Figure 12-2**; values are provided at 10km resolution. A different colour gradient is used for each species. Bottlenose dolphin in (a) represents the offshore ecotype, and therefore does not include the distributions of resident bottlenose dolphin populations (such as Moray East) Waggitt *et al.,* 2019).

[18] *These density maps show the presence of offshore bottlenose dolphin only, and do not therefore include consideration of the resident populations around the UK and northern Europe coastlines.*

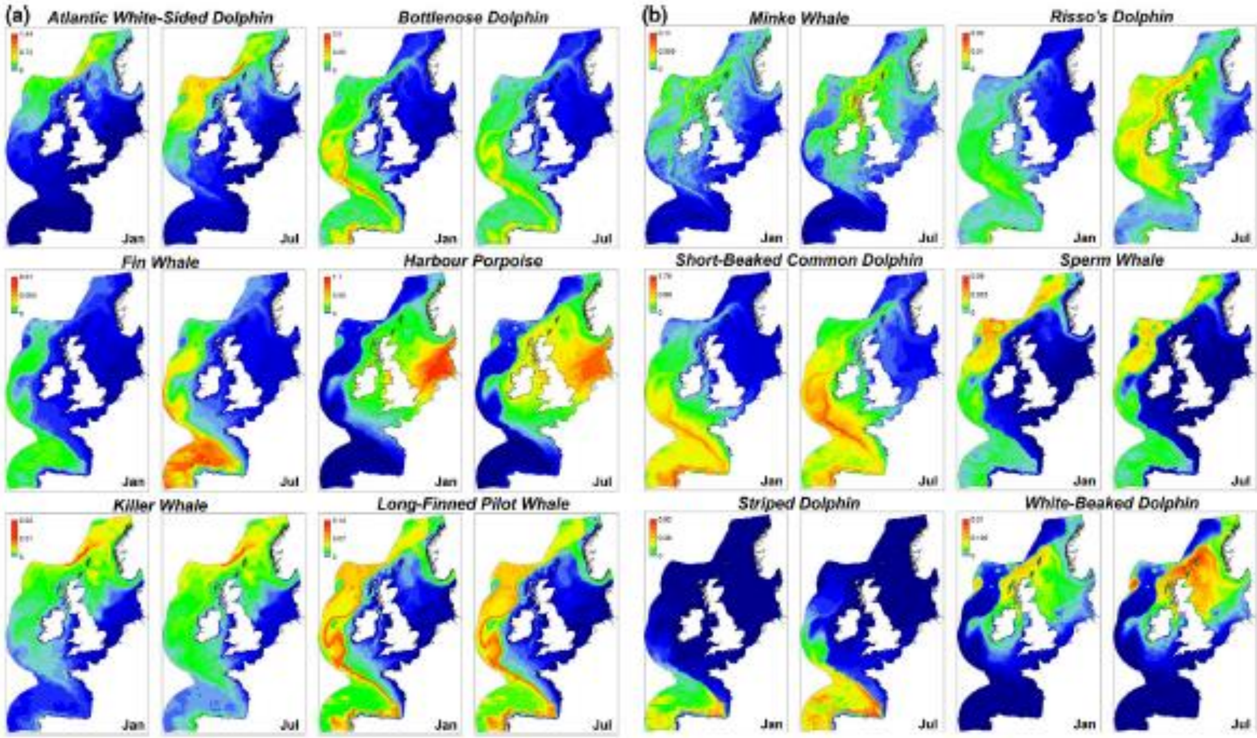

Figure 12-2 Spatial variation in predicted densities (animals per km^2) of cetacean species in January and July in the North-East Atlantic (taken from Waggitt et al., 2019)

Two species of seal are found in the UK, the grey seal and the harbour seal. The grey seal is found on both sides of the North Atlantic Ocean although the greatest proportion of the population is found in UK waters. The UK population of harbour seals has in recent years been in decline, but is now increasing and is close to the level it was before the decline occurred. The decline in population levels varies between colonies, with some in Scotland experiencing high levels of declines, while others were stable or increasing. Approximately 36% of the world's grey seals breed in the UK, of which 81% are from sites in Scotland, with the main colonies being in the Outer Hebrides and Orkney (SCOS, 2020). Approximately 32% of the European harbour seal population are found in the UK, which has declined from approximately 40% in 2002 (SCOS, 2020).

Within the Firth of Forth the closest designated grey seal haul-out site[19] is Inchkeith, approximately 4.5km from the proposed development. There are haul-out sites for grey and harbour seal in the Firth of Forth and along the east coast of Scotland (**Figure 12-3**; SCOS, 2020), therefore there is the potential for foraging seal within the vicinity of the proposed development. The nearest major (and protected) haul-out sites are located approximately 43km at the Isle of May SAC and the Berwickshire and North Northumberland Coast SAC (63km), designated for grey seal, and approximately 64km to the Firth of Tay and Eden Estuary SAC from the proposed development, designated for harbour seal (**Figure 12-3**; SCOS, 2020).

Global positioning system (GPS) tracking data from tagged grey and harbour seals indicates there is the potential for grey seal to be present in the proposed development and Forth of Firth area, and to have travelled from some distance from the north and south, although harbour seal are less likely to be travel from significant distance **(Figure 12-4**; Carter *et al.,* 2020).

[19] The Protection of Seals (Designation of Haul-Out Sites) (Scotland) Order 2014

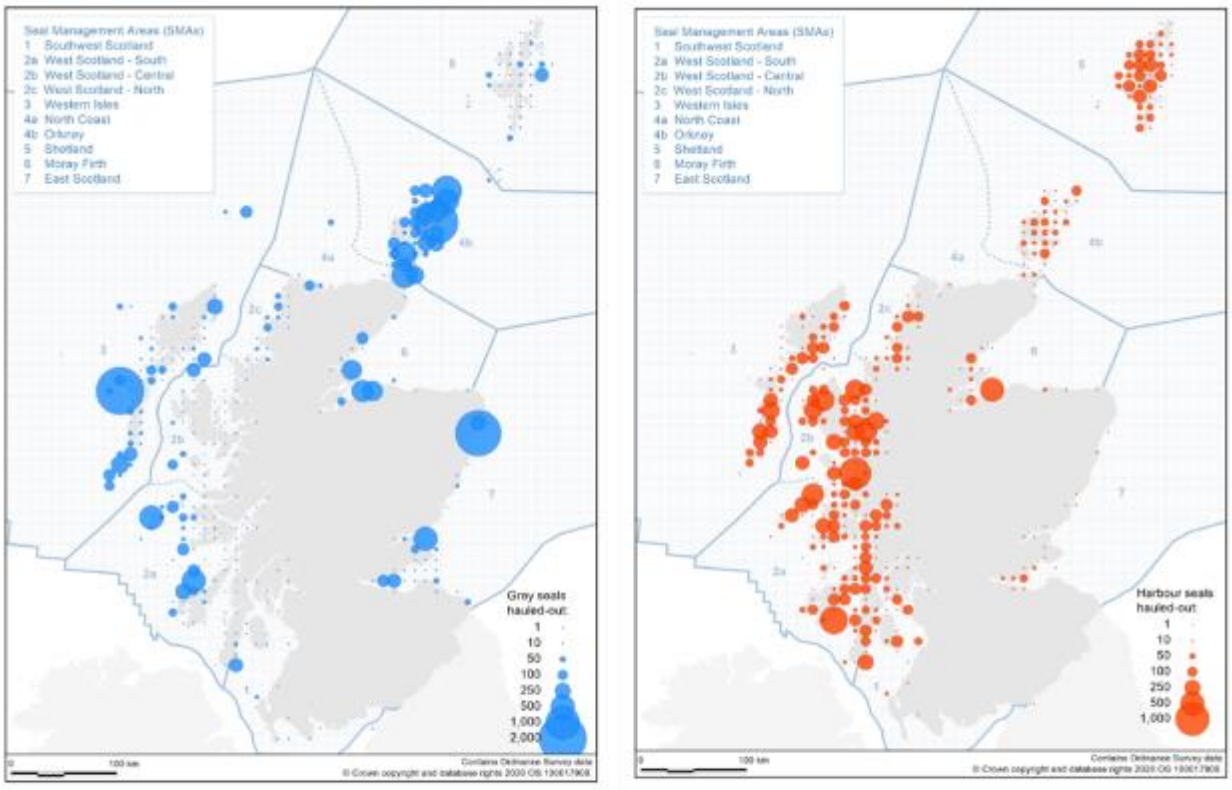

Figure 12-3 Map of (i) grey seal (blue) and (ii) harbour seal (red) distribution by 10 km squares based on haul-out counts obtained from the most recent aerial surveys carried out during the harbour seal moult in August 2016-2019 (taken from SCOS, 2020)

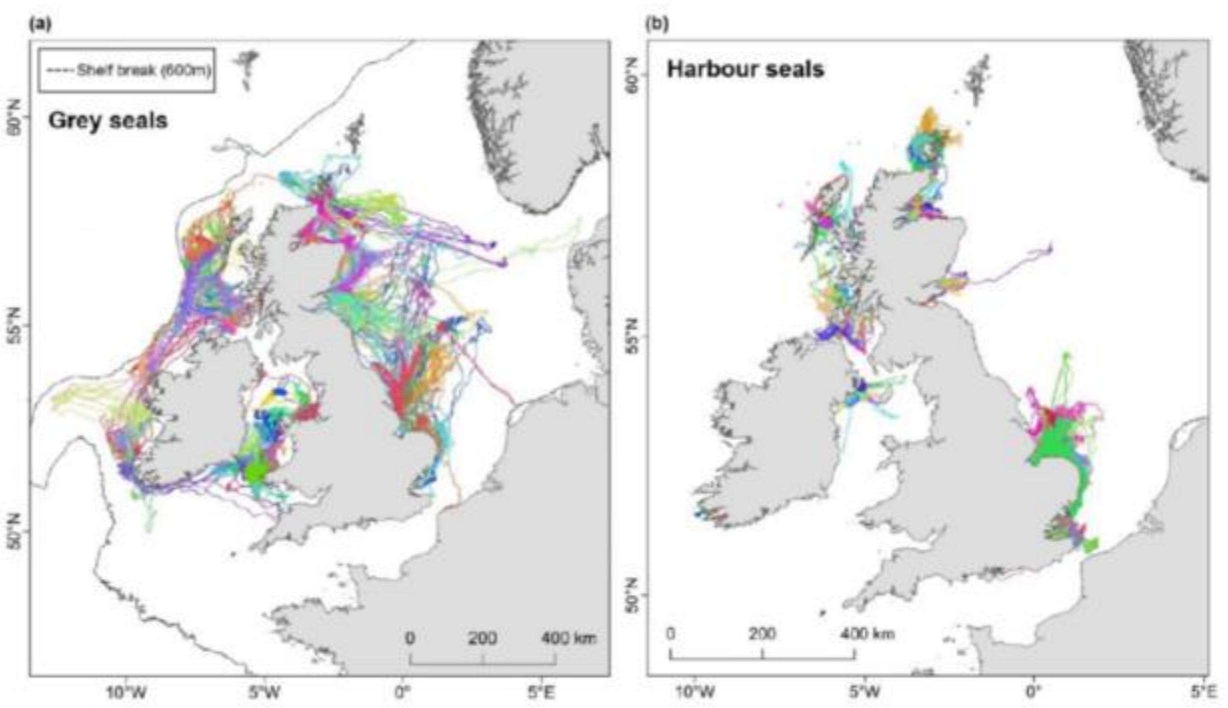

Figure 12-4 GPS tracking data for (a) grey and (b) harbour seals (taken from Carter et al., 2020)

The following sections focus on the key marine mammal species in the Firth of Forth area, including harbour porpoise, bottlenose dolphin, white-beaked dolphin, minke whale, grey seal, and harbour seal. However, there are other species that, while relatively rare in the area presently, are becoming increasingly common, such as humpback whale and sei whale. The information on these species in the area is sparse, and they are therefore not considered further for the proposed development. However, the key impact of underwater noise considers the potential for impact to whale species through the assessment on minke whale. The resultant impact ranges and areas would be the same for the rarer whale species as they are for minke whale, and any mitigations would protect both humpback whale and sei whale, as they will be designed to protect minke whale. Therefore, while not considered in detail, these two rarer whale species will be fully mitigated for due to the potential for underwater noise impacts, and there would therefore be no significant impact to either of these species, if they were to increase in presence in the area.

12.7.1 Harbour Porpoise

12.7.1.1 Distribution and Abundance

Within the North Sea area, harbour porpoise are the most common marine mammal species. Heinänen and Skov (2015) identified that within the North Sea, water depth and hydrodynamic variables are the most important factors in harbour porpoise densities in species areas, in both winter and summer seasons. The seabed sediments also play an important role in determining areas of high harbour porpoise density, as well as the number of vessels present in the area.

The proposed development is located in SCANS-III survey block R (**Figure 12-1**) and the estimated abundance of harbour porpoise in this survey block is 38,646 harbour porpoise (95% Confidence interval (CI) = 20,584- 66,524); with a density estimate of 0.599 individuals/km^2 (Coefficient of variation (CV) = 0.287 (Hammond *et al.,* 2021).

For harbour porpoise, the Waggitt *et al.* (2019) distribution maps show a clear pattern of high harbour porpoise density in the southern North Sea, and the coasts of south-east England, for both January and July (Waggitt *et al.,* 2019). Examination of this data, including all 10km grids that overlap with the proposed development indicates an average annual density estimate of 0.461 individuals per km^2.

There are three MUs for harbour porpoise around the UK: North Sea; West Scotland; and the Celtic and Irish Sea (IAMMWG, 2021). The proposed development is located in the North Sea (NS) MU for harbour porpoise, which has an abundance estimate of 346,601 (CV= 0.09; 95% CI = 289,498 – 419,967; IAMMWG, 2021).

12.7.1.2 Diet and Prey Species

The distribution and occurrence of harbour porpoise and other marine mammals is most likely to be related to the availability and distribution of their prey species. For example, sandeels (*Ammodytidae*), which are known prey for harbour porpoise, exhibit a strong association with particular surface sediments.

The diet of the harbour porpoise consists of a wide variety of fish, including pelagic schooling fish, as well as demersal and benthic species, especially Gadoids, Clupeids and Ammodytes. Other prey species such as cephalopods, other molluscs, crustaceans and polychaetes have also been recorded. The diet varies geographically, seasonally and annually, reflecting changes in available food resources and differences in diet between sexes or age classes (Berrow and Rogan, 1995; Kastelein *et al.,* 1997; Börjesson *et al.,* 2003; Santos and Pierce, 2003; Santos *et al.,* 2004).

