REPORT

Port of Leith – Outer Berth

Habitats Regulations Appraisal - Screening for LSE and Provision of Information to Inform Appropriate Assessment

Client: Forth Ports Limited

Reference: PC2045-RHD-ZZ-XX-RP-EV-0009

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Acronym	Acronym description
AON	Apparently Occupied Nest
BTO	British Trust for Ornithology
cSAC	Candidate Special Areas of Conservation
EIA	Environmental Impact Assessment
HRA	Habitats Regulations Appraisal
IROPI	Imperative reasons of overriding public interest
LSE	Likely Significant Effect
MMO	Marine Mammal Observer
MU	Management Unit
NMFS	National Marine Fisheries Service
NSN	National Site Network
OFFSABC	Outer Firth of Forth and St. Andrews Bay Complex (SPA)
OWF	Offshore Wind Farm
Psac	Possible Special Areas of Conservation
Pspa	Potential Special Protection Area
PTS	Permanent Threshold Shift
SNH	Scottish Natural Heritage
SAC	Special Areas of Conservation
SCANS-III	Small Cetaceans in the European Atlantic and North Sea
SEL	Sound Exposure Level
SPL	Sound Pressure Level
SMS	Site Management Statement
SMP	Seabird Monitoring Programme
SPA	Special Protection Areas
SPMT	Self-Propelled Modular Transporter
SSC	Suspended Sediment Concentration
SSSI	Site of Special Scientific Interest
TSHD	Trailer Suction Hopper Dredger
TTS	Temporary Threshold Shift
WeBS	Wetland Bird Survey

1 Introduction

1.1 Background to the Project

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.

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. The development of the outer berth at Port of Leith (the 'proposed development') would (see **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**).

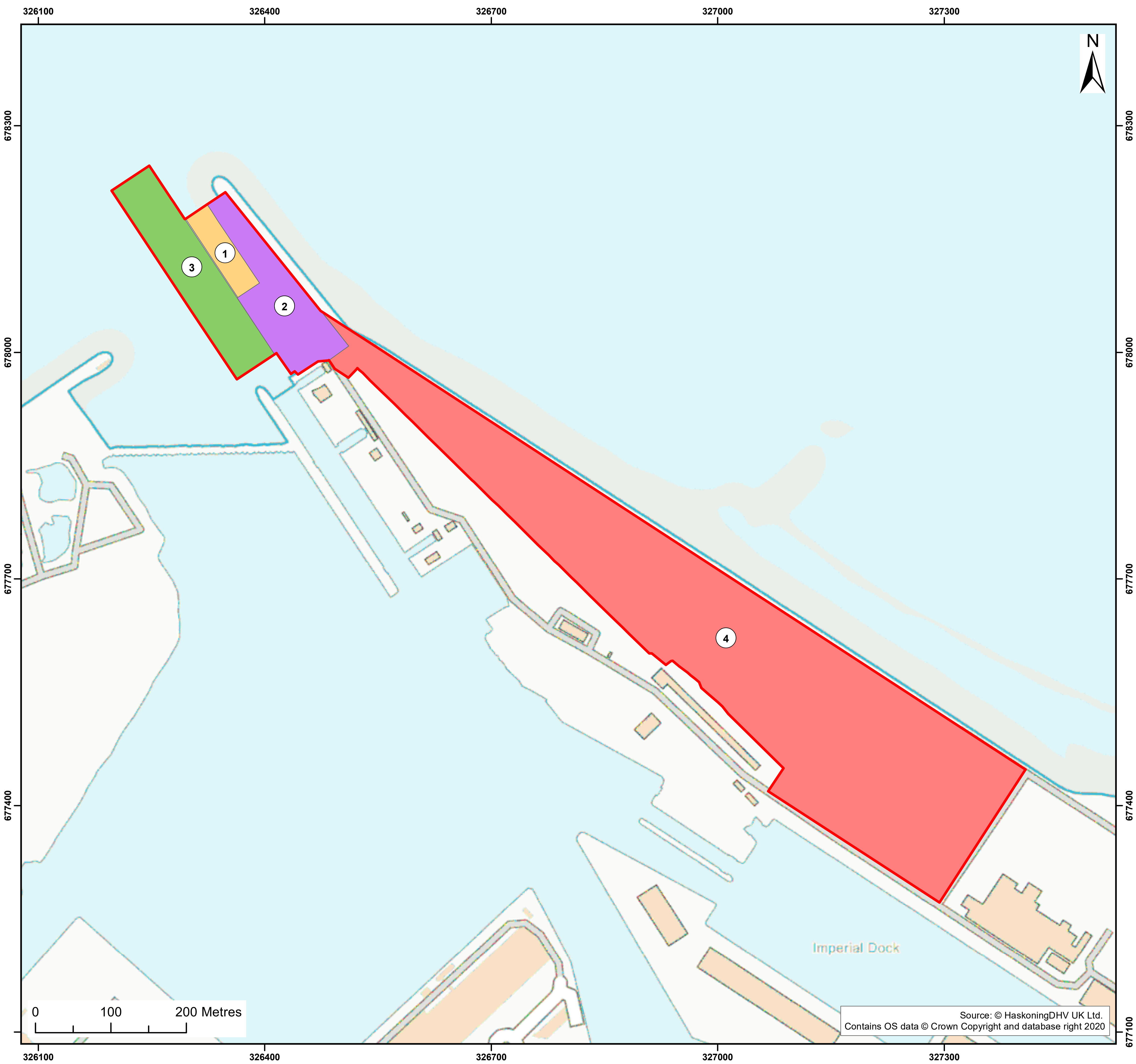
1.2 Purpose of this Report

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

This report is supported by three appendices:

- **Appendix 1**: 2021/22 Baseline Estuarine Bird Survey report, which provides information on the abundance and distribution of estuarine birds in the vicinity of the Proposed Development; and
- **Appendix 2** (Report: Underwater Noise Propagation Modelling for Construction Works at Port of Leith, Scotland); and,
- **Appendix 3** (Technical Note: Marine Mammal and Fish Technical Report for Underwater Noise Impacts).

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

Title:

Port of Leith Outer Berth Development

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2 The Proposed Development

2.1 Summary of 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).

2.2 Construction Phase

2.2.1 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 2-1 and Figure 2-2**.

2.2.1.1 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 (**Figure 2-3**). 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 2-1**.

Table 2-1 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**

2.2.1.2 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.

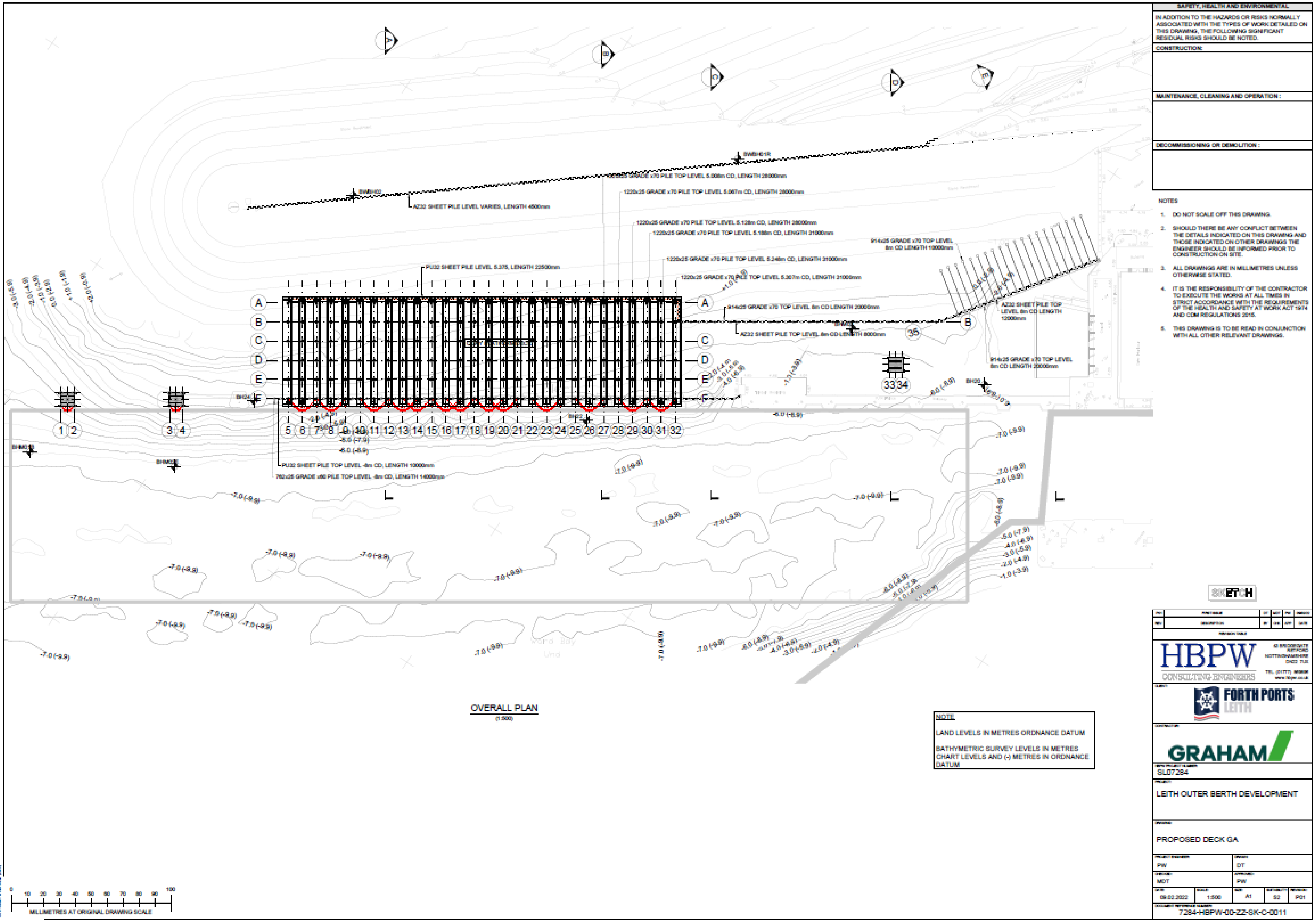


Figure 2-1 *Plan view of the pile layout of the outer berth*

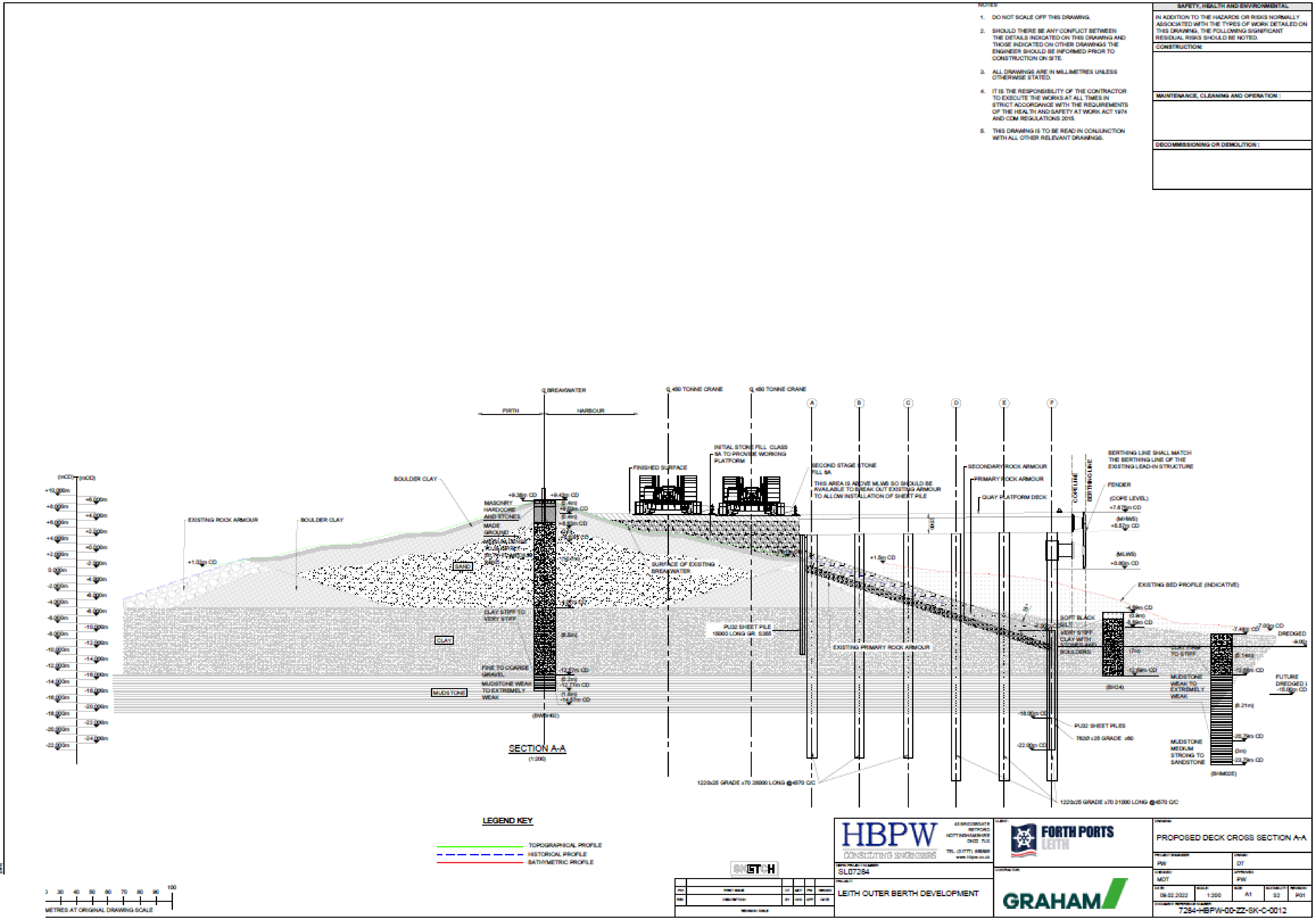


Figure 2-2 *A typical cross section of outer berth and landward area*

Figure 2-3 Removal of existing infrastructure

2.2.1.3 Piling and Area of Hardstanding

Piling platforms would be created on the breakwater to enable the crane to hold the piling hammer (**Figure 2-4**). 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 2-1**. 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 (**Figure 2-5**). 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 2-2**.

2.2.2 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 2-4 Installation of the piles

Figure 2-5 Placement of the precast beams, omni planks and pouring of the concrete deck

2.2.3 Berth Pocket

The existing berth pocket (Area 4) 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 2-2**.

Table 2-2 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**

2.2.4 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.

2.2.5 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.

2.3 Operational Phase

2.3.1 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 2-6)**. 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 2-6 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.

2.3.2 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.

2.3.3 Maintenance Dredging

The requirement for maintenance dredging during the operation of the proposed development has been predicted using the MIKE3-Mud Transport (MT) model. 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, 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.

3 Habitats Regulations Appraisal

3.1 Legislation

The HRA process covers those sites designated under the European Council Directive 2009/147/EC on the conservation of wild birds (the '*Birds Directive*') and Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora (the '*Habitats Directive*'). The UK also has to meet its obligations under relevant international agreements such as the Ramsar Convention.

The UK exited the EU on 31st January 2020; however, the application of the HRA process remains largely unchanged due to the introduction of the EU Exit Regulations 2019.

3.1.1 International Legislation

3.1.1.1 The Ramsar Convention

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

3.1.2 European Legislation

3.1.2.1 The Birds Directive

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

3.1.2.2 The Habitats Directive

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

3.1.3 National Legislation

3.1.3.1 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).

3.2 The HRA Process

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

This report provides the information to support a HRA Screening for LSE for the Proposed Development and consequent information to inform an Appropriate Assessment where LSE cannot be excluded. Specifically, it sets out the following:

- An overview of the HRA process;
- The designated sites considered relevant to the HRA;
- The qualifying features and conservation objectives of the relevant designated sites;
- Identification of pathways and impacts considered;
- Screening of potential effects;
- Provision of information to inform an Appropriate Assessment where screening concludes that LSE cannot be excluded.

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

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

3.2.1 Stages of HRA

The HRA process (in its entirety) follows a four-staged approach, as detailed in NatureScot (then Scottish Natural Heritage; 'SNH') Natura Casework Guidance (SNH, 2014), which is described further below and in **Plate 3.1**.

1. **What is the plan or project:** to establish whether there is sufficient information on the plan or project (location, extent, timings).
2. **Is the plan or project directly connected with or necessary to site management for nature conservation:** works which are clearly necessary to the management of the site, or that provide value to the site are not required to undertake further assessment.
3. **Is the plan or project likely to have a significant effect:** The process of identifying potentially relevant designated sites, and whether the Proposed Development is likely to have a significant effect on the qualifying features of the site, either alone or in-combination with other plans and

projects. If it is concluded at this stage that there is no potential for LSE, there is no requirement to carry out subsequent stages of the HRA.

4. **Undertake an Appropriate Assessment:** Where a LSE for a designated site(s) cannot be ruled out, either alone or in-combination with other plans and projects, assessment of the potential effects on the integrity of the site(s), again either alone or in-combination with other plans and projects, in view of its qualifying features and conservation objectives is required. Where an adverse effect on integrity cannot be excluded, an assessment of mitigation options is carried out and mitigation measures (where available) are proposed to address the effects. If, after taking account of mitigation, an adverse effect on integrity cannot be excluded, the HRA must progress to Stages 3 and 4.
5. **Can it be ascertained that the plan or project will not adversely affect site integrity:** the appropriate authority must decide if the plan or project in question will or will not adversely affect the integrity of the site/s.
6. **Are there Alternative Solutions:** Identifying and examining alternative ways of achieving the objectives of the project to establish whether there are solutions that would avoid or have a lesser effect on the site(s).
7. **Would a priority habitat or species be adversely affected:** priority habitats and species are afforded a greater level of protection under the Regulations, this stage determines whether Stage 8 or Stage 9 should be undertaken.
8. **Are there Imperative reasons of overriding public interest (IROPI) (non-priority habitats and/or species):** Where no alternative solution exists, the next stage of the process is to assess whether the development is necessary for IROPI and, if so, the identification of compensatory measures needed to maintain the overall coherence of the designated site network.
9. **Are there IROPI (priority habitats and/or species):** as above, for priority habitats and/or species, where there are *exceptional* health, safety, or environmental benefits, or other reasons for IROPI.

3.2.2 Types of Designated Sites included in HRA

The classes of designations considered by HRA are:

- Ramsar sites;
- SPAs and Potential SPAs (pSPAs); and,
- SACs, Possible SACs (pSACs) and Candidate SACs (cSACs).

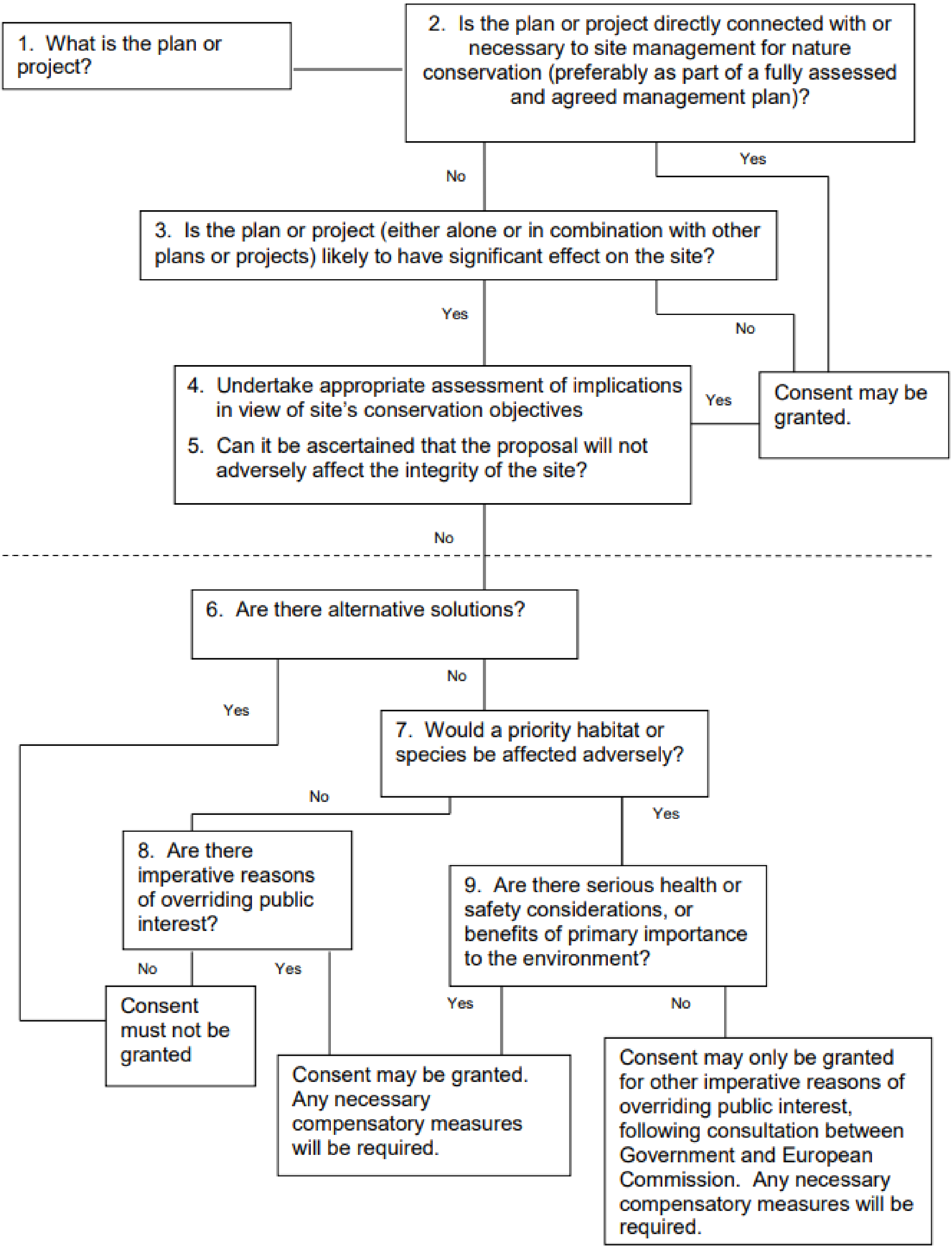


Plate 3.1 The HRA Process (SNH, 2014)

4 Stage 1: Screening

4.1 Approach to Screening

Screening is based on a conceptual 'source-pathway-receptor' approach. This approach identifies likely environmental effects resulting from the proposed construction and operation of the Proposed Development. The parameters are defined as follows:

- Source – the origin of a potential effect (noting that one source may have several pathways and receptors).
- Pathway – the means by which the effect of the activity could impact a receptor.
- Receptor – the element of the receiving environment that is impacted.

Where there is no pathway, or the pathway has sufficient distance such that the effect from the source has dissipated to a negligible level before reaching the receptor, there may be justification for the screening out of that particular receptor (i.e. feature) for the designated site in question.

Note that designated sites are screened in if, for any one of their qualifying features (i.e. a species or habitat), a source-pathway-receptor relationship and potential for LSE cannot be ruled out (including in-combination effects). However, each qualifying feature of that designated site will be considered separately and it may be that the screening process rules out LSE for some features at this stage. As described above, mitigation is not taken into account at Stage 1, but can be considered where relevant in the Stage 2 assessment.

The approach to screening for each receptor is based on the known distribution, ecology and sensitivities of each receptor group and therefore the potential for being affected. Where there is insufficient information available at this stage to screen out a designated site, the site is screened in for further consideration.

Based on the HRA guidance specifically developed for the Firth of Forth area (HRA on the Firth of Forth – A Guide for Developers and Regulators (SNH, 2016)[3]), and early consultation that was undertaken on the project, it has been determined that the designated sites that should be considered within the HRA screening assessment are (**Figure 4.1**):

- **Outer Firth of Forth and St Andrews Bay Complex (OFFSABC) SPA** - 0km from the Proposed Development.
- **Firth of Forth SPA and Ramsar site -** 0km from the Proposed Development.
- **Imperial Dock Lock, Leith SPA -** Less than 1km from the Proposed Development.
- **Forth Islands SPA** - Approximately 4km from the Proposed Development.
- **River Teith 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.

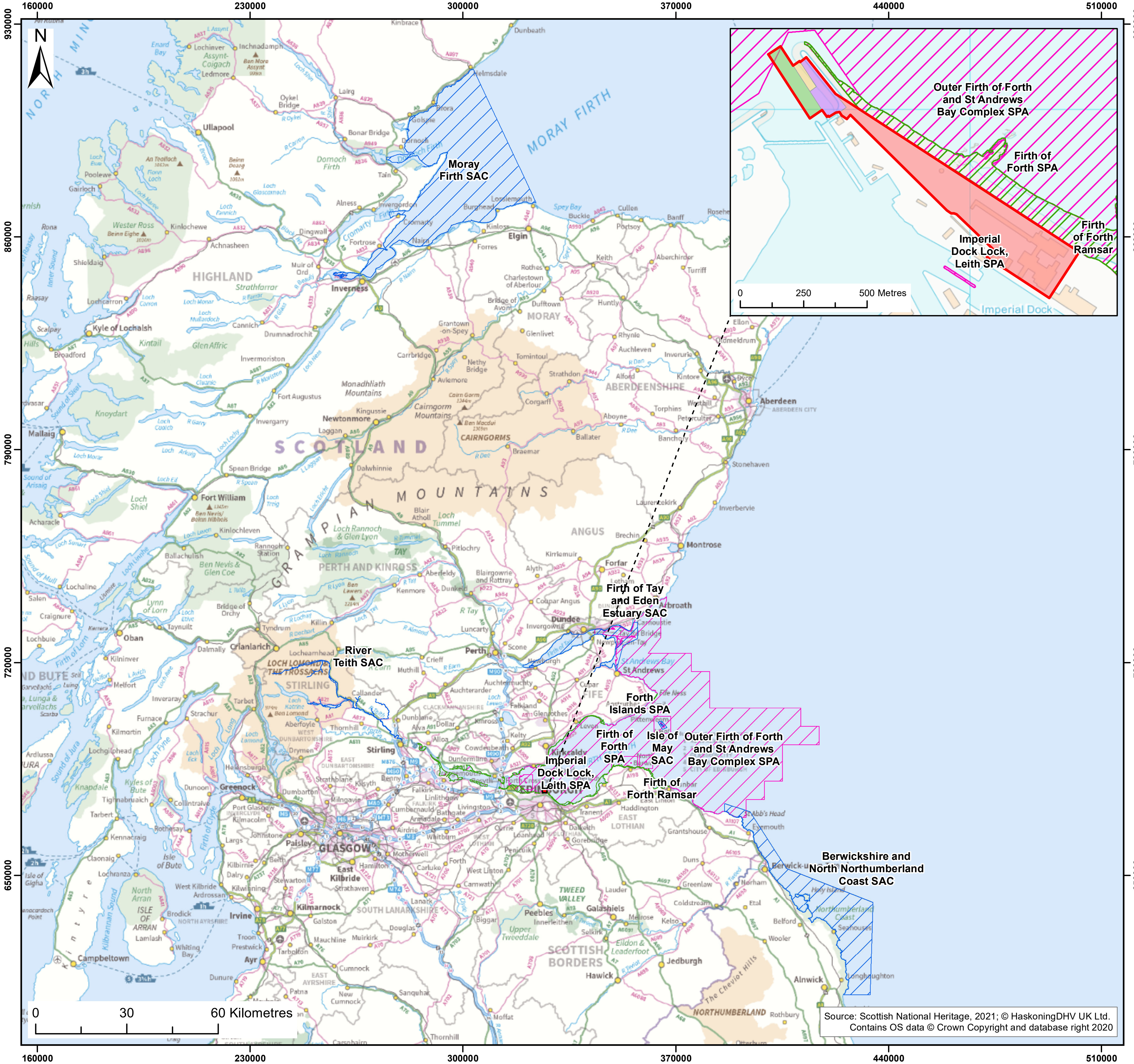
[3] https://www.nature.scot/sites/default/files/2019-07/Habitats%20Regulations%20Appraisal%20%28HRA%29%20on%20the%20Firth%20of%20Forth%20-%20A%20Guide%20for%20developers%20and%20regulators_1.pdf

- **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.

The closest qualifying features related to benthic and intertidal habitats are approximately 43km (Isle of May SAC) and 64km (Firth of Tay and Eden Estuary SAC) from the Proposed Development, respectively. Consequently, where a designated site listed above has qualifying features related to benthic and intertidal habitats, these have been screened out of the HRA. As such, the following features are the focus of this HRA Screening assessment:

- Fish;
- Ornithology; and,
- Marine mammals.

While an initial HRA screening report was issued to Marine Scotland and City of Edinburgh Council in November 2021, **Section 4.2** of this document represents a repeat of the screening based on current information, including output from site-specific surveys that were concluded in March 2022, to identify any other features for which Appropriate Assessment may be needed.



Legend:

- Red line boundary
- 1 - Quayside and mooring dolphin
- 2 - Existing jetty, and backland infill / hardstanding area
- 3 - Laydown area for OWF support
- 4 - Dredging works

Designated sites

- Ramsar
- Special Area of Conservation
- Special Protected Area

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

Title: Designated sites

Figure: 4.1 Drawing No: PB2045-200-001

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01	28/06/2021	JT	GS	A3	1:1,250,000

Co-ordinate system: British National Grid

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4.2 Screening for LSE from the Proposed Development alone

4.2.1 Fish

4.2.1.1 Screening of designated sites

River Teith SAC

The SNH 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 4.1**) 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 (the third, brook lamprey *Lampetra planeri* is a non-migratory freshwater feature and therefore not considered in this assessment).

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 in 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).

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. Individuals will remain at sea for up to two years before returning to freshwater from October to December.

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 in larger rivers (SNH, 2016).

4.2.1.2 Potential effects of the Proposed Development on SAC features

There is the potential for the following effects of the Proposed Development on SAC transitional fish features during construction:

- Generation of underwater noise from piling operations and other construction activities (such as dredging), which could have physiological / behavioural response impacts or may form a 'barrier' to migration routes (noting that piling impacts would be managed by standard implementation of JNCC protocol for 'soft-start' piling (JNCC, 2010);

- Impacts due to changes to water quality (e.g., increased suspended sediment, changes to hydrological regime), which again may have physiological effects or may form a barrier to migration); and,
- Impacts due to a change in habitat quality (e.g. increased sedimentation, loss of habitat).

During operation, there would not be any significant change during the operational phase compared to the existing activity levels, given that there is no expected significant increase in vessel traffic as a result of the Proposed Development.

4.2.1.3 Results of screening for LSE

Table 4.1 provides the results of the Screening for LSE as a result of the Proposed Development on fish species of the River Tay SAC.

Table 4.1 Alone Screening for LSE on fish species of the River Teith SAC

Qualifying feature	Potential effect	LSE concluded
Sea lamprey	Generation of underwater noise from piling operations and other construction activities	**Yes**
	Impacts due to changes to water quality (e.g., increased suspended sediment, changes to hydrological regime)	**Yes**
	Impacts due to a change in habitat quality (e.g. increased sedimentation, loss of habitat)	**Yes**
River lamprey	Generation of underwater noise from piling operations and other construction activities	**Yes**
	Impacts due to changes to water quality (e.g., increased suspended sediment, changes to hydrological regime)	**Yes**
	Impacts due to a change in habitat quality (e.g. increased sedimentation, loss of habitat)	**Yes**
Atlantic salmon	Generation of underwater noise from piling operations and other construction activities	**Yes**
	Impacts due to changes to water quality (e.g., increased suspended sediment, changes to hydrological regime)	**Yes**
	Impacts due to a change in habitat quality (e.g. increased sedimentation, loss of habitat)	**Yes**

4.2.2 Ornithology

4.2.2.1 Screening of designated sites

The designated sites for ornithological features that have been screened into the HRA are:

- OFFSABC SPA (UK9020316);
- Firth of Forth SPA (UK9004411) and Ramsar Site (UK13017);
- Imperial Dock Lock, Leith SPA (UK9004451); and,
- Forth Islands SPA (UK9004171).

The locations of the above designations in relation to the Proposed Development are shown in **Figure 4.1**).

Outer Firth of Forth and St Andrews Bay Complex SPA

The OFFSABC SPA covers an extensive marine area off the east coast of Scotland, totalling 2,720.68km^2, including the Firth of Forth. This marine area has one of the largest and most diverse marine bird concentrations in Scotland and is designated for a total of 21 seabird and waterbird species (SNH & JNCC, 2020). A list of the qualifying features is presented in **Table 4.2**.

Table 4.2 Summary of the OFFSABC SPA qualifying features

Site name	Distance to Proposed Development	Species designated
OFFSABC SPA	0km	**Annex 1 populations of European importance** Non-breeding: • Red-throated diver *Gavia stellata* • Slavonian grebe *Podiceps auritus* • Little gull *Larus minutus* Breeding: • Common tern *Sterna hirundo* • Arctic tern *Sterna paradisaea* **Migratory populations of European importance** Non-breeding: • Eider *Somateria mollissima* Breeding: • Shag *Phalacrocorax aristotelis* • Gannet *Morus bassanus* **Non-breeding waterfowl assemblage** Long-tailed duck *Clangula hyemalis*, common scoter *Melanitta nigra*, velvet scoter *Melanitta fusca*, goldeneye *Bucephala clangula*, red-breasted merganser *Mergus serrator*. **Breeding seabird assemblage** Puffin *Fratercula arctica*, kittiwake *Rissa tridactyla*, Manx shearwater *Puffinus puffinus*, guillemot *Uria aalge*, herring gull *Larus argentatus.* **Non-breeding seabird assemblage** Black-headed gull *Chroicocephalus ridibundus*, common gull *Larus canus*, herring gull, guillemot, shag, kittiwake, razorbill.

Firth of Forth SPA and Ramsar Site

The Firth of Forth SPA and Ramsar Site is formed of an estuarine and coastal complex, covering an area of 63.2km^2 of coastline around the Firth of Forth, with extensive intertidal flats and rocky shores, saltmarsh, lagoons and sand dunes (SNH, 2018a). A list of the qualifying ornithological features is presented in **Table 4.3**.

Table 4.3 Summary of the Firth of Forth SPA / Ramsar Site qualifying features

Site name	Distance to Proposed Development	Species designated
Firth of Forth SPA (and Ramsar site)	0km	**Annex 1 populations of European importance** Non-breeding: • Red-throated diver • Slavonian grebe[1] • Golden plover *Pluvialis apricaria* • Bar-tailed godwit[1] *Limosa lapponica* Post-breeding (passage): • Sandwich tern[1] *Thalasseus sandvicensis* **Migratory populations of European importance** Non-breeding: • Pink-footed goose[1] *Anser brachyrhynchus* • Shelduck[1] *Tadorna tadorna* • Knot[1] *Calidris canutus* • Redshank[1] *Tringa totanus* • Turnstone[1] *Arenaria interpres* **Non-breeding waterfowl assemblage**[1] Great-crested grebe *Podiceps cristatus*, cormorant *Phalacrocorax carbo*, scaup *Aythya marila*, eider, long-tailed duck, common scoter, velvet scoter, goldeneye[1], red-breasted merganser, oystercatcher *Haematopus ostralegus*, ringed plover *Charadrius hiaticula*, grey plover *Pluvialis squatarola*, dunlin *Calidris alpina*, curlew *Numenius arquata*, mallard *Anas platyrhynchos*, lapwing *Vanellus vanellus* and wigeon *Anas penelope*.
Notes: [1] Listed in both the SPA citation and Ramsar Site citation.		

Imperial Dock Lock, Leith SPA

The Imperial Dock Lock, Leith SPA is located on a man-made structure at the mouth of the Imperial Dock in the heart of the Port of Leith, covering a total area of 0.001km^2. This site is designated as it regularly supports a breeding population of common tern (SNH, 2004) (see **Table 4.4**).

Table 4.4 Summary of the Imperial Dock Lock, SPA qualifying features

Site name	Distance to Proposed Development	Species designated
Imperial Dock Lock, Leith SPA	0.8km	**Annex 1 populations of European importance** Breeding: • Common tern.

Forth Islands SPA

The Forth Islands SPA covers a series of islands that support the main seabird colonies within the Firth of Forth and totals an area of 97.97km^2. The islands covered by the site include the Isle of May, Inchmickery, Fidra, The Lamb, Craigleith, Bass Rock, and Long Craig. A list of the qualifying features is presented in **Table 4.5**.

Table 4.5 Summary of the Forth Islands SPA qualifying features

Site name	Distance to Proposed Development	Species designated
Forth Islands SPA	3.6km	**Annex 1 populations of European importance** Breeding: • Arctic tern • Common tern • Roseate tern *Sterna dougallii* • Sandwich tern **Migratory populations of European importance** Breeding • Gannet • Lesser black-backed gull • Puffin • Shag **Breeding seabird assemblage** Razorbill, guillemot, kittiwake, herring gull, cormorant.

4.2.2.2 Baseline information on SPA qualifying species in the vicinity of the Proposed Development

Estuarine bird survey 2021/22

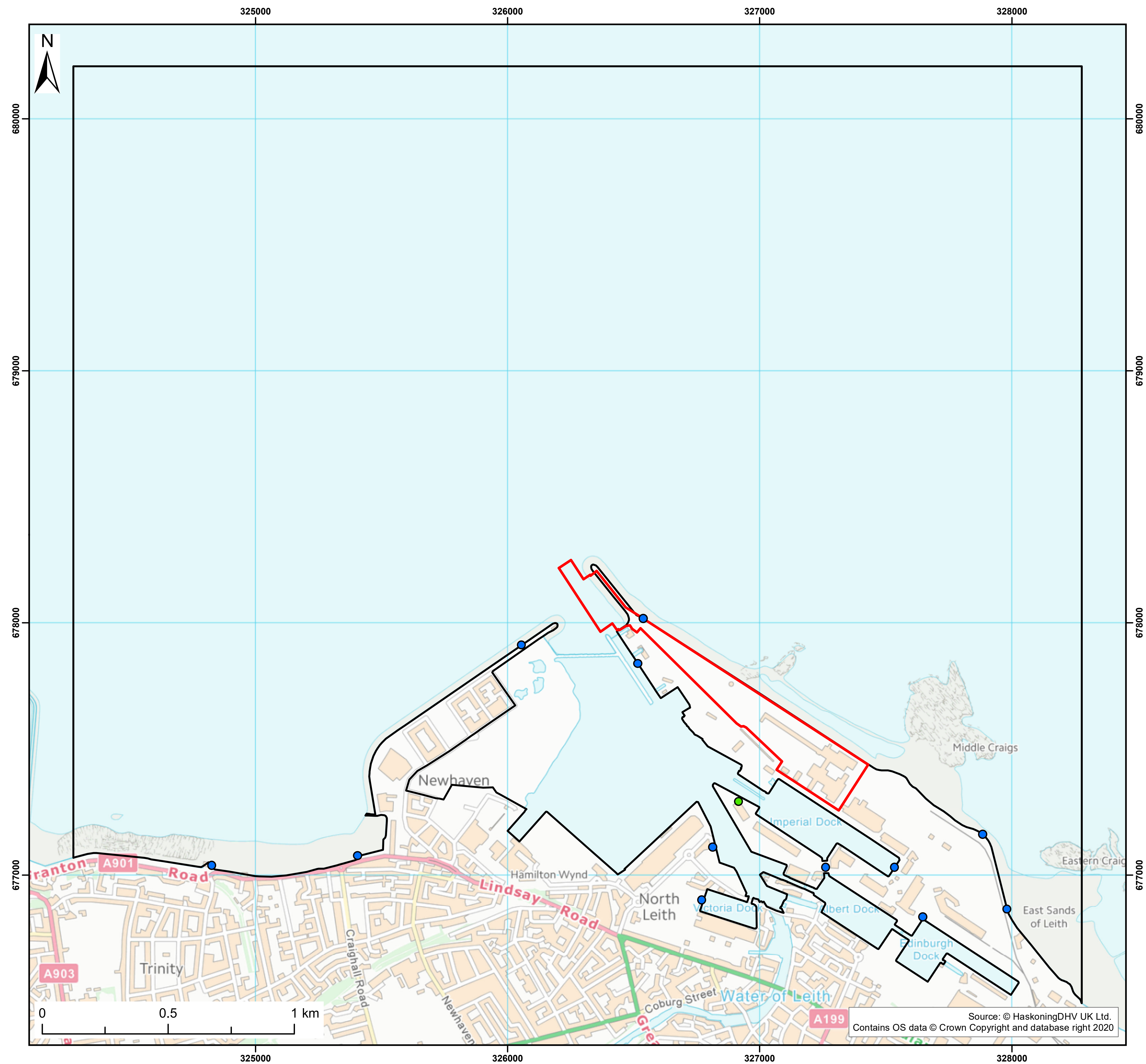
Baseline ornithology at the Port of Leith has been characterised through estuarine bird surveys of the Port and surrounding marine and coastal areas. The baseline information from the surveys, including species-specific accounts relating to the abundance and distribution of SPA / Ramsar Site features in the study area, has been compiled in a Baseline Estuarine Bird Survey Report, which is provided as **Appendix 1** and should be read in conjunction with this HRA document.

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, which were undertaken from May to July 2021 (inclusive), denoting the number of apparently occupied nests (AON) at Imperial Dock Lock, Leith Special Protection Area (SPA); and,
- Twice-monthly common tern flight behaviour surveys at the SPA colony, which were undertaken from May to July 2021 (inclusive).

The ornithological study area, presented in **Figure 4.12**), extends 2km to the east and west of Leith Outer Berth and 2km offshore of the Outer Berth. 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.

The full methodology for the surveys is described in **Appendix 1**. In view of the overall aim of the surveys (i.e. to provide sufficient robust baseline information for the purpose of this HRA and other environmental assessments), the scope and methodology, including the extent of the survey area, was agreed with NatureScot in April 2021. The advice received from NatureScot (principally, that the scope of the survey was fit for purpose) is provided in **Appendix 1**.



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 Study Area

Figure: 4.2 | Drawing No: PC2045-RHD-ZZ-ZZ-DR-EV-0016

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
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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 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).

Over the course of the survey period (i.e. 25 survey visits), a total of 32 SPA / Ramsar Site features 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).

The peak high tide (+/- 3 hrs) and low tide (+/- 3 hrs) counts of the 32 features are presented in **Table 4.6**. SPA / Ramsar features that are omitted from the table were not present during any of the survey visits. For monthly peak counts, please refer to species-specific accounts in **Appendix 1**.

*Table 4.6 Peak low tide and high tide counts of qualifying SPA / Ramsar site interest features (overall peak in **bold**)*

Species		Low tide (+/- 3 hr.)		High tide (+/- 3 hr.)	
		Peak count	Month	Peak count	Month
Waterfowl					
Eider	*Somateria mollissima*	651	Jun.	**976**	Aug.
Shelduck	*Tadorna tadorna*	3	May	**4**	Feb.
Mallard	*Anas platyrhynchos*	**81**	Nov.	71	Oct.
Common scoter	*Melanitta nigra*	**22**	Aug.	0	-
Velvet scoter	*Melanitta fusca*	**27**	Mar.	10	Mar.
Long-tailed duck	*Clangula hyemalis*	**1**	Jan.	0	-
Red-breasted merganser	*Mergus serrator*	**38**	Mar.	17	Mar.
Goldeneye	*Bucephala clangula*	268	Jan.	**413**	Jan.
Great crested grebe	*Podiceps cristatus*	**2**	May	**2**	Jan.
Oystercatcher	*Haematopus ostralegus*	284	Mar.	**289**	Nov.
Ringed plover	*Charadrius hiaticula*	24	Sep.	**35**	Sep.
Curlew	*Numenius arquata*	**12**	Jul.	10	Apr.
Bar-tailed godwit	*Limosa lapponica*	13	Jan.	**27**	Apr.
Turnstone	*Arenaria interpres*	26	Dec.	**43**	Jan.
Knot	*Calidris canutus*	**48**	Mar.	47	Dec.
Dunlin	*Calidris alpina*	**270**	Nov.	136	Nov.
Redshank	*Tringa totanus*	146	Dec.	**192**	Nov.
Seabirds					
Kittiwake	*Rissa tridactyla*	52	Sep.	**57**	Sep.
Black-headed gull	*Chroicocephalus ridibundus*	1,177	Nov.	**1,534**	Nov.
Common gull	*Larus canus*	**27**	Apr.	8	Sep.
Herring gull	*Larus argentatus*	**1,303**	Sep.	1,108	Sep.
Lesser black-backed gull	*Larus fuscus*	**523**	Sep.	441	Aug.

Species		Low tide (+/- 3 hr.)		High tide (+/- 3 hr.)	
		Peak count	Month	Peak count	Month
Sandwich tern	*Sterna sandvicensis*	69	Sep.	**84**	Aug.
Common tern	*Sterna hirundo*	839	Aug.	**c.2,000**	May
Roseate tern	*Sterna dougallii*	0	-	**1**	May
Guillemot	*Uria aalge*	**995**	Sep.	826	Sep.
Razorbill	*Alca torda*	200	Aug.	**209**	Aug.
Puffin	*Fratercula arctica*	**3**	May	**3**	Jul.
Red-throated diver	*Gavia stellata*	**2**	May	**2**	Nov.
Gannet	*Morus bassanus*	**48**	Sep.	6	Apr.
Shag	*Phalacrocorax aristotelis*	**53**	Sep.	28	Sep.
Cormorant	*Phalacrocorax carbo*	**141**	Sep.	139	Sep.

Baseline common tern colony surveys

In addition to the estuarine bird surveys outlined above, a twice-monthly common tern-specific study was undertaken to determine the level and nature of activity at the Imperial Dock Lock, Leith SPA colony during the breeding season. The survey recorded colony counts between May 2021 and July 2021, inclusive. Full details of the survey, including details of the methodology (undertaken as per JNCC protocol (Walsh et al., 1995)) and full results, are provided in **Appendix 1**.

Common terns were first recorded on the site in May. The peak number of Apparently Occupied Nests (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 SMP 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 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. A 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 4.3**).

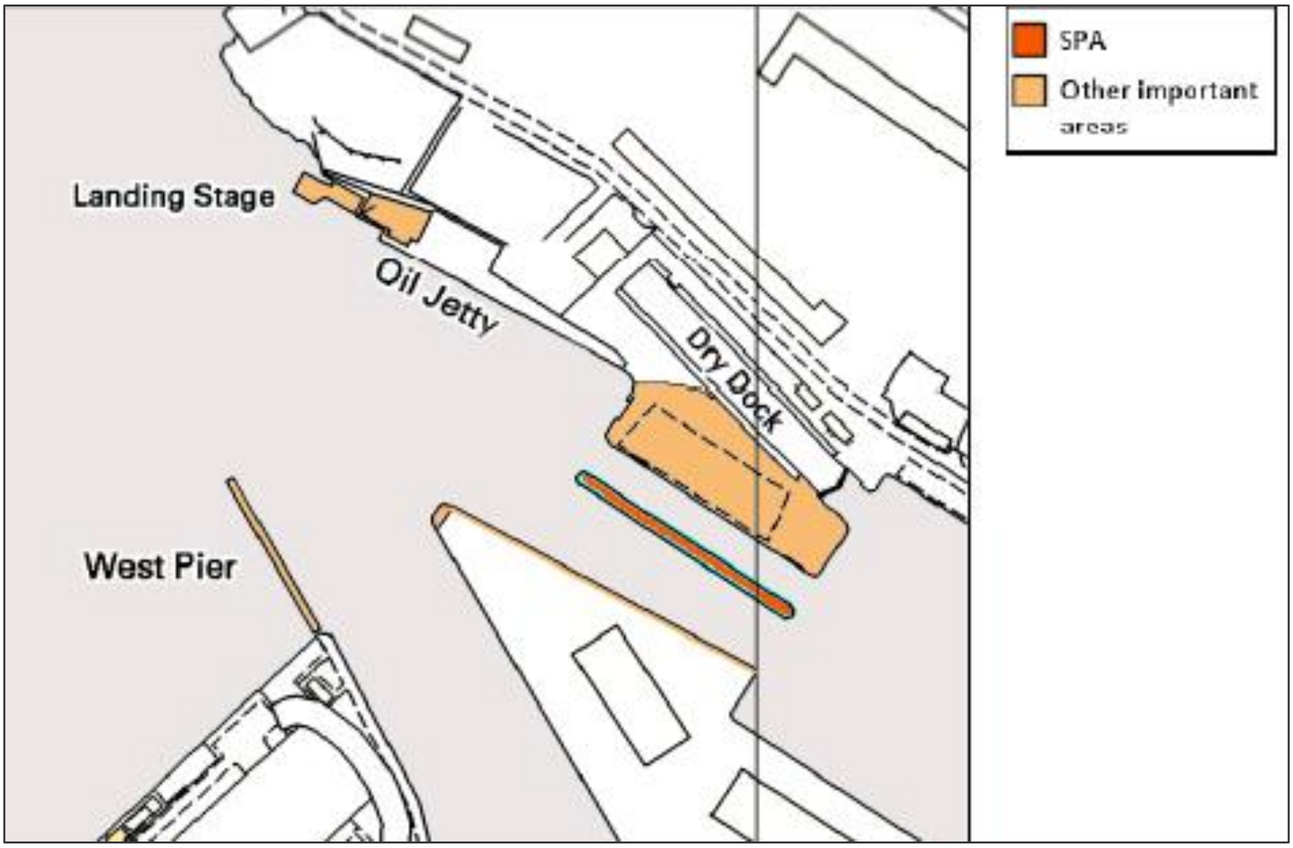


Figure 4.3 Areas used by adult and juvenile common terns (taken from Jennings, 2012)

Common tern flight surveys

In tandem with the colony surveys, common tern flight behaviour surveys were also undertaken whereby the direction of each individual 'flyover' by common terns accessing or leaving the colony were attributed to one of four sectors providing access to the open sea, as shown in **Figure 4.4.** Heights of individual flights were recorded, in categories of <5m, 5-10m, 10-20m and 20m+. Full details regarding the methodology, which was agreed with NatureScot and mirrors the methodology employed by Jennings (2012), and the results of the flight surveys are provided in **Appendix 1**.

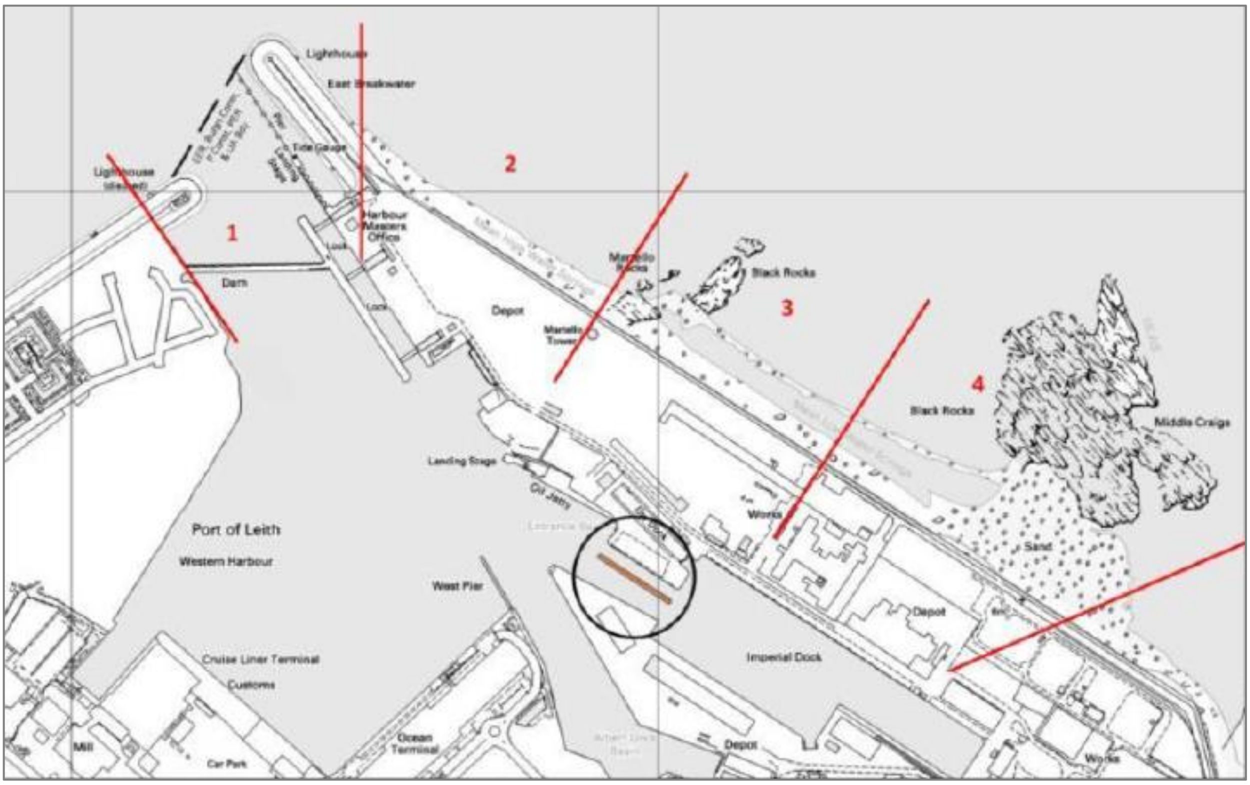


Figure 4.4 Common tern flight survey sectors at Port of Leith (taken from Jennings, 2012)

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 falling into the 10-20m and 20m+ categories. 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.

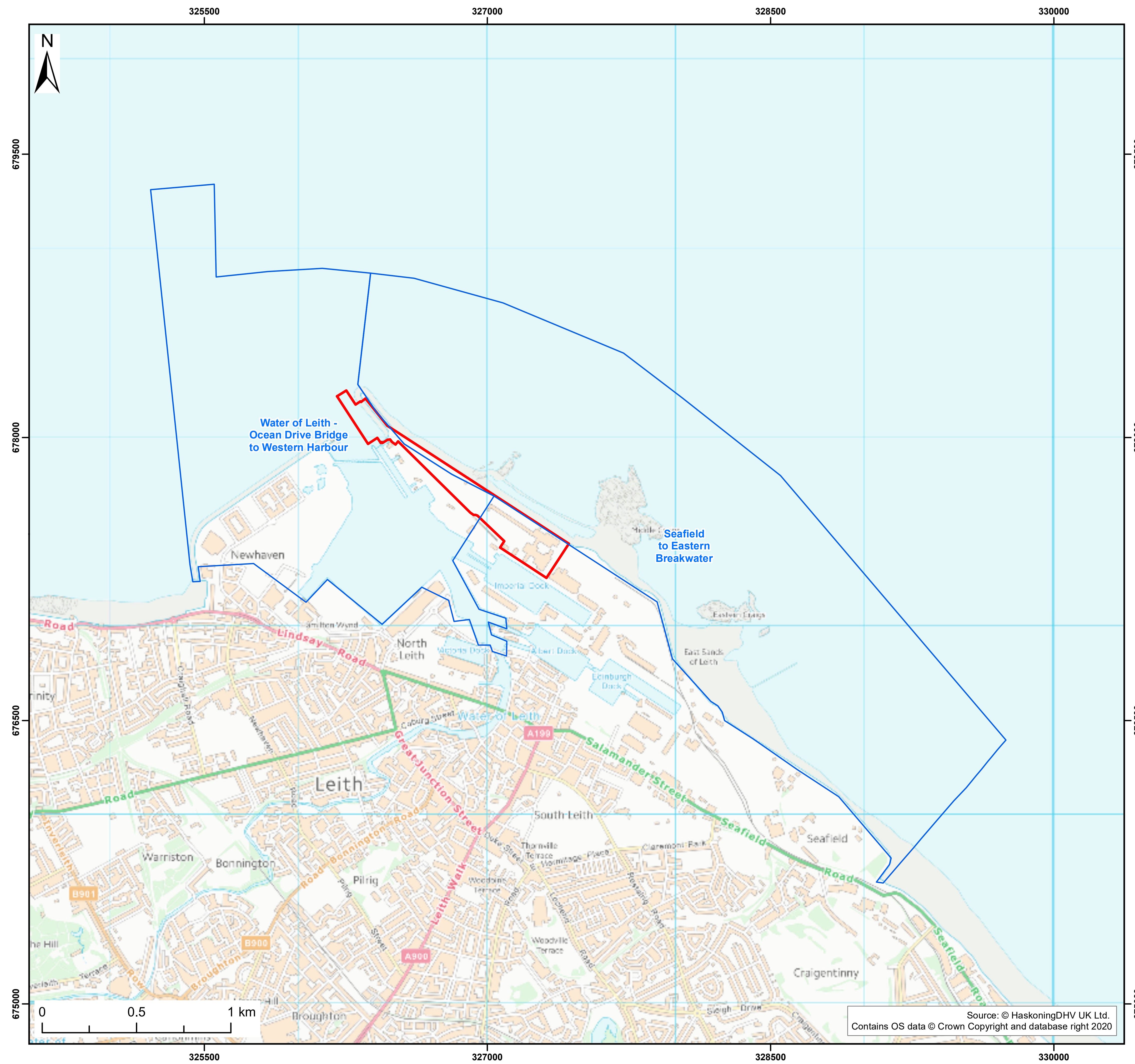
Supplementary baseline data

Supplementary baseline data on estuarine bird abundance in and around the Port has been obtained from the British Trust for Ornithology (BTO) Wetland Bird Survey[4] (WeBS). The WeBS scheme monitors the numbers and distribution of non-breeding waterbirds in the UK. Under the scheme, core counts are undertaken monthly in estuaries at high tide throughout the year. At high water, the available area of intertidal habitat is minimal and the waterbirds which use estuarine areas tend to concentrate in coastal roost sites. Core monthly counts therefore provide an indication of the total numbers of birds of a given species present in a given sector in a given month. The data presented are high tide counts from the following sectors which both overlap with the Proposed Development (see **Figure 4.5**):

- Water of Leith – Ocean Drive Bridge to Western Harbour (sector no. 83440), overlapping with and extending to the west of the development area; and,
- Seafield to Eastern Breakwater (sector no. 83441), overlapping with and extending to the east of the development area.

Available core count data for these count sectors in the most recent 5-year period are presented in **Table 4.7** and **Table 4.8**. Data are only available for either sector since 2018, hence the tables present peak monthly counts (the peak numbers of a given species recorded in a given month during the overall period for which data are available) rather than mean peaks. SPA / Ramsar features that are omitted from the table were not present during any of the WeBS counts.

[4] *https://www.bto.org/our-science/projects/wetland-bird-survey*



Legend:

- Red Line Boundary
- WeBS Sectors

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

Title:

WeBS Core Count Sectors

Figure:	Drawing No:
4.5	PC2045-RHD-ZZ-ZZ-DR-EV-0018

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
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Table 4.7 High Tide Counts of SPA qualifying species at Water of Leith - Ocean Drive to Western Harbour (WeBS Core Count Sector 83440). Darker blue shading indicates peak monthly counts.

Species	Peak Monthly Count July 2018 – June 2020											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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
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
Herring gull	500	62	103	83	27	160	81	68	114	104	109	228
Lesser black-backed gull	0	0	20	10	15	31	32	56	140	9	9	11
Mallard	8	27	25	3	3	14	10	30	46	9	14	24
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

Table 4.8 High Tide Counts of SPA qualifying species at Seafield to Eastern Breakwater (WeBS Core Count Sector 83441). Darker blue shading indicates SPA species recorded on site and peak monthly counts.

Species	Peak Monthly Count February 2018 – June 2020											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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 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
Dunlin	0	0	33	0	7	1	11	3	4	28	3	2
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
Golden Plover	0	0	0	0	0	0	0	1	0	0	0	0
Great-crested grebe	2	1	0	0	0	0	0	0	0	0	1	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
Long-tailed duck	0	3	0	0	0	0	0	0	0	0	0	0
Mallard	0	5	34	11	13	13	0	5	0	0	16	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
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
Roseate tern	0	0	0	0	0	0	0	0	0	0	0	0

Species	Peak Monthly Count February 2018 – June 2020											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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
Turnstone	35	66	33	27	3	5	3	29	36	25	33	31
Velvet scoter	6	0	0	5	0	0	0	0	0	0	2	0
Wigeon	2	0	0	0	0	0	0	0	0	0	0	0

Royal HaskoningDHV

Baseline abundance data in the context of SPA populations

For the purposes of screening, the peak annual counts from the 2021/22 surveys and WeBS counts from sectors 83440 and 83441 from 2018/19 to 2019/20 are used to provide an overall indication of the peak numbers present close to the Proposed Development, and the proportion of the population of a given SPA this represents (**Table 4.9** to **Table 4.12**). Features that are omitted from the tables were not present during the 2021/22 surveys or in any of the WeBS counts. For most SPAs, two population counts are given for a species: the numbers from the SPA citation at the time of classification, and updated population estimates from either Furness (2015) or WeBS (mean peak for the Forth Estuary, 2015/16 to 2019/20). Only one estimate is given for the OFFSABC SPA as this site has been recently classified (December 2020).

Table 4.9 Peak counts of qualifying species of the OFFSABC SPA compared with SPA citation populations (Nature Scot, 2020). Highlighted cells indicate where peak counts exceed 1% of the SPA population.

Species	Citation population (individuals)	2021/22 estuarine bird survey		WeBS Sector 83440 (2018/19 to 2019/20)		WeBS Sector 84441 (2018/19 to 2019/20)	
		Peak count	% SPA	Peak count	% SPA	Peak count	% SPA
Qualifying features							
Arctic tern	1,784	0	0.0%	1	<0.1%	1	<0.1%
Common tern	1,080	2,000	>100%	200	18.5%	2	0.2%
Eider	21,546	976	4.5%	220	1.0%	713	3.3%
Gannet	10,945	48	0.4%	0	0.0%	0	0.0%
Red-throated diver	851	2	0.2%	0	0.0%	7	0.8%
Shag	4,800	53	1.1%	3	<0.1%	34	0.7%
Named non-breeding waterfowl assemblage components							
Common scoter	4,677	22	0.5%	3	<0.1%	8	0.2%
Goldeneye	589	413	70.1%	504	85.6%	114	19.4%
Long-tailed duck	1,948	1	0.1%	0	0.0%	3	0.2%
Red-breasted merganser	431	38	8.8%	10	2.3%	26	6.0%
Velvet scoter	775	27	3.5%	0	0.0%	6	0.8%
Named breeding seabird assemblage components							
Guillemot	28,123	995	3.5%	0	0.0%	0	0.0%
Kittiwake	12,020	52	0.4%	0	0.0%	55	0.5%
Herring gull	3,044	1,303	42.8%	500	16.4%	0	0.0%
Puffin	61,086	3	<0.1%	0	0.0%	0	0.0%
Named non-breeding seabird assemblage components							
Black-headed gull	26,835	1,534	5.7%	3,000	11.1%	0	0.0%
Common gull	14,647	27	0.2%	20	0.1%	0	0.0%
Guillemot	21,968	995	4.5%	0	0.0%	0	0.0%
Herring gull	12,313	1,303	10.6%	500	4.1%	0	0.0%
Kittiwake	3,191	52	1.6%	0	0.0%	0	0.0%
Razorbill	5,481	209	3.8%	0	0.0%	0	0.0%
Shag	2,426	53	2.2%	3	0.1%	34	1.4%

Table 4.10 Peak counts of qualifying species of the Firth of Forth SPA and Ramsar site compared with SPA citation populations (SNH, 2018a) and the most recent 5 year mean peak counts (2015/16 to 2019/20) for the Forth Estuary (Frost et al. 2021). Highlighted cells indicate where peak counts exceed 1% of the SPA population.

Species	SPA citation population (individuals)	WeBS peak mean (2015/16 to 2019/20)	2021/22 estuarine bird survey			WeBS Sector 83440 (2018/19 to 2019/20)			WeBS Sector 84441 (2018/19 to 2019/20)		
			Peak count	% SPA	% WeBS peak mean	Peak count	% SPA	% WeBS peak mean	Peak count	% SPA	% WeBS peak mean
Qualifying features											
Bar-tailed godwit	1,974	1,142	27	1.4%	2.4%	0	0.0%	0.0%	9	0.6%	0.8%
Golden plover	2,949	1,261	0	0.0%	0.0%	0	0.0%	0.0%	1	<0.1%	<0.1%
Knot	9,258	3,370	48	0.5%	1.4%	0	0.0%	0.0%	1	<0.1%	<0.1%
Pink-footed goose	10,852	17,544	0	0.0%	0.0%	0	0.0%	0.0%	150	1.3%	0.9%
Red-throated diver	90	51	2	2.2%	3.9%	0	0.0%	0.0%	7	7.8%	13.7%
Redshank	4,341	4,932	192	4.4%	3.9%	1	<0.1%	<0.1%	160	3.7%	3.2%
Sandwich tern	1,617	1,270	84	5.2%	6.6%	125	7.7%	9.8%	15	0.9%	1.2%
Shelduck	4,509	3,628	4	0.1%	0.1%	0	0.0%	0.0%	3	<0.1%	<0.1%
Turnstone	860	680	43	5.0%	6.3%	0	0.0%	0.0%	66	7.7%	9.7%
Named non-breeding waterfowl assemblage component species											
Common scoter	2,880	3,575	22	0.8%	0.6%	3	0.1%	0.1%	8	0.3%	0.2%
Cormorant	682	522	141	20.7%	27.0%	13	1.9%	2.5%	50	7.3%	9.6%
Curlew	1,928	3,392	12	0.6%	0.4%	1	<0.1%	<0.1%	30	1.6%	0.9%
Dunlin	9,514	6,061	270	2.8%	4.5%	0	0.0%	0.0%	33	0.4%	0.5%
Eider	9,400	5,018	976	10.4%	19.4%	220	2.3%	4.4%	713	7.6%	14.2%
Goldeneye	3,004	1,577	413	13.7%	26.2%	504	16.8%	32.0%	114	3.8%	7.2%
Great-crested grebe	720	85	2	0.3%	2.4%	0	0.0%	0.0%	2	0.3%	2.4%
Mallard	2,564	1,164	81	3.2%	7.0%	46	1.8%	4.0%	34	1.3%	2.9%
Long-tailed duck	1,045	181	1	0.1%	0.6%	0	0.0%	0.0%	3	0.3%	1.7%

Species	SPA citation population (individuals)	WeBS peak mean (2015/16 to 2019/20)	2021/22 estuarine bird survey			WeBS Sector 83440 (2018/19 to 2019/20)			WeBS Sector 84441 (2018/19 to 2019/20)		
			Peak count	% SPA	% WeBS peak mean	Peak count	% SPA	% WeBS peak mean	Peak count	% SPA	% WeBS peak mean
Oystercatcher	7,846	6,782	289	3.7%	4.3%	16	0.2%	0.2%	270	3.4%	4.0%
Red-breasted merganser	670	296	38	5.7%	12.8%	10	1.5%	3.4%	26	3.9%	8.8%
Ringed plover	328	310	35	10.7%	11.3%	0	0.0%	0.0%	77	23.5%	24.8%
Velvet scoter	635	883	27	4.3%	3.1%	0	0.0%	0.0%	6	0.9%	0.7%
Wigeon	2,139	2,570	0	0.0%	0.0%	0	0.0%	0.0%	2	0.1%	0.1%

Table 4.11 Peak counts of qualifying species of the Imperial Dock Lock Leith SPA compared with the SPA citation population (SNH, 2004) and updated estimates (Furness, 2015). Highlighted cells indicate where peak counts exceed 1% of the SPA population.

