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ORKNEY ISLANDS COUNCIL

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Harbour Authority

Scapa Deep Water Quay
Environmental Impact Assessment Report:
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Note: The above image is indicative and provided for information purposes only

JULY 2023

SCAPA DEEP WATER QUAY EIAR

VOLUME 3

TECHNICAL APPENDIX 2

Technical Appendix 2.1	**Project Description & Potential Methodology**
Technical Appendix 2.2	**Dredging Best Practicable Environmental Option Report**
Technical Appendix 2.3	**Navigational Risk Assessment**
Technical Appendix 2.4	**Outline Business Case**

TECHNICAL APPENDIX 2.1

Document Information

Project Number	212089
Project Name	Orkney Islands Council Technical Advisor
Document Title	SDWQ - Project Description & Potential Methods
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Client	Orkney Islands Council
Client Representative	David Sawkins
Project Manager	Shane Jamieson
Project Partner	Andrew Sandison

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28/07/2023	P03	Issued	APS	SJ	

This document has been produced by Arch Henderson for: Orkney Islands Council.

Background

This proposal comprises approx. 597m long main quayside berth with general -15m CD water depth, incorporating a 135m quayside pocket with -20m CD water depth. Further north tug (3No.) and pilot boat (2No.) berth approx. 180m long with depths between -6 and -9m CD. Laydown area directly behind quay face approx. 22.85 Hectares. There will also be an access road from the A961 to the site.

The main purpose of this facility would be to undertake any/multiple industry activity that requires both deep-water berthing and large laydown area. There are specific market opportunities in the offshore wind and oil and gas sectors.

The proposal for Hatston comprises a 300m extension to the existing pier and the creation of 7.5 hectares of quayside laydown area through reclamation; there will be a ship lift and fuel facility incorporated in the development.

Both of these projects are currently being developed into scheme design and a site investigation has now been completed for both sites.

Contents

1.0 Introduction

The following RAMS looks at the proposed construction activities of providing a deep water quay development, with general fill provided from the creation of laydown area and potential industrial site, and armour protection imported from both local and imported sources.

The overall location plan (Drawing 202042EIA-110) and phased layouts (Drawings 202042EIA-400 (Works Phase 1 Overall), 202042EIA-500 (Works Phase 2 Overall) and 202042EIA-600 (Works Phase 3 Overall) attached in Appendix A) shows phased details of proposed development together with surrounding infrastructure that requires to be protected during the works and when the facility comes into use.

The main areas of risk are the existing foreshore marine environment during quay construction together with disturbance of land through waste overburden excavation and storage (organic and clay) and water runoff protection of land and marine habitat.

2.0 Information Available

A hydrographic and sub bottom survey of the seabed has been obtained from Orkney Islands Council and existing OS maps for the proposed site with all levels indicated as being relative to Chart Datum for marine and land sites.

It is proposed that the main quay berth depth at the site should be a minimum of minus 15m to Chart Datum with a further phased deep water site to between minus 20 and 24m Chart Datum to allow for potential future requirements.

Based on Admiralty Charts and Tide Tables, the sea levels assumed in the feasibility report have been taken as follows based on most onerous data for quay design -

Mean High Water Springs	+3.6m Chart Datum
Mean Low Water Springs	+0.7m Chart Datum

0.0m Chart Datum is 1.69m below Ordinance Datum

3.0 Site Conditions and Services

After considering a number of other site locations, the chosen site for the proposed deep water development is just south of Burn of Deepdale in the Bay of Deepdale on the east side of Scapa and approx. 1200m from Royal Oak Military Wreck exclusion zone and approx. 835m from a fish farm site to south. The site would be accessed from a new two lane bitmac road approx. 1000m long and one footpath off the proposed realigned A961 road (by others). New services would be routed down the new access road within verge and adjacent swale ditches.

4.0 Scheme Proposal

Laydown Site

The primary principal of creating the deep water development site is to maximise and balance all excavated inert stone excavation from land to fill and form reclaimed land and quay works in the sea with all waste material not suitable for this purpose (organic soil, vegetated peat and clays) deposited and managed into material bunds on perimeter of the phased development site.

Initial construction will commence to form the access road to main cut and fill site together with laying of all ducts and services to the site within road verge. Initial bitmac surfacing will only be at new junction onto main A961 road until completion of deep water development site, at which time, the final road surfacing would take place.

The site would then have perimeter V ditches cut and silt retention installed ahead of land being stripped of all non- inert material (organic soil, vegetated peat along with unsuitable clays).

This shall be temporally stockpiled until the initial laydown areas are created to commence site perimeter storage bunds. Excavation would then progress to select, screen and stock pile inert stone and suitable glacial till that are free from all organic and clay material. This operation is likely to take place over several months (estimated 10 to 14 months per phase) and will involve heavy tracked plant to both excavate and rip material, together with pre-treatment of the harder strata through drilling 100mm dia. holes and controlled delayed explosives (approx. 25Kg per hole.)

Further to market engagement with specialist contractor then land earthworks production is currently estimated at **10,000m³ / week** (20,000T / week) per drilling rig used.

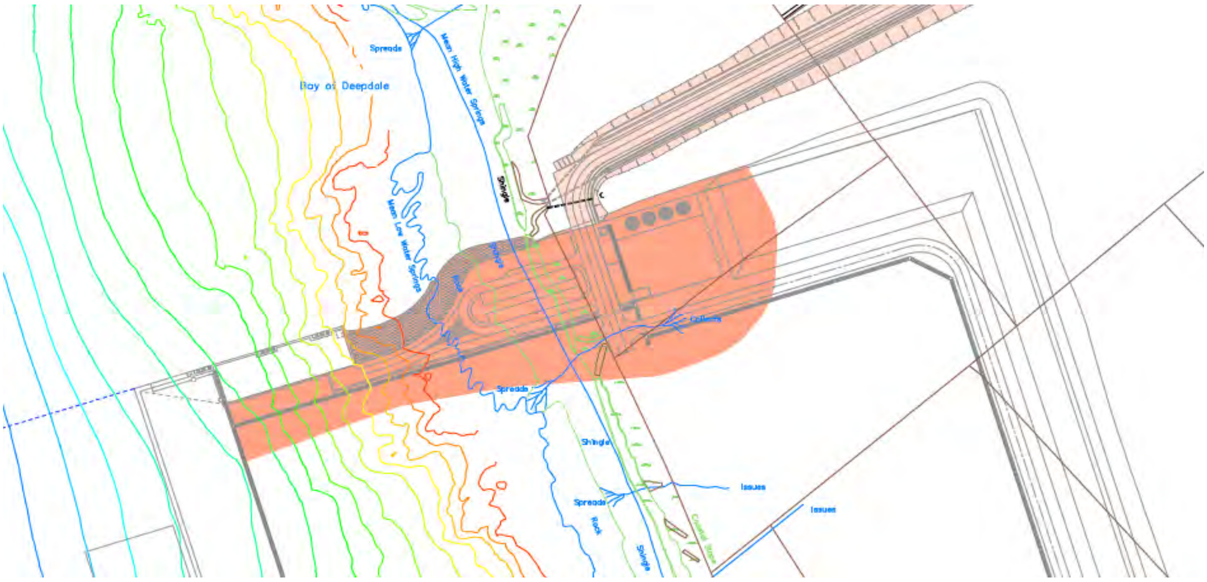
It is anticipated that up to 4no drilling rigs could be used per phase on site at any one time, therefore production would be upwards **of 40,000m³ / week** (80,000T / week). With anticipated downtime / other site logistics this is reduced to estimated **35,000m³ / week** (approx. 70,000T / week).

The stockpile material described above would then become the main inert material fill source for future reclamation and quay works. Estimated volume of fill required in Phase 1 is approx. 925,000m³ (26 weeks to produce) with 125,000m³ of unsuitable overburden that will be stored and landscaped in permanent bunds around perimeter of site. Phase 2 approx. 765,000m³ (22 weeks to produce) with 60,000m³ of unsuitable overburden that will again be stored and landscaped in permanent bunds around perimeter of site.

Surface water management - Cut off ditches above works to prevent any water flowing on to site. SUDS settlement ponds likely required to minimise sediment flowing into sea. Potential flocculants balls proposed which can be used to aid ease of removal of sediments within settlement ponds. Would require SEPA approval.

Reclamation and Quay Works

Once sufficient suitable stockpiles of inert fill material is won the initial reclamation works would commence by forming the north perimeter reclamation bund leading from access road to the rear of proposed quay works (Phasing Sketch below).

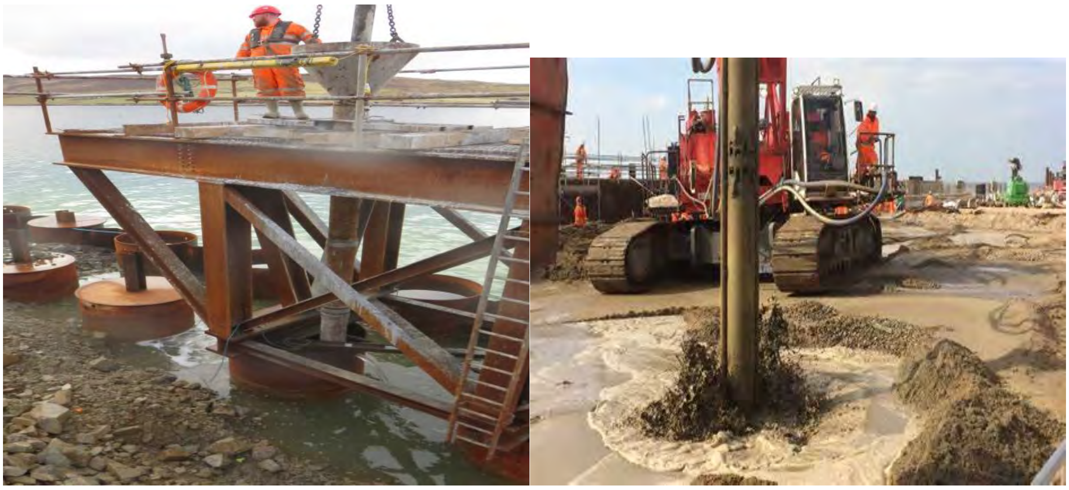


The bund slope faces would have geotextile placed together with silt booms placed in sea as the bund is progressed in order to mitigate the migration of fines followed by the placement of secondary and primary rock armour. While some secondary armour may be won on site, it is considered that the majority of armour stone will require to be imported to the site by either road or sea to cover a rock armour slope area in two interlocking layers of approx. 5,600m^3. Once this reclamation perimeter bund and armour slope is formed then this shall provide the main land route to access the quay works construction site (-10m Chart Datum) for labour, plant and construction materials.

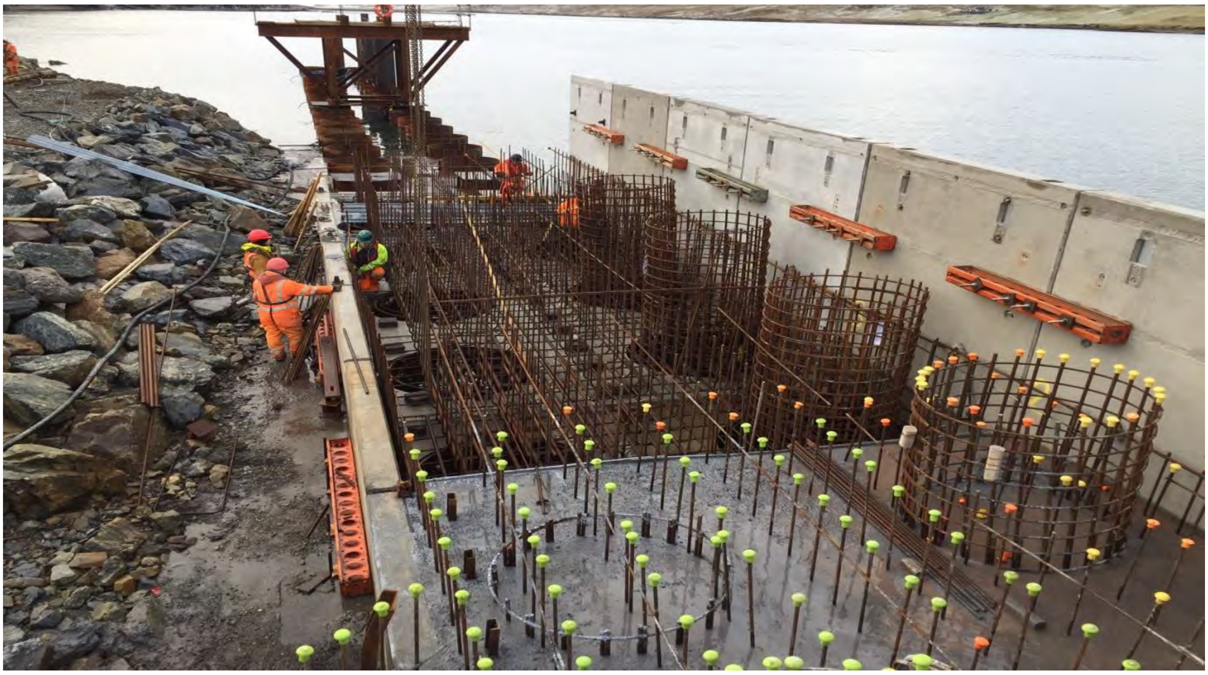
The main quay berth face is currently proposed as a solid quay constructed of steel tubular piles with interlocking sheet piles forming a combi wall solution with a further inner tied sheet pile anchor wall. This design solution has been assessed as appropriate at scheme design stage but may vary once final design and build tender procurement is progressed and contractors individual construction methods are known. This combi quay wall will support a concrete cope and deck directly behind followed by general hard core surfaced laydown reclamation area and drainage outside immediate wall active wedge area.

The anticipated tubular steel piles (approx. 2.1m dia.) for the quay wall require drilled rock sockets to provide suitable pile toe fixity below -15m CD dredge level. Bauer BG41 Drill rigs or similar will work over water from temporary piling platforms from the reclamation bund or a jack up barge with silt booms placed to seaward side.

Drill cuttings would be directed to temporary filter and silt beds on land with no discharge of cuttings to sea or watercourse. Tubular piles and sheet piles are expected to be vibro hammered to required depth (20 to 40 minutes /day) with no impact hammers anticipated at this stage. Piles will then be filled with tremie concrete.



After vibro piling compaction of reclamation fill and undertaking acceptable plate bearing tests of fill. tie rods are then installed and secured between front face and rear sheet pile wall and pre cast and in-situ concrete cope placed.



As the quay works advance south then the reclamation fill would advance behind thus affording additional sea fetch protection together with added silt boom used to shore.

Once suitable vibro treatment of quay fill has been undertaken to compact and reduce future consolidation and settlement (H pile on vibro hammer) then concrete deck immediately behind quay face will be placed (generally no less than 6 months after fill takes place) with remaining reclamation and laydown area capped and compacted with graded hard core surface with falls to V ditch and French drains.

Works phase 2 will always follow on from phase 1. Phase 3 would follow on after 1 and 2 quay works complete. Works Phase 1 starts Q4 2024 to Q4 2027. Works Phase 2 to be complete Q4 2028. See separate programme for overall durations.

Dredging

A further construction phase to the development is to dredge approx. 86,000m3 in front of Phase 1 and 2 new quay face to a depth of -15m Chart Datum using back hoe dredging technique followed by transfer of inert stone waste to split hopper barge for deposit within reclamation behind quay wall or, if unsuitable (silts – estimated approx. 30%/25,000m3), to a licenced offshore disposal site.

Phase 3 works to dredge approx. 90,000m3 to depth range -20 CD would be undertaken after completion of Phase 2 quays works using mostly back hoe dredging technique together with potentially cutter suction of isolated hard spots. All suitable inert dredge material would again be transferred ashore to Phase 2 south shore return and fill formation support to a precast and reinforced concrete slipway. No blasting is envisaged.

5.0 Risk Assessment & Method Statement

1.0 An updated otter survey to any previous study will be undertaken along immediate foreshore not more than 2 weeks before marine works commence on site. Any actions required from this study will be agreed and implemented before any works commence.

2.0 The total extent of the proposed marine works will be set out from fixed shore based control stations linked to Ordnance Survey coordinated grid system. Moored marker buoys will be placed on perimeter line of marine works to clearly mark the total extent of works.

3.0 Only inert stone fill free of all fine clay and organic material from adjacent industrial site excavation will be used for forming proposed marine access and reclamation core bund construction.

4.0 Ahead of filling works commencing from the foreshore then a silt boom will be moored out from shore ahead of advancing fill operation.

5.0 As core filling commences and advances inside moored marker buoys then completed core bund exposed slope profiles will have geotextile membrane placed and secured to slopes between MHWS and seabed toe to reduce migration of sediment as far as possible.

6.0 The advancing head of the perimeter core bund will be protected by the silt boom moored and advanced in front as core bund works progress.

7.0 Once a slope work front is finished and position and profile accurately checked against contract setting out coordinates then inert secondary and primary stone armour will carefully place over the protective geotextile slope membrane to permanently secure in place.

8.0 During construction works then a banksman will be observing any marine, sediment and material movement including further mitigation as required due to changing weather, wave and tidal action.

Only experienced marine contractors will be invited to tender for the works and they will be asked to submit a Contract Environmental Management Plan (CEMP), RAMS and Contractor Waste Management Plan (WMP) for approval by statutory authorities and construction contract as required and before any works commence on site. The CEMP will include construction restrictions during breeding seasons and methods for preventing and dealing with fuel and construction plant and material spillage during the works.

TECHNICAL APPENDIX 2.2

Scapa Deep Water Quay (SDWQ)
Dredging Best Practicable Environmental Option Report

May 2023

CONTROL SHEET

Client:	Orkney Islands Council
Project Title:	Scapa Deep Water Quay (SDWQ)
Report Title:	Dredging Best Practicable Environmental Option Report
Document number:	13145
Project number:	674795

Issue Record

Issue	Status	Author	Reviewer	Approver	Issue Date
1	Final	CCAS	GD	GD	11/05/2023
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EnviroCentre Limited Office Locations:

Glasgow **Edinburgh** **Inverness** **Banchory**

Registered Office: Craighall Business Park 8 Eagle Street Glasgow G4 9XA
Tel 0141 341 5040 info@envirocentre.co.uk www.envirocentre.co.uk

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Contents

Appendices

Tables

1 INTRODUCTION

EnviroCentre Ltd. has been appointed by Orkney Islands Council Harbour Authority (OICHA) to undertake a Best Practicable Environmental Options appraisal (BPEO) in support of the dredge licence for capital dredging to help develop the deepwater quay at Scapa. The development of Scapa Deep Water Quay comprises the design and construction of a new harbour facility comprising approx. 597m long main quayside berth with general -15m CD water depth, incorporating a 135m quayside pocket with -20m CD water depth. Further north tug (3No.) and pilot boat (2No.) berth approx. 180m long with depths between -6 and -9m CD. Laydown area directly behind quay face approx. 22.85 Hectares. There will also be an access road from the A961 to the site.

The main purpose of this facility would be to undertake any/multiple industry activity that requires both deep-water berthing and large laydown area. There are specific market opportunities in the offshore wind and oil and gas sectors.

As part of the licensing process applicants are required to undertake a Best Practicable Environmental Option (BPEO) assessment for the disposal routes for the prospective dredge material in conjunction with the assessment of the chemical and physical properties of the same material to ensure that quality of the material is suitable for the identified disposal route(s).

1.1 Background Information

As outlined above, the works will comprise an element of dredging split in to three phase areas

Sampling was undertaken in March and April 2022 which comprised collection of 13 boreholes and Washprobe samples from the dredge areas. The samples were predominately sand with variable silt and gravel content.

The proposed dredge areas and volumes are detailed in Table 1-1 below with the dredge areas presented and sample locations provided in drawing 21-1031-EHL-001 in Appendix A.

Table 1-1: Proposed Dredge Areas and Approximate Dredge Volumes

Dredge Area	Approximate Total Dredge Volume (m^3)	Target Dredge Depth (m below Chart Datum)	Dredge Thickness range (m)*
Phase 1 & 2	83,000	-15m	Variable <1.0m to c7m

1.2 Scope of Report

The purpose of this report is to review each of the available potential disposal options for the dredged materials. The options which are not considered to be practicable are rejected and the reasons for doing so are explained.

Those options which are practicable are examined in detail and assessed against the following considerations: -

- Environmental;
- Strategic; and

- Cost.

The report then compares the practicable disposal options and draws a conclusion on the BPEO.

1.3 Sediment Sampling and Nature of Marine Sediments on Site

Samples from the proposed dredge area were collected in March and April 2022 and submitted for analysis in line with Marine Scotland's guidance and the agreed sampling plan. The sample logs are provided in Appendix B with Laboratory certificates and data summary tables in Appendix C.

Due to extreme weather conditions during the sampling and extensive weather related delays, and associated mounting costs, a number of the original boreholes were abandoned, and samples collected and tested from the ones achieved. Correspondence was undertaken with Marine Scotland in December 2022 to highlight these constraints, and it was agreed that the available information was considered suitable for the dredge application and that no further sampling would be required.

Sediment type across all dredge areas was predominately sand with varying gravel and silt content.

The following sections details the exceedances of the Revised Action Levels (RALs) with further consideration of these exceedances undertaken in Section 3.

1.3.1 Metals

Exceedances of the RALs for metals can be summarised as follows:

- Arsenic –5 of 34 samples recorded arsenic levels above RAL1. The maximum concentration recorded was 27.8mg/kg.
- Cadmium –0 of 34 samples recorded cadmium levels above RAL1. The maximum concentration recorded was 0.13 mg/kg.
- Copper – 3 of 34 samples recorded copper levels above RAL1. The maximum concentration recorded was 84.1 mg/kg.
- Chromium – 1 of 34 samples recorded chromium levels above RAL1. The maximum concentration recorded was 51.4 mg/kg.
- Lead – 1 of 34 samples recorded lead levels above RAL1. The maximum concentration recorded was 50.7 mg/kg.
- Mercury – 0 of 34 samples recorded mercury levels above RAL1. The maximum concentration recorded was 0.13 mg/kg.
- Nickel – 1 of 34 samples recorded nickel levels above RAL1. The maximum concentration recorded was 31.8 mg/kg.
- Zinc – 1 of 34 samples recorded zinc levels above RAL1. The maximum concentration recorded was 161 mg/kg.

There were no exceedances of RAL2 for metals recorded within any of the 34 samples collected.

1.3.2 Tributyl Tin (TBT)

All samples were recorded below the laboratory limit of detection (LOD) and all samples recorded below RAL1.

1.3.3 Polyaromatic Hydrocarbons (PAHs)

No samples recorded PAH concentrations above RAL1.

1.3.4 Polychlorinated Biphenyls (PCBs)

All samples recorded individual PCB congeners below RAL1. The highest recorded total ICES 7 concentration was 0.0019 mg/kg.

1.3.5 Total Hydrocarbons (THC)

1 of 34 samples recoded hydrocarbons above RAL1. The maximum recorded is 123 mg/kg.

1.4 Report Usage

The information and recommendations contained within this report have been prepared in the specific context stated above and should not be utilised in any other context without prior written permission from EnviroCentre Limited.

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2 DISCUSSION OF AVAILABLE DISPOSAL OPTIONS

The BPEO process is geared towards identifying a preferred overall strategy from the perspective of the environment as a whole, as opposed to detailed optimisation of any one selected scheme. It is a structured and systematic process to identify and compare strategic options in a transparent manner. Alternatives are evaluated in terms of their projected implications for the environment together with consideration of practicability, social and economic issues as well as within a wider strategic context.

The key stages of a BPEO are:

- Identification of options;
- Screening of options;
- Selection of assessment criteria;
- Analysis and evaluation of criteria; and
- Evaluation of BPEO.

Further details on methodology are provided within each section.

2.1 Identification and Screening of Available Disposal Options

A number of options are available for disposal of dredged sediments. The options considered are provided in Table 2-1 along with justification for screening out those options which have not been taken forward for further consideration.

Table 2-1: Initial Best Practicable Available Options

Location	Options	Screening Assessment	Carry forward?
Shore/Estuary/ Riverbank	Leave in situ	Not an option due to the project specific requirements to create berthing at the pier and navigable approaches.	No
	Infilling of an existing dry dock/harbour facility/development site (re-use)	The project requires a significant amount of infill behind the quay wall for reclamation. It is envisaged that up to 70% of all dredged material from Phase 1 and Phase 2. Will be utilised as infill with the remainder of structurally unsuitable material proposed to be disposed of at sea at a licensed disposal ground.	Yes
	Beach Nourishment	Specific beach nourishment projects would require to be supported by Environmental Assessments as a minimum to inform how the project could affect the environment as a result of disturbance to the intertidal area, changes to the sediment levels, the variable composition and quality of the material and measures devised from the assessment outcomes to minimise impacts on the environment. The dredge material comprises a mixture of gravel, sand and silt. Fine sediments (i.e. silt) is not suitable for beach nourishment in the traditional sense.	No
Land	Landfill Disposal	This is possible but it is unlikely that this option will offer long term solution due to lack of space at landfills. Landfill space is currently at a premium and does not offer a sustainable solution either financially or environmentally for the disposal of dredged arisings. Dredged material likely to require treatment first in a dewatering facility. Significant cost associated with set up of dewatering facility at the quayside plus transportation and additional costs associated with gaining the necessary planning and regulatory consents. OIC were contacted with regards to landfills in proximity to the site. Bossack Waste Transfer and Landfill Facility near Kirkwall has a daily capacity of 225 tonnes of inert waste or 5,000 tonnes /year so would not be a viable option for disposal. Transporting to another landfill would require marine transport plus road transport.	No
	Land Incineration	The dredged material consists of non-combustible material (silts, sands, gravels, shells) with a low combustible component and very high-water content.	No

	Application to Agricultural Land	The dredged material would need to be treated to reduce salt concentrations to acceptable levels. Would require detailed chemical analysis and assessment as well as a Waste Management License Exemption. Would require special precautions during spreading in relation to the risk of odour and watercourses / aquifers. The availability of land for this option will be limited within a reasonable haulage distance of the dredge arisings. Large volumes each year are unlikely to be viable to dispose of in this manner and would potentially have a detrimental effect on existing terrestrial habitats.	No
	Recycling	Recycling of dredged material is theoretically possible, however, due to the varied lithology there would need to be either segregation during dredging works to minimise the entrainment of fine-grained material into the sands, or energy and water rich processing on land.	No
Sea	Aquatic disposal direct to seabed.	Relatively low cost, minimal transportation requirements compared to all other options and potential for low environmental risk. The closest spoil grounds are Stromness B being the closest is located approximately 16km South. It would be proposed that only unsuitable material for construction works would be deposited within the disposal site i.e. material with high silt content.	Yes

2.2 Summary of Identified BPEO Options

Following review of the available options and the proposed construction requirements a combination of proposed reuse/sea disposal has been identified as the BPEO. The remote nature of the site and distance from the mainland, precludes the majority of the other options on the basis of not being practical options.

The chemical quality of the material is typically acceptable for sea based disposal, however further consideration of the RAL1 exceedances outlined previously is provided in Section 3.

3 FURTHER ASSESSMENT

3.1 Chemical Quality

Up to 5 samples from 34 in total recorded exceedances of RAL1 for metals and one sample recorded a marginal exceedance of Total Petroleum Hydrocarbons (TPH).

Further consideration is given to this result using the Canadian Council Ministers of the Environment (CCME) Canadian Sediment Quality Guidelines for the Protection of Aquatic Life considering both the Effects Range Low (ERL) and Probable Effects Level (PEL). This is summarised in the table below.

Table 3-1: Further Assessment Summary

Contaminant	Number of RAL1 Exceedances of 34 samples	Number of ERL Exceedances of 34 samples	Number of PEL Exceedances of 34 samples
Arsenic	5	N/A	0
Copper	3	3	0
Chromium	1	0	0
Lead	1	1	0
Nickle	1	N/A	N/A
Zinc	1	1	0
TPH	1	N/A	N/A

In summary, there are no exceedances of Probable Effect Levels or RAL2 where one is available for review.

3.2 Water Framework Directive Assessment

As outlined in the Water Framework Directive Assessment: estuarine and coastal waters, there are several key receptors which can be impacted upon which need considered.

- Hydromorphology
- Biology – habitats
- Biology – fish
- Water quality
- Protected areas

A WFD assessment has not been undertaken as the proposed works have an accompanying Environmental Impact Assessment Report detailing all of this information.

3.3 Potential Risk to Water Quality and Marine Life

The potential risks to water quality at the dredge sites and disposal site are further considered below.

Contaminant levels within the proposed dredge material for sea disposal are considered to be very low and not considered to represent a significant risk to the overall water quality either at the dredge site or proposed disposal site(s). The key risks to water quality are from the dredging exercise and also disposal where there may be periods of higher suspended solids which are likely to be both localised and temporary in nature. The larger grained material like gravel and sands will drop to the sea floor quickly, and any changes in suspended solids/turbidity will be driven by the finer grained material content, silts and clay sized particles. Where finer grained materials are cohesive, they will sink to the sea floor rapidly. The bulk of the dredge material is to be used for reclamation/construction works, with the unsuitable, higher silt containing material, proposed to be disposed of at Stromness B. The average content of various particle sizes is detailed below om Table 3-2.

Table 3-2: Summary of PSA Data

Dredge Area	Gravel (>2mm)	Sand (0.063mm<Sand<2mm)	Silt & Clay (<0.063mm)	Quantity to be dredged m^3
SDWQ Phase 1 and 2	17%	60%	23%	83,000
	14,110m^3	49,800m^3	19,090m^3	

The dominant sediment type across the majority of the dredge areas is sand. Considering the dredge volume as a whole using averaged particle size analysis data, the dominant sediment type is sand comprising 60% of the total and the remainder made up of 23% silt and 17% comprising gravel sized fractions.

Given that an average of 60% of the sediment across all dredge areas comprises sand and gravel, it is considered that the majority of the deposited sediment will fall out of suspension quickly at the disposal site with limited lateral spread.

The remaining portion of the dredge 23% or 19,090m^3 of dredge material comprises silt/clay sized particles. This material is considered to have a longer suspension time than sand and gravel sized particles when in suspension. It is understood that the unsuitable material for engineering purposes may be disposed of and would likely have a larger proportion of silt. Any effects from the disposal of the material is considered to be both localised and temporary.

Marine Scotland do not hold any information on the disposal sites.

In summary, the associated risk with degradation of water quality directly associated with the proposed disposal is considered to be Low i.e. unlikely to cause a change in status of the waterbodies in question at both the dredge and disposal sites.

3.4 Conclusions and Recommendations

Review of available chemical quality information has low level/frequency exceedances for a arsenic (5), copper (3), Total Hydrocarbon content, chromium, lead, nickel and zinc recorded a single exceedance for their respective RAL1. Assessment of key receptors identified from the Water Framework Directive assessment for estuarine and coastal waters concluded that there is a low risk of the sediments impacting upon the overall ecological or chemical status. Additionally, the contaminants of concern levels recorded in the sediment are not considered likely to have a significant adverse impact on the sediment quality already located within the disposal grounds as the majority of the samples and associated contaminants of concern were recorded below RAL1.

Overall, based on the multiple lines of evidence approach adopted to further assess the exceedances identified in the sediment assessment, the material proposed for dredging is considered suitable for sea disposal, however, the majority of the material to be dredged will be re-used within the construction of the proposed quay, with material which does not meet the requirements for engineering purposes proposed to be of disposed of at the closest disposal site.

Based on the chemical quality of the sediment samples retrieved and tested from the dredge site, the sea disposal and re-use of the material is considered to have no significant long-term impact on the marine environment.

REFERENCES

Marine Scotland (2017). Pre-Dredge Sampling Guidance Version 2: Scottish Government.
Marine Scotland (2015). Guidance for Marine Licence Applicants Version 2: Scottish Government.

APPENDICES

A FIGURES

PROJECT: Scapa Deep Water Quay & Haston Pier Development - Marine GI

TITLE: Exploratory hole location plan (Scapa DWQ)

CLIENT: Orkney Islands Council

ENGINEER: Arch Henderson LLP

KEY:
- ⊕ Borehole
- ▼ Wash Probes

CAUSEWAY GEOTECH

SCALE: NTS@A3		DATE: 16/05/2022	
DRWN:	BS	SERIES: 1 of 1	DWG No: 21-1031-EHL-001
CHCK:	NH		

B SAMPLE LOGS

APPENDIX B

BOREHOLE LOGS

CAUSEWAY GEOTECH	**Project No.** **21-1031**	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI **Client:** Orkney Islands Council **Client's Rep:** Arch Henderson LLP	**Borehole ID** **BH-M01**

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	345139.28 E 1003689.78 N
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	12.80	

Final Depth:	12.80 m	**Start Date:**	14/01/2022	**Driller:**	MJ/KW	Sheet 1 of 2 Scale: 1:50
Elevation:	-10.10 mCD	**End Date:**	15/01/2022	**Logger:**	JG+RC	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)
0.00 - 0.50	ES9	Marine Scotland - SS1		
0.50	ES1			
0.50 - 1.50	B4			
1.00 - 1.50	ES10	Marine Scotland - SS2		
1.50	D7			
1.50 - 2.50	B5			
1.50 - 1.95	SPT (S)	N=18 (1,1/3,4,5,6) Hammer SN = 1353	1.50	
2.00	ES2			
2.50 - 3.00	B6			
2.50 - 3.00	ES11	Marine Scotland - SS3		
3.00	D8		3.00	
3.00	ES3			
3.00 - 3.45	SPT(S) N=30 (4,6/7,7,8,8) Hammer SN = 1353			
3.70	C1			
3.80				
3.80	C2			
4.95	C3			
5.30				
5.40	C4			
5.60	C5			
6.80				
7.10	C6			
7.25	C7			
8.30				
8.50	C8			

TCR	SCR	RQD
100	19	19
100	85	47
97	81	33
100	93	53
100	79	27

FI
6
15
12
16
7

Level mCD	Depth (m)	Description
		Medium dense grey slightly gravelly silty fine to medium SAND with shell fragments (up to 5mm). Gravel is subangular to subrounded fine of various lithologies.
-12.60	2.50	Orangish brown thinly laminated slightly gravelly silty fine to medium SAND. Gravel is angular fine to medium of various lithologies.
-13.10	3.00	Dark grey clayey slightly gravelly fine to coarse SAND. Gravel is angular fine to coarse of sandstone.
-13.50	(0.40) 3.40	Possible weathered SANDSTONE recovered as light orangish grey clayey gravelly fine to coarse sand. Gravel is angular fine to coarse of sandstone.
-13.80	(0.30) 3.70	Weak (locally medium strong) indistinctly thinly laminated fine grained light brownish orange and whitish grey SANDSTONE. Partially weathered: reduced strength and much closer fracture spacing. Discontinuities: 1. 0 to 20 degree joints closely spaced (50/110/250) planar, rough, unstained and clean. 2. 55 to 75 degree joints from 4.50m to 4.80m, 5.10m to 5.20m, 5.20m to 5.30m and 6.90m tom 7.00m, planar, rough, unstained and clean.
-17.10	(3.30) 7.00	Medium strong (locally weak) indistinctly thinly laminated fine grained light brownish orange and whitish grey SANDSTONE. Partially weathered: slightly reduced strength, closer fracture spacing occasional heavy dark orangish brown discolouration and occasional clay infill. Discontinuities: 1. 0 to 20 degree joints closely spaced (30/140/300) planar, rough, occasional clay infill on joint surfaces up to 40mm deep. 2. 55 to 75 degree joints from 8.60m to 8.90m, 9.50m to 9.60m and 10.30m to 10.40m, planar, rough and occasional heavy dark orangish brown staining on joint surfaces up to 40mm deep.

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Casing Details

To (m)	Diam (mm)
3.00	177
12.80	150

Water Added

From (m)	To (m)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 19.00m
All elevations/reduced levels given in mCD

Core Barrel	**Flush Type**	**Termination Reason**	**Last Updated**
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH

Project No. 21-1031	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI		**Borehole ID** BH-M01
	Client: Orkney Islands Council		
	Client's Rep: Arch Henderson LLP		

Method	Plant Used	Top (m)	Base (m)	Coordinates
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	345139.28 E 1003689.78 N
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	12.80	

Final Depth: 12.80 m	**Start Date:** 14/01/2022	**Driller:** MJ/KW	Sheet 2 of 2 Scale: 1:50
Elevation: -10.10 mCD	**End Date:** 15/01/2022	**Logger:** JG+RC	FINAL

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mCD	Depth (m)	Legend	Description	Water	Backfill
9.70	C9										Medium strong (locally weak) indistinctly thinly laminated fine grained light brownish orange and whitish grey SANDSTONE. Partially weathered: slightly reduced strength, closer fracture spacing occasional heavy dark orangish brown discolouration and occasional clay infill. Discontinuities: 1. 0 to 20 degree joints closely spaced (30/140/300) planar, rough, occasional clay infill on joint surfaces up to 40mm deep. 2. 55 to 75 degree joints from 8.60m to 8.90m, 9.50m to 9.60m and 10.30m to 10.40m, planar, rough and occasional heavy dark orangish brown staining on joint surfaces up to 40mm deep. *11.00m to 11.30m: AZCL - Probable bed of extremely weak sandstone washed out during drilling.*		
9.80		83	75	37	9								
10.45	C10												
10.75	C11												
					AZCL				(5.80)				
11.30		100	97	67	8								
11.50	C12												
12.50	C13												
12.65	C14												
12.80								-22.90	12.80		End of Borehole at 12.80m		

Water Strikes			
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Chiselling Details		
From (m)	To (m)	Time (hh:mm)

Casing Details		Water Added	
To (m)	Diam (mm)	From (m)	To (m)
3.00	177		
12.80	150		

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 19.00m
All elevations/reduced levels given in mCD

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH

Project No.	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI		**Borehole ID**
21-1031	**Client:** Orkney Islands Council		**BH-M02**
	Client's Rep: Arch Henderson LLP		

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	1.20	345180.32 E 1003713.59 N
Rotary Coring	Fraste Duo CXL Rotosonic	1.20	14.00	

Final Depth:	14.00 m	**Start Date:**	20/01/2022	**Driller:**	KW	Sheet 1 of 2 Scale: 1:50
Elevation:	-8.78 mCD	**End Date:**	20/01/2022	**Logger:**	JG+RC	FINAL

Depth (m)	Sample / Tests	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mCD	Depth (m)	Description
0.00 - 0.70	B2									Grey very gravelly silty fine to coarse SAND with shell fragments (up to 5mm). Gravel is subangular to subrounded fine to coarse of various lithologies.
0.50	ES1									
0.70 - 1.00	B3							-9.48	0.70	Orangish brown thinly laminated silty fine to medium SAND.
1.00 - 1.20	B4							-9.78	1.00	Yellowish brown fine to medium SAND.
		75	18	0	AZCL NI			-9.98	1.20 (0.50)	Dark brownish grey clayey slightly gravelly fine to coarse SAND. Gravel is subrounded fine to coarse of mixed lithologies. *1.20m to 1.40m: AZCL - Probable bed of sand and gravel washed out during drilling.*
1.70	C1							-10.48	1.70	Very weak thinly laminated fine grained light brownish yellow and brownish white SANDSTONE. Partially weathered: reduced strength and much closer fracture spacing. Discontinuities: 1. 5 to 15 degree bedding fractures closely spaced (10/65/200) planar, smooth, unstained and clean. 2. 55 to 65 degree joints from 2.35m to 2.55m and 2.80m to 2.90m, undulating, rough, unstained and clean.
2.00										
2.00	C2	100	71	23	14				(1.20)	
								-11.68	2.90	Weak indistinctly thinly laminated fine grained light brownish grey and light brownish yellow SANDSTONE. Partially weathered: slightly reduced strength, much closer fracture spacing and occasional heavy brownish black discolouration on fracture surfaces. Discontinuities: 1. 0 to 20 degree bedding fractures, closely spaced (10/75/200) planar, smooth, unstained, clean. 2. 55 to 65 degree joints from 3.30m to 3.50m, 3.60m to 3.70m and 3.80m to 3.90m, undulating, rough, occasional heavy brow black staining on joint surfaces up to 0.5mm deep and clean. *4.10m to 5.00m: AZCL - Probable bed of extremely weak sandstone washed out during drilling.*
3.00	C3									
3.20	C4									
3.50					>20					
3.80	C5	41	25	0	AZCL				(2.10)	
5.00		97	74	26	20			-13.78	5.00	Weak (locally medium strong) indistinctly thickly laminated fine grained dark brownish yellow SANDSTONE. Partially weathered: slightly reduced strength, much closer fracture spacing and occasional heavy dark orangish brown discolouration on fracture surfaces. Discontinuities: 1. 0 to 15 degree bedding fractures very closely spaced (10/50/150)m planar, smooth, occasional heavy dark orangish brown staining on fracture surfaces up to 40mm deep.
5.45	C6								(1.35)	
6.30	C7									
								-15.13	6.35	Medium strong (locally weak) indistinctly thinly laminated fine grained light greyish orange and light brownish orange SANDSTONE. Partially weathered: slightly reduced strength, closer fracture spacing and occasional heavy dark orangish brown discolouration on fracture surfaces. Discontinuities: 1. 0 to 15 degree bedding fractures, closely spaced (10/150/500) planar, smooth, occasional heavy dark orangish brown staining on fracture surfaces up to 100mm deep. 2. 25 to 45 degree joints medium spaced (200/470/1500) planar, smooth, occasional heavy dark orangish brown staining on joint surfaces up to 5mm deep. 3. 65 to 75 degree joint from 11.40m to 11.65m, planar, rough, heavy dark brown staining on joint surface., 10mm deep.
6.50		100	95	63	7					
6.85	C8									
7.60	C9									
7.70	C10									
8.00										
8.00	C11	100	90	79	11					
9.00	C12									

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 19.60m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
1.20	177
14.00	150

Water Added

From (m)	To (m)

Core Barrel	**Flush Type**	**Termination Reason**	**Last Updated**
SK6L		Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH	**Project No.** **21-1031**	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI **Client:** Orkney Islands Council **Client's Rep:** Arch Henderson LLP	**Borehole ID** **BH-M02**

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	1.20	345180.32 E
Rotary Coring	Fraste Duo CXL Rotosonic	1.20	14.00	1003713.59 N

Final Depth: 14.00 m	**Start Date:** 20/01/2022	**Driller:** KW	Sheet 2 of 2 Scale: 1:50
Elevation: -8.78 mCD	**End Date:** 20/01/2022	**Logger:** JG+RC	FINAL

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mCD	Depth (m)	Description
9.30	C13									Medium strong (locally weak) indistinctly thinly laminated fine grained light greyish orange and light brownish orange SANDSTONE. Partially weathered: slightly reduced strength, closer fracture spacing and occasional heavy dark orangish brown discolouration on fracture surfaces. Discontinuities: 1. 0 to 15 degree bedding fractures, closely spaced (10/150/500) planar, smooth, occasional heavy dark orangish brown staining on fracture surfaces up to 100mm deep. 2. 25 to 45 degree joints medium spaced (200/470/1500) planar, smooth, occasional heavy dark orangish brown staining on joint surfaces up to 5mm deep. 3. 65 to 75 degree joint from 11.40m to 11.65m, planar, rough, heavy dark brown staining on joint surface., 10mm deep. *9.50m to 9.70m: AZCL - Probable bed of extremely weak sandstone washed out during drilling.*
9.50		80	53	34	AZCL 13 20					
11.00										
11.00	C14	96	82	62	8				(7.65)	
12.50		100	97	45	>20 9					
13.20	C15									
13.75	C16									
14.00								-22.78	14.00	End of Borehole at 14.00m

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Chiselling Details

From (m)	To (m)	Time (hh:mm)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 19.60m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
1.20	177
14.00	150

Water Added

From (m)	To (m)

Core Barrel	**Flush Type**	**Termination Reason**	**Last Updated**
SK6L		Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH	**Project No.** **21-1031**	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI **Client:** Orkney Islands Council **Client's Rep:** Arch Henderson LLP	**Borehole ID** **BH-M03**

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**				Sheet 1 of 2 Scale: 1:50
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	4.50	345123.20 E 1003736.66 N	**Final Depth:** 11.90 m	**Start Date:** 24/01/2022	**Driller:** MJ	
Rotary Coring	Fraste Duo CXL Rotosonic	4.50	11.90		**Elevation:** -10.42 mCD	**End Date:** 25/01/2022	**Logger:** JG+RC	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)
0.00 - 0.50	ES11	Marine Scotland - SS1		
0.00 - 1.50	B5			
0.50	ES1			
1.00	ES2			
1.00 - 1.50	ES12	Marine Scotland - SS2		
1.50	D8			
1.50 - 3.00	B6			
1.50 - 1.95	SPT (S)	N=10 (1,0/2,2,3,3) Hammer SN = 1353	1.50	
2.00	ES3			
2.50 - 3.00	ES13	Marine Scotland - SS3		
3.00	D9			
3.00	ES4			
3.00 - 4.30	B7			
3.00 - 3.45	SPT (S)	N=18 (3,4/4,5,4,5) Hammer SN = 1353	3.00	
4.50	D10		4.50	
4.50 - 4.95	SPT(S) N=32 (5,6/7,7,8,10) Hammer SN = 1353			
4.70	C1			
5.90				
6.15	C3			
6.80	C4			
6.95	C5			
7.40				
8.70	C6			
8.90				
8.90	C7			
9.20	C8			

Core run (m)	TCR	SCR	RQD
4.50 - 5.90	96	16	13
5.90 - 7.40	100	89	56
7.40 - 8.90	97	77	33
8.90 -			

FI interval (m)	FI
4.50 - 5.60	
5.60 - 8.00	8
8.00 - 8.70	9
8.70 -	

Level mCD	Depth (m)	Description
-13.42	3.00	Loose to medium dense grey slightly gravelly silty fine to coarse SAND with shell fragments (up to 5mm). Gravel is subangular to subrounded fine of various lithologies.
-14.72	4.30	Medium dense grey slightly gravelly silty fine to coarse SAND with shell fragments (up to 3mm). Gravel is subrounded to rounded fine of various lithologies.
-15.22	(0.50) 4.80	Stiff yellowish brown very sandy silty CLAY. Sand is fine to medium.
-16.02	(0.80) 5.60	Very stiff light yellowish grey sandy slightly gravelly silty CLAY. Sand is fine to medium. Gravel is angular fine to coarse of sandstone. (Possible weathered bedrock)
-19.12	(3.10) 8.70	Medium strong (locally weak) indistinctly thinly laminated fine grained light yellowish grey SANDSTONE. Partially weathered: slightly reduced strength, closer fracture spacing and occasional heavy dark orangish brown discolouration on fracture surfaces. Discontinuities: 1. 10 to 20 degree bedding fractures medium spaced (20/220/400) planar, rough, occasional heavy dark orangish brown staining on fracture surfaces up to 2mm deep. 2. 65 to 75 degree joints from 7.40m to 8.30m and 8.30m to 8.70m, planar, rough, occasional heavy dark orangish brown staining on joint surfaces up to 0.5mm.
		Medium strong (locally weak) indistinctly thinly laminated fine grained light orangish grey SANDSTONE. Partially weathered: slightly reduced strength. Discontinuities: 1. 10 to 20 degree bedding fractures, medium spaced (20/210/400) planar, rough, unstained and clean.

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 18.60m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
4.50	177
11.90	150

Water Added

From (m)	To (m)

Core Barrel	**Flush Type**	**Termination Reason**	**Last Updated**
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH

Project No.	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI		**Borehole ID**
21-1031	**Client:** Orkney Islands Council		**BH-M03**
	Client's Rep: Arch Henderson LLP		

Method	**Plant Used**	**Top (m)**	**Base (m)**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	4.50
Rotary Coring	Fraste Duo CXL Rotosonic	4.50	11.90

Coordinates

345123.20 E
1003736.66 N

Final Depth: 11.90 m	**Start Date:** 24/01/2022	**Driller:** MJ	Sheet 2 of 2
Elevation: -10.42 mCD	**End Date:** 25/01/2022	**Logger:** JG+RC	Scale: 1:50
			FINAL

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mCD	Depth (m)	Legend	Description	Water	Backfill
9.45	C9										Medium strong (locally weak) indistinctly thinly laminated fine grained light orangish grey SANDSTONE. Partially weathered: slightly reduced strength. Discontinuities: 1. 10 to 20 degree bedding fractures, medium spaced (20/210/400) planar, rough, unstained and clean.		
9.80	C10	95	95	79	5				(1.70)				
10.40								-20.82	10.40				
10.40	C11	100	83	31	9				(1.50)		Medium strong indistinctly thinly laminated fine grained dark greyish orange SANDSTONE. Partially weathered: slightly reduced strength and closer fracture spacing. Discontinuities: 1. 5 to 15 degree bedding fractures closely spaced (10/100/500) planar, rough, unstained and clean. 2. 55 to 65 degree joints from 11.10m to 11.25m and 11.70m to 11.90m, planar, rough, unstained and clean.		
11.50	C12												
11.90								-22.32	11.90		End of Borehole at 11.90m		

9.5 10.0 10.5 11.0 11.5 12.0 12.5 13.0 13.5 14.0 14.5 15.0 15.5 16.0 16.5 17.0 17.5 18.0 18.5

TCR SCR RQD FI

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Chiselling Details

From (m)	To (m)	Time (hh:mm)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 18.60m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
4.50	177
11.90	150

Water Added

From (m)	To (m)

Core Barrel	**Flush Type**	**Termination Reason**	**Last Updated**
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH

Project No. 21-1031	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI **Client:** Orkney Islands Council **Client's Rep:** Arch Henderson LLP	**Borehole ID** BH-M04

Method	Plant Used	Top (m)	Base (m)	Coordinates
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	345152.16 E
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	13.50	1003798.70 N

Final Depth: 13.50 m	**Start Date:** 04/03/2022	**Driller:** MJ	Sheet 1 of 2 Scale: 1:50
Elevation: -8.97 mCD	**End Date:** 05/03/2022	**Logger:** NP+RC	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)
0.00 - 0.50	ES5	Marine Scotland - SS1		
0.00 - 1.50	B8			
0.50	ES1			
1.00	ES2			
1.00 - 1.50	ES6	Marine Scotland - SS2		
1.50	D10			
1.50 - 3.00	B9			
1.50 - 1.95	SPT (S)	N=10 (1,1/2,2,3,3) Hammer SN = 1353	1.50	
2.00	ES3			
2.50 - 3.00	ES7	Marine Scotland - SS3		
3.00	D11		3.00	
3.00	ES4			
3.00 - 3.45	SPT(S) N=48 (5,8/9,9,10,20) Hammer SN = 1353			
3.70	C1			
4.50				
5.00	C2			
6.00				
6.00	C3			
6.40	C4			
6.50	C5			
6.90	C6			
7.20	C7			
7.50				
7.70	C8			
8.60	C9			
9.00				

Core run (m)	TCR	SCR	RQD
3.00 - 4.50	58	9	9
4.50 - 6.00	100	89	30
6.00 - 7.50	87	73	29
7.50 - 9.00	100	89	58

FI
AZCL
NI
11
13
>20
18
AZCL
12

Level mCD	Depth (m)	Description
		Loose to medium dense grey very gravelly silty fine to coarse SAND with shell fragments (up to 5mm). Gravel is subangular fine to medium of various lithologies.
-10.47	1.50	Very stiff grey slightly sandy slightly gravelly silty CLAY. Sand is fine to coarse. Gravel is subangular fine to coarse of various lithologies.
-11.87	2.90	Weathered SANDSTONE recovered as: white and orange fine to medium sand.
-11.97	3.00 (1.10)	Weathered SANDSTONE recovered as firm light brownish yellow very sandy gravelly clay. Sand is fine to coarse. Gravel is subangular fine to coarse of sandstone. *3.00m to 3.55m: AZCL - Disturbance due to SPT has lead to subsequent wash out of material.*
-13.07	4.10 (0.40)	Medium strong (locally weak) indistinctly thinly laminated fine grained light brownish yellow and whitish grey SANDSTONE. Partially weathered: reduced strength, much closer fracture spacing and occasional clay infill on fracture surfaces. Discontinuities: 1. 0 to 15 degree bedding fractures, closely spaced (10/150/300) planar, rough, unstained and occasional clay infill on fracture surfaces up to 20mm thick. 2. 65 to 75 degree joints from 3.55m to 3.85m, planar, rough, unstained , clay infill on joint surfaces up to 20mm thick.
-13.47	4.50 (2.70)	Medium strong (locally weak) indistinctly thinly laminated fine grained light yellowish and brown and whitish grey SANDSTONE. Partially weathered: slightly reduced strength, much closer fracture spacing and occasional heavy dark orangish brown discolouration on fracture surface. Discontinuities: 1. 10 to 25 degree bedding fractures clsoely spaced (10/120/250) planar, rough, occasional heavy dark ornagish brown staining in fracture surfaces up to 20mm thick.
-16.17	7.20	Medium strong indistinctly thinly laminated fine grained whitish grey SANDSTONE. Partially weathered: slightly reduced strength, closer fracture spacing, occasional light brownish orange discolouration on fracture surfaces and occasional clay infill on fracture surfaces. Discontinuities: 1. 0 to 20 degree bedding fractures, medium spaced (30/210/550) planar rough, occasional light brownish orange staining on fracture surfaces up to 0.5mm deep and occasional clay infill up to 30mm thick. 2. 55 to 75 degree joints from 7.50m to 7.70m, 8.20m to 8.40m and 10.50m to 10.80m, planar, rough, occasional light brownish orange staining on joint surfaces up to 0.5mm deep. *7.30m to 7.50m: AZCL - Probable bed of extremely weak sandstone washed out during drilling.*

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 16.10m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
3.00	177
13.50	150

Water Added

From (m)	To (m)

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH	**Project No.** 21-1031	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI **Client:** Orkney Islands Council **Client's Rep:** Arch Henderson LLP	**Borehole ID** BH-M04

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	345152.16 E 1003798.70 N
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	13.50	

Final Depth:	13.50 m	**Start Date:** 04/03/2022	**Driller:** MJ	Sheet 2 of 2	Scale: 1:50
Elevation:	-8.97 mCD	**End Date:** 05/03/2022	**Logger:** NP+RC	FINAL	

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mCD	Depth (m)	Legend	Description	Water	Backfill
9.40	C10	100	100	100	4				(6.30)		Medium strong indistinctly thinly laminated fine grained whitish grey SANDSTONE. Partially weathered: slightly reduced strength, closer fracture spacing, occasional light brownish orange discolouration on fracture surfaces and occasional clay infill on fracture surfaces. Discontinuities: 1. 0 to 20 degree bedding fractures, medium spaced (30/210/550) planar rough, occasional light brownish orange staining on fracture surfaces up to 0.5mm deep and occasional clay infill up to 30mm thick. 2. 55 to 75 degree joints from 7.50m to 7.70m, 8.20m to 8.40m and 10.50m to 10.80m, planar, rough, occasional light brownish orange staining on joint surfaces up to 0.5mm deep. *10.80m to 10.95m: Very weak indistinctly thinly laminated light greyish green MUDSTONE.*		
9.70	C11												
10.00	C12												
10.50		97	87	55	13								
11.20	C13												
12.00		100	91	77	7								
12.25	C14												
12.45	C15												
13.25	C16												
13.50								-22.47	13.50		End of Borehole at 13.50m		

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Chiselling Details

From (m)	To (m)	Time (hh:mm)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 16.10m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
3.00	177
13.50	150

Water Added

From (m)	To (m)

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

Project No. **21-1031**	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI **Client:** Orkney Islands Council **Client's Rep:** Arch Henderson LLP		**Borehole ID** **BH-M05**

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	4.50	345092.93 E
Rotary Coring	Fraste Duo CXL Rotosonic	4.50	10.80	1003832.55 N

Final Depth: 10.80 m	**Start Date:** 05/03/2022	**Driller:** MJ	Sheet 1 of 2 Scale: 1:50
Elevation: -11.22 mCD	**End Date:** 06/03/2022	**Logger:** NP+EM	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	Level mCD	Depth (m)	Description
0.00 - 0.50	ES5	Marine Scotland - SS1					Loose to medium dense greyish brown gravelly silty fine to coarse SAND with shell fragments (up to 5mm). Gravel is subangular fine to medium of various lithologies.
0.00 - 1.50	B8						
0.50	ES1						
1.00	ES2						
1.00 - 1.50	ES6	Marine Scotland - SS2					
1.50	D11						
1.50 - 3.00	B9						
1.50 - 1.95	SPT (S)	N=23 (2,5/5,6,6,6) Hammer SN = 1353	1.50				
2.00	ES3						
2.50 - 3.00	ES7	Marine Scotland - SS3			-13.72	2.50	Stiff grey slightly sandy slightly gravelly silty CLAY. Sand is fine to coarse.. Gravel is subangular fine to medium of various lithologies and shell fragments (up to 4mm).
3.00	D12						
3.00	ES4						
3.00 - 4.50	B10						
3.00 - 3.45	SPT (S)	N=26 (5,6/6,6,7,7) Hammer SN = 1353	3.00				
4.50	D13		4.50		-15.72	4.50	Very stiff brown slightly sandy very gravelly CLAY with high cobble content. Sand is fine to coarse. Gravel is subangular fine to coarse of sandstone. Cobbles are subangular of sandstone and mudstone.
4.50 - 4.87	SPT(S) N=50 (8,8/50 for 220mm) Hammer SN = 1353						
						(1.00)	*4.50m to 5.00m: AZCL - Disturbance due to SPT has lead to subsequent wash out of material.*
							Weak indistinctly thinly laminated well cemented SANDSTONE. Partially weathered: slightly reduced strength, slightly closer fracture spacing with discolouration and clay deposits on some fracture surfaces. Discontinuities: 1. 35 to 25 degree bedding fractures, medium spaced (150/408/450) slightly undulating, rough with strong patchy brown and orangish brown staining on some fracture surfaces. 2. 0 to 5 degree joint at 6.50m, planar, rough, clean. 3. 60 to 80 degree joint at 6.70m to 7.05m, slightly undulating, rough with strong dark brown staining and patchy greyish white clay deposists (up to 4mm thick) on joint surface.
					-16.72	5.50	
5.60	C1						
5.90	C2						
6.00							
6.30	C3						
						(1.90)	
							Weak thinly laminated light orangish brown medium grained moderately cemented SANDSTONE. Partially weathered: reduced strength, slightly closer fracture spacing with discolouration and clay deposits on fracture surfaces. Discontinuities: 1. 20 to 30 degree bedding fractures closely spaced (80/161/200) plana, rough with patchy orangish brown staining on few fracture surfaces and light orange clay deposits (up to 3mm thick) on most fracture surfaces. 2. 70 to 80 degree joint at 8.20m to 8.33m, planar, smooth to rough, clean.
					-18.62	7.40	
7.50							
7.50	C4						
						(1.45)	
8.50	C5						
							Weak (locally medium strong) thinly laminated light orangish brown medium grained well cemented SANDSTONE. Partially weathered: closer fracture spacing with discolouration and clay deposits on fracture surfaces.
					-20.07	8.85	
9.00							
9.30	C6						

TCR	SCR	RQD
60	46	23
100	90	53
100	94	26

FI
AZCL
11
5
18
10

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 18.0m
All elevations/reduced levels given in mCD

Casing Details		Water Added	
To (m)	Diam (mm)	From (m)	To (m)
4.50	177		
10.80	150		

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

Project No.	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI		**Borehole ID**
21-1031	**Client:**	Orkney Islands Council	**BH-M05**
	Client's Rep:	Arch Henderson LLP	

Method	Plant Used	Top (m)	Base (m)	Coordinates
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	4.50	345092.93 E
Rotary Coring	Fraste Duo CXL Rotosonic	4.50	10.80	1003832.55 N

Final Depth:	10.80 m	**Start Date:**	05/03/2022	**Driller:**	MJ	Sheet 2 of 2 Scale: 1:50
Elevation:	-11.22 mCD	**End Date:**	06/03/2022	**Logger:**	NP+EM	FINAL

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mCD	Depth (m)	Legend	Description	Water	Backfill
		100	96	26					(1.95)		Weak (locally medium strong) thinly laminated light orangish brown medium grained well cemented SANDSTONE. Partially weathered: closer fracture spacing with discolouration and clay deposits on fracture surfaces. 1. 20 to 30 degree bedding fractures closely spaced (560/162/300) planar, rough, with occasional patchy dark brown discolouration on some fracture surfaces and occasional patchy light greyish white clay deposits (up to 3mm thick) on some fracture surfaces. 2. 50 to 60 degree joint at 9.15m to 9.40m and 9.90m to 10.05m, slightly undulating rough with patchy dark brown discolouration on joint surface. *9.70m to 9.85m: Bed of extremely weak sandstone*		
10.50 10.50 10.60 10.80	 C7 C8	100	83	50				-22.02	10.80				
		TCR	SCR	RQD	FI						End of Borehole at 10.80m		

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Chiselling Details

From (m)	To (m)	Time (hh:mm)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 18.0m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
4.50	177
10.80	150

Water Added

From (m)	To (m)

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH	**Project No.** **21-1031**	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI **Client:** Orkney Islands Council **Client's Rep:** Arch Henderson LLP	**Borehole ID** **BH-M06**

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	345121.94 E 1003893.44 N
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	12.00	

Final Depth: 12.00 m	**Start Date:** 06/03/2022	**Driller:** MJ	Sheet 1 of 2 Scale: 1:50
Elevation: -10.51 mCD	**End Date:** 07/03/2022	**Logger:** NP+RC	FINAL

Depth (m)	Sample / Tests	Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mCD	Depth (m)	Description
0.00 - 0.50	ES5	Marine Scotland - SS1									Loose to medium dense grey slightly gravelly silty fine to coarse SAND with shell fragments (up to 4mm). Gravel is subangular fine to medium.
0.00 - 1.50	B8										
0.50	ES1										
1.00	ES2										
1.00 - 1.50	ES6	Marine Scotland - SS2									
1.50	D10								-12.01	1.50	Very stiff grey slightly sandy slightly gravelly silty CLAY. Sand is fine to coarse. Gravel is subangular fine to medium of various lithologies.
1.50 - 3.00	B9										
1.50 - 1.95	SPT (S)	N=11 (1,2/2,3,3,3) Hammer SN = 1353					1.50				
2.00	ES3										
2.50 - 3.00	ES7	Marine Scotland - SS3									
3.00	D11		84			6	3.00				
3.00	ES4										
3.00 - 3.45	SPT(S) N=32 (7,7/7,8,8,9) Hammer SN = 1353										
3.15	C1										
									-13.71	3.20	Weak (locally medium strong) indistinctly thinly laminated fine grained orangish grey SANDSTONE. Partially weathered: reduced strength, much closer fracture spacing, occasional heavy dark orangish brown discolouration on fracture surfaces and occasional sandy clay infill on fracture surfaces. Discontinuities: 1. 5 to 20 degree bedding fractures, closely spaced (10/125/300) planar, smooth, occasional heavy dark orangish brown staining on fracture surfaces up to 1mm deep and occasional sandy clay infill on fracture surfaces up to 30mm thick. 2. 65 to 75 degree joints from 3.10m to 4.10m, 5.20m to 5.50m to 5.60m, 6.30m to 6.50m, 6.80m to 6.90m, 7.60m to 8.00m, 8.20m to 8.80m, 9.00m ti 9.40m, undulating, smooth and occasional heavy dark orangish brown staining on joint surfaces up to 1mm thick.
3.30	C2										
4.50			94			10					
4.70	C3										
5.90	C4										
6.00			88								
6.30	C5									(8.80)	
6.55	C6										
7.50			94			9					
7.90	C7										
9.00											

Water Strikes			
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 17.00m
All elevations/reduced levels given in mCD

Casing Details		**Water Added**	
To (m)	Diam (mm)	From (m)	To (m)
3.00	177		
12.00	150		

Core Barrel	**Flush Type**	**Termination Reason**	**Last Updated**
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH

Project No. **21-1031**	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI **Client:** Orkney Islands Council **Client's Rep:** Arch Henderson LLP		**Borehole ID** **BH-M06**

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	345121.94 E 1003893.44 N
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	12.00	

Final Depth: 12.00 m	**Start Date:** 06/03/2022	**Driller:** MJ	Sheet 2 of 2 Scale: 1:50
Elevation: -10.51 mCD	**End Date:** 07/03/2022	**Logger:** NP+RC	FINAL

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mCD	Depth (m)	Legend	Description	Water	Backfill
9.80	C8	100			7						Weak (locally medium strong) indistinctly thinly laminated fine grained orangish grey SANDSTONE. Partially weathered: reduced strength, much closer fracture spacing, occasional heavy dark orangish brown discolouration on fracture surfaces and occasional sandy clay infill on fracture surfaces. Discontinuities: 1. 5 to 20 degree bedding fractures, closely spaced (10/125/300) planar, smooth, occasional heavy dark orangish brown staining on fracture surfaces up to 1mm deep and occasional sandy clay infill on fracture surfaces up to 30mm thick. 2. 65 to 75 degree joints from 3.10m to 4.10m, 5.20m to 5.50m to 5.60m, 6.30m to 6.50m, 6.80m to 6.90m, 7.60m to 8.00m, 8.20m to 8.80m, 9.00m ti 9.40m, undulating, smooth and occasional heavy dark orangish brown staining on joint surfaces up to 1mm thick. *10.50m: Firm sandy clay infill on joint surfaces up to 50mm deep.* *11.25m to 12.00m: AZCL - Lower half of core run unable to be retrieved from base of borehole due to fractured nature of material.*		
10.50													
10.50	C9	51			>20 AZCL								
12.00								-22.51	12.00		End of Borehole at 12.00m		

9.5 10.0 10.5 11.0 11.5 12.0 12.5 13.0 13.5 14.0 14.5 15.0 15.5 16.0 16.5 17.0 17.5 18.0 18.5

TCR SCR RQD FI

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Chiselling Details

From (m)	To (m)	Time (hh:mm)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 17.00m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
3.00	177
12.00	150

Water Added

From (m)	To (m)

Core Barrel	**Flush Type**	**Termination Reason**	**Last Updated**
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH

Project No.	Project Name: Scapa Deep Water Quay & Hatston Pier Development - Marine GI	Borehole ID
21-1031	Client: Orkney Islands Council	BH-M07
	Client's Rep: Arch Henderson LLP	

Method	Plant Used	Top (m)	Base (m)	Coordinates
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	4.50	345062.99 E 1003927.90 N
Rotary Coring	Fraste Duo CXL Rotosonic	4.50	12.00	

Final Depth: 12.00 m	**Start Date:** 07/03/2022	**Driller:** MJ	Sheet 1 of 2 Scale: 1:50
Elevation: -11.32 mCD	**End Date:** 09/03/2022	**Logger:** RC+NP	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)
0.00 - 0.50	ES5	Marine Scotland - SS1		
0.00 - 1.50	B8			
0.50	ES1			
1.00	ES2			
1.00 - 1.50	ES6	Marine Scotland - SS2		
1.50	D11			
1.50 - 3.00	B9			
1.50 - 1.95	SPT (C)	N=20 (3,4/4,5,5,6) Hammer SN = 1353	1.50	
2.00	ES3			
2.50 - 3.00	ES7	Marine Scotland - SS3		
3.00	D12			
3.00	ES4			
3.00 - 4.50	B10			
3.00 - 3.45	SPT (S)	N=26 (5,6/6,7,6,7) Hammer SN = 1353	3.00	
4.50	D13		4.50	
4.50 - 4.93	SPT(S) N=50 (8,9/50 for 280mm) Hammer SN = 1353			
6.00			6.00	
6.00 - 6.40	SPT(C) N=50 (9,12/50 for 245mm) Hammer SN = 1353			
7.45	C1			
7.50				
8.20	C2			
8.60	C3			
9.00				
9.10	C4			
9.30	C5			

TCR	SCR	RQD	FI
33	0	0	AZCL
60	9	0	AZCL >20
80	28	0	>20 10 AZCL

Level mCD	Depth (m)	Description
		Medium dense grey gravelly silty fine to coarse SAND with shell fragments (up to 5mm). Gravel is subangular fine to medium of various lithologies.
-13.82	2.50	Medium dense grey very gravelly silty fine to coarse SAND. Gravel is subangular fine of various lithologies.
-14.72	3.40	Stiff to very stiff brownish grey sandy gravelly silty CLAY. Sand is fine to coarse. Gravel is subangular fine to coarse of various lithologies.
-15.42	4.10	Very stiff dark greyish brown slightly sandy gravelly CLAY with medium cobble content. Sand is fine to coarse. Gravel is angular to subangular fine to coarse of sandstone and mudstone. Cobbles are of mudstone. *4.50m to 5.50m: AZCL - Disturbance due to SPT has lead to subsequent wash out of material.* *6.00m to 6.50m: AZCL - Disturbance due to SPT has lead to subsequent wash out of material.* Weak indistinctly thinly laminated fine grained moderately cemented light orangish grey SANDSTONE. Partially weathered: reduced strength, much closer fracture spacing, occasional light brownish orange discolouration on fracture surfaces and occasional sandy clay infill on fracture surfaces. Discontinuities: 1. 5 to 20 degree bedding fractures closely spaced (10/70/100) planar, rough, occasional light brownish orange staining on fracture surfaces up to 1mm deep and occasional sandy clay infill up to 10mm thick. 2. 65 to 75 degree joints from 6.50m to 6.80m, 7.50m to 7.60m and 7.60m to 7.90m, undulating, rough, occasional light brownish orange staining and occasional sandy clay infill up to 3mm thick.
	(3.00)	
-18.42	7.10	Very weak (locally weak) indistinctly thinly laminated fine grained moderately cemented light greyish orange SANDSTONE. Partially weathered: reduced strength, closer fracture spacing and frequent heavy brownish orange discolouration on fracture surfaces. Discontinuities: 1. 5 to 20 degree bedding fractures closely spaced (30/130/450), planar, rough and frequent heavy light brownish orange staining up to the entire diameter of core.
	(1.10)	
-19.52	8.20	2. 25 to 45 degree joints medium spaced (150/290/700) planar, rough and frequent heavy light brownish orange staining up to entire diameter of core. 3. 65 to 75 degree joints from 8.20m to 8.50m, 10.10m to 10.50m and 10.70m to 11.00m, undulating, rough and frequent heavy light brownish orange staining up to entire diameter of core. *8.65m to 9.00m: AZCL - Probable bed of extremely weak sandstone washed out during drilling.*

Water | Backfill

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 22.00m
All elevations/reduced levels given in mCD

Casing Details		Water Added	
To (m)	Diam (mm)	From (m)	To (m)
4.50	177		
12.00	150		

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH	Project No.	Project Name: Scapa Deep Water Quay & Hatston Pier Development - Marine GI	Borehole ID
	21-1031	Client: Orkney Islands Council	BH-M07
		Client's Rep: Arch Henderson LLP	

Method	Plant Used	Top (m)	Base (m)	Coordinates
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	4.50	345062.99 E 1003927.90 N
Rotary Coring	Fraste Duo CXL Rotosonic	4.50	12.00	

Final Depth:	12.00 m	**Start Date:**	07/03/2022	**Driller:**	MJ	Sheet 2 of 2 Scale: 1:50
Elevation:	-11.32 mCD	**End Date:**	09/03/2022	**Logger:**	RC+NP	FINAL

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mCD	Depth (m)	Description	Water	Backfill
9.40	C6	93	59	24	10					Very weak (locally weak) indistinctly thinly laminated fine grained moderately cemented light greyish orange SANDSTONE. Partially weathered: reduced strength, closer fracture spacing and frequent heavy brownish orange discolouration on fracture surfaces. Discontinuities: 1. 5 to 20 degree bedding fractures closely spaced (30/130/450), planar, rough and frequent heavy light brownish orange staining up to the entire diameter of core. 2. 25 to 45 degree joints medium spaced (150/290/700) planar, rough and frequent heavy light brownish orange staining up to entire diameter of core. 3. 65 to 75 degree joints from 8.20m to 8.50m, 10.10m to 10.50m and 10.70m to 11.00m, undulating, rough and frequent heavy light brownish orange staining up to entire diameter of core. *11.30m to 12.00m: AZCL - Lower half of core run unable to be retrieved from base of borehole due to fractured nature of material.*		
10.50		53	0	0	>20				(3.80)			
11.20	C7				AZCL							
12.00								-23.32	12.00	End of Borehole at 12.00m		

Water Strikes				Chiselling Details		
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)	From (m)	To (m)	Time (hh:mm)

Casing Details		Water Added	
To (m)	Diam (mm)	From (m)	To (m)
4.50	177		
12.00	150		

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 22.00m
All elevations/reduced levels given in mCD

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH

Project No.	Project Name: Scapa Deep Water Quay & Hatston Pier Development - Marine GI	Borehole ID
21-1031	Client: Orkney Islands Council	BH-M08
	Client's Rep: Arch Henderson LLP	

Method	Plant Used	Top (m)	Base (m)	Coordinates
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	345091.71 E 1003988.52 N
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	12.00	

Final Depth: 12.00 m	**Start Date:** 22/03/2022	**Driller:** MJ	Sheet 1 of 2	Scale: 1:50
Elevation: -10.31 mCD	**End Date:** 23/03/2022	**Logger:** NP+EM	FINAL	

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)
0.00 - 1.50	B5			
0.50	ES1			
1.00	ES2			
1.50	D7			
1.50 - 3.00	B6			
1.50 - 1.95	SPT (S)	N=15 (2,2/4,3,4,4) Hammer SN = 1353	1.50	
2.00	ES3			
3.00	D8		3.00	
3.00	ES4			
3.00 - 3.45	SPT(S) N=30 (6,7/7,7,8,8) Hammer SN = 1353			
4.50			4.50	
4.50	D9			
4.50 - 4.65	SPT(S) N=50 (25 for 90mm/50 for 60mm) Hammer SN = 1353			
4.90	C1			
5.85	C2			
6.00				
6.20	C3			
6.90	C4			
7.05	C5			
7.50				
7.50	C6			
9.00				

Run (m)	TCR	SCR	RQD	FI
3.00 - 4.50	26			AZCL
4.50 - 6.00	76	60	26	AZCL 6
6.00 - 7.50	83	63	30	12 AZCL
7.50 - 9.00	100	25	16	12 NI

Level mCD	Depth (m)	Description
-11.81	1.50	Medium dense grey very gravelly silty fine to coarse SAND with shell fragments (up to 9mm). Gravel is subangular fine to coarse of various lithologies.
-13.31	3.00	Stiff to very stiff brownish grey slightly sandy slightly gravelly silty CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular fine to medium of various lithologies. Cobbles are subangular.
-15.31	5.00 (2.00)	Very stiff dark greyish brown slightly sandy slightly gravelly CLAY with medium cobble content. Sand is fine to coarse. Gravel is subangular fine to coarse of various lithologies. Cobbles are subrounded of mudstone. *3.00m to 4.10m: AZCL - Disturbance due to SPT has lead to subsequent wash out of material.* *4.50m to 4.90m: AZCL - Disturbance due to SPT has lead to subsequent wash out of material.*
-19.61	9.30 (4.30)	Weak (locally medium strong) thinly laminated light orangish brown fine to medium grained moderately cemented SANDSTONE. Partially weathered: slightly reduced strength, slightly closer fracture spacing, with clay deposits on fracture surfaces. Discontinuities: 1. 10 to 20 degree bedding fractures, medium spaced (110/407/500), planar, rough, with patchy light orangish brown clay deposits (<1mm thick) on few fracture surfaces. 2. 60 to 90 degree joint at 5.50m to 5.80m, undulating, rough with patchy light greyish white clay deposits on joint surface. 3. Possible 90 degree joint at 6.30m to 7.10m, probably undulating, rough with orangish brown patchy staining on joint surface, otherwise clean. 4. 45 degree joint at 5.85m, slightly undulating, rough, clean. *7.20m to 7.50m: AZCL - Probable bed of extremely weak sandstone washed out during drilling.*

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Casing Details

To (m)	Diam (mm)
3.00	177
12.00	150

Water Added

From (m)	To (m)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 16.50m
All elevations/reduced levels given in mCD

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH

Project No.	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI		**Borehole ID**
21-1031	**Client:**	Orkney Islands Council	**BH-M08**
	Client's Rep:	Arch Henderson LLP	

Method	Plant Used	Top (m)	Base (m)	Coordinates
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	345091.71 E 1003988.52 N
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	12.00	

Final Depth:	12.00 m	**Start Date:**	22/03/2022	**Driller:**	MJ	Sheet 2 of 2 Scale: 1:50
Elevation:	-10.31 mCD	**End Date:**	23/03/2022	**Logger:**	NP+EM	FINAL

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mCD	Depth (m)	Legend	Description	Water	Backfill
9.35	C7										Medium strong (locally weak) thickly laminated light orangish brown medium grained well cemented SANDSTONE. Partially weathered: much closer fracture spacing, slightly reduced strength with discolouration and clay deposits on fracture surfaces. Discontinuities: 1. 15 to 25 degree bedding fractures, closely spaced (40/166/800) planar, rough with patchy brown clay deposits and orangish brown staining on fractures surfaces and fracture staining. 2. 70 to 90 degree joint at 8.10m to 9.00m, and 9.90m to 10.30m, undulating, rough with patchy faint orangish brow staining on joint surfaces, otherwise clean. 3. 50 to 60 degree joint at 7.70m to 7.80m, 11.75m to 12.00m, slightly undulating, rough, clean.		
9.60	C8												
9.80	C9	100	87	46									
10.50													
10.50	C10				4				(2.70)				
11.00	C11												
		100	95	65									
11.55	C12												
12.00								-22.31	12.00		End of Borehole at 12.00m		

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Chiselling Details

From (m)	To (m)	Time (hh:mm)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 16.50m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
3.00	177
12.00	150

Water Added

From (m)	To (m)

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH

Project No. 21-1031	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI		**Borehole ID** BH-M09
	Client: Orkney Islands Council		
	Client's Rep: Arch Henderson LLP		

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	345032.04 E 1004023.35 N
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	10.50	

Final Depth: 10.50 m	**Start Date:** 23/03/2022	**Driller:** MJ	Sheet 1 of 2 Scale: 1:50
Elevation: -12.25 mCD	**End Date:** 24/03/2022	**Logger:** RC+NP	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)
0.00 - 0.50	ES5	Marine Scotland - SS1		
0.00 - 1.50	B8			
0.50	ES1			
1.00	ES2			
1.00 - 1.50	ES6	Marine Scotland - SS2		
1.50	D10			
1.50 - 3.00	B9			
1.50 - 1.95	SPT (S)	N=15 (2,3/3,4,4,4) Hammer SN = 1353	1.50	
2.00	ES3			
2.50 - 3.00	ES7	Marine Scotland - SS3		
3.00	D11		3.00	
3.00	ES4			
3.00 - 3.45	SPT(S) N=34 (6,7/8,8,9,9) Hammer SN = 1353			
4.50				
4.50	C1			
4.60	C2			
5.10	C3			
6.00				
6.10	C4			
6.90	C5			
7.30	C6			
7.50				
8.10	C7			
9.00				

TCR	SCR	RQD	FI
27	3	0	AZCL >20
53	20	0	>20 AZCL
100	89	55	10
100	61	12	12 20

Level mCD	Depth (m)	Description
-14.75	2.50	Medium dense grey very gravelly silty fine to coarse SAND with shell fragments (up to 8mm). Gravel is subangular fine to medium of various lithologies.
-15.25	3.00	Stiff to very stiff brownish grey sandy gravelly silty CLAY. Sand is fine to coarse. Gravel is subangular fine to coarse of sandstone and mudstone.
-18.25	6.00 (3.00)	Medium strong (locally weak) indistinctly thinly laminated fine grained, moderately cemented SANDSTONE. Partially weathered: reduced strength, much closer fracture spacing and occasional heavy brownish black discolouration on fracture surfaces. Discontinuities: 1. 5 to 20 degree bedding fractures, closely spaced (10/65/100) planar, rough and occasional heavy brownish black staining on fracture surfaces up to 10mm deep. 2. 65 to 75 degree joints from 3.00m to 3.30m and 4.70m to 5.00m,. undulating, rough and occasional heavy brownish black staining on joint surfaces up to 1mm deep. *3.00m to 4.10m: AZCL - Disturbance due to SPT has lead to subsequent wash out of material.* *5.30m to 6.00m: AZCL - Probable bed of extremely weak sandstone washed out during drilling.*
	(4.50)	Medium strong to strong (locally weak) indistinctly thinly laminated fine grained moderately cemented light orangish grey SANDSTONE. Partially weathered: slightly reduced strength, closer fracture spacing, occasional heavy brownish ornate discolouration on fracture surfaces and occasional sandy clay infill on fracture surfaces. Discontinuities: 1. 5 to 25 degree bedding fractures closely spaced (20/140/300) planar, rough, occasional heavy brownish orange staining on fracture surfaces up to 1mm deep and occasional sandy clay infill on fracture surfaces up to 40mm thick. 2. 25 to 45 degree joints medium spaced (200/500/1000) planar, rough and frequent heavy brownish orange staining on joint surfaces up to 2mm deep. 3. 65 to 75 degree joints from 7.50m to 7.80m, 7.80m to 8.00m, 8.40m to 8.50m, 9.50m to 9.40m and 9.90m to 10.50m, undulating, rough and occasional light brownish orange staining up to 0.5mm deep.

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 19.00m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
3.00	177
10.50	150

Water Added

From (m)	To (m)

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

Project No. **21-1031**	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI **Client:** Orkney Islands Council **Client's Rep:** Arch Henderson LLP		**Borehole ID** **BH-M09**

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	345032.04 E 1004023.35 N
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	10.50	

Final Depth: 10.50 m	**Start Date:** 23/03/2022	**Driller:** MJ	Sheet 2 of 2 Scale: 1:50
Elevation: -12.25 mCD	**End Date:** 24/03/2022	**Logger:** RC+NP	FINAL

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mCD	Depth (m)	Description
9.50	C8									Medium strong to strong (locally weak) indistinctly thinly laminated fine grained moderately cemented light orangish grey SANDSTONE. Partially weathered: slightly reduced strength, closer fracture spacing, occasional heavy brownish ornate discolouration on fracture surfaces and occasional sandy clay infill on fracture surfaces. Discontinuities: 1. 5 to 25 degree bedding fractures closely spaced (20/140/300) planar, rough, occasional heavy brownish orange staining on fracture surfaces up to 1mm deep and occasional sandy clay infill on fracture surfaces up to 40mm thick. 2. 25 to 45 degree joints medium spaced (200/500/1000) planar, rough and frequent heavy brownish orange staining on joint surfaces up to 2mm deep. 3. 65 to 75 degree joints from 7.50m to 7.80m, 7.80m to 8.00m, 8.40m to 8.50m, 9.50m to 9.40m and 9.90m to 10.50m, undulating, rough and occasional light brownish orange staining up to 0.5mm deep.
9.70	C9	100	56	26	14					
10.50								-22.75	10.50	End of Borehole at 10.50m

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Chiselling Details

From (m)	To (m)	Time (hh:mm)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 19.00m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
3.00	177
10.50	150

Water Added

From (m)	To (m)

Core Barrel	**Flush Type**	**Termination Reason**	**Last Updated**
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH	Project No.	Project Name: Scapa Deep Water Quay & Hatston Pier Development - Marine GI	Borehole ID
	21-1031	Client: Orkney Islands Council	BH-M10
		Client's Rep: Arch Henderson LLP	

Method	Plant Used	Top (m)	Base (m)	Coordinates
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	345061.10 E 1004083.93 N
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	12.00	

Final Depth: 12.00 m	**Start Date:** 24/03/2022	**Driller:** MJ	Sheet 1 of 2 Scale: 1:50
Elevation: -10.05 mCD	**End Date:** 25/03/2022	**Logger:** NP+RC	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)
0.00 - 1.50	B5			
0.50	ES1			
1.00	ES2			
1.50	D7			
1.50 - 3.00	B6			
1.50 - 1.95	SPT (S)	N=10 (1,1/2,2,3,3) Hammer SN = 1353	1.50	
2.00	ES3			
3.00	D8		3.00	
3.00	ES4			
3.00 - 3.42	SPT(S) N=50 (6,7/50 for 275mm) Hammer SN = 1353			
4.35	C1			
4.50				
4.50	C2			
4.60	C3			
6.00				
6.20	C4			
7.30	C5			
7.50				
7.95	C6			
8.30	C7			
9.00				

Core run (m)	TCR	SCR	RQD
3.00 - 4.50	67	17	0
4.50 - 6.00	100	57	0
6.00 - 7.50	100	78	21
7.50 - 9.00	100	85	55

FI
AZCL
12
13
9
13

Level mCD	Depth (m)	Description
		Loose to medium dense grey very gravelly silty fine to coarse SAND with shell fragments (up to 11mm). Gravel is subangular fine to medium of various lithologies.
-11.54	1.50	Stiff to very stiff brownish grey slightly gravelly very sandy silty CLAY. Sand is fine to coarse. Gravel is subangular fine to medium of various lithologies.
-12.54	2.50	Highly weathered brown SANDSTONE. (Drillers description)
-12.90	2.85	Light brown and orangish brown banded SANDSTONE (Driller's description)
-13.04	3.00 (0.80)	Weathered SANDSTONE recovered as: stiff dark greyish orange very sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular fine to coarse of sandstone. *3.00m to 3.50m: AZCL - Disturbance due to SPT has lead to subsequent wash out of material.*
-13.84	3.80 (1.15)	Weak thinly laminated fine grained greyish orange SANDSTONE. Partially weathered: significantly reduced strength, closer fracture spacing, frequent heavy dark brownish orange discolouration on fracture surfaces. Discontinuities: 1. 5 to 20 degree bedding fractures closely spaced (20/165/250) planar rough, frequent heacy dark brownish orange staining up to whole diameter of core deep and frequent, light greenish grey sandy clay infill on fracture surfaces.
-15.00	4.95 (2.75)	Weak indistinctly thinly laminated fine grained dark yellowish grey SANDSTONE. Partially weathered: reduced strength, much closer fracture spacing and occasional heavy brownish black discolouration on fracture surfaces and occasional sandy clay infill on fracture surfaces. Discontinuities: 1. 5 to 25 degree bedding fractures closely spaced (10/110/350) planar, rough, occasional orangish brown staining up to full diameter of core an occasional brownish black staining up to 0.5mm deep and occasional sandy clay infill up to 10mm thick. 2. 65 to 75 degree joints from 4.95m to 5.05m, 5.05m to 5.45m, 5.90m to 6.20m, 6.30m to 6.70m and 6.80m to 7.35m, undulating, rough and frequent heavy brownish black staining up to 1mm deep.
-17.74	7.70	Medium strong (locally weak) indistinctly thinly laminated fine grained light yellowish grey SANDSTONE. Partially weathered: slightly reduced strength, closer fracture spacing and occasional brownish black and brownish orange discolouration on fracture surfaces. Discontinuities: 1. 5 to 15 degree bedding fractures closely spaced (30/190/400) planar, rough and occasional heavy brownish black staining up to 1mm deep. 2. 45 to 55 degree joints at 9.20m, 10.00m and 11.70m, planar, rough and occasional brownish black staining up to 10mm deep. 3. 65 to 75 degree joints from 7.70m to 7.80m, 7.90m to 8.05m, 8.60m to 9.00m and 9.00m to 9.50m, undulating, rough and frequent heavy brownish black and orangish brown staining on joint surfaces up to 3mm deep.