12.7.2 Bottlenose Dolphin

12.7.2.1 Distribution and Abundance

A resident population of bottlenose dolphin is present in the Moray Firth, and are known to travel south along the coast to the Firth of Tay. Historically, very few sightings of bottlenose dolphin were recorded south of the Firth of Forth on the east coast of the UK, however, in recent years an increase in bottlenose dolphins in the north-east of England has been reported (Aynsley, 2017), with one individual from the Moray Firth population being recorded as far south as The Netherlands.

For the entire SCANS-III survey area, bottlenose dolphin abundance in the summer of 2016 was estimated to be 19,201, with an overall estimated density of 0.0159/km^2 (CV = 0.242; 95% CI = 11,404 - 29,670; Hammond *et al.*, 2021). The SCANS-III survey block R which proposed development is located, has abundance and density estimates for bottlenose dolphin (Hammond *et al.*, 2021) of 1,924 bottlenose dolphin (95% CI = 0 - 5,048) and a density estimate of 0.0298 bottlenose dolphin/km^2 (CV = 0.861).

For bottlenose dolphin, the distribution maps (**Figure 13-2**; Waggitt *et al.,* 2019) show a clear pattern of higher density to the western coastal areas of the UK, extending south to the Bay of Biscay. Densities of bottlenose dolphin in the North Sea are very low in comparison (Waggitt *et al.,* 2019). Examination of this data, including all 10km grids that overlap with proposed development, indicates an average annual density estimate of 0.00008 individuals per km^2. However, as noted above, the Waggitt *et al.,* (2019) distribution maps include data for the offshore eco-type of bottlenose dolphin, and therefore would not provide accurate mapping for areas with resident bottlenose dolphin populations (such as the east coast of Scotland).

The IAMMWG (2021) define seven MUs for bottlenose dolphin. The proposed development site is located in the Coastal East Scotland (CES) MU; the CES has an abundance estimate of 189 (95% CI = 155 – 216; IAMMWG, 2021). However, a more recent population estimate for the CES area is available, with a population estimate of 224 (CV = 0.023; 95% CI = 214 – 234; Arso Civil *et al*., 2021). This more recent population estimate for the CES area will be used in place of the IAMMWG estimate.

12.7.2.2 Diet and Prey Species

Bottlenose dolphin are opportunistic feeders and take 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, reveals that the main prey are cod *Gadus morhua* (29.6% by weight), saithe *Pollachius virens* (23.6% by weight), and whiting *Merlangius merlangus* (23.4% by weight), although other species including salmon *Salmo salar* (5.8% by weight), haddock *Melanogrammus aeglefinus* (5.4% by weight) and cephalopods (2.5% by weight) were also identified in lower number (Santos *et al.,* 2001).

12.7.3 White-beaked Dolphin

12.7.3.1 Distribution and Abundance

White-beaked dolphin are the second most commonly occurring cetacean in UK shelf waters, regularly encountered in coastal and offshore waters while very rare in deeper waters beyond the shelf edge (DECC, 2016). Their distribution is generally restricted to the northern half of UK waters, with greatest abundance in the central and northern North Sea, Orkney and Shetland and north-west Scotland (DECC, 2016). The results of the JCP Phase III Report (Paxton *et al*., 2016) identified that for white-beaked dolphin, densities are low across much of UK waters, with higher densities shown to be in the Hebrides and the northern North Sea.

For the entire SCANS-III survey area, white-beaked dolphin abundance in the summer of 2016 was estimated to be 36,287 with an overall estimated density of 0.0300/km^2 (CV = 0.288; 95% CI = 18,694 - 61,869; Hammond *et al.*, 2021). The SCANS-III surveys show higher densities in the northern North Sea area. The proposed development is located in SCANS-III survey block R (Hammond *et al*., 2021) with an abundance estimate of 15,694 white-beaked dolphin (95% CI = 3,022-33,340) and a density estimate of 0.243 white-beaked dolphin/km^2 (CV = 0.484).

For white-beaked dolphin, the distribution maps (**Figure 13-2**; Waggitt *et al.,* 2019) show a clear pattern of higher density in the northern North Sea, and around the coasts of Scotland, with decreasing densities southwards of Scotland along the east coast of England. There is also a clear seasonal difference in the densities of white-beaked dolphin, with higher densities in July, particularly to the north of their range (Waggitt *et al*., 2019). Examination of this data, including all 10km grids that overlap with proposed development, indicates an average annual density estimate of 0.008 individuals per km^2.

There is a single MU for white-beaked dolphin, the Celtic and Greater North Seas (CGNS) MU. The reference population for white-beaked dolphin in the CGNS MU is 43,951 animals (CV = 0.22; 95% CI = 28,439 – 67,924; IAMMWG, 2021).

12.7.3.2 Diet and Prey Species

Analysis of the stomach contents of white-beaked dolphin have shown that the species feed on a wide range of fish and squid species, including cod, whiting, and hake *Merluccius merluccius* (Kinze *et al.,* 1997; Reeves *et al.,* 1999). White-beaked dolphin have also been observed to associate with herring *Clupea harengus* (Harmer, 1927; Fraser, 1946; Evans, 1980) and mackeral *Scomber scombrus* (Evans *et al.,* 1987) shoals, and anecdotal evidence from fisherman in Scotland suggests that individuals seen inshore may coincide with mackerel appearing in the same areas (Canning *et al.,* 2008).

Dietary analysis for 22 white-beaked dolphin stranded around the UK coast between 1992 and 2003 (Canning *et al.,* 2008) found that while a wide variety of prey species were identified, the majority of prey were from a much smaller number of species. Haddock and whiting were the most predominantly found, representing 43% and 24% respectively of the total reconstructed weight, cod represented a further 11% of the total reconstructed weight.

12.7.4 Minke Whale

12.7.4.1 Distribution and Abundance

Minke whales are widely distributed around the UK, with higher densities recorded on the West coast of Scotland and the western North Sea (Reid *et al.,* 2003). They occur mainly on the continental shelf in water depths less than 200m and are predominantly a seasonal visitor to UK waters, with sightings increasing from May to October, with sightings rare outside of this period (e.g. JCP data; Paxton *et al.,* 2016). All minke whales in UK waters are considered to be part of the Celtic and Greater North Seas MU (IAMMWG, 2021).

For the entire SCANS-III survey area, minke whale abundance in the summer of 2016 was estimated to be 13,101 with an overall estimated density of 0.0108/km^2 (CV = 0.345; 95% CI = 7,050 – 26,721; Hammond *et al.,* 2021). The proposed development is located within SCANS-III survey block R (Hammond *et al.,* 2021) where there is an abundance estimate of 2,498 minke whale (95% CI = 604-6,791) and a density estimate of 0.0387 individuals/km^2 (CV = 0.614).

For minke whale, the distribution maps (**Figure 13-2**; Waggitt *et al.,* 2019) show a clear pattern of higher density in the northern North Sea, and around the coasts of Scotland, Ireland and within the Celtic and Irish Seas, with decreasing densities southwards of Scotland along the east coast of England. There is a clear seasonal difference in the densities of minke whale, with higher densities in July, which is particularly evident in the north of their range (Waggitt *et al.,* 2019). Examination of this data, including all 10km grids that overlap with proposed development indicates an average annual density estimate of 0.0035 individuals per km^2.

There is single MU for minke whale, the CGNS MU. The reference population for minke whales in the CGNS MU is 20,118 animals (CV = 0.18; 95% CI = 14,061 – 28,786; IAMMWG, 2021).

12.7.4.2 Diet and Prey Species

Minke whales feed on a variety of fish species, including herring, cod and haddock. Minke whale feed by engulfing large volumes of prey and water, which they then 'sieve' out of through their baleen plates and swallow their prey whole. Sandeels and mackerel were found to be the most dominant prey species for minke whale in the northern North Sea (Windsland *et al.,* 2007).

12.7.5 Grey Seal

12.7.5.1 Distribution and Abundance

Grey seals only occur in the North Atlantic, Barents and Baltic Sea with their main concentrations on the east coast of Canada and United States of America and in north-west Europe (SCOS, 2020). Approximately 36% of the world's grey seals breed in the UK, and 81% of these breed at colonies in Scotland with the main concentrations in the Outer Hebrides and in Orkney. They haul out on land to rest, moult and breed and forage at sea where they range widely, frequently travelling for up to 30 days with over 100km between haul-out sites (SCOS, 2020).

Compared with other times of the year, grey seals in the UK spend longer hauled out during their annual moult (between December and April) and during their breeding season, in eastern England, pupping occurs mainly between early November and mid-December (SCOS, 2020).

Grey seal forage in the open sea and they may range widely to forage and frequently travel over 100km between haul-out sites (SCOS, 2020). Foraging trips can last anywhere between one and 30 days. Tracking of individual grey seals has shown that most foraging probably occurs within 100km of a haul-out site, although they can feed up to several hundred kilometres offshore (SCOS, 2020). Grey seals are likely to present in and around the proposed development (SCOS, 2020; Russell *et al.,* 2017; Carter *et al.,* 2020).

Carter *et al.,* (2020) provides habitat-based predictions of at-sea distribution for grey and harbour seals in the British Isles. The habitat preference approach predicted distribution maps provide estimates per species, on a 5km x 5km grid, of relative at-sea density for seals hauling-out in the British Isles. It is important to note that Carter *et al.* (2020) provides *relative density* (i.e. percentage of at-sea population within each 5km x 5km grid square), whereas previous usage maps (Russel *et al.,* 2017) have presented *absolute density* (i.e. number of animals).

For grey seal, the mean predicted *relative density* for all grid squares that overlap with the proposed development is 0.627/km^2 of, a relative density of very high when compared to the overall distributions of grey seal (Carter *et al*., 2020).

The grey seal *absolute density* estimates for the proposed development, calculated from the 5km x 5km grid cells that overlap with the proposed development. The mean at-sea density estimates from this data has been used in the assessment, as the worst-case, with a grey seal density estimate of 1.063 individuals per km^2 (Russell *et al.,* 2017).

Grey seal population trends are assessed from the counts of pups born during the autumn breeding season, when females congregate on land to give birth (SCOS, 2020). The pup production estimates are converted to estimates of total population size (1+ aged population) using a mathematical model and projected forward (SCOS, 2020). The most recent surveys of the principal grey seal breeding sites Scotland, Wales, Northern Ireland and south-west England, resulted in an estimate of 68,050 pups (95% CI = 60,500-75,100; SCOS 2020). When the pup production estimates are converted to estimates of total population size, there was an estimated 149,700 grey seals in 2019 (approximate 95% CI = 120,000-174,900; SCOS, 2020). The most recent counts of grey seal in the August surveys 2016-2019, estimated that the minimum count of grey seals in the UK was 42,765 (SCOS, 2020).

As grey seal travel up to 100km from haul-out sites for foraging, a larger MU area has been used for the assessment to ensure that the wider population is considered for the impact assessments. The reference population extent for grey seal will therefore incorporate the Moray Firth MU and East Scotland MU (IAMMWG, 2013; SCOS, 2020). Assessments have been made against the East Scotland MU (as is the one within which the proposed development lies) and against the Moray Firth and East Scotland MUs together. The reference population for these areas are as follows:

- East Scotland MU = 3,683 grey seal (SCOS, 2020)
- Moray Firth MU = 1,657 grey seal (SCOS, 2020)

12.7.5.2 Haul-out Sites

As noted above, the nearest grey seal haul-out site is Inchkeith, approximately 4.5km from the proposed development. Other nearby haul-out sites include Inchmickery and Cow & Calves, and Kinghorn Rocks (approximately 5.5km and 9.5km from the proposed development respectively). **Figure 12-3** indicates approximately 200 grey seals haul-out at Inchkeith, and approximately 150 at Inchmickery and Cow & Calves (SCOS, 2020). Grey seals are known to pup at the Inchkeith haul-out site. There are also a number of other grey seal haul-out sites in the Firth of Forth area, including at the Isle of May and Berwickshire and Northumberland Coast SAC.

12.7.5.3 Diet and Prey Species

Grey seals will typically forage in the open sea and return regularly to land to haul-out, although they may frequently travel up to 100km between haul-out sites. Foraging trips generally occur within 100km of their haul-out sites, although grey seal can travel up to several hundred kilometres offshore to forage (SCOS, 2019). Grey seal generally travel between known foraging areas and back to the same haul-out site, but will occasionally move to a new site. For example, movements have been recorded between haul-out sites on the east coast of England and the Outer Hebrides (SCOS, 2019).

Grey seals are generalist feeders, feeding on a wide variety of prey species (SCOS, 2019; Hammond and Grellier, 2006). Diet varies seasonally and from region to region (SCOS, 2019).

In the North Sea, principal prey items are sandeel, whitefish (such as cod, haddock, whiting and ling *Molva molva*) and flatfish (plaice *Pleuronectes platessa*, sole *Solea solea*, flounder *Platichthys flesus*, and dab *Limanda limanda*) (Hammond and Grellier, 2006). Amongst these, sandeels are typically the predominant prey species.

Food requirements depend on the size of the seal and fat content (oiliness) of the prey, but an average consumption estimate of an adult is 4 to 7kg per seal per day depending on the prey species (SCOS, 2019).

12.7.6 Harbour Seal

12.7.6.1 Distribution and Abundance

Harbour seals have a circumpolar distribution in the Northern Hemisphere and are divided into five sub-species. The population in European waters represents one subspecies *Phoca vitulina vitulina* (SCOS, 2020). Harbour seals are widespread around the west coast of Scotland and throughout the Hebrides and Northern Isles. On the east coast of the UK, their distribution is more restricted with concentrations in the major estuaries of the Thames, The Wash, Firth of Tay and the Moray Firth.

Harbour seals come ashore in sheltered waters, typically on sandbanks and in estuaries, but also in rocky areas. They give birth to their pups in June and July and moult in August. At these, as well as other times of the year, harbour seals haul-out on land regularly in a pattern that is often related to the tidal cycle. They forage at sea and haul-out on land to rest, moult and breed.

Harbour seals normally feed within 40km and 50km around their haul out sites (SCOS, 2020). Tracking studies have shown that harbour seal typically travel between 50km and 100km offshore and can travel 200km between haul-out sites (Lowry *et al*., 2001; Sharples *et al*., 2012). The range of these trips varies depending on the location and surrounding marine habitat.