Species	SPA citation population (individuals)	Furness (2015)	2021/22 estuarine bird survey			WeBS Sector 83440 (2018/19 to 19/20)			WeBS Sector 84441 (2018/19 to 19/20)		
			Peak count	%SPA	% SPA Furness 2015	Peak count	% SPA	% SPA Furness 2015	Peak count	% SPA	% SPA Furness 2015
Qualifying features											
Common tern	1,116	1,636	2,000	>100%	>100%	200	17.9%	12.2%	2	0.2%	0.1%

Table 4.12 Peak counts of qualifying species of the Forth Islands SPA compared with SPA citation populations (SNH, 2018b) and updated estimates (Furness 2015). Highlighted cells indicate where peak counts exceed 1% of the SPA population

Species	SPA citation population* (individuals)	Furness (2015)	2021/22 estuarine bird survey			WeBS Sector 83440 (2018/19 to 19/20)			WeBS Sector 84441 (2018/19 to 19/20)		
			Peak count	%SPA	% SPA Furness 2015	Peak count	% SPA	% SPA Furness 2015	Peak count	% SPA	% SPA Furness 2015
Qualifying features											
Arctic tern	1080	530	0	0.0%	0.0%	1	<0.1%	0.2%	1	<0.1%	0.2%
Common tern	668	52	2,000	>100%	>100%	200	29.9%	>100%	2	0.3%	3.8%

Species	SPA citation population* (individuals)	Furness (2015)	2021/22 estuarine bird survey			WeBS Sector 83440 (2018/19 to 19/20)			WeBS Sector 84441 (2018/19 to 19/20)		
			Peak count	%SPA	% SPA Furness 2015	Peak count	% SPA	% SPA Furness 2015	Peak count	% SPA	% SPA Furness 2015
Gannet	43,200	110,964	48	0.1%	<0.1%	0	0.0%	0.0%	0	0.0%	0.0%
Lesser black-backed gull	3,000	3,216	441	14.7%	13.7%	140	4.6%	4.4%	0	0.0%	0.0%
Puffin	28,000	124,462	3	<0.1%	<0.1%	0	0.0%	0.0%	0	0.0%	0.0%
Roseate tern	16	6	1	6.3%	16.7%	0	0	0	0	0	0
Sandwich tern	880	0	84	9.5%	n/a	125	14.2%	n/a	15	1.7%	n/a
Shag	4,800	1,700	53	1.1%	3.1%	3	<0.1%	0.2%	34	0.7%	2.0%
Named breeding seabird assemblage components											
Cormorant	400	160	141	35.3%	88.1%	13	3.2%	8.1%	50	12.5%	31.3%
Guillemot	32,000	29,348	995	3.1%	3.4%	0	0.0%	0.0%	0	0.0%	0.0%
Herring gull	13,200	5,654	1,303	9.9%	23.0%	500	3.8%	8.8%	0	0.0%	0.0%
Kittiwake	16,800	6,200	52	0.3%	0.8%	0	0.0%	0.0%	55	0.3%	0.9%
Razorbill	2,800	5,250	209	7.5%	4.0%	0	0.0%	0.0%	0	0.0%	0.0%

*The SPA citation is dated 2018 however the population estimates for qualifying features are for time periods between 1992 and 2001

4.2.2.3 Potential effects of the Proposed Development on SPA / Ramsar Site features

Construction phase

Potential impacts on bird species from construction activities include:

- Temporary or permanent habitat loss – small areas of open water and terrestrial habitat are likely to be temporarily and / or permanently lost.
- Disturbance – disturbance (noise and visual) to breeding and non-breeding birds, although it should be noted that the site is currently an active port subject to high existing levels of disturbance. Sources of disturbance are likely to include noise, lighting, presence of people and plant / machinery and vehicular / shipping traffic, both onshore and offshore. Due to the existing busy nature of the port, and that the Proposed Development is within the access channel and current port area, it is not considered that there would be the potential for significant effect due to the presence of vessels and / or people during construction.
- Water quality impacts affecting prey availability – due to the potential release of contaminants and increased turbidity.
- Loss of prey due to underwater noise, impacts to sub-sea habitats, and changes to water quality.

Operational phase

It is considered that there would not be any potential for significant impacts during the operational phase of the Proposed Development, given no significant changes are proposed to the current activities at the Port of Leith. The Port of Leith already accepts vessels of a similar size to those that support the offshore renewables industry, in terms of length, height and deadweight; it is just the wider beam (width) that prevents these vessels from being able to access the lock. As such, the ability for the Port of Leith to accept these vessels is not considered to represent a change to the existing situation.

Overall, the Proposed Development would have a beneficial impact to the surrounding environment, due to the proposed decommissioning of the existing Shawcor facility, which is a current source of air and noise emissions, as well as having a negative visual appearance. The use of the area as a laydown for the offshore renewables industry, would comprise a uniform stone surface and utilise more quiet modern equipment, including Self-Propelled Modular Transporters (SPMTs). The provision of cutting-edge technology, such as shore power, would reduce the need for vessels to be 'idling' at the berth with engines running, therefore reducing noise and emissions to air. In addition, it is expected that any vessel would be more modern, and therefore cleaner and quieter, than vessels that are currently using the port, due to their use within the offshore wind industry, which is relatively new, and continually expanding.

Overall, therefore the operational phase is not considered to have the potential to cause a LSE on any of the qualifying features and Conservation Objectives of the designated sites screened into the HRA. As such, the operational phase is not considered further within this report.

4.2.2.4 Results of screening for LSE

The alone Screening for LSE of the SPAs and qualifying features is presented in **Table 4.13**. Screening has been based on the peak counts from baseline count data in relation to SPA populations, as shown in **Table 4.9** to **Table 4.12**. A qualifying species has been screened in for Appropriate Assessment if the baseline data indicates that the species may be present in the ornithological study area in numbers representing more than 1% of the SPA population. A qualifying assemblage has been screened in if the data indicates that one or more component species may be present in numbers representing more than 1% of the SPA population.

Table 4.13 Alone Screening for LSE on qualifying features of the SPAs and Ramsar site

Site	Qualifying feature	LSE concluded
Firth of Forth SPA and Ramsar site	**Bar-tailed godwit**	**Yes**
	Golden plover	No
	Knot	**Yes**
	Pink-footed goose	**Yes**
	Red-throated diver	**Yes**
	Redshank	**Yes**
	Sandwich tern	**Yes**
	Shelduck	No
	Slavonian grebe	No
	Turnstone	**Yes**
	Waterfowl assemblage (great-crested grebe, **cormorant**, scaup, **eider**, long-tailed duck, common scoter, **velvet scoter**, **goldeneye**, **red-breasted merganser**, **oystercatcher**, **ringed plover**, grey plover, **dunlin**, curlew).	**Yes**
Imperial Dock Lock, Leith SPA	**Common tern**	**Yes**
Forth Islands SPA	Arctic tern	No
	Common tern	**Yes**
	Gannet	No
	Lesser black-backed gull	**Yes**
	Puffin	No
	Roseate tern	**Yes**
	Sandwich tern	**Yes**
	Shag	**Yes**
	Seabird assemblage, breeding (**razorbill**, **guillemot**, kittiwake, **herring gull**, **cormorant**)	**Yes**
OFFSABC SPA	Arctic tern	No
	Common tern	**Yes**
	Eider	**Yes**
	Gannet	No
	Little gull	No
	Red-throated diver	No
	Shag	**Yes**
	Slavonian grebe	No
	Wintering waterfowl assemblage (Common scoter, **goldeneye**, long-tailed duck, **red-breasted merganser**, velvet scoter)	**Yes**
	Breeding seabird assemblage (puffin, kittiwake, Manx shearwater, **guillemot**, **herring gull**).	**Yes**
	Non-breeding seabird assemblage (**Black-headed gull**, common gull, **herring gull**, **guillemot**, **shag**, kittiwake, **razorbill**)	**Yes**

4.2.3 Marine Mammals

4.2.3.1 Screening of Designated Sites

As outlined in **Section 0**, the SNH guidance document (*HRA on the Firth of Forth – A Guide for Developers and Regulators*; SNH, 2016) states that the following designated sites for marine mammal species be considered (see **Figure 4.1**):

- Isle of May SAC;
- Firth of Tay and Eden Estuary SAC;
- Berwickshire and North Northumberland Coast SAC; and,
- Moray Firth SAC.

4.2.3.2 Potential effects of the Proposed Development on SAC features

There is the potential for the following effects of the Proposed Development to marine mammals:

- Generation of underwater noise from piling operations and other construction activities (such as dredging) which could have physiological and/or behavioural response impacts; and,
- Indirect impacts due to changes to water quality (e.g., increased suspended sediment, changes to hydrological regime) and prey availability.
- Piling would be temporary and for a short period only. Underwater noise impacts would be managed using standard mitigation measures in line with the *Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise*[5]. This will ensure that the potential effect ranges for instantaneous permanent auditory injury are mitigated for and therefore not significant.

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 effect as a result of the presence of construction vessels (including as a result of underwater noise, and an increase in collision risk), either at the Proposed Development, or while transiting past any nearby seal haul-out sites.

Activities during the operational phase would be in line with current activities, and therefore there would be no effects to marine mammals during operation of the berth.

4.2.3.3 Results of screening for LSE

Table 4.14 provides the results of the Screening for LSE as a result of the Proposed Development on marine mammals.

Table 4.14 Alone Screening for LSE on marine mammal qualifying features of the SACs

Designated site	Qualifying feature	Potential effect	LSE concluded
Isle of May SAC	Grey seal	Generation of underwater noise from piling operations and other construction activities	**Yes**
		Disturbance to seal haul-out sites	No
		Indirect impacts due to changes to water quality (e.g., increased suspended sediment, changes to hydrological regime) and prey availability	**Yes**

[5] https://data.jncc.gov.uk/data/31662b6a-19ed-4918-9fab-8fbcff752046/JNCC-CNCB-Piling-protocol-August2010-Web.pdf

Designated site	Qualifying feature	Potential effect	LSE concluded
		Increase in collision risk presence and underwater noise disturbance due to increase in vessels	No
Firth of Tay and Eden Estuary	Harbour seal	Generation of underwater noise from piling operations and other construction activities	**Yes**
		Disturbance to seal haul-out sites	No
		Indirect impacts due to changes to water quality (e.g., increased suspended sediment, changes to hydrological regime) and prey availability	**Yes**
		Increase in collision risk presence and underwater noise disturbance due to increase in vessels	No
Berwickshire and North Northumberland Coast SAC	Grey seal	Generation of underwater noise from piling operations and other construction activities	**Yes**
		Disturbance to seal haul-out sites	No
		Indirect impacts due to changes to water quality (e.g., increased suspended sediment, changes to hydrological regime) and prey availability	**Yes**
		Increase in collision risk presence and underwater noise disturbance due to increase in vessels	No
Moray Firth SAC	Bottlenose dolphin	Generation of underwater noise from piling operations and other construction activities	**Yes**
		Increase in collision risk presence and underwater noise disturbance due to increase in vessels	No
		Indirect impacts due to changes to water quality (e.g., increased suspended sediment, changes to hydrological regime) and prey availability	**Yes**

4.3 In-combination assessment

Projects with the potential for in-combination are those located within 5km of the Proposed Development, as beyond this distance it would not be expected that there is the potential for combined disturbance to individuals affected by the Proposed Development and other projects. This 5km screening distance has been used for both bird species and fish. For wider ranging species (such as seals and bottlenose dolphin), it is important to consider projects over a wider area. For seals, projects are considered if they are located within the Firth of Forth, and for bottlenose dolphin, due to the SAC they are associated with being within the Moray Firth, projects are considered if they are located within the Firth of Forth, as well as off the east coast of Scotland, between the Proposed Development and the inner Moray Firth.

The projects within the areas as noted above are included in **Table 4.15**, with an indication as to whether they will be considered further due to a temporal overlap with the construction of the Proposed Development.

Table 4.15 Projects with potential for in-combination effects with the Proposed Development

Project	Location (approximate distance from the Proposed Development)	Stage	Date of Activity	Screened in for further consideration
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

Project	Location (approximate distance from the Proposed Development)	Stage	Date of Activity	Screened in for further consideration
NorthConnect HVDC Cable	Landfall at Peterhead, 187km (195km around the coastline)	Application approved	2019-2023 (operational by 2023[6] with overall construction period of 54 months[7])	**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
Neart na Gaoithe Offshore Wind Farm (Revised Design)	Firth of Forth, approximately 60km	Under construction	Construction from 2019-2022[8]	**Yes** – potential for overlap in construction timeframes
Port of Cromarty Firth - Phase 4 Development, Invergordon Service Base	Cromarty Firth, approximately 198km (351km around the coastline)	Under construction	Construction 2019-2021	No – construction periods would not overlap
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
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
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
Inch Cape Offshore Windfarm Revised Design	Firth of Forth, approximately 61km (landfall at Prestonpans – 11km)	Application approved	Construction 2021-2025. Offshore construction is due to commence in 2023, and foundation installation to begin in 2024[9]	**Yes** – potential for overlap in construction timeframes
Kincardine Offshore Windfarm	Aberdeenshire, approximately 136km (139km around the coastline)	Under construction	Construction 2016-2021[10]	No – construction periods would not overlap
Moray East Offshore Windfarm	Moray Firth, approximately 233km (281km around the coastline)	Under construction	The Moray East project is currently under construction. At the time of writing, all foundations and wind turbines have been installed. Operational activities commenced on the 13th January 2022 , and this project is therefore considered to be	No – project is now operational

6 https://marine.gov.scot/sites/default/files/hvdcca1.pdf
7 https://marine.gov.scot/sites/default/files/02_project_description_0.pdf
8 https://marine.gov.scot/sites/default/files/combined_document_-_revised.pdf
9 https://www.4coffshore.com/windfarms/united-kingdom/project-dates-for-inch-cape-uk54.html
10 www.4coffshore.com

Project	Location (approximate distance from the Proposed Development)	Stage	Date of Activity	Screened in for further consideration
			operational and part of the baseline environmental.	
Moray West Offshore Windfarm	Moray Firth, approximately 224km (291km around the coastline)	Application approved	Construction 2024-2026[10]	No – construction periods would not overlap
Sea Wall Repair and Extension – Alexandra Parade	Peterhead, approximately 189km (195km around the coastline)	Application approved	Construction 2020-2024[11]	**Yes** – potential for overlap in construction
Grangemouth Flood Protection Scheme	Firth of Forth, approximately 30km (31km around the coastline)	Pre-application	Five to year ten year construction, starting from 2022[12]	**Yes** – potential for overlap in construction
Ardersier Port Development	Moray Firth, approximately 185km (344km around the coastline)	Application approved	Construction to commence in 2019	**Yes** – potential for overlap in construction

Table 4.16 indicates the designated sites (and features) for which there is the potential for in-combination effects with the projects screened in for further consideration in **Table 4.15**.

[11] https://marine.gov.scot/sites/default/files/environmental_appraisal_document_redacted.pdf
[12] https://marine.gov.scot/sites/default/files/grangemouth_fps_eia_scoping_report_final_for_submission.pdf

Table 4.16 In combination Screening for LSE of designated sites (and features)

Project	Designated site	Features screened in	Potential for in-combination effect?
Nigg Energy Park East Quay	River Teith SAC	• Sea lamprey, river lamprey, and Atlantic salmon	No – more than 5km from the Proposed Development
	Firth of Forth SPA and Ramsar site	• Bar-tailed godwit, knot, pink-footed goose, red-throated diver, redshank, Sandwich tern and turnstone; • Non-breeding waterbird assemblage.	
	Imperial Dock Lock Leith SPA	• Common tern.	
	Forth Islands SPA	• Common tern, lesser black-backed gull, roseate tern, Sandwich tern and shag; • Breeding seabird assemblage.	
	OFFSABC SPA	• Common tern, eider and shag; • Non-breeding waterbird assemblage; • Breeding seabird assemblage; • Non-breeding seabird assemblage.	
	Isle of May SAC	• Grey seal	No – not within the Firth of Forth study area
	Firth of Tay and Eden Estuary SAC	• Harbour seal	
	Berwickshire and North Northumberland Coast SAC	• Grey seal	
	Moray Firth SAC	• **Bottlenose dolphin**	**Yes – within area used by the bottlenose dolphin population of the Moray Firth SAC**
NorthConnect HVDC Cable	River Teith SAC	• Sea lamprey, river lamprey, and Atlantic salmon	No – more than 5km from the Proposed Development
	Firth of Forth SPA and Ramsar site	• Bar-tailed godwit, knot, pink-footed goose, red-throated diver, redshank, Sandwich tern and turnstone; • Non-breeding waterbird assemblage.	
	Imperial Dock Lock Leith SPA	• Common tern.	
	Forth Islands SPA	• Common tern, lesser black-backed gull, roseate tern, Sandwich tern and shag; • Breeding seabird assemblage.	
	OFFSABC SPA	• Common tern, eider and shag; • Non-breeding waterbird assemblage; • Breeding seabird assemblage; • Non-breeding seabird assemblage.	
	Isle of May SAC	• Grey seal	No – not within the Firth of Forth study area

Project	Designated site	Features screened in	Potential for in-combination effect?
	Firth of Tay and Eden Estuary SAC	• Harbour seal	
	Berwickshire and North Northumberland Coast SAC	• Grey seal	
	Moray Firth SAC	• **Bottlenose dolphin**	**Yes – within area used by the bottlenose dolphin population of the Moray Firth SAC**
Seagreen Alpha and Bravo Offshore Wind Farms (Optimised Project)	River Teith SAC	• Sea lamprey, river lamprey, and Atlantic salmon	No – more than 5km from the Proposed Development
	Firth of Forth SPA and Ramsar site	• Bar-tailed godwit, knot, pink-footed goose, red-throated diver, redshank, Sandwich tern and turnstone; • Non-breeding waterbird assemblage.	
	Imperial Dock Lock Leith SPA	• Common tern.	
	Forth Islands SPA	• Common tern, lesser black-backed gull, roseate tern, Sandwich tern and shag; • Breeding seabird assemblage.	
	OFFSABC SPA	• Common tern, eider and shag; • Non-breeding waterbird assemblage; • Breeding seabird assemblage; • Non-breeding seabird assemblage.	
	Isle of May SAC	• **Grey seal**	**Yes - within the Firth of Forth study area**
	Firth of Tay and Eden Estuary SAC	• **Harbour seal**	
	Berwickshire and North Northumberland Coast SAC	• **Grey seal**	
	Moray Firth SAC	• **Bottlenose dolphin**	**Yes – within area used by the bottlenose dolphin population of the Moray Firth SAC**
Neart na Gaoithe Offshore Wind Farm (Revised Design)	River Teith SAC	• Sea lamprey, river lamprey, and Atlantic salmon	No – more than 5km from the Proposed Development
	Firth of Forth SPA and Ramsar site	• Bar-tailed godwit, knot, pink-footed goose, red-throated diver, redshank, Sandwich tern and turnstone; • Non-breeding waterbird assemblage.	
	Imperial Dock Lock Leith SPA	• Common tern.	
	Forth Islands SPA	• Common tern, lesser black-backed gull, roseate tern, Sandwich tern and shag; • Breeding seabird assemblage.	

Project	Designated site	Features screened in	Potential for in-combination effect?
	OFFSABC SPA	• Common tern, eider and shag; • Non-breeding waterbird assemblage; • Breeding seabird assemblage; • Non-breeding seabird assemblage.	
	Isle of May SAC	• **Grey seal**	**Yes - within the Firth of Forth study area**
	Firth of Tay and Eden Estuary SAC	• **Harbour seal**	
	Berwickshire and North Northumberland Coast SAC	• **Grey seal**	
	Moray Firth SAC	• **Bottlenose dolphin**	**Yes – within area used by the bottlenose dolphin population of the Moray Firth SAC**
Inch Cape Offshore Windfarm Revised Design	River Teith SAC	• Sea lamprey, river lamprey, and Atlantic salmon	No – more than 5km from the Proposed Development
	Firth of Forth SPA and Ramsar site	• Bar-tailed godwit, knot, pink-footed goose, red-throated diver, redshank, Sandwich tern and turnstone; • Non-breeding waterbird assemblage.	
	Imperial Dock Lock Leith SPA	• Common tern.	
	Forth Islands SPA	• Common tern, lesser black-backed gull, roseate tern, Sandwich tern and shag; • Breeding seabird assemblage.	
	OFFSABC SPA	• Common tern, eider and shag; • Non-breeding waterbird assemblage; • Breeding seabird assemblage; • Non-breeding seabird assemblage.	
	Isle of May SAC	• **Grey seal**	No – within the study area for each species, however, offshore construction not due to commence until 2023, and foundation installation due to begin in 2024. Therefore, not potential for overlap with construction of the Proposed Development.
	Firth of Tay and Eden Estuary SAC	• **Harbour seal**	
	Berwickshire and North Northumberland Coast SAC	• **Grey seal**	
	Moray Firth SAC	• **Bottlenose dolphin**	
Sea Wall Repair and Extension – Alexandra Parade	River Teith SAC	• Sea lamprey, river lamprey, and Atlantic salmon	No – more than 5km from the Proposed Development
	Firth of Forth SPA and Ramsar site	• Bar-tailed godwit, knot, pink-footed goose, red-throated diver, redshank, Sandwich tern and turnstone; • Non-breeding waterbird assemblage.	

Project	Designated site	Features screened in	Potential for in-combination effect?
	Imperial Dock Lock Leith SPA	• Common tern.	
	Forth Islands SPA	• Common tern, lesser black-backed gull, roseate tern, Sandwich tern and shag; • Breeding seabird assemblage.	
	OFFSABC SPA	• Common tern, eider and shag; • Non-breeding waterbird assemblage; • Breeding seabird assemblage; • Non-breeding seabird assemblage.	
	Isle of May SAC	• Grey seal	No – not within the Firth of Forth study area
	Firth of Tay and Eden Estuary SAC	• Harbour seal	
	Berwickshire and North Northumberland Coast SAC	• Grey seal	
	Moray Firth SAC	• **Bottlenose dolphin**	**Yes – within area used by the bottlenose dolphin population of the Moray Firth SAC**
Grangemouth Flood Protection Scheme	River Teith SAC	• Sea lamprey, river lamprey, and Atlantic salmon	No – more than 5km from the Proposed Development
	Firth of Forth SPA and Ramsar site	• Bar-tailed godwit, knot, pink-footed goose, red-throated diver, redshank, Sandwich tern and turnstone; • Non-breeding waterbird assemblage.	
	Imperial Dock Lock Leith SPA	• Common tern.	
	Forth Islands SPA	• Common tern, lesser black-backed gull, roseate tern, Sandwich tern and shag; • Breeding seabird assemblage.	
	OFFSABC SPA	• Common tern, eider and shag; • Non-breeding waterbird assemblage; • Breeding seabird assemblage; • Non-breeding seabird assemblage.	
	Isle of May SAC	• **Grey seal**	**Yes - within the Firth of Forth study area**
	Firth of Tay and Eden Estuary SAC	• **Harbour seal**	
	Berwickshire and North Northumberland Coast SAC	• **Grey seal**	
	Moray Firth SAC	• **Bottlenose dolphin**	**Yes – within area used by the bottlenose dolphin population of the Moray Firth SAC**

Project	Designated site	Features screened in	Potential for in-combination effect?
Ardersier Port Development	River Teith SAC	• Sea lamprey, river lamprey, and Atlantic salmon	No – more than 5km from the Proposed Development
	Firth of Forth SPA and Ramsar site	• Bar-tailed godwit, knot, pink-footed goose, red-throated diver, redshank, Sandwich tern and turnstone; • Non-breeding waterbird assemblage.	
	Imperial Dock Lock Leith SPA	• Common tern.	
	Forth Islands SPA	• Common tern, lesser black-backed gull, roseate tern, Sandwich tern and shag; • Breeding seabird assemblage.	
	OFFSABC SPA	• Common tern, eider and shag; • Non-breeding waterbird assemblage; • Breeding seabird assemblage; • Non-breeding seabird assemblage.	
	Isle of May SAC	• Grey seal	No – not within the Firth of Forth study area
	Firth of Tay and Eden Estuary SAC	• Harbour seal	
	Berwickshire and North Northumberland Coast SAC	• Grey seal	
	Moray Firth SAC	• **Bottlenose dolphin**	**Yes – within area used by the bottlenose dolphin population of the Moray Firth SAC**

5 Conclusion of the Screening Assessment

5.1 Conclusion of Screening for LSE

Table 5.1 summarises the sites and features where LSE has been concluded and therefore is a subject for the Appropriate Assessment.

Table 5.1 Summary of screening for LSE

Designated Site	Feature
River Teith SAC	• Sea lamprey, river lamprey and Atlantic salmon.
Firth of Forth SPA and Ramsar Site	• Bar-tailed godwit, knot, pink-footed goose, red-throated diver, redshank, Sandwich tern and turnstone; • Non-breeding waterfowl assemblage
Imperial Dock Lock Leith SPA	• Common tern.
Forth Islands SPA	• Common tern, lesser black-backed gull, roseate tern, Sandwich tern and shag; • Breeding seabird assemblage.
OFFSABC SPA	• Common tern, eider and shag; • Non-breeding waterfowl assemblage; • Breeding seabird assemblage; • Non-breeding seabird assemblage.
Isle of May SAC	• Grey seal
Firth of Tay and Eden Estuary SAC	• Harbour seal
Berwickshire and North Northumberland Coast SAC	• Grey seal
Moray Firth SAC	• Bottlenose dolphin

6 Appropriate Assessment: Transitional Fish

6.1 Approach to assessment

This chapter, which forms the second stage of the HRA process, provides information to determine whether the potential effects of the Proposed Development will have an adverse effect on the conservation objectives and site integrity for SACs screened into Appropriate Assessment for transitional fish.

6.1.1 Data sources

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

- SNH's (now NatureScot) Habitats Regulations Appraisal (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 2** for full details of modelling methodology and outputs);
- Numerical dispersion modelling of sediment brought into suspension during the proposed dredging and disposal activities (as described in **Section 7.1.2.3**); and
- Sediment sample analysis of source material, as described in the accompanying EIA Report.

6.1.2 Overview of effect pathways screened in

6.1.2.1 Underwater noise

Details of elements of the Proposed Development that may act as a source of underwater noise are presented in **Appendix 2** and **Appendix 3**. Notably, such sources would constitute:

- Piling of tubular and sheet piles, with a duration of 5 to 5.5 months, with up to 3 piles installed per day (an average of less than 2) at a rate of 2 hours per pile;
- 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.

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 *et al.*, 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 (Hastings and Popper, 2005). The impacts can be summarised into three broad categories:

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

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

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

It should be noted that all piling would be subjected to the 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.

6.1.2.2 Changes in water quality

Dredging of fine material during the construction phase of the Proposed Development would result in a temporary increase in suspended sediment concentration (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 potentially act as a barrier to migratory movements in transitional fish.

Total dredging for the Proposed Development would be 47,000 m^3 from the pre works and 54,000 m^3 from the berth pockets. Out of 101,000 m^3 of material, around 85 % of the material would be non-erodible (i.e. glacial till, mudstone and revetment rock). Only c.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 the accompanying EIA Report for the Proposed Development. **Figure 6.1** presents modelled bottom layer sediment plumes indicating the predicted maximum SSC during dredging activity. **Figure 6.2** 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.

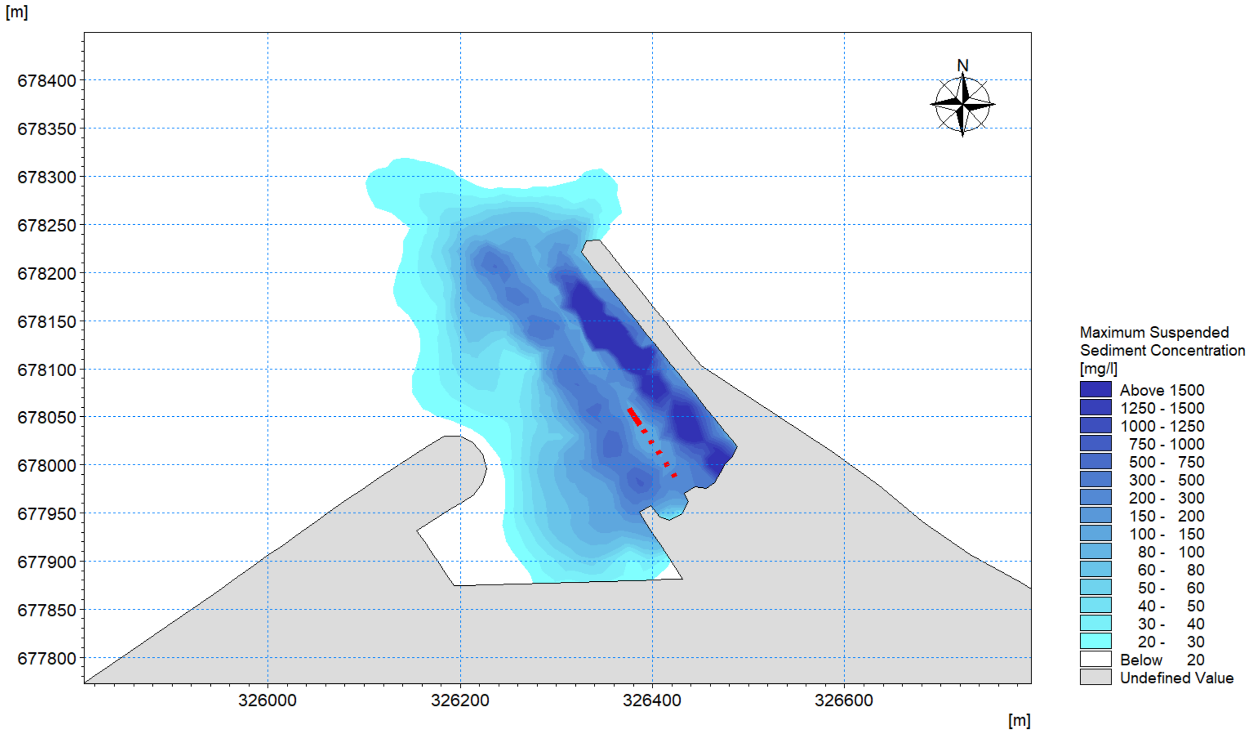


Figure 6.1 Modelled maximum suspended sediment concentrations at the bottom layer during dredging

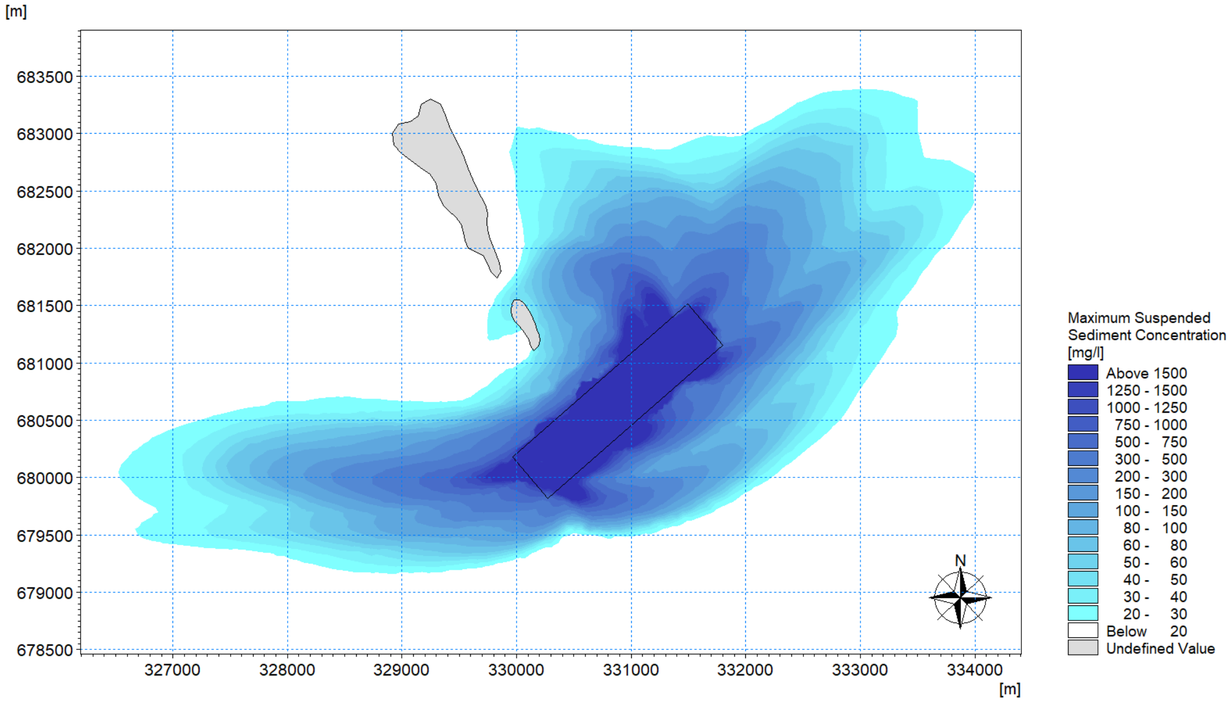


Figure 6.2 Modelled maximum suspended sediment concentrations at the bottom layer during dredging

6.1.2.3 Changes in habitat quality

In terms of physical loss of habitat used by fish, this would constitute a small area of c.1.8 ha 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 (Area 4 in **Figure 1.1**).

In addition to physical loss of habitat, suspension and transportation of fine sediment during dredge / disposal activities would result in subsequent deposition as the 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 for estuarine fish species.

The extent of the sediment deposition predicted from the proposed dredging (and subsequent disposal), based on the sediment plume dispersion modelling, is described in detail in the accompanying EIA Report for the Proposed Development. Predicted deposition from the plume generated from dredging would amount to a maximum of about 0.225m in a very small, isolated region near the entrance to the Port. After this initial deposition, this sediment would be continually re-suspended to reduce the thickness even further to a point where it will be effectively zero. This will be the longer-term outcome once the sediment supply from dredging has ceased. Any predicted increase in bed thickness at the disposal site 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 5mm) (see **Figure 6.3**).

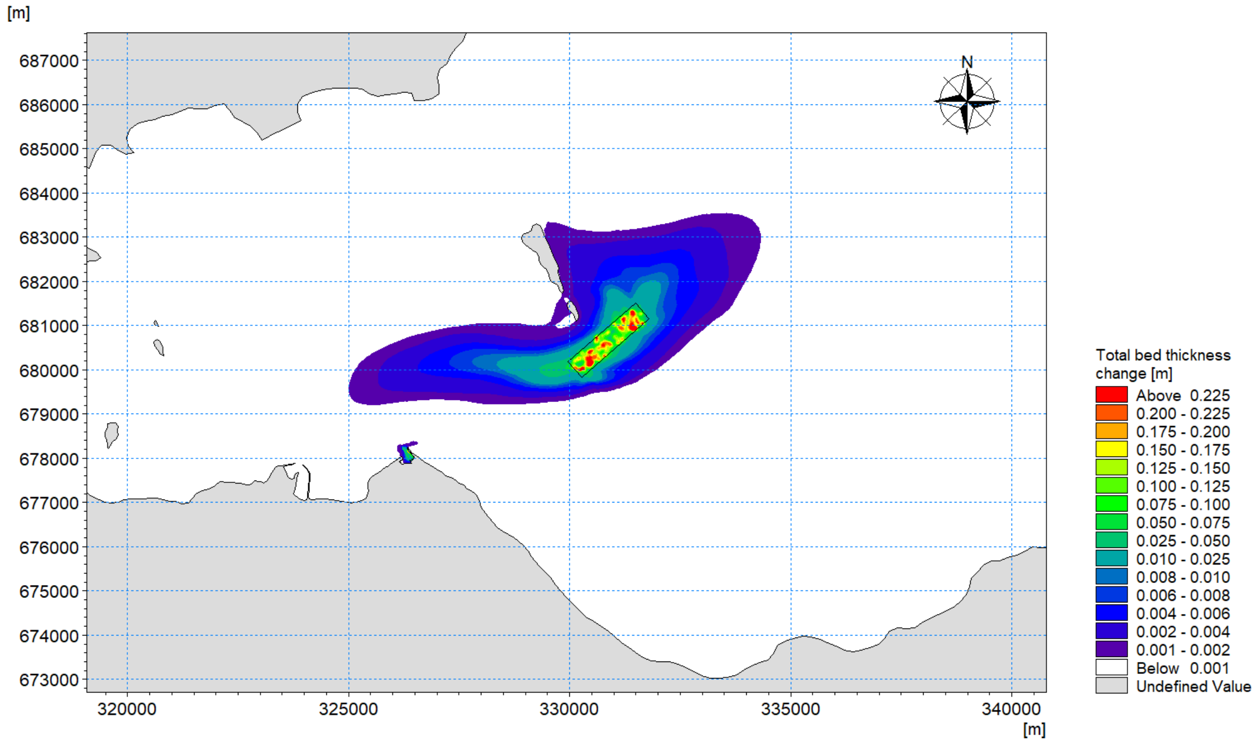


Figure 6.3: Predicted changes in seabed elevation due to deposition from the plume caused by dredging of the berth pocket associated with the outer berth

6.1.3 In-combination effects

The in-combination screening (**Table 4.16**) concluded no likely significant in-combination effects on the River Teith SAC since all projects are more than 5km away from the Proposed Development, hence there would be no spatial overlap of underwater noise-related effects (considered to be the most-far reaching effect of the Proposed Development). Given the screening conclusion, in-combination effects have not been considered in the Appropriate Assessment that follows.

6.2 River Teith SAC

6.2.1 Description of designation

The River Teith in eastern Scotland represents part of the east coast range of sea lamprey in the UK, and also supports a strong population of river lamprey. It is the most significant tributary of the River Forth. It lacks any significant artificial boundaries to migration, has good water quality and has the necessary habitat types to support the full lamprey life-cycle (extensive gravel beds with marginal silt beds). Atlantic salmon also spawn in the river and are present as a qualifying Annex II species, though is not a primary reason for site selection.

6.2.2 Conservation objectives

The Conservation Objectives for sea and river lamprey, and Atlantic salmon, are:

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

River lamprey and Atlantic salmon within the River Teith SAC are in favourable condition, and sea lamprey are in an unfavourable condition.

6.2.3 Features screened in

Following the initial screening for LSE presented in **Chapter 0**, the following features are considered in the Appropriate Assessment for this SAC:

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

6.2.4 Potential effects of the Proposed Development

6.2.4.1 Underwater noise

All features

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 noise modelling methodology and output is provided in **Appendix 2**, and the assessment of impacts is presented in **Appendix 3**. Both appendices should be read in conjunction with this section of the HRA.

While lamprey or salmon within 50m of the piling source would be exposed to injurious noise levels from a single strike of a tubular pile, a 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 (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, 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 Forth estuary. 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 move 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 over 5 to 5.5 months, no more than one migration season (either upstream by mature adults or downstream by juveniles / pre-adults) 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 considerably smaller than that predicted from piling activity and again would have no significant effect on the capability of lamprey and salmon to navigate along the estuary during migration.

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

6.2.4.2 Changes in water quality

All features

The extent of the sediment plumes, outlined in **Figure 6.1**, show that significant increase in SSC during dredging activity 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 are likely to be less than 20mg/l, which is irrelevant in the context of a dynamic estuarine system such as that present in the Forth. As noted, the Forth estuary at the location of the Proposed Development is approximately 8km wide, hence there would be no significant obstruction or ‘barrier effect’ to migrating lamprey and salmon.

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 the accompanying EIA Report for the Proposed Development. The analyses indicate that contaminant levels within the sediment are sufficiently low that offshore disposal of the material is considered appropriate (as determined through comparison against Cefas action levels) and therefore would not pose a significant risk to migrating 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 200 mg/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 to 200mg/l) possible at distances of up to c.2km north and c.500m south of the site. The sediment plumes shown in **Figure 6.2** represent the modelled 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. The numerical modelling outlined in the accompanying EIA Report for the Proposed Development indicates that a return to baseline SSC would be expected within 1.5 hours of disposal.

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.

Given the above, it is concluded that the effects of predicted changes in water quality at the dredge and disposal site noise on migrating sea lamprey, river lamprey and Atlantic salmon would not have an adverse effect on the integrity of the River Teith SAC.

6.2.4.3 Changes in habitat quality

The area of subtidal habitat (1.8ha) physically lost as a result of the dredging at the berth pocket is infinitesimal in the context of available subtidal habitat within the wider Firth of Forth and would have no measurable effect on fish species.

While sedimentation arising from dredging and disposal activity would not affect migratory movement of lamprey and salmon, the former may be present in the Firth of Forth during periods of adult life (prior to upstream migration). Modelling of sediment dispersion and subsequent deposition shown in **Figure 6.3** indicates that, at both the disposal and dredge location, sediment deposition would be of a very low magnitude and, over time, would be continually resuspended until effectively zero. Only within the footprint of the licensed disposal site would deposition represent a predicted bed level increase of more than 0.1m, and at a distance of more than 1km from the disposal site it would be less than 0.005m (5mm). In the context of the overall marine area within the wider Firth of Forth, this would have a very minor effect on the availability of habitat for species such as lamprey.

It is concluded that the effects of predicted changes in habitat quality on migrating sea lamprey, river lamprey and Atlantic salmon would not have an adverse effect on the integrity of the River Teith SAC.

7 Appropriate Assessment: Birds

7.1 Approach to assessment

This chapter, which forms the second stage of the HRA process, provides information to determine whether the potential effects of the Proposed Development will have an adverse effect on the conservation objectives and site integrity for each SPA and qualifying species screened into Appropriate Assessment for estuarine ornithology.

7.1.1 Data sources

Project-specific baseline estuarine bird surveys (see **Section 4.2.2.2** and **Appendix 1**) provide information on the abundance and distribution of features that have been considered in the Appropriate Assessment. Other sources of data that have been used in providing the required evidence for the assessment include:

- SPA site citations for Firth of Forth SPA (SNH, 2018a), Forth Islands SPA (SNH, 2018b), OFFSABC SPA (NatureScot, 2020) and Imperial Dock Lock, Leith SPA (SNH, 2004);
- Ramsar Site Information Sheet for Firth of Forth Ramsar Site (JNCC, 2005);
- Site Management Statements (SMS) for the Sites of Special Scientific Interest (SSSI) that underpin the Forth Islands SPA;
- BTO 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 (see also **Section 4.2.2.2**);
- JNCC's Seabird Monitoring Programme (SMP) (JNCC, 2022), a collaborative database of seabird breeding activity which includes colony counts at the Imperial Dock Lock, Leith SPA and the Forth Islands SPA;
- SNH's (now NatureScot) Habitats Regulations Appraisal (HRA) on the Firth of Forth: A Guide for developers and regulators (SNH, 2016);
- Numerical dispersion modelling of sediment brought into suspension during the proposed dredging and disposal activities (as described in **Section 7.1.2.3**); and
- Sediment sample analysis of source material, as described in the accompanying EIA Report.

In addition to the above, a number of other scientific sources have been used to provide evidence to support the conclusions of the ornithological assessments. Such sources are referenced and listed in the **'References'** section of this document (**Chapter 9**).

7.1.2 Overview of effect pathways screened in

7.1.2.1 Disturbance

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. However, the actual effects of disturbance are complex and there is increasing evidence that the behavioural response is not a reliable means of predicting the ultimate effect on the population. For example, a major disturbance event, causing birds to leave the site altogether, may not be significant if alternative sites are available in the general area, while a number of apparently small, insignificant disturbance events may become cumulatively significant if this leads to an overall critical reduction in available feeding time.

Some bird species may habituate to disturbance; indeed, it is considered likely that many of the birds using the Port and adjacent habitats would already show a degree of habituation to anthropogenic activity, and this is taken into account in the assessments that follow.

Given the location of the Proposed Development within a busy working port environment, sources of visual disturbance related to both the construction and operation phases (i.e. the presence of machinery, plant, vehicles and vessels on the quayside and within / just seaward of the impounded docks, plus the use of lighting in working areas) would be synonymous with existing day-to-day port activity (e.g. Jennings, 2012; see also **Appendix 1** for details of anthropogenic disturbance sources recorded during the 2021/22 surveys). Estuarine bird features of the SPAs / Ramsar Sites considered in the Appropriate Assessment that regularly use the study area are expected to have a high degree of tolerance and habituation to such sources of disturbance.

In terms of noise disturbance, a distinction may be made between 'continuous' (L_{Aeq}) and maximum (impulsive) noise levels (L_{Amax}) when considering the impact on birds. Impulsive noises are the most likely to cause disturbance reactions in birds, particularly 'irregular' impulsive noises (for example, a sudden gunshot or explosion). During the construction phase, it is assumed that the greatest noise disturbance to estuarine birds using the study area is likely to arise as impulsive noise from impact pile driving, although this would be persistent during operational hours and would instead be classed as a 'regular' noise source

Sources of non-impulsive noise arising from the construction phase (e.g. vessel, plant, vehicle and machinery noises), and even 'irregular' but occasional impulsive noises caused by e.g. dropped items, would be in keeping with the baseline noise climate expected in a working port environment and are not likely to have a significant or prolonged effect on ornithological receptors. In the long term, the number of vessels accessing the Port as a result of the Proposed Development is not expected to significantly increase.

As such, the assessments of disturbance-related effects in the Appropriate Assessment that follow focus specifically on the potential effects that may arise from noise emissions during piling activity. As well as direct disturbance effects on birds, the potential indirect effects of disturbance of prey resources due to underwater noise during the piling has also been considered.

7.1.2.2 Physical loss of habitat loss

Temporary habitat 'loss' arising from disturbance effects during construction are considered in the relevant assessments related to disturbance (see **Section 7.1.2.1**). During operation, sources of disturbance would be in keeping with those that exist at a busy working port environment hence there would be no net 'loss' of habitat available for use.

In terms of physical loss of habitat used by birds, this would constitute a small area of open water and a section of rubble mound on the internal face of the East Breakwater at the entrance to the Port, where the new berth and hardstanding area would be installed (Areas 1 and 2 in **Figure 1.1**), covering an area of c.2ha.

The installation of the proposed laydown area (Area 3 in **Figure 1.1**) would constitute a change of use rather than a loss of habitat, from use of an area of hardstanding for pipe storage and coating to an area of hardstanding for OWF component storage and transhipment.

7.1.2.3 Water quality effects

Dredging 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 temporary displacement of prey items of piscivorous species from the affected range (detail on the potential impacts on marine fish resources is provided in the accompanying EIA Report for the Proposed Development). Furthermore, high turbidity as a result of increased SSC limits visibility through the water, which may adversely affect the ability of aerial predators, such as tern species, to detect prey items in the affected range (Cook and Burton, 2010).

Total dredging for the Proposed Development would be 47,000 m^3 from the pre works and 54,000 m^3 from the berth pockets. Out of 101,000 m^3 of material, around 85 % of the material would be non-erodible (i.e. glacial till, mudstone and revetment rock). Only c.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 the accompanying EIA Report for the Proposed Development. **Figure 6.1** and **Figure** 6.2 present modelled bottom layer sediment plumes indicating the predicted maximum SSC during the dredge and disposal period.

In terms of sediment-bound contaminants, the chemical nature of material to be dredged has been analysed and all contaminants are at levels low enough to be deemed safe for offshore disposal. As such, risk of the effect of contaminants on prey species has not been considered further.

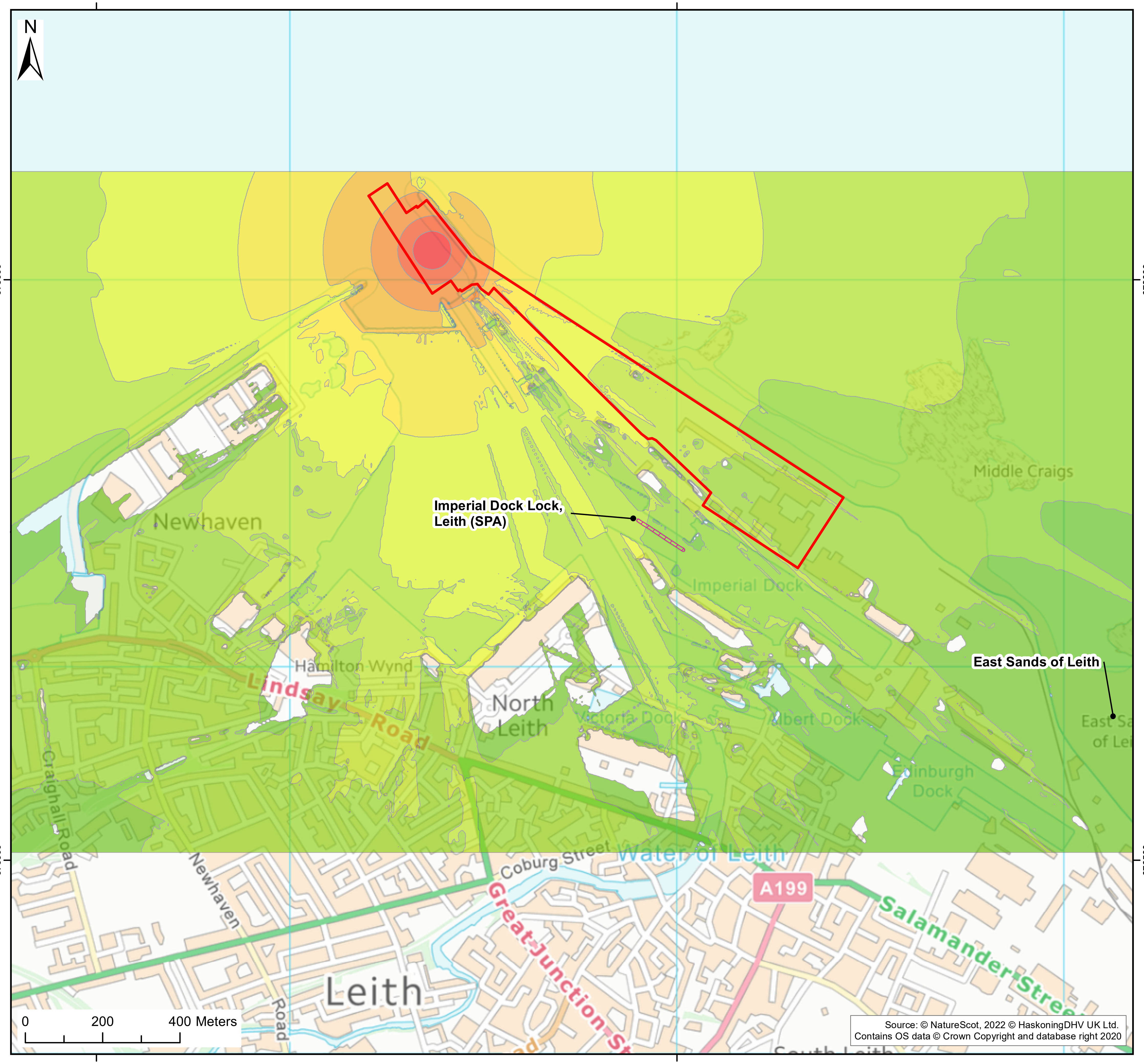
7.1.3 Assessing noise disturbance levels

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. A contour plot showing the modelled 'maximum' L_{Amax} noise levels is presented in **Figure 7.1**).

The L_{AMax} noise levels likely to be emitted by the proposed 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 in this chapter are all within the Port itself, or along the shoreline to the east, this model set up is considered to be sufficient.

Baseline L_{AMax} noise levels have also been predicted in the vicinity of the Imperial Dock Lock common tern colony, 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'. A contour plot showing the modelled baseline 'maximum' L_{Amax} noise levels at Imperial Dock Lock is presented in **Figure 7.2**)
.



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: 7.1 | 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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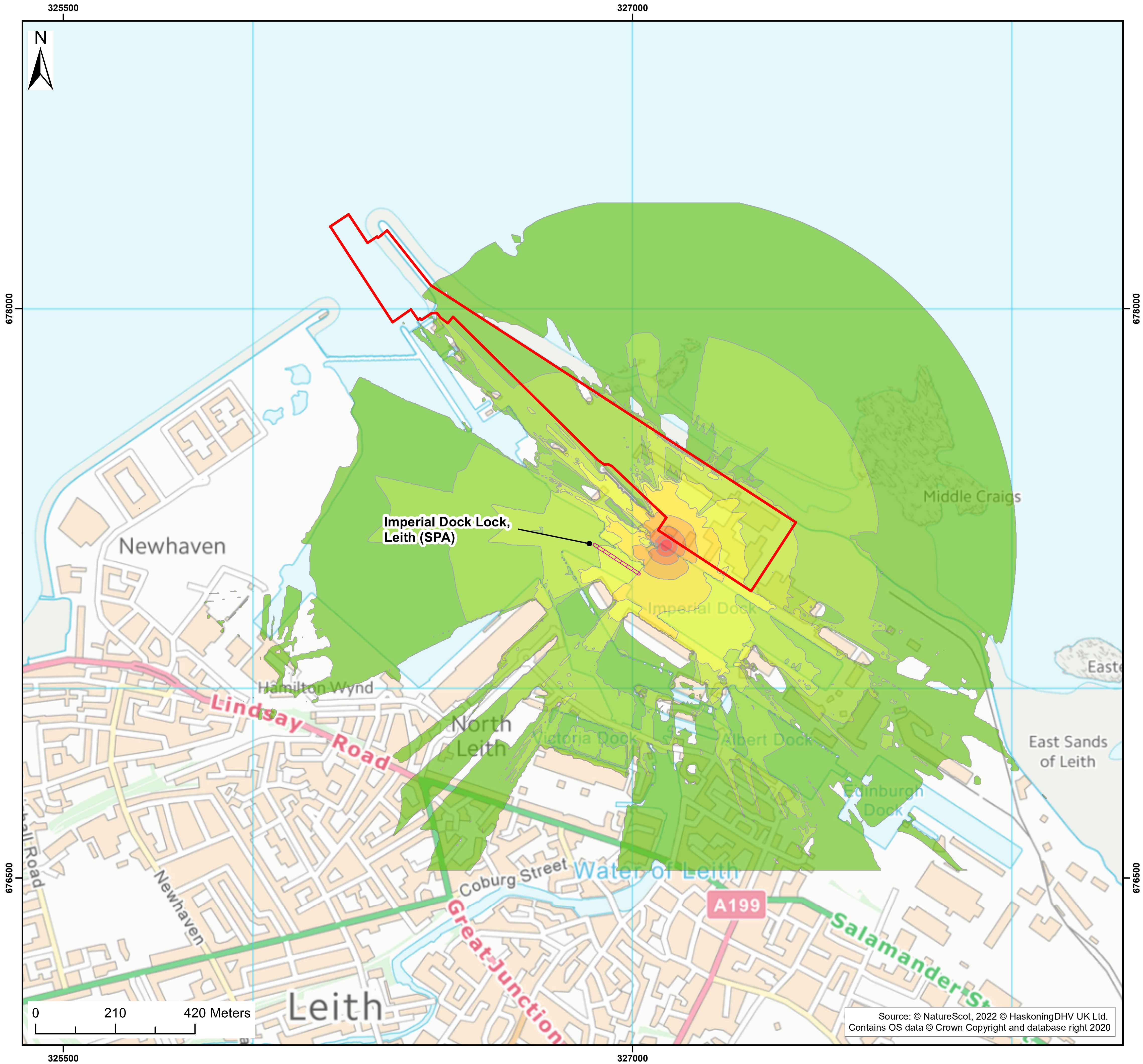

Legend:

- 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:

Baseline Operational LAmax Noise Levels at Imperial Dock Lock

Figure: 7.2	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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7.1.4 In-combination effects

The Inch Cape OWF landfall site at Prestonpans (11km from the Proposed Development), the Grangemouth Flood Protection Scheme (30km from the Proposed Development), the Neart na Gaoithe OWF array and cable route (60km from the Proposed Development) and the Seagreen Alpha and Bravo OWFs cable route (69km from the Proposed Development) all overlap with the Firth of Forth SPA / Ramsar Site and / or the OFFSABC SPA to some extent. However, the in-combination screening (**Table 4.16**) concluded no likely significant in-combination effects on any SPAs since all projects are more than 5km away from the Proposed Development, hence there would be no spatial overlap of disturbance-related effects (considered to be the most-far reaching effect of the Proposed Development). Given the screening conclusion, in-combination effects have not been considered in the Appropriate Assessments that follow.

7.2 Firth of Forth SPA and Ramsar Site

7.2.1 Description of designation

The Firth of Forth SPA and Ramsar Site, covering an area of 6,317 ha, is a complex of estuarine and coastal habitats in south east Scotland stretching from Alloa to the coasts of Fife and East Lothian. The site includes extensive invertebrate-rich intertidal flats and rocky shores, areas of saltmarsh, lagoons and sand dune.

7.2.2 Conservation objectives

The SPA's conservation objectives are:

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

7.2.3 Features screened in

Following the initial screening for LSE presented in **Chapter 0**, the following features are considered in the Appropriate Assessment for this SPA owing to the fact that a significant proportion (i.e. >1.0%) of the respective SPA populations may use the study area during the non-breeding season:

- Non-breeding bar-tailed godwit;
- Non-breeding knot;
- Non-breeding pink-footed goose;
- Non-breeding redshank;
- Non-breeding turnstone; and,
- Passage Sandwich tern.

In addition the qualifying wintering waterbird assemblage is also considered in the Appropriate Assessment owing to the fact that a significant proportion (i.e. >1.0%) of the respective SPA populations of one or more named component species may use the study area during the wintering season.

7.2.4 Potential effects of the Proposed Development alone

7.2.4.1 Disturbance

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), and are considered to be applicable to the assessment of non-breeding features of the SPA.

Wright *et al.* (2010) investigated the effects of impulsive noise to 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 but with return to the area, are most likely between around 65dB(A) and 75 dB(A).

Similarly, Cutts *et al.* (2009 and 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 7.1**, indicates that noise emissions in the immediate vicinity of the piling may be over 100dB L_{Amax} and reduces with increased distance from the source.

Based on the noise levels predicted in **Figure 7.1**¸ 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 to low and responses are most likely to range from head turning and scanning to temporary flight with return. At 60dB or less, the noise disturbance stimuli is considered to be low and little to no response would be expected.

In terms of the coastal areas likely to be exposed to noise levels that may elicit high to moderate levels of disturbance (i.e. above 70dB), affected habitats would include a stretch of the coastline immediately east of the works encompassing the East Breakwater and adjacent beach / foreshore, plus a stretch of the coastline to the west encompassing the West Breakwater. However, key intertidal habitats at East Sands of Leith, Middle Craigs and Eastern Craigs are predicted to experience noise levels that correlate with moderate to low levels of disturbance.

Qualifying waterbird features

For most of the non-breeding waterbird features considered in the Appropriate Assessment, namely bar-tailed godwit, knot, redshank and turnstone, the most important location within the study area for both foraging and loafing / roosting activity is an expansive area of soft sediment offered at the East Sands of Leith (see distribution maps in **Appendix 1**) and adjacent rocky outcrop (Eastern Craig), c.2km from the source of piling activity. At that location, L_{Amax} noise levels are predicted to be around 60 to 70dB(A), hence disturbance responses are likely to be moderate to low, ranging from no visible response to localised redistribution on the foreshore (Cutts et al., 2009 and 2013). During the 2021/22 surveys, bar-tailed godwit, knot and redshank were rarely recorded elsewhere in the study area. While turnstone foraging and roosting activity was distributed across the study area, this species displayed a preference for the East Sands of Leith and the adjacent Eastern Craigs, and the nearby Middle Craigs (c.1.3km from the source of piling activity, predicted L_{Amax} of 65 to 70dB). Reasonable numbers of turnstone use the foreshore at Newhaven, also over 1.5km from the piling. This indicates that it is very likely that foraging and resting individuals that may be displaced from areas close to the piling would readily redistribute locally within the study area.

Pink-footed geese were recorded during a single WeBS count in Sector 83341, to the east of the Proposed Development (see **Section 4.2.2.2**), but were not recorded at any time during the 2021/22 surveys (aside from a flock flying over the site on one occasion). It is likely, therefore, that the study area is not of particular importance to pink-footed geese and the record within the WeBS sector is not a regular occurrence. As noted in SNH (2016), pink-footed geese in the SPA favour farmland for foraging during the day and roost on the estuary at night. The only part of the study area that offers a reasonable expanse of estuarine habitat is at the East Sands of Leith, where, as discussed, predicted noise levels are anticipated to lead to moderate to low levels of disturbance, ranging from no visible response to localised redistribution on the foreshore (Cutts et al., 2009 and 2013).

The above evidence indicates that much of the preferentially-used foraging and roosting habitat within the study area (i.e. East Sands of Leith and the Middle and East Craigs) would be exposed to noise levels within a range that would be expected to result, at worst, in minor disturbance responses such as elevated alertness and / or localised redistribution (Wright et al, 2010; Cutts et al., 2009 and 2013). Individuals that use habitat in close proximity to the piling activity (e.g. on the foreshore adjacent to the East Breakwater), where disturbances levels are predicted to be high to moderate, would be able to easily relocate to those preferential habitats as an alternative for foraging and / or resting. It should be noted that the temporal magnitude of piling-associated noise disturbance would be short-term (a period of 5 to 5.5 months), hence would only have the capacity to affect a single non-breeding season. Birds 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.

Consequently, it is concluded that predicted disturbance of non-breeding waterbird features due to piling activity would not have an adverse effect on the integrity of the Firth of Forth SPA / Ramsar Site.

Wintering waterbird assemblage

In addition to the named qualifying features, a number of other assemblage component species have been recorded in the study area in numbers exceeding 1% of the respective SPA population (see **Table 4.10**).

Most of these species preferentially use locations where noise disturbance effects are predicted to be moderate to low (i.e. East Sands of Leith, Middle and Eastern Craigs, Newhaven foreshore), or were widely distributed across the entire survey area (see distribution maps for component species in **Appendix 1**).

Given the setting within and adjacent to a working port environment, it is likely that most species would have a degree of tolerance to anthropogenic activity, and the ability to habituate to sources of disturbance. For individual birds that regularly use habitats where noise levels are likely to result in high to moderate disturbance (e.g. the foreshore adjacent to the East Breakwater, the Western Harbour and marine areas close to the piling source), alternate habitat within the local area would be available at the East Sands of Leith, Middle and Eastern Craigs, and other areas within the Port, where noise levels would be lower. A maximum of one non-breeding season could overlap with the proposed piling activity. Again, it should be noted that the temporal magnitude of piling-associated noise disturbance would be short-term (a period of 5 to 5.5 months), hence would only have the capacity to affect a single non-breeding season.

The baseline surveys did indicate notable sensitivities related to non-breeding ringed plover and goldeneye (see **Appendix 1**). The former, periodically present throughout the year, may be more at risk of adverse effects than other waders as this species appeared to favour the stretch of foreshore between the East Breakwater and the Middle Craigs, much of which would be exposed to noise levels exceeding 70dB. The latter was only present during the wintering months (November to February) but was generally restricted in its range to the sheltered waters within the impounded dock system and the embayment to the south west of the Port. Some of the dockland areas used would be exposed to noise levels exceeding 70dB.

The Waterbird Disturbance Mitigation Toolkit (Cutts et al., 2013) notes that ringed plover are an ‘extremely tolerant species that habituates to anthropogenic activities rapidly’. 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; though there is little other evidence with regard to ringed plover reaction to noise, it is considered likely that they would have a high threshold given their general high tolerance. The Toolkit concludes that a noise level of up to 75dB is considered acceptable at the bird. 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, 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. The use of JNCC soft-start protocol (JNCC, 2010) would facilitate such habituation. In the event of displacement, alternative soft sediment habitat is available at East Sands of Leith, where predicted noise levels are less than 70dB, 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.

For goldeneye, it is apparent from the 2021/22 baseline surveys that this species favours sheltered waters around the Port during winter months, particularly for loafing. Such areas include the embayment in the south western part of the study area 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 noise levels below 70dB, hence only low to moderate disturbance responses would be expected (Cutts et al., 2009 and 2013). There is little to no published evidence relating to goldeneye sensitivity and response to disturbance during the wintering period; however, the 2021/22 surveys indicated that large numbers of goldeneye use the impounded dock system itself during winter, 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 Imperial Dock Lock, Leith SPA, indicates that baseline L_{Amax} noise levels at this location during existing port operations can exceed 80dB (see **Figure 7.2**). 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 would 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.

Consequently, it is concluded that predicted noise disturbance of the non-breeding waterbird assemblage would not have an adverse effect on the integrity of the Firth of Forth SPA / Ramsar Site.

Passage Sandwich tern

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 in the far southwest of the study area (see **Appendix 1**). Both roosting locations are in excess of 1.5km from the piling source.

The studies regarding noise disturbance effects on waterbirds undertaken by Wright et al. (2010) and Cutts et al. (2009 and 2013) can only be regarded as providing general context to assessment regarding Sandwich terns, as behavioural responses in terns may differ from waterbirds and gulls; however, is likely to provide a broad indication of noise levels and associated behavioural responses. A study of more direct relevance was undertaken on breeding crested terns (a close relative of Sandwich tern) 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.

Broad-based and qualitative consideration has been given to seabird responses to disturbances in offshore environments when commuting or foraging by Garthe and Hüppop (2004) and 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’). Sandwich 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 away from breeding colonies.

At the main roosting locations recorded during the baseline surveys, maximum noise levels are predicted to be less than 70dB L_{Amax} (see **Figure 7.1**), hence it is anticipated that behavioural responses would be moderate to low, ranging from no effect to increased alertness or localised redistribution.

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 or the Newhaven foreshore, there would be no significant risk to the abundance or wider distribution of the SPA population. It should be noted that the temporal magnitude of piling-associated noise disturbance would be short term (a period of 5 to 5.5 months), hence would only have the capacity to affect a single passage season.

As such, it is concluded that predicted disturbance of passage Sandwich tern due to piling activity would not have an adverse effect on the integrity of the Firth of Forth SPA / Ramsar Site.

7.2.4.2 Loss of habitat

All features

The footprint of the Proposed Development lies adjacent to, but does not overlap, the SPA / Ramsar Site. As such, there would be no physical loss of foraging and / or resting habitat for waterbird features in the SPA / Ramsar Site itself.

In terms of physical loss of habitat outside the SPA boundary, this would constitute a small area of open water and a section of rubble mound on the internal face of the East Breakwater at the entrance to the Port where the new berth and hardstanding area would be installed (Areas 1 and 2 in **Figure 1.1**). The distribution maps presented in **Appendix 1** provide evidence that these locations are of no particular importance to SPA features (birds recorded there were recorded in larger numbers elsewhere).

In the context of subtidal / intertidal habitat available within and adjacent to the SPA, the affected area would represent a negligible area of (low-importance) foraging habitat for SPA features such as waterfowl, Sandwich tern and cormorants, hence would not have significant functional linkage.

As such, it is concluded that physical loss of habitat arising from the Proposed Development would not have an adverse effect on the integrity of the Firth of Forth SPA / Ramsar Site.

7.2.4.3 Water quality effects

Sandwich tern and piscivorous / partly piscivorous component species of the non-breeding waterbird assemblage

Significant increases in SSC would not extend beyond the entrance to the Port (i.e. the immediate vicinity of the dredging activity; see **Figure 6.1**) during dredging, nor extensively beyond the limits of the disposal site during disposal activity. This would represent a very small proportion of the marine habitat available to piscivorous features in and adjacent to the SPA / Ramsar Site. As an example, Sandwich terns have a foraging range of 34.3km (standard deviation of 23.2km) during the breeding season, and during the non-breeding season this species would not be constrained by a need to return to a nest site hence would be able to forage even more widely. For assemblage component species such as goldeneye, the sheltered waters in the embayment to the southwest of the Port, which are favoured for foraging activity, would be unaffected by sediment plumes. As per the distribution maps from the 2021/22 surveys provided in **Appendix 1**, no features present within the study area have a reliance on foraging activity within the affected area.

Dredging activities will operate on a 24/7 basis during the campaign; however, given the campaign will last around four months the temporal magnitude of the effect would be short-term and would overlap with no more than one non-breeding season. Following completion, baseline SSC would be restored across the affected area and there would be no long-term effect on foraging capability.

Based on the above, it is concluded that the indirect effects that changes in water quality may have on foraging waterbirds during dredging activity would not have an adverse effect on the integrity of the Firth of Forth SPA / Ramsar Site.

7.3 Imperial Dock Lock, Leith SPA

7.3.1 Description of designation

The Imperial Dock Lock, Leith SPA is a man-made structure at the mouth of the Imperial Dock in the heart of the Port of Leith. The boundary of the SPA is coincidental with that of the lock itself. The SPA, separated from the rest of the port by a narrow cut, regularly supports one of the largest colonies of breeding common terns in Scotland. Colonisation of the lock resulted from the relocation of birds from natural islands in the Firth of Forth which were abandoned due to unsustainable levels of predation by gulls.