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 17.00m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
3.00	177
12.00	150

Water Added

From (m)	To (m)

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH	**Project No.**	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI	**Borehole ID**
	21-1031	**Client:** Orkney Islands Council	**BH-M10**
		Client's Rep: Arch Henderson LLP	

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	345061.10 E 1004083.93 N
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	12.00	

Final Depth: 12.00 m	**Start Date:** 24/03/2022	**Driller:** MJ	Sheet 2 of 2 Scale: 1:50
Elevation: -10.05 mCD	**End Date:** 25/03/2022	**Logger:** NP+RC	FINAL

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mCD	Depth (m)	Legend	Description	Water	Backfill
											Medium strong (locally weak) indistinctly thinly laminated fine grained light yellowish grey SANDSTONE. Partially weathered: slightly reduced strength, closer fracture spacing and occasional brownish black and brownish orange discolouration on fracture surfaces. Discontinuities: 1. 5 to 15 degree bedding fractures closely spaced (30/190/400) planar, rough and occasional heavy brownish black staining up to 1mm deep. 2. 45 to 55 degree joints at 9.20m, 10.00m and 11.70m, planar, rough and occasional brownish black staining up to 10mm deep. 3. 65 to 75 degree joints from 7.70m to 7.80m, 7.90m to 8.05m, 8.60m to 9.00m and 9.00m to 9.50m, undulating, rough and frequent heavy brownish black and orangish brown staining on joint surfaces up to 3mm deep.		
9.70	C8												
10.00	C9	85	65	32									
10.50													
10.60	C10				3				(4.30)				
11.20	C11	100	90	81									
12.00								-22.04	12.00		End of Borehole at 12.00m		
		TCR	SCR	RQD	FI								

9.5 10.0 10.5 11.0 11.5 12.0 12.5 13.0 13.5 14.0 14.5 15.0 15.5 16.0 16.5 17.0 17.5 18.0 18.5

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Chiselling Details

From (m)	To (m)	Time (hh:mm)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 17.00m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
3.00	177
12.00	150

Water Added

From (m)	To (m)

Core Barrel	**Flush Type**	**Termination Reason**	**Last Updated**
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH

Project No. 21-1031	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI		**Borehole ID** BH-M11
	Client: Orkney Islands Council		
	Client's Rep: Arch Henderson LLP		

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	344997.29 E 1004104.77 N
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	9.00	

Final Depth: 9.00 m	**Start Date:** 26/03/2022	**Driller:** MJ	Sheet 1 of 2 Scale: 1:50
Elevation: -14.41 mCD	**End Date:** 27/03/2022	**Logger:** NP	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)
0.00 - 0.50	ES5	Marine Scotland - SS1		
0.00 - 1.50	B8			
0.50	ES1			
1.00	ES2			
1.00 - 1.50	ES6	Marine Scotland - SS2		
1.50	D10			
1.50 - 3.00	B9			
1.50 - 1.95	SPT (S)	N=16 (2,3/3,4,4,5) Hammer SN = 1353	1.50	
2.00	ES3			
2.50 - 3.00	ES7	Marine Scotland - SS3		
3.00	D11		3.00	
3.00	ES4			
3.00 - 3.29	SPT(S) N=50 (6,8/50 for 140mm) Hammer SN = 1353			
4.20	C1			
4.50				
5.30	C2			
5.60	C3			
6.00				
6.40	C4			
7.30	C5			
7.50				
7.50	C6			
8.15	C7			
8.60	C8			
9.00				

Core run (m)	TCR	SCR	RQD
3.00 - 4.50	30	0	0
4.50 - 6.00	100	72	40
6.00 - 7.50	100	97	55
7.50 - 9.00	100	100	34

Depth (m)	FI
3.00 - 4.10	AZCL
4.10 - 4.50	12
4.50 - 5.10	>20
5.10 - 6.20	3
6.20 - 9.00	5

Level mCD	Depth (m)	Description
-16.41	2.00	Medium dense grey very gravelly silty fine to coarse SAND with shell fragments (up to 6mm). Gravel is subangular fine to medium of various lithologies.
	(2.10)	Highly weathered white SANDSTONE recovered as sandy subangular fine to coarse gravel and subangular cobbles. *3.00m to 4.10m: AZCL - Disturbance due to SPT has lead to subsequent wash out of material.*
-18.51	4.10	Very weak, probably thinly laminated, medium grained, well cemented, light orangish brown SANDSTONE.
	(0.40)	
-18.91	4.50	Very weak, thinly laminated, fine grained, poorly cemented, light brown highly fractured SANDSTONE. Partially weathered, reduced strength, much closer fracture spacing with pervasive orangish brown discolouration, closed. Discontinuities: 1. 10 to 15 degree bedding fractures, very thinly spaced (5/40/60), planar, smooth, with pervasive light brown staining on fracture surfaces. 2. 80 to85 degree joints, probably very closely spaced, undulating, smooth.
	(0.25)	
-19.16	4.75	
	(0.35)	
-19.51	5.10	Weak, thinly bedded, medium grained, moderately well cemented, orangish brown SANDSTONE. Partially weathered, reduced strength, close fracture spacing with pervasive orangish brown discolouration. Discontinuities: 1. 10 to 15 degree bedding fractures, thinly spaced (30/85/95), planar, rough, with orangish brown staining on fracture surfaces. 2. 60 degree joint at 4.80m to 4.90m, undulating, smooth, with orangish brown fine sand deposits and orangish brown staining on joint surfaces. 3. 70 to 80 degree joint at 4.90m to 5.10m, undulating, rough, with pervasive orangish brown staining on joint surfaces.
	(1.10)	Extremely weak, probably very thinly laminated, orangish brown and greenish grey MUDSTONE. Highly weathered, highly reduced strength, pervasive greenish grey discolouration from 5.20m to 6.05m Discontinuities: 1. 5 degree bedding fracture at 5.60m, planar, smooth, with pervasive greenish grey staining on fracture surfaces. 2. 70 degree joints at 5.15m to 5.25m and 5.20m to 5.40m, planar, smooth, with pervasive greenish grey staining on joint surfaces.
-20.61	6.20	
	(2.80)	Medium strong (locally weak), thinly laminated to thinly bedded, fine grained, well cemented, light orangish brown SANDSTONE. Partially weathered, slightly closer fracture spacing with occasional orangish brown discolouration. Discontinuities: 1. 10 to 25 degree bedding fractures, medium spaced (100/345/800), planar, rough, with dark orangish brown staining on some fracture surfaces.
-23.41	9.00	

Water Strikes			
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 20.20m
All elevations/reduced levels given in mCD

Casing Details		**Water Added**	
To (m)	Diam (mm)	From (m)	To (m)
3.00	177		
9.00	150		

Core Barrel	**Flush Type**	**Termination Reason**	**Last Updated**
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH	**Project No.** **21-1031**	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI **Client:** Orkney Islands Council **Client's Rep:** Arch Henderson LLP	**Borehole ID** **BH-M11**

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	344997.29 E
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	9.00	1004104.77 N

Final Depth: 9.00 m	**Start Date:** 26/03/2022	**Driller:** MJ	Sheet 2 of 2 Scale: 1:50
Elevation: -14.41 mCD	**End Date:** 27/03/2022	**Logger:** NP	FINAL

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mCD	Depth (m)	Legend	Description	Water	Backfill
											Medium strong (locally weak), thinly laminated to thinly bedded, fine grained, well cemented, light orangish brown SANDSTONE. Partially weathered, slightly closer fracture spacing with occasional orangish brown discolouration. Discontinuities: 1. 10 to 25 degree bedding fractures, medium spaced (100/345/800), planar, rough, with dark orangish brown staining on some fracture surfaces. 2. 25 degree joint at 8.00m to 8.05m, planar, smooth. 3. 65 to 75 degree joints at 6.90m to 7.20m, 8.10m to 8.25m and 8.50m to 8.65m, slightly undulating, rough, with dark brown staining on 6.90m to 7.20m joint surfaces penetrating to the base of the strata. *8.25m to 8.65m: 65 to 75 degree probably closely spaced incipient joints.*		
											End of Borehole at 9.00m		
		TCR	SCR	RQD	FI								

9.5
10.0
10.5
11.0
11.5
12.0
12.5
13.0
13.5
14.0
14.5
15.0
15.5
16.0
16.5
17.0
17.5
18.0
18.5

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Chiselling Details

From (m)	To (m)	Time (hh:mm)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 20.20m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
3.00	177
9.00	150

Water Added

From (m)	To (m)

Core Barrel	**Flush Type**	**Termination Reason**	**Last Updated**
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH	**Project No.** **21-1031**	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI **Client:** Orkney Islands Council **Client's Rep:** Arch Henderson LLP	**Borehole ID** **BH-M12**

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	1.50	345016.39 E 1004186.20 N
Rotary Coring	Fraste Duo CXL Rotosonic	1.50	12.00	

Final Depth: 12.00 m	**Start Date:** 27/03/2022	**Driller:** MJ	Sheet 1 of 2	Scale: 1:50
Elevation: -10.84 mCD	**End Date:** 28/03/2022	**Logger:** EM+NP	FINAL	

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)
0.00 - 1.50	B3			
0.50	ES1			
1.00	ES2			
1.50	D4		1.50	
1.50 - 1.95	SPT(S) N=38 (6,7/7,9,10,12) Hammer SN = 1353			
2.35	C1			
2.75	C2			
3.00				
3.00	C3			
3.45	C4			
4.50				
4.80	C5			
5.80	C6			
6.00				
6.40	C7			
7.50				
7.70	C9			
8.25	C10			
9.00				

Run (m)	TCR	SCR	RQD	FI
1.50 - 3.00	50	30	15	AZCL 6
3.00 - 4.50	100	85	38	16
4.50 - 6.00	100	82	42	7
6.00 - 7.50	100	86	38	NI 5
7.50 - 9.00	100	96	83	4

Level mCD	Depth (m)	Description
		Medium dense grey very gravelly very silty fine to coarse SAND with shell fragments (up to 5mm). Gravel is subangular fine to coarse of various lithologies.
-11.34	0.50	Highly weathered brown SANDSTONE recovered as subangular fine to coarse gravel and subangular cobbles.
-12.34	1.50 (2.90)	Medium strong indistinctly thinly laminated light creamy brown fine grained moderately cemented SANDSTONE. Partially weathered: closer fracture spacing, slightly reduced strength with sandy clay deposits and discolouration on fracture surfaces. Discontinuities: 1. 30 to 40 degree bedding fractures closely spaced (40/93/150) planar, rough with patchy orangish brown sandy clay deposits (1mm thick) on rare surfaces and strong patchy orangish brown staining on most fracture surfaces. 2. 75 to 85 degree joint at 3.20m to 3.45m, planar, rough with patchy brown staining on joint surface. 3. 50 to 60 degree joint at 3.80m to 4.00m, planar, rough with orangish brown staining on joint surface. *1.50m to 2.25m: AZCL - Disturbance due to SPT has lead to subsequent wash out of material.*
-15.24	4.40 (7.60)	Medium strong (locally weak) thickly laminated light greyish white fine grained moderately cemented SANDSTONE. Partially weathered: closer fracture spacing, slightly reduced strength with discolouration and clay deposits and clay infill on fracture surfaces. Discontinuities: 1. 5 to 15 degree bedding fractures medium spaced (85/400/650) planar, rough with strong orangish brown staining on most fracture surfaces, patchy black staining on few fracture surfaces and patchy orangish brown sandy clay deposits (up to 5mm thick) on some fracture surfaces. 2. 50 to 60 degree joints at 5.10m to 5.40m, 5.60m to 5.80m, 6.60m to 6.95m, 7.50m to 7.70m, 8.10m to 8.25m, 8.50m to 8.65m, 10.70m to 10.85m, 10.95m to 11.15m, planar, rough with strong orangish brown staining on most joint surfaces, patchy black staining on few surfaces and occasional patchy light brown clay deposits on few surfaces. 3. 80 to 90 degree joint at 5.35m to 5.60m, 6.40m to 6.90m, 8.60m to 8.90m, planar to slightly undulating rough with orangish brown staining and black staining on some fracture surfaces. *7.50m to 7.60m: Light grey and orangish brown gravelly clay infill.*

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Casing Details

To (m)	Diam (mm)
1.50	177
12.00	150

Water Added

From (m)	To (m)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 16.30m
All elevations/reduced levels given in mCD

Core Barrel	**Flush Type**	**Termination Reason**	**Last Updated**
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH	**Project No.** **21-1031**	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI **Client:** Orkney Islands Council **Client's Rep:** Arch Henderson LLP	**Borehole ID** **BH-M12**

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	1.50	345016.39 E 1004186.20 N
Rotary Coring	Fraste Duo CXL Rotosonic	1.50	12.00	

Final Depth: 12.00 m	**Start Date:** 27/03/2022	**Driller:** MJ	Sheet 2 of 2 Scale: 1:50
Elevation: -10.84 mCD	**End Date:** 28/03/2022	**Logger:** EM+NP	FINAL

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mCD	Depth (m)	Legend	Description	Water	Backfill
9.40	C11	100	84	40							Medium strong (locally weak) thickly laminated light greyish white fine grained moderately cemented SANDSTONE. Partially weathered: closer fracture spacing, slightly reduced strength with discolouration and clay deposits and clay infill on fracture surfaces. Discontinuities: 1. 5 to 15 degree bedding fractures medium spaced (85/400/650) planar, rough with strong orangish brown staining on most fracture surfaces, patchy black staining on few fracture surfaces and patchy orangish brown sandy clay deposits (up to 5mm thick) on some fracture surfaces. 2. 50 to 60 degree joints at 5.10m to 5.40m, 5.60m to 5.80m, 6.60m to 6.95m, 7.50m to 7.70m, 8.10m to 8.25m, 8.50m to 8.65m, 10.70m to 10.85m, 10.95m to 11.15m, planar, rough with strong orangish brown staining on most joint surfaces, patchy black staining on few surfaces and occasional patchy light brown clay deposits on few surfaces. 3. 80 to 90 degree joint at 5.35m to 5.60m, 6.40m to 6.90m, 8.60m to 8.90m, planar to slightly undulating rough with orangish brown staining and black staining on some fracture surfaces.		
10.10	C12				11								
10.50		93	81	73									
10.70	C13												
11.30	C14				4								
12.00								-22.84	12.00		End of Borehole at 12.00m		

Water Strikes				**Chiselling Details**		
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)	From (m)	To (m)	Time (hh:mm)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 16.30m
All elevations/reduced levels given in mCD

Casing Details		**Water Added**	
To (m)	Diam (mm)	From (m)	To (m)
1.50	177		
12.00	150		

Core Barrel	**Flush Type**	**Termination Reason**	**Last Updated**
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH	**Project No.** **21-1031**	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI **Client:** Orkney Islands Council **Client's Rep:** Arch Henderson LLP	**Borehole ID** **BH-M13**

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	344991.90 E
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	10.50	1004221.83 N

Final Depth: 10.50 m	**Start Date:** 28/03/2022	**Driller:** MJ	Sheet 1 of 2 Scale: 1:50
Elevation: -11.57 mCD	**End Date:** 29/03/2022	**Logger:** NP	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)
0.00 - 0.50	ES5	Marine Scotland - SS1		
0.00 - 1.50	B8			
0.50	ES1			
1.00	ES2			
1.00 - 1.50	ES6	Marine Scotland - SS2		
1.50	D10			
1.50 - 3.00	B9			
1.50 - 1.95	SPT (S)	N=13 (1,2/3,3,3,4) Hammer SN = 1353	1.50	
2.00	ES3			
2.50 - 3.00	ES7	Marine Scotland - SS3		
3.00	D11		3.00	
3.00	ES4			
3.00 - 3.44	SPT(S) N=50 (6,8/50 for 290mm) Hammer SN = 1353			
4.10	C1			
4.50				
5.00	C2			
5.20	C3			
5.25	C4			
6.00				
6.10	C5			
6.60	C6			
7.50				
8.00	C7			
9.00				
9.00	C8			
9.25	C9			

Run (m)	TCR	SCR	RQD
3.00 - 4.50	40	0	0
4.50 - 6.00	95	70	16
6.00 - 7.50	97	97	53
7.50 - 9.00	96	80	33
9.00 -			

Depth (m)	FI
3.00 - 3.90	AZCL
3.90 - 4.50	NI
4.50 - 5.15	9
5.15 - 5.90	>20
5.90 -	6

Level mCD	Depth (m)	Description
		Medium dense light grey gravelly silty fine to coarse SAND with shell fragments (up to 7mm). Gravel is subangular fine to coarse of various lithologies. *1.50m to 2.00m: Very silty from 1.50m*
-13.57	2.00	Highly weathered brown SANDSTONE recovered as subangular coarse gravel and subangular cobbles.
-14.57	3.00	Weathered SANDSTONE recovered as subangular medium to coarse gravel and subangular cobbles. *3.00m to 3.90m: AZCL - Disturbance due to SPT has lead to subsequent wash out of material.*
	(1.50)	Weak light brown indistinctly thinly bedded well cemented fine grained SANDSTONE. Partially weathered: slightly reduced strength slightly closer fracture spacing with dark orangish brown discolouration. Discontinuities: 1. Probable 5 to 15 degree bedding fractures, medium spaced (40/160/215) undulating, smooth. 2. 70 to 75 degree joints at 4.55m to 4.80m, 4.80m to 5.00m, undulating, rough with dark orangish brown staining on joint surfaces, penetrating up to 3mm from joint surfaces.
-16.07	4.50	
	(0.65)	
-16.72	5.15	Weak (locally medium strong) light orangish brown thickly laminated poorly cemented fine grained SANDSTONE. Partially weathered: slightly reduced strength, closer fracture spacing with orangish brown discolouration. Discontinuities: 1. 0 to 5 degree bedding fractures, very closely spaced (20/50/180) planar, smooth, with orangish brown staining on some fracture surfaces. 2. 40 to 45 degree joint at 5.15m to 5.20m, an 5.50m to 5.55m planar, smooth. 3. 70 to 90 degree joints at 5.65m to 5.90m, undulating, rough with orangish brown staining on joint surfaces penetrating up to 3mm from joint surfaces.
	(0.75)	
-17.47	5.90	Medium strong to strong light orangish brown indistinctly thinly bedded moderately, well cemented fine grained SANDSTONE. Partially weathered: slightly reduced strength, slightly closer fracture spacing with localised pervasive orangish brown discolouration. Discontinuities: 1. 15 to 25 degree bedding fractures, medium spaced (40/350/820) planar, smooth with orangish brown staining on joint surfaces, locally penetrating up to 6mm fracture surfaces. 2. 50 to 70 degree joints, probably medium spaced, planar and undulating with orangish brown staining on joint surfaces, locally penetrating up to 5mm from joint surface. *8.50m to 9.00m: Dark orangish brown staining on fracture surfaces.*
	(4.60)	

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 18.00m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
3.00	177
10.50	150

Water Added

From (m)	To (m)

Core Barrel	**Flush Type**	**Termination Reason**	**Last Updated**
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

Project No. **21-1031**	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI **Client:** Orkney Islands Council **Client's Rep:** Arch Henderson LLP	**Borehole ID** **BH-M13**

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	344991.90 E
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	10.50	1004221.83 N

Final Depth: 10.50 m	**Start Date:** 28/03/2022	**Driller:** MJ	Sheet 2 of 2 Scale: 1:50
Elevation: -11.57 mCD	**End Date:** 29/03/2022	**Logger:** NP	FINAL

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mCD	Depth (m)	Legend	Description	Water	Backfill
10.10	C10	100	96	59							Medium strong to strong light orangish brown indistinctly thinly bedded moderately, well cemented fine grained SANDSTONE. Partially weathered: slightly reduced strength, slightly closer fracture spacing with localised pervasive orangish brown discolouration. Discontinuities: 1. 15 to 25 degree bedding fractures, medium spaced (40/350/820) planar, smooth with orangish brown staining on joint surfaces, locally penetrating up to 6mm fracture surfaces. 2. 50 to 70 degree joints, probably medium spaced, planar and undulating with orangish brown staining on joint surfaces, locally penetrating up to 5mm from joint surface.		
10.50								-22.07	10.50		End of Borehole at 10.50m		

9.5 10.0 10.5 11.0 11.5 12.0 12.5 13.0 13.5 14.0 14.5 15.0 15.5 16.0 16.5 17.0 17.5 18.0 18.5

TCR SCR RQD FI

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Chiselling Details

From (m)	To (m)	Time (hh:mm)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 18.00m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
3.00	177
10.50	150

Water Added

From (m)	To (m)

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH	**Project No.** 21-1031	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI **Client:** Orkney Islands Council **Client's Rep:** Arch Henderson LLP

Borehole ID
BH-M14

Method	Plant Used	Top (m)	Base (m)	Coordinates
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	344915.81 E 1004164.01 N
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	9.00	

Final Depth:	9.00 m	**Start Date:**	29/03/2022	**Driller:**	MJ
Elevation:	-18.13 mCD	**End Date:**	30/03/2022	**Logger:**	EM+NP

Sheet 1 of 2
Scale: 1:50
FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)
0.00 - 0.50	ES5	Marine Scotland - SS1		
0.00 - 1.50	B8			
0.50	ES1			
1.00	ES2			
1.00 - 1.50	ES6	Marine Scotland - SS2		
1.50	D10			
1.50 - 3.00	B9			
1.50 - 1.95	SPT (S)	N=11 (1,1/2,2,3,4) Hammer SN = 1353	1.50	
2.00	ES3			
2.50 - 3.00	ES7	Marine Scotland - SS3		
3.00	D11		3.00	
3.00	ES4			
3.00 - 3.45	SPT(S) N=28 (3,4/6,6,7,9) Hammer SN = 1353			
3.50	C1			
3.70	C2			
4.50				
5.40	C3			
5.80	C4			
6.00				
6.00	C5			
6.50	C6			
7.05	C7			
7.40	C8			
7.50				
8.40	C9			
9.00				

Core run (m)	TCR	SCR	RQD
3.00 - 4.50	100	63	23
4.50 - 6.00	100	88	43
6.00 - 7.50	100	98	84
7.50 - 9.00	100	92	51

Interval (m)	FI
3.00 - 3.30	
3.30 - 4.40	11
4.40 - 4.75	>20
4.75 - 6.00	7
6.00 - 7.40	2
7.40 - 8.40	16
8.40 - 9.00	7

Level mCD	Depth (m)	Description
		Medium dense grey gravelly silty fine to coarse SAND with shell fragments (up to 9mm) and unfragmented gastropod shells (up to 19mm). Gravel is subangular fine to medium of various lithologies.
-21.13	3.00 (0.30)	Greyish brown subrounded fine to coarse GRAVEL of sandstone with high cobble content. Cobbles are subrounded of sandstone.
-21.43	3.30 (1.10)	Weak thinly laminated light brown fine grained well cemented SANDSTONE. Partially weathered: slightly closer fractures spacing, slightly reduced strength with discolouration and clay deposits on fracture surfaces. Discontinuities: 1. 30 to 40 degree bedding fractures closely spaced (30/92/120) planar, smooth with patchy orangish brown staining on occasional surfaces and patchy light brown sandy clay deposits (<1mm thick) on most fracture surfaces. 2. 60 to 70 degree joint at 3.65m to 3.80m, undulating, rough with patchy brown andy clay deposits (up to 2mm thick) and patchy faint dark brown discolouration joint surface.
-22.53	4.40 (0.35)	
-22.88	4.75 (1.25)	Weak thinly laminated orangish brown fine grained medium cemented SANDSTONE. Partially weathered: reduced strength with clay deposits. Discontinuities: 1. 30 to 40 degree bedding fractures very closely spaced (10/28/80) slightly undulating, rough with frequent patchy light grey clay deposits (up to 4mm thick) on most fracture surface.
-24.13	6.00 (1.40)	Weak indistinctly thickly laminated light brown fine grained medium cemented SANDSTONE. Partially weathered; slightly closer fractures spacing with clay deposits and discolouration. Discontinuities: 1. 25 to 35 degree bedding fractures closely spaced (30/150/230) undulating, rough with patchy brown clay deposits (<2mm thick) on some fracture surfaces. 2. 0 to 5 degree joint at 4.85m, slightly undulating, rough with patchy light brown clay deposits (<1mm thick) on joint surface. 3. 80 to 85 degree joint at 5.20m to 5.30m planar, rough with patchy light brown clay deposits (<1mm thick) on joint surface.
-25.53	7.40 (1.60)	Medium strong thinly laminated light grey fine grained well cemented SANDSTONE. Partially weathered: slightly closer fracture spacing. Discolouration on fracture surfaces. Discontinuities: 1. 20 to 30 degree bedding fractures closely spaced (10/200/800) planar, rough with pervasive, orangish brown staining penetrating from fracture surfaces and patchy dark reddish brown discolouration on some fracture surfaces, otherwise clean.
-27.13	9.00	Weak (locally medium strong) thinly laminated light brown fine

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Casing Details

To (m)	Diam (mm)
3.00	177
9.00	150

Water Added

From (m)	To (m)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 25.00m
All elevations/reduced levels given in mCD

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

	Project No. **21-1031**	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI **Client:** Orkney Islands Council **Client's Rep:** Arch Henderson LLP	**Borehole ID** **BH-M14**

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	344915.81 E
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	9.00	1004164.01 N

Final Depth: 9.00 m	**Start Date:** 29/03/2022	**Driller:** MJ	Sheet 2 of 2 Scale: 1:50
Elevation: -18.13 mCD	**End Date:** 30/03/2022	**Logger:** EM+NP	FINAL

Depth (m)	**Samples / Field Records**	**TCR**	**SCR**	**RQD**	**FI**	**Casing Depth (m)**	**Water Depth (m)**	**Level mCD**	**Depth (m)**	**Legend**	**Description**	**Water**	**Backfill**
											Weak (locally medium strong) thinly laminated light brown fine grained moderately cemented SANDSTONE. Partially weathered: much closer fracture spacing with discolouration and clay deposits on fracture surfaces. Discontinuities: 1. 0 to 10 degree bedding fractures, closely spaced (5/80/180) planar, smooth with orangish brown staining on some fracture surfaces and light brown sandy clay deposits (up to 20mm thick) on fracture surfaces. *8.40m: Black staining on fracture surface.* *8.70m to 8.72m: Light brown sandy clay infill.*		
											End of Borehole at 9.00m		
		TCR	**SCR**	**RQD**	**FI**								

9.5 10.0 10.5 11.0 11.5 12.0 12.5 13.0 13.5 14.0 14.5 15.0 15.5 16.0 16.5 17.0 17.5 18.0 18.5

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Chiselling Details

From (m)	To (m)	Time (hh:mm)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 25.00m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
3.00	177
9.00	150

Water Added

From (m)	To (m)

Core Barrel	**Flush Type**	**Termination Reason**	**Last Updated**
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

CAUSEWAY GEOTECH	**Project No.** **21-1031**	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI **Client:** Orkney Islands Council **Client's Rep:** Arch Henderson LLP	**Borehole ID** **BH-M15**

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	344911.66 E 1004235.99 N
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	9.00	

Final Depth:	9.00 m	**Start Date:**	30/03/2022	**Driller:**	MJ	Sheet 1 of 2 Scale: 1:50
Elevation:	-17.71 mCD	**End Date:**	31/03/2022	**Logger:**	NP	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)
0.00 - 0.50	ES5	Marine Scotland - SS1		
0.00 - 1.50	B8			
0.50	ES1			
1.00	ES2			
1.00 - 1.50	ES6	Marine Scotland - SS2		
1.50	D10			
1.50 - 3.00	B9			
1.50 - 1.95	SPT (S)	N=11 (1,1/2,3,3,3) Hammer SN = 1353	1.50	
2.00	ES3			
2.50 - 3.00	ES7	Marine Scotland - SS3		
3.00	D11		3.00	
3.00	ES4			
3.00 - 3.45	SPT(S) N=34 (4,6/8,8,9,9) Hammer SN = 1353			
4.35	C1			
4.50				
5.20	C2			
5.40	C3			
6.00				
6.20	C4			
7.50				
8.20	C5			
8.50	C6			
9.00				

Core run (m)	TCR	SCR	RQD
3.00 - 4.50	33	0	0
4.50 - 6.00	100	73	0
6.00 - 7.50	100	92	0
7.50 - 9.00	100	95	19

FI
AZCL
NI
11
15
>20
14

Level mCD	Depth (m)	Description
		Loose to medium dense grey very gravelly silty fine to coarse SAND with shell fragments (up to 8mm) and unfragmented articulated brachiopod shells (up to 31mm). Gravel is subangular fine to medium of various lithologies.
-19.21	1.50	Medium dense grey gravelly silty fine to coarse SAND with low cobble content and shell fragments (up to 7mm) and unfragmented gastropod shells (up to 12mm). Gravel is subangular fine to medium of various lithologies. Cobbles are subrounded of sandstone.
-20.71	3.00 (1.40)	Weathered SANDSTONE recovered as subangular fine to coarse gravel of sandstone with low cobble content. Cobbles are subangular of sandstone. *3.00m to 4.10m: AZCL - Disturbance due to SPT has lead to subsequent wash out of material.*
-22.11	4.40 (0.10)	Highly weathered SANDSTONE recovered as silty fine sand.
-22.21	4.50 (1.80)	Medium strong light orangish brown indistinctly thinly bedded fine grained moderately well cemented SANDSTONE. Partially weathered: slightly reduced strength, closer fracture spacing with orangish brown discolouration. Discontinuities: 1. 5 to 15 degree bedding fractures, closely spaced (40/90/220), planar, smooth with patchy dark orangish brown staining on fracture surfaces ad light brown patchy clay deposits on some fracture surfaces. 2. 70 to 90 degree joint at 4.50m to 5.00m, 5.03m to 5.35m, 5.35m to 5.65m, 5.70m to 6.15, and 6.15m to 6.30m, undulating, smooth with dark orangish brown staining, penetrating up to 5mm from joint surfaces and patchy light brown clay deposits on some joint surfaces.
-24.01	6.30 (0.60)	Weak light brown mottled orangish brown indistinctly thinly bedded partly cemented fine grained SANDSTONE. Partially weathered: slightly reduced strength, slightly closer fracture spacing with dark orangish brown discolouration. Discontinuities: 1. 15 to 20 degree bedding fractures, closely spaced 930/85/110) planar, smooth with patchy dark orangish brown staining on joint surfaces and occasional light brown clay deposits on joint surfaces. 2. 80 to 85 degree joints at 6.30m to 6.70m and 6.35m to 6.70m, undulating, smooth with patchy dark orangish brown staining on joint surfaces and occasional light brown clay deposits on joint surfaces. 2. 80 to 85 degree joints at 6.30m to 6.70m and 6.35m to 6.70m, undulating, smooth with patchy dark orangish brown staining on joint surfaces.
-24.61	6.90 (0.50)	
-25.11	7.40 (0.50)	
-25.61	7.90 (1.10)	Medium strong orangish brown very thinly bedded poorly cemented fine grained SANDSTONE. Partially weathered: reduced strength, closer fracture spacing with pervasive orangish brown discolouration. Discontinuities: 1. 15 to 20 degree bedding fracture, very closely spaced (10/25/70) planar, smooth with pervasive orangish brown staining on fracture surfaces. 2. 85 to 90 degree joints at 6.90m to 7.25m and 7.05m to 7.40m,
-26.71	9.00	

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 24.00m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
3.00	177
9.00	150

Water Added

From (m)	To (m)

Core Barrel	**Flush Type**	**Termination Reason**	**Last Updated**
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH

Project No.	Project Name: Scapa Deep Water Quay & Hatston Pier Development - Marine GI	Borehole ID
21-1031	Client: Orkney Islands Council Client's Rep: Arch Henderson LLP	BH-M15

Method	Plant Used	Top (m)	Base (m)	Coordinates
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	344911.66 E 1004235.99 N
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	9.00	

Final Depth:	9.00 m	**Start Date:**	30/03/2022	**Driller:**	MJ
Elevation:	-17.71 mCD	**End Date:**	31/03/2022	**Logger:**	NP

Sheet 2 of 2

Scale: 1:50

FINAL

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mCD	Depth (m)	Legend	Description	Water	Backfill
					11						Medium strong orangish brown very thinly bedded poorly cemented fine grained SANDSTONE. Partially weathered: reduced strength, closer fracture spacing with pervasive orangish brown discolouration. Discontinuities: 1. 15 to 20 degree bedding fracture, very closely spaced (10/25/70) planar, smooth with pervasive orangish brown staining on fracture surfaces. 2. 85 to 90 degree joints at 6.90m to 7.25m and 7.05m to 7.40m, undulating, smooth with dark orangish brown staining on joint surfaces. *7.25m: Thick light brown soft clay infill on 15 degree bedding fracture.*		
											Medium strong light brown indistinctly thinly bedded well cemented fine grained SANDSTONE. Partially weathered: slightly reduced strength, slightly closer fracture spacing with patchy orangish brown discolouration. Discontinuities: 1. 5 to 15 degree bedding fractures, closely spaced (50/70/120) planar, smooth, with patchy orangish brown staining on fracture surfaces.		
											Medium strong (locally weak) light orangish brown indistinctly thinly bedded very well cemented fine grained SANDSTONE. Partially weathered: slightly reduced strength, slightly closer fracture spacing with localised orangish brown and greenish grey discolouration. Discontinuities: 1. 15 to 25 degree bedding fractures, closely spaced (30/110/350) planar, smooth with patchy orangish brown staining on fracture surfaces. 2. 70 to 80 degree joints at 8.25m to 8.34m and 8.80m to 9.00m, undulating, rough with orangish brown staining on joint surfaces, penetrating up to 7mm from joint surface. *8.15m to 8.25m: Weak thickly laminated orangish brown and greenish grey poorly cemented sandstone.*		
											End of Borehole at 9.00m		
		TCR	SCR	RQD	FI								

9.5 10.0 10.5 11.0 11.5 12.0 12.5 13.0 13.5 14.0 14.5 15.0 15.5 16.0 16.5 17.0 17.5 18.0 18.5

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Chiselling Details

From (m)	To (m)	Time (hh:mm)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 24.00m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
3.00	177
9.00	150

Water Added

From (m)	To (m)

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH	**Project No.** **21-1031**	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI **Client:** Orkney Islands Council **Client's Rep:** Arch Henderson LLP	**Borehole ID** **BH-M16**

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	2.00	344975.43 E
Rotary Coring	Fraste Duo CXL Rotosonic	2.00	8.00	1004255.73 N

Final Depth: 8.00 m	**Start Date:** 02/04/2022	**Driller:** KW	Sheet 1 of 1 Scale: 1:50
Elevation: -10.09 mCD	**End Date:** 02/04/2022	**Logger:** RC +TMcA	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)
0.00 - 0.50	ES3	Marine Scotland - SS1		
0.00 - 1.00	B5			
0.50	ES1			
1.00	ES2			
1.00 - 1.50	B6			
1.00 - 1.50	ES4	Marine Scotland - SS2		
1.50	D7			
1.50 - 1.95	SPT (S)	N=14 (2,4/3,3,4,4) Hammer SN = 1353	1.50	
2.00	C1			
2.85	C2			
3.00	D8		3.00	
3.00 - 3.45	SPT(S) N=34 (4,5/8,9,8,9) Hammer SN = 1353			
3.50				
4.10	C3			
5.00				
6.00	C4			
6.50				
7.30	C5			
7.50	C6			
7.75	C7			
8.00				

Run (m)	TCR	SCR	RQD	FI
2.00 - 3.50	100	38	13	>20 14
3.50 - 5.00	100	65	19	14
5.00 - 6.50	100	63	9	14 17
6.50 - 8.00	100	62	29	17 9

Level mCD	Depth (m)	Description
		Loose to medium dense grey slightly gravelly silty fine to coarse SAND with shell fragments (up to 5mm) and unfragmented articulated brachiopod shells (up to 25mm). Gravel is subangular fine of various lithologies.
-11.89	1.80	Weathered yellowish white banded SANDSTONE. (Drillers description)
-12.09	2.00	Medium strong (locally weak) indistinctly thinly laminated fine grained light yellowish grey SANDSTONE. Partially weathered: reduced strength, closer fracture spacing. occasional light brownish orange discolouration on fracture surfaces and occasional sandy clay infill on fracture surfaces. Discontinuities: 1. 5 to 25 degree bedding fractures closely spaced (10/115/300), planar, rough, occasional light brownish orange staining up to 1mm deep and occasional sandy clay infill on fracture surfaces up to 1mm thick. 2. 25 to 45 degree joints at 2.60m to 2.80m, 3.00m, 3.30m to 4.30m and 4.70m, planar, rough and staining on joint surfaces up to 1mm deep. 3. 65 to 75 degree joints from 2.30m to 2.60m, 3.10m to 3.50m, 3.80m to 4.10m, 4.10m to 4.40m, undulating, rough ad occasional light brownish orange staining on joint surfaces up to 1mm deep.
	(4.30)	
-16.39	6.30	Weak (locally medium strong) indistinctly thinly laminated fine grained dark yellowish grey SANDSTONE. Partially weathered: reduced strength, closer fracture spacing and frequent heavy brownish orange discolouration on fracture surfaces. Discontinuities: 1. 5 to 25 degree bedding fractures closely spaced (10/130/350) planar, rough and frequent heavy brownish orange staining up to 10mm deep. 2. 65 to 75 degree joints from 6.70m to 6.85m and 7.10m to 7.50m, undulating, rough and frequent heavy brownish orange staining up to 1mm deep.
	(1.70)	
-18.09	8.00	End of Borehole at 8.00m

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Casing Details

To (m)	Diam (mm)
2.00	177
8.00	150

Water Added

From (m)	To (m)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 16.50m
All elevations/reduced levels given in mCD

Core Barrel	**Flush Type**	**Termination Reason**	**Last Updated**
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH

Project No. 21-1031	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI		**Borehole ID** BH-M17
	Client: Orkney Islands Council		
	Client's Rep: Arch Henderson LLP		

Method	Plant Used	Top (m)	Base (m)	Coordinates
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	1.00	345017.31 E 1004268.57 N
Rotary Coring	Fraste Duo CXL Rotosonic	1.00	7.00	

Final Depth:	7.00 m	**Start Date:**	01/04/2022	**Driller:**	KW	Sheet 1 of 1 Scale: 1:50
Elevation:	-8.53 mCD	**End Date:**	01/04/2022	**Logger:**	NP +TMcA	FINAL

Depth (m)	Sample / Tests	Field Records
0.00 - 0.50	B3	
0.00 - 0.50	ES2	Marine Scotland - SS1
0.50	ES1	
1.00	C1	
1.45	C2	
2.50		
2.65	C3	
2.80	C4	
3.30	C5	
4.00		
4.15	C6	
4.30	C7	
5.50		
5.65	C8	
7.00		

Core run (m)	TCR	SCR	RQD
1.00 - 2.50	100	12	8
2.50 - 4.00	100	59	0
4.00 - 5.50	100	30	0
5.50 - 7.00	65	0	0

Depth (m)	FI
1.00 - 1.45	NI
1.45 - 2.50	>20
2.50 - 4.15	
4.15 - 4.95	10
4.95 - 6.10	14
6.10 - 7.00	AZCL

Level mCD	Depth (m)	Description
		Grey very gravelly silty fine to coarse SAND with shell fragments (up to 3mm). Gravel is subangular fine to medium of various lithologies.
-9.03	0.50	Weathered yellowish white banded SANDSTONE. (Drillers description)
-9.53	1.00 (0.45)	Highly weathered SANDSTONE recovered as orangish brown gravelly fine to coarse SAND with low cobble content. Gravel is subangular fine to coarse. Cobbles are subangular.
-9.98	1.45 (5.55)	Weak (locally very weak) indistinctly thinly bedded light orangish brown moderately well cemented fine grained SANDSTONE. Partially weathered: slightly reduced strength, closer fracture spacing with orangish brown discolouration. Discontinuities: 1. 15 to 20 degree bedding fractures, medium spaced (70/205/310) planar, smooth with dark orangish brown staining on fracture surfaces, penetrating up to 3mm from fracture surfaces, light brown clay deposits on some fracture surfaces. 2. 55 to 65 degree joints, widely spaced (120/1118/1550) planar and undulating, smooth, with dark orangish brown staining on joint surfaces. 3. 75 to 85 degree joints at 1.65m to 2.00m, 1.90m to 2.25m, 2.25m to 2.95m, 3.50m to 4.70m and 4.60m to 5.15m, undulating, smooth with dark orangish brown staining on joint surfaces, penetrating 3m from joint surface. *6.10m to 7.00m: AZCL - Lower section of core run unable to be retrieved from base of borehole due to fractured nature of material.*
-15.53	7.00	End of Borehole at 7.00m

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Casing Details

To (m)	Diam (mm)
1.00	177
7.00	150

Water Added

From (m)	To (m)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 15.00m
All elevations/reduced levels given in mCD

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH

Project No. 21-1031	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI	**Borehole ID** BH-M26
	Client: Orkney Islands Council	
	Client's Rep: Arch Henderson LLP	

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	344972.76 E
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	10.50	1004158.34 N

Final Depth: 10.50 m	**Start Date:** 31/03/2022	**Driller:** MJ	Sheet 1 of 2	Scale: 1:50
Elevation: -14.83 mCD	**End Date:** 01/04/2022	**Logger:** NP+RC	FINAL	

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)
0.00 - 1.50	B5			
0.50	ES1			
1.00	ES2			
1.50	D7			
1.50 - 3.00	B6			
1.50 - 1.95	SPT (S)	N=17 (3,4/4,3,5,5) Hammer SN = 1353	1.50	
2.00	ES3			
3.00	D8		3.00	
3.00	ES4			
3.00 - 3.45	SPT(S) N=27 (5,5/6,6,7,8) Hammer SN = 1353			
3.40	C1			
3.60	C2			
4.45	C3			
4.50				
5.25	C4			
6.00				
6.10	C5			
6.60	C6			
7.50				
8.50	C7			
9.00				
9.20	C8			

TCR	SCR	RQD	FI
100	6	0	>20
61	5	0	AZCL
100	17	0	19
			>20
100	19	0	17

Level mCD	Depth (m)	Description
		Loose grey gravelly silty fine to coarse SAND with shell fragments (up to 3mm). Gravel is subangular fine to medium of various lithologies.
-16.03	1.20	Medium dense grey very gravelly silty fine to coarse SAND with shell fragments (up to 4mm). Gravel is subangular fine to medium of various lithologies.
-17.33	2.50	Highly weathered orangish brown SANDSTONE. (Drillers Description)
-17.83	3.00	Weak (locally medium strong) indistinctly thinly bedded fine grained light orangish grey SANDSTONE. Partially weathered: reduced strength, much closer fracture spacing, occasional light brownish orange discolouration on fracture surfaces and frequent sandy clay infill on fracture surfaces. Discontinuities: 1. 5 to 20 degree bedding closely spaced (10/90/150) planar, smooth, occasional light brownish ornate staining up to 2m deep and frequent sandy clay infill on fracture surfaces up to 50mm thick. 2. 65 to 75 degree joints from 4.20m to 4.50m, 4.50m to 5.00m and 6.00m to 6.20m, planar, smooth and occasional light brownish orange staining up to 2mm deep. *5.40m to 6.00m: AZCL - Probable bed of extremely weak sandstone washed out during drilling.*
	(3.20)	
-21.03	6.20	Weak indistinctly thinly laminated fine grained light orangish grey SANDSTONE. Partially weathered: reduced strength, much closer fractures spacing and frequent heavy dark brownish orange discolouration on fracture surfaces. Discontinuities: 1. 10 to 25 degree bedding fractures, closely spaced (10/90/200) planar, rough and frequent heavy dark brownish orange staining up to 30mm deep. 2. 45 to 55 degree joints closely spaced (50/180/450) planar, rough and frequent heavy dark brownish orange staining up to 50mm deep. 3. 65 to 75 degree joints from 7.50m to 7.80m and 7.90m to 8.00m, planar, rough and frequent heavy dark brownish orange staining up to 50mm deep.
	(1.80)	
-22.83	8.00	Weak (locally medium strong) indistinctly thinly laminated fine grained light orangish grey SANDSTONE. Partially weathered: slightly reduced strength, much closer fracture spacing and occasional heavy dark brownish orange discolouration on fracture surfaces. Discontinuities: 1. 15 to 25 degree bedding fractures, medium spaced (50/22/350) planar rough and occasional heavy dark brownish orange staining up to 0.5mm deep. 2. 65 to 75 degree joints from 8.00m to 8.40m, 8.40m to 8.80m and 9.30m to 9.70m, planar, rough and occasional dark brownish orange staining up to 0.5mm deep.
	(2.50)	

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 21.20m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
3.00	177
10.50	150

Water Added

From (m)	To (m)

Core Barrel	**Flush Type**	**Termination Reason**	**Last Updated**
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH

Project No.	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI		**Borehole ID**
21-1031	**Client:**	Orkney Islands Council	**BH-M26**
	Client's Rep:	Arch Henderson LLP	

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	344972.76 E 1004158.34 N
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	10.50	

Final Depth:	10.50 m	**Start Date:**	31/03/2022	**Driller:**	MJ	Sheet 2 of 2	Scale: 1:50
Elevation:	-14.83 mCD	**End Date:**	01/04/2022	**Logger:**	NP+RC	FINAL	

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mCD	Depth (m)	Legend	Description	Water	Backfill
9.90	C9	71	25	0	AZCL					⁘	Weak (locally medium strong) indistinctly thinly laminated fine grained light orangish grey SANDSTONE. Partially weathered: slightly reduced strength, much closer fracture spacing and occasional heavy dark brownish orange discolouration on fracture surfaces. Discontinuities: 1. 15 to 25 degree bedding fractures, medium spaced (50/22/350) planar rough and occasional heavy dark brownish orange staining up to 0.5mm deep. 2. 65 to 75 degree joints from 8.00m to 8.40m, 8.40m to 8.80m and 9.30m to 9.70m, planar, rough and occasional dark brownish orange staining up to 0.5mm deep. *10.00m to 10.50m: AZCL - Lower section of core run unable to be retrieved from base of borehole due to fractured nature of material.*		■
10.50								-25.33	10.50		End of Borehole at 10.50m		
		TCR	SCR	RQD	FI								

9.5 10.0 10.5 11.0 11.5 12.0 12.5 13.0 13.5 14.0 14.5 15.0 15.5 16.0 16.5 17.0 17.5 18.0 18.5

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Chiselling Details

From (m)	To (m)	Time (hh:mm)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 21.20m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
3.00	177
10.50	150

Water Added

From (m)	To (m)

Core Barrel	**Flush Type**	**Termination Reason**	**Last Updated**
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

C DATA SUMMARY TABLES AND LAB CERTIFICATES

Summary Table A

Sampling Results Incorporated with BPEO Assessment (mg/kg)

	AL1	AL2	BAC	ERL	PEL	Dredge Phase 1 and Phase 2											
Source			CSEMP	CSEMP	Canada	BH-M01 (SS1) 0.00-0.50m	BH-M01 (SS2) 1.00-1.50m	BH-M01 (SS3) 2.50-3.00m	BH-M03 (SS1) 0.00-0.50m	BH-M03 (SS2) 1.00-1.50m	BH-M03 (SS3) 2.50-3.00m	BH-M07 (SS1) 0.00-0.50m	BH-M07 (SS2) 1.00-1.50m	BH-M07 (SS3) 2.50-3.00m	BH-M09 (SS1) 0.00-0.50m	BH-M09 (SS2) 1.00-1.50m	BH-M09 (SS3) 2.50-3.00m
Arsenic	20	70	25		41.6	3.5	3.7	27.8	7.9	19.5	21	10.4	4.1	5.1	13.3	12.6	19.6
Cadmium	0.4	4	0.31	1.2	4.2	0.07	0.1	0.07	0.14	0.11	0.11	0.07	0.06	0.05	0.07	0.09	0.13
Chromium	50	370	81	81	160	6.8	6.9	8.3	10.6	14.6	13.1	14.9	8.1	7.8	11.2	11.8	26.1
Copper	30	300	27	34	108	5.5	5.4	8.4	8.1	12.6	84.1	12.4	5.7	8.2	6.9	7.3	14.7
Mercury	0.25	1.5	0.07	0.15	0.7	0.02	0.01	0.09	0.01	0.02	0.03	0.01	0.01	0.01	0.01	0.01	0.05
Nickel	30	150	36	-	-	4.8	4.7	3.2	8.7	16.1	11.4	14.1	6.8	7.6	8.9	9.1	22.9
Lead	50	400	38	47	112	4.7	3.5	7.6	5.6	10.8	10.3	12.4	4.9	5.2	7.2	8.1	15.5
Zinc	130	600	122	150	271	13.8	11.4	15.5	19	32.4	18.6	32.5	12.6	21	15.6	16.5	46.3
Napthalene	0.1		0.08	0.16	0.391	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Acenaphthylene	0.1		-	-	0.128	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Acenaphthene	0.1		-	-	0.0889	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Fluorene	0.1		-	-	0.144	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Phenanthrene	0.1		0.032	0.24	0.544	0.001	0.001	0.001	0.00161	0.00185	0.001	0.00166	0.00166	0.001	0.001	0.0012	0.00157
Anthracene	0.1		0.05	0.085	0.245	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Fluoranthene	0.1		0.039	0.6	1.494	0.001	0.001	0.001	0.00152	0.00166	0.001	0.00111	0.00133	0.001	0.00105	0.00142	0.00152
Pyrene	0.1		0.024	0.665	1.398	0.00202	0.00171	0.001	0.00198	0.00212	0.001	0.00218	0.00196	0.001	0.0018	0.00249	0.0029
Benzo(a)anthracene	0.1		0.016	0.261	0.693	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Chrysene	0.1		0.02	0.384	0.846	0.00302	0.0026	0.001	0.00381	0.003	0.00133	0.0034	0.00237	0.00106	0.00262	0.00404	0.00479
Benzo(b)fluoranthene	0.1		-	-	-	0.00146	0.00113	0.001	0.00157	0.00172	0.001	0.00115	0.00165	0.001	0.00121	0.00185	0.00219
Benzo(k)fluoranthene	0.1		-	-	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Benzo(a)pyrene	0.1		0.03	0.384	0.763	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Indeno(1,2,3cd)pyrene	0.1		0.103	0.24	-	0.001	0.001	0.001	0.001	0.00108	0.001	0.001	0.00104	0.001	0.001	0.001	0.001
Benzo(ghi)perylene	0.1		0.08	0.085	-	0.001	0.001	0.001	0.00147	0.00167	0.00138	0.00127	0.00161	0.001	0.00102	0.00116	0.00125
Dibenzo(a,h)anthracene	0.01		-	-	0.135	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
TPH	100		-	-	-	8.68	10.6	2.58	40.9	25.3	34.4	13.2	12	9.73	9.76	21.2	36.5
PCBs	0.02	0.18	-	-	0.189	0.00056	0.00056	0.00056	0.00056	0.00056	0.00056	0.00056	0.00056	0.00056	0.00056	0.00056	0.00056
TBT	0.1	0.5	-	-	-	0.001	0.001	0.001	0.001	0.001	0.001	0.005	0.005	0.005	0.005	0.005	0.005

Source	BH-M11 (SS1) 0.00-0.50m	BH-M11 (SS2) 1.00-1.50m	BH-M11 (SS3) 2.50-3.00m	BH-M13 (SS1) 0.00-0.50m	BH-M13 (SS2) 1.00-1.50m	BH-M13 (SS3) 2.50-3.00m	BH-M14 (SS1) 0.00-0.50m	BH-M14 (SS2) 1.00-1.50m	BH-M14 (SS3) 2.50-3.00m	BH-M15 (SS1) 0.00-0.50m	BH-M15 (SS2) 1.00-1.50m	BH-M15 (SS3) 2.50-3.00m
Arsenic	19	17.9	27.8	9.2	5.2	4.9	7.1	6.8	7.2	5.1	5.7	9.3
Cadmium	0.15	0.1	0.16	0.1	0.09	0.31	0.15	0.13	0.15	0.1	0.08	0.11
Chromium	27.4	17.6	14.9	11.1	10.1	11.6	14.8	13.1	12.7	9.7	10.3	16.6
Copper	15	8	21.6	9.5	5.9	46.4	18.3	8.9	10.1	6.2	6	10
Mercury	0.02	0.01	0.03	0.01	0.01	0.13	0.04	0.02	0.03	0.01	0.01	0.01
Nickel	24.2	11.4	20.6	10.8	8	8.3	12.2	10.7	10.5	7.7	8.8	14.5
Lead	17.7	9.8	15.4	7	5	16.6	10.6	7.5	9.3	5.6	5.5	9.1
Zinc	47.3	21.9	46.8	21.8	15	15.8	26.6	23.6	39.7	17.4	17	27.2
Napthalene	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Acenaphthylene	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Acenaphthene	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Fluorene	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Phenanthrene	0.00129	0.00176	0.001	0.00107	0.001	0.001	0.00296	0.00115	0.001	0.001	0.001	0.001
Anthracene	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Fluoranthene	0.00106	0.00216	0.001	0.00159	0.00126	0.001	0.001	0.00205	0.00145	0.001	0.001	0.001
Pyrene	0.00207	0.00355	0.001	0.00196	0.00181	0.001	0.00133	0.0026	0.00189	0.001	0.00103	0.00131
Benzo(a)anthracene	0.001	0.00127	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Chrysene	0.00371	0.00746	0.001	0.00297	0.00273	0.001	0.00167	0.00207	0.00183	0.00137	0.0016	0.00178
Benzo(b)fluoranthene	0.00107	0.00286	0.001	0.00222	0.00153	0.001	0.001	0.00234	0.00159	0.001	0.001	0.001
Benzo(k)fluoranthene	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.00143	0.001	0.001	0.001	0.001
Benzo(a)pyrene	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.00103	0.001	0.001	0.001	0.001
Indeno(1,2,3cd)pyrene	0.001	0.0011	0.001	0.00119	0.001	0.001	0.001	0.00193	0.001	0.001	0.001	0.001
Benzo(ghi)perylene	0.00116	0.00176	0.001	0.00153	0.00127	0.001	0.001	0.00232	0.00126	0.001	0.001	0.001
Dibenzo(a,h)anthracene	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
TPH	14	16.1	38.9	21.5	15.5	3.83	9.28	14.2	18.6	8.15	8.23	11.7
PCBs	0.00056	0.00056	0.00056	0.00056	0.00075	0.00056	0.00199	0.00056	0.00056	0.00056	0.00056	0.00056
TBT	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.001	0.005	0.005	0.005

Source	WP-M27 (SS1) 0.00-0.15m	BH-M16 (SS1) 0.00-0.50m	BH-M16 (SS2) 1.00-1.50m	BH-M17 (SS1) 0.00-0.50m	BH-M04 (SS1) 0.00-0.50m	BH-M04 (SS2) 1.00-1.50m	BH-M04 (SS3) 2.50-3.00m	BH-M05 (SS1) 0.00-0.50m	BH-M05 (SS2) 1.00-1.50m	BH-M05 (SS3) 2.50-3.00m	MAX	AVERAGE	No. Exceed RAL 1	No. Exceed RAL 2	No.Exceed BAC?	No. Exceed ERL	No. Exceed PEL?
Arsenic	6.2	10	11.3	7.6	24.6	23.8	19.9	16.6	14.5	11.7	27.8	12.35	5	0	2	N/A	0
Cadmium	0.1	0.17	0.14	0.07	0.29	0.19	0.32	0.17	0.11	0.15	0.32	0.13	0	0	2	0	0
Chromium	11.2	16	19.7	6.4	51.4	34.5	36.5	27.8	24.6	23.3	51.4	16.51	1	0	0	0	0
Copper	8	8.6	11.7	7.1	40	18.4	21.4	11.9	9.9	10.3	84.1	14.49	3	0	3	3	0
Mercury	0.01	0.01	0.01	0.02	0.12	0.04	0.03	0.01	0.01	0.01	0.13	0.03	0	0	3	0	0
Nickel	9.9	13.6	16.3	5.1	31.8	27.4	29	18.6	16.3	15.7	31.8	13.23	1	0	0	N/A	N/A
Lead	6.4	8.9	11.5	23.6	50.7	25.8	23.5	12.8	10.2	8.9	50.7	11.68	1	0	1	1	0
Zinc	24.3	29	33.6	9.1	161	80.8	82.1	46.6	45.8	36.7	161	33.07	1	0	1	1	0
Napthalene	0.001	0.001	0.001	0.001	0.00138	0.00138	0.00143	0.00128	0.00122	0.00402	0.00402	0.001	0	N/A	0	0	0
Acenaphthylene	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.00116	0.00116	0.001	0	N/A	N/A	N/A	0
Acenaphthene	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.00134	0.00134	0.001	0	N/A	N/A	N/A	0
Fluorene	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.00177	0.00177	0.001	0	N/A	N/A	N/A	0
Phenanthrene	0.00155	0.00415	0.00148	0.001	0.0036	0.00448	0.00281	0.0011	0.00114	0.00667	0.00667	0.002	0	N/A	0	0	0
Anthracene	0.001	0.00161	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.00192	0.00192	0.001	0	N/A	0	0	0
Fluoranthene	0.00269	0.0114	0.001	0.001	0.00174	0.00179	0.00123	0.00108	0.00154	0.00994	0.0114	0.002	0	N/A	0	0	0
Pyrene	0.00318	0.0106	0.00108	0.001	0.00288	0.00264	0.00306	0.00305	0.00178	0.00932	0.0106	0.002	0	N/A	0	0	0
Benzo(a)anthracene	0.00116	0.00526	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.00494	0.00526	0.001	0	N/A	0	0	0
Chrysene	0.00257	0.00688	0.00171	0.001	0.00443	0.00383	0.00309	0.00322	0.00209	0.00767	0.00767	0.003	0	N/A	0	0	0
Benzo(b)fluoranthene	0.00235	0.00494	0.001	0.001	0.00183	0.00145	0.00165	0.0017	0.00184	0.00687	0.00687	0.002	0	N/A	N/A	N/A	N/A
Benzo(k)fluoranthene	0.00133	0.00289	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.00305	0.00305	0.001	0	N/A	N/A	N/A	N/A
Benzo(a)pyrene	0.00136	0.00478	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.00571	0.00571	0.001	0	N/A	0	0	0
Indeno(1,2,3cd)pyrene	0.00223	0.00309	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.0042	0.0042	0.001	0	N/A	0	0	N/A
Benzo(ghi)perylene	0.00247	0.00394	0.001	0.001	0.00175	0.00145	0.00144	0.00107	0.0013	0.00515	0.00515	0.001	0	N/A	0	0	N/A
Dibenzo(a,h)anthracene	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.00128	0.00128	0.001	0	N/A	N/A	N/A	0
TPH	17.4	11.2	13.5	7.09	59.9	46.8	123	42.2	20.2	23.6	123	22.64	1	N/A	N/A	N/A	N/A
PCBs	0.00056	0.00056	0.00056	0.00056	0.00056	0.00056	0.0006	0.00056	0.00056	0.00056	0.00199	0.0006	0	0	N/A	N/A	0
TBT	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.00500	0.0042	0	0	N/A	N/A	N/A

Note: Underlined Values are   LOD. Values highlighted red are equal to or greater than AL1.

PEL Data Source: http://ceqg-rcqe.ccme.ca/en/index.html#void

Summary Table B

SDWQ Phase 1 and Phase 2 Dredge Areas

All units in mg/kg

	AL1	AL2	BAC	<ERL	PEL	Dredge Average	Exceed AL1?	Exceed AL2?	Exceed BAC?	Exceed ERL ?	Exceed PEL?
Source			CSEMP	CSEMP	Canada						
Arsenic	20	70	25	-	41.6	12.4	No	No	No	N/A	No
Cadmium	0.4	4	0.31	1.2	4.2	0.1	No	No	No	No	No
Chromium	50	370	81	81	160	16.5	No	No	No	No	No
Copper	30	300	27	34	108	14.5	No	No	No	No	No
Mercury	0.25	1.5	0.07	0.15	0.7	0.0	No	No	No	No	No
Nickel	30	150	36	-	-	13.2	No	No	No	N/A	N/A
Lead	50	400	38	47	112	11.7	No	No	No	No	No
Zinc	130	600	122	150	271	33.1	No	No	No	No	No
					-						
Napthalene	0.1	-	0.08	0.16	0.319	0.00	No	N/A	No	No	No
Acenaphthylene	0.1	-	-	-	0.128	0.00	No	N/A	N/A	N/A	No
Acenaphthene	0.1	-	-	-	0.0889	0.00	No	N/A	N/A	N/A	No
Fluorene	0.1	-	-	-	0.144	0.00	No	N/A	N/A	N/A	No
Phenanthrene	0.1	-	0.032	0.24	0.544	0.00	No	N/A	No	No	No
Anthracene	0.1	-	0.05	0.085	0.245	0.00	No	N/A	No	No	No
Fluoranthene	0.1	-	0.039	0.6	1.494	0.00	No	N/A	No	No	No
Pyrene	0.1	-	0.024	0.665	1.398	0.00	No	N/A	No	No	No
Benzo(a)anthracene	0.1	-	0.016	0.261	0.693	0.00	No	N/A	No	No	No
Chrysene	0.1	-	0.02	0.384	0.846	0.00	No	N/A	No	No	No
Benzo(b)fluoranthene	0.1	-	-	-	-	0.00	No	N/A	N/A	N/A	N/A
Benzo(k)fluoranthene	0.1	-	-	-	-	0.00	No	N/A	N/A	N/A	N/A
Benzo(a)pyrene	0.1	-	0.03	0.384	0.763	0.00	No	N/A	No	No	No
Indeno(1,2,3cd)pyrene	0.1	-	0.103	0.24	-	0.00	No	N/A	No	No	N/A
Benzo(ghi)perylene	0.1	-	0.08	0.085	-	0.00	No	N/A	No	No	N/A
Dibenzo(a,h)anthracene	0.01	-	-	-	0.135	0.00	No	N/A	N/A	N/A	No
TPH	100	-	-	-	-	22.64	No	N/A	N/A	N/A	N/A
PCBs	0.02	0.18	-	-	0.189	0.001	No	No	N/A	N/A	No
TBT	0.1	0.5	-	-	-	0.0042	No	No	N/A	N/A	N/A

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

SOCOTEC

Test Report ID	**MAR1394**	
Issue Version	1	
Customer	Causeway Geotech Ltd, 8 Drumahiskey Road, Ballymoney, Co. Antrim, BT53 7QL	
Customer Reference	Scapa Flow Marie Scotland Sediment Testing	
Date Sampled	23-Mar- 02-Apr-2022	
Date Received	11-Apr-22	
Date Reported	09-May-22	
Condition of samples	Cold	Satisfactory

Authorised by:	Marya Hubbard
Position:	Laboratory Manager

Any additional opinions or interpretations found in this report, are outside the scope of UKAS accreditation.

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR1394
Issue Version	1
Customer Reference	Scapa Flow Marie Scotland Sediment Testing

		Units	%	%	%	%	%	Mg/m3	N/A
		Method No	ASC/SOP/303	ASC/SOP/303	SUB_01*	SUB_01*	SUB_01*	SOCOTEC Doncaster*	SUB_02*
		Limit of Detection	0.2	0.2	N/A	N/A	N/A	N/A	N/A
		Accreditation	UKAS	UKAS	N	N	N	N	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**Total Moisture @ 120°C**	**Total Solids**	**Gravel (>2mm)**	**Sand (63-2000 µm)**	**Silt (<63 µm)**	**Particle Density**	**Asbestos**
BH-M01 (SS1) 0.00-0.50m	MAR1394.01	Sediment	16.3	83.7	7.6	73.8	18.6	2.72	NAIIS
BH-M01 (SS2) 1.00-1.50m	MAR1394.02	Sediment	14.6	85.4	5.5	82.4	12.1	2.69	NAIIS
BH-M01 (SS3) 2.50-3.00m	MAR1394.03	Sediment	11.6	88.4	10.1	47.9	42.0	2.66	NAIIS
BH-M03 (SS1) 0.00-0.50m	MAR1394.04	Sediment	14.3	85.7	8.3	64.6	27.0	2.71	NAIIS
BH-M03 (SS2) 1.00-1.50m	MAR1394.05	Sediment	13.8	86.2	11.0	53.1	35.9	2.74	NAIIS
BH-M03 (SS3) 2.50-3.00m	MAR1394.06	Sediment	14.3	85.7	10.4	25.8	63.9	Not Amenable*	NAIIS
BH-M07 (SS1) 0.00-0.50m	MAR1394.07	Sediment	16.1	83.9	20.9	57.8	21.2	2.51	NAIIS
BH-M07 (SS2) 1.00-1.50m	MAR1394.08	Sediment	18.7	81.3	19.1	60.9	20.0	Not Amenable*	NAIIS
BH-M07 (SS3) 2.50-3.00m	MAR1394.09	Sediment	14.3	85.7	17.6	67.8	14.6	Not Amenable*	NAIIS
BH-M09 (SS1) 0.00-0.50m	MAR1394.10	Sediment	23.0	77.0	23.5	52.9	23.6	0.72	NAIIS
BH-M09 (SS2) 1.00-1.50m	MAR1394.11	Sediment	17.5	82.5	11.6	64.9	23.5	2.76	NAIIS
BH-M09 (SS3) 2.50-3.00m	MAR1394.12	Sediment	12.7	87.3	25.2	54.2	20.7	Not Amenable*	NAIIS
BH-M11 (SS1) 0.00-0.50m	MAR1394.13	Sediment	12.9	87.1	17.8	65.2	17.0	2.69	NAIIS
BH-M11 (SS2) 1.00-1.50m	MAR1394.14	Sediment	13.1	86.9	8.7	61.9	29.4	2.70	NAIIS
BH-M11 (SS3) 2.50-3.00m	MAR1394.15	Sediment	12.6	87.4	20.0	45.3	34.7	Not Amenable*	NAIIS
BH-M13 (SS1) 0.00-0.50m	MAR1394.16	Sediment	19.3	80.7	9.3	75.3	15.4	Not Amenable*	NAIIS
BH-M13 (SS2) 1.00-1.50m	MAR1394.17	Sediment	17.1	82.9	10.3	59.4	30.3	2.71	NAIIS
BH-M13 (SS3) 2.50-3.00m	MAR1394.18	Sediment	12.0	88.0	20.8	40.2	39.0	2.69	NAIIS
BH-M14 (SS1) 0.00-0.50m	MAR1394.19	Sediment	17.9	82.1	22.9	61.9	15.2	Not Amenable*	NAIIS
BH-M14 (SS2) 1.00-1.50m	MAR1394.20	Sediment	23.3	76.7	20.6	63.8	15.6	Not Amenable*	NAIIS
BH-M14 (SS3) 2.50-3.00m	MAR1394.21	Sediment	16.0	84.0	19.9	63.2	16.8	2.66	NAIIS
BH-M15 (SS1) 0.00-0.50m	MAR1394.22	Sediment	20.3	79.7	34.4	47.8	17.9	2.72	NAIIS
BH-M15 (SS2) 1.00-1.50m	MAR1394.23	Sediment	17.2	82.8	28.6	48.8	22.5	2.68	NAIIS
BH-M15 (SS3) 2.50-3.00m	MAR1394.24	Sediment	15.5	84.5	32.4	50.2	17.3	2.71	NAIIS
WP-M27 (SS1) 0.00-0.15m	MAR1394.25	Sediment	22.4	77.6	21.5	57.5	21.0	2.66	NAIIS
BH-M16 (SS1) 0.00-0.50m	MAR1394.26	Sediment	16.5	83.5	27.4	51.7	20.9	2.69	NAIIS
BH-M16 (SS2) 1.00-1.50m	MAR1394.27	Sediment	13.3	86.7	30.4	51.8	17.8	Not Amenable*	NAIIS
BH-M17 (SS1) 0.00-0.50m	MAR1394.28	Sediment	12.2	87.8	20.1	42.9	37.1	2.71	NAIIS
Reference Material (% Recovery)			N/A	N/A	N/A	N/A	N/A	N/A	N/A
QC Blank			N/A	N/A	N/A	N/A	N/A	N/A	N/A

* See Report Notes

NAIIS - No Asbestos Identified In Sample

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR1394
Issue Version	1
Customer Reference	Scapa Flow Marie Scotland Sediment Testing

		Units	% M/M
		Method No	WSLM59*
		Limit of Detection	0.02
		Accreditation	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**TOC**
BH-M01 (SS1) 0.00-0.50m	MAR1394.01	Sediment	0.22
BH-M01 (SS2) 1.00-1.50m	MAR1394.02	Sediment	0.17
BH-M01 (SS3) 2.50-3.00m	MAR1394.03	Sediment	0.05
BH-M03 (SS1) 0.00-0.50m	MAR1394.04	Sediment	0.26
BH-M03 (SS2) 1.00-1.50m	MAR1394.05	Sediment	0.18
BH-M03 (SS3) 2.50-3.00m	MAR1394.06	Sediment	0.07
BH-M07 (SS1) 0.00-0.50m	MAR1394.07	Sediment	0.17
BH-M07 (SS2) 1.00-1.50m	MAR1394.08	Sediment	0.25
BH-M07 (SS3) 2.50-3.00m	MAR1394.09	Sediment	0.15
BH-M09 (SS1) 0.00-0.50m	MAR1394.10	Sediment	0.27
BH-M09 (SS2) 1.00-1.50m	MAR1394.11	Sediment	0.25
BH-M09 (SS3) 2.50-3.00m	MAR1394.12	Sediment	0.21
BH-M11 (SS1) 0.00-0.50m	MAR1394.13	Sediment	0.17
BH-M11 (SS2) 1.00-1.50m	MAR1394.14	Sediment	0.23
BH-M11 (SS3) 2.50-3.00m	MAR1394.15	Sediment	0.13
BH-M13 (SS1) 0.00-0.50m	MAR1394.16	Sediment	0.30
BH-M13 (SS2) 1.00-1.50m	MAR1394.17	Sediment	0.28
BH-M13 (SS3) 2.50-3.00m	MAR1394.18	Sediment	0.05
BH-M14 (SS1) 0.00-0.50m	MAR1394.19	Sediment	0.27
BH-M14 (SS2) 1.00-1.50m	MAR1394.20	Sediment	0.23
BH-M14 (SS3) 2.50-3.00m	MAR1394.21	Sediment	0.17
BH-M15 (SS1) 0.00-0.50m	MAR1394.22	Sediment	0.38
BH-M15 (SS2) 1.00-1.50m	MAR1394.23	Sediment	0.36
BH-M15 (SS3) 2.50-3.00m	MAR1394.24	Sediment	0.26
WP-M27 (SS1) 0.00-0.15m	MAR1394.25	Sediment	0.28
BH-M16 (SS1) 0.00-0.50m	MAR1394.26	Sediment	0.24
BH-M16 (SS2) 1.00-1.50m	MAR1394.27	Sediment	0.28
BH-M17 (SS1) 0.00-0.50m	MAR1394.28	Sediment	0.24
Reference Material (% Recovery)			95
QC Blank			<0.02

* See Report Notes

NAIIS - No Asbestos Identified In Sample

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID MAR1394
Issue Version 1
Customer Reference Scapa Flow Marie Scotland Sediment Testing

		Units	mg/Kg (Dry Weight)							
		Method No	ICPMSS*							
		Limit of Detection	0.5	0.04	0.5	0.5	0.01	0.5	0.5	2
		Accreditation	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Mercury**	**Nickel**	**Lead**	**Zinc**
BH-M01 (SS1) 0.00-0.50m	MAR1394.01	Sediment	3.5	0.07	6.8	5.5	0.02	4.8	4.7	13.8
BH-M01 (SS2) 1.00-1.50m	MAR1394.02	Sediment	3.7	0.10	6.9	5.4	0.01	4.7	3.5	11.4
BH-M01 (SS3) 2.50-3.00m	MAR1394.03	Sediment	27.8	0.07	8.3	8.4	0.09	3.2	7.6	15.5
BH-M03 (SS1) 0.00-0.50m	MAR1394.04	Sediment	7.9	0.14	10.6	8.1	<0.01	8.7	5.6	19.0
BH-M03 (SS2) 1.00-1.50m	MAR1394.05	Sediment	19.5	0.11	14.6	12.6	0.02	16.1	10.8	32.4
BH-M03 (SS3) 2.50-3.00m	MAR1394.06	Sediment	21.0	0.11	13.1	84.1	0.03	11.4	10.3	18.6
BH-M07 (SS1) 0.00-0.50m	MAR1394.07	Sediment	10.4	0.07	14.9	12.4	<0.01	14.1	12.4	32.5
BH-M07 (SS2) 1.00-1.50m	MAR1394.08	Sediment	4.1	0.06	8.1	5.7	<0.01	6.8	4.9	12.6
BH-M07 (SS3) 2.50-3.00m	MAR1394.09	Sediment	5.1	0.05	7.8	8.2	<0.01	7.6	5.2	21.0
BH-M09 (SS1) 0.00-0.50m	MAR1394.10	Sediment	13.3	0.07	11.2	6.9	<0.01	8.9	7.2	15.6
BH-M09 (SS2) 1.00-1.50m	MAR1394.11	Sediment	12.6	0.09	11.8	7.3	<0.01	9.1	8.1	16.5
BH-M09 (SS3) 2.50-3.00m	MAR1394.12	Sediment	19.6	0.13	26.1	14.7	0.05	22.9	15.5	46.3
BH-M11 (SS1) 0.00-0.50m	MAR1394.13	Sediment	19.0	0.15	27.4	15	0.02	24.2	17.7	47.3
BH-M11 (SS2) 1.00-1.50m	MAR1394.14	Sediment	17.9	0.10	17.6	8.0	0.01	11.4	9.8	21.9
BH-M11 (SS3) 2.50-3.00m	MAR1394.15	Sediment	27.8	0.16	14.9	21.6	0.03	20.6	15.4	46.8
BH-M13 (SS1) 0.00-0.50m	MAR1394.16	Sediment	9.2	0.10	11.1	9.5	0.01	10.8	7.0	21.8
BH-M13 (SS2) 1.00-1.50m	MAR1394.17	Sediment	5.2	0.09	10.1	5.9	<0.01	8.0	5.0	15.0
BH-M13 (SS3) 2.50-3.00m	MAR1394.18	Sediment	4.9	0.31	11.6	46.4	0.13	8.3	16.6	15.8
BH-M14 (SS1) 0.00-0.50m	MAR1394.19	Sediment	7.1	0.15	14.8	18.3	0.04	12.2	10.6	26.6
BH-M14 (SS2) 1.00-1.50m	MAR1394.20	Sediment	6.8	0.13	13.1	8.9	0.02	10.7	7.5	23.6
BH-M14 (SS3) 2.50-3.00m	MAR1394.21	Sediment	7.2	0.15	12.7	10.1	0.03	10.5	9.3	39.7
BH-M15 (SS1) 0.00-0.50m	MAR1394.22	Sediment	5.1	0.10	9.7	6.2	0.01	7.7	5.6	17.4
BH-M15 (SS2) 1.00-1.50m	MAR1394.23	Sediment	5.7	0.08	10.3	6.0	<0.01	8.8	5.5	17.0
BH-M15 (SS3) 2.50-3.00m	MAR1394.24	Sediment	9.3	0.11	16.6	10.0	<0.01	14.5	9.1	27.2
WP-M27 (SS1) 0.00-0.15m	MAR1394.25	Sediment	6.2	0.10	11.2	8.0	<0.01	9.9	6.4	24.3
BH-M16 (SS1) 0.00-0.50m	MAR1394.26	Sediment	10.0	0.17	16.0	8.6	0.01	13.6	8.9	29.0
BH-M16 (SS2) 1.00-1.50m	MAR1394.27	Sediment	11.3	0.14	19.7	11.7	0.01	16.3	11.5	33.6
BH-M17 (SS1) 0.00-0.50m	MAR1394.28	Sediment	7.6	0.07	6.4	7.1	0.02	5.1	23.6	9.1
Certified Reference Material SETOC 774 (% Recovery)			99	96	93	97	90	99	93	98
QC Blank			<0.5	<0.04	<0.5	<0.5	<0.01	<0.5	<0.5	<2

* See Report Notes

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR1394
Issue Version	1
Customer Reference	Scapa Flow Marie Scotland Sediment Testing

		Units	µg/Kg (Dry Weight)	
		Method No	ASC/SOP/301	
		Limit of Detection	1	1
		Accreditation	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**Dibutyltin (DBT)**	**Tributyltin (TBT)**
BH-M01 (SS1) 0.00-0.50m	MAR1394.01	Sediment	<1	<1
BH-M01 (SS2) 1.00-1.50m	MAR1394.02	Sediment	<1	<1
BH-M01 (SS3) 2.50-3.00m	MAR1394.03	Sediment	<1	<1
BH-M03 (SS1) 0.00-0.50m	MAR1394.04	Sediment	<1	<1
BH-M03 (SS2) 1.00-1.50m	MAR1394.05	Sediment	<1	<1
BH-M03 (SS3) 2.50-3.00m	MAR1394.06	Sediment	<1	<1
BH-M07 (SS1) 0.00-0.50m	MAR1394.07	Sediment	<5	<5
BH-M07 (SS2) 1.00-1.50m	MAR1394.08	Sediment	<5	<5
BH-M07 (SS3) 2.50-3.00m	MAR1394.09	Sediment	<5	<5
Certified Reference Material QSP076MS(% Recovery)			51	56
QC Blank			<1	<1

* See Report Notes

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR1394
Issue Version	1
Customer Reference	Scapa Flow Marie Scotland Sediment Testing

		Units	µg/Kg (Dry Weight)	
		Method No	ASC/SOP/301	
		Limit of Detection	1	1
		Accreditation	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**Dibutyltin (DBT)**	**Tributyltin (TBT)**
BH-M09 (SS1) 0.00-0.50m	MAR1394.10	Sediment	<5	<5
BH-M09 (SS2) 1.00-1.50m	MAR1394.11	Sediment	<5	<5
BH-M09 (SS3) 2.50-3.00m	MAR1394.12	Sediment	<5	<5
BH-M11 (SS1) 0.00-0.50m	MAR1394.13	Sediment	<5	<5
BH-M11 (SS2) 1.00-1.50m	MAR1394.14	Sediment	<5	<5
BH-M11 (SS3) 2.50-3.00m	MAR1394.15	Sediment	<5	<5
BH-M13 (SS1) 0.00-0.50m	MAR1394.16	Sediment	<5	<5
BH-M13 (SS2) 1.00-1.50m	MAR1394.17	Sediment	<5	<5
BH-M13 (SS3) 2.50-3.00m	MAR1394.18	Sediment	<5	<5
Certified Reference Material QSP076MS (% Recovery)			85	60
QC Blank			<1	<1

* See Report Notes

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR1394
Issue Version	1
Customer Reference	Scapa Flow Marie Scotland Sediment Testing

		Units	µg/Kg (Dry Weight)	
		Method No	ASC/SOP/301	
		Limit of Detection	1	1
		Accreditation	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**Dibutyltin (DBT)**	**Tributyltin (TBT)**
BH-M14 (SS1) 0.00-0.50m	MAR1394.19	Sediment	<5	<5
BH-M14 (SS2) 1.00-1.50m	MAR1394.20	Sediment	<5	<5
BH-M14 (SS3) 2.50-3.00m	MAR1394.21	Sediment	<1	<1
BH-M15 (SS1) 0.00-0.50m	MAR1394.22	Sediment	<5	<5
BH-M15 (SS2) 1.00-1.50m	MAR1394.23	Sediment	<5	<5
BH-M15 (SS3) 2.50-3.00m	MAR1394.24	Sediment	<5	<5
WP-M27 (SS1) 0.00-0.15m	MAR1394.25	Sediment	<5	<5
BH-M16 (SS1) 0.00-0.50m	MAR1394.26	Sediment	<5	<5
BH-M16 (SS2) 1.00-1.50m	MAR1394.27	Sediment	<5	<5
BH-M17 (SS1) 0.00-0.50m	MAR1394.28	Sediment	<5	<5
Certified Reference Material QSP077MS (% Recovery)			116	169
QC Blank			<1	<1

* See Report Notes

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR1394
Issue Version	1
Customer Reference	Scapa Flow Marie Scotland Sediment Testing

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304
		Limit of Detection	1	1	1	1	1	1
		Accreditation	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**ACENAPTH**	**ACENAPHY**	**ANTHRACN**	**BAA**	**BAP**	**BBF**
BH-M01 (SS1) 0.00-0.50m	MAR1394.01	Sediment	<1	<1	<1	<1	<1	1.46
BH-M01 (SS2) 1.00-1.50m	MAR1394.02	Sediment	<1	<1	<1	<1	<1	1.13
BH-M01 (SS3) 2.50-3.00m	MAR1394.03	Sediment	<1	<1	<1	<1	<1	<1
BH-M03 (SS1) 0.00-0.50m	MAR1394.04	Sediment	<1	<1	<1	<1	<1	1.57
BH-M03 (SS2) 1.00-1.50m	MAR1394.05	Sediment	<1	<1	<1	<1	<1	1.72
BH-M03 (SS3) 2.50-3.00m	MAR1394.06	Sediment	<1	<1	<1	<1	<1	<1
BH-M07 (SS1) 0.00-0.50m	MAR1394.07	Sediment	<1	<1	<1	<1	<1	1.15
BH-M07 (SS2) 1.00-1.50m	MAR1394.08	Sediment	<1	<1	<1	<1	<1	1.65
BH-M07 (SS3) 2.50-3.00m	MAR1394.09	Sediment	<1	<1	<1	<1	<1	<1
BH-M09 (SS1) 0.00-0.50m	MAR1394.10	Sediment	<1	<1	<1	<1	<1	1.21
BH-M09 (SS2) 1.00-1.50m	MAR1394.11	Sediment	<1	<1	<1	<1	<1	1.85
BH-M09 (SS3) 2.50-3.00m	MAR1394.12	Sediment	<1	<1	<1	<1	<1	2.19
BH-M11 (SS1) 0.00-0.50m	MAR1394.13	Sediment	<1	<1	<1	<1	<1	1.07
BH-M11 (SS2) 1.00-1.50m	MAR1394.14	Sediment	<1	<1	<1	1.27	<1	2.86
Certified Reference Material Quasimeme QPH105MS (% Recovery)			82	140	90	81	86	70
QC Blank			<1	<1	<1	<1	<1	<1

For full analyte name see method summaries

~ Indicates result is for an In-house Reference Material as no Certified Reference Materials are avaliable.

As the method uses surrogate standards to correct for losses, the RM results are reported as percentage trueness, not recovery.

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR1394
Issue Version	1
Customer Reference	Scapa Flow Marie Scotland Sediment Testing

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304
		Limit of Detection	1	1	1	1	1	1
		Accreditation	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**BENZGHIP**	**BKF**	**CHRYSENE**	**DBENZAH**	**FLUORANT**	**FLUORENE**
BH-M01 (SS1) 0.00-0.50m	MAR1394.01	Sediment	<1	<1	3.02	<1	<1	<1
BH-M01 (SS2) 1.00-1.50m	MAR1394.02	Sediment	<1	<1	2.60	<1	<1	<1
BH-M01 (SS3) 2.50-3.00m	MAR1394.03	Sediment	<1	<1	<1	<1	<1	<1
BH-M03 (SS1) 0.00-0.50m	MAR1394.04	Sediment	1.47	<1	3.81	<1	1.52	<1
BH-M03 (SS2) 1.00-1.50m	MAR1394.05	Sediment	1.67	<1	3.00	<1	1.66	<1
BH-M03 (SS3) 2.50-3.00m	MAR1394.06	Sediment	1.38	<1	1.33	<1	<1	<1
BH-M07 (SS1) 0.00-0.50m	MAR1394.07	Sediment	1.27	<1	3.40	<1	1.11	<1
BH-M07 (SS2) 1.00-1.50m	MAR1394.08	Sediment	1.61	<1	2.37	<1	1.33	<1
BH-M07 (SS3) 2.50-3.00m	MAR1394.09	Sediment	<1	<1	1.06	<1	<1	<1
BH-M09 (SS1) 0.00-0.50m	MAR1394.10	Sediment	1.02	<1	2.62	<1	1.05	<1
BH-M09 (SS2) 1.00-1.50m	MAR1394.11	Sediment	1.16	<1	4.04	<1	1.42	<1
BH-M09 (SS3) 2.50-3.00m	MAR1394.12	Sediment	1.25	<1	4.79	<1	1.52	<1
BH-M11 (SS1) 0.00-0.50m	MAR1394.13	Sediment	1.16	<1	3.71	<1	1.06	<1
BH-M11 (SS2) 1.00-1.50m	MAR1394.14	Sediment	1.76	<1	7.46	<1	2.16	<1
Certified Reference Material Quasimeme QPH105MS (% Recovery)			100	85	80	87	82	87
QC Blank			<1	<1	<1	<1	<1	<1

For full analyte name see method summaries

~ Indicates result is for an In-house Reference Material as no Certified Reference Materials are avaliable.

As the method uses surrogate standards to correct for losses, the RM results are reported as percentage trueness, not recovery.

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID MAR1394
Issue Version 1
Customer Reference Scapa Flow Marie Scotland Sediment Testing

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/306
		Limit of Detection	1	1	1	1	100
		Accreditation	UKAS	UKAS	UKAS	UKAS	N
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**INDPYR**	**NAPTH**	**PHENANT**	**PYRENE**	**THC**
BH-M01 (SS1) 0.00-0.50m	MAR1394.01	Sediment	<1	<1	<1	2.02	8680
BH-M01 (SS2) 1.00-1.50m	MAR1394.02	Sediment	<1	<1	<1	1.71	10600
BH-M01 (SS3) 2.50-3.00m	MAR1394.03	Sediment	<1	<1	<1	<1	2580
BH-M03 (SS1) 0.00-0.50m	MAR1394.04	Sediment	<1	<1	1.61	1.98	40900
BH-M03 (SS2) 1.00-1.50m	MAR1394.05	Sediment	1.08	<1	1.85	2.12	25300
BH-M03 (SS3) 2.50-3.00m	MAR1394.06	Sediment	<1	<1	<1	<1	34400
BH-M07 (SS1) 0.00-0.50m	MAR1394.07	Sediment	<1	<1	1.66	2.18	13200
BH-M07 (SS2) 1.00-1.50m	MAR1394.08	Sediment	1.04	<1	1.66	1.96	12000
BH-M07 (SS3) 2.50-3.00m	MAR1394.09	Sediment	<1	<1	<1	<1	9730
BH-M09 (SS1) 0.00-0.50m	MAR1394.10	Sediment	<1	<1	<1	1.80	9760
BH-M09 (SS2) 1.00-1.50m	MAR1394.11	Sediment	<1	<1	1.20	2.49	21200
BH-M09 (SS3) 2.50-3.00m	MAR1394.12	Sediment	<1	<1	1.57	2.90	36500
BH-M11 (SS1) 0.00-0.50m	MAR1394.13	Sediment	<1	<1	1.29	2.07	14000
BH-M11 (SS2) 1.00-1.50m	MAR1394.14	Sediment	1.10	<1	1.76	3.55	16100
Certified Reference Material Quasimeme QPH105MS (% Recovery)			88	100	85	88	98~
QC Blank			<1	<1	<1	<1	<100

For full analyte name see method summaries
~ Indicates result is for an In-house Reference Material as no Certified Reference Materials are avaliable.
As the method uses surrogate standards to correct for losses, the RM results are reported as percentage trueness, not recovery.