Harbour seal are likely present in lower number around the proposed development, as harbour seal densities in the area are generally lower than for grey seals (SCOS, 2020; Russell *et al.,* 2017; Carter *et al.,* 2020).

For harbour seal, the mean predicted *relative density* for each grid square that overlaps with the proposed development is 0.258/km^2, a relative density of very low when compared to the overall distributions of harbour seal (Carter *et al*., 2020).

The harbour seal *absolute density* estimates for the proposed development area has been calculated from the 5km x 5km cells (Russell *et al.,* 2017). The mean at-sea density estimate has been used in the assessment, as the worst-case, with a mean harbour seal density estimate of 0.336 individuals per km^2.

Harbour seal are counted while they are on land during their August moult, giving a minimum estimate of population size (SCOS, 2020). Combining the most recent counts (2016-2019) gives a total of 31,774 counted in the UK. Scaling this by the estimated proportion hauled out (0.72 (95% CI = 0.54-0.88)) produces an estimated total population for the UK in 2019 of 44,100 harbour seal (approximate 95% CI = 36,100-58,800; SCOS, 2020).

As for grey seal, the reference population extent for harbour seal will incorporate the East Scotland MU and Moray Firth MU (IAMMWG, 2013; SCOS, 2020). The reference population for harbour seal is therefore currently based on the following most recent estimates for the:

- East Scotland MU = 343 harbour seal (SCOS, 2020)
- Moray Firth MU = 1,077 harbour seal (SCOS, 2020)

Assessments will be done in the context of the nearest MU as well as the wider reference population. As a worst-case it is assumed that all seals are from the nearest MU, the East Scotland MU, although the more realistic assessment is based on wider reference population which takes into account movement of seals.

12.7.6.2 Haul-out Sites

The nearest harbour seal haul-out sites are Inchmickery and Cow & Calves (approximately 5.5km from the proposed development), and Kinghorn Rocks (approximately 9.5km from the proposed development). **Figure 12-3** indicates between 50 and 100 harbour seal seals haul-out at Kinghorn Rocks, and between 10 and 50 at Inchmickery and Cow & Calves (SCOS, 2020). There are also a number of other harbour seal haul-out sites in the Firth of Forth area, including within the Firth of Tay and Eden Estuary SAC.

12.7.6.3 Diet and Prey Species

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, 2020). It is estimated harbour seals eat 3-5kg per adult seal per day depending on the prey species (SCOS, 2020).

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 30-45km 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 than grey seals and do not travel as far from haul-outs.

12.7.7 Summary of Marine Mammals

The known densities and populations of marine mammals at the proposed development, as described within the sections above, are summarised in **Table 12-8** below.

Table 12-8 Marine mammal densities and reference populations used in the underwater noise assessments

Marine mammal species	Density (/km^2)	Source of density estimate	Reference population	Source of reference population
Harbour porpoise	0.599	SCANS-III Survey Block R (Hammond *et al.*, 2021)	346,601	NS MU (IAMMWG, 2021)
Bottlenose dolphin	0.0298	SCANS-III Survey Block R (Hammond *et al.*, 2021)	224	Updated population estimate for the CES MU Arso Civil *et al.*, 2021)
White-beaked dolphin	0.243	SCANS-III Survey Block R (Hammond *et al.*, 2021)	43,951	CGNS MU (IAMMWG, 2021)
Minke whale	0.0387	SCANS-III Survey Block R (Hammond *et al.*, 2021)	20,118	CGNS MU (IAMMWG, 2021)
Grey seal	1.063	Russell *et al.,* 2017	3,683; 5,340	East Scotland (ES) MU (Special Committee on Seals (SCOS), 2020); ES & Moray Firth (MF) MU (SCOS, 2020)
Harbour seal	0.336	Russell *et al.,* 2017	343; 1,420	ES MU (SCOS, 2020); ES & MF MU (SCOS, 2020)

12.8 Potential Impacts During Construction

The potential impacts on marine mammals considered during the construction phase are:

- Potential for auditory injury and / or behavioural impacts from underwater noise during piling;
- Potential for auditory injury and / or behavioural impacts from underwater noise during dredging works;

- Any changes to water quality; and,
- Any changes in prey availability.

Any increase in vessels through the construction phase is expected to be minimal, and in line with current use of the port and surrounding area. Therefore, it is not expected that there would be any potential for impact as a result of the presence of construction vessels (including impacts as a result of underwater noise, or collision risk), either at the proposed development, or while transiting past any nearby seal haul-out sites. Due to the distance between seal haul-out sites and the proposed development, there is not expected to be any potential for direct impact to the sites. Therefore, the potential for any impact from vessels is scoped out of further assessment.

12.8.1 Potential for Impacts from Underwater Noise during Tubular Piling

Impact piling has long been established as a source of high level underwater noise (Würsig *et al.,* 2000; Caltrans, 2001; Nedwell *et al.,* 2003; 2007; Parvin *et al.,* 2006; Thomsen *et al.,* 2006). If a marine mammal is located very close to the piling sound source, the high peak pressure sound levels have the potential to cause death or physical injury, with a severe injury having the potential to lead to death, without mitigation. 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 PTS (Permanent Threshold Shift) or from a temporary loss in hearing sensitivity, or TTS (Temporary Threshold Shift). 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}).

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). As such, sensitivity to PTS from pile driving noise is assessed as high for harbour porpoise, bottlenose dolphin, white-beaked dolphin, and minke whale. 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; however, using the precautionary approach, both seal species are given a sensitivity of high to the impact of PTS exposures. 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 from the effects.

Harbour porpoise, bottlenose dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal are assessed as having medium sensitivity to TTS onset or for disturbance due to underwater noise.

12.8.1.1 Underwater Noise Modelling

The underwater noise modelling report is provided in **Appendix 10-1**[20], and a further assessment for the resultant underwater ranges (for both marine mammals and fish species) is provided in **Appendix 10-2**.

[20] *As a worst-case scenario, the underwater noise modelling modelled the use of a suction dredger, as this produces the highest sound levels. The modelling was also based on the assumption that all tubular piling would be installed by impact piling; however, there could be the requirement to drill piles that cannot be driven to the required depth. As drilling piles generates less noise than impact piling, the modelling has been based on the worst case scenario. Only the larger diameter piles have been included in the model as the worst case.*

12.8.1.2 Assessment of Impact due to Tubular Piling

Potential for PTS onset

The underwater noise modelling results and resultant assessments for the for PTS in harbour porpoise, bottlenose dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal are presented in **Table 12-9.**

The modelling for the single strike piling has been undertaken using the maximum hammer energy of 280kJ. The range for cumulative SEL (SEL_{cum}) for PTS is the distance an animal would need to be from the pile location to not be at risk of PTS from cumulative exposure (in this case, due to three piles being installed in one 24 hour period). SEL_{cum} determines the potential risk of PTS from the repeated percussive strikes required to install a single pile. The ranges at which an individual could experience PTS are assessed as a result of cumulative exposure during the entire piling duration of six hours (two hours per pile, up to three piles per day), based on the animals fleeing at a precautionary average swimming speed.

Table 12-9 Impact ranges and areas, and maximum number of individuals (and % of reference population) that could be at risk of PTS from tubular (impact) piling

Potential Impact	Receptor	Impact range (and area)	Maximum number of individuals (% of reference population)	Magnitude
PTS without mitigation – single strike	Harbour porpoise	<50m <0.01km^2	0.006 harbour porpoise (0.000002% NS MU)	Permanent effect with negligible magnitude (less than 0.001% of the reference population anticipated to be exposed to effect, without mitigation).
	Bottlenose dolphin	<50m <0.01km^2	0.0003 bottlenose dolphin (0.0001% CES MU)	
	White-beaked dolphin	<50m <0.01km^2	0.002 white-beaked dolphin (0.000006% CGNS MU)	
	Minke whale	<50m <0.01km^2	0.0004 minke whale (0.000002% MU)	
	Grey seal	<50m <0.01km^2	0.01 grey seal (0.0003% of the ES MU; or 0.0002% of the ES & MF MUs)	
	Harbour seal	<50m <0.01km^2	0.003 harbour seal (0.00098% of the ES MU; or 0.0002% of the ES & MF MUs	
PTS without mitigation – cumulative exposure	Harbour porpoise	<100m <0.1km^2	0.06 harbour porpoise (0.00002% NS MU)	Permanent effect with negligible magnitude (less than 0.001% of the reference population anticipated to be exposed to effect, without mitigation).
	Bottlenose dolphin	<100m <0.1km^2	0.003 bottlenose dolphin (0.001% CES MU)	Permanent effect with low magnitude (between 0.001% and 0.01% of the reference population anticipated to be exposed to effect, without mitigation).
	White-beaked dolphin	<100m <0.1km^2	0.02 white-beaked dolphin (0.00006% CGNS MU)	Permanent effect with negligible magnitude (less than 0.001% of the reference population anticipated to be exposed to effect, without mitigation).
	Minke whale	<100m <0.1km^2	0.004 minke whale (0.00002% CGNS MU)	

Potential Impact	Receptor	Impact range (and area)	Maximum number of individuals (% of reference population)	Magnitude
	Grey seal	<100m <0.1km^2	0.1 grey seal (0.003% of the ES MU; or 0.002% of the ES & MF MUs)	Permanent effect with low magnitude (between 0.001% and 0.01% of the reference population anticipated to be exposed to effect, without mitigation).
	Harbour seal	<100m <0.1km^2	0.034 harbour seal (0.0098% of the ES MU; or 0.002% of the ES & MF MUs)	

The impact range for all marine mammal species, due to a single strike of tubular (impact) piling is less than 50m (**Table 12-9**). The magnitude of the potential impact without any mitigation is negligible for all marine mammal species, with less than 0.001% of the relevant reference populations anticipated to be exposed to the effect without mitigation.

The impact range (without mitigation) within which PTS onset could occur from cumulative exposure, due to up to three piles being installed in a 12 hour period (a total of six hours of piling) for all marine mammal species is 100m (**Table 12-9**). This takes into account the anticipated soft-start and ramp-up procedure, as provided within **Appendix 10-1**. The magnitude of the potential impact without any mitigation is assessed as negligible for harbour porpoise white-beaked dolphin and minke whale, and low for bottlenose dolphin, and grey and harbour seal.

It should be noted that assessment for PTS from cumulative exposure is highly precautionary for the following reasons:

- The maximum impact ranges, based on the worst-case exposure levels an animal may receive at different depths in the water column, have been used in the assessment; this is highly conservative as it is unlikely a marine mammal would remain at this depth level;
- The assessment does not take account of periods where exposure will be reduced when they are at the surface or heads are out of the water; and,
- The cumulative noise dose received by the marine mammal will be largely dependent on the swimming speed, and whether the animal moves away from the noise source rapidly as a flee response.

Potential for TTS onset

The underwater noise modelling results and resultant assessments for the for TTS in harbour porpoise, bottlenose dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal are presented in **Table 12-10**.

As for PTS, the range for cumulative SEL (SEL_{cum}) for TTS is the distance an animal would need to be from the pile location to not be at risk of TTS from cumulative exposure due to three piles being installed in one 24 hour period. The ranges at which an individual could experience TTS are assessed as a result of cumulative exposure during the entire piling duration of six hours, based on the animals fleeing at a precautionary average swimming speed.

Table 12-10 Impact ranges and areas, and maximum number of individuals (and % of reference population) that could be at risk of TTS from tubular (impact) piling

Potential Impact	Receptor	Impact range (and area)	Maximum number of individuals (% of reference population)	Magnitude
TTS without mitigation – single strike	Harbour porpoise	60m 0.01km^2	0.006 harbour porpoise (0.000002% NS MU)	Temporary effect with negligible magnitude (less than 1% of the reference population anticipated to be exposed to effect, without mitigation).
	Bottlenose dolphin	<50m <0.01km^2	0.0003 bottlenose dolphin (0.0001% CES MU)	
	White-beaked dolphin	<50m <0.01km^2	0.002 white-beaked dolphin (0.000006% CGNS MU)	
	Minke whale	<50m <0.01km^2	0.0004 minke whale (0.000002% MU)	
	Grey seal	<50m <0.01km^2	0.01 grey seal (0.0003% of the ES MU; or 0.0002% of the ES & MF MUs)	
	Harbour seal	<50m <0.01km^2	0.003 harbour seal (0.001% of the ES MU; or 0.0002% of the ES & MF MUs)	
TTS without mitigation – cumulative exposure	Harbour porpoise	780m 0.5km^2	0.30 harbour porpoise (0.0001% NS MU)	Temporary effect with negligible magnitude (less than 1% of the reference population anticipated to be exposed to effect, without mitigation).
	Bottlenose dolphin	<100m <0.1km^2	0.003 bottlenose dolphin (0.0014% CES MU)	
	White-beaked dolphin	<100m <0.1km^2	0.02 white-beaked dolphin (0.00006% CGNS MU)	
	Minke whale	200m <0.1km^2	0.004 minke whale (0.00002% MU)	
	Grey seal	<100m <0.1km^2	0.1 grey seal (0.003% of the ES MU; or 0.002% of the ES & MF MUs)	
	Harbour seal	<100m <0.1km^2	0.034 harbour seal (0.01% of the ES MU; or 0.002% of the ES & MF MUs)	

The maximum impact range (without mitigation) within which TTS onset could occur due to a single strike, is 60m for harbour porpoise, and less than 50m for all other species (**Table 12-10**). The magnitude of the potential impact without any mitigation is assessed as negligible for all species, with less than 1% of the relevant reference population anticipated to be exposed to the temporary effect without mitigation.

The impact range (without mitigation) within which TTS onset could occur from cumulative exposure over 12 hours (up to six hours of piling) for harbour porpoise is up to 780m, and less than 100m for all other species (**Table 12-10**). The magnitude of the potential impact without any mitigation is assessed as negligible for all marine mammal species, with 1% or less of the relevant reference populations anticipated to be exposed to the temporary effect without mitigation.

Potential for disturbance

For marine mammal species, there is currently no agreed threshold for disturbance from underwater noise. The US National Marine Fisheries Service guidance (NMFS, 2018a) sets the Level B harassment threshold[21] for marine mammals at 160 dB re 1 µPa (root mean square (rms)) for impulsive noise and 120 dB re 1 µPa (rms) for continuous noise. However, Southall *et al.* (2021) found that simple all-or-nothing thresholds such as these, that attempt to relate single noise exposure parameters (e.g., received noise level) and behavioural response across broad taxonomic grouping and sound types, can lead to severe errors in predicting effects.