7.3.2 Conservation objectives

The SPA's conservation objectives are:

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

7.3.3 Features screened in

Following the initial screening for LSE presented in **Chapter 0**, breeding common terns from the SPA (the only qualifying feature) is considered in the Appropriate Assessment owing to the fact that a significant proportion of the SPA population may use the study area during the breeding and post-breeding season.

7.3.4 Potential effects of the Proposed Development alone

7.3.4.1 Disturbance

Disturbance to common terns at the breeding colony

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.

As noted for the Firth of Forth SPA (**Section 7.2.4.1**), sources of visual disturbance related to the construction and operation of the Proposed Development would be synonymous with existing day-to-day port activity. As such, common terns present within the Port are expected to have a high degree of tolerance and habituation to such sources of disturbance, hence would not be significantly affected.

Similarly, sources of non-impulsive noise arising from the construction phase, and even 'irregular' but occasional impulsive noises caused by e.g. dropped items, would be in keeping with the baseline noise climate expected in a working port environment and are not likely to have a significant or prolonged effect on common terns.

As such, the assessment of disturbance-related effects on common terns from the SPA focuses specifically on the potential effects that may arise from noise emissions during piling activity.

The studies regarding noise disturbance effects on waterbirds undertaken by Wright et al. (2010) and Cutts et al. (2009 and 2013), described in **Section 7.2.4.1**, 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 unmitigated piling works is between 67 and 71dB at the SPA, as shown in the L_{Amax} contour plot in **Figure 7.1**. 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 the SPA; another large colony at Shotton Steelworks in Deeside, North Wales, is a further example). The colony at the SPA occurs in a location where vessels of 30 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 regular 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 7.2**, 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 7.1**). 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 during piling and, secondly, piling noise levels at the colony would be lower than those that are experienced during existing port operations.

Historically (and typical of tern species), common terns 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 (see **Appendix 1** for full detail), 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.

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. It should be noted that the temporal magnitude of piling-associated noise disturbance would be short term (a period of 5 to 5.5 months), hence would only have the capacity to affect a single breeding season.

As such, it is expected that worst-case noise disturbance, arising from impact piling activity during the common tern breeding season, would not have a significant impact on common terns at the SPA colony.

Consequently, it is concluded that predicted disturbance of breeding common tern due to piling activity would not have an adverse effect on the integrity of the Imperial Dock Lock, Leith SPA.

Disturbance to common terns during the post-breeding season

During the post-breeding season, particularly in August, relatively large groups numbers of common tern from the SPA are still present in the Port but are not confined to 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 4.3**). 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, temporary displacement from roosting sites close to the piling source temporarily reduce the overall available habitat within the Port.

To provide mitigation for this, and therefore to reduce the likelihood of adverse effect, a piling shroud would be installed on the rig during piling activities if they were to be undertaken during the post-breeding period (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 sound emission data.

When considering a reduction of 7dB on the predicted L_{Amax}, the extent to which noise levels may result in high to moderate disturbance to common tern roosting within the Port would be considerably reduced. There would be an increase in the amount of nearby alternative habitat available for roosting / loafing (i.e. a decrease in the area of habitat that may be temporarily 'lost' due to noise disturbance), thereby increasing the adaptability of terns that could be displaced during works. 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 common tern would have a high degree of tolerance and habituation.

Given the above, and based on the fact that the piling noise emissions would only have the capacity to affect a maximum of one post-breeding seasons, **it is concluded that predicted disturbance of post-breeding common tern due to piling activity would not have an adverse effect on the integrity of the Imperial Dock Lock, Leith SPA**.

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 at the SPA. 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 low-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 **Figure 4.4**) 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 by 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 below.

Based on the evidence above, it is concluded that predicted disturbance of foraging common tern from the breeding colony due to piling activity would not have an adverse or effect on the integrity of the Imperial Dock Lock, Leith SPA.

Indirect effects of underwater noise disturbance on prey resources

Underwater noise during construction may injure, disturb and displace fish prey species of common tern. If the abundance and / or availability of prey is reduced through displacement or mortality arising from underwater noise, this could adversely affect common tern breeding success.

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 or vibro-piling (see the assessment of impacts of underwater noise on fish in **Appendix 3**). Vessel use in the construction phase would be in keeping with the activities in a working port environment, and in the long term there would be no significant increase in vessel use as a consequence of the Proposed Development. Piling will be undertaken over an anticipated period of 5 to 5.5 months, hence any indirect impact on common tern foraging ability would be short-term and would overlap with a maximum of one common tern breeding season.

The predicted effects of underwater noise from the proposed piling on fish is described in **Appendix 3**. 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 (JNCC, 2010), 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 also, disturbance / displacement levels are likely to be limited outside of TTS range.

As noted, however, common terns generally 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 not result in any disturbance / displacement of fish prey items.

Consequently, it is concluded that indirect effects of underwater noise on prey items of foraging common tern from the breeding colony would not have an adverse effect on the integrity of the Imperial Dock Lock, Leith SPA.

7.3.4.2 Habitat loss and change of use

Temporary habitat ‘loss’ arising from disturbance effects during construction are considered in **Section 7.3.4.1**. During operation, sources of disturbance would be in keeping with those that exist at a busy working port environment hence there would be no net ‘loss’ of habitat available for use.

In terms of physical loss of habitat used by birds, this would constitute a small area of open water and a section of rubble mound on the internal face of the East Breakwater at the entrance to the Port where the new berth and hardstanding area would be installed (Areas 1 and 2 in **Figure 1.1**). Evidence from the 2021/22 estuarine bird survey (**Appendix 1**), and supporting evidence from Jennings (2012), indicates that common terns from the SPA generally do not forage within the footprint of Areas 1 and 2 of the Proposed Development, hence there would be no adverse effect on foraging activity due to this loss of marine area.

As described in **Appendix 1**, 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 4.4**. 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 during the operation phase (from the existing 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), implications of which may range from additional energy expenditure to abandonment of the colony. 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 SPA population would be long-term and would overlap with breeding seasons for an indefinite period.

Although a change of use, sources of disturbance within the laydown area are considered to be less than are currently present, given that the noise and air emissions from the existing pipe-coating plant would be absent and replaced by comparatively low intensity activity when moving components into and out of position. There would be no further disturbances caused by the presence of pipe-loading vessels in the cut immediately adjacent to the colony, which Jennings (2012) documented as a historical cause of notable and prolonged disturbance at the colony. In this respect, the proposed change of use would be beneficial to the common terns breeding at the site.

In terms of the effect that the presence of OWF components may have, flight heights through flight sectors 2 and 3 (**Figure 4.4**) 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 **Appendix 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.

Plate 7.1 View across Imperial Dock Lock towards flight sector 3 (Jennings, 2012), 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 (through the seaward entrance to the Port; 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 flight detour, in the context of the mean maximum foraging range of common tern (Wilson et al., 2014; Woodward et al., 2019), would be negligible.

Given that common terns from the SPA colony already demonstrate 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), common terns from the SPA are considered to be tolerant to the proposed change of use and would readily and easily adapt to the presence of OWF components.

Consequently, it is concluded that the physical changes to habitat arising from the change of use would not have an adverse effect on the integrity of the Imperial Dock Lock, Leith SPA.

7.3.4.3 Water quality effects

The extent of the sediment plume predicted from the proposed dredging is described in detail in the accompanying EIA Report for the Proposed Development and significant increases in SSC would not extend beyond the dredge footprint at the mouth of the Port (see also **Figure 6.1**). 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), hence the overall proportion of available foraging habitat for terns from the SPA would be very small. Additionally, 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 at the SPA. This was also noted during foraging ecology surveys undertaken by Jennings (2012). This provides further evidence that the majority of breeding terns would, therefore, forage beyond the potential extent of any sediment plume.

Any individuals that do occasionally forage in the affected area would be able to use alternate unaffected marine areas within the study area and elsewhere within foraging range. Following completion of the dredging activity, baseline suspended sediment levels in the affected area would be restored and the affected area would once again be available for foraging. Dredging activities will operate on a 24/7 basis during the campaign; however, given the campaign will last around four months the temporal magnitude of the effect would be short-term and would overlap with no more than one breeding season.

Based on the above, it is concluded that the indirect effects that changes in water quality may have on foraging common terns during dredging activity would not have an adverse effect on the integrity of the Imperial Dock Lock, Leith SPA.

7.4 Forth Islands SPA

7.4.1 Description of designation

The Forth Islands SPA consists of a series of islands supporting the main seabird colonies in the Firth of Forth. The islands of Inchmickery, Isle of May , Fidra, The Lamb, Craigleith and Bass Rock were originally classified in 1990. An extension to the site in 2004 incorporated the island of Long Craig which, at the time of classification, supported the largest colony of roseate tern in Scotland. A seaward extension of the SPA in 2004 extended approximately 2km into the marine environment to include the seabed, water column and surface within core foraging areas for seabirds from the colonies.

7.4.2 Conservation objectives

The SPA's conservation objectives are:

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

7.4.3 Features screened in

Following the initial screening for LSE presented in **Section 0**, the following features are considered in the Appropriate Assessment for this SPA owing to the fact that a significant proportion of the respective SPA populations may use the study area during the breeding season:

- Breeding common tern;
- Breeding lesser black-backed gull;

[Redacted]

- Breeding Sandwich tern; and
- Breeding shag.

In addition the qualifying breeding seabird assemblage is also considered in the Appropriate Assessment as a significant proportion of the respective SPA populations of one or more named component species may use the study area during the breeding season.

The SMSs for the underpinning SSSIs indicate where colonies of the above species are located in the SPA, and is summarised in **Table 7.1**. The information in the SMS regarding breeding colonies has been compared with SMP data between 2010 and 2021, which confirmed that the SMS accurately reflect the latest breeding status for common tern, Sandwich tern, lesser black-backed gull and shag. [Redacted] [Redacted]

Table 7.1 Breeding colonies at Forth Islands SPA, as per SMS for underpinning SSSIs

Colony	Distance from Proposed Development	Corresponding SMS	Screened-in species that breed at the colony
Inchmickery	6km	Inchmickery SSSI	Lesser black-backed gull; shag
Long Craig	13.5km	Long Craig SSSI	Common tern; roseate tern
Fidra	26km		
The Lamb	28km	Forth Islands SSSI	Lesser black-backed gull; shag
Craigleith	30km		
Bass Rock	35km	Bass Rock SSSI	Lesser black-backed gull; shag
Isle of May	45km	Isle of May SSSI	Common tern; Sandwich tern; lesser black-backed gull; shag

7.4.4 Potential effects of the Proposed Development alone

7.4.4.1 Disturbance

As noted for other SPAs, sources of visual disturbance related to both the construction and operation phases (i.e. the presence of machinery, plant, vehicles and vessels on the quayside and within / just seaward of the impounded docks, plus the use of lighting in working areas) would be synonymous with day-to-day port activity. As such, individuals from the Forth Islands SPA breeding colonies that regularly use the study area are expected to have a high degree of tolerance and habituation to such sources of disturbance, hence would not be adversely affected. Similarly, sources of non-impulsive noise arising from the construction phase (e.g. vessel, plant, vehicle and machinery noises), and even 'irregular' but occasional impulsive noises caused by e.g. dropped items, would be in keeping with the baseline noise climate expected in a working port environment and are not likely to have a significant or prolonged effect on ornithological receptors. In the long term, the number of vessels accessing the Port as a result of the Proposed Development is not expected to significantly increase.

As such, the assessment of disturbance-related effects on breeding seabird features from the Forth Islands SPA focuses specifically on the potential effects that may arise from noise emissions during piling activity.

Common tern, [Redact tern and Sandwich tern

Within the SPA, common tern colonies are located at Long Craig, c.13.5km from the Proposed Development, and the Isle of May, c.45km from the Proposed Development. The mean maximum foraging range (+/-1 SD) for common tern is 17.6km (+/-9.1km), as per Woodward et al. (2019). While the foraging range from the colony at Isle of May would not extend to the study area, there is potential for foraging terns from Long Craig to be present in the study area during the breeding season.

Wilson et al. (2014) modelled the predicted usage of marine areas around UK common tern SPA breeding colonies, including the Forth Islands SPA. The modelled predictive usage of the study area by common terns from the Long Craig colony is very low. This was supported by the findings of the 2021/22 baseline estuarine bird surveys, which recorded very low usage of the study area specifically by foraging common terns, with a maximum of 17 foraging individuals recorded (out of a peak count of 2,000 common terns recorded in the survey area). It is extremely likely that this small number of foraging individuals would be associated with the Imperial Dock Lock SPA colony rather than the Long Craig colony, given the proximity of the former to the Proposed Development. Even in the unlikely event that these birds were instead part of the Forth Islands SPA population, the survey area represents a small proportion of the available marine area to foraging birds from Long Craig, and terns could readily forage elsewhere in the general vicinity.

[Redacted]

Sandwich terns breed in significant numbers only on the Isle of May, c.45km from the Proposed Development. The mean-maximum foraging range (+/-1 SD) of Sandwich tern is 34.3km (+/-23.2km), as per Woodward et al. (2019), hence it is unlikely that there would be any significant use of the study area by foraging Sandwich terns from the colony. This evidence is supported by the 2021/22 baseline estuarine bird survey, which indicated zero usage of the study area during the migration-free breeding period (June; Furness, 2015) and a maximum of 21 individuals in August, during post-breeding migration (see **Appendix 1** for details). The latter count, although representing around 2% of the SPA population, is likely to be supplemented by post-breeding migrant birds from other colonies outside the SPA.

The roosting and loafing birds present in the study area during the post-breeding season are considered to be part of the Firth of Forth SPA passage population rather than the Isle of May breeding population and are considered in the relevant section (**Section 7.2.4.1**) rather than here.

It is evident that the coastal waters within the study area that may be subject to noise-based disturbance from the Proposed Development are not important in terms of foraging common terns, roseate terns and Sandwich terns from the SPA. There is no risk of disturbance within the core foraging areas of the SPA that were incorporated as part of the SPA extension into the marine area. The small numbers of terns that may occasionally forage within the study area would have adequate alternative resources available within the general vicinity, hence energy expenditure costs would be minimal. Furthermore, the duration of the piling activity would overlap with a maximum of one breeding season, with future breeding seasons unaffected.

[Redacted]

Based on the above, it is concluded that the effects of disturbance on foraging common tern [Redacted] **nd Sandwich tern activity would not have an adverse effect on the integrity of the Forth Islands SPA.**

Lesser black-backed gull

Lesser black-backed gull colonies are present at Inchmickery, Isle of May, Fidra, The Lamb, Craigleith and Bass Rock. The mean maximum foraging range (+/-1 SD) for lesser black-backed gull is 127.0km (+/-109.0km), as per Woodward et al. (2019), hence the Proposed Development is within the foraging range of birds from all of those colonies. However, given the size of the foraging range, the area affected by noise disturbance during piling would represent a very small proportion of the marine habitat available. Lesser

[13] https://www.nature.scot/rare-tern-breeds-isle-may#:~:text=No%20other%20roseate%20terns%20currently,eye%2Dcatching%20sea%2Dbird.

black-backed gulls in the Firth in Forth will also readily forage on e.g. human waste, carrion and live prey in terrestrial areas (SNH, 2016), further minimising the proportion of available foraging habitat that may be affected by noise disturbance.

During the migration-free breeding season (May to July; Furness, 2015), counts of lesser black-backed gull in the 2021/22 surveys (see **Appendix 1**) were relatively low (between c.10 and 80 individuals), representing between 0.5% and 2.5% of the SPA population. Most were recorded using the study area for loafing / roosting, rather than foraging. The peak counts recorded in August and September, which were considerably higher, are within the post-breeding migration season (August to October; Furness, 2015) and are likely to be supplemented by counts of migrating individuals from colonies not associated with the SPA and / or non-breeding individuals.

It is evident that the coastal waters within the study area that may be subject to noise-based disturbance from the Proposed Development represent a very small proportion of the foraging habitat available to lesser black-backed gulls from the SPA colonies and there would be adequate alternative resources available both during the breeding and post-breeding period. There is no risk of disturbance within the core foraging areas of the SPA that were incorporated as part of the SPA extension into the marine area. The gulls that choose to use the study area (including the Port itself) for roosting / loafing whilst on foraging trips are expected to be tolerant of disturbance associated with anthropogenic activity. Furthermore, the duration of the piling activity would overlap with a maximum of one breeding season, with future breeding seasons unaffected.

Based on the above, it is concluded that the effects of disturbance on lesser black-backed gull activity would not have an adverse effect on the integrity of the Forth Islands SPA.

Shag

Shag colonies are present at Inchmickery, Isle of May, Fidra, The Lamb, Craigleith and Bass Rock. The mean maximum foraging range (+/-1 SD) for shag is 13.2km (+/- 10.5km), as per Woodward et al. (2019), hence the Proposed Development is within the foraging range only of birds from the Inchmickery colony.

The 2021/22 estuarine bird survey (see **Appendix 1**) provides evidence of low usage by shag during the breeding season. During the migration-free breeding season (March to July), the peak count of 8 shags represents less than 1% of the SPA population. Only during the post-breeding migration season (August to October) do the numbers in the study area exceed 1% of the SPA population, at which time of the year it is likely that counts would be supplemented by migrating birds from colonies that are not associated with the SPA.

As such, it is evident that the coastal waters within the study area that may be subject to noise-based disturbance from the Proposed Development are of low importance to birds associated with the SPA breeding colonies, and those that do occasionally forage there, including during the post-breeding season, would have adequate alternative marine habitat available. There is no risk of disturbance within the core foraging areas of the SPA that were incorporated as part of the SPA extension into the marine area. Furthermore, piling activities would only overlap with a maximum of one breeding season.

Based on the above, it is concluded that the effects of disturbance on shag activity would not have an adverse effect on the integrity of the Forth Islands SPA.

Breeding seabird assemblage

As discussed above, the main components of the breeding seabird assemblage in the SPA (i.e. those that are qualifying features in their own right) would not be significantly adversely affected. Of the other named component species, herring gull, guillemot, razorbill and cormorant have been recorded in numbers exceeding 1% of the SPA population (see **Section 4.2.2.2** and **Appendix 1**).

Cormorant colonies are present on Fidra, The Lamb and Craigleith. With a mean maximum foraging range (+/-1 SD) of 25.6km (+/-8.3km), as per Woodward et al. (2019), the study area is at the far edge of the potential foraging range, hence birds associated with the SPA colonies are unlikely to regularly forage around the Port area during the breeding season. Razorbill, guillemot and herring gull colonies are present at Bass Rock, Isle of May, Fidra, The Lamb and Craigleith, with a herring gull colony additionally present at Inchmickery. The foraging ranges for these species would overlap with the affected area; however, given the mean maximum foraging range for all four species (cormorant, as stated, plus razorbill: 88km (+/- 75.9km); guillemot: 73.2km (+/- 80.5km); herring gull: 58.8km (+/- 26.8km; Woodward et al., 2019), the affected area would represent a very small proportion of the overall marine habitat available for foraging activity.

Herring gull in particular were abundant in and around the Port during baseline surveys (see **Appendix 1**), hence it is assumed that gulls that choose to use the study area (including the Port itself) for roosting / loafing whilst on foraging trips are expected to be tolerant of disturbance associated with port-related activity and other anthropogenic activity. 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).

Razorbill and guillemot were present in significant numbers only during the post-breeding migration season (August to October), hence it is likely that counts were supplemented by migrating birds from other colonies that are not associated with the SPA. Regardless, post-breeding birds are not constrained in their foraging ability by a need to return to nesting sites, further increasing the availability of alternative marine habitat for foraging.

The 2021/22 surveys indicated that foreshore near to the East Breakwater is a regular roosting / loafing habitat for groups of more than 20 cormorants and may be used by post-breeding birds associated with the SPA. It is likely that there would be noise levels at this location in exceedance of 70dB (**Figure X**), which may lead to moderate to high disturbance responses, including temporary abandonment of the roost. However, regular roosts were also recorded at 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 low-moderate (Wright et al., 2010; Cutts et al., 2009 and 2013). Cormorant is common and widespread in the Firth of Forth (SNH, 2016), therefore it is likely that birds would be able to readily adapt by roosting in alternative locations both within the study area and elsewhere in the local vicinity. The Proposed Development would overlap with a maximum of one post-breeding season.

Based on the above, it is concluded that the effects of disturbance on the breeding seabird assemblage would not have an adverse effect on the integrity of the Forth Islands SPA.

Indirect effects of underwater noise disturbance on prey resources

Appendix 1 provides a description of the effects of underwater noise on marine fish species and, as described in **Section 7.3.4.1**, there may be minor displacement of fish within 1.2km of the proposed piling activity, over a period of 5 to 5.5 months (hence affecting a maximum of one breeding season).

For most of the features considered in the Appropriate Assessment, the affected area would be outside of the foraging range for birds from the SPA breeding colonies. For some species, namely lesser black-backed gull, shag from the Inchmickery colony and common tern from the Long Craig colony, the mean maximum foraging range overlaps with the affected area. However, as detailed above, the importance of the survey area for these features is low, and the affected area (assuming a TTS range of 1.2km) would represent a very small proportion (less than 1%) of the foraging habitat available to breeding birds from the SPA colonies (assuming mean maximum foraging ranges set out in Woodward et al., 2019).

Based on the above, it is concluded that indirect effects of underwater noise on prey items of foraging seabirds from SPA breeding colonies would not have an adverse effect on the integrity of the Forth Islands SPA.

7.4.4.2 Loss of habitat

All features

Temporary habitat 'loss' arising from disturbance effects during construction are considered in **Section 7.4.4.2**. During operation, sources of disturbance would be in keeping with those that exist at a busy working port environment hence there would be no net 'loss' of habitat available for use.

In terms of physical loss of habitat used by birds, this would constitute a small area of open water and a section of rubble mound on the internal face of the East Breakwater at the entrance to the Port where the new berth and hardstanding area would be installed (Areas 1 and 2 in **Figure 1.1**). The distribution maps presented in **Appendix 1** provide evidence that these locations are of no particular importance to SPA features (birds recorded there were recorded in larger numbers elsewhere). A conversion from existing use to the proposed laydown area would not represent a material change in the habitat type or availability within the Port estate itself.

In the context of the marine habitat available to foraging birds from the Forth Islands SPA colonies, the area of physical loss would be infinitesimal and would have no effect on foraging ability.

It is concluded that the effects of physical habitat loss would not have an adverse effect on the integrity of the Forth Islands SPA.

7.4.4.3 Water quality effects

All features

The extent of the sediment plume predicted from the proposed dredging is described in detail in the accompanying EIA Report for the Proposed Development and significant increases in SSC would not extend beyond the dredge footprint at the mouth of the Port (see also **Figure 6.1**)

For most of the features considered in the Appropriate Assessment, the affected area would be outside of the foraging range for birds from the SPA breeding colonies. For some species, namely lesser black-backed gull, shag from the Inchmickery colony and common tern from the Long Craig colony, the mean maximum foraging range overlaps with the affected area. However, as detailed above, the importance of the survey area for these features is low, and the affected area would represent a very small proportion (less than 1%) of the foraging habitat available to breeding birds from the SPA colonies (assuming mean maximum foraging ranges set out in Woodward *et al*., 2019).

Based on the above, it is concluded that changes in water quality leading to effects on prey items of foraging seabirds from SPA breeding colonies would not have an adverse effect on the integrity of the Forth Islands SPA.

7.5 Outer Firth of Forth and St Andrews Bay Complex SPA

7.5.1 Description of designation

The OFFSABC SPA is a large estuarine / marine site consisting of the two closely adjacent Firths of Forth and Tay, covering an area of 272,068 ha. In the mid-Firth of Forth a belt of mud-rich sediments lies between areas of sandy gravels and shell material on either side along the shore. As the estuary widens towards the outer firth, there are extensive areas of sandy and gravelly muds and fine sediments. This is in contrast to St Andrews Bay, which contains clean sands and gravels with only small areas of muddy sediments. Water depth is variable but large areas, in both the Firth of Forth and St Andrews Bay, are shallow and less than 10m deep.

The area supports a wide variety of both pelagic and demersal fish, including sandeels, and crustaceans, molluscs and marine worms, all of which, especially sandeels, comprise the prey of waterbird and seabird species.

7.5.2 Conservation objectives

The conservation objectives of the SPA are:

- To ensure that the qualifying features are in favourable condition and make an appropriate contribution to achieving Favourable Conservation Status; and
- To ensure that the integrity of the SPA is restored in the context of environmental changes by meeting the following objectives for each qualifying feature:
  - The populations of qualifying features are viable components of the site;
  - The distributions of the qualifying features throughout the site are maintained by avoiding significant disturbance of the species; and
  - The supporting habitats and processes relevant to the qualifying features and their prey / food resources are maintained, or where appropriate restored.

7.5.3 Features screened in

Following the initial screening for LSE presented in **Section 0**, the following features of the OFFSABC SPA are considered in the Appropriate Assessment, owing to the fact that a significant proportion of the respective SPA populations may use the study area during the relevant seasons:

- Breeding common tern;
- Breeding shag; and,
- Non-breeding eider.

In addition the following qualifying assemblages are also considered in the Appropriate Assessment owing to the fact that a significant proportion of the respective SPA populations of one or more named component species may use the study area during the relevant seasons:

- Breeding seabird assemblage;
- Wintering seabird assemblage; and,
- Wintering waterfowl assemblage.

7.5.4 Potential effects of the Proposed Development alone

7.5.4.1 Disturbance

Breeding common tern and shag and overall breeding seabird assemblage

As well as common tern and shag, breeding seabird assemblage component species that were present in the baseline data in numbers exceeding 1% of the SPA population include guillemot and herring gull.

In terms of the general area of marine habitat affected by noise disturbance, the extent to which noise-related disturbance from piling activity may lead to high to moderate behavioural responses such as displacement would represent a very small proportion (less than 0.5%) of the overall SPA. Based on this, it is evident that there would be plentiful alternative marine habitat available for foraging activity within the SPA.

The OFFSABC SPA is a marine site that encompasses the subtidal waters in which breeding seabirds from adjacent breeding colony SPAs may forage. Breeding common tern in the SPA, particularly those within the vicinity of the Proposed Development, originate from the colonies at Imperial Dock Lock, Leith SPA and the Forth Islands SPA. Breeding shag, guillemot and herring gull are likely to originate from the Forth Islands SPA. As such, the conclusions of the assessment for those sites (see **Sections 7.3** and **7.4**) are considered to equally apply to the OFFSABC SPA.

As such, it is concluded that predicted disturbance of breeding seabird features and assemblage component species due to piling activity would not have an adverse effect on the integrity of the OFFSABC SPA.

Wintering seabird assemblage

A number of component species of the non-breeding seabird assemblage were present in the baseline data in numbers exceeding 1% of the relevant SPA populations, namely black-headed gull, herring gull, kittiwake, razorbill, guillemot and shag.

In terms of the use of the study area itself, gull species were some of the most abundance species present (particularly herring gull and black-headed gull) and were widely distributed throughout the study area during the 2021/22 baseline survey (see **Appendix 1** for species specific accounts and distribution maps). This included 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 may exceed 70dB (see **Figure 7.1**), though there was no evidence that such areas are preferentially used. There was significant usage of Imperial Dock, where the contour plot shown in **Figure 7.2** indicates baseline maximum noise levels are comparable to the predicted noise levels from the proposed piling. Gulls within the Port are therefore predicted to be tolerant to relatively high levels of anthropogenic disturbance; indeed 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).

Razorbill and guillemot were present offshore in reasonably large numbers only during the post-breeding season. As described in **Section 7.4.4.1**, post-breeding birds would not be constrained by the need to return to a nest hence alternative marine habitat is available throughout the Firth of Forth and the wider SPA.

Given that all non-breeding seabird features / assemblage component species are present during the non-breeding season, they are not confined in their foraging range by the need to return to a specific breeding or roost site. As noted above, the extent to which noise-related disturbance from piling activity may lead to high to moderate behavioural responses such as displacement would represent a tiny proportion (less than 0.5%) of the overall SPA, therefore adequate alternate resources are available. Following completion of the piling activity, baseline noise levels are expected to be restored and foraging activity in affected areas would resume. The piling duration (5 to 5.5 months) would overlap with a maximum of one non-breeding season.

It is concluded that predicted disturbance of non-breeding seabird features and assemblage component species due to piling activity would not have an adverse effect on the integrity of the OFFSABC SPA.

Wintering waterfowl assemblage

Of the waterfowl species that are qualifying non-breeding features of the SPA (or are named components of the non-breeding assemblage), goldeneye, red-breasted merganser, velvet scoter and eider were recorded in numbers exceeding 1% of the relevant SPA populations.

Red-breasted merganser and velvet scoter were observed only in marine habitats throughout the survey area. Given the very small proportion of the SPA affected by noise disturbance during the piling works, it is expected that these species could readily forage elsewhere within close proximity, and would be able to return to affected areas following completion of the piling works.

Goldeneye and eider both demonstrated notable usage of the Port during the 2021/22 baseline surveys (see **Appendix 1** for distribution maps and species-specific accounts). Goldeneye have been discussed in **Section 7.2.4.1**), regarding the Firth of Forth SPA, and the conclusions of that assessment apply here.

Eider were recorded regularly roosting 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 7.1**) would be in excess of 70db L_{Amax} and, at the nearest points, 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 7.2**). 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, and given the duration of the piling works, a maximum of just one non-breeding season would be affected.

Based on the above, it is concluded that predicted disturbance of non-breeding seabird features and assemblage component species due to piling activity would not have an adverse effect on the integrity of the OFFSABC SPA.

7.5.4.2 Loss of habitat

The marine footprint of the Proposed Development slightly overlaps with the SPA, as shown in **Figure 4.1**, though the area in question represents an infinitesimal proportion of the overall area available to seabird and waterbird features within the SPA.

In terms of the local distribution of SPA features within the study area, the distribution maps from the 2021/22 surveys, provided in **Appendix 1**, indicate no particular reliance on the affected area by features of the SPA, hence alternate marine habitat would be available for foraging / resting elsewhere in the study area.

As such, it is concluded that physical loss of habitat arising from the Proposed Development would not have an adverse effect on the integrity of the Firth of Forth SPA / Ramsar Site.

7.5.4.3 Water quality effects

All features

Significant increases in SSC would not extend beyond the entrance to the Port (i.e. the immediate vicinity of the dredging activity; see **Figure 6.1**) during dredging, nor extensively beyond the limits of the disposal site during disposal activity (see **Figure 6.2**). This would represent a very small proportion (less than 0.1%) of the marine area within the SPA, hence the consequent loss of foraging habitat in the SPA as a whole would be *de minimis*.

As noted in **Section 7.2.4.3** (regarding Firth of Forth SPA), waterbirds and seabirds recorded during the 2021/22 surveys showed no particular reliance on the affected area within the study area for foraging, hence would be able to use alternate habitat within and outside of the study area.

Dredging activities will operate on a 24/7 basis during the campaign; however, given the campaign will last around four months the temporal magnitude of the effect would be short-term and would overlap with no more than one non-breeding season. Following completion, baseline SSC would be restored across the affected area and there would be no long-term effect on foraging capability.

Based on the above, it is concluded that the indirect effects that changes in water quality may have on foraging seabirds and waterbirds during dredging activity would not have an adverse effect on the integrity of the OFFSABC SPA.

8 Appropriate Assessment: Marine Mammals

8.1 Approach to Assessment

8.1.1 Data Sources

A number of publicly available datasets and information on marine mammals in the area were used and included in the baseline review and assessment of effects. These are listed in **Table 8.1**.

Table 8.1 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.
Management Units (MUs) for cetaceans in UK waters (IAMMWG, 2021).	2021	UK waters	Provides information on cetacean MUs for the proposed offshore development area.
Abundance estimation and movements of bottlenose dolphin along the east coast of Scotland (Arso Civil et al., 2021)	2009-2019	East coast, Scotland	Provides abundance estimates for bottlenose dolphin on the east coast.
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.

8.1.2 Overview of Effect Pathways Screened In

As described in **Section 4.2.3.2**, the potential effects on marine mammals considered during the construction phase are:

- Potential for auditory injury and / or behavioural effects from underwater noise during piling;
- Potential for auditory injury and / or behavioural effects from underwater noise during dredging works;
- Any changes to water quality;
- Any changes in prey availability; and
- In-combination effects.

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 effects as a result of the presence of construction vessels (including 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 effect to the sites. Therefore, the potential for any effect from vessels is screened out of further assessment.

There is not expected to be any significant change, through operation, compared to the existing activity levels at the Port of Leith; therefore, it is not expected that there would be any potential to effect marine mammals during the operational phase, and all operational impacts have been screened out of further assessment.

8.1.2.1 Underwater Noise Effects

Underwater Noise Modelling

The underwater noise modelling report is provided in **Appendix 2**, and an assessment of the predicted effects on marine fauna (namely marine mammals and fish species) is provided in **Appendix 3**.

Potential for Effects from Underwater Noise during (Tubular) Impact 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 in very close proximity to the piling sound source, the high peak pressure sound levels have the potential to cause 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. 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). Pinnipeds use sound both in air and water for social and reproductive interactions (Southall *et al.,* 2007), but not for finding prey. Therefore, Thompson *et al.,* (2012) suggest damage to hearing in pinnipeds may not be as sensitive as it could be in cetaceans. The effect would be permanent and marine mammals within the potential impact area are considered to have very limited capacity to avoid such effects, and unable to recover from the effects.

Potential for PTS onset during Tubular (Impact) Piling

The underwater noise modelling results for the potential for PTS in bottlenose dolphin, grey seal and harbour seal are presented in **Table 8.2**.

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 8.2 Impact ranges and areas that could be at risk of PTS from tubular (impact) piling

Potential Impact	Receptor	Impact range	Impact Area
PTS without mitigation – single strike	Bottlenose dolphin	<50m	<0.01km2
	Grey seal	<50m	<0.01km2
	Harbour seal	<50m	<0.01km2

Potential Impact	Receptor	Impact range	Impact Area
PTS without mitigation – cumulative exposure	Bottlenose dolphin	<100m	<0.1km2
	Grey seal	<100m	<0.1km2
	Harbour seal	<100m	<0.1km2

The impact range for bottlenose dolphin, grey seal, and harbour seal, due to a single strike of tubular (impact) piling is less than 50m (**Table 8.2**). 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 less than 100m (**Table 8.2**). This takes into account the anticipated soft-start and ramp-up procedure as per JNCC (2010).

It should be noted that the 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 during Tubular (Impact) Piling

The underwater noise modelling results for the potential for TTS in bottlenose dolphin, grey seal and harbour seal are presented in **Table 8.3**.

As for PTS, the range for cumulative SEL 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 8.3 Impact ranges and areas for the risk of TTS from tubular (impact) piling

Potential Impact	Receptor	Impact range	Impact area
TTS without mitigation – single strike	Bottlenose dolphin	<50m	<0.01km2
	Grey seal	<50m	<0.01km2
	Harbour seal	<50m	<0.01km2
TTS without mitigation – cumulative exposure	Bottlenose dolphin	<100m	<0.01km2
	Grey seal	<100m	<0.01km2
	Harbour seal	<100m	<0.01km2

The maximum impact range (without mitigation) within which TTS onset could occur due to a single strike, is less than 50m for all other species (**Table 8.3**). The impact range (without mitigation) within which TTS onset could occur from cumulative exposure over 12 hours (up to six hours of piling) is less than 100m for all species (**Table 8.3**).

Potential for disturbance during Tubular (Impact) Piling

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[14] 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 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. Bottlenose dolphins were not 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 bottlenose dolphin can be disturbed from a very localised area, and for a short-period of time.

Potential for Effects from Underwater Noise during Sheet (Vibro) Piling

Potential for PTS and TTS onset during Sheet Piling

The potential underwater noise impact ranges and areas for bottlenose dolphin grey seal and harbour seal, for PTS or TTS onset, as a result of underwater noise during sheet-piling activities, are shown in **Table 8.4**. The modelling assumes up to 12 hours of sheet piling could be undertaken per day.

Table 8.4 Impact ranges and areas for the potential for PTS or TTS onset as a result of underwater noise associated with sheet piling activities

Potential Impact	Receptor	Impact range	Impact area
PTS without mitigation – cumulative exposure (over 12 hours)	Bottlenose dolphin	<100m	0.03km^2
	Grey seal	<100m	0.03km^2
	Harbour seal	<100m	0.03km^2
TTS without mitigation – cumulative exposure (over 12 hours)	Bottlenose dolphin	<100m	0.03km^2
	Grey seal	<100m	0.03km^2
	Harbour seal	<100m	0.03km^2

The maximum impact range (without mitigation) within which either PTS or TTS onset could occur due to cumulative exposure from sheet piling is less than 100m for all other species (**Table 8.4**).

Potential for disturbance during sheet piling

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

[14] 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.

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 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. Bottlenose dolphins were not excluded from the area as a result of the piling, but fine-scale changes in the local abundance were detected, and dolphins were present in the area less often when impact vibro-piling was occurring, compared to when no activity was occurring (Graham *et al*., 2017). As for impact piling, this indicates that bottlenose dolphin can be disturbed, but from a very localised area, and for a short-period of time.

Mitigation for Piling Works

Mitigation will be undertaken for all piling works at the Proposed Development (for both tubular and sheet piling), in accordance with the best practice guidance for minimising the risk of injury to marine mammals from piling noise provided by the JNCC (2010).

Mitigation will 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 will 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, as per JNCC (2010).
- 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.

Potential for Effect from Underwater Noise during Dredging Activities

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 Hopper Dredger (TSHD) 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).

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.

Potential for PTS and TTS onset during Dredging Activities

The potential impact range and areas, due to dreading, for bottlenose dolphin, grey seal and harbour seal are shown in **Table 8.5**. 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 or TTS onset as per the Southall *et al*. (2019) threshold criteria.

Table 8.5 Impact ranges and areas, for potential PTS and TTS onset as a result of underwater noise associated with dredging activities

Potential Impact	Receptor	Impact range	Impact area)
PTS without mitigation – cumulative exposure (over 12 hours)	Bottlenose dolphin	<100m	0.03km^2
	Grey seal	<100m	0.03km^2
	Harbour seal	<100m	0.03km^2
TTS without mitigation – cumulative exposure (over 12 hours)	Bottlenose dolphin	<100m	0.03km^2
	Grey seal	<100m	0.03km^2
	Harbour seal	<100m	0.03km^2

Potential for Disturbance during Dredging Activities

McQueen *et al.* (2020) found that habitat avoidance was not at a sufficient spatial scale to pose risks seals, in the context of activity in dredging areas (adjacent to navigation channels and port infrastructure areas)[15]. The unweighted 140 dB re 1 µPa SPL generic threshold level for behavioural avoidance of pinnipeds in water is exceeded at distances up to approximately 400m from the dredge (McQueen e*t al.,* 2020).

[15] *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*

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.

8.1.2.2 Indirect Effects

The potential for indirect effects to marine mammals include effects due to potential changes in water quality, and changes in prey availability.

Potential for Changes to Water Quality

Potential changes in water quality during construction could occur through:

- Increase in SSC in water body due to dredging and disposal;
- Potential release of historic contamination in sediments during dredging and disposal; and,
- Accidental spills or leaks from construction plant or vessels.

Any direct effects 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 effects via prey species.

Potential increase in suspended sediment concentrations

An increase in SSC 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.

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 because other senses are utilised, and vision is not relied upon solely.

Potential release of historic contamination in sediments during dredging and disposal

Samples of sediments at the dredging site found contaminants slightly exceeding MS AL1 some trace metals and polycyclic aromatic hydrocarbons, however, did not identify any contaminants above MS AL2 (full details of sediment chemical analysis is provided in the accompanying EIA Report for the Proposed Development). The modelling indicates that the higher concentrations of sediment in the disposal sediment plume would be restricted to a small area within the disposal area, with lower concentrations (less than 10mg/l) extending beyond the boundaries of the Proposed Development. The disposal activities would be intermittent over the dredging campaign, and modelling has indicated that background SSC levels would be restored between each disposal event. Due to this rapid dispersal rate and the low levels of contamination in the material to be disposed, a decline in water quality at the disposal site is not anticipated.

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 in a sea, means that any potential for changes to water quality are insignificant.

Accidental spills or leaks from construction plant or vessels

During construction there is a risk of accidental spill or leaks affecting the water environment (i.e. coastal waters and sediment) from the following sources:

- Oils and fuels stored on site;
- Construction and refuelling machinery or site vehicles; and
- Concrete and cement in construction works.

The effect of the potential spill and leaks incidences during construction on water quality would be dependent on the scale and nature of the incident. Adherence to the proposed methodologies and standard best practice measures described in **Section 2.2**, supported by a Construction and Environmental Management Plan, the potential for accidental spill or leaks is considered to be low, and therefore there to be no risk to marine mammals.

Potential for Changes to Prey Availability

As outlined in **Section 6.1.2**, the potential impacts on fish species during construction can result from:

- Generation of underwater noise from piling operations, which could have physiological and/or behavioural response impacts; and
- In-direct effects due to changes to water quality (e.g., increased suspended sediment).

Bottlenose dolphin are opportunistic feeders, feeding on wide range of prey species and have large foraging ranges (see **Section 8.5.3.2**) and are therefore not considered to be sensitive to changes in prey resources.

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 **Sections 8.2.3.3** and **8.3.3.2**). As for bottlenose dolphin, grey seal and harbour seal are not considered to be sensitive to changes in prey resources.

Potential for Underwater Noise Effects on Fish (Prey) Species

A full assessment of underwater noise impacts to fish species is included in **Appendix 3** and the accompanying EIA Report for the Proposed Development.

Underwater noise from piling and dredging activities during construction may injure, disturb and displace prey species. If the abundance and / or availability of prey is reduced through displacement or mortality arising from underwater noise, this could adversely affect marine mammal receptors.

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 or vibro-piling.

Evidence of the effects of underwater noise from the proposed piling on fish is described in **Appendix 3**. For all fish species, potential mortal injury could only occur in a very limited range (less than 100m) of the source, and the mitigations for marine mammals as outlined in **Section 8.1.2.1**, would allow for fish species to vacate the area before full hammer energy was achieved. 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 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.

Given the above, and based on the short-term nature of the effect, it is concluded that there would not be a significant reduction in prey availability, and, as noted above for water quality changes, marine mammal species are able to prey upon a wide range of species, and therefore a small and localised displacement effect would not have a significant effect on any marine mammal within the vicinity of the Proposed Development.

Potential for In-Direct Effects on Prey Availability due to Changes in Water Quality

As described in full detail in the accompanying EIA Report, dredging of fine material during the construction phase of the Proposed Development would result in a temporary increase in SSC, which has the potential to impact upon prey species, including behavioural responses, such as temporary displacement of those species from the affected range. This in turn has the potential to affect marine mammal species that feed on such resources.

The extent of the sediment plume predicted from the proposed dredging (and subsequent disposal) is described in detail in the EIA Report and is summarised in **Figure 6.1** and **Figure 6.2**. 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.

Dredging activities will operate on a 24/7 basis during the campaign; however, given the campaign will last around four months, the temporal magnitude of the effect would be short-term and temporary.

The potential for significant effects to prey species due to increased SSC is unlikely, given the very localised and temporary nature of the potential effect, and this, alongside the foraging ability of marine mammals, indicates a very low risk of any effect to the availability of prey species.

Any trace contaminants would be bound to fine particles and would only be present within the sediment plume itself. As noted above, analysis of the sediment present in the dredge area indicates that contaminant levels within the sediment are low enough that disposal of such sediment would not pose a significant risk to fish (prey species).

8.1.2.3 In-combination Effects

The initial screening for in-combination effects and projects is included in **Section 4.3**. Other projects and effect pathways taken forward for in-combination assessment are summarised in **Table 8.6**.

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 in-combination project screened in, with relevant potential effects for marine mammals, is the Grangemouth Flood Protection Scheme, at 30km from the Proposed Development, the following in-combination assessment will focus on the potential for in-combination underwater noise effects only. In addition, as each project is required to provide mitigation for any potential for PTS onset, there is no potential for PTS onset at the Proposed Development (as all potential PTS will be mitigated for). Therefore, the following underwater noise assessment will include the potential for TTS onset and disturbance only.

Table 8.6 Summary of in-combination projects, effects, and designated sites (for marine mammals) taken forward for assessment

<table>
<tr><th>Project</th><th>Screened in for further consideration (and reasoning)</th><th>Marine mammal designated site/s screened in for</th><th>Potential effects to be considered</th></tr>
<tr><td>Nigg Energy Park East Quay</td><td>Yes – potential for overlap in construction timeframes</td><td rowspan="4">Bottlenose dolphin; Moray Firth SAC</td><td rowspan="7">TTS onset and / or disturbance due to underwater noise</td></tr>
<tr><td>NorthConnect HVDC Cable</td><td>Yes – potential for overlap in construction timeframes</td></tr>
<tr><td>Sea Wall Repair and Extension – Alexandra Parade</td><td>Yes – potential for overlap in construction</td></tr>
<tr><td>Ardersier Port Development</td><td>Yes – potential for overlap in construction</td></tr>
<tr><td>Seagreen Alpha and Bravo Offshore Wind Farms (Optimised Project)</td><td>Yes – potential for overlap in construction timeframes</td><td rowspan="3">Bottlenose dolphin; Moray Firth SAC
Grey seal; Isle of May SAC & Berwickshire and North Northumberland Coast SAC
Harbour seal; Firth of Tay and Eden Estuary SAC</td></tr>
<tr><td>Neart na Gaoithe Offshore Wind Farm (Revised Design)</td><td>Yes – potential for overlap in construction timeframes</td></tr>
<tr><td>Grangemouth Flood Protection Scheme</td><td>Yes – potential for overlap in construction</td></tr>
</table>

8.2 Isle of May SAC

8.2.1 Description of Designation

The Isle of May SAC is located at the entrance to the Firth of Forth, approximately 43km from the Proposed Development. This site supports a breeding colony of grey seal, with the largest east coast breeding colony of grey seals in Scotland, and the fourth-largest breeding colony in the UK (JNCC, 2021).

Grey seals haul-out on land to rest, moult, and breed. Foraging trips can last between one and 30 days, and usually occurs within 100km of their haul-out site, although individuals have been reported to travel up to several hundred kilometres offshore to forage (SCOS, 2020). In Scotland, grey seal pupping occurs between September and December, with the moult occurring between December and April the following year (Hague *et al.,* 2020).

Tagging studies of grey seal within UK waters have been undertaken since 1988, with a total of 285 individuals tracked within Scottish waters. These studies show that there is connectivity with the Proposed Development and the Isle of May Coast SAC, with individuals travelling from the SAC through the Firth of Forth, and near to the Proposed Development (Hague *et al.,* 2020).

8.2.2 Conservation Objectives

The Isle of May SAC Conservation Objectives for grey seal are:

- To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features; and,
- To ensure for the qualifying species that the following are maintained in the long term:
    - Population of the species as a viable component of the site
    - Distribution of the species within site

- Distribution and extent of habitats supporting the species
- Structure, function and supporting processes of habitats supporting the species
- No significant disturbance of the species

Grey seal within the Isle of May SAC are in favourable condition.

8.2.3 Features Screened In

Grey seal are the only feature screened in for further assessment.

8.2.3.1 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 worlds 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 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 5x5 km 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 5 km x 5 km 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 5 km x 5 km 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% Confidence Interval (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 will be used for the assessments, to ensure that the wider population is considered for the impact assessments. The reference population extent for grey seal will therefore incorporate both the East Scotland MU and the Moray Firth MU (IAMMWG, 2013; SCOS, 2020). Assessments will be made against the East Scotland MU (as is the one within the Proposed Development lies), and against the Moray Firth and East Scotland MU together. The reference population for these areas are as follows:

- East Scotland (ES) MU = 3,683 grey seal (SCOS, 2020)
- Moray Firth (MF) MU = 1,657 grey seal (SCOS, 2020)

8.2.3.2 Haul-out sites

Grey seal pup production at the Isle of May SAC has been relatively stable since the late 1990s, with approximately 2,000 pups born each year (SCOS, 2020). Approximately 2,050 recorded in 2010 (Russell *et al*., 2019), and approximately 2,300 in 2014 (SCOS, 2016). Based on the grey seal count of 2008-2017, the overall abundance in the east coast of Scotland is estimated to be 3,683 (SCOS, 2020).

8.2.3.3 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 *Ammodytes sp*., whitefish (such as cod *Gadus morhua*, haddock *Melanogrammus aeglefinus*, whiting *Merlangius merlangus* 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).

8.2.4 Potential Effects of the Proposed Development Alone

8.2.4.1 Underwater Noise Effects

Underwater Noise from Piling Activities

Potential for PTS or TTS onset from Piling Activities

As noted above, the most recent count of grey seal at the Isle of May SAC was approximately 2,300 in 2014 (SCOS, 2016). The potential for tubular piling effects on grey seal have been put into context of this SAC population, as well as the wider reference populations as described above, using the underwater noise modelling results presented in **Appendix 2**, and the initial assessments of underwater noise effects as presented in **Appendix 3**. The results of this assessment are provided in **Table 8.7**.

Table 8.7 Impact ranges and areas, and maximum number of individuals (and % of reference population) that could be at risk of PTS or TTS onset from tubular (impact) and sheet (vibro) piling

Piling Activity	Potential Impact	Receptor	Impact range (and area)	Maximum number of individuals (% of reference population)
Tubular (impact) piling	PTS without mitigation – single strike	Grey seal	<50m <0.01km^2	0.01 grey seal (0.0005% of the Isle of May (IoM) SAC population; 0.0003% of the ES MU; or 0.0002% of the ES & MF MUs)

Piling Activity	Potential Impact	Receptor	Impact range (and area)	Maximum number of individuals (% of reference population)
	PTS without mitigation – cumulative exposure	Grey seal	<100m <0.1km^2	0.11 grey seal (0.005% of the IoM SAC population; 0.003% of the ES MU; or 0.002% of the ES & MF MUs)
	TTS without mitigation – single strike	Grey seal	<50m <0.01km^2	0.01 grey seal (0.0005% of the IoM SAC population; 0.0003% of the ES MU; or 0.0002% of the ES & MF MUs)
	TTS without mitigation – cumulative exposure	Grey seal	<100m <0.1km^2	0.11 grey seal (0.005% of the IoM SAC population; 0.003% of the ES MU; or 0.002% of the ES & MF MUs)
Sheet (vibro) piling	PTS without mitigation – cumulative exposure (over 12 hours)	Grey seal	<100m 0.03km^2	0.03 grey seal (0.0015% of the IoM SAC population; 0.0009% of the ES MU; or 0.0006% of the ES & MF MUs)
	TTS without mitigation – cumulative exposure (over 12 hours)	Grey seal	<100m 0.03km^2	0.03 grey seal (0.0015% of the IoM SAC population; 0.0009% of the ES MU; or 0.0006% of the ES & MF MUs)

The number of grey seal at potential risk of either PTS or TTS onset, as a result of piling activity, is less than 0.2 (up to a maximum of 0.11 individuals in all cases), with a maximum population level effect of up to 0.005% of the Isle of May SAC being affected (**Table 8.7**). It should be noted that assuming all individuals will be from the Isle of May SAC is over-precautionary, and it is more likely that the grey seal that may be present in the vicinity of the Proposed Development, are from haul-out sites closer to the site, taking into account the distance to the Isle of May SAC (of 43km). In addition, mitigation measures will be in place for all piling works, as described in **Section 8.1.2.1**.

Therefore, given the very low number of individuals at risk of effect from either PTS or TTS onset, and that the Isle of May SAC is not located within close proximity of the Proposed Development, and the mitigation measures that will be put in place for all piling activities, it is concluded that **there would be no potential for adverse effect on the integrity of grey seal, as a designated feature of the Isle of May SAC, due to underwater noise effects from piling works**.

Potential for Disturbance from Piling Activities

While there is the potential for a displacement response from the area for grey seal, it is expected that they would return once the activity has been completed, and therefore any effects from underwater noise as a result of piling will be both localised and temporary. The area surrounding the Port of Leith is already a busy marine area, and any seals in the vicinity of the Proposed Development would be used to increased levels of marine traffic and noisy environments. Given the busy nature of the area, that the piling works will be small in scale and temporary, any potential for disturbance would be localised, and would be unlikely to cause any significant disturbance to grey seal in the area, there is unlikely to be the potential for any significant effect on grey seal, as a result of piling activity.

Taking into account the above, including the limited potential for a disturbance effect on any grey seal, and that the Isle of May SAC is not located within close proximity of the Proposed Development, it is concluded that **there would be no potential for adverse effect on the integrity of grey seal, as a designated feature of the Isle of May SAC, due to underwater noise effects from piling works**.

Underwater Noise from Dredging Activities

Potential for PTS or TTS onset from Dredging Activities

The potential for underwater noise effects on grey seal due to dredging activities have been put into context of Isle of May SAC population, as well as the wider reference populations as described above, using the underwater noise modelling results presented in **Appendix 2**, and the initial assessments of underwater noise effects as presented in **Appendix 3**. The results of this assessment are provided in **Table 8.8**.

Table 8.8 Impact ranges and areas, and maximum number of individuals (and % of reference population) that could be at risk of PTS or TTS onset due to dredging activities

Piling Activity	Potential Impact	Receptor	Impact range (and area)	Maximum number of individuals (% of reference population)
Dredging	PTS without mitigation – cumulative exposure (over 12 hours)	Grey seal	<100m 0.03km^2	0.03 grey seal (0.0015% of the IoM SAC population; 0.0009% of the ES MU; or 0.0006% of the ES & MF MUs)
	TTS without mitigation – cumulative exposure (over 12 hours)	Grey seal	<100m 0.03km^2	0.03 grey seal (0.0015% of the IoM SAC population; 0.0009% of the ES MU; or 0.0006% of the ES & MF MUs)

The number of grey seal at potential risk of either PTS or TTS onset, as a result of dredging, is less than 0.1 (0.03 individuals), with a maximum population level effect of up to 0.0015% of the Isle of May SAC being affected (**Table 8.8**). As for the assessment for piling above, assuming all individuals will be from the Isle of May SAC is over-precautionary, and it is more likely that the grey seal that may be present in the vicinity of the Proposed Development, are from haul-out sites closer to the site, taking into account the distance to the Isle of May SAC (of 43km).

Therefore, given the very low number of individuals at risk of effect from either PTS or TTS onset, and that the Isle of May SAC is not located within close proximity of the Proposed Development, it is concluded that **there would be no potential for adverse effect on the integrity of grey seal, as a designated feature of the Isle of May SAC, due to underwater noise effects from piling works**.

Potential for Disturbance from Dredging Activities

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 individuals returning to the area shortly after the sound source is stopped, or on completion of the works. As noted for piling, the area surrounding the Port of Leith is a busy marine area, and any seals present in the area would be used to increased levels of underwater noise. Given the busy nature of the area, that the dredging works will be small in scale and temporary, any potential for disturbance would be localised, and that it is unlikely to cause any significant disturbance to grey seal in the area, it is unlikely that there would be any potential for any significant effect on grey seal, as a result of dredging activity.

Taking into account the above, including the limited potential for a disturbance effect on any grey seal, and that the Isle of May SAC is not located within close proximity of the Proposed Development, it is concluded that **there would be no potential for adverse effect on the integrity of grey seal, as a designated feature of the Isle of May SAC, due to underwater noise effects from dredging activities**.

8.2.4.2 In-direct Effects

Potential for In-direct Effects as a Result of Changes to Water Quality

The potential for indirect effect to grey seal from changes to water quality would be from any increase in SSC, the release of contaminated sediments through dredging, and accidental spills and leaks. As described in **Section 8.1.2.2**, none of the potential effects noted above would have the potential for any significant effect on grey seal, and therefore, **there would be no potential for adverse effect on the integrity of grey seal, as a designated feature of the Isle of May SAC, due to a change in water quality**.

Potential for Indirect Effects as a Result of Changes to Prey Availability

The potential for effects to fish (marine mammal prey species) are described in **Section 8.1.2.2**.

Grey seal are generalist feeders, and therefore any small scale and temporary changes in prey availability would have no effect on the grey seal ability to forage in the area. As described above, all effects to fish (prey species) would be over a localised area and would be temporary only. There are no significant effects identified for fish (prey species). Therefore, **there would be no potential for adverse effect on the integrity of grey seal, as a designated feature of the Isle of May SAC, due to a change in prey availability.**

8.2.5 Potential effects of the Proposed Development in combination with other projects

The potential for in-combination effects have been assessed in **Table 8.9**. In summary, there is no potential for significant effect to bottlenose dolphin, as a result of any other project screened in, in-combination with the Proposed Development. Therefore, **there would be no potential for adverse effect on the integrity of grey seal, as a designated feature of the Isle of May SAC, due to in-combination effects.**

Table 8.9 In-combination assessment for grey seal at the Isle of May SAC

In-combination project	In-combination Project Information	Proposed Development Assessment		In-combination Project Assessment		Overall In-Combination Assessment
		Potential Effect	Assessment	Potential Effect	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[16]. 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)	0.11 grey seal (0.005% of the IoM SAC population; 0.003% of the ES MU; or 0.002% of the ES & MF MUs). No potential for adverse effect.	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[17]. This is significantly higher than the expected hammer energy of 280kJ at the Proposed Development.	The potential for TTS onset has not been assessed.	An in-combination assessment of TTS is not possible.
		Disturbance effects	Localised and temporary effect only, no potential for significant level of disturbance to any individuals. No potential for adverse effect.	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, in-combination with the low number of grey seal that may be disturbed as a result of the piling activities at Seagreen Alpha and Bravo, and that it is unlikely that all grey seal in the vicinity of the project would be from the Isle of May SAC, it is concluded that there is unlikely to be any significant effect to grey seal, and therefore there is **no potential for adverse effect on the integrity of the site**.
Neart na Gaoithe Offshore Wind Farm (Revised Design)	The Neart na Gaoithe wind farm is currently under construction. There is therefore the potential for	TTS (highest potential impact range of 100m for TTS cumulative exposure due to sheet piling used as the worse-case)	0.11 grey seal (0.005% of the IoM SAC population; 0.003% of the ES MU; or 0.002% of the ES & MF MUs). No potential for adverse effect.	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 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	Due to the temporary nature of the piling at the Proposed Development, and that any effect to grey seal at Neart na Gaoithe would be temporary, and that it is unlikely that all grey seal in the vicinity of the projects would be from the Isle of May SAC, it is concluded that there is unlikely to be any significant effect to grey seal within the Isle of May SAC, and therefore there

[16] https://marine.gov.scot/sites/default/files/seagreen_s36c_application_screening_report.pdf
[17] https://marine.gov.scot/sites/default/files/chapter_10_marine_mammals.pdf

In-combination project	In-combination Project Information	Proposed Development Assessment		In-combination Project Assessment		Overall In-Combination Assessment
		Potential Effect	Assessment	Potential Effect	Assessment	
	piling to overlap with the piling at the Proposed Development.				the area, and the duration of potential exposure would be low, and therefore was concluded that there would not be a significant impact.	is **no potential for adverse effect on the integrity of the site**.
		Disturbance effects	Localised and temporary effect only, no potential for significant level of disturbance to any individuals. No potential for adverse effect.	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, in-combination with the low number of grey seal that may be disturbed as a result of the piling activities at Neart na Gaoithe, and that it is unlikely that all grey seal in the vicinity of the project would be from the Isle of May SAC, it is concluded that there is unlikely to be any significant effect to grey seal, and therefore there is **no potential for adverse effect on the integrity of the site**.
Grangemouth Flood Protection Scheme	To date, only the EIA Scoping report is available, and no formal application for the scheme has been submitted. Within the EIA Scoping Report[18], it is stated that construction would be undertaken	TTS (highest potential impact range of 100m for TTS cumulative exposure due to sheet piling used as the worse-case)	0.11 grey seal (0.005% of the IoM SAC population; 0.003% of the ES MU; or 0.002% of the ES & MF MUs). No potential for adverse effect.	N/A		While an in-combination assessment for this project is not possible, it is expected that, due to the planned activities, any potential effects would be less than those of the Proposed Development, and given the expected localised and temporary nature of any effects, there is no potential for significant in-combination effect to grey seal, and therefore **no potential for adverse effect on the integrity of the site**.
		Disturbance effects	Localised and temporary effect only, no potential for significant level of disturbance to any individuals. No potential for adverse effect.			

[18] https://marine.gov.scot/sites/default/files/grangemouth_fps_eia_scoping_report_final_for_submission.pdf

In-combination project	In-combination Project Information	Proposed Development Assessment		In-combination Project Assessment		Overall In-Combination Assessment
		Potential Effect	Assessment	Potential Effect	Assessment	
	from 2022, for a period of between five and 10 years. However, given that no formal application has been submitted, it is considered unlikely that the construction of this flood protection scheme would overlap with the Proposed Development.					

8.3 Firth of Tay and Eden Estuary SAC

8.3.1 Description of Designation

The Firth of Tay and Eden Estuary SAC supports a nationally important breeding colony of harbour seal, which form part of the east coast population of seals that typically utilise sandbanks.

Harbour seal haul-out on land to rest, breed, and moult, with the core pupping period being between June and July. Harbour seal generally take foraging trips of between 30km and 50km, however, movements of harbour seal vary among individuals, and have reported foraging trips of up to 200km (Lowry *et al.,* 2001; Sharples *et al.,* 2012).

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

8.3.2 Conservation Objectives

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

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

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

8.3.3 Features Screened In

Harbour seal are the only feature screened in for further assessment.

8.3.3.1 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 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 5 km x 5 km 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:

- ES MU = 343 harbour seal (SCOS, 2020).
- MF 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.

The latest harbour seal count (from 2019) in the Firth of Tay and Eden Estuary SAC was 41 (SCOS, 2020), and the population in this site has been in decline since the 2000s; the 1990 to 2002 count within the SAC was 641 (Hague *et al.,* 2020), compared to the current site of 41. The count of harbour seal within the SAC has been stable, at between 29 and 60, since 2013 (**Plate 8.1**; SCOS, 2020). While there is some connectivity of individuals from the Firth of Tay and Eden Estuary SAC within the wider area, this SAC population is the most isolated harbour seal SAC population in Scotland, with the majority of individuals staying within close proximity of the SAC. Only a small proportion of the wider East Scotland population are associated with haul-out sites within the Firth of Tay and Eden Estuary SAC (**Plate 8.1**; SCOS, 2020).

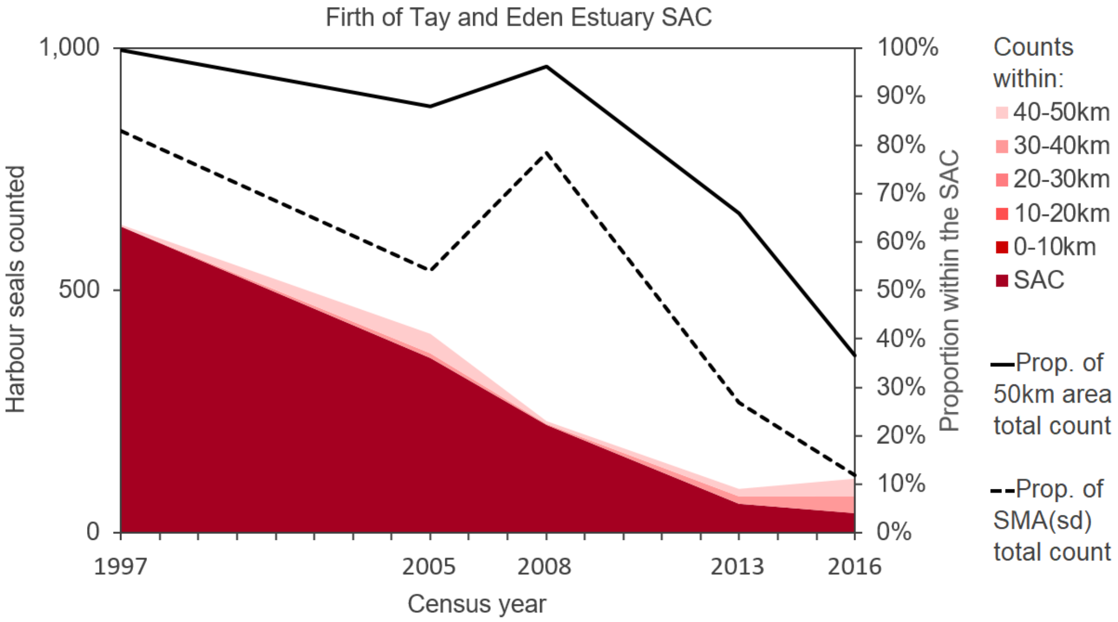

Plate 8.1 Harbour seal counts in the Firth of Tay and Eden Estuary SAC, and up to 50km from the SAC. The dotted black line shows the SAC count as a proportion of the total count for East Scotland MU (SCOS, 2020).

8.3.3.2 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 30km-45km in the Moray Firth (Tollit *et al.,* 1998; Thompson and Miller 1990). Telemetry studies indicate that the tracks of tagged harbour seals have a more coastal distribution than grey seals and do not travel as far from haul-outs.

8.3.4 Potential Effects of the Proposed Development Alone

8.3.4.1 Underwater Noise Effects

Underwater Noise from Piling Activities

Potential for PTS or TTS onset from Piling Activities

As noted above, the most recent count of harbour seal at the Firth of Tay and Eden Estuary SAC was approximately 41 in 2019 (SCOS, 2020). The potential for tubular piling effects on harbour seal have been put into context of this SAC population, as well as the wider reference populations as described above, using the underwater noise modelling results presented in **Appendix 2**, and the initial assessments of underwater noise effects as presented in **Appendix 3**. The results of this assessment are provided in **Table 8.10**.

Table 8.10 Impact ranges and areas, and maximum number of individuals (and % of reference population) that could be at risk of PTS or TTS onset from tubular (impact) and sheet (vibro) piling

Piling Activity	Potential Impact	Receptor	Impact range (and area)	Maximum number of individuals (% of reference population)
Tubular (impact) piling	PTS without mitigation – single strike	Harbour seal	<50m <0.01km2	0.0034 harbour seal (0.008% of the Firth of Tay and Eden Estuary (FT & EE) SAC; 0.00098% of the ES MU; 0.0002% of the ES & MF MUs)

Piling Activity	Potential Impact	Receptor	Impact range (and area)	Maximum number of individuals (% of reference population)
	PTS without mitigation – cumulative exposure	Harbour seal	<100m <0.1km^2	0.0034 harbour seal (0.08% of FT & EE SAC; 0.0098% of the ES MU; 0.002% of the ES & MF MUs)
	TTS without mitigation – single strike	Harbour seal	<50m <0.01km^2	0.0034 harbour seal (0.008% of FT & EE SAC; 0.00098% of the ES MU; 0.0002% of the ES & MF MUs)
	TTS without mitigation – cumulative exposure	Harbour seal	<100m <0.1km^2	0.034 harbour seal (0.08% of FT & EE SAC; 0.0098% of the ES MU; 0.002% of the ES & MF MUs)
Sheet (vibro) piling	PTS without mitigation – cumulative exposure (over 12 hours)	Harbour seal	<100m 0.03km^2	0.01 harbour seal (0.026% of FT & EE SAC; 0.003% of the ES MU; 0.0007% of the ES & MF MUs)
	TTS without mitigation – cumulative exposure (over 12 hours)	Harbour seal	<100m 0.03km^2	0.01 harbour seal (0.026% of FT & EE SAC; 0.003% of the ES MU; 0.0007% of the ES & MF MUs)

The number of harbour seal at potential risk of either PTS or TTS onset, as a result of piling activity, 0.01 or less in all cases, with a maximum population level effect of up to 0.026% of the Berwickshire and Northumberland Coast SAC being affected (**Table 8.10**). It should be noted that assuming all individuals will be from this site is over-precautionary, and it is more likely that the harbour seal that may be present in the vicinity of the Proposed Development, are from haul-out sites closer to the site, taking into account the distance to the SAC, and that the harbour seal associated with this site are generally more isolated than individuals from other SACs. In addition, mitigation measures will be in place for all piling works, as described in **Section 8.1.2.1**.