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR1394
Issue Version	1
Customer Reference	Scapa Flow Marie Scotland Sediment Testing

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304
		Limit of Detection	1	1	1	1	1	1
		Accreditation	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**ACENAPTH**	**ACENAPHY**	**ANTHRACN**	**BAA**	**BAP**	**BBF**
BH-M11 (SS3) 2.50-3.00m	MAR1394.15	Sediment	<1	<1	<1	<1	<1	<1
BH-M13 (SS1) 0.00-0.50m	MAR1394.16	Sediment	<1	<1	<1	<1	<1	2.22
BH-M13 (SS2) 1.00-1.50m	MAR1394.17	Sediment	<1	<1	<1	<1	<1	1.53
BH-M13 (SS3) 2.50-3.00m	MAR1394.18	Sediment	<1	<1	<1	<1	<1	<1
BH-M14 (SS1) 0.00-0.50m	MAR1394.19	Sediment	<1	<1	<1	<1	<1	<1
BH-M14 (SS2) 1.00-1.50m	MAR1394.20	Sediment	<1	<1	<1	<1	1.03	2.34
BH-M14 (SS3) 2.50-3.00m	MAR1394.21	Sediment	<1	<1	<1	<1	<1	1.59
BH-M15 (SS1) 0.00-0.50m	MAR1394.22	Sediment	<1	<1	<1	<1	<1	<1
BH-M15 (SS2) 1.00-1.50m	MAR1394.23	Sediment	<1	<1	<1	<1	<1	<1
BH-M15 (SS3) 2.50-3.00m	MAR1394.24	Sediment	<1	<1	<1	<1	<1	<1
WP-M27 (SS1) 0.00-0.15m	MAR1394.25	Sediment	<1	<1	<1	1.16	1.36	2.35
BH-M16 (SS1) 0.00-0.50m	MAR1394.26	Sediment	<1	<1	1.61	5.26	4.78	4.94
BH-M16 (SS2) 1.00-1.50m	MAR1394.27	Sediment	<1	<1	<1	<1	<1	<1
BH-M17 (SS1) 0.00-0.50m	MAR1394.28	Sediment	<1	<1	<1	<1	<1	<1
Certified Reference Material Quasimeme QPH105MS (% Recovery)			81	113	92	76	78	66
QC Blank			<1	<1	<1	<1	<1	<1

For full analyte name see method summaries

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Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID MAR1394
Issue Version 1
Customer Reference Scapa Flow Marie Scotland Sediment Testing

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304
		Limit of Detection	1	1	1	1	1	1
		Accreditation	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**BENZGHIP**	**BKF**	**CHRYSENE**	**DBENZAH**	**FLUORANT**	**FLUORENE**
BH-M11 (SS3) 2.50-3.00m	MAR1394.15	Sediment	<1	<1	<1	<1	<1	<1
BH-M13 (SS1) 0.00-0.50m	MAR1394.16	Sediment	1.53	<1	2.97	<1	1.59	<1
BH-M13 (SS2) 1.00-1.50m	MAR1394.17	Sediment	1.27	<1	2.73	<1	1.26	<1
BH-M13 (SS3) 2.50-3.00m	MAR1394.18	Sediment	<1	<1	<1	<1	<1	<1
BH-M14 (SS1) 0.00-0.50m	MAR1394.19	Sediment	<1	<1	1.67	<1	<1	<1
BH-M14 (SS2) 1.00-1.50m	MAR1394.20	Sediment	2.32	1.43	2.07	<1	2.05	<1
BH-M14 (SS3) 2.50-3.00m	MAR1394.21	Sediment	1.26	<1	1.83	<1	1.45	<1
BH-M15 (SS1) 0.00-0.50m	MAR1394.22	Sediment	<1	<1	1.37	<1	<1	<1
BH-M15 (SS2) 1.00-1.50m	MAR1394.23	Sediment	<1	<1	1.60	<1	<1	<1
BH-M15 (SS3) 2.50-3.00m	MAR1394.24	Sediment	<1	<1	1.78	<1	<1	<1
WP-M27 (SS1) 0.00-0.15m	MAR1394.25	Sediment	2.47	1.33	2.57	<1	2.69	<1
BH-M16 (SS1) 0.00-0.50m	MAR1394.26	Sediment	3.94	2.89	6.88	<1	11.4	<1
BH-M16 (SS2) 1.00-1.50m	MAR1394.27	Sediment	<1	<1	1.71	<1	<1	<1
BH-M17 (SS1) 0.00-0.50m	MAR1394.28	Sediment	<1	<1	<1	<1	<1	<1
Certified Reference Material Quasimeme QPH105MS (% Recovery)			83	85	78	74	83	80
QC Blank			<1	<1	<1	<1	<1	<1

For full analyte name see method summaries

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Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID MAR1394
Issue Version 1
Customer Reference Scapa Flow Marie Scotland Sediment Testing

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/306
		Limit of Detection	1	1	1	1	100
		Accreditation	UKAS	UKAS	UKAS	UKAS	N
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**INDPYR**	**NAPTH**	**PHENANT**	**PYRENE**	**THC**
BH-M11 (SS3) 2.50-3.00m	MAR1394.15	Sediment	<1	<1	<1	<1	38900
BH-M13 (SS1) 0.00-0.50m	MAR1394.16	Sediment	1.19	<1	1.07	1.96	21500
BH-M13 (SS2) 1.00-1.50m	MAR1394.17	Sediment	<1	<1	<1	1.81	15500
BH-M13 (SS3) 2.50-3.00m	MAR1394.18	Sediment	<1	<1	<1	<1	3830
BH-M14 (SS1) 0.00-0.50m	MAR1394.19	Sediment	<1	<1	2.96	1.33	9280
BH-M14 (SS2) 1.00-1.50m	MAR1394.20	Sediment	1.93	<1	1.15	2.60	14200
BH-M14 (SS3) 2.50-3.00m	MAR1394.21	Sediment	<1	<1	<1	1.89	18600
BH-M15 (SS1) 0.00-0.50m	MAR1394.22	Sediment	<1	<1	<1	<1	8150
BH-M15 (SS2) 1.00-1.50m	MAR1394.23	Sediment	<1	<1	<1	1.03	8230
BH-M15 (SS3) 2.50-3.00m	MAR1394.24	Sediment	<1	<1	<1	1.31	11700
WP-M27 (SS1) 0.00-0.15m	MAR1394.25	Sediment	2.23	<1	1.55	3.18	17400
BH-M16 (SS1) 0.00-0.50m	MAR1394.26	Sediment	3.09	<1	4.15	10.6	11200
BH-M16 (SS2) 1.00-1.50m	MAR1394.27	Sediment	<1	<1	1.48	1.08	13500
BH-M17 (SS1) 0.00-0.50m	MAR1394.28	Sediment	<1	<1	<1	<1	7090
Certified Reference Material Quasimeme QPH105MS (% Recovery)			76	93	90	87	100~
QC Blank			<1	<1	<1	<1	<100

For full analyte name see method summaries
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Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID MAR1394
Issue Version 1
Customer Reference Scapa Flow Marie Scotland Sediment Testing

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302
		Limit of Detection	0.08	0.08	0.08	0.08	0.08	0.08	0.08
		Accreditation	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**PCB28**	**PCB52**	**PCB101**	**PCB118**	**PCB138**	**PCB153**	**PCB180**
BH-M01 (SS1) 0.00-0.50m	MAR1394.01	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M01 (SS2) 1.00-1.50m	MAR1394.02	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M01 (SS3) 2.50-3.00m	MAR1394.03	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M03 (SS1) 0.00-0.50m	MAR1394.04	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M03 (SS2) 1.00-1.50m	MAR1394.05	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M03 (SS3) 2.50-3.00m	MAR1394.06	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M07 (SS1) 0.00-0.50m	MAR1394.07	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M07 (SS2) 1.00-1.50m	MAR1394.08	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M07 (SS3) 2.50-3.00m	MAR1394.09	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M09 (SS1) 0.00-0.50m	MAR1394.10	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M09 (SS2) 1.00-1.50m	MAR1394.11	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M09 (SS3) 2.50-3.00m	MAR1394.12	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M11 (SS1) 0.00-0.50m	MAR1394.13	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M11 (SS2) 1.00-1.50m	MAR1394.14	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M11 (SS3) 2.50-3.00m	MAR1394.15	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M13 (SS1) 0.00-0.50m	MAR1394.16	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M13 (SS2) 1.00-1.50m	MAR1394.17	Sediment	<0.08	<0.08	<0.08	<0.08	0.13	0.22	<0.08
BH-M13 (SS3) 2.50-3.00m	MAR1394.18	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M14 (SS1) 0.00-0.50m	MAR1394.19	Sediment	0.21	0.26	0.28	0.31	0.30	0.29	0.34
Certified Reference Material Quasimeme QOR145MS (% Recovery)			103~	87	96~	96~	98~	97~	96~
QC Blank			<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08

For full analyte name see method summaries

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Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR1394
Issue Version	1
Customer Reference	Scapa Flow Marie Scotland Sediment Testing

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302
		Limit of Detection	0.08	0.08	0.08	0.08	0.08	0.08	0.08
		Accreditation	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**PCB28**	**PCB52**	**PCB101**	**PCB118**	**PCB138**	**PCB153**	**PCB180**
BH-M14 (SS2) 1.00-1.50m	MAR1394.20	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M14 (SS3) 2.50-3.00m	MAR1394.21	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M15 (SS1) 0.00-0.50m	MAR1394.22	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M15 (SS2) 1.00-1.50m	MAR1394.23	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M15 (SS3) 2.50-3.00m	MAR1394.24	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
WP-M27 (SS1) 0.00-0.15m	MAR1394.25	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M16 (SS1) 0.00-0.50m	MAR1394.26	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M16 (SS2) 1.00-1.50m	MAR1394.27	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M17 (SS1) 0.00-0.50m	MAR1394.28	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Certified Reference Material Quasimeme QOR145MS (% Recovery)			97~	87	98~	88	97~	98~	98~
QC Blank			<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08

For full analyte name see method summaries

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Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR1394
Issue Version	1
Customer Reference	Scapa Flow Marie Scotland Sediment Testing

REPORT NOTES

Method Code	Sample ID	The following information should be taken into consideration when using the data contained within this report
WSLM59*	MAR1394.01-28	Analysis was conducted by an internal SOCOTEC laboratory. UKAS accredited analysis by this laboratory is under UKAS number 1252.
ICPMSS*	MAR1394.01-28	Analysis was conducted by an internal SOCOTEC laboratory. UKAS accredited analysis by this laboratory is under UKAS number 1252.
SOCOTEC Doncaster*	MAR1394.01-28	Analysis was conducted by an internal SOCOTEC laboratory.
SOCOTEC Doncaster*	MAR1394.06, 08, 09, 12, 15, 16, 19, 20, 27	Unsuitable to test due to Gravel and Shell content.
SUB_01*	MAR1394.01-28	Analysis was conducted by an approved subcontracted laboratory.
SUB_02*	MAR1394.01-28	Analysis was conducted by an approved subcontracted laboratory.
ASC/SOP/301	MAR1394.07-20, 22-28	The matrix of this sample has been found to interfere with the result for this test. The sample has therefore been diluted, but in doing so, the detection limit for this test has been elevated.
ASC/SOP/303/304	MAR1394.01-28	Chrysene is known to coelute with Triphenylene and these peaks can not be resolved. It is believed Triphenylene is present in these samples therefore it is suggested that the Chrysene results should be taken as a Chrysene (inc. Triphenylene).This should be taken into consideration when utilising the data.

DEVIATING SAMPLE STATEMENT

Deviation Code	Deviation Definition	Sample ID	Deviation Details. The following information should be taken into consideration when using the data contained within this report
D1	Holding Time Exceeded	N/A	N/A
D2	Sample Contaminated through Damaged Packaging	N/A	N/A
D3	Sample Contaminated through Sampling	N/A	N/A
D4	Inappropriate Container/Packaging	N/A	N/A
D5	Damaged in Transit	N/A	N/A
D6	Insufficient Quantity of Sample	N/A	N/A
D7	Inappropriate Headspace	N/A	N/A
D8	Retained at Incorrect Temperature	N/A	N/A
D9	Lack of Date & Time of Sampling	N/A	N/A
D10	Insufficient Sample Details	N/A	N/A
D11	Sample integrity compromised or not suitable for analysis	N/A	N/A

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR1394
Issue Version	1
Customer Reference	Scapa Flow Marie Scotland Sediment Testing

Method	**Sample and Fraction Size**	**Method Summary**
Total Solids	Wet Sediment	Calculation (100%-Moisture Content).Moisture content determined by drying a portion of the sample at 120°C to constant weight.
Particle Size Analysis	Wet Sediment	Wet and dry sieving followed by laser diffraction analysis.
Total Organic Carbon (TOC)	Air dried and ground	Carbonate removal and sulphurous acid/combustion at 1600°C/NDIR.
Metals	Air dried and seived to <63µm	Aqua-regia extraction followed by ICP analysis.
Organotins	Wet Sediment	Solvent extraction and derivatisation followed by GC-MS analysis.
Polyaromatic Hydrocarbons (PAH)	Wet Sediment	Solvent extraction and clean up followed by GC-MS analysis.
Total Hydrocarbon Content (THC)	Wet Sediment	Solvent extraction and clean up followed by GC-FID analysis.
Polychlorinated Biphenyls (PCBs)	Air dried and seived to <2mm	Solvent extraction and clean up followed by GC-MS-MS analysis.
Organochlorine Pesticides (OCPs)	Air dried and seived to <2mm	Solvent extraction and clean up followed by GC-MS-MS analysis.

Analyte Definitions					
Analyte Abbreviation	Full Analyte name	Analyte Abbreviation	Full Analyte name	Analyte Abbreviation	Full Analyte name
ACENAPTH	Acenaphthene	C2N	C2-naphthalenes	THC	Total Hydrocarbon Content
ACENAPHY	Acenaphthylene	C3N	C3-naphthalenes	AHCH	alpha-Hexachlorcyclohexane
ANTHRACN	Anthracene	CHRYSENE	Chrysene	BHCH	beta-Hexachlorcyclohexane
BAA	Benzo[a]anthracene	DBENZAH	Dibenzo[ah]anthracene	GHCH	gamma-Hexachlorcyclohexane
BAP	Benzo[a]pyrene	FLUORANT	Fluoranthene	DIELDRIN	Dieldrin
BBF	Benzo[b]fluoranthene	FLUORENE	Fluorene	HCB	Hexachlorobenzene
BEP	Benzo[e]pyrene	INDPYR	Indeno[1,2,3-cd]pyrene	DDD	p,p'-Dichlorodiphenyldichloroethane
BENZGHIP	Benzo[ghi]perylene	NAPTH	Naphthalene	DDE	p,p'-Dichlorodiphenyldichloroethylene
BKF	Benzo[k]fluoranthene	PERYLENE	Perylene	DDT	p,p'-Dichlorodiphenyltrichloroethane
C1N	C1-naphthalenes	PHENANT	Phenanthrene		
C1PHEN	C1-phenanthrene	PYRENE	Pyrene		

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID	**MAR01357**	
Issue Version	1	
Customer	Causeway Geotech Ltd, 8 Drumahiskey Road, Ballymoney, Co. Antrim, BT53 7QL	
Customer Reference	Scapa Flow Marine Scotland Sediment Testing	
Date Sampled	04-05-Mar-2022	
Date Received	16-Mar-22	
Date Reported	12-Apr-22	
Condition of samples	Cold	Satisfactory

Authorised by: Marya Hubbard

Position: Laboratory Manager

Any additional opinions or interpretations found in this report, are outside the scope of UKAS accreditation.

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID MAR01357
Issue Version 1
Customer Reference Scapa Flow Marine Scotland Sediment Testing

		Units	%	%	%	%	%	Mg/m3	N/A
		Method No	ASC/SOP/303	ASC/SOP/303	SUB_01*	SUB_01*	SUB_01*	SOCOTEC Doncaster*	SUB_02*
		Limit of Detection	0.2	0.2	N/A	N/A	N/A	N/A	N/A
		Accreditation	UKAS	UKAS	N	N	N	N	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**Total Moisture @ 120°C**	**Total Solids**	**Gravel (>2mm)**	**Sand (63-2000 µm)**	**Silt (<63 µm)**	**Particle Density**	**Asbestos**
BH-M04 (SS1) 0.00-0.50m	MAR01357.001	Sediment	15.6	84.4	14.1	69.1	16.8	2.66	NAIIS
BH-M04 (SS2) 1.00-1.50m	MAR01357.002	Sediment	13.3	86.7	14.2	66.6	19.2	2.72	NAIIS
BH-M04 (SS3) 2.50-3.00m	MAR01357.003	Sediment	13.3	86.7	20.0	65.8	14.2	2.67	NAIIS
BH-M05 (SS1) 0.00-0.50m	MAR01357.004	Sediment	12.7	87.3	15.1	59.5	25.4	2.73	NAIIS
BH-M05 (SS2) 1.00-1.50m	MAR01357.005	Sediment	12.9	87.1	14.2	69.6	16.2	2.72	NAIIS
BH-M05 (SS3) 2.50-3.00m	MAR01357.006	Sediment	21.0	79.0	10.9	72.6	16.5	2.54	NAIIS
		Reference Material (% Recovery)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		QC Blank	N/A	N/A	N/A	N/A	N/A	N/A	N/A

* See Report Notes
NAIIS - No Asbestos Identified In Sample

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID MAR01357
Issue Version 1
Customer Reference Scapa Flow Marine Scotland Sediment Testing

		Units	% M/M
		Method No	WSLM59*
		Limit of Detection	0.02
		Accreditation	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**TOC**
BH-M04 (SS1) 0.00-0.50m	MAR01357.001	Sediment	0.26
BH-M04 (SS2) 1.00-1.50m	MAR01357.002	Sediment	0.21
BH-M04 (SS3) 2.50-3.00m	MAR01357.003	Sediment	0.23
BH-M05 (SS1) 0.00-0.50m	MAR01357.004	Sediment	0.22
BH-M05 (SS2) 1.00-1.50m	MAR01357.005	Sediment	0.25
BH-M05 (SS3) 2.50-3.00m	MAR01357.006	Sediment	0.27
		Reference Material (% Recovery)	105
		QC Blank	<0.02

* See Report Notes

NAIIS - No Asbestos Identified In Sample

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR01357
Issue Version	1
Customer Reference	Scapa Flow Marine Scotland Sediment Testing

		Units	mg/Kg (Dry Weight)							
		Method No	ICPMSS*							
		Limit of Detection	0.5	0.04	0.5	0.5	0.01	0.5	0.5	2
		Accreditation	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Mercury**	**Nickel**	**Lead**	**Zinc**
BH-M04 (SS1) 0.00-0.50m	MAR01357.001	Sediment	24.6	0.29	51.4	40.0	0.12	31.8	50.7	161
BH-M04 (SS2) 1.00-1.50m	MAR01357.002	Sediment	23.8	0.19	34.5	18.4	0.04	27.4	25.8	80.8
BH-M04 (SS3) 2.50-3.00m	MAR01357.003	Sediment	19.9	0.32	36.5	21.4	0.03	29.0	23.5	82.1
BH-M05 (SS1) 0.00-0.50m	MAR01357.004	Sediment	16.6	0.17	27.8	11.9	<0.01	18.6	12.8	46.6
BH-M05 (SS2) 1.00-1.50m	MAR01357.005	Sediment	14.5	0.11	24.6	9.9	<0.01	16.3	10.2	45.8
BH-M05 (SS3) 2.50-3.00m	MAR01357.006	Sediment	11.7	0.15	23.3	10.3	<0.01	15.7	8.9	36.7
Certified Reference Material SETOC 774 (% Recovery)			107	105	109	108	101	107	103	103
QC Blank			<0.5	<0.04	<0.5	<0.5	<0.01	<0.5	<0.5	<2

* See Report Notes

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR01357
Issue Version	1
Customer Reference	Scapa Flow Marine Scotland Sediment Testing

		Units	µg/Kg (Dry Weight)	
		Method No	ASC/SOP/301	
		Limit of Detection	1	1
		Accreditation	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**Dibutyltin (DBT)**	**Tributyltin (TBT)**
BH-M04 (SS1) 0.00-0.50m	MAR01357.001	Sediment	<5	<5
BH-M04 (SS2) 1.00-1.50m	MAR01357.002	Sediment	<5	<5
BH-M04 (SS3) 2.50-3.00m	MAR01357.003	Sediment	<5	<5
BH-M05 (SS1) 0.00-0.50m	MAR01357.004	Sediment	<5	<5
BH-M05 (SS2) 1.00-1.50m	MAR01357.005	Sediment	<5	<5
BH-M05 (SS3) 2.50-3.00m	MAR01357.006	Sediment	<5	<5
Certified Reference Material QSP076MS (% Recovery)			93	104
QC Blank			<1	<1

* See Report Notes

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Test Report ID	MAR01357
Issue Version	1
Customer Reference	Scapa Flow Marine Scotland Sediment Testing

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304
		Limit of Detection	1	1	1	1	1	1
		Accreditation	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**ACENAPTH**	**ACENAPHY**	**ANTHRACN**	**BAA**	**BAP**	**BBF**
BH-M04 (SS1) 0.00-0.50m	MAR01357.001	Sediment	<1	<1	<1	<1	<1	1.83
BH-M04 (SS2) 1.00-1.50m	MAR01357.002	Sediment	<1	<1	<1	<1	<1	1.45
BH-M04 (SS3) 2.50-3.00m	MAR01357.003	Sediment	<1	<1	<1	<1	<1	1.65
BH-M05 (SS1) 0.00-0.50m	MAR01357.004	Sediment	<1	<1	<1	<1	<1	1.70
BH-M05 (SS2) 1.00-1.50m	MAR01357.005	Sediment	<1	<1	<1	<1	<1	1.84
BH-M05 (SS3) 2.50-3.00m	MAR01357.006	Sediment	1.34	1.16	1.92	4.94	5.71	6.87
Certified Reference Material Quasimeme QPH105MS (% Recovery)			88	127	97	89	91	73
QC Blank			<1	<1	<1	<1	<1	<1

For full analyte name see method summaries

~ Indicates result is for an In-house Reference Material as no Certified Reference Materials are avaliable.

As the method uses surrogate standards to correct for losses, the RM results are reported as percentage trueness, not recovery.

Certificate of Analysis

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Test Report ID	MAR01357
Issue Version	1
Customer Reference	Scapa Flow Marine Scotland Sediment Testing

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304
		Limit of Detection	1	1	1	1	1	1
		Accreditation	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**BENZGHIP**	**BKF**	**CHRYSENE**	**DBENZAH**	**FLUORANT**	**FLUORENE**
BH-M04 (SS1) 0.00-0.50m	MAR01357.001	Sediment	1.75	<1	4.43	<1	1.74	<1
BH-M04 (SS2) 1.00-1.50m	MAR01357.002	Sediment	1.45	<1	3.83	<1	1.79	<1
BH-M04 (SS3) 2.50-3.00m	MAR01357.003	Sediment	1.44	<1	3.09	<1	1.23	<1
BH-M05 (SS1) 0.00-0.50m	MAR01357.004	Sediment	1.07	<1	3.22	<1	1.08	<1
BH-M05 (SS2) 1.00-1.50m	MAR01357.005	Sediment	1.30	<1	2.09	<1	1.54	<1
BH-M05 (SS3) 2.50-3.00m	MAR01357.006	Sediment	5.15	3.05	7.67	1.28	9.94	1.77
Certified Reference Material Quasimeme QPH105MS (% Recovery)			96	99	90	96	98	86
QC Blank			<1	<1	<1	<1	<1	<1

For full analyte name see method summaries

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As the method uses surrogate standards to correct for losses, the RM results are reported as percentage trueness, not recovery.

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Test Report ID	MAR01357
Issue Version	1
Customer Reference	Scapa Flow Marine Scotland Sediment Testing

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/306
		Limit of Detection	1	1	1	1	100
		Accreditation	UKAS	UKAS	UKAS	N	N
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**INDPYR**	**NAPTH**	**PHENANT**	**PYRENE**	**THC**
BH-M04 (SS1) 0.00-0.50m	MAR01357.001	Sediment	<1	1.38	3.60	2.88	59900
BH-M04 (SS2) 1.00-1.50m	MAR01357.002	Sediment	<1	1.38	4.48	2.64	46800
BH-M04 (SS3) 2.50-3.00m	MAR01357.003	Sediment	<1	1.43	2.81	3.06	123000
BH-M05 (SS1) 0.00-0.50m	MAR01357.004	Sediment	<1	1.28	1.10	3.05	42200
BH-M05 (SS2) 1.00-1.50m	MAR01357.005	Sediment	<1	1.22	1.14	1.78	20200
BH-M05 (SS3) 2.50-3.00m	MAR01357.006	Sediment	4.20	4.02	6.67	9.32	23600
Certified Reference Material Quasimeme QPH105MS (% Recovery)			90	103	94	101	92~
QC Blank			<1	<1	<1	<1	<1

For full analyte name see method summaries

~ Indicates result is for an In-house Reference Material as no Certified Reference Materials are avaliable.

As the method uses surrogate standards to correct for losses, the RM results are reported as percentage trueness, not recovery.

Certificate of Analysis

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Test Report ID MAR01357
Issue Version 1
Customer Reference Scapa Flow Marine Scotland Sediment Testing

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302
		Limit of Detection	0.08	0.08	0.08	0.08	0.08	0.08	0.08
		Accreditation	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**PCB28**	**PCB52**	**PCB101**	**PCB118**	**PCB138**	**PCB153**	**PCB180**
BH-M04 (SS1) 0.00-0.50m	MAR01357.001	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M04 (SS2) 1.00-1.50m	MAR01357.002	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M04 (SS3) 2.50-3.00m	MAR01357.003	Sediment	<0.08	0.12	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M05 (SS1) 0.00-0.50m	MAR01357.004	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M05 (SS2) 1.00-1.50m	MAR01357.005	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M05 (SS3) 2.50-3.00m	MAR01357.006	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Certified Reference Material Quasimeme QOR143MS (% Recovery)			79	103	96	108	98	101	91
QC Blank			<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08

For full analyte name see method summaries

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Test Report ID MAR01357
Issue Version 1
Customer Reference Scapa Flow Marine Scotland Sediment Testing

REPORT NOTES

Method Code	Sample ID	The following information should be taken into consideration when using the data contained within this report
WSLM59*	MAR01357.001-006	Analysis was conducted by an internal SOCOTEC laboratory. UKAS accredited analysis by this laboratory is under UKAS number 1252.
ICPMSS*	MAR01357.001-006	Analysis was conducted by an internal SOCOTEC laboratory. UKAS accredited analysis by this laboratory is under UKAS number 1252.
SOCOTEC Doncaster*	MAR01357.001-006	Analysis was conducted by an internal SOCOTEC laboratory.
SUB_01*	MAR01357.001-006	Analysis was conducted by an approved subcontracted laboratory.
SUB_02*	MAR01357.001-006	Analysis was conducted by an approved subcontracted laboratory.
ASC/SOP/301	MAR01357.001-006	The matrix of this sample has been found to interfere with the result for this test. The sample has therefore been diluted, but in doing so, the detection limit for this test has been elevated.
ASC/SOP/303/304	MAR01357.001-006	Chrysene is known to coelute with Triphenylene and these peaks can not be resolved. It is believed Triphenylene is present in these samples therefore it is suggested that the Chrysene results should be taken as a Chrysene (inc. Triphenylene).This should be taken into consideration when utilising the data.

DEVIATING SAMPLE STATEMENT

Deviation Code	Deviation Definition	Sample ID	Deviation Details. The following information should be taken into consideration when using the data contained within this report
D1	Holding Time Exceeded	N/A	N/A
D2	Handling Time Exceeded	N/A	N/A
D3	Sample Contaminated through Damaged Packaging	N/A	N/A
D4	Sample Contaminated through Sampling	N/A	N/A
D5	Inappropriate Container/Packaging	N/A	N/A
D6	Damaged in Transit	N/A	N/A
D7	Insufficient Quantity of Sample	N/A	N/A
D8	Inappropriate Headspace	N/A	N/A
D9	Retained at Incorrect Temperature	N/A	N/A
D10	Lack of Date & Time of Sampling	N/A	N/A
D11	Insufficient Sample Details	N/A	N/A
D12	Sample integrity compromised or not suitable for analysis	N/A	N/A

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Method	Sample and Fraction Size	Method Summary
Total Solids	Wet Sediment	Calculation (100%-Moisture Content).Moisture content determined by drying a portion of the sample at 120°C to constant weight.
Particle Size Analysis	Wet Sediment	Wet and dry sieving followed by laser diffraction analysis.
Total Organic Carbon (TOC)	Air dried and ground	Carbonate removal and sulphurous acid/combustion at 1600°C/NDIR.
Metals	Air dried and seived to <63µm	Aqua-regia extraction followed by ICP analysis.
Organotins	Wet Sediment	Solvent extraction and derivatisation followed by GC-MS analysis.
Polyaromatic Hydrocarbons (PAH)	Wet Sediment	Solvent extraction and clean up followed by GC-MS analysis.
Total Hydrocarbon Content (THC)	Wet Sediment	Solvent extraction and clean up followed by GC-FID analysis.
Polychlorinated Biphenyls (PCBs)	Air dried and seived to <2mm	Solvent extraction and clean up followed by GC-MS-MS analysis.

Analyte Definitions

Analyte Abbreviation	Full Analyte name	Analyte Abbreviation	Full Analyte name	Analyte Abbreviation	Full Analyte name
ACENAPTH	Acenaphthene	C2N	C2-naphthalenes	THC	Total Hydrocarbon Content
ACENAPHY	Acenaphthylene	C3N	C3-naphthalenes	AHCH	alpha-Hexachlorcyclohexane
ANTHRACN	Anthracene	CHRYSENE	Chrysene	BHCH	beta-Hexachlorcyclohexane
BAA	Benzo[a]anthracene	DBENZAH	Dibenzo[ah]anthracene	GHCH	gamma-Hexachlorcyclohexane
BAP	Benzo[a]pyrene	FLUORANT	Fluoranthene	DIELDRIN	Dieldrin
BBF	Benzo[b]fluoranthene	FLUORENE	Fluorene	HCB	Hexachlorobenzene
BEP	Benzo[e]pyrene	INDPYR	Indeno[1,2,3-cd]pyrene	DDD	p,p'-Dichlorodiphenyldichloroethane
BENZGHIP	Benzo[ghi]perylene	NAPTH	Naphthalene	DDE	p,p'-Dichlorodiphenyldichloroethylene
BKF	Benzo[k]fluoranthene	PERYLENE	Perylene	DDT	p,p'-Dichlorodiphenyltrichloroethane
C1N	C1-naphthalenes	PHENANT	Phenanthrene		
C1PHEN	C1-phenanthrene	PYRENE	Pyrene		

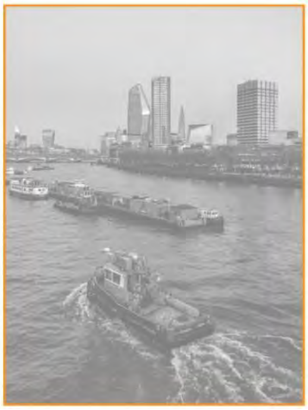
TECHNICAL APPENDIX 2.3

ORKNEY ISLANDS COUNCIL

SCAPA FLOW DEEPWATER QUAY NRA





Report Number:	21UK1812
Issue:	01
Date:	27 April 2022

MARINE AND RISK CONSULTANTS LTD

Prepared for: Orkney Islands Council

Council Offices
Kirkwall
Orkney
KW15 1NY

Author(s): William Heaps

QC: David Foster

Date	Release	Prepared	Authorised	Notes
24 Feb 2022	Draft A	WH	AC	For Client Comment
27 Apr 2022	Issue 01	WH	AV	Final version (No comments from client)

Marine and Risk Consultants Ltd
Marico Marine
Bramshaw
Lyndhurst
Hampshire
SO43 7JB
United Kingdom

Telephone: + 44 (0) 2380 811133
Email: officeUK@maricogroup.com

EXECUTIVE SUMMARY

This Navigational Risk Assessment (NRA) report has been prepared by Marine and Risk Consultants Limited (Marico Marine) for Orkney Islands Council (OIC) to support the proposed development of a new deep-water quay in Scapa Flow, within the Orkney Islands Statutory Harbour Authority (SHA) Area.

This NRA references the OIC Safety Management System (SMS), which aims to enhance safety within Scapa Flow by ensuring that all marine navigation hazards are identified, control measures are in place, and levels of risks are acceptable. In particular, reference is made to the NRA undertaken on behalf of OIC by Marico Marine for the Scapa Flow SHA area (Report 15UK1073, Navigational Risk Assessment: Scapa Flow, Issue 01, 24 February 2016).

This assessment has concluded that there is little significant new navigational risk associated with either the construction or operation of the proposed Scapa Flow Deep Water Quay.

The project site is located in an area of very low present day traffic density, and which is already subject to numerous effective risk control measures (VTS, Pilotage, Towage, etc). As a result of both of these factors, incident frequency is also low.

There will be an inevitable increase in navigation risk through the introduction of a new structure, generating an increased volume of traffic. However, the increase in risk is low, on top of an already low baseline.

While this assessment has found that navigation risk will be low, or in a small number of scenarios, within the ALARP band both during the construction and operational phases, the following recommendations are made:

- Existing control measures should be kept in place (VTS, Pilotage, Towage) during both construction and operation phases;
- Good communications should be maintained with stakeholders throughout (NTMs, website, meetings etc). There will be a need for close liaison between the OICHA and the contractors during the construction phase and between OICHA and the berth operator during the operational phase.;
- Communication should be established with local leisure users who may be currently using an inshore route at the project site, noting no input to this NRA;
- If inshore leisure use is found to be significant, a plan to manage these vessels during construction and operation phases should be developed;
- A Navigation Management Plan for the construction phase should be designed and implemented to reduce the chance of ship-to-ship collisions between craft involved in the construction phase;
- All of the risks should be kept under review as the project is developed, and once the facility is operational, OICs PMSC NRA should be updated and kept under review to reflect the new operations.

CONTENTS

FIGURES

TABLES

ANNEXES

ABBREVIATIONS

Abbreviation	Detail
AIS	Automatic Identification System
AToNs	Aids to Navigation
COLREGs	Convention on International Regulations for Preventing Collisions at Sea
CPA	Closest Point of Approach
CMR	Construction Monitoring Report
DML	Deemed Marine Licence
DWR	Deep-Water Route
KWh	Kilowatt-hour
IMO	International Maritime Organisation
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
LOA	Length Over-All
m	Metre
MAIB	Marine Accident Investigation Branch
Marico Marine	Marine and Risk Consultants Ltd
MCA	Maritime and Coastguard Agency
MGN	Marine Guidance Note
MMO	Marine Management Organisation
nm	Nautical Mile
NRA	Navigation Risk Assessment
NtM	Notice to Mariners
OICHA	Orkney Islands Council Harbour Authority
RCM	Risk Control Measures
SHA	Statutory Harbour Authority
SDWQ	Scapa Deep Water Quay
SMS	Safety Management System
SOLAS	Safety Of Life At Sea
TSS	Traffic Separation Scheme
VHF	Very High Frequency
VMS	Vessel Monitoring System
VTS	Vessel Traffic Study

1 INTRODUCTION

This Navigational Risk Assessment (NRA) report has been prepared by Marine and Risk Consultants Limited (Marico Marine) for Orkney Islands Council (OIC) to support the proposed development of a new deep-water quay in Scapa Flow, within the Orkney Islands Statutory Harbour Authority (SHA) Area.

This NRA references the OIC Safety Management System (SMS), which aims to enhance safety within Scapa Flow by ensuring that all marine navigation hazards are identified, control measures are in place, and levels of risks are acceptable. In particular, reference is made to the NRA undertaken on behalf of OIC by Marico Marine for the Scapa Flow SHA area (Report 15UK1073, Navigational Risk Assessment: Scapa Flow, Issue 01, 24 February 2016).

1.1 BACKGROUND AND SCOPE

The Port Marine Safety Code (PMSC)[1] establishes a national standard for every aspect of port marine safety and aims to enhance safety for those who use or work within ports, their ships, passengers and the environment. The PMSC applies to all harbour authorities in the UK that have statutory powers and duties.

The PMSC promotes the principle that all harbour authorities shall base their policies and procedures relating to marine operations on a formal identification of hazards and assessment of risk to marine operations. They shall maintain a SMS based on a formal navigational risk assessment, and any subsequent supporting risk assessments deemed necessary as the SMS develops and evolves over time as a result of changing trade and harbour usage.

The development of the proposed new facility is clearly a change in trade and usage warranting a review of the existing NRA. However, in order to support the consenting process for this large project, a full NRA considering the effects of both the construction and operation phases of the new jetty has been undertaken, and the results of the assessment will be used to update OIC's PMSC assessment in due course.

It should be noted that this assessment **only** considers the impact of the project on navigational safety, through assessing risks to vessels navigating in the project area. Other impacts of the project (for example on the land and marine environments) are being assessed separately as part of the consenting process.

This new NRA complies with the PMSC and its associated Guide to Good Practice[2], and was conducted in accordance with the International Maritime Organisation (IMO) Formal Safety Assessment (FSA) methodology for risk assessments. It comprises the following four stages:

- Stage 1: Data Gathering and Vessel Traffic Analysis;

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[1] Port Marine Safety Code, Department for Transport, November 2016

[2] A Guide to Good Practice on Port Marine Operations, Prepared in Conjunction with the Port Marine Safety Code, DfT, February 2018

- Stage 2: Hazard Identification;
- Stage 3: Risk Assessment; and
- Stage 4: Identification of Risk Control Measures.

The Scapa Flow SHA area (from the 2016 NRA) is shown in **Figure 1**.

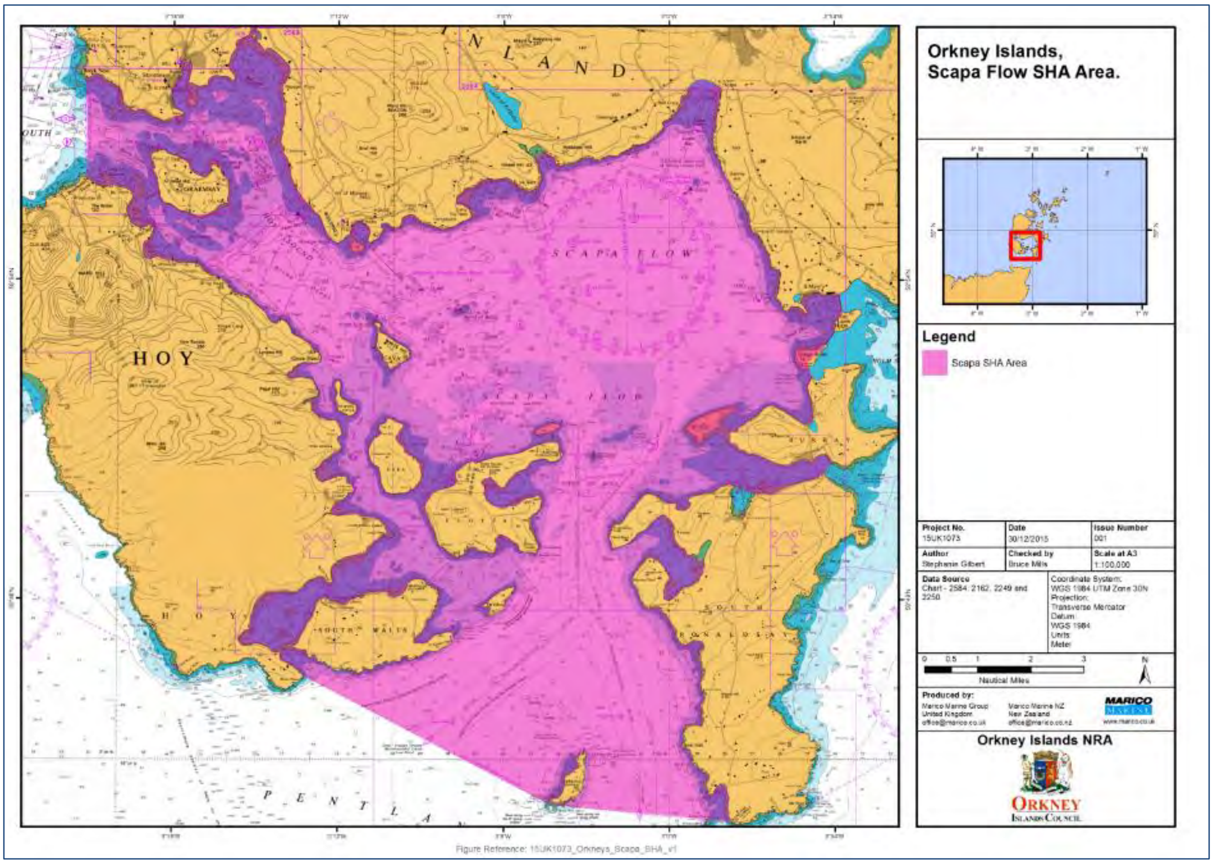

Figure 1: Scapa Flow SHA Area.

1.2 PROJECT DESCRIPTION

OIC, the Orkney Islands Harbour Authority, has published the "Orkney Harbours Masterplan Phase 1"[3]. This plan has identified "*a structured framework for the physical development and transformation of Orkney's harbours over a 20-year period*". The Orkney Harbours Masterplan Phase 1 comprises proposals at six, harbour locations, one of which is a deep-water quay in Scapa Flow.

The following project description is taken from the Masterplan:

There is no deep-water pier infrastructure in Scapa Flow located on the Orkney mainland coast. As part of option development consideration was given to possible locations for deep water quayside infrastructure in proximity to

---

[3] OIC Master Plan March 2020 https://www.orkneyharbours.com/masterplan

the existing Scapa Pier, with a suitable site potentially identified to the south of Scapa Pier. This proposal comprises 300m of quayside with water depth of - 20m CD, and a 75m wide approach quay with 5+ hectares of landside area – options for an extended pier or inclusion of dolphins could be considered during feasibility stage, depending on market opportunities at the time.

The main purpose of this facility would be to undertake any/multiple industry activity that requires both deep-water berthing and large laydown area. There are specific market opportunities in the offshore wind and oil and gas sectors. This is also a potential location for the development of a LNG storage and supply hub.

With regard to offshore wind, there are several lease areas earmarked for development around Orkney, with Orkney the preferred location as a hub for construction and O&M – Scapa Deep Water Quay is the optimal site for this activity.

In the oil and gas sector large structures and vessels could come alongside for repairs and maintenance.

Scapa Flow is already identified as a national strategic asset and this development will further enhance its role.

Figure 2: Artist's Impression of Proposed Quay

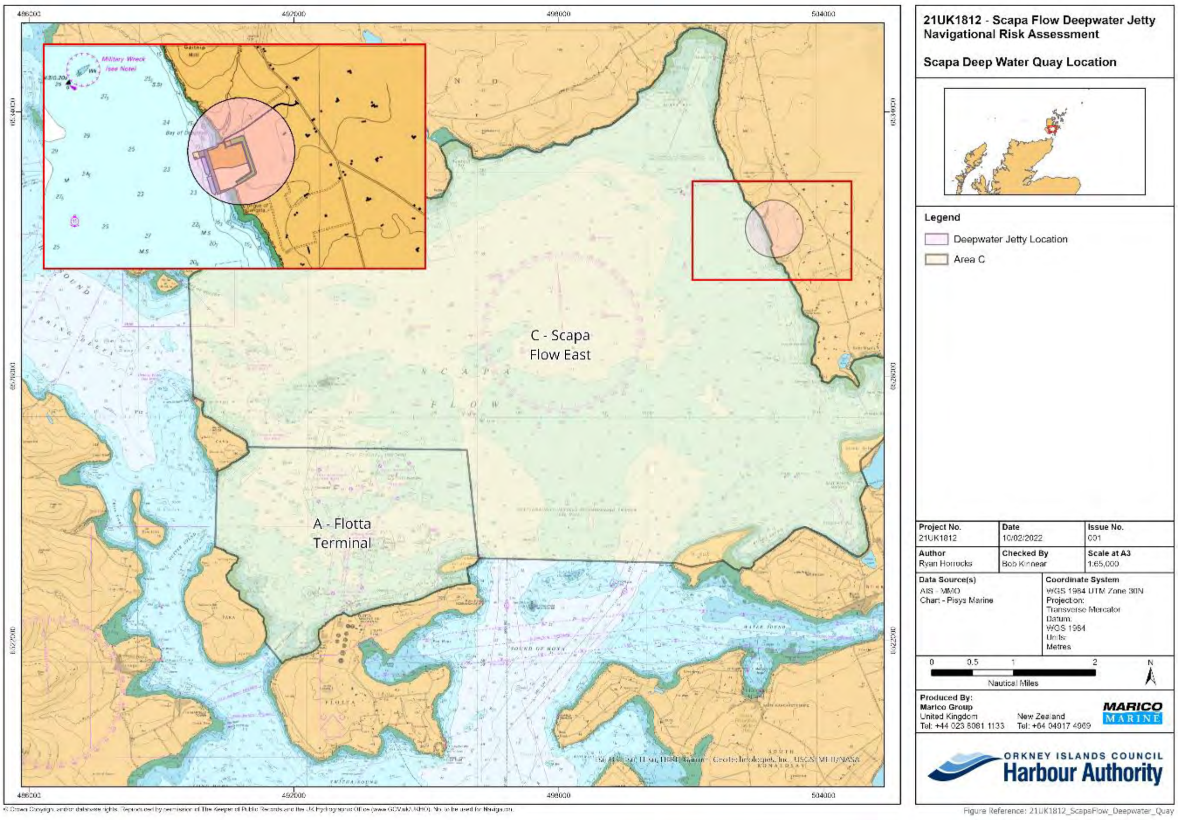

Figure 3: Scapa Deep Water Quay Location

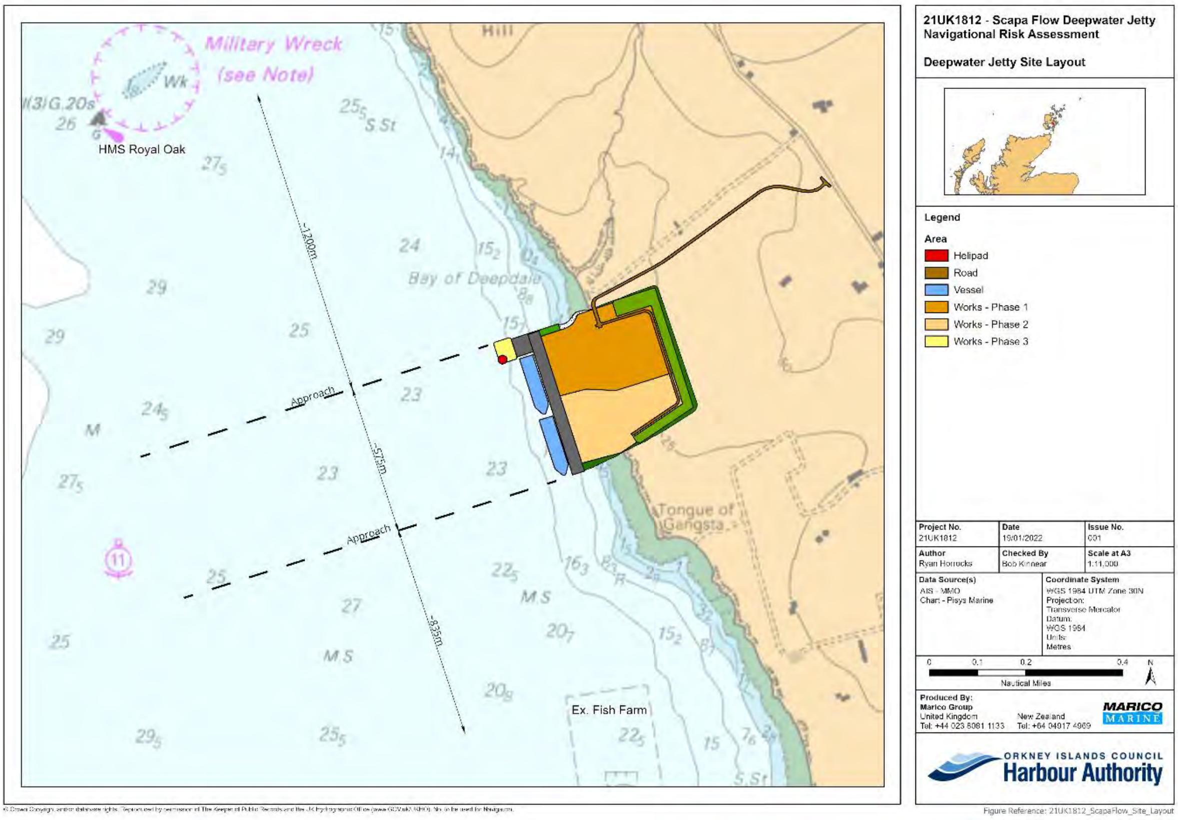

Figure 4: Scapa Deep Water Quay Site Layout

2 DATA GATHERING

In order to inform the new NRA, the following sources of data were referenced to inform the NRA process:

- A review of the design and location of the new quay, along with assessment of the volume and type of additional marine vessel traffic that it is anticipated will use the new facility;
- A review of existing vessel traffic in Scapa Flow and the immediate vicinity of the study area. (Using the most recent data available, noting that although regularly reviewed, the PMSC NRA is now 8 years old);
- Review of available navigational incident data for the project area; and
- Consultation with marine stakeholders to verify traffic analysis, and incident data.

2.1 PROJECT ASSESSMENT

While the project design is still in the early stages, the anticipated timetable[4] for works will be:

- The access road will be constructed first, approx. 2023;
- During 2023 there will be tenders for the construction with award of contract to start construction in 2024 (on completion of access road). This will also state that construction needs to be completed by the end of 2026. This is the whole pier, quay area and storage area;
- Proposed first mobilisation to SDWQ in the first part of 2027;
- This will then allow (turbine) construction at sea to start 2028; and
- The first offshore wind turbines expected to be operational by 2030.

Therefore, marine construction will take place during calendar years 2024 to 2026, and operations are due to commence from 2027.

The type of construction is termed “combi-wall” which is a method of using tubular and sheet piles in a very efficient manner that reduces any effects on the environment to a minimum and also reduces costs with the efficient use of steel piles.

2.2 PROJECT RELATED VESSEL TRAFFIC

2.2.1 Construction Phase

Until tenders are issued for construction works, the type and volume of vessel traffic associated with the construction of the new facility is unknown. However, it would be reasonable to assume that while much of the construction activity will be from landward, there will be a need for some construction vessels to be used for the marine aspects of the new quay. The deep water already available will result in minimal (if any)

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[4] Source: OIC Marine Department, email communication.

dredging activity, but it would be expected that there will be some requirement for marine traffic related to delivery of materials, piling, quay construction and other activities such as fender installation. This is likely to include jack-up platforms, tugs, work boats, survey craft, and possibly crew transfer vessels. The number of vessels and movements will be small in relation to current traffic levels in the study area, but the assessors have made an allowance for such traffic being both present at the construction site and making occasional transits to and from site (from Scapa Pier, and in and out of the boundaries of the study area).

2.2.2 Operational Phase

Traffic volumes during operations will be very dependent on the ultimate commercial users of the new facility, and the success of the project in attracting such users to the facility. However, the economic predictions for the new quay have been made on the following assessment of likely marine traffic, once operational, and these numbers have been used during the assessment of navigational risk during the operational phase of the new facility.

Table 1: Predicted Operational Vessel Traffic Numbers

Vessels at SDWQ (Operational Phase)				
Year	Activity		Vessels	
	Delivery	Installation	Delivery	Installation
2028	70 piles	Phase 1 piles - 50	**8**	**2**
	50 jackets	Phase 1 jackets - 50	**5**	**6**
	30 turbines		**5**	
2029	70 piles	Phase 1 turbines - 50	**8**	**10**
	60 jackets	Phase 2 piles - 60	**6**	**2**
	30 turbines		**5**	
2030	30 piles	Phase 2 jackets - 60	**4**	**7**
	60 jackets	Phase 3 piles - 60	**6**	**2**
	50 turbines		**8**	
2031	60 turbines	Phase 2 turbines - 60	**10**	**12**
		Phase 3 jackets - 60		**7**
2032		Phase 3 turbines - 60		**12**

Once again, total numbers of traffic movements generated are relatively small in relation to existing traffic density, and this has been taken into consideration during the operational phase NRA.

2.2.3 Other Future Traffic Changes

Once the new facility is operational, it is anticipated that some existing traffic (notably OIC tugs and Pilot vessels may relocate their bases from Scapa Pier to the new quay. While this will have no significant effect on overall traffic numbers within the study area, traffic density will decrease in the northern extents of the study area (Scapa Pier) and be increased in the vicinity of the new development, relative to the current situation. This has also been considered in the operational phase NRA.

2.3 VESSEL TRAFFIC ANALYSIS

A full understanding of vessel traffic in the project area is an important and integral part of the NRA and therefore the following tools / techniques have been used to analyse the vessel traffic, including the traffic profile (i.e. numbers and types), traffic density and traffic routes:

- Traffic Plots;
- Traffic Density Analysis; and
- Gate Analysis.

2.3.1 Vessel Categories

Scapa Flow is used by a wide variety of commercial and recreational vessels, and it comprises a number of distinct areas, each with different geographic and operational characteristics. The following vessel type categories (**Table 2**) were identified during the 2016 NRA and have been retained for consistency. For the purposes of this assessment, a new category (J) of Construction Vessels has been added to the 2016 list.

Table 2: Vessel Categories.

Ref	Vessel Type Category	Including
A	Cruise Ship	All cruise ships.
B	Inshore Fishing Vessel	Trawler, Creel.
C	Inter-Island Ferry	Inter-Island Ferry, Flotta Passenger Launch.
D	Large Commercial Vessel	General Cargo, Product Tanker, Large Offshore Support Vessel. (windfarm construction), Offshore Fishing Vessel (not fishing in the harbour area). Large Naval vessels (> frigate)
E	Mainland Ferry	Northlink Ferries, Pentland Ferries, John O'Groats Ferry.
F	Recreational Vessel	Sailing Yacht, Motor Yacht, Sailing Dinghy, Rigid Hull Inflatable Boat (RHIB), Personal Watercraft (PWC).
G	Small Commercial Vessel	Fish Farm Vessel, General Workboat, Harbour Launch, Offshore Renewables Vessel, Diving Support Boat, Pilot Boat, Agent Launch, Small Passenger Vessel (≤12 passengers), Law Enforcement Vessel, Cruise Ship Tender, small naval vessels
H	Towage Vessel	Towage Tug, Escort Tug.
I	Large Tanker	LPG Tanker, Crude Oil Tanker, Gas Tanker, LNG Tanker
J	Construction vessels	Barges, jack ups, dredgers and associated workboats

2.3.2 Study Area

The 2016 NRA divided Scapa Flow into 5 distinct areas as shown in **Figure 5** below. However, for this project specific NRA the study area is restricted to area C (Scapa Flow East).

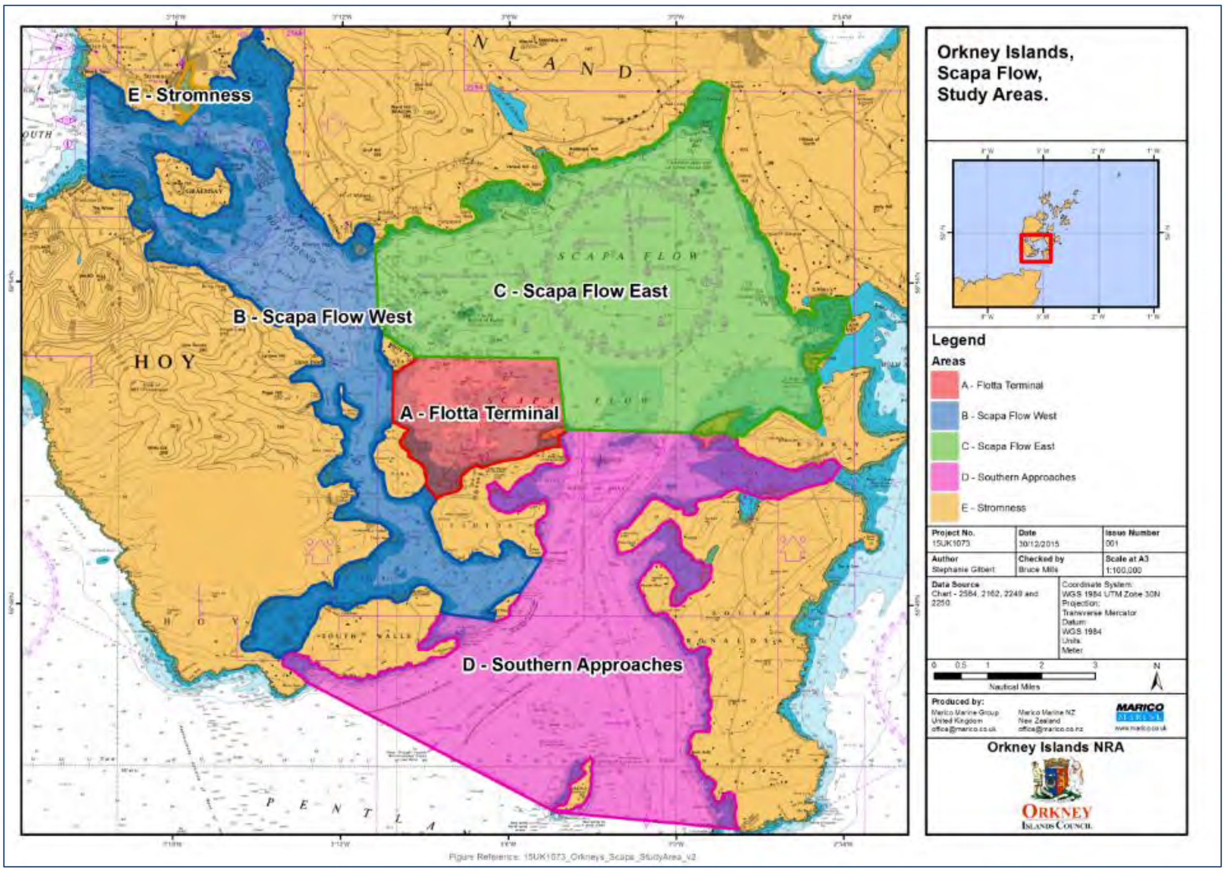

Figure 5: Scapa Flow Risk Areas (2016 NRA).

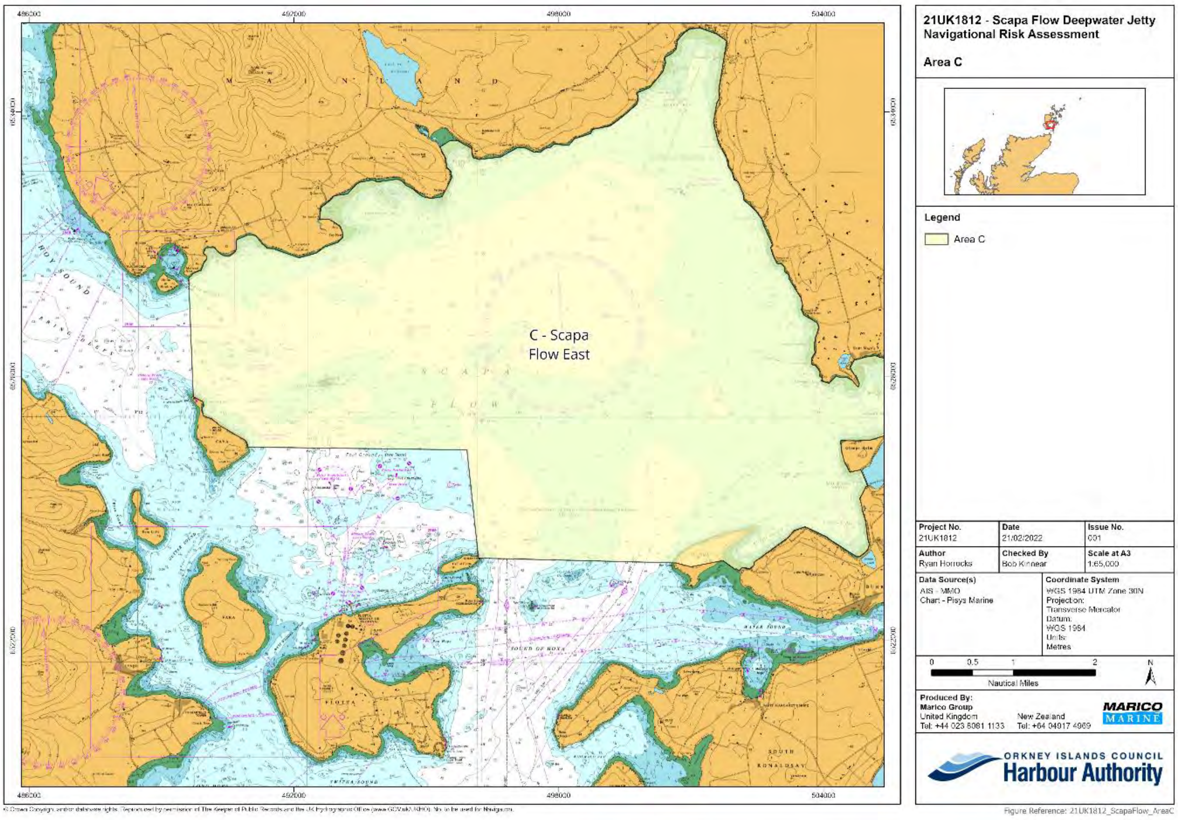

Figure 6: Scapa Deep Water Quay NRA Project Study Area

2.3.3 Vessel Traffic Data

The principal input to the analysis was Automatic Identification System (AIS) data.

It was not possible to extract recent data from the Orkney Harbours Vessel Traffic Services (VTS) System, so AIS data was acquired from the MMO and covers the first two weeks of every month in 2019. This data is considered representative of all traffic using the study area – particularly as 2019 predates any effect of the Covid-19 restrictions which have influenced more recent data. The AIS dataset covers the entire geographic limits of the study area and includes all vessels carrying “Class A” or “Class B” AIS transponders.

Note that some types of vessels are not required by legislation to carry AIS transponders and are therefore under-represented in the AIS data set. An estimate of the percentage of vessels in each category that carry transponders was made during 2016 and is provided in **Table 3**. It is likely that percentages may have increased slightly since that time for those vessels with less than 100% estimates. This information formed an important input to the risk assessment as it enhanced the accuracy and validity of traffic data in Scapa Flow.

Table 3: Estimated Percentage of Vessels with Class A or Class B AIS Transponders.

Ref	Vessel Type Category	Percentage
A	Cruise Ship	100%
B	Inshore Fishing Vessel	75%
C	Inter-Island Ferry	100%
D	Large Commercial Vessel	100%
E	Mainland Ferry	100%
F	Recreational Vessel	10%
G	Small Commercial Vessel	80%
H	Towage Vessel	100%
I	Large Tanker	100%

2.3.4 Traffic Plots – by Vessel Type

All vessel tracks extracted from the 2019 data (first two weeks of every month for the whole year) are given below, by vessel type. Traffic can be seen entering into the study area from Scapa Flow West and from the Southern approaches. Tracks for all vessel types show that they tend to follow fairly predictable regular routes. See **section 2.3.6** for a discussion regarding traffic density.

Note that the vessel categories supplied in the MMO AIS data cannot be exactly mapped to the categories as shown in **Table 2**, and best efforts have been made to match in the plots below. In particular note that cargo vessels is an MMO category that appears to be very wide ranging, and may in fact capture other vessel types.

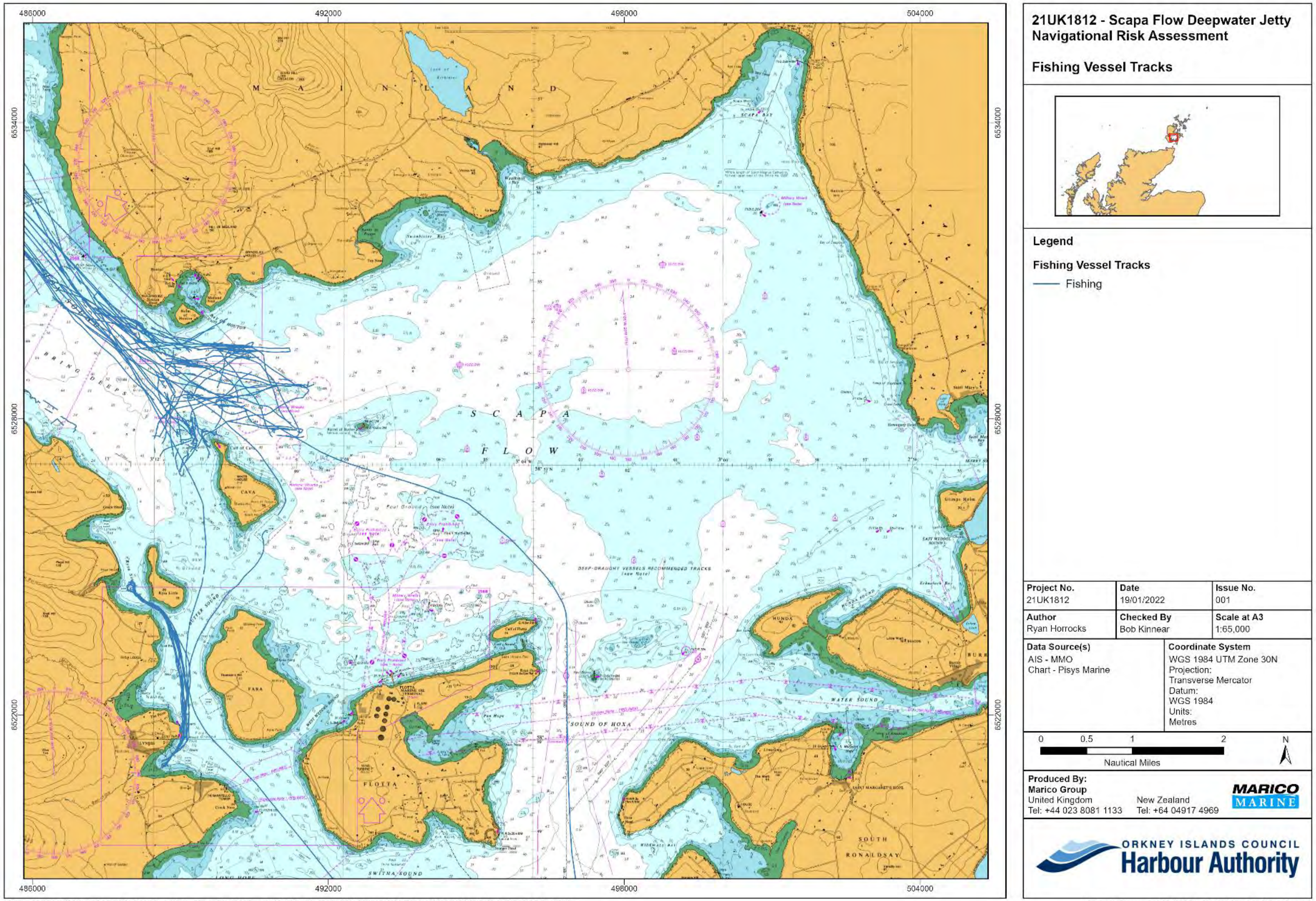

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Figure Reference: 21UK1812_ScapaFlow_Fishing_Vessels

Figure 7: Fishing Vessel Tracks

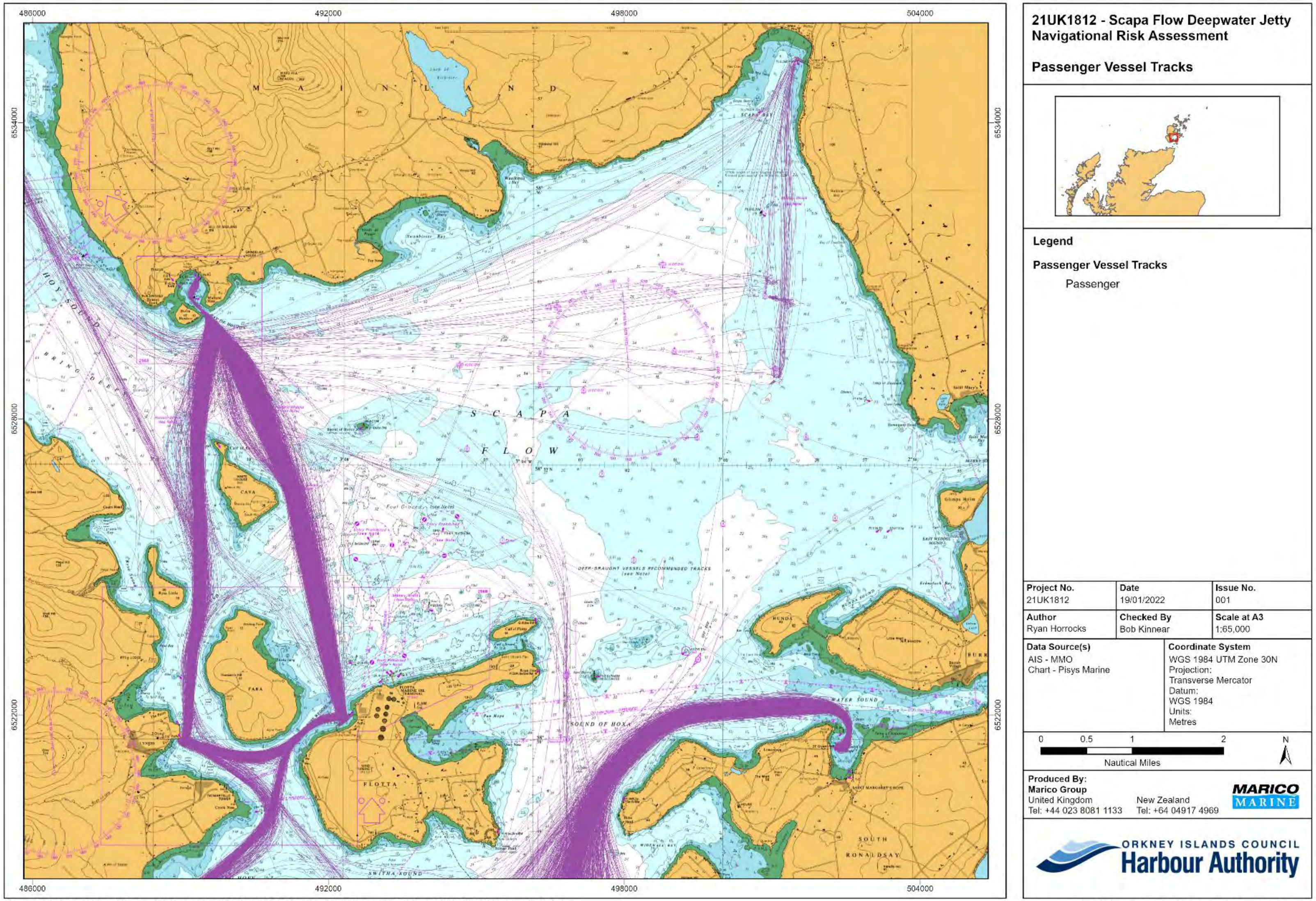

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Figure Reference: 21UK1812_ScapaFlow_Passenger_Vessels

Figure 8: Passenger Vessel Tracks

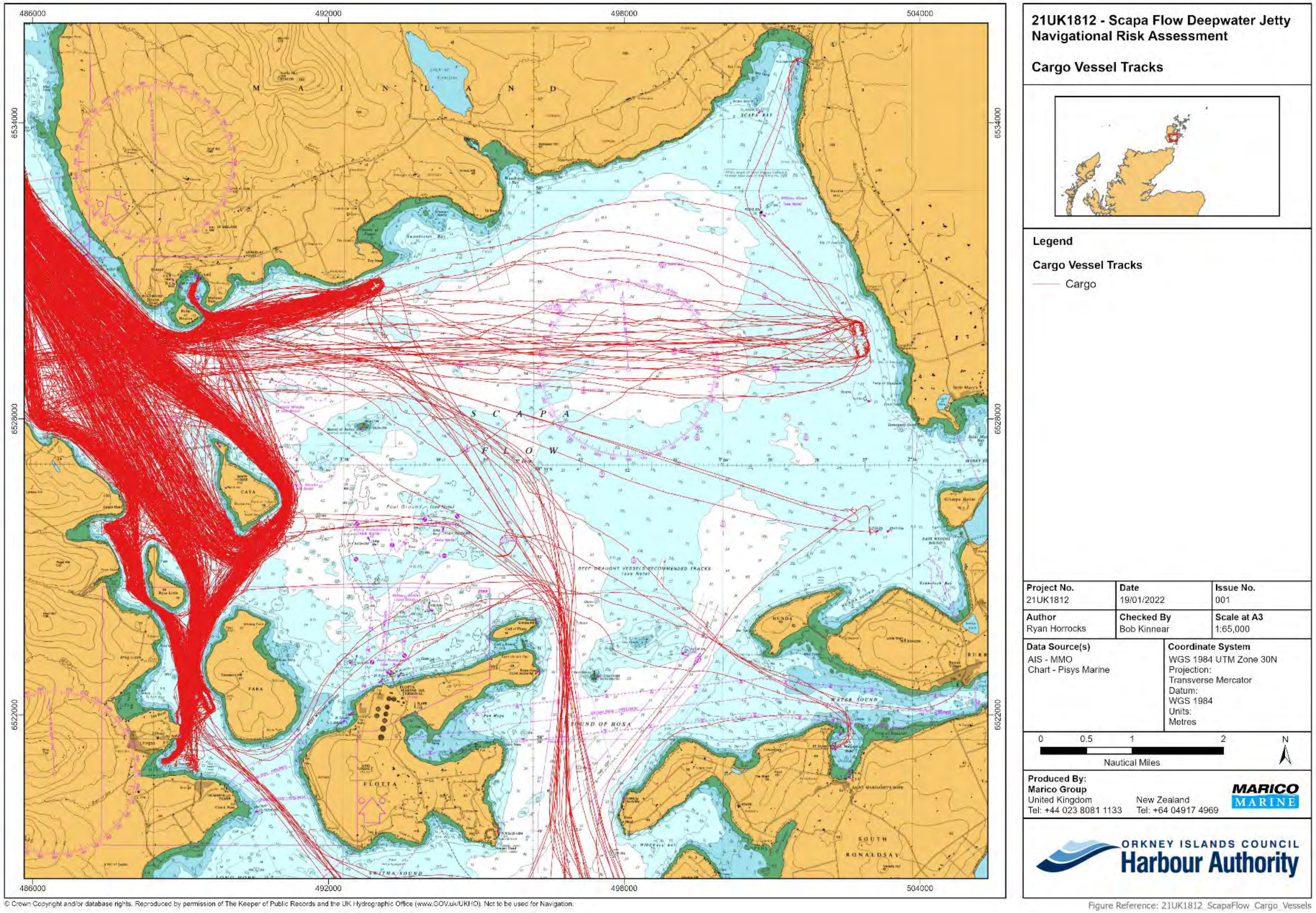
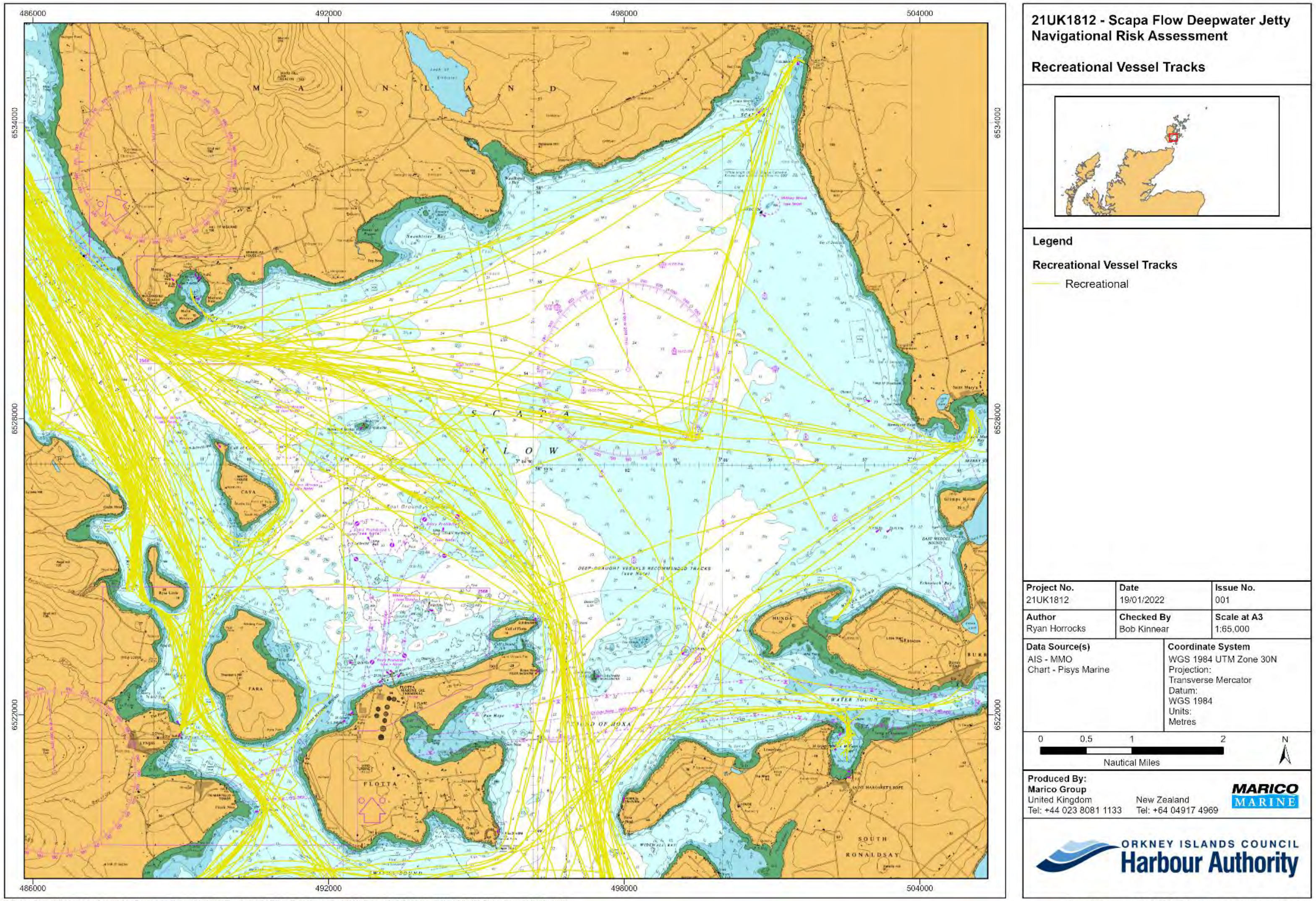


Figure 9: Cargo Vessel Tracks



21UK1812 - Scapa Flow Deepwater Jetty Navigational Risk Assessment

Recreational Vessel Tracks

Legend

Recreational Vessel Tracks

Recreational

Project No.	Date	Issue No.
21UK1812	19/01/2022	001
Author	**Checked By**	**Scale at A3**
Ryan Horrocks	Bob Kinnear	1:65,000

Data Source(s)
AIS - MMO
Chart - Pisys Marine

Coordinate System
WGS 1984 UTM Zone 30N
Projection:
Transverse Mercator
Datum:
WGS 1984
Units:
Metres

Produced By:
Marico Group
United Kingdom
Tel: +44 023 8081 1133
New Zealand
Tel: +64 04917 4969

MARICO MARINE

ORKNEY ISLANDS COUNCIL
Harbour Authority

Figure Reference: 21UK1812_ScapaFlow_Recreational_Vessels

Figure 10: Recreational Vessel Tracks

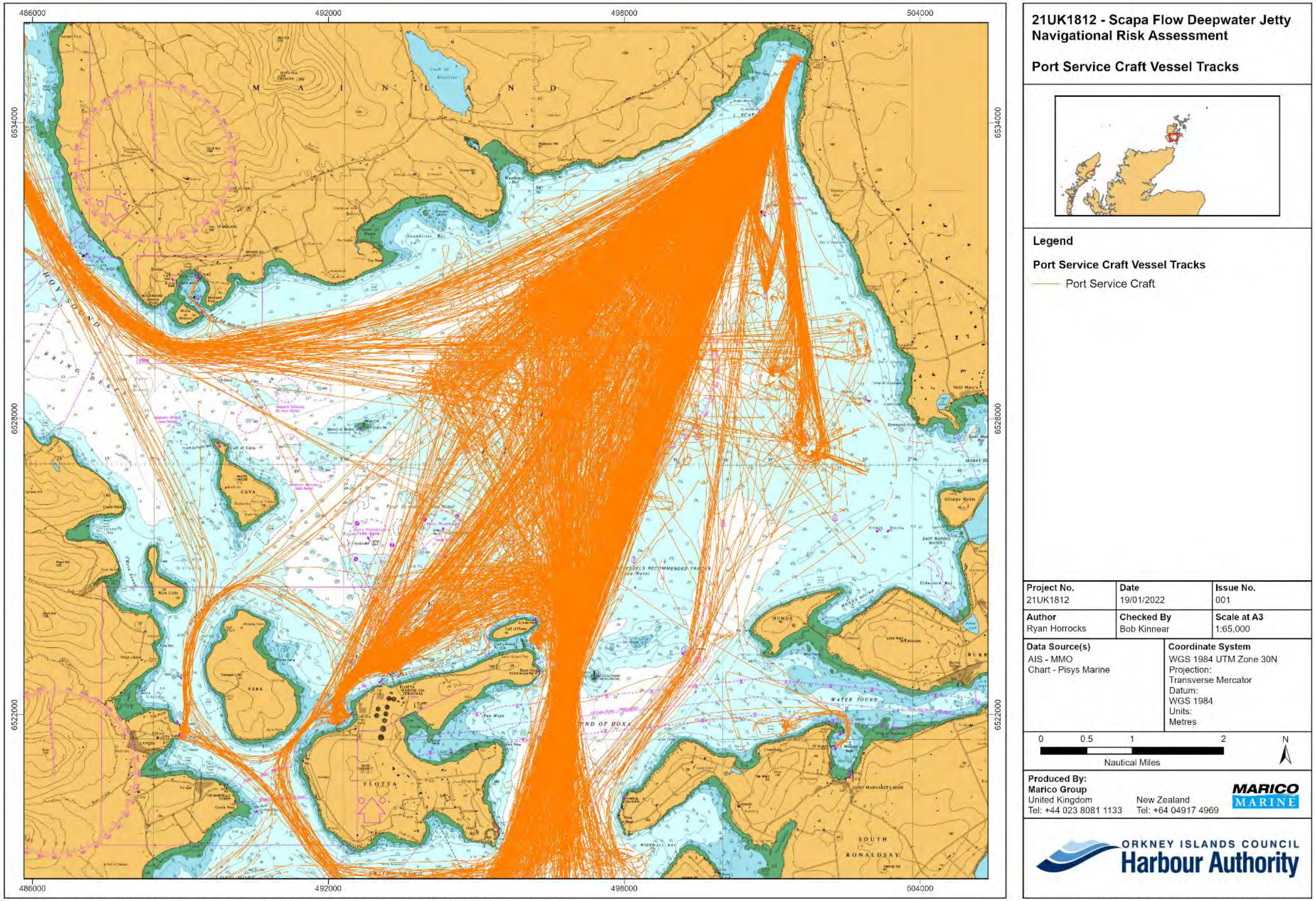


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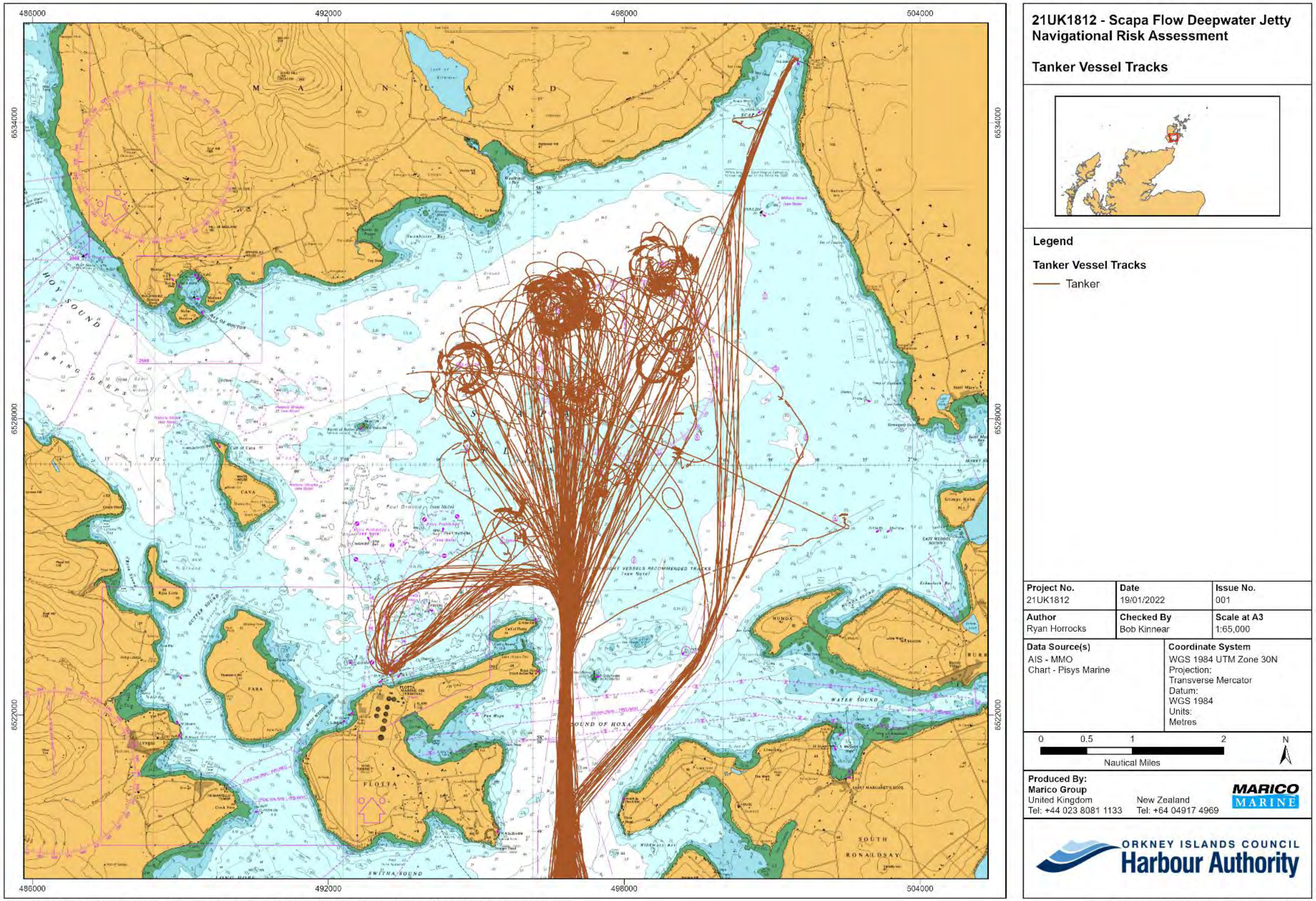
Figure Reference: 21UK1812_ScapaFlow_Port_Service_Craft_Vessels

Figure 11: Port Service Vessel Tracks



21UK1812 - Scapa Flow Deepwater Jetty Navigational Risk Assessment

Tanker Vessel Tracks

Legend

Tanker Vessel Tracks

— Tanker

Project No.	Date	Issue No.
21UK1812	19/01/2022	001
Author	**Checked By**	**Scale at A3**
Ryan Horrocks	Bob Kinnear	1:65,000

Data Source(s)	Coordinate System
AIS - MMO Chart - Pisys Marine	WGS 1984 UTM Zone 30N Projection: Transverse Mercator Datum: WGS 1984 Units: Metres

Produced By:
Marico Group
United Kingdom
Tel: +44 023 8081 1133

New Zealand
Tel: +64 04917 4969

MARICO MARINE

ORKNEY ISLANDS COUNCIL Harbour Authority

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Figure Reference: 21UK1812_ScapaFlow_Tanker_Vessels

Figure 12: Tanker Tracks

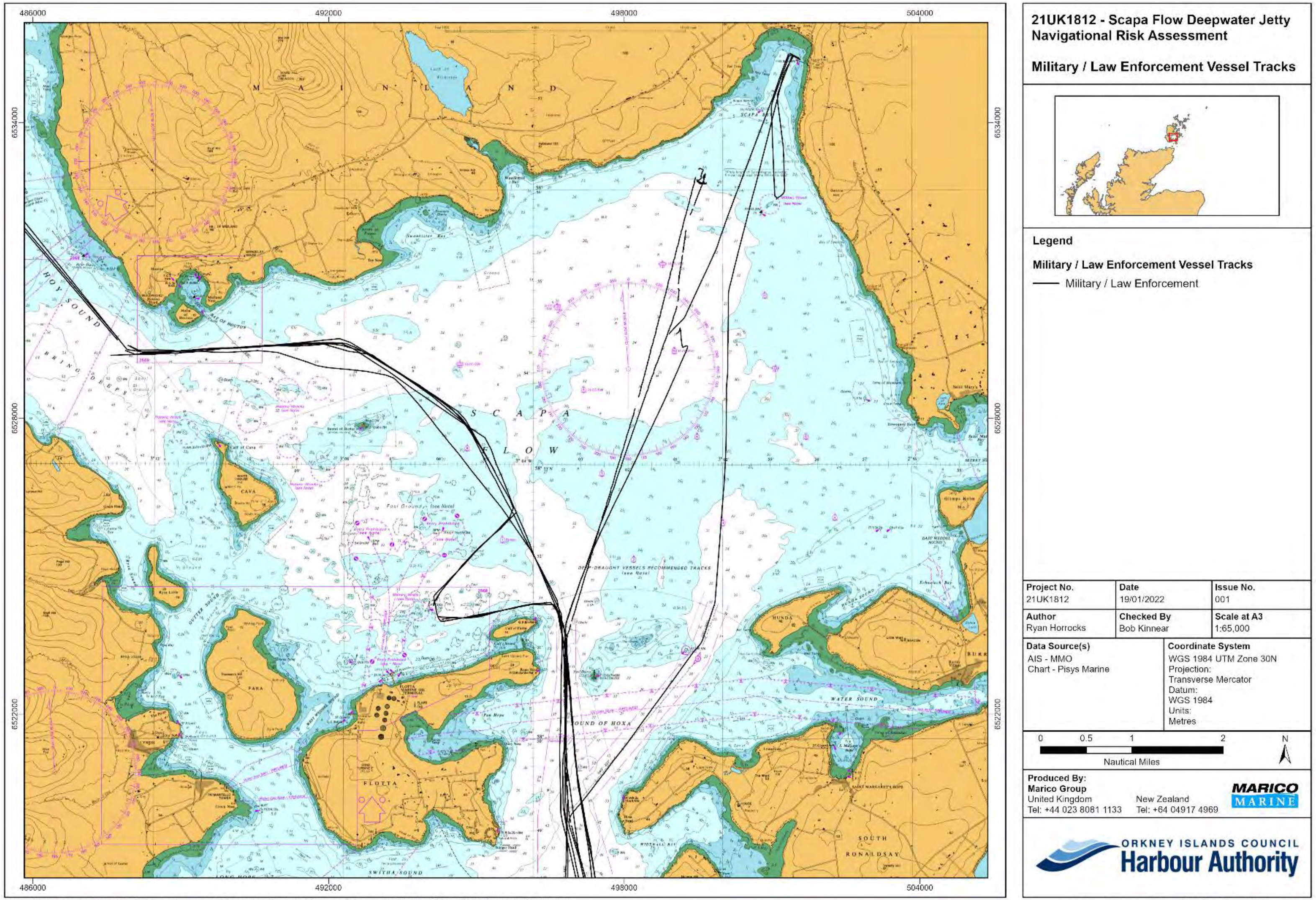

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Figure Reference: 21UK1812_ScapaFlow_Military_Vessels

Figure 13: Military Vessel Tracks

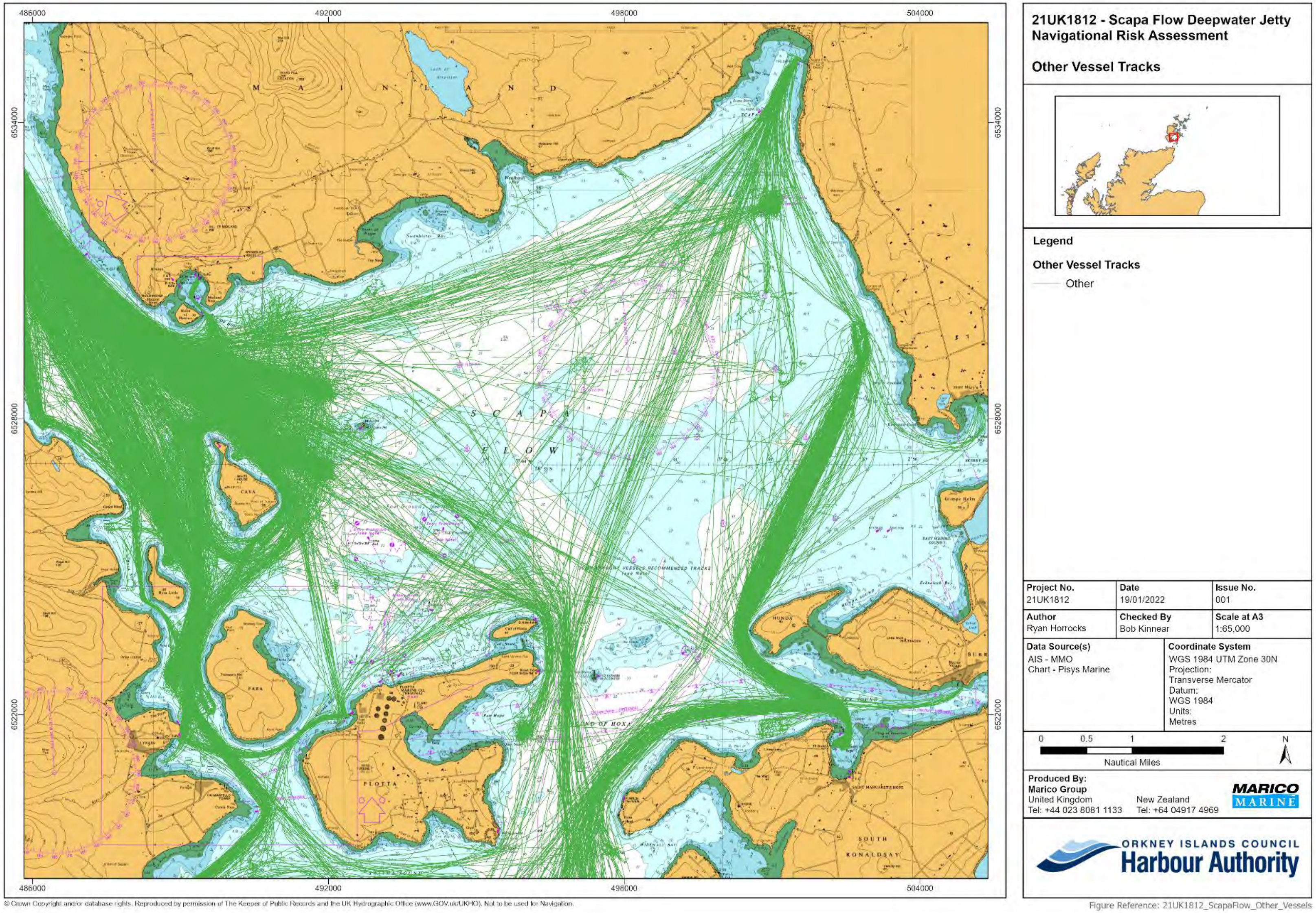

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Figure Reference: 21UK1812_ScapaFlow_Other_Vessels

Figure 14: Other Vessel Tracks

2.3.5 Traffic Plots – All Traffic

The vessel track plots in this section (derived from the same 2019 AIS data described in **section 2.3.3** above) illustrate tracks for all vessel types (the entire AIS data set).