During a harbour development project in Scotland, the behavioural response of harbour porpoise and bottlenose dolphin was recorded, both for impact piling and vibro-piling, using an array of acoustic recording devices (Graham *et al*., 2017). Monitoring was undertaken for a year prior to construction, and during construction. The impact piling sound level was recorded as being 240 dB re 1 µPa. Neither harbour porpoise or bottlenose dolphins were excluded from the area as a result of the piling, but fine-scale changes in the local abundance were detected, and bottlenose dolphins were present in the area less often when impact piling was occurring, compared to where no activity was occurring (Graham *et al*., 2017). This indicates that harbour porpoise and bottlenose dolphin can be disturbed from a very localised area, and for a short-period of time.

While there is the potential for a displacement response from the area for any marine mammal species, it is predicted that they would return once the activity has been completed, and therefore any impacts from underwater noise as a result of piling will be both localised and temporary. Therefore, there is unlikely to be the potential for any significant impact on marine mammals. Any disturbance would be temporary and they would be expected to return to the area once the noise had ceased or they had become habituated to the sound. The magnitude of impact for all marine mammal species is assessed as being low, due to the predicted short-term nature and localised potential for disturbance.

Mitigation measures

Mitigation will be undertaken for all piling works at the proposed development, in accordance with the best practice guidance for minimising the risk of injury to marine mammals from piling noise provided by the JNCC[22] (JNCC, 2010). Mitigation measures include:

- The establishment of a mitigation zone of 200m from the piling location
    - The JNCC guidance recommends a mitigation zone of 500m, however, due to the small impact ranges predicted for the proposed development (of less than 100m for (PTS), a reduced mitigation zone of 200m would be used.
- Only commence piling operations during the hours of daylight and good visibility (and within the 12 hour construction window).
- Pre–piling search for marine mammals of mitigation zone by Marine Mammal Observer(s) (MMOs).
    - Delay if marine mammals detected within the mitigation zone.
- Soft-start and ramp-up of piling for a period of not less than 20 minutes.
- Pre–construction activity search and soft-start procedure should be repeated before piling recommences, if piling operations pause for a period of greater than 10 minutes.
- All mitigation procedures, soft-start and ramp-up, and reporting requirements, are as per the JNCC guidelines, with the exception of the reduced mitigation zone.

[21] *Level B Harassment is defined as having the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioural patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild.*

[22] *https://data.jncc.gov.uk/data/31662b6a-19ed-4918-9fab-8fbcff752046/JNCC-CNCB-Piling-protocol-August2010-Web.pdf*

Impact significance

PTS onset

Taking into account the receptor sensitivity (of high for all marine mammal species), and the potential magnitude of the effect (of negligible for all species), the impact significance for PTS in all species, from either a single strike or for cumulative exposure, has been assessed as being of **minor adverse significance** (**Table 12-11**).

The residual impact of the potential risk of PTS onset to marine mammals as a result of underwater noise during tubular piling would be reduced to **negligible significance, which is not significant in EIA terms**, with the adoption of the mitigation measures (**Table 12-11**).

Table 12-11 Assessment of impact significance for the potential for PTS onset in marine mammals from underwater noise during tubular (impact) piling

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
PTS onset during tubular piling – single strike	Harbour porpoise Bottlenose dolphin White-beaked dolphin Minke whale Grey seal Harbour seal	High	Negligible	Minor adverse	Procedures as per JNCC protocol (JNCC, 2010).	Negligible
PTS onset during tubular piling - cumulative exposure	Harbour porpoise Bottlenose dolphin White-beaked dolphin Minke whale Grey seal Harbour seal	High	Negligible	Minor adverse	Procedures as per JNCC protocol (JNCC, 2010).	Negligible

TTS onset

Taking into account the receptor sensitivity (of medium for all marine mammal species), and the potential magnitude of the effect (of negligible for all species), the impact significance for TTS in all species, from either a single strike or for cumulative exposure, has been assessed as being of **minor adverse significance**.

While the piling mitigation measures are designed to protect marine mammals from PTS onset, they would also reduce the potential for TTS onset, as they are designed to ensure (as far as is possible) that there are no marine mammal species within close proximity to the piling location prior to piling commencing. The residual impact of the potential risk of TTS onset to marine mammals as a result of underwater noise during tubular piling would therefore remain of **minor adverse significance, which is not significant in EIA terms**, with the adoption of the mitigation measures (**Table 12-12**).

Table 12-12 Assessment of impact significance for the potential for TTS onset in marine mammals from underwater noise during tubular (impact) piling

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
TTS onset during tubular piling – single strike	Harbour porpoise Bottlenose dolphin White-beaked dolphin Minke whale Grey seal Harbour seal	High	Negligible	Minor adverse	Procedures as per JNCC protocol (JNCC, 2010).	Minor adverse

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
TTS onset during tubular piling - cumulative exposure	Harbour porpoise Bottlenose dolphin White-beaked dolphin Minke whale Grey seal Harbour seal	High	Negligible	Minor adverse	Procedures as per JNCC protocol (JNCC, 2010).	Minor adverse

Potential for disturbance

Taking into account the receptor sensitivity (of medium for all marine mammal species), and the potential magnitude of the effect (of minor for all species), the impact significance for disturbance in all species has been assessed as being of **minor adverse significance, which is not significant in EIA terms** (**Table 12-13**).

Table 12-13 Assessment of impact significance for the potential disturbance of marine mammals from underwater noise during tubular (impact) piling

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
Disturbance due to tubular (impact) piling	Harbour porpoise Bottlenose dolphin White-beaked dolphin Minke whale Grey seal Harbour seal	Medium	Low	Minor adverse	-	Minor adverse

12.8.2 Potential for Impacts from Underwater Noise during Sheet Piling

12.8.2.1 Underwater Noise Modelling

The underwater noise modelling report is provided in **Appendix 10-1**, and a further assessment for the resultant underwater ranges (for both marine mammals and fish species) is provided in **Appendix 10-2**.

12.8.2.2 Assessment of Impact due to Sheet Piling

Potential for PTS and TTS onset

The number of harbour porpoise, bottlenose dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal that could be at risk of PTS or TTS onset, as a result of underwater noise during sheet-piling activities (**Table 12-14**) has been assessed based on the number of animals that could be present in each of the modelled impact ranges and areas. The modelling assumes up to 12 hours of sheet piling could be undertaken per day.

Table 12-14 Impact ranges and areas, and maximum number of individuals (and % of reference population) that could be at risk of PTS or TTS onset as a result of underwater noise associated with sheet piling activities, based on underwater noise modelling

Potential Impact	Receptor	Impact range (and area)	Maximum number of individuals (% of reference population)	Magnitude
PTS without mitigation – cumulative exposure (over 12 hours)	Harbour porpoise	<100m 0.03km^2	0.02 harbour porpoise (0.000005% NS MU)	Permanent effect with negligible magnitude (less than 0.001% of the reference population anticipated to be exposed to effect, without mitigation).
	Bottlenose dolphin	<100m 0.03km^2	0.0009 bottlenose dolphin (0.0004% CES MU)	
	White-beaked dolphin	<100m 0.03km^2	0.008 white-beaked dolphin (0.00002% CGNS MU)	

Potential Impact	Receptor	Impact range (and area)	Maximum number of individuals (% of reference population)	Magnitude
	Minke whale	<100m 0.03km^2	0.001 minke whale (0.000006% CGNS MU)	
	Grey seal	<100m 0.03km^2	0.03 grey seal (0.0009% of the ES MU; or 0.0006% of the ES & MF MUs)	
	Harbour seal	<100m 0.03km^2	0.01 harbour seal (0.003% of the ES MU; or 0.0007% of the ES & MF MUs)	Permanent effect with negligible to low magnitude (less than 0.001% to 0.001%-0.01% of the reference population anticipated to be exposed to effect, without mitigation).
TTS without mitigation – cumulative exposure (over 12 hours)	Harbour porpoise	220m 0.15km^2	0.09 harbour porpoise (0.00003% NS MU)	Temporary effect with negligible magnitude (less than 1% of the reference population anticipated to be exposed to effect, without mitigation).
	Bottlenose dolphin	<100m 0.03km^2	0.0009 bottlenose dolphin (0.0004% CES MU)	
	White-beaked dolphin	<100m 0.03km^2	0.008 white-beaked dolphin (0.00002% CGNS MU)	
	Minke whale	<100m 0.03km^2	0.001 minke whale (0.000006% MU)	
	Grey seal	<100m 0.03km^2	0.03 grey seal (0.0009% of the ES MU; or 0.0006% of the ES & MF MUs)	
	Harbour seal	<100m 0.03km^2	0.01 harbour seal (0.003% of the ES MU; or 0.0007% of the ES & MF MUs)	

The magnitude of the potential impact of PTS and TTS onset as a result of sheet (vibro-piling) noise, is negligible for all marine mammal species, with less than 0.001% of the reference population likely to be affected for any permanent impacts (PTS), and less than 1% at risk of temporary impact (TTS) (**Table 12-14**).

Potential for disturbance

There are a limited but growing number of studies reporting threshold effects for non-impulsive, low frequency sounds (National Marine Fisheries Service (NMFS), 2018a). Gomez *et al.* (2016) found the sound levels received by the animals did not explain the severity of behavioural responses; more severe behavioural response severity scores were not consistently related to higher received levels and less severe behavioural response severity scores were not consistently related to lower received levels. When comparing one cetacean functional hearing group (considered a general proxy for species with similar known or expected hearing capabilities) with one type of sound (which provides a general proxy for frequency, duration, and source level of the sound source), the received levels still did not vary in relation with the severity of behavioural responses (Gomez *et al.,* 2016).

As described for impact piling above, during a harbour development project in Scotland, the behavioural response of harbour porpoise and bottlenose dolphin was recorded, both for impact piling and vibro-piling (Graham *et al*., 2017). The vibro-piling sound level was recorded as being 192 dB re 1 µPa. Neither harbour porpoise or bottlenose dolphins were excluded from the area as a result of the piling, but fine-scale changes in the local abundance were detected, and both species were present in the area less often when impact vibro-piling was occurring, compared to where no activity was occurring (Graham *et al*., 2017). As for impact piling, this indicates that harbour porpoise and bottlenose dolphin can be disturbed from a very localised area, and for a short-period of time.

While there is the potential for a displacement response from the area for any marine mammal species, it is predicted that they would return once the activity has been completed, and therefore any impacts from underwater noise as a result of sheet piling will be both localised and temporary. Therefore, there is unlikely to be the potential for any significant impact on marine mammals. Any disturbance would be temporary and they would be expected to return to the area once the noise had ceased or they had become habituated to the sound. The magnitude of impact for all marine mammal species is assessed as being low, due to the predicted short-term nature and localised potential for disturbance.

Mitigation measures

Mitigation measures include:

- The establishment of a mitigation zone of 200m from the piling location
    - The JNCC guidance recommends a mitigation zone of 500m, however, due to the small impact ranges predicted for the proposed development (of less than 100m for (PTS), a reduced mitigation zone of 200m would be used.
- Only commence piling operations during the hours of daylight and good visibility (and within the 12 hour construction window).
- Pre–piling search for marine mammals of mitigation zone by Marine Mammal Observer(s) (MMOs).
    - Delay if marine mammals detected within the mitigation zone.

Impact significance

PTS and TTS onset

Taking into account the receptor sensitivity (of high for PTS and medium for TTS for all marine mammal species) and the potential magnitude of the effect (of negligible for all species), the impact significance for PTS and TTS in all species, from cumulative exposure, has been assessed as being of **minor adverse significance**.

The residual impact of the potential risk of PTS or TTS onset to marine mammals as a result of underwater noise during sheet piling would be reduced to a **negligible significance, which is not significant in EIA terms**, with the adoption of the mitigation measures (**Table 12-15**).

Table 12-15 Assessment of impact significance for the potential for PTS onset in marine mammals from underwater noise during sheet (vibro) piling

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
PTS onset during sheet piling – cumulative exposure	Harbour porpoise Bottlenose dolphin White-beaked dolphin Minke whale Grey seal Harbour seal	Medium	Negligible	Minor adverse	- Establishment of a mitigation zone - Only commence piling operations during the hours of daylight and good visibility - Pre–piling search for marine mammals of mitigation zone by MMO	Negligible
TTS onset during sheet piling – cumulative exposure	Harbour porpoise Bottlenose dolphin White-beaked dolphin Minke whale Grey seal Harbour seal	Medium	Negligible	Minor adverse		Negligible

Potential for disturbance

Taking into account the receptor sensitivity (of medium for all marine mammal species) and the potential magnitude of the effect (of minor for all species), the impact significance for disturbance in all species has been assessed as being of **minor adverse significance, which is not significant in EIA terms** (**Table 12-16**).

Table 12-16 Assessment of impact significance for the potential for disturbance to marine mammals from underwater noise during sheet (vibro) piling

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
Disturbance due to sheet (vibro) piling	Harbour porpoise Bottlenose dolphin White-beaked dolphin Minke whale Grey seal Harbour seal	Medium	Low	Minor adverse	-	Minor adverse

12.8.3 Potential Impacts from Underwater Noise during Dredging Works

The dredging process emits continuous, broadband sound into the marine environment. Sound Pressure Levels (SPLs) can vary widely, dependent on the dredger type, operational stage, or environmental conditions (e.g. sediment type, water depth, salinity and seasonal phenomena such as thermoclines; Jones and Marten, 2016). These factors will also affect the propagation of sound from dredging activities and along with ambient sound already present, will influence the distance at which sounds can be detected.

Sound sources for Trailer Suction Hoper Dredger (TSHD) have been modelled to provide a worst case scenario. Sound sources include the draghead on the seabed, material going through the underwater pipe, 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 TSHD dredgers are typically low frequencies, up to and including 1kHz (Robinson *et al.,* 2011). Underwater noise from a TSHD is comparable to those for a cargo ship travelling at modest speed (between 8 and 16 knots) (Theobald *et al.,* 2011).

Based on reviews of published sources of underwater noise during dredging activities (e.g. Thomsen *et al.,* 2006; CEDA, 2011; Theobald *et al.,* 2011; WODA, 2013; Todd *et al.,* 2014), sound levels that marine mammals may be exposed to during dredging activities are usually below auditory injury thresholds or PTS exposure criteria; however, TTS cannot be ruled out if marine mammals are exposed to noise for prolonged periods (Todd *et al.,* 2014), although marine mammals remaining in close proximity to such activities for long periods of time is unlikely.