Therefore, given the very low number of individuals at risk of effect from either PTS or TTS onset, and that the SAC is not located within close proximity of the Proposed Development, in addition to the mitigation measures that will be put in place for all piling activities, it is concluded that **there would be no potential for adverse effect on the integrity of harbour seal, as a designated feature of the Firth of Tay and Eden Estuary SAC, due to underwater noise effects from piling works**.

Potential for Disturbance from Piling Activities

As for grey seal, while there is the potential for a displacement response from the area for harbour seal, it is expected that they would return once the activity has been completed, and therefore any effects from underwater noise as a result of piling will be both localised and temporary. The area surrounding the Port of Leith is already a busy marine area, and any seals in the vicinity of the Proposed Development would be used to increased levels of marine traffic and noisy environments. Given the busy nature of the area, that the piling works will be small in scale and temporary, any potential for disturbance would be localised, and would be unlikely to cause any significant disturbance to harbour seal in the area, there is unlikely to be the potential for any significant effect on harbour seal, as a result of piling activity.

Taking into account the above, including the limited potential for a disturbance effect on any harbour seal, and that the Firth of Tay and Eden Estuary SAC is not located within close proximity of the Proposed Development, it is concluded that **there would be no potential for adverse effect on the integrity of harbour seal, as a designated feature of the Firth of Tay and Eden Estuary SAC, due to underwater noise effects from piling works**.

Underwater Noise from Dredging Activities

Potential for PTS or TTS onset from Dredging Activities

As for the potential effect of piling, the potential for underwater noise effects on harbour seal due to dredging activities have been put into context of the Firth of Tay and Eden Estuary SAC population, as well as the wider reference populations, using the underwater noise modelling results presented in **Appendix 2**, and the initial assessments of underwater noise effects as presented in **Appendix 3**. The results of this assessment are provided in **Table 8.11**.

Table 8.11 Impact ranges and areas, and maximum number of individuals (and % of reference population) that could be at risk of PTS or TTS onset due to dredging activities

Piling Activity	Potential Impact	Receptor	Impact range (and area)	Maximum number of individuals (% of reference population)
Dredging	PTS without mitigation – cumulative exposure (over 12 hours)	Harbour seal	<100m	0.01 harbour seal (0.026% of FT & EE SAC; 0.003% of the ES MU; 0.0007% of the ES & MF MUs)
	TTS without mitigation – cumulative exposure (over 12 hours)	Harbour seal	<100m	0.01 harbour seal (0.026% of FT & EE SAC; 0.003% of the ES MU; 0.0007% of the ES & MF MUs)

The number of harbour seal at potential risk of either PTS or TTS onset, as a result of dredging, is up to 0.01 individuals, with a maximum population level effect of up to 0.026% of the Berwickshire and North Northumberland SAC being affected (**Table 8.11**). As for the assessment for piling above, assuming all individuals will be from the Firth of Tay and Eden Estuary SAC is over-precautionary, and it is more likely that the harbour seal that may be present in the vicinity of the Proposed Development, are from haul-out sites closer to the site, taking into account the distance to the site, and the low level of connectivity of individuals from the SAC to the wider area.

Therefore, given the very low number of individuals at risk of effect from either PTS or TTS onset, and that the SAC is not located within close proximity of the Proposed Development, it is concluded that **there would be no potential for adverse effect on the integrity of harbour seal, as a designated feature of the Firth of Tay and Eden Estuary SAC, due to underwater noise effects from piling works**.

Potential for Disturbance from Dredging Activities

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 individuals returning to the area shortly after the sound source is stopped, or on completion of the works. As noted for piling, the area surrounding the Port of Leith is a busy marine area, and any seals present in the area would be used to increased levels of underwater noise. Given the busy nature of the area, that the dredging works will be small in scale and temporary, any potential for disturbance would be localised, and that it is unlikely to cause any significant disturbance to harbour seal in the area, it is unlikely that there would be any potential for any significant effect on harbour seal, as a result of dredging activity.

Taking into account the above, including the limited potential for a disturbance effect on any harbour seal, and that the SAC is not located within close proximity of the Proposed Development, it is concluded that **there would be no potential for adverse effect on the integrity of harbour seal, as a designated feature of the Firth of Tay and Eden Estuary SAC, due to underwater noise effects from dredging activities**.

8.3.4.2 In-direct Effects

Potential for In-direct Effects as a Result of Changes to Water Quality

The potential for indirect effect to harbour seal from changes to water quality would be from any increase in SSC, the release of contaminated sediments through dredging, and accidental spills and leaks. As described in **Section 8.1.2.2**, none of the potential effects noted above would have the potential for any significant effect on harbour seal, and therefore, **there would be no potential for adverse effect on the integrity of harbour seal, as a designated feature of the Firth of Tay and Eden Estuary SAC, due to a change in water quality**.

Potential for In-direct Effects as a Result of Changes to Prey Availability

The potential for effects to fish (marine mammal prey species) are described in **Section 8.1.2.2**, and assessed fully in the accompanying EIA Report for the Proposed Development.

Harbour seal are generalist feeders, and therefore any small scale and temporary changes in prey availability would have no effect on the harbour seal ability to forage in the area. As described above, all effects to fish (prey species) would be over a localised area and would be temporary only. There are no significant effects identified for fish (prey species). Therefore, **there would be no potential for adverse effect on the integrity of harbour seal, as a designated feature of the Firth of Tay and Eden Estuary SAC, due to a change in prey availability.**

8.3.4.3 In-Combination Effects

The potential for in-combination effects have been assessed in **Table 8.12**. In summary, there is no potential for significant effect to bottlenose dolphin, as a result of any other project screened in, in-combination with the Proposed Development. Therefore, **there would be no potential for adverse effect on the integrity of harbour seal, as a designated feature of the Firth of Tay and Eden Estuary SAC, due to in-combination effects.**

Table 8.12 In-combination assessment for harbour seal at the Firth of Tay and Eden Estuary SAC

In-combination project	In-combination Project Information	Proposed Development Assessment		In-combination Project Assessment		Overall In-Combination Assessment
		Potential Effect	Assessment	Potential Effect	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[19]. 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)	0.034 harbour seal (0.08% of FT & EE SAC; 0.0098% of the ES MU; 0.002% of the ES & MF MUs) No potential for adverse effect.	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[20]. This is significantly higher than the expected hammer energy of 280kJ at the Proposed Development.	The potential for TTS onset has not been assessed.	An in-combination assessment of TTS is not possible.
		Disturbance effects	Localised and temporary effect only, no potential for significant level of disturbance to any individuals. No potential for adverse effect.	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, and the unlikelihood of any harbour seal from the Firth of Tay and Eden Estuary SAC being present in the vicinity, in-combination 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 is unlikely to be any significant effect to harbour seal, and therefore there is **no potential for adverse effect on the integrity of the site**.
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 (0.08% of FT & EE SAC; 0.0098% of the ES MU; 0.002% of the ES & MF MUs) No potential for adverse effect.	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	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	Due to the temporary nature of the piling at the Proposed Development, and that any effect to harbour seal at Neart na Gaoithe would be temporary, and that it is unlikely that all harbour seal in the vicinity of the projects would be from the Firth of Tay and Eden Estuary SAC, it is concluded that there

[19] https://marine.gov.scot/sites/default/files/seagreen_s36c_application_screening_report.pdf
[20] https://marine.gov.scot/sites/default/files/chapter_10_marine_mammals.pdf

In-combination project	In-combination Project Information	Proposed Development Assessment		In-combination Project Assessment		Overall In-Combination Assessment
		Potential Effect	**Assessment**	**Potential Effect**	**Assessment**	
				pile driving only (the 'drive only' scenario).	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.	is unlikely to be any significant effect to harbour seal, and therefore there is **no potential for adverse effect on the integrity of the site**.
		Disturbance effects	Localised and temporary effect only, no potential for significant level of disturbance to any individuals. No potential for adverse effect.	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[21].	Due to the localised and temporary nature of the piling at the Proposed Development, in-combination with the conclusion that piling at Neart na Gaoithe would not alter the harbour seal population of the Firth of Tay and Eden Estuary SAC, and that it is unlikely that all harbour seal in the vicinity of the project would be from this SAC, it is concluded that there is unlikely to be any significant effect to harbour seal of the Firth of Tay and Eden Estuary SAC, and therefore there is **no potential for adverse effect on the integrity of the site**.
Grangemouth Flood Protection Scheme	To date, only the EIA Scoping report is available, and no formal application for the scheme has been submitted. Within the EIA Scoping	TTS (highest potential impact range of 100m for TTS cumulative exposure due to sheet piling used as the worse-case)	0.034 harbour seal (0.08% of FT & EE SAC; 0.0098% of the ES MU; 0.002% of the ES & MF MUs)	N/A		While an in-combination assessment for this project is not possible, it is expected that, due to the planned activities, any potential effects would be less than those of the Proposed Development, and given the expected

[21] https://marine.gov.scot/sites/default/files/appropriate_assessment_1.pdf

In-combination project	In-combination Project Information	Proposed Development Assessment		In-combination Project Assessment		Overall In-Combination Assessment
		Potential Effect	Assessment	Potential Effect	Assessment	
	Report[22], it is stated that construction would be undertaken from 2022, for a period of between five and 10 years. However, given that no formal application has been submitted, it is considered unlikely that the construction of this flood protection scheme would overlap with the Proposed Development.		No potential for adverse effect.			localised and temporary nature of any effects, there is no potential for significant in-combination effect to harbour seal, and therefore **no potential for adverse effect on the integrity of the site**.
		Disturbance effects	Localised and temporary effect only, no potential for significant level of disturbance to any individuals. No potential for adverse effect.			

[22] https://marine.gov.scot/sites/default/files/grangemouth_fps_eia_scoping_report_final_for_submission.pdf

8.4 Berwickshire and North Northumberland Coast SAC

8.4.1 Description of Designation

There are two main pup production locations within the Berwickshire and North Northumberland Coast SAC, one at the Farne Islands and one at Fast Castle. In 2010, pup production was estimated to be 1,700 at Fast Castle and 1,500 at the Farne Islands, a total of 3,200 within the SAC as a whole (Russell *et al.,* 2019). Overall, pup production in the SAC is increasing since 2005 (SCOS, 2020). The latest grey seal count for the Northumberland sites was 6,427 in 2018 (SCOS, 2020). Based on the grey seal count of 2008-2017, the overall abundance in the east coast of Scotland is estimated to be 3,683 (SCOS, 2020).

Tagging studies of grey seal within UK waters show that there is connectivity with the Proposed Development and the Berwickshire and North Northumberland Coast SAC, with individuals travelling from the SAC through the Firth of Forth, and near to the Proposed Development (Hague *et al.,* 2020).

The SAC includes a protected grey seal haul-out site at Fast Castle, which is approximately 58km from the Proposed Development.

8.4.2 Conservation Objectives

The Berwickshire and North Northumberland Coast SAC Conservation Objectives for grey seal are:

- To ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the Favourable Conservation Status of its qualifying features, by maintaining or restoring:
    - The extent and distribution of qualifying natural habitats and habitats of the qualifying species
    - The structure and function (including typical species) of qualifying natural habitats
    - The structure and function of the habitats of the qualifying species
    - The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely
    - The populations of each of the qualifying species
    - The distribution of qualifying species within the site

Grey seal within the Berwickshire and North Northumberland Coast SAC are in favourable condition.

8.4.3 Features Screened In

Grey seal are the only feature screened in for assessment. See **Section 8.2.3** above for a description of the grey seal baseline.

8.4.4 Potential Effects of the Proposed Development Alone

8.4.4.1 Underwater Noise Effects

Underwater Noise from Piling Activities

Potential for PTS or TTS onset from Piling Activities

As noted above, the most recent count of grey seal at the Berwickshire and North Northumberland SAC was 6,427 in 2018 (SCOS, 2020). The potential for tubular piling effects on grey seal have been put into context of this SAC population, as well as the wider reference populations as described above, using the underwater noise modelling results presented in **Appendix 2**, and the initial assessments of underwater noise effects as presented in **Appendix 3**. The results of this assessment are provided in **Table 8.13**.

Table 8.13 Impact ranges and areas, and maximum number of individuals (and % of reference population) that could be at risk of PTS or TTS onset from tubular (impact) and sheet (vibro) piling

Piling Activity	Potential Impact	Receptor	Impact range (and area)	Maximum number of individuals (% of reference population)
Tubular (impact) piling	PTS without mitigation – single strike	Grey seal	<50m <0.01km^2	0.01 grey seal (0.0002% of the Berwickshire and North Northumberland Coast (B & NNC) SAC population; 0.0003% of the ES MU; or 0.0002% of the ES & MF MUs)
	PTS without mitigation – cumulative exposure	Grey seal	<100m <0.1km^2	0.11 grey seal (0.002% of the B & NNC SAC population; 0.003% of the ES MU; or 0.002% of the ES & MF MUs)
	TTS without mitigation – single strike	Grey seal	<50m <0.01km^2	0.01 grey seal (0.0002% of the B & NNC SAC population; 0.0003% of the ES MU; or 0.0002% of the ES & MF MUs)
	TTS without mitigation – cumulative exposure	Grey seal	<100m <0.1km^2	0.11 grey seal (0.002% of the B & NNC SAC population; 0.003% of the ES MU; or 0.002% of the ES & MF MUs)
Sheet (vibro) piling	PTS without mitigation – cumulative exposure (over 12 hours)	Grey seal	<100m 0.03km^2	0.03 grey seal (0.0005% of the B & NNC SAC population; 0.0009% of the ES MU; or 0.0006% of the ES & MF MUs)
	TTS without mitigation – cumulative exposure (over 12 hours)	Grey seal	<100m 0.03km^2	0.03 grey seal (0.0005% of the B & NNC SAC population; 0.0009% of the ES MU; or 0.0006% of the ES & MF MUs)

The number of grey seal at potential risk of either PTS or TTS onset, as a result of piling activity, is less than 0.2 (up to a maximum of 0.11 individuals in all cases), with a maximum population level effect of up to 0.002% of the Berwickshire and North Northumberland Coast SAC being affected (**Table 8.13**). It should be noted that assuming all individuals will be from the Isle of May SAC is over-precautionary, and it is more likely that the grey seal that may be present in the vicinity of the Proposed Development, are from haul-out sites closer to the site, taking into account the distance to the SAC (of 58km). In addition, mitigation measures will be in place for all piling works, as described in **Section 8.1.2.1**.

Therefore, given the very low number of individuals at risk of effect from either PTS or TTS onset, and that the Berwickshire and North Northumberland Coast SAC is not located within close proximity of the Proposed Development, and the mitigation measures that will be put in place for all piling activities, it is concluded that **there would be no potential for adverse effect on the integrity of grey seal, as a designated feature of the Berwickshire and North Northumberland Coast SAC, due to underwater noise effects from piling works**.

Potential for Disturbance from Piling Activities

The potential for disturbance to grey seal of the Berwickshire and North Northumberland Coast SAC would as for the assessment of disturbance to grey seal within the Isle of May SAC. Therefore, see **Section 8.2.4.1** for more information on the potential for effect.

In conclusion, as for the Isle of May SAC assessed above, taking into account the limited potential for a disturbance effect on any grey seal, and that the Berwickshire and North Northumberland Coast SAC is not located within close proximity to the Proposed Development, it is concluded that **there would be no**

potential for adverse effect on the integrity of grey seal, as a designated feature of the Berwickshire and North Northumberland Coast SAC, due to underwater noise effects from piling works.

Underwater Noise from Dredging Activities

Potential for PTS or TTS onset from Dredging Activities

The potential for underwater noise effects on grey seal due to dredging activities have been put into context of Berwickshire and North Northumberland Coast SAC population, as well as the wider reference populations as described above, using the underwater noise modelling results presented in **Appendix 2**, and the initial assessments of underwater noise effects as presented in **Appendix 3**. The results of this assessment are provided in **Table 8.14**.

Table 8.14 Impact ranges and areas, and maximum number of individuals (and % of reference population) that could be at risk of PTS or TTS onset due to dredging activities

Piling Activity	Potential Impact	Receptor	Impact range (and area)	Maximum number of individuals (% of reference population)
Dredging	PTS without mitigation – cumulative exposure (over 12 hours)	Grey seal	<100m 0.03km^2	0.03 grey seal (0.0005% of the B & NNC SAC population; 0.0009% of the ES MU; or 0.0006% of the ES & MF MUs)
	TTS without mitigation – cumulative exposure (over 12 hours)	Grey seal	<100m 0.03km^2	0.03 grey seal (0.0005% of the B & NNC SAC population; 0.0009% of the ES MU; or 0.0006% of the ES & MF MUs)

The number of grey seal at potential risk of either PTS or TTS onset, as a result of dredging, is less than 0.1 (0.03 individuals), with a maximum population level effect of up to 0.0005% of the Berwickshire and North Northumberland Coast SAC being affected (**Table 8.14**). As for the assessment for piling above, assuming all individuals will be from the SAC is over-precautionary, and it is more likely that the grey seal that may be present in the vicinity of the Proposed Development, are from haul-out sites closer to the site, taking into account the distance to the Berwickshire and North Northumberland Coast SAC (of 58km).

Therefore, given the very low number of individuals at risk of effect from either PTS or TTS onset, and that the Berwickshire and North Northumberland Coast SAC is not located within close proximity of the Proposed Development, it is concluded that **there would be no potential for adverse effect on the integrity of grey seal, as a designated feature of the Berwickshire and North Northumberland Coast SAC, due to underwater noise effects from piling works**.

Potential for Disturbance from Dredging Activities

The potential for disturbance to grey seal of the Berwickshire and North Northumberland Coast SAC would as for the assessment of disturbance to grey seal within the Isle of May SAC. Therefore, see **Section 8.2.4.1** for more information on the potential for effect.

In conclusion, as for the Isle of May SAC assessed above, taking into account the limited potential for a disturbance effect on any grey seal, and that the Berwickshire and North Northumberland Coast SAC is not located within close proximity to the Proposed Development, it is concluded that **there would be no potential for adverse effect on the integrity of grey seal, as a designated feature of the Berwickshire and North Northumberland Coast SAC, due to underwater noise effects from dredging activities**.

8.4.4.2 In-direct Effects

Potential for In-direct Effects as a Result of Changes to Water Quality

The potential for indirect effect to grey seal from changes to water quality would be from any increase in SSC, the release of contaminated sediments through dredging, and accidental spills and leaks. As described in **Section 8.1.2.2**, none of the potential effects noted above would have the potential for any significant effect on grey seal, and therefore, **there would be no potential for adverse effect on the integrity of grey seal, as a designated feature of the Berwickshire and North Northumberland Coast SAC, due to a change in water quality**.

Potential for In-direct Effects as a Result of Changes to Prey Availability

The potential for effects to fish (marine mammal prey species) are described in **Section 8.1.2.2** and assessed fully in the accompanying EIA Report for the Proposed Development.

Grey seal are generalist feeders, and therefore any small scale and temporary changes in prey availability would have no effect on the grey seal ability to forage in the area. As described above, all effects to fish (prey species) would be over a localised area, and would be temporary only. There are no significant effects identified for fish (prey species). Therefore, **there would be no potential for adverse effect on the integrity of grey seal, as a designated feature of the Berwickshire and North Northumberland Coast SAC, due to a change in prey availability.**

8.4.4.3 In-Combination Effects

The potential for in-combination effects have been assessed in **Table 8.15**. In summary, there is no potential for significant effect to bottlenose dolphin, as a result of any other project screened in, in-combination with the Proposed Development. Therefore, **there would be no potential for adverse effect on the integrity of grey seal, as a designated feature of the Berwickshire and North Northumberland Coast SAC, due to in-combination effects.**

Table 8.15 In-combination assessment for grey seal at the Berwickshire and North Northumberland Coast SAC

In-combination project	In-combination Project Information	Proposed Development Assessment		In-combination Project Assessment		Overall In-Combination Assessment
		Potential Effect	Assessment	Potential Effect	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[23]. 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)	0.11 grey seal (0.005% of the IoM SAC population; 0.003% of the ES MU; or 0.002% of the ES & MF MUs). No potential for adverse effect.	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[24]. This is significantly higher than the expected hammer energy of 280kJ at the Proposed Development.	The potential for TTS onset has not been assessed.	An in-combination assessment of TTS is not possible.
		Disturbance effects	Localised and temporary effect only, no potential for significant level of disturbance to any individuals. No potential for adverse effect.	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, in-combination with the low number of grey seal that may be disturbed as a result of the piling activities at Seagreen Alpha and Bravo, and that it is unlikely that all grey seal in the vicinity of the project would be from Berwickshire and North Northumberland Coast SAC, it is concluded that there is unlikely to be any significant effect to grey seal, and therefore there is **no potential for adverse effect on the integrity of the site**.
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)	0.11 grey seal (0.005% of the IoM SAC population; 0.003% of the	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-	The assessments predicted that between 1,263 and 1,833 grey seal may receive noise levels capable of causing	Due to the temporary nature of the piling at the Proposed Development, and that any effect to grey seal at Neart na Gaoithe would be temporary, and that it is unlikely that

[23] https://marine.gov.scot/sites/default/files/seagreen_s36c_application_screening_report.pdf
[24] https://marine.gov.scot/sites/default/files/chapter_10_marine_mammals.pdf

In-combination project	In-combination Project Information	Proposed Development Assessment		In-combination Project Assessment		Overall In-Combination Assessment
		Potential Effect	Assessment	Potential Effect	Assessment	
			ES MU; or 0.002% of the ES & MF MUs). No potential for adverse effect.	drill-drive' scenario) or under pile driving only (the 'drive only' scenario).	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.	all grey seal in the vicinity of the projects would be from the Berwickshire and North Northumberland Coast SAC, it is concluded that there is unlikely to be any significant effect to grey seal within the SAC, and therefore there is **no potential for adverse effect on the integrity of the site**.
		Disturbance effects	Localised and temporary effect only, no potential for significant level of disturbance to any individuals. No potential for adverse effect.	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, in-combination with the low number of grey seal that may be disturbed as a result of the piling activities at Neart na Gaoithe, and that it is unlikely that all grey seal in the vicinity of the project would be from the Berwickshire and North Northumberland Coast SAC, it is concluded that there is unlikely to be any significant effect to grey seal, and therefore there is **no potential for adverse effect on the integrity of the site**.
Grangemouth Flood Protection Scheme	To date, only the EIA Scoping report is available, and no formal application for the scheme has been submitted. Within the EIA Scoping Report[25], it is stated that construction would be undertaken from 2022, for a period of between five and 10 years. However, given that no formal application has	TTS (highest potential impact range of 100m for TTS cumulative exposure due to sheet piling used as the worse-case)	0.11 grey seal (0.005% of the IoM SAC population; 0.003% of the ES MU; or 0.002% of the ES & MF MUs).	N/A		While an in-combination assessment for this project is not possible, it is expected that, due to the planned activities, any potential effects would be less than those of the Proposed Development, and given the expected localised and temporary nature of any effects, there is no potential for significant in-

[25] https://marine.gov.scot/sites/default/files/grangemouth_fps_eia_scoping_report_final_for_submission.pdf

In-combination project	In-combination Project Information	Proposed Development Assessment		In-combination Project Assessment		Overall In-Combination Assessment
		Potential Effect	Assessment	Potential Effect	Assessment	
	been submitted, it is considered unlikely that the constriction of this flood protection scheme would overlap with the Proposed Development.		No potential for adverse effect.			combination effect to grey seal, and therefore **no potential for adverse effect on the integrity of the site**.
		Disturbance effects	Localised and temporary effect only, no potential for significant level of disturbance to any individuals. No potential for adverse effect.			

8.5 Moray Firth SAC

8.5.1 Description of Designation

The Moray Firth SAC in north-east Scotland supports the only known resident population of bottlenose dolphin in the North Sea. Individuals are present all year round, and, while they range widely in the Moray Firth, they appear to favour particular areas. The bottlenose dolphin is a wide-ranging species and occurs across the continental shelf. Historically, very few sightings of bottlenose dolphin were recorded further south on the east coast of the UK, however, in recent years an increase in bottlenose dolphins in the north-east of England have been reported (Aynsley, 2017), with one individual from the Moray Firth population being recorded as far south as The Netherlands (NatureScot, 2021).

8.5.2 Conservation Objectives

The Moray Firth SAC Conservation Objectives for bottlenose dolphin are:

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

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

8.5.3 Features Screened In

Bottlenose dolphin are the only feature of the Moray Firth SAC screened in for further assessment.

8.5.3.1 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. 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 (Coefficient of Variation (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 (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.

Since 1989, the Moray Firth bottlenose dolphin population has been studied through the use of Photo-ID methods. This ongoing work has shown that the population range beyond the boundary of the Moray Firth SAC, and throughout the CES MU, and as noted above, some individuals from the Moray Firth population have been shown to travel along the east coast of Scotland, as far south as Berwickshire (NatureScot, 2021). The population of dolphins in the Moray Firth SAC is therefore the same as that of the CES MU. The population of bottlenose dolphins associated with the Moray Firth is 224, as stated above.

8.5.3.2 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 (29.6% by weight), saithe *Pollachius virens* (23.6% by weight), and whiting (23.4% by weight), although other species including salmon (5.8% by weight), haddock (5.4% by weight) and cephalopods (2.5% by weight) were also identified in lower number (Santos *et al.,* 2001).

8.5.4 Potential Effects of the Proposed Development Alone

8.5.4.1 Underwater Noise Effects

Underwater Noise from Piling Activities

Potential for PTS or TTS onset from Piling Activities

As noted above, the most recent population estimate for bottlenose dolphin at the Moray Firth SAC is 224 (Arso Civil *et al*,. 2021). The potential for tubular piling effects on bottlenose dolphin have been put into context of this SAC population, which, as noted above, is the same as the wider reference population, using the underwater noise modelling results presented in **Appendix 2**, and the initial assessments of underwater noise effects as presented in **Appendix 3**. The results of this assessment are provided in **Table 8.16**.

Table 8.16 Impact ranges and areas, and maximum number of individuals (and % of reference population) that could be at risk of PTS or TTS onset from tubular (impact) and sheet (vibro) piling

Piling Activity	Potential Impact	Receptor	Impact range (and area)	Maximum number of individuals (% of reference population)
Tubular (impact) piling	PTS without mitigation – single strike	Bottlenose dolphin	<50m <0.01km^2	0.0003 bottlenose dolphin (0.0001% Moray Firth (MF) SAC)
	PTS without mitigation – cumulative exposure	Bottlenose dolphin	<100m <0.1km^2	0.003 bottlenose dolphin (0.001% MF SAC)
	TTS without mitigation – single strike	Bottlenose dolphin	<50m <0.01km^2	0.0003 bottlenose dolphin (0.0001% MF SAC)
	TTS without mitigation – cumulative exposure	Bottlenose dolphin	<100m <0.1km^2	0.003 bottlenose dolphin (0.001% MF SAC)
	PTS without mitigation – cumulative exposure (over 12 hours)	Bottlenose dolphin	<100m 0.03km^2	0.0009 bottlenose dolphin (0.0004% MF SAC)

Piling Activity	Potential Impact	Receptor	Impact range (and area)	Maximum number of individuals (% of reference population)
Sheet (vibro) piling	TTS without mitigation – cumulative exposure (over 12 hours)	Bottlenose dolphin	<100m $0.03km^2$	0.0009 bottlenose dolphin (0.0004% MF SAC)

The number of bottlenose dolphin at potential risk of either PTS or TTS onset, as a result of piling activity, is 0.003 or less in all cases, with a maximum population level effect of up to 0.001% of the Moray Firth SAC being affected (**Table 8.16**). While the number of bottlenose dolphin at risk of either PTS or TTS onset is very low, mitigation measures will be in place for all piling works, as described in **Section 8.1.2.1.**

Therefore, it is concluded that there would be no potential for adverse effect on the integrity of bottlenose dolphin, as a designated feature of the Moray Firth SAC, due to underwater noise effects from piling works.

Potential for Disturbance from Piling Activities

As described in **Section 8.1.2.1,** there is the potential for a displacement response from the area for as a result of piling activities. However, the reduction in bottlenose dolphin presence would not be significant, and any individuals disturbed would return to the area following the cessation of piling. Therefore, any effects from underwater noise as a result of piling will be both localised and temporary. The area surrounding the Port of Leith is already a busy marine area, and any bottlenose dolphins in the vicinity of the Proposed Development would be used to increased levels of marine traffic and noisy environments. Given the busy nature of the area, that the piling works will be small in scale and temporary, any potential for disturbance would be localised, and would be unlikely to cause any significant disturbance to individuals in the area, there is unlikely to be the potential for any significant effect on bottlenose dolphin, as a result of piling activity.

Taking into account the above, including the limited potential for a disturbance effect on any bottlenose dolphin, it is concluded that **there would be no potential for adverse effect on the integrity bottlenose dolphin, as a designated feature of the Moray Firth SAC, due to underwater noise effects from piling works**.

Underwater Noise from Dredging Activities

Potential for PTS or TTS onset from Dredging Activities

As for the potential effect of piling, the potential for underwater noise effects on bottlenose dolphin due to dredging activities have been put into context of Moray Firth SAC population, as well as the wider reference populations, using the underwater noise modelling results presented in **Appendix 2**, and the initial assessments of underwater noise effects as presented in **Appendix 3**. The results of this assessment are provided in **Table 8.17**.

Table 8.17 Impact ranges and areas, and maximum number of individuals (and % of reference population) that could be at risk of PTS or TTS onset due to dredging activities

Piling Activity	Potential Impact	Receptor	Impact range (and area)	Maximum number of individuals (% of reference population)
Dredging	PTS without mitigation – cumulative exposure (over 12 hours)	Bottlenose dolphin	<100m $0.03km^2$	0.0009 bottlenose dolphin (0.0004% MF SAC)
	TTS without mitigation – cumulative exposure (over 12 hours)	Bottlenose dolphin	<100m $0.03km^2$	0.0009 bottlenose dolphin (0.0004% MF SAC)

The number of bottlenose dolphin at potential risk of either PTS or TTS onset, as a result of dredging, is up to 0.001 individuals, with a maximum population level effect of up to 0.0004% of the Moray Firth SAC population being affected (**Table 8.17**).

Therefore, given the very low number of individuals at risk of effect from either PTS or TTS onset, **it is concluded that there would be no potential for adverse effect on the integrity of bottlenose dolphin, as a designated feature of Moray Firth SAC, due to underwater noise effects from dredging activities**.

Potential for Disturbance from Dredging Activities

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 individuals returning to the area shortly after the sound source is stopped, or on completion of the works. As noted for piling, the area surrounding the Port of Leith is a busy marine area, and any bottlenose dolphin present in the area would be used to increased levels of underwater noise. Given the busy nature of the area, that the dredging works will be small in scale and temporary, any potential for disturbance would be localised, and that it is unlikely to cause any significant disturbance to individuals in the area, it is unlikely that there would be any potential for any significant effect on the SAC population, as a result of dredging activity.

Taking into account the above, including the limited potential for a disturbance effect on any bottlenose dolphin, **it is concluded that there would be no potential for adverse effect on the integrity of bottlenose dolphin, as a designated feature of the Moray Firth SAC, due to underwater noise effects from dredging activities**.

8.5.4.2 In-direct Effects

Potential for In-direct Effects as a Result of Changes to Water Quality

The potential for indirect effect to bottlenose dolphin from changes to water quality would be from any increase in SSC, the release of contaminated sediments through dredging, and accidental spills and leaks. As described in **Section 8.1.2.2**, none of the potential effects noted above would have the potential for any significant effect on bottlenose dolphin, and therefore, **there would be no potential for adverse effect on the integrity of bottlenose dolphin, as a designated feature of the Moray Firth SAC, due to a change in water quality**.

Potential for In-direct Effects as a Result of Changes to Prey Availability

The potential for effects to fish (marine mammal prey species) are described in **Section 8.1.2.2**, and assessed fully in the accompanying EIA Report for the Proposed Development.

Bottlenose dolphin are generalist feeders, and therefore any small scale and temporary changes in prey availability would have no effect on the bottlenose dolphin ability to forage in the area. As described above, all effects to fish (prey species) would be over a localised area and would be temporary only. There are no significant effects identified for fish (prey species). Therefore, **there would be no potential for adverse effect on the integrity of bottlenose dolphin, as a designated feature of the Moray Firth SAC, due to a change in prey availability.**

8.5.4.3 In-Combination Effects

The potential for in-combination effects have been assessed in **Table 8.18**. In summary, there is no potential for significant effect to bottlenose dolphin, as a result of any other project screened in, in-combination with the Proposed Development. Therefore, **there would be no potential for adverse effect on the integrity of bottlenose dolphin, as a designated feature of the Moray Firth SAC, due to in-combination effects.**

Table 8.18 In-combination assessment for bottlenose dolphin at the Moray Firth SAC

In-combination project	In-combination Project Information	Proposed Development Assessment		In-combination Project Assessment		Overall In-Combination Assessment
		Potential Effect	Assessment	Potential Effect	Assessment	
Nigg Energy Park East Quay	Nigg Energy Park East Quay Expansion includes an area of reclamation, sheet piling, and dredging[26]. An updated ES was submitted in 2019, to include a revised blasting methodology[27].	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% MF SAC) No potential for adverse effect.	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 effect to bottlenose dolphin at Nigg Energy Park is a low risk, and would be temporary, it is concluded that there is unlikely to be any significant effect to bottlenose dolphin, and therefore there is **no potential for adverse effect on the integrity of the site**.
		Disturbance effects	Localised and temporary effect only, no potential for significant level of disturbance to any individuals. No potential for adverse effect.	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 effect to bottlenose dolphin at Nigg Energy Park is a low risk, and would be temporary, it is concluded that there is unlikely to be any significant effect to bottlenose dolphin of the Moray Firth SAC, and therefore there is **no potential for adverse effect on the integrity of the site**.
NorthConnect HVDC Cable	This project is for a interconnector cable between Scotland and Norway, with a length of approximately 110 – 120km[28]. Landfall will be constructed using Horizontal Directional Drilling (HDD). Activities that would produce underwater noise include	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% MF SAC) No potential for adverse effect.	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.	**There is no risk of in-combination TTS onset at the Proposed Development and the NorthConnect project.**
		Disturbance effects	Localised and temporary effect only, no potential for	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	Due to the localised and temporary nature of the piling at the Proposed Development, and that any effect to

[26] http://marine.gov.scot/datafiles/lot/ahep/es/vol2/Volume%202%20Environmental%20Statement%20Ch%2015.pdf
[27] https://marine.gov.scot/sites/default/files/environmental_impact_assessment_report_redacted.pdf
[28] https://marine.gov.scot/sites/default/files/02_project_description_0.pdf

In-combination project	In-combination Project Information	Proposed Development Assessment		In-combination Project Assessment		Overall In-Combination Assessment
		Potential Effect	Assessment	Potential Effect	Assessment	
	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.		significant level of disturbance to any individuals. No potential for adverse effect.		potential for significant impact to bottlenose dolphin.	bottlenose dolphin due to the NorthConnect project is a low risk, and would be temporary, it is concluded that there is unlikely to be any significant effect to bottlenose dolphin of the Moray Firth SAC, and therefore there is **no potential for adverse effect on the integrity of the site**.
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% MF SAC) No potential for adverse effect.	TTS from construction activities[29]	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.	**There is no risk of in-combination TTS onset at the Proposed Development and the sea wall repair project.**
		Disturbance effects	Localised and temporary effect only, no potential for significant level of disturbance to any individuals. No potential for adverse effect.	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 effect 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 is unlikely to be any significant effect to bottlenose dolphin of the Moray Firth SAC, and therefore there is **no potential for adverse effect on the integrity of the site**.
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,	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% MF SAC) No potential for adverse effect.	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.	**There is no risk of in-combination TTS onset at the Proposed Development and the Ardersier Port Development.**

[29] https://marine.gov.scot/sites/default/files/environmental_appraisal_document_redacted.pdf

In-combination project	In-combination Project Information	Proposed Development Assessment		In-combination Project Assessment		Overall In-Combination Assessment
		Potential Effect	Assessment	Potential Effect	Assessment	
	and quay wall construction (using vibro-piling)[30]. Construction may take place until 2024, and therefore there is the potential for construction phase overlap with the Proposed Development.	Disturbance effects	Localised and temporary effect only, no potential for significant level of disturbance to any individuals. No potential for adverse effect.	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 effect to bottlenose dolphin due to the Ardersier Port Development is a low risk, and would be temporary, it is concluded that there is unlikely to be any significant effect to bottlenose dolphin of the Moray Firth SAC, and therefore there is **no potential for adverse effect on the integrity of the site**.
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[31]. 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% MF SAC) No potential for adverse effect.	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[32]. This is significantly higher than the expected hammer energy of 280kJ at the Proposed Development.	The potential for TTS onset has not been assessed.	An in-combination assessment of TTS is not possible.
		Disturbance effects	Localised and temporary effect only, no potential for	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	Due to the localised and temporary nature of the piling at the Proposed Development, in-combination with

[30] https://marine.gov.scot/sites/default/files/volume_2_envionmental_impact_assessment_report_redacted.pdf
[31] https://marine.gov.scot/sites/default/files/seagreen_s36c_application_screening_report.pdf
[32] https://marine.gov.scot/sites/default/files/chapter_10_marine_mammals.pdf

In-combination project	In-combination Project Information	Proposed Development Assessment		In-combination Project Assessment		Overall In-Combination Assessment
		Potential Effect	Assessment	Potential Effect	Assessment	
			significant level of disturbance to any individuals. No potential for adverse effect.		concurrently) activities. This equates to up to 2.3% of the assessed reference population.	the low number of bottlenose dolphin that may be disturbed as a result of the piling activities at Seagreen Alpha and Bravo, it is concluded that there is unlikely to be any significant effect to bottlenose dolphin, and therefore there is **no potential for adverse effect on the integrity of the site**.
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% MF SAC) No potential for adverse effect	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 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 effect to bottlenose dolphin at Neart na Gaoithe is a low risk, and would be temporary, it is concluded that there is unlikely to be any significant effect to bottlenose dolphin, and therefore there is **no potential for adverse effect on the integrity of the site**.
		Disturbance effects	Localised and temporary effect only, no potential for significant level of disturbance to any individuals. No potential for adverse effect.	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 is unlikely to be any significant effect to bottlenose dolphin of the Moray Firth SAC, and therefore there is **no potential for adverse effect on the integrity of the site**.

In-combination project	In-combination Project Information	Proposed Development Assessment		In-combination Project Assessment		Overall In-Combination Assessment
		Potential Effect	Assessment	Potential Effect	Assessment	
Grangemouth Flood Protection Scheme	To date, only the EIA Scoping report is available, and no formal application for the scheme has been submitted. Within the EIA Scoping Report[33], it is stated that construction would be undertaken from 2022, for a period of between five and 10 years. However, given that no formal application has been submitted, it is considered unlikely that the constriction of this flood protection scheme would 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% MF SAC) No potential for adverse effect.	N/A		While an in-combination assessment for this project is not possible, it is expected that, due to the planned activities, any potential effects would be less than those of the Proposed Development, and given the expected localised and temporary nature of any effects, there is no potential for significant in-combination effect to bottlenose dolphin, and therefore **no potential for adverse effect on the integrity of the site**.
		Disturbance effects	Localised and temporary effect only, no potential for significant level of disturbance to any individuals. No potential for adverse effect.			

[33] https://marine.gov.scot/sites/default/files/grangemouth_fps_eia_scoping_report_final_for_submission.pdf

9 Conclusions

The Stage 1 (screening) assessment concluded that, during the construction phase of the Proposed Development, LSE could not be excluded for designated features of the following sites:

- Transitional fish features of the River Teith SAC;
- Some (not all) estuarine breeding and non-breeding ornithological features of the Firth of Forth SPA and Ramsar Site, Imperial Dock Lock, Leith SPA, Forth Islands SPA and OFFSABC SPA; and,
- Marine mammal features of the Isle of May SAC, Firth of Tay and Eden Estuary SAC, Berwickshire and North Northumberland Coast SAC and Moray Firth SAC.

There would not be any significant change during the operational phase compared to the existing activity levels, given that there would be no significant increase in vessel traffic as a result of the Proposed Development. The operational phase does not have the potential to cause LSE to any of the qualifying features of the above sites with respect to their Conservation Objectives. As such, no operational mitigation measures are necessary.

The information provided to inform the Appropriate Assessment in **Chapters 6**, **0** and **8** has concluded that there would be no adverse effect on the integrity of the sites listed above during the construction phase of the Proposed Development, and that, in respect of any construction stage impacts identified in this HRA, these can be mitigated by compliance with industry standard construction techniques.

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Appendix 1: 2021/22 Baseline Estuarine Bird Survey Report

REPORT

Port of Leith – Outer Berth

Port of Leith Bird Surveys Report 2021-22

Client: Forth Ports Limited

Reference: PC2045-RHD-ZZ-XX-RP-EV-0010

Status: Final/00

Date: 08 April 2022

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Classification
Project related

Royal HaskoningDHV

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Royal HaskoningDHV

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Acronyms

Acronym	Acronym description
AON	Apparently Occupied Nest
BoCC5	Birds of Conservation Concern 5
BTO	British Trust for Ornithology
EIA	Environmental Impact Assessment
HRA	Habitats Regulations Appraisal
MHWS	Mean High Water Springs
OFFSABC	Outer Firth of Forth and St. Andrew's Bay Complex [SPA]
SEPA	Scottish Environmental Protection Agency
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
VP	Vantage Point
WeBS	Wetland Bird Survey

1 Introduction

1.1 Background

Forth Ports Limited ("Forth Ports") is seeking to improve the berth seaward of the lock gates at the entrance to the Port of Leith, Edinburgh ("the Port"), to support vessels that are too wide to pass through the gates, including vessels associated with the offshore renewables energy industry. The proposed development includes improvement of the berth, creation of an area of hardstanding for loading / unloading at the berth, creation of a laydown area for storage / transhipment of renewable energy components and capital dredging to enlarge the existing berth pocket.

Royal HaskoningDHV was commissioned by Forth Ports to co-ordinate an estuarine bird survey at the Port and adjacent coastline for the purpose of providing baseline data ahead of the proposed development. Additionally, an active colony count and flight behaviour survey of the common tern *Sterna hirundo* colony within the Port was commissioned for the purpose of understanding the current breeding season activity within the colony. Survey fieldwork was managed by Tom Edwards, of 3E Services Ltd., an experienced ecologist with prior experience of estuarine bird surveys in the Firth of Forth for Royal HaskoningDHV and Forth Ports.

There were three elements associated with the survey (as agreed with NatureScot, correspondence by email on 28th April 2021 – see **Appendix 1**):

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

1.2 Purpose of the Survey Report

This Survey Report describes the results of the above surveys and thereby provides an overall baseline based on a full year of count data (including both the breeding and non-breeding seasons). It presents distribution and count information for the impounded dock system, the coastline to the west of the Port and the coastline along the eastern / northern side of the Port, as well as nearshore and offshore marine areas. It uses that information to indicate the importance of the survey study area in the context of wider species populations in the Firth of Forth.

The survey data and conclusions, supplemented by existing published data, has been used to inform both a Habitats Regulations Appraisal (HRA), undertaken in accordance with the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended) ("the Habitats Regulations"), and an Environmental Impact Assessment (EIA), undertaken in accordance with the Marine Works (EIA) Regulations 2007 (as amended), for the Proposed Development.

2 Ornithological nature conservation designations

2.1 Overview of nearby designations

The Imperial Dock Lock, Leith SPA, located within the impounded dock system in the Port, is part of the UK site network, protected for the purpose of nature conservation under the Habitats Regulations and designated in this instance due to a nationally important population of breeding common terns on the dockside. The SPA is located *c.*100m from the Proposed Development at the nearest point.

In addition, the Proposed Development is located adjacent to the Firth of Forth SPA and Ramsar Site and slightly overlaps with the Outer Firth of Forth and St Andrews Bay Complex (OFFSABC) SPA. The Firth of Forth SPA, underpinned in coastal areas by the Firth of Forth Site of Special Scientific Interest (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 / seabirds. 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 Port is also approximately 3.5km from the Forth Islands SPA, a seabird breeding colony SPA which lies offshore. 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, and has no non-breeding features. While the SPA incorporates the core marine foraging grounds for qualifying breeding features, birds from the colonies may also forage throughout the Firth of Forth.

Figure 2.1 illustrates the location of the Proposed Development in relation to the above SPAs.

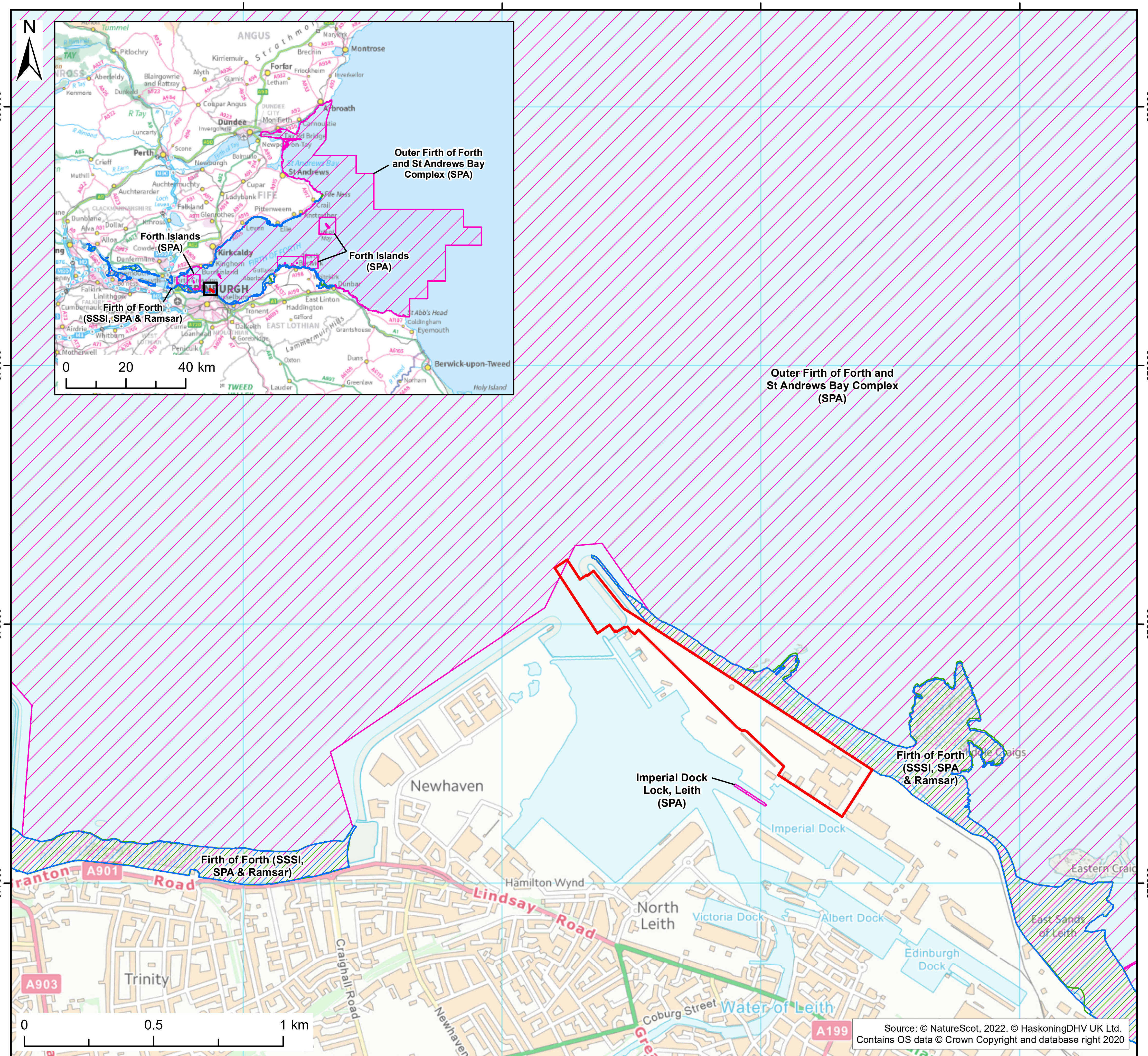
2.2 Ornithological features

Details of the qualifying ornithological features of the SPAs and Ramsar site are described in **Table 2.1**. Features of the underpinning SSSI correspond with those of the Firth of Forth SPA and Ramsar site.

Table 2.1 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.
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*, [Redacted] 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 also 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:

Designation	Features
	• Non-breeding red throated diver *Gavia stellata*, Slavonian grebe *Podiceps auritus*, 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 *Anser brachyrhynchus*, shelduck *Tadorna tadorna*, knot *Calidris canutus*, redshank *Tringa totanus* and turnstone *Arenaria interpres*. The site also 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 penelope*, 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, [Redacted] [Redacted red-breasted merganser, oystercatcher, [Redacted, grey plover and dunlin. The site qualifies under Ramsar Criterion 5 by regularly supporting waterbirds in numbers of 20,000 individuals or more. The site qualifies under Ramsar Criterion 6 by regularly supporting 1% or more of the individuals in a population of waterbirds: • [Redacted] , pink-footed goose, shelduck, knot, redshank, turnstone, [Redacte [R ed and Sandwich tern.
Outer Firth of Forth and St Andrews Bay Complex 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.



Legend:

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

Client: Forth Ports Limited	Project: Port of Leith - Outer Berth
Title: Ornithological Nature Conservation Designations	
Figure: 2.1	Drawing No: PC2045-RHD-ZZ-ZZ-DR-EV-0017

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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3 Estuarine bird survey methodology

3.1 Survey study area

The survey study area, agreed with NatureScot as part of the survey specification and presented in **Figure 3.1**, extended 2km to the east and west of Leith Outer Berth and to a distance of 2km offshore of the Outer Berth. 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. To facilitate the recording of estuarine birds, the study area was split into three constituent sectors:

- S1: the coastal, intertidal, marine and offshore areas in the western half of the study area;
- S2: the coastal, intertidal, marine and offshore areas in the eastern half of the study area; and
- S3: the impounded dock system and adjacent quaysides / port areas within the Port estate.

3.1.1 Western half of the study area (S1)

The western half of the study area (i.e. west of Leith Outer Berth) extends a distance of 2km west of Leith Outer Berth and incorporates the shoreline adjacent to West Breakwater, Newhaven Harbour and the seafront to the west of Newhaven Harbour, plus an embayment formed between Granton East Harbour and the West Breakwater. The intertidal zone along the Newhaven waterfront extends *c.*100-150m from mean high-water springs (MHWS). The sector is characterised by regular recreational usage as there is public access along this section of coastline, hence regular use of the foreshore and breakwater by walkers (including dog walkers), swimmers, anglers and kayakers. The sector is regularly used by both motorised and non-motorised vessels given its sheltered location and proximity to the Newhaven and Granton Harbours. This sector also encompasses three small scrapes / pools on land just south of the West Breakwater lighthouse.

Habitats within this sector include:

- A man-made promenade and breakwater, with amenity grassland and drainage swales;
- Seawall and revetment with algae;
- 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.

The intertidal area to the west of Newhaven Harbour lies within the Firth of Forth SPA / Ramsar Site. Marine areas within this sector lie within the OFFSABC SPA.

3.1.2 Eastern half of the study area (S2)

To the east, the study area extends a distance of 2km from Leith Outer Berth and incorporates the shoreline adjacent to East Breakwater and the frontage to the Port. The intertidal zone along this stretch is narrow but is interspersed with rocky outcrops such as Martello Rocks, Black Rocks, Middle Craigs and Eastern Craigs, some of which are partly exposed at high tide. At the far east end of the study area, adjacent to the Eastern

Craigs, is a wider expanse of intertidal soft sediment known as the East Sands of Leith. Given that the shoreline along this stretch forms part of the Port boundary, there is limited access and is less likely to be subject to anthropogenic disturbance due to recreational activity such as anglers and dog walkers, although is exposed to port-associated and vessel-related disturbances.

Habitats within this sector include:

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

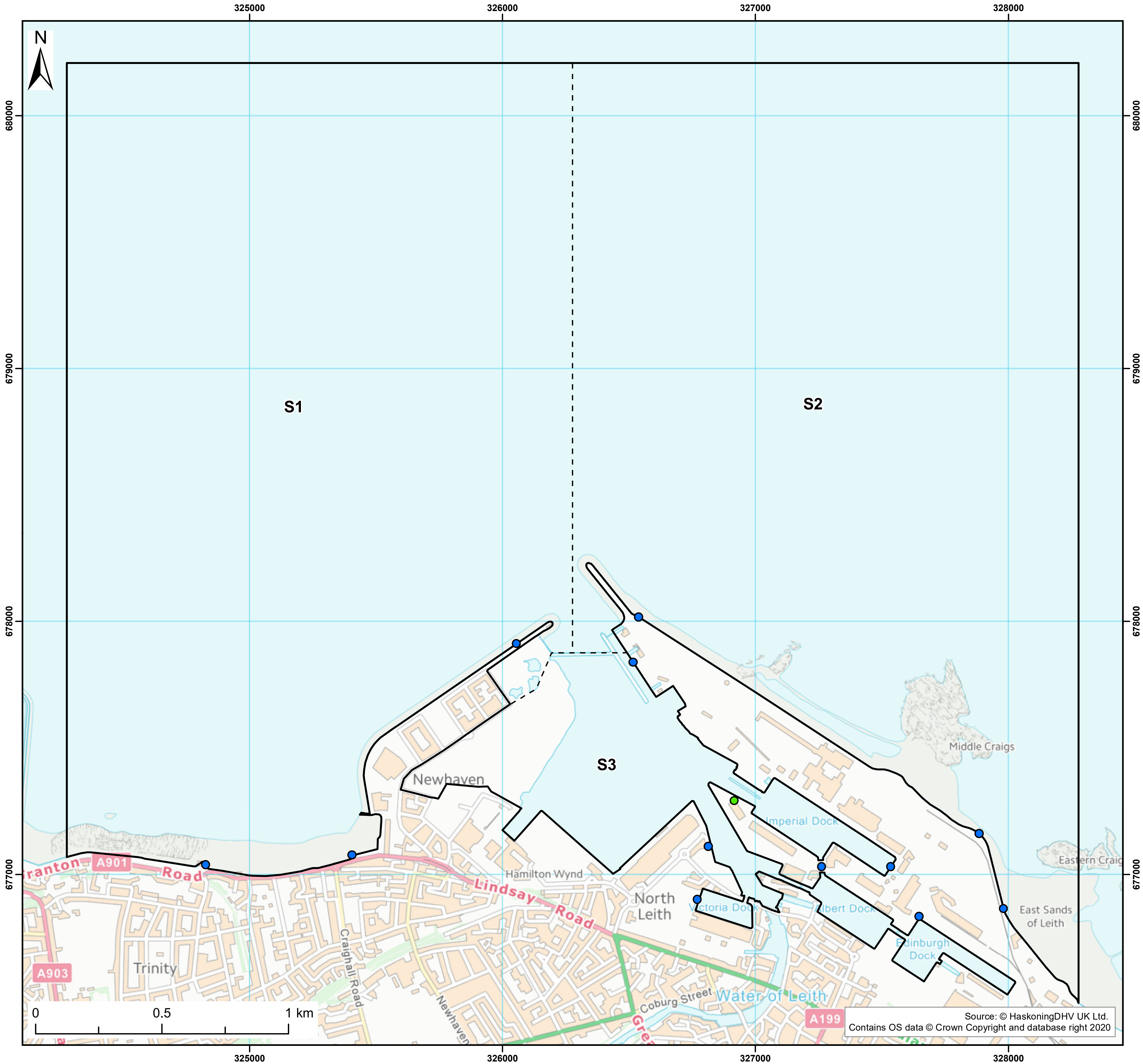
The intertidal component of this sector lies within the Firth of Forth SPA / Ramsar Site. Marine areas within this sector lie within the OFFSABC SPA.

3.1.3 Impounded docks and Port estate (S3)

The sector within the impounded dock system incorporates all docks, including Western Harbour, Imperial Dock, Prince of Wales Dock, Albert Dock, Edinburgh Dock and Victoria Dock, and associated quaysides. The sector extends south to Victoria Bridge, where the Water of Leith enters the Port. This sector is characterised by Port activity, including regular use of vessels, plant and vehicles and the presence of Port workers within the Port estate. The Imperial Dock Lock, Leith SPA is located within this sector.

Habitats within this sector include:

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



Legend:

- Survey Area
- Count Sector Boundary
- 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:	3.1	Drawing No:	PC2045-RHD-ZZ-ZZ-DR-EV-0015		
Revision:	Date:	Drawn:	Checked:	Size:	Scale:
01	03/03/2022	FC	BH	A3	1:15,000

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3.2 Field survey methods

3.2.1 Survey frequency

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. This approach was agreed with NatureScot (see **Appendix 1**). In addition, Forth Ports 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).

Owing to the size and logistics of the site, it was necessary for each survey visit to be conducted over two days, with the western half of the study area (S1) counted on one day and the eastern half of the study area (S2) counted on the other. Counts in the impounded dock system (S3) took place on either day.

3.2.2 Recording the abundance and distribution of birds

Estuarine bird count methods were based on the British Trust for Ornithology (BTO) Wetland Bird Survey (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 the strategically positioned vantage points (VPs) identified in **Figure 3.1**, 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. Wherever possible, every effort was made to ensure birds were not double-counted from one VP to the next to ensure that peak counts were as accurate as possible.

All species were recorded using standard BTO two-letter codes and behaviour was recorded using registrations representing loafing activity (L), roosting (R), foraging (F) and flying (Y). Definitions for the above activities are as follows:

- **Loafing birds** were inactive but showed alert behaviour such as head turning;
- **Roosting birds** were inactive with no signs of alert behaviour (often with eyes closed or head tucked under the wing);
- **Foraging birds** were those observed actively seeking food resources within the study area; and
- **Flying birds** were those commuting through the site but not interacting directly with the study area when observed.

Although the survey was not designed to act as a detailed breeding bird survey of the site, any incidental observations of breeding / nesting activity when on site were recorded.

3.2.3 Recording disturbances and weather conditions

The distribution of estuarine birds may be affected by anthropogenic disturbance associated, for example, with recreational use (e.g. walking, dog-walking, angling, bait digging) or activities associated with the operation of the Port (e.g. vessel, plant and vehicle movements). During each survey visit, sources of any observable disturbance events were recorded on the survey forms and the comparative magnitude of such disturbances (i.e. 'low', 'medium', 'high') indicated, with low representing very minor behavioural change, medium representing head turning and / or short-distance movement and high representing prolonged or long-distance movement. However, it should be noted that it was not an aim of the survey to study in detail the behavioural responses to disturbance.

During each survey visit, weather conditions were recorded on the survey forms. Details recorded included wind speed (Beaufort scale), wind direction, rainfall (none, light, moderate or heavy), cloud cover (%) and visibility.

3.2.4 Survey limitations

As noted above, it was necessary for each survey visit to be conducted over two days. While it is acknowledged that there would be some variation in the distribution of estuarine birds in the study area from day to day, twice monthly visits reduce the risk that this would carry and such variations would not significantly detract from the overall conclusions of the study. Wherever possible, the two-day survey visits were planned to be undertaken over consecutive dates when conditions remained consistent.

Visibility challenges in the study area relate to sea fog (or 'haar'), which is periodically present in the Firth of Forth, particularly early in the morning, and increased sea state. While VPs were suitably spaced to easily view the shoreline and nearshore areas even in poor visibility, offshore areas to a distance of 2km are less easy to view during rougher seas or periods of haar. However, surveys were planned in advance to avoid, whenever possible, non-conducive conditions (noting that sometimes it was unforeseen, or unavoidable given light / tide constraints) and the repetition of surveys (i.e. two surveys a month) increases the reliability of counts. Again, this limitation is not considered to significantly detract from the conclusions of the study.

3.2.5 Evaluation of data

The field map registrations have been digitised to present distribution maps for birds of conservation interest (i.e. SPA / Ramsar / SSSI features) that were regularly present during the surveys and / or were present in significant numbers (i.e. in numbers exceeding 1% of the regional reference populations – see below for further detail). These distribution maps are presented in **Appendix 2** and have been used to illustrate the areas of usage within the Port and wider study area and identify key locations. Each individual distribution map presents all records of the species in question throughout the entire survey period (i.e. from March 2021 to March 2022). The maps do not present the maximum number of birds present at any one time – information on peak counts in the study area are instead detailed in **Section 5**.

Peak counts of SPA / Ramsar / SSSI features, defined as the maximum number of a given feature present in any single count of the study area, have been set into the context of reference populations to provide an indication of the importance of the study area for those features at a regional scale. The peak count data supplement WeBS data and have been used in the EIA and HRA for the proposed development. This is standard practice for ornithological assessments as the peak count / mean peak is considered to give a conservative indication of the population within a given area. Peak counts presented in this report did not include flying birds, as defined above, as they were not observed directly using the study area (this is consistent with the approach used for WeBS core counts).

For the purpose of this study, populations across the entire Firth of Forth are deemed to be appropriate regional receptor populations for contextual reference for the numbers present in the study area. For waterbird species, regional receptor populations used are one or both of the following:

- The latest WeBS five-year mean peaks (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 seabird species the reference SPA populations have been applied as the regional receptor populations.

Following convention, if the peak count of a given species exceeds 1% of the regional population, the study area is evaluated as having regional importance for that species. For the most part, the regional importance is categorised as 'low' if the peak count represents between 1% and 5% of the regional population, 'moderate' if it represents between 5% and 20% of the regional population and 'high' if it represents more than 20%. If the peak count does not exceed 1% of the regional total the study area is evaluated as having no regional importance (i.e. it is of local importance only). 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 taken into account when concluding the level of regional importance.

4 Tern survey methodology

Common tern surveys were undertaken twice monthly from May to July 2021, inclusive, and at different times of the day to account for any daily variation. Colony counts and flight behaviour surveys were undertaken during each visit.

4.1 Colony counts

Colony counts were undertaken from a suitable VP to the south of the colony (see **Figure 3.1**) 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 count of AON, based on the presence of apparently incubating adults, was undertaken during each visit.

4.2 Flight surveys

A generally established protocol for tern flight surveys was not available at the time of undertaking; however, it was agreed with NatureScot (see **Appendix 1**) 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, shown in **Figure 4.1**. Working from each sector in turn, the surveyor undertook 20-minute counts of common tern flights passing through each sector 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+, with buildings and other structures used as a visual reference. The data obtained from the survey was used to provide an estimate of the flight rate (i.e. number of flights per hour) through a given sector and at a given height.

Sector 1 formed the only route to sea that did not involve traversing over the Port estate and encompassed birds that flew in and out through the mouth of the Port. Sectors 2, 3 and 4 in **Figure 4.1** encompassed the east / north side of the Port estate. Sector 3 forms the shortest route between the colony and the open sea.

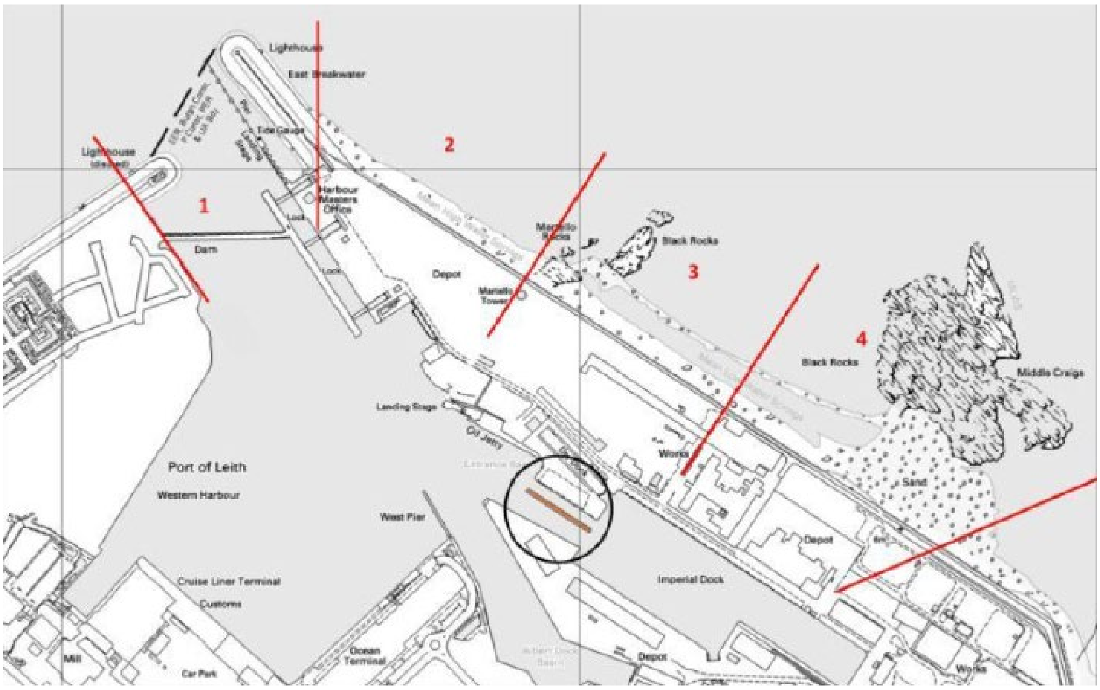

Figure 4.1 Common tern flight survey sectors at Port of Leith (taken from Jennings, 2012)

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5 Estuarine bird survey results

5.1 Survey dates and conditions

The survey visits were undertaken twice a month with at least one week between the first and second visit. Dates and weather conditions for each survey are listed in **Table 5.1**.

Wherever possible, survey dates were timed to coincide with favourable weather conditions; however, given the inaccuracies in advance forecasting and the limitations imposed by coinciding hours of daylight and target tides (particularly during winter months) this was not always possible. For the most part, visibility was recorded in the 1-5km, 5-10km and 10km+ range and was noted as sufficient for surveying the entire study area from the identified VPs, although occasionally sea state may have impaired counts at the most offshore extent of the study area. During a small number of survey visits, early morning visibility was reduced due to 'haar' or sea fog, which caused difficulty in counting birds at a distance of more than a few hundred metres offshore but cleared up for counts later in the day and did not affect counts of birds using the shoreline or nearshore area. On all occasions, weather conditions were broadly consistent over the two days of a given survey visit.

Average spring tidal ranges in the outer Firth of Forth are around 4 to 5m, compared with neap tidal ranges of around 2 to 3m, hence availability of intertidal habitat may vary throughout the lunar cycle. However, by undertaking twice-monthly surveys at least one week apart, different phases of the moon are encompassed by the study.