The data is visualised as:

- All tracks by vessel type;
- Traffic density by season (Summer / Winter);
- All traffic density (identifying the busiest zones of the study area); and
- Gate analysis showing the density of shipping crossing tracks parallel to, and perpendicular to the new quay face.

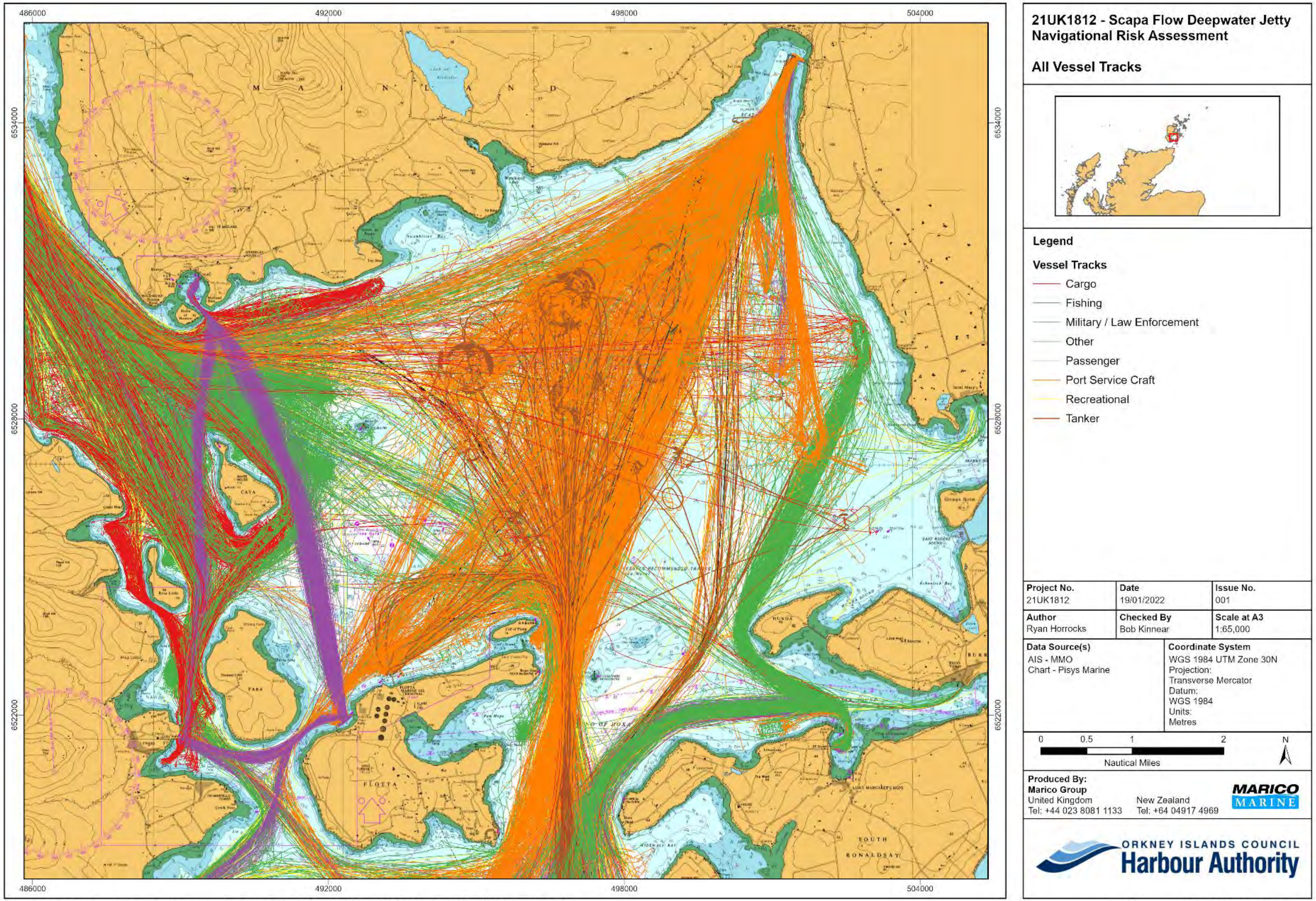

Figure Reference: 21UK1812_ScapaFlow_All_Vessels

Figure 15: All Vessel Tracks by Vessel Type

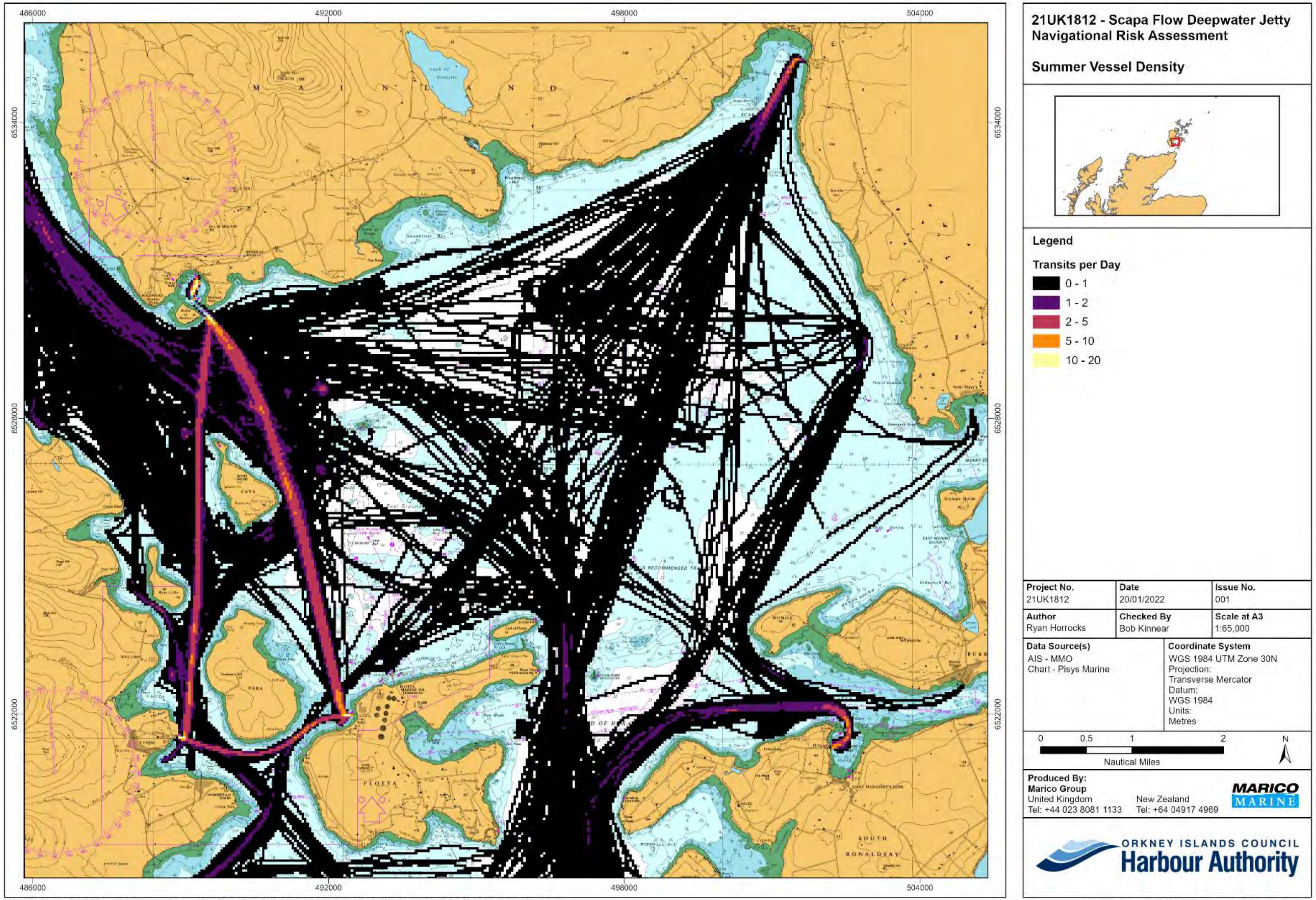

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Figure Reference: 21UK1812_ScapaFlow_Summer_Density

Figure 16: Summer Vessel Density

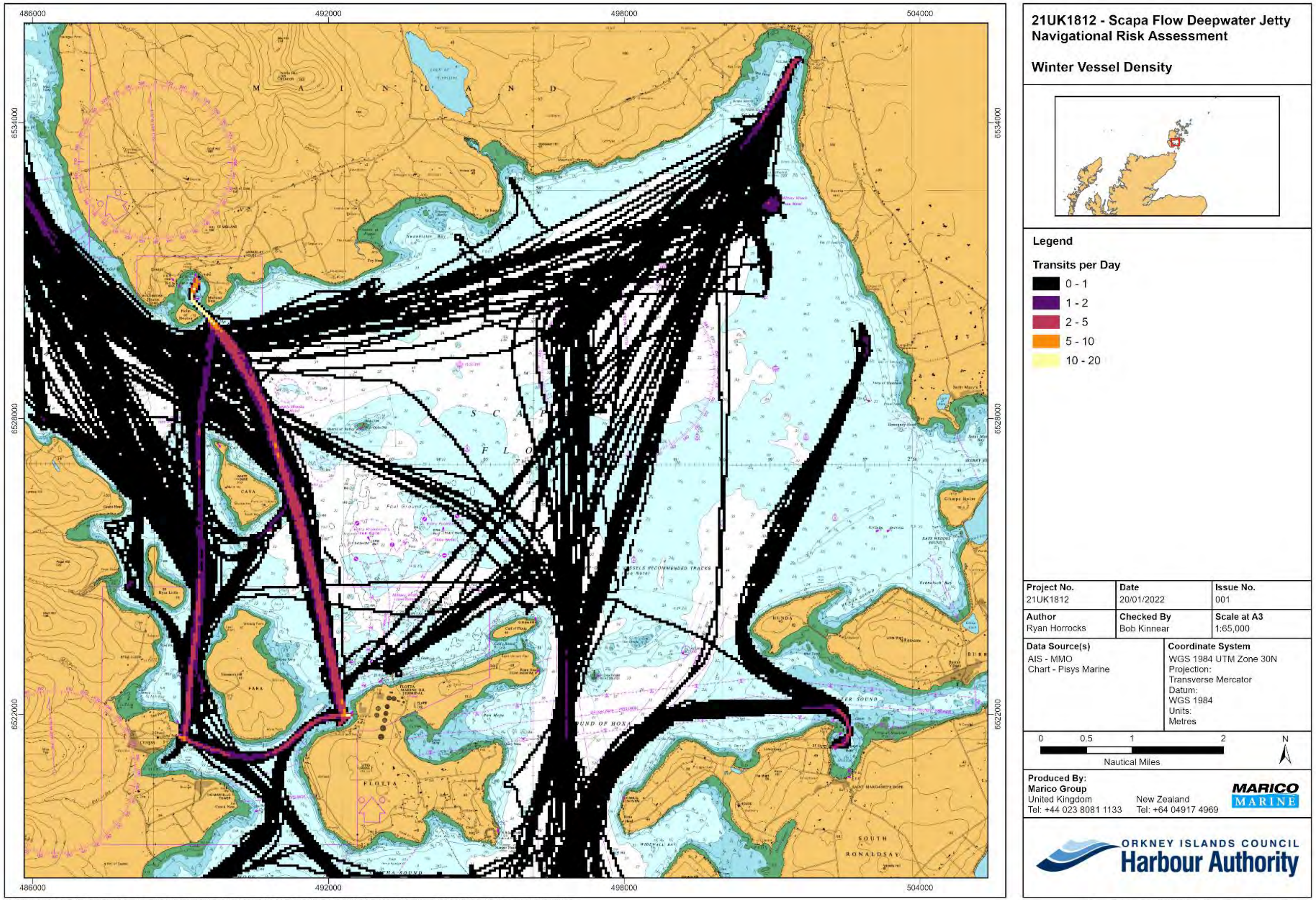

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Figure Reference: 21UK1812_ScapaFlow_Winter_Density

Figure 17: Winter Traffic Density

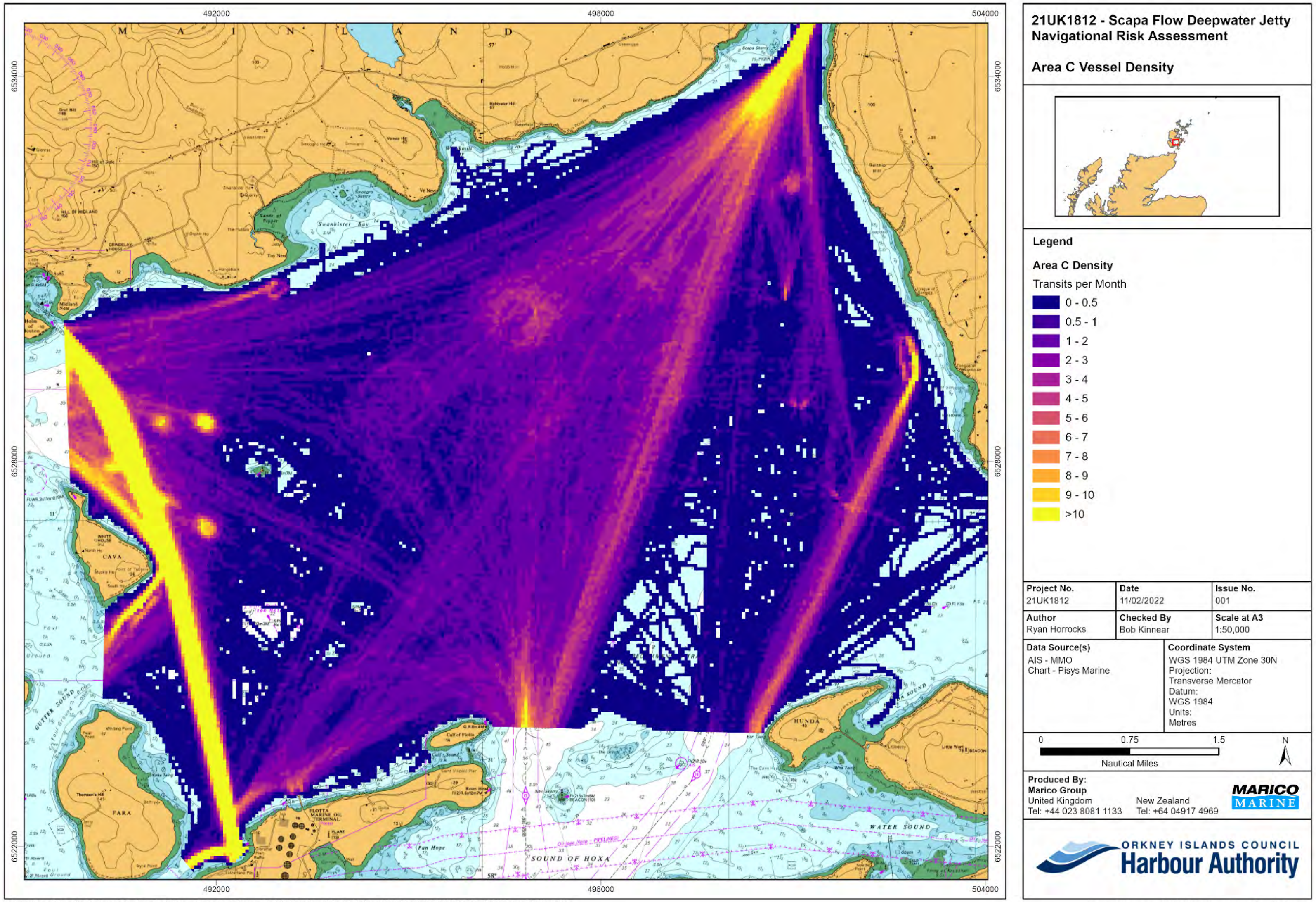

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Figure Reference: 21UK1812_ScapaFlow_AreaC_Density

Figure 18: Overall Traffic Density

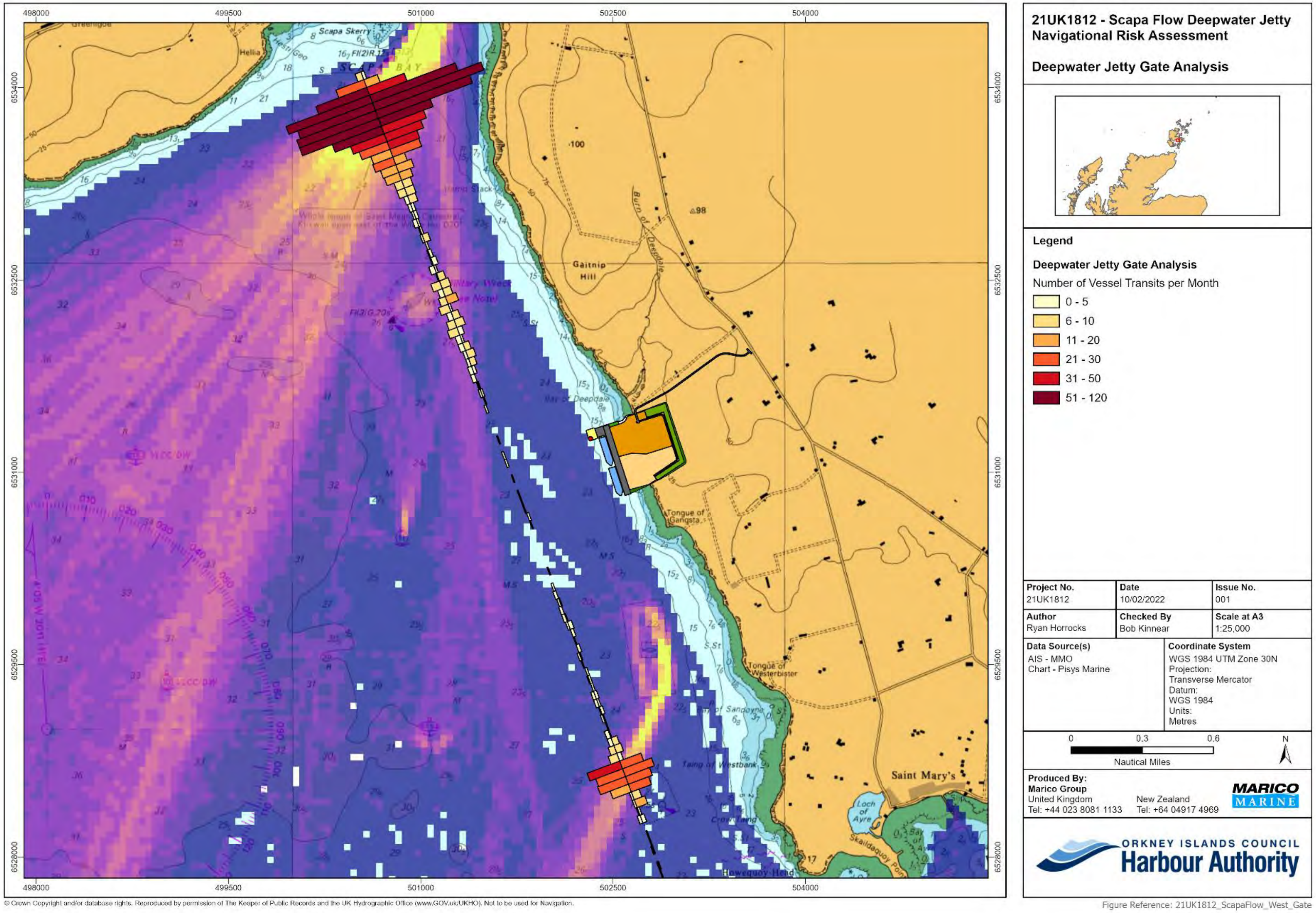

Figure 19: Gated Traffic Density (Crossing line parallel to key face)

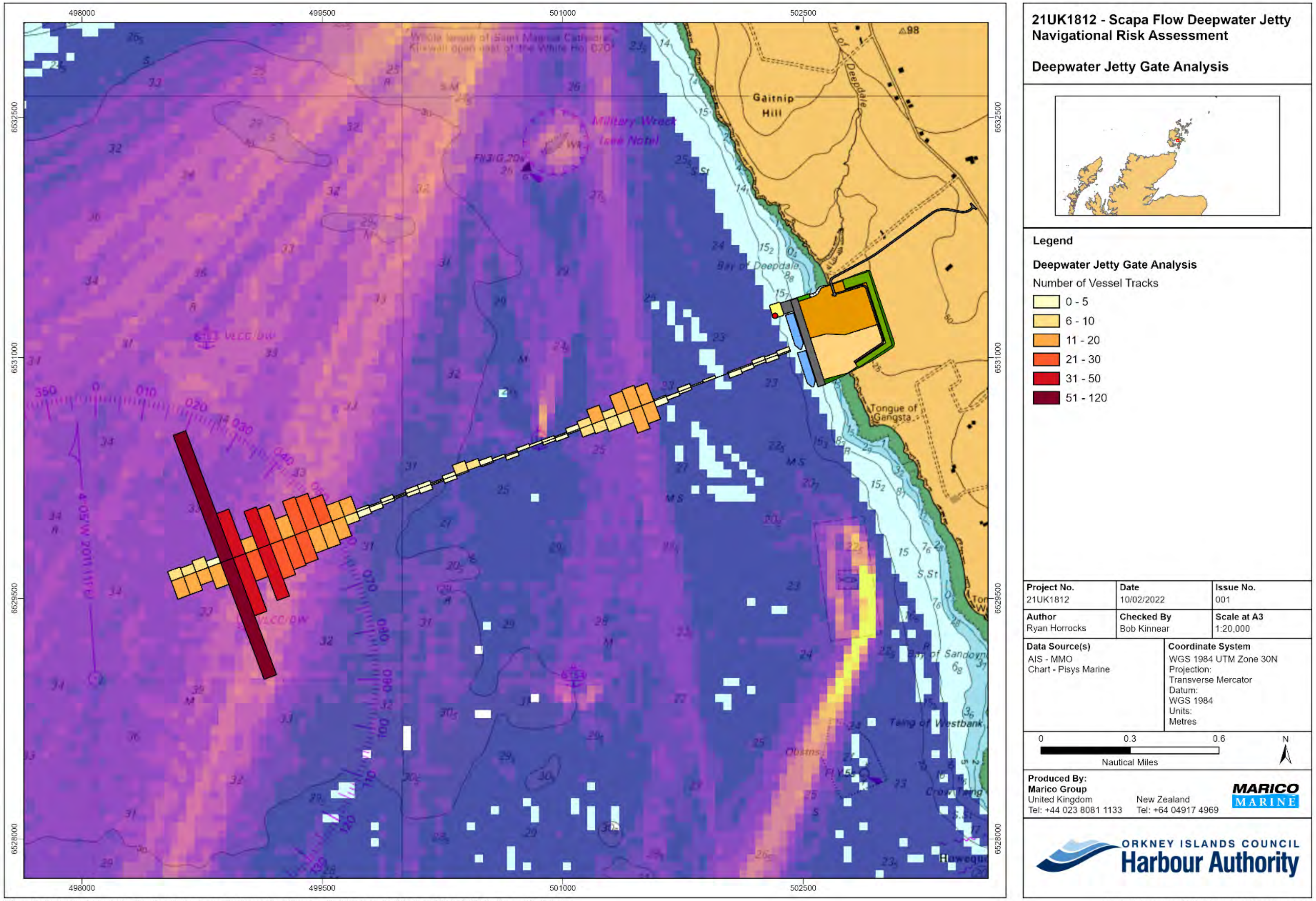

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Figure Reference: 21UK1812_ScapaFlow_Jetty_Gate

Figure 20: Traffic Density (Crossing line perpendicular to quay face)

2.3.6 Commentary

While Scapa Flow is used by a wide variety of vessels, away from regular tracks and “hotspots” such as the numbered anchorages, Scapa Pier, the fish farm locations and dive sites, overall traffic density is low (see **Figure 18**).

In particular, the area in the immediate vicinity of the proposed project location has very low traffic densities, with most traffic passing in a North / South direction some distance offshore (illustrated by **Figure 20**). There is, however, a small amount of regular traffic (smaller vessels) passing the proposed quay face approximately 0.5 nM off shore.

Figure 19 shows that the very few vessels that navigate in towards the project are from seaward, perpendicular to the shore.

Overall traffic density in the project area is at the lowest level for any part of Scapa Flow.

It has been noted that the data analysed does not include non-AIS equipped vessels; however there is no evidence that the area is intensively used by such vessels (consultation / incident data).

It was also noted that a very small number of small leisure vessels (Kayaks) may navigate close in shore past the project area, but infrequently.

In summary, the data analysis supports the local stakeholder view that the project area has very low traffic densities at present, and while the development of the pier will therefore result in a significant increase in vessel numbers in comparison with the current situation, the overall number of movements will remain low in real terms.

2.4 INCIDENT ANALYSIS

Information relating to accidents / incidents that have occurred in the past have been used as an input to the hazard identification and risk assessment process. In particular, the incident record helps inform the likely frequency of identified hazards occurring and gives an insight into the most likely and worst credible outcomes in the study area.

For this assessment historical data was available from the following sources:

- The Marine Accident Investigation Branch (MAIB)
- The Royal National Lifeboat Institution (RNLI); and
- Orkney Islands Council (the SHA)

2.4.1 MAIB Incidents

The following incidents have been recorded in or close to the study area by the MAIB between June 1997 and September 2020:

Table 4: Incidents recorded by MAIB (By incident type)

Type	Date
Accident to Person	28/04/2002
Accident to Person	09/10/2002
Accident to Person	12/03/2004
Capsizing/Listing	25/08/1999
Fire/Explosion	18/09/2001
Flooding/Foundering	12/04/1999
Flooding/Foundering	20/01/2005
Grounding	30/05/2004
Grounding	29/12/2012
Grounding/Stranding	15/09/2016
Grounding/Stranding	19/08/2020
Hazardous Incident	23/03/1999
Hazardous Incident	26/04/2007
Hazardous Incident	23/02/2012
Loss of control	24/09/2020
Mechanical Failure / Loss of Control	12/06/1997
Mechanical Failure / Loss of Control	01/06/2001
Mechanical Failure / Loss of Control	19/01/2005

Type	Date
Mechanical Failure / Loss of Control	09/05/2005
Other	09/04/2014
Unknown	02/07/2017

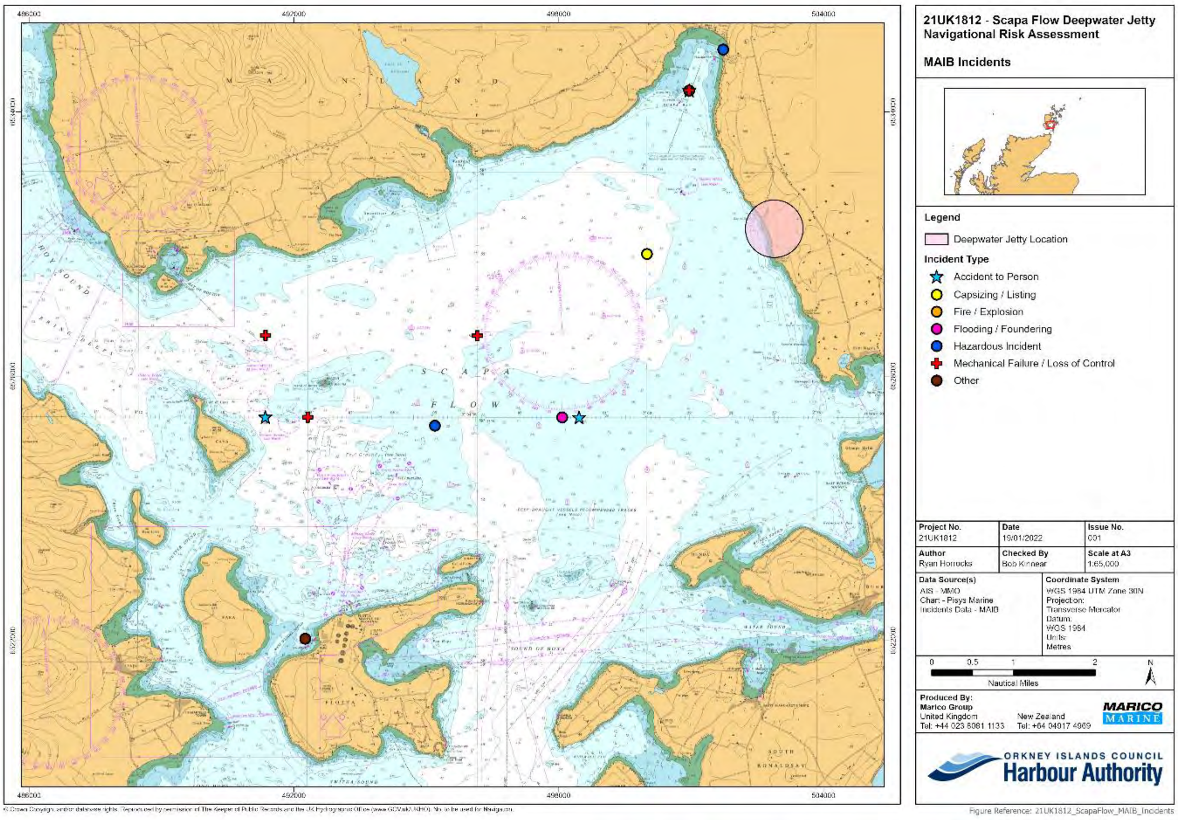


Figure 21: Locations of Incidents recorded by the MAIB.

2.4.2 RNLI Incidents

The following incidents have been recorded in or close to the study area by the MAIB between 2016 and 2020:

Table 5: Incidents recorded by RNLI(By incident type)

Type	Date	Incident
Scuba diving	19/10/2016	Person in distress
Scuba diving	24/10/2016	Illness
Scuba diving	29/12/2016	Illness
Other marine vessels - Other reason	01/03/2014	Machinery failure
Scuba diving	05/04/2008	Person missing
Scuba diving	05/04/2008	Person missing
Scuba diving	26/05/2013	Person missing
Scuba diving	28/05/2013	Person missing

Type	Date	Incident
Motorboating - Other reason	28/05/2012	Machinery failure
Scuba diving	14/07/2009	In danger of drowning
Small craft - Rowing	30/07/2014	Thought to be in trouble
Scuba diving	12/08/2009	Ill crewman on vessel
Angling from boat - Other reason	30/08/2014	Machinery failure
Scuba diving	10/09/2008	Ill crewman on vessel
Scuba diving	05/10/2015	Thought to be in trouble
Scuba diving	20/10/2010	Ill crewman on vessel
Scuba diving	30/10/2011	Person missing
Unknown	02/03/2019	Unknown
Scuba diving	24/07/2018	Unknown
Powered boat - other reason	13/09/2017	Equipment failure
Unknown	16/09/2018	Unknown
Scuba diving	06/10/2017	Unknown
Powered boat - man overboard	26/09/2018	Vessel abandoned derelict or adrift
Other marine vessels - other reason	06/10/2019	Unknown
Other marine vessels - ill crewman	25/11/2019	Unknown
Powered boat - other reason	31/12/2018	Out of fuel
Other marine vessels - ill crewman	25/11/2019	Unknown
Other marine vessels - ill crewman	25/11/2019	Unknown
Other	01/08/2020	Unknown
Other	08/08/2020	Unknown
Diving vessel	28/10/2020	Unknown
Scuba diver	28/10/2020	Unknown

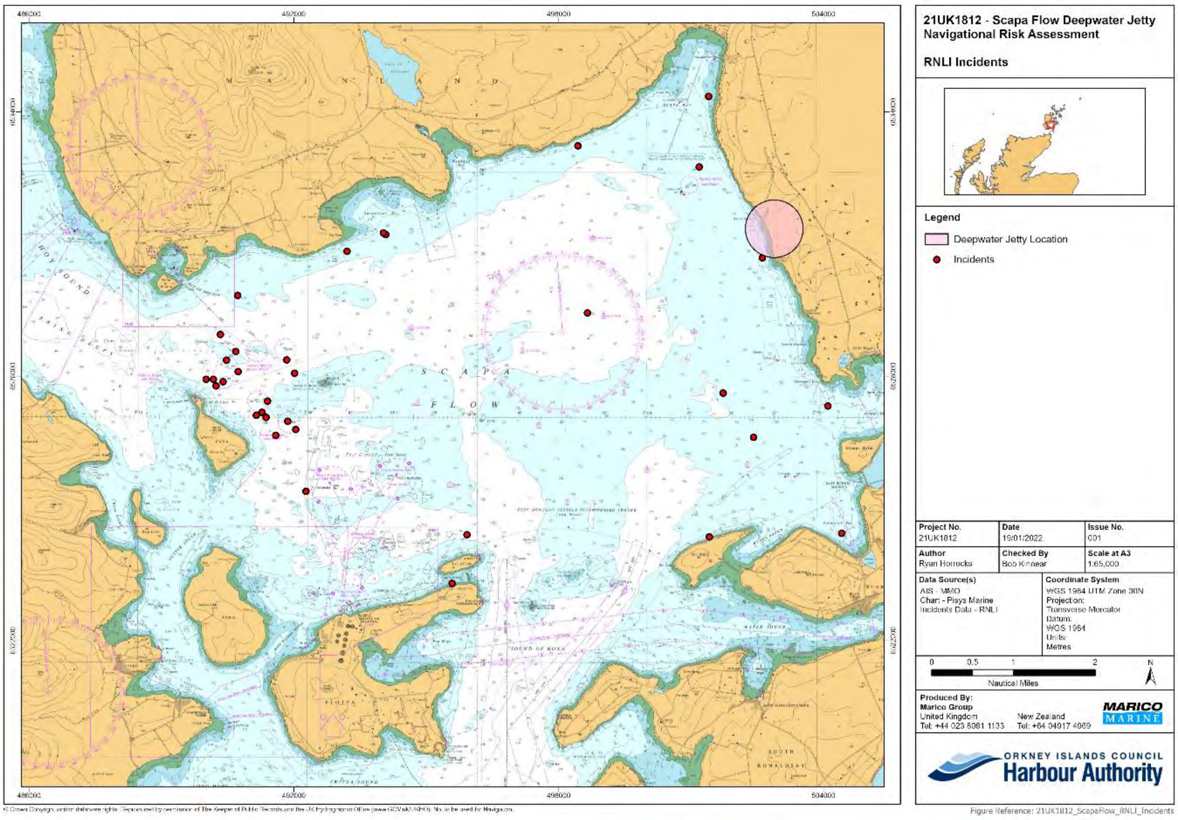


Figure 22: Locations of Incidents recorded by the RNLI.

2.4.3 OIC Incidents

The following incidents have been recorded in or close to the study area by the OIC between January 2007 and February 2022:

Table 6: Incidents recorded by OIC (By incident type)

Type	Date	Incident
Anchor Dragging	3 Feb 2020	San Jac into Anchor dragging
Anchor Dragging	31 Oct 2020	Vega Scorpio dragging anchor
Anchor Dragging	26 Nov 2021	2 Ballasted tankers dragged anchor in Scapa Flow
Contact	17 Jan 2016	Light contact buring STS Berthing
Diving (Recreation or Commercial)	16 Sep 2011	Flotta Lass close pass to dive boat Karin that had divers down
Diving (Recreation or Commercial)	13 Oct 2013	Divers missing from dive vessel Sharon Rose Scapa Flow
Diving (Recreation or Commercial)	5 May 2015	Diver got bends Scapa Flow
Diving (Recreation or Commercial)	11 May 2015	Unconscious diver Scapa Flow
Foundering	29 Aug 2011	Sea Cadet Dory overturned at mooring, Scapa

Type	Date	Incident
Foundering	30 Aug 2012	Small speedboat swamped and capsized
Mooring Breakout	19 Mar 2007	Recreational Vessel 'Clytus' Broken Moorings
Mooring Breakout	29 Dec 2012	Yacht broke moorings
Near-Miss	15 Sep 2016	Tug Harald near-miss
Near-Miss	14 Feb 2020	Solaway Fisher mooring difficulties
Pollution	27 Jul 2009	Oil Spill on Scapa Pier
Pollution	2 Dec 2014	Oil Spill Scapa
Pollution	17 Dec 2015	Oil spill
Pollution	15 Apr 2016	Fuel spill from platform Regalia
Pollution	13 Oct 2016	Pollution from MV John Jolly

2.4.4 Commentary

The available incident data from three separate sources, and covering a period in excess of 10 years, confirms Stakeholder opinion that the incident rate in Scapa flow is low. Most of the incidents recorded are spread across the whole study area, with very few in the vicinity of the project area. The data records a high number of non-navigational incidents which are not relevant to this study.

The type of incident considered most likely to have a significant impact in the east of Scapa Flow is a tanker breaking away from one of the anchorages in extreme weather, and this would have potential to cause significant impact on the new quay which is to leeward of the anchorages. However, while such incident types have been recorded, they have always been contained by existing control measures, and the frequency of a worst credible event has been assessed as low.

2.5 STAKEHOLDER CONSULTATION

In order to inform this assessment a number of comprehensive consultation meetings were held with OIC Marine Services personnel and requested with other stakeholders in Scapa Flow. Minutes of the meetings (which were all conducted remotely, due to travel restrictions, and for economy) are shown in **Annex C** The primary aim was to collect data and other information to enhance the NRA, and ensure, as far as possible, that all relevant issues are taken into account during the assessment.

These meetings were facilitated by Marico Marine personnel the agenda shown in **Annex B**.

The following stakeholders were approached (**Table 7**).

Table 7: List of Stakeholders Consulted

Consultee	Contact details	Comment
OIC Marine	Richard Wild/ David Sawkins	Complete
Scottish Sea Farms	Richard Darbyshire	No response
Kirkwall Kayak Club	Kristian Cooper Chair Peter Woodward Vice Chair Dennis Bichan Secretary	No response
EMEC	Donald Leaver Environment and Consents Specialist	No response
Leask Marine	Douglas Leask	No response
Green marine	Jason Schofield	No response
Orkney Fisherman's Association	Hannah Fennell	Responded, but no substantive comment.

2.5.1 Consultation Outcome

As indicated in **Table 7** above, there was a very poor response to the request for stakeholder input into this NRA, which can only be taken to indicate that the proposed development does not raise any navigational concerns for current users. It is recognised that the project is at an early stage, and as awareness of the development increases amongst the local community, concerns may be raised in the future.

The expert assessors undertaking this NRA, attempted to consider likely impacts on all users when assessing the navigational risk.

The consultation meeting with representatives of OIC was wide ranging, and provided confidence that data obtained (Vessel types, density, incident history, etc.) was representative and accurate for the purposes of informing the risk assessment.

3 HAZARD IDENTIFICATION

IMO Guidelines define a hazard as *"something with the potential to cause harm, loss or injury"*, the realisation of which results in an accident. The likelihood that the hazard will be realised can be combined with an estimate of the consequence, and this combination is termed "risk". Risk is therefore a measure of the likelihood and the consequence of a particular hazard.

It is important that the hazard identification process follows a structured and systematic process that is thorough and comprehensive. It must identify common hazards as well as hazards that may never have occurred in Scapa Flow in the past but are nonetheless possible and credible.

3.1 HAZARD IDENTIFICATION

Hazards relating to navigation within Scapa Flow were identified using a variety of methods, including stakeholder consultation meetings / workshops, review of incident records, and traffic analysis. The Data Gathering (Stage 1) was the principal input to the Hazard Identification (Stage 2).

3.1.1 Hazard Categories

Scapa Flow is used by a wide variety of commercial and recreational operators and this results in a high number of potential hazards. In order to focus the overall NRA and provide a structured hazard identification process, the following hazard categories identified during the original SHA assessment were used, but with two additional specific additional hazards during the construction phase (**Table 8**). Categorising hazards in this way also helps in the determination of risk control measures pertinent to the geographic location of each hazard.

Note that Health and Safety (H&S) hazards are not included within the scope of this NRA, for example slips/trips/falls.

Table 8: Hazard Categories.

Ref	Hazard Category	Comments
A	Anchor Dragging	When a vessel unintentionally moves from its anchored position because the anchor has failed to hold. This may be due to a combination of strong winds, large waves, adverse anchoring (seabed) conditions, mechanical failure, or poor seamanship / anchoring technique.
B	Collision	When two or more vessels impact each other whilst manoeuvring.
C	Contact	When one or more vessels makes physical contact with a fixed object such as a pier / jetty or a mooring buoy. This hazard is sometimes referred to as "allision" when contact is made with a fixed structure, or a "striking" when contact is made with a floating structure (e.g. navigation buoy or anchored ship).
D	Diving	Diving incident involving Recreational or Commercial diving.

Ref	Hazard Category	Comments
E	Girting	Sometimes referred to as "Girding". This is when a towline under tension exerts a heeling moment which results in excessive heel that could cause the tug to capsize.
F	Grounding	When a vessel unintentionally makes contact with the seabed.
G	Grounding in vicinity of construction site	Only used in construction assessment, considering additional risk of construction vessels grounding
H	Mooring Incident / Breakout	When a vessel ranges (moves excessively) whilst alongside the berth or when one or more mooring lines fail resulting in the vessel unintentionally breaking away from its moored position. This may be due to a combination of strong winds, large waves, adverse mooring arrangements (bollards) or poor seamanship / mooring technique.
I	Mooring Incident / Breakout on construction site	Only used in construction assessment, considering additional risk of construction vessels suffering mooring / breakout incidents.

3.2 NAVIGATION HAZARDS – CONSTRUCTION PHASE

The Hazard Identification process identified a total of 61 hazards for the study area during the construction phase of the project, as shown in **Table 9**. The full Hazard Logs with additional information are shown in **Annex D**

Table 9: Construction Phase Navigation Hazards.

Hazard ID	Category	Hazard Title	Hazard Detail
1	Anchor Dragging	Anchor dragging - Construction Vessel	A construction Vessel unintentionally moves from its anchored position because the anchor has failed to hold.
2	Anchor Dragging	Anchor Dragging - Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry	A Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry unintentionally moves from its anchored position because the anchor has failed to hold.
3	Anchor Dragging	Anchor dragging - Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel	An Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel unintentionally moves from its anchored position because the anchor has failed to hold.
4	Anchor Dragging	Anchor Dragging - Large Tanker	A Large Tanker unintentionally moves from its anchored position because the anchor has failed to hold.
5	Collision	Construction Vessel - Construction Vessel	A Construction Vessel collides with another Construction Vessel.

Hazard ID	Category	Hazard Title	Hazard Detail
6	Collision	Construction Vessel - Large Tanker	A Construction Vessel collides with a Large Tanker.
7	Collision	Construction Vessel - Towage Vessel	A Construction Vessel collides with a Towage Vessel.
8	Collision	Cruise Ship / Mainland Ferry - Construction Vessel	A Cruise Ship / Mainland Ferry collides with a Construction Vessel.
9	Collision	Cruise Ship / Mainland Ferry - Cruise Ship / Mainland Ferry	A Cruise Ship / Mainland Ferry collides with another Cruise Ship / Mainland Ferry.
10	Collision	Cruise Ship / Mainland Ferry - Inshore Fishing Vessel	A Cruise Ship / Mainland Ferry collides with an Inshore Fishing Vessel.
11	Collision	Cruise Ship / Mainland Ferry - Inter-Island Ferry	A Cruise Ship / Mainland Ferry collides with an Inter-Island Ferry.
12	Collision	Cruise Ship / Mainland Ferry - Large Commercial Vessel	A Cruise Ship / Mainland Ferry collides with a Large Commercial Vessel.
13	Collision	Cruise Ship / Mainland Ferry - Large Tanker	A Cruise Ship / Mainland Ferry collides with a Large Tanker.
14	Collision	Cruise Ship / Mainland Ferry - Recreational Vessel	A Cruise Ship / Mainland Ferry collides with a Recreational Vessel.
15	Collision	Cruise Ship / Mainland Ferry - Small Commercial Vessel	A Cruise Ship / Mainland Ferry collides with a Small Commercial Vessel.
16	Collision	Cruise Ship / Mainland Ferry - Towage Vessel	A Cruise Ship / Mainland Ferry collides with a Towage Vessel.
17	Collision	Inshore Fishing Vessel - Construction Vessel	An Inshore Fishing Vessel collides with a Construction Vessel.
18	Collision	Inshore Fishing Vessel - Inshore Fishing Vessel	An Inshore Fishing Vessel collides with another Inshore Fishing Vessel.
19	Collision	Inshore Fishing Vessel - Inter-Island Ferry	An Inshore Fishing Vessel collides with an Inter-Island ferry.
20	Collision	Inshore Fishing Vessel - Large Commercial Vessel	An Inshore Fishing Vessel collides with a Large Commercial Vessel.
21	Collision	Inshore Fishing Vessel - Large Tanker	An Inshore Fishing Vessel collides with a Large Tanker.
22	Collision	Inshore Fishing Vessel - Recreational Vessel	An Inshore Fishing Vessel collides with a Recreational Vessel.
23	Collision	Inshore Fishing Vessel - Small Commercial Vessel	An Inshore Fishing Vessel collides with a Small Commercial Vessel.
24	Collision	Inshore Fishing Vessel - Towage Vessel	An Inshore Fishing Vessel collides with a Towage Vessel.
25	Collision	Inter-Island Ferry - Construction Vessel	An Inter-Island Ferry collides with a Construction Vessel.

Hazard ID	Category	Hazard Title	Hazard Detail
26	Collision	Inter-Island Ferry - Inter-Island Ferry	An Inter-Island Ferry collides with another Inter-Island Ferry.
27	Collision	Inter-Island Ferry - Large Commercial Vessel	An Inter-Island Ferry collides with a Large Commercial Vessel.
28	Collision	Inter-Island Ferry - Large Tanker	An Inter-Island Ferry collides with a Large Tanker.
29	Collision	Inter-Island Ferry - Recreational Vessel	An Inter-Island Ferry collides with a Recreational Vessel.
30	Collision	Inter-Island Ferry - Small Commercial Vessel	An Inter-Island Ferry collides with a Small Commercial Vessel.
31	Collision	Inter-Island Ferry - Towage Vessel	An Inter-Island Ferry collides with a Towage Vessel.
32	Collision	Large Commercial Vessel - Large Tanker	A Large Commercial Vessel collides with a Large Tanker.
33	Collision	Large Commercial Vessel - Construction Vessel	A Large Commercial Vessel collides with a Construction Vessel.
34	Collision	Large Commercial Vessel - Large Commercial Vessel	A Large Commercial Vessel collides with another Large Commercial Vessel.
35	Collision	Large Commercial Vessel - Recreational Vessel	A Large Commercial Vessel collides with a Recreational Vessel.
36	Collision	Large Commercial Vessel - Small Commercial Vessel	A Large Commercial Vessel collides with a Small Commercial Vessel.
37	Collision	Large Commercial Vessel - Towage Vessel	A Large Commercial Vessel collides with a Towage Vessel.
38	Collision	Large Tanker - Large Tanker	A Large Tanker collides with another Large Tanker.
39	Collision	Recreational Vessel - Construction Vessel	A Recreational Vessel collides with a Construction Vessel.
40	Collision	Recreational Vessel - Large Tanker	A Recreational Vessel collides with a Large Tanker.
41	Collision	Recreational Vessel - Recreational Vessel	A Recreational Vessel collides with another Recreational Vessel.
42	Collision	Recreational Vessel - Small Commercial Vessel	A Recreational Vessel collides with a Small Commercial Vessel.
43	Collision	Recreational Vessel - Towage Vessel	A Recreational Vessel collides with a Towage Vessel.
44	Collision	Small Commercial Vessel - Large Tanker	A Small Commercial Vessel collides with a Large Tanker.
45	Collision	Small Commercial Vessel - Small Commercial Vessel	A Small Commercial Vessel collides with another Small Commercial Vessel.

Hazard ID	Category	Hazard Title	Hazard Detail
46	Collision	Small Commercial Vessel - Towage Vessel	A Small Commercial Vessel collides with a Towage Vessel.
47	Collision	Towage Vessel - Large Tanker	A Towage Vessel collides with a Large Tanker.
48	Collision	Towage Vessel - Towage Vessel	A Towage Vessel collides with another Towage Vessel.
49	Contact	Contact - Construction Vessel	A Construction Vessel contacts a fixed object inc new Quay
50	Contact	Contact - Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry	A Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry contacts a fixed object including new Quay.
51	Contact	Contact - Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel	An Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel contacts a fixed object inc new Quay
52	Diving	Diving Incident	A diving incident involving a Recreational (including wreck diving) and / or Commercial Vessel.
53	Diving	Diving Incident on construction site	A diving incident involving commercial divers in connection with construction
54	Girting	Girting Incident	A towline under tension exerts a heeling moment which results in excessive heel that causes the tug to capsize (Including on construction site)
55	Grounding	Grounding - Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry	A Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry runs aground.
56	Grounding	Grounding - Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel	An Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel runs aground.
57	Grounding	Grounding - Large Tanker	A Large Tanker runs aground.
58	Grounding in vicinity of construction site	Grounding - Construction Vessel	A Construction Vessel runs aground.
59	Mooring Incident / Breakout	Mooring Incident / Breakout - Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry	A Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry breaks away from her moorings.

Hazard ID	Category	Hazard Title	Hazard Detail
60	Mooring Incident / Breakout	Mooring Incident / Breakout - Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel	An Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel breaks away from her moorings.
61	Mooring Incident / Breakout on construction site	Mooring Incident Construction Vessel	A Construction Vessel breaks away from her moorings.

3.3 NAVIGATION HAZARDS – OPERATIONAL PHASE

The Hazard Identification process identified a total of 48 hazards for the study area during the operational phase of the project, as shown in **Table 10**. The full Hazard Logs with additional information are shown in **Annex E.**

Table 10: Operational Phase Navigation Hazards.

Hazard ID	Category	Hazard Title	Hazard Detail
1	Anchor Dragging	Anchor Dragging - Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry	A Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry unintentionally moves from its anchored position because the anchor has failed to hold.
2	Anchor Dragging	Anchor dragging - Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel	An Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel unintentionally moves from its anchored position because the anchor has failed to hold.
3	Anchor Dragging	Anchor Dragging - Large Tanker	A Large Tanker unintentionally moves from its anchored position because the anchor has failed to hold.
4	Collision	Cruise Ship / Mainland Ferry - Cruise Ship / Mainland Ferry	A Cruise Ship / Mainland Ferry collides with another Cruise Ship / Mainland Ferry.
5	Collision	Cruise Ship / Mainland Ferry - Inshore Fishing Vessel	A Cruise Ship / Mainland Ferry collides with an Inshore Fishing Vessel.
6	Collision	Cruise Ship / Mainland Ferry - Inter-Island Ferry	A Cruise Ship / Mainland Ferry collides with an Inter-Island Ferry.
7	Collision	Cruise Ship / Mainland Ferry - Large Commercial Vessel	A Cruise Ship / Mainland Ferry collides with a Large Commercial Vessel.
8	Collision	Cruise Ship / Mainland Ferry - Large Tanker	A Cruise Ship / Mainland Ferry collides with a Large Tanker.

Hazard ID	Category	Hazard Title	Hazard Detail
9	Collision	Cruise Ship / Mainland Ferry - Recreational Vessel	A Cruise Ship / Mainland Ferry collides with a Recreational Vessel.
10	Collision	Cruise Ship / Mainland Ferry - Small Commercial Vessel	A Cruise Ship / Mainland Ferry collides with a Small Commercial Vessel.
11	Collision	Cruise Ship / Mainland Ferry - Towage Vessel	A Cruise Ship / Mainland Ferry collides with a Towage Vessel.
12	Collision	Inshore Fishing Vessel - Inshore Fishing Vessel	An Inshore Fishing Vessel collides with another Inshore Fishing Vessel.
13	Collision	Inshore Fishing Vessel - Inter-Island Ferry	An Inshore Fishing Vessel collides with an Inter-Island ferry.
14	Collision	Inshore Fishing Vessel - Large Commercial Vessel	An Inshore Fishing Vessel collides with a Large Commercial Vessel.
15	Collision	Inshore Fishing Vessel - Large Tanker	An Inshore Fishing Vessel collides with a Large Tanker.
16	Collision	Inshore Fishing Vessel - Recreational Vessel	An Inshore Fishing Vessel collides with a Recreational Vessel.
17	Collision	Inshore Fishing Vessel - Small Commercial Vessel	An Inshore Fishing Vessel collides with a Small Commercial Vessel.
18	Collision	Inshore Fishing Vessel - Towage Vessel	An Inshore Fishing Vessel collides with a Towage Vessel.
19	Collision	Inter-Island Ferry - Inter-Island Ferry	An Inter-Island Ferry collides with another Inter-Island Ferry.
20	Collision	Inter-Island Ferry - Large Commercial Vessel	An Inter-Island Ferry collides with a Large Commercial Vessel.
21	Collision	Inter-Island Ferry - Large Tanker	An Inter-Island Ferry collides with a Large Tanker.
22	Collision	Inter-Island Ferry - Recreational Vessel	An Inter-Island Ferry collides with a Recreational Vessel.
23	Collision	Inter-Island Ferry - Small Commercial Vessel	An Inter-Island Ferry collides with a Small Commercial Vessel.
24	Collision	Inter-Island Ferry - Towage Vessel	An Inter-Island Ferry collides with a Towage Vessel.
25	Collision	Large Commercial Vessel - Large Tanker	A Large Commercial Vessel collides with a Large Tanker.
26	Collision	Large Commercial Vessel - Large Commercial Vessel	A Large Commercial Vessel collides with another Large Commercial Vessel.
27	Collision	Large Commercial Vessel - Recreational Vessel	A Large Commercial Vessel collides with a Recreational Vessel.
28	Collision	Large Commercial Vessel - Small Commercial Vessel	A Large Commercial Vessel collides with a Small Commercial Vessel.

Hazard ID	Category	Hazard Title	Hazard Detail
29	Collision	Large Commercial Vessel - Towage Vessel	A Large Commercial Vessel collides with a Towage Vessel.
30	Collision	Large Tanker - Large Tanker	A Large Tanker collides with another Large Tanker.
31	Collision	Recreational Vessel - Large Tanker	A Recreational Vessel collides with a Large Tanker.
32	Collision	Recreational Vessel - Recreational Vessel	A Recreational Vessel collides with another Recreational Vessel.
33	Collision	Recreational Vessel - Small Commercial Vessel	A Recreational Vessel collides with a Small Commercial Vessel.
34	Collision	Recreational Vessel - Towage Vessel	A Recreational Vessel collides with a Towage Vessel.
35	Collision	Small Commercial Vessel - Large Tanker	A Small Commercial Vessel collides with a Large Tanker.
36	Collision	Small Commercial Vessel - Small Commercial Vessel	A Small Commercial Vessel collides with another Small Commercial Vessel.
37	Collision	Small Commercial Vessel - Towage Vessel	A Small Commercial Vessel collides with a Towage Vessel.
38	Collision	Towage Vessel - Large Tanker	A Towage Vessel collides with a Large Tanker.
39	Collision	Towage Vessel - Towage Vessel	A Towage Vessel collides with another Towage Vessel.
40	Contact	Contact - Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry	A Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry contacts a fixed object including new Quay.
41	Contact	Contact - Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel	An Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel contacts a fixed object inc. new Quay
42	Diving	Diving Incident	A diving incident involving a Recreational (including wreck diving) and / or Commercial Vessel.
43	Girting	Girting Incident	A towline under tension exerts a heeling moment which results in excessive heel that causes the tug to capsize.
44	Grounding	Grounding - Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry	A Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry runs aground.

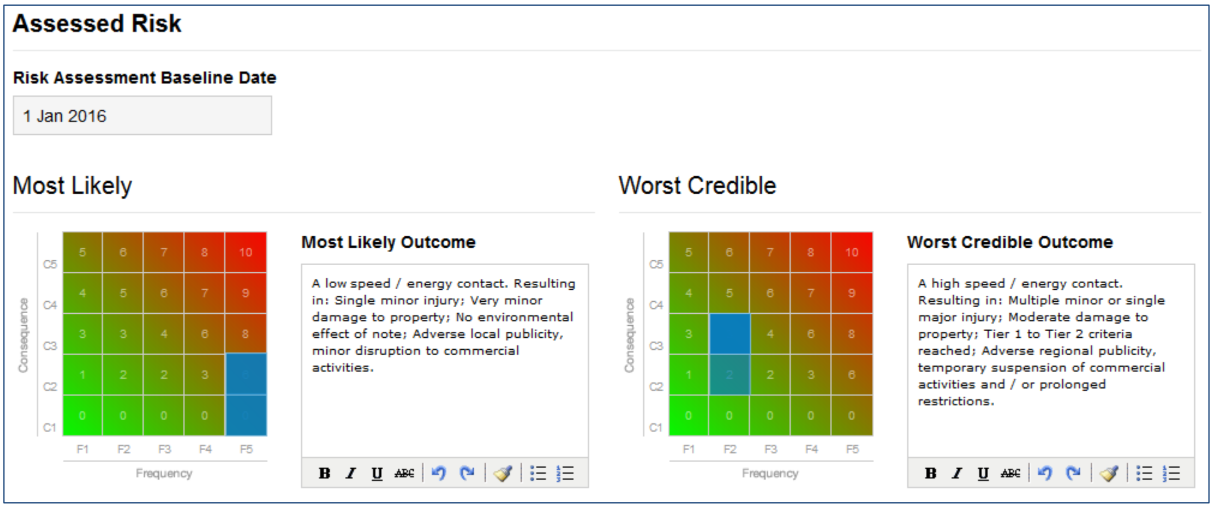
Hazard ID	Category	Hazard Title	Hazard Detail
45	Grounding	Grounding - Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel	An Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel runs aground.
46	Grounding	Grounding - Large Tanker	A Large Tanker runs aground.
47	Mooring Incident / Breakout	Mooring Incident / Breakout - Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry	A Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry breaks away from her moorings.
48	Mooring Incident / Breakout	Mooring Incident / Breakout - Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel	An Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel breaks away from her moorings.

4 RISK ASSESSMENT

This risk assessment complies with the PMSC and its associated Guide to Good Practice and was conducted in accordance with the International Maritime Organisation (IMO) Formal Safety Assessment (FSA) methodology for risk assessments. A detailed description of the methodology is provided in **Annex A** Overview of the Risk Assessment Methodology.

A standard 5x5 risk matrix was used (see **Figure 23**) and each hazard was assessed twice. Firstly, to determine the risk associated with the "*most likely*" outcome of the hazard and secondly to determine the risk associated with the "*worst credible*" outcome for each hazard. The results are then combined to give a total Risk Score for each Hazard.

This approach provides a realistic and thorough assessment of risk, which reflects reality, in that relatively few incidents result in the "worst credible" outcome.



Assessed Risk

Risk Assessment Baseline Date

1 Jan 2016

Most Likely

Consequence	F1	F2	F3	F4	F5
C5	5	6	7	8	10
C4	4	5	6	7	9
C3	3	3	4	6	8
C2	1	2	2	3	🟦
C1	0	0	0	0	🟦

Frequency

Most Likely Outcome

A low speed / energy contact. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.

Worst Credible

Consequence	F1	F2	F3	F4	F5
C5	5	6	7	8	10
C4	4	5	6	7	9
C3	3	🟦	4	6	8
C2	1	2	2	3	6
C1	0	0	0	0	0

Frequency

Worst Credible Outcome

A high speed / energy contact. Resulting in: Multiple minor or single major injury; Moderate damage to property; Tier 1 to Tier 2 criteria reached; Adverse regional publicity, temporary suspension of commercial activities and / or prolonged restrictions.

Figure 23: Example Risk Matrix.

4.1.1 Assessment of Frequency and Consequence

For both the construction and operational phases of the proposed new facility, an assessment of frequency was made for a notional "*most likely*" and "*worst credible*" likelihood of occurrence, for each hazard. These were combined with assessments of typical consequences to people, property, environment and business. The frequency and consequence bands used for this NRA are shown in **Annex A.**

The frequency and consequence assessments were largely based on the data / information collected during Stage 1 of this NRA.

This data / information was supplemented by expert judgement and specialist knowledge provided by the assessment team, who have considerable experience in undertaking NRAs of this type in ports / harbours all around the world, including the Orkney harbours.

4.1.2 Risk Scores

The frequency and consequence scores are combined to give two separate risk scores that represent the "*most likely*" and the "*worst credible*" risk for each hazard. These two scores are further combined to give a final risk score for each hazard, between 0 (negligible) and 10 (high). The risk scores are sorted into a Ranked Hazard List that shows the highest risk hazards prioritised at the top and the lowest at the bottom (see **Section 4.2**).

Risks are deemed to be negligible, low, As Low as Reasonably Practicable (ALARP), significant or high, as per **Table 11**. ALARP represents that risk band where the level of risk is neither acceptable nor unacceptable. It is the risk band for which further investment of resources for risk reduction may not be justifiable – i.e. risks which fall within the ALARP band have to be reduced unless there is a disproportionate cost to the benefits obtained.

A navigation hazard with a risk score that is "significant" or "high" is termed "unacceptable" and as such additional risk control measures should be implemented. This may range from stopping the activities which bring about such high-risk hazards or by measures which seek to reduce the likelihood and / or consequence of the hazard occurrence.

Table 11: Risk Scoring.

Risk Score	Risk Definition	Action Taken
0 - 1.99	Negligible	The risk is acceptable and at level where operational safety is unaffected.
2 - 3.99	Low	The risk is acceptable and at level where operational safety is assumed.
4 - 6.99	ALARP	The risk is neither acceptable nor unacceptable. Risks in the ALARP band are to be managed to a level which is "As Low As Reasonably Practicable", based on the cost-effectiveness of implementing additional risk control measures. These risks and associated risk control measures shall be regularly reviewed as part of the Safety Management System.
7 - 8.99	Significant	The risk is unacceptable and additional risk control measures shall be identified and implemented as soon as possible (or the activity / operation temporarily suspended). These risks and associated risk control measures shall be regularly reviewed as part of the Safety Management System.
9 - 10	High	The risk is unacceptable and additional risk control measures shall be identified and implemented immediately (or the activity / operation permanently suspended). These risks and associated risk control measures shall be regularly reviewed as part of the Safety Management System.

4.2 RISK ASSESSMENT RESULTS

4.2.1 Construction Phase

Table 12 shows a summary of the Ranked Hazard List for the construction phase of the new quay. More details on each hazard are provided in **Annex D**, which also contains the associated risk scores in terms of the "*most likely*" and the "*worst credible*" consequences to people, property, environment and business.

Table 12: Summary of the Ranked Hazard List.

Rank	Hazard Ref.	Accident Category	Hazard Title	Risk Overall
1	5	Collision	Construction Vessel - Construction Vessel	**5.21**
2	15	Collision	Cruise Ship / Mainland Ferry - Small Commercial Vessel	**4.56**
3	12	Collision	Cruise Ship / Mainland Ferry - Large Commercial Vessel	**4.2**
4	58	Grounding in vicinity of construction site	Grounding - Construction Vessel	**3.92**
5	55	Grounding	Grounding - Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry	**3.74**
6	10	Collision	Cruise Ship / Mainland Ferry - Inshore Fishing Vessel	**3.69**
7	8	Collision	Cruise Ship / Mainland Ferry - Construction Vessel	**3.65**
8	13	Collision	Cruise Ship / Mainland Ferry - Large Tanker	**3.64**
9	9	Collision	Cruise Ship / Mainland Ferry - Cruise Ship / Mainland Ferry	**3.5**
10	11	Collision	Cruise Ship / Mainland Ferry - Inter-Island Ferry	**3.5**
11	39	Collision	Recreational Vessel - Construction Vessel	**3.5**
12	61	Mooring Incident / Breakout on construction site	Mooring Incident Construction Vessel	**3.5**
13	59	Mooring Incident / Breakout	Mooring Incident / Breakout - Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry	**3.43**
14	7	Collision	Construction Vessel - Towage Vessel	**3.4**
15	17	Collision	Inshore Fishing Vessel - Construction Vessel	**3.4**
16	23	Collision	Inshore Fishing Vessel - Small Commercial Vessel	**3.4**
17	33	Collision	Large Commercial Vessel - Construction Vessel	**3.4**
18	36	Collision	Large Commercial Vessel - Small Commercial Vessel	**3.4**

Rank	Hazard Ref.	Accident Category	Hazard Title	Risk Overall
19	45	Collision	Small Commercial Vessel - Small Commercial Vessel	**3.4**
20	46	Collision	Small Commercial Vessel - Towage Vessel	**3.4**
21	56	Grounding	Grounding - Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel	**3.39**
22	53	Diving	Diving Incident on construction site	**3.31**
23	14	Collision	Cruise Ship / Mainland Ferry - Recreational Vessel	**3.25**
24	34	Collision	Large Commercial Vessel - Large Commercial Vessel	**3.18**
25	32	Collision	Large Commercial Vessel - Large Tanker	**3.11**
26	57	Grounding	Grounding - Large Tanker	**3.04**
27	27	Collision	Inter-Island Ferry - Large Commercial Vessel	**2.95**
28	28	Collision	Inter-Island Ferry - Large Tanker	**2.95**
29	31	Collision	Inter-Island Ferry - Towage Vessel	**2.89**
30	35	Collision	Large Commercial Vessel - Recreational Vessel	**2.86**
31	38	Collision	Large Tanker - Large Tanker	**2.83**
32	6	Collision	Construction Vessel - Large Tanker	**2.81**
33	25	Collision	Inter-Island Ferry - Construction Vessel	**2.81**
34	26	Collision	Inter-Island Ferry - Inter-Island Ferry	**2.81**
35	30	Collision	Inter-Island Ferry - Small Commercial Vessel	**2.81**
36	44	Collision	Small Commercial Vessel - Large Tanker	**2.81**
37	4	Anchor Dragging	Anchor Dragging - Large Tanker	**2.74**
38	20	Collision	Inshore Fishing Vessel - Large Commercial Vessel	**2.71**
39	21	Collision	Inshore Fishing Vessel - Large Tanker	**2.71**
40	42	Collision	Recreational Vessel - Small Commercial Vessel	**2.71**
41	43	Collision	Recreational Vessel - Towage Vessel	**2.71**
42	60	Mooring Incident / Breakout	Mooring Incident / Breakout - Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel	**2.63**
43	24	Collision	Inshore Fishing Vessel - Towage Vessel	**2.61**
44	50	Contact	Contact - Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry	**2.56**
45	52	Diving	Diving Incident	**2.49**
46	49	Contact	Contact - Construction Vessel	**2.37**
47	2	Anchor Dragging	Anchor Dragging - Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry	**2.34**
48	40	Collision	Recreational Vessel - Large Tanker	**2.33**
49	29	Collision	Inter-Island Ferry - Recreational Vessel	**2.21**

Rank	Hazard Ref.	Accident Category	Hazard Title	Risk Overall
50	37	Collision	Large Commercial Vessel - Towage Vessel	**2.15**
51	47	Collision	Towage Vessel - Large Tanker	**2.15**
52	16	Collision	Cruise Ship / Mainland Ferry - Towage Vessel	**1.88**
53	54	Girting	Girting Incident	**1.88**
54	18	Collision	Inshore Fishing Vessel - Inshore Fishing Vessel	**1.85**
55	22	Collision	Inshore Fishing Vessel - Recreational Vessel	**1.85**
56	19	Collision	Inshore Fishing Vessel - Inter-Island Ferry	**1.73**
57	41	Collision	Recreational Vessel - Recreational Vessel	**1.69**
58	51	Contact	Contact - Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel	**1.69**
59	1	Anchor Dragging	Anchor dragging - Construction Vessel	**1.54**
60	3	Anchor Dragging	Anchor dragging - Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel	**1.54**
61	48	Collision	Towage Vessel - Towage Vessel	**1.54**

4.2.2 Operational Phase

Table 13 shows a summary of the Ranked Hazard List for the operational phase of the new quay. More details on each hazard are provided in **Annex E** which also contains the associated risk scores in terms of the "*most likely*" and the "*worst credible*" consequences to people, property, environment and business.

Table 13: Summary of the Ranked Hazard List – Operational Phase.

Rank	Hazard Ref.	Accident Category	Hazard Title	Risk Overall
1	10	Collision	Cruise Ship / Mainland Ferry - Small Commercial Vessel	**4.56**
2	7	Collision	Cruise Ship / Mainland Ferry - Large Commercial Vessel	**4.2**
3	44	Grounding	Grounding - Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry	**3.74**
4	5	Collision	Cruise Ship / Mainland Ferry - Inshore Fishing Vessel	**3.69**
5	8	Collision	Cruise Ship / Mainland Ferry - Large Tanker	**3.64**

Rank	Hazard Ref.	Accident Category	Hazard Title	Risk Overall
6	4	Collision	Cruise Ship / Mainland Ferry - Cruise Ship / Mainland Ferry	**3.5**
7	6	Collision	Cruise Ship / Mainland Ferry - Inter-Island Ferry	**3.5**
8	47	Mooring Incident / Breakout	Mooring Incident / Breakout - Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry	**3.43**
9	17	Collision	Inshore Fishing Vessel - Small Commercial Vessel	**3.4**
10	28	Collision	Large Commercial Vessel - Small Commercial Vessel	**3.4**
11	36	Collision	Small Commercial Vessel - Small Commercial Vessel	**3.4**
12	37	Collision	Small Commercial Vessel - Towage Vessel	**3.4**
13	45	Grounding	Grounding - Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel	**3.39**
14	9	Collision	Cruise Ship / Mainland Ferry - Recreational Vessel	**3.25**
15	26	Collision	Large Commercial Vessel - Large Commercial Vessel	**3.18**
16	25	Collision	Large Commercial Vessel - Large Tanker	**3.11**
17	46	Grounding	Grounding - Large Tanker	**3.04**
18	20	Collision	Inter-Island Ferry - Large Commercial Vessel	**2.95**
19	21	Collision	Inter-Island Ferry - Large Tanker	**2.95**
20	24	Collision	Inter-Island Ferry - Towage Vessel	**2.89**
21	27	Collision	Large Commercial Vessel - Recreational Vessel	**2.86**
22	30	Collision	Large Tanker - Large Tanker	**2.83**
23	19	Collision	Inter-Island Ferry - Inter-Island Ferry	**2.81**
24	23	Collision	Inter-Island Ferry - Small Commercial Vessel	**2.81**
25	35	Collision	Small Commercial Vessel - Large Tanker	**2.81**
26	3	Anchor Dragging	Anchor Dragging - Large Tanker	**2.74**
27	14	Collision	Inshore Fishing Vessel - Large Commercial Vessel	**2.71**
28	15	Collision	Inshore Fishing Vessel - Large Tanker	**2.71**
29	33	Collision	Recreational Vessel - Small Commercial Vessel	**2.71**
30	34	Collision	Recreational Vessel - Towage Vessel	**2.71**
31	48	Mooring Incident / Breakout	Mooring Incident / Breakout - Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel	**2.63**
32	18	Collision	Inshore Fishing Vessel - Towage Vessel	**2.61**

Rank	Hazard Ref.	Accident Category	Hazard Title	Risk Overall
33	40	Contact	Contact - Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry	**2.56**
34	42	Diving	Diving Incident	**2.49**
35	1	Anchor Dragging	Anchor Dragging - Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry	**2.34**
36	31	Collision	Recreational Vessel - Large Tanker	**2.33**
37	22	Collision	Inter-Island Ferry - Recreational Vessel	**2.21**
38	29	Collision	Large Commercial Vessel - Towage Vessel	**2.15**
39	38	Collision	Towage Vessel - Large Tanker	**2.15**
40	11	Collision	Cruise Ship / Mainland Ferry - Towage Vessel	**1.88**
41	43	Girting	Girting Incident	**1.88**
42	12	Collision	Inshore Fishing Vessel - Inshore Fishing Vessel	**1.85**
43	16	Collision	Inshore Fishing Vessel - Recreational Vessel	**1.85**
44	13	Collision	Inshore Fishing Vessel - Inter-Island Ferry	**1.73**
45	32	Collision	Recreational Vessel - Recreational Vessel	**1.69**
46	41	Contact	Contact - Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel	**1.69**
47	2	Anchor Dragging	Anchor dragging - Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel	**1.54**
48	39	Collision	Towage Vessel - Towage Vessel	**1.54**

5 RISK CONTROL MEASURES

There are a number of over-arching merchant shipping regulations that apply in all ports / harbours in the UK, and the most applicable include (but not limited to):

- International Convention for the Safety of Life at Sea (SOLAS), 1974 (and amendments);
- The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (or STCW), 1978 (and amendments);
- The International Regulations for Preventing Collisions at Sea (COLREGs); and
- The Merchant Shipping (Oil Pollution Preparedness, Response Co-operation Convention) Regulations 1998, Statutory Instrument 1998 No. 1056.

5.1 EXISTING RISK CONTROL MEASURES

The 2016 PMSC NRA sought to identify all other applicable Risk Control Measures (RCM) currently in place within Scapa Flow. These included:

- Aids to Navigation (e.g. Lights, Buoys and Beacons);
- Charts and Publications (e.g. Admiralty Charts, Sailing Directions, Tide Tables, Orkney Islands Council Ports Handbook for Orkney, 6th Edition);
- Emergency Plans (e.g. Port Emergency Plan, OPRC plan);
- Pier Fendering;
- Hydrographic Policy and Survey Programme;
- Local Regulations (e.g. Byelaws: (Petroleum) Byelaws 1980, Vehicles Byelaws 1980, (Liquefied Gases) Byelaws 1978, and General Bye-Laws 1977);
- Patrols and Local Traffic Control (e.g. cruise ship and major event escort by harbour craft);
- Permit System (e.g. Permits to Work: Diving, Hot Works, Bunkering);
- Pier Manning (e.g. OIC personnel patrolling piers);
- Pilotage Service (including Pilotage, PECs, Pilotage Directions, Training and Revalidation);
- Pollution Control Equipment (Tier 1 equipment);
- Prior Notification Procedure (including movement and berth planning);
- Search and Rescue (SAR) and Emergency Services (including HM Coastguard, RNLI, Blue Light Services);
- Ship to Ship (STS) Procedure (including operational procedures, intended sequence of events, designated anchor position, mooring configuration, tug deployment and pilotage, oil spill response, liaison requirements, and security requirements);
- Ship Towage;
- Ship Towage Guidelines (for the allocation of tugs to individual ship movements); and

- Vessel Traffic Services (VTS), including VTS equipment, VTS procedures.

5.2 ADDITIONAL RISK CONTROL MEASURES

Navigation hazards that were scored as high or significant risk are termed “intolerable”, and as such additional risk control measures should be implemented. This may range from stopping the activities which bring about such high-risk hazards or by measures which seek to reduce the likelihood and / or consequence of hazard occurrence.

All the navigation hazards identified and scored for the Scapa Flow NRA fell into the negligible, low or ALARP categories of risk, so the current navigation activities are deemed to be largely acceptable.

This does not however mean that mitigation for the ALARP hazards must not be considered. There is a rationale underlying any risk assessments that no matter how low the risk, there remains, no matter how small, a possibility that accidents or incidents may still occur. There are also underlying principles of the Port Marine Safety Code (PMSC) which encourage port authorities and operators to operate as safely as possible and implement a coherent and clear SMS.

The relationship between the NRA and the OIC SMS is shown in **Figure 24**: Relationship between the NRA and the Safety Management System.

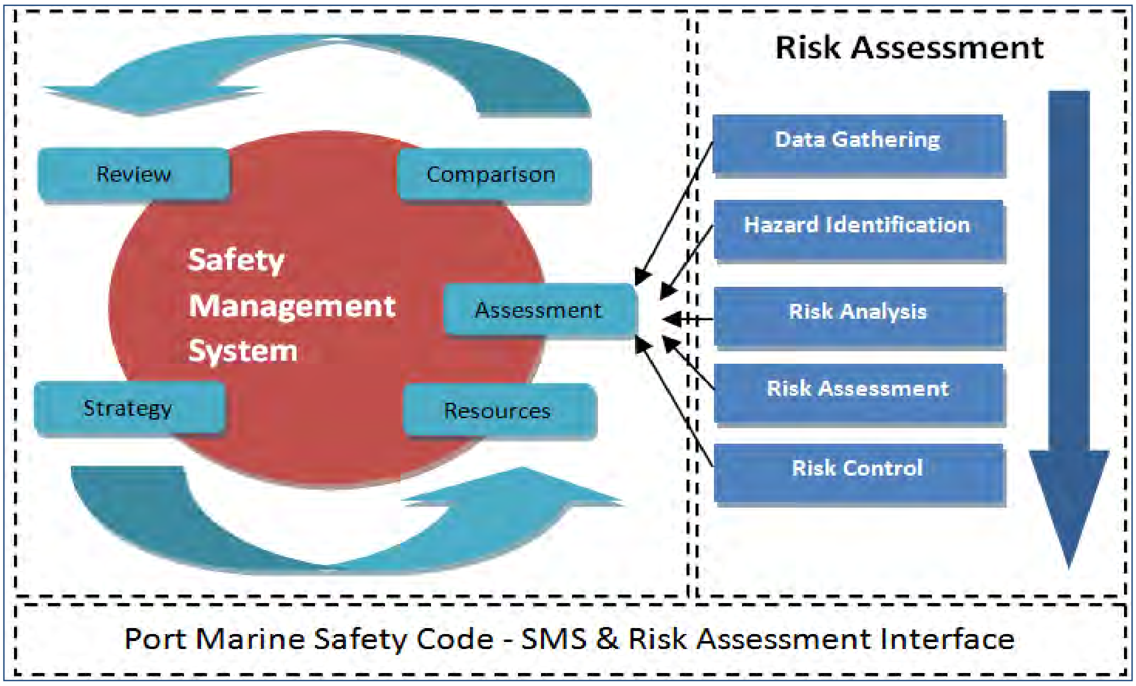


Figure 24: Relationship between the NRA and the Safety Management System.

5.2.1 High Risks and Significant Risks

No hazards were assessed to be in the High Risk or Significant Risk band for either the construction or operation phase of the project.

5.2.2 ALARP Risks

5.2.2.1 Construction Phase

Three of the 61 hazards were assessed to be within the ALARP band, with risk scores between 4.20–5.21. This is in the central band of the ALARP region; however efforts should nonetheless be made to reduce this risk further, based on the cost-effectiveness of implementing additional risk control measures. These hazards and their associated control measures should be regularly reviewed as part of the OIC and Project Safety Management System. They are:

- A Construction Vessel collides with another Construction Vessel.
- A Cruise Ship / Mainland Ferry collides with a Small Commercial Vessel.
- A Cruise Ship / Mainland Ferry collides with a Large Commercial Vessel.

However, it is noted that the two hazards involving cruise vessels are very unlikely to happen in the project vicinity, the relatively high-risk scores being attributable to the severity of outcome in the remote event the hazard is realised.

The highest risk hazard is directly related to the construction activity, and it is recommended that in addition to the ongoing traffic monitoring and direction provided by the OIC VTS, a navigation management plan is developed and implemented to manage all vessels involved in the construction project.