Underwater noise as a result of dredging activity also has the potential to disturb marine mammals (Pirotta *et al.,* 2013). Therefore, there is the potential for short, perhaps medium-term behavioural reactions and disturbance to marine mammals in the area during dredging activities. Marine mammals may exhibit varying behavioural reactions intensities as a result of exposure to noise (Southall *et al.,* 2007).

The sensitivity of marine mammals to underwater noise during dredging activities is considered to be medium in this assessment as a precautionary approach. Marine mammals within the potential disturbance area are considered to have limited capacity to avoid such effects, although any disturbance to marine mammals would be temporary and they would be expected to return to the area once the disturbance had ceased or they had become habituated to the sound.

12.8.3.1 Underwater Noise Modelling

The underwater noise modelling report is provided in **Appendix 10-1**, and a further assessment information for the resultant underwater ranges (for both marine mammals and fish species) is provided in **Appendix 10-2**.

12.8.3.2 Assessment of Impact due to Dredging

Potential for PTS and TTS onset

The number of harbour porpoise, bottlenose dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal that could be at risk of PTS or TTS onset, as a result of underwater noise during dredging activities (**Table 12-17**) has been assessed based on the number of animals that could be present in each of the modelled impact ranges and areas. The results of the underwater noise modelling show that at the source levels predicted for the dredging activities, any marine mammal would have to remain in close proximity (i.e. less than 100m) of the sound source for 12 hours to be exposed to levels of sound that are sufficient to induce PTS as per the Southall *et al*. (2019) threshold criteria.

Table 12-17 Impact ranges and areas, and maximum number of individuals (and % of reference population) that could be at risk of PTS or TTS onset as a result of underwater noise associated with dredging activities, based on underwater noise modelling

Potential Impact	Receptor	Impact range (and area)	Maximum number of individuals (% of reference population)	Magnitude
PTS without mitigation – cumulative exposure (over 12 hours)	Harbour porpoise	<100m $0.03km^2$	0.02 harbour porpoise (0.000005% NS MU)	Permanent effect with negligible magnitude (less than 0.001% of the reference population anticipated to be exposed to effect, without mitigation).
	Bottlenose dolphin	<100m $0.03km^2$	0.0009 bottlenose dolphin (0.0004% CES MU)	
	White-beaked dolphin	<100m $0.03km^2$	0.008 white-beaked dolphin (0.00002% CGNS MU)	
	Minke whale	<100m $0.03km^2$	0.001 minke whale (0.000006% CGNS MU)	
	Grey seal	<100m $0.03km^2$	0.03 grey seal (0.0009% of the ES MU; or 0.0006% of the ES & MF MUs)	
	Harbour seal	<100m $0.03km^2$	0.01 harbour seal (0.003% of the ES MU; or 0.0007% of the ES & MF MUs)	Permanent effect with negligible to low magnitude (less than 0.001% to 0.001% to 0.01% of the reference population anticipated to be exposed to effect, without mitigation).
TTS without mitigation – cumulative exposure (over 12 hours)	Harbour porpoise	250m $0.2km^2$	0.12 harbour porpoise (0.00003% NS MU)	Temporary effect with negligible magnitude (less than 1% of the reference population anticipated to be exposed to effect, without mitigation).
	Bottlenose dolphin	<100m $0.03km^2$	0.0009 bottlenose dolphin (0.0004% CES MU)	
	White-beaked dolphin	<100m $0.03km^2$	0.008 white-beaked dolphin (0.00002% CGNS MU)	
	Minke whale	<100m $0.03km^2$	0.001 minke whale (0.000006% MU)	
	Grey seal	<100m $0.03km^2$	0.03 grey seal (0.0009% of the ES MU; or 0.0006% of the ES & MF MUs)	
	Harbour seal	<100m $0.03km^2$	0.01 harbour seal (0.003% of the ES MU; or 0.0007% of the ES & MF MUs)	

The magnitude of the potential impact of PTS and TTS onset as a result of dredging activity is negligible for all marine mammal species, with less than 0.001% of the reference population likely to be affected for any permanent impacts (PTS), and less than 1% at risk of temporary impact (TTS).

Mitigation measures

Due to the small impact ranges, and low number of individuals at risk, no mitigation measures are required for dredging activities.

Impact significance

Taking into account the receptor sensitivity (of high for PTS and medium for TTS for all marine mammal species) and the potential magnitude of the effect (of negligible for all species), the impact significance for PTS and TTS in all species, from cumulative exposure, has been assessed as being of **minor adverse significance, which is not significant in EIA terms** (**Table 12-18**).

Table 12-18 Assessment of impact significance for the potential for PTS onset in marine mammals from underwater noise during dredging

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
PTS onset during dredging – cumulative exposure	Harbour porpoise Bottlenose dolphin White-beaked dolphin Minke whale Grey seal Harbour seal	Medium	Negligible	Minor adverse	None required	Minor adverse
TTS onset during dredging – cumulative exposure	Harbour porpoise Bottlenose dolphin White-beaked dolphin Minke whale Grey seal Harbour seal	Medium	Negligible	Minor adverse	None required	Minor adverse

Potential for disturbance

McQueen *et al.* (2020) found that habitat avoidance was not at a sufficient spatial scale to pose risks to harbour porpoises or seals, in the context of activity in dredging areas (adjacent to navigation channels and port infrastructure areas)[23]. The unweighted 140 dB re 1 µPa SPL generic threshold level for behavioural avoidance of high-frequency cetaceans and pinnipeds in water is exceeded at distances up to approximately 400m from the dredge (McQueen e*t al.,* 2020).

For behavioural assessments, there are a myriad of significant data gaps that contribute to the uncertainty of the assessment. The major sources of uncertainty are clear exposure–response relationships among observed marine mammal behavioural studies (McQueen *et al.,* 2020). In some cases, there are orders of magnitude differences in reported sound thresholds for similar behavioural reactions, likely influenced by the difficulties with behavioural response scoring (Gomez *et al*., 2016) and study-specific context (e.g., multivariate exposure conditions; Ellison *et al.,* 2012). Although there is the potential for behavioural response to the construction activities and excavation works it is anticipated to be localised in effect and short in duration with animals returning to the area shortly after the sound source is stopped or completion of the works.

Although there is the potential for behavioural response to the dredging activities, it is anticipated to be localised in effect and short in duration, with animals returning to the area shortly after the sound source is

[23] using the maximum source level of 192 dB re 1 µPa-m, SELs for the marine mammals were calculated using the sheet for "non-impulsive, continuous, mobile sources" from the publicly available NMFS (2018b) spreadsheet tool

stopped or completion of the works. Therefore, there is unlikely to be the potential for any significant impact on marine mammals, and the magnitude of impact for all marine mammal species is assessed as being low, due to the predicted short-term nature and localised potential for disturbance.

Taking into account the receptor sensitivity (of medium for all marine mammal species), and the potential magnitude of the effect (of minor for all species), the impact significance for disturbance in all species has been assessed as being of **minor adverse significance, which is not significant in EIA terms** (**Table 12-19**).

Table 12-19 Assessment of impact significance for the potential for disturbance to marine mammals from underwater noise during dredging

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
Disturbance due to dredging	Harbour porpoise Bottlenose dolphin White-beaked dolphin Minke whale Grey seal Harbour seal	Medium	Low	Minor adverse	-	Minor adverse

12.8.4 Potential for Indirect Impacts to Marine Mammals

The potential for indirect impacts to marine mammals include impacts due to potential changes in water quality and changes in prey availability.

12.8.4.1 Potential for Changes to Water Quality

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. Studies have shown that vision is not essential to seal survival, or ability to forage (Todd *et al*., 2014).

Increased turbidity is unlikely to have a substantial direct impact on marine mammals that often inhabit naturally turbid or dark environments. This is likely because other senses are utilised, and vision is not relied upon solely. Therefore, harbour porpoise, bottlenose dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal have a negligible sensitivity to increases in suspended sediments during construction.

Any direct impacts to marine mammals as a result of any contaminated sediment during construction activities are unlikely as any exposure is more likely to be through potential indirect impacts via prey species, as assessed in **Section 12.8.4.2**. Therefore, marine mammals are considered to have a negligible sensitivity to any direct impacts from suspended sediment during construction activities.

Increase in SSC in water body due to dredging and disposal
An increase in SSCs during the dredging and disposal for the proposed development could lead to a potential reduction in water clarity and therefore quality. Modelling results predict the increase in SSC to be highly localised and temporary during dredging and that they would be highest at the bottom while minimum at the surface layers within the water column. Dredging will be non-continuous and SSC levels will dissipate to within background levels between dredging activities (see **Chapter 8 Marine Water and Sediment Quality**).

The magnitude of the temporary effect of increase in SSCs for all species is **low**. The overall impact significance is **negligible**.

Potential Release of Contaminates during Dredging and Disposal
Any trace contaminants disturbed during dredging would be bound to fine sediment particles hence would only be present within the sediment plume. Chemical analysis of the source dredge material has been undertaken and is reported in **Section 8.5.5**. The analyses indicate that contaminant levels within the sediment are suitable for offshore disposal (as determined through comparison against Cefas action levels).

A small quantity of contaminated disposal material, limited sediment exposure coupled with good dilution capacity provided due to the location of the development and disposal ground, it is considered that magnitude of impact for all species would be **low,** and the overall impact significance is **negligible**.

Mitigation measures
No mitigation measures are required beyond the implementation of good practice during construction works.

Impact significance
The residual impact of the potential risk of indirect impacts on marine mammals as a result change to water quality would be of **negligible significance, which is not significant in EIA terms** (**Table 12-20**).

Table 12-20 Assessment of impact significance of indirect impacts on marine mammals from changes to water quality

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
Increase in SSCs	Harbour porpoise Bottlenose dolphin White-beaked dolphin Minke whale Grey seal Harbour seal	Negligible	Low	Negligible	None required	Negligible
Potential release of contaminates		Negligible	Low	Negligible	None required	Negligible

12.8.4.2 Potential for Changes to Prey Availability

The diet of the harbour porpoise consists of a wide variety of prey species and varies geographically and seasonally, reflecting changes in available food resources. Harbour porpoise have relatively high daily energy demands and need to capture enough prey to meet its daily energy requirements. It has been estimated that, depending on the conditions, harbour porpoise can rely on stored energy (primarily blubber) for three to five days, depending on body condition (Kastelein *et al*., 1997). Harbour porpoise are therefore considered to have low to medium sensitivity to changes in prey resources.

Bottlenose dolphin and white-beaked dolphin are opportunistic feeders, feeding on wide range of prey species and have large foraging ranges (see **Section 12.7**) and are therefore considered to have low sensitivity to changes in prey resources.

Minke whale feed on a variety of prey species, but in some areas, they have been found to prey upon specific species at the population level (see **Section 12.7**). Therefore, minke whale are considered to have a low to medium sensitivity to changes in prey resource.

Grey and harbour seal feed on a variety of prey species, both are considered to be opportunistic feeders, feeding on wide range of prey species and they are able to forage in other areas and have relatively large foraging ranges (see **Section 12.7**). Grey seal and harbour seal are therefore considered to have low sensitivity to changes in prey resources. Grey seal feed on a variety of prey species. Both species of seal are considered to be opportunistic feeders that are able to forage in other areas and have relatively large foraging ranges. Grey seals are therefore considered to have low sensitivity to changes in prey resources.

A full assessment of underwater noise impacts to fish species is included in **Section 10.6.1**.

All potential impacts are assessed as being of either negligible or minor significance. Therefore, the potential for a change in prey availability to marine mammals, due to either underwater noise impacts or a change in water quality, is assessed as being of minor magnitude to all marine mammal species.

Mitigation measure
No mitigation measures are required.

Impact significance
The residual impact of the potential risk of indirect impacts on marine mammals as a result change in prey availability would be of **minor adverse significance, which is not significant in EIA terms** (**Table 12-21**).

Table 12-21 Assessment of impact significance of indirect impacts on marine mammals from changes in prey availability

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
Indirect impacts to prey availability due to underwater noise impacts to fish species	Harbour porpoise Minke whale	Low to medium	Low	Minor adverse	None required	Minor adverse
	Bottlenose dolphin White-beaked dolphin Grey seal Harbour seal	Low	Low	Minor adverse	None required	Minor adverse
Indirect impacts to prey availability due to water quality impacts to fish species	Harbour porpoise Minke whale	Low to medium	Low	Minor adverse	None required	Minor adverse
	Bottlenose dolphin White-beaked dolphin Grey seal Harbour seal	Low	Low	Minor adverse	None required	Minor adverse

12.9 Potential Impacts During Operation

There is not expected to be any significant change, through operation, compared to the existing activity levels; therefore, it is not expected that there would be any potential to impact marine mammals during the operational phase and thus scoped out of further assessment.

12.10 Summary

Table 12-22 summarises the significance of all potential impacts to marine mammal species, as assessed in this chapter. Negligible and minor adverse impacts are not significant in EIA terms.

Table 12-22 Summary of potential impacts to marine mammals

Potential Impact	Receptor	Impact significance	Mitigation proposed	Residual impact
Underwater noise during tubular piling				
PTS onset during tubular piling – single strike or cumulative exposure	Harbour porpoise Bottlenose dolphin White-beaked dolphin Minke whale Grey seal Harbour seal	Minor adverse	Procedures as per JNCC protocol (JNCC, 2010)	Negligible
TTS onset during tubular piling – single strike or cumulative exposure		Minor adverse		Negligible

Potential Impact	Receptor	Impact significance	Mitigation proposed	Residual impact
Disturbance due to tubular (impact) piling		Minor adverse	None required	Minor adverse
Underwater noise during sheet piling				
PTS onset during sheet piling – cumulative exposure	Harbour porpoise Bottlenose dolphin White-beaked dolphin Minke whale Grey seal Harbour seal	Minor adverse	- Establishment of a mitigation zone - Only commence piling operations during the hours of daylight and good visibility - Pre–piling search for marine mammals of mitigation zone by MMO	Negligible
TTS onset during sheet piling – cumulative exposure		Minor adverse		Negligible
Disturbance due to sheet piling		Minor adverse	None required	Minor adverse
Underwater noise during dredging				
PTS onset during dredging – cumulative exposure	Harbour porpoise Bottlenose dolphin White-beaked dolphin Minke whale Grey seal Harbour seal	Minor adverse	None required	Minor adverse
TTS onset during dredging – cumulative exposure		Minor adverse	None required	Minor adverse
Disturbance due to dredging		Minor adverse	None required	Minor adverse
Indirect effects due to a change in water quality and prey availability				
Indirect impacts to prey availability due to underwater noise or water quality impacts to fish species	Harbour porpoise Minke whale	Minor adverse	None required	Minor adverse
	Bottlenose dolphin White-beaked dolphin Grey seal Harbour seal	Minor adverse	None required	Minor adverse

13 Cumulative Impact Assessment

13.1 Introduction

In addition to the determination of the potential impacts from the proposed development in isolation, the EIA Regulations require that an assessment is made of the potential for cumulative impacts, which considers the impacts from the proposed development cumulatively with other proposed projects.