Table 5.1 Dates and weather conditions for each site visit, Mar. 2021 to Feb. 2022

Month (visit #)	Date	Low tide count (+/- 3hr.)			High tide count (+/- 3 hr.)		
		Beaufort scale	Rain	Visibility (km)	Beaufort scale	Rain	Visibility (km)
Mar. '21 (1)	28/03	8-9 WSW	None	5-10	9 SW	None	5-10
	29/03	9 SW	None	5-10	9 SW	None	5-10
Mar. '21 (2)	30/03	7 SW	None	5-10	7 SW	None	5-10
	31/03	2-4 N	None	5-10	4 NE	Light	5-10
Apr. '21 (1)	12/04	2 NW	None	10+	2 WNW	None	10+
	13/04	1	None	10+	1	None	10+
Apr. '21 (2)	19/04	0	None	5-10	0	None	1-5
	20/04	2 WNW	None	5-10	2 WNW	None	5-10
May '21 (1)	01/05	1 ENE	None	10+	1 ENE	None	10+
	02/05	4 W	None	10+	2 W	None	10+
May '21 (2)		2 NE	None	1-5	2 NE	None	1-5
		1 NE	None	<1	2 NE	None	5-10
Jun. '21 (1)	10/06	6 SW	None	5-10	6 SW	None	10+
	11/06	7 W	None	5-10	7 W	None	5-10
Jun. '21 (2)	19/06	2-3 E	Light	5-10	2-3 E	None	5-10
	20/06	2-3 WSW	None	5-10	1 WNW	None	5-10
Jul. '21 (1)	03/07	1 SE	None	1-5	2 SE	Light	1-5
	04/07	1 SE	None	<1	1 SE	None	1-5

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Month (visit #)	Date	Low tide count (+/- 3hr.)			High tide count (+/- 3 hr.)		
		Beaufort scale	Rain	Visibility (km)	Beaufort scale	Rain	Visibility (km)
Jul. '21 (2)	17/07	5 SW	None	10+	4 SW	None	10+
	18/07	3 SW	None	10+	2 SW	None	10+
Aug. '21 (1)	06/08	5 SW	Moderate	1-5	5 SE	Light	1-5
	07/08	3-6 NE	None	5-10	5 SE	None	5-10
Aug. '21 (2)	23/08	2 NE	None	1-5	3 NE	None	1-5
	24/08	1 NE	None	<1	3-4 NE	None	1-5
Sep. '21 (1)	05/09	2 SE	None	5-10	3-4 S	None	5-10
	06/09	4-6 SW	Light	1-5	7 SW	None	1-5
Sep. '21 (2)	16/09	5 W	None	5-10	5 W	None	5-10
	17/09	5 SSE	None	5-10	5 SSW	None	5-10
Oct. '21 (1)	04/10	2 SW	None	10+	3 SW	None	10+
	05/10	4 NW	Moderate	1-5	4 N	Moderate	1-5
Oct. '21 (2)	16/10	1 SW	None	5-10	1 E	None	5-10
	17/10	2 NE	Moderate	<1	1 NE	Light	1
Nov. '21 (1)	06/11	8-9 SW	Heavy	<1	8-9 WSW	Heavy	1-5
	07/11	8 W	None	5-10	7 WNW	None	5-10
Nov. '21 (2)	13/11	1-2 W	None	5-10	2 WSW	None	5-10
	14/11	2 S	None	5-10	1 S	None	5-10
Dec. '21 (1)	06/12	3-4 WSW	None to heavy	5-10	3 WSW	None	10+
	07/12	3 ESE	None	10+	5 ESE	Moderate	1-5
Dec. '21 (2)	12/12	1 S	None	5-10	1 S	None	10+
	13/12	2 WSW	None	10+	2 WSW	None	5-10
Jan. '22 (1)	11/01	3 SW	None	10+	3 SW	None	10+
	12/01	3-4 WSW	None	5-10	3-4 WSW	None	5-10
Jan. '22 (2)	18/01	2 SW	None	5-10	3 SW	None	5-10
	19/01	3 W	None	10+	3 W	None	10+
Feb. '22 (1)	02/02	2 SW	None	5-10	3 WSW	None	5-10
	03/02	4-5 SW	None	10+	4-5 WSW	None	5-10
Feb. '22 (2)	24/02	5 SW	None	5-10	4 SSW	Brief snow	1-5
	26/02	3 SW	None	10+	2 SW	None	10+
Mar. '22 (1)	19/03	2 NW	None	10+	4 NE	None	5-10
	20/03	2 SW	None	10+	3 SW	None	10+

5.2 Overview of count data

Over the course of the 25 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:

- 12 wildfowl species (mute swan, eider, shelduck, mallard, teal, [Redacted] scoter, [Red [Reda long-tailed duck, goosander, red-breasted merganser [Redacted]
- Great crested grebe;
- 11 wader species (oystercatcher, common sandpiper, [Redacted] , curlew, [Redacted] , turnstone, knot, sanderling, dunlin and redshank);
- 6 gull species (kittiwake, black-headed gull, common gull, great black-backed gull, herring gull and lesser black-backed gull);
- [tern species (Sandwich tern, common tern [Redacted]
- Arctic skua;
- 3 auk species (guillemot, razorbill and puffin);
  [Redacted]
- Fulmar;
- Gannet;
- 2 cormorant species (cormorant and shag); and
- Grey heron.

Table 5.2, **Table 5.3** and **Table 5.4** present peak low tide and high tide counts of the estuarine bird species recorded in each of the three sectors. The tables indicate the months in which peak counts were recorded. **Table 5.5** presents the peak low tide and high tide counts across the entirety of the study area.

Table 5.2 Peak counts in western half of study area (S1), March 2021 to March 2022

Species		Low tide (+/- 3 hr.)		High tide (+/- 3 hr.)	
		Peak count	Month	Peak count	Month
Mute swan	*Cygnus olor*	5	Jan.	9	Jan.
Eider	*Somateria mollissima*	97	Mar. '21	68	Feb.
Mallard	*Anas platyrhynchos*	47	Oct.	46	Oct.
Teal	*Anas crecca*	3	Dec.	2	Jan.
Surf scoter	*Melanitta perspicallata*	0	-	1	Apr.
Long-tailed duck	*Clangula hyemalis*	1	Jan.	0	-
Goosander	*Mergus merganser*	12	Sep.	10	Sep.
Red-breasted merganser	*Mergus serrator*	10	Mar. '21	6	Mar. '21
[Redact					
Great crested grebe	*Podiceps cristatus*	1	Jan.	2	Jan.
Oystercatcher	*Haematopus ostralegus*	29	Feb.	35	Jan.
Common sandpiper	*Actitis hypoleucos*	1	Jul.	0	-
[Redacted]					
Curlew	*Numenius arquata*	3	Feb.	0	-
Turnstone	*Arenaria interpres*	14	Dec.	14	Jan.
Redshank	*Tringa totanus*	5	Mar. '21	5	Nov.
Kittiwake	*Rissa tridactyla*	5	Apr.	1	Apr.
Black-headed gull	*Chroicocephalus ridibundus*	141	Sep.	84	Feb.
Common gull	*Larus canus*	6	Sep.	8	Sep.
Great black-backed gull	*Larus marinus*	16	Sep.	5	Feb.
Herring gull	*Larus argentatus*	699	Sep.	270	Aug.
Lesser black-backed gull	*Larus fuscus*	254	Sep.	78	Sep.
Sandwich tern	*Sterna sandvicensis*	20	Aug.	29	Aug.
Common tern	*Sterna hirundo*	9	May	1	Jul.
Arctic skua	*Stercorarius parasiticus*	1	Oct.	0	-
Guillemot	*Uria aalge*	227	Aug.	272	Aug.
Razorbill	*Alca torda*	170	Aug.	130	Aug.
Puffin	*Fratercula arctica*	3	Sep.	3	Jul.
[Redacted]					
Gannet	*Morus bassanus*	8	Apr.	6	Apr.
Shag	*Phalacrocorax aristotelis*	4	Jan.	7	Feb.
Cormorant	*Phalacrocorax carbo*	21	Aug.	8	Aug.; Oct.
Grey heron	*Ardea cinerea*	3	Oct.	1	Dec.

Table 5.3 Peak counts in eastern half of study area (S2), March 2021 to March 2022

Species		Low tide (+/- 3 hr.)		High tide (+/- 3 hr.)	
		Peak count	Month	Peak count	Month
Mute swan	*Cygnus olor*	1	Dec.	1	Jan.
Eider	*Somateria mollissima*	611	Jun.	963	Aug.
Shelduck	*Tadorna tadorna*	2	Mar. '21; Apr; Feb	4	Feb.
Mallard	*Anas platyrhynchos*	38	Nov.	15	Feb.
[Redacted]					
Goosander	*Mergus merganser*	7	Sep.	8	Sep.
Red-breasted merganser	*Mergus serrator*	28	Mar. '21	11	Mar. '21
[Redact					
Great crested grebe	*Podiceps cristatus*	2	May	0	-
Oystercatcher	*Haematopus ostralegus*	284	Mar. '21	287	Nov.
Common sandpiper	*Actitis hypoleucos*	0	-	2	Jul.
[Redacted]					
Curlew	*Numenius arquata*	10	Jul.	10	Apr.
[Redacted]					
Turnstone	*Arenaria interpres*	18	Feb.	41	Jan.
Knot	*Calidris canutus*	48	Mar. '21	47	Dec.
Sanderling	*Calidris alba*	2	Jul.	10	Dec.
Dunlin	*Calidris alpina*	270	Nov.	136	Nov.
Redshank	*Tringa totanus*	145	Dec.	187	Nov.
Kittiwake	*Rissa tridactyla*	52	Sep.	57	Sep.
Black-headed gull	*Chroicocephalus ridibundus*	790	Nov.	943	Nov.
Common gull	*Larus canus*	27	Apr.	3	Jul.
Great black-backed gull	*Larus marinus*	49	Dec.	50	Sep.
Herring gull	*Larus argentatus*	577	May	768	Sep.
Lesser black-backed gull	*Larus fuscus*	256	Sep.	363	Aug.
Sandwich tern	*Sterna sandvicensis*	58	Sep.	70	Sep.
Common tern	*Sterna hirundo*	323	Aug.	350	Aug.
Guillemot	*Uria aalge*	824	Sep.	739	Sep.
Razorbill	*Alca torda*	100	Sep.	181	Sep.
Puffin	*Fratercula arctica*	1	Jul.	0	-
[Redacted]					
Fulmar	*Fulmarus glacialis*	3	Jan.	3	Apr.

Species		Low tide (+/- 3 hr.)		High tide (+/- 3 hr.)	
		Peak count	Month	Peak count	Month
Gannet	*Morus bassanus*	45	Sep.	1	Several
Shag	*Phalacrocorax aristotelis*	53	Sep.	28	Sep.
Cormorant	*Phalacrocorax carbo*	119	Sep.	123	Sep.
Grey heron	*Ardea cinerea*	1	Apr; Sep; Jan	0	-

Table 5.4 Peak counts at S3: impounded docks and Port estate, March 2021 to March 2022

Species		Low tide (+/- 3 hr.)		High tide (+/- 3 hr.)	
		Peak count	Month	Peak count	Month
Mute swan	*Cygnus olor*	6	Nov.; Jan.	7	Jan.
Eider	*Somateria mollissima*	237	Mar. '21	242	Mar. '22
Shelduck	*Tadorna tadorna*	2	May	2	May
Mallard	*Anas platyrhynchos*	47	Oct.	40	Mar. '21
Goosander	*Mergus merganser*	6	Jul.	2	Oct.
Red-breasted merganser	*Mergus serrator*	0	-	1	Feb.
[Redact					
Oystercatcher	*Haematopus ostralegus*	3	Nov.	61	Jul.
Common sandpiper	*Actitis hypoleucos*	2	Jul.	0	-
[Redacted]					
Kittiwake	*Rissa tridactyla*	38	Aug.	44	Aug.
Black-headed gull	*Chroicocephalus ridibundus*	364	Dec.	586	Dec.
Common gull	*Larus canus*	3	Dec.	3	Dec.
Great black-backed gull	*Larus marinus*	21	Dec.	35	Oct.
Herring gull	*Larus argentatus*	689	Dec.	597	Nov.
Lesser black-backed gull	*Larus fuscus*	42	Apr.	50	Jun.
Sandwich tern	*Sterna sandvicensis*	0	-	16	Jul.
Common tern	*Sterna hirundo*	800	Jul.	*c.*2,000	May
[Redacted					
Guillemot	*Uria aalge*	6	Oct.	7	Oct.
Razorbill	*Alca torda*	5	Sep.	9	Sep.
Shag	*Phalacrocorax aristotelis*	1	Oct.; Nov.	3	Jul.
Cormorant	*Phalacrocorax carbo*	16	Nov.	23	Jul.
Grey heron	*Ardea cinerea*	2	Jul.	2	Nov.

Table 5.5 Peak counts across the entire study area, March 2021 to March 2022

Species		Low tide (+/- 3 hr.)		High tide (+/- 3 hr.)	
		Peak count	Month	Peak count	Month
Mute swan	*Cygnus olor*	8	Dec.; Jan.	17	Jan.
Eider	*Somateria mollissima*	651	Jun.	976	Aug.
Shelduck	*Tadorna tadorna*	3	May	4	Feb.
Mallard	*Anas platyrhynchos*	81	Nov.	71	Oct.
Teal	*Anas crecca*	3	Dec.	2	Jan.
[Redacted]					
Surf scoter	*Melanitta perspicallata*	0	-	1	Apr.
[Redacted					
Long-tailed duck	*Clangula hyemalis*	1	Jan.	0	-
Goosander	*Mergus merganser*	12	Sep.	10	Sep.
Red-breasted merganser	*Mergus serrator*	38	Mar. '21	17	Mar. '21
[Redact					
Great crested grebe	*Podiceps cristatus*	2	May	2	Jan.
Oystercatcher	*Haematopus ostralegus*	284	Mar. '21	289	Nov.
Common sandpiper	*Actitis hypoleucos*	2	Jul.	2	Jul.
[Redacted]					
Curlew	*Numenius arquata*	12	Jul.	10	Apr.
[Redacted]					
Turnstone	*Arenaria interpres*	26	Dec.	43	Jan.
Knot	*Calidris canutus*	48	Mar. '21	47	Dec.
Sanderling	*Calidris alba*	2	Jul.	10	Dec.
Dunlin	*Calidris alpina*	270	Nov.	136	Nov.
Redshank	*Tringa totanus*	146	Dec.	192	Nov.
Kittiwake	*Rissa tridactyla*	52	Sep.	57	Sep.
Black-headed gull	*Chroicocephalus ridibundus*	1,177	Nov.	1,534	Nov.
Common gull	*Larus canus*	27	Apr.	8	Sep.
Great black-backed gull	*Larus marinus*	72	Dec.	70	Dec.
Herring gull	*Larus argentatus*	1,303	Sep.	1,108	Sep.
Lesser black-backed gull	*Larus fuscus*	523	Sep.	441	Aug.
Sandwich tern	*Sterna sandvicensis*	69	Sep.	84	Aug.
Common tern	*Sterna hirundo*	839	Aug.	*c.*2,000	May
[Redacted					
Arctic skua	*Stercorarius parasiticus*	1	Oct.	0	-

Species		Low tide (+/- 3 hr.)		High tide (+/- 3 hr.)	
		Peak count	Month	Peak count	Month
Guillemot	*Uria aalge*	995	Sep.	826	Sep.
Razorbill	*Alca torda*	200	Aug.	209	Aug.
Puffin	*Fratercula arctica*	3	May	3	Jul.
[Redacted]					
Fulmar	*Fulmarus glacialis*	3	Jan.	3	Apr.
Gannet	*Morus bassanus*	48	Sep.	6	Apr.
Shag	*Phalacrocorax aristotelis*	53	Sep.	28	Sep.
Cormorant	*Phalacrocorax carbo*	141	Sep.	139	Sep.
Grey heron	*Ardea cinerea*	3	Oct.	2	Nov.; Dec.

The most numerous species recorded was common tern (peak count of *c*.2,000 individuals), 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 (peak count of 1,534 individuals) and herring gull (1,303 individuals), eider (976 individuals) and, during the post-migration breeding period, auks (particularly guillemot; peak count of 995 individuals). Oystercatcher was the most abundant wader species recorded in the study area (peak count of 289 individuals).

5.3 Species accounts for SPA / Ramsar / SSSI features

Of the species recorded in the study area, 32 are species that either qualify in their own right as features of the SPAs / Ramsar Site (and underpinning SSSI) listed in **Table 2.1** or are named components of qualifying assemblages. This section provides further detail on the counts and distribution of such species. Note that common tern is not included in this section; full detail for this species is instead provided in **Section 6** of this report.

Where reference is made to distribution maps, these are **Figures A.1** to **A.26** in **Appendix 2**.

[Redacted]

[Redacted]

5.3.2 Black-headed gull

Moderate to high numbers of black-headed gulls were recorded throughout the survey period (see **Table 5.7**). Highest numbers were recorded between October and February and lowest numbers between April and July. A peak count of 1,534 individuals was recorded during the second November high tide count. Distribution of this species across the overall study area, plus an indication of the behaviour observed, is illustrated in **Figure A.2**.

Black-headed gulls were recorded across the site, though loafing / roosting behaviour was particularly prominent during high tide (+/-3 hrs) counts within the impounded dock system and on quaysides within the Port, including use of the East Breakwater and the existing structure at Leith Outer Berth. Loafing / roosting behaviour was also frequently recorded on the intertidal areas in the far west (Newhaven seafront) and far east (East Sands of Leith) of the study area. Foraging activity was concentrated around the East Sands of Leith during low tide (+/-3 hr) counts, with large groups foraging at this location. Notable numbers were also observed foraging along the Newhaven seafront.

In the context of regional numbers, the peak count of 1,534 individuals represents 5.7% of the OFFSABC SPA reference population (26,835 individuals; NatureScot, 2020). Although the peak count represents more than 5% of the reference population, black-headed gull is known to be widespread and numerous throughout the Firth of Forth (SNH, 2016) and, as such, it is unlikely that the study area would have any particular importance in the context of the wider area. As such, the study area is considered to have **low regional importance** for black-headed gull.

Table 5.7 Monthly peak counts of black-headed gull, March 2021 to March 2022

Sector	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
S1	0	0	0	0	18	47	141	58	71	101	74	125	0
S2	145	1	5	7	81	179	385	684	943	647	527	537	13
S3	0	0	0	0	35	92	142	415	556	586	264	495	8
All	**145**	**1**	**5**	**7**	**100**	**236**	**489**	**1,107**	**1,534**	**871**	**755**	**851**	**20**

5.3.3 Common gull

Very low to low numbers of common gulls were recorded throughout the survey period (see **Table 5.8**). Distribution of this species across the study area and an indication of the behaviour observed is illustrated in **Figure A.3**.

Observations were principally in the east half of the study area, with very small numbers present in the impounded dock system and a small group of up to eight individuals recorded in the west half of the study area in September. A peak count of 27 individuals was recorded during the second April low tide count, which was considerably higher than any other month. This group was recorded primarily loafing / roosting at the East Sands of Leith.

Foraging behaviour was only recorded on five occasions, mostly at the East Sands of Leith and each time by groups of 1 to 3 individuals.

Common gull is widespread and numerous throughout the Firth of Forth (SNH, 2016) and, in the context of regional numbers, the peak count represents 0.2% of the OFFSABC SPA reference population (14,647 individuals; NatureScot, 2020). As such, the study area is considered to have **no regional importance** for common gull (i.e. local importance only).

Table 5.8 Monthly peak counts of common gull, March 2021 to March 2022

Sector	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
S1	0	0	0	0	0	0	8	0	0	0	0	0	0
S2	0	27	1	0	4	0	0	0	0	2	3	1	2
S3	0	0	0	0	1		1	0	0	3	2	0	0
All	**0**	**27**	**1**	**0**	**4**	**0**	**8**	**0**	**0**	**4**	**4**	**1**	**2**

[Redacted]

5.3.5 Cormorant

Cormorants were recorded in varying numbers throughout the survey period (see **Table 5.9**). Counts in August (107 individuals) and September (141 individuals) were significantly higher than all other months; lowest counts were recorded between December and May. Distribution of this species across the study area and an indication of behaviour observed is illustrated in **Figure A.5**.

The highest counts were of loafing / roosting birds recorded in the east half of the survey, particularly in the far east area (East Sands of Leith and Eastern Craigs), at the Middle Craigs and along the beach to the east of the East Breakwater. Smaller numbers were recorded in the dock system, although an old wooden pier structure near the entrance to the Victoria and Albert Docks was regularly used for loafing / roosting.

By comparison, foraging activity was recorded at a relatively low intensity, and was distributed throughout most of the marine area.

During the breeding season (April to August; Furness, 2015), a peak count of 107 individuals was recorded during the second August survey visit. In the context of regional numbers, 107 birds represent 26.8% of the Forth Islands SPA breeding season reference population (200 pairs; SNH 2016).

During the non-breeding season (September to March; Furness, 2015), a peak count of 141 individuals was recorded during the second September survey visit. The peak count represents 20.7% of the Firth of Forth

SPA non-breeding season reference population (682 individuals; NatureScot, 2018b) and 27% of the WeBS 5-year mean peak in the Forth Estuary (522 individuals; 2015/16 to 2019/20).

Monthly peaks in August and September were significantly higher than all other counts (the next highest count was 65 individuals in November). Given that August and September are at the height of the post-breeding migration period (Furness, 2015), numbers are likely to be considerably elevated by migrating birds from other regions. As such, and given the fact that cormorant is known to be widespread and common throughout the Firth of Forth (SNH, 2016), the study area is considered to have **moderate regional importance** for this species despite the peak count representing more than 20% of the reference population.

Table 5.9 Monthly peak counts of cormorant, March 2021 to March 2022

Sector	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
S1	5	3	5	5	4	21	8	8	5	4	3	3	1
S2	10	9	13	38	47	103	123	43	48	10	5	11	2
S3	0	0	1	4	23	0	14	10	16	1	2	1	4
All	**15**	**10**	**16**	**43**	**51**	**107**	**141**	**46**	**65**	**12**	**8**	**15**	**6**

5.3.6 Curlew

Very low to low numbers of curlew were recorded throughout the survey period (see **Table 5.10**), with absence in some months. A peak count of 12 loafing / foraging individuals was recorded during the second July low tide count. Distribution of this species across the study area and an indication of the behaviour observed is illustrated in **Figure A.6**.

Observations were almost entirely in the eastern half of the survey (very small numbers were recorded at the west end of the study area). Generally speaking, at high tide birds were recorded along the upper foreshore of the beach between East Breakwater and Middle Craigs. At low tide, birds were predominantly recorded foraging on the intertidal rock and soft sediment at Middle Craigs and East Sands of Leith, in the far east of the study area.

Curlew is widespread and numerous throughout the Firth of Forth (SNH, 2016). In the context of regional numbers, the peak count of 12 individuals represents 0.6% of the Firth of Forth SPA reference population (1,928 individuals; SNH, 2016) and 0.4% of the WeBS 5-year mean peak in the Forth Estuary site (3,392 individuals; 2015/16 to 2019/20). As such, the study area is considered to have **no regional importance** for curlew.

Table 5.10 Monthly peak counts of curlew, March 2021 to March 2022

Sector	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
S1	0	0	0	0	2	0	0	0	0	0	0	3	0
S2	2	10	1	0	10	0	6	6	6	2	7	4	7
All	**2**	**10**	**1**	**0**	**12**	**0**	**6**	**6**	**6**	**2**	**7**	**7**	**7**

5.3.7 Dunlin

Dunlin was absent from the site for most of the year. Very low to low numbers were present in September and December. In November, however, a large group of 270 individuals was recorded during the second count of the month (see **Table 5.11**). Distribution of this species across the study area and an indication of the behaviour observed is illustrated in **Figure A.7**.

Dunlin were recorded almost exclusively from the East Sands of Leith, at the far east of the study area. Foraging groups were recorded at low tide on the intertidal soft sediment, whilst at high tide (+/-3 hrs) the groups were recorded loafing / roosting at the Eastern Craigs.

Dunlin are known to be widespread and numerous throughout the Firth of Forth (SNH, 2016, and in the context of regional numbers, the peak count of 270 individuals represents 2.8% of the Firth of Forth SPA reference population (9,514 individuals; SNH, 2016) and 4.5% of the WeBS 5-year mean peak in the Forth Estuary (6,061 individuals; 2015/16 to 2019/20). As such, the study area is considered to have **low regional importance** for dunlin.

Table 5.11 Monthly peak counts of dunlin, March 2021 to March 2022

Sector	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
S2	0	0	0	0	0	0	16	0	270	2	0	0	0
All	**0**	**0**	**0**	**0**	**0**	**0**	**16**	**0**	**270**	**2**	**0**	**0**	**0**

5.3.8 Eider

Eider were ubiquitous throughout the survey period and were the most abundant waterfowl species recorded (see **Table 5.12**). Highest numbers were observed from June to September, with numbers then reducing over the winter months. A peak count of 976 roosting, loafing and foraging individuals was recorded at high tide (+/- 3 hrs) during the first August survey visit. Distribution of this species across the study area and an indication of the behaviour observed is illustrated in **Figure A.8**.

Eider sightings were distributed across the entirety of the study area, in offshore, nearshore and intertidal habitats as well as within the impounded dock system. Large groups of loafing / roosting eider were recorded regularly around the East Breakwater, along the Middle Craigs and Eastern Craigs, and at the East Sands of Leith. Comparatively large numbers were also recorded loafing / roosting in sheltered waters within the Port, particularly at Imperial Dock.

Foraging activity was mainly recorded offshore, at a distance of *c*.500m or more offshore, generally in the eastern half of the study area, with only small groups or individuals recorded foraging in nearshore areas.

In the context of regional numbers, the peak count represents 10.4% of the Firth of Forth SPA reference population (9,400 individuals; NatureScot, 2018b) and 19.4% of the WeBS 5-year mean peak in the Forth Estuary (5,018 individuals; 2015/16 to 2019/20). As such, the study area is considered to have **moderate regional importance** for eider; however, eider is known to be common in the outer Firth of Forth and, furthermore, counts in late summer / early autumn are likely to be inflated by the presence of young birds (SNH, 2016).

Eider is a named component of the qualifying non-breeding waterbird assemblage of the OFFSABC SPA. The peak count of 976 individuals represents 4.5% of the SPA reference population (21,546 individuals; NatureScot, 2020).

Table 5.12 Monthly peak counts of eider, March 2021 to March 2022

Sector	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
S1	97	52	28	17	18	35	22	20	5	48	45	69	88
S2	198	120	171	666	456	963	522	96	18	237	156	107	237
S3	237	36	58	45	147	35	17	9	3	4	7	8	242
All	**414**	**154**	**213**	**703**	**542**	**976**	**540**	**105**	**21**	**255**	**182**	**135**	**495**

5.3.9 Gannet

Very low to moderate numbers of gannet were recorded in April, August, September and October (coinciding with migration periods), and were absent at all other times (see **Table 5.13**). Distribution of this species across the study area and an indication of the behaviour observed is illustrated in **Figure A.9**.

Gannets were generally recorded at a distance of *c.*1km or more offshore, either loafing on the water or foraging. Small numbers were recorded in nearshore areas, particularly around the Middle Craigs in the eastern side of the study area.

A peak count of 48 loafing individuals was recorded at high tide (+/- 3 hrs) during the first September survey visit. Gannet is locally numerous in the outer Firth of Forth (SNH, 2016), and in the context of regional numbers the peak count represents 0.1% of the Forth Islands SPA reference population (21,600 pairs; SNH, 2016) and 0.4% of the OFFSABC SPA reference population (10,945 individuals; NatureScot, 2020). As such, the study area is considered to have **no regional importance** for gannet (i.e. local importance only).

Table 5.13 Monthly peak counts of gannet, March 2021 to March 2022

Sector	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
S1	0	8	0	0	0	0	3	0	0	0	0	0	0
S2	0	0	0	0	0	6	45	1	0	0	0	0	1
All	**0**	**8**	**0**	**0**	**0**	**6**	**48**	**1**	**0**	**0**	**0**	**0**	**1**

[Redacted]

[Redacted]

5.3.11 Great crested grebe

Very low numbers of great crested grebe were recorded loafing and foraging offshore in May, December and January (see **Table 5.15**). In the west half of the study area (S1) a peak count of two (one foraging, one loafing) was recorded during the second January high tide count. In the east half of the study area (S2) the only record was two loafing individuals during the second low tide count in May. In the context of regional numbers, the peak count represents 0.3% of the Firth of Forth SPA reference population (720 individuals; SNH, 2016) and 2.4% of the WeBS 5-year mean peak in the Forth Estuary site (85 individuals; 2015/16 to 2019/20). As such, the study area is considered to have **no to low regional importance** for great crested grebe.

Table 5.15 Monthly peak counts of great crested grebe, March 2021 to March 2022

Sector	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
S1	0	0	0	0	0	0	0	0	0	1	2	0	0
S2	0	0	2	0	0	0	0	0	0	0	0	0	0
All	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**2**	**0**	**0**

5.3.12 Guillemot

For most of the year, guillemot were either absent from the study area or present only in low to very low numbers (see **Table 5.16**). However, high numbers were recorded during the months of August and September, which coincides with the post-migration breeding season. A peak count of 995 individuals, primarily loafing offshore, was recorded at low tide (+/- 3 hrs) during the first September survey visit. Distribution of this species across the study area and an indication of the behaviour observed is illustrated in **Figure A.11**.

Almost all guillemot recorded in the study area were displaying loafing behaviour. Sightings were distributed across the marine area out to a distance of c.1km offshore, though it may be that birds further offshore were difficult to see. Large groups of guillemot together on the sea were most regularly recorded in the central part of the study area near to the entrance to the Port, although reasonably sized groups were seen in marine areas both in the west and east of the study area.

Guillemot is locally numerous in the outer Firth of Forth (SNH, 2016), and in the context of regional numbers the peak count represents 2.6% of the Forth Islands SPA reference population (16,000 pairs; SNH, 2016) and 2.9% of the OFFSABC SPA reference population (28,123 individuals; NatureScot, 2020). August and September are at the height of the post-breeding migration period in UK waters (Furness, 2015), when numbers are likely to be considerably elevated by migrating birds from other regions. Outside of these months, abundance in the study area was very low. As such, the study area is considered to have **no to low regional importance** for guillemot.

Table 5.16 Monthly peak counts of guillemot, March 2021 to March 2022

Sector	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
S1	0	0	1	0	2	272	167	13	3	0	0	0	0
S2	0	1	1	0	0	132	824	8	1	0	0	0	0
S3	0	0	0	0	0	0	6	7	0	0	0	0	0
All	**0**	**0**	**2**	**0**	**2**	**404**	**995**	**26**	**4**	**0**	**0**	**0**	**0**

5.3.13 Herring gull

Herring gulls were ubiquitous throughout the survey period and were present in reasonably high numbers each month (see **Table 5.17**). A peak count of 1,303 individuals was recorded during the first September survey visit. Distribution of this species across the study area and an indication of the behaviour observed is illustrated in **Figure A.12**.

Loafing / roosting birds were observed on a regular basis across the entirety of the shoreline and nearshore in the study area and within all areas of the impounded dock system. Groups of birds were present on the quaysides and within the Port estate itself. Large numbers were also recorded loafing in offshore areas.

Foraging activity was concentrated in intertidal / nearshore areas at Middle Craigs, Eastern Craigs and the East Sands of Leith at low tide (+/-3 hrs), all of which are near to the eastern boundary of the study area. Lower intensity foraging activity was also recorded along the shoreline at Newhaven, in the western half of the study area. Reasonably large groups of birds were also recorded foraging in offshore areas.

During the breeding season (March to August; Furness, 2015), a peak count of 879 individuals was recorded during the second August survey visit. In the context of regional numbers, 879 birds represents 6.6% of the Forth Islands SPA breeding season reference population (6,600 pairs; SNH 2016). During the non-breeding season (September to February; Furness, 2015), a peak count of 1,303 individuals was recorded during the first September survey visit. The peak count represents 10.6% of the OFFSABC SPA non-breeding season reference population (12,313 individuals; NatureScot, 2020). Although the peak count represents more than 5% of the reference population, herring gull is known to be widespread and numerous throughout the Firth of Forth (SNH, 2016) and, as such, it is unlikely that the study area would have any particular importance in the context of the wider area. As such, the study area is considered to have **low regional importance** for herring gull.

Table 5.17 Monthly peak counts of black-headed gull, March 2021 to March 2022

Sector	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
S1	119	75	74	52	64	270	699	76	166	93	48	68	78
S2	144	201	577	357	260	560	768	145	409	316	316	123	448
S3	64	45	55	135	28	105	113	113	597	689	410	386	497
All	**302**	**303**	**666**	**419**	**345**	**879**	**1,303**	**299**	**973**	**847**	**632**	**577**	**953**

5.3.14 Kittiwake

Kittiwakes were absent, or present in low to very low numbers, throughout most of the year (see **Table 5.18**); however, higher numbers were recorded specifically in August and September (which coincides with the post-breeding migration season (Furness, 2015). A peak count of 57 roosting / loafing individuals was recorded during the first September survey visit. Distribution of this species across the study area and an indication of the behaviour observed is illustrated in **Figure A.13**.

When present in August and September, kittiwake abundance was, for the most part, accounted for by groups of resting birds present on the existing structures at Leith Outer Berth and along the western wall of the entrance lock to the Port, at both high and low tide. It is likely that these structures were used as a resting point for groups of post-breeding passage birds. Foraging activity was mainly recorded in low numbers offshore.

Kittiwake is widespread and locally numerous in the outer Forth Estuary (SNH, 2016) and, in the context of regional numbers, the peak count of 57 individuals represents 0.3% of the Forth Islands SPA reference population (8,400 pairs; SNH, 2016). As such, the study area is considered to have **no regional importance** for kittiwake (i.e. local importance only).

Kittiwake is a named component of the qualifying breeding and non-breeding seabird assemblages of the OFFSABC SPA. The peak count during the breeding season (March to August; Furness, 2015) represents 0.4% of the SPA breeding season reference population (12,020 individuals; NatureScot, 2020). The peak count during the non-breeding season (September to February; Furness, 2015) represents 1.8% of the SPA non-breeding season reference population (3,191 individuals; NatureScot, 2020).

Table 5.18 Monthly peak counts of kittiwake, March 2021 to March 2022

Sector	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
S1	0	5	0	0	0	0	0	2	0	0	0	0	0
S2	0	33	7	0	0	0	57	0	0	0	0	0	0
S3	0	0	0	0	0	44	0	0	0	0	0	0	0
All	**0**	**34**	**7**	**0**	**0**	**44**	**57**	**2**	**0**	**0**	**0**	**0**	**0**

5.3.15 Knot

Knot were recorded in varying numbers in Mar, April, July and December, and were absent at all other times (see **Table 5.19**). A peak count of 48 foraging individuals was recorded at low tide (+/-3 hrs) during the second March survey visit. Distribution of this species across the study area and an indication of the behaviour observed is illustrated in **Figure A.14**.

Observations were exclusively in the eastern half of the survey, with almost all recorded at East Sands of Leith (in the far east of the study area). At high tide, birds were recorded along the upper shore, while at low tide birds were recorded foraging on the intertidal soft sediment.

Knot is widespread and locally numerous in the Firth of Forth (SNH), and in the context of regional numbers the peak count of 48 individuals represents 0.5% of the Firth of Forth SPA reference population (9,258 individuals; SNH, 2016) and 1.4% of the WeBS 5-year mean peak in the Forth Estuary (3,370 individuals; 2015/16 to 2019/20). As such, the study area is considered to have **no to low regional importance** for knot.

Table 5.19 Monthly peak counts of knot, March 2021 to March 2022

Sector	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
S2	48	11	0	0	2	0	0	0	0	47	0	0	13
All	**48**	**11**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**47**	**0**	**0**	**13**

Royal HaskoningDHV

5.3.16 Lesser black-backed gull

Lesser black-backed gull numbers recorded in the study area were highly variable throughout the survey period (see **Table 5.20**). During the main winter months of December to February, this species was absent. Low to moderate numbers were present in spring, early summer and autumn; however, significantly higher numbers were present in August (441 individuals) and September (523 individuals). Distribution of this species across the study area and an indication of the behaviour observed is illustrated in **Figure A.15**.

Lesser black-backed gulls were observed across the entirety of the study area, particularly in nearshore and coastal areas, as well as within the impounded dock system. Distribution of roosting / loafing birds appeared to be fairly even across the study area, although notably large groups were present within the dock system, particularly Edinburgh Dock and the Western Harbour, on the Middle Craigs rocky outcrop and the beach at East Sand of Leith, and along the East Breakwater.

Foraging numbers were lower, and mostly recorded at low tide. The distribution of foraging activity was concentrated around the intertidal habitat at the East Sands of Leith, Middle Craigs and Eastern Craigs, near to the eastern boundary of the study area.

During the breeding season (April to August; Furness, 2015), a peak count of 441 individuals was recorded during the second August survey visit. In the context of regional numbers, 441 birds represents 14.7% of the Forth Islands SPA reference population (1,500 pairs; SNH 2016). During the non-breeding season (September to February; Furness, 2015), a peak count of 523 individuals was recorded during the first September survey visit, representing 17.4% of the reference population. While these counts exceed 5% of the regional reference population, monthly peaks in August and September were significantly higher than all other counts and, given that this is the height of the post-breeding migration period in UK waters (Furness, 2015), numbers are likely to be considerably elevated by migrating birds from other regional populations. As such, and given the fact that lesser black-backed gull is known to be widespread and numerous throughout the Forth Estuary (SNH, 2016), the study area is considered to have **low regional importance** for this species.

Table 5.20 Monthly peak counts of lesser black-backed gull, March 2021 to March 2022

Sector	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
S1	4	6	16	14	5	34	254	6	3	0	0	0	0
S2	28	51	52	42	11	363	256	22	0	0	0	0	1
S3	7	42	27	50	31	44	33	20	3	0	0	0	13
All	**35**	**75**	**62**	**76**	**35**	**441**	**523**	**43**	**6**	**0**	**0**	**0**	**13**

5.3.17 Long-tailed duck

A single long-tailed duck was recorded foraging on the sea off Newhaven during the second January low tide count. Given that this was an isolated record, it is likely that it was an incidental sighting of a migrating individual. Regardless, in the context of regional numbers, the peak count represents 0.1% of the Firth of Forth SPA reference population (1,045 individuals; SNH, 2016) and 0.6% of the WeBS 5-year mean peak in the Forth Estuary (181 individuals; 2015/16 to 2019/20). As such, the study area is considered to have **no regional importance** for long-tailed duck (i.e. local importance only).

Although a named feature of the qualifying non-breeding waterbird assemblage of the OFFSABC SPA, one individual represents 0.05% of the SPA reference population (1,948 individuals; NatureScot, 2020).

5.3.18 Mallard

Low to moderate numbers of mallard were recorded year-round, with a peak count of 81 individuals recorded at low tide (+/- 3 hrs) during the second November survey visit (see **Table 5.21**). Distribution of this species across the study area and an indication of the behaviour observed is illustrated in **Figure A.16**.

Mallards were mainly recorded within the impounded dock system, with observations of loafing / roosting individuals in Edinburgh Dock, Victoria Dock, Imperial Dock and particularly Albert Dock and the Western Harbour. Foraging and resting mallards were also regularly associated with the small scrapes on the brownfield land just to the south of the West Breakwater lighthouse. Mallards were rarely recorded along the shoreline outside of the Port, although a group of 38 individuals was recorded together on the intertidal soft sediment habitat near to Middle Craigs, in the eastern half of the study area, during the second November survey visit.

In the context of regional numbers, the peak count of 81 individuals represents 3.2% of the Firth of Forth SPA reference population (2,564 individuals; SNH, 2016). While 81 individuals represents 7.0% of the WeBS 5-year mean peak in the Forth Estuary (1,164 individuals; 2015/16 to 2019/20), mallard is widespread and common throughout the Firth of Forth (SNH, 2016). As such, the study area is considered to have **low regional importance** for mallard.

Table 5.21 Monthly peak counts of mallard, March 2021 to March 2022

Sector	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
S1	6	8	13	22	11	17	45	47	41	36	31	25	6
S2	0	0	0	0	0	0	0	8	38	0	0	15	1
S3	40	1	14	8	26	0	0	47	33	13	2	30	8
All	**44**	**9**	**25**	**28**	**34**	**17**	**45**	**75**	**81**	**48**	**31**	**55**	**15**

5.3.19 Oystercatcher

Moderate to relatively high numbers of oystercatcher were present in the survey year-round (see **Table 5.22**), with the highest numbers recorded during the wintering season. A peak count of 289 roosting / loafing individuals was recorded at high tide (+/- 3 hrs) during the first November survey visit. Distribution of this species across the study area and an indication of behaviour observed is illustrated in **Figure A.17**.

Oystercatchers were recorded along the shoreline across most the study area. The largest numbers recorded were at high tide (+/-3 hrs), when loafing / roosting behaviour was the main activity observed. Resting birds, including large groups of birds, were distributed mainly along the foreshore in the eastern half of the study area, between East Breakwater and the eastern boundary of the study area. The highest densities were recorded at the East Sands of Leith (near the eastern boundary).

Foraging activity was primarily recorded on soft sediment and rocky outcrop habitats at low tide (+/-3 hrs). The most regularly used habitats were those at East Sands of Leith and Middle and Eastern Craigs, near the eastern boundary of the study area. Foraging birds were also present in smaller numbers along the Newhaven shoreline (in the western half of the study area) as well as on the beach to the east of East Breakwater.

Oystercatcher is widespread and numerous throughout the Firth of Forth (SNH, 2016) and, in the context of regional numbers, the peak count of 289 individuals represents 3.7% of the Firth of Forth SPA reference population (7,846 individuals; SNH, 2016) and 4.2% of the WeBS 5-year mean peak in the Forth Estuary

(6,782 individuals; 2015/16 to 2019/20). As such, the study area is considered to have **low regional importance** for oystercatcher.

Table 5.22 Monthly peak counts of oystercatcher, March 2021 to March 2022

Sector	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
S1	3	2	3	2	5	18	12	8	11	26	35	29	0
S2	284	90	71	67	131	138	271	208	287	197	163	147	164
S3	0	0	0	0	61	1	0	0	3	0	2	0	0
All	**284**	**90**	**74**	**69**	**131**	**156**	**277**	**214**	**289**	**197**	**198**	**168**	**164**

5.3.20 Puffin

Very low numbers of puffins were recorded loafing offshore in May and July (see **Table 5.23**). In the west half of the study area (S1) a peak count of three was recorded in both months. In the east half of the study area (S2) a single loafing individual was recorded during the first low tide count in July. Although a qualifying breeding feature of the Forth Islands SPA, the peak count of three individuals represents 0.01% of the SPA reference population (14,000 pairs; NatureScot, 2018a). Puffin is also a named component of the qualifying breeding seabird assemblage of the OFFSABC SPA; however, three individuals represent less than 0.01% of the SPA reference population (61,086 individuals; NatureScot 2020). The study area is considered to have **no regional importance** for puffin.

Table 5.23 Monthly peak counts of puffin, March 2021 to March 2022

Sector	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
S1	0	0	3	0	3	0	0	0	0	0	0	0	0
S2	0	0	0	0	1	0	0	0	0	0	0	0	0
All	**0**	**0**	**3**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

5.3.21 Razorbill

Razorbills were present in relatively high numbers during the post-breeding migration period (August and September), and much lower numbers at all other times of the year (see **Table 5.24**). They were absent from the site during the migration-free breeding period (May to July; Furness, 2015). A peak count of 209 individuals, primarily loafing offshore, was recorded at high tide (+/- 3 hrs) during the second August survey visit. Distribution of this species across the study area and an indication of the behaviour observed is illustrated in **Figure A.18**.

Almost all birds recorded were loafing on the water, with very few observed foraging. Observations were distributed across the study area, with groups present in both offshore and nearshore areas. Highest concentrations were recorded near the entrance to the Port and off the West Breakwater. Small numbers were recorded in the impounded dock system, in the western harbour.

Razorbill is locally numerous in the outer Firth of Forth (SNH, 2016), and in the context of regional numbers the peak count represents 7.5% of the Forth Islands SPA reference population (1,400 pairs; SNH, 2016) and 3.8% of the OFFSABC SPA reference population (5,481 individuals; NatureScot, 2020). August and September are at the height of the post-breeding migration period in UK waters (Furness, 2015), when numbers are likely to be considerably elevated by migrating birds from other regions. Outside of these months, abundance in the study area was very low. As such, the study area is considered to have **no to low regional importance** for razorbill.

Table 5.24 Monthly peak counts of razorbill, March 2021 to March 2022

Sector	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
S1	0	19	0	0	0	170	19	18	1	1	0	0	1
S2	0	1	0	0	0	79	181	0	2	2	0	0	3
S3	0	0	0	0	0	0	9	3	0	0	0	0	0
All	**0**	**19**	**0**	**0**	**0**	**209**	**203**	**21**	**3**	**2**	**0**	**0**	**4**

5.3.22 Red-breasted merganser

Red-breasted merganser were absent from the study area between May and September and were present in low numbers in April and October to December. Higher counts were recorded between January and March, with a peak of 38 roosting / loafing individuals recorded at low tide (+/- 3 hrs) during the second March survey visit (see **Table 5.25**). Distribution of this species across the study area and an indication of the behaviour observed is illustrated in **Figure A.19**.

Both foraging and loafing / roosting activity was recorded in nearshore and offshore areas throughout the study area, although with concentrations notably increasing towards the east and west boundaries of the study area (perhaps to avoid vessel traffic to and from the Port). In nearshore areas, resting and foraging individuals were recorded in highest numbers between Middle Craigs and Eastern Craigs.

Red-breasted merganser is widespread across the Firth of Forth (SNH, 2016); however, in the context of regional numbers, the peak count of 38 individuals represents 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). As such, the study area is considered to have **moderate regional importance** for red-breasted merganser.

Red-breasted merganser is a named component of the qualifying non-breeding waterbird assemblage of the OFFSABC SPA. The peak count of 38 individuals represents 8.8% of the SPA reference population (431 individuals; NatureScot, 2020).

Table 5.25 Monthly peak counts of red-breasted merganser, March 2021 to March 2022

Sector	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
S1	10	4	0	0	0	0	0	0	2	5	4	4	7
S2	28	1	0	0	0	0	0	8	8	3	21	6	2
S3	0	0	0	0	0	0	0	0	0	0	0	1	0
All	**38**	**5**	**0**	**0**	**0**	**0**	**0**	**8**	**8**	**6**	**24**	**9**	**7**

5.3.23 Redshank

Redshank were recorded in varying numbers throughout the survey period, and in some months were absent from the site (see **Table 5.26**). A peak count of 192 foraging individuals was recorded at high tide (+/- 3 hrs) during the second November survey visit. Distribution of this species across the study area and an indication of the behaviour observed is illustrated in **Figure A.20**.

Although redshank were recorded along much of the coastline in the study area, including small numbers along the foreshore near to Newhaven, the vast majority of individuals – notably large groups of 100+ birds – were recorded at the East Sands of Leith (in the far east of the study area). Elsewhere, birds were recorded singly or in very small groups. Foraging activity was primarily recorded at low tide (+/-3 hrs) on intertidal soft sediment and rocky outcrops such as Eastern Craigs. Loafing / roosting activity was generally recorded at high tide (+/-3 hrs) with the highest numbers observed along the upper shore at East Sands of Leith.

Redshank are widespread and numerous throughout the Firth of Forth (SNH, 2016) and, in the context of regional numbers, the peak count of 192 individuals represents 4.4% of the Firth of Forth SPA reference population (4,341 individuals; SNH, 2016) and 3.9% of the WeBS 5-year mean peak in the Forth Estuary site (4,932 individuals; 2015/16 to 2019/20). As such, the study area is considered to have **low regional importance** for redshank.

Table 5.26 Monthly peak counts of redshank, March 2021 to March 2022

Sector	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
S1	5	0	0	0	0	4	0	1	5	1	1	2	0
S2	80	80	0	0	0	4	52	139	187	145	66	111	23
All	**80**	**80**	**0**	**0**	**0**	**4**	**52**	**139**	**192**	**146**	**66**	**111**	**23**

[Redacted]

[Redacted]

5.3.27 Sandwich tern

Sandwich terns were only recorded in summer / early autumn (July to October), with significantly higher counts in August (84 individuals) and September (70 individuals) (see **Table 5.29**). Distribution of this species across the study area and an indication of the behaviour observed is illustrated in **Figure A.23**.

Most birds were recorded loafing / roosting at high tide (+/-3 hrs) on the upper shore at East Sands of Leith, with smaller numbers recorded loafing along the shoreline near Newhaven. There were no records of loafing / roosting activity within the Port estate or near to Leith Outer Berth. Foraging activity was recorded nearshore throughout the study area, but generally in very low numbers. Slightly larger groups were recorded foraging in the far west of the study area.

During the return migration period and the migration-free breeding season (March to May and June, respectively; Furness, 2015), Sandwich terns were absent from the study area. The highest counts, in the second August survey visit and first September survey visit, fell within the post-breeding migration period. In the context of regional numbers, the peak count of 84 individuals represents 5.2% of the Firth of Forth SPA passage reference population (1,617 individuals; SNH 2016). Although marginally above the 5% threshold, Sandwich terns are common and widespread in the outer Firth of Forth (SNH, 2016), hence the study area is considered to have **low regional importance** for this species.

Table 5.29 Monthly peak counts of Sandwich tern, March 2021 to March 2022

Sector	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
S1	0	0	0	0	1	29	11	4	0	0	0	0	0
S2	0	0	0	0	0	55	70	4	0	0	0	0	0
S3	0	0	0	0	16	0	0	0	0	0	0	0	0
All	**0**	**0**	**0**	**0**	**16**	**84**	**70**	**4**	**0**	**0**	**0**	**0**	**0**

5.3.28 Shag

Shag were present in varying numbers throughout the year, although generally relatively low in abundance. However, a peak count of 53 individuals, recorded during the first September survey visit, was considerably greater than in any other month (see **Table 5.30**). Distribution of this species across the study area and an indication of the behaviour observed is illustrated in **Figure A.24**.

Foraging activity was widely spread across the entire marine extent within the study area (including a couple of instances within the impounded dock system) and was recorded during both low tide and high tide counts. Roosting / loafing birds tended to frequent the eastern half of the study area, particularly on the rocky outcrops at Middle Craigs and Eastern Craigs but also along the shoreline near to the East Breakwater.

Shag is a qualifying breeding feature of the Forth Islands SPAs and the OFFSABC SPA. It is also a named component of the qualifying non-breeding seabird assemblage of the OFFSABC SPA.

During the breeding season (February to August; Furness, 2015), a peak count of eight individuals was recorded in February and March. In the context of regional numbers, eight birds represent 0.2% of the Forth Islands SPA breeding season reference population (2,400 pairs; SNH 2016). As such, the study area is considered to have **no regional importance** during the breeding season.

During the non-breeding season (September to March; Furness, 2015), a peak count of 53 individuals was recorded during the first September survey visit. The peak count represents 2.2% of the OFFSABC SPA non-breeding season reference population (2,426 individuals; NatureScot, 2020). As such, and given the fact that shag is known to be widespread and common in the outer Firth of Forth, particularly in late summer when moulting birds are present in the estuary (SNH, 2016), the study area is considered to have **no to low regional importance** for this species during the non-breeding season.

Table 5.30 Monthly peak counts of shag, March 2021 to March 2022

Sector	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
S1	0	3	1	0	0	0	0	0	0	3	4	7	1
S2	8	4	2	2	3	0	53	20	8	12	14	8	1
S3	0	0	0	0	3	0	0	1	1	0	0	0	0
All	**8**	**7**	**2**	**2**	**3**	**0**	**53**	**21**	**9**	**15**	**15**	**11**	**2**

5.3.29 Shelduck

Shelduck was only recorded in very low numbers between March and June, and again in January and February, and was absent at all other times of the year (see **Table 5.31**). A peak count of only four individuals was recorded at high tide (+/- 3 hrs) during the second February survey visit. Distribution of this species across the study area and an indication of the behaviour observed is illustrated in **Figure A.25**.

Apart from two birds loafing within the western harbour, all were recorded in the eastern half of the study area, primarily at or seaward of the East Sands of Leith (located in the far east of the study area). Most were recorded loafing, with some displaying foraging activity on the intertidal soft sediment at low tide (+/-3 hrs).

Shelduck are widespread and numerous in the Firth of Forth (SNH, 2016) and, in the context of regional numbers, the peak count of four individuals represents 0.1% of the Firth of Forth SPA reference population (4,509 individuals; SNH, 2016) and 0.1% of the WeBS 5-year mean peak in the Forth Estuary (3,628 individuals; 2015/16 to 2019/20). As such, the study area is considered to have **no regional importance** for shelduck (i.e. local importance only).

Table 5.31 Monthly peak counts of shelduck, March 2021 to March 2022

Sector	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
S2	2	2	1	1	0	0	0	0	0	0	1	4	0
S3	0	0	2	0	0	0	0	0	0	0	0	0	0
All	**2**	**2**	**3**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**4**	**0**

5.3.30 Turnstone

Turnstone were recorded in varying numbers throughout the survey period, but were largely absent from the site during the summer months of May to August (see **Table 5.32**). A peak count of 43 roosting / loafing individuals was recorded at high tide (+/-3 hrs) during the first January survey visit. Distribution of this species across the study area and an indication of the behaviour observed is illustrated in **Figure A.26**.

Turnstone were recorded along most of the shoreline in the study area, although were absent from the promenade / West Breakwater and within the dock system. Areas of activity included the foreshore at Newhaven, the beach to the east of the East Breakwater and the East Sands of Leith. The latter, in the far east of the study area, was where the largest groups were recorded. Foraging was the predominant activity displayed. Highest numbers were generally recorded at high tide, when both foraging and loafing activity was exhibited. At low tide, birds were generally recorded foraging.

Turnstone is locally common in the outer Firth of Forth (SNH, 2016). In the context of regional numbers, the peak count represents 5.0% of the Firth of Forth SPA reference population (860 individuals; SNH, 2016) and 6.3% of the WeBS 5-year mean peak in the Forth Estuary site (680 individuals; 2015/16 to 2019/20). As such, the study area is considered to have **low to moderate regional importance** for turnstone.

Table 5.32 Monthly peak counts of turnstone, March 2021 to March 2022

Sector	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
S1	2	12	1	0	0	0	3	7	2	14	14	8	6
S2	5	8	3	0	1	0	19	35	12	16	41	18	8
All	**5**	**14**	**4**	**0**	**1**	**0**	**19**	**42**	**14**	**26**	**43**	**25**	**8**

[Redacted]

5.4 Summary of importance in a regional context

As described in the species-specific accounts, several SPA / Ramsar Site features (and named component species of qualifying assemblages) were recorded in the study area in numbers that are considered to have some level of regional importance (i.e. low, medium or high importance). A summary of the distribution,

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seasonality and importance (in a regional context) of those species is presented in **Table 5.33**. 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).

Table 5.33 Summary of importance (in a regional context) of the study area for species recorded in the 2021-22 survey

Species	Abundance (min to max.)	Main distribution and behaviour when present	Seasons present in notable numbers	Importance in regional context (see Appendix 11.1)
[Redacted]				
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
Dunlin	0 – 270	Almost exclusively foraging / loafing at East Sands of Leith	Autumn passage (Nov.)	Low
Eider	21 – 976	Loafing / roosting activity across the study area, particularly around East Breakwater and the eastern shoreline. Foraging activity focused offshore.	All year (highest numbers during breeding season (Jun. to Sep.))	Moderate
[Redacted]				
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
Mallard	9 – 81	Loafing / roosting within the impounded dock system, plus associated with three small scrapes near West Breakwater.	All year	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
Red-breasted merganser	0 – 38	Loafing and foraging activity concentrated both nearshore	Non-breeding season (Oct. to Apr.)	Moderate

Species	Abundance (min to max.)	Main distribution and behaviour when present	Seasons present in notable numbers	Importance in regional context (see Appendix 11.1)
		and offshore towards the west and east boundaries of the study area.		
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

[Redacted]

Species	Abundance (min to max.)	Main distribution and behaviour when present	Seasons present in notable numbers	Importance in regional context (see Appendix 11.1)
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
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

5.5 Other notable species of conservation interest

Alongside the SPA / Ramsar site / SSSI features documented in **Sections 5.3** and **5.4**, above, a number of other estuarine species of conservation interest were recorded using the study area between March and September 2021. This included one Annex I and Schedule 1 species[1]:

[Redacted]

A single peregrine (listed as an Annex I and Schedule 1 species) was recorded flying through the study area in September, though did not interact with the site.

Additionally, a single Arctic skua was recorded foraging offshore during the first October survey visit and is likely to be an incidental sighting. This is not an Annex I or Schedule 1 species; however, it is on the red list of the Birds of Conservation Concern 5 (BoCC5) (Stanbury *et al.*, 2021).

5.6 Incidental records of potential nesting activity

While the estuarine bird survey was not intended as (nor should it be interpreted as) a survey of nesting activity within the Port (common tern colony counts notwithstanding), the timing of the surveys between March and September was such that incidental observations indicating breeding / nesting activity could also be recorded.

[1] *Afforded protection under Annex I of Directive 2009/147/EC on the conservation of wild birds ('the Birds Directive') and Schedule 1 to the Wildlife and Countryside Act 1981, as amended.*

The following observations were noted:

- From May to September, a pair of mute swans with four cygnets were regularly recorded in the freshwater pools at Lighthouse Park, near to the West Breakwater;
- A further mute swan with six cygnets was recorded in Albert Dock Basin in May;
- In May and June, mallards with ducklings were recorded in the freshwater pools at Lighthouse Park, near to the West Breakwater; and,
- Two eiders, each with ducklings, were recorded in the Outer Harbour / Western Harbour in June.

6 Tern survey results

Colony counts and flight surveys at Imperial Dock Lock, Leith SPA, within the Port, were undertaken twice a month from May to July 2021. Survey dates are listed in **Table 6.1**.

Table 6.1 Common tern survey dates

Survey Month	Visit 1	Visit 2
May 2021	1st / 2nd	29th / 30th
June 2021	10th / 11th	19th / 20th
July 2021	3rd / 4th	17th / 18th

6.1 Colony counts

During the 2021 common tern survey, breeding activity was first recorded at the colony during the survey visit on 1-2nd May, when eight AONs were recorded. By the time of the second colony count, undertaken on 30-31st May, there were 264 AONs, which represented the peak count over the entire survey period. The number of AONs recorded decreased through June and July, with approximately 14 AONs remaining during the final colony count on 17-18th July. The peak count of 264 AONs is below the SPA citation population of 558 pairs; however, NatureScot and the Scottish Environmental Protection Agency (SEPA) currently class the SPA as being in 'favourable' condition[2].

During the 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 within the dock system itself), indicating that most birds from the colony appeared to commute outside the study area to forage. Common terns have a mean-maximum flight 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).

Following completion of the tern colony survey, common terns were still recorded in the estuarine bird counts. While a peak count of 2,000 individuals was recorded at the height of the breeding period in May, a count of 839 roosting / loafing birds were present in the Port during the first survey visit of August (although no AONs were present by this point), which may have also included post-breeding migrants from other colonies. By September, very few common terns were observed, and the species was absent from October onwards.

6.2 Common tern observations in the estuarine bird survey

Common terns were recorded in the estuarine bird survey from May to September (see **Table 6.2**). A peak count of around 2,000 individuals was recorded during the second May count, which coincided with the peak count of AONs. Distribution of this species across the study area and an indication of the behaviour observed is illustrated in **Figure A.4**.

Throughout the breeding period, common terns were almost exclusively recorded near to the colony at Imperial Dock. During August, however, once birds had started to leave the colony post-breeding, a number of loafing individuals were recorded elsewhere in the Port, including near to the East Breakwater and on the western wall of the entrance lock. As noted above, records of foraging activity in the survey area were sporadic and low intensity.

[2] Protected Nature Sites (sepa.org.uk)

Table 6.2 Monthly peak counts of common tern

Sector	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.
S1	0	0	9	0	1	1	6	0	0	0	0	0
S2	0	0	17	0	8	350	0	0	0	0	0	0
S3	0	0	*c.*2,000	700	802	516	0	0	0	0	0	0
All	**0**	**0**	***c.*2,000**	**700**	**802**	**839**	**6**	**0**	**0**	**0**	**0**	**0**

6.3 Flight surveys

Full results of the flight survey are published in **Appendix 3** and summarised in **Table 6.3**, which describes the peak flight rate (i.e. the maximum number of movements per hour) recorded into and out of each sector across the entire survey period. The highest peak flight rates were recorded in Sector 3, particularly at heights of 10-20m (a peak of 522 inbound and 594 outbound flights per hour), followed by flights above 20m (a peak of 249 inbound and 231 outbound flights per hour). Sector 1 (i.e. through the mouth of the Port) was the second busiest flight sector, again mostly at heights of 10-20m (a peak of 126 inbound and 96 outbound flights per hour) and 20m+ (a peak of 189 inbound and 90 outbound flights per hour).

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.

Table 6.3 Peak rates of inbound and outbound common tern flights

Sector No.	Inbound flights (per hour)				Outbound flights (per hour)			
	0-5m	5-10m	10-20m	20m+	0-5m	5-10m	10-20m	20m+
1	21	45	126	189	75	75	96	90
2	3	69	54	123	15	60	51	69
3	9	96	522	249	39	114	594	231
4	9	39	36	156	9	75	51	48

The peak flight rates are representative of the month-by-month trend, which is presented in **Figure 6.1.** The figure clearly indicates that in each month Sector 3, which is the shortest route between the colony and the Firth of Forth, is the busiest sector (accounting for around 45-55% of all flights each month), followed by Sector 1, which provides a relatively unobstructed route to sea through the mouth of the Port (around 25% of all flights). Sector 4 is generally the least used as a flight path.

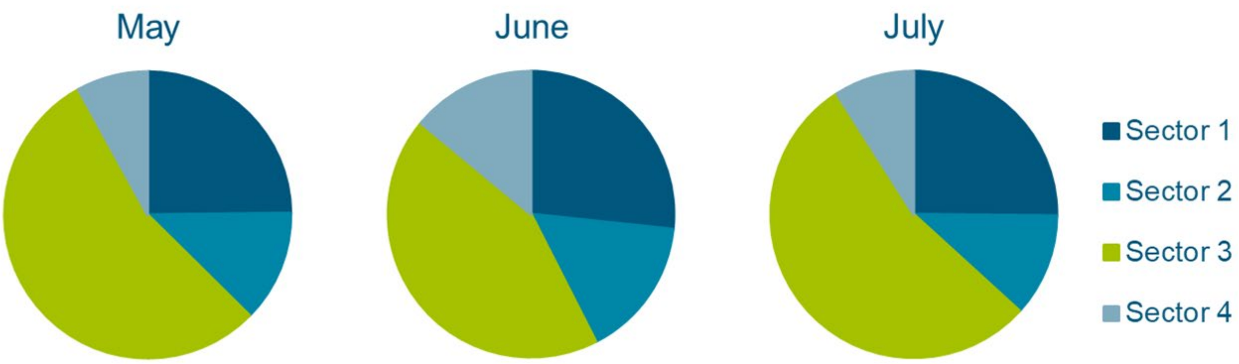

Figure 6.1 Proportion of monthly flights within each sector

Figure 6.2 demonstrates the proportion of total flights (i.e. all flights recorded during the survey period) within each flight height category. In most of the sectors, including the sectors with the busiest flight activity (Sectors 1 and 3), flight heights in the 0-5m and 5-10m categories were comparatively few, with around 75-85% of flights split relatively evenly between the 10-20m and 20m+ categories. In the less-traversed Sector 4, most flights (around 60%) were at an altitude of more than 20m, which is likely reflective of the fact that there is a greater number of taller structures / buildings present in this sector.

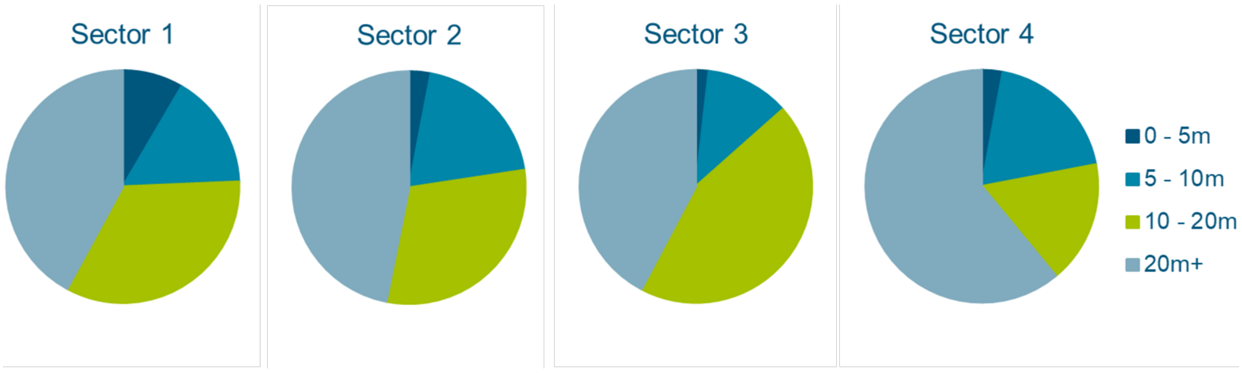

Figure 6.2 Proportion of total flights (May to July) within each flight height category

Similar methodology was undertaken for establishing common tern flight paths from the colony in 2008, 2009 and 2010 (Jennings, 2012). The 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 correlates with the findings of the 2008-10 surveys and is therefore likely to be representative of the typical situation during the breeding season at the Port. One minor difference is the increased proportion of flights within the 20m+ flight height category – in 2021, 40-60% of flights were within this category (dependent on Sector), whilst in 2008-10, 10-40% of flights were within this category.

7 Human disturbances

Disturbances from anthropogenic activities were noted during a number of counts, the sources of which are presented in **Table 7.1**.

Table 7.1 Disturbances recorded during survey visits

Survey	Location	Source of disturbance
Mar. '21 (1)	S1	Walkers and dogs on foreshore
	S3	Vehicle activity
Mar. '21 (2)	S1	Walkers and dogs on foreshore
Apr. '21 (1)	S1	Walkers, dogs and anglers on foreshore, motorised and unmotorised vessels in harbour
	S2 and S3	Large vessel left Port; motorised and unmotorised vessels offshore
Apr. '21 (2)	S1	Fishing boat in harbour, anglers on foreshore
May '21 (1)	S1 and S2	Motorised vessel commuting through study area
	S1	Swimmers and kayak off foreshore, anglers along breakwater
May '21 (2)	All sectors	Motorised and unmotorised vessel activity
	S1	Dredging at Newhaven Marina; walkers along foreshore; fishing vessel in harbour
Jun. '21 (1)	S1	Walkers and dogs along foreshore
	S3	Vehicle and worker activity
Jun. '21 (2)	All sectors	Vessels commuting through study area
	S1	Walkers and dogs along foreshore
Jul. '21 (1)	S1 and S2	Motorised and unmotorised vessels commuting through study area
Jul. '21 (2)	S1	Harbour busy with sailboats, kayakers, paddle boarders; walkers / dogs and anglers present along the foreshore
	S1 and S2	Motorised and unmotorised vessels commuting through study area
Aug. '21 (1)	Sector 1	Walkers, dogs and anglers on foreshore
	S3	Vehicle activity
Aug. '21 (2)	S1	Walkers, dogs and shell fishers on foreshore
	S2	Bait diggers / shell fishers on foreshore
	S3	Vehicle and worker activity
Sep. '21 (1)	S1	Walkers, dogs and anglers on foreshore
	S2	Walkers on foreshore
	S2 and S3	Vessel and vehicle activity
Sep. '21 (2)	S1	Motorised vessel in harbour, walkers and dogs on foreshore
	S3	Motorised vessels entering port
Oct. '21 (2)	S1	Walkers and dogs on foreshore
	S2 and S3	Vehicles and worker activity
Nov. '21 (1)	S1	Walkers and dogs on foreshore
	S3	Vehicles and vessel activity

Survey	Location	Source of disturbance
Nov. ‘21 (2)	S1	Walkers, dogs and anglers, motorised vessels in harbour
	S2 and S3	Vehicles and vessel activity
Dec. ‘21 (1)	S1	Walkers and dogs on foreshore
	S3	Vessel entering port
Dec. ‘21 (2)	S1	Walkers, fishing vessel in harbour
	S2	Kayakers near shore
Jan. ’22 (1)	S1	Fishing vessel commuting through harbour, walkers and dog on foreshore
Jan. ‘22 (2)	S1	Walker on foreshore, motorised vessel commuting through sector
	S3	Construction traffic
Feb. ‘22 (1)	S3	Vessel activity
Feb. ‘22 (2)	S1	Swimmers, walkers and dogs along shoreline. Kayak nearshore plus two motorised vessels commuting through sector
Mar. ’22 (1)	S1	Walkers and dogs on foreshore, anglers, and motorised and unmotorised vessels
	S2 and S3	Vehicles and vessel activity

Whilst the above disturbances may have resulted in minor displacement / redistribution of birds or temporary behavioural modification, none of the disturbances would be considered atypical for the study area therefore the ‘representativeness’ of the counts is not considered to have been compromised.

There is public access to Newhaven foreshore and the West Breakwater (S1), 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 (S2), as there is limited public access along the shorefront. However, at the far east end of the study area, near to East Sands of Leith, there was occasional disturbance from walkers and bait diggers.