5.2.2.2 Operation Phase

Two of the 48 hazards were assessed to be within the ALARP band, with risk scores between 4.20 and 4.56. This is towards the lower end of the ALARP region; however efforts should nonetheless be made to reduce this risk further, based on the cost-effectiveness of implementing additional risk control measures. These hazards and their associated control measures should be regularly reviewed as part of the OIC Safety Management System. They are:

- A Cruise Ship / Mainland Ferry collides with a Small Commercial Vessel.
- A Cruise Ship / Mainland Ferry collides with a Large Commercial Vessel.

Both of these hazards pre-exist the proposed development, and have not been made more likely by the project, although they could of course occur in the project study area.

5.2.3 Negligible and Low Risks

All of the remaining 48 of the 51 hazards that were identified for both phases fell within the “negligible” or “low risk” regions, therefore no additional risk controls are formally required.

6 CONCLUSIONS

This assessment has concluded that there is little significant new navigational risk associated with either the construction or operation of the proposed Scapa Flow Deep Water Quay.

The project site is located in an area of very low present day traffic density, and which is already subject to numerous effective risk control measures (VTS, Pilotage, Towage, etc). As a result of both of these factors, incident frequency is also low.

There will be an inevitable increase in navigation risk through the introduction of a new structure, generating an increased volume of traffic. However, the increase in risk is low, on top of an already low baseline.

7 RECOMMENDATIONS

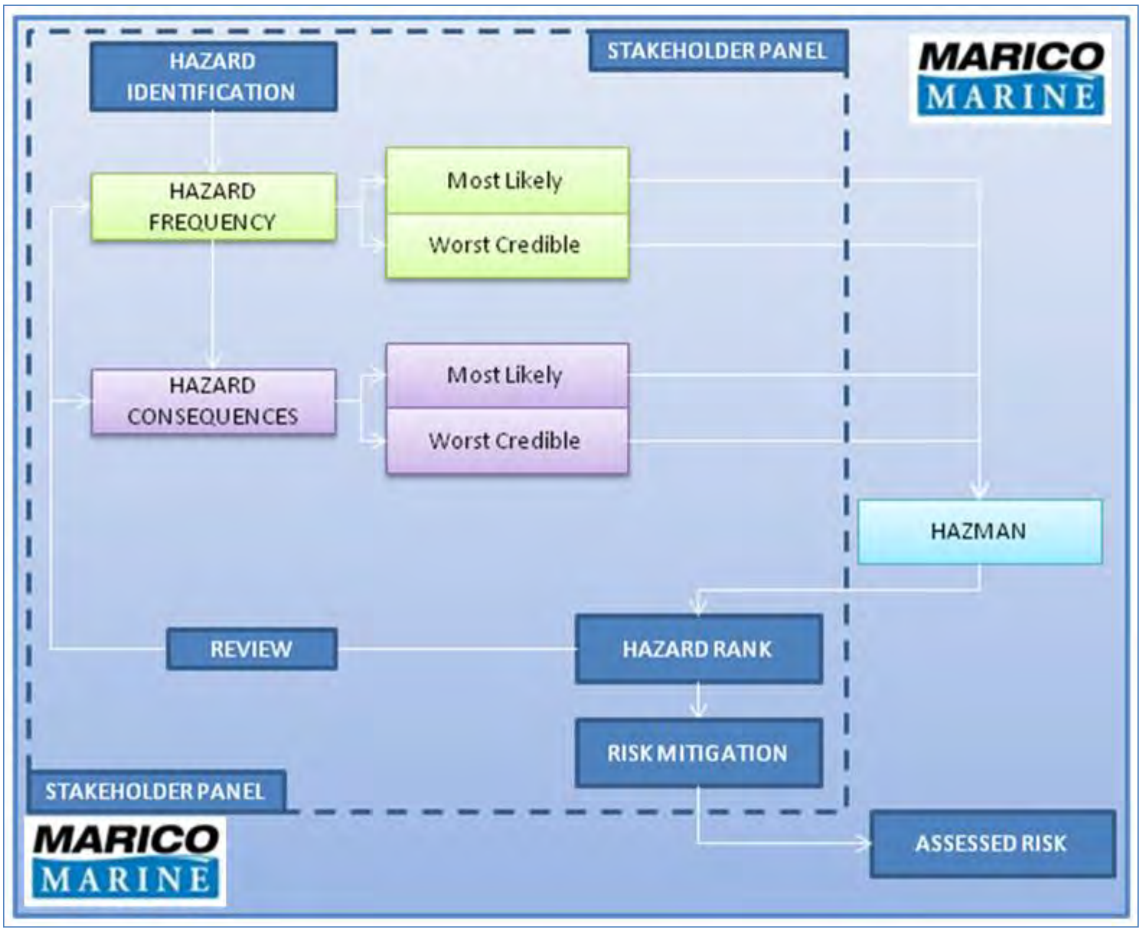
While this assessment has found that navigation risk will be low, or in a small number of scenarios, within the ALARP band both during the construction and operational phases, the following recommendations are made:

- Existing control measures should be kept in place (VTS, Pilotage, Towage) during both construction and operation phases;
- Good communications should be maintained with stakeholders throughout (NTMs, website, meetings etc). There will be a need for close liaison between the OICHA and the contractors during the construction phase and between OICHA and the berth operator during the operational phase.;
- Communication should be established with local leisure users who may be currently using an inshore route at the project site, noting no input to this NRA;
- If inshore leisure use is found to be significant, a plan to manage these vessels during construction and operation phases should be developed;
- A Navigation Management Plan for the construction phase should be designed and implemented to reduce the chance of ship-to-ship collisions between craft involved in the construction phase;
- All of the risks should be kept under review as the project is developed, and once the facility is operational, OICs PMSC NRA should be updated and kept under review to reflect the new operations.

Annex A NRA Methodology

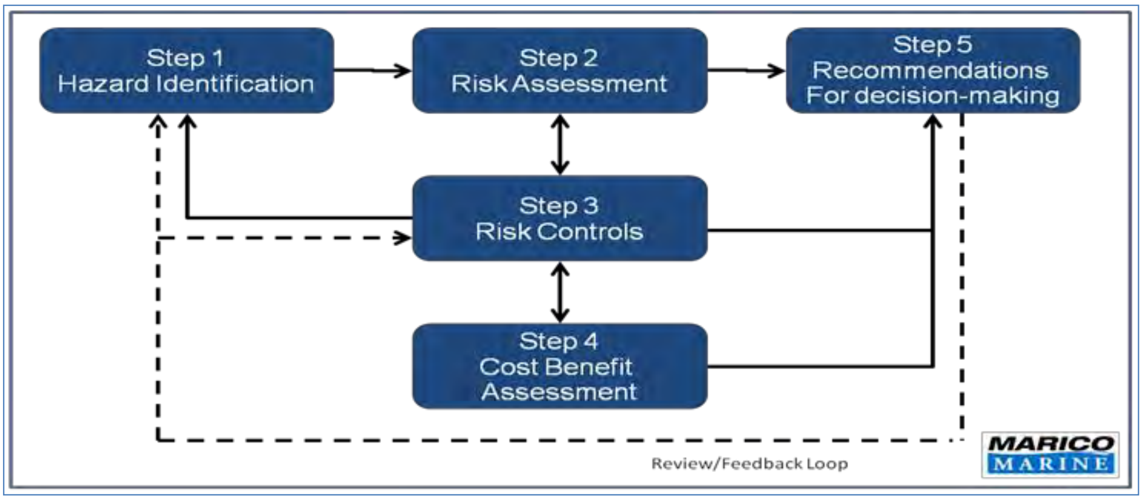
RISK ASSESSMENT METHODOLOGY

The Navigation risk assessment methodology was based on the Formal Safety Assessment methodology as adopted by IMO. It also follows the guidance set out within the Port Marine Safety Code. Marico Marine uses a form of risk assessment that has been specifically adapted for navigational use. It is unique to Marico and is fundamentally based on concepts of "Most Likely" and "Worst Credible", which reflect the range of outcomes arising from a shipping accident. This approach matches marine incident data that is customarily available. It is relevant that incident data often shows a high frequency of "Most Likely" events, separated from a much lower frequency of "Worst Credible" events.



Marico hazard identification and risk assessment process.

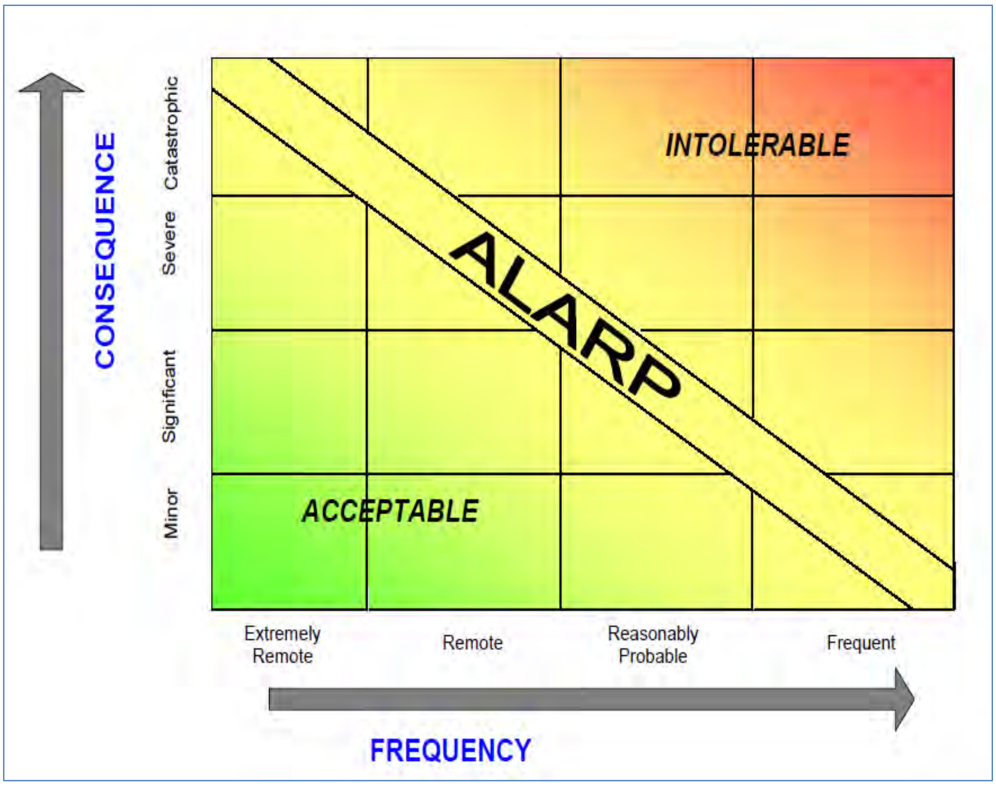
The NRA for the project was carried out using the Marico Marine "HAZMAN II" program to provide ranked hazard reports. The data handled within "HAZMAN II" can subsequently form the basis for an on-going navigational Safety Management System (SMS).



Formal Safety Assessment Risk Assessment Process.

IMO Guidelines define a hazard as "*something with the potential to cause harm, loss or injury*", the realisation of which results in an accident. The potential for a hazard to be realised can be combined with an estimate or known consequence of outcome. This combination is termed "risk". Risk is therefore a measure of the frequency and consequence of a particular hazard. One way to compare risk levels is to use a matrix approach as illustrated below. At the lowest end of the scale, frequency is extremely remote and consequence insignificant such that a risk can be said to be negligible. At the high end, where hazards are defined as frequent and the consequence catastrophic, then risk is termed intolerable. Between the two lies an area known "As Low As Reasonably Practicable" (ALARP).

The IMO guidelines allow the selection of definitions of frequency and consequence to be made by the organisation carrying out the risk assessment. This is important, as it allows risk to be applied in a qualitative and comparative way. To identify high risk levels in a purely mathematically quantitative way would require a large volume of casualty data, which is rarely available in the maritime context. ALARP can be accepted as being "Tolerable", if the further reduction of the risk is impracticable, or if the cost of such reduction would obviously be highly disproportionate to the improvement. It can also be considered "Tolerable", if the cost of reducing the risk is greater than any improvement gained.



Frequency / Consequence Chart.

The NRA used accident categories to organise hazards for assessment. The hazard categories identified as relevant to this study are likely to be:

- Anchor dragging;
- Collision;
- Contact;
- Diving incident;
- Girting;
- Grounding; and
- Mooring incident / breakout.

Each hazard was reviewed with respect to cause and effect. Frequencies were then derived for notional "Most Likely" and "Worst Credible" hazard events in each case, using the frequency bands defined below.

Frequency Criteria.

Scale	Description	Definition
F5	Frequent	An event that could be expected to occur more than once per year.
F4	Likely	An event that could be expected to occur between 1 to 10 years.
F3	Possible	An event that could be expected to occur between 10 to 100 years.
F2	Unlikely	An event that could be expected to occur between 100 to 1000 years.
F1	Remote	An event that could be expected to occur less than once in 1000 years.

Assessment of Consequence

Using the assessed notional frequency for the "*most likely*" and "*worst credible*" scenarios for each hazard, an assessment was made for the consequences to people, property, environment and business, using the categories and criteria below.

Consequence Categories and Criteria.

Cat.	People	Property	Environment	Business
C1	Negligible			
	Very minor injury (e.g. bruising).	Very minor damage to property.	No effect of note. Tier 1 may be declared but criteria not necessarily met.	Very short-term disruption to services (1-2hrs) with ensuing loss of revenue.
		Costs <£10k	Costs <£10k	Costs <£10k
C2	Minor			
	Single minor injury.	Minor damage to property.	Tier 1 – Tier 2 criteria reached. Small operational (oil) spill with little effect on environmental amenity.	Adverse local publicity. Short-term loss of revenue including minor disruption to commercial activities (<1 day).
		Costs £10k –£100k	Costs £10K–£100k	Costs £10k – £100k
C3	Moderate			
	Multiple minor or single major injury.	Moderate damage to property.	Tier 2 spill criteria reached but capable of being limited to immediate area within area.	Adverse regional publicity. Temporary suspension of commercial activities and/or prolonged restrictions (1≥7 days).
		Costs£ 100k - £1M	Costs £100k -£1M	Costs £100k - £1M
C4	Major			
	Multiple major injuries or single fatality.	Major damage to property.	Tier 3 criteria reached with pollution requiring national support. Chemical spillage or small gas release.	Adverse national publicity. Medium-term suspension of operations or prolonged restrictions, major disruption to commercial activities.
		Costs £1M -10M	Costs £1M - £10M	Costs £1M -£10M
C5	Catastrophic			
	Multiple fatalities	Catastrophic damage to property.	Tier 3 oil spill criteria reached. International support required. Widespread shoreline contamination. Serious chemical or gas release. Significant threat to environmental amenity.	Adverse international publicity. Long-term suspension of operations, prolonged restrictions, and/or termination of commercial activities.
		Costs>£10M	Costs >£10M	Costs >£10M

Note that the Oil Pollution Preparedness, Response Co-operation Convention[5] defines the following response levels for oil spills in the United Kingdom:

- Tier 1 Local (within the capability of the operator on site): A Tier 1 response is the lowest response level and requires resources to be available locally. Depending on the characteristics of the oil this may or may not include the use of dispersants. By definition these resources must be at or near the incident site. It is expected that these resources will be deployed as quickly as operational circumstances allow.
- Tier 2 Regional (beyond the in-house capability of the operator): For larger pollution incidents, local resources may be insufficient to deliver a proper response. In these cases it may be that resources from a regional centre will be required. A key component of UK offshore Tier 2 response is that operators are expected to have this capability mobilised and applied within 2 to 6 hours of an oil pollution incident.
- Tier 3 National (requiring national resources): For very large pollution incidents, resources supplied from national and international sources may be required. A key component of UK offshore Tier 3 response is that operators are expected to have this capability mobilised and applied within 6 to 18 hours of an oil pollution incident.

Using the assessed notional frequency for the “Most Likely” and “Worst Credible” scenarios for each hazard, the probable consequences associated with each were assessed in terms of damage to:

- People - Personal injury, fatality etc.;
- Property – including third party;
- Environment - Oil pollution etc.; and
- Business - Reputation, financial loss, public relations etc.

The magnitude of each is then assessed using the consequence categories as shown in the table below. These have been set such that the consequences in respect of property, environment and business have similar monetary equivalent outcomes.

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[5] The Merchant Shipping (Oil Pollution Preparedness, Response Co-operation Convention) Regulations 1998, Statutory Instrument 1998 No. 1056

Project Risk Matrix.

Consequences	**Cat 5**	5.1	5.9	7.0	8.3	10.0
	Cat 4	4.1	4.9	5.9	7.4	9.4
	Cat 3	2.9	3.5	4.4	5.9	8.3
	Cat 2	1.5	1.8	2.4	3.5	5.9
	Cat 1	0	0	0	0	0
	Frequency (movements)	**>10,000**	**1,000-10,000**	**500-1,000**	**100-500**	**<100**

Navigation hazards are identified by the project team, and scored for "frequency" and "consequence" and in terms of a "Most Likely" and "Worst Credible" outcome, with results documented in a "Hazard Log".

Risk bands.

Matrix Outcome	Risk Definition	Action Taken
0 & 1	Negligible Risk	A level where operational safety is unaffected.
2 & 3	Low risk	A level where operational safety is assumed.
4 ,5 and 6	As Low As Reasonably Practicable (ALARP)	A level defined by study at which risk control in place is reviewed. It should be kept under review in the ensuing SMS.
7 & 8	Significant Risk	A level where existing risk control is automatically reviewed and suggestions made where additional risk control could be applied if appropriate. Significant risk can occur in the average case or in individual categories. New risk controls identified should be introduced in a timescale of two years.
9 & 10	High Risk	A level requiring immediate mitigation.

Risk is then calculated for each consequence category (e.g. people, property, environment and business) based on the scores in the hazard log, using a risk matrix. Risk scores are calculated for each hazard under the "Most Likely" and "Worst Credible" scenarios for each of the consequence criteria. This generates eight individual risk scores per hazard. These risk scores are documented in the "Ranked Hazard Lists". The risk scores are then analysed further to obtain four indices for each hazard as follows:

- The average risk score of the categories in the 'most likely' set;
- The average risk score of the categories in the 'worst credible' set;
- The maximum risk score of the categories in the 'most likely' set; and
- The maximum risk score of the categories in the 'worst credible' set.

These scores were then combined to produce a single numeric value representing each of the four indices. The hazard list was then sorted in order of the aggregate of the four indices to produce a 'Ranked Hazard

List' with the highest risk hazards prioritised at the top. The ranked hazard list documents the individual category risk scores in more detail.

All risk scores, whether individual per consequence category, or overall for a hazard are scored on a scale of 0 (low risk) to 10 (high risk). Where the resultant risk levels cannot be considered in the low / negligible risk range, possible risk mitigation measures are identified for implementation.

Annex B Sample Stakeholder Meeting Agenda

Stakeholder Meeting Agenda

Item	Description
1	**Introductions**
2	**Overview of development proposal**
2.1	Overall
2.2	Marine
3	**Overview of current marine traffic in the area**
3.1	Traffic
3.2	Anchorages
4	**Any known incidents in area**
5	**Any other anticipated changes in the area or future “developments” known to consultee**
6	**Any other information relevant to safety of navigation**
6.1	e.g Special control measures, AtoNs etc.

Annex C Stakeholder Meeting Minutes

Minutes – Scapa Flow Deepwater Jetty NRA Consultation– 21UK11812

Orkney Marine Team

Client:	Orkney Islands Council	
Project:	21UK1812	
Attendees:	William Heaps (WH)	Marico Marine
	David Foster (DF)	Marico Marine / OIC Designated Person
	David Sawkins (DS)	OIC – DHM (Strategy)
	Richard Wild (RW)	OIC – DHM (Ops)
	Lee Groat (LG)	OIC – Class 1 Pilot
	Michael ? (M)	OIC – Tug Master
	Douglas Manson (DM)	OIC – Marine Supervisor Pilot v/l and Tugs
Venue:	“Teams” video conference	
Date of Meeting:	15:00 to 15:45 5 January 2021	

Item	Action item / Notes for the record	Action
1	**Introductions**	
1.1	Brief introductions of all those present were led by DS. Most attendees were already known to each other. WH mentioned that he would be leading the NRA as DF wished to retain independence as DP to the Council, but DF would still be available for advice and information. WH further noted that this meeting was exclusively for OIC stakeholders, but some third parties were also being contacted (Scottish Sea Farms) – advice on any others was requested (see below).	WH
2	**Overview of development proposal**	
2.1	As all attendees were aware of the proposals, and the area affected, this agenda item was omitted; however, WH stressed that the current Navigation Risk Assessment was just that – and only considers navigation safety in connection with the proposals. There will be alternative opportunities to comment on other aspects of the development.	
3	**Overview of current marine traffic in the area**	
3.1	Traffic: The area in the immediate vicinity of the proposed new quay is not currently busy for commercial traffic. Almost all current nearby traffic passes in a N/S (or S/N) direction departing from or bound to Scapa Pier. Tracks (to be confirmed in due course from AIS analysis) were reported to be well to the west of the shore, some 2-3 nm from the coast, leaving the fish farm and Royal Oak wreck to the east. Principal traffic in the area was identified as: • Support vessels for rigs at anchorages (see below) – anchor handlers, tugs, supply vessels, crew change vessels. Can be very busy, but sporadic. All traffic keeps west of Royal Oak. • OICHA tugs and pilot vessels operating out of Scapa. • Fish Farm support vessels – mainly to the south (operating from St Margaret’s Hope) and away from study area, but occasionally (1 / month?) transit to Scapa to use slipway.	

Item	Action item / Notes for the record	Action
	• Coastal tankers –approximately once every three weeks to Scapa,but use westerly route as above. • Workboats / inshore fishing vessels. low density but do occasionally transit area when bound to from Scapa pier. Also, crew change vessels for rigs. Should be consulted (DS to provide contact details). • EMEC area to south currently in use but tends to be serviced from Stromness. Consult to confirm. • Leisure use by traditional yachts, etc. is very low, but it was noted that along shore kayaking from Scapa to St Mary's is becoming popular and this was the class of vessel most likely to be impacted by the development. Seek representative to consult. • Royal Naval vessels visiting Royal Oak, and annual wreck surveys continue – unchanged since previous NRA, and all keep well to west of development.	DS / WH WH WH
3.2	Anchorages: No.s 11, 5 and STS 4 are the closest to the development, though the nearest (No. 11) is approximately 1 nm from the current shoreline at the proposed jetty site. All of these anchorages remain in regular (though not constant use) and would be expected to continue to be used in a similar way throughout both construction and operational phases of the development. It was noted by LG that Anchorage 11 currently has ground tackle laid on the seabed ready for use, but while longstanding, this arrangement is not permanent, and the tackle could be removed at any time. There is no hazard to surface navigation when the moorings are on the seabed. At the other anchorages, vessels use their own anchors It was noted that additional future use of the anchorages in connection with activities at the new jetty, once operational, is currently unknown. While it is anticipated that significant vessels *may* use some of the anchorages in connection with the new business, there is currently no detail available, nor is it known which anchorages may be used. It was agreed that the NRA would note possible increased use, but a revision would be required in due course if and when details are known.	WH
4	**Any known incidents in area since previous NRA**	
4.1	Marico have access to OIC's incident data base, which will inform the NRA. However, incidents in the area are rare. LG noted that the most likely incident nearby would be vessels dragging anchors due to extreme weather which can affect Scapa Flow despite the generally sheltered nature of the anchorages in comparison with open waters. There have been such incidents, but none have developed into a situation where vessels have grounded or been driven close to the project area.	
5	**Any other anticipated changes in the area or future "developments" known to consultee**	
5.1	None. DS noted that any expansions to fish farms, etc. would require OIC consent, in any event.	
6	**Any other information relevant to safety of navigation**	
6.1	There have been no significant changes since the PMSC NRA undertaken on behalf of OIC, which will inform the new NRA. WH received confirmation that the project area is fully covered by VTS, Radar etc, and that OIC are able to direct traffic in the area (including assignation of anchorages).	

Annex D Ranked Risk Register (Construction)

Rank	Hazard Ref.	Accident Category	Hazard Title	Hazard Detail	Consequence Descriptions		Risk By Consequence Category								Risk Overall	Remarks
							ML				WC					
					Most Likely (ML)	Worst Credible (WC)	Environment	People	Property	Stakeholders	Environment	People	Property	Stakeholders		
1	5	Collision	Construction Vessel - Construction Vessel	A Construction Vessel collides with another Construction Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple fatalities; Moderate damage to property; Tier 1 to Tier 2 criteria reached; Adverse national publicity, medium-term suspension of operations or prolonged restrictions.	0	6	0	6	2	7	4	6	**5.21**	This hazard includes Cruise Ship tenders with passengers embarked.
2	15	Collision	Cruise Ship / Mainland Ferry - Small Commercial Vessel	A Cruise Ship / Mainland Ferry collides with a Small Commercial Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse regional publicity, temporary suspension of commercial activities and / or prolonged restrictions.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple fatalities; Moderate damage to property; Tier 1 to Tier 2 criteria reached; Adverse national publicity, medium-term suspension of operations or prolonged restrictions.	0	3	0	6	2	6	3	5	**4.56**	This hazard includes Cruise Ship tenders with passengers embarked.
3	12	Collision	Cruise Ship / Mainland Ferry - Large Commercial Vessel	A Cruise Ship / Mainland Ferry collides with a Large Commercial Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Adverse regional publicity, temporary suspension of commercial activities and / or prolonged restrictions.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple fatalities; Catastrophic damage to property; Tier 2 spill criteria reached but capable of being limited to immediate area; Adverse international publicity, long-term suspension of operations, prolonged restrictions and / or termination of commercial activities.	0	0	0	4	3	6	6	6	**4.2**	
4	58	Grounding in vicinity of construction site	Grounding - Construction Vessel	A Construction Vessel runs aground.	Low speed / energy grounding, vessel able to refloat without assistance. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	High speed / energy grounding, vessel unable to refloat without assistance. Resulting in: Multiple injuries; Moderate damage to property; Tier 1 to Tier 2 criteria reached; Adverse local publicity, minor disruption to commercial activities.	0	6	0	0	2	3	3	5	**3.92**	This hazard includes Cruise Ship tenders with passengers embarked.
5	55	Grounding	Grounding - Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry	A Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry runs aground.	Low speed / energy grounding, vessel able to refloat without assistance. Resulting in: Single minor injury; Minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	High speed / energy grounding, vessel unable to refloat without assistance. Resulting in: Multiple fatalities; Major damage to property; Tier 2 spill criteria reached but capable of being limited to immediate area; Adverse national publicity, medium-term suspension of operations or prolonged restrictions.	0	2	2	2	3	6	5	5	**3.74**	
6	10	Collision	Cruise Ship / Mainland Ferry - Inshore Fishing Vessel	A Cruise Ship / Mainland Ferry collides with an Inshore Fishing Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse regional publicity, temporary suspension of operations and / or prolonged restrictions.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple major injuries or single fatality; Moderate damage to property; Tier 1 to Tier 2 criteria reached; Adverse national publicity, medium-term suspension of operations or prolonged restrictions.	0	2	0	4	2	5	3	5	**3.69**	

Rank	Hazard Ref.	Accident Category	Hazard Title	Hazard Detail	Consequence Descriptions		Risk By Consequence Category								Risk Overall	Remarks
							ML				WC					
					Most Likely (ML)	Worst Credible (WC)	Environment	People	Property	Stakeholders	Environment	People	Property	Stakeholders		
7	8	Collision	Cruise Ship / Mainland Ferry - Construction Vessel	A Cruise Ship / Mainland Ferry collides with a Construction Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse regional publicity, temporary suspension of commercial activities and / or prolonged restrictions.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple fatalities; Moderate damage to property; Tier 1 to Tier 2 criteria reached; Adverse national publicity, medium-term suspension of operations or prolonged restrictions.	0	2	0	4	1	5	3	4	**3.65**	This hazard includes Cruise Ship tenders with passengers embarked.
8	13	Collision	Cruise Ship / Mainland Ferry - Large Tanker	A Cruise Ship / Mainland Ferry collides with a Large Tanker.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Adverse regional publicity, temporary suspension of operations and / or prolonged restrictions.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple fatalities; Catastrophic damage to property; Tier 3 oil spill criteria reached. International support required; Adverse international media publicity, long-term suspension of operations, prolonged restrictions and / or termination of commercial activities.	0	0	0	3	5	5	5	5	**3.64**	
9	9	Collision	Cruise Ship / Mainland Ferry - Cruise Ship / Mainland Ferry	A Cruise Ship / Mainland Ferry collides with another Cruise Ship / Mainland Ferry.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Adverse regional publicity, temporary suspension of commercial activities and / or prolonged restrictions.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple fatalities; Catastrophic damage to property; Tier 2 spill criteria reached but capable of being limited to immediate area; Adverse international publicity, long-term suspension of operations, prolonged restrictions and / or termination of commercial activities.	0	0	0	3	3	5	5	5	**3.5**	
10	11	Collision	Cruise Ship / Mainland Ferry - Inter-Island Ferry	A Cruise Ship / Mainland Ferry collides with an Inter-Island Ferry.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Adverse regional publicity, temporary suspension of commercial activities and / or prolonged restrictions.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple fatalities; Catastrophic damage to property; Tier 2 spill criteria reached but capable of being limited to immediate area; Adverse international publicity, long-term suspension of operations, prolonged restrictions and / or termination of commercial activities.	0	0	0	3	3	5	5	5	**3.5**	
11	39	Collision	Recreational Vessel - Construction Vessel	A Recreational Vessel collides with a Construction Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple major injuries or single fatality; Moderate damage to property; No environmental effect of note; Adverse regional publicity, temporary suspension of commercial activities and / or prolonged restrictions.	0	0	0	3	0	6	4	4	**3.5**	This hazard includes Cruise Ship tenders with passengers embarked.
12	61	Mooring Incident / Breakout on	Mooring Incident Construction Vessel	A Construction Vessel breaks away from her moorings.	Mooring lines in propeller / bow thruster, damage to gangway, lines parted. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Grounding or Contact. Resulting in: Multiple minor or single major injury; Moderate damage to property; Tier 1 to Tier 2 criteria reached; Adverse local publicity, minor disruption to commercial activities.	0	6	0	0	2	3	3	3	**3.5**	This hazard includes Cruise Ship tenders with passengers embarked.

Rank	Hazard Ref.	Accident Category	Hazard Title	Hazard Detail	Consequence Descriptions		Risk By Consequence Category								Risk Overall	Remarks
							ML				WC					
					Most Likely (ML)	Worst Credible (WC)	Environment	People	Property	Stakeholders	Environment	People	Property	Stakeholders		
13	59	Mooring Incident / Breakout	Mooring Incident / Breakout - Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry	A Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry breaks away from her moorings.	Mooring lines in propeller / bow thruster, damage to gangway, lines parted. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Grounding or Contact. Resulting in: Multiple major injuries or single fatality; Major damage to property; Tier 2 spill criteria reached but capable of being limited to immediate area; Adverse national publicity, medium-term suspension of operations or prolonged restrictions.	0	3	0	0	3	5	5	5	**3.43**	
14	7	Collision	Construction Vessel - Towage Vessel	A Construction Vessel collides with a Towage Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple fatalities; Moderate damage to property; Tier 1 to Tier 2 criteria reached; Adverse national publicity, medium-term suspension of operations or prolonged restrictions.	0	2	0	2	2	6	3	5	**3.4**	This hazard includes Cruise Ship tenders with passengers embarked.
15	17	Collision	Inshore Fishing Vessel - Construction Vessel	An Inshore Fishing Vessel collides with a Construction Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple fatalities; Moderate damage to property; Tier 1 to Tier 2 criteria reached; Adverse national publicity, medium-term suspension of operations or prolonged restrictions.	0	2	0	2	2	6	3	5	**3.4**	This hazard includes Cruise Ship tenders with passengers embarked.
16	23	Collision	Inshore Fishing Vessel - Small Commercial Vessel	An Inshore Fishing Vessel collides with a Small Commercial Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple fatalities; Moderate damage to property; Tier 1 to Tier 2 criteria reached; Adverse national publicity, medium-term suspension of operations or prolonged restrictions.	0	2	0	2	2	6	3	5	**3.4**	This hazard includes Cruise Ship tenders with passengers embarked.
17	33	Collision	Large Commercial Vessel - Construction Vessel	A Large Commercial Vessel collides with a Construction Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple fatalities; Moderate damage to property; Tier 1 to Tier 2 criteria reached; Adverse national publicity, medium-term suspension of operations or prolonged restrictions.	0	2	0	2	2	6	3	5	**3.4**	This hazard includes Cruise Ship tenders with passengers embarked.
18	36	Collision	Large Commercial Vessel - Small Commercial Vessel	A Large Commercial Vessel collides with a Small Commercial Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple fatalities; Moderate damage to property; Tier 1 to Tier 2 criteria reached; Adverse national publicity, medium-term suspension of operations or prolonged restrictions.	0	2	0	2	2	6	3	5	**3.4**	This hazard includes Cruise Ship tenders with passengers embarked.
19	45	Collision	Small Commercial Vessel - Small Commercial Vessel	A Small Commercial Vessel collides with another Small Commercial Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple fatalities; Moderate damage to property; Tier 1 to Tier 2 criteria reached; Adverse national publicity, medium-term suspension of operations or prolonged restrictions.	0	2	0	2	2	6	3	5	**3.4**	This hazard includes Cruise Ship tenders with passengers embarked.

Rank	Hazard Ref.	Accident Category	Hazard Title	Hazard Detail	Consequence Descriptions		Risk By Consequence Category								Risk Overall	Remarks
							ML				WC					
					Most Likely (ML)	Worst Credible (WC)	Environment	People	Property	Stakeholders	Environment	People	Property	Stakeholders		
20	46	Collision	Small Commercial Vessel - Towage Vessel	A Small Commercial Vessel collides with a Towage Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple fatalities; Moderate damage to property; Tier 1 to Tier 2 criteria reached; Adverse national publicity, medium-term suspension of operations or prolonged restrictions.	0	2	0	2	2	6	3	5	**3.4**	This hazard includes Cruise Ship tenders with passengers embarked.
21	56	Grounding	Grounding - Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel	An Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel runs aground.	Low speed / energy grounding, vessel able to refloat without assistance. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	High speed / energy grounding, vessel unable to refloat without assistance. Resulting in: Multiple fatalities; Moderate damage to property; Tier 1 to Tier 2 criteria reached; Adverse local publicity, minor disruption to commercial activities.	0	3	0	0	2	6	3	2	**3.39**	This hazard includes Cruise Ship tenders with passengers embarked.
22	53	Diving	Diving Incident on construction site	A diving incident involving commercial divers in connection with construction	Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Resulting in: Multiple major injuries or single fatality; Very minor damage to property; No environmental effect of note; Adverse regional publicity, temporary suspension of operations and / or prolonged restrictions.	0	3	0	0	0	6	0	6	**3.31**	
23	14	Collision	Cruise Ship / Mainland Ferry - Recreational Vessel	A Cruise Ship / Mainland Ferry collides with a Recreational Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse regional publicity, temporary suspension of commercial activities and / or prolonged restrictions.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple major injuries or single fatality; Moderate damage to property; No environmental effect of note; Adverse national publicity, medium-term suspension of operations or prolonged restrictions.	0	2	0	3	0	5	3	5	**3.25**	
24	34	Collision	Large Commercial Vessel - Large Commercial Vessel	A Large Commercial Vessel collides with another Large Commercial Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple major injuries or single fatality; Major damage to property; Tier 3 criteria reached with pollution requiring national support; Adverse national publicity, medium-term suspension of operations or prolonged restrictions.	0	0	0	2	5	5	5	5	**3.18**	
25	32	Collision	Large Commercial Vessel - Large Tanker	A Large Commercial Vessel collides with a Large Tanker.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, short-term loss of revenue including minor disruption to commercial activities.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple major injuries or single fatality; Major damage to property; Tier 3 oil spill criteria reached. International support required; Adverse national publicity, medium-term suspension of operations and / or prolonged restrictions.	0	0	0	2	5	4	4	4	**3.11**	

Rank	Hazard Ref.	Accident Category	Hazard Title	Hazard Detail	Consequence Descriptions		Risk By Consequence Category								Risk Overall	Remarks
							ML				WC					
					Most Likely (ML)	Worst Credible (WC)	Environment	People	Property	Stakeholders	Environment	People	Property	Stakeholders		
26	57	Grounding	Grounding - Large Tanker	A Large Tanker runs aground.	Low speed / energy grounding, vessel able to refloat without assistance. Resulting in: Single minor injury; Minor damage to property; No environmental effect of note; Very short-term disruption to services.	High speed / energy grounding, vessel unable to refloat without assistance. Resulting in: Multiple minor or single major injury; Major damage to property; Tier 3 oil spill criteria reached. International support required; Adverse international media publicity, long-term suspension of operations, prolonged restrictions and / or termination of commercial activities.	0	2	2	0	5	3	4	5	**3.04**	
27	27	Collision	Inter-Island Ferry - Large Commercial Vessel	An Inter-Island Ferry collides with a Large Commercial Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple fatalities; Major damage to property; Tier 1 to Tier 2 criteria reached; Adverse international publicity, long-term suspension of operations, prolonged restrictions and / or termination of commercial activities.	0	2	0	2	1	5	4	5	**2.95**	
28	28	Collision	Inter-Island Ferry - Large Tanker	An Inter-Island Ferry collides with a Large Tanker.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple fatalities; Major damage to property; Tier 1 to Tier 2 criteria reached; Adverse international media publicity, long-term suspension of operations, prolonged restrictions and / or termination of commercial activities.	0	2	0	2	1	5	4	5	**2.95**	
29	31	Collision	Inter-Island Ferry - Towage Vessel	An Inter-Island Ferry collides with a Towage Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple fatalities; Major damage to property; Tier 1 to Tier 2 criteria reached; Adverse national publicity, medium-term suspension of operations or prolonged restrictions.	0	2	0	2	1	5	4	4	**2.89**	
30	35	Collision	Large Commercial Vessel - Recreational Vessel	A Large Commercial Vessel collides with a Recreational Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple major injuries or single fatality; Moderate damage to property; No environmental effect of note; Adverse regional publicity, temporary suspension of commercial activities and / or prolonged restrictions.	0	2	0	2	0	5	3	3	**2.86**	
31	38	Collision	Large Tanker - Large Tanker	A Large Tanker collides with another Large Tanker.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple major injuries or single fatality; Catastrophic damage to property; Tier 3 oil spill criteria reached. International support required; Adverse national publicity, medium-term suspension of operations and / or prolonged restrictions.	0	0	0	0	6	5	6	5	**2.83**	

Rank	Hazard Ref.	Accident Category	Hazard Title	Hazard Detail	Consequence Descriptions		Risk By Consequence Category								Risk Overall	Remarks
							ML				WC					
					Most Likely (ML)	Worst Credible (WC)	Environment	People	Property	Stakeholders	Environment	People	Property	Stakeholders		
32	6	Collision	Construction Vessel - Large Tanker	A Construction Vessel collides with a Large Tanker.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple fatalities; Moderate damage to property; Tier 1 to Tier 2 criteria reached; Adverse national publicity, medium-term suspension of operations or prolonged restrictions.	0	2	0	2	1	5	3	4	**2.81**	This hazard includes Cruise Ship tenders with passengers embarked.
33	25	Collision	Inter-Island Ferry - Construction Vessel	An Inter-Island Ferry collides with a Construction Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple fatalities; Moderate damage to property; Tier 1 to Tier 2 criteria reached; Adverse national publicity, medium-term suspension of operations or prolonged restrictions.	0	2	0	2	1	5	3	4	**2.81**	This hazard includes Cruise Ship tenders with passengers embarked.
34	26	Collision	Inter-Island Ferry - Inter-Island Ferry	An Inter-Island Ferry collides with another Inter-Island Ferry.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple fatalities; Major damage to property; Tier 1 to Tier 2 criteria reached; Adverse international publicity, long-term suspension of operations, prolonged restrictions and / or termination of commercial activities.	0	1	0	1	1	5	4	5	**2.81**	
35	30	Collision	Inter-Island Ferry - Small Commercial Vessel	An Inter-Island Ferry collides with a Small Commercial Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple fatalities; Moderate damage to property; Tier 1 to Tier 2 criteria reached; Adverse national publicity, medium-term suspension of operations or prolonged restrictions.	0	2	0	2	1	5	3	4	**2.81**	This hazard includes Cruise Ship tenders with passengers embarked.
36	44	Collision	Small Commercial Vessel - Large Tanker	A Small Commercial Vessel collides with a Large Tanker.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple fatalities; Moderate damage to property; Tier 1 to Tier 2 criteria reached; Adverse national publicity, medium-term suspension of operations or prolonged restrictions.	0	2	0	2	1	5	3	4	**2.81**	This hazard includes Cruise Ship tenders with passengers embarked.
37	4	Anchor Dragging	Anchor Dragging - Large Tanker	A Large Tanker unintentionally moves from its anchored position because the anchor has failed to hold.	Anchor dragging detected and remedial action taken. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Contact or grounding. Resulting in: Multiple minor or single major injury; Major damage to property; Tier 3 oil spill criteria reached. International support required; Adverse international media publicity, long-term suspension of operations, prolonged restrictions and / or termination of commercial activities.	0	0	0	0	6	3	5	6	**2.74**	Anchor dragging during STS operation / lay-up.

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							ML				WC					
					Most Likely (ML)	Worst Credible (WC)	Environment	People	Property	Stakeholders	Environment	People	Property	Stakeholders		
38	20	Collision	Inshore Fishing Vessel - Large Commercial Vessel	An Inshore Fishing Vessel collides with a Large Commercial Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple major injuries or single fatality; Moderate damage to property; No environmental effect of note; Adverse regional publicity, temporary suspension of commercial activities and / or prolonged restrictions.	0	2	0	0	0	5	3	3	**2.71**	
39	21	Collision	Inshore Fishing Vessel - Large Tanker	An Inshore Fishing Vessel collides with a Large Tanker.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple major injuries or single fatality; Moderate damage to property; No environmental effect of note; Adverse regional publicity, temporary suspension of operations and / or prolonged restrictions.	0	2	0	0	0	5	3	3	**2.71**	
40	42	Collision	Recreational Vessel - Small Commercial Vessel	A Recreational Vessel collides with a Small Commercial Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple major injuries or single fatality; Moderate damage to property; No environmental effect of note; Adverse regional publicity, temporary suspension of commercial activities and / or prolonged restrictions.	0	0	0	2	0	5	3	3	**2.71**	This hazard includes Cruise Ship tenders with passengers embarked.
41	43	Collision	Recreational Vessel - Towage Vessel	A Recreational Vessel collides with a Towage Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple major injuries or single fatality; Moderate damage to property; No environmental effect of note; Adverse regional publicity, temporary suspension of commercial activities and / or prolonged restrictions.	0	0	0	2	0	5	3	3	**2.71**	
42	60	Mooring Incident / Breakout	Mooring Incident / Breakout - Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel	An Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel breaks away from her moorings.	Mooring lines in propeller / bow thruster, damage to gangway, lines parted. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Grounding or Contact. Resulting in: Multiple minor or single major injury; Moderate damage to property; Tier 1 to Tier 2 criteria reached; Adverse local publicity, minor disruption to commercial activities.	0	3	0	0	2	3	3	2	**2.63**	This hazard includes Cruise Ship tenders with passengers embarked.
43	24	Collision	Inshore Fishing Vessel - Towage Vessel	An Inshore Fishing Vessel collides with a Towage Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple major injuries or single fatality; Moderate damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	0	2	0	0	0	5	3	2	**2.61**	
44	50	Contact	Contact - Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry	A Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry contacts a fixed object including new Quay.	A low speed / energy contact. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	A high speed / energy contact. Resulting in: Multiple minor or single major injury; Moderate damage to property; Tier 1 to Tier 2 criteria reached; Adverse regional publicity, temporary suspension of commercial activities and / or prolonged restrictions.	0	2	0	2	2	3	3	3	**2.56**	Reduced to exclude stromness ferry berthing

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							ML				WC					
					Most Likely (ML)	Worst Credible (WC)	Environment	People	Property	Stakeholders	Environment	People	Property	Stakeholders		
45	52	Diving	Diving Incident	A diving incident involving a Recreational (including wreck diving) and / or Commercial Vessel.	Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Resulting in: Multiple major injuries or single fatality; Very minor damage to property; No environmental effect of note; Adverse regional publicity, temporary suspension of operations and / or prolonged restrictions.	0	2	0	0	0	5	0	3	**2.49**	
46	49	Contact	Contact - Construction Vessel	A Construction Vessel contacts a fixed object inc. new Quay	A low speed / energy contact. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	A high speed / energy contact. Resulting in: Multiple major injuries, or single fatality; Minor damage to property; No environmental effect of note; Adverse local publicity, major disruption to commercial activities.	0	0	0	0	0	6	2	6	**2.37**	This hazard includes Cruise Ship tenders with passengers embarked.
47	2	Anchor Dragging	Anchor Dragging - Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry	A Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry unintentionally moves from its anchored position because the anchor has failed to hold.	Anchor dragging detected and remedial action taken. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Contact or grounding. Resulting in: Multiple major injuries or single fatality; Major damage to property; Tier 2 spill criteria reached but capable of being limited to immediate area; Adverse national publicity, medium-term suspension of operations or prolonged restrictions.	0	0	0	0	3	5	5	5	**2.34**	
48	40	Collision	Recreational Vessel - Large Tanker	A Recreational Vessel collides with a Large Tanker.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple major injuries or single fatality; Moderate damage to property; No environmental effect of note; Adverse regional publicity, temporary suspension of commercial activities and / or prolonged restrictions.	0	2	0	2	0	4	3	3	**2.33**	
49	29	Collision	Inter-Island Ferry - Recreational Vessel	An Inter-Island Ferry collides with a Recreational Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple major injuries or single fatality; Moderate damage to property; No environmental effect of note; Adverse regional publicity, temporary suspension of commercial activities and / or prolonged restrictions.	0	2	0	0	0	4	3	3	**2.21**	
50	37	Collision	Large Commercial Vessel - Towage Vessel	A Large Commercial Vessel collides with a Towage Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple major injuries or single fatality; Major damage to property; Tier 1 to Tier 2 criteria reached; Adverse regional publicity, temporary suspension of commercial activities and / or prolonged restrictions.	0	0	0	0	2	5	5	3	**2.15**	
51	47	Collision	Towage Vessel - Large Tanker	A Towage Vessel collides with a Large Tanker.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple major injuries or single fatality; Major damage to property; Tier 1 – Tier 2 criteria reached; Adverse regional publicity, temporary suspension of operations and / or prolonged restrictions.	0	0	0	0	2	5	5	3	**2.15**	

Rank	Hazard Ref.	Accident Category	Hazard Title	Hazard Detail	Consequence Descriptions		Risk By Consequence Category								Risk Overall	Remarks
							ML				WC					
					Most Likely (ML)	Worst Credible (WC)	Environment	People	Property	Stakeholders	Environment	People	Property	Stakeholders		
52	16	Collision	Cruise Ship / Mainland Ferry - Towage Vessel	A Cruise Ship / Mainland Ferry collides with a Towage Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple major injuries or single fatality; Major damage to property; Tier 1 to Tier 2 criteria reached; Adverse national publicity, medium-term suspension of operations or prolonged restrictions.	0	0	0	0	1	4	4	4	1.88	
53	54	Girting	Girting Incident	A towline under tension exerts a heeling moment which results in excessive heel that causes the tug to capsize (Including on construction site)	Tug recovers. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Tug is capsized. Resulting in: Multiple major injuries or single fatality; Major damage to property; Tier 1 to Tier 2 criteria reached; Adverse national publicity, medium-term suspension of operations or prolonged restrictions.	0	0	0	0	1	4	4	4	1.88	
54	18	Collision	Inshore Fishing Vessel - Inshore Fishing Vessel	An Inshore Fishing Vessel collides with another Inshore Fishing Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple major injuries or single fatality; Moderate damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	0	0	0	0	0	5	3	2	1.85	
55	22	Collision	Inshore Fishing Vessel - Recreational Vessel	An Inshore Fishing Vessel collides with a Recreational Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple major injuries or single fatality; Moderate damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	0	0	0	0	0	5	3	2	1.85	
56	19	Collision	Inshore Fishing Vessel - Inter-Island Ferry	An Inshore Fishing Vessel collides with an Inter-Island ferry.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple major injuries or single fatality; Moderate damage to property; Tier 1 to Tier 2 criteria reached; Adverse regional publicity, temporary suspension of commercial activities and / or prolonged restrictions.	0	0	0	0	1	4	3	3	1.73	
57	41	Collision	Recreational Vessel - Recreational Vessel	A Recreational Vessel collides with another Recreational Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple minor or single major injury; Minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	0	0	0	0	0	4	2	2	1.69	
58	51	Contact	Contact - Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel	An Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel contacts a fixed object inc new Quay	A low speed / energy contact. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	A high speed / energy contact. Resulting in: Multiple minor or single major injury; Minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	0	0	0	0	0	4	2	2	1.69	This hazard includes Cruise Ship tenders with passengers embarked.

Rank	Hazard Ref.	Accident Category	Hazard Title	Hazard Detail	Consequence Descriptions		Risk By Consequence Category								Risk Overall	Remarks
							ML				WC					
					Most Likely (ML)	Worst Credible (WC)	Environment	People	Property	Stakeholders	Environment	People	Property	Stakeholders		
59	1	Anchor Dragging	Anchor dragging - Construction Vessel	A construction Vessel unintentionally moves from its anchored position because the anchor has failed to hold.	Anchor dragging detected and remedial action taken. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Contact or grounding. Resulting in: Multiple minor or single major injury; Moderate damage to property; Tier 1 to Tier 2 criteria reached; Adverse local publicity, minor disruption to commercial activities.	0	0	0	0	2	3	3	2	**1.54**	
60	3	Anchor Dragging	Anchor dragging - Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel	An Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel unintentionally moves from its anchored position because the anchor has failed to hold.	Anchor dragging detected and remedial action taken. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Contact or grounding. Resulting in: Multiple minor or single major injury; Moderate damage to property; Tier 1 to Tier 2 criteria reached; Adverse local publicity, minor disruption to commercial activities.	0	0	0	0	2	3	3	2	**1.54**	
61	48	Collision	Towage Vessel - Towage Vessel	A Towage Vessel collides with another Towage Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple minor or single major injury; Moderate damage to property; Tier 1 to Tier 2 criteria reached; Adverse local publicity, minor disruption to commercial activities.	0	0	0	0	2	3	3	2	**1.54**	

Annex E Ranked Risk Register (Operation)

Rank	Hazard Ref.	Accident Category	Hazard Title	Hazard Detail	Consequence Descriptions		Risk By Consequence Category								Risk Overall	Remarks
							ML				WC					
					Most Likely (ML)	Worst Credible (WC)	Environment	People	Property	Stakeholders	Environment	People	Property	Stakeholders		
1	10	Collision	Cruise Ship / Mainland Ferry - Small Commercial Vessel	A Cruise Ship / Mainland Ferry collides with a Small Commercial Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse regional publicity, temporary suspension of commercial activities and / or prolonged restrictions.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple fatalities; Moderate damage to property; Tier 1 to Tier 2 criteria reached; Adverse national publicity, medium-term suspension of operations or prolonged restrictions.	0	3	0	6	2	6	3	5	**4.56**	This hazard includes Cruise Ship tenders with passengers embarked.
2	7	Collision	Cruise Ship / Mainland Ferry - Large Commercial Vessel	A Cruise Ship / Mainland Ferry collides with a Large Commercial Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Adverse regional publicity, temporary suspension of commercial activities and / or prolonged restrictions.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple fatalities; Catastrophic damage to property; Tier 2 spill criteria reached but capable of being limited to immediate area; Adverse international publicity, long-term suspension of operations, prolonged restrictions and / or termination of commercial activities.	0	0	0	4	3	6	6	6	**4.2**	
3	44	Grounding	Grounding - Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry	A Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry runs aground.	Low speed / energy grounding, vessel able to refloat without assistance. Resulting in: Single minor injury; Minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	High speed / energy grounding, vessel unable to refloat without assistance. Resulting in: Multiple fatalities; Major damage to property; Tier 2 spill criteria reached but capable of being limited to immediate area; Adverse national publicity, medium-term suspension of operations or prolonged restrictions.	0	2	2	2	3	6	5	5	**3.74**	
4	5	Collision	Cruise Ship / Mainland Ferry - Inshore Fishing Vessel	A Cruise Ship / Mainland Ferry collides with an Inshore Fishing Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse regional publicity, temporary suspension of operations and / or prolonged restrictions.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple major injuries or single fatality; Moderate damage to property; Tier 1 to Tier 2 criteria reached; Adverse national publicity, medium-term suspension of operations or prolonged restrictions.	0	2	0	4	2	5	3	5	**3.69**	
5	8	Collision	Cruise Ship / Mainland Ferry - Large Tanker	A Cruise Ship / Mainland Ferry collides with a Large Tanker.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Adverse regional publicity, temporary suspension of operations and / or prolonged restrictions.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple fatalities; Catastrophic damage to property; Tier 3 oil spill criteria reached. International support required; Adverse international media publicity, long-term suspension of operations, prolonged restrictions and / or termination of commercial activities.	0	0	0	3	5	5	5	5	**3.64**	

Rank	Hazard Ref.	Accident Category	Hazard Title	Hazard Detail	Consequence Descriptions		Risk By Consequence Category								Risk Overall	Remarks
							ML				WC					
					Most Likely (ML)	Worst Credible (WC)	Environment	People	Property	Stakeholders	Environment	People	Property	Stakeholders		
6	4	Collision	Cruise Ship / Mainland Ferry - Cruise Ship / Mainland Ferry	A Cruise Ship / Mainland Ferry collides with another Cruise Ship / Mainland Ferry.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Adverse regional publicity, temporary suspension of commercial activities and / or prolonged restrictions.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple fatalities; Catastrophic damage to property; Tier 2 spill criteria reached but capable of being limited to immediate area; Adverse international publicity, long-term suspension of operations, prolonged restrictions and / or termination of commercial activities.	0	0	0	3	3	5	5	5	**3.5**	
7	6	Collision	Cruise Ship / Mainland Ferry - Inter-Island Ferry	A Cruise Ship / Mainland Ferry collides with an Inter-Island Ferry.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Adverse regional publicity, temporary suspension of commercial activities and / or prolonged restrictions.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple fatalities; Catastrophic damage to property; Tier 2 spill criteria reached but capable of being limited to immediate area; Adverse international publicity, long-term suspension of operations, prolonged restrictions and / or termination of commercial activities.	0	0	0	3	3	5	5	5	**3.5**	
8	47	Mooring Incident / Breakout	Mooring Incident / Breakout - Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry	A Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry breaks away from her moorings.	Mooring lines in propeller / bow thruster, damage to gangway, lines parted. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Grounding or Contact. Resulting in: Multiple major injuries or single fatality; Major damage to property; Tier 2 spill criteria reached but capable of being limited to immediate area; Adverse national publicity, medium-term suspension of operations or prolonged restrictions.	0	3	0	0	3	5	5	5	**3.43**	
9	17	Collision	Inshore Fishing Vessel - Small Commercial Vessel	An Inshore Fishing Vessel collides with a Small Commercial Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple fatalities; Moderate damage to property; Tier 1 to Tier 2 criteria reached; Adverse national publicity, medium-term suspension of operations or prolonged restrictions.	0	2	0	2	2	6	3	5	**3.4**	This hazard includes Cruise Ship tenders with passengers embarked.
10	28	Collision	Large Commercial Vessel - Small Commercial Vessel	A Large Commercial Vessel collides with a Small Commercial Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple fatalities; Moderate damage to property; Tier 1 to Tier 2 criteria reached; Adverse national publicity, medium-term suspension of operations or prolonged restrictions.	0	2	0	2	2	6	3	5	**3.4**	This hazard includes Cruise Ship tenders with passengers embarked.
11	36	Collision	Small Commercial Vessel - Small Commercial Vessel	A Small Commercial Vessel collides with another Small Commercial Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple fatalities; Moderate damage to property; Tier 1 to Tier 2 criteria reached; Adverse national publicity, medium-term suspension of operations or prolonged restrictions.	0	2	0	2	2	6	3	5	**3.4**	This hazard includes Cruise Ship tenders with passengers embarked.

Rank	Hazard Ref.	Accident Category	Hazard Title	Hazard Detail	Consequence Descriptions		Risk By Consequence Category								Risk Overall	Remarks
							ML				WC					
					Most Likely (ML)	Worst Credible (WC)	Environment	People	Property	Stakeholders	Environment	People	Property	Stakeholders		
12	37	Collision	Small Commercial Vessel - Towage Vessel	A Small Commercial Vessel collides with a Towage Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple fatalities; Moderate damage to property; Tier 1 to Tier 2 criteria reached; Adverse national publicity, medium-term suspension of operations or prolonged restrictions.	0	2	0	2	2	6	3	5	**3.4**	This hazard includes Cruise Ship tenders with passengers embarked.
13	45	Grounding	Grounding - Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel	An Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel runs aground.	Low speed / energy grounding, vessel able to refloat without assistance. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	High speed / energy grounding, vessel unable to refloat without assistance. Resulting in: Multiple fatalities; Moderate damage to property; Tier 1 to Tier 2 criteria reached; Adverse local publicity, minor disruption to commercial activities.	0	3	0	0	2	6	3	2	**3.39**	This hazard includes Cruise Ship tenders with passengers embarked.
14	9	Collision	Cruise Ship / Mainland Ferry - Recreational Vessel	A Cruise Ship / Mainland Ferry collides with a Recreational Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse regional publicity, temporary suspension of commercial activities and / or prolonged restrictions.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple major injuries or single fatality; Moderate damage to property; No environmental effect of note; Adverse national publicity, medium-term suspension of operations or prolonged restrictions.	0	2	0	3	0	5	3	5	**3.25**	
15	26	Collision	Large Commercial Vessel - Large Commercial Vessel	A Large Commercial Vessel collides with another Large Commercial Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple major injuries or single fatality; Major damage to property; Tier 3 criteria reached with pollution requiring national support; Adverse national publicity, medium-term suspension of operations or prolonged restrictions.	0	0	0	2	5	5	5	5	**3.18**	
16	25	Collision	Large Commercial Vessel - Large Tanker	A Large Commercial Vessel collides with a Large Tanker.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, short-term loss of revenue including minor disruption to commercial activities.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple major injuries or single fatality; Major damage to property; Tier 3 oil spill criteria reached. International support required; Adverse national publicity, medium-term suspension of operations and / or prolonged restrictions.	0	0	0	2	5	4	4	4	**3.11**	

Rank	Hazard Ref.	Accident Category	Hazard Title	Hazard Detail	Consequence Descriptions		Risk By Consequence Category								Risk Overall	Remarks
							ML				WC					
					Most Likely (ML)	Worst Credible (WC)	Environment	People	Property	Stakeholders	Environment	People	Property	Stakeholders		
17	46	Grounding	Grounding - Large Tanker	A Large Tanker runs aground.	Low speed / energy grounding, vessel able to refloat without assistance. Resulting in: Single minor injury; Minor damage to property; No environmental effect of note; Very short-term disruption to services.	High speed / energy grounding, vessel unable to refloat without assistance. Resulting in: Multiple minor or single major injury; Major damage to property; Tier 3 oil spill criteria reached. International support required; Adverse international media publicity, long-term suspension of operations, prolonged restrictions and / or termination of commercial activities.	0	2	2	0	5	3	4	5	**3.04**	
18	20	Collision	Inter-Island Ferry - Large Commercial Vessel	An Inter-Island Ferry collides with a Large Commercial Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple fatalities; Major damage to property; Tier 1 to Tier 2 criteria reached; Adverse international publicity, long-term suspension of operations, prolonged restrictions and / or termination of commercial activities.	0	2	0	2	1	5	4	5	**2.95**	
19	21	Collision	Inter-Island Ferry - Large Tanker	An Inter-Island Ferry collides with a Large Tanker.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple fatalities; Major damage to property; Tier 1 to Tier 2 criteria reached; Adverse international media publicity, long-term suspension of operations, prolonged restrictions and / or termination of commercial activities.	0	2	0	2	1	5	4	5	**2.95**	
20	24	Collision	Inter-Island Ferry - Towage Vessel	An Inter-Island Ferry collides with a Towage Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple fatalities; Major damage to property; Tier 1 to Tier 2 criteria reached; Adverse national publicity, medium-term suspension of operations or prolonged restrictions.	0	2	0	2	1	5	4	4	**2.89**	
21	27	Collision	Large Commercial Vessel - Recreational Vessel	A Large Commercial Vessel collides with a Recreational Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple major injuries or single fatality; Moderate damage to property; No environmental effect of note; Adverse regional publicity, temporary suspension of commercial activities and / or prolonged restrictions.	0	2	0	2	0	5	3	3	**2.86**	

Rank	Hazard Ref.	Accident Category	Hazard Title	Hazard Detail	Consequence Descriptions		Risk By Consequence Category								Risk Overall	Remarks
							ML				WC					
					Most Likely (ML)	Worst Credible (WC)	Environment	People	Property	Stakeholders	Environment	People	Property	Stakeholders		
22	30	Collision	Large Tanker - Large Tanker	A Large Tanker collides with another Large Tanker.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple major injuries or single fatality; Catastrophic damage to property; Tier 3 oil spill criteria reached. International support required; Adverse national publicity, medium-term suspension of operations and / or prolonged restrictions.	0	0	0	0	6	5	6	5	**2.83**	
23	19	Collision	Inter-Island Ferry - Inter-Island Ferry	An Inter-Island Ferry collides with another Inter-Island Ferry.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple fatalities; Major damage to property; Tier 1 to Tier 2 criteria reached; Adverse international publicity, long-term suspension of operations, prolonged restrictions and / or termination of commercial activities.	0	1	0	1	1	5	4	5	**2.81**	
24	23	Collision	Inter-Island Ferry - Small Commercial Vessel	An Inter-Island Ferry collides with a Small Commercial Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple fatalities; Moderate damage to property; Tier 1 to Tier 2 criteria reached; Adverse national publicity, medium-term suspension of operations or prolonged restrictions.	0	2	0	2	1	5	3	4	**2.81**	This hazard includes Cruise Ship tenders with passengers embarked.
25	35	Collision	Small Commercial Vessel - Large Tanker	A Small Commercial Vessel collides with a Large Tanker.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple fatalities; Moderate damage to property; Tier 1 to Tier 2 criteria reached; Adverse national publicity, medium-term suspension of operations or prolonged restrictions.	0	2	0	2	1	5	3	4	**2.81**	This hazard includes Cruise Ship tenders with passengers embarked.
26	3	Anchor Dragging	Anchor Dragging - Large Tanker	A Large Tanker unintentionally moves from its anchored position because the anchor has failed to hold.	Anchor dragging detected and remedial action taken. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Contact or grounding. Resulting in: Multiple minor or single major injury; Major damage to property; Tier 3 oil spill criteria reached. International support required; Adverse international media publicity, long-term suspension of operations, prolonged restrictions and / or termination of commercial activities.	0	0	0	0	6	3	5	6	**2.74**	Anchor dragging during STS operation / lay-up.
27	14	Collision	Inshore Fishing Vessel - Large Commercial Vessel	An Inshore Fishing Vessel collides with a Large Commercial Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple major injuries or single fatality; Moderate damage to property; No environmental effect of note; Adverse regional publicity, temporary suspension of commercial activities and / or prolonged restrictions.	0	2	0	0	0	5	3	3	**2.71**	

Rank	Hazard Ref.	Accident Category	Hazard Title	Hazard Detail	Consequence Descriptions		Risk By Consequence Category								Risk Overall	Remarks
							ML				WC					
					Most Likely (ML)	Worst Credible (WC)	Environment	People	Property	Stakeholders	Environment	People	Property	Stakeholders		
28	15	Collision	Inshore Fishing Vessel - Large Tanker	An Inshore Fishing Vessel collides with a Large Tanker.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple major injuries or single fatality; Moderate damage to property; No environmental effect of note; Adverse regional publicity, temporary suspension of operations and / or prolonged restrictions.	0	2	0	0	0	5	3	3	**2.71**	
29	33	Collision	Recreational Vessel - Small Commercial Vessel	A Recreational Vessel collides with a Small Commercial Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple major injuries or single fatality; Moderate damage to property; No environmental effect of note; Adverse regional publicity, temporary suspension of commercial activities and / or prolonged restrictions.	0	0	0	2	0	5	3	3	**2.71**	This hazard includes Cruise Ship tenders with passengers embarked.
30	34	Collision	Recreational Vessel - Towage Vessel	A Recreational Vessel collides with a Towage Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple major injuries or single fatality; Moderate damage to property; No environmental effect of note; Adverse regional publicity, temporary suspension of commercial activities and / or prolonged restrictions.	0	0	0	2	0	5	3	3	**2.71**	
31	48	Mooring Incident / Breakout	Mooring Incident / Breakout - Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel	An Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel breaks away from her moorings.	Mooring lines in propeller / bow thruster, damage to gangway, lines parted. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Grounding or Contact. Resulting in: Multiple minor or single major injury; Moderate damage to property; Tier 1 to Tier 2 criteria reached; Adverse local publicity, minor disruption to commercial activities.	0	3	0	0	2	3	3	2	**2.63**	This hazard includes Cruise Ship tenders with passengers embarked.
32	18	Collision	Inshore Fishing Vessel - Towage Vessel	An Inshore Fishing Vessel collides with a Towage Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple major injuries or single fatality; Moderate damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	0	2	0	0	0	5	3	2	**2.61**	
33	40	Contact	Contact - Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry	A Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry contacts a fixed object including new Quay.	A low speed / energy contact. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	A high speed / energy contact. Resulting in: Multiple minor or single major injury; Moderate damage to property; Tier 1 to Tier 2 criteria reached; Adverse regional publicity, temporary suspension of commercial activities and / or prolonged restrictions.	0	2	0	2	2	3	3	3	**2.56**	Reduced to exclude stromness ferry berthing

Rank	Hazard Ref.	Accident Category	Hazard Title	Hazard Detail	Consequence Descriptions		Risk By Consequence Category								Risk Overall	Remarks
							ML				WC					
					Most Likely (ML)	Worst Credible (WC)	Environment	People	Property	Stakeholders	Environment	People	Property	Stakeholders		
34	42	Diving	Diving Incident	A diving incident involving a Recreational (including wreck diving) and / or Commercial Vessel.	Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Resulting in: Multiple major injuries or single fatality; Very minor damage to property; No environmental effect of note; Adverse regional publicity, temporary suspension of operations and / or prolonged restrictions.	0	2	0	0	0	5	0	3	**2.49**	
35	1	Anchor Dragging	Anchor Dragging - Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry	A Cruise Ship / Mainland Ferry / Large Commercial Vessel / Inter-Island Ferry unintentionally moves from its anchored position because the anchor has failed to hold.	Anchor dragging detected and remedial action taken. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Contact or grounding. Resulting in: Multiple major injuries or single fatality; Major damage to property; Tier 2 spill criteria reached but capable of being limited to immediate area; Adverse national publicity, medium-term suspension of operations or prolonged restrictions.	0	0	0	0	3	5	5	5	**2.34**	
36	31	Collision	Recreational Vessel - Large Tanker	A Recreational Vessel collides with a Large Tanker.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple major injuries or single fatality; Moderate damage to property; No environmental effect of note; Adverse regional publicity, temporary suspension of commercial activities and / or prolonged restrictions.	0	2	0	2	0	4	3	3	**2.33**	
37	22	Collision	Inter-Island Ferry - Recreational Vessel	An Inter-Island Ferry collides with a Recreational Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Single minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple major injuries or single fatality; Moderate damage to property; No environmental effect of note; Adverse regional publicity, temporary suspension of commercial activities and / or prolonged restrictions.	0	2	0	0	0	4	3	3	**2.21**	
38	29	Collision	Large Commercial Vessel - Towage Vessel	A Large Commercial Vessel collides with a Towage Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple major injuries or single fatality; Major damage to property; Tier 1 to Tier 2 criteria reached; Adverse regional publicity, temporary suspension of commercial activities and / or prolonged restrictions.	0	0	0	0	2	5	5	3	**2.15**	
39	38	Collision	Towage Vessel - Large Tanker	A Towage Vessel collides with a Large Tanker.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple major injuries or single fatality; Major damage to property; Tier 1 – Tier 2 criteria reached; Adverse regional publicity, temporary suspension of operations and / or prolonged restrictions.	0	0	0	0	2	5	5	3	**2.15**	

Rank	Hazard Ref.	Accident Category	Hazard Title	Hazard Detail	Consequence Descriptions		Risk By Consequence Category								Risk Overall	Remarks
							ML				WC					
					Most Likely (ML)	Worst Credible (WC)	Environment	People	Property	Stakeholders	Environment	People	Property	Stakeholders		
40	11	Collision	Cruise Ship / Mainland Ferry - Towage Vessel	A Cruise Ship / Mainland Ferry collides with a Towage Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple major injuries or single fatality; Major damage to property; Tier 1 to Tier 2 criteria reached; Adverse national publicity, medium-term suspension of operations or prolonged restrictions.	0	0	0	0	1	4	4	4	**1.88**	
41	43	Girting	Girting Incident	A towline under tension exerts a heeling moment which results in excessive heel that causes the tug to capsize.	Tug recovers. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Tug is capsized. Resulting in: Multiple major injuries or single fatality; Major damage to property; Tier 1 to Tier 2 criteria reached; Adverse national publicity, medium-term suspension of operations or prolonged restrictions.	0	0	0	0	1	4	4	4	**1.88**	
42	12	Collision	Inshore Fishing Vessel - Inshore Fishing Vessel	An Inshore Fishing Vessel collides with another Inshore Fishing Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple major injuries or single fatality; Moderate damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	0	0	0	0	0	5	3	2	**1.85**	
43	16	Collision	Inshore Fishing Vessel - Recreational Vessel	An Inshore Fishing Vessel collides with a Recreational Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple major injuries or single fatality; Moderate damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	0	0	0	0	0	5	3	2	**1.85**	
44	13	Collision	Inshore Fishing Vessel - Inter-Island Ferry	An Inshore Fishing Vessel collides with an Inter-Island ferry.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple major injuries or single fatality; Moderate damage to property; Tier 1 to Tier 2 criteria reached; Adverse regional publicity, temporary suspension of commercial activities and / or prolonged restrictions.	0	0	0	0	1	4	3	3	**1.73**	
45	32	Collision	Recreational Vessel - Recreational Vessel	A Recreational Vessel collides with another Recreational Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple minor or single major injury; Minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	0	0	0	0	0	4	2	2	**1.69**	

Rank	Hazard Ref.	Accident Category	Hazard Title	Hazard Detail	Consequence Descriptions		Risk By Consequence Category								Risk Overall	Remarks
							ML				WC					
					Most Likely (ML)	Worst Credible (WC)	Environment	People	Property	Stakeholders	Environment	People	Property	Stakeholders		
46	41	Contact	Contact - Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel	An Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel contacts a fixed object inc new Quay	A low speed / energy contact. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	A high speed / energy contact. Resulting in: Multiple minor or single major injury; Minor damage to property; No environmental effect of note; Adverse local publicity, minor disruption to commercial activities.	0	0	0	0	0	4	2	2	**1.69**	This hazard includes Cruise Ship tenders with passengers embarked.
47	2	Anchor Dragging	Anchor dragging - Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel	An Inshore Fishing Vessel / Recreational Vessel / Small Commercial Vessel / Towage Vessel unintentionally moves from its anchored position because the anchor has failed to hold.	Anchor dragging detected and remedial action taken. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Contact or grounding. Resulting in: Multiple minor or single major injury; Moderate damage to property; Tier 1 to Tier 2 criteria reached; Adverse local publicity, minor disruption to commercial activities.	0	0	0	0	2	3	3	2	**1.54**	
48	39	Collision	Towage Vessel - Towage Vessel	A Towage Vessel collides with another Towage Vessel.	One or both vessels take avoiding action resulting in a slow speed / energy collision. Resulting in: Very minor injury; Very minor damage to property; No environmental effect of note; Very short-term disruption to services.	Neither vessel takes avoiding action resulting in a high speed / energy collision. Resulting in: Multiple minor or single major injury; Moderate damage to property; Tier 1 to Tier 2 criteria reached; Adverse local publicity, minor disruption to commercial activities.	0	0	0	0	2	3	3	2	**1.54**	

TECHNICAL APPENDIX 2.4

OUTLINE BUSINESS CASE

ORKNEY HARBOURS MASTERPLAN PHASE 1

ANNEX A

ASSUMPTIONS LOG

November 2022

ORKNEY ISLANDS COUNCIL

ORKNEY ISLANDS COUNCIL
Marine Services
& Transportation

CONTENTS

TABLES

1 INTRODUCTION

1.1 Introduction

This Annex comprises a log of assumptions underpinning the updated Outline Business Case (OBC) for the Orkney Harbours Masterplan Phase 1 proposals and should be read in conjunction with the OBC Report.

1.2 Structure of this Report

The remainder of this Report is structured as follows:

- Section 2: projects within OBC scope.
- Section 3: project capital costs.
- Section 4: project operating costs.
- Section 5: harbour dues and charges.
- Section 6: offshore wind assumptions.
- Section 7: other sectoral assumptions.
- Section 8: financial assumptions.
- Section 9: economic impact estimates assumptions.

2 PROJECTS WITHIN OBC SCOPE

2.1 Orkney Harbours Masterplan Phase 1

The projects were defined and developed as part of the Orkney Harbours Masterplan Phase 1 (the “Masterplan”). The Masterplan was approved in April 2020 and is a blueprint providing a framework for the long-term future of Orkney’s harbour infrastructure. The Masterplan has been adopted as Planning Policy Advice and has status as a material consideration in the determination of relevant planning and works licence applications.

This first phase of the Masterplan details a vision for the physical transformation of harbours across five locations on and around the Orkney Mainland. The second phase will then go on to consider the development of smaller harbours and piers across the wider Orkney archipelago. The three projects being taken forward at this time are described in the following paragraphs.

2.2 Scapa Deep Water Quay

Scapa Deep Water Quay comprises new harbour infrastructure on the Scapa Flow coastline of Mainland Orkney between Kirkwall and Holm within the 125m^2 natural deep water harbour of Scapa Flow.

The exemplar design has been updated to reflect the results of site investigations, a wave study, and in-depth discussions with offshore wind developers and Tier 1 contractors regarding operational requirements. In particular the way in which 20m water depth can be provided has been revised – rather than building out an extension a pocket can be dredged along the main quay.

- ✓ 625m of quayside: 515m with water depth of 15m below Chart Datum (CD) and 110m with water depth of 20m.
- ✓ 115m of inner berthing (currently earmarked for Orkney Harbour Authority vessels, sheltered behind an extended north quay).
- ✓ In the region of 18 hectares of laydown area behind the quay: ample space for laydown, cranes and assembly facilities to be developed.
- ✓ Minimum capacity of load bearing quay and laydown area behind is 25 tonnes per square metre.
- ✓ Shore power.
- ✓ Access road connecting the facility to the main road between Kirkwall and Holm (A961).

As part of the enabling works OIC is progressing with the realignment of the A961 which will incorporate a new junction for the site access road and installation of site service connections.

2.3 Orkney Logistics Base (Hatston) Expansion

Hatston Pier and Terminal (to be rebranded as Orkney Logistics Base; and referred to as such in this Report) is located on the Orkney Mainland coast to the immediate northwest of Kirkwall. It is Orkney's primary commercial terminal and gateway to Aberdeen and north to Shetland. The longest existing berth is 385m in length, offering 10.5m draft. The original pier was built in 2002, and a 160m extension was completed in 2013. The proposed expansion comprises:

- ✓ 300m outer quay extension.
- ✓ Water depth of 10m below Chart Datum.
- ✓ 125m inner berth with linkspan and adjacent boat lift.
- ✓ 7.5 hectares of additional land close to the quay through reclamation.
- ✓ Ex-pipe fuel supply and storage, with ability to offer low or zero carbon fuels in the future.

Key activities will include core base for offshore wind Operations and Maintenance (O&M), oil and gas supply, freight and ferries, boat repair, aquaculture and logistics. This location could also be a hub for servicing other marine renewable (e.g. tidal and wave) devices in the future.

2.4 Lyness Storage Facility

Lyness is an existing facility located on the island of Hoy, which had particular prominence as a former wartime Royal Navy base. This location has been identified as suitable for storing equipment such as cables, chains and anchors.

Investment is required to create a hard standing laydown area behind the quay. There is one site in close proximity to the quayside comprising 3.76 hectares which will be developed with 250mm thick concrete slab to provide a suitable laydown area for these activities.

3 CAPITAL COSTS

3.1 Introduction

This section sets out assumptions regarding the capital cost of each project.

Arch Henderson LLP ("Arch Henderson") provided high level cost estimates for each of the projects in 2021 along with Exemplar Designs for Scapa Deep Water Quay and Orkney Logistics Base projects. Following the completion of site investigations (land and marine) in 2022 these costs have been updated along with estimated cost of enhancements at Lyness (September 2022).

General assumptions underpinning costs provided by Arch Henderson:

- Exclude Optimism Bias (OB), Environmental Impact Assessment (EIA), land purchase, legal and VAT costs.
- Dredging costs (where relevant) are based on all dredging being carried out at the same time. If it is not, there would be additional costs.
- Costs assume that the construction element of each project phase (relevant to Scapa Deep Water Quay and Orkney Logistics Base) is standalone. Should phases be carried out at the same time, it is expected that savings could be made through shared mobilisation, better access to site and general item costs.
- Cost of any land purchases are based on discussions with Crown Estate Scotland (CES).

1.5% of the total construction costs is retained into the year following completion of the works. This is a means of ensuring that any issues with the works that emerge will be addressed by the contractor. In the model the 1.5% been retained for each of Scapa Deep Water Quay, Orkney Logistics Base and Lyness.

3.2 Scapa Deep Water Quay

Key assumptions relating to Scapa Deep Water Quay are:

- Arch Henderson provided updated costs for Scapa Deep Water Quay in September 2022 (202042 Scapa Preliminary High Level Cost Estimates Report) following analysis of the site investigation findings.
- All costs based on applicable submitted contractor rates over the last seven years within Northern Isles with appropriate contingency, inflation and fuel surcharge added to Q2 2024.
- Cost of EIA is taken from procurement process to appoint Environmental Consultant plus estimated additional fees associated with additional environment-related studies). The EIA cost is split between Scapa Deep Water Quay and Orkney Logistics Base.
- Arch Henderson proposes an OB of 40% is applied until EIA submitted.

Table 1 presents capital costs for Scapa Deep Water Quay, excluding OB. The costs are currently split into three phases; this may change as the exemplar design is further developed.

Table 1 Scapa Deep Water Quay Capital Costs

Project Component (£'000)	2022	2023	2024	2025	2026	Total
Phase 0						
EIA	0	237	50	0	0	287
Site investigations, consents	1,080	412	0	0	0	1,492
Total	**1,080**	**649**	**50**	**0**	**0**	**1,779**
Phase 1						
Design / engineering	215	1,312	226	226	226	2,205
Dredging	0	0	419	837	837	2,093
Quay	0	0	17,117	34,233	34,233	85,584
Contingency	0	0	1,789	3,579	3,579	8,947
Total	**215**	**1,312**	**19,551**	**38,875**	**38,875**	**98,828**
Phase 2						
Design / engineering	0	638	319	319	319	1,595
Dredging	0	0	436	872	872	2,180
Quay	0	0	13,438	26,876	26,876	67,191
Contingency	0	0	1,405	2,810	2,810	7,024
Total	**0**	**638**	**15,598**	**30,877**	**30,877**	**77,990**
Phase 3						
Design / engineering	0	179	89	89	89	447
Dredging	0	0	852	1,703	1,703	4,258
Quay	0	0	1,957	3,913	3,913	9,783
Contingency	0	0	193	386	386	965
Total	**0**	**179**	**3,091**	**6,092**	**6,092**	**15,453**
Total	**1,295**	**2,778**	**38,289**	**75,844**	**75,844**	**194,051**

3.3 Orkney Logistics Base

Key assumptions relating to capital costs for the Orkney Logistics Base project are:

- Arch Henderson provided updated costs for Orkney Logistics Base project in October 2022 (212089 Hatston Development: Exemplar Design Check – Updated High Level Cost Estimates Report) following analysis of the site investigation findings.
- All costs based on applicable submitted contractor rates over the last seven years within Northern Isles with suitable quantity contingency, inflation and fuel surcharge added to Q2 2025.
- Cost of EIA taken from procurement process to appoint Environmental Consultant plus estimated additional fees associated with additional

environment-related studies). The EIA cost is split between Scapa Deep Water Quay and Orkney Logistics Base.

- Arch Henderson provided an estimated cost for a 820-tonne boatlift (source: Planet Marina, Italy): £3.5m including civils and service works on site.
- Arch Henderson provided an estimate of £4.75m for inclusion of a link span.
- Arch Henderson proposes an OB of 30% is applied until EIA submitted.

Table 2 presents capital costs for the Orkney Logistics Base project, excluding OB.

Table 2 Orkney Logistics Base Capital Costs

Project component (£'000)	2022	2023	2024	2025	2026	2027	2028	Total
Phase 0								
EIA	0	163	0	0	0	0	0	163
SI & consents	315	315	0	0	0	0	0	631
Total	**315**	**478**	**0**	**0**	**0**	**0**	**0**	**794**
Phase 1								
Design / engineering	0	40	40	0	0	0	0	80
Construction	0	0	7,493	0	0	0	0	7,493
Contingency	0	0	749	0	0	0	0	749
Total	**0**	**40**	**8,282**	**0**	**0**	**0**	**0**	**8,322**
Phase 2								
Design / engineering	0	563	281	281	0	0	0	1,125
Dredging	0	0	0	0	0	618	412	1,030
Quay construction	0	0	0	0	0	23,942	23,942	47,884
Contingency	0	0	0	0	0	2,509	2,470	4,979
Total	**0**	**563**	**281**	**281**	**0**	**27,069**	**26,825**	**55,018**
Phase 3								
Design / engineering	0	113	56	56	0	0	0	225
Dredging	0	0	0	0	0	0	0	0
Quay	0	0	0	0	0	6,098	6,098	12,197
Boatlift	0	0	0	0	0	0	3,500	3,500
Linkspan	0	0	0	0	0	0	4,750	4,750
Contingency	0	0	0	0	0	610	610	1,220
Total	**0**	**113**	**56**	**56**	**0**	**6,708**	**14,958**	**21,891**
Total	**0**	**715**	**8,620**	**338**	**0**	**33,777**	**41,783**	**86,026**

3.4 Lyness

Key assumptions relating to Lyness are:

- An estimated costs was provided by Arch Henderson in September 2022. This was based on real project examples, including a tender return in June 2022 for preparation and laying of a 225mm reinforced concrete surface with drainage, lighting and fencing which had a cost of £172 per square metre.

- Fibre reinforced concrete can be repaired more easily thus a rate of £150 per square metre is proposed until further information about actual usage is acquired. This equates to in the region of £1.5 million per hectare.
- The current (oil) remediation work ongoing at Lyness is due to be completed in 2023/2024.
- It is assumed that Lyness will not be taken forward until there is some form of agreement with a developer regarding its utilisation. For now, it is assumed that the Lyness project will be taken forward in 2029/2030.

Table 3 Lyness Capital Costs

Project component (£'000)	2029	2030	Total
Design / engineering	10	10	20
Resurfacing	2,070	3,570	5,640
Contingency	207	357	564
Total	**2,287**	**3,937**	**6,224**

3.5 Optimism Bias

The contingency included in the capital expenditure is an allowance made for the cost of residual risks in case they occur. These are risks that cannot be avoided, shared or managed. Optimism Bias (OB) takes into account our demonstrated, systematic tendency to underestimate costs and overestimate benefits. The Green Book recommends that an explicit adjustment be made to the costs, benefits and phasing preferably based on outcomes of comparable projects against budget or using its generic OB percentages if there is no other evidence.

An upper bound of 70% OB was initially applied to Scapa Deep Water Quay and 30% to Orkney Logistics Base. Following the completion of site investigation and an update of the Exemplar Design the levels for Scapa Deep Water Quay has been reduced. The following level of OB will be applied to each project for now:

- Scapa Deep Water Quay: 40% OB.
- Orkney Logistics Base: 30% OB.
- Lyness: 40% OB.

For Lyness this level of OB will be reviewed following a further site visit and design consideration; for the other two projects the OB level will be reviewed following completion of the EIA.

OB is only applied to dredging and construction costs.

It should also be noted that an additional 10% contingency is included in the capital cost in addition to OB. The contingency included in the capital expenditure is an allowance made for the cost of residual risks in case they occur. These are risks that cannot be avoided, shared or managed.

Table 4 Scapa Deep Water Quay Capital Costs – With and Without OB

Project component (£'000)	Without OB	With OB (where applicable)
EIA	287	287
SI & consents	1,492	1,492
Design / engineering	4,247	4,247
Dredging	8,530	11,942
Quay	162,558	227,581
Contingency	16,937	16,937
Total	**194,051**	**262,486**

Table 5 Orkney Logistics Base Capital Costs – With and Without OB

Project component (£'000)	Without OB	With OB (where applicable)
EIA	163	163
SI & consents	631	631
Design / engineering	1,430	1,430
Dredging	1,030	1,339
Quay construction	67,574	87,846
Boatlift	3,500	3,500
Linkspan	4,750	4,750
Contingency	6,948	6,948
Total	**86,026**	**106,607**

Table 6 Lyness Capital Costs – With and Without OB

Project component (£'000)	Without OB	With OB (where applicable)
Design / engineering	20	20
Resurfacing	5,640	7,896
Contingency	564	564
Total	**2,287**	**8,480**

4 OPERATING COSTS

4.1 Introduction

There will be additional operating costs resulting from the investments. These are in 2022 prices and summarised in this Section.

4.2 Pier Workers Employed by OIC Marine Services

It is assumed that there will be a requirement for additional pier workers at Scapa Deep Water Quay, Orkney Logistics Base and Lyness.

Assumed wage of a pier worker is £34,755 (including on-costs)[1].

Table 7 Additional Pier Workers

Location	Additional staff
Scapa Deep Water Quay	2 full-time and 1 part-time pier workers from 2027
Orkney Logistics Base	1 full-time and 2 part-time pier workers from 2030
Lyness	1 full-time pier worker from 2030

4.3 Maintenance

For Scapa Deep Water Quay an annual maintenance cost of £395,000 is assumed, with a view to covering future costs associated with for example fender / anode replacement. This amount also includes 25% contingency[2].

For Orkney Logistics Base it is estimated that annual maintenance will cost £162,740[3]. This represents 50% of the current maintenance budget for Hatston.

The existing maintenance budget for Lyness is around £50,000 though this is mostly associated with the ferry terminal. An additional £25,000 per annum is assumed based on increased usage of the new operational area and vessel movements.

4.4 CES Seabed Charges

New or extended harbour infrastructure will be subject to CES charges for the additional seabed footprint. As CES owns part of the foreshore at Scapa Deep Water Quay a similar leasing agreement is required for this.

Leasing agreements for Scapa Deep Water Quay and the new infrastructure at Orkney Logistics Base will need to be agreed with CES before construction commences.

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[1] OIC Marine Services, September 2022.
[2] Arch Henderson, September 2022.
[3] OIC Marine Services, September 2022.

Until such time that the exact charges can be defined, Table 8 presents indicative charges based on a cost of £1.41 per square metre (comparable with Orkney Logistics Base). The charge will start at zero during the first year of construction increasing to £1.41 in Year 5. At this time a review with CES will take place.