A useful ground rule in EIA is that the environmental impacts of any other development that is already built and operational is effectively included within the baseline conditions, so such effects are already taken account of in the EIA process and can be excluded from the CIA; however, projects that are in the planning process need to be considered. Any that are ahead of the development being assessed (i.e. likely to be submitted or receive consent before the development being assessed or are currently being built) must be taken into account during a CIA. Any that are substantially further back in the planning process and are unlikely to be submitted or get consent until after the development being assessed, can be disregarded because the developer of that project should be taking the effects of the current development into account in their own EIA.

The key aspects for consideration when undertaking CIA are:

- The temporal and geographic (spatial) boundaries of the effects of activities;
- Interactions between the activities and the environment;
- The environmental effects of the project (including future projects and activities); and,
- Thresholds of sensitivity of the existing environment.

CIA is limited to those plans and projects for which sufficient information exists to allow consideration of the potential for such an effect to arise. In the absence of such publicly available data, it is not possible to undertake a detailed cumulative assessment, but it is possible to make judgements on the likely potential impacts on the basis of the characteristics of the other projects being considered and whether there is the potential for the impacts of the various projects to interact spatially or temporally.

To assess potential for cumulative effects a ‘screening’ assessment has been carried out to determine whether the identified projects have the potential to give rise to cumulative impacts with the proposed development and, therefore, whether further assessment is required. The findings of the screening assessment are presented in **Table 13-1**.

Table 13-1 Long list of projects for consideration of cumulative impacts

Project	Location (approximate distance from the proposed development)	Stage	Date of Activity	Considered for CIA
Grangemouth Flood Protection Scheme	Firth of Forth, approximately 30km (31km around the coastline)	Pre-application	Five to ten year construction, starting from 2022[24]	No - Only the EIA Scoping report was available,which stated that construction would be undertaken from 2022, for a period of between five and 10 years. Given that no formal application has been submitted, it is unlikely that this scheme would overlap

[24] https://marine.gov.scot/sites/default/files/grangemouth_fps_eia_scoping_report_final_for_submission.pdf

Project	Location (approximate distance from the proposed development)	Stage	Date of Activity	Considered for CIA
				with the proposed development.
Neart na Gaoithe Offshore Wind Farm (Revised Design)	Firth of Forth, approximately 60km	Under construction	Construction from 2019-2022[25]	**Yes – potential for overlap in construction timeframes**
Inch Cape Offshore Windfarm Revised Design	Firth of Forth, approximately 61km (landfall at Prestonpans – 11km)	Application approved	Construction 2021-2024	**Yes – potential for overlap in construction timeframes**
Seagreen Alpha and Bravo Offshore Wind Farms (Optimised Project)	Forth of Forth, approximately 69km from cable corridor and 96km from windfarm site (or 73km from cable corridor and 98km from windfarm site around the coastline)	Application approved	Expected to be fully commissioned by 2023	**Yes – potential for overlap in construction timeframes**
Kincardine Offshore Windfarm	Aberdeenshire, approximately 136km (139km around the coastline)	Under construction	Construction 2016-2021[26]	No – construction periods would not overlap
European Offshore Wind Deployment Centre	Aberdeenshire, 151km (158km around the coastline)	Operational	N/A	No – as the project is currently operational, it is considered to be part of the baseline
Ardersier Port Development	Moray Firth, approximately 185km (344km around the coastline)	Application approved	Construction to commence in 2019	**Yes – potential for overlap in construction**
NorthConnect HVDC Cable	Landfall at Peterhead, 187km (195km around the coastline)	Application approved	2019-2023 (operational by 2023[27] with overall construction period of 54 months[28])	**Yes – potential for overlap in construction timeframes**
Sea Wall Repair and Extension – Alexandra Parade	Peterhead, approximately 189km (195km around the coastline)	Application approved	Construction 2020-2024[29]	**Yes – potential for overlap in construction**
Nigg Energy Park East Quay	Cromarty Firth, approximately 196km (340km around the coastline)	Under construction	Construction from 2021-2022	**Yes – potential for overlap in construction timeframes**
Hywind Scotland Pilot Park	Aberdeenshire, 197km (201km around the coastline)	Operational	N/A	No – as the project is currently operational, it is considered to be part of the baseline
Port of Cromarty Firth - Phase 4 Development,	Cromarty Firth, approximately 198km (351km around the coastline)	Under construction	Construction 2019-2021	No – construction periods would not overlap

[25] https://marine.gov.scot/sites/default/files/combined_document_-_revised.pdf
[26] www.4coffshore.com
[27] https://marine.gov.scot/sites/default/files/hvdcca1.pdf
[28] https://marine.gov.scot/sites/default/files/02_project_description_0.pdf
[29] https://marine.gov.scot/sites/default/files/environmental_appraisal_document_redacted.pdf

Project	Location (approximate distance from the proposed development)	Stage	Date of Activity	Considered for CIA
Moray West Offshore Windfarm	Moray Firth, approximately 224km (291km around the coastline)	Application approved	Construction 2024-2026[26]	No – construction periods would not overlap
Moray East Offshore Windfarm	Moray Firth, approximately 233km (281km around the coastline)	Under construction	Operational by 2022	**Yes – potential for overlap in construction timeframes**
Beatrice Offshore Windfarm	Moray Firth, approximately 243km (299km around the coastline)	Operational	N/A	No – as the project is currently operational, it is considered to be part of the baseline

13.2 Assessment of Cumulative Impacts

Based on the screening assessment the following projects have been screed into the CIA:

- Neart na Gaoithe Offshore Wind Farm (Revised Design)
- Inch Cape Offshore Windfarm Revised Design
- Seagreen Alpha and Bravo Offshore Wind Farms (Optimised Project)
- Ardersier Port Development
- NorthConnect HVDC Cable
- Sea Wall Repair and Extension – Alexandra Parade
- Nigg Energy Park East Quay
- Moray East Offshore Windfarm

Given the significant distance the projects are from the proposed development, the closest being 60km away, cumulative effects only have the potential to occur to marine mammals given their wide ranging habits

13.2.1 Assessment of Cumulative Impact for Marine Mammals

Due to the limited potential for any effect from either a change in water quality or a change in prey availability, and that the nearest other project screened in with relevant potential effects for marine mammals is the Neart na Gaoithe Offshore Wind Farm, at 60km from the proposed development, the CIA focuses on the potential for cumulative underwater noise impacts only. In addition, as each project is required to provide mitigation for any potential for PTS onset, there is no potential for cumulative PTS onset impacts to occur. Therefore, the assessment only considers the potential for TTS onset and disturbance cumulative impacts.

The potential for cumulative impacts for harbour porpoise is presented in **Table 13-2**, bottlenose dolphin in **Table 13-3**, white-beaked dolphin in **Table 13-4**, minke whale in **Table 13-5**, grey seal in **Table 13-6** and harbour seal in **Table 13-7**.

In summary, there is no potential for significant impact to any species, as a result of any other project screened in, together with the proposed development. The magnitude of impact is assessed as low for all species, and with the sensitivity of medium for TTS onset and disturbance, the overall impact assessment for all marine mammal species is **minor adverse, which is not significant in EIA terms**.

Table 13-2 Cumulative assessment for harbour porpoise

Cumulative project	Cumulative Project Information	Proposed Development Assessment		Cumulative Project Assessment		Overall Cumulative Assessment
		Potential Impact	Assessment	Potential Impact	Assessment	
Seagreen Alpha and Bravo Offshore Wind Farms (Optimised Project)	The Seagreen Alpha and Bravo wind farms are currently under construction. Jacket foundation installation (through piling) will take place through 2022[30]. The wind farms are expected to reach commercial operation in 2023. There is therefore the potential for piling to overlap with the piling at the proposed development. TTS was not considered and therefore no cumulative assessment can be carried out.	Disturbance effects	Localised and temporary effect only, no potential for significant level of disturbance to any individuals. No potential for significant impact.	Disturbance from piling (as the worst-case)	The assessment concludes that up to 1,452 harbour porpoise may be disturbed due to the piling (of both monopile and pin-pile concurrently) activities. This equates to up to 0.41% of the assessed reference population.	Due to the localised and temporary nature of the piling at the proposed development, together with the low proportion of the harbour porpoise wider population that may be disturbed as a result of the piling activities at Seagreen Alpha and Bravo, it is concluded that there would be **no significant cumulative impact** to the harbour porpoise population due to disturbance.
Neart na Gaoithe Offshore Wind Farm (Revised Design)	The Neart na Gaoithe wind farm is currently under construction. There is therefore the potential for piling to overlap with the piling at the proposed development.	TTS (highest potential impact range of 100m for TTS cumulative exposure due to sheet piling used as the worse-case)	0.30 harbour porpoise (0.0001% of the NS MU). No potential for significant impact.	TTS from piling (as the worst-case). Piling at the Neart na Gaoithe wind farm would either be using a combination of pile driving and drilling (the 'drive-drill-drive' scenario) or under pile driving only (the 'drive only' scenario)[31].	The assessments predicted that up to 53 harbour porpoise may receive noise levels capable of causing TTS. However, it was also predicted that the individuals would avoid the area, and the duration of potential exposure would be low, and therefore was concluded that there would not be a significant impact.	Due to the temporary nature of the piling at the proposed development, and that any impact to harbour porpoise at Neart na Gaoithe would be temporary, it is concluded that there would be **no significant cumulative impact** to harbour porpoise due to TTS onset.
		Disturbance effects	Localised and temporary effect only, no potential for significant level of disturbance to any individuals. No potential for significant impact.	Disturbance from piling (as the worst-case)	The assessment concludes that total displacement of harbour porpoise may occur up to 18km from the piling location. Therefore, for the 'drill-drive-drill' scenario up to 385 individuals may be disturbed, and under the 'drive only' scenario, up to 460 porpoise may be displaced.	Due to the localised and temporary nature of the piling at the proposed development, together with the low number of individuals that may be disturbed as a result of the piling activities at Neart na Gaoithe, it is concluded that there would be **no significant cumulative impact** to harbour porpoise as a result of disturbance.

Table 13-3 Cumulative assessment for bottlenose dolphin

Cumulative project	Cumulative Project Information	Proposed Development Assessment		Cumulative Project Assessment		Overall Cumulative Assessment
		Potential Impact	Assessment	Potential Impact	Assessment	
Nigg Energy Park East Quay	Nigg Energy Park East Quay Expansion includes an area of reclamation, sheet piling, and dredging[32]. An updated ES was submitted in 2019, to include a revised blasting methodology[33].	TTS (highest potential impact range of 100m for TTS cumulative exposure due to sheet piling used as the worse-case)	0.003 bottlenose dolphin (0.001% CES MU) No potential for significant impact.	TTS from blasting & piling	Up to 0.1 bottlenose dolphin may be at risk of TTS onset, due to unmitigated blasting. With a bubble curtain, up to 0.0009 individuals may be at risk of TTS onset. For piling activities, TTS onset could occur up to 3.15km from the pile location. This would be a temporary effect, and the presence of Girdle Ness will effectively stop underwater noise from travelling up to that distance.	Due to the temporary nature of the piling at the proposed development, and that any impact to bottlenose dolphin at Nigg Energy Park is a low risk, and would be temporary, it is concluded that there would be **no significant cumulative impact** to bottlenose dolphin due to TTS onset.
		Disturbance effects	Localised and temporary effect only, no potential for significant level of disturbance to any individuals. No potential for significant impact.	Disturbance from blasting & piling	Population modelling was undertaken to determine the potential for behavioural effect due to the blasting works. The conclusion of this was that there would be no significant long-term effect on any marine mammal populations. For piling activities, disturbance could occur up to 10.5km from the pile location. However, underwater noise levels in the area are already high, and would not be expected to cause any significant level of effect on bottlenose dolphin.	Due to the localised and temporary nature of the piling at the proposed development, and that any impact to bottlenose dolphin at Nigg Energy Park is a low risk, and would be temporary, it is concluded that there would be **no significant cumulative impact** to bottlenose dolphin due to disturbance.
NorthConnect HVDC Cable	This project is for a interconnector cable between Scotland and Norway, with a length of approximately 110 – 120km[34]. Landfall will be	TTS (highest potential impact range of 100m for TTS cumulative	0.003 bottlenose dolphin (0.001% CES MU) No potential for significant impact.	TTS from construction activities	There is no risk of TTS onset to bottlenose dolphin due to the low noise levels associated with the activities. There is therefore no potential for significant impact to bottlenose dolphin.	**No potential for cumulative impact** from TTS onset.