Within the dock system (S3) 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) associated with Newhaven and Granton Harbours. Vessel activity was concentrated offshore, although there was regular nearshore activity by sailing vessels and kayaks at Newhaven.

8 Summary of important habitats within the study area

The estuarine bird surveys and tern-specific surveys described in this document indicate the following key habitats 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 SPA / Ramsar Site features, numbers of which may be of regional importance, appeared to show preference for those habitats during the surveys described in this document (see distribution maps in **Appendix 11.1**).

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Appendix 1 Consultation with NatureScot regarding the surveys

Ben Hughes

From: Malcolm Fraser <[redacted]>
Sent: 28 April 2021 16:07
To: Ben Hughes
Subject: RE: Port of Leith bird survey consultation

Hello Ben –

I'm going to provide our advice by email to save a little time, I hope that's acceptable to you.

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.

I hope these comments are useful – get back in touch if you would like to discuss.

All the best.

--
Malcolm Fraser (he/ him)| Area Officer – Forth
NatureScot | Silvan House, 3rd Floor East, 231 Corstorphine Road, Edinburgh, EH12 7AT | [redacted]
nature.scot | @nature_scot | *Scotland's Nature Agency* | *Buidheann Nàdair na h-Alba*

From: Ben Hughes <[redacted]>
Sent: 26 April 2021 09:31
To: Malcolm Fraser <[redacted]>
Subject: RE: Port of Leith bird survey consultation

Hi Malcolm,

Thanks for getting back to me so quickly.
Top line is noted, and I look forward to receiving the comments.

Thanks again,

Ben

Ben Hughes MSc
Consultant | **Environment**

T [redacted]
E [redacted] | **W** www.royalhaskoningdhv.com
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Please consider the environment before printing this e-mail

From: Malcolm Fraser <[redacted]>
Sent: 26 April 2021 09:29
To: Ben Hughes <[redacted]>
Subject: RE: Port of Leith bird survey consultation

This message was sent from an **e-mail domain unknown to Royal HaskoningDHV**. Please be cautious.

Hello Ben –

Yes I have some comments back from our ornithology advisors, and I'll send them on to you asap.

Our top line is that the surveys you have planned are suitable for establishing a baseline against which to assess the effect of the proposed development.

All the best.

--
Malcolm Fraser (he/ him)| Area Officer – Forth
NatureScot | Silvan House, 3rd Floor East, 231 Corstorphine Road, Edinburgh, EH12 7AT | [redacted]
nature.scot | @nature_scot | *Scotland's Nature Agency* | *Buidheann Nàdair na h-Alba*

From: Ben Hughes <[redacted]>
Sent: 26 April 2021 09:27
To: Malcolm Fraser <[redacted]>
Subject: RE: Port of Leith bird survey consultation

Hi Malcolm,

Hope all is well.
I was just wondering if there was any update on the progress of the below request?

Thanks,

Ben

Ben Hughes MSc
Consultant | Environment

T [redacted]
E [redacted]| **W** www.royalhaskoningdhv.com
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From: Malcolm Fraser <[redacted]>
Sent: 15 April 2021 11:32
To: Ben Hughes <[redacted]>
Subject: RE: Port of Leith bird survey consultation

Hello Ben –

Thanks for contacting us about survey methods and schedule at Port of Leith.

I note that you've already started estuarine bird surveys, and that tern surveys are due to start in May.

I'll be your point of contact at NatureScot. I've just asked my ornithology colleagues for advice on your proposal, and will get back to you as soon as I can. My contact details are below if you need to get in touch.

All the best.

--
Malcolm Fraser (he/ him)| Area Officer – Forth
NatureScot | Silvan House, 3rd Floor East, 231 Corstorphine Road, Edinburgh, EH12 7AT | [redacted]
nature.scot | @nature_scot | *Scotland's Nature Agency* | *Buidheann Nàdair na h-Alba*

From: Ben Hughes <[redacted]>
Sent: 13 April 2021 11:00
To: FORTH <[redacted]>
Cc: Jamie Gardiner <[redacted]>
Subject: Port of Leith bird survey consultation

To whom it may concern,

I hope this email finds you well. I have been directed to this address by the NatureScot switchboard.

I am a consultant representing a developer who is in the early stages of a potential port-based development application at the Port of Leith, Edinburgh. As part of the work preceding the application process, the developer is undertaking a year-long programme of bird surveys running from March 2021 to February 2022, which will be used to inform future environmental assessment / HRA. We are seeking to consult with Nature Scot on the scope of those surveys. The survey area encompasses parts of the Outer Firth of Forth and St Andrews Bay Complex pSPA, the Firth of Forth SPA and the Imperial Dock Lock Leith SPA.

The proposed methodology, including information on the study area and the count techniques to be employed, is provided in the attached Survey Specification document. As stated in the attached document, the study area has been based on an assumption that impact piling at the development site is a potential requirement. As you will note, we are proposing three types of survey in the area – estuarine bird surveys, tern colony counts at Imperial Dock Lock Leith SPA, and tern flight behaviour surveys. Due to time constraints, the first of the estuarine bird surveys have been undertaken; however, we invite comment for the surveys going forward / confirmation on their suitability. As stated above, the purpose of these surveys is to provide sufficient baseline information on the use of the area by SPA features and other estuarine birds for undertaking HRA and other necessary environmental assessments.

Given that the tern surveys are proposed for May to July, we unavoidably have a tight timeframe in which to finalise the scope of those surveys. As such, I would greatly appreciate NatureScot's views on the proposed survey methodology as quickly as possible. Please do not hesitate to contact me if there are any questions that would facilitate the consultation process.

Thanks and regards,

Ben Hughes MSc
Consultant | Environment

T [redacted]
E[redacted]| **W** www.royalhaskoningdhv.com
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Appendix 2 Distribution maps for SPA / Ramsar Site / SSSI features

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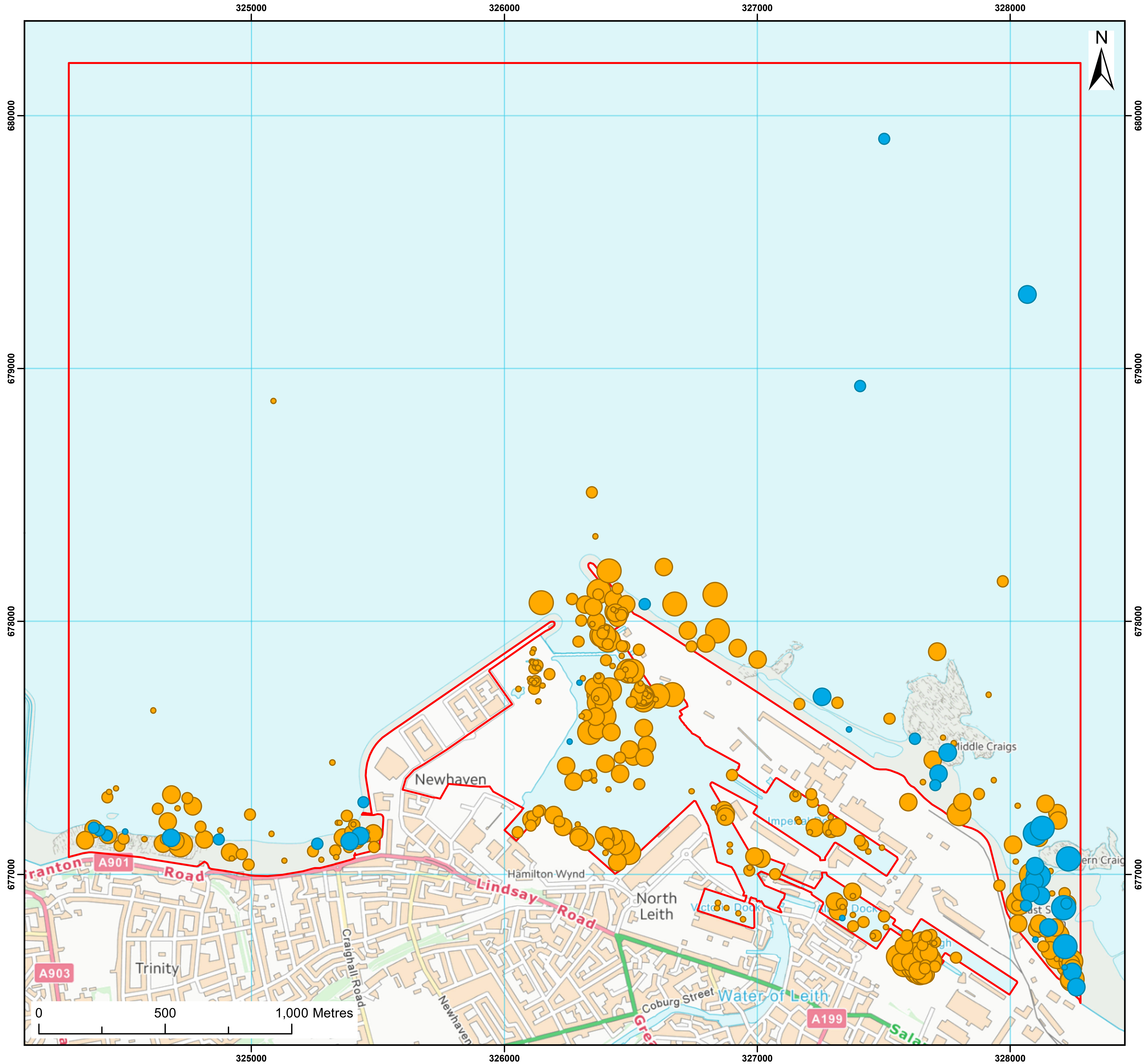

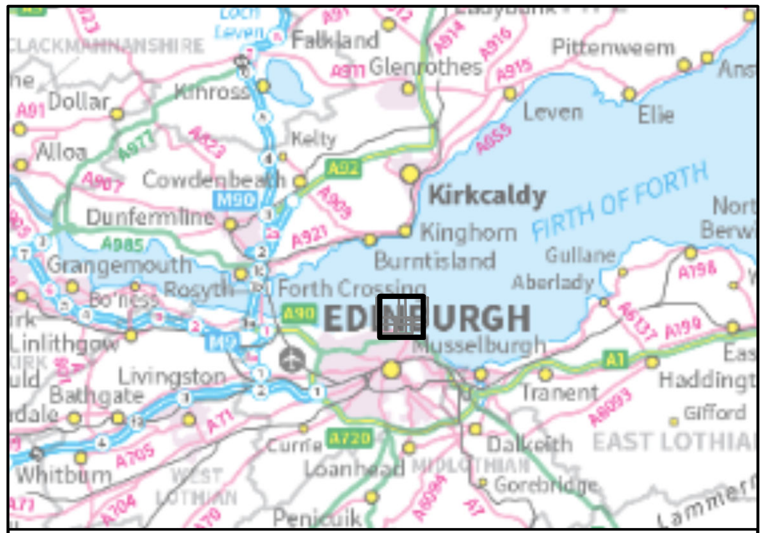

Legend:

Study Area

Foraging Black-headed gull (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

Loafing/Roosting Black-headed gull (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

Client: Forth Ports Limited

Project: Port of Leith - Outer Berth

Title: Distribution map of Black-headed gull recorded during estuarine surveys, March 2021 to March 2022

Figure: A.2

Drawing No: PC2045-RHD-ZZ-ZZ-DR-EV-0020

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
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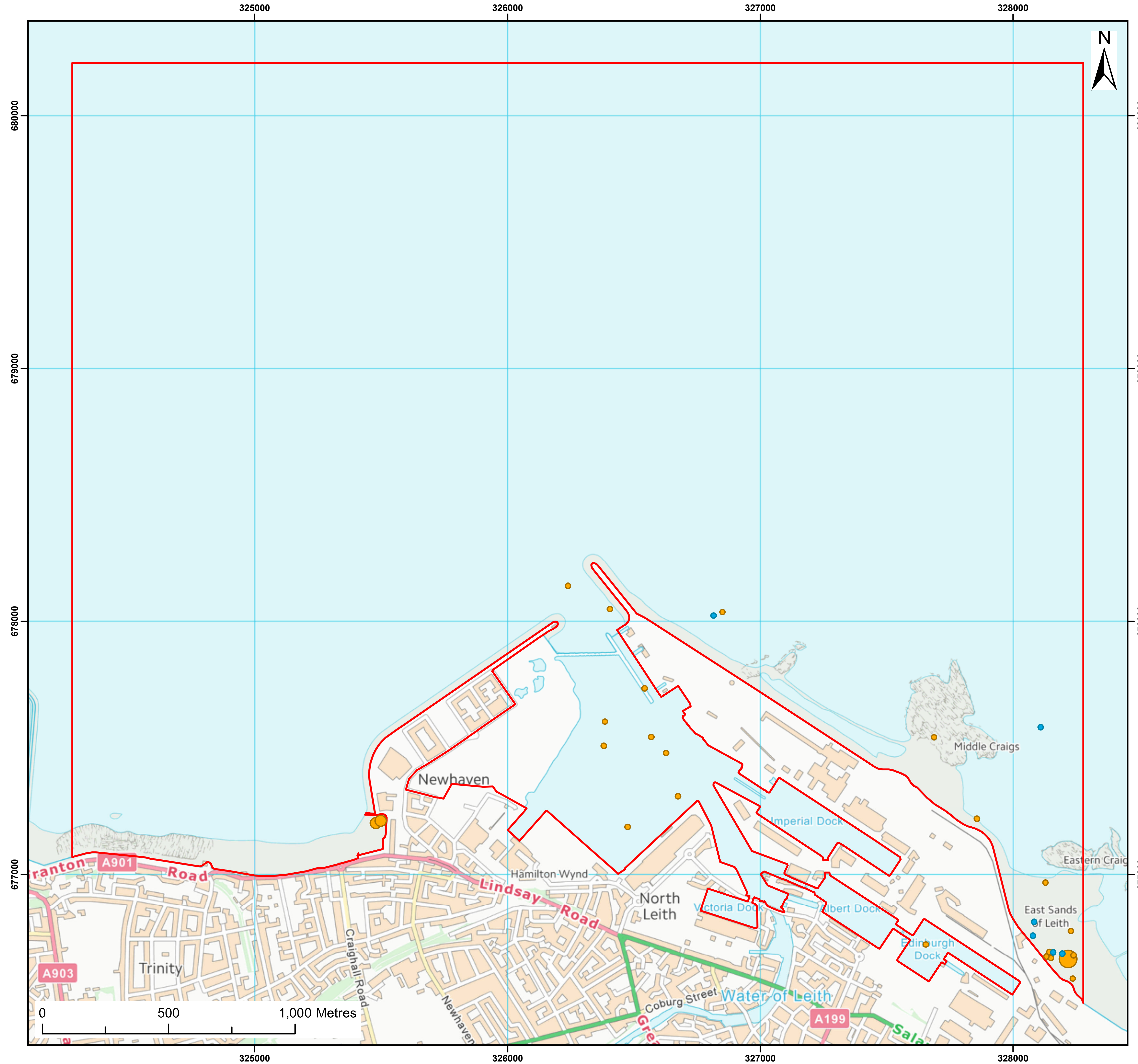

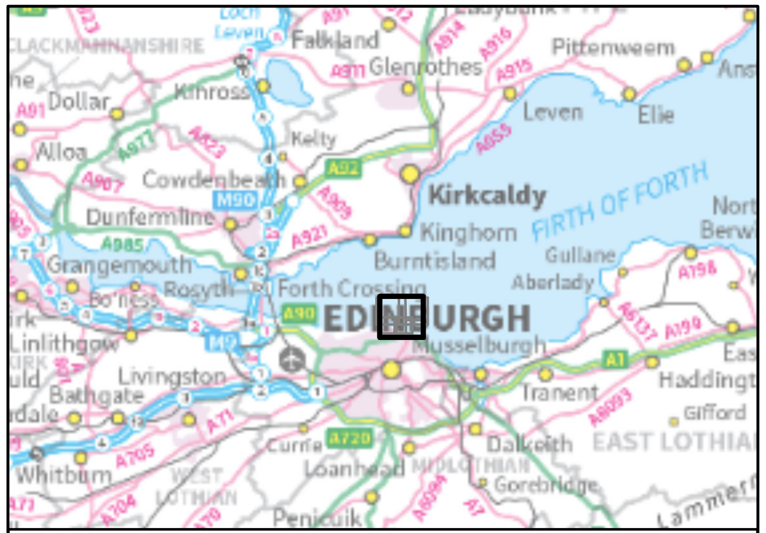

Legend:

Red outline	Study Area

Foraging Common gull (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

Loafing/Roosting Common gull (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

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

Title:

Distribution map of Common gull recorded during estuarine surveys, March 2021 to March 2022

Figure: A.3 Drawing No: PC2045-RHD-ZZ-ZZ-DR-EV-0021

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
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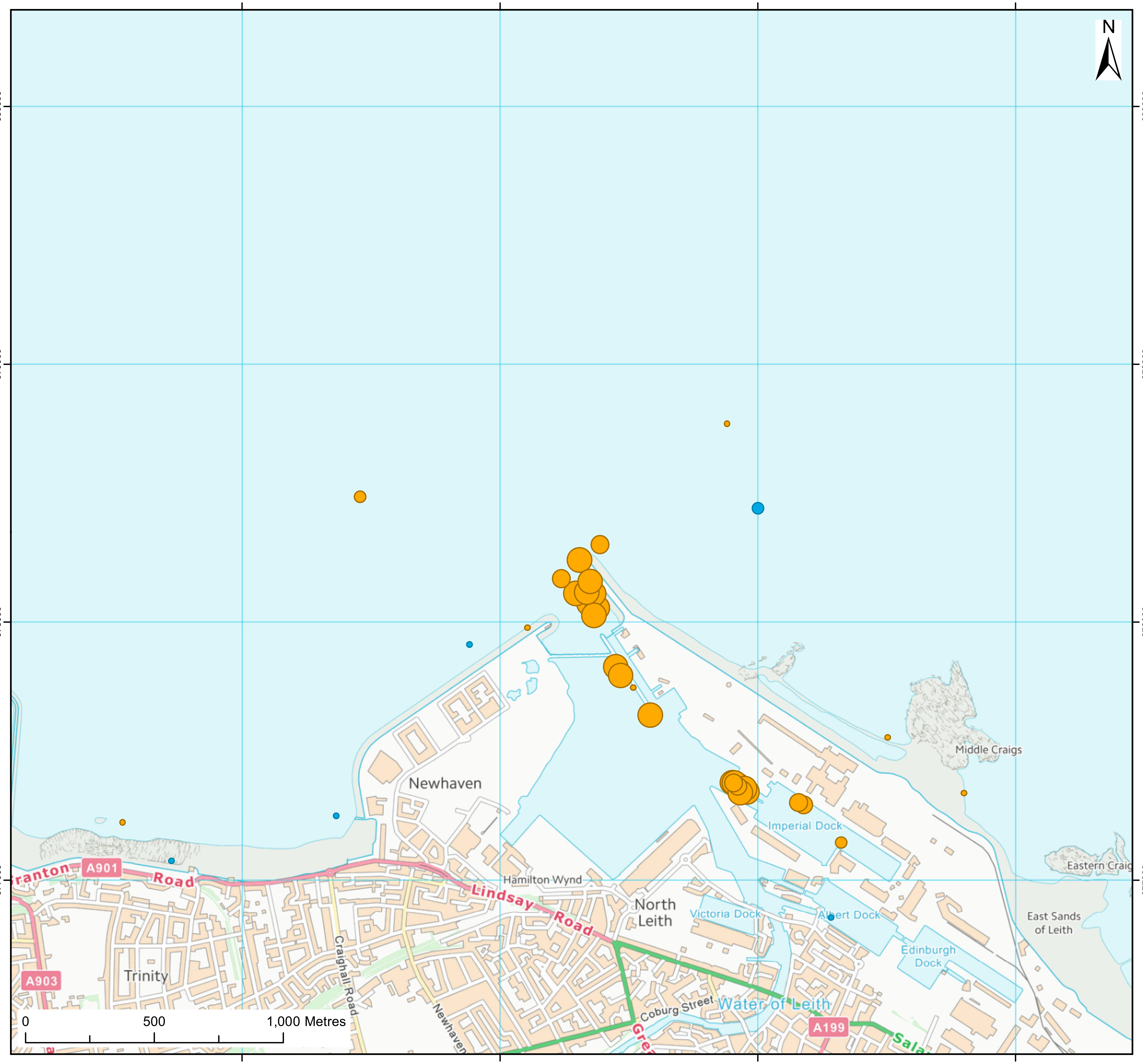

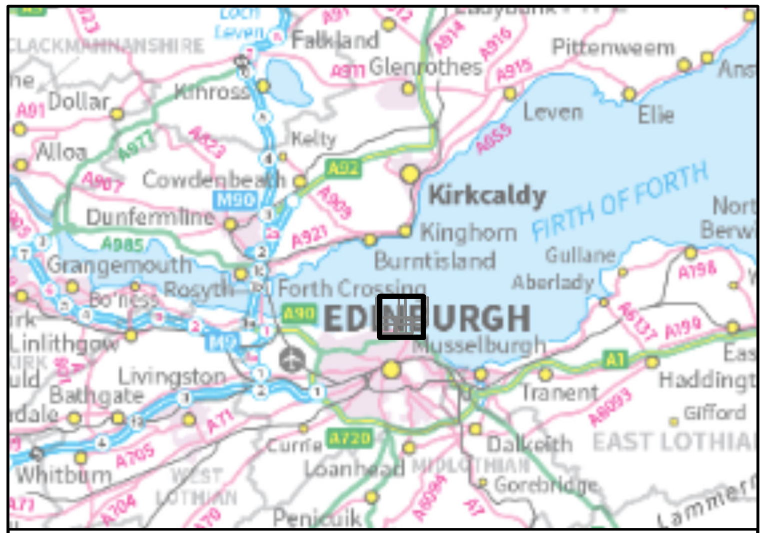

Legend:

Foraging Common tern (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

Loafing/Roosting Common tern (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

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

Title:

Distribution map of Cormmon tern recorded during estuarine surveys, March 2021 to March 2022

Figure: A.4	Drawing No: PC2045-RHD-ZZ-ZZ-DR-EV-0022

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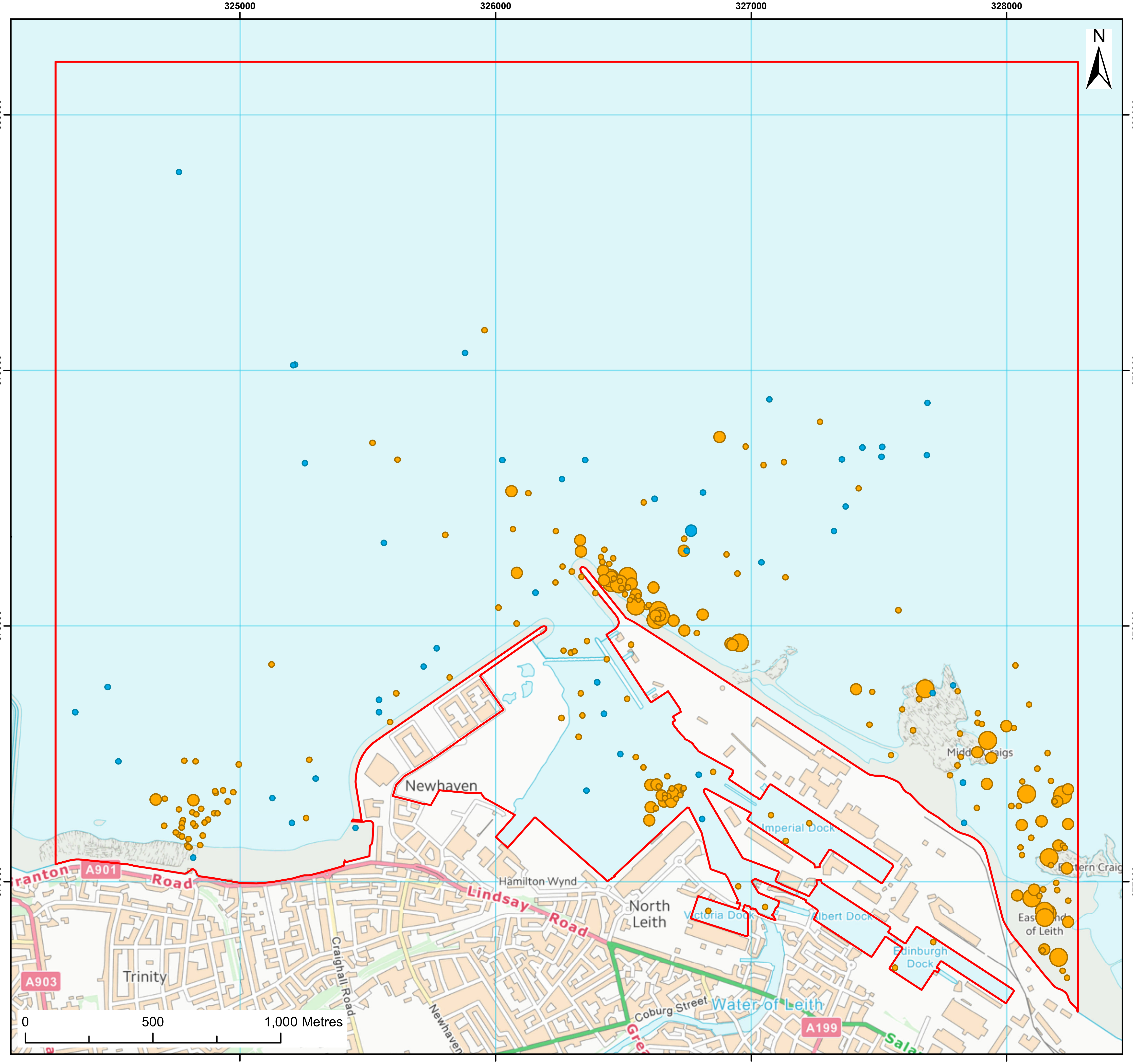

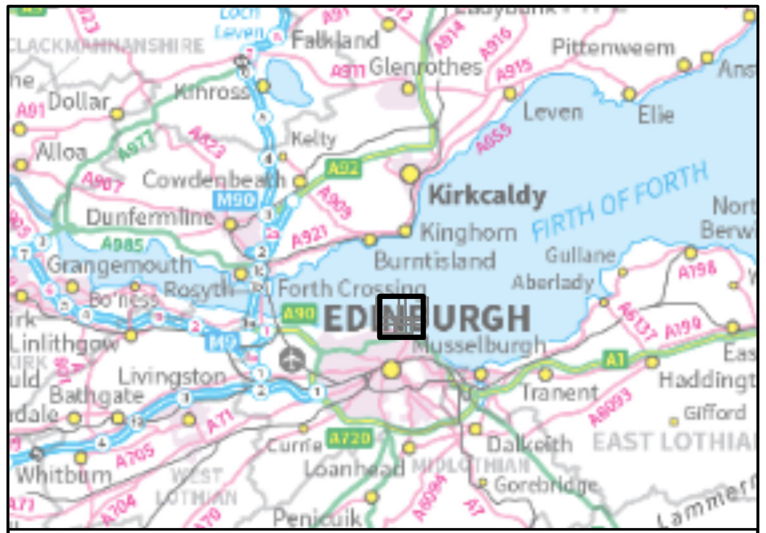

Legend:

Study Area

Foraging Cormorant (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

Loafing/Roosting Cormorant (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

Client: Forth Ports Limited

Project: Port of Leith - Outer Berth

Title:

Distribution map of Cormorant recorded during estuarine surveys, March 2021 to March 2022

Figure: A.5

Drawing No: PC2045-RHD-ZZ-ZZ-DR-EV-0023

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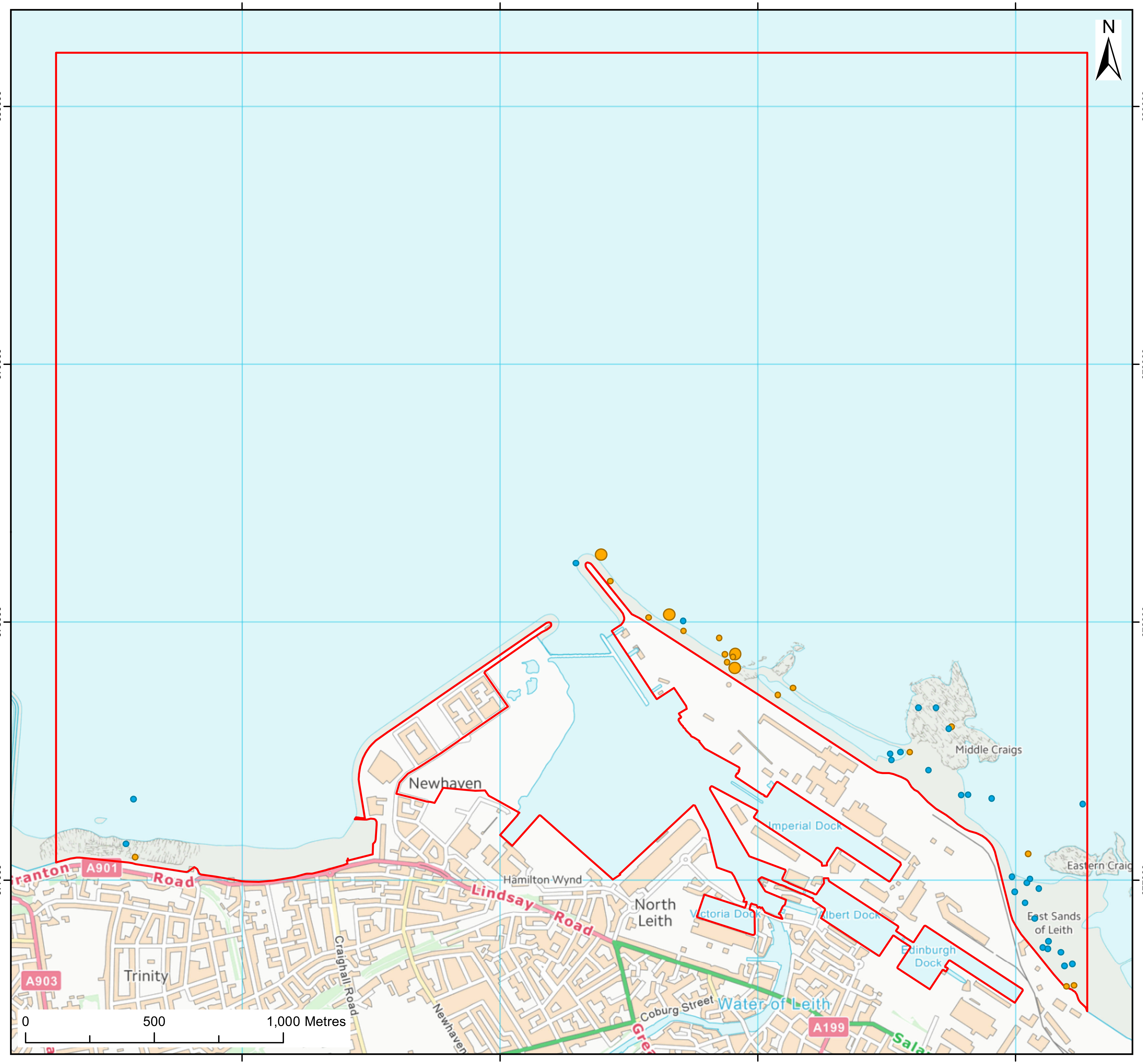

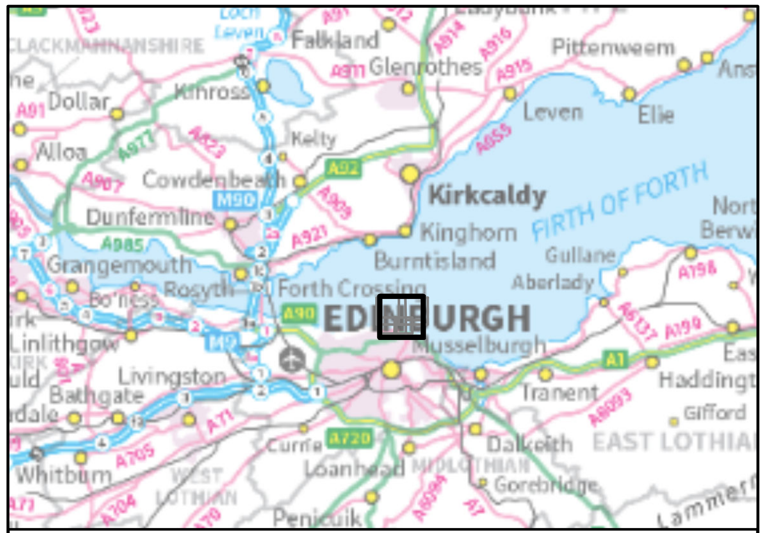

Legend:

Study Area

Foraging Curlew (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

Loafing/Roosting Curlew (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

Client: Forth Ports Limited

Project: Port of Leith - Outer Berth

Title: Distribution map of Curlew recorded during estuarine surveys, March 2021 to March 2022

Figure: A.6 | Drawing No: PC2045-RHD-ZZ-ZZ-DR-EV-0024

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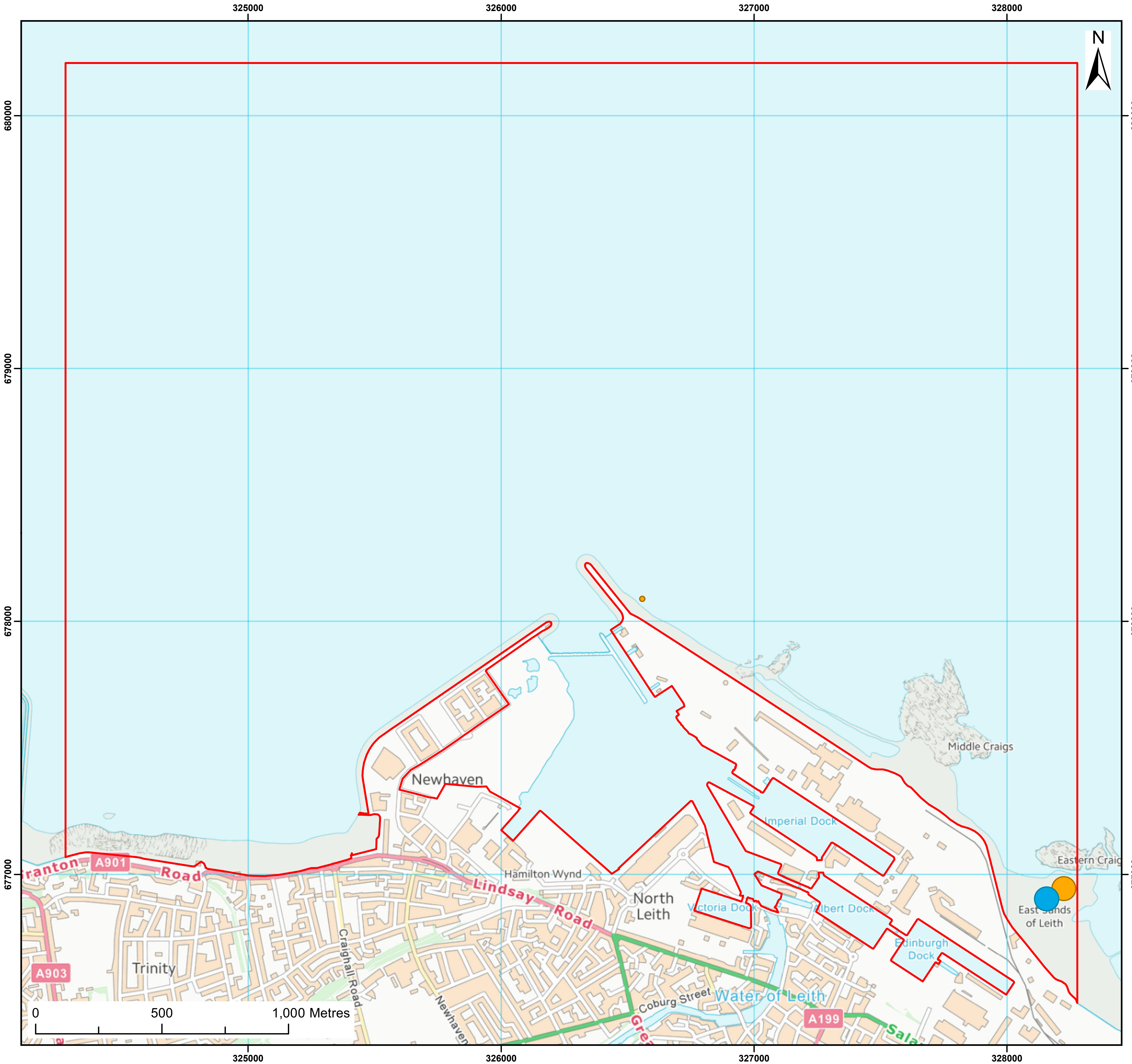

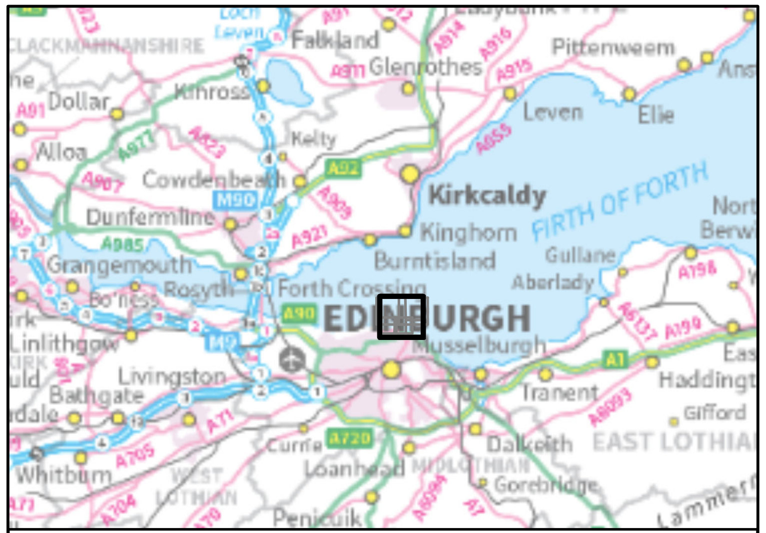

Legend:

Study Area

Foraging Dunlin (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

Loafing/Roosting Dunlin (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

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

Title:

Distribution map of Dunlin recorded during estuarine surveys, March 2021 to March 2022

Figure: A.7

Drawing No: PC2045-RHD-ZZ-ZZ-DR-EV-0025

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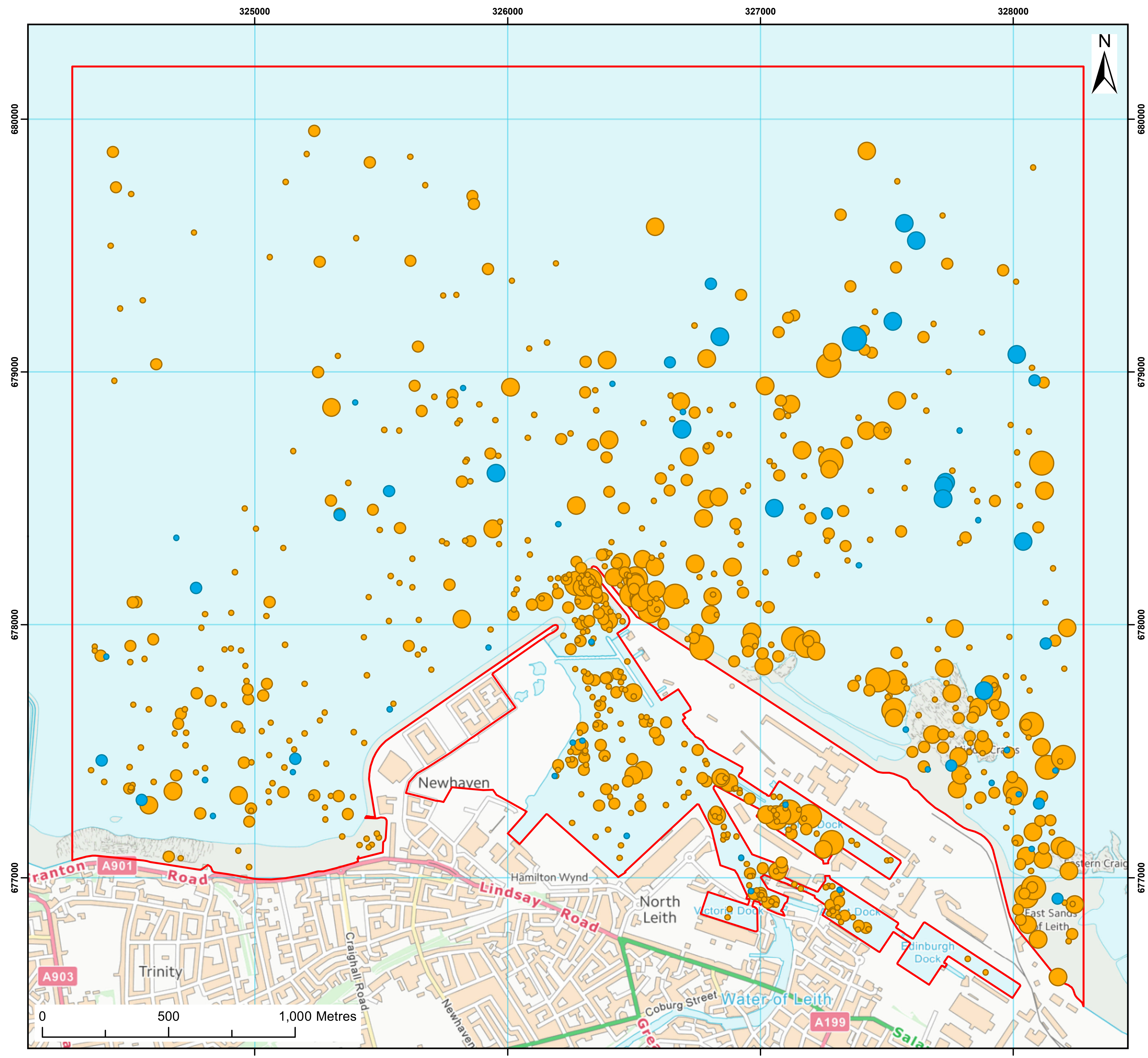

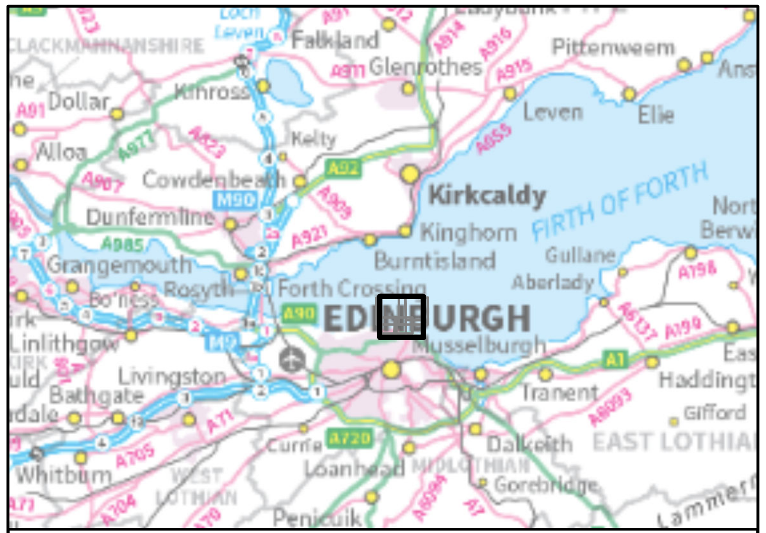

Legend:

Study Area

Foraging Eider (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

Loafing/Roosting Eider (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

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

Title:

Distribution map of Eider recorded during estuarine surveys, March 2021 to March 2022

Figure: A.8 | Drawing No: PC2045-RHD-ZZ-ZZ-DR-EV-0026

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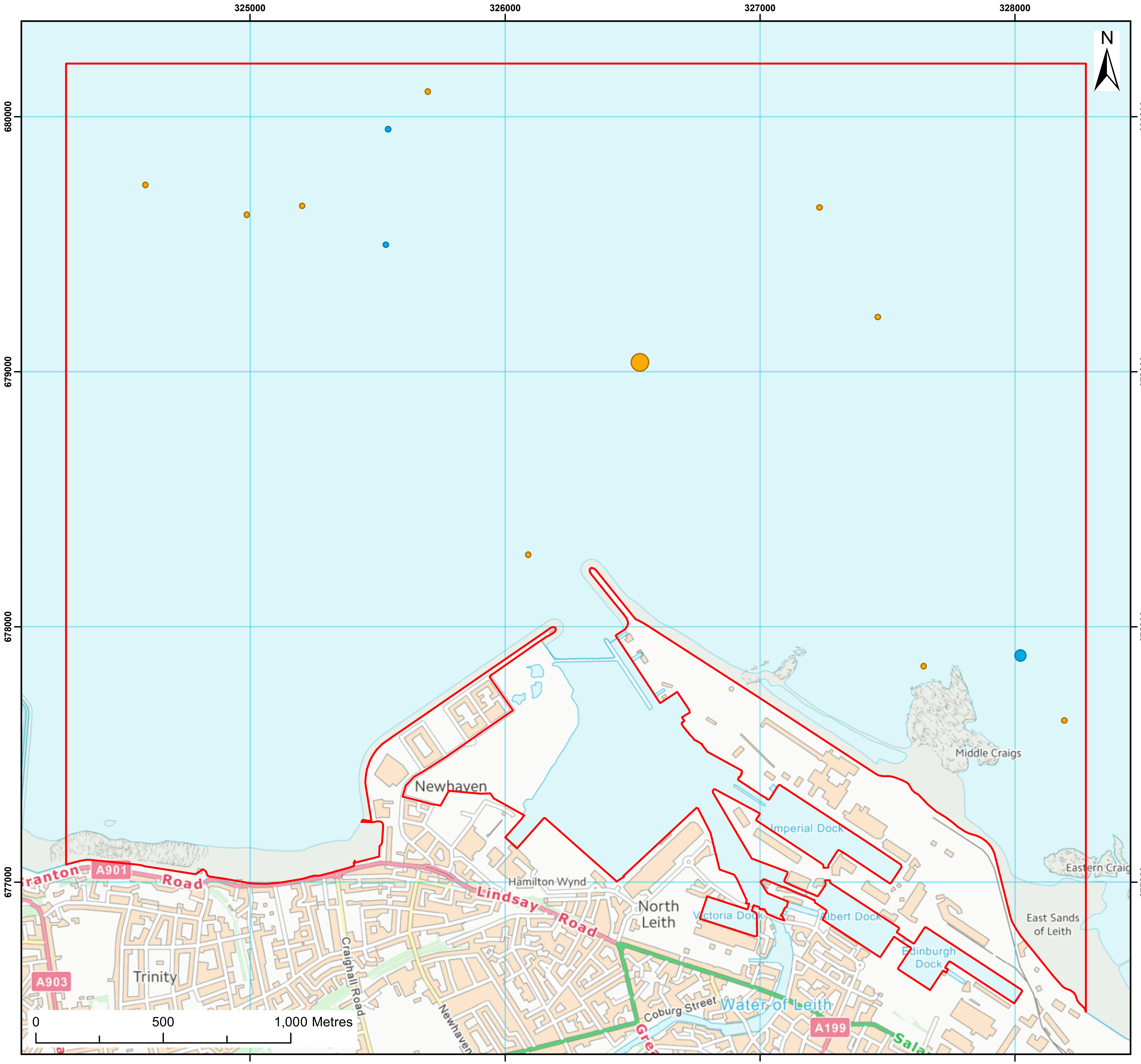

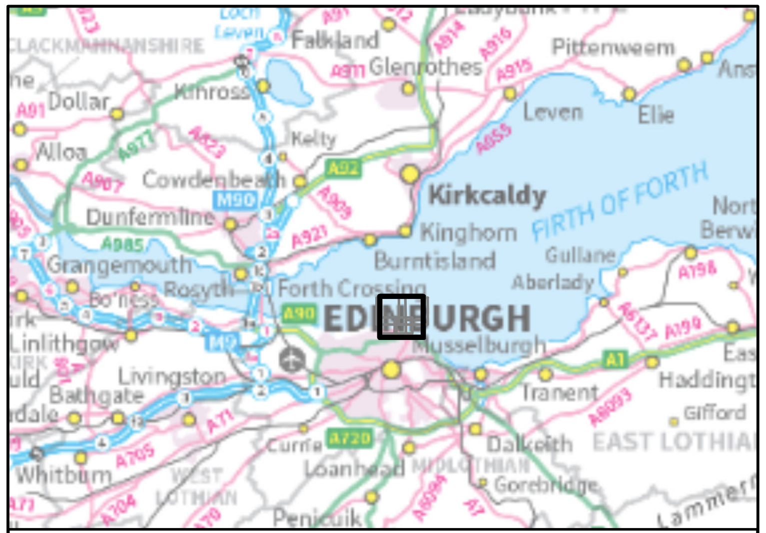

Legend:

Study Area

Foraging Gannet (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

Loafing/Roosting Gannet (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

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

Title:

Distribution map of Gannet recorded during estuarine surveys, March 2021 to March 2022

Figure: A.9 | Drawing No: PC2045-RHD-ZZ-ZZ-DR-EV-0027

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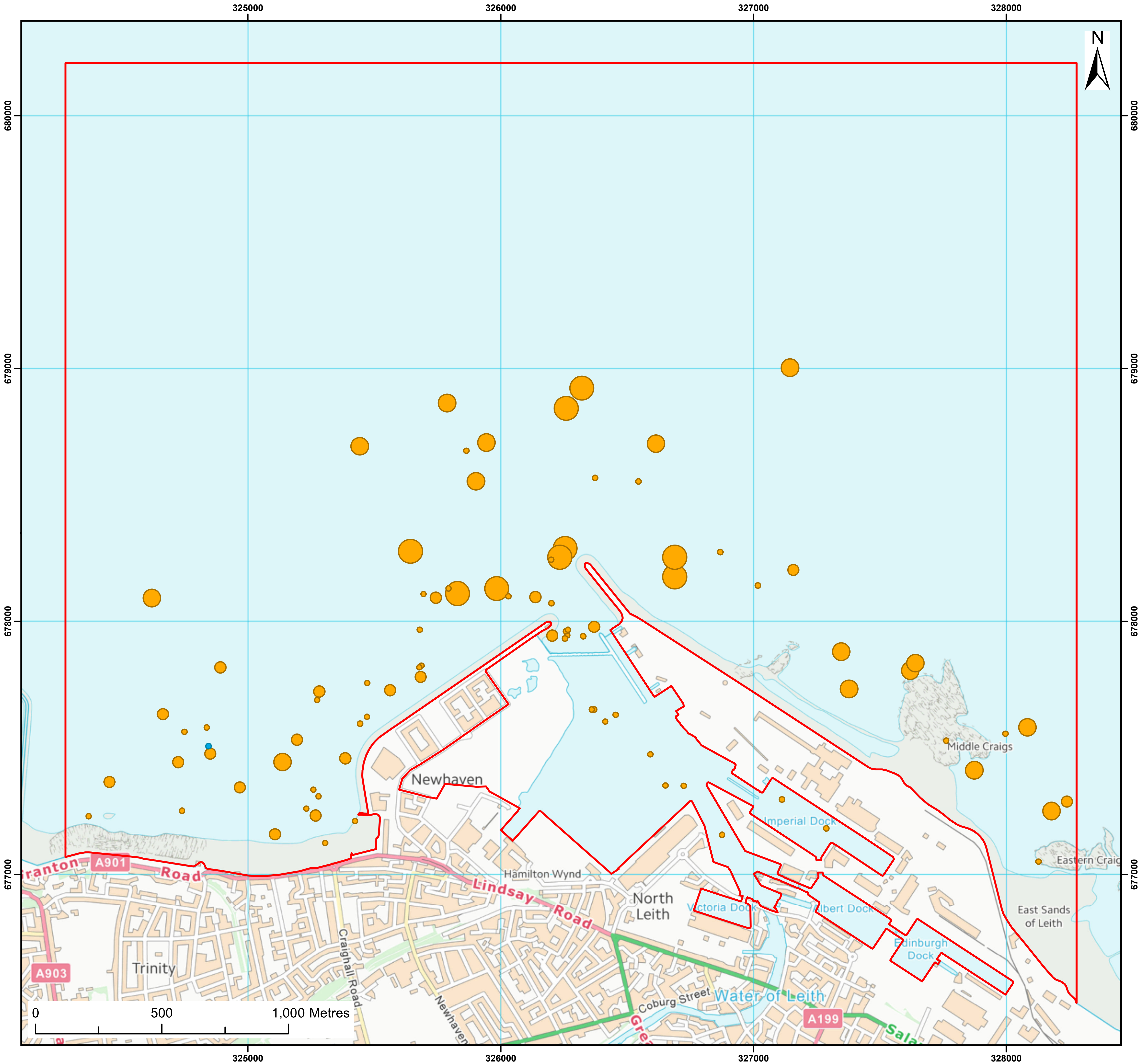

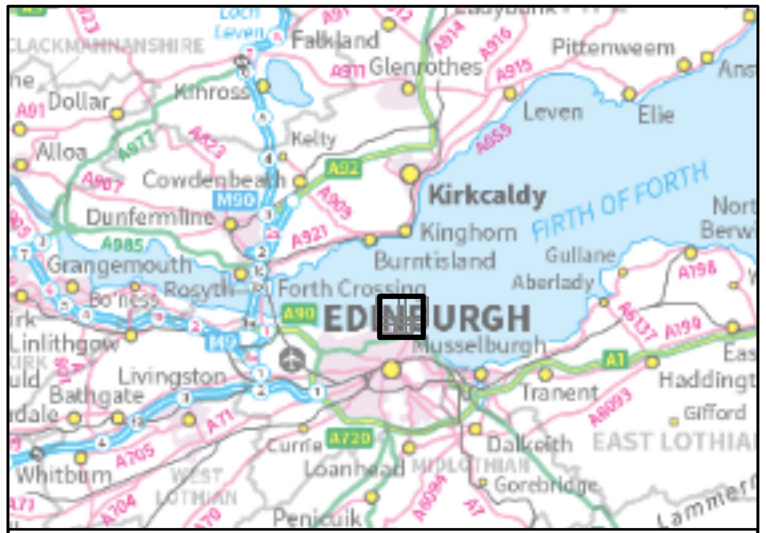

Legend:

Study Area

Foraging Guillemot (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

Loafing/Roosting Guillemot (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

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

Title:

Distribution map of Guillemot recorded during estuarine surveys, March 2021 to March 2022

Figure:	A.11	Drawing No:	PC2045-RHD-ZZ-ZZ-DR-EV-0029

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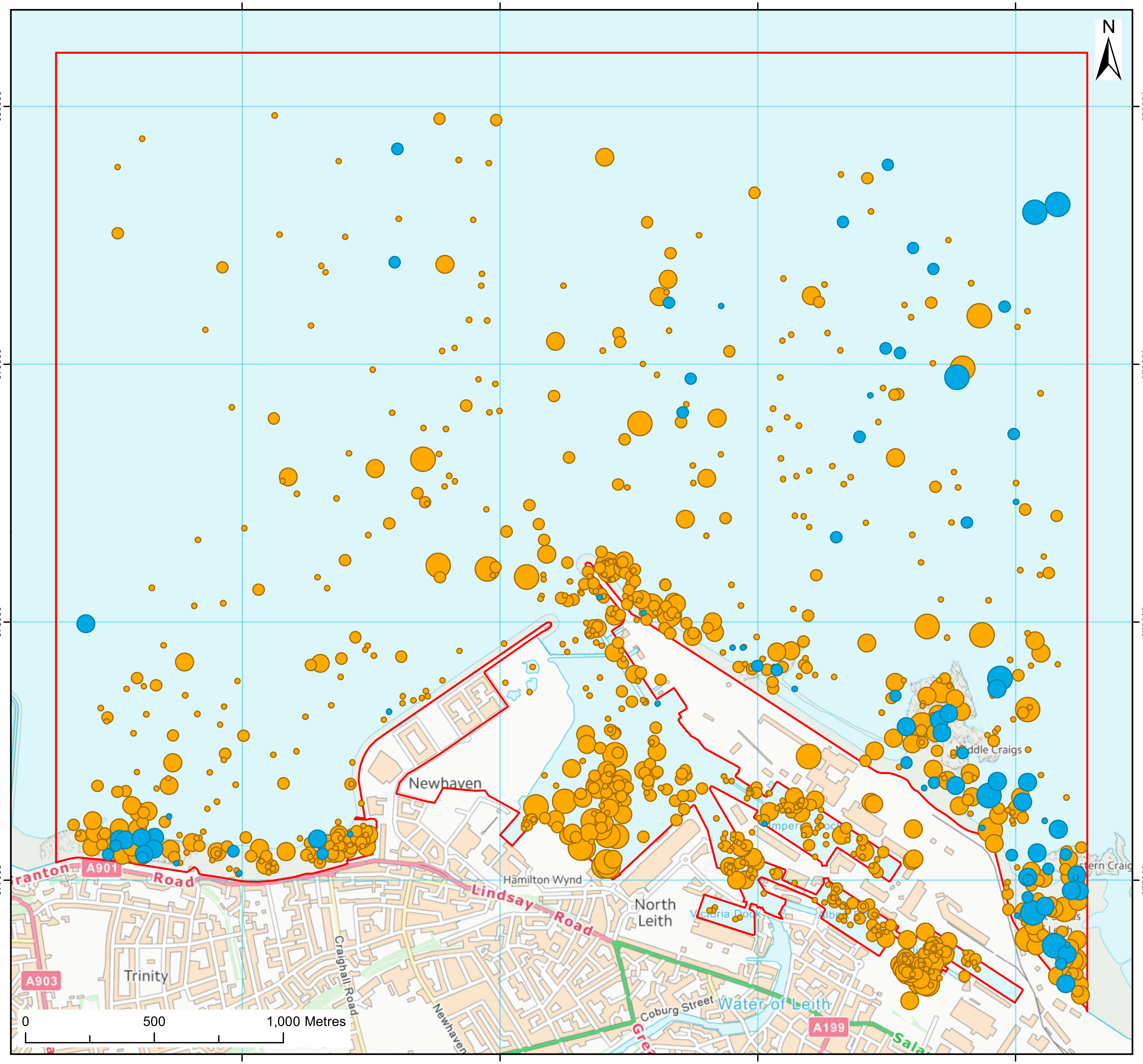

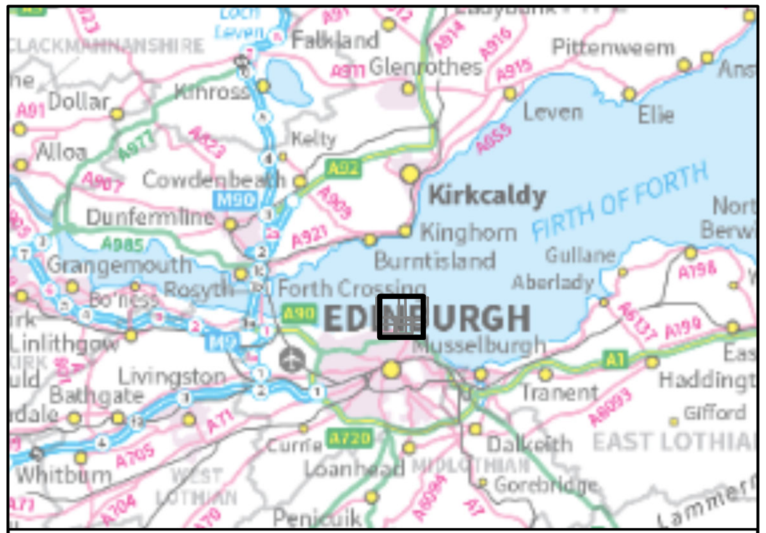

Legend:

Study Area

Foraging Herring gull (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

Loafing/Roosting Herring gull (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

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

Title:

Distribution map of Herring gull recorded during estuarine surveys, March 2021 to March 2022

Figure: A.12 | Drawing No: PC2045-RHD-ZZ-ZZ-DR-EV-0030

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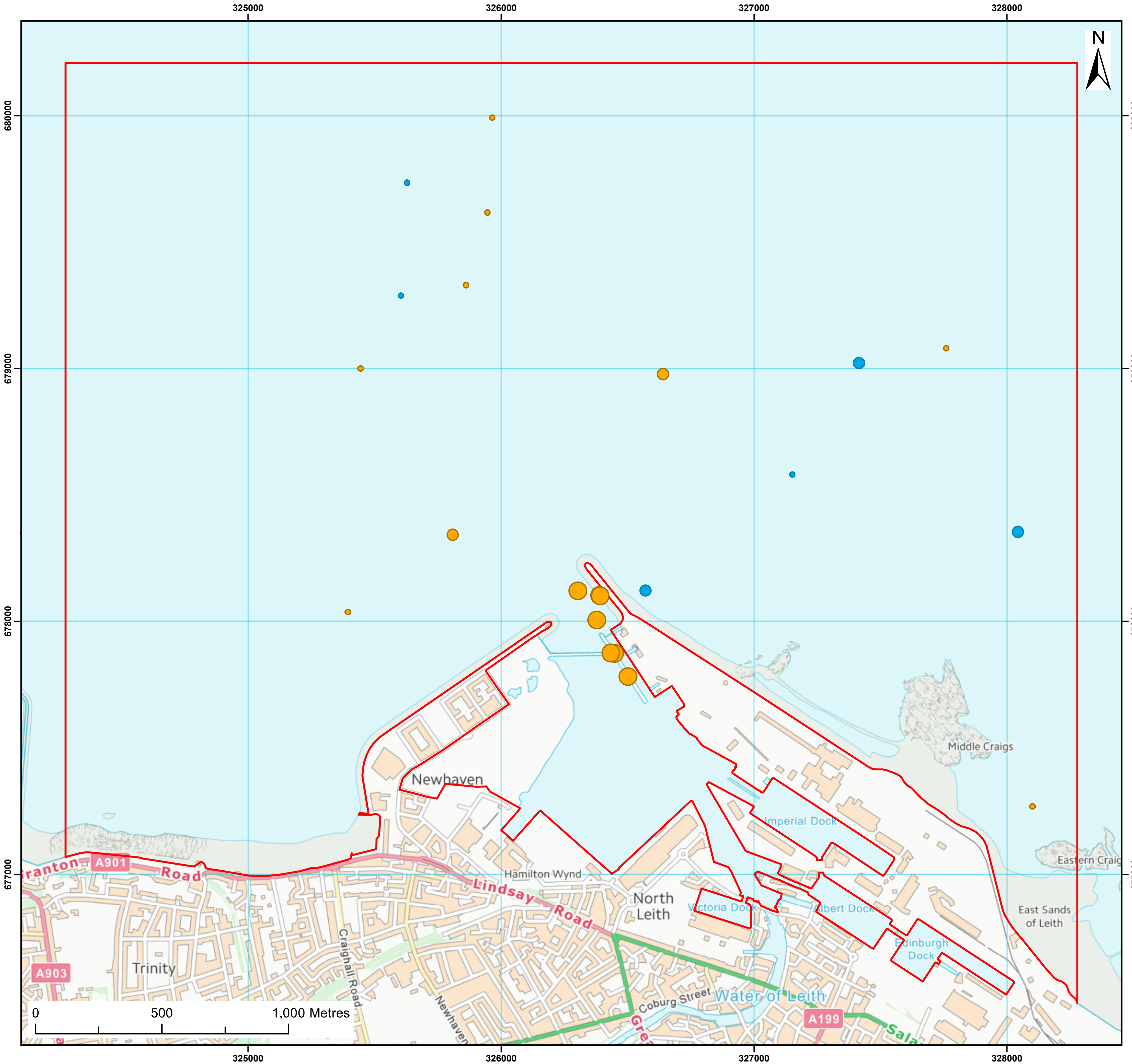

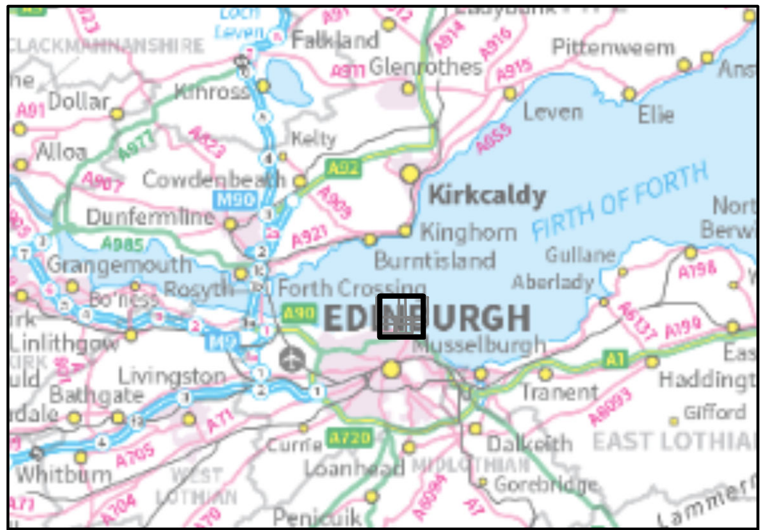

Legend:

Study Area

Foraging Kittiwake (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

Loafing/Roosting Kittiwake (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

Client: Forth Ports Limited

Project: Port of Leith - Outer Berth

Title: Distribution map of Kittiwake recorded during estuarine surveys, March 2021 to March 2022

Figure: A.13

Drawing No: PC2045-RHD-ZZ-ZZ-DR-EV-0031

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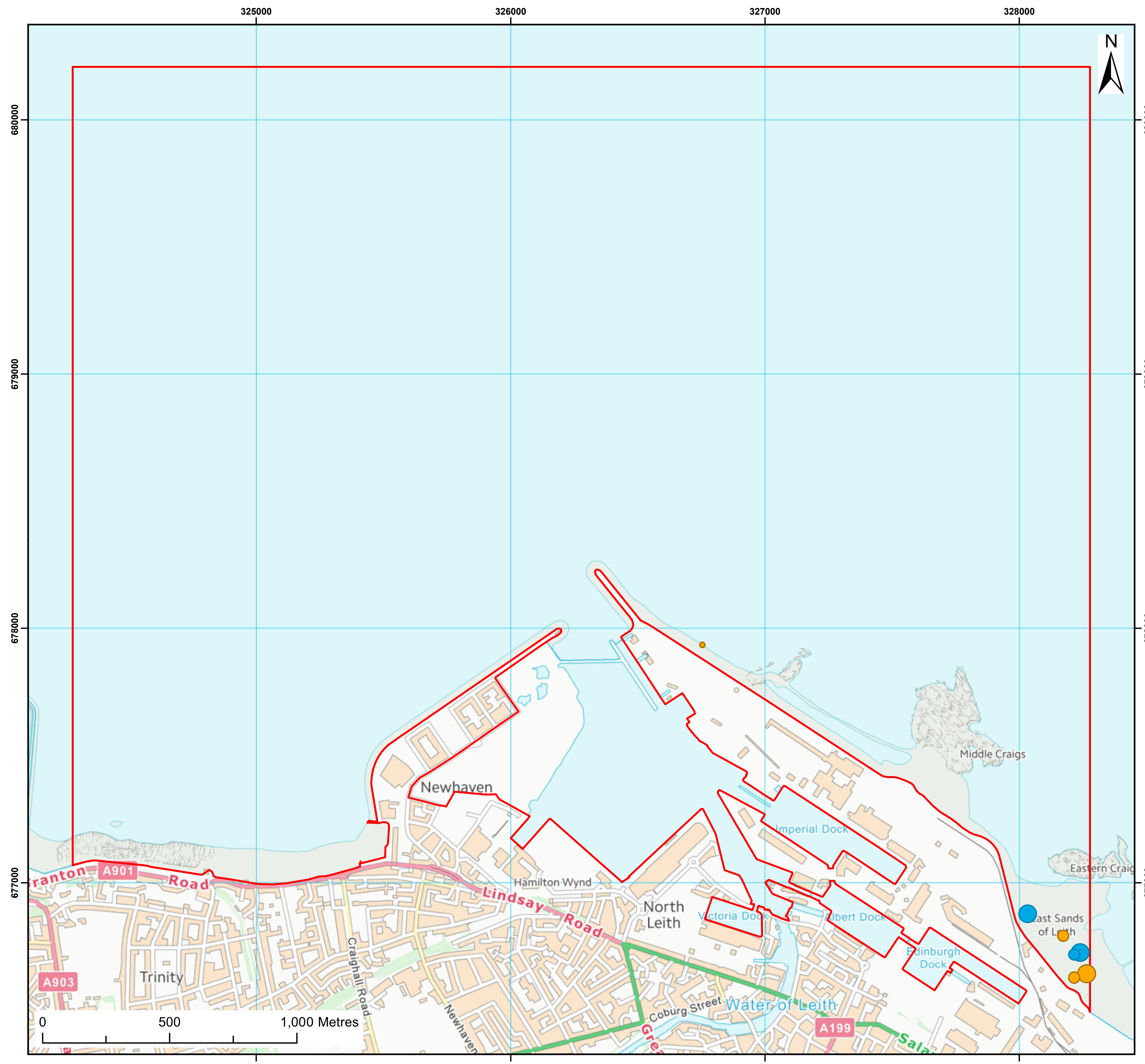