Table 8 CES Seabed and Foreshore Leases (Estimated)

Location	Square Metres	Lease Per Annum £
Scapa Deep Water Quay (foreshore)	21,938	30,933
Scapa Deep Water Quay (seabed)	116,579	164,379
Orkney Logistics Base (seabed)	21,700	30,597
Lyness	n/a	n/a

4.5 Additional Costs Associated with Pilotage and Towage

For pilotage there will be an additional cost in the form of an extra pilot from 2028 onwards at a cost of £129,700 including on-costs per annum[4].

The activities at each of the three locations will require pilotage, towage, and pilotage for towages. This will incur additional fuel costs which are included in the overall operating costs.

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[4] OIC Marine Services, September 2022.

5 HARBOUR DUES, FEES & OTHER CHARGES

5.1 Introduction

Harbour dues and charges used in the model assumptions have been taken from the OIC Harbour Authority Schedule of Charges for 2022/2023. Some new charges have been created and will be included in subsequent schedules.

At present charges are in 2022 prices. Dues and charges in Table 9 are associated with offshore wind activity, although do apply to activities in other sectors.

Table 9 Revised Harbour Dues and Charges

Harbour Dues		
General Cargo Vessels, Tankers & Bulk Carriers Utilising an OIC Pier	£/GT per 4 days	£0.59
Vessels Entering the Harbour Area but Not Utilising an OIC Pier	£/GT per 4 days	£0.24
Berth Fees		
Any Vessel Involved in Offshore Wind Activity Utilising an OIC Pier	£/GT per day	£0.18
Wet Storage Fees		
Any Vessels, Devices and Barges Not in Possession of an ITC69 Certificate Utilising an OIC Pier	Per linear metre	£50.00
Any Vessels, Devices and Barges Not in Possession of an ITC69 Certificate at Anchor	Per m2	£1.18
Goods Dues		
Wind Farm Components	£/tonne	£12.00
Anchors, Moorings, Chains	£/tonne	£3.00
Land Fees		
Lease of Land (utilised) (premium)	£/m2 per year	£35.00
Lease of Land (unutilised) (non premium)	£/m2 per year	£20.00
Pilotage		
Pilotage (up to 4,000 GT)	£/single vessel movement	£407.68
Pilotage for Each Additional 100GT	£/single vessel movement	£3.64
Pilotage for a Tow	£/single tow movement	£530.40
Towage		
Assisting On / Off Berth (assume 1.5 hrs required)	£/hour	£738.40
Towage Escort Services (assume 3 hrs required)	£/hour	£738.40

6 OFFSHORE WIND ASSUMPTIONS

6.1 Introduction

This Section sets out assumptions underpinning envisaged offshore wind activity taking place in Orkney, utilising Orkney's piers and harbours and wet storage in Scapa Flow.

The first ScotWind leasing round saw CES issue option agreements for 17 projects around the coastal waters of Scotland. A seabed lease will be provided to developers once they have secured the necessary consents. More than half of these sites are within proximity to Orkney and Scapa Flow.

Orkney's geographical advantage is echoed in the *'Ports for Offshore Wind'* Report (Arup, 2020) which shows that Orkney and Scapa Flow are within an acceptable proximity to more than half of ScotWind sites representing 13GW of power and more than 800 turbines.

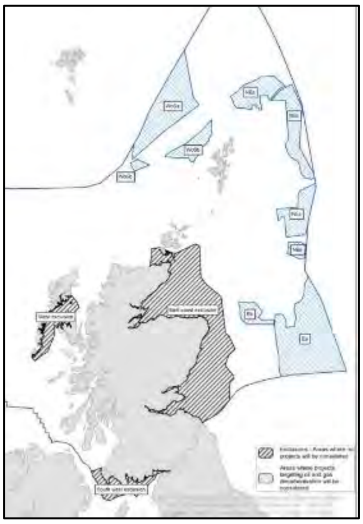
"*Suitable to support multiple fixed-bottom and floating projects (particularly semi-submersible technology), providing long-term potential*."

"Scapa Flow has significant potential for semi-submersible assembly facilities."

In terms of identifying the offshore wind opportunity in greater detail this has been guided by understanding the physical requirements necessary to support construction / assembly and O&M, further bolstered through discussions with offshore wind developers, Tier 1 contractors and other ports. Offshore wind sites highlighted in pink opposite are those in closest proximity to Orkney – developers of both sites have expressed an interest in using Orkney as a base.

Those highlighted in yellow are regarded as realistic opportunities and dialogue with developers of these sites is underway.

A second ScotWind leasing round may commence in 2024 – while actual sites are not yet known, it is expected that this further round will be similar to the first.



Another leasing round is underway, known as INTOG – Innovation and Targeted Oil and Gas offshore wind leasing – with Option Agreements to be finalised during 2023. These will be smaller scale projects focussed on floating offshore wind in the proximity of oil and gas structures with the aim of decarbonising these structures. There will be a cap of 4GW for this round and turbines will be smaller to balance with electrification demands of the structures.

In terms of what activities will take place in Orkney:

- Scapa Deep Water Quay: construction / assembly / marshalling base. Offshore wind components would be shipped to this facility where final construction works would take place – welding, blasting, painting, maintenance, etc. Components, with some potentially assembled on site, loaded and transported to the wind farm site and installed. For heavy maintenance Scapa Deep Water Quay is the ideal location for bringing new / replacement components. Several developers have indicated that they would use Scapa Deep Water Quay as a construction / assembly base.
- Orkney Logistics Base: O&M base. One developer has already expressed an interest in setting up an O&M base at Orkney Logistics Base. It is envisaged that

at least one other developer could be attracted to Orkney (although this has not been included in the analysis).

- Lyness: this is the location identified for the storage of anchors, chains and cables.
- Stromness: this is the location identified as suitable for the accommodation of smaller rapid response O&M craft, particularly for sites to the west of Orkney. At present this has not been included in the analysis as West of Orkney Windfarm have identified Scrabster as their preferred location for O&M and other sites to the west have not yet defined where their O&M base would be.

The following paragraphs set out estimated timescales for delivery of components, installation of turbines; heavy maintenance and O&M; and illustrative assumptions regarding vessel usage, component tonnages and harbour utilisation.

6.2 Summary of Forecast Offshore Wind Activity in Orkney

It is clear that there is a considerable opportunity for Orkney. Table 10 summarises assumptions regarding future offshore wind activity in Orkney, indicating each of the offshore farm sites, GW, number of turbines and estimated years when those turbines might be fully installed.

Table 10 Offshore Wind Sites Offering Opportunity for Orkney

Site	Type	Size (GW)	No. Turbines
N1 West of Orkney	Fixed	2.000	110
NE2 Thistle Wind Partners	Floating	1.008	56
N2 Northland Power	Floating	1.500	83
NE3 Falck Renewables	Floating	1.000	55
NE8 Bay Wa	Floating	0.960	53
E2 Vattenfall	Floating	0.798	44
INTOG Site 1	Floating	0.500	28
INTOG Site 2	Floating	0.500	28
Total			457

Table 11 Offshore Wind Sites – Estimated Timescales for Installation

Site	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
N1 West of Orkney	30	50	30									
NE2 Thistle Wind Partners					16	20	20					
N2 Northland Power										30	30	23
NE3 Falck Renewables						25	30					
NE8 Bay Wa							25	28				
E2 Vattenfall				22	22							
INTOG Site 1							7	7	7	7		
INTOG Site 2							7	7	7	7		

6.3 Component Dimensions

Based on information from literature such as BVG associates ‘Guide to an offshore wind farm’ and validation from developers a summary of components and their tonnage is presented below. It should be noted that these data are indicative and may vary between developers and offshore wind farms.

Nacelles
- Nacelle + hub mass 850 tonnes
- 21m L x 10m W

Blades
- Blade mass 65 tonnes
- Length 115m

Towers
- 3 tower units per turbine
- Tower unit mass 300 tonnes
- Length 43m

Jackets (fixed)
- 4 pile structures (pile length 75m)
- Jacket mass 2,086 tonnes

Sub-substructure (floating)
- Floater mass 4,000 tonnes
- Anchors and mooring required for one floater 6,000 tonnes

6.4 Vessels

The components described above are of considerable size and weight. While contracts have not been procured yet developers are considering what type of vessels – and even exactly *which* vessels – they will need to charter to deliver and install fixed and floating turbines. A range of vessels have been assumed, based on discussions with developers, for a variety of purposes. At the time of delivery and installation it may not be these exact vessels, however it will be vessels of a similar type and gross tonnage (GT).

A summary of assumptions relating to vessels, capacity and how they might be utilised is presented in Table 12.

Table 12 Illustration of Vessels, GT and Capacity

Vessel (illustrative)	GT	Capacity
mv FAIRPARTNER	15,022	Piles – 10
mv OSPREY	38,722	Jackets – 10
mv BOLDWIND	8,604	Nacelles + hubs – 4 Blades – 12 Tower sections – 12 Moorings & anchors for floating – 1 set
North Sea Barge	5,200	Piles – 10 / Jackets – 3 Nacelles + hubs – 6 Tower sections – 18 Blades – 18
BREMEN FIGHTER (tug)	1,300	n/a
mv VOLTAIRE	46,300	Components for 5 turbines (excluding jacket / floater)
LES ALIZE	58,100	n/a
mv SEAYWAY ALFALIFT	51,087	Floater – 1
BEAR (AHST)	2,590	Moorings & anchors for floating – 1 set

6.5 Offshore Wind Site 1 (Plan Option N1 / West of Orkney)

6.5.1 N1 – Developer Information

Plan Option N1 (now known as the 'West of Orkney Windfarm') was awarded to a joint venture comprising Corio Generation, TotalEnergies and Renewable Infrastructure Development Group (RIDG).

The site covers 657km^2 and is located 30km to the west of Orkney. This is likely to be one of the first sites to generate power, with generation initially scheduled for 2029.

West of Orkney Windfarm has been in discussion with OIC since 2019 and there are now regular meetings and discussions regarding technical aspects and operations.

6.5.2 N1 – Key Assumptions

At the time of writing it is envisaged that there will be circa 110 18MW turbines (fixed) with a 30-year lifespan.

West of Orkney Windfarm have expressed an interest in using Scapa Deep Water Quay as their construction / assembly port. This location will also be utilised for heavy maintenance activities. A decision has yet to be made regarding the location of an O&M Base (it is likely to be Scrabster, though could possibly be Orkney Logistics Base).

Delivery of West of Orkney Windfarm components to Scapa Deep Water Quay will commence in 2027 with installation taking place over four years from 2028.

It is understood that some assembly work will take place such as putting jacket sections together, painting, welding, blasting, etc. Tower components may also be assembled before being transported to the site where the turbines will be installed.

It is assumed that a period of heavy maintenance / renewal would commence in 2038 (ten years after the first installation commenced) and continue over a seven-year period, with 50% of nacelles and blades being replaced. Given the harsher sea conditions of the site location, it may be that substantially more maintenance is required that assumed here.

While decommissioning (2058 onwards) would create additional harbour dues and other benefits in the future this is beyond the 30-year period of analysis.

6.5.3 N1 – Delivery to Scapa Deep Water Quay

The estimated number of components to be delivered to Scapa Deep Water Quay is shown in Table 13, based on the assumption that there will be 110 turbines. Tonnages of components are shown in

Table 14.

Table 13 N1 Components – Delivery Schedule

Component	2027	2028	2029	2030	Total
Piles	150	170	120		440
Jackets	30	50	30		110
Tower units		150	180		330
Blades			100	230	330
Nacelles + Hubs		30	40	40	110

Table 14 N1 Components – Tonnages

Component	2027	2028	2029	2030	Total
Piles	87,000	98,600	69,600	0	255,200
Jackets	62,580	104,300	62,580	0	229,460
Tower units	0	15,000	18,000	0	33,000
Blades	0	0	6,500	14,950	21,450
Nacelles + Hubs	0	25,500	34,000	34,000	93,500

Based on the vessels and capacity described earlier the total number of vessel movements have been calculated (see Table 15) for delivery of components.

Vessels such as mv FAIRPARTNER and mv OSPREY would deliver piles and jackets to Scapa Deep Water Quay, while a vessel such as the mv BOLDWIND would deliver tower units, blades and nacelles and hubs.

Table 15 N1 Vessel Movements – Delivery

	2027	2028	2029	2030
mv FAIRPARTNER (piles)	15	17	12	0
mv OSPREY (jackets)	3	5	3	0
mv BOLDWIND (tower units)	0	13	15	0
mv BOLDWIND (blades)	0	0	9	20
mv BOLDWIND (nacelles + hubs)	0	8	10	10

It is assumed that these vessels will require pilotage and towage getting on and off the quay.

6.5.4 N1 – Installation

Installation of turbines is assumed to comprise the following activities:

Installation of the piles and jackets will take place first. A Semi-Submersible Crane Vessel (SSCV) such as the Les Alize will mobilise at Scapa Deep Water Quay for a period of ten days before proceeding to the site, where it will remain for the installation period, followed by a similar period of demobilisation.

Piles and jackets will be transported from Scapa Deep Water Quay to the site by barge (e.g. North Sea Barge) towed by a tug (e.g. BREMEN FIGHTER) and installed. It is assumed that these barges will spend layover time in Scapa Flow (average of 90 days per season per barge).

The remaining components will be transported from Scapa Deep Water Quay by a jack-up vessel such as the mv VOLTAIRE, which can transport components for up to five turbines.

The substations would be transported from another location to the site for installation.

Table 16 shows the assumed schedule for components being delivered to site for installation while

Table 17 presents vessel movements.

Table 16 N1 Components – Delivery Schedule Installation

Components	2028	2029	2030	2031
Piles	150	150	140	
Jackets	30	50	30	
Tower units		60	100	170
Blades		60	100	170
Nacelles + hubs		20	40	50

Table 17 N1 Vessel Movements – Installation

Vessel	2028	2029	2030	2031
North Sea Barge (feeder barge) (piles)	15	15	14	0
North Sea Barge (feeder barge) (jackets)	10	17	10	0
BREMEN FIGHTER	25	32	24	0
mv VOLTAIRE (remaining components)	0	4	8	10

The mv VOLTAIRE will require pilotage and towage for each movement.

The BREMNER FIGHTER will require pilotage for each movement as well as an additional pilotage charge as there is a tow underway. A 3-hour towage escort service will be necessary for each movement also.

6.5.5 N1 – Operations & Maintenance

At present West of Orkney Windfarm has indicated that the O&M base may be in Scrabster. If based at Orkney Logistics Base a control centre facility would be developed and part of the quayside area dedicated for laydown and handling of equipment. An ESVAGT Service Operations Vessel (SOV) would be based at Orkney Logistics Base and make fortnightly round trips to the site, with the purpose of undertaking regular maintenance.

It is envisaged that smaller 'rapid response' craft would be based at Orkney Logistics Base or Stromness able to make trips to and from the site at short notice and quickly – for the fast movement of personnel for example.

For this site (N1) an O&M base at Orkney Logistics Base is not currently included in the assumptions.

6.5.6 N1 – Heavy Maintenance

In addition to standard maintenance there will need to be a programme of heavy maintenance, involving the refurbishment / servicing and/or replacement of key components, particularly the nacelle / hub and blades.

It is assumed that a seven-year heavy maintenance programme commences in 2038. It is assumed that 50% of all nacelles and blades are replaced; new or refurbished components would be delivered to Scapa Deep Water Quay by a vessel such as the mv BOLDWIND and then picked up by the mv VOLTAIRE and taken to site for replacement. It is assumed that the mv VOLTAIRE would make three calls per annum at Scapa Deep Water Quay to pick up components.

All of these vessels would require pilotage and towage on and off the quay.

Table 18 reports the number of components being replaced as part of the heavy maintenance schedule; Table 19 sets out the vessel movements required for heavy maintenance throughout the period.

Table 18 N1 Components – Delivery Schedule Heavy Maintenance

Components	2038	2039	2040	2041	2042	2043	2044
Nacelles + hubs	8	8	8	8	8	8	8
Blades	24	24	24	24	24	24	24

Table 19 N1 Vessel Movements – Heavy Maintenance

Vessels	2038	2039	2040	2041	2042	2043	2044
mv BOLDWIND (nacelles + hubs)	2	2	2	2	2	2	2
mv BOLDWIND (blades)	2	2	2	2	2	2	2
mv VOLTAIRE (Jack-Up Vessel)	3	3	3	3	3	3	3

6.5.7 N1 – Land Lease

At this time it is difficult to know what agreements might be formed with the various developers as and when they come on stream. As West of Orkney Windfarm is likely to be the first user of Scapa Deep Water Quay it is assumed that they would wish to lease 18 hectares from 2027 through to 2030, with a potential reduction to six hectares in 2031 as installation scales down and completes.

For heavy maintenance it is assumed for now that nine hectares would be leased for the seven years.

6.6 Offshore Wind Site 2 (Plan Option NE2 / Thistlewind Partners)

6.6.1 NE2 – Developer Information

Plan Option NE2 was awarded to Thistle Wind Partners (TWP) a consortium of Deme, Quar and Aspiravi. The developer has named this site ‘Cluaran Ear-Thuath’.

Cluaran Ear-Thuath covers 200km^2 and is located around 35 km to the east of Orkney.

There have been several discussions between OIC and TWP focussing on their operational requirements in relation to Scapa Deep Water Quay and Scapa Flow for storage / construction / assembly and the Orkney Logistics Base as O&M Hub.

6.6.2 NE2 – Key Assumptions

It is understood that there will be 56 18MW turbines (floating) with a 30-year lifespan. The substructures may be brought to Scapa Deep Water Quay by vessel and handled alongside (it is assumed that the substructures will need some work / maintenance, etc before being towed to site where they would be assembled). Anchors and moorings will be stored at Lyness.

The turbines will be delivered and installed over the period 2031 – 2034.

TWP Partners have indicated that they wish to set up their O&M Base at Orkney Logistics Hub.

It is assumed that a period of heavy maintenance / renewal would commence in 2042 and continue over a seven-year period, with 50% of nacelles and blades being replaced. While decommissioning (2062 onwards) would create additional harbour dues and other benefits in the future this is beyond the 30-year period of analysis.

6.6.3 NE2 – Delivery to Scapa Deep Water Quay & Lyness

A total of 56 substructures (floaters) will be individually transported to Scapa Deep Water Quay by a semi-submersible crane vessel (SSCV) such as the Seaways ALFALIFT.

The floater would remain alongside the quay for a minimum period of five days for preparatory works prior to installation.

Tower units, blades and nacelles will be delivered to Scapa Deep Water Quay by a vessel such as the mv BOLDWIND, while anchors and moorings would be delivered to Lyness by an Anchor Handling Service Tug (AHST) such as the Boskalis BEAR.

Table 20 NE2 Delivery Schedule – Scapa Deep Water Quay

Component	2031	2032	2033	Total
Floaters	16	20	20	56
Tower units	48	60	60	168
Blades	48	60	60	168
Nacelles + Hubs	16	20	20	56

Table 21 NE2 Delivery Schedule – Lyness

	2031	2032	2033	Total
Anchors & Moorings	16	20	20	56

The tonnages of components are shown in Table 22; these are used in the calculation of wharfage (apart from the floater; charges associated with it are based on linear metres for sitting alongside the quay).

Table 22 NE2 Component Tonnages – Delivery

	2031	2032	2033
Floaters	64,000	80,000	80,000
Tower units	4,800	6,000	6,000
Blades	3,120	3,900	3,900
Nacelles + Hubs	13,600	17,000	17,000
Anchors & Moorings	96,000	120,000	120,000

Based on the vessels and capacities described earlier the total number of vessel movements have been calculated.

Table 23 NE2 Vessel Movements – Delivery to Scapa Deep Water Quay & Lyness

Vessel	2031	2032	2033
mv ALFALIFT (floaters to Scapa Flow)	16	20	20
BEAR AHSV (anchors & moorings to Lyness)	16	20	20
mv BOLDWIND (tower units)	4	5	5
mv BOLDWIND (blades)	4	5	5
mv BOLDWIND (nacelles + hubs)	4	5	5

All vessels will require pilotage and towage on and off the quay.

6.6.4 NE2 – Installation

Installation of turbines is assumed to comprise the following activities.

Each floater will be towed from Scapa Deep Water Quay to the site, where the full turbine will be assembled. It is assumed that two tugs similar to the BREMEN FIGHTER would be used for towing.

Components will be transported from Scapa Deep Water Quay to the site by the mv VOLTAIRE jack-up vessel.

Anchors and moorings would be brought from Lyness to the site by an AHST, prior to integration.

The substations would be transported from another location (e.g. where they were manufactured / assembled) to the offshore wind site for installation.

Vessel movements are shown in Table 24.

Table 24 NE2 Vessel Movements – Installation

Vessel	2032	2033	2034
mv VOLTAIRE	4	4	4
BREMEN FIGHTER	32	40	40
BEAR (AHST)	16	20	20

6.6.5 NE2 – Operations & Maintenance

TWP wish to set up an O&M base at Orkney Logistics Base. This would likely include the setting up of a control centre, warehouse area, as well as laydown for handling and maintenance of smaller components and an available berth for regular calls. There would be some cargo over the quay but difficult to quantify at this stage, as well as supplies and crew changes.

A Supply Offshore Vessel (SOV) such as the ESVAGT (5,230 GT) would be permanently based at the Orkney Logistics Base and would generally make two-weekly trips around the offshore wind farm site. This would equate roughly 26 calls per annum; it is not envisaged that this type of vessel will require towage or pilotage.

It is envisaged that smaller 'rapid response' craft would be based at Orkney Logistics Base able to make trips to and from the site at short notice and quickly – for the fast movement of personnel for example.

It is envisaged that Orkney Logistics Base could be an O&M base for an additional developer; however, at this time this has not been modelled.

It is assumed that the developer will pay an annual land lease for two hectares of land based on a rate of £35 per square metre.

Table 25 NE2 Vessel Movements – O&M

Vessel	2032	2033	2034	2035	2040	2045	2050	2052
ESVAGT	9	18	26	26	26	26	26	26

6.6.6 NE2 – Heavy Maintenance

In addition to standard maintenance there will need to be a programme of heavy maintenance, involving the refurbishment / servicing and/or replacement of key components, particularly the nacelle / hub and blades.

It is assumed that a seven-year heavy maintenance programme commences in 2042. It is assumed that 50% of all nacelles and blades are replaced; new or refurbished components would be delivered to Scapa Deep Water Quay by a vessel such as the mv BOLDWIND and then picked up by the mv VOLTAIRE and taken to site for replacement. It is assumed that the mv VOLTAIRE would need to make only one call at Scapa Deep Water Quay to pick up components; there might only be a few calls per annum over the maintenance period given the limited maintenance assumed.

All vessels would require pilotage and towage on and off the quay.

6.6.7 NE2 – Storage at Lyness

It is assumed that all sets of anchors and moorings will be delivered and stored at Lyness on a rolling basis before being transferred to site prior to installation of the turbine. The developer would likely need the full hectarage of land available at Lyness (3.76 hectares over the period of installation and for 9 months of each year).

6.6.8 NE2 – Land Lease

It is assumed that TWP would wish to lease six hectares in 2031, rising to nine hectares per annum from 2032 to 3034.

For heavy maintenance it is assumed that 4.5 hectares would be leased for the seven years.

6.7 Offshore Wind Site 3 (Plan Option E2 / Vattenfall)

6.7.1 E2 – Key Assumptions

The rights to develop Plan Option E2 have been awarded to a partnership comprising Vattenfall and Fred.Olsen Seawind.

Site E is located 67 km northeast of Aberdeen and comprises 200 km^2.

This partnership intends to utilise a Mobile Port Solution to assemble floating turbines in the sea. Fred Olsen himself has visited Orkney and has declared an interest in using Scapa Flow to do this.

6.7.2 E2 – Delivery to Scapa Deep Water Quay / Scapa Flow

A total of 44 substructures (floaters) will be individually transported to Scapa Flow by a semi-submersible crane vessel (SSCV) such as the Seaways ALFALIFT. The Mobile Port Solution (MPS) would position itself in Scapa Flow and remain there for the season. It is estimated that the MPS is a minimum of 10,000 square metres in area. It is important to note that an MPS will still require a quayside facility where components can be stored prior to integration.

Tower units, blades and nacelles will be delivered to Scapa Deep Water Quay. It is assumed that no anchors or moorings would be delivered to Lyness, rather a port closer to the installation site would be used.

Table 26 E2 Delivery Schedule – Scapa Deep Water Quay

Component	2030	2031	Total
Floaters	22	22	44
Tower units	66	66	132
Blades	66	66	132
Nacelles + Hubs	22	22	44

The tonnages of components are shown in Table 27; these are used in the calculation of wharfage (apart from the floater and MPS; charges associated with these structures are based on area rather than tonnage for wet storage).

Table 27 E2 Component Tonnages – Delivery

Component	2030	2031
Floaters	88,000	88,000
Tower units	6,600	6,600
Blades	4,290	4,290
Nacelles + Hubs	18,700	18,700

Based on the vessels and capacity described earlier the total number of vessel movements have been calculated for delivering floaters to Scapa Flow and components to Scapa Deep Water Quay.

Table 28 E2 Vessel Movements – Delivery

Vessel	2030	2031
mv ALFALIFT (floaters to Scapa Flow)	22	22
mv BOLDWIND (tower units)	6	6
mv BOLDWIND (blades)	6	6
mv BOLDWIND (nacelles + hubs)	6	6

All vessels will require pilotage and towage.

6.7.3 E2 – Installation

Installation of turbines is assumed to comprise the following activities.

Each floater will sit in Scapa Flow supported by the developer's MPS and a jack-up vessel such as the mv VOLTAIRE. The MPS and jack-up vessel will remain in the Flow, possibly moving around to find the greatest shelter, for the entire season.

The components (e.g. tower units, blades, nacelles + hubs) will be transferred from Scapa Deep Water Quay to the MPS in the Flow by barges (e.g. North Sea Barge) towed by a tug similar to the BREMEN FIGHTER.

The assembled floaters will be towed out to site by a minimum of two tugs (such as the BREMEN FIGHTER).

Vessel movements are shown in Table 29.

Table 29 E2 Vessel Movements – Installation

Vessel	2031	2032
North Sea Barge (nacelles + hubs)	4	4
North Sea Barge (tower units)	4	4
North Sea Barge (blades)	4	4
BREMEN FIGHTER (1 tug per barge)	12	12
BREMEN FIGHTER (2 per floater tow)	44	44

6.7.4 E2 – Heavy Maintenance

It is assumed that heavy maintenance of components would be done at a port location closer to the offshore wind farm site. This may change as the developer firms up their operational plans.

6.7.5 E2 – Land Lease

It is assumed that the developer would wish to least an area of land commensurate to what will be required in terms of components, while being able to work alongside another developer potentially. It is assumed that six hectares would be leased annually between 2030 and 2032.

6.8 Additional Offshore Wind Sites

6.8.1 Key Assumptions

For offshore wind farm sites N2, NE3 and NE8 and a minimum of two INTOG sites it is assumed that only wet storage will be required. That is, floaters or even semi-assembled turbines are stored in the sheltered areas of Scapa Flow until they are ready to be towed out to site. Based on discussions with industry and developers this assumption is realistic.

No assumption regarding use of Scapa Deep Water Quay or Lyness has been made although this may change as developers firm up their operational plans.

Table 30 provides an estimation of how many floating turbines will use wet storage in Scapa Flow.

Table 30 Offshore Wind Sites – Wet Storage Only

Site	2033	2034	2035	2036	2037	2038	2039
N2 Northland Power					30	30	23

NE3 Falck Renewables	25	30					
NE8 Bay Wa		25	28				
INTOG Site 1		7	7	7	7		
INTOG Site 2		7	7	7	7		

Table 31 presents estimated number of wet storage days, assuming that each floater spends on average five days in wet storage.

Table 31 Volume of Wet Storage

Site	2033	2034	2035	2036	2037	2038	2039
N2 Northland Power	0	0	0	0	150	150	115
NE3 Falck Renewables	125	150	0	0	0	0	0
NE8 Bay Wa	0	125	140	0	0	0	0
INTOG Site 1	0	35	35	35	35	0	0
INTOG Site 2	0	35	35	35	35	0	0

For each day of wet storage a float will be charged £1.18 per square metre.

Each floater will be brought to Scapa Flow, towed on barge by two sea-going tugs (e.g. BREMNER FIGHTER). Each floater will be towed out in a similar manner. Table 32 indicates the number of vessel movements required.

Table 32 Vessel Movements for Wet Storage (into and out of Scapa Flow)

Vessel	2033	2034	2035	2036	2037	2038	2039
BREMNER FIGHTER	100	276	168	56	176	120	92

The BREMNER FIGHTER will require pilotage and towage.

6.9 Lyness – Usage Assumptions in More Detail

Lyness has been highlighted in the offshore wind scenarios as a suitable location for storing anchors and moorings prior to installation on site for floating offshore wind turbines.

It is not envisaged that the anchors and moorings will be stored for long periods, rather short periods of time in the run up to installation.

It is envisaged that one set of anchors and moorings might require 0.5 hectares, thus at any one time four to five sets could be stored. It is assumed that the developers will lease land at Lyness during the installation period only and for the operational season of circa nine months.

There is also a strong potential for Lyness to be used as a site for storing cables, which will be required once the offshore wind farms are operational. This has not been modelled at present.

The capital investment required at Lyness will not take place until there is a developer commitment to utilise this location – for example a commitment from TWP in 2030 is assumed, which will lead to infrastructure works taking place within that same year if possible.

7 OTHER SECTORAL ASSUMPTIONS

7.1 Introduction

This Section sets out assumptions underpinning forecast activities at Scapa Deep Water Quay and Orkney Logistics Base across a range of sectors: oil and gas, boat repair, ferry services, etc.

7.2 Scapa Deep Water Quay

7.2.1 Maintenance of Offshore Structures / Platforms

Key assumptions regarding this market segment are:

- Rigs and platforms (oil and gas) would not come alongside until 2032 if offshore wind activity takes place as forecast.
- A daily charge of £5,000 will apply.
- All rig movements will require pilotage, which is calculated based on GT. An average of 16,700 GT per rig is assumed in the model.
- There is substantial spend in the Orkney supply chain, particularly when a rig or platform is mobbing / demobbing which is likely for the longer refurbishment periods. This could be in the region of £100,000 per month[5]. For shorter less intense periods of maintenance the spend will be a lot less – in the region of £10,000 per month.[6]

Table 33 Rigs and Platforms Alongside: Assumptions

Activity	Number per annum	Length of stay
Rigs / platforms alongside – refurbishment	Four	45 days
Rigs / platforms alongside – minor maintenance	Five	7 days

7.2.2 Other Vessel Calls at Scapa Deep Water Quay (Passing / Visiting)

Key assumptions regarding this market segment are:

- Vessels will call at Scapa Deep Water Quay particularly for supplies and crew changes, or for maintenance and layover – some of these will be tankers that are already in Scapa Flow, either visiting Flotta Oil Terminal or involved in a Ship-to-Ship (STS) transfer and others will be passing vessels.
- Harbour dues, berth fees, pilotage and towage will be applicable to all.

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[5] It is known that up to £150,000 per month is spent on the local supply chain by a rig anchored in Scapa Flow – a lower figure of £100,000 per month is assumed as there would be no workboat trips to and from the rig required.

[6] It is assumed that for less intensive maintenance that the figure would be lower than that spent by rigs at anchor when laying over (£30,000 per month, mostly attributable to work boat trips).

- Based on discussions between Orkney Harbour Authority and visiting vessels it is assumed that circa £2,000 per vessel call is spent on the local supply chain.

Table 34 Vessels Alongside: Assumptions

Activity	Number per annum	Length of stay
Tankers (55,000 GT)	10	8 days
Cargo vessels (10,000 GT)	50	4 days

7.3 Orkney Logistics Base

7.3.1 Oil and gas

There is an opportunity for Orkney to attract more oil and gas supply vessels to the expanded Orkney Logistics Base, which will have available quayside space all year round, fuel provision and laydown area in close proximity to the quay – all new features which make Orkney more attractive to this sector.

Orkney is in much closer proximity to West of Shetland than Aberdeen or Peterhead and several operators have indicated that they would consider using this facility more frequently, particularly for re-fuelling and potentially for other activities such as crew and supply changes.

Assumptions regarding this market sector are as follows:

- 66 oil and gas supply vessel calls per annum by 2033.
- Initially calls will be for fuel and crew changes.
- By 2040 there will be an expanded oil and gas supply operation in place.

7.3.2 Boat Repair

Key assumptions for this market segment are:

- It is assumed that a tender process would lead to a private operator taking on a lease for the boat lift, estimated to be at £45,000 per annum.
- Based on known turnover of small boatyards elsewhere in Scotland a build up to an annual turnover of £500,000 is assumed.

7.3.3 Ferry and Freight Services

For the harbour revenue projections it is assumed that the Freight Plus vessel would have a gross tonnage of around 9,000 and that eight calls per annum would be included in the analysis. This is to represent additional freight-only sailings during the busiest time of year (August / September) when there is a significant outflow of livestock from Shetland and Orkney, impacting on overall capacity.

It is also assumed that a vessel of a similar size would make 30 calls per annum. Given the larger capacity of the new linkspan it is envisaged that there would be more calls from other freight vessels. This could be associated with delivering components for other renewable energy projects across onshore wind, tidal stream and wave energy sub-sectors, or other types of cargo.

7.3.4 Potential for New Harbour Users and Tenants

The expansion at Orkney Logistics Base will create a significant amount of prime operational land both close to the quay and within the wider hinterland of the facility.

It is assumed that three new businesses are attracted to Orkney Logistics Base, each leasing one hectare at £20 per square per annum over a long lease period.

Key facts underpinning this assumption include:

- Known aspirations of aquaculture companies in Orkney to expand their businesses.
- Tidal stream and wave energy developments will start to increase during the 2030’s which could lead to companies looking to expand their operations, buildings and land area in Orkney.
- It is likely that companies in the oil and gas sector may consider land lease as business grows over time.
- A substantial number of existing businesses are already seeking new land and facilities at the Orkney Logistics Base; while there would be some displacement such moves will also enable local companies to expand and thus create additional economic impacts.

8 FINANCIAL ASSUMPTIONS

8.1 Introduction

This Section sets out assumptions used in the Funding Cashflow model.

Data and assumptions are entered for three projects individually where appropriate but the Funding Cashflow (FCF) model has the ability to show results for projects individually or in any combination of two or three projects together.

Projects included are:

- Scapa Deep Water Quay (SDWQ).
- Orkney Logistics Base.
- Lyness.

Table 35 Inflation

Element	Cell Reference	Notes
Capital Costs	InputsA! Rows 7-15	Values extracted for 3 projects from the OBC model. OBC values profiled over capital programme and assumed to be priced to year in which they occur. FCF model applies 0% indexation.
Operating Costs	InputsA! Rows 20-39	Staff, Crown Estate, Maintenance and Pilotage and Towage Fuel Costs extracted for 3 projects from the OBC model. OBC values are in 2022 price terms. Indexation for all elements is applied at 2% pa (CPI long term inflation target) with the exception of the years 2023-2027 when OBR November 2022 CPI inflation forecasts are assumed. In 2025 when the forecast is -0.8% the FCF model assumes a 0% change in the expectation that project costs are unlikely to reduce.
Revenue	InputsA! Rows 43-55	Harbour Dues related to relevant sources for the for 3 projects have been extracted from the OBC model. OBC values are in 2022 price terms. Indexation for all elements is applied at 2% pa (CPI long term inflation target) with the exception of the years 2023-2027 when OBR November 2022 CPI inflation forecasts are assumed. In 2025 when the forecast is -0.8% the FCF model assumes a 0% change in the expectation that harbour dues would not be reduced in such a scenario.

Table 36 Costs / Revenues

Element	Cell Reference	Notes
Capital Costs	InputsA! Rows 117-125	Values both excluding and including expected Optimism Bias are extracted from OBC model (R.Capex worksheet). Excluding Optimising Bias: SDWQ – £194,051k Orkney Logistics Base – £86,026k Lyness – £6,224k Including Optimising Bias: SDWQ – £262,486k Orkney Logistics Base – £106,607k Lyness – £8,480k
Operating Costs	InputsA! Rows 130-149	Values are extracted from OBC model (R.Opex + Direct Employment worksheet) In the period to 2052 real costs total: SDWQ – £25,564k Orkney Logistics Base – £6,388k Lyness – £1,537k
Revenue	InputsA! Rows 153-165	Values are extracted from OBC model (R.Economic BASE) In the period to 2052 real costs total: SDWQ – £186,084k Orkney Logistics Base – £53,132k Lyness – £3,946k

Table 37 Grants

Element	Cell Reference	Notes
West of Orkney Wind – Project Cost support including Environmental Impact Assessment	InputsA! Row 175	2023 – £1,500k
Floating Offshore Wind Manufacturing Investment Scheme (FLOWMIS)	InputsA! Row 187	2023 – £50,000k
Scottish Government	InputsA! Row 189	2023 – £16,667k 2024 – £16,667k 2025 – £16,667k
Orkney Islands Council (OIC) – Orkney Logistics Base Phase 1	InputsA! Row 195 (detail in rows 199-208)	Funding already committed Orkney Logistics Base Phase 1 2022 – £315k 2023 – £518k 2024 – £8,263k 2025 – £19k

Table 38 Inputs / Calculations: 'CES Loan' Worksheet

Element	Cell Reference	Notes
Drawdown	CES Loan! Rows 4-5	Land: 2024 – £3,200k drawdown Other Project Costs: 2026 – £6,800k drawdown
Repayment Date	CES Loan! Rows 15-16	10 years from drawdown Land – 2033 Other Project Costs – 2035
Interest Rate	CES Loan! Rows 47-48	No interest is payable annually but the amount to be repaid at the end of the loan period is increased in line with CPI inflation. The CFC model shows this as an effective rolled up interest on the loan balance. CPI inflation follows the same assumption as operating costs and revenues: - 2023-2027: OBR November 2022 CPI inflation forecasts - 2025: 0% rather than forecast -0.8% - Other years: 2% based on long term CPI target It should be noted that the CPI based rolled up interest rate on the CES loan will not be fixed throughout the project. To the extent that OIC are confident that revenues will change in line with CPI this variability may not be a problem (in fact it may be attractive in helping allow costs and revenues to be equally

Element	Cell Reference	Notes
		impacted by inflation) but it is an important issue to note.
Repayment Value	CES Loan! Rows 58 & 76	Land: £3,694k Other Project Costs: £8,119k
Rent	CES Loan! Rows 30, 35 & 40	£0.70m^2 payable in relation to the Land related CES Loan only. Forecast land area of 27.277 hectares (272,770m^2). Rent payable throughout loan term with a 2-year holiday period from drawdown. No uplift in rent has been assumed in the model although it is understood that CES expect there to be a rent review at year 6

Table 39 Inputs / Calculations: 'PWLB Loan' Worksheet

Element	Cell Reference	Notes
Drawdown	PWLB Loan! Rows 3-29	Modelled to provide 'balance' funding in each year of the capital programme for Capital Costs that are not funded by CES Loan or Grants. Drawdown requirement takes into account surplus cash balances from previous periods. At the end of each year interest and principal related to the outstanding loan balance needs to be repaid. To avoid model circularity this is not funded in the same year. This effectively creates a modelled cashflow deficit at the end of the year but that amount is included in the following year's funding requirement so the model actually assumes a zero cost 1 day overdraft (interest and principal is paid at the end of the year and drawdown is made at the start of the year).
Repayment Date	PWLB Loan! Row 35	2052 in line with the end of the project evaluation period. In practice the loan could be extended to the extent that surplus revenue from the relevant project/s was assumed to continue beyond that date.
Interest Rate	PWLB Loan! Row 39	4.540% Based on PWLB rates of 21/11/22 - annuity repayment basis with an approximated average 26-year term. It should be noted that if PWLB funding was used to provide such 'balance' funding:

Element	Cell Reference	Notes
		- The drawdown in each year would create a separate loan with an interest rate fixed at the time of drawdown Each loan would receive a different interest rate rather than a single rate for all PWLB funding outstanding
Repayment Value	PWLB Loan! Rows 42-44	The model calculates the equal repayment required to ensure the outstanding balance in each year is repaid (with interest) by 2052. The annuity repayment is amended with each drawdown during the construction programme but then remains fixed from 2030 onwards.
Drawdown	PWLB Loan! Rows 3-29	Modelled to provide 'balance' funding in each year of the capital programme for Capital Costs that are not funded by CES Loan or Grants. Drawdown requirement takes into account surplus cash balances from previous periods. At the end of each year interest and principal related to the outstanding loan balance needs to be repaid. To avoid model circularity this is not funded in the same year. This effectively creates a modelled cashflow deficit at the end of the year but that amount is included in the following year's funding requirement so the model actually assumes a zero cost 1 day overdraft (interest and principal is paid at the end of the year and drawdown is made at the start of the year).

8.2 Cashflow Overdraft

The CFC model is structured in a way which forces scheduled interest and principal repayments to be made on both the PWLB and CES Loans. These repayments will be made in the model irrespective of funds actually being available and this results in an effective overdraft on the project cash balance.

When such a scenario occurs an interest charge has been included in the model, with the cost being applied in the period following the overdraft.

The overdraft interest rate is currently assumed to be at the same level as the PWLB loan rate being 4.540% (InputsA! C214).

9 ECONOMIC IMPACT ESTIMATES ASSUMPTIONS

9.1 Introduction

This Section sets out the key assumptions underpinning the economic analysis.

The impacts are for the Orkney economy. They do not include the wider economic impacts across the rest of Scotland or rest of UK. In the Economic Base Case only revenues for organisations that are based in and owned in Orkney are included.

9.2 Time Horizon

The analysis is annual from 2022 to 2052. While this can be extended to 50 years in line with Green Book guidance on very long-lived assets, if the scenarios can be well-defined that far into the future, the standard approach is to use a 30 year period.

9.3 Prices

All financial figures are expressed in 2022 prices.

9.4 Discount Rate

For the calculations in the Economic Base, a discount rate of 3.5% has been applied to all costs and benefits, as per HM Treasury Green Book.

9.5 GVA

As noted above in the Economic Base Case revenues are not included for organisations that are not locally owned. However, the labour cost element of the direct GVA associated with the employment created in e.g. offshore O&M has been included within the impacts as these jobs are based in Orkney.

In general, GVA: output ratios from the Scottish Annual Business Survey and Scottish Government's *Scotland's Marine Economic Statistics* have been used in the calculation of GVA. However, in some cases the ratios have been adjusted to ensure a reasonable and credible relationship between GVA, output and employment.

9.6 Employment

All employment figures shown are expressed in FTE (Full-Time Equivalent) jobs.

9.7 Economic Multipliers

Indirect and induced revenue, GVA and employment impacts have been calculated based on multipliers from Scottish Government's Input-Output Tables. These multipliers are at the level of the Scottish economy. Therefore, they have been scaled down to the level of the Orkney economy to account for leakage to other parts of the Scottish economy. This assumed that the multipliers for Orkney are as follows:

- Indirect – 40% of Scottish level multiplier.
- Induced – 70% of Scottish level multiplier.

Again, in some cases the multipliers have been adjusted to ensure a reasonable and credible relationship between GVA, output and employment.

9.8 Economic Impacts of Construction

The economic impact estimates are at the level of the Orkney economy. They do not include the wider impacts in the rest of Scotland or further afield.

The impacts are dominated by the civil engineering element of the works. It accounts for over 95% of the projected capital costs across the three locations.

The impact shown should be seen as indicative best estimates based on currently available information and related assumptions. This reflects a number of uncertainties. These are set out below.

The estimates shown for the direct jobs for civil engineering are for ones that could take place in Orkney. Given the size of the projects a significant proportion of these posts could be filled by people from outside Orkney working there on a temporary basis.

However, the percentage is not known at this time. Given their temporary status these would spend much less money in local shops and other outlets than permanent residents of Orkney. Further, those non-residents who are directly employed would likely have their accommodation costs met by their employer. This is, however, reflected in the estimates by adjusting (i.e. reducing) the induced impacts accordingly.

The actual share of direct jobs taken up by people from outside Orkney will, in part, depend on the location of the lead contractor. They may have their own pool of itinerant labour that they would look to use.

The actual direct employment impacts could be lower than currently estimated. First, the estimates have been based on applying ratios (from the 2019 Scottish Annual Business Survey) of capital spend to employment to produce estimates of direct full-time job years.

However, the pandemic and subsequent construction price inflation could mean there is no reversion over time back to the 2019 ratios. Thus, the spend required to create a job year could remain higher than in the 2019 data, thus reducing the employment impacts.

Second, there could be economies of scale due to the large scale of the proposed construction projects. This is not reflected in the general spend / direct job ratio for civil engineering as this encompasses all sizes of projects. The construction works here are of a scale that could enable the use of larger equipment and machinery and less labour intensive methods. This would act to reduce the number of workers required.

Based on scaling down Scottish level employment multipliers (from Scottish Government's Scottish Input-Output Tables) to reflect the size of the Orkney economy it is estimated that up to 40% of the total Scottish indirect impacts from the Civil Engineering works could occur in Orkney businesses. This would be potentially around 300 job years of indirect employment between 2022 and 2030.

The scale of sub-contracting with Orkney businesses would depend on the capacity of the island's construction sector, i.e. its size and scope. The latest available relevant data are from 2019 Scottish Annual Business Survey. They show:

- Total construction sector: 140 business units with around 800 people employed.
- Civil engineering sector alone: 16 business units with around 100 people employed.

These data understate the full size of the construction sector in Orkney. That is because they exclude businesses that are not registered for VAT and/or PAYE.

Further, not all of the indirect employment would be with subcontractors. It would also include purchases of materials and other types of goods and services from suppliers based in Orkney.

The apparent size of the Orkney construction sector suggests it could be well placed to secure a good proportion of sub-contracting opportunities. However, this would depend on the procurement practices of the higher tier companies involved in the construction project.

For the other activities such as EIA, site investigations, consents, and manufacture of the boatlift, it has been assumed that the lead contractors will be located outside Orkney. However, it also has been assumed that 30% of indirect and induced impacts from these activities would occur in Orkney. That would be through using local sub-contractors, staff spending time and money in Orkney while making site visits, etc.

The GVA estimates have used data from the 2019 Scottish Business Survey, and multipliers from the Scottish-Input Output Tables scaled down to reflect the scale of Orkney's economy. Direct GVA includes only the labour cost element. That is because the profit element will leak out of the Orkney economy to the lead contractors based elsewhere.

SCAPA DEEP WATER QUAY EIAR

VOLUME 3

TECHNICAL APPENDIX 3

Technical Appendix 3.1	**EIA Scoping Report**
Technical Appendix 3.2	**Orkney Islands Council Scoping Opinion**
Technical Appendix 3.3	**Marine Scotland – Licensing Operations Team Scoping Opinion**

TECHNICAL APPENDIX 3.1

Orkney Island Council Harbour Authority (OICHA) Scapa Deep Water Quay Development - EIA Scoping Report

March 2021

Orkney Island Council Harbour Authority (OICHA) Scapa Deep Water Quay Development - EIA Scoping Report

Client: Orkney Island Council Harbour Authority (OICHA)

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Reviewer: Dr C G Fleming

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Glasgow

Craighall Business Park
8 Eagle Street
Glasgow
G4 9XA
0141 341 5040
info@envirocentre.co.uk
www.envirocentre.co.uk

Aberdeen

Banchory Business Centre
Burn O'Bennie Road
Banchory
AB31 5ZU
01330 826 596

Inverness

Alder House
Cradlehall Business Park
Inverness
IV2 5GH
01463 794 212

This report has been prepared by EnviroCentre Limited with all reasonable skill and care, within the terms of the Contract with Orkney Island Council Harbour Authority (OICHA) ("the Client"). EnviroCentre Limited accepts no responsibility of whatever nature to third parties to whom this report may be made known.

Contents

Appendices

A Drawings

Tables

1 INTRODUCTION

1.1 Background

EnviroCentre Ltd has been appointed by Orkney Island Council Harbour Authority (OICHA) to undertake an Environmental Impact Assessment (EIA) in relation to the proposed development of Scapa Deep Water Quay (SDWQ), ~8km south of Kirkwall at Bay of Deepdale, Scapa Flow (as demonstrated within Appendix A: Drawing No 673702-014). The purpose of this report is to seek a Scoping Opinion from the appropriate Regulatory Authority as required by the relevant Environmental Impact Assessment (EIA) legislation.

This report has been laid out as follows:

- Section 1 introduces the applicant, the project team and the regulatory background to which this Scoping Request is made;
- Section 2 sets out a description of the proposed development upon which to base an appraisal of potentially significant environmental effects upon. Please note: the development description may evolve as the engineering design progresses but in principle is expected to be unchanged;
- Section 3 sets out the approach to EIA based upon the legislative context introduced within section 1;
- Sections 4 – 8 discuss potentially significant environmental effects on a topic by topic basis.
- Section 9 draws together the conclusions reached for each topic considered in the scoping report.

1.2 The Applicant

OICHA is responsible for the safe and efficient operation of 29 piers and harbours, including Scapa Flow. It is owned by OIC, who are the Statutory Harbour Authority, and is one of the UK's most diverse commercial ports.

In August 2020, OICHA launched the Orkney Harbours Masterplan Phase 1, (after OIC approval in April 2020) a proposed and ambitious £230 million infrastructure vision to be completed over a 20 year period. Proposals focus on harbour infrastructure enhancements that will generate jobs, additional revenue and attract new business. It represents the first step in a review of Orkney Harbour Authority-owned infrastructure to create a base for innovation and secure the long-term future for the community.

The Masterplan embraces decarbonisation and transition away from fossil fuels. The infrastructure proposals have been designed to enable Orkney to manage this transition while continuing to generate social and economic benefit from ongoing oil and gas activity. Harbour users and key stakeholders were consulted from the outset to help gain an understanding of the issues, constraints and opportunities associated with the harbour infrastructure around Orkney through workshops and interviews. The range of stakeholders includes local communities, harbour users, potential funders and environmental bodies such as NatureScot.

Phase 1 of the Masterplan considers five main locations on the Orkney mainland, namely and in no priority

1. Scapa Deep Water Quay;
2. Hatston Pier;
3. Scapa Pier;
4. Kirkwall Pier; and

5. Stromness.

It is proposed that a future Phase 2 will develop smaller harbours and piers across the archipelago.

Full details of the Masterplan can be found at http://www.orkneyharboursmasterplan.com/.

1.3 Project Team

This Scoping Report has been prepared by EnviroCentre Ltd with input from other organisations shown in Table 1.1.

Table 1-1: The Project Team

Topic	Specialist
EIA, Ecology, Water, Noise and Other Assessments	EnviroCentre Ltd.
Landscape and Visual	Doug Harman Landscape Planning
Cultural Heritage and Archaeology	Orkney Research Centre for Archaeology (ORCA)
Engineering Design	Arch Henderson

1.4 The Legislative Context

The continued management and development of harbours in Orkney is subject to local, national and European legislation of which the following is the principal legislation relevant to the current development programme:

- Orkney County Council Act 1974: section 7 of this Act provides that "*The Council may construct, place, maintain and operate in and over a harbour area such works as are required for or in connection with the exercise by them of any of their functions under this Act an may alter, renew or extend any works so constructed or placed.*"
- The Harbours Act 1964 (when not contained within the Orkney County Council Act 1974;
- The Town and Country Planning (Scotland) Act 1997, as amended by the Planning etc. (Scotland) Act 2006 – for works on land and to the mean low water mark. An application for Planning Permission will be determined by OIC;
- The Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017 (hereafter referred to as 'the EIA Regulations');
- The Marine (Scotland) Act 2010 (Marine Licences) – Under Section 20(1) of the Marine (Scotland) Act 2010 (from 0 -12nm) and Section 65(1) of the Marine and Coastal Access Act 2009 (from 12 – 200nm)[1], a marine licence from Scottish Ministers is required if organisations intend on carrying out certain acts in the Scottish marine area such as:
    - the deposit or removal of a substance or object;
    - Construction, alteration and improvement works,
    - Dredging, and
    - The deposit or use of explosives.
- Marine Scotland stipulate that any associated dredging works taking place that involves disposal at sea, then a Marine Licence for Sea Disposal may also be required; and
- The Marine Works (Environmental Impact Assessment) Regulations 2017) (for works below the mean low water mark) (hereafter referred to as 'the Marine EIA Regulations').

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[1] Circular 1/2015 The Relationship Between the Statutory Land Use Planning System and Marine Planning and Licensing - http://www.gov.scot/Publications/2015/06/5851/4

1.5 Screening Opinion

As the proposed development contains elements which are above and below Mean High Water Springs (MHWS), which constitutes the dividing line between terrestrial and marine planning, consents will be required from both the Council (for any elements not covered under OICHAs' permitted development rights) and Marine Scotland.

A Screening Request was submitted to both OIC and MSLOT in July 2020 to confirm if the proposed development, as described in Section 2.1 and 2.2 of this document was deemed to fall within either Schedule 1 or 2 development as defined by the EIA Regulations and the Marine EIA Regulations.

OIC confirmed in their Screening Opinion, dated 3 August 2020 that the proposed development is considered to constitute Schedule 1 development as it falls under Paragraph 8 (2) of the EIA Regulations.

MSLOT confirmed in their Screening Opinion, dated 22 July 2020, that the proposed works are considered to constitute Schedule 1 development as it falls under Paragraph 8 (2) of the Marine EIA Regulations.

In both cases Paragraph 8 (2) refers to:

> "*Trading ports, piers for loading and unloading connected to land and outside ports (excluding ferry piers) which can take vessels of over 1,350 tonnes*".

Accordingly, an EIA will be prepared to cover both consents under both the EIA Regulations and Marine EIA Regulations.

1.6 Scoping under the EIA and Marine EIA Regulations 2017

The general environmental topic areas to be considered within the context of EIA are summarised below:-

- Population / Human Health;
- Biodiversity (e.g. Fauna and flora);
- Land (e.g. land take) / Soil (e.g. organic matter, erosion, compaction, sealing);
- Water (e.g. hydromorphological changes, quantity and quality);
- Air Quality;
- Noise and Vibration;
- Climate (e.g. greenhouse gas emissions, impacts relevant to adaptation;
- Material Assets;
- Cultural Heritage (e.g. architectural and archaeological); and
- Landscape.

Both terrestrial and marine EIA Regulations state that a developer may ask the relevant regulatory body for their formal opinion on the information to be supplied in the EIA Report (a 'scoping opinion'). This provision allows the developer to be clear about what the regulatory authority considers the significant effects of the development are likely to be and, therefore, the topics on which the EIA report should focus."

Additional objectives of EIA Scoping are to:

- Establish the availability of baseline data;
- Request that statutory consultees provide any relevant environmental information relating to the site and surrounding area;

- Define a survey and assessment framework through which comprehensive impact assessment can be achieved; and
- Provide a focus for the planning authority and the consultees' considerations – in terms of:
  - Potential impacts to be assessed;
  - Assessment methodologies to be used;
  - Other areas which should be considered; and
  - Any other environmental issues of perceived concern.

Each regulation requires that any scoping request should be accompanied by:

- A description of the location of the development, including a plan to identify the land;
- A description of the proposed development, and of its likely significant effects on the environment; and
- Such other information or representations as the developer may wish to provide or make.

1.7 Consultation and Stakeholders

The Applicant recognises the importance of consultation and community involvement throughout the project development process in line with "PAN 3/2010 Community Engagement" (PAN 3/2010). PAN 1/2013 also reinforces the importance of public involvement in the Scoping process and makes it clear that the EIA process is intended to ensure that consultation bodies and the public have the opportunity to express their opinion on both the proposed development and the EIA Report (EIAR).

The Applicant has already held informal discussions with local stakeholders and has sought initial advice from OIC Planning and Marine Scotland Licensing Operations Team (MSLOT). This advice has been reflected in this Report and will be taken forward to the design of the proposed development as appropriate.

1.8 Report Usage

The information and recommendations contained within this report have been prepared in the specific context stated above and should not be utilised in any other context without prior written permission from EnviroCentre.

If this report is to be submitted for regulatory approval more than 12 months following the report date, it is recommended that it is referred to EnviroCentre for review to ensure that any relevant changes in data, best practice, guidance or legislation in the intervening period are integrated into an updated version of the report.

Whilst the Client has a right to use the information as appropriate EnviroCentre do not accept liability to any third party for the contents of this report unless written agreement is secured in advance, stating the intended use of the information.

EnviroCentre accept no liability for use of the report for purposes other than those for which it was originally provided, unless EnviroCentre have confirmed it is appropriate for the new context.

2 THE PROPOSED DEVELOPMENT

2.1 The Site and Surrounding Area

Drawing No 673702-014 shows the site in context with its surrounds and is contained in Drawings, Appendix A.

2.1.1 The Site

Scapa Deep Water Quay will be situated circa 4km south from Scapa Pier – before Holm and round about Deepdale. It is currently untouched coastline comprising a gravelly beach and in places exposed rock bordered on the landside by a rock face circa 3m in height. The land above the rock face comprises rough grazing which slopes upwards to the east and the A961. The Burn of Deepdale is to the north with a rocky promontory forming a natural barrier to the south. There is currently a rough track from the A961 to the coastline.

2.1.2 The Surrounding Area

The preferred location of the deep water quay is set within a rural area of the mainland island which is largely pastureland. Isolated residential dwellings and farmsteads are located along the extent of the A961. Gaitnip Hill Local Nature Conservation Site is located to the north of the Burn of Deepdale.

2.2 The Proposed Development

The drawings listed below present illustrative layouts of the planned development and are contained within Appendix A:

- Site Location Plan (Drawing No 202042 / FS-01 Rev P1, dated February 2021);
- Phase 1 Overall Layout (Drawing No 202042 / FS-10 Rev P1, dated February 2021);
- Phase 2 Overall Layout (Drawing No 202042 / FS-20 Rev P1, dated February 2021);
- Phase 3 Overall Layout (Drawing No 202042 / FS-30 Rev P1, dated March 2021); and
- Site Access Road: Proposed Layout (Drawing No 202042 / FS-40 Rev P1, dated February2021)

2.2.1 The Need for the Development

There are specific market opportunities in the offshore wind and oil and gas sectors that need access to deep water pier infrastructure. However there is currently no such facility located on the Orkney mainland coast. As part of the Orkney Harbours Masterplan Phase 1 development, consideration was given to several possible locations for a deep water quayside facility with the site at Deepdale, to the south of Scapa Pier being the final preferred option.

The main purpose of this facility would be to undertake multiple industrial activities that require both deep-water berthing and large laydown area. It is envisaged that the main activity will be the construction / assembly and maintenance of offshore wind turbines.

This is also a potential location for the development of a storage and supply hub for future marine fuels, as contained within the Islands Deal documents signed off at Heads of Terms level on 17 March 2021.

2.2.2 Outline Design Principles

This proposal comprises the creation of a 575m of quayside with water depth of -15m CD, a 110m x 75m quay extension with water depth of -20m CD and formation of 18 hectares of laydown area (not including the quay areas). The proposal will also include an access road leading from the A961 to the laydown area.

The development is designed to be built in three phases although the ordering of Phases 2 and 3 will be dependent on the economic need for these facilities. The phasing details are:

Phase 1
- Installation of the access road from the A961 to the site;
- Excavation of current landform along with reclamation of shore to form 12Ha of laydown area bounded by bunds on the north and eastern edges;
- Creation of 450m of berthing by formation of a quay 300m x ~46m wide with a 100m wide section on the northern edge providing water depth of up to -15m CD; and
- Dredging adjacent to the newly formed quay.

Phase 2
- Excavation of current landform along with reclamation of shore to form an additional 6Ha of laydown area to the south of Phase 1 laydown area. The bund on the eastern edge will be extended along the length of the new laydown area and partially along the southern edge;
- Extension of the Phase 1 quay area by 275m x ~46m to the south; and
- Dredging adjacent to the newly formed quay extension to provide -15m CD water depth.

Phase 3
- Creation of a 110m x 75m quay extension on the northern edge of Phase 1 quay out to -20m CD ; and
- Dredging on the northern side of the newly formed quay extension to provide -20m CD water depth.

It should be noted that as a design principle it has been attempted to balance any dredging or cut into the land with construction and/or reclamation requirements. Sea disposal of dredging material will be avoided as far as possible.

2.2.3 Construction

It is intended that the contract for construction of the facility will be awarded as a design and build. Therefore until the preferred Contractor is identified the exact construction methodologies cannot be confirmed at this stage in the development process. However, based on professional advice from the project engineers the following construction activities are anticipated:

Access Road Construction
- Installation of access road to main cut and fill site;
- Laying of all ducts and services to the site within the road verge;
- Initial bitmac surfacing at junction of access road with main road; and
- Laying of the final road surfacing on completion of the development.

Laydown Area (Phases 1 and 2)
- Installation of perimeter V ditches and silt retention prior to stripping operations commencing;
- Stripping of all non-inert material (organic soil and peat along with unsuitable clays) and creation of temporary stockpiles;
- Heavy tracked plant used to excavate and rip material;

- For harder strata the excavation may require pre-treatment through drilling and controlled delayed explosives;
- Recovered material would be screened and suitable inert stone and glacial till (both to be free of all organic and clay material) to be stockpiled on site for use as fill in future reclamation and quay works;
- All non-inert material recovered during initial site stripping and the main excavation operations to be used to form perimeter bunds; and
- Works estimated to take place over several months for both development phases.

Initial Reclamation (Phase 1 only)

- Prior to work commencing a silt boom will be moored out from the foreshore;
- The north perimeter bund will be formed from suitably won materials extending from the access road to the rear of the proposed quay works;
- The advancing head of the perimeter core bund will be protected by the silt boom which shall advance in front of the work;
- As the northern bund progresses, geotextile will be placed on the northern slope to mitigate the migration of fines; and
- Secondary armour and primary armour stone to be placed on top of the geotextile.

(Note: it is envisaged that the majority of armour stone will be brought to site by sea.)

Reclamation and Quay Works (**All Phases**)

- In Phase 1 the bund and armoured slope formed in the initial reclamation phase shall be used for labour, plant and construction materials to access the quay works and laydown area construction sites. For Phase 2 and Phase 3 construction work access will be from Phase 1; and
- Tubular steel piles (approximately 1.6m to 2.2m diameter) will be installed as follows:
    - Drill rigs to work over water from temporary piling platforms from the reclamation bund or a jack up barge to install tubular and sheet piles;
    - Both types of piles to be installed by vibro-hammer to required depth;
    - Piles will then be filled with tremie concrete, tie rods installed and secured between the front face and rear sheet pile wall and a concrete cope formed;
    - Quay infill to be vibro-treated to compact and reduce future consolidation and settlement; and
    - Concrete deck immediately behind the quay face shall be placed no less than 6 months after fill takes place.

Reclamation and Quay Works (**Phases 1 and 2 only**)

- As the quay works advance south then the reclamation fill would advance behind thereby affording additional sea fetch protection to the silt boom used to shore; and
- Once concrete deck behind the quay face is placed then the remaining reclamation and laydown area shall be capped and compacted with graded hard core with the surface falling to V ditch and French drains.

(Note: Impact hammer piling is not envisaged at this stage of the development but may potentially be required.)

Dredging

- Dredging to required depth in front of new quay face using back hoe dredger; and
- Depending on suitability, dredged material may be used for fill or disposed at a suitably licensed marine site if absolutely necessary.

Prior to dredging a Site Investigation (SI) will be carried out to determine the Best Practicable Environmental Option (BPEO) for the dredging spoil. This will determine whether the dredge material will be suitable for use as infill material.

3 APPRAISAL OF POTENTIALLY SIGNIFICANT ENVIRONMENTAL EFFECTS

3.1 Introduction

Both OIC Planning and MSLOT have confirmed that the proposed development will fall under Schedule 1 of the 2017 EIA and Marine EIA Regulations. It is therefore appropriate to request a Scoping Opinion from each regulatory body under the EIA and Marine EIA Regulations. As required, sufficient baseline information has been provided regarding the proposed development and the surrounding and receiving environment upon which to base a decision.

This Scoping Report is submitted to OIC Planning and MSLOT with the intention that it should form the basis of their Scoping Opinion.

The information contained in this document is based on our current understanding of the nature of the site and the proposed development and preliminary assessment of the potential environmental impacts of the proposed development.

3.2 Topic Areas to be Included

Our current thinking in the terms of the topics which fall within the scope of the EIA and subsequent EIAR are listed below:

- Water Environment and Coastal Processes;
- Ecology;
- Archaeology and Cultural Heritage;
- Seascape, Landscape and Visual; and
- Airborne Noise.

The approach to the appraisal of each of these topic areas is outlined in Sections 4 – 8 with the inclusion of baseline data where available. The appraisals will consider the potential environmental impacts related to both the construction and operational phases, where applicable, and either scope in or out the need for further assessment through the EIA process.

3.3 Other Assessments

This section describes those issues which are relevant to the proposed development however do not in our view merit or justify a full chapter within the EIAR.

On the basis of professional judgement and review of baseline conditions, full impact assessment is not considered necessary for the following topics:

- Climate Change;
- Air Quality;
- Accidents and Natural Disasters; and
- Population and Human Health.

The justifications for our intended discounting the above environmental topics from inclusion as full chapters in the EIAR are provided below.

3.3.1 Climate Change

Climate change has taken a prominent position within policy and legislation at a national level, with the Climate Change (Emissions Reduction Targets) (Scotland) Act 2019 setting a target date of net-zero emissions of all greenhouse gases by 2045. The Climate Change Plan update published in December 2020 provides a pathway for Scotland to meet the emissions reduction targets through to 2032. It identifies that public bodies have a part to play in decarbonising Scotland through leading by example.

As mentioned in Section 1.2, OICHA have developed a Masterplan which provides a framework for improving and expanding existing harbours and assets so that Orkney becomes a world leading maritime hub providing world class facilities. Decarbonisation of shipping and ports as well as the transition of fuels from hydrocarbons to carbon free are central to the Masterplan proposals and will allow new opportunities and diversification of existing ones to continue for future generations.

The proposed development at Deepdale will be able to accommodate multiple activities in the energy sector such as construction, operation and maintenance of offshore wind farm components and maintenance of structures and vessels. There is also the potential to incorporate a storage and supply hub for future marine fuels at the site.

It is therefore considered at the scoping stage that the proposed development would not result in a significant effect upon climate given the nature of the development (Refer to Section 2.2.2). Any increase in emissions created during either construction or operation is likely to be negligible, and for the construction phase pollution and emissions control would be discussed within a detailed Construction Environmental Management Plan (CEMP).

Discussion of the vulnerability of the project to climate change is primarily concerned with the water environment, including flood risk and wave overtopping due to increases in sea level. This will be taken into account in the design of the facility.

3.3.2 Air Quality

The development site is located within a relatively rural area influenced by maritime weather conditions. In order to inform the Scoping Report, the relevant 1km background air quality concentration maps were obtained from the Scottish Air Quality and DEFRA websites. The 2019 measured annual average concentrations of NO_2, PM_{10} and $PM_{2.5}$ for Orkney indicates that air quality is good with the pollutant concentrations being well below the relevant National Air Quality Objectives of $40 \mu g/m^3$, $18 \mu g/m^3$ and $10 \mu g/m^3$ respectively. The 2019 Air Quality Annual Progress Report for OIC (the most up-to-date report available) does not identify any Air Quality Management Areas (AQMAs) within the council area. In addition OIC does not currently operate any automatic air quality monitoring stations within their boundary.

The development however, has the potential to impact local air quality in a number of ways with the key issues in relation to this environmental topic being traffic emissions from the local road network both surrounding and accessing the site and dust emissions during the construction phase.

This is a new facility which is sited within a rural location. It should be noted that the A961 public road is a key route for ferry traffic, with cars and HGVs travelling daily to and from St Margaret’s Hope to travel on the ferry service operated by Pentland Ferries. It is envisaged at this stage in the project that the traffic generated by the development will be restricted to site workers. Marine assets and supplies will largely be brought to and from site by sea with only some materials/goods being transported overland sporadically. As such the increase in traffic on the local road network as a result of the development is regarded as being insignificant.

Construction of the proposed development is considered to be a temporary impact and can be controlled through developing a site-specific Dust Management Plan as part of a Construction Environmental Management Plan (CEMP). The dust impact assessment requires specific information on site operations during construction, including preparatory earthworks, general construction and the potential for trackout. Currently this information is still being finalised. It is therefore proposed to defer the construction dust assessment and formulation of a Construction Dust Management Plan until such time as details on construction activities have been finalised.

Accordingly, it is proposed to discount Air Quality from further EIA assessment.

3.3.3 Accidents and Natural Disasters

Similar to other ports, there is potential for accidents to occur, however OICHA operate a Marine Safety Management System / Standard Operating Procedures to promote safe and efficient harbour operations and is compliant with the Port Marine Safety Code. The OIC Marine Services division of OICHA ensures that all operations under their jurisdiction are done in such a manner so as to keep safe its users, the public, the harbour area and the environment. These procedures will also be introduced at this new facility once operational thereby reducing the likelihood of accidents occurring.

The proposed development is not located within an area of significant seismic activity, nor is climatic factors prone to creating disasters such as tsunamis, hurricanes or catastrophic flooding.

Accordingly consideration of accidents and natural disasters is scoped out of the EIA.

3.3.4 Population and Human Health

Although the proposed development will be a new facility within a rural area a Safety Management System / Standard Operating Procedures will be introduced by OICHA when site operations commence (as noted in Section 3.3.3). During its construction and operational phases it is therefore considered there will be no significant direct or indirect impact on either population or human health as a result of the development subject to other assessments (i.e. Air Quality etc)

3.4 Cumulative Assessment

It is acknowledged that the proposed development is part of a larger Masterplan for the area which has been promoted by the Applicant. However, it is not proposed to incorporate a section within the EIA report dedicated to cumulative assessment. Instead, the chapter for each environmental discipline will consider the potential for cumulative impacts within their individual impact assessments.

4 WATER ENVIRONMENT AND COASTAL PROCESSES

4.1 Introduction

The water environment is considered to encompass hydrology, hydrogeology and water quality, whilst coastal processes are considered to encompass tides, waves and sediment transport processes. This section of the Scoping Report will therefore address all of these subject areas, in addition to geology. The associated interactions between the water environment, ecology and fisheries will be considered within the ecology section of this document.

The Water Framework Directive (WFD) (Council Directive 2000/60/EC) aims to protect and enhance water bodies within Europe and covers all estuarine and coastal waters out to 1 nautical mile. This requires that there is no deterioration in the quality of surface or groundwater bodies and aims to achieve good ecological status or potential. The implications of the WFD must be considered when assessing this project and the details of how compliance will be achieved provided in the EIA.

The development proposals for construction, and associated dredging, have the potential to cause changes to the baseline hydro(geo)logical conditions and the ongoing coastal processes at the site, and in the wider area. Given the importance of water as a valued resource, coastal processes to the surrounding environment, and of ensuring sustainable development, this initial assessment of the water environment and coastal processes is considered essential.

4.2 Proposed Development

The proposed development is located on the southern shore of the Orkney mainland, approximately 8km south of Kirkwall. It is located on the coastline within Scapa Flow, approximately 4km south of the existing Scapa Pier.

4.3 Baseline Conditions

4.3.1 Geology and Soils

The online British Geological Survey (BGS) 1:50,000 map identifies that the development site is mainly underlain by siltstone, mudstone and sandstone of the Caithness Flagstone Formation[2].

The BGS 1:50,000 map shows that superficial deposits are absent from the shoreline. Till (Devension – Diamicton) underlies the site approximately 100m inland of the shore.

The site is underlain by a moderately productive aquifer of sandstone, siltstones, mudstones and conglomerates yielding small amounts of groundwater locally.

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[2] British Geology Survey 1:50,000 (Geology of Britain Viewer- http://mapapps.bgs.ac.uk/geologyofbritain/home.html)

4.3.2 Tidal Water Levels

The closest port referenced in Admiralty tide tables is Kirkwall (standard port). Tidal water levels at the Kirkwall Standard Port as presented within the Admiralty tide tables are shown in Table 4-1[3]. The mean tidal range at Kirkwall is 2.4m during spring tides and 1.1m during neap tides.

Table 4-1: Tidal range at Kirkwall Standard Port

Tide Condition	Chart Datum (mCD)	Ordnance Datum (mAOD)
Highest Astronomical Tide (HAT)	3.5	2.1
Mean High Water Spring (MHWS)	3.0	1.6
Mean High Water Neap (MHWN)	2.4	1.0
Mean Low Water Neap (MLWN)	1.3	-0.1
Mean Low Water Spring (MLWS)	0.6	-0.8

*Chart datum correction for Ordinance datum is -1.4 (relative to OD at Newlyn)

Extreme sea levels have been predicted around the whole UK coastline and published by the Environmental Agency / Department for Environmental Food and Rural Affairs report[4]. These extreme levels include the effects of both tides and storm surge but not the effect of amplification within estuaries or sea lochs. In order to provide better estimates around the Scottish coastline, SEPA have updated the original estimates. However, it is noted that the proposed development site is situated inshore of the estuary limit of the extreme sea level predictions for Scapa Flow, and therefore predictions from the Coastal Flood Boundary programme cannot be applied directly to the site.

The SEPA derived extreme sea levels, predicted at the closest point to the development within Scapa Flow (offshore of the prediction limits), are 2.77m Above Ordnance Datum (AOD) for the 1 in 200 year return period event and 2.89mAOD for the 1 in 1,000 year return period event. SEPA recommend a 2100 climate change uplift of 0.93m for coastal levels. Therefore the 1 in 200 year return period plus climate change event at the prediction location has a level of 3.70mAOD and the 1 in 1000 year return period plus climate change event has a level of 3.82mAOD

4.3.3 Coastal Processes

Tidal Currents along the nearshore within Scapa Flow are insignificant, with the exception of the entrances to Scapa Flow. The fetch lengths for wind generation of waves are restricted by the surrounding topography, with wave conditions tending to be dominated by locally generated wind-waves. The entrances to Scapa Flow dissipate much of the offshore wave energy limiting propagation of waves generated around the Orkney Islands into Scapa Flow. Much of the coastline near to the proposed site is fronted by a rock platform with shingle and sand beaches. There is little littoral transport other than limited reworking of glacial till, input of sediment to Scapa Flow is restricted by the construction of the Churchill Barriers[5]. The European Nature Information System (EUNIS) seabed habitat map shows the dominant seabed habitat around the proposed development to be infralittoral sandy mud and infralittoral mixed sediment in a low energy environment[6].

No seabed sediment is indicated for approximately 500m west from the shore at the proposed development site. Slightly gravelly muddy sand is shown from approximately 500m west of the shore[7].

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[3] UK Hydrographic Office, 2020 (Admiralty Tide Tables – Volume 1B)

[4] McMillan et al, 2011. Coastal Flood Boundary Conditions for UK Mainland and Islands. Environment Agency.

[5] Ramsay and Brampton, 2000. Coastal Cells in Scotland: Cell 10 – Orkney.

[6] EUNIS 2017 (https://emodnet.eu/en).

[7] Marine Scotland (https://marinescotland.atkinsgeospatial.com/nmpi/)

Due to the nature of the seabed substrate in the vicinity of the proposed development, and the lack of fine sediment, it is not anticipated that there are significant local active sediment transport processes.

Analysis of historical coastline alignments show no major changes to the coastline since 1890 and there has been no significant erosion observed[8].

4.3.4 Hydrology

The Burn of Deepdale and Burn of Button flow from the northeast and east, respectively before converging and flowing into Scapa Flow immediately north of the proposed development. Both watercourses have a combined catchment of approximately 1.96km^2 upstream of the point of discharge to Scapa Flow.

There are likely other small inflows discharging into Scapa Flow, as well as piped drainage. The inflow of freshwater remains insignificant relative to the much larger volume of seawater exchanged within Scapa Flow.

4.3.5 Water Quality

The coastal waters of Scapa Flow are classified under the Water Framework Directive (WFD) monitoring programme as a coastal waterbody. The waterbody is classified as being of overall ‘Good’ status in 2018, with a hydromorphological status of ‘High’. There are no watercourses discharging to Scapa Flow large enough to be classified under the WFD.

4.3.6 Flood Risk

The SEPA flood maps do not indicate any fluvial flood risk from the watercourses identified in the vicinity of the development site, this is because the watercourses, and associated catchments, are too small to be included by this method. Isolated areas of pluvial flood risk are identified within low lying areas corresponding to the channels and banks of the Burn of Deepdale and the Burn of Button. It is considered that these areas shown as pluvial flood risk correspond to the likely zones of fluvial flood risk.

A review of the SEPA online flood maps identifies that the lower coastal edge of the proposed development site are at high risk of coastal flooding[9]. This prediction does not account for the potential effects of climate change, local bathymetry or wave action.

4.4 Potentially Significant Effects (Construction)

The proposed development will involve construction activities within, or in close proximity to, the water environment (particularly coastal) including construction of the quay, capital dredging works, land reclamation and formation of the access road, and the creation of a laydown area. The key potential environmental impacts on the water environment during construction are detailed below:

- Potential impact to coastal process including wave action, tidal currents and sediment transport;
- Potential changes in infiltration rates, flood risk and drainage;
- Potential contamination of the water environment (coastal, fluvial and groundwater) from spillages, runoff and/or sediment transfer (oil, fuel, suspended solids and potential contaminates in soil); and

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[8] Dynamic coast online map available at: http://www.dynamiccoast.com/webmap.html

[9] SEPA, 2020 (http://map.sepa.org.uk/floodmap/map.htm)

- Potential interaction between water environment and ecology.

4.5 Potentially Significant Effects (Operation)

The completed development will be within, or in close proximity to, the water environment and may result in the following potential impacts on the water environment once constructed:

- Potential impact to coastal process including wave action tidal currents and sediment transport;
- Potential contamination of the water environment from wastewater, site discharge and or traffic; and
- Potential interaction between the water environment and ecology.

4.6 Inclusion of Exclusion from EIA

The construction activities involved within the proposed development including dredging, construction of the quay, and land reclamation all have the potential to impact the coastal processes within Scapa Flow. However, the development site is considered to have low energy without significant sediment transport, with an absence of fine sediment. In this context it is considered that a qualitative assessment of the impact of the proposed development on coastal processes, including wave action, tidal current and sediment transport is appropriate.

Dredging is proposed to take place as shown in Drawing Nos SK09112020-01, 02 and 03, Appendix A), however, given the limited dredge extent proposed, the low energy nature of the coastal environment, and the general absence of fine sediment and significant sediment transport, a qualitative assessment of the potential impact of dredging on water quality and the production of suspended sediments is considered appropriate.

SEPA flood maps do not show risk of fluvial flooding from watercourses within the vicinity of the site due to the small size of the watercourses and associated catchments. Any fluvial flood risk is considered to be limited to the immediate surrounds of these minor watercourses, as highlighted by the SEPA pluvial flood risk maps. It is therefore proposed to scope out the assessment of fluvial flood risk.

The proposed development is noted to be water compatible for operational reasons. It is considered that given the scale of proposals, the proposed land reclamation works would have a negligible impact on local sea levels. The development design will take account of extreme sea levels and future sea level rise predictions, as appropriate. Therefore it is proposed to scope out the further assessment of coastal flood risk.

The construction of the site has the potential to generate pollutants/contaminates which could impact the water quality of the nearby water environment. The prevention of pollution during construction and operation of the plant will be a key focus of the EIA. It is considered that if best practise is implemented following appropriate guidance, creation of a pollution prevention plan and surface water management plan, and installation of sustainable urban drainage measures that will not be detrimental to the existing environmental conditions. Therefore any potentially significant effects are readily mitigated.

4.7 Assessment Methodology

4.7.1 Design and Mitigation

During the EIA process where any significant effects are identified for the water environment or coastal processes then recommendations for design alterations or mitigation measures which could avoid, reduce or resolve the adverse effects will be identified.

4.7.2 EIA Methodology

The assessment will follow standard EIA procedures and will include:

- Desk based review of the proposed development and surrounding water environment;
- Consultation with key stakeholders to obtain relevant information and ensure their concerns are addressed within the EIAR;
- Establish baseline conditions:
    - Review of coastal processes including bathymetry, tidal currents, wave action, seabed sediment and sediment transport;
    - Review of hydrology, water quality and drainage;
    - Review of geology and soils on site; and
    - Reporting of baseline conditions to help inform potential impacts from the development.
- Carry out an EIA assessment:
    - Identify potential sensitive environmental receptors and environmental constraints;
    - Identify any potential impacts and impact significance;
    - Identification and assessment of appropriate mitigation measures to reduce and avoid any potential impacts of the proposed development; and
    - Statement of residual impacts.

Baseline data will be used along with expert opinions to qualitatively assess the potential impacts of the proposed development and the significance to receptors. The potential impacts will be evaluated in comparison with water quality standards and objectives, environmental quality standards and sediment quality standards.

5 ECOLOGY

5.1 Introduction

The assessment of ecology will consider the geographical area potentially affected by the proposed development within Deepdale Bay on the eastern shores of Scapa Flow, known as Scapa Deep Water Quay (SDWQ). Particular attention will be given to:

- Terrestrial habitats and species;
- Birds; and
- Marine habitats, fish and mammals.

The proposed development has the potential to affect ecology in the development footprint in terms of direct habitat losses. It is also envisaged that a range of other effects on terrestrial and marine ecology in the wider area could occur.

The potential impacts of the proposed development on the water environment, including hydrology, hydrogeology, water quality and coastal processes, will be considered in the Water and Coastal Processes section of the scoping report; however any impacts on the water environment will be taken into consideration in the ecological scoping appraisal.

5.2 Baseline Conditions

5.2.1 Designated sites

There are three statutory designated sites within 10km of SDWQ.

Orkney Mainland Moors Special Protection Area (SPA) comprises four areas of moorland on Mainland Orkney. At its closest point it lies within 6km of SDWQ. The predominant habitats include extensive areas of blanket bog, heaths and mires. These upland areas support 5.9% of the UK's breeding and 2% of the UK's overwintering Hen Harrier (*Circus cyaneus*) population, 2% of the UK's breeding Short-eared Owl (*Asio flammeus*) population. In both cases one of very few sites to support such dense and significant numbers. The area also supports 2% of the UK's breeding Red-throated Diver (*Gavia stellata*) population. This site's boundaries also correspond to **Keelylang Hill and Swartaback Burn Site of Special Scientific Interest** (SSSI), which is designated for breeding Hen Harrier.

The **North Orkney proposed SPA** (pSPA) is afforded the same level of protection as a designated site. This pSPA is located to the north of Mainland Orkney and encompasses 227km^2 of the waters between the islands of Shapinsay, Rousay, Egilsay and Wyre, including Deer Sound, Shapinsay Sound and Wide Firth. SDWQ also lies within 6km of the North Orkney pSPA. The area included within the pSPA supports populations of European importance of the following Annex 1 species: Great Northern Diver (*Gavia immer*), Slavonian Grebe (*Podiceps auritus*) and Red-throated Diver. It also supports migratory populations of European importance of the following species: Common Eider (*Somateria mollissima*), Long-tailed Duck (*Clangula hyemalis*), Velvet Scoter (*Melanitta fusca*), Red-breasted Merganser (*Mergus serrator*) and European Shag (*Phalacrocorax aristotelis*).

The **Scapa Flow proposed SPA** (pSPA) comprises a total area of 371km^2 located within Scapa Flow - an enclosed sea area, sheltered by Mainland Orkney to the north, Hoy, South Walls and Flotta to the west and south, and Burray and South Ronaldsay to the east. The Flow is linked to the Pentland Firth in the south through the Sound of Hoxa, and to the Atlantic Ocean in the west through Hoy Sound. The site also includes nearshore waters to the east of Orkney, extending from South Ronaldsay to Deerness, and including the sheltered shallow waters of Holm Sound, between Burray and East Mainland. Prior to construction of the Churchill Barriers in World War II, there were openings between Scapa Flow and Holm Sound to the North Sea. The offshore elements of SDWQ lie within the boundary of the Scapa Flow pSPA. The area included within the pSPA supports populations of European importance of the following Annex 1 species: Great Northern Diver, Red-throated Diver, Black-throated Diver (*Gavia arctica*), and Slavonian Grebe. It also supports migratory populations of European importance of the following species: European Shag, Common Eider, Long-tailed Duck, Common Goldeneye (*Bucephala clangula*) and Red-breasted Merganser.

There is also one non-statutory designated site within 500m of the onshore areas of the SDWQ site - **Gaitnip Hill Local Nature Conservation Site** (LNCS) covers 120 hectares of moorland and grassland on Holm. The site includes a number of nationally important habitats and species, and is considered important for breeding birds of prey, including Hen Harrier, Short-eared Owl, and Merlin (*Falco columbarius*). It also supports a variety of nesting waders and passerines.

5.2.2 Habitats and species

The following list includes all terrestrial and intertidal habitats and species afforded legal protection, those included within the UK BAP and LBAP, and all bird species that are considered to have the potential to suffer negative effects from the proposed development:

- Coastal vegetated shingle;
- Otter (*Lutra lutra*);
- Great Northern Diver;
- Red-throated Diver;
- Black-throated Diver;
- Slavonian Grebe;
- European Shag;
- Common Eider;
- Long-tailed Duck;
- Common Goldeneye; and
- Red-breasted Merganser.

5.2.3 Marine Mammals

All species of dolphin, porpoise and whale are European Protected Species (EPS). The marine mammal species most often encountered in the waters around Orkney, and therefore the most likely to suffer negative effects from the proposed development are listed below. All appear on the UK BAP (other than Grey Seal) and the Orkney LBAP.

- Harbour Porpoise (*Phocoena phocoena*);
- Minke Whale (*Balaenoptera acutorostrata*);
- Bottle-nosed Dolphin (*Tursiops truncates*);
- Risso's Dolphin (*Grampus griseus*);
- White-beaked Dolphin (*Lagenorhynchus albirostris*);
- Atlantic White-sided Dolphin (*Lagenorhynchus acutus*);
- Common Dolphin (*Delphinus delphis*);
- Killer Whale (*Orcinus orca*);
- Grey Seal (*Halichoerus grypus*); and
- Common Seal (*Phoca vitulina*).

5.2.4 Fish

The Orkney coastline is well known for its Sea Trout fishing and there are many commercial sea fish caught in the area. Sea Trout is a UK BAP species. There are no rivers designated for fish on Mainland Orkney but the development site may be on or close to a fish migratory path. Further baseline data on fish will be collated for the EIAR.

5.3 Potentially Significant Effects (Construction)

The following potential negative impacts on ecology could occur during the construction phase of the proposed development:

- Terrestrial habitat loss which will lead to a loss of potential foraging, roosting, commuting and nesting opportunities for a range of species;
- Accidental spills from vessels, plant and on-site storage of fuels and chemicals leading to pollution of habitats and potential harm to a range of species and habitats;
- Increased noise through construction activities (dredging, piling, blasting, plant movement, etc.) leading to disturbance and displacement of foraging, roosting or nesting species;
- Increased visual stimuli through construction activities (personnel and plant movement, etc.) leading to disturbance and displacement of foraging, roosting or nesting species;
- Increased, un-natural lighting leading to disturbance and displacement of foraging, roosting or nesting species;
- Presence of temporary new structures creating potential collision risk for a range of bird species;
- A potential change of hydrological flow which may alter the composition of the habitats present;
- Direct loss of intertidal and subtidal habitat over the footprint of the development;
- Underwater acoustic noise and shock during piling leading to altered behaviour, this could include lethal and sub lethal impacts on marine mammals and their prey species;
- Seabed excavation works during construction leading to disturbance of and potential loss of benthic communities and marine species, which in turn could lead to a reduction in or dispersal of prey items for a range of marine mammals and bird species;
- Temporary increase in suspended sediment and/or deposition from dredging and construction creating physical disturbance in the marine environment; and
- Increased vessel numbers causing disturbance in the marine environment.