[30] https://marine.gov.scot/sites/default/files/seagreen_s36c_application_screening_report.pdf
[31] https://marine.gov.scot/sites/default/files/chapter_13_-_marine_mammals.pdf
[32] http://marine.gov.scot/datafiles/lot/ahep/es/vol2/Volume%202%20Environmental%20Statement%20Ch%2015.pdf
[33] https://marine.gov.scot/sites/default/files/environmental_impact_assessment_report_redacted.pdf
[34] https://marine.gov.scot/sites/default/files/02_project_description_0.pdf

Cumulative project	Cumulative Project Information	Proposed Development Assessment		Cumulative Project Assessment		Overall Cumulative Assessment
		Potential Impact	Assessment	Potential Impact	Assessment	
	constructed using Horizontal Directional Drilling (HDD). Activities that would produce underwater noise include geophysical survey equipment, HDD works, cable burial and rock placement. Activities may be undertaken from until 2024,and therefore there is the potential for the construction phase to overlap with that of the proposed development.	exposure due to sheet piling used as the worse-case)				
		Disturbance effects	Localised and temporary effect only, no potential for significant level of disturbance to any individuals. No potential for significant impact.	Disturbance from construction activities	Disturbance response for bottlenose dolphin was predicted to occur up to 464m from the source of noise. There is therefore no potential for significant impact to bottlenose dolphin.	Due to the localised and temporary nature of the piling at the proposed development, and that any impact to bottlenose dolphin due to the NorthConnect project is a low risk, and would be temporary, it is concluded that there would be **no significant cumulative impact** to bottlenose dolphin due to disturbance.
Sea Wall Repair and Extension – Alexandra Parade	Activities to be undertaken include excavation, and placement of rock armour. Works to be completed by the end of 2022, and therefore there is the potential for overlap with the construction of the proposed development.	TTS (highest potential impact range of 100m for TTS cumulative exposure due to sheet piling used as the worse-case)	0.003 bottlenose dolphin (0.001% CES MU) No potential for significant impact.	TTS from construction activities[35]	There is no risk of TTS onset to bottlenose dolphin due to the low noise levels associated with the activities. There is therefore no potential for significant impact to bottlenose dolphin.	**No potential for cumulative impact** from TTS onset.
		Disturbance effects	Localised and temporary effect only, no potential for significant level of disturbance to any individuals. No potential for significant impact.	Disturbance from construction activities	Disturbance response for bottlenose dolphin was predicted to occur up to 30m from the source of noise. There is therefore no potential for significant impact to bottlenose dolphin.	Due to the localised and temporary nature of the piling at the proposed development, and that any impact to bottlenose dolphin due to the sea wall repair at Alexandra Parade is a low risk, and would be temporary, it is concluded that there would be **no significant cumulative impact** to bottlenose dolphin due to disturbance.
Ardersier Port Development	This project is to develop a port and port related series for energy uses at a former fabrication yard. Construction activities will include dredging, and quay wall construction (using vibro-piling)[36]. Construction may take place until 2024, and therefore there is the potential for construction phase overlap with the proposed development.	TTS (highest potential impact range of 100m for TTS cumulative exposure due to sheet piling used as the worse-case)	0.003 bottlenose dolphin (0.001% CES MU) No potential for significant impact.	TTS from piling works (vibro-piling only)	TTS from vibro-piling may occur in bottlenose dolphins up to 1m from the source. This is within the standard mitigation zone of 500m (JNCC, 2010), and therefore, there would no potential for TTS onset in bottlenose dolphins.	**No potential for cumulative impact** from TTS onset.
		Disturbance effects	Localised and temporary effect only, no potential for significant level of disturbance to any individuals. No potential for significant impact.	Disturbance effects from piling works (vibro-piling only)	The potential for disturbance was not assessed. However, given the activities being undertaken at this project, it can be assumed that any disturbance effect would be the similar as the at the proposed development.	Due to the localised and temporary nature of the piling at the proposed development, and that any impact to bottlenose dolphin due to the Ardersier Port Development is a low risk, and would be temporary, it is concluded that there would be **no significant cumulative impact** to bottlenose dolphin due to disturbance.
Seagreen Alpha and Bravo Offshore Wind Farms (Optimised Project)	The Seagreen Alpha and Bravo wind farms are currently under construction. Jacket foundation installation (through piling) will take place through 2022[37]. The wind farms are expected to reach commercial operation in 2023. There is therefore the potential for piling to overlap with the piling at the proposed development.	TTS (highest potential impact range of 100m for TTS cumulative exposure due to sheet piling used as the worse-case)	0.003 bottlenose dolphin (0.001% CES MU) No potential for significant impact.	TTS from piling (as the worst-case). Piling at the Seagreen Alpha and Bravo wind farms is for the piling of either 10m or 2m diameter piles, with a 3,000kJ hammer energy[38]. This is significantly higher than the expected hammer energy of 280kJ at the proposed development.	The potential for TTS onset has not been assessed.	**No potential for cumulative impact** from TTS onset.
		Disturbance effects	Localised and temporary effect only, no potential for significant level of	Disturbance from piling (as the worst-case)	The assessment concludes that up to 4.5 bottlenose dolphin may be disturbed due to the piling (of both monopile and pin-pile concurrently) activities. This equates to up to 2.3% of the assessed reference population.	Due to the localised and temporary nature of the piling at the proposed development, together with the low number of bottlenose dolphin that may be disturbed as a result of the piling activities at

[35] https://marine.gov.scot/sites/default/files/environmental_appraisal_document_redacted.pdf
[36] https://marine.gov.scot/sites/default/files/volume_2_envionmental_impact_assessment_report_redacted.pdf
[37] https://marine.gov.scot/sites/default/files/seagreen_s36c_application_screening_report.pdf
[38] https://marine.gov.scot/sites/default/files/chapter_10_marine_mammals.pdf

Cumulative project	Cumulative Project Information	Proposed Development Assessment		Cumulative Project Assessment		Overall Cumulative Assessment
		Potential Impact	Assessment	Potential Impact	Assessment	
			disturbance to any individuals. No potential for significant impact.			Seagreen Alpha and Bravo, it is concluded that there would be **no significant cumulative impact** to bottlenose dolphin due to disturbance.
Neart na Gaoithe Offshore Wind Farm (Revised Design)	The Neart na Gaoithe wind farm is currently under construction. There is therefore the potential for piling to overlap with the piling at the proposed development.	TTS (highest potential impact range of 100m for TTS cumulative exposure due to sheet piling used as the worse-case)	0.003 bottlenose dolphin (0.001% CES MU) No potential for significant impact.	TTS from piling (as the worst-case). Piling at the Neart na Gaoithe wind farm would either be using a combination of pile driving and drilling (the 'drive-drill-drive' scenario) or under pile driving only (the 'drive only' scenario)[39].	The assessments predicted that between up to six bottlenose dolphins may receive noise levels capable of causing TTS. However, no bottlenose dolphins were recorded within 8km of the wind farm, and therefore the risk of any individuals being at risk of TTS onset is very low, and not significant.	Due to the temporary nature of the piling at the proposed development, and that any impact to bottlenose dolphin at Neart na Gaoithe is a low risk, and would be temporary, it is concluded that there would be **no significant cumulative impact** to bottlenose dolphin due to TTS onset.
		Disturbance effects	Localised and temporary effect only, no potential for significant level of disturbance to any individuals. No potential for significant impact.	Disturbance from piling (as the worst-case)	The assessment concludes that total displacement of bottlenose dolphin may occur up to 13.3km from the piling location. However, no bottlenose dolphins were recorded within 8km of the wind farm, and therefore the risk of any individuals being affected by displacement is very low, and not significant.	Due to the localised and temporary nature of the piling at the proposed development, and that it is unlikely that bottlenose dolphin would be present in the vicinity of Neart na Gaoithe, it is concluded that there would be **no significant cumulative impact** to bottlenose dolphin due to disturbance.

Table 13-4 Cumulative assessment for white-beaked dolphin

Cumulative project	Cumulative Project Information	Proposed Development Assessment		Cumulative Project Assessment		Overall Cumulative Assessment
		Potential Impact	Assessment	Potential Impact	Assessment	
Seagreen Alpha and Bravo Offshore Wind Farms (Optimised Project)	The Seagreen Alpha and Bravo wind farms are currently under construction. Jacket foundation installation (through piling) will take place through 2022[40]. The wind farms are expected to reach commercial operation in 2023. There is therefore the potential for piling to overlap with the piling at the proposed development.	Disturbance effects	Localised and temporary effect only, no potential for significant level of disturbance to any individuals. No potential for significant impact.	Disturbance from piling (as the worst-case)	The assessment concludes that up to 590 white-beaked dolphin may be disturbed due to the piling (of both monopile and pin-pile concurrently) activities. This equates to up to 1.62% of the assessed reference population.	Due to the localised and temporary nature of the piling at the proposed development, together with the low proportion of white-beaked dolphin that may be disturbed as a result of the piling activities at Seagreen Alpha and Bravo, it is concluded that there would be **no significant cumulative impact** to white-beaked dolphin due to disturbance.
Neart na Gaoithe Offshore Wind Farm (Revised Design)	The Neart na Gaoithe wind farm is currently under construction. There is therefore the potential for piling to overlap with the piling at the proposed development.	TTS (highest potential impact range of 100m for TTS cumulative exposure due to sheet piling used as the worse-case)	0.02 white-beaked dolphin (0.00006% of the CGNS MU). No potential for significant impact.	TTS from piling (as the worst-case). Piling at the Neart na Gaoithe wind farm would either be using a combination of pile driving and drilling (the 'drive-drill-drive' scenario) or under pile driving only (the 'drive only' scenario)[41].	The assessments predicted that between 64 and 72 white-beaked dolphin may receive noise levels capable of causing TTS. However, it was also predicted that the individuals would avoid the area, and the duration of potential exposure would be low, and therefore was concluded that there would not be a significant impact.	Due to the temporary nature of the piling at the proposed development, and that any impact to white-beaked dolphin at Neart na Gaoithe would be temporary, it is concluded that there would be **no significant cumulative impact** to white-beaked dolphin due to TTS onset.
		Disturbance effects	Localised and temporary effect only, no potential for significant level of disturbance to any individuals. No potential for significant impact.	Disturbance from piling (as the worst-case)	The assessment concludes that total displacement of grey seal may occur up to 13.3km from the piling location. Therefore, for the 'drive only' scenario, up to 28 white-beaked dolphin may be displaced.	Due to the localised and temporary nature of the piling at the proposed development, together with the low number of white-beaked dolphin that may be disturbed as a result of the piling activities at Neart na Gaoithe, it is concluded that there would be **no significant cumulative impact** to white-beaked dolphin due to disturbance..

[39] *https://marine.gov.scot/sites/default/files/chapter_13_-_marine_mammals.pdf*
[40] *https://marine.gov.scot/sites/default/files/seagreen_s36c_application_screening_report.pdf*
[41] *https://marine.gov.scot/sites/default/files/chapter_13_-_marine_mammals.pdf*

Table 13-5 Cumulative assessment for minke whale

Cumulative project	Cumulative Project Information	Proposed Development Assessment		Cumulative Project Assessment		Overall Cumulative Assessment
		Potential Impact	Assessment	Potential Impact	Assessment	
Seagreen Alpha and Bravo Offshore Wind Farms (Optimised Project)	The Seagreen Alpha and Bravo wind farms are currently under construction. Jacket foundation installation (through piling) will take place through 2022[42]. The wind farms are expected to reach commercial operation in 2023. There is therefore the potential for piling to overlap with the piling at the proposed development.	Disturbance effects	Localised and temporary effect only, no potential for significant level of disturbance to any individuals. No potential for significant impact.	Disturbance from piling (as the worst-case)	The assessment concludes that up to 94 minke whale may be disturbed due to the piling (of both monopile and pin-pile concurrently) activities. This equates to up to 0.40% of the assessed reference population.	Due to the localised and temporary nature of the piling at the proposed development, together with the low number of minke whale that may be disturbed as a result of the piling activities at Seagreen Alpha and Bravo, it is concluded that there would be no significant cumulative impact to minke whale due to disturbance.
Neart na Gaoithe Offshore Wind Farm (Revised Design)	The Neart na Gaoithe wind farm is currently under construction. There is therefore the potential for piling to overlap with the piling at the proposed development.	TTS (highest potential impact range of 100m for TTS cumulative exposure due to sheet piling used as the worse-case)	0.004 minke whale (0.0002% of the CGNS MU). No potential for significant impact.	TTS from piling (as the worst-case). Piling at the Neart na Gaoithe wind farm would either be using a combination of pile driving and drilling (the ‘drive-drill-drive’ scenario) or under pile driving only (the ‘drive only’ scenario)[43].	The assessments predicted that between 77 and 88 minke whale may receive noise levels capable of causing TTS. However, it was also predicted that the individuals would avoid the area, and the duration of potential exposure would be low, and therefore was concluded that there would not be a significant impact.	Due to the temporary nature of the piling at the proposed development, and that any impact to minke whale at Neart na Gaoithe would be temporary, it is concluded that there would be no significant cumulative impact to minke whale due to TTS onset.
		Disturbance effects	Localised and temporary effect only, no potential for significant level of disturbance to any individuals. No potential for significant impact.	Disturbance from piling (as the worst-case)	The assessment concludes that total displacement of minke whale may occur up to 42km from the piling location. Therefore, for the ‘drill-drive-drill’ scenario up to 77 individuals may be disturbed, and under the ‘drive only’ scenario, up to 88 minke whale may be displaced.	Due to the localised and temporary nature of the piling at the proposed development, together with the low number of minke whale that may be disturbed as a result of the piling activities at Neart na Gaoithe, it is concluded that there would be no significant cumulative impact to minke whale due to disturbance.

Table 13-6 Cumulative assessment for grey seal

Cumulative project	Cumulative Project Information	Proposed Development Assessment		Cumulative Project Assessment		Overall Cumulative Assessment
		Potential Impact	Assessment	Potential Impact	Assessment	
Seagreen Alpha and Bravo Offshore Wind Farms (Optimised Project)	The Seagreen Alpha and Bravo wind farms are currently under construction. Jacket foundation installation (through piling) will take place through 2022[44]. The wind farms are expected to reach commercial operation in 2023. There is therefore the potential for piling to overlap with the piling at the proposed development.	Disturbance effects	Localised and temporary effect only, no potential for significant level of disturbance to any individuals. No potential for significant impact.	Disturbance from piling (as the worst-case)	The assessment concludes that up to 51 grey seal may be disturbed due to the piling (of both monopile and pin-pile concurrently) activities. This equates to up to 0.47% of the assessed reference population.	Due to the localised and temporary nature of the piling at the proposed development, together with the low number of grey seal that may be disturbed as a result of the piling activities at Seagreen Alpha and Bravo, it is concluded that there would be **no significant cumulative impact** to grey seal due to disturbance.
Neart na Gaoithe Offshore Wind Farm (Revised Design)	The Neart na Gaoithe wind farm is currently under construction. There is therefore the potential for piling to overlap with the piling at the proposed development.	TTS (highest potential impact range of 100m for TTS cumulative exposure due to	0.11 grey seal (0.003% of the ES MU; or 0.002% of the ES & MF MUs). No potential for significant impact.	TTS from piling (as the worst-case). Piling at the Neart na Gaoithe wind farm would either be using a combination of pile driving and drilling (the ‘drive-drill-drive’ scenario) or under pile	The assessments predicted that between 1,263 and 1,833 grey seal may receive noise levels capable of causing TTS. However, it was also predicted that the individuals would avoid the area, and the duration of potential exposure would be low, and therefore was concluded that there would not be a significant impact.	Due to the temporary nature of the piling at the proposed development, and that any impact to grey seal at Neart na Gaoithe would be temporary, it is concluded that there would be **no significant cumulative impact** to grey seal due to TTS onset.