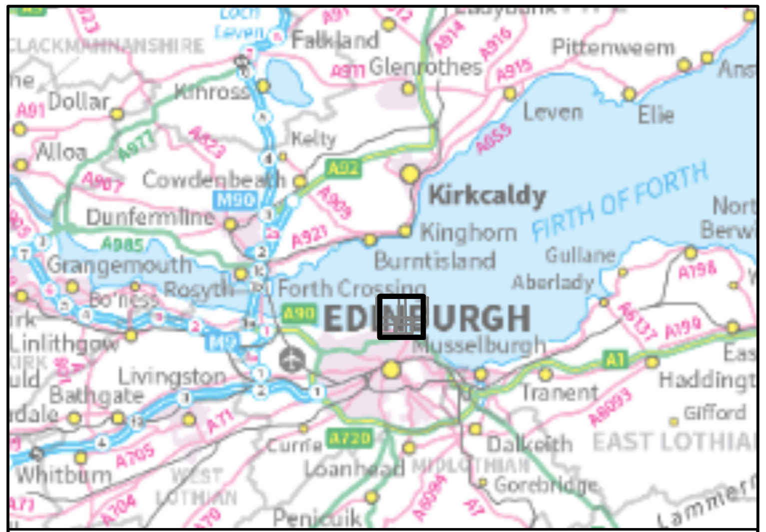

Legend:

Study Area

Foraging Knot (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

Loafing/Roosting Knot (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

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

Title:

Distribution map of Knot recorded during estuarine surveys, March 2021 to March 2022

Figure: A.14 Drawing No: PC2045-RHD-ZZ-ZZ-DR-EV-0032

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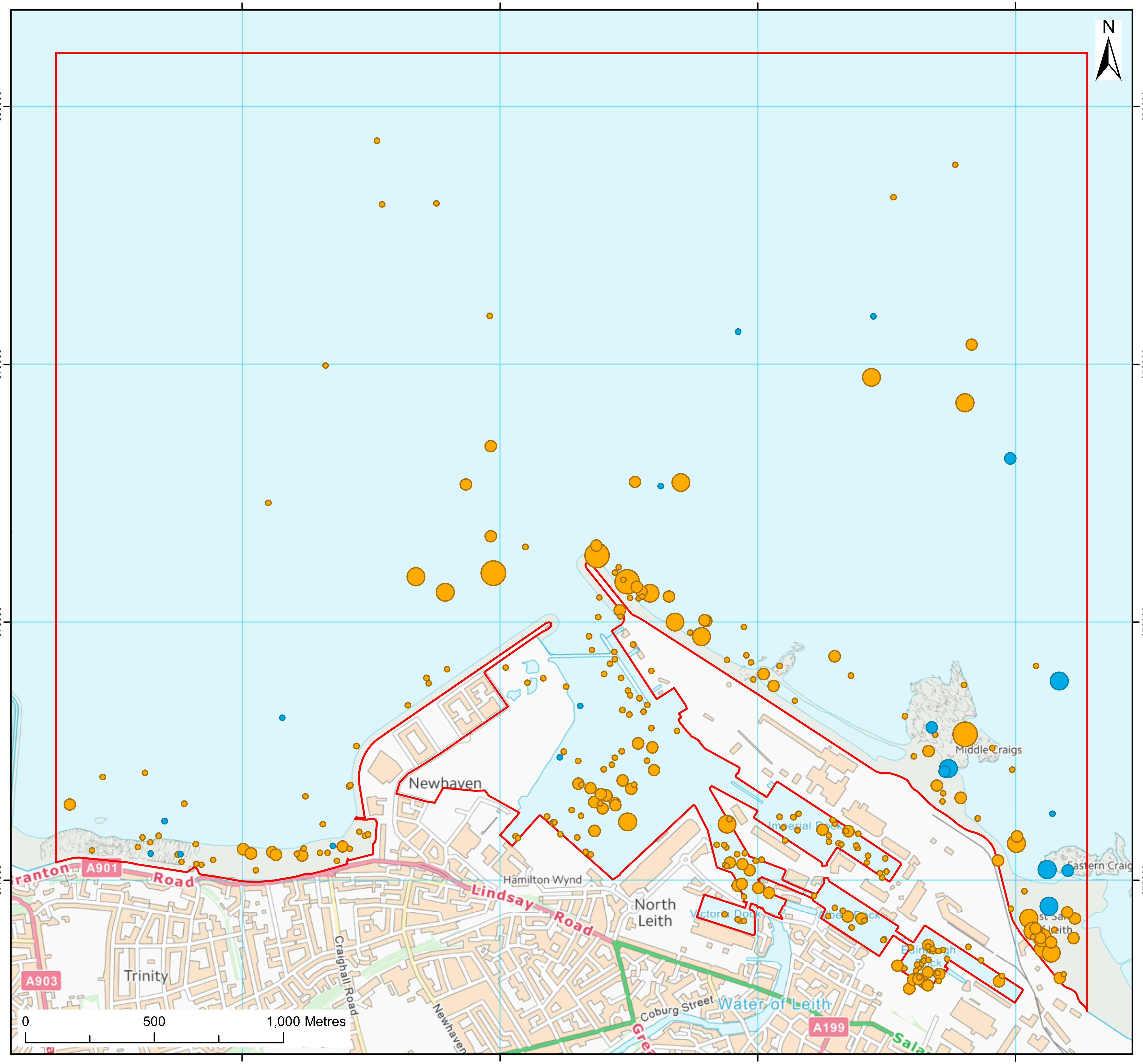

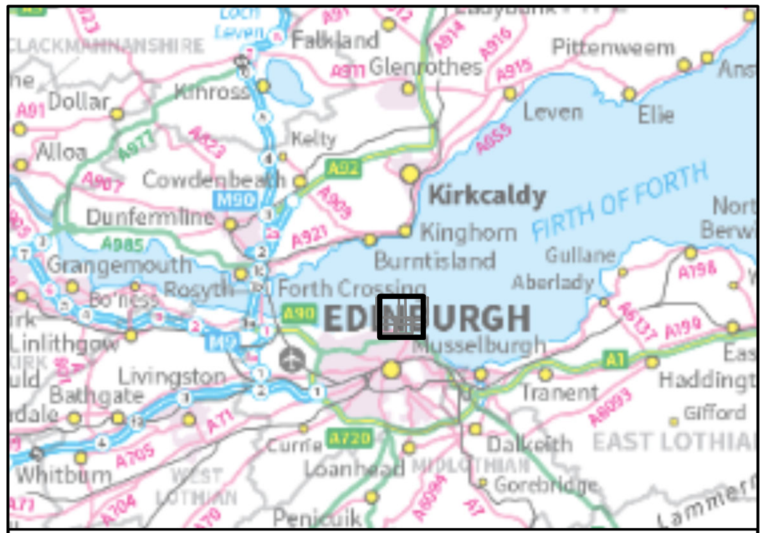

Legend:

Study Area

Foraging Lesser black-backed gull (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

Loafing/Roosting Lesser black-backed gull (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

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

Title:

Distribution map of Lesser black-backed gull recorded during estuarine surveys, March 2021 to March 2022

Figure: A.15 | Drawing No: PC2045-RHD-ZZ-ZZ-DR-EV-0033

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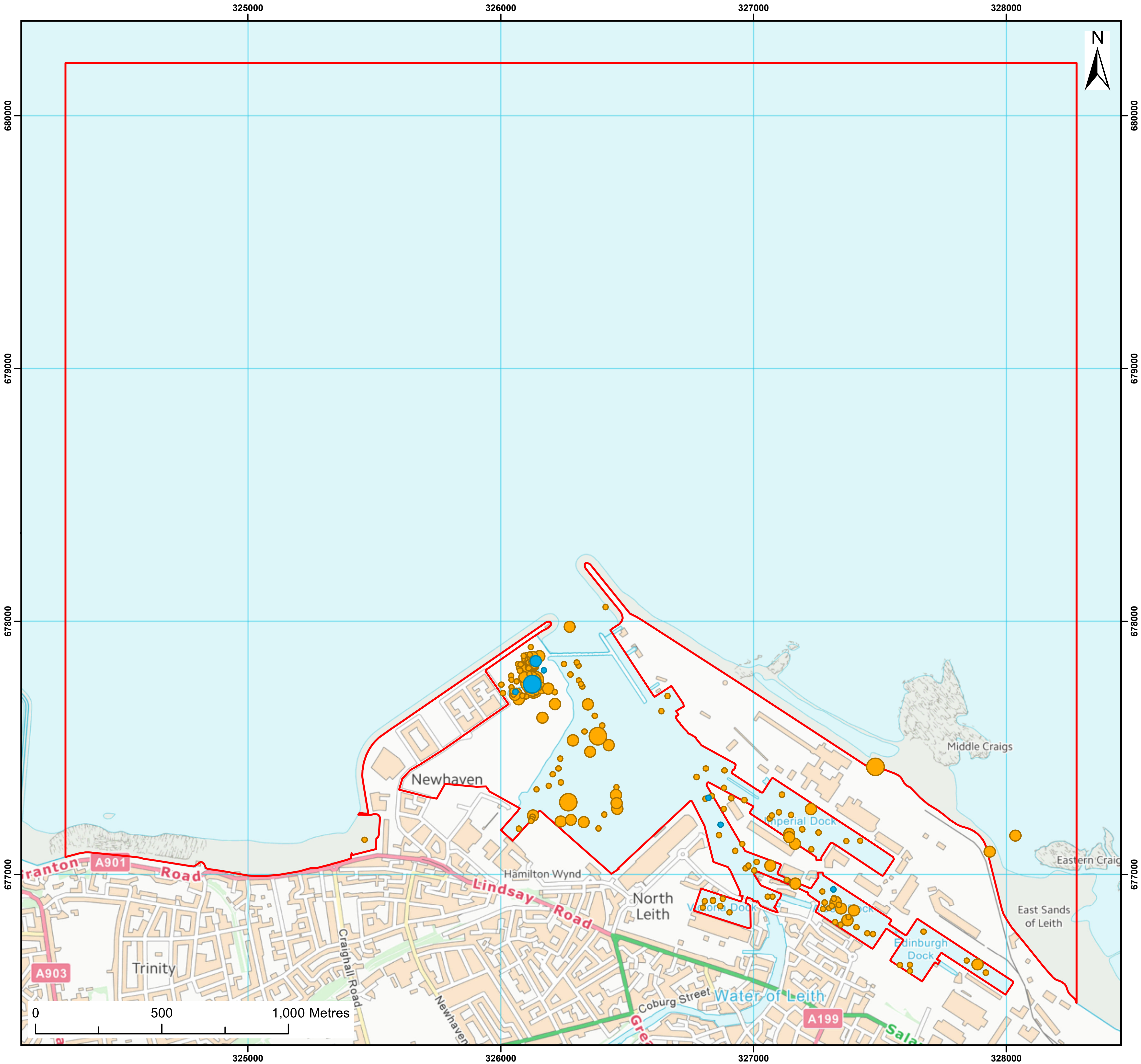

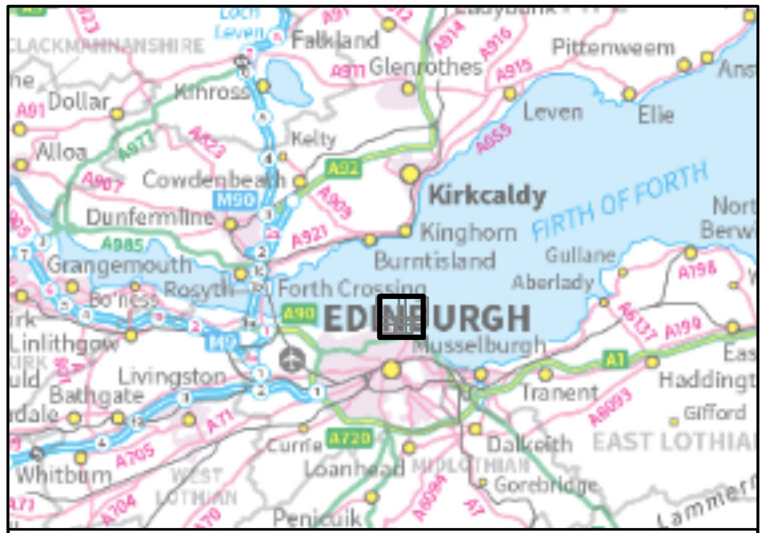

Legend:

Study Area

Foraging Mallard (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

Loafing/Roosting Mallard (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

Client: Forth Ports Limited

Project: Port of Leith - Outer Berth

Title: Distribution map of Mallard recorded during estuarine surveys, March 2021 to March 2022

Figure: A.16

Drawing No: PC2045-RHD-ZZ-ZZ-DR-EV-0034

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
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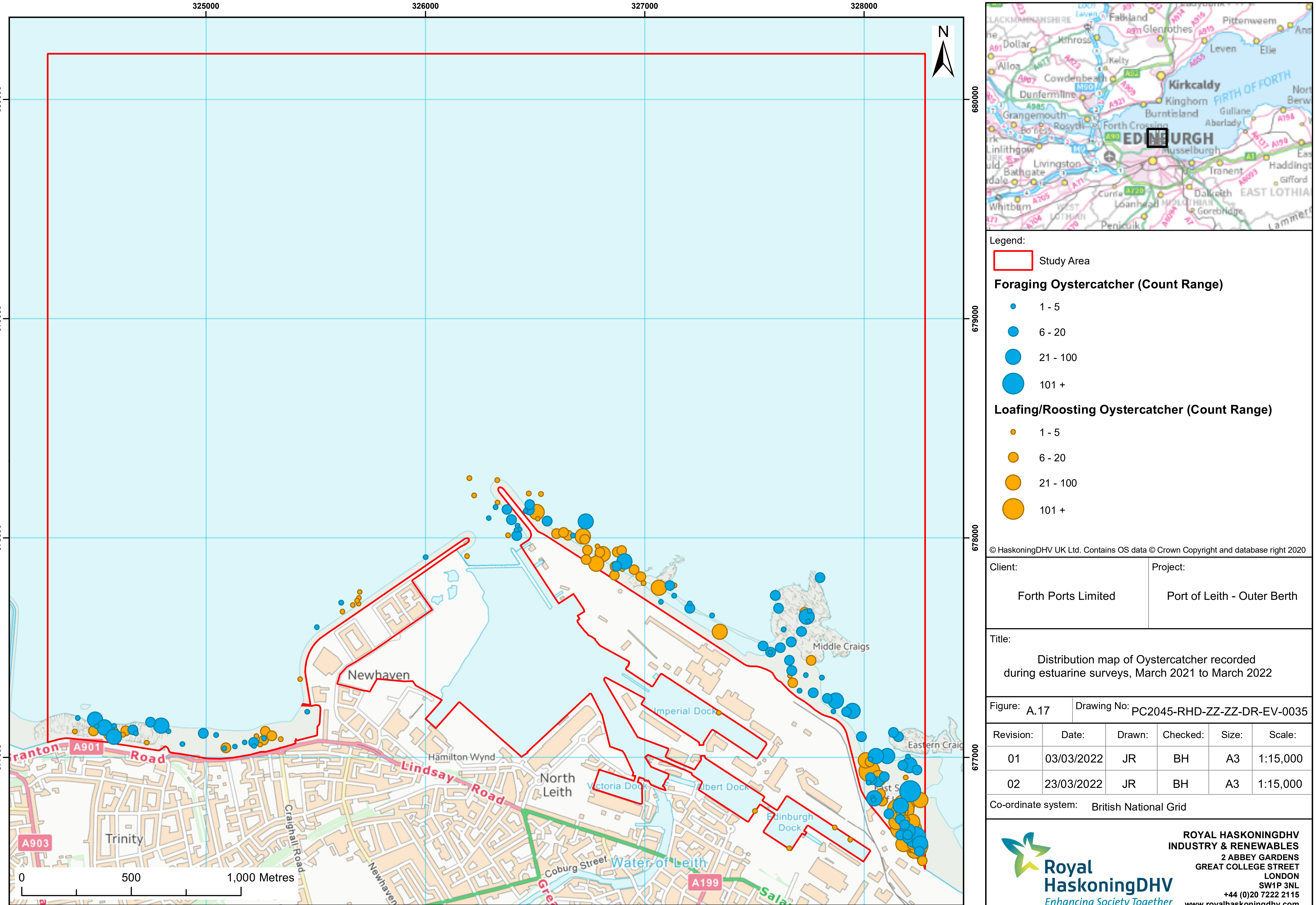

Legend:

Study Area

Foraging Oystercatcher (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

Loafing/Roosting Oystercatcher (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

Client: Forth Ports Limited

Project: Port of Leith - Outer Berth

Title: Distribution map of Oystercatcher recorded during estuarine surveys, March 2021 to March 2022

Figure: A.17

Drawing No: PC2045-RHD-ZZ-ZZ-DR-EV-0035

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
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Co-ordinate system: British National Grid

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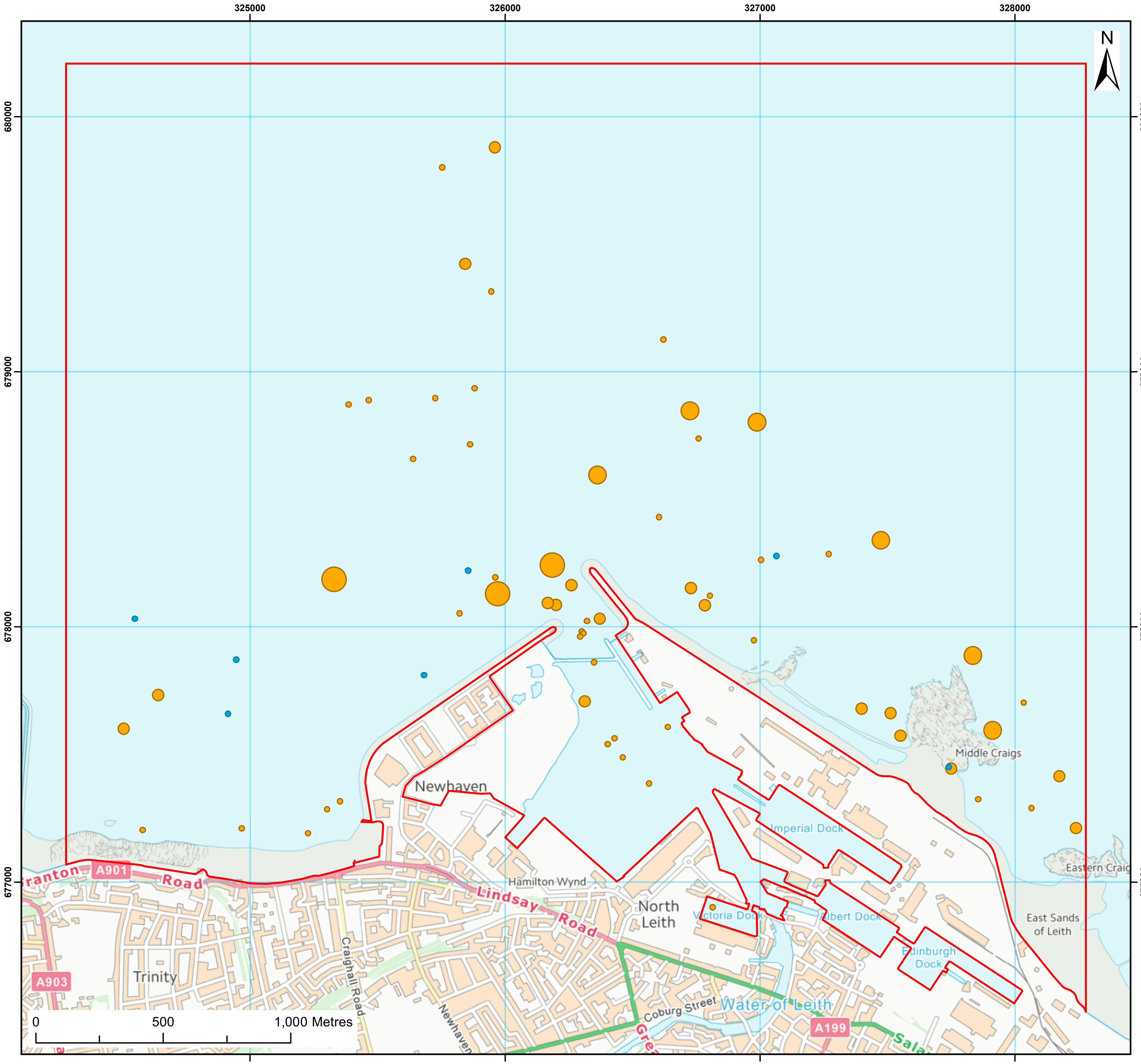

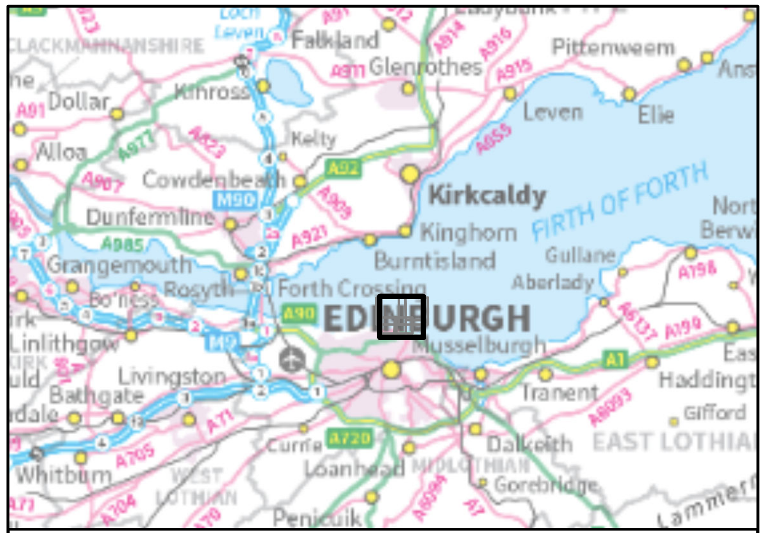

Legend:

Study Area

Foraging Razorbill (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

Loafing/Roosting Razorbill (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

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

Title:

Distribution map of Razorbill recorded during estuarine surveys, March 2021 to March 2022

Figure: A.18 | Drawing No: PC2045-RHD-ZZ-ZZ-DR-EV-0036

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
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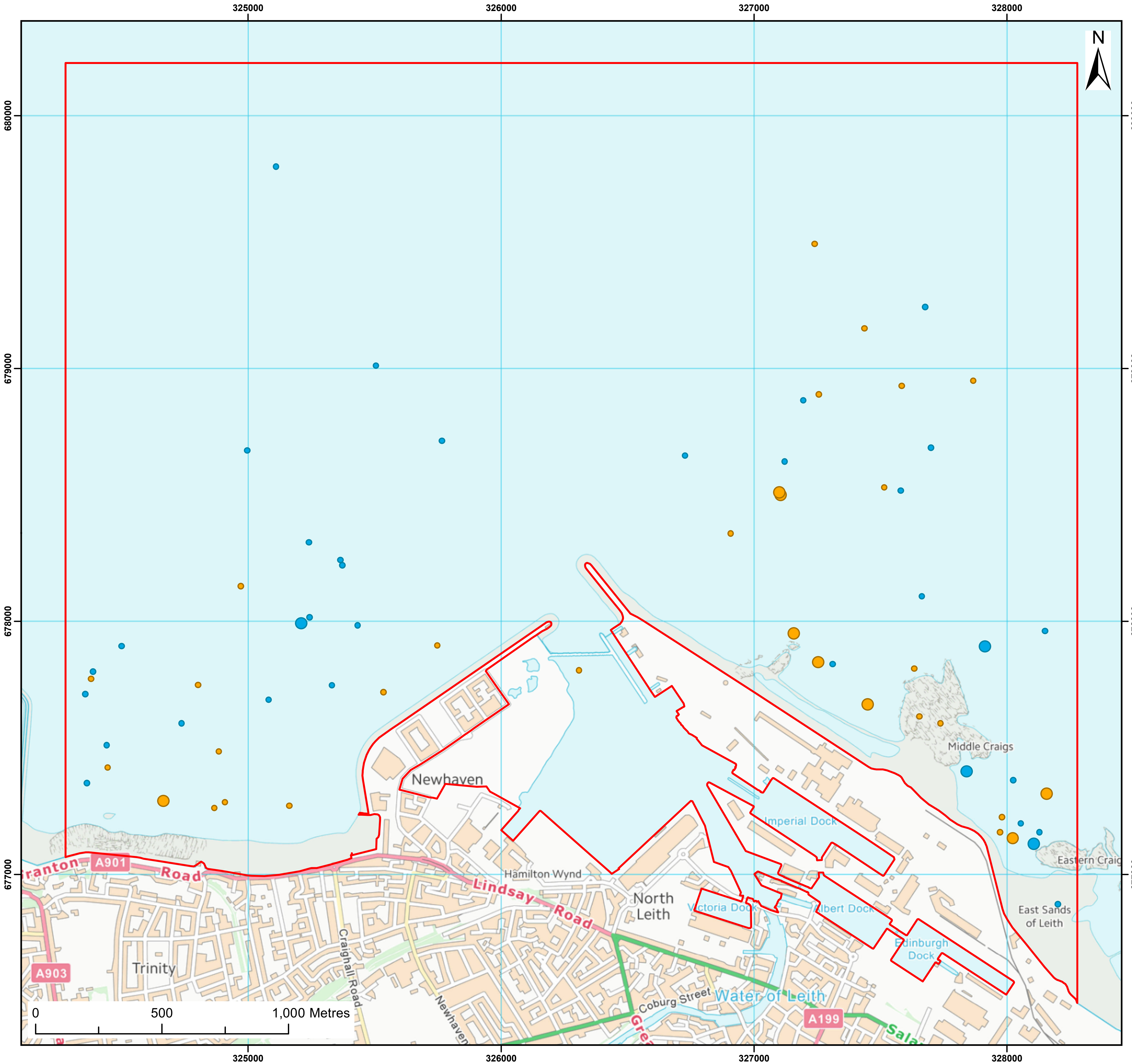

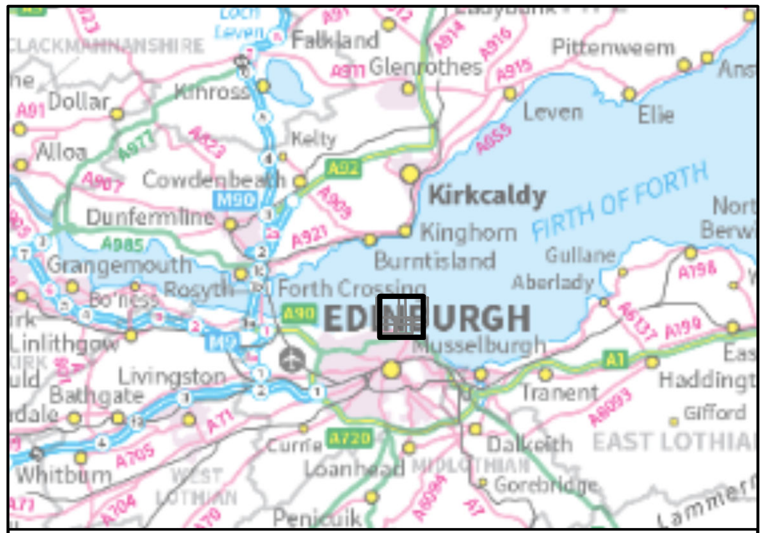

Legend:

Study Area

Foraging Red-breasted merganser (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

Loafing/Roosting Red-breasted merganser (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

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

Title:

Distribution map of Red-breasted merganser recorded during estuarine surveys, March 2021 to March 2022

Figure: A.19 Drawing No: PC2045-RHD-ZZ-ZZ-DR-EV-0037

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
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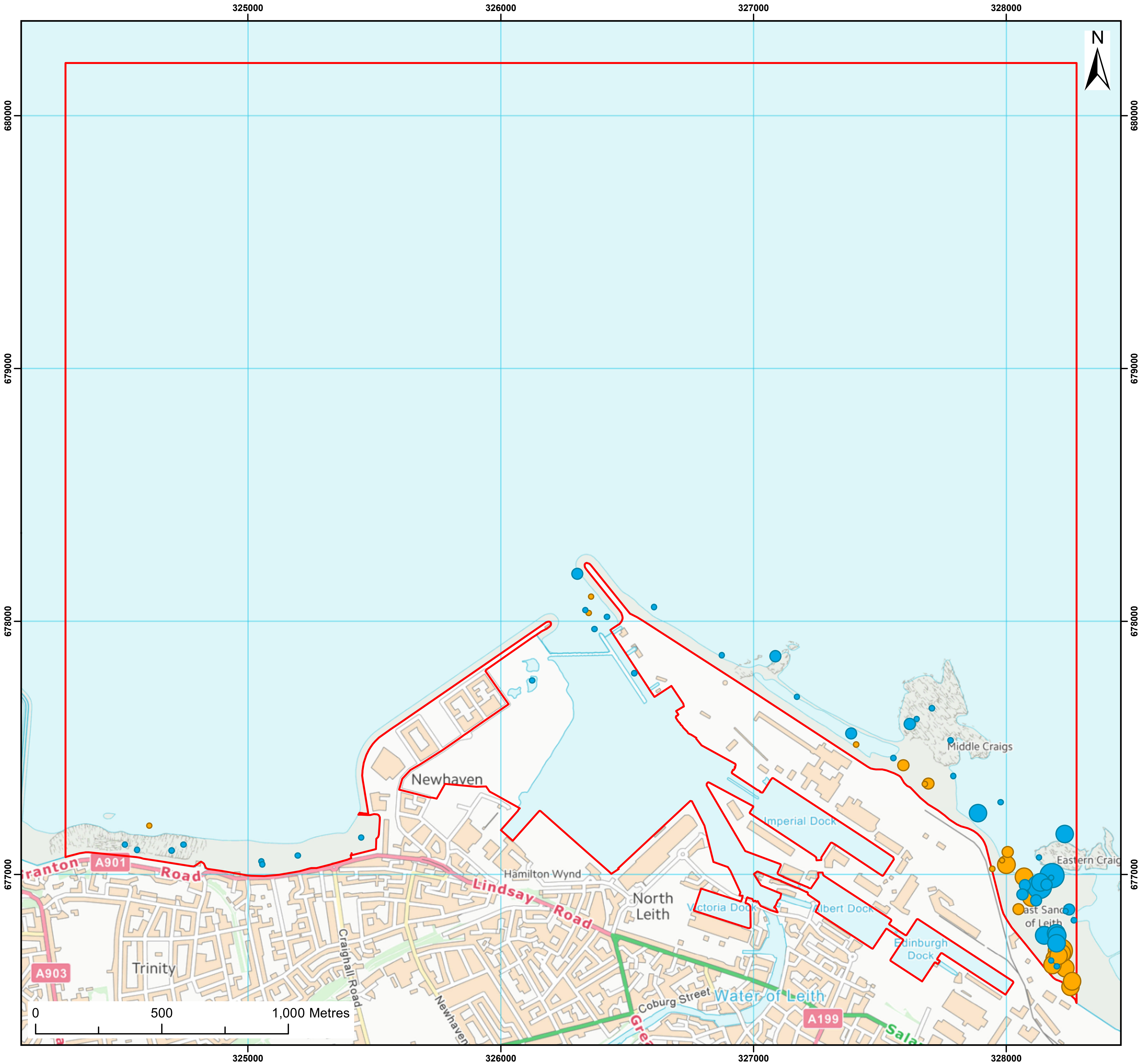

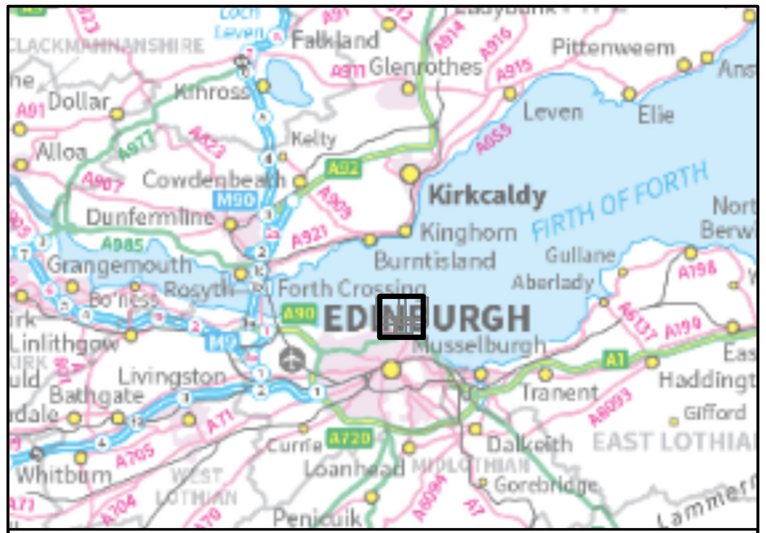

Legend:

Study Area

Foraging Redshank (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

Loafing/Roosting Redshank (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

Client: Forth Ports Limited

Project: Port of Leith - Outer Berth

Title: Distribution map of Redshank recorded during estuarine surveys, March 2021 to March 2022

Figure: A.20

Drawing No: PC2045-RHD-ZZ-ZZ-DR-EV-0038

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
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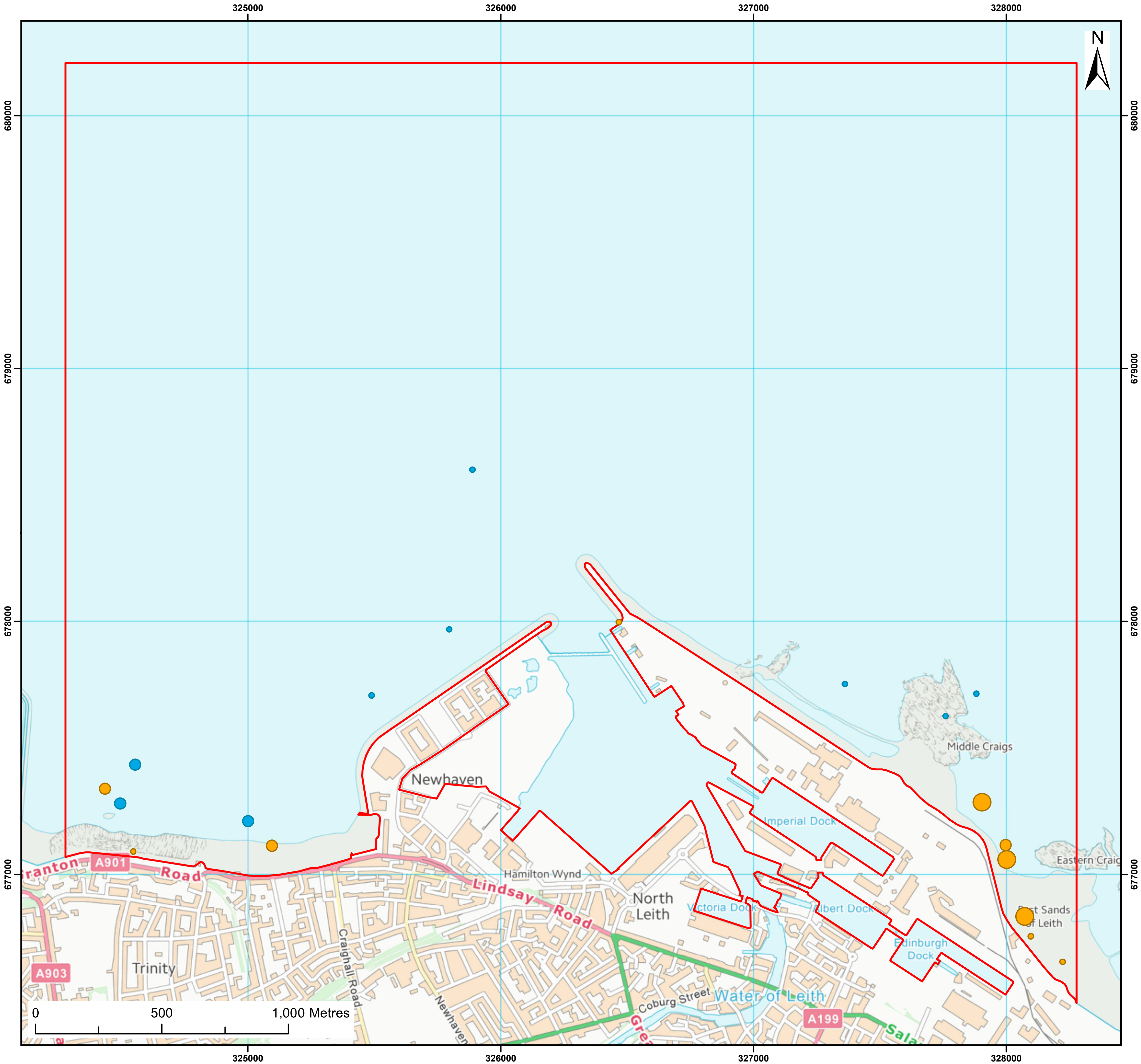

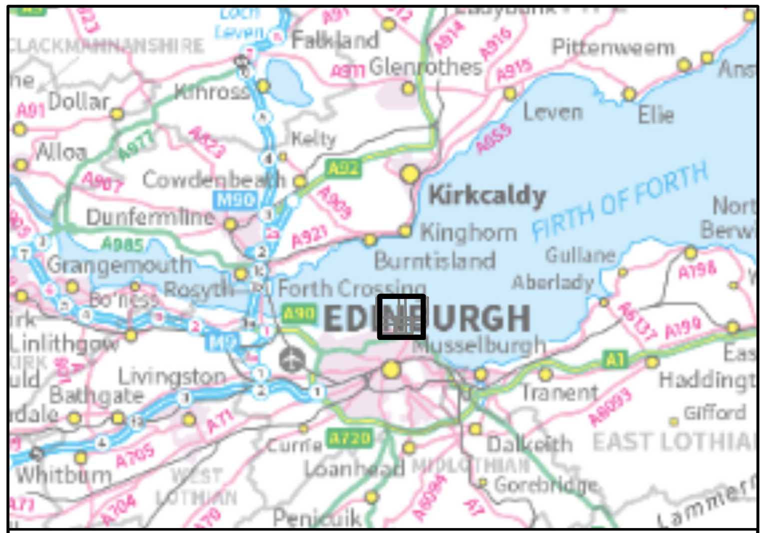

Legend:

Study Area

Foraging Sandwich tern (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

Loafing/Roosting Sandwich tern (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

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

Title:

Distribution map of Sandwich tern recorded during estuarine surveys, March 2021 to March 2022

Figure:	Drawing No:
A.23	PC2045-RHD-ZZ-ZZ-DR-EV-0041

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
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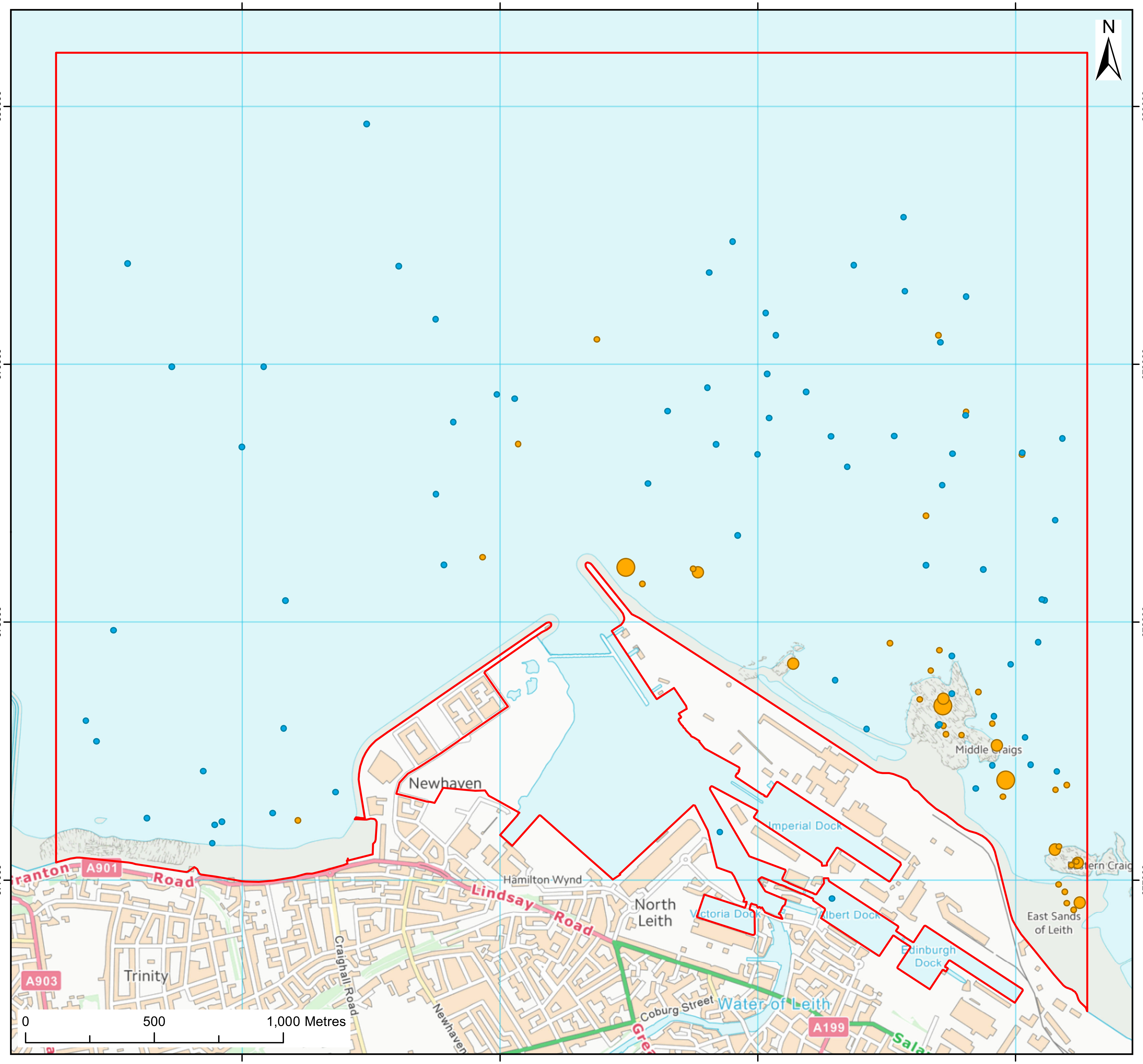

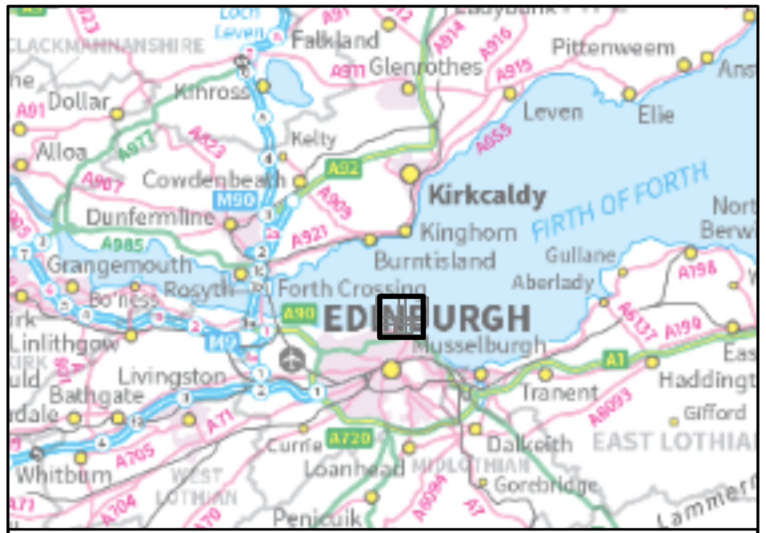

Legend:

Study Area

Foraging Shag (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

Loafing/Roosting Shag (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

Client: Forth Ports Limited

Project: Port of Leith - Outer Berth

Title: Distribution map of Shag recorded during estuarine surveys, March 2021 to March 2022

Figure: A.24

Drawing No: PC2045-RHD-ZZ-ZZ-DR-EV-0042

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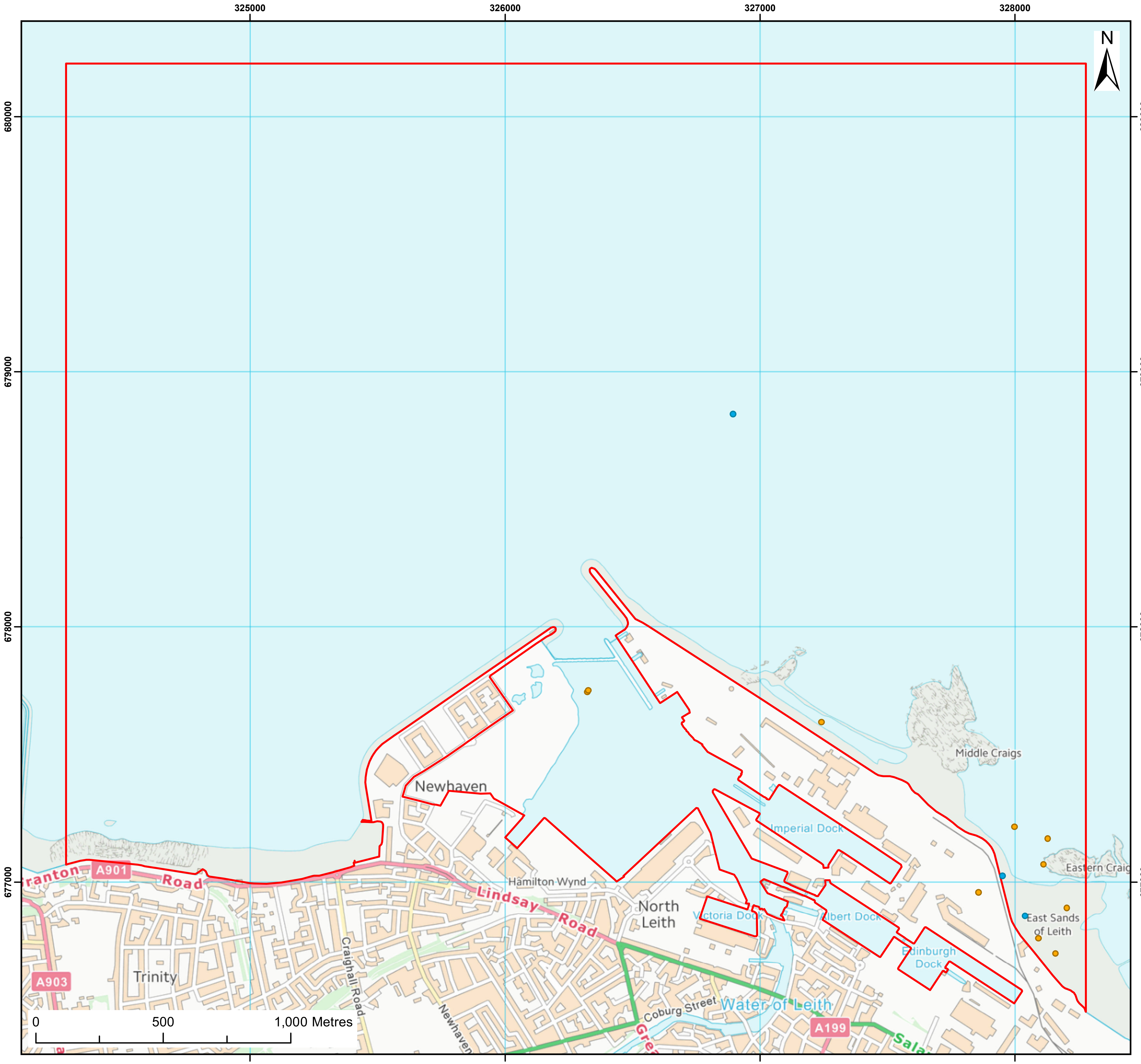

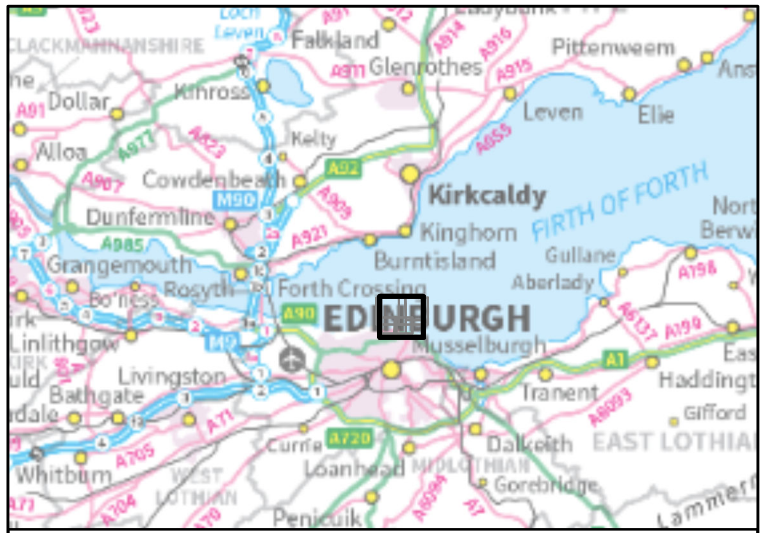

Legend:

Study Area

Foraging Shelduck (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

Loafing/Roosting Shelduck (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

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

Title:

Distribution map of Shelduck recorded during estuarine surveys, March 2021 to March 2022

Figure: A.25 Drawing No: PC2045-RHD-ZZ-ZZ-DR-EV-0043

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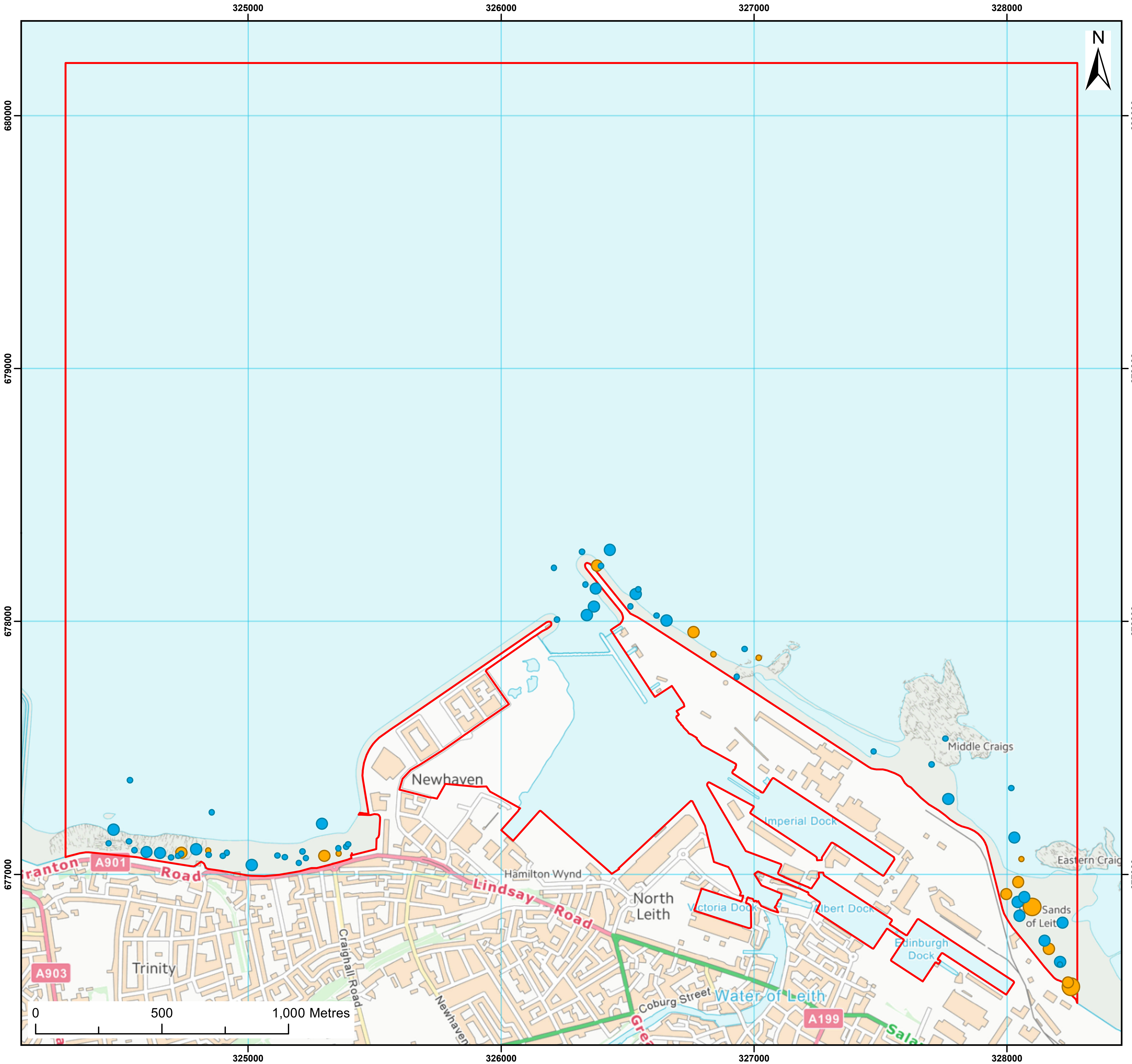

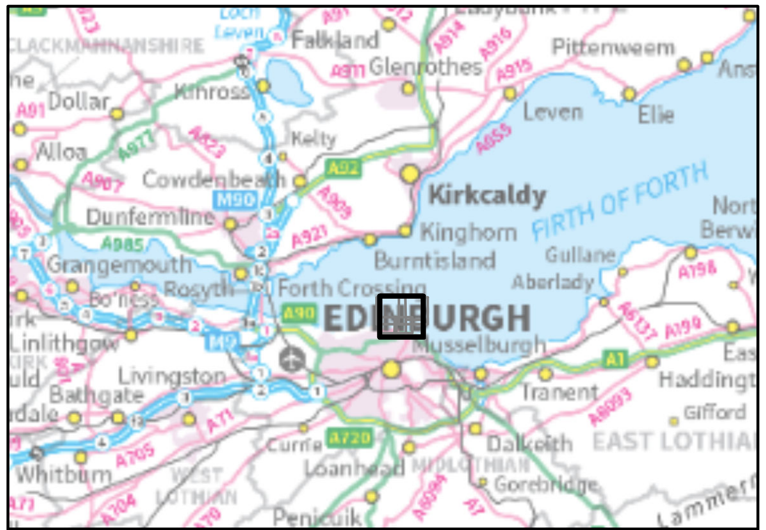

Legend:

Study Area

Foraging Turnstone (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

Loafing/Roosting Turnstone (Count Range)

- 1 - 5
- 6 - 20
- 21 - 100
- 101 +

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

Title:

Distribution map of Turnstone recorded during estuarine surveys, March 2021 to March 2022

Figure: A.26 Drawing No: PC2045-RHD-ZZ-ZZ-DR-EV-0044

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Appendix 3 Tern flight surveys

Table A 1 Rate of inbound and outbound common tern flights through flight sector 1

Survey visit number		Inbound flights (per hour)				Outbound flights (per hour)			
		0-5m	5-10m	10-20m	20m+	0-5m	5-10m	10-20m	20m+
May	1	0	0	9	6	0	6	9	3
	2	6	33	30	33	0	21	33	6
June	1	21	45	30	63	36	12	69	75
	2	6	9	27	36	0	3	63	66
July	1	0	21	126	123	0	36	96	90
	2	6	21	39	189	75	75	66	57

Table A 2 Rate of inbound and outbound common tern flights through flight sector 2

Survey visit number		Inbound flights (per hour)				Outbound flights (per hour)			
		0-5m	5-10m	10-20m	20m+	0-5m	5-10m	10-20m	20m+
May	1	0	0	0	6	0	0	0	6
	2	0	0	9	66	0	0	0	12
June	1	0	9	0	24	0	6	15	9
	2	3	69	54	15	6	60	51	12
July	1	3	15	36	54	15	15	30	27
	2	0	3	54	123	0	0	27	69

Table A 3 Rate of inbound and outbound common tern flights through flight sector 3

Survey visit number		Inbound flights (per hour)				Outbound flights (per hour)			
		0-5m	5-10m	10-20m	20m+	0-5m	5-10m	10-20m	20m+
May	1	0	0	0	39	0	0	0	60
	2	0	0	3	180	0	0	18	129
June	1	0	3	24	111	0	0	36	231
	2	9	96	102	21	39	114	108	21
July	1	0	42	522	249	0	96	594	213
	2	9	12	6	63	0	9	0	30

Table A 4 Rate of inbound and outbound common tern flights through flight sector 4

Survey visit number		Inbound flights (per hour)				Outbound flights (per hour)			
		0-5m	5-10m	10-20m	20m+	0-5m	5-10m	10-20m	20m+
May	1	0	0	0	6	0	0	0	9
	2	0	0	0	12	0	0	0	36
June	1	0	0	0	12	0	0	0	42
	2	3	39	36	9	9	75	51	18
July	1	0	0	9	156	0	3	21	48
	2	9	12	6	63	0	9	0	30

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Appendix 2: Underwater Noise Propagation Modelling for Construction Works at Port of Leith, Scotland

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Underwater noise propagation modelling for construction works at Port of Leith, Scotland

Fergus Midforth, Richard Barham

11 March 2022

Subacoustech Environmental Report No. P303R0102

Document No.	*Date*	*Written*	*Approved*	*Distribution*
P303R0101	*04/03/2022*	*F Midforth*	*T Mason*	*G Starmore (Haskoning)*
P303R0102	*11/03/2022*	*F Midforth*	*T Mason*	*G Starmore (Haskoning)*

This report is a controlled document. The report documentation page lists the version number, record of changes, referencing information, abstract and other documentation details.

List of contents

Glossary

Term	Definition
Decibel (dB)	A customary scale commonly used (in various ways) for reporting levels of sound. A difference of 10 dB corresponds to a factor of 10 in sound power. The actual sound measurement is compared to a fixed reference level and the "decibel" value is defined to be $10\log_{10}(actual/reference)$ where $(actual/reference)$ is a power ratio. Because sound power is usually proportional to sound pressure squared, the decibel value for sound pressure is $20\log_{10}(actual\ pressure/reference\ pressure)$. The standard reference for underwater sound is 1 micropascal (µPa). The dB symbol is followed by a second symbol identifying the specific reference value (e.g., re 1 µPa).
Peak pressure	The highest pressure above or below ambient that is associated with a sound wave.
Peak-to-peak pressure	The sum of the highest positive and negative pressures that are associated with a sound wave.
Permanent Threshold Shift (PTS)	A permanent total or partial loss of hearing caused by acoustic trauma. PTS results in irreversible damage to the sensory hair cells of the air, and thus a permanent reduction of hearing acuity
Sound Exposure Level (SEL) Cumulative (SEL_{cum})	The constant sound level acting for one second, which has the same amount of acoustic energy, as indicated by the square of the sound pressure, as the original sound. It is the time-integrated, sound-pressure-squared level. SEL is typically used to compare transient sound events having different time durations, pressure levels, and temporal characteristics. Noise exposure within an extended duration can be captured in a cumulative SEL.
Sound Pressure Level (SPL)	The sound pressure level is an expression of sound pressure using the decibel (dB) scale; the standard frequency pressures of which are 1 µPa for water and 20 µPa for air.
Temporary Threshold Shift (TTS)	Temporary reduction of hearing acuity because of exposure to sound over time. Exposure to high levels of sound over relatively short time periods could cause the same amount of TTS as exposure to lower levels of sound over longer time periods. The mechanisms underlying TTS are not well understood, but there may be some temporary damage to the sensory cells. The duration of TTS varies depending on the nature of the stimulus.
Unweighted sound level	Sound levels which are "raw" or have not been adjusted in any way, for example to account for the hearing ability of a species.
Weighted sound level	A sound level which has been adjusted with respect to a "weighting envelope" in the frequency domain, typically to make an unweighted level relevant to a particular species. Examples of this are the dB(A), where the overall sound level has been adjusted to account for the hearing ability of humans in air, or the filters used by Southall *et al*. (2019) for marine mammals.

1 Introduction

Subacoustech has undertaken underwater noise modelling and analysis to assess the potential impact of underwater noise from the proposed construction of a new berth at the Port of Leith, Scotland, on marine mammals and fish. Construction may involve the installation of tubular and sheet piles by impact and vibration piling, in addition to dredging works. These sources will create noise, which must be suitably assessed.

1.1 Survey area

The modelling location used for this study in the Port of Leith is shown in Figure 1-1. This is understood to be approximately the location of the outermost dolphin that may be constructed for the berth, and represents the worst case scenario location for underwater noise modelling. This is discussed further in section 3.1.

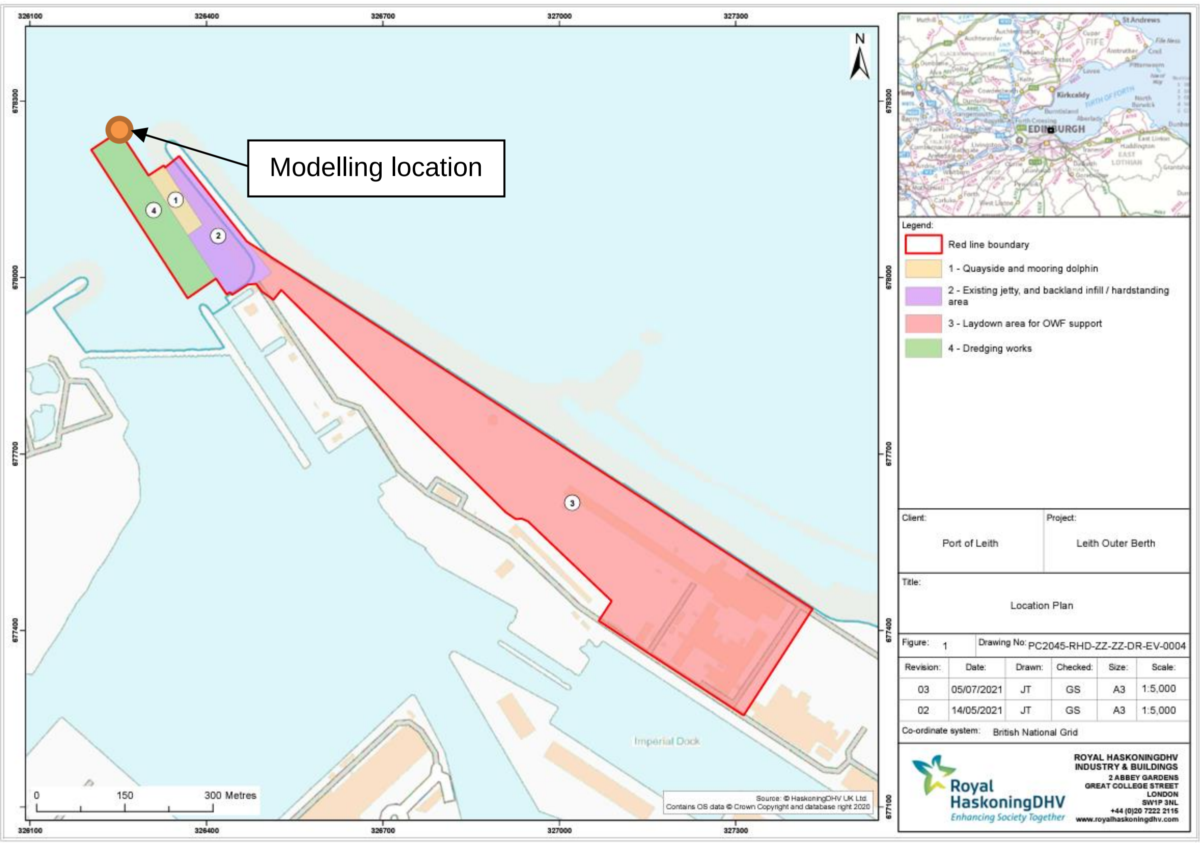

Figure 1-1 Location of proposed construction works at the Port of Leith and the location used for detailed underwater sound propagation modelling

1.2 Assessment overview

In this report impact piling has been assessed using detailed underwater noise modelling. All other construction methods have been assessed using simple modelling methods due to the relatively low noise level produced by these activities for this project.

A detailed assessment of the potential underwater noise from works in the Port of Leith is presented, and covers the following:

- Review of background information on the units for measuring and assessing underwater noise (section 2.1);

- The underwater noise metrics and criteria used to assess the possible environmental effect in marine receptors (section 2.2);
- Discussion of the approach, input parameters and assumptions for the noise modelling undertaken (section 3);
- Presentation of the modelling and interpretation of the results using suitable noise metrics and criteria (section 4); and
- Summary and conclusions (section 5).

2 Measurement of underwater noise

2.1 Underwater noise

Sound travels much faster in water (approximately 1,500 m/s) than in air (340 m/s). Since water is a relatively incompressible, dense medium, the pressure associated with underwater sound tends to be much higher than in air. As an example, background noise levels in the sea of 130 dB re 1 µPa SPL_{RMS} for UK coastal waters are not uncommon (Nedwell *et al*. 2003; Nedwell *et al.* 2007).

It should be noted that stated underwater noise levels should not be confused with noise levels in air, which use a different scale.

2.1.1 Units of measurement

Sound measurements underwater are usually expressed using the decibel (dB) scale, which is a logarithmic measure of sound. A logarithmic scale is used because, rather than equal increments of sound having an equal increase in effect, typically each doubling of sound level will cause a roughly equal increase of “loudness.”

Any quantity expressed in this scale is termed a “level.” If the unit is sound pressure, expressed on the dB scale, it will be termed a “sound pressure level.”

The fundamental definition of the dB scale is given by:

$$Level = 10 \times \log_{10}\left(\frac{Q}{Q_{ref}}\right)$$

where Q is the quantity being expressed on the scale, and Q_{ref} is the reference quantity.

The dB scale represents a ratio. It is therefore used with a reference unit, which expresses the base from which the ratio is expressed. The reference quantity is conventionally smaller than the smallest value to be expressed on the scale so that any level quoted is positive. For example, a reference quantity of 20 µPa is used for sound in air since that is the lower threshold of human hearing.

When used with sound pressure, the pressure value is squared. So that variations in the units agree, the sound pressure must be specified as units of Root Mean Square (RMS) pressure squared. This is equivalent to expressing the sound as:

$$Sound\ pressure\ level = 20 \times \log_{10}\left(\frac{P_{RMS}}{P_{ref}}\right)$$

For underwater sound, a unit of 1 µPa is typically used as the reference unit (P_{ref}); a Pascal is equal to the pressure exerted by one Newton over one square metre, one micropascal equals one millionth of this.

Unless otherwise defined, all noise levels in this report are referenced to 1 µPa.