5.4 Potentially Significant Effects (Operation)

The following potential negative impacts on ecology could occur during the operational phase of the proposed development:

- Accidental spills from vessels, plant and on-site storage of fuels and chemicals leading to pollution of habitats and potential harm to a range of species and habitats;
- Increased noise through operational activities (plant movement, etc.) leading to disturbance and displacement of foraging, roosting or nesting species;
- Increased visual stimuli through operational activities (personnel and plant movement, etc.) leading to disturbance and displacement of foraging, roosting or nesting species;
- Increased, un-natural lighting leading to disturbance and displacement of foraging, roosting or nesting species;
- Presence of new structures creating potential collision risk for a range of bird species;
- Dredging activity may lead to potential disturbance of and potential loss of benthic communities and marine species, which in turn could lead to a reduction in or dispersal of prey items for a range of marine mammals and bird species;

- Temporary increase in suspended sediment and/or deposition from dredging and construction creating physical disturbance in the marine environment; and
- Increased vessel numbers post construction causing disturbance in the marine environment.

5.5 Design and Mitigation

5.5.1 Terrestrial Habitats and Species

Habitat loss impacts on terrestrial habitat will be mitigated by design. Good practice mitigation measures will be recommended to minimise the impacts of construction and specific operation activities on terrestrial habitats and species. These will include a pre-construction otter survey.

5.5.2 Birds

The proposed area of terrestrial works is within grazing land and contains limited foraging opportunities for a low range of species.

The proposed area of the development within Scapa Flow has the potential to impact upon a wide range of protected species and those qualifying species of the Scapa Flow pSPA, particularly during the winter months when the birds are present.

To better understand the usage of the proposed site and to ensure any disturbance or displacement to nesting, foraging or roosting birds is minimised during construction and operation, a calendar year of wintering and breeding bird surveys is recommended to ascertain the locations of bird aggregations, numbers of birds present, and the species which frequent the area of proposed development.

A suite of vantage point surveys over the winter months is also proposed in order to better understand the species present, their numbers, preferred areas within the Flow, and their behaviour in certain areas / water depths, etc.

5.5.3 Marine habitats, fish and mammals

Underwater noise modelling for construction activities will be carried out, focussing on the key species above (including fish species). Potential impacts on marine mammals and their prey will be designed out where possible. Any additional mitigation will be designed to be site and species specific, taking into account the additional noise producing activities occurring in Scapa Flow.

The Joint Nature Conservation Committee (JNCC) *Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise* (2010)[10] will be consulted to design a site specific mitigation protocol, if required.

Mitigation proposals will be agreed through discussion with NatureScot and Marine Scotland to ensure they provide the appropriate protection for marine mammals during construction and it may well be necessary to apply for an EPS licence from the licensing authority, Marine Scotland, prior to commencing construction works.

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[10] JNCC Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise (2010) available online: http://jncc.defra.gov.uk/pdf/JNCC_Guidelines_Piling%20protocol_August%202010.pdf

5.6 Inclusion and Exclusion from EIAR

5.6.1 Terrestrial Habitats and Species

Terrestrial habitats and species will be scoped out of the EIA process. Potential impacts will be mitigated by design and a pre-construction survey will be undertaken for otter (Refer to Section 5.5.1).

5.6.2 Birds

Low tide counts and vantage point surveys are currently being undertaken, as outlined in Section 5.5.2, and initial findings indicate that with the successful implementation of mitigation measures, it is considered unlikely that there would be any significant effects on the bird populations as a result of the proposed development. However, in line with NatureScot comments[11] on the Appropriate Assessment (AA) of the Draft Orkney Harbour Masterplan Phase 1[12], it is suggested that a Habitats Regulations Appraisal (HRA) is undertaken to assess any potential LSE on the qualifying species of the North Orkney pSPA and the Scapa Flow pSPA.

Bird species that nest and forage on the terrestrial habitats adjacent to the proposed development have not been considered for assessment within the EIAR as neither assemblage will suffer significant habitat loss or will lose important roosting or foraging grounds as a result of the proposed development.

The Orkney Mainland Moors SPA will not be included in the EIA, as the SDWQ site does not constitute optimal habitat for its qualifying species, and there is no likely significant effect (LSE) on the integrity of the designation as a result of the proposed development.

5.6.3 Marine habitats, fish and mammals

Marine mammals and their prey will be included in the EIA.

5.7 Assessment Methodology

The assessment of predicted impacts will be undertaken against a baseline and the significance of effects assessed using standard EIAR criteria (i.e. as developed by the Institute of Environmental Management and Assessment (IEMA)).

The methodology for the Ecological Impact Assessment (EcIA) will follow the Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine, Version 1.1 (CIEEM, 2018 (updated 2019)). The British Standard for Biodiversity: Code of Practice for Planning and Development (BS 42020:2013) cites the CIEEM EcIA Guidelines as the acknowledged reference on ecological impact assessment. The guidelines are consistent with the British Standard, which provides recommendations on topics such as professional practice, proportionality, pre-application discussions, ecological surveys, adequacy of ecological information, reporting and monitoring.

The assessment will include all direct and indirect, lethal and non-lethal impacts on ecology that could reasonably occur during construction work and in operation of the development.

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[11] Letter Ref CDM158120 dated 24/02/2020

[12] Draft Orkney Harbours Masterplan Phase 1, Habitats Regulation Appraisal Screening Assessment, Report No P2214_RN4683_Rev1, dated 19 July 2019.

6 ARCHAEOLOGY AND CULTURAL HERITAGE

6.1 Introduction

This chapter provides an overview of the existing archaeological and cultural heritage baseline in the immediate area of the proposed development. It identifies potential effects on this baseline by the proposed development during construction and operation. Any potentially significant effects that are predicted will be recommended for scoping into an impact assessment. An overview of appropriate methodology for the assessment of these potentially significant effects is identified. An overview of possible mitigation, avoidance or enhancement measures that could be implemented is also provided.

This chapter takes account of consultation responses to the Strategic Environmental Assessment (SEA), HRA and AA for the Orkney Harbours Masterplan Phase 1. Historic Environment Scotland (HES) noted the presence of HMS Royal Oak c. 1km northwest of the proposed development, and considered that:

- there is the potential for impacts on unknown maritime heritage assets;
- further survey work and mitigation may be required at project design stage to avoid impacts on two high archaeological potential geophysical anomalies in close proximity to the development noted in the Canmore database;
- there is a requirement to indicate whether dredging will be required, that the limited area for reclamation may require further survey at project stage, and once any dredge disposal sites are determined, impacts on relevant sites in their vicinity also need to be considered; and
- significant adverse impacts on the setting of assets in our remit in the vicinity of the proposals are unlikely.

In addition to the legislative context outlined in Section 1.4 above, key legislation and policy relevant to the historic environment includes:

- The Protection of Military Remains Act 1986 (PoMRA) has the principal concern to protect the sanctity of vessels and aircraft that are military maritime graves. HMS Royal Oak is protected under this Act, with a 200m radius exclusion zone around it. Any aircraft lost while in military service is automatically protected under this Act;
- The Historic Environment Policy Statement for Scotland (HEPS) 2019 includes policies that decisions affecting any part of the historic environment require understanding of its significance and consideration of avoiding or minimising detrimental impacts;
- Historic Environment Scotland Designation Policy and Selection Guidance 2019 stands alongside HEPS 2019 and outlines the principles and criteria that underpin the statutory designation of historic assets; and
- The Pentland Firth and Orkney Waters Marine Spatial Plan (PFOW MSP, 2016) and the Orkney Local Development Plan (2017) policies concerning the protection of and approaches to the historic environment.

6.2 Baseline Conditions

The key reference sources reviewed for the baseline overview were:

- The Historic Environment and Cultural Heritage section on the Marine Scotland Information website, https://marine.gov.scot/themes/historic-environment-and-cultural-heritage [accessed 16-17/01/2021];

- Statutory lists, registers and designated areas, including List of Designated Wrecks and Historic Marine Protected Areas;
- UK Hydrographic Office (UKHO) wreck register and relevant nautical charts; and
- The National Record of the Historic Environment via the Canmore and Pastmap online databases (https://canmore.org.uk/; https://pastmap.org.uk/ [accessed January 2021]).

The importance of identified historic environment receptors has been evaluated to inform the assessment of potential effects for scoping in or out of an EIA. The level of importance assigned depends on a number of factors, including intrinsic, contextual and associative characteristics (HES Designation Policy and Selection Guidance 2019) and general guidelines used by statutory authorities and agencies such as the Scottish Government and HES.

The study area comprised a 1km radius from the centre of the proposed development (see Figure 6.1, Appendix A), although some assets out with this were considered in relation to potential effects on setting.

6.2.1 Marine

There are no marine cultural heritage statutory designations within the study area, nor are there any assets that are in the proposal for the designation of Historic Marine Protected Area in Scapa Flow https://www.gov.scot/publications/proposal-designate-two-historic-marine-protected-areas/pages/3/ [accessed 22/01/2021]. There are no UKHO charted wrecks, dead wrecks or non-sub contacts within the study area.

HMS Royal Oak is located 1.5km (0.87nm) to the northwest of the proposed development, marked by a large green buoy. It is a designated war grave of national importance and protected from any disturbance under PoMRA.

Hominids and humans have occupied the UK continental shelf (UKCS) at various times for more than 700,000 years but finds showing this are incredibly rare. Submerged landscapes are where human beings and early hominids previously lived or hunted on terrain which was at that time dry land, or where they exploited fish and shellfish on the coast which is now submerged.

Some 12,000 years ago, at the end of the last Ice Age, relative sea levels around Orkney may have been 30-40m lower than present only reaching current levels approximately 2,000 BC (Dawson & Wickham Jones, 2007; Dawson et al, 2017). There are known submerged paleoenvironmental remains in the shallow margins of Scapa Flow, such as the peats and tree trunks at Widewall Bay, South Ronaldsay (Timpany et al, 2017). It is unlikely that there are any submerged palaeoenvironmental deposits within the proposed development footprint, which is located on / at the edge of the rock platform along the coastal edge, but there may be potential in the muddy sediments that lie below the sand on the seabed 150m out from the shoreline.

Canmore has a number of ship losses listed as generic ‘’In Scapa Flow’ and there is a low possibility that some vessels could be in the development area. A number of wartime aircraft went missing in Scapa Flow and there is a low possibility of finding one within the area, which although not likely, cannot be discounted. Any aircraft would automatically fall under PoMRA. There are still missing torpedoes from U47 and the Luftwaffe attacked ships anchored in Scapa Flow, but there are none recorded in the area of the proposed development.

A Multi-Beam Echo Sounder (MBES) survey was conducted in the area in 2010, from which two anomalies were identified that could be anthropogenic and potentially of high archaeological interest, and were therefore entered into the Canmore database (MBES Contacts 1 and 2). Subsequently, a sidescan sonar (SSS) survey of the area in 2020 identified potentially anthropogenic anomalies, which were dived on (SULA Diving, 2020[13]). Four items of vessel debris were identified (Wreckage sites 1-4).

The marine historic environment assets with known locations are listed in Table 6.1 and shown on Figure 6.1.

Table 6-1: Overview of identified marine historic environment assets

Name	Canmore ID	Description	Date lost	Source	Importance
Wreckage 1	-	Heat exchanger, outer casing badly degraded. Piped very degraded. 4m from Wreckage 2.	Unknown	1	Low-Negligible
Wreckage 2	-	Heat exchanger, outer casing badly degraded. 4m from Wreckage 1.	Unknown	1	Low-Negligible
Wreckage 3	-	Debris that appears to be keel section of a steel vessel, filled with concrete ballast. Likely to relate to Wreckage 4	Unknown	1	Low-Negligible
Wreckage 4	-	Debris that appears to be lower bow section of a steel vessel, filled with concrete ballast. Likely to relate to Wreckage 3	Unknown	1	Low-Negligible
MBES Contact 1	330777	MBES anomaly presenting as oval mound 14.5m by 9.7m by 1.5m high, in 18m water depth. Considered of high archaeological potential.	N/A	2	Unknown
MBES Contact 2	330776	MBES anomaly presenting as oval mound 14.5m by 14m by 1.7m high in 25m water depth. Considered of high archaeological potential.	N/A	2	Unknown
Degaussing range	269584	World War Two degaussing range area.	N/A	2	Moderate

Source: 1 SULA Diving 2020; 2 Canmore

The pieces of wreckage that were identified by diving on the SSS survey contacts have been assessed as being of low-negligible historic value. This is because of their poor condition and cannot be identified as from any particular vessels, even though they are of 20th-century date, and may be the result of historic naval activity in Scapa Flow (SULA Diving, 2020).

The two MBES contacts may not have high potential for being archaeology, because they did not show in the 2020 SSS survey and are not really of the right proportions to be vessels. However, they cannot be discounted.

In World War Two, a deep-water degaussing range was laid near the Tongue of Gangsta, some 1 to 1.5km south of the proposed development (Figure 6.1; National Archives Kew, ADM 116-5790 Fleet Base Scapa Flow 1937-1946). The range was designed to de magnetize ships so they would not set off German magnetic mines. The area would have had a grid of copper cables laid over the seabed

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[13] SULA Diving. (2021). *Investigation of seabed wreckage off the Bay of Deepdale, Scapa Flow, Orkney.* Report for Department of Marine Services, Orkney Islands Council.

which the ship would pass over to be degaussed. This operation was run from the Backakelday degaussing shore station (Canmore 269584). The area of the range is indicated by the Prohibited Anchorage shown on Admiralty chart *Scapa Flow and Approaches (North Sheet) 1944*. It is possible that the copper grid survives below modern sediments, and would represent the remains of what was a significant operation during WW2, contributing to the collection of historic environment resources in Scapa Flow.

6.2.2 Onshore

There are no cultural heritage statutory designations within the proposed development area and apart from two C-listed farmsteads, there are none in the wider study area. There are no known historic environment assets within the onshore footprint of the proposed development. The onshore historic environment assets with known locations are listed in Table 6.2 and shown on Figure 6.1.

The known sites in the study area fall into three broad categories:

- Prehistoric - probably Bronze Age - burials and burnt mounds, which are likely to be of at least moderate importance;
- Post-medieval and 19th-century farmsteads, mostly of low importance, but two of which are C-Listed, and so should be considered of moderate importance; and
- WW2 military sites associated with the protection of the Scapa Flow Naval Base, many of which are considered of moderate importance because of their state of preservation and thus their contribution to the collection of historic environment resources in Orkney that evidence a conflict of international significance.

There is potential for unknown prehistoric remains to be found, reflected by the presence of cist burials and a burnt mound by the Burn of Gangsta (Sites 2375 and 2385), and barrows and a burnt mound north of Rashieburn (Site 2342).

It is likely that settlement remains from the Norse and medieval periods are likely to be at the sites of farmsteads with place names indicative of this, such as West Bu and Netherbutton, with a negligible risk that there are any such unknown remains within the development footprint. It is a similar case for post-medieval farmsteads and wartime remains.

Table 6-2: Overview of identified onshore historic environment assets

Name	Canmore ID	LB #	Type	Description	Period	Importance
RAF Netherbutton	314832		Military Housing	Wardens house for staff at the RAF Netherbutton station. Much altered and still occupied.	WW2	Low
RAF Netherbutton, Chain Home Radar Station	81727		Military Camp	Remains of Netherbutton Radar Station, military camp and anti-aircraft defences situated on both sides of the A961, visible as concrete bases and structures.	WW2	Moderate
Burn Of Button	269283		Engine House	Main generator house for RAF Netherbutton Radar Station. Brick and concrete building c.13m square set within earthern banks to protect from bomb blast.	WW2	Moderate
Rashieburn House and Steading	316861		Farmstead	Farmstead.	Post-medieval	Low
Netherbutton	179645	LB46383	Farmstead	C-Listed farmstead, boundary walls and gate piers.	19th-century	Moderate
Backakelday, Royal Navy Degaussing Range Station	269584		Naval	Royal Navy degaussing station. Personnel accommodated at West Bur farmsteading.	WW2	Moderate
Howa	179642, 256355, 256356, 256357	LB46381	Farmstead	C-Listed farmstead, including components of farmhouse, dwelling, byre, barn and kiln.	19th-century	Moderate
West Bu	182634		Farmstead	Farmstead.	Post-medieval	Low
St Clair Farm	269282		Military Camp	Location of WW2 military camp, remains no longer extant.	WW2	Negligible
Turnpike, Midhouse Battery	292436		Barrage Balloon Site	Barrage balloon site, no longer extant.	WW2	Negligible

Name	Canmore ID	LB #	Type	Description	Period	Importance
Turnpike, Midhouse Battery	296577		Searchlight	Location of searchlight emplacement, no longer extant.	WW2	Negligible
Turnpike, Midhouse Battery	269491		Radar site	Platform for mobile radar unit. Still present	WW2	Low
Turnpike, Midhouse Battery	104559		Anti-aircraft Battery	Remains of the command and control block for Midhouse heavy anti-aircraft battery. Crew accommodation camp, gun-emplacements, light anti-aircraft position and most of associated buildings no longer extant.	WW2	Low
Gutterpool	182635		Farmstead	Courtyard farmstead.	Post-medieval	Low
The Five Hillocks, Rashieburn	2342		Barrows	A group of 8 mounds, one of which is a burnt mound.	Prehistoric (Bronze Age?)	Moderate
Burn Of Gangsta, burnt mound	2375		Burnt mound	Damaged mound of burnt stones and black earth. Typical location beside running water.	Prehistoric (Bronze Age?)	Moderate
Backakelday cists	2385		Burial cists	Two cist burials found, including skeleton and cremation, left in place.	Prehistoric (Bronze Age?)	Moderate

6.3 Potentially Significant Effects (Construction)

6.3.1 Marine

"Construction or infrastructure installation works have the potential for both direct and indirect impacts to historic assets located … on the seabed, either as direct damage to historic features or through seabed disturbance, or secondary effects such as changes to coastal processes and sediment dynamics" (PFOW MSP 2016).

No work will be conducted in (as a legal requirement) or within 50m of the 200m exclusion zone around HMS *Royal Oak*. Therefore, there will be no direct impact on the vessel, and this is scoped out of the EIA.

The proposed development footprint has been finalised and avoidance of all identified marine heritage assets has been embedded in the project design. Therefore, direct impacts on these can be scoped out of an EIA. There will be a small amount of dredging and seabed or bedrock clearance down to -20m CD for the pier footprint and berthing pockets in order to provide the deep water facility (see Figure 6.1) and the north end of this activity will be close to MBES Contact 1. Avoidance is the primary mitigation, however if this cannot be guaranteed because of the close proximity, then inclusion of this specific impact in an EIA may be required.

Although MBES and SSS surveys have been conducted over the area, reducing the likelihood of potential impacts, there is still the potential for significant impact on debris that was not identified by reviews of those surveys. Such debris could include wartime remains, like aircraft engines and UXO. This potential impact should be included in an EIA.

A magnetometer survey of the area (conducted at specifications for archaeological review, as in Plets et al 2013) and dropcam or diver inspection of any anomalies identified assessing the nature and significance of these anomalies, would complement the results of the MBES and SSS surveys and act as a final check against any significant seabed impact on unknown maritime heritage assets, as well as identifying if MBES Contact 1 is of archaeological interest and requires avoidance.

If this mitigation strategy is agreed prior to the EIA process then there would be no requirement to include impacts on unknown marine assets in that process, because the necessary mitigations to reduce/eliminate impacts would already be in place. This management of the risk is likely to be part of planning consent conditions.

Table 6-3: Potential impacts and mitigations for marine historic environment receptors

Impact	Description	Potential Significance (prior to mitigation)	Scoping	Mitigation

Geotechnical coring for construction engineering	Seabed disturbance resulting in loss or damage of submerged prehistoric deposits	Not Significant	Out	Geotechnical coring will be within the development footprint, which is on the rock platform along the coastal edge, and therefore will not impact deposits of paleoenvironmental interest.
Dredging / seabed clearance for construction	Seabed disturbance resulting in loss or damage to unknown heritage assets on the seabed	Significant	In (Unless mitigation agreed prior to EIA)	Magnetometer survey in the vicinity of the development footprint to complement the results of the MBES and SSS surveys.
Dredging / seabed clearance for construction	Seabed disturbance resulting in loss or damage to known heritage assets on the seabed. MBES Contact 1 is very close to the area for dredging/clearance	Potentially Significant	In (For MBES Contact 1, unless mitigation agreed prior to EIA)	Avoidance. There are no known heritage assets on the seabed within the construction and dredging footprint. Potential for impact on MBES Contact 1 could be addressed by magnetometer survey to investigate if it is of heritage value.
Deposition of dredged material	Compression of heritage assets on the seabed	Not Significant	Out	Dredged material will be used for infill of laydown area onshore. Material not suitable for this will be disposed of to a licensed disposal ground which will not have any archaeological assets present.
Deepened access channels out with development footprint	Seabed disturbance resulting in loss or damage to heritage assets on the seabed	Not Significant	Out	There will be no requirement to lower the seabed out with the construction footprint and berthing pocket.
Construction vessel anchoring	Seabed disturbance resulting in loss or damage to heritage assets on the seabed	Not Significant	Out	There will be no construction vessel anchoring.

6.3.2 Onshore

“Construction or infrastructure installation works have the potential for both direct and indirect impacts to historic assets located in coastal areas… either as direct damage to historic features or through …. secondary effects” (PFOW MSP 2016).

No known historic assets lie within the footprint of the onshore development as shown on Figure 6.1, and if the footprint (assumed to include laydown areas and constructions areas) is not changed then no known heritage assets will be directly impacted onshore, and can be scoped out of the EIA, as avoidance of any known onshore heritage assets (especially the assets beside the main road and new access road) is part of the embedded project design.

Table 6-4: Potential impacts and mitigations for onshore historic environment receptors

Impact	Description	Potential Significance (prior to mitigation)	Scoping	Mitigation
Ground excavation and clearance for construction footprint	Ground-breaking disturbance resulting in loss or damage to unknown heritage assets	Significant	In (Unless mitigation agreed prior to EIA)	Walkover survey, Intrusive evaluation, Watching brief.
Ground excavation and clearance for construction footprint	Ground-breaking disturbance resulting in loss or damage to known heritage assets	Not Significant	Out	There are no known heritage assets within the onshore development footprint.
Deposition of excavated material from construction	Disturbance resulting in loss or damage to known and unknown heritage assets	Not Significant	Out	No material will be deposited out with development footprint. If unsuitable for deposition here, it will be taken to a licensed disposal facility.

There is potential for significant effects on unknown prehistoric heritage assets, which should be scoped in to an EIA, and a negligible likelihood for any impacts on unknown medieval, post-medieval and modern assets, which are scoped out. Mitigation strategies prior to and during construction could reduce or eliminate such effects. Such strategies would include a walkover survey as part of the EIA in order to identify if any remains are visible, intrusive archaeological evaluations prior to construction and an archaeological watching brief during construction could reduce or eliminate such effects. If such strategies are agreed prior to the EIA process then there would be no requirement to include impacts on unknown prehistoric heritage assets in an EIA process, because the necessary mitigations to reduce/eliminate impacts would already be in place. Management of the risk is likely to be part of planning consent conditions.

6.4 Potentially Significant Effects (Operation)

“Inappropriate development has the potential to affect the setting of historic assets located in both coastal and marine areas” (PFOW MSP 2016).

There are potentially significant direct and indirect effects of the proposed development on both marine and onshore heritage assets during the operation of the proposed development. A worst-case scenario has been assumed, summarised in Table 6.5.

Scouring of seabed deposits by propellor wash from large vessels has the potential to impact heritage assets on the seabed. A magnetometer survey of the area (conducted at specifications for archaeological review, as in Plets et al 2013) and dropcam or diver inspection of any anomalies identified assessing the nature and significance of these anomalies, would complement the results of the MBES and SSS surveys and act as a check against significant seabed impact on unknown maritime heritage assets. Guidelines for vessels on approach, manoeuvring and departure, and regular monitoring of and reporting on the relevant area of seabed during operation of the facility would further mitigate any impact. Regular monitoring by SSS is likely to be a standard part of the operating procedures in order to ensure the approach is kept free of debris.

If this mitigation strategy is agreed prior to the EIA process then there would be no requirement to include impacts on unknown marine assets in that process, because the necessary mitigations to reduce/eliminate impacts would already be in place. This management of the risk is likely to be part of planning consent conditions.

Table 6-5: Potential impacts and mitigations for historic environment receptors

Impact	Description	Potential Impact (prior to mitigation)	Scoping	Mitigation
Scouring of seabed from propellor wash	Scouring of seabed deposits to expose and damage heritage assets and submerged prehistoric deposits	Significant	In (Unless mitigation agreed prior to EIA)	Guidelines for vessels on approach, manoeuvring and departure. Magnetometer survey of the approach, followed by regular monitoring and reporting.
Anchoring of maintenance and inspection vessels out with development footprint	Seabed disturbance resulting in loss or damage to heritage assets on the seabed	Not Significant	Out	There will be no anchorage out with the berth pockets or in designated anchorage areas.
Effect of the built installation on the setting of heritage assets	Size and visibility of the development, including night-time visibility, may affect the understanding, appreciation and experience of a historic asset, and thus a historic asset's cultural significance.	Significant	In	To be determined

Effect of accessing the built installation on the setting of heritage assets	Size, frequency and visibility, including night-time visibility, of the visiting vessels may affect the understanding, appreciation and experience of a historic asset, and thus a historic asset's cultural significance.	Significant	In	To be determined
Cumulative effect	Possible Scapa Pier development potentially adding to effects identified.	Significant	In	To be determined

The creation of a large brightly-lit quay projecting into Scapa Flow could have a significant effect on the setting of heritage assets, as could the use of the facility by large vessels. Effects that should be included in an assessment include those on the maritime approach to Scapa Bay where Kirkwall Cathedral has acted as a dominant seamark, the visibility of the marker for HMS *Royal Oak*, especially from viewpoints such as the Royal Oak Remembrance Garden and Memorial at Scapa, as well as the listed buildings in the study area.

There is the potential for a significant cumulative effect on heritage assets, especially on marine receptors, and on the setting of assets from the proposed development at Scapa Pier, and will be included in an EIA.

6.5 Assessment Methodology

On the basis of the potentially significant impacts identified, it is proposed that an EIA of the proposed development is undertaken. For potential impacts scoped in, the assessment will be conducted based on analysis of existing desk-based sources, field survey data that already exists for the vicinity (SULA Diving 2020) and any new data collected specifically for the project, such as seabed magnetometry at suitable specifications for archaeological review (Plets et al 2013), dropcam images, and walkover survey. Suitable visualisations for the assessment of effects on setting should also be created. This will provide the basis for a robust EIA, and for the statutory authorities to be satisfied that they are making an informed decision

The importance of marine and onshore historic environment receptors would be evaluated to inform the assessment. The level of importance assigned depends on a number of factors, including intrinsic, contextual and associative characteristics (HES Designation Policy and Selection Guidance 2019 and Annexes) and general guidelines used by statutory authorities and agencies such as the Scottish Government and HES. These are:

- Historic Environment Scotland Designation Policy and Selection Guidance 2019;
- English Heritage. (2012). Ships and Boats: Prehistory to Present. Designation Selection Guide. Swindon: English Heritage; and
- Wessex Archaeology. (2011). Assessing Boats and Ships 1860-1913, 1914-1938, 1939-1950. Archaeological Desk-Based Assessment in 3 volumes. Salisbury: Wessex Archaeology.

Where avoidance of impact cannot be embedded in the project design, assessment of the significance of direct impact will be made in the EIA, based on standard guidance (CIfA 2014 and as revised[14]; HES 2016[15]; HES & SNH 2018[16]). The preparation of marine and onshore heritage Written Schemes of Investigation and Protocols for Accidental Discoveries could be produced as part of the EIA to avoid or mitigate accidental impacts and manage any accidental discoveries of archaeological interest. These would be based on standard professional guidelines. An evidence-based approach will be used to design suitable mitigation strategies in consultation with MS-LOT, HES, OICHA and OIC.

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[14] CIfA. (2014). *Standard and guidance for historic environment desk-based assessment*. Reading: Chartered Institute for Archaeologists.

[15] HES. (2016). *Managing Change in the Historic Environment: Setting*. Edinburgh:HES

[16] HES & SNH. (2018). *Environmental Impact Assessment Handbook: Guidance for competent authorities, consultation bodies, and others involved in the Environmental Impact Assessment process in Scotland*. v5. Edinburgh:HES; Inverness: SNH [now naturescot].

7 SEASCAPE/LANDSCAPE AND VISUAL

7.1 Introduction

This section addresses the potential significant adverse effects of the proposed development on the seascape, landscape, and visual resources of the site and surrounding area. Landscape and visual resources are defined respectively within paragraph 3.21 of the Guidelines for Landscape and Visual Impact Assessment (GLVIA) [17] as:

"*…the constituent elements of the landscape, its specific aesthetic or perceptual qualities and the character of the landscape"* and *"…the people who will be affected by changes in views or visual amenity at different places*".

Considering the coastal location of the site, the coastal (or seascape) character is also an important factor to consider. As defined by NatureScot[18] (formerly SNH), coastal character is made up of physical characteristics of the hinterland, coastline and sea, as well as visual aspects and perceptions.

To help determine the need for, and to ascertain the potential scope of a Seascape/Landscape and Visual Impact Assessment (SLVIA) as part of an EIA, an appraisal has been undertaken, informed by a site visit, to identify the following:

- The landscape/coastal character of the site and surrounding area;
- The coverage of any landscape designations across the site and surrounding area;
- Important views and viewpoints towards the site from the surrounding landscape/seascape;
- Any potentially significant landscape/coastal and visual effects during construction and post-completion; and
- Recommendations for mitigating any potentially significant adverse effects.

7.2 Baseline Conditions

The purpose of this baseline assessment is to identify the existing landscape, coastal and visual resource of the site and surrounding area, against which any potential significant effects of the proposed development would be predicted. Although significant effects are unlikely to be experienced beyond 5 km from the site, the assessment of the following receptors have been identified within an indicative study area of 15 km:

- The site and its setting;
- Landscape character;
- Coastal character;
- Landscape designations; and
- Key views and visual receptors.

7.2.1 The Site and Its Setting

The site is situated on the coastline of the Bay of Deepdale, approximately 8km to the south of Kirkwall at its closest point. It is accessed via a rough farm track that leads in a south-westerly direction over

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[17] Landscape Institute and the Institute of Environmental Management and Assessment (2013). *The Guidelines for Landscape and Visual Impact Assessment, version 3.*

[18] Scottish Natural Heritage (2017). *Guidance Note: on Coastal Character Assessment.*

several fields of open pasture from the nearby A961. The site occupies an undeveloped section of exposed coastline that comprises mostly gravel beach and exposed rock that overall, exhibits a strong semi-natural coastal character. The Burn of Deepdale drains into the bay immediately to the north of the site and a nearby small rocky promontory forms a degree of localised containment to the south. The surrounding landscape to the north, east and south has a prevailing open rural character with a pattern of scattered farmsteads and dwellings. To the west, the isles of Flotta and Hoy provide a relatively distant backdrop to the expanse of Scapa Flow.

7.2.2 Landscape *Character*

As detailed in the Landscape Character Assessment[19] (LCA), the site of the proposed development is located within the *Inclined Coastal Pasture* Landscape Character Type (LCT). This LCT consists of gently sloping agricultural land falling to the coast, and includes bay coastlines which lack the topographic enclosure of the *Enclosed Bays* LCT. They occur as long coastal strips on Orkney Mainland, Hoy, South Ronaldsay, Rousay, and Eday, and in smaller tracts on Burray and Stronsay. Its key characteristics are:

- Gentle slopes falling to the coast which include unenclosed bay coastlines;
- A mix of improved and rough pastures with a variety of semi-natural habitats including small amounts of tree and shrub cover;
- Rectilinear field patterns often with strong orientation to coastline;
- Mixture of small-scale clusters of resettled crofts and less developed geometric landscape of estate farms;
- Occasional large houses and farms with tree frameworks;
- Roads running parallel to coast, usually inland, giving access to the coastal fringe and higher pastures;
- Rich coastal archaeology, particularly evident at the coast;
- Restricted views inland dominated by an open, sometimes hilly skyline; and
- Extensive views out to sea over fields which appear to merge with the sea.

7.2.3 Coastal Character

As detailed in the *Orkney and North Caithness Coastal Character Assessment*[20]*,* the site of the proposed development is located within the *Hemp Stack to Bay of Deepdale* coastal character area (CCA) and is described as follows:

Location and extent: This coast extends from Hemp Stack in the north-west to the Bay of Deepdale in the south-east;

Maritime influence: The influence of Scapa Flow and its maritime character including changeable light conditions, tidal movements, and boat traffic especially oil tankers is strongest from along the cliff edge. The War Grave of HMS Royal Oak is visible marked by buoy. The simple, narrow, coastal edge comprises cliff face, some rock and shingle, and breaking waves. A characteristic ‘crimped’ effect is clearly visible along the cliff line with localised indentations, points, ravines, stacks, and waterfalls.

Character of coastal edge: This exposed stretch of isolated coastline is characterised by relatively high, rugged cliffs overlooking an animated expanse of flow which is seldom calm. The high cliff edge itself experiences a sense of exposure and close proximity to the dynamic sea, enhanced by onshore winds, with open views along the coastline to the north and south and across Scapa Flow to distant,

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[19] Scottish Natural Heritage (2018). *National programme of Landscape Character Assessment* (LCT 302).
[20] Scottish Natural Heritage (2016). *Orkney and North Caithness Coastal Character Assessment.*

silhouetted landmasses including Hoy, Fara, Cava, Flotta, Burray and South Ronaldsay. Views through the Sound of Hoxa to 'open sea' are also obtained.

Character of immediate hinterland: Elevated, hinterland falls to the west over steep, convex slopes interrupting views of the coastline and creating a sense of shelter and distance from the sea, i.e. a limited opportunity to easily experience the smells and sounds of the sea. Pasture and arable land, rough grassland, and dark heath flank the cliff tops and extend east over plateau towards the A961. The simple, open landscape character of hinterland results in vertical elements such as telegraph poles and fence lines appearing prominent. Access to the coast is limited to boat or remote cliff top footpaths.

Extent of human influence: Settlement is sparse and largely outwith the immediate exposed hinterland, along the A961 to the east with isolated farmsteads on exposed plateau.

Views: Views from the A961 are substantially interrupted by convex slopes and the nature of the ridgeline landscape.

7.2.4 Landscape Designations

There are 40 National Scenic Areas (NSAs) in Scotland, with their outstanding scenery, represent Scotland's finest landscapes. The Planning etc. (Scotland) Act 2006 gives a statutory basis to NSAs and describes them as an area "*of outstanding scenic value in a national context*." The purpose of the NSA designation is both to identify our finest scenery and to ensure it is protected from inappropriate development.

There are no landscape designations in close proximity to the site although the *Hoy and West Mainland* NSA is located approximately 11 km to the west.

Hoy and West Mainland NSA Special Qualities

As described by NatureScot (formerly SNH)[21], the NSA exhibits the following Special Qualities:

- A palimpsest of geology, topography, archaeology and land use;
- An archaeological landscape of World Heritage Status;
- The spectacular coastal scenery;
- Sandstone and flagstone as an essence of Orkney;
- A long-settled and productive land and sea;
- The contrast between the fertile farmland and the unimproved moorland;
- A landscape of contrasting curves and lines;
- Land and water in constantly changing combinations under the open sky;
- The high hills of Hoy;
- The townscape of Stromness, its setting and its link with the sea; and
- The traditional buildings and crofting patterns of Rackwick.

7.2.5 Key Views and Visual Receptors

Important views from the site are focused across Scapa Flow to distant, silhouetted landmasses including Hoy, Fara, Cava, Flotta, Burray and South Ronaldsay.

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[21] Scottish Natural Heritage (2010). *The Special Qualities of the National Scenic Areas.*

Nearby visual receptors are largely restricted to agricultural workers, residents of several nearby scattered dwellings, occasional recreational users (coastal and inland) and road users along the A967. From the sea, boat users would also experience views towards the site.

7.3 Potentially Significant Effects (Construction)

In the locality, the construction of the proposed development would be very noticeable and effects would primarily result from activity associated with piling, ground excavations and the construction of laydown areas and piers. This is likely to include views of a crane, construction infrastructure, storage of materials, with noise, activity and movement of large vehicles. As such, the construction phase is likely to significantly affect the views of some nearby residents, road users and recreational users.

In considering the undeveloped and prevailing semi-natural character of the coastal edge and open rural character of the hinterland, construction activity would also notably detract from many of the landscape and coastal characteristics and consequently, effects on coastal character are also very likely to be significant.

7.4 Potentially Significant Effects (Operation)

In considering the preceding assessment of Baseline Conditions, this section identifies any potential significant effects predicted during the operational phase.

7.4.1 Landscape and Coastal Character

Once operational, the proposed development would result in an increase in vessel activity across parts of Scapa Flow with the laydown areas used for storage with associated noise, activity and movement of large vehicles. Although boat traffic and oil tankers are characteristic to Scapa Flow, the following effects are likely to be significant:

- Development would compromise the simple, narrow, coastal edge and notably contrast with its undeveloped and semi-natural appearance;
- Development would interrupt the pattern of the characteristic ‘crimped’ effect that is clearly visible along the cliff line with localised indentations, points, ravines, stacks, and waterfalls; and
- Development would contrast with the prevailing open rural hinterland and its sparsely settled nature.

7.4.2 Landscape Designations

Considering the relatively long distance from the site to the NSA, it is unlikely that any significant effects on NSA Special Qualities would be experienced.

7.4.3 Visual Receptors

Although no detailed analysis of the zone of theoretical visibility has been undertaken at this stage, it is evident that apart from relatively long views across open sea, landward views to and from the site are relatively localised due to the convex nature of the intervening sloping landform.

However, from several nearby dwellings, a short section of the A961 and some nearby accessible coastal areas, the proposed development would appear quite prominent, especially from the sea. In the locality therefore, it would create a major visual focus, tend to affect a large proportion of the view with uncharacteristic elements or pattern introduced. Although parts of the proposed development are likely to be screened from the A961, some significant visual effects are likely to be experienced in the local area.

7.5 Design and Mitigation

Where any significant landscape, coastal and visual effects are identified as part of the SLVIA process, recommendations for mitigation which could be implemented in order to avoid, reduce or remedy adverse effects will be identified. As part of this, some design aims will be suggested to help ensure that as far as possible, the proposed development minimises its impact and integrates positively with its sensitive coastal setting.

7.6 Inclusion or Exclusion from EIA

Based on the findings of this appraisal and the associated likely potential for some significant effects during construction and post-completion, it is recommended that a full Seascape, Landscape and Visual Impact Assessment (SLVIA) is undertaken as part of an EIA.

7.7 Assessment Methodology

To be undertaken by a Chartered Member of Landscape Institute, the approach to the SLVIA will follow the *Guidelines for Landscape and Visual Impact Assessment* (GLVIA)[22] and other current best practice guidance where relevant.

Foremost, the SLVIA aims to identify, predict and evaluate any likely significant effects during the construction and operational phases of the proposed development, on the landscape, seascape and visual resources of the site, its setting and the wider study area. Where any significant adverse effects are identified, mitigation measures are considered, and where possible, embedded within the design of the proposed development.

As an overview, the objectives of the SLVIA are to:

- provide a summary description of the scoping and consultation responses relating to landscape, coastal and visual issues;
- describe the assessment methodology and significance criteria used to inform the assessment process;
- identify the main landscape-related policy, legislation and guidance;
- identify and assess the landscape, coastal and visual baseline conditions;
- identify and evaluate the potential landscape, coastal and visual effects, including direct, indirect and cumulative, based on the worst-case parameters as currently known;
- identify broad design principles for subsequent project development and other mitigation measures that may be appropriate to address likely residual significant effects; and
- evaluate any residual effects remaining, following the implementation of any further mitigation measures suggested.

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[22] Landscape Institute and the Institute of Environmental Management and Assessment (2013). *The Guidelines for Landscape and Visual Impact Assessment, version 3.*

8 AIRBORNE NOISE

8.1 Introduction

The noise assessment will consider the potential for noise generated by the development to impact existing residential receptors during the construction and operational phases. The effects of construction noise on marine life shall be considered as part of the ecological scope of works as discussed in Section 5.5.3.

8.2 Baseline Conditions

The site of the proposed SDWQ is located in a rural location overlooking the shipping channels of Scapa Flow approximately 4km south of Scapa Pier. The noise environment at the site is considered to be characterised by natural sounds (i.e. waves, wind, birds) punctuated with man-made sound from mainly shipping movements and potentially distant road traffic noise from the A961.

The closest residential receptors to the proposed SDWQ are a pair of guesthouses located approximately 650m to the east of the proposed development and approximately 350m to the south of the proposed access road, with partial line of sight to the quay and laydown area, and full line of sight to the new access road. Also noted is a collection of farmhouses approximately 1km to the south-east with partial line of sight to the quay, laydown area and access road. There are several residential receptors approximately 1km – 1.3km to the east, adjacent to the A961, with line of sight of the new access road. Some of these properties may also have partial line of sight to the quay and laydown area.

8.3 Potentially Significant Effects (Construction)

The noise from certain construction activities has the potential to impact existing noise sensitive receptors. Construction activities are temporary in nature, with the degree of impact during each phasing stage depending upon;

- The nature of construction activities being carried out; this includes the type and size of machinery / plant involved, combinations of activities occurring simultaneously and HGV routes in and around the site;
- Location of construction activities relative to the closest noise sensitive receptors;
- Duration of proposed activities;
- Construction site operating times; and
- Extent of noise mitigation measures in place.

Noise generating activities during the construction phase are understood to include;

- Construction of new access road;
- Excavation of current landform and reclamation of shore to form laydown area;
- Formation of bunds around eastern, and parts of the north and southern perimeters of proposed laydown area using reclaimed materials;
- Dredging of area around proposed quay;
- Piling of structure for quay wall;
- Infilling of material to form reclaimed land;
- Delivery and tipping of materials; and
- HGV and plant movements in and around the site.

The majority of construction works are anticipated to be carried out between the hours of 07:00 to 19:00hrs Monday to Friday and 07:00 to 13:00hrs on Saturdays. Construction activities scheduled to occur outside of these periods have a greater potential to impact on residential receptors due them occurring during more sensitive periods, and when background noise levels are lower.

8.4 Potentially Significant Effects (Operation)

During the operational phase, new proposed noise generating activities have the potential to increase the day and night-time existing baseline noise levels at surrounding noise sensitive receptors. Due to their proximity to the Bay of Deepdale, noise sensitive receptors at the guesthouses to the east and the farmhouses to the south have the greatest potential for an increase in current noise levels due to operational activities at the quay and laydown area. It is noted that the existing topography and proposed bunds surrounding the laydown area are likely to break the line of sight at these properties and mitigate any increase in noise levels.

The majority of marine assets and supplies will be brought to and from the site primarily by sea, with HGVs being used to move materials overland occasionally as required. As the majority of loading / unloading activities will occur during the daytime, night-time movements are not considered to be likely. The majority of traffic accessing the site via the A961 and new access road will be site workers, including those involved in offshore wind farm assembly, predominantly during the daytime hours. Road traffic noise, including increase in road traffic associated with the operational phase is therefore not considered likely to be significant.

Noise generating activities which shall be carried out during the operational phase include;

- Deep-water ship berthing and mooring;
- Ship loading / unloading activities; including operation of cranes;
- Movement of materials between ships and laydown area;
- Construction / assembly and maintenance of offshore wind turbines;
- Plant and HGV movements within quay and laydown area; and
- Loading / unloading of HGVs.

Should the storage and supply hub for future marine fuels be constructed on the site, additional consideration would be required for associated operations, including additional LGV/HGV movements and industrial plant.

8.5 Inclusion or Exclusion from EIA

An operational noise assessment shall be carried out as part of the EIA.

As mentioned in Section 2.2.4, it is intended that the contract for construction of the facility will be awarded as a design and build. Therefore until the preferred Contractor is identified the exact construction methodologies cannot be confirmed at this stage in the development process. The construction noise assessment will be deferred until this point when information on assumed schedules and associated plant shall be used in the assessment, informed by discussions with the lead Contractor. A construction phase noise assessment would inform the proposed CEMP for the Works and would be agreed with OIC and MSLOT prior to commencement.

The baseline data collected as part of the operational assessment shall also be used to inform the construction noise assessment (post planning consent).

8.6 Assessment Methodology

8.6.1 Baseline Noise Monitoring

It is proposed to carry out existing baseline noise monitoring, the results of which shall be used alongside calculated predicted levels in the assessment of construction and operational activities.

The existing baseline noise monitoring shall comprise of the following stages;

- Measurement of existing baseline environment at a sample of 2 or 3 areas considered to be representative of the most exposed noise sensitive receptors surrounding the site. The location of the proposed monitoring locations will be confirmed through consultation with OIC;
- The monitoring shall be carried out during week days and nights, and repeated at each position on more than one date; and
- The monitoring is likely to incorporate a mixture of attended and unattended monitoring, allowing subjective observations to be noted at each position and considered period.

8.6.2 Operational Noise

Operational noise shall be predicted and assessed at the most exposed residential receptors following guidance provided in the Scottish Government Publication *TAN 2011: Technical Advice Note: Assessment of Noise*, and *BS4142:2014+A1:2019 Methods for Rating and Assessing Industrial and Commercial Sound*.

Baseline noise surveys pre-construction shall be carried out to determine the existing noise climate (Refer to Section 8.6.1).

It is recognised that operational activities are likely to vary considerably from day to day; therefore a reasonable worst-case scenario of concurrent noise generating operational activities will be used. Predicted increases in levels above baseline shall be assessed in order to determine the significance of effects. The results of the assessment can be used to inform operational noise mitigation measures to be employed at the site and if required, to inform the heights of the proposed bunds surrounding the laydown area.

The operational noise assessment shall comprise of the following stages;

- Review of proposed operational activities, locations and noise data;
- Prediction of operational noise from proposed development using CadnaA 3D noise modelling software at the location of the most exposed sensitive receptors;
- Carry out an assessment of change in noise levels as a result of site operations, in accordance with the TAN associated with PAN 1/2011 (using principles defined in BS4142), comparing existing operations (before) to existing and proposed operations (after); and
- If required, make recommendations on mitigation measures to reduce any operational noise impact at existing residential receptors and to inform operational noise management plan.

9 CONCLUSIONS

The conclusions of the detailed scoping appraisals identified that the topic areas listed below are considered to merit a full impact assessment and thereby documented within an EIAR.

- Airborne Noise (Operational phase only);
- Archaeology and Cultural Heritage (The impacts on heritage assets for both phases and potential for cumulative effects with Scapa Pier development);
- Ecology (Marine mammals and their prey during the construction phase only);
- Seascape, Landscape and Visual (both phases); and
- Water Environment and Coastal Processes (Qualitative assessment for coastal processes and water quality for both phases).

In addition to the above, a Habitats Regulations Appraisal (HRA) will be undertaken to assess any potential LSE on the qualifying species of the North Orkney pSPA and the Scapa Flow pSPA.

On the basis of professional judgement and the findings of the scoping appraisal, full EIA's are not considered necessary for the following topics, however supporting statements and information will be provided for each topic within the introductory chapters of the EIAR:

- Accidents and Natural Disasters (both phases);
- Airborne Noise (Construction phase deferred until later in the development process);
- Air Quality (both phases);
- Climate Change (both phases);
- Ecology (Both phases apart from the risk associated with marine mammals and their prey during the construction phase);
- Population and Human Health (both phases); and
- Water Environment and Coastal Processes (Flood risk for both phases).

The Highland Council Guidance Note – Construction Environmental Management Process for Large Scale Projects[23] sets out a robust Environmental Management Process that incorporates the findings of the ES as well as other requirements from consents, licenses, legislation and best practise. It is proposed that a Construction Environmental Management Document and Plans (CEMD and CEMPs) be developed in accordance with this Guidance Note so as to provide site specific practical mitigation measures to ensure that during the construction phase the environment is protected. The CEMD and associated CEMP's would be a working document which would be updated throughout the construction phase of the project. It would also provide a clear roadmap of the key roles and responsibilities during construction works. An Environmental Manager would be identified who would be responsible for the implementation of the CEMD and associated CEMPs, ensuring that all agreed measures are applied and adhered to.

Note: The CEMD and associated CEMPs would be finalised on receipt of Planning / Marine Consent and would aid discharge of planning/marine license conditions. It would also form part of the tender documents during the contracting phase of the development.

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[23] The Highland Council Guidance Note – Construction Environmental Management Process for Large Scale Projects, dated August 2010.

APPENDICES

A DRAWINGS

TECHNICAL APPENDIX 3.2

The Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017.

Scoping Opinion.

Application reference:	21/160/SCO
Complete application received:	16 April 2021
Consultation expiry:	14 May 2021
Expiry date:	21 May 2021
Development description:	Scoping opinion request to excavate hillside and reclaim land to create a laydown area, construct a deep water pier and an access road
Location of development:	Bay of Deepdale, Scapa Flow, Orkney
Applicant:	Orkney Islands Council (Marine Services).
Agent:	EnviroCentre Ltd

1. Introduction

Under the provisions of Regulation 17 of The Town and Country Planning (Environmental Impacts Assessment) (Scotland) Regulations 2017 (‘The Regulations’), this Scoping Opinion has been adopted by Orkney Islands Council, as planning authority.

2. The Scoping Opinion

Orkney Island Council adopts this Scoping Opinion having taken into account the information provided by the Applicant in the request dated 31 March 2021 in respect of the specific characteristics of the proposed development and representations received in response to the consultation undertaken.

Orkney Island Council considers that sufficient information has been submitted in order for a scoping opinion to be issued to meet the requirements of Regulation 17(2) of the EIA Regulations. That is, a request must include:

(a) a description of the location of the development, including a plan sufficient to identify the land;
(b) a brief description of the nature and purpose of the development and of its likely significant effects on the environment; and

(c) such other information or representations as the developer may wish to provide or make.

The proposed development is considered to be Schedule 1 (Paragraph 8 (2)) development under the Regulations.

This Scoping Opinion sets out the information that Orkney Islands Council considers should be included in the EIA and EIA Report for the proposed development. In formulating this Scoping Opinion, Orkney Islands Council has taken account of the requirements of the EIA Regulations 2017, the nature and scale of the proposed development, the nature of the receiving environment, current best practice in the preparation of EIA Reports, and the views expressed by the organisations and bodies that responded to the consultation.

This Scoping Opinion is based on information contained in the Applicant's written request for a Scoping Opinion and information available at today's date. The adoption of this Scoping Opinion by Orkney Islands Council does not preclude Orkney Islands Council from requiring of the Applicant information in connection with any Environmental Impact Assessment (EIA) Report submitted in connection with its application for planning permission for the development. This Scoping Opinion will not prevent Orkney Islands Council from seeking additional information at the application stage.

3. Consultation on proposed scope of the EIA

Orkney Islands Council has a duty under Regulation 17(4) of the EIA Regulations 2017 to consult before adopting a Scoping Opinion. The below listed bodies were all consulted, as either statutory consultation bodies or other bodies which Orkney Islands Council considers likely to have an interest in the proposed development by reason of their specific environmental responsibilities or local and regional competencies.

- Historic Environment Scotland
- NatureScot (Scottish Natural Heritage)
- Scottish Environment Protection Agency (SEPA)
- Scottish Water
- Marine Scotland
- Orkney Trout Fishing Association
- Orkney Fisheries Association
- Airfield Superintendent
- Highlands and Islands Airports Ltd
- Kirkwall Airport- Senior Pilot
- Engineering Services
- Development and Marine Planning
- Marine Services

- RYA Scotland
- Roads Services
- The Royal Society for the Protection of Birds (RSPB)
- Environmental Health
- Orkney Archaeologist
- Northern Lighthouse Board

The full list of consultation responses received is attached to this Scoping Opinion as Appendix 1. Each should be read in full for detailed requirements from individual consultees and for comprehensive guidance, advice and, where appropriate, templates for preparation of the EIA Report.

Unless stated to the contrary in this Scoping Opinion, Orkney Islands Council expects the EIA Report to include all matters raised by the consultees.

4. Procedure

4.1. Consideration of alternatives

4.1.1.

Schedule 4, paragraph 2 of the Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017 requires that all EIAs should include information on the main alternatives studied and an indication of the main reasons for choosing the selected option, with reference to the environmental effects. The EIA Report should therefore contain details of considered alternative approaches and why the proposed development was selected, focussing on the specific extent, direction and phasing proposed, reasons for discounting other sites. This will be particularly important to help address cumulative impact.

4.1.2.

NatureScot advises that the EIA Report should include an assessment of alternative locations or layout to the proposed development (see Appendix 1).

4.2. Schedule 4 – Information for inclusion in an EIA Report

As stated in Schedule 4 of The Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017 and confirmed in Planning Circular 1/2017: Environmental Impact Assessment regulations, the EIA report must include the following information.

1.

A description of the development, including in particular:

(a) Description of the location of the development.

(b) Description of the physical characteristics of the whole development, including, where relevant, requisite demolition works, and the land-use requirements during the construction and operational phases.

(c) Description of the main characteristics of the operational phase of the development (in particular any production process), for instance, energy demand and energy used, nature and quantity of the materials and natural resources (including water, land, soil and biodiversity) used.

(d) An estimate, by type and quantity, of expected residues and emissions (such as water, air, soil and subsoil pollution, noise, vibration, light, heat, radiation and quantities and types of waste produced during the construction and operation phases.

2.

A description of the reasonable alternatives (for example in terms of development design, technology, location, size and scale) studied by the developer, which are relevant to the proposed project and its specific characteristics, and an indication of the main reasons for selecting the chosen option, including a comparison of the environmental effects.

3.

A description of the relevant aspects of the current state of the environment (baseline scenario) and an outline of the likely evolution thereof without implementation of the development as far as natural changes from the baseline scenario can be assessed with reasonable effort on the basis of the availability of environmental information and scientific knowledge.

4.

A description of the factors specified in Regulation 4(3) likely to be significantly affected by the development: population, human health, biodiversity (for example fauna and flora), land (for example land take), soil (for example organic matter, erosion, compaction, sealing), water (for example hydromorphological changes, quantity and quality), air, climate (for example greenhouse gas emissions, impacts relevant to adaptation), material assets, cultural heritage, including architectural and archaeological aspects, and landscape.

5.

A description of the likely significant effects of the development on the environment resulting from, inter alia:

(a) the construction and existence of the development, including, where relevant, demolition works;

(b) the use of natural resources, in particular land, soil, water and biodiversity, considering as far as possible the sustainable availability of these resources;

(c) the emission of pollutants, noise, vibration, light, heat and radiation, the creation of nuisances, and the disposal and recovery of waste;

(d) the risks to human health, cultural heritage or the environment (for example due to accidents or disasters);

(e) the cumulation of effects with other existing and/or approved projects, taking into account any existing environmental problems relating to areas of particular environmental importance likely to be affected or the use of natural resources;

(f) the impact of the project on climate (for example the nature and magnitude of greenhouse gas emissions) and the vulnerability of the project to climate change;

(g) the technologies and the substances used.

The description of the likely significant effects on the factors specified in Regulation 4(3) should cover the direct effects and any indirect, secondary, cumulative, transboundary, short-term, medium- term and long-term, permanent and temporary, positive and negative effects of the development. This description should take into account the environmental protection objectives established at Union or Member State level which are relevant to the project [including in particular those established under Council Directive 92/43/ EEC3 and Directive 2009/147/ EC].

6.

A description of the forecasting methods or evidence, used to identify and assess the significant effects on the environment, including details of difficulties (for example technical deficiencies or lack of knowledge) encountered compiling the required information and the main uncertainties involved.

7.

A description of the measures envisaged to avoid, prevent, reduce or, if possible, offset any identified significant adverse effects on the environment and, where appropriate, of any proposed monitoring arrangements (for example the preparation of a post-project analysis). That description should explain the extent, to which significant adverse effects on the environment are avoided, prevented, reduced or offset, and should cover both the construction and operational phases.

8.

A description of the expected significant adverse effects of the development on the environment deriving from the vulnerability of the development to risks of major accidents and/or disasters which are relevant to the project concerned. Relevant information available and obtained through risk assessments pursuant to European Union legislation such as Directive 2012/18/ EU of the European Parliament and of the Council or Council Directive 2009/71/Euratom or relevant assessments carried out pursuant to national legislation may be used for this purpose provided that the requirements of this Directive are met. Where appropriate, this description should include measures envisaged to prevent or mitigate the significant adverse effects of such events on the environment and details of the preparedness for and proposed response to such emergencies.

9.

A non-technical summary of the information provided under paragraphs 1 to 8.

10.

A reference list detailing the sources used for the descriptions and assessments included in the EIA report.

5. Matters proposed to be considered within the Scoping Opinion Request

5.1.

The Applicant proposes to scope in the following matters:

- Water Environment and Coastal Processes.
- Ecology.
- Archaeology and Cultural Heritage.
- Seascape, Landscape and Visual.
- Airborne Noise.

5.2.

The Applicant proposes to scope out the following matters:

- Climate Change.
- Air Quality.
- Accidents and Natural Disasters.
- Population and Human Health.

6. Site-Specific Issues

6.1.

In order to make the scope of the EIA Report acceptable, in conjunction with consideration of the above general information requirements, it is considered that the following points should be addressed in accordance with the details set out in the remainder of this Scoping Opinion:

- Water Environment and Coastal Processes.
- Ecology.
- Archaeology and Cultural Heritage.
- Seascape, Landscape and Visual.
- Airborne Noise.
- Climate Change.
- Transport.
- Air Quality.

- Socio-Economics.
- Aviation/ Risk of Hazards and Accidents.

6.2 Details

6.2.1.

NatureScot notes detail is required regarding the proposed construction methodology, particularly in terms of defining construction activities such as dredge spoil disposal and potential use of explosives to reconfigure the coastline. Where it will not be possible to fully define construction activities at the point of application submission, a worst case scenario (Rochdale envelope approach) should be defined against which potential impacts can be assessed.

6.2.2.

NatureScot note that there is confusion in the Scoping Request Report regarding HRA and advise that the Orkney Harbours Masterplan Post Adoption Statement and Habitats Regulations Assessment (HRA), Strategic Environmental Assessment (SEA) and comments made by **NatureScot** on these documents should be reviewed by the Applicant to inform the EIA.

6.2.3.

NatureScot also note that the Scoping Request Report identifies that appraisals will consider the potential environmental impacts related to both the construction and operational phases, where applicable. However, it notes that the report also identifies a site-investigation phase within the Report and thus potential impacts relating to site investigation works should be included in the assessment where appropriate, in particular with respect to marine and terrestrial birds.

6.2.4

It is our view that the site-investigation phase could be consider under the heading of ‘Site Investigation and Construction’, rather than assessing three phases of development. However, either approach would be acceptable.

6.2.5.

The **Highlands & Islands Airport** consultant response, notes that the site lies within the safeguarded area for Kirkwall Airport and that should the main activity at the pier involve construction, assembly and maintenance of offshore wind turbines, these could interfere with instrument flight procedures for the airport. In this context, further details of the likely use of the pier are required in the description of development of the EIAR and where necessary mitigation measures outlined in the EIAR to address aviation safety.

6.2.6.

In relation to the operation phase of the development, consideration must be given to shipping routes to and from the development. The impact of these shipping routes will be relevant to various topics/chapters in the EIA Report.

6.3. Water Environment and Coastal Processes

6.3.1.

The Scoping Request Report identifies that the Water Environment and Coastal Processes Chapter of the EIAR will cover:

- Potential impact to coastal process including wave action, tidal currents and sediment transport during construction and operational phases (qualitative assessment only); and
- Potential contamination of the water environment (coastal, fluvial and groundwater) from spillages, runoff and/or sediment transfer (oil, fuel, suspended solids and potential contaminates in soil), dredging, wastewater, site discharge and traffic during the construction and operational phases

6.3.2.

The Scoping Request Report proposes to scope out fluvial and coastal flooding. It also notes that by following best practice, including a pollution prevention plan and surface water management plan, significant effects on water quality could be mitigated. It is therefore not clear on whether the Applicant is proposing to scope water quality into or out of the EIA.

6.3.2.

The Scoping Request Report confirms that the EIA chapter will set out a review of the baseline, identify receptors and environmental constraints, identify potential impacts and impact significance, identify mitigation and clarify residual impacts. In assessing significance, impacts will be compared to water, environment and sediment quality standards.

6.3.3.

The Scoping Request Report sets out a baseline for water environmental and coastal processes, including a commentary on extreme sea levels. It notes that predictions from the coastal Flood Boundary programme cannot be applied directly to the site. It references the SEPA derived extreme sea level, predicted at the closest point to the development. Using these predicted levels plus a 2100 climate change uplift, it notes that the 1 in 200 year return period plus climate change event at the prediction location has a level of 3.70m AOD and the 1 in 1000 year return period plus climate change event has a level of 3.82m AOD.

6.3.4.

In relation to the extreme sea levels, the **Engineering Services** consultee response, notes that the proposed quay edge is set at 5.31m AOD, which is higher than the 1:200 and 1:1000 year event by a reasonable margin. However, they note that current UK extreme sea level data is not considered reliable and significantly under-estimates values. The SEPA forthcoming revised coastal flood mapping, should help address problems identified for UK Coastal Flood Boundary data for Scapa Flow and Pentland Firth, but the modelled data will need to be verified with measured data. The recommendation is that the EIA obtains the best possible predicted tide level data for the development site and recorded data for verification purposes. Furthermore, they note that when reliable, verified maximum still water levels have been obtained, allowances to account for predicted sea level change over the anticipated lifetime of the development and wave action should be applied. The **Engineering Services** consultation response also confirms that there is no indication of significant flood risk outwith watercourse channels within the development area.

6.3.5.

The **SEPA** consultation response refers back to the consultation response they prepared in relation to the Bay of Deepwater Deep Water Quay screening request (ref. no. 20/238/SCR). They advised in this response, dated 5 August 2020, that "1 in 200 year flood level for the area is estimated at 3.97m Above Ordnance Datum (AOD), taken from the Orkney Strategic Flood Risk Assessment". This seems to differ from the baseline outlined in the scoping request and the Applicant should seek to clarify these differences. **SEPA** has also confirmed that with regards to matters within their remit, they are satisfied with the proposed topics to be covered within the EIAR or supporting statements.

6.3.6.

SEPA request that assessment in the EIAR, or one of the supporting statements, is expanded to include Groundwater Dependent Terrestrial Ecosystems (GWDTE). This should include adequate information to demonstrate compliance with the Guidance on Assessing the Impacts of Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems. GWDTE should therefore be assessed within the EIA Report.

6.3.7.

The **NatureScot** consultation response appears to query whether at this stage the Applicant can confidently conclude that significant changes to coastal processes are unlikely and whether a qualitative assessment approach is appropriate. They note that "At present, due to the scale of the development and without any detailed information regarding construction methodology, dredge spoil disposal, impacts from coastal reconfiguration from use of explosives or appropriate mitigation measures, it is recommended that potential impacts on coastal processes and subsequent impacts on benthic habitat and foraging marine birds are assessed within the EIA".

6.3.8.

The **OIC Policy Officer's** consultation response requires that the potential effects of all stages of the development on the water environment should be assessed and addressed, with particular regard to potential for impacts on the Burn of Deepdale/Button, drainage ditches, as well as the marine environment, through poorly sited and managed stockpiles of soil. These assessments should be undertaken in line with guidance which is available from the SEPA. It does not clarify in the response whether a stand alone assessment is required or if the assessment should be within the EIA Report. The response also notes that the effects of the proposed development on water quality in relation to fish farms should be considered.

6.3.9.

The **Policy Officer** notes that the “assessment of effects on coastal processes should be informed by advice from NatureScot regarding sediment transport in the vicinity of the proposed development and benthic habitat surveys to determine proximity to and interactions with potentially sensitive habitat features, particularly PMFs. There is a hydrodynamic model of Scapa Flow that may be useful for the purposes of assessment. Further information is also required to determine the nature of the sediment proposed to be dredged and the proposed method of disposal of dredged materials and associated effects”.

6.3.10.

Having regard to the Scoping Request Report and the advice of the consultees, the Water Environmental and Coastal Processes Chapter of the EIAR should cover:

- Potential impact to coastal process including wave action, tidal currents and sediment transport during construction and operational phases; and
- Potential contamination of the water environment (coastal, fluvial (including Burn of Deepdale/Button, drainage ditches and groundwater) from spillages, runoff and/or sediment transfer (oil, fuel, suspended solids and potential contaminates in soil), dredging, wastewater, site discharge and traffic during the construction and operational phases
- Potential impacts on Groundwater and associated ecosystems

6.3.11.

We recommend that the Applicant discusses the methodology for assessing the impact on coastal processes with NatureScot to agree whether a qualitative assessment is appropriate.

6.3.12.

Coastal and Fluvial flood risk can be scoped out of the assessment, but a standalone Flood Risk Assessment (FRA) should be submitted as an Appendix to the EIA Report. In preparing the FRA and baseline section of the EIA Chapter, the Applicant should seek agreement on likely 1 in 200 year and 1 in 1000 flood levels at the site with **SEPA** and **Engineering Services.**

6.4. Natural Heritage/Ecology

6.4.1.

The Scoping Request Report identifies that the Ecology Chapter of the EIAR will consider the geographical area potentially affected by the proposed development within Deepdale Bay and will assess the impact of the proposed development on marine mammals and their prey. The following receptors have been scoped out of the EIA: terrestrial habitats and species and birds.

6.4.2.

The Scoping Request Report sets out the baseline conditions in respect of the following ecological receptors, drawing from a desk-based assessment, rather than site surveys:

- Orkney Mainland Moors SPA (coincides with Keelylang Hill and Swartaback Burn SSSI).
- North Orkney pSPA.
- The Scapa Flow pSPA.
- The Gaitnip Hill LNCS.
- All terrestrial and intertidal habitats and species afforded legal protection, those included within the UK BAP and LBAP, and all bird species that are considered to have the potential to suffer negative effects from the proposed development.
- The marine mammal species most often encountered in the waters around Orkney, and therefore the most likely to suffer negative effects from the proposed development.
- Sea Trout. It is noted that further baseline data on fish will be collated for the EIAR.

6.4.3.

In terms of the assessment methodology, the Scoping Request Report states that the assessment of predicted impacts will be undertaken against a baseline and the significance of effects assessed using standard EIAR criteria (i.e. as developed by the Institute of Environmental Management and Assessment (IEMA)). It goes on to say that the methodology for the Ecological Impact Assessment (EcIA) will follow the Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine, Version 1.1 (CIEEM, 2018 (updated 2019)).

6.4.4.

In relation to the potential effects identified in the Scoping Request Report, **NatureScot** raise concerns that potentially significant impacts from the proposed development to natural heritage have not been recognised. **NatureScot** do not consider that it is possible to scope out the majority of ecological receptors at this stage as no details are provided on proposed construction methodology and mitigation.

6.4.5.

In addition to the potential effects identified in the Scoping Request Report, the potential for significant effects on the following receptors has been identified by the following consultees: **NatureScot, RSPB** and **Policy Officer** (see Appendix 1) and should be included in the assessment within the EIA Report:

6.4.6. Designated Sites

The EIA Report should give full consideration to:

- **Scapa Flow pSPA:** As noted by **NatureScot,** the **Policy Officer** and the **RSPB,** the proposal is located within the Scapa Flow pSPA designated for its breeding red-throated diver and non-breeding black-throated diver, eider, goldeneye, great northern diver, long-tailed duck, red-breasted merganser, shag and Slavonian grebe. Potential impacts to features may arise from the permanent displacement of birds from the development footprint; disturbance of birds in the vicinity of the proposal during site investigation, construction and/or operational phases and the temporary or permanent loss of or damage to prey-supporting habitats in the development vicinity or at dredge spoil disposal sites. Of potentially greater importance than direct impacts is the associated increased levels of vessel traffic that are the intended consequence of the proposal. Many of the features of this site exhibit high or very high levels of behavioural sensitivity to vessel movements and the potential for impact on site integrity is highest for those species with relatively high levels of habitat specialisation and/or relatively small populations within this site. This includes black-throated diver, red-throated diver and Slavonian grebe. It remains unclear how the nature, routing and frequency/volume of vessel traffic through the Scapa Flow pSPA are anticipated to change as a consequence of this development. Therefore, it is important that the EIA and HRA also includes an assessment of these wider operational phase impacts. Guidance on surveys to be undertaken to inform the assessment of impacts on the pSPA are set out below.
- **Hoy SPA:** As noted by **NatureScot**, the proposal has connectivity to cliff-nesting seabird interests of the Hoy SPA, including fulmar, great-black backed gull, great skua, common guillemot, kittiwake and puffin, as well as breeding red-throated diver. The proposal is well within foraging ranges of the cliff-nesting seabird features of the Hoy SPA and there is potential for disturbance to these features, although likely sensitivities are less than for wintering waterbirds. The footprint of the proposal itself is outwith the 10km foraging range for breeding red-throated diver associated with the Hoy SPA. However, as detailed above increased vessel traffic associated with the proposal within wider parts of Scapa Flow could therefore affect the breeding red-throated diver Hoy SPA population and should be assessed.
- **Orkney Mainland Moors SPA:** As noted by **NatureScot**, the proposal is within 10km of parts of the Orkney Mainland Moors SPA, and hence potentially within the foraging range of breeding red-throated divers from this site, although actual diver nesting locations within the SPA may be more distant. Associated vessel movements across wider parts of Scapa Flow could affect the breeding red-throated diver Hoy SPA population and should be assessed.
- **North Orkney SPA: NatureScot** would not consider there to be any connectivity for assessment purposes with the North Orkney pSPA, unless there are associated vessel movements during the construction phase (e.g. to deliver equipment or materials or to remove dredge spoil). This should be clarified in the EIA.
- **Loch of Stenness Special Area of Conservation (SAC):** As noted by **NatureScot**, the Loch of Stenness SAC is designated for its coastal lagoon feature and is of particular importance due to its large size and northern location. There is connectivity between the proposal and the SAC, and the

potential that invasive non-native species could be introduced during construction or operation. Therefore, there is the potential for significant effects on this protected area which should be considered in the EIA.

- **Sanday SAC:** As noted by **NatureScot**, the proposal is located within the 50km buffer radii of the Sanday SAC designated for harbour seal. Therefore, it is considered that any harbour seal present within Scapa Flow to be connected to this SAC and should be assessed within the EIA.
- **Sites of Special Scientific Interest (SSSI):** As noted by **NatureScot**, a number of the European sites detailed above are also designated as SSSIs. The designated features of these SSSIs that may be affected by the proposal are the same features covered by the European site designations and thus impacts to these features should be covered. The only exception to this is Waulkmill SSSI located approximately 7km west of the proposal, whose saltmarsh feature could be affected. This site may need to be considered in further detail when information is available on potential impacts to coastal processes and dredge spoil disposal.
- **Gaitnip Hill Local Nature Conservation Site:** As noted by the **RSPB** and the **Policy Officer**, the proposed development is adjacent to the Gaitnip Hill Local Nature Conservation Site (LNCS) which has been classified for supporting nationally important species such as hen harrier, short-eared owl, curlew and lapwing. Given the proximity and scale of the development, Gaitnip Hill LNCS and the species it supports is likely to impacted by the development through disturbance from construction and operational activity due to increased noise, lighting and vehicle movements. The EIAR should therefore include an assessment of the potential effects of the proposed development on the species supported by the Gaitnip Hill LNCS during construction and operation and identify mitigation where appropriate.

6.4.7. Ornithology

The proposal has the potential to impact upon a number of SPAs designated for marine birds, including from potential disturbance from vessel movements associated with the proposed developments. It is not clear from Section 5.5.2 of the Scoping Request Report exactly what terrestrial and marine bird surveys are proposed and in which season. The **Policy Officer** clarifies that bird surveys should be undertaken at the appropriate times of the year in accordance with guidance provided by **NatureScot**. The following surveys will be required for marine birds:

- Autumn through spring (September/October to April) surveys will be required for wintering waterbird features of the Scapa Flow pSPA.
- Surveys to determine usage of the development footprint and surrounding area by red-throated divers in the main chick-rearing period (late June to mid-August) would be helpful to assess potential impacts for this species.

6.4.8.

Given the scale and location of the proposed development, **NatureScot** would recommend two years of bird survey to inform impacts to marine birds. However, one year may be sufficient depending on the results of the first year's survey. The Applicant should provide details to NATURESCOT of the findings of the first relevant year’s surveys, including full analyses and consideration of any relevant additional contextual or supporting information, in sufficient time, and they will advise on the requirement for a second years survey. Notwithstanding this, it is noted by **NatureScot** that despite their prior provision of relevant advice, they have not yet seen a final survey methodology for marine survey. The Applicant should therefore submit their proposed methodology prior to survey work commencing to ensure that it is sufficient to inform the development.

6.4.9.

The following surveys, as identified by **NatureScot** and the **Policy Officer** will be required for terrestrial birds:

- Simple survey work over the area, with an appropriate buffer zone of 500m around the site layout would adequately characterise the species present. A single year’s survey of terrestrial breeding bird species will be all that is required, however, in accordance with comments made by NATURESCOT, any wintering bird surveys, should be undertaken in line with a methodology to be agreed by NATURESCOT.

6.4.10. Marine Mammals, Habitats and Fish

- Benthic ecology and Priority Marine Features (PMF): **NatureScot** note there is limited existing information available regarding benthic species and habitats present in the vicinity of the proposal. However, there are known kelp beds, a PMF, in the immediate vicinity that may be affected. Given the limited data and scale of the proposal **NatureScot** and the **Policy Officer** require that Benthic habitat surveys (re Scapa Flow pSPA) should be undertaken to inform the assessment of the likely effects of all stages of the development on the pSPA and its qualifying features. The purpose of surveys would be to establish the benthic habitats and species present at the development location with particular focus on identifying presence of any PMFs. Where PMFs are identified, the extent and quality (e.g. condition, density etc.) of the features should be confirmed to help inform assessment. A combination of video/photo methods and grab sampling would be appropriate, but of these two methods collection of video/photo data would be the priority. The EIAR should include an assessment of the likely effects of the proposed development on the availability of foraging habitat for these species, as well as the capacity for species to move to alternative areas within the pSPA to avoid disturbance. The conclusions of the assessment should be used to help shape the final development proposal and inform mitigation plans.
- Seals: **NatureScot** agree that there is the potential for impacts to both grey and harbour seals from the proposed development and at this stage they recommend impacts to seals are assessed for all phases of the development. The proposal is within a harbour seal conservation area and there are a number of designated seal haul-outs close to the proposal. **NatureScot** have previously provided advice to the Applicant on underwater noise modelling and can provide further advice if needed. Mitigation should be proposed relating to the findings of this modelling.

- Basking shark: NATURESCOT note there is no mention of basking shark within the Scoping Report. Basking sharks are a protected fish species and PMF, and regularly sighted in Scapa Flow. Therefore, an assessment on potential impacts on this species should be undertaken as part of the EIA and any mitigation should be detailed in the EIA Report. The Applicant should note that they may require a basking shark licence.
- Marine Mammals (including cetaceans): The Scoping Request Report is not clear as to what impacts upon marine mammals and their prey will be assessed in the EIAR. The assessment within the EIAR should include, as a minimum the potential impact for noise disturbance to cetacean, which could lead to panic, confusion and temporary disorientation, with potential for strandings and exclusion from feeding areas.
- Fish - As per the scoping report, the EIA Report should include baseline data on fish. There are currently several aquaculture sites registered with **Marine Scotland Science (MMS)** in the vicinity of the site, which should be considered.

6.4.11. Intertidal habitat and other habitats

Section 5.3 of the Scoping Request Report identifies the potential for negative impacts on intertidal and subtidal habitats during construction through direct loss but there is no further mention of assessment. **NatureScot** confirm that impacts to the intertidal habitat should also be included within the EIAR. This should include the results of an intertidal survey, as requested by the **Policy Officer**, to identify the habitats and species that are likely to be impacted by the development.

6.4.12.

SEPA request that assessment in the EIAR, or one of the supporting statements, is expanded to include Groundwater Dependent Terrestrial Ecosystems (GWDTE). This should include adequate information to demonstrate compliance with the Guidance on Assessing the Impacts of Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems. GWDTE should therefore be assessed within the EIA Report.

6.4.13. Biosecurity

As noted by the **RSPB** and **NatureScot**, there is no mention of terrestrial or Marine Invasive Non-Native Species (INNS) or biosecurity within the Scoping Report. There is the potential for introduction and spread of marine INNS as a result of the proposed development during construction and operation. Furthermore, a number of marine INNS are already present in Orkney waters and activities during construction and operation could facilitate spread. Biosecurity should be fully considered (including its potential impact on human health) and measures to avoid and prevent this possible significant adverse effect on the environment, along with any proposed monitoring arrangements, should be included within the scope of the Ecology chapter of the EIAR. Site-based biosecurity plans for the proposal at the construction and operational phases to assist with managing the spread and introduction of marine INNS should be produced. There are a wide range of additional potential biosecurity measures that could be developed **NatureScot** can advise further and on biosecurity plans if required.

6.4.14. Otters

The Scoping Request Report states that terrestrial habitats and species will be scoped out of the EIAR, on the basis that potential impacts will be mitigated by design and a pre-construction otter survey. Both **NatureScot** and the **Policy Officer** agree with the need for an otter survey encompassing the entire area likely to be affected by development of both the quay, laydown areas and its access road and that if impacts are identified then there will be a need for mitigation measures to be outlined in a Species Protection Plan. Neither consultee clearly confirm that impacts on otter should be scoped into the EIA, but given the lack of certainty as to what the likely impacts are, otters should be scoped into the EIA.

6.4.15.

In summary, ecology should be scoped into the EIA and should include a baseline section summarising the findings of the surveys identified above. Impacts upon the following should be included in the EIA Report: Designated sites; Ornithology; Marine Mammals and their prey, Marine Habitats; Otters; Intertidal Habitat and Biosecurity.

6.5. Historic Environment

6.5.1.

The Applicant proposes to scope in Marine and Terrestrial heritage (above and below ground). Specifically it will consider:

- Impact on debris/unknown maritime heritage assets during construction, not identified through survey work to date, including wartime remains and UXO. If further survey work is undertaken ahead of submission of application and mitigation strategy is agreed prior to EIA process, then impacts on unknown maritime heritage assets would be scoped out of the EIA.
- Impact on MBES Contact 1 from dredging and seabed or bedrock clearance during construction, unless mitigation agreed prior to submission of EIA.
- Impact on unknown prehistoric heritage assets during construction, unless mitigation is agreed ahead of EIA submission.
- Impact on marine heritage assets by scouring of seabed deposits by propeller wash from large vehicles during the operational phase, unless mitigation and monitoring outlined in scoping report is agreed ahead of the EIA submission.
- Impact of the brightly lit quay and large vessels on the setting of heritage assets, including those on the maritime approach to Scapa Bay where Kirkwall Cathedral has acted as a dominant seamark, the visibility of the marker for HMS Royal Oak, especially from viewpoints such as the Royal Oak Remembrance Garden and Memorial at Scapa, as well as the listed buildings in the study area.
- Cumulative effects on heritage assets and their settings, particularly marine receptors

6.5.2.

In relation to setting, the HMS Royal Oak historic asset will be scoped out of the EIA on the grounds no work will be undertaken in or within 50m of the 200m exclusion zone. Impact on onshore heritage assets and unknown medieval, post medieval and modern assets have also been scoped out of the EIA.

6.5.3.

Section 6.5 sets out the proposed assessment methodology for the Heritage chapter of the EIA Report. It notes that the heritage assessment will be conducted based on analysis of existing desk-based sources, field survey data that already exists for the vicinity (SULA Diving 2020) and any new data collected specifically for the project, such as seabed magnetometry at suitable specifications for archaeological review (Plets et al 2013), dropcam images, and walkover survey. Suitable visualisations for the assessment of effects on setting should also be created. Section 6.5 clarifies the guidance documents that will be followed in assessing the heritage effects of the proposed development.

6.5.4.

Historic Environment Scotland (HES) advice, set out at Appendix 1, confirms that they agree with the scope of the EIA in relation to impacts upon marine assets (e.g., known marine historic assets scoped out, impacts from dredging and propeller scour on MBES contact 1 scoped in). They agree further survey work would help to better understand the potential for debris/ordnance not previously identified and that likely effects on these unknown assets should be addressed through assessment of impacts from dredging and propeller scour.

6.5.5.

HES confirm that there are no scheduled monuments, category A listed buildings, Inventory battlefields, gardens and designed landscapes or World Heritage Sites within the proposed development boundary. **HES** welcome the commitment to scope in cumulative operational impacts on the settings of cultural heritage assets. They are content that the proposed development is unlikely to have significant effects on the site or setting of any terrestrial assets within their statutory remit.

6.5.6.

In terms of methodology, **HES** agree with proposed study area and are content that the baseline section of the Scoping Request Report has identified known marine historic environment assets in the study area. **HES** comment on the reference in the scoping report that the use of a mitigation strategy may avoid the need for a full detailed assessment in the EIA. They disagree with this approach and clarify that if the Scoping Report has identified further works that need to be undertaken to understand a potential environmental impact, then that area of interest cannot be scoped out of the ongoing EIA process.

6.5.7.

HES notes that the EIA Report should include robust mitigation measures for cultural heritage assets that could experience significant impacts from the works. They recommend that a Protocol for Archaeological Discoveries should be included as additional mitigation for impacts on unknown historic environment assets unless evidence is presented that would make such an imposition unnecessary.

6.5.8. County Archaeologist

The County Archaeologist made comments in relation to the EIA Screening Request, and it is considered that these remain valid. Having regard to the Scoping Request Report and consultation responses above, marine and land based cultural heritage and archaeology should be scoped into the EIA Report, for both the construction and operational phases of development. The assets/impacts to be considered are as set out in the scoping report. For the avoidance of doubt the scope should include assessment of:

- Impact on debris/unknown maritime heritage assets during construction, not identified through survey work to date, including wartime remains and UXO
- Impact on MBES Contact 1 from dredging and seabed or bedrock clearance during construction
- Impact on unknown prehistoric heritage assets during construction.
- Impact on marine heritage assets by scouring of seabed deposits by propeller wash from large vehicles during the operational phase.
- Impact of the brightly lit quay and large vessels on the setting of heritage assets.
- Cumulative effects on heritage assets and their settings, particularly marine receptors

6.5.9.

In line with HES guidance, it is not accepted that any of the above can be scoped out of the EIA, on the basis that further investigation and mitigation will be established in the future.

6.6. Seascape, Landscape and Visual Impacts

6.6.1.

The Applicant proposes to undertake a full seascape, landscape and visual impact assessment as part of the EIA. The assessment will follow the Guidelines for Landscape and Visual Impact Assessment (GLVIA). The Scoping Report notes that key views from the site are focused across Scapa Flow to distant, silhouetted landmasses, including Hoy, Fara, Cava, Flotta, Burray and South Ronaldsay. Visual receptors are largely restricted to agricultural workers, residents of several nearby scattered dwellings, occasional recreational users (coastal and inland) and road users along the A967. From the sea, boat users would also experience views towards the site.

6.6.2.

The **Policy Officer** consultation response (see Appendix 1) notes “the effects on landscape, seascape and coastal character are likely to be significant as a result of the proposed development and a full SLVIA should be required as part of the EIAR. This should include an assessment of cumulative effects. In the absence of an identified zone of theoretical visibility it is not possible to comment at this stage on the identification of seascape, landscape and visual receptors. Due to the proposed nature and scale of the development including large vertical structures (e.g. cranes, assembly of offshore wind turbines etc) it is likely that seascape, landscape and visual impacts will be experienced across a geographically widespread area. It is therefore considered premature to concluded in the scoping report at para. 7.4.2 that '*Considering the relatively long distance from the site to the NSA, it is unlikely that any significant effects on NSA Special Qualities would be experienced'*. It is recommended that the developer should identify the zone of theoretical visibility and consult the planning authority to identify viewpoints and key receptors. This is likely to include historic environment assets."

6.6.3.

NatureScot consultation response (see Appendix 1) notes: Due to the location and scale of the proposal, including the potential for large vertical structures to be present during construction and operation, it is recommended that potential impacts on the Hoy and West Mainland National Scenic Area (NSA) is given further consideration in the EIA Report.

6.6.4.

Having regard to the Scoping Request Report and consultee responses, a full seascape, landscape and visual impact assessment should be scoped into the EIA, including assessment of the impact of the proposed development on the Hoy and West Mainland NSA. As part of this assessment a ZTV should be prepared and used to identify viewpoints and key receptors, in consultation with the planning authority.

6.7. Noise and Air Quality

6.7.1.

The Applicant proposes to defer a construction noise assessment until the lead contractor has been appointed (likely to be post planning consent). This noise assessment would inform the proposed CEMP and would be agreed with OIC and MSLOT prior to commencement of development. An operational noise assessment will be scoped into the EIA.

6.7.2.

The scoping report confirms that construction of the proposed development is considered to have temporary air quality impacts that can be controlled through developing a site-specific Dust Management Plan as part of a CEMP. The dust impact assessment requires specific information, which is currently being finalised. The dust assessment will therefore also be deferred.

6.7.3.

The Applicant notes that the key impact on air quality from the proposed development once operational will be traffic emissions. However, it concludes that "the increase in traffic on the local road network as a result of the development is regarded as being insignificant" and seeks to scope operational effects out the EIA.

6.7.4.

The **Policy Officer** notes that the EIA process should assess construction and operational impacts on the amenity of local residents and businesses due to noise, vibration, dust or other impacts. This should include an assessment of the noise effects, during construction and operation, on fish farms.

6.7.5.

Whilst the exact construction methodology may not be known at the point of submitting the EIA, a worst case scenario of what the construction process may entail, including information on likely plant, vehicles, HGV movements etc. should be defined in the introductory sections of the EIA. With appropriate mitigation, including the provision of a Framework CEMP/ Dust Mitigation Strategy defined within the EIA, it should be possible to scope noise and air quality out during the construction phase of the proposed development. A standalone noise assessment will be required, the findings of which may be required to inform the ecology chapter of the EIA Report.

6.7.6.

Operational noise should be scoped into the EIA.

6.7.7.

As noted in section 6.11 below, further works needs to be undertaken to better understand likely operational traffic movements and until this work is undertaken air quality impacts from operational road traffic should be scoped into the EIA

6.8. Climate Change

6.8.1.

The Applicant proposes to scope out climate change based on the focus of the masterplan being on decarbonisation of ships and ports and the accommodation of multiple activities in the energy sector, such as the construction, operation and maintenance of offshore wind farm components, and that any negative greenhouse gas emissions impacts during construction or operational phases would be negligible and insignificant. No separate chapter on climate change resilience is required, with the Applicant noting that the primary concern would be the water environment, which would be covered in that chapter of the EIA Report.

6.8.2.

The **NatureScot** consultation response (see Appendix 1) states: “It is noted in Section 3.3.1 of the Report that it is proposed to exclude climate change impacts on the grounds that any negative impacts would be insignificant, as the facility may be used to support decarbonisation of marine fuels and support future offshore windfarm developments. However, it states in Section 2.2.1 potential use of the facility by the oil and gas sector. Due to the scale of the development we would expect some impacts from construction. If there are potentially significant positive or negative climate change benefits, including from the construction phase, these should be considered within the EIA”.