[42] https://marine.gov.scot/sites/default/files/seagreen_s36c_application_screening_report.pdf
[43] https://marine.gov.scot/sites/default/files/chapter_13_-_marine_mammals.pdf
[44] https://marine.gov.scot/sites/default/files/seagreen_s36c_application_screening_report.pdf

Cumulative project	Cumulative Project Information	Proposed Development Assessment		Cumulative Project Assessment		Overall Cumulative Assessment
		Potential Impact	Assessment	Potential Impact	Assessment	
		sheet piling used as the worse-case)		driving only (the 'drive only' scenario)[45].		
		Disturbance effects	Localised and temporary effect only, no potential for significant level of disturbance to any individuals. No potential for significant impact.	Disturbance from piling (as the worst-case)	The assessment concludes that total displacement of grey seal may occur up to 15km from the piling location. Therefore, for the 'drill-drive-drill' scenario up to 95 seals may be disturbed, and under the 'drive only' scenario, up to 113 grey seal may be displaced.	Due to the localised and temporary nature of the piling at the proposed development, together with the low number of grey seal that may be disturbed as a result of the piling activities at Neart na Gaoithe, it is concluded that there would be **no significant cumulative impact** to grey seal due to disturbance.

Table 13-7 Cumulative assessment for harbour seal

Cumulative project	Cumulative Project Information	Proposed Development Assessment		Cumulative Project Assessment		Overall Cumulative Assessment
		Potential Impact	Assessment	Potential Impact	Assessment	
Seagreen Alpha and Bravo Offshore Wind Farms (Optimised Project)	The Seagreen Alpha and Bravo wind farms are currently under construction. Jacket foundation installation (through piling) will take place through 2022[46]. The wind farms are expected to reach commercial operation in 2023. There is therefore the potential for piling to overlap with the piling at the proposed development.	Disturbance effects	Localised and temporary effect only, no potential for significant level of disturbance to any individuals. No potential for significant impact.	Disturbance from piling (as the worst-case)	The assessment concludes that up to 0.29 harbour seal may be disturbed due to the piling (of both monopile and pin-pile concurrently) activities. This equates to up to 0.06% of the assessed reference population.	Due to the localised and temporary nature of the piling at the proposed development, together with the very low number of harbour seal that may be disturbed as a result of the piling activities at Seagreen Alpha and Bravo, it is concluded that there would be **no significant cumulative impact** to harbour seal due to disturbance.
Neart na Gaoithe Offshore Wind Farm (Revised Design)	The Neart na Gaoithe wind farm is currently under construction. There is therefore the potential for piling to overlap with the piling at the proposed development.	TTS (highest potential impact range of 100m for TTS cumulative exposure due to sheet piling used as the worse-case)	0.034 harbour seal (0.0098% of the ES MU; 0.002% of the ES & MF MUs) No potential for significant impact.	TTS from piling (as the worst-case). Piling at the Neart na Gaoithe wind farm would either be using a combination of pile driving and drilling (the 'drive-drill-drive' scenario) or under pile driving only (the 'drive only' scenario).	The assessments predicted that between 95 and 152 harbour seal may receive noise levels capable of causing TTS. However, it was also predicted that the individuals would avoid the area, and the duration of potential exposure would be low, and therefore was concluded that there would not be a significant impact.	Due to the temporary nature of the piling at the proposed development, and that any impact to harbour seal at Neart na Gaoithe would be temporary, it is concluded that there would be **no significant cumulative impact** to harbour seal due to TTS onset.
		Disturbance effects	Localised and temporary effect only, no potential for significant level of disturbance to any individuals. No potential for significant impact.	Disturbance from piling (as the worst-case)	The assessment concludes that total displacement of harbour seal may occur up to 15km from the piling location, and that between 283 and 314 individuals may be exposure to sound levels high enough to cause behavioural changes. However, population modelling has shown that this would alter the existing harbour seal population trend, and that therefore there would be no significant effect on the population as whole[47].	Due to the localised and temporary nature of the piling at the proposed development, together with the conclusion that piling at Neart na Gaoithe would not alter the harbour seal population, it is concluded that there would be **no significant cumulative impact** to harbour seal due to disturbance.

[45] https://marine.gov.scot/sites/default/files/chapter_13_-_marine_mammals.pdf
[46] https://marine.gov.scot/sites/default/files/seagreen_s36c_application_screening_report.pdf
[47] https://marine.gov.scot/sites/default/files/appropriate_assessment_1.pdf

14 Summary of Potential Impacts and Mitigation Measures

14.1 Introduction

This chapter provides an overall summary of the findings of the EIA for the receptors where further assessment work has been undertaken, including:

- Coastal processes;
- Marine water and sediment quality;
- Marine and coastal ecology;
- Fish and shellfish resource;
- Ornithology; and,
- Marine mammals.

Table 14-1 and **Table 14-2** list the potential environmental impacts that are predicted to arise during the construction and operational phases of the proposed development, respectively. The significance of each of the potential impacts is stated, along with any mitigation measures that are recommended to avoid or reduce adverse impacts. The residual impact (i.e., the significance of the potential impact remaining following mitigation) is also stated. Negligible and minor adverse impacts are not significant in EIA terms.

Table 14-1 Summary of the significance of potential environmental impacts, mitigation and residual impacts during the construction phase of the proposed development

Potential Impact	Receptor	Impact Significance	Mitigation Measures	Residual Impact
Coastal Process				
Changes in sea-bed level due to capital dredging of the berth pocket associated with the outer berth	Seabed	Negligible (near-field) No impact (far-field)	None required	Negligible (near-field) No impact (far-field)
Changes in sea-bed level due to deposition of the sediment plume at within Narrow Deep disposal site	Seabed	Negligible (near-field) Negligible (far-field)	None required	Negligible (near-field) Negligible (far-field)
Marine water and sediment quality				
Increase in SSC due to dredging	Marine Water Quality	Minor adverse	None required	Minor adverse
Increase in SSC due to disposal	Marine Water Quality	Minor adverse	None required	Minor adverse
Deterioration in water quality due to release of sediment-bound contaminants	Marine Water Quality	Minor adverse	None required	Minor adverse
Marine and Coastal Ecology				
Direct loss of benthic habitats within the footprint of the proposed development	Marine and Coastal Ecology	Minor adverse	None required	Minor adverse
Smothering of benthic habitats as a result of the proposed dredging and disposal activities	Marine Benthic Ecology	Negligible	None required	Negligible
Release of contaminants during dredging and disposal	Marine Benthic Ecology	Minor adverse	None required	Minor adverse
Impacts on otter due to disturbance and change in availability of prey resource	Otters	Minor adverse	None required	Minor adverse
Fish and Shellfish Ecology				
Underwater noise	Migratory fish (salmon, trout, European eel)	Minor adverse	Soft start procedures as per JNCC protocol (JNCC, 2010).	Minor adverse
	Migratory fish (sea lamprey and river lamprey)	Negligible		Negligible
Changes in water quality	All fish	Minor adverse	None required.	Minor adverse

Potential Impact	Receptor	Impact Significance	Mitigation Measures	Residual Impact
Changes in habitat availability	All fish and shellfish	Minor adverse	None required.	Minor adverse
Ornithology				
Noise disturbance from impact piling	Breeding common terns at Imperial Dock Lock	Minor adverse	Soft start procedures as per JNCC protocol (JNCC, 2010).	Minor adverse
	Post-breeding terns within the Port	Moderate adverse	Use of piling shroud to reduce source noise levels. Soft start procedures as per JNCC protocol (JNCC, 2010).	Minor adverse
	Foraging common terns	Minor adverse	Soft start procedures as per JNCC protocol (JNCC, 2010).	Minor adverse
	Other seabirds screened in for assessment	Minor adverse		Minor adverse
	Non-breeding waterbirds screened in for assessment	Minor adverse		Minor adverse
Change in prey availability due to changes in water quality	Piscivorous / partly piscivorous species screened in for assessment	Minor adverse	None required.	Minor adverse
	Non-piscivorous species screened in for assessment	Negligible		Negligible
Change in prey availability due to underwater noise	Piscivorous / partly-piscivorous species screened in for assessment	Minor adverse	None required.	Minor adverse
	Non-piscivorous species screened in for assessment	Negligible		Negligible
Marine Mammals				
Underwater noise during tubular piling				
PTS onset during tubular piling – single strike or cumulative exposure	Harbour porpoise Bottlenose dolphin	Minor adverse	Procedures as per JNCC protocol (JNCC, 2010).	Negligible

Potential Impact	Receptor	Impact Significance	Mitigation Measures	Residual Impact
TTS onset during tubular piling – single strike or cumulative exposure	White-beaked dolphin Minke whale Grey seal Harbour seal	Minor adverse		Negligible
Disturbance due to tubular (impact) piling		Minor adverse	None required	Minor adverse
Underwater noise during sheet piling				
PTS onset during sheet piling – cumulative exposure	Harbour porpoise Bottlenose dolphin White-beaked dolphin Minke whale Grey seal Harbour seal	Minor adverse	- Establishment of a mitigation zone - Only commence piling operations during the hours of daylight and good visibility - Pre–piling search for marine mammals of mitigation zone by MMO	Negligible
TTS onset during sheet piling – cumulative exposure		Minor adverse		Negligible
Disturbance due to sheet piling		Minor adverse	None required	Minor adverse
Underwater noise during dredging				
PTS onset during dredging – cumulative exposure	Harbour porpoise Bottlenose dolphin White-beaked dolphin Minke whale Grey seal Harbour seal	Minor adverse	None required	Minor adverse
TTS onset during dredging – cumulative exposure		Minor adverse	None required	Minor adverse
Disturbance due to dredging		Minor adverse	None required	Minor adverse
Indirect effects due to a change water quality and prey availability				
Indirect impacts to prey availability due to underwater noise or water quality impacts to fish species	Harbour porpoise Minke whale	Minor adverse	None required	Minor adverse
	Bottlenose dolphin White-beaked dolphin Grey seal Harbour seal	Minor adverse	None required	Minor adverse

Table 14-2 Summary of the significance of potential environmental impacts, mitigation and residual impacts during the operational phase of the proposed development

Coastal Process				
Changes to the tidal current regime due to the presence of the outer berth and associated berth pocket	Tidal regime	Negligible (near-field) No impact (far-field)	None required	Negligible (near-field) No impact (far-field)
Changes to sediment transport and erosion/accretion patterns due to the presence of the outer berth and associated berth pocket	Sediment transport	Negligible (near-field) No impact (far-field)	None required	Negligible (near-field) No impact (far-field)
Marine and Coastal Ecology				
Changes in erosion and accretion patterns	Marine Benthic Ecology	No Impact	None required	No Impact
Ornithology				
Impact of change of use on common tern movement	Breeding common terns at Imperial Dock Lock	Minor adverse	None required.	Minor adverse

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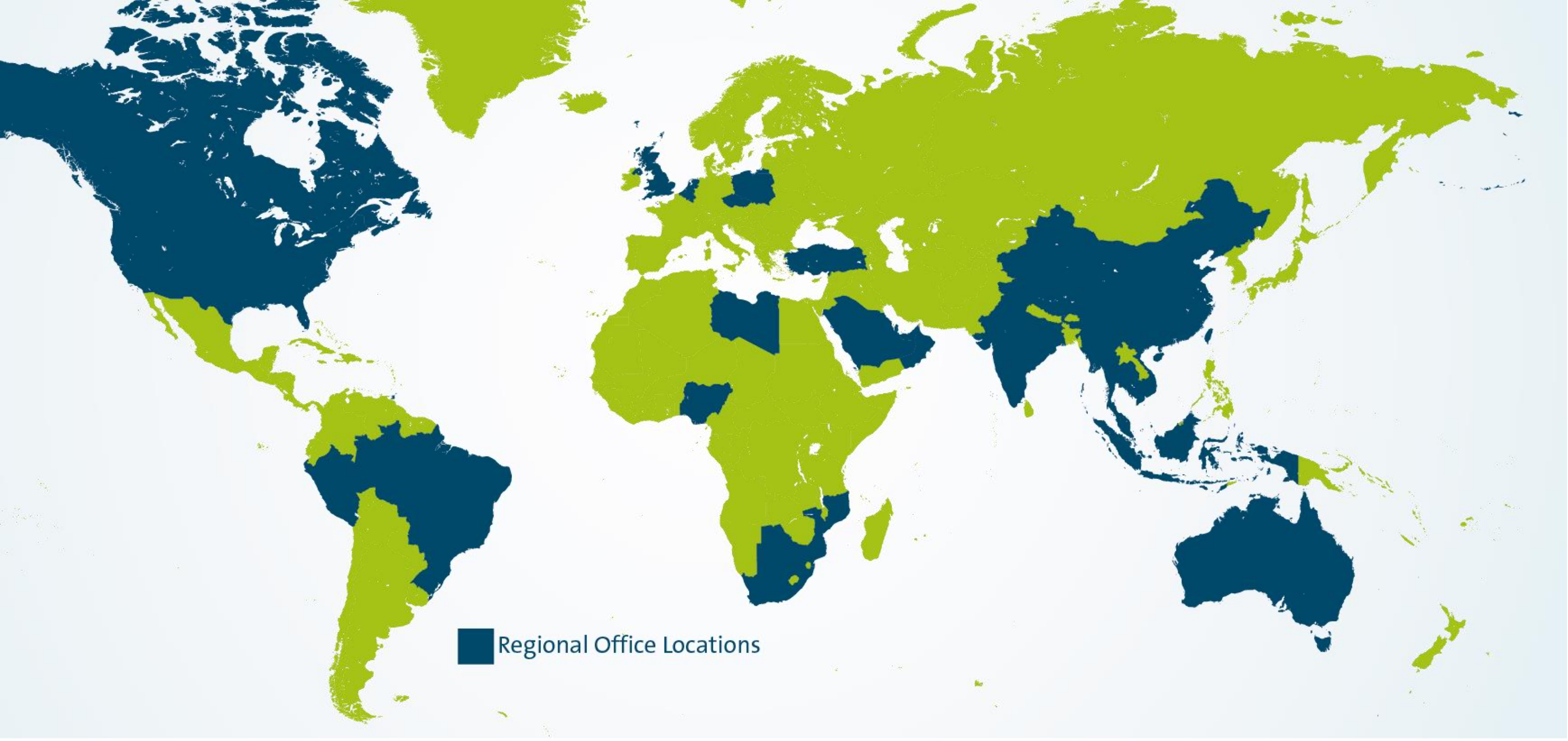

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