2.1.2 Sound Pressure Level (SPL)

The Sound Pressure Level (SPL) is normally used to characterise noise and vibration of a continuous nature, such as drilling, boring, continuous wave sonar, or background sea and river noise levels. To calculate the SPL, the variation in sound pressure is measured over a specific period to determine the RMS level of the time-varying sound. The SPL can therefore be considered a measure of the average unweighted level of sound over the measurement period.

Where SPL is used to characterise transient pressure waves, such as that from impact piling, seismic airgun or underwater blasting, it is critical that the period over which the RMS level is calculated is quoted. For instance, in the case of a pile strike lasting a tenth of a second, the mean taken over a tenth of a second will be ten times higher than the mean averaged over one second. Often, transient sounds such as these are quantified using “peak” SPLs or Sound Exposure Levels (SELs).

Unless otherwise defined, all SPL noise levels in this report are referenced to 1 µPa. It is recognised that ISO 18405 (2017) defines SPL in reference to the unit 1 μPa^2. As the key publications used in this assessment use the unit 1 µPa, this terminology will also be used in this report. This does not affect any results or values.

2.1.3 Peak Sound Pressure Level (SPL_{peak})

Peak SPLs are often used to characterise transient sound from impulsive sources, such as percussive impact piling. SPL_{peak} is calculated using the maximum variation of the pressure from positive to zero within the wave. This represents the maximum change in positive pressure (differential pressure from positive to zero) as the transient pressure wave propagates.

A further variation of this is the peak-to-peak SPL ($SPL_{peak\text{-}to\text{-}peak}$) where the maximum variation of the pressure from positive to negative is considered. Where the wave is symmetrically distributed in positive and negative pressure, the peak-to-peak pressure will be twice the peak level, or 6 dB higher (see section 2.1.1).

2.1.4 Sound Exposure Level (SEL)

When considering the noise from transient sources, the issue of the duration of the pressure wave is often addressed by measuring the total acoustic energy (energy flux density) of the wave. This form of analysis was used by Bebb and Wright (1953, 1954a, 1954b, 1955), and later by Rawlins (1987), to explain the apparent discrepancies in the biological effect of short and long-range blast waves on human divers. More recently, this form of analysis has been used to develop criteria for assessing injury ranges for fish and marine mammals from various noise sources (Popper *et al.*, 2014; Southall *et al.*, 2019).

The SEL sums the acoustic energy over a measurement period, and effectively takes account of both the SPL of the sound and the duration it is present in the acoustic environment. Sound Exposure (SE) is defined by the equation:

$$SE = \int_0^T p^2(t)dt$$

where p is the acoustic pressure in Pascals, T is the total duration of the sound in seconds, and t is the time in seconds. The SE is a measurement of acoustic energy and has units of Pascal squared seconds (Pa^2s).

To express the SE on a logarithmic scale by means of a dB, it must be compared with a reference acoustic energy level (${p^2}_{ref}$) and a reference time (T_{ref}). The SEL is then defined by:

$$SEL = 10 \times \log_{10}\left(\frac{\int_0^T p^2(t)dt}{{p^2}_{ref}T_{ref}}\right)$$

By selecting a common reference pressure (p_{ref}) of 1 µPa for assessments of underwater noise, the SEL and SPL can be compared using the expression:

$$SEL = SPL + 10 \times \log_{10} T$$

where the SPL is a measure of the average level of broadband noise and the SEL sums the cumulative broadband noise energy.

This means that, for continuous sounds of less than one second, the SEL will be lower than the SPL. For periods greater than one second, the SEL will be numerically greater than the SPL (i.e., for a continuous sound of 10 seconds duration, the SEL will be 10 dB higher than the SPL; for a sound of 100 seconds duration the SEL will be 20 dB higher than the SPL, and so on).

Where a single impulse noise such as the soundwave from a pile strike is considered in isolation, this can be represented by a “single strike" SEL or SEL_{ss}.

2.2 Analysis of environmental effects

2.2.1 Background

Over the last 20 years it has become increasingly evident that noise from human activities in and around underwater environments can have an impact on the marine species in the area. The extent to which intense underwater sound might cause adverse impacts in species is dependent upon the incident sound level, source frequency, duration of exposure, and/or repetition rate of an impulsive sound (see, for example, Hastings and Popper, 2005). As a result, scientific interest in the hearing abilities of aquatic species has increased. Studies are primarily based on evidence from high level sources of underwater noise such as blasting or impact piling, as these sources are likely to have the greatest immediate environmental impact and therefore the clearest observable effects, although interest in chronic noise exposure is increasing.

The impacts of underwater sound on marine species can be broadly summarised as follows:

- Physical traumatic injury and fatality;
- Auditory injury (either permanent or temporary); and
- Disturbance.

The following sections discuss the underwater noise criteria used in this study with respect to species of marine mammals and fish that may be present around the Port of Leith.

The main metrics and criteria that have been used in this study to aid assessment of environmental effects come from three key papers covering underwater noise and its effects:

- Southall *et al*. (2019) marine mammal noise exposure criteria; and
- Popper *et al*. (2014) sound exposure guidelines for fishes and sea turtles.

At the time of writing these include the most up to date and authoritative criteria for assessing environmental effects for use in impact assessments.

2.2.2 Marine mammals

2.2.2.1 Southall et al. (2019) criteria

The Southall *et al*. (2019) paper is effectively an update of the previous Southall *et al.* (2007) paper and provides identical thresholds to those from the National Marine Fisheries Service (NMFS) (2018) guidance for marine mammals.

The Southall *et al*. (2019) guidance groups marine mammals into groups of similar species and applies filters to the unweighted noise to approximate the hearing sensitivities of the receptor in question. The hearing groups given in Southall *et al*. (2019) are summarised in Table 2-1 and Figure 2-1. Further groups for sirenians and other marine carnivores in water are also given, but these have not been used for this study as those species are not commonly found in the Irish Sea.

Table 2-1 Marine mammal hearing groups (from Southall et al., 2019)

Hearing group	Generalised hearing range	Example species
Low-frequency cetaceans (LF)	7 Hz to 35 kHz	Baleen whales
High-frequency cetaceans (HF)	150 Hz to 160 kHz	Dolphins, toothed whales, beaked whales, bottlenose whales (including bottlenose dolphin)
Very high-frequency cetaceans (VHF)	275 Hz to 160 kHz	True porpoises (including harbour porpoise)
Phocid carnivores in water (PCW)	50 Hz to 86 kHz	True seals (including harbour seal)

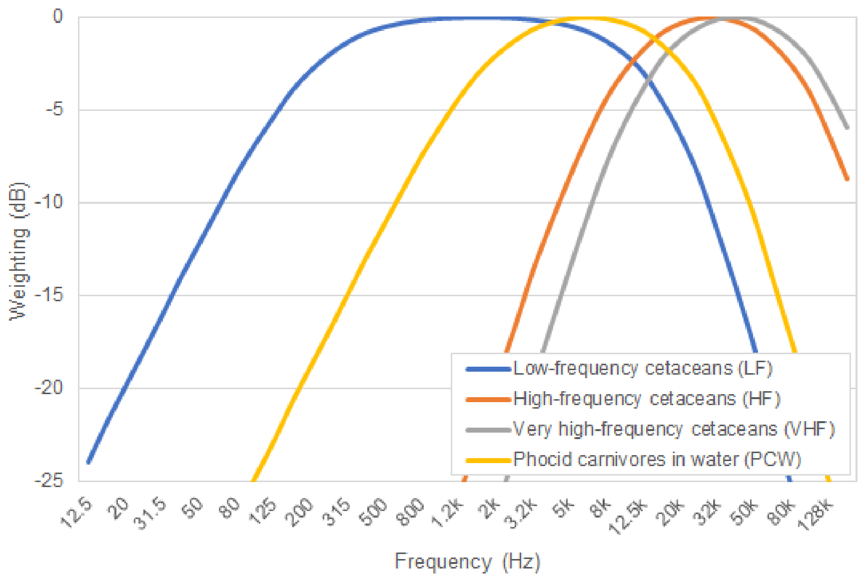

Figure 2-1 Auditory weighting functions for low-frequency cetaceans (LF), high-frequency cetaceans (HF), very high-frequency cetaceans (VHF), and phocid carnivores in water (PCW) (from Southall et al., 2019)

Southall *et al*. (2019) also gives individual criteria based on whether the noise source is considered impulsive or non-impulsive. Southall *et al*. (2019) categorises impulsive noises as having high peak sound pressure, short duration, fast rise-time and broad frequency content at source, and non-impulsive sources as steady-state noise. Explosives, impact piling and seismic airguns are considered impulsive noise sources and sonars, vibropiling, drilling and other low-level continuous noises are considered non-impulsive. A non-impulsive noise does not necessarily have to have a long duration.

Southall *et al*. (2019) presents single strike, unweighted peak criteria (SPL_{peak}) and cumulative weighted sound exposure criteria (SEL_{cum}, i.e., can include the accumulated exposure of multiple pulses) for both permanent threshold shift (PTS), where unrecoverable (but incremental) hearing damage may occur, and temporary threshold shift (TTS), where a temporary reduction in hearing sensitivity may occur in individual receptors. These dual criteria (SPL_{peak} and SEL_{cum}) are only used for impulsive noise: the criteria set giving the greatest calculated range is used as the PTS impact range.

As sound pulses propagate through the environment and dissipate, they also lose their most injurious characteristics (e.g., rapid pulse rise time and high peak sound pressure) and become more like a “non-pulse” at greater distances; Southall *et al*. (2019) briefly discusses this. Active research is currently underway into the identification of the distance at which the pulse can be considered effectively non-impulsive, and Hastie *et al*. (2019) have analysed a series of impulsive data to investigate it. Although the situation is complex, the paper reported that most of the signals crossed their threshold for rapid rise time and high peak sound pressure characteristics associated with impulsive noise at around 3.5 km from the source. However, research by Martin *et al*. (2020) casts doubt on these findings, showing that noise in this category should be considered impulsive as long as it is above effective quiet, or a noise sufficiently low enough that it does not contribute significantly to any auditory impairment or injury. Non-impulsive criteria from Southall *et al.* (2019) have been included in this study for the clearly continuous-type noise sources.

Although the use of impact ranges derived using the impulsive criteria are recommended for all but the clearly non-impulsive sources (such as drilling), it should be recognised that where calculated ranges are beyond 3.5 km they would be expected to become increasingly less impulsive and harmful, and the impact range is therefore likely to be somewhere between the modelled impulsive and non-impulsive impact range. Where the impulsive impact range is significantly greater than 3.5 km, the non-impulsive range should be considered.Table 2-2 and Table 2-3 present the criteria from Southall *et al*. (2019) for the onset of PTS and TTS risk for each of the key marine mammal hearing groups, considering both impulsive and non-impulsive sources.

Table 2-2 Single strike SPL_{peak} criteria for PTS and TTS in marine mammals (Southall et al., 2019)

Southall *et al*. (2019)	**Unweighted SPL_{peak} (dB re 1 μPa)**	
	Impulsive	
	PTS	**TTS**
Low-frequency cetaceans (LF)	219	213
High-frequency cetaceans (HF)	230	224
Very high-frequency cetaceans (VHF)	202	196
Phocid carnivores in water (PCW)	218	212

Table 2-3 Impulsive and non-impulsive SEL_{cum} criteria for PTS and TTS in marine mammals (Southall et al., 2019)

Southall *et al*. (2019)	**Weighted SEL_{cum} (dB re 1 μPa²s)**			
	Impulsive		**Non-impulsive**	
	PTS	**TTS**	**PTS**	**TTS**
Low-frequency cetaceans (LF)	183	168	199	179
High-frequency cetaceans (HF)	185	170	198	178
Very high-frequency cetaceans (VHF)	155	140	173	153
Phocid carnivores in water (PCW)	185	170	201	181

Where SEL_{cum} are required, a fleeing animal model has been used for marine mammals. This assumes that a receptor, when exposed to high noise levels, will swim away from the noise source. For this, the following flee speeds have been used for each marine mammal group:

- 2.1 ms^{-1} for low-frequency cetaceans (LF) (SNH, 2016);
- 1.52 ms^{-1} for high-frequency cetaceans (HF) (Bailey and Thompson, 2006);
- 1.4 ms^{-1} for very high-frequency cetaceans (VHF) (SNH, 2016); and

- 1.8 ms^{-1} for phocid carnivores in water (PCW) (SNH, 2016).

These are considered worst case assumptions as marine mammals are expected to be able to swim much faster under stress conditions.

2.2.3 Fish

2.2.3.1 Popper et al. (2014) criteria

The large number of, and variation in, fish species leads to a greater challenge in production of a general noise criterion, or range of criteria, for the assessment of noise impacts. Whereas previous studies applied broad criteria based on limited studies of fish that are not present in UK waters (e.g., McCauley *et al*., 2000) or measurement data not intended to be used as criteria (Hawkins *et al*., 2014), the publication of Popper *et al*. (2014) provides an authoritative summary of the latest research and guidelines for fish exposure to sound and uses categories for fish that are representative of the species present in UK waters.

The Popper *et al*. (2014) study groups species of fish by whether they possess a swim bladder, and whether it is involved in its hearing; a group for fish eggs and larvae is also included. The guidance also gives specific criteria (as both unweighted SPL_{peak} and unweighted SEL_{cum} values) for a variety of noise sources.

For this study, criteria for impact piling and continuous noise sources have been considered; these are summarised in Table 2-4 to Table 2-5.

Table 2-4 Criteria for mortality and potential mortal injury, recoverable injury and TTS in species of fish from impact piling noise (Popper et al., 2014)

Type of animal	Mortality and potential mortal injury	Impairment	
		Recoverable injury	TTS
Fish: no swim bladder	> 219 dB SEL_{cum} > 213 dB peak	> 216 dB SEL_{cum} > 213 dB peak	>> 186 dB SEL_{cum}
Fish: swim bladder is not involved in hearing	210 dB SEL_{cum} > 207 dB peak	203 dB SEL_{cum} > 207 dB peak	> 186 dB SEL_{cum}
Fish: swim bladder involved in hearing	207 dB SEL_{cum} > 207 dB peak	203 dB SEL_{cum} > 207 dB peak	186 dB SEL_{cum}
Sea turtles	> 210 dB SEL_{cum} > 207 dB peak	See Table 2-6	See Table 2-6
Eggs and larvae	> 210 dB SEL_{cum} > 207 dB peak	See Table 2-6	See Table 2-6

Table 2-5 Criteria for recoverable injury and TTS in species of fish from continuous noise sources (including dredging and vibropiling) (Popper et al., 2014)

Type of animal	Impairment	
	Recoverable injury	TTS
Fish: swim bladder involved in hearing	170 dB RMS for 48 hrs	158 dB RMS for 12 hrs

Where insufficient data are available, Popper *et al*. (2014) also gives qualitative criteria that summarise the effect of the noise as having either a high, moderate or low effect on an individual in either the near-field (tens of metres), intermediate-field (hundreds of metres), or far-field (thousands of metres). These qualitative effects are reproduced in Table 2-6 to Table 2-7.

Table 2-6 Summary of the qualitative effects on species of fish from impact piling noise (Popper et al., 2014) (N = Near-field; I = Intermediate-field; F = Far-field)

Type of animal	Impairment			Behaviour
	Recoverable injury	TTS	Masking	
Fish: no swim bladder	See Table 2-4	See Table 2-4	(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: swim bladder is not involved in hearing	See Table 2-4	See Table 2-4	(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: swim bladder involved in hearing	See Table 2-4	See Table 2-4	(N) High (I) High (F) Moderate	(N) High (I) High (F) Moderate
Sea turtles	(N) High (I) Low (F) Low	(N) High (I) Low (F) Low	(N) High (I) Moderate (F) Low	(N) High (I) Moderate (F) Low
Eggs and larvae	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low

Table 2-7 Summary of the qualitative effects on fish from continuous noise (including dredging and vibropiling) from Popper et al. (2014) (N = Near-field; I = Intermediate-field; F = Far-field)

Type of animal	Mortality and potential mortal injury	Impairment			Behaviour
		Recoverable injury	TTS	Masking	
Fish: no swim bladder	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: swim bladder is not involved in hearing	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: swim bladder involved in hearing	(N) Low (I) Low (F) Low	See Table 2-5	See Table 2-5	(N) High (I) High (F) High	(N) High (I) Moderate (F) Low
Sea turtles	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) High (I) Moderate (F) Low
Eggs and larvae	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low	(N) Moderate (I) Moderate (F) Low

Both fleeing animal and stationary animal models have been used to cover the SEL_{cum} criteria for fish. It is recognised that there is limited evidence for fish fleeing from high level noise sources in the wild, and it would reasonably be expected that the reaction would differ between species. Most species are likely to move away from a sound that is loud enough to cause harm (Dahl *et al*., 2015; Popper *et al*., 2014), some may seek protection in the sediment and others may dive deeper in the water column. For those species that flee, the speed chosen for this study of 1.5 m/s is relatively slow in relation to data from Hirata (1999) and thus is considered somewhat conservative.

Although it is feasible that some species will not flee, those that are likely to remain are thought more likely to be benthic species or species without a swim bladder; these are the least sensitive species. For example, from Popper *et al*. (2014): "There is evidence (e.g., Goertner *et al*., 1994; Stephenson *et al*., 2010; Halvorsen *et al*., 2012) that little or no damage occurs to fish without a swim bladder except at very short ranges from an in-water explosive event. Goertner (1978) showed that the range from an explosive event over which damage may occur to a non-swim bladder fish is in the order of 100 times less than that for swim bladder fish."

Stationary animal modelling has been included in this study, based on research from Hawkins *et al*. (2014) and other modelling for similar EIA projects. However, basing the modelling on a stationary (zero flee speed) receptor is likely to greatly overestimate the potential risk to fish species, assuming that an individual would remain in the high noise level region of the water column, especially when considering the precautionary nature of the parameters already built into the cumulative exposure calculations.

2.2.3.2 Particle motion

The criteria defined in the above section all define the noise impacts on fishes in terms of sound pressure or sound pressure-associated functions (i.e., SEL). It has been identified by researchers (e.g., Popper and Hawkins (2019), Nedelec *et al*. (2016), Radford *et al.* (2012)) that some species of fish, as well as invertebrates, actually detect particle motion rather than pressure. Particle motion describes the back-and-forth movement of a tiny theoretical 'element' of water, substrate or other media as a sound wave passes, rather than the pressure caused by the action of the force created by this movement. Particle motion is usually defined in reference to the velocity of the particle (often a peak particle velocity, PPV), but sometimes the related acceleration or displacement of the particle is used. Note that species in the "Fish: swim bladder involved in hearing" category, the most sensitive species, are sensitive to sound pressure.

Popper and Hawkins (2018) state that in derivation of the sound pressure-based criteria in Popper *et al.* (2014) it may be the unmeasured particle motion detected by the fish, to which the fish were responding: there is a relationship between particle motion and sound pressure in a medium. This relationship is very difficult to define where the sound field is complex, such as close to the noise source or where there are multiple reflections of the sound wave in shallow water. Even these terms "shallow" and "close" do not have simple definitions.

The primary reason for the continuing use of sound pressure as the criteria, despite particle motion appearing to be the physical measure to which the fish react or sense, is a lack of data (Popper and Hawkins, 2018) both in respect of predictions of the particle motion level as a consequence of a noise source such as piling, and a lack of knowledge of the sensitivity of a fish, or a wider category of fish, to a particle motion value. There continue to be calls for additional research on the levels of and effects with respect to levels of particle motion. Until sufficient data are available to enable revised thresholds based on the particle motion metric, Popper *et al.* (2014) continues to be the best source of criteria in respect to fish impacts (Andersson *et al.,* 2016, Popper and Hawkins*,* 2019).

3 Modelling methodology

To estimate the underwater noise levels likely to arise during the construction works at Port of Leith, predictive noise modelling has been undertaken. The methods described in this section, and used within this report, meet the requirements set by the National Physical Laboratory (NPL) Good Practice Guide 133 for underwater noise measurement (Robinson *et al*., 2014).

Of the those considered, the noise source most important to consider is impact piling due to the noise level and duration it will be present (Bailey *et al*., 2014). As such, the noise related to impact piling activities is the primary focus of this study. As such, a simple modelling approach has been used for noise sources other than piling that may be present during construction works at Port of Leith.

3.1 The INSPIRE model

The modelling of impact piling has been undertaken using the INSPIRE underwater noise model. The INSPIRE model (currently version 5.1) is a semi-empirical underwater noise propagation model based around a combination of numerical modelling, based around a combined geometric and energy flow/hysteresis loss method, and actual measured data. It is designed to calculate the propagation of noise in shallow, mixed water, typical of the conditions around the UK and very well suited to the region around the Port of Leith. The model has been tuned for accuracy using over 80 datasets of underwater noise propagation from monitoring around offshore piling activities.

The model provides estimates of unweighted SPL_{peak}, SEL_{ss}, and SEL_{cum} noise levels, as well as various other weighted noise metrics. Calculations are made along 180 equally spaced radial transects (one every two degrees). For each modelling run a criterion level can be specified allowing a contour to drawn, within which a given effect may occur. These results can then be plotted over digital bathymetry data so that impact ranges can be clearly visualised, as necessary. INSPIRE also produces these contours as GIS shapefiles.

INSPIRE considers a wide array of input parameters, including variations in bathymetry and source frequency to ensure accurate results are produced specific to the location and nature of the piling operation. It should also be noted that the results should be considered conservative as maximum design parameters and worst-case assumptions have been selected for:

- Piling hammer blow energies;
- Soft start, ramp up profile, and strike rate;
- Total duration of piling; and
- Receptor swim speeds.

3.1.1 Modelling parameters

The location selected for modelling is at the northmost extent of the site. This location, summarised in Table 3-1 and illustrated in Figure 1-1, was selected as it has the fewest physical obstructions to noise propagation allowing for the most conservative impact ranges to be calculated.

Table 3-1 Summary of underwater noise location at Port of Leith

Latitude	Longitude	Water depth (mean tide)
55.99154°N	003.18389°W	6.1 m

The impact piling scenario considered in this report considers pile dimension, total piling time duration, and hammer energies used in construction. For this assessment a 1220 mm pile is to be installed using an IHC S-280 hammer with maximum energy 280 kJ. 5,400 pile strikes occur over 2 hours with three piles installed per day. This scenario is further described in Table 3-2.

Table 3-2 Summary of impact piling scenario, including soft start, for calculating SEL_{cum} using IHC S-280 hammer. Modelling assumes 3 piles installed per day

Hammer energy percentage	20%	40%	60%	80%	100%
Strike energy	56 kJ	112 kJ	168 kJ	224 kJ	280 kJ
Number of strikes	225	225	225	225	4,500
Duration	5	5	5	5	100
Strike rate	45	45	45	45	45

Although these values are indicative for the proposed piling rather than guaranteed, they are expected to represent the worst case that could occur for the activity in terms of the duration of piling, and number of strikes used, especially at maximum energy.

Noise modelling requires knowledge of the source level, which is the theoretical noise level at one metre from the noise source. The INSPIRE model assumes that the noise source – the hammer striking the pile – acts as an effective single point, as it will appear at a distance. The source level is estimated based on the pile diameter and the blow energy imparted on the pile by the hammer. This is adjusted depending on the water depth at the modelling location to allow for the length of pile in contact with the water, which can affect the amount of noise that is transmitted from the pile into its surroundings. It is worth noting that the 'source level' technically does not exist in the context of many shallow water noise sources (Heaney *et al*., 2020). In practice, in underwater noise modelling such as this, it is effectively an 'apparent source level' and simply a value that can be used to produce correct noise levels at range (for a specific model), as required in impact assessments.

The unweighted, single strike SPL_{peak} and SEL_{ss} source levels estimated for this study are provided in Table 3-3. These figures are presented in accordance with typical requests by regulatory authorities, although as indicated above they are not necessarily compatible or comparable with any other model or predicted source levels.

Table 3-3 Summary of maximum unweighted source levels used for modelling

Modelling scenario	SPL_{peak} source level	SEL_{ss} source level
1220 mm diameter pile 280 kJ max hammer energy	226.2 dB re 1 µPa @ 1 m	201.9 dB re 1 µPa²s @ 1 m

With the inclusion of measured noise propagation data for similar offshore piling operations in UK waters, the INSPIRE model intrinsically accounts for various environmental conditions. This includes the differences that can occur with the temperature and salinity of the water, as well as the sediment type surrounding the site. Data from the British Geological Survey show that the seabed surrounding in and around Port of Leith is generally made up of gravel, mud, and sand.

Digital bathymetry, from the European Marine Observation and Data Network (EMODnet), has been used for this modelling. Mean tidal depth has been used throughout.

3.2 Simple modelling

Although impact piling is expected to be the primary noise source during offshore construction and development (Bailey *et al*., 2014), several other anthropogenic noise sources may be present. Each of these has been considered, and relevant biological noise criteria presented, in this section.

Table 3-4 provides a summary of the various noise producing sources, aside from impact piling, that are expected to be present during the construction works at Port of Leith.

Table 3-4 Summary of the possible noise making activities at Port of Leith other than impact piling

Activity	Description
Dredging	Dredging may be required to remove material and prepare the site for piling operations. Excavators have been specified to carry out dredging operations in the construction methodology, however for this assessment suction dredging has been assumed as a worst-case noise source.
Vibropiling	Vibropiling has been identified as a construction technique for installing sheet piles at the site.

The NPL Good Practice Guide 133 for underwater noise measurements (Robinson *et al*., 2014) indicates that under certain circumstances, a simple modelling approach may be considered acceptable. Such an approach has been used for these noise sources, which are variously either quiet compared to impact piling, or where detailed modelling would imply unjustified accuracy. The high-level overview of modelling that has been presented here is considered sufficient and there would be little benefit in using a more detailed model at this stage. The limitations of this approach are noted, including the lack of frequency or bathymetric dependence.

3.2.1 Modelling parameters

For the purposes of identifying the greatest noise levels, approximate subsea noise levels have been predicted using a simple modelling approach based on measurement data from Subacoustech Environmental's own underwater noise measurement database, scaled to relevant parameters for the site and to the specific noise sources to be used. The calculation of underwater noise transmission loss for the non-impulsive sources is based on an empirical analysis of the noise measurements taken along transects around these sources by Subacoustech Environmental. The predictions use the following principle fitted to the measured data, where R is the range from the source, N is the transmission loss, and α is the absorption loss.

$$Recieved\ level = Source\ level\ (SL) - N\log_{10} R - \alpha R$$

Predicted source levels and propagation calculations for the construction activities are presented in Table 3-5 along with a summary of the number of datasets used in each case.

Table 3-5 Summary of the estimated unweighted source levels and transmission losses for the different construction noise sources considered

Source	Estimated unweighted source level	Approximate transmission loss	Comments
Suction dredging	186 dB re 1 µPa @ 1 m (RMS)	$19\log_{10} R - 0.0009R$	Based on five datasets from suction and cutter suction dredgers.
Vibropiling	193 dB re 1 µPa @ 1 m (RMS)	$18\log_{10} R$ (no absorption term)	Based on three datasets of vibropiling activities in rivers and harbours.

For SEL_{cum} calculations, the duration the noise is present also needs to be considered, with all sources operating for a worst-case 12 hours in any given 24-hour period.

To account for the weightings required for modelling using the Southall *et al*. (2019) criteria (Section 2.2.2.1), reductions in source level have been applied to the various noise sources. Figure 3-1 shows the representative noise measurements used, which have been adjusted for the source levels given in

Table 3-5. Table 3-6 presents details of the reductions in source levels for each of the weightings used for modelling.

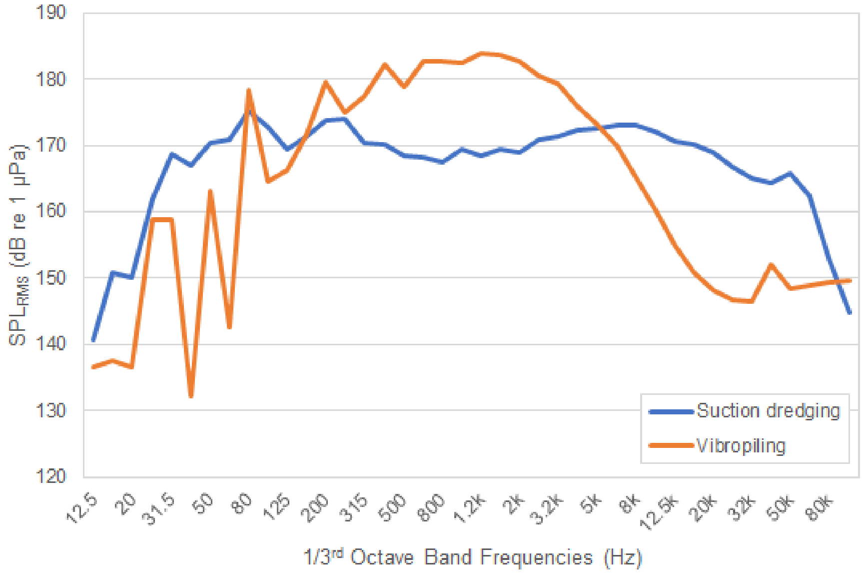

Figure 3-1 Summary of the 1/3rd octave frequency bands used as a basis for the Southall et al. (2019) weightings used in the simple modelling

Table 3-6 Reductions in source level for the different construction noise sources considered when the Southall et al. (2019) weightings are applied

Source	**Reduction in source level from the unweighted level (Southall *et al*. 2019)**			
	LF	**HF**	**VHF**	**PCW**
Suction Dredging	2.5 dB	7.9 dB	9.6 dB	4.2 dB
Vibropiling	2.4 dB	16 dB	20.8 dB	4.4 dB

4 Modelling results

As discussed in Section 3, two modelling methodologies have been utilised to predict the potential noise and subsequent impacts from the construction works at the Port of Leith. The results from this modelling are presented in the following sections.

For the results presented throughout this section, any predicted ranges smaller than 50 m and areas less than 0.01 km^2 for single strike criteria, and ranges smaller than 100 m and areas less than 0.1 km^2 for cumulative criteria, have not been presented. At ranges this close to the noise source, the modelling processes are unable to model to a sufficient level of accuracy due to acoustic effects near the pile. Ranges are given as “less than” this limit.

4.1 Impact piling (detailed modelling)

Table 4-1 to Table 4-4 present the modelling results in terms of the Southall *et al*. (2019) marine mammal criteria and the Popper *et al*. (2014) fish criteria, covering the parameters described in Section 3.1.1. All SEL_{cum} ranges assume the animal flee speeds in Section 2.2.2.1.

All marine mammal PTS ranges are predicted to be smaller than 100 m. The largest predicted TTS impact ranges are for VHF cetaceans, with maximum predicted impact ranges of up to 780 m.

For fish, the largest recoverable injury ranges (203 dB SEL_{cum} threshold) are predicted out to a maximum of 190 m when considering a stationary animal, which reduces to less than 100 m for fleeing animal calculations. Maximum TTS impact ranges (186 dB SEL_{cum} threshold) are predicted out to 1.2 km for stationary animals, and these ranges also reduce to less than 100 m when considering fleeing animals.

Table 4-1 Summary of the modelled impact ranges using the impulsive Southall et al. (2019) unweighted SPL_{peak} criteria for marine mammals

Southall *et al*. (2019) Unweighted SPL_{peak}		**Area**	**Max range**	**Min range**	**Mean range**
PTS	219 dB (LF)	< 0.01 km^2	< 50 m	< 50 m	< 50 m
	230 dB (HF)	< 0.01 km^2	< 50 m	< 50 m	< 50 m
	202 dB (VHF)	< 0.01 km^2	< 50 m	< 50 m	< 50 m
	218 dB (PCW)	< 0.01 km^2	< 50 m	< 50 m	< 50 m
TTS	213 dB (LF)	< 0.01 km^2	< 50 m	< 50 m	< 50 m
	224 dB (HF)	< 0.01 km^2	< 50 m	< 50 m	< 50 m
	196 dB (VHF)	0.01 km^2	60 m	50 m	50 m
	212 dB (PCW)	< 0.01 km^2	< 50 m	< 50 m	< 50 m

Table 4-2 Summary of the modelled impact ranges using the impulsive Southall et al. (2019) weighted SEL_{cum} criteria for marine mammals assuming a fleeing animal model

Southall *et al*. (2019) Weighted SEL_{cum}		**Area**	**Max range**	**Min range**	**Mean range**
PTS	183 dB (LF)	< 0.1 km^2	< 100 m	< 100 m	< 100 m
	185 dB (HF)	< 0.1 km^2	< 100 m	< 100 m	< 100 m
	155 dB (VHF)	< 0.1 km^2	< 100 m	< 100 m	< 100 m
	185 dB (PCW)	< 0.1 km^2	< 100 m	< 100 m	< 100 m
TTS	168 dB (LF)	< 0.1 km^2	200 m	100 m	130 m
	170 dB (HF)	< 0.1 km^2	<100 m	<100 m	<100 m
	140 dB (VHF)	0.5 km^2	780 m	130 m	340 m
	170 dB (PCW)	< 0.1 km^2	< 100 m	< 100 m	< 100 m

Table 4-3 Summary of the modelled impact ranges using the Popper et al. (2019) unweighted SPL_{peak} impact piling criteria for fish

Popper *et al*. (2014) Unweighted SPL_{peak}	**Area**	**Max range**	**Min range**	**Mean range**
213 dB	< 0.01 km²	< 50 m	< 50 m	< 50 m
207 dB	< 0.01 km²	< 50 m	< 50 m	< 50 m

Table 4-4 Summary of the modelled impact ranges using the Popper et al. (2014) unweighted SEL_{cum} impact piling criteria for fish assuming both fleeing and stationary animal models

Popper *et al*. (2014) Unweighted SEL_{cum}		**Area**	**Max range**	**Min range**	**Mean range**
Fleeing ($1.5\ ms^{-1}$)	219 dB	< 0.1 km²	< 100 m	< 100 m	< 100 m
	216 dB	< 0.1 km²	< 100 m	< 100 m	< 100 m
	210 dB	< 0.1 km²	< 100 m	< 100 m	< 100 m
	207 dB	< 0.1 km²	< 100 m	< 100 m	< 100 m
	203 dB	< 0.1 km²	< 100 m	< 100 m	< 100 m
	186 dB	< 0.1 km²	< 100 m	< 100 m	< 100 m
Stationary	219 dB	< 0.1 km²	< 100 m	< 100 m	< 100 m
	216 dB	< 0.1 km²	< 100 m	< 100 m	< 100 m
	210 dB	< 0.1 km²	< 100 m	< 100 m	< 100 m
	207 dB	< 0.1 km²	120 m	100 m	110 m
	203 dB	0.1 km²	190 m	160 m	180 m
	186 dB	1.9 km²	1200 m	260 m	710 m

The relatively low impact ranges seen here are due to the low piling energy and shallow depths at the piling location.

4.2 Other noise sources (simple modelling)

The predicted impact ranges from dredging and vibropiling noise have been assessed using a simple modelling approach, as discussed in Section 3.2. Table 4-5 and Table 4-6 summarise the predicted impact range for these noise sources. All the sources in this section are considered non-impulsive or continuous.

Given the modelled impact ranges, marine mammals would have to be closer than 100 m from the continuous noise source at the start of the activity to acquire the necessary exposure to induce PTS as per Southall *et al*. (2019). The exposure calculation assumes the same receptor swim speed as the impact piling modelling.

For fish, there is a low to negligible risk of any injury or TTS with reference to the SPL_{RMS} guidance for continuous noise sources in Popper *et al*. (2014).

All sources presented here are much quieter than those presented for impact piling in Section 4.1.

Table 4-5 Summary of the impact ranges for the different construction noise sources using the non-impulsive criteria from Southall et al. (2019) for marine mammals

Southall *et al*. (2019) Weighted SEL_{cum}		**Suction dredging**	**Vibropiling**
PTS	199 dB (LF)	< 100 m	< 100 m
	198 dB (HF)	< 100 m	< 100 m
	173 dB (VHF)	< 100 m	< 100 m
	201 dB (PCW)	< 100 m	< 100 m
TTS	179 dB (LF)	< 100 m	< 100 m
	178 dB (HF)	< 100 m	< 100 m
	153 dB (VHF)	250 m	220 m
	181 dB (PCW)	< 100 m	< 100 m

Table 4-6 Summary of the impact ranges for fish from Popper et al. (2014) for shipping and continuous noise, covering the different construction noise sources

Popper *et al*. (2014) Unweighted SPL_{RMS}	**Suction dredging**	**Vibropiling**
Recoverable injury 170 dB (48 hours)	< 50 m	< 50 m
TTS 158 dB (12 hours)	< 50 m	90 m

Note the exposure times required by the criteria for fish exposure to continuous noise.

5 Summary and conclusions

Subacoustech Environmental have undertaken a study on behalf of HaskoningDHV UK to assess the potential underwater noise and its effects during construction works at Port of Leith, Scotland.

The level of underwater noise from impact piling has been estimated using the semi-empirical underwater noise model INSPIRE. The modelling considers a wide variety of input parameters including bathymetry, hammer blow energy, strike rate, and receptor fleeing speed.

A single, representative modelling location was selected as it has the least physical obstructions to noise propagation allowing for the most conservative impact ranges to be calculated.

The modelling results were analysed in terms of relevant noise metrics for marine mammals (Southall *et al*., 2019) and fish (Popper *et al*., 2014). For marine mammals, all PTS impact ranges were predicted to be smaller than 100 m, with maximum TTS impact ranges of up to 780 m predicted for VHF cetaceans. For fish injury, ranges of up to 190 m and TTS ranges of up to 1.2 km are predicted when considering a stationary receptor. These ranges are reduced to less than 100 m when considering a fleeing animal.

Noise from dredging and vibropiling were considered using a high-level, simple modelling approach. The noise levels for these noise sources are predicted to well below those for impact piling noise, could only occur where an individual was less than 100 m from the source.

Vibropiling and dredging are significantly quieter activities than impact piling. Were vibropiling or dredging to occur near to and at the same time as impact piling, the additional noise from vibropiling or dredging will not lead to an increase in total impact range predicted for impact piling alone.

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Appendix 3: Marine Mammal and Fish Technical Report for Underwater Noise Impacts

Report

Port of Leith – Outer Berth

Marine Mammal and Fish Technical Report for Underwater Noise Impacts

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Classification
Project related

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Abbreviations

CD	Chart Datum
CEMP	Construction Environmental Management Plan
dB	Decibels
HF	High Frequency Cetaceans
Hz	Hertz
IAMMWG	Inter-Agency Marine Mammal Working Group
JNCC	Joint Nature Conservation Committee
kJ	Kilojoule
km/h	Kilometre per hour
LF	Low Frequency Cetaceans
m	Metre
m/s	Metre per second
MU	Management Unit
MMOs	Marine Mammal Observer(s)
PTS	Permanent Threshold Shift
PCW	Pinnipeds in water
RMS	Root Mean Square
SEL	Sound Exposure Level
SEL_{cum}	Cumulative Sound Exposure Level
SEL_{ss}	Single Strike Sound Exposure Level
SCOS	Special Committee on Seals
SPL	Sound Pressure Level
SPL_{peak}	Peak Sound Pressure Level
TTS	Temporary Threshold Shift
EMODnet	European Marine Observation and Data Network
VHF	Very high Frequency Cetaceans

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A1 Introduction

This report details the underwater noise modelling assessments for all underwater noise impacts associated with the outer berth at the Port of Leith (referred to throughout as ‘the Proposed Development’).

A1.1 Activities of the Project that may cause Underwater Noise

A1.1.1 Construction Phase

The proposed development would include:

- A 125m section of existing berth redevelopment
    - To be piled (both impact piling and vibro-piling will be used)
- Capital dredging to enlarge the existing berth pocket

Piling Works

Piling platforms would be created on the breakwater to enable the crane to hold the piling hammer. Up to 168 tubular piles (6 rows of 28 piles) of approximately 1.2m diameter and 39 tubular piles of diameter 0.76 m would be installed. To support the tubular piles and landward development, sheet piles would also be installed. Details on the parameters required for the underwater noise modelling are provided in **Table 1**.

Table 1 Piling Parameters

Piling Descriptor	Proposed Development Specific Design Information
Pile diameter	1.22m - 6 rows of 28 piles each; 0.76 m 39 piles in front row
Maximum hammer blow energy	Tubular piling: 280kJ (max), 56 kJ (starting) Sheet-piling: 65kJ (max)
Details on the soft start and ramp up	As per JNCC protocol: Soft-start / ramp-up of 20 minutes, starting at 20% hammer energy
Piling duration	2 hours per tubular pile
Overall piling programme	Programme duration for piling: 160 days (but not continuous)
Number of piles that could potentially be installed within 24 hours	Peak production could be 3 piles a day (average less than 2)

Dredging Works

Before the piles can be installed, a dredging campaign is required for excavation of material from revetment slope to remove the overburden and referred as ‘pre-works dredge’. In a second dredge campaign, the existing berth pocket 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. The total dredge quantity is 101,000 m^3.

Dredging would be undertaken using a backhoe dredger supported by a barge to take the dredged arisings to the offshore disposal site.

A2 Underwater Noise Modelling

To inform the impact assessment of piling and dredging during the proposed development, underwater noise modelling was carried out by Subacoustech to estimate the noise levels likely to arise during the works. See **Appendix 10-1** of the EIA Report.

A3 Assessment of Underwater Noise Impacts to Marine Mammal Species

The following assessment uses the underwater noise impact ranges and areas, with the known densities and populations of marine mammals at the proposed development as are summarised in **Table 2** below.

Table 2 Marine mammal densities and reference populations used in the underwater noise assessments

Marine mammal species	Density	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	North Sea Management Unit (MU) (Inter-Agency Marine Mammal Working Group (IAMMWG), 2021)
Bottlenose dolphin	0.0298	SCANS-III Survey Block R (Hammond *et al.*, 2021)	224	Updated population estimate for the Coastal East Scotland (CES) MU (Hammond & Arso Civil, 2021)
White-beaked dolphin	0.243	SCANS-III Survey Block R (Hammond *et al.*, 2021)	43,951	Celtic & Greater North Seas (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)

A3.1 Tubular Piling

A3.1.1 PTS exposure from Single Strike

The number of marine mammals that could therefore be anticipated to be exposed to the potential for Permanent Threshold Shift (PTS) onset due to a single strike is presented in **Table 3**.

Table 3 Maximum number of individuals (and % of reference population) that could be at risk of PTS from a single piling strike

Potential Impact	Receptor	Criteria and threshold (Southall *et al.*, 2019)	Maximum number of individuals (% of reference population)	Magnitude
PTS without mitigation – single strike	Harbour porpoise	202 dB re 1 µPa unweighted SPL_{peak}	0.006 harbour porpoise (0.000002% NS MU) based on the SCANS-III Block R density of 0.599/km^2.	Permanent effect with negligible magnitude (less than 0.001% of the reference population anticipated to be exposed to effect, without mitigation).

Potential Impact	Receptor	Criteria and threshold (Southall *et al*., 2019)	Maximum number of individuals (% of reference population)	Magnitude
	Bottlenose dolphin	230 dB re 1 µPa unweighted SPL_{peak}	0.0003 bottlenose dolphin (0.0001% of updated CES MU) based on the SCANS-III Block R density of 0.0298/km².	Permanent effect with negligible magnitude (less than 0.001% of the reference population anticipated to be exposed to effect, without mitigation).
	White-beaked dolphin	230 dB re 1 µPa unweighted SPL_{peak}	0.002 white-beaked dolphin (0.000006% CGNS MU) based on the SCANS-III Block R density of 0.243/km².	Permanent effect with negligible magnitude (less than 0.001% of the reference population anticipated to be exposed to effect, without mitigation).
	Minke whale	219 dB re 1 µPa unweighted SPL_{peak}	0.0004 minke whale (0.000002% CGNS MU) based on the SCANS-III Block R density of 0.0387/km².	Permanent effect with negligible magnitude (less than 0.001% of the reference population anticipated to be exposed to effect, without mitigation).
	Grey seal	218 dB re 1 µPa unweighted SPL_{peak}	0.01 grey seal (0.0003% of the ES MU; or 0.0002% of the ES & MF MUs) based on the density of 1.06/km².	Permanent effect with negligible magnitude (less than 0.001% of the reference population anticipated to be exposed to effect, without mitigation).
	Harbour seal	218 dB re 1 µPa unweighted SPL_{peak}	0.003 harbour seal (0.00098% of the ES MU; or 0.0002% of the ES & MF MUs) based on the density of 0.335/km².	Permanent effect with negligible magnitude (less than 0.001% of the reference population anticipated to be exposed to effect, without mitigation).

A3.1.2 PTS Exposure from Cumulative Exposure

The number of marine mammals that could be anticipated to be exposed to the potential for PTS onset, due to cumulative exposure to up to three piles (six hours of piling) per day is presented in **Table 4**.

Table 4 Maximum number of individuals (and % of reference population) that could be at risk of PTS from cumulative exposure

Potential Impact	Receptor	Criteria and threshold (Southall *et al.*, 2019)	Maximum number of individuals (% of reference population)	Magnitude
PTS without mitigation – cumulative exposure	Harbour porpoise	155 dB re 1 µPa²s weighted SEL_{cum}	0.06 harbour porpoise (0.00002% NS MU) based on the SCANS-III Block R density of 0.599/km².	Permanent effect with negligible magnitude (less than 0.001% of the reference population anticipated to be exposed to effect, without mitigation).
	Bottlenose dolphin	185 dB re 1 µPa²s weighted SEL_{cum}	0.003 bottlenose dolphin (0.001% of updated CES MU) based on the SCANS-III Block R density of 0.0298/km².	Permanent effect with low magnitude (between 0.001% and 0.01% of the reference population anticipated to be

Potential Impact	Receptor	Criteria and threshold (Southall *et al.*, 2019)	Maximum number of individuals (% of reference population)	Magnitude
				exposed to effect, without mitigation).
	White-beaked dolphin	185 dB re 1 µPa^{2}s weighted SEL_{cum}	0.02 white-beaked dolphin (0.00006% CGNS MU) based on the SCANS-III Block R density of 0.243/km^2.	Permanent effect with negligible magnitude (less than 0.001% of the reference population anticipated to be exposed to effect, without mitigation).
	Minke whale	183 dB re 1 µPa^{2}s weighted SEL_{cum}	0.004 minke whale (0.00002% CGNS MU) based on the SCANS-III Block R density of 0.0387/km^2.	Permanent effect with negligible magnitude (less than 0.001% of the reference population anticipated to be exposed to effect, without mitigation).
	Grey seal	185 dB re 1 µPa^{2}s weighted SEL_{cum}	0.1 grey seal (0.003% of the ES MU; or 0.002% of the ES & MF MUs) based on the density of 1.06/km^2.	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	185 dB re 1 µPa^{2}s weighted SEL_{cum}	0.034 harbour seal (0.0098% of the ES MU; or 0.002% of the ES & MF MUs) based on the density of 0.335/km^2.	Permanent effect with low magnitude (between 0.001% and 0.01% of the reference population anticipated to be exposed to effect, without mitigation).

A3.1.3 TTS Exposure and Fleeing Response from Single Strike

The number of marine mammals that could therefore be anticipated to be exposed to the potential for TTS onset due to a single strike of a pile is presented in **Table 5**.

Table 5 Maximum number of individuals (and % of reference population) that could be at risk of TTS

Potential Impact	Receptor	Criteria and threshold (Southall *et al.*, 2019)	Maximum number of individuals (% of reference population)	Magnitude
TTS without mitigation – single strike	Harbour porpoise	196 dB re 1 µPa unweighted SPL_{peak}	0.006 harbour porpoise (0.000002% NS MU) based on the SCANS-III Block R density of 0.599/km^2.	Temporary effect with negligible magnitude (less than 1% of the reference population anticipated to be exposed to effect, without mitigation).
	Bottlenose dolphin	224 dB re 1 µPa unweighted SPL_{peak}	0.0003 bottlenose dolphin (0.0001% of updated CES MU) based on the SCANS-III	Temporary effect with negligible magnitude (less than 1% of the reference population anticipated to be

Potential Impact	Receptor	Criteria and threshold (Southall *et al.*, 2019)	Maximum number of individuals (% of reference population)	Magnitude
			Block R density of 0.0298/km^2.	exposed to effect, without mitigation).
	White-beaked dolphin	224 dB re 1 µPa unweighted SPL_{peak}	0.002 white-beaked dolphin (0.000006% CGNS MU) based on the SCANS-III Block R density of 0.243/km^2.	Temporary effect with negligible magnitude (less than 1% of the reference population anticipated to be exposed to effect, without mitigation).
	Minke whale	213 dB re 1 µPa unweighted SPL_{peak}	0.0004 minke whale (0.000002% CGNS MU) based on the SCANS-III Block R density of 0.0387/km^2.	Temporary effect with negligible magnitude (less than 1% of the reference population anticipated to be exposed to effect, without mitigation).
	Grey seal	212 dB re 1 µPa unweighted SPL_{peak}	0.01 grey seal (0.0003% of the ES MU; or 0.0002% of the ES & MF MUs) based on the density of 1.06/km^2.	Temporary effect with negligible magnitude (less than 1% of the reference population anticipated to be exposed to effect, without mitigation).
	Harbour seal	212 dB re 1 µPa unweighted SPL_{peak}	0.003 harbour seal (0.001% of the ES MU; or 0.0002% of the ES & MF MUs) based on the density of 0.335/km^2.	Temporary effect with negligible magnitude (less than 1% of the reference population anticipated to be exposed to effect, without mitigation).

A3.1.4 TTS Exposure and Fleeing Response from Cumulative Exposure

The number of marine mammals that could be anticipated to be exposed to the potential for Temporary Threshold Shift (TTS) onset due to the cumulative exposure of is presented in **Table 6**.

Table 6 Maximum number of individuals (and % of reference population) that could be at risk of TTS from cumulative exposure

Potential Impact	Receptor	Criteria and threshold (Southall *et al.*, 2019)	Maximum number of individuals (% of reference population)	Magnitude
TTS without mitigation – cumulative exposure	Harbour porpoise	140 dB re 1 µPa^{2}s weighted SEL_{cum}	0.30 harbour porpoise (0.0001% NS MU) based on the SCANS-III Block R density of 0.599/km^2.	Temporary effect with negligible magnitude (less than 1% of the reference population anticipated to be exposed to effect, without mitigation).

Potential Impact	Receptor	Criteria and threshold (Southall *et al.*, 2019)	Maximum number of individuals (% of reference population)	Magnitude
	Bottlenose dolphin	170 dB re 1 µPa^{2}s weighted SEL_{cum}	0.003 bottlenose dolphin (0.001% of updated CES MU) based on the SCANS-III Block R density of 0.0298/km^2.	Temporary effect with negligible magnitude (less than 1% of the reference population anticipated to be exposed to effect, without mitigation).
	White-beaked dolphin	170 dB re 1 µPa^{2}s weighted SEL_{cum}	0.02 white-beaked dolphin (0.00006% CGNS MU) based on the SCANS-III Block R density of 0.243/km^2.	Temporary effect with negligible magnitude (less than 1% of the reference population anticipated to be exposed to effect, without mitigation).
	Minke whale	168 dB re 1 µPa^{2}s weighted SEL_{cum}	0.004 minke whale (0.00002% CGNS MU) based on the SCANS-III Block R density of 0.0387/km^2.	Temporary effect with negligible magnitude (less than 1% of the reference population anticipated to be exposed to effect, without mitigation).
	Grey seal	170 dB re 1 µPa^{2}s weighted SEL_{cum}	0.1 grey seal (0.003% of the ES MU; or 0.002% of the ES & MF MUs) based on the density of 1.06/km^2.	Temporary effect with negligible magnitude (less than 1% of the reference population anticipated to be exposed to effect, without mitigation).
	Harbour seal	170 dB re 1 µPa^{2}s weighted SEL_{cum}	0.034 harbour seal (0.01% of the ES MU; or 0.002% of the ES & MF MUs) based on the density of 0.335/km^2.	Temporary effect with negligible magnitude (less than 1% of the reference population anticipated to be exposed to effect, without mitigation).

A3.2 Sheet Piling

A3.2.1 PTS from Cumulative Exposure

The number of harbour porpoise, bottlenose dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal that could be at risk of PTS onset, as a result of underwater noise during sheet-piling activities (**Table 7**) 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.

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Table 7 Maximum number of individuals (and % of reference population) that could be at risk of PTS onset as a result of underwater noise associated with sheet piling activities, based on underwater noise modelling

Potential Impact	Receptor	Criteria and threshold (Southall *et al*., 2019)	Maximum number of individuals (% of reference population)	Magnitude
PTS without mitigation – cumulative exposure (over 12 hours)	Harbour porpoise	173 dB re 1 µPa^{2}s weighted SEL_{cum}	0.02 harbour porpoise (0.000005% NS MU) based on the SCANS-III Block R density of 0.599/km^2.	Permanent effect with negligible magnitude (less than 0.001% of the reference population anticipated to be exposed to effect, without mitigation).
	Bottlenose dolphin	198 dB re 1 µPa^{2}s weighted SEL_{cum}	0.0009 bottlenose dolphin (0.0004% of updated CES MU) based on the SCANS-III Block R density of 0.0298/km^2.	Permanent effect with negligible magnitude (less than 0.001% of the reference population anticipated to be exposed to effect, without mitigation).
	White-beaked dolphin	198 dB re 1 µPa^{2}s weighted SEL_{cum}	0.008 white-beaked dolphin (0.00002% CGNS MU) based on the SCANS-III Block R density of 0.243/km^2.	Permanent effect with negligible magnitude (less than 0.001% of the reference population anticipated to be exposed to effect, without mitigation).
	Minke whale	199 dB re 1 µPa^{2}s weighted SEL_{cum}	0.001 minke whale (0.000006% CGNS MU) based on the SCANS-III Block R density of 0.0387/km^2.	Permanent effect with negligible magnitude (less than 0.001% of the reference population anticipated to be exposed to effect, without mitigation).
	Grey seal	201 dB re 1 µPa^{2}s weighted SEL_{cum}	0.03 grey seal (0.0009% of the ES MU; or 0.0006% of the ES & MF MUs) based on the density of 1.06/km^2.	Permanent effect with negligible magnitude (less than 0.001% of the reference population anticipated to be exposed to effect, without mitigation).
	Harbour seal	201 dB re 1 µPa^{2}s weighted SEL_{cum}	0.01 harbour seal (0.003% of the ES MU; or 0.0007% of the ES & MF MUs) based on the density of 0.335/km^2.	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).

A3.2.2 TTS from Cumulative Exposure

The number of harbour porpoise, bottlenose dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal that could be at risk of TTS onset, as a result of underwater noise during sheet-piling activities (**Table 8**) 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 8 Maximum number of individuals (and % of reference population) that could be at risk of TTS onset as a result of underwater noise associated with sheet piling activities, based on underwater noise modelling

Potential Impact	Receptor	Criteria and threshold (Southall *et al*., 2019)	Maximum number of individuals (% of reference population)	Magnitude
TTS without mitigation – cumulative exposure (over 12 hours)	Harbour porpoise	153 dB re 1 μPa^{2}s weighted SEL_{cum}	0.09 harbour porpoise (0.00003% NS MU) based on the SCANS-III Block R density of 0.599/km^2.	Temporary effect with negligible magnitude (less than 1% of the reference population anticipated to be exposed to effect, without mitigation).
	Bottlenose dolphin	178 dB re 1 μPa^{2}s weighted SEL_{cum}	0.0009 bottlenose dolphin (0.0004% CES MU) based on the SCANS-III Block R density of 0.0298/km^2.	Temporary effect with negligible magnitude (less than 1% of the reference population anticipated to be exposed to effect, without mitigation).
	White-beaked dolphin	178 dB re 1 μPa^{2}s weighted SEL_{cum}	0.008 white-beaked dolphin (0.00002% CGNS MU) based on the SCANS-III Block R density of 0.243/km^2.	Temporary effect with negligible magnitude (less than 1% of the reference population anticipated to be exposed to effect, without mitigation).
	Minke whale	179 dB re 1 μPa^{2}s weighted SEL_{cum}	0.001 minke whale (0.000006% CGNS MU) based on the SCANS-III Block R density of 0.0387/km^2.	Temporary effect with negligible magnitude (less than 1% of the reference population anticipated to be exposed to effect, without mitigation).
	Grey seal	181 dB re 1 μPa^{2}s weighted SEL_{cum}	0.03 grey seal (0.0009% of the ES MU; or 0.0006% of the ES & MF MUs) based on the density of 1.06/km^2.	Temporary effect with negligible magnitude (less than 1% of the reference population anticipated to be exposed to effect, without mitigation).
	Harbour seal	181 dB re 1 μPa^{2}s weighted SEL_{cum}	0.01 harbour seal (0.003% of the ES MU; or 0.0007% of the ES & MF MUs) based on the density of 0.335/km^2.	Temporary effect with negligible magnitude (less than 1% of the reference population anticipated to be exposed to effect, without mitigation).

A3.3 Dredging

A3.3.1 PTS from Cumulative Exposure

The number of harbour porpoise, bottlenose dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal that could be at risk of PTS onset, as a result of underwater noise during dredging activities (**Table 9**) 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 dredging could be undertaken per day.

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Table 9 Maximum number of individuals (and % of reference population) that could be at risk of PTS onset as a result of underwater noise associated with dredging, based on underwater noise modelling

Potential Impact	Receptor	Criteria and threshold (Southall *et al.*, 2019)	Maximum number of individuals (% of reference population)	Magnitude
PTS without mitigation – cumulative exposure (over 12 hours)	Harbour porpoise	173 dB re 1 µPa^{2}s weighted SEL_{cum}	0.02 harbour porpoise (0.000005% NS MU) based on the SCANS-III Block R density of 0.599/km^2.	Permanent effect with negligible magnitude (less than 0.001% of the reference population anticipated to be exposed to effect, without mitigation).
	Bottlenose dolphin	198 dB re 1 µPa^{2}s weighted SEL_{cum}	0.0009 bottlenose dolphin (0.0004% CES MU) based on the SCANS-III Block R density of 0.0298/km^2.	Permanent effect with negligible magnitude (less than 0.001% of the reference population anticipated to be exposed to effect, without mitigation).
	White-beaked dolphin	198 dB re 1 µPa^{2}s weighted SEL_{cum}	0.008 white-beaked dolphin (0.00002% CGNS MU) based on the SCANS-III Block R density of 0.243/km^2.	Permanent effect with negligible magnitude (less than 0.001% of the reference population anticipated to be exposed to effect, without mitigation).
	Minke whale	199 dB re 1 µPa^{2}s weighted SEL_{cum}	0.001 minke whale (0.000006% CGNS MU) based on the SCANS-III Block R density of 0.0387/km^2.	Permanent effect with negligible magnitude (less than 0.001% of the reference population anticipated to be exposed to effect, without mitigation).
	Grey seal	201 dB re 1 µPa^{2}s weighted SEL_{cum}	0.03 grey seal (0.0009% of the ES MU; or 0.0006% of the ES & MF MUs) based on the density of 1.06/km^2.	Permanent effect with negligible magnitude (less than 0.001% of the reference population anticipated to be exposed to effect, without mitigation).
	Harbour seal	201 dB re 1 µPa^{2}s weighted SEL_{cum}	0.01 harbour seal (0.003% of the ES MU; or 0.0007% of the ES & MF MUs) based on the density of 0.335/km^2.	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).

A3.3.2 TTS from Cumulative Exposure

The number of harbour porpoise, bottlenose dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal that could be at risk of TTS onset, as a result of underwater noise during sheet-piling activities (**Table 10**) 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 10 Maximum number of individuals (and % of reference population) that could be at risk of TTS onset as a result of underwater noise associated with sheet piling activities, based on underwater noise modelling

Potential Impact	Receptor	Criteria and threshold (Southall *et al.*, 2019)	Maximum number of individuals (% of reference population)	Magnitude
TTS without mitigation – cumulative exposure (over 12 hours)	Harbour porpoise	153 dB re 1 µPa^{2}s weighted SEL_{cum}	0.12 harbour porpoise (0.00003% NS MU) based on the SCANS-III Block R density of 0.599/km^2.	Temporary effect with negligible magnitude (less than 1% of the reference population anticipated to be exposed to effect, without mitigation).
	Bottlenose dolphin	178 dB re 1 µPa^{2}s weighted SEL_{cum}	0.0009 bottlenose dolphin (0.0004% CES MU) based on the SCANS-III Block R density of 0.0298/km^2.	Temporary effect with negligible magnitude (less than 1% of the reference population anticipated to be exposed to effect, without mitigation).
	White-beaked dolphin	178 dB re 1 µPa^{2}s weighted SEL_{cum}	0.008 white-beaked dolphin (0.00002% CGNS MU) based on the SCANS-III Block R density of 0.243/km^2.	Temporary effect with negligible magnitude (less than 1% of the reference population anticipated to be exposed to effect, without mitigation).
	Minke whale	179 dB re 1 µPa^{2}s weighted SEL_{cum}	0.001 minke whale (0.000006% CGNS MU) based on the SCANS-III Block R density of 0.0387/km^2.	Temporary effect with negligible magnitude (less than 1% of the reference population anticipated to be exposed to effect, without mitigation).
	Grey seal	181 dB re 1 µPa^{2}s weighted SEL_{cum}	0.03 grey seal (0.0009% of the ES MU; or 0.0006% of the ES & MF MUs) based on the density of 1.06/km^2.	Temporary effect with negligible magnitude (less than 1% of the reference population anticipated to be exposed to effect, without mitigation).
	Harbour seal	181 dB re 1 µPa^{2}s weighted SEL_{cum}	0.01 harbour seal (0.003% of the ES MU; or 0.0007% of the ES & MF MUs) based on the density of 0.335/km^2.	Temporary effect with negligible magnitude (less than 1% of the reference population anticipated to be exposed to effect, without mitigation).

A4 Assessment of Underwater Noise Impacts to Fish Species

Certain aspects of the construction phase have the potential to impact on fish (both resident and migratory species, including those who migrate within the coastal waters and those who migrate in and out of the Firth of Forth) due to the generation of underwater noise and vibration. This particularly relates to piling activities, but also to noise and vibration generated during dredging.

In the worst-case scenario, excessive noise may lead to temporary behavioural disturbance of resident and migratory fish species and even mortality. Given that the proposed piles are to be installed near to open water, there is potential for noise disturbance to impact on fish migrations along the coast and potentially in and out of the Forth estuary, in addition to causing disturbance to resident species.

A4.1 Tubular Piling

Fish species are mobile and would be expected to vacate the area with the onset of piling, and therefore are of low sensitivity to impacts over the course of piling. In addition, the piling location is very close to open water, and would be unlikely to causes any barrier to movement of species in the vicinity of the proposed development, and into and out of the Forth estuary.

With regard to the underwater noise impacts from piling, all fish species would be at risk of serious injury or fatality, or recoverable injury, due to a single strike of a tubular pile, if they were closer than 50m to the source of the piling noiseError! Reference source not found..

For cumulative exposure from piling (assuming up to three piles could be installed per 12-hour construction day), the most sensitive fish species (those with a swim bladder involved in hearing), would be at risk of fatality and serious injury if they remained within 120m of the piling source for six hours of piling, or recoverable injury if they remained within 190m for six hours of piling. As noted above, this is based on a stationary receptor (i.e., a fish species would not flee from the area), which is unlikely for most species. Based on a fleeing response (with a swim speed of 1.5m/s), the cumulative impact range for fish species with a swim bladder involved in hearing would be 100m. For the other species groups, including eggs and larvae, all potential cumulative impact ranges are less than 100m, meaning individuals would have to remain within 100m of the piling location, for a total of six hours, to be at risk of fatality, serious injury, or recoverable injury. This is considered unlikely, as fish species are more likely to move out of the area at the onset of piling. Considering the very localised area of impact, the short-term nature of the works, and the temporary impact, the potential for recoverable injury is of negligible magnitude.

There is the potential for a TTS in all fish species, as a result of tubular piling (for up to six hours a day), at a distance of up to 1,200m, assuming that the fish remain stationary and do not flee. The results for a fleeing fish (assuming a swim speed of 1.5m/s) are that an individual would be at risk of TTS onset if they were within 100m of the piling location.

In terms of migratory species, the key migratory route for fish is considered to be in and out of the mouth of the estuary. The mouth of the Firth of Forth, where the piling will take place, is approximately 5km wide, considerably larger than any of the predicted impact ranges for fish species. Based on the predicted maximum impact range for mortality and potential mortal injury from impact piling (both peak from impulsive sound and cumulatively over the course of installing one pile for both the stationary and fleeing animal models), it is concluded that such impacts would not extend into the main migratory routes used by fish species. It is therefore concluded that there would be no risk of mortality or mortal injury to migratory fish species, and no impact is predicted.

A4.2 Sheet Piling

The modelling results show that recoverable injury to fish from sheet piling noise could only be expected at very close range to the piling location (<50m for recoverable injury) for fish species with a swim bladder involved in hearing (the most sensitive to noise impacts), and there is the potential for TTS onset for fish that remain within 90m of the piling location, for a period of 12 hours. It is very unlikely that any fish species would remain within either 50m or 90m of the piling location for that period of time.

Given the spatial extent of the noise impacts arising from the proposed dredging, the magnitude of the effect is considered to be low (in the context of the significant areas of coastal waters available for use around the predicted impact zone which offer the same or similar conditions for fish would be unaffected).

Given the width of the Forth of Forth at the piling location, (of approximately 5km), and the spatial extent of the potential impact (of less than 90m), it is concluded that there would be no impact on migratory species (either moving in or out of the Tees estuary) as a result of the sheet piling. In addition, it is concluded that the predicted highly localised extent of the noise impact would also have no impact on fish species migrating up and down the coastline.

A4.3 Dredging

With regard to the proposed dredging works, the modelling has shown that recoverable injury to fish could only be expected at very close range to the noise sources (distances of less than 50m from the noise source). TTS onset is predicted for fish at distances up to 50m from the dredging. Fish species would have to remain within 50m of the dredger for a period of 12 hours to be at risk of either recoverable injury, or TTS onset, which is considered to be highly unlikely.

Given the spatial extent of the noise disturbance impact arising from the proposed dredging, the magnitude of the effect is considered to be low (in the context of the significant areas of coastal waters available for use around the predicted impact zone which offer the same or similar conditions for fish would be unaffected).

Given the width of the Firth of Forth (approximately 5km), and the spatial extent of the potential impact, it is concluded that there would be no impact on migratory species (either moving in or out of the Forth) as a result of the dredging.

A5 Requirements for Mitigations

A5.1 Piling Activities

A5.1.1 Marine Mammals

As a precautionary procedure, the mitigations will be in place for both tubular and sheet piling and would be included in the Construction Environmental Management Plan (CEMP), to ensure that no marine mammals are exposed to the potential for PTS onset from the piling works. This will be based on the best available information, methodologies, and industry best practice.

The proposed mitigation would therefore be designed to ensure no presence of marine mammal species within 200m (as a precautionary distance) of the piling location. The mitigations will follow best practice guidance for minimising the risk of injury to marine mammals from piling noise detailed by the Joint Nature Conservation Committee (JNCC)[1] (JNCC, 2010).

This would 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 will be used.
- Only piling construction 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.

[1] *https://data.jncc.gov.uk/data/24cc180d-4030-49dd-8977-a04ebe0d7aca/JNCC-Guidelines-Explosives-Guidelines-201008-Web.pdf*

- 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.

A5.1.2 Fish Species

No mitigation measures are considered necessary to manage the potential risks to resident and migratory fish from the proposed dredging works. There would be no residual impact to migratory species.

In order to minimise the risk of mortality, mortal injury or impairment to resident fish from the proposed impact piling, a soft start approach would be adopted in accordance with the JNCC's guidelines ('statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from impact piling'). Although this guidance is strictly focussed on marine mammals, it is concluded that part of the guidance (specifically the adoption of soft start techniques for piling) would allow any resident species to leave the area of greatest disturbance. This would minimise the risk to fish from underwater noise, as fish would be anticipated to move out of the rea (thus avoiding impacts from occurring) prior to the noise from the piling reaching its peak levels.

A6 References

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