6.8.3.

The **RSPB** consider that the EIAR should include analysis of the carbon-cost of this development and the indirect climate impacts, given that the development could facilitate future oil and gas supply operations, and the Scottish Government's ambitious targets for net-zero emissions by 2045.

6.8.4.

It is considered that the matter of Climate Change Resilience will be successfully covered in relevant technical chapters of the EIA Report and there is no requirement for a stand alone chapter. The introductory sections of the EIA Report should include a section on climate change, including analysis of the carbon cost of the development and signposting where climate change matters are considered within the technical EIA chapters and information explaining how the development will ensure it operates as a decarbonised shipping port which would produce only negligible increases in emissions, as stated in the Scoping Report (section 3.3.1).

6.8.5.

The Scoping Report doesn't provide any information on the likely greenhouse gas emissions associated with the construction phase of the proposed development, including the release of carbon from any peat disturbed within the development area, nor does it reference IEMA's guidance suggesting that all greenhouse gas emissions are significant in the current climate change emergency. In this context, whilst it may be possible to scope out greenhouse gas emissions during the construction phase, the Applicant will need to provide more evidence to justify this approach.

6.8.6.

In terms of operational greenhouse gas effects, at this stage the proposed development is not catering for specific uses, rather Section 2.2.1 of the Scoping Report clarifies the types of activities that could be introduced as a result of the proposed development. These uses include both renewable energy related uses and fossil fuel. Consideration should be given to likely operational effects as currently known. As noted above, whilst it may be possible to scope out greenhouse gas emissions during the operational phase, the Applicant will need to provide more evidence to justify this approach.

6.8.7.

In the absence of further information, climate change should therefore be scoped into the EIA Report.

6.8.8.

The Council should be consulted on any future plans to include the supply of fossil fuels or storage of alternative fuels in the operational development, to establish the need for EIA at this stage.

6.9. Population, Human Health, Accidents and Natural Disasters

6.9.1.

The Applicant proposes to scope out Human Health, Accidents and Natural Disasters on the grounds that the port will operate under a Safety Management System / Standard Operating Procedures to promote safe and efficient harbour operations.

6.9.2.

The **Highlands and Islands Airport (HIAL)** consultation response, at Appendix 1, notes that the turbines that are proposed to be constructed, assembled and maintained within the development area, could affect the instrument flight procedures for the airport. In the interests of aviation safety, HIAL could not accept degradation of this service and would work with the development towards resolution.

6.9.3.

The introductory sections of the EIA should provide information regarding the proposed use of the site, including if known, a worst case scenario as to the likely operation of the turbine business. If due to the nature of this business, significant adverse effects are likely on instrument flight procedures for the airport, the Applicant should liaise with the HIAL to agree mitigation, which should be documented in the EIA and the topic covered as required within the EIA.

6.9.4.

Further information is required regarding the operation of the development including associated vessel movements and associated risk of accident from oil remaining on the wreck of HMS Royal Oak.

6.9.5.

In summary, it is agreed that population can be scoped out of the EIA Report on this basis. However, human health/accidents will need to be scoped in/considered in the EIAR to ensure aviation safety is adequately addressed.

6.10. Soil/Ground Conditions

6.10.1.

The Scoping Request Report at section 4.3.1 considers the baseline conditions in relation to geology and soils.

6.10.2.

SEPA request that assessment in the EIAR, or one of the supporting statements, is expanded to include peat. This should include adequate information to demonstrate compliance with the Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and Minimisation of Waste. Mitigation should be identified where appropriate; for example a Peat Management Plan may be required.

6.10.3.

As there is little information regarding peat and soils included within the Scoping Request Report to enable OIC to come to a view on the likely significant effects, then soils/peat/ground conditions should be scoped into the EIA.

6.11. Transport

6.11.1.

The scoping request does not consider whether the topic of ‘transport’ should be included within the EIA, although within section 3.3.2 Air Quality it notes that “the A961 public road is a key route for ferry traffic, with cars and HGVs travelling daily to and from St Margaret’s Hope to travel on the ferry service operated by Pentland Ferries. It is envisaged at this stage in the project that the traffic generated by the development will be restricted to site workers. Marine assets and supplies will largely be brought to and from site by sea with only some materials/goods being transported overland sporadically. As such the increase in traffic on the local road network as a result of the development is regarded as being insignificant*”.*

6.11.2.

The Scoping request includes a plan showing the proposed new access road. It shows two alternative junction arrangements; one connecting with the existing A961 and the second connecting with proposed A961 re-alignment (by others).

6.11.3.

Roads Services consultation response notes that very little information has been provided in the scoping request in relation to the effects of the proposed development on the existing public road infrastructure. Given that the proposal involves construction of a new access road and the realignment of the A961 this indicates that the development is highly likely to have significant impacts on the existing public road infrastructure. The consultee therefore requires that the effects of both construction and operational traffic on the public road network must be identified in the EIA.

6.11.4.

The works to be undertaken include a new access road and a new junction onto the A961 and the realignment of the A961. Given the lack of information provided in the scoping request, it is necessary to scope the topic of transport in.

6.12. Socio-Economics

6.12.1.

The scoping response does not consider the potential socio-economic effects of the proposed development in any detail.

6.12.2.

The **Policy Officer** requires that the EIA needs to demonstrate that significant adverse social, economic and operational effects on existing activities and infrastructure have been avoided or appropriately mitigated. The assessment should consider the significant direct economic impacts, indirect/wider economic impacts, demographic impacts, impacts local infrastructure and services. This should include consideration of effects upon fish farms, commercial fishing opportunities and coastal and/or marine recreational activities.

6.12.3.

Given the workforce required for the construction phase, assessment should be made of any impact on transport routes (flights and ferries) to and from Orkney, as well as impact on available residential accommodation.

6.12.14.

Given that no information has been provided as to the likely socio-economic effects of the proposed development and that there is potential for significant effects, this topic should be scoped into the EIA and should consider those issues raised by the **Policy Officer**.

6.13. Cumulative Effects

6.13.1.

The EIA Report should include details of the cumulative impacts of the development. Notwithstanding the information included within the submitted Scoping report, the Applicant should undertake a thorough assessment of all consented and forthcoming proposals, noting that the 2017 Regulations require the information contained within the EIA Report to be up to date at the point of determination (previously it was taken to be submission). Cumulative impacts should be considered in terms of both operational cumulative effects as well as the cumulative effects during the construction phase.

6.13.2.

The following types of projects should be included in such an assessment, (subject to available information):

a. Existing completed projects.

b. Approved but uncompleted projects.

c. Ongoing activities.

d. Plans or projects for which an application has been made and which are under consideration by the consenting authorities.

e. Plans and projects which are reasonably foreseeable, i.e. projects for which an application has not yet been submitted, but which are likely to progress before completion of the development and for which sufficient information is available to assess the likelihood of cumulative and in-combination effects.

6.13.3.

NatureScot notes: “We note the intention of undertaking a cumulative assessment as part of the EIA, cumulative impacts will also need to be assessed as part of the HRA. Section 3.4 of the Scoping Report focusses on cumulative assessment with regards to other proposed harbour developments. However, the cumulative assessment needs to take into consideration other sectors including aquaculture, renewable energy developments, cable installations etc… further information on cumulative assessment was provided to the Applicant as part of the consultation on the Orkney Harbour Masterplan. We consider that the Orkney Islands Council are best placed to advise the Applicants on which proposals to include in the cumulative assessment”.

6.13.4.

The **RSPB** request that a potential development at Scapa Pier for which a screening request was submitted (planning reference **20/239/SCR**) is included in the cumulative assessment. It also specifically requests that the cumulative assessment should include all other existing and planned developments with the potential to impact upon Scapa Flow pSPA.

6.13.5.

The **Policy Officer** requires that the assessment of cumulative effects should consider whether other projects would make potential effects more likely to occur, would make potential effects more likely to occur at a significant level or would generate any new or different effects. The cumulative impact assessments should consider likely significant cumulative effects from: other harbour developments, including the proposed development/activities at Hatston; offshore wind and marine renewable energy development/activities; Aquaculture development/activities; and general shipping activities. Consultation with local planning authority is encouraged to agree cumulative schemes. Consideration should be given as to how appropriate planning and timing of works could reduce potential adverse cumulative and in-combination effects.

6.13.6.

A list of developments for inclusion in Cumulative Effects Assessment is attached to this Scoping Opinion as Appendix 2. The cumulative effects chapter must contain consideration of intra-project and synergistic effects as well as inter-project effects.

7. Mitigation

7.1.

Orkney Islands Council is required to make a reasoned conclusion on the significant effects of the proposed development on the environment as identified in the EIA. The mitigation measures suggested for any significant environmental impacts identified should be presented as a conclusion to each chapter or in another clearly identified section of the chapter. Each chapter should seek to clearly identify relevant embedded (primary/tertiary) mitigation and monitoring measures and additional/secondary mitigation. Applicants are also asked to provide a consolidated schedule of all mitigation measures proposed in the environmental assessment, provided in tabular form, where that mitigation is relied upon in relation to reported conclusions of likelihood or significance of impacts, and how any mitigation would be secured and who is responsible for implementing the mitigation.

7.2.

NatureScot advise that depending on the results of the ecological survey work to inform the development and in relation to proposed mitigation, ongoing surveys may be required to monitor construction and operational impacts.

8. Next Steps

8.1.

It is acknowledged that the EIA process is iterative and should inform the final layout and design of proposed developments. Elements of the proposed development may change and evolve as the planning application progresses. It is a matter for the Applicant, in preparing an EIA Report, to ensure these changes are captured effectively.

8.2.

Orkney Islands Council notes that further engagement between relevant parties in relation to the refinement of the design of this proposed development will be required and would request that the Council is kept informed of on-going discussions in relation to this.

8.3.

Orkney Islands Council encourages the use of digital EIA techniques to present the information in the EIA Report in ways that make understanding of the impacts and mitigation accessible to all readers. The Applicant may wish to refer to the digital EIA primer document published by IEMA (Digital Impact Assessment – Primer for embracing innovation and digital working, 2020). To facilitate uploading to the planning portal, the EIA Report and its associated documentation, when submitted, should be accompanied with a CD containing the EIA Report and its associated documentation divided into appropriately named separate files of sizes no more than 5 MB. This will also assist consultees.

8.4.

Applicants are reminded that there will be limited opportunity to materially vary the form and content of the proposed development post submission.

8.5.

Orkney Islands Council recommends that the EIA Report be produced in line with best practice:

- The EIA Report should be a standalone and self-contained document - not be a collection of disparate reports. It should be clearly and coherently structured with a narrative of assessment drawn through the document.
- The EIA Report should have clear and consistent chapter, section and paragraph naming and numbering for ease of understanding. Technical appendices should be clearly referenced throughout the EIA Report and numbered and presented in a way that affords ready access to the supporting information for specialist and non-specialist readers alike.
- The EIA Report should be as concise as possible, in line with the principle of proportionate EIA, with supporting technical information placed in logically ordered and clearly labelled appendices. The Applicant should provide sufficient figures, drawings photographs or other visual representations required to clearly illustrate the proposed development and any other information needed to understand the potential effects associated with its construction. These should also be logically ordered and labelled clearly.
- A common approach to the use of terminology should be adopted throughout the EIA Report, to ensure consistency and ease of understanding for all users of the document. A glossary of technical terms and a list of abbreviations and acronyms should be included in the EIA Report, covering all of the technical chapters and appendices.
- The EIA Report should provide an objective and realistic description of the likely significant impacts of the proposed development, both beneficial and adverse. The information presented should be comprehensible to both technical specialists and non-specialists alike.
- The Non-Technical Summary (NTS) should comprise a summary of the assessment in plain language, and should be supported by appropriate plans graphics, photographs, photomontages and other visual representations as necessary. This should be a standalone document and not a chapter within, or an appendix to, the EIA Report.
- When finalising the EIA Report, applicants are asked to provide a summary in tabular form of where within the EIA Report each of the specific matters raised in this scoping opinion has been addressed.

Notes

The EIA Report must be prepared by competent experts and contributors, outlining relevant expertise or qualifications of such experts. The detail of which should be included within or accompany the EIA Report, along with a statement from the developer.

Please note Scottish Planning Policy:
https://www.gov.scot/Publications/2014/06/5823

This Opinion is hereby adopted under the provisions of Regulation 17(10) of the Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017 and shall be placed on the register in accordance with Regulation 28.

It will be important to ensure that, in taking the EIA process through to the completion of the EIA Report, the information contained within the Scoping Report is accurately reflected within the main text of the EIA Report. For example, the information provided in response to the items to be scoped out, should be taken through to the main EIA Report. Under the 2017 EIA Regulations the Scoping Opinion issues by the Council is binding to the Applicant.

Date

14 October 2021

Signed

Jamie Macvie MRTPI, Planning Manager, Development Management

Scoping Opinion sent to:

Orkney Islands Council (Marine Services).

Appendix 1

Consultation Responses.

Appendix 2

Cumulative Schemes.

Appendix 1

Consultation Responses

Tuesday, 27 April 2021

Local Planner
Development Management, Development and Infrastructure
Orkney Islands Council
Kirkwall
KW15 1NY

Development Operations
The Bridge
Buchanan Gate Business Park
Cumbernauld Road
Stepps
Glasgow
G33 6FB

Development Operations
Freephone Number - 0800 3890379
E-Mail - DevelopmentOperations@scottishwater.co.uk
www.scottishwater.co.uk

Dear Sir/Madam

SITE: Bay Of Deepdale, Scapa Flow, Orkney, KW17 2RZ
PLANNING REF: 21/160/SCO
OUR REF: DSCAS-0038654-BZ5
PROPOSAL: Scoping opinion request to excavate hillside and reclaim land to create a laydown area, construct a deep water pier and an access road

Please quote our reference in all future correspondence

Audit of Proposal

Scottish Water has no objection to this planning application; however, the applicant should be aware that this does not confirm that the proposed development can currently be serviced and would advise the following:

Drinking Water Protected Areas

A review of our records indicates that there are no Scottish Water drinking water catchments or water abstraction sources, which are designated as Drinking Water Protected Areas under the Water Framework Directive, in the area that may be affected by the proposed activity.

Surface Water

For reasons of sustainability and to protect our customers from potential future sewer flooding, Scottish Water will not accept any surface water connections into our combined sewer system.

There may be limited exceptional circumstances where we would allow such a connection for brownfield sites only, however this will require significant justification from the customer taking account of various factors including legal, physical, and technical challenges.

In order to avoid costs and delays where a surface water discharge to our combined sewer system is anticipated, the developer should contact Scottish Water at the earliest opportunity with strong evidence to support the intended drainage plan prior to making a connection request. We will assess this evidence in a robust manner and provide a decision that reflects the best option from environmental and customer perspectives.

General notes:

- Scottish Water asset plans can be obtained from our appointed asset plan providers:
    - Site Investigation Services (UK) Ltd
    - Tel: 0333 123 1223
    - Email: sw@sisplan.co.uk
    - www.sisplan.co.uk
- Scottish Water's current minimum level of service for water pressure is 1.0 bar or 10m head at the customer's boundary internal outlet. Any property which cannot be adequately serviced from the available pressure may require private pumping arrangements to be installed, subject to compliance with Water Byelaws. If the developer wishes to enquire about Scottish Water's procedure for checking the water pressure in the area, then they should write to the Customer Connections department at the above address.
- If the connection to the public sewer and/or water main requires to be laid through land out-with public ownership, the developer must provide evidence of formal approval from the affected landowner(s) by way of a deed of servitude.
- Scottish Water may only vest new water or waste water infrastructure which is to be laid through land out with public ownership where a Deed of Servitude has been obtained in our favour by the developer.
- The developer should also be aware that Scottish Water requires land title to the area of land where a pumping station and/or SUDS proposed to vest in Scottish Water is constructed.
- Please find information on how to submit application to Scottish Water at our Customer Portal.

Next Steps:

All Proposed Developments

All proposed developments require to submit a Pre-Development Enquiry (PDE) Form to be submitted directly to Scottish Water via our Customer Portal prior to any formal Technical Application being submitted. This will allow us to fully appraise the proposals.

Where it is confirmed through the PDE process that mitigation works are necessary to support a development, the cost of these works is to be met by the developer, which Scottish Water can contribute towards through Reasonable Cost Contribution regulations.

Non Domestic/Commercial Property:

>>

Since the introduction of the Water Services (Scotland) Act 2005 in April 2008 the water industry in Scotland has opened to market competition for non-domestic customers. All Non-domestic Household customers now require a Licensed Provider to act on their behalf for new water and waste water connections. Further details can be obtained at www.scotlandontap.gov.uk

Trade Effluent Discharge from Non Dom Property:

- Certain discharges from non-domestic premises may constitute a trade effluent in terms of the Sewerage (Scotland) Act 1968. Trade effluent arises from activities including; manufacturing, production and engineering; vehicle, plant and equipment washing, waste and leachate management. It covers both large and small premises, including activities such as car washing and launderettes. Activities not covered include hotels, caravan sites or restaurants.
- If you are in any doubt as to whether the discharge from your premises is likely to be trade effluent, please contact us on 0800 778 0778 or email TEQ@scottishwater.co.uk using the subject "Is this Trade Effluent?". Discharges that are deemed to be trade effluent need to apply separately for permission to discharge to the sewerage system. The forms and application guidance notes can be found here.
- Trade effluent must never be discharged into surface water drainage systems as these are solely for draining rainfall run off.
- For food services establishments, Scottish Water recommends a suitably sized grease trap is fitted within the food preparation areas, so the development complies with Standard 3.7 a) of the Building Standards Technical Handbook and for best management and housekeeping practices to be followed which prevent food waste, fat oil and grease from being disposed into sinks and drains.
- The Waste (Scotland) Regulations which require all non-rural food businesses, producing more than 50kg of food waste per week, to segregate that waste for separate collection. The regulations also ban the use of food waste disposal units that dispose of food waste to the public sewer. Further information can be found at www.resourceefficientscotland.com

I trust the above is acceptable however if you require any further information regarding this matter please contact me on **0800 389 0379** or via the e-mail address below or at planningconsultations@scottishwater.co.uk.

Yours sincerely,

Pamela Strachan
Development Operations Analyst
Tel: 0800 389 0379
developmentoperations@scottishwater.co.uk

Scottish Water Disclaimer:

"It is important to note that the information on any such plan provided on Scottish Water's infrastructure, is for indicative purposes only and its accuracy cannot be relied upon. When the exact location and the nature of the infrastructure on the plan is a material requirement then you should undertake an appropriate site investigation to confirm its actual position in the ground and to determine if it is suitable for its intended purpose. By using the plan you agree that Scottish Water will not be liable for any loss, damage or costs caused by relying upon it or from carrying out any such site investigation."

From: harbours <harbour@orkney.gov.uk>
Sent: 05 May 2021 15:35
To: planningconsultation <planningconsultation@orkney.gov.uk>
Subject: RE: Scoping Application Consultation 21/160/SCO

Classification: OFFICIAL

Good Afternoon,

Mariner Services have no comment at this time.

Kind Regards
Terri

Development & Infrastructure
Marine Services

marine scotland
science

Scottish Government
Riaghaltas na h-Alba
gov.scot

T: +44 (0)131 244 4013 F: +44 (0)131 244 0944
Email: MS.FFPlanning@gov.scot

Our ref: FFP-21-027
Your ref: 21/160/SCO

14/05/2021

Dear Ms Gillon,

Development at Bay of Deepdale, Scapa Flow by Orkney Islands Council

We have reviewed the application submitted and offer the following comment:

Aquaculture Animal Health

There are currently several aquaculture sites registered with Marine Scotland Science located in the vicinity of the development at Bay of Deepdale, Scapa Flow proposed by Orkney Islands Council (see map). The nearest aquaculture site is situated ~1.5km south of the proposed development; it is an active marine cage Atlantic salmon site, operated by Scottish Sea Farms Ltd.

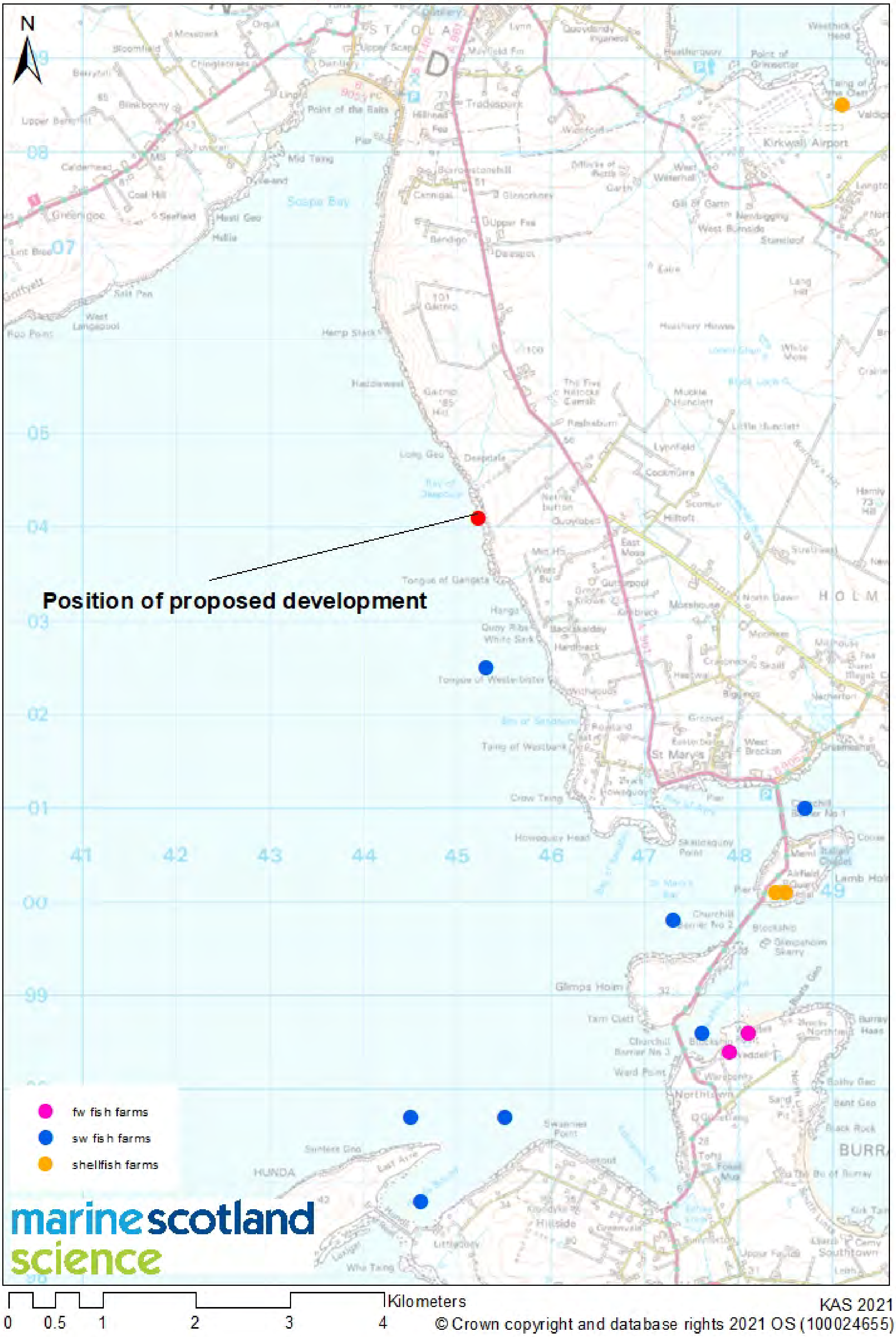
Yours sincerely

Marine Scotland Science

Appended:
Map: Aquaculture sites in the vicinity of proposed development at Bay of Deepdale, Scapa Flow.

Marine Laboratory, 375 Victoria Road,
Aberdeen AB11 9DB
www.gov.scot/marinescotland

Aquaculture sites in the vicinity of proposed development at Bay of Deepdale, Scapa Flow



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From: Safeguarding <Safeguarding@hial.co.uk>
Sent: 14 May 2021 14:44
To: planningconsultation <planningconsultation@orkney.gov.uk>
Subject: Scoping Application Consultation 21/160/SCO

Your Ref: 2021/0084/KOI
HIAL Ref: 21/160/SCO

Dear Sir/Madam,

PROPOSAL: Scoping opinion request to excavate hillside and reclaim land to create a laydown area, construct a deep water pier and an access road
LOCATION: Bay Of Deepdale, Scapa Flow, Orkney

This development falls within the safeguarded area for Kirkwall Airport.

The report states that the envisaged main activity of the site will be construction, assembly & maintenance of offshore wind turbines.

The turbines could possibly affect the Instrument Flight Procedures for the airport. In the interests of aviation safety, HIAL could not accept degradation of this service. It should be noted that HIAL would work with the developer towards a resolution. However, HIAL are likely to object to any proposal which impacts the Instrument Flight Procedures.

Regards,

Safeguarding Team
Highlands and Islands Airports Limited

HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA

By email to:
planningconsultation@orkney.gov.uk

Margaret Gillon
Orkney Islands Council (Planning)
Development Management
Council Offices
School Place
Kirkwall
Orkney
KW15 1NY

Longmore House
Salisbury Place
Edinburgh
EH9 1SH

Enquiry Line: 0131-668-8716
HMConsultations@hes.scot

Our case ID: 300045527
Your Ref: 21/160/SCO

17 May 2021

Dear Margaret Gillon

The Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017
Scoping opinion request to excavate hillside and reclaim land to create a laydown area, construct a deep water pier and an access road - Bay Of Deepdale, Scapa Flow, Orkney
Scoping Report

Thank you for your consultation which we received on 26 April 2021 about the above scoping report. We have reviewed the details in terms of our historic environment interests. This covers World Heritage Sites, scheduled monuments and their settings, category A-listed buildings and their settings, inventory gardens and designed landscapes, inventory battlefields and historic marine protected areas (HMPAs). In this case, our advice also includes matters relating to marine archaeology outwith the scope of the terrestrial planning system.

Your own archaeological and cultural heritage advisors will also be able to offer advice on the scope of the cultural heritage assessment. This may include heritage assets not covered by our interests, such as unscheduled archaeology, and category B- and C-listed buildings.

Proposed Development

We understand that the proposed development comprises the creation of a 575m quayside with water depth of -15m CD, a 110m x 75m quay extension with water depth of -20m CD, and formation of a laydown area including an access road from the A961 to the laydown area. The works will include excavation of current landform, reclamation of shore and dredging adjacent to the quays.

Scope of assessment

Marine assets

There are no recorded marine historic environment assets within the construction area itself and the Scoping Report provides sufficient information to conclude that the risk of there being any unidentified assets is extremely low. We consider that those sites that have been identified in the baseline assessment are sufficiently far away that impacts from the majority of construction work should not be a risk.

We agree that potential significant construction effects from the proposed dredging works should be scoped in to further detailed assessment to ensure that potential impacts on MBES contact 1 are addressed in the final EIA.

We also agree that potential significant operational effects from propeller scour should be scoped in to further detailed assessment to ensure that potential impacts on MBES contact 1 are addressed in the final EIA.

We note that the scoping report identified the potential for debris/stray finds/ordnance which have not been identified by previous surveys and may rest within the development area. Further survey is proposed to help understand the potential for such material within the development area. Given that it is proposed to scope in potential effects which may affect such assets from dredging and propeller scour this should also identify any potential significant effects on these assets. We have provided further comment on the scoping report's approach to mitigation in the section below.

Terrestrial assets
We can confirm that there are no scheduled monuments, category A listed buildings, Inventory battlefields, gardens and designed landscapes or World Heritage Sites within the proposed development boundary.

We note and welcome the commitment to scope in cumulative operational impacts on the settings of cultural heritage assets given in Section 6.4 of the Scoping Report. We are content that the proposed development is unlikely to have significant effects on the site or setting of any terrestrial assets within our statutory remit and we therefore have no further comments on the potential effects of the development for our statutory terrestrial interests.

Scoping Report
We are content with the study area identified in the Scoping Report for marine historic environment assets. We are content that the baseline assessment provided identifies the known marine historic environment assets within the development area and in the surrounding study area.

A detailed assessment methodology for assessment of effects on the historic environment is not provided within the Scoping Report, however, we welcome that the report indicates that the guidance in the EIA Handbook will be used. We would be happy to provide advice on a detailed methodology if that would be helpful.

We note the frequent references throughout the cultural heritage section of the report to the use of a mitigation strategy to avoid the need for full detailed assessment in the EIA. For example, at section 6.3.1 of the Scoping Report it is stated that:

"If this mitigation strategy is agreed prior to the EIA process then there would be no requirement to include impacts on unknown marine assets in that process, because the necessary mitigations to reduce/eliminate impacts would already be in place. This management of the risk is likely to be part of planning consent conditions."

The process outlined in section 6.3.1 for further survey work is not a mitigation strategy, it is a brief statement about future investigations. Survey is not mitigation; it provides background information for mitigation.

We would not expect mitigation to be controlled through planning conditions. The EIA process is intended to assess the potential environmental impacts and then address them in the design of the project. Any further mitigation required following the design should also be laid out clearly in the resulting EIA Report. This process should be adhered to, both to enable the decision maker to make an informed decision and to comply with the relevant legislation.

The proposed works are welcome but it is not possible at this stage to understand how they would result in anything being scoped out of the EIA process. Even if the results indicate that there would be no impact on archaeological assets or deposits, this would be an essential component of the cultural heritage section of the EIA. If the Scoping Report has identified further works that need to be undertaken to understand a potential environmental impact, then that area of interest cannot be scoped out of the ongoing EIA process.

The EIA Report should include robust mitigation measures for cultural heritage assets that could experience significant impacts from the works.

There is no mention of a Protocol of Archaeological Discoveries or other mechanism to check areas of disturbance for archaeological artefacts. It is possible that the potential for such material in the affected areas is so low that such an exercise is not merited in this case, but we would expect this issue to be addressed in the EIA.

Further information

The Historic Environment Policy for Scotland (HEPS 2019) was adopted on the 01 May 2019 and replaced the Historic Environment Scotland Policy Statement (HESPS 2016). The Historic Environment Policy for Scotland is a strategic policy document for the whole of the historic environment and is underpinned by detailed policy and guidance. This includes our Managing Change in the Historic Environment Guidance Notes. All of these documents are available online at www.historicenvironment.scot/heps.

Practical guidance and information about the EIA process can also be found in the EIA Handbook (2018). Technical advice is available on our Technical Conservation website at http://conservation.historic-scotland.gov.uk/.

We hope this is helpful. Please contact us if you have any questions about this response. The officer managing this case is Victoria Clements who can be contacted by phone on 0131 668 8730 or by email on Victoria.Clements@hes.scot.

Yours sincerely

Historic Environment Scotland

Scoping Application Consultation

Planning Authority Name	**Orkney Islands Council**
Date of Consultation	**26th April 2021**
Response required by	**17th May 2021**
Planning Authority Reference	**21/160/SCO**
Nature of Proposal (Description)	**Scoping opinion request to excavate hillside and reclaim land to create a laydown area, construct a deep water pier and an access road**
Site	**Bay Of Deepdale, Scapa Flow, Orkney**
Site Postcode	**N/A**
Site Gazetteer UPRN	
Proposal Location Easting	**345223**
Proposal Location Northing	**1004096**
Area of application site (Metres)	**311269**
Clarification of Specific Reasons for Consultation	
Development Hierarchy Level	**N/A**
Supporting Documentation URL	http://planningandwarrant.orkney.gov.uk/online-applications/ Please enter - 21/160/SCO
List of Available Supporting Documentation	**As above URL**
Offline Documents available?	**N/A**
Date of Validation by Planning Authority	**16th April 2021**
Governing Legislation	**THE TOWN AND COUNTRY PLANNING ENVIRONMENTALIMPACT ASSESSMENT (SCOTLAND) REGULATIONS 2017**
Consultation Type	**Scoping**
Consultation Stage	**N/A**
Is this a re-consultation of an existing application?	**No**
EIA Required	**Yes**
EIA Regulations	**Yes**
Use Class (Current)	
Use Class (Proposed)	
Does the application conform with the Structure Plan / Local	

Plan Land Use	
Additional Comments relating to Structure Plan / Local Plan Use	**N/A**
Transport Assessment or Travel Plan	**N/A**
Applicant Name	**Orkney Islands Council**
Applicant Organisation Name	
Applicant Address	
Agent Name	**EnviroCentre Ltd**
Agent Organisation Name	
Agent Address	
Agent Phone Number	**N/A**
Agent Email Address	**N/A**
PA Office	**Development Management**
Case Officer	**Ms Margaret Gillon**
Case Officer Phone number	**01856 873535 EX 2505**
Case Officer email address	**margaret.gillon@orkney.gov.uk**
PA Response To	**planningconsultation@orkney.gov.uk**

The proposed development site is spread over three locations: construction of an access road leading from the A961 down through the valley to the coast; excavation and levelling of an area of land above the shore and in the intertidal zone; and construction of the quay within the Bay of Deepdale. The construction phase would impact on a range of natural resources, including land, soil, water and biodiversity; and there is also potential for impacts on water, biodiversity and marine processes during the operational phase.

Policy Context

Scotland's National Marine Plan should inform the preparation of the EIAR for this proposed development and any subsequent consent applications.

The Orkney Local Development Plan policies should be considered in relation to this proposed development. Policy 12 Coastal Development is of particular relevance. The environmental effects of the proposed development should be assessed and addressed in line with the requirements of Orkney Local Development Plan Policy 9: *Natural Heritage and Landscape*, and Supplementary Guidance: *Natural Environment*. These documents are available on the Council's website at http://www.orkney.gov.uk/Service-Directory/O/Orkney-Local-Development-Plan.htm and http://www.orkney.gov.uk/Service-Directory/D/natural-environment.htm

The developer is also advised to refer to the Orkney Local Biodiversity Action Plan which is available at https://www.orkney.gov.uk/Service-Directory/L/Local-Biodiversity-Plan.htm. Please note that, although the current version of the LBAP covers the period 2018-2022, the Audit and Habitat Action Plans from the 2002 Plan provide much of the context to the current Plan and continue to be relevant to the protection and enrichment of biodiversity in the Orkney Isles.

The Pilot Pentland Firth and Orkney Waters Marine Spatial Plan should be considered in relation to the proposed development. The Plan has been approved by Scottish Ministers for use by the Marine Scotland Licensing Operations Team (MS-LOT) as a material consideration in the determination of marine licence and section 36 consent applications within the Pentland Firth and Orkney Waters area. The Plan's Sectoral and General Policies should be considered alongside the relevant legislation, policies and plans set out in Section 3 and Annex 2 of the Plan. As a non-statutory Plan, it complements and supports existing ambitions and responsibilities rather than replace them.

The Highland Council and Orkney Islands Council have adopted the pilot Plan as non-statutory planning guidance, acknowledging the status of the Plan as a material consideration in the determination of relevant planning applications. Orkney Islands Council has also adopted the Plan as a material consideration in the determination of works licence applications in the Orkney Harbour Area.

To implement the Plan's overall vision, aims and objectives, the Plan's policy framework consists of a suite of General Policies and Sectoral Polices. All the policies in the Plan are afforded equal weight in decision-making and should be read in conjunction with each other.

The pilot Plan's General Policies, in principle, apply to all development(s) and activities and should be considered in relation to port and harbour development. The relevance of the General Policies to any given development and/or activity varies depending on the particular circumstances including type, scale, location and any potential impacts. All the General Policies, Sectoral Policy 6 and Sectoral Policy 7 are considered relevant to the proposal to excavate hillside and reclaim land to create a laydown area, construct a deep water pier and an access road at the Bay of Deepdale.

The conclusions reached in the scoping report should not determine what should or should not be scoped in until such time as the feedback from the statutory consultees has been received and considered.

Scapa Flow pSPA

The site of the proposed quay development is located within the Scapa Flow proposed Special Protection Area (pSPA) where the qualifying features are breeding red-throated diver, and non-breeding (wintering) great northern diver, black-throated diver, Slavonian grebe, common eider, long-tailed duck, red-breasted merganser, and European shag. Bird surveys should therefore be undertaken at the appropriate times of year, in line with guidance provided by NatureScot, to obtain updated information about the numbers and distribution of species which may be affected by the development proposal including potential disturbance by vessel movements associated with the development.

Benthic habitat surveys should also be undertaken, to assess likely effects on the availability of foraging habitat for these species, as well as the capacity for species to move to alternative areas within the pSPA to avoid disturbance.

The findings from these surveys should then inform assessment of the likely effects of all stages of the development on the pSPA and its qualifying features. The conclusions of the assessment should be used to help shape the final development proposal and inform mitigation plans.

Effects on pSPA bird features should be considered in the EIAR, as well as in the HRA.

Gaitnip Hill Local Nature Conservation Site (LNCS)

The proposed development site is located immediately to the south of the Gaitnip LNCS, a site which is important for a variety of breeding birds, including birds of prey. Although no development is proposed on any part of the LNCS there is still potential for indirect effects, for example from light pollution. The EIA should assess the likely effects on the LNCS and identify mitigation measures where appropriate.

Wider ornithology

Landward elements of the development have potential to impact on a number of bird species which may nest in the area, so breeding bird surveys should be undertaken in line with guidance provided by NatureScot, to obtain updated information about the species which may be affected. The findings of these surveys should inform mitigation measures to avoid or minimise disturbance to breeding birds and their fledglings.

Intertidal habitats

An intertidal survey should be undertaken to identify the habitats and species that are likely to be impacted by the development. The UK BAP / LBAP habitat Coastal vegetated shingle is listed in Section 5.2.2 of the Scoping Report; however, other intertidal habitats included in the Scottish Biodiversity List / Orkney LBAP may be present within the area.

Benthic habitats and Priority Marine Features

Benthic surveys should identify the range of benthic habitats and species within the area that could be affected by the proposal, focussing particularly on the potential presence of Priority Marine Features (PMFs). Further information on those habitats and species that are identified as PMFs is available on the NatureScot website at https://www.nature.scot/naturescot-commissioned-report-406-descriptions-scottish-priority-marine-features-pmfs

The findings of these surveys should inform mitigation plans to avoid or minimise disturbance and/or damage to benthic habitats and species, in particular those identified as PMFs.

Cetaceans and basking sharks

Cetaceans are regularly sighted within Scapa Flow where, due to the semi-enclosed nature of the Flow and the limited availability of escape routes, noise disturbance could lead to panic, confusion and temporary disorientation, with potential for cetacean strandings to occur. It could also cause exclusion from feeding areas.

All cetacean species (whales, dolphins and porpoise) are classed as European Protected Species. If any activity is likely to cause disturbance or injury to a European Protected Species, a license is required to undertake the activity legally.

Additionally, if any activity associated with the development proposal is likely to cause to disturbance or injury to basking sharks, a licence would also be required to undertake activity legally. Records of basking shark sightings along the Holm coast have been reported to the Orkney Wildlife Information and Recording Centre. The locations of these records are indicated at https://orkneylibrary.org.uk/orkney-wildlife-information-and-records-centre/mapping/

Assessment should therefore be undertaken to determine the potential effects on cetaceans and basking sharks at all stages of the development proposal and to identify mitigation measures that would avoid or minimise the risk of disturbance.

Any EPS licensing requirement should be discussed with the Marine Scotland Licencing Operations Team (MS-LOT). Information on licensing is available on the Scottish Government website at
https://www.gov.scot/policies/marine-and-fisheries-licensing/european-protected-species/

Seals

Both grey and harbour seals are found within Orkney waters and the Scapa Flow coastline includes several designated seal haulout sites. The locations of these sites are displayed on the National Marine Plan interactive map at
https://marinescotland.atkinsgeospatial.com/nmpi/default.aspx?layers=446

Seals also haul out in other, undesignated locations and significant numbers of the animals have been seen hauled out on the rocky intertidal to the south of the proposed development site between Deepdale and the Westerbister fish farm.

Both grey and harbour seals are susceptible to disturbance, including underwater noise and the animals are particularly vulnerable during their pupping seasons. Grey seal pups remain on land for the first three weeks of their life and are reliant on their mothers returning onshore to feed them. Harbour seal numbers in Orkney waters have decreased significantly in recent years and it is important that they are not subjected to additional pressures. Assessment should therefore be undertaken of the likely effects of all stages of the development on both grey and harbour seals and the findings used to identify mitigations measures that would avoid or minimise disturbance.

European Protected Species – otter

Survey work previously undertaken confirmed the presence of otters in the area around the Burn of Button and the southern end of Gaitnip Hill. With the proposed development now focused on an area to the south of the burn, a further otter survey would need to be undertaken, that would encompass the entire area likely to be affected by development of both the quay,

laydown areas and its access road. The findings of the survey should enable any licensing requirement to be determined. Guidance on otter licences for development is available on the NatureScot website at https://www.nature.scot/professional-advice/protected-areas-and-species/licensing/species-licensing-z-guide/otters/otters-licences-development
A species protection plan should be drawn up if evidence of otters, their holts, couches or other places of shelter are found on or near the development site.

The water environment

The habitat 'Burns and Canalised Burns' is identified in the Orkney Local Biodiversity Action Plan as a locally important habitat and should be added to the list in Section 5.2.2. The Burn of Deepdale / Button may support spawning habitat for seatrout, a Priority Marine Species. Although seatrout spend much of their time at sea, they return to freshwater to spawn. The developer is advised to contact the Orkney Trout Fishing Association for further information.

The potential effects of all stages of the development on the water environment should be assessed and addressed. Careful consideration should be given to any planned onsite storage of excavated soils, as stockpiles of bare soil are vulnerable to erosion, particularly during wet weather. Poorly sited stockpiles may pose a risk to the Burn of Deepdale / Button and associated drainage ditches, as well as the marine environment. These assessments should be undertaken in line with guidance which is available from the SEPA website at www.SEPA.org.uk/.

Coastal processes

Section 4.6 of the scoping report states that '*the construction activities involved within the proposed development including dredging, construction of the quay, and land reclamation all have the potential to impact the coastal processes within Scapa Flow. However, the development site is considered to have low energy without significant sediment transport, with an absence of fine sediment. In this context it is considered that a qualitative assessment of the impact of the proposed development on coastal processes, including wave action, tidal current and sediment transport is appropriate'.*

The assessment of effects on coastal processes should be informed by advice from NatureScot regarding sediment transport in the vicinity of the proposed development and benthic habitat surveys to determine proximity to and interactions with potentially sensitive habitat features, particularly PMFs. There is a hydrodynamic model of Scapa Flow that may be useful for the purposes of assessment. Further information is also required to determine the nature of the sediment proposed to be dredged and the proposed method of disposal of dredged materials and associated effects.

Assessment of alternatives

The EIAR should include an assessment of the alternatives considered to this development including factors to minimise environmental impacts.

Archaeology and cultural heritage

Scoping comments on archaeology and cultural heritage have been provided by the OIC County Archaeologist.

Local communities - Amenity, noise and roads

The scoping report concludes that increases in traffic on the local road network as a result of the development are regarded as insignificant. It is recommended that OIC Roads be consulted to establish any potential requirement for a traffic impact assessment.

The EIA process should assess construction and operational impacts on the amenity of local residents and businesses due to noise, vibration, dust or other impacts. The scoping report states that an assessment of construction noise should be deferred until later in the development process.

Seascape/landscape and visual

The effects on landscape, seascape and coastal character are likely to be significant as a result of the proposed development and a full SLVIA should be required as part of the EIAR. This should include an assessment of cumulative effects.

In the absence of an identified zone of theoretical visibility it is not possible to comment at this stage on the identification of seascape, landscape and visual receptors. Due to the proposed nature and scale of the development including large vertical structures (e.g. cranes, assembly of offshore wind turbines etc) it is likely that seascape, landscape and visual impacts will be experienced across a geographically widespread area. It is therefore considered premature to concluded in the scoping report at para. 7.4.2 that '*Considering the relatively long distance from the site to the NSA, it is unlikely that any significant effects on NSA Special Qualities would be experienced'*. It is recommended that the developer should identify the zone of theoretical visibility and consult the planning authority to identify viewpoints and key receptors. This is likely to include historic environment assets.

Socio-economic impact assessment

The EIA will need to demonstrate that significant adverse social, economic and operational effects on existing activities and/or infrastructure have been avoided or, where avoidance is not possible, adverse effects have been appropriately mitigated. The assessment should consider the significant direct economic impacts, indirect/wider economic impacts, demographic impacts, impacts local infrastructure and services.

Other users of the coastal and marine environment

An assessment of how the development proposal will comply with National Marine Plan policy GEN 4 *Co-existence* should be undertaken as part of the EIA process. This should include any significant effects on:

- Fish farms and operations due to noise, water quality (silt, smothering etc) during construction phase, and noise and disturbance during operational phase.
- Commercial fishing opportunities taking into account seasonality and the year-round operation of the affected fishery and any displacement effects.
- Coastal and/or marine recreational activities.

Cumulative impact assessment

National Marine Plan policy Gen 21 *Cumulative impacts* states the requirement for public authorities to address cumulative impacts on ecosystems in decision making. The scoping report explains that cumulative impacts will be assessed for each relevant EIA topic.

The assessment of cumulative effects should consider whether other projects would make potential effects more likely to occur, would make potential effects more likely to occur at a significant level or would generate any new or different effects.

The cumulative impact assessments should consider likely significant cumulative effects from:

- Other harbour developments, including the proposed development/activities at Hatston.
- Offshore wind and marine renewable energy development/activities.
- Aquaculture development/activities.
- General shipping activities.

It is recommended that the developer should consult the planning authority to determine which new developments are currently live within the planning system prior to undertaking the cumulative impacts assessments.

It is likely that appropriate planning and timing of works will help to minimise the potential for negative cumulative and in-combination effects.

Positive effects for biodiversity

As required by the Planning (Scotland) Act 2019, National Planning Framework 4 will establish outcomes for how development will contribute to securing ‘positive effects for biodiversity’. As the Scapa Deep Water Quay is a Candidate National Development, it is recommended that the developer should consider potential options for delivering such positive effects for biodiversity at the earliest opportunity.

Northern
Lighthouse
Board

84 George Street
Edinburgh EH2 3DA

Tel: 0131 473 3100
Fax: 0131 220 2093

Website: www.nlb.org.uk
Email: enquiries@nlb.org.uk

Your Ref: EIA Scoping 21/159/SCO and 21/160/SCO
Our Ref: GB/ML/O2_01_124

Ms Margaret Gillon
Case Officer
Orkney Islands Council
School Place
Kirkwall
Orkney
KW15 1NY

14 May 2021

THE TOWN AND COUNTRY PLANNING ENVIRONMENTAL IMPACT ASSESSMENT (SCOTLAND) REGULATIONS 2017

Orkney Islands Council Harbour Authority – Expansion of Hatston Pier and Harbour – Hatston and Construction of Scapa Deep Water Quay – Scapa Flow – Orkney Islands

Thank you for your e-mail correspondence dated 4th May 2021 relating to the EIA Scoping opinion submitted by **Orkney Islands Council** for their proposals to extend Hatston Pier/ Harbour and construct a new Scapa Deep Water Quay, Scapa Flow, Orkney Islands.

Northern Lighthouse Board are content with the proposed EIA study and will respond in full to the Planning Permission application.

Yours sincerely

Peter Douglas
Navigation Manager

Scottish Environment
Protection Agency
Buidheann Dìon
Àrainneachd na h-Alba

Our ref: 1124
Your ref: 21/160/SCO

Contact by email:
planning.north@sepa.org.uk

18 May 2021

Margaret Gillon
Orkney Islands Council
Department of Development Services
Council Offices
School Place
Kirkwall
KW15 1NY

By email only to: planningconsultation@orkney.gov.uk

Dear Ms Gillon

The Town and Country Planning Environmental Impact Assessment (Scotland) Regulations 2017
Planning application: 21/160/SCO
Scoping opinion request to excavate hillside and reclaim land to create a laydown area, construct a deep water pier and an access road
Bay Of Deepdale, Scapa Flow, Orkney

Thank you for consulting SEPA on the scoping opinion for the above development proposal by way of your email received on 26 April 2021.

Further to our advice on the Orkney Harbours Masterplan Phase 1, which this is part of, we provided site-specific comments on this proposal at the screening stage, refer our letter of 5 August 2020 (our reference PCS/172174). In this letter we commented “The information provided is drawn from the recent Orkney Harbours Masterplan Phase 1 (March 2020)”. As you will be aware we provided comments on the draft, refer our letter of 22 July 2019 (our reference PCS/165962) and note the references from this within 1.2.5 Information Arising from Previous Consultation, for example the need to carry out a survey to determine if Groundwater Dependent Terrestrial Ecosystems are present so these can be avoided. We welcome the identification of local sensitives and the Table in Section 1.3 of potential effects and mitigation, including that a peat management plan will be developed and peat habitats avoided where possible.”

While there is reference to peat in the scoping report - “Stripping of all non-inert material (organic soil and peat along with unsuitable clays)”, the only other related reference states “All non-inert material recovered during initial site stripping and the main excavation operations to be used to form perimeter bunds”.

We therefore request that assessment in the EIAR, or one of the supporting statements, is expanded to include GWDTE and peat. This should include adequate information to demonstrate compliance with the Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and Minimisation of Waste and Guidance on Assessing the Impacts of Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems. For example in regard to peat, a Peat Management Plan demonstrating the proposal avoids the disturbance and excavation of peat, and appropriate reuse of peat on site.

In regard to other matters within our remit, we are satisfied with the proposed topics to be covered within the EIAR or supporting statements.

If you have any queries relating to this letter, please contact me by email at planning.north@sepa.org.uk.

Yours sincerely

Alison Wilson
Senior Planning Officer
Planning Service

ECopy to: Emma Cormack, EnviroCentre Ltd, ecormack@envirocentre.co.uk; Margaret Gillon, Orkney Islands Council, margaret.gillon@orkney.gov.uk

Disclaimer
This advice is given without prejudice to any decision made on elements of the proposal regulated by us, as such a decision may take into account factors not considered at this time. We prefer all the technical information required for any SEPA consents to be submitted at the same time as the planning or similar application. However, we consider it to be at the applicant's commercial risk if any significant changes required during the regulatory stage necessitate a further planning application or similar application and/or neighbour notification or advertising. We have relied on the accuracy and completeness of the information supplied to us in providing the above advice and can take no responsibility for incorrect data or interpretation, or omissions, in such information. If we have not referred to a particular issue in our response, it should not be assumed that there is no impact associated with that issue. For planning applications, if you did not specifically request advice on flood risk, then advice will not have been provided on this issue. Further information on our consultation arrangements generally can be found on our website planning pages.

From: Pauline McGrow <Pauline.McGrow@ryascotland.org.uk>
Sent: 19 May 2021 13:46
To: planningconsultation <planningconsultation@orkney.gov.uk>
Subject: RE: Scoping Application Consultation 21/160/SCO

Dear Sir/Madam,

I write to inform you that we are supportive of this application and have no further comments that we wish to make at this stage.

Kind Regards

Pauline

Orkney Islands Council Planning Department
By email: planningconsulatation@orkney.gov.uk

Cc. Marine Scotland Licensing Operations Team
By email: MS.MarineLicensing@gov.scot

20 May 2021

Dear Margaret,

Scoping – Scapa Deep Water Quay – Scapa Flow, Orkney (Orkney Islands Council Reference: 21/160/SCO)

Thank you for consulting RSPB Scotland on the above scoping report.

We believe Marine Scotland has received a sperate request for the adoption of a scoping opinion under The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017. The same report (EnviroCentre Report No 9435, Project No 673702, Status: final, dated 30 March 2021) has been supplied to accompany both requests. Our comments are therefore relevant to both organisations.

RSPB Scotland advises that this proposal has potential to impact on a number of bird species of conservation importance. Having reviewed the Scoping report, we wish to highlight the following comments.

Location

The proposed location lies within the Scapa Flow proposed Special Protection Area (pSPA), designated for the areas' international importance for large numbers of great northern diver, red-throated diver, black-throated diver, Slavonian grebe as well as migratory populations of European shag, common eider, long-tailed duck, common goldeneye and red-breasted merganser. These species are attracted to the sheltered sounds and bays of the coastline in order to forage and rest and are also utilised by breeding species such as common eider and red-throated diver during the spring and summer.

Appropriate Assessment

Given the nature of the development and the proximity to the pSPA, we wish to highlight that that the OIC/ Marine Scotland, as the competent authority, must consider the Habitat Regulations and will need to undertake and appropriate assessment on the basis on potential adverse impacts to the pSPA species.

Terrestrial ecology

RSPB Scotland
Orkney Office
12 – 14 North End Road
Stromness
KW16 3AG

Tel 01856 850176
Fax 01856 851311

Facebook: RSPB Scotland
Twitter: @ RSPB Scotland
rspb.org.uk

Patron: Her Majesty the Queen Chairman of Council: Kevin Cox President: Miranda Krestovnikoff
Chairman, Committee for Scotland: Professor Colin Galbraith Director, RSPB Scotland: Anne McCall Regional Director: George Campbell
The RSPB is a registered Charity: England & Wales no 207076, Scotland no SC037654

The proposed location is adjacent to the Gaitnip Hill Local Nature Conservation Site (LNCS) which has been classified for supporting nationally important species such as hen harrier, short-eared owl, curlew and lapwing. Given the proximity and scale of the development, Gaitnip Hill LNCS and the species it supports is likely to impacted by the development through disturbance from construction and operational activity due to increased noise, lighting and vehicle movements. We would therefore welcome inclusion of this site in the Environmental Impact Assessment Report (EIAR).

Climate

We are surprised that the development's impact on climate change has been scoped out of further analysis based on the rationale that there will be a negligible impact from the development, which includes the construction of a large new quay, reclaimed laydown area and new access road. Whilst the development includes the provision of suitable handling facilities for renewable energy components and the storage of alternative fuels, it would also facilitate future oil and gas supply operations (see section 2.2.1 of the Scoping Report). Given the Scottish Government's ambitious targets for net-zero emissions by 2045, we consider further analysis of the carbon-cost of this development and the indirect climate impacts should be included in the EIAR.

Biosecurity

The scoping report makes no mention of Biosecurity. This is an important matter – invasive non-native species can spread quickly, damage human health and overwhelm native ecosystems. It can also result in substantial economic expenditure on control and eradiation under the Environmental Liability (Scotland) Regulations, the "polluter pays" principle. As highlighted in NatureScot's Marine Biosecurity planning report,[1] there is now a legal requirement to take all reasonable steps and all due diligence to avoid "*causing an animal to be in a place outwith its native range*", and "*planting or causing any plant species to grow in the wild outwith its native range*", [2] which includes through the accidental transfer and spread on non-native species. We recommend Biosecurity is fully considered and advise that the measures to avoid and prevent this possible significant adverse effect on the environment, along with any proposed monitoring arrangements, are included within the scope of the Ecology chapter within the EIAR.

Cumulative Impacts

A screening consultation was carried out in July 2020 for a further development at Scapa Pier (planning reference **20/239/SCR**). Although this is at an early stage, an assessment of what cumulative impacts may occur should both developments be granted permission should be included in the EIAR. Additionally, the cumulative impact assessment should include all other existing and planned developments with the potential to impact upon Scapa Flow pSPA.

We hope you find these comments helpful. Should you wish to discuss of any of the above please do not hesitate to contact me.

Yours sincerely,

JWells

Josephine Wells
Conservation Officer
josephine.wells@rspb.org.uk.

---

[1] Payne, R.D., Cook, E.J. and Macleod, A. (2014). Marine Biosecurity Planning – Guidance for producing site and operation-based plans for preventing the introduction of non-native species. Report by SRSL Ltd. in conjunction with Robin Payne to the Firth of Clyde Forum and Scottish Natural Heritage

[2] Wildlife and Natural Environment (Scotland) Act 2011 (legislation.gov.uk)

NatureScot
Scotland's Nature Agency
Buidheann Nàdair na h-Alba

Ms Margaret Gillon
Orkney Islands Council

Sent by email to: planningconsultation@orkney.gov.uk

Your ref: 21/160/SCO
Our ref: CEA162869

21 May 2021

Dear Ms Gillon,

The Town & Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017
Scoping opinion to excavate hillside and reclaim land to create a laydown area, construct a deep water pier and an access road – Bay of Deepdale, Scapa Flow, Orkney

Thank you for your email of 26 April 2021, requesting our scoping advice for the above proposal and for granting an extension to the consultation deadline.

Summary
We advise that there is the potential for this proposal to result in significant adverse effects on the Scapa Flow proposed Special Protection Area (pSPA). **If it is not possible to mitigate these impacts then we may object to the proposal**.

Background
We were previously consulted on the Strategic Environment Assessment (SEA) and Habitats Regulations Appraisal (HRA) of the Orkney Harbour Masterplan, of which this proposal is a component. Considerable advice was given on the potential impacts from this proposed development on the natural heritage and we encourage the applicant to review the Post Adoption Statement and HRA, as well as the advice provided, to help inform the Environmental Impact Assessment (EIA).

We have also subsequently provided advice to the applicant on wintering bird survey methodology. However, we have not seen a final methodology from the applicant or any survey results. It was made clear in our advice that the draft methodology reviewed would not be suitable to inform project level assessment but could be used to supplement existing survey work to inform the design of project level surveys or pre-application.

Scoping Advice
Based on the information provided in the Scoping Report, we have concerns that potentially significant impacts to the natural heritage from this proposed development have not been recognised.

There are potentially significant impacts on ecological interests of international importance that may be difficult to mitigate. In particular, the most significant natural heritage interests likely to be affected are the features of the Scapa Flow pSPA. We have provided advice to the applicant on the assessment of these impacts, particularly wintering bird survey methods. We are keen to continue to support the applicant in progressing the EIA and in the development of mitigation where possible.

It is noted in the Scoping Report that the applicant wishes to scope out all ecological receptors from full assessment within the EIA apart from 'marine mammals and their prey during the construction phase only'. At this stage, due to the location and scale of the development, and with no details on proposed construction methodology and mitigation, it is not possible in our opinion to scope out the majority of ecological receptors from full assessment.

Furthermore, it is unclear how impacts from certain construction activities such as dredge spoil disposal and use of explosives to reconfigure coastline will be assessed as these options will not be determined until later in the process following Site Investigations. Therefore, at this stage it is not possible to judge likely impacts unless a clear worst case scenario (Rochdale envelope approach) be defined with respect to these and other relevant aspects of the proposal against which potential impacts can be assessed.

Details on the key natural heritage issues and specific comments on the scope of work required in relation to these is provided in the annex to this letter. Our advice is proportionate to the information presented in the Scoping Report. With respect to the scope of the EIA more generally, please refer to our advice note[i].

Habitats Regulations Appraisal (HRA)

There appears to be some confusion in the Scoping Report over the HRA process. As detailed above considerable advice was given to the applicant on the HRA of the Orkney Harbour Masterplan and we advise the applicant to review this advice. Further information on the HRA process is available on our website[ii].

Our advice is given without prejudice to a full and detailed consideration of the impacts of the proposal if it is submitted as a formal application.

The advice in this letter is provided by NatureScot, the operating name of Scottish Natural Heritage.

I hope you find these comments helpful. Should you wish to discuss this response then please don't hesitate to contact me.

Yours sincerely,

Kim McEwen
Operations Officer – Northern Isles and North Highland
Kim.mcewen@nature.scot
01463 701671

Annex 1. We advise that the proposed development raises the following key issues in relation to natural heritage.

European Protected Areas

The proposed development is likely to have a significant effect on qualifying interests of the Scapa Flow pSPA, Hoy SPA, Orkney Mainland Moors SPA, Loch of Stenness Special Area of Conservation (SAC) and Sanday SAC. Therefore, effects on these sites features should be assessed for all phases of the development in the EIAR, as well as HRA. The EIA must provide sufficient information for the Competent Authority to be able to undertake appropriate assessments in view of these site's conservation objectives for their qualifying interests. Details of qualifying interests and conservation objectives can be found on our website[iii].

Scapa Flow pSPA

The proposal is located within the Scapa Flow pSPA designated for its breeding red-throated diver and non-breeding black-throated diver, eider, goldeneye, great northern diver, long-tailed duck, red-breasted merganser, shag and Slavonian grebe. Potential impacts to features may arise from the permanent displacement of birds from the development footprint; disturbance of birds in the vicinity of the proposal during site investigation, construction and/or operational phases and the temporary or permanent loss of or damage to prey-supporting habitats in the development vicinity or at dredge spoil disposal sites. Of potentially greater importance than direct impacts is the associated increased levels of vessel traffic that are the intended consequence of the proposal. Many of the features of this site exhibit high or very high levels of behavioural sensitivity to vessel movements and the potential for impact on site integrity is highest for those species with relatively high levels of habitat specialisation and/or relatively small populations within this site. This includes black-throated diver, red-throated diver and Slavonian grebe. It remains unclear how the nature, routing and frequency/volume of vessel traffic through the Scapa Flow pSPA are anticipated to change as a consequence of this development. Therefore, it is important that the EIA and HRA also includes an assessment of these wider operational phase impacts.

Hoy SPA

The proposal has connectivity to cliff-nesting seabird interests of the Hoy SPA, including fulmar, great-black backed gull, great skua, common guillemot, kittiwake and puffin, as well as breeding red-throated diver. The proposal is well within foraging ranges of the cliff-nesting seabird features of the Hoy SPA and there is potential for disturbance to these features, although likely sensitivities are less than for wintering waterbirds. The footprint of the proposal itself is outwith the 10km foraging range for breeding red-throated diver associated with the Hoy SPA. However, as detailed above increased vessel traffic associated with the proposal within wider parts of Scapa Flow could have connectivity to the Hoy SPA population and should be assessed.

Orkney Mainland Moors SPA

The proposal is within 10km of parts of the Orkney Mainland Moors SPA, and hence potentially within the foraging range of breeding red-throated divers from this site, although actual diver nesting locations within the SPA may be more distant. Associated vessel movements across wider parts of Scapa Flow could have connectivity to red-throated divers from this site and should also be assessed.

North Orkney SPA
We would not consider there to be any connectivity for assessment purposes with the North Orkney pSPA, unless there are associated vessel movements during the construction phase (e.g. to deliver equipment or materials or to remove dredge spoil). If this is the case then information on the features of this site can be found on our website[iii].

Loch of Stenness Special Area of Conservation (SAC)
The Loch of Stenness SAC is designated for its coastal lagoon feature and is of particular importance due to its large size and northern location. There is connectivity between the proposal and the SAC, and the potential that invasive non-native species could be introduced during construction or operation. Therefore, in our view, there is the potential for significant effects on this protected area.

Sanday SAC
The proposal is located within the 50km buffer radii of the Sanday SAC designated for harbour seal. Therefore, we would consider any harbour seal present within Scapa Flow to be connected to this SAC and should be assessed.

In order to comply with the Habitats Regulations, **Habitats Regulations Appraisals will have to demonstrate that the proposed development will not adversely affect the integrity of European Sites** listed above.

Sites of Special Scientific Interest (SSSI)
A number of the European sites detailed above are also designated as SSSIs. The designated features of these SSSIs that may be affected by the proposal are the same features covered by the European site designations and thus impacts to these features should be covered. The only exception to this is Waulkmill SSSI located approximately 7km west of the proposal, whose saltmarsh feature could be affected. This site may need to be considered in further detail when information is available on potential impacts to coastal processes and dredge spoil disposal.

Ornithology
As detailed above the proposal has the potential to impact upon a number of SPAs designated for marine birds. It is not clear from Section 5.5.2 exactly what terrestrial and marine bird surveys are proposed and in which season. Autumn through spring (September/October to April) surveys will be required for wintering waterbird features of the Scapa Flow pSPA. In addition, the new proposed location has a shallower water depth than the original location at Gaitnip and as such is potentially of greater importance to foraging red-throated diver in the breeding season. Surveys to determine usage of the development footprint and surrounding area by red-throated divers in the main chick-rearing period (late June to mid-August) would be helpful to assessing potential impacts for this species.

For a development of this scale and location we would recommend two years of bird survey to inform impacts to marine birds. However, one year may be sufficient depending on the results of the first year's survey. We recommend that the applicant provides details of the findings of the first relevant year's surveys, including full analyses and consideration of any relevant additional contextual or supporting information, in sufficient time to enable us to advise on the requirement for a second years survey.

Although we have previously provided advice to the applicant on aspects of the marine survey work required we have not yet seen a final survey methodology. Therefore, we would be keen to review methodology prior to survey work commencing to ensure that it is sufficient to inform the development.

Section 5.6.2 of the Scoping report suggests that the proposed area of terrestrial works is within grazing land that contains limited foraging opportunities for a low range of species and as such are being scoped out of the EIA. While the nature of the land is pasture, this does not necessarily imply it has no value. Furthermore, the proposal is located immediately adjacent to the Gaitnip Hill, Holm Local Nature Conservation Site designated for a number of breeding birds, including Schedule 1 hen harrier, merlin and short-eared owl. In addition, peregrine may be utilising this undeveloped coastline for foraging and breeding. Therefore, we recommend that simple survey work over the area, with an appropriate buffer zone of 500m around the site layout would adequately characterise the species present. A single year's survey of terrestrial bird species will be all that is required. At this stage we think it is unlikely that there will be any *terrestrial* bird cumulative impacts but this should be explicitly stated in the EIAR if this is the case.

European Protected Species (EPS)
Otter
It is noted and welcomed that an otter survey will be undertaken. We have advice on survey requirements, mitigation and licensing on our website[iv]. If any impacts on otters are identified then mitigation measures should be provided in a Species Protection Plan.

Cetaceans
As detailed in Section 5.2.3 of the Scoping Report all species of dolphin, porpoise and whale are EPS. However, the list of species to be scoped in for assessment should also include humpback, fin, sperm, long-finned pilot and sei, curvier's beaked whale along with striped dolphin. Marine mammals, including cetaceans should be scoped in for all phases of the development. We previously provided advice on underwater noise modelling as part of the consultation on the Orkney Harbour Masterplan, and can provide further advice to the applicant if required. Mitigation should be proposed relating to the findings of this modelling and the applicant should be made aware that they may require a licence.

Benthic ecology and Priority Marine Features (PMF)
There is limited existing information available regarding benthic species and habitats present in the vicinity of the proposal. However, there are known kelp beds, a PMF, in the immediate vicinity that may be affected. Given the limited data and scale of the proposal we recommend survey work is undertaken to inform the EIA. The purpose of surveys would be to establish the benthic habitats and species present at the development location with particular focus on identifying presence of any PMFs. Where PMFs are identified, the extent and quality (e.g. condition, density etc.) of the features should be confirmed to help inform assessment. A combination of video/photo methods and grab sampling would be appropriate, but of these two methods collection of video/photo data would be the priority. We can provide further advice to the applicant on video survey methodology if required.

Seals
We agree that there is the potential for impacts to both grey and harbour seals from the proposed development but at this stage we recommend impacts to seals are assessed for all phases of the development. As mentioned above harbour seals in Scapa Flow may be connected to the Sanday SAC. Furthermore, the proposal is within a harbour seal conservation area[v] and there are a number of

designated seal haul-outs close to the proposal. Information on designated seal haul-outs can be found on the NMPi website[vi]. As above we previously provided advice to the applicant on underwater noise modelling and can provide further advice if needed. Mitigation should be proposed relating to the findings of this modelling.

Basking shark
There is no mention of basking shark within the Scoping Report. Basking sharks are a protected fish species and PMF, and regularly sighted in Scapa Flow. Therefore, an assessment on potential impacts on this species should be undertaken as part of the EIA and any mitigation should be detailed in the EIAR. The applicant should be made aware that they may require a basking shark licence.

Intertidal habitat
Section 5.3 of the Report identifies the potential for negative impacts on intertidal and subtidal habitats during construction through direct loss but there is no further mention of assessment within the Report. Our advice regarding subtidal habitats is covered above but impacts to the intertidal habitat should also be included within the EIAR.

Marine Invasive Non-Native Species (mINNS)
There is no mention of mINNS or biosecurity within the Scoping Report and we recommend that the potential impacts of mINNS be considered in the EIAR. There is the potential for introduction and spread of mINNS as a result of the proposed development during construction and operation. Furthermore, a number of mINNS are already present in Orkney waters and activities during construction and operation could facilitate spread. We recommend that site-based biosecurity plans for the proposal at the construction and operational phases to assist with managing the spread and introduction of mINNS are produced. There are a wide range of additional potential biosecurity measures that could be developed and we would be happy to advise further and on biosecurity plans if required.

Landscape and visual
Due to the location and scale of the proposal, including the potential for large vertical structures to be present during construction and operation, it is recommended that potential impacts on the Hoy and West Mainland National Scenic Area (NSA) is given further consideration in the EIAR.

Climate change
It is noted in Section 3.3.1 of the Report that it is proposed to exclude climate change impacts on the grounds that any negative impacts would be insignificant, as the facility may be used to support decarbonisation of marine fuels and support future offshore windfarm developments. However, it states in Section 2.2.1 potential use of the facility by the oil and gas sector. Due to the scale of the development we would expect some impacts from construction. If there are potentially significant positive or negative climate change benefits, including from the construction phase, these should be considered within the EIA.

Coastal processes
It states in Section 4.6 of the Scoping Report that it is not anticipated for the development to lead to any significant changes to coastal processes and thus a qualitative assessment is all that’s required. At present, due to the scale of the development and without any detailed information regarding construction methodology, dredge spoil disposal, impacts from coastal reconfiguration from use of explosives or

appropriate mitigation measures, it is recommended that potential impacts on coastal processes and subsequent impacts on benthic habitat and foraging marine birds are assessed within the EIA.

Site investigation phase

Section 3.2 states that appraisals will consider the potential environmental impacts related to both the construction and operational phases, where applicable. Just to note that there is mention of a site-investigation phase within the Report and thus potential impacts relating to site investigation works should be included in the assessment where appropriate, in particular with respect to marine and terrestrial birds.

Cumulative Assessment

We note the intention of undertaking a cumulative assessment as part of the EIA, cumulative impacts will also need to be assessed as part of the HRA. Section 3.4 of the Scoping Report focusses on cumulative assessment with regards to other proposed harbour developments. However, the cumulative assessment needs to take into consideration other sectors including aquaculture, renewable energy developments, cable installations etc… further information on cumulative assessment was provided to the applicant as part of the consultation on the Orkney Harbour Masterplan. We consider that the Orkney Islands Council are best placed to advise the applicants on which proposals to include in the cumulative assessment.

Monitoring

Depending on the results of the ecological survey work to inform the development and on mitigation proposed it may be worth highlighting at this stage that ongoing surveys may be required to monitor construction and operational impacts.

Assessment of alternatives

The EIAR should also include an assessment of alternative locations or layouts to the proposed development.

Biodiversity enhancements

As part of the SEA process it was hoped that consideration could be given to the inclusion of opportunities for environmental enhancement as well as economic and social benefits. Potential examples of this was provided as part of the SEA consultation and we would be happy to discuss this further with the applicant.

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[i] https://www.nature.scot/handbook-environmental-impact-assessment-guidance-competent-authorities-consultees-and-others

[ii] https://www.nature.scot/professional-advice/planning-and-development/environmental-assessment/habitats-regulations-appraisal-hra

[iii] https://sitelink.nature.scot/home

[iv] https://www.nature.scot/professional-advice/planning-and-development/planning-and-development-advice/planning-and-development-protected-species

[v] https://marine.gov.scot/information/conservation-areas-common-seals

[vi] https://marinescotland.atkinsgeospatial.com/nmpi/default.aspx?layers=446

Scoping Application Consultation

Planning Authority Name	**Orkney Islands Council**
Date of Consultation	**26th April 2021**
Response required by	**17th May 2021**
Planning Authority Reference	**21/160/SCO**
Nature of Proposal (Description)	**Scoping opinion request to excavate hillside and reclaim land to create a laydown area, construct a deep water pier and an access road**
Site	**Bay Of Deepdale, Scapa Flow, Orkney**
Site Postcode	**N/A**
Site Gazetteer UPRN	
Proposal Location Easting	**345223**
Proposal Location Northing	**1004096**
Area of application site (Metres)	**311269**
Clarification of Specific Reasons for Consultation	
Development Hierarchy Level	**N/A**
Supporting Documentation URL	http://planningandwarrant.orkney.gov.uk/online-applications/ Please enter - 21/160/SCO
List of Available Supporting Documentation	**As above URL**
Offline Documents available?	**N/A**
Date of Validation by Planning Authority	**16th April 2021**
Governing Legislation	**THE TOWN AND COUNTRY PLANNING ENVIRONMENTALIMPACT ASSESSMENT (SCOTLAND) REGULATIONS 2017**
Consultation Type	**Scoping**
Consultation Stage	**N/A**
Is this a re-consultation of an existing application?	**No**
EIA Required	**Yes**
EIA Regulations	**Yes**
Use Class (Current)	
Use Class (Proposed)	
Does the application conform with the Structure Plan / Local	

Plan Land Use	
Additional Comments relating to Structure Plan / Local Plan Use	**N/A**
Transport Assessment or Travel Plan	**N/A**
Applicant Name	**Orkney Islands Council**
Applicant Organisation Name	
Applicant Address	
Agent Name	**EnviroCentre Ltd**
Agent Organisation Name	
Agent Address	
Agent Phone Number	**N/A**
Agent Email Address	**N/A**
PA Office	**Development Management**
Case Officer	**Ms Margaret Gillon**
Case Officer Phone number	**01856 873535 EX 2505**
Case Officer email address	**margaret.gillon@orkney.gov.uk**
PA Response To	**planningconsultation@orkney.gov.uk**

Fluvial Flood Risk

There is no indication of significant flood risk outwith watercourse channels within the development area.

Coastal Flood Risk

The proposed quay edge level of 5.31m Above Ordnance Datum is higher than both the predicted 1:200 and 1:000 year event extreme sea levels plus climate change allowance by what appears to be a reasonable margin. However, current UK extreme sea level data (UK Coastal Flood Boundary data) for Scapa Flow is not considered to be reliable – **significantly under-estimating** values for Burray and South Ronaldsay, for example.

It is hoped that SEPAs forthcoming revised coastal flood mapping will go some way to addressing problems identified with the UK Coastal Flood Boundary data for Scapa Flow and the Pentland Firth but the modelled data will need to be verified with measured data. It is therefore recommended that particular attention is paid to obtaining the best possible predicted tide level data for the development site and to obtaining recorded data for verification purposes.

When reliable, verified maximum still water levels have been obtained, allowances to account for predicted sea level change over the anticipated lifetime of the development and wave action should be applied.

PW

Scoping Application Consultation

Planning Authority Name	**Orkney Islands Council**
Date of Consultation	**26th April 2021**
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List of Available Supporting Documentation	**As above URL**
Offline Documents available?	**N/A**
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Governing Legislation	**THE TOWN AND COUNTRY PLANNING ENVIRONMENTALIMPACT ASSESSMENT (SCOTLAND) REGULATIONS 2017**
Consultation Type	**Scoping**
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Is this a re-consultation of an existing application?	**No**
EIA Required	**Yes**
EIA Regulations	**Yes**
Use Class (Current)	
Use Class (Proposed)	
Does the application conform with the Structure Plan / Local	

Plan Land Use	
Additional Comments relating to Structure Plan / Local Plan Use	**N/A**
Transport Assessment or Travel Plan	**N/A**
Applicant Name	**Orkney Islands Council**
Applicant Organisation Name	
Applicant Address	
Agent Name	**EnviroCentre Ltd**
Agent Organisation Name	
Agent Address	
Agent Phone Number	**N/A**
Agent Email Address	**N/A**
PA Office	**Development Management**
Case Officer	**Ms Margaret Gillon**
Case Officer Phone number	**01856 873535 EX 2505**
Case Officer email address	**margaret.gillon@orkney.gov.uk**
PA Response To	**planningconsultation@orkney.gov.uk**

The scoping report has very little information in relation to the effects that this development will have on the existing public road infrastructure, given that the proposal includes the construction of a new access road and the realignment of the A961 this indicates that the development is highly likely to have a significant impact on the existing public road infrastructure. Therefore the effects of both construction traffic and operational traffic on the public road network must be identified and considered in any EIA that may be submitted as part of the planning process.

D.W.

Appendix 2

Cumulative Schemes for consideration in the EIA Report

Planning reference	Address	Description of Development	Status
20/037/TPPMAJ	Quanterness (Land Near), St Ola, Orkney.	Erect 6 wind turbines (maximum height 149.9 metres, maximum wind farm capacity 50MW), erect a meteorological mast (maximum height 90 metres) and a substation, create an access and construct access tracks, and associated infrastructure.	Awaiting decision – called in by Scottish Government.
20/313/TPPMAJ	Lyness (land near), Hoy, Orkney	Erect 6 wind turbines (maximum height 149.9 metres, maximum wind farm capacity 50MW), erect a meteorological mast (maximum height 90 metres) and a substation, construct access tracks, a water crossing and underground cabling, create a borrow pit, and associated infrastructure.	Awaiting decision – called in by Scottish Government.
20/239/SCR	Scapa Pier, Scapa, Orkney.	Screening opinion request to extend a pier and reclaim land to create laydown and operational area	Screening opinion adopted 19.03.21.

		and slipway.	
15/409/MAR	Scapa Flow, Near Tongue of Westerbister, Holm.	Create a salmon farming site, comprising 16 x 100m circumference cages, 2 x 8 in a 60m grid and include a feed barge.	Approved 10.02.16.

TECHNICAL APPENDIX 3.3

marinescotland

Scottish Government
Riaghaltas na h-Alba
gov.scot

T: +44 (0)300 244 5046
E: MS.MarineLicensing@gov.scot

Marine Scotland - Licensing Operations Team Scoping Opinion

Scoping Opinion adopted by the Scottish Ministers under Part 4 of The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017

Orkney Island Council Harbour Authority

Scapa Deep Water Quay Development

21 October 2021

Contents

1. Introduction

1.1 Background

1.1.1 On 31 March 2021, the Scottish Ministers received a scoping report ("the Scoping Report") from Orkney Island Council Harbour Authority ("the Applicant") as part of its request for a scoping opinion relating to Scapa Deep Water Quay Development ("the Proposed Works"). In accordance with regulation 14 of The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017 ("the 2017 MW Regulations") the Scottish Ministers considered the content of the Scoping Report to be sufficient.

1.1.2 This scoping opinion is adopted by the Scottish Ministers under the 2017 MW Regulations ("the Scoping Opinion") in response to the Applicant's request and should be read in conjunction with the Scoping Report. The matters contained in the Scoping Report have been carefully considered by the Scottish Ministers and use has been made of professional judgment, based on expert advice from stakeholders and Marine Scotland in-house expertise and experience. This Scoping Opinion identifies the scope of impacts to be addressed and the method of assessment to be used in the Environmental Impact Assessment Report ("EIA Report") for the Proposed Works. The Scottish Ministers, in adopting this Scoping Opinion, have, in accordance with the 2017 MW Regulations, taken into account the information provided by the Applicant, in particular, information in respect of the specific characteristics of the Proposed Works, including its location and technical capacity and its likely impact on the environment. In addition, the Scottish Ministers have taken into account the representations made to them in response to the scoping consultation they have undertaken. In examining the EIA Report, and any other environmental information, the Scottish Ministers will seek to reach an up to date reasoned conclusion on the significant effects on the environment from the Proposed Works. This reasoned conclusion will be considered as up to date if the Scottish Ministers are satisfied that current knowledge and methods of assessment have been taken account of. For the avoidance of doubt, this Scoping Opinion does not preclude the Scottish Ministers from requiring the Applicant to submit additional information in connection with any EIA Report submitted with applications for marine licences under the Marine (Scotland) Act 2010 ("the 2010 Act"). In the event that the Applicant does not submit applications for marine licences under the 2010 Act for the Proposed Works within 12 months of the date of this Scoping Opinion, the Scottish Ministers strongly recommend that the Applicant seeks further advice from them regarding the validity of the Scoping Opinion.

2. The Proposed Works

2.1 Introduction

2.1.1 This chapter provides a summary of the description of the Proposed Works provided by the Applicant in the Scoping Report together with the Scottish Ministers' general comments in response. The details of the Proposed Works in the Scoping Report have not been verified by the Scottish Ministers and are assumed to be accurate.

2.2 Description of the Proposed Works

2.2.1 The Proposed Works comprises of the creation of a deep water quay and laydown area in the Bay of Deepdale, located approximately 4 kilometres ("km") south of Scapa Pier, before Holm and by Deepdale. The site is currently untouched coastline. The Proposed Works include dredging, construction, the deposit or use of explosives and the deposit or removal of substances or objects in the Scottish marine area.

2.2.2 The Proposed Works will include the creation of a 575 metres ("m") quayside with water depth of -15 m Chart Datum ("CD"), a 110 m x 75 m quay extension with a water depth of -20 m CD and the formation of 18 hectares ("Ha") of laydown area – not including the quay areas. The laydown area includes aspects both above and below mean high water springs ("MHWS").

2.2.3 The Proposed Works will be completed in three phases. Phases 2 and 3 may be switched in ordering. Each phase consists of the following;

Phase 1

- Excavation of current landform which may require pre-treatment through drilling and controlled delayed explosives,
- Reclamation of the shore to form a 12 Ha laydown area,
- Bunds on the northern and eastern edges of reclaimed land which include geotextile and armour stone,
- Tubular and sheet piles installed by vibro-hammer for quay works
- Construction of a quay 300 m x ~46 m wide, this will have a 100 m wide section on the northern edge creating a 450 m berthing,
- Dredging adjacent to the newly formed quay (21 500m^2 to -15 m CD), and sea deposit of dredge material where it is unsuitable for infill in laydown or use in construction.

Phase 2

- Excavation of current landform which may require pre-treatment through drilling and controlled delayed explosives,
- Reclamation of shore to form an additional 12 Ha of laydown area to the south of the Phase 1 laydown area,
- Extension of a bund on the eastern edge to be extended along the length of the new laydown area and partially along the southern edge,
- Tubular and sheet piles installed by vibro-hammer for quay works,

- Extension of the Phase 1 quay area by 275 m x ~46 m to the south,
- Dredging adjacent to the newly formed quay extension to provide -15 m CD water depth (16 500m^2) and sea deposit of dredge material where it is unsuitable for infill in laydown or use in construction.

Phase 3

- Construction of a 110 m x 75 m quay extension on the northern edge of Phase 1 quay out to a depth of -20 m CD,
- Tubular and sheet piles installed by vibro-hammer for quay works,
- Dredging on the northern side of the newly formed quay extension to provide -20 m CD water depth (13 800m^2).

2.2.4 The Proposed Works aim to avoid sea deposit of dredge material as much as possible through the inclusion of dredge material and removed land into the construction and/or land reclamation requirements. However dredge material may be deposited at a suitably designated site if absolutely necessary.

2.2.5 Impact hammer piling might be required in phases 1 and 2. Works are estimated to take place over several months for phases 1 and 2.

2.2.6 It is noted that the Scoping Report lists the licensable marine activities but does not clearly establish which activities or aspects of activities are below MHWS and all activities for which ‘regulatory approval’ will be sought.

2.3 Onshore/Planning

2.3.1 The Scottish Ministers are aware the Applicant has sought a separate scoping opinion from Orkney Island Council for the associated onshore works. It is essential that the EIA Report concerning onshore works will be available at the time that the EIA Report for the Proposed Works is being considered so that all the information relating to the project as a ‘whole’ is presented. The EIA Report for the Proposed Works must consider the cumulative impacts with the onshore works.

2.3.2 The Scottish Ministers advise that the EIA Report must be explicitly clear about what licensable marine activities are proposed to be carried out below MHWS during the Proposed Works and must also detail which activities could overlap with the Local Authority’s remit.

2.4 The Scottish Ministers’ Comments

Description of the Proposed Works

2.4.1 The Scottish Ministers note that a Strategic Environmental Assessment (“SEA”) and Habitat Regulations Appraisal (“HRA”) were undertaken for the Orkney Harbours Masterplan which included the Proposed Works. A detailed review of environmental baselines was undertaken covering a number of receptors and taking into account responses from consultees. An assessment of the impact of the Proposed Works on these receptors was also completed as part of the SEA. This information has not been considered or presented in the Scoping Report sufficiently. Further advice was also provided by consultees on survey methodologies to address areas of potential concern. The Scottish Ministers advise that these surveys should have been undertaken to evidence the scoping and justify which receptors are scoped in or out of the EIA Report. The Scottish Ministers also note that mitigation and monitoring was proposed as part of the SEA, which takes into consideration the consultation responses. This information has also not been included in the Scoping Report and no justification has been provided as to why these measures are no longer appropriate. The Scottish Ministers would expect inclusion of baseline assessments, surveys and results, ongoing monitoring and proposed mitigation to be included in the Scoping Report. Without satisfactory evidence being provided to justify scoping a receptor out, the precautionary principle has been applied and that receptor has been scoped in. Furthermore, without this information, the Scottish Ministers are unable to provide targeted advice on the content of the Scoping Report. This might increase the risk of additional information being required under the 2017 MW Regulations to ensure completeness and quality of the EIA Report. The Scottish Ministers advise that the assessments from the SEA and plan level HRA should be used to inform the EIA Report and that all previously identified mitigation and monitoring should be included or a justification provided as to why they are no longer appropriate.

2.4.2 Furthermore, the Scottish Ministers acknowledge the Applicant’s intention to apply a ‘Design and Build’ approach but note that there is still a lack of detail of the construction methodology. The Applicant has not included any quantities, or estimation of quantities of materials to be used in the construction or dredging activities. There is also no information on the types of material to be used in the construction works, and very limited information on the duration of the Proposed Works. The Scottish Minister’s advice can only be based on the information provided.

2.4.3 The Scottish Ministers advise that worst case scenario in terms of impacts to each receptor must be considered in the EIA Report.

2.4.4 The Scottish Ministers do not consider ‘suitably won material’ as a sufficient description and require further information on what materials are to be used in construction and what materials may require deposit at sea in a designated sea deposit site. In Section 2.2.2 of the Scoping Report it is proposed that the design principle will attempt to balance dredging with construction and/or land reclamation and in Section 2.2.3 of the Scoping

Report it is proposed that a site investigation will be undertaken to determine the best practicable environmental opinion for the use of the dredge material. The Scottish Ministers advise that this must be undertaken early to inform the options for use of the dredge material. The Scottish Ministers advise that particle analysis and chemical analysis must be undertaken to determine suitability of use and/or deposit at sea. The Applicant must consider alternative options in case the dredge material is not suitable for use in construction and/or land reclamation and must clearly detail all options. The Scottish Ministers advise that the environmental impacts of whichever material is used must be assessed in the EIA Report including but not limited to the transport of materials to site. If road transport of materials is required, the Applicant should refer to the advice from Transport Scotland regarding assessments that may be required. If, at the time of writing the EIA Report, there is still any uncertainty, the Scottish Ministers advise that the worst case scenario must be defined and assessed.

2.4.5 The Scottish Ministers also advise that any impacts relating to site investigation works must be included in the assessment.

2.4.6 Section 2.2.3 of the Scoping Report proposes that the construction phase will be awarded as a Design and Build and it will therefore be detailed within the Design Envelope of the EIA Report. The Scottish Ministers advise that the EIA Report should provide a full and detailed description and consideration of the nature and scope of the construction and operational phases, including the types of activities for which regulatory approval is required, their frequency, and how activities will be carried out for the Proposed Works. This should include consideration for the potential overlapping of activities with those required for the Hatston Pier proposal and any other proposed activity in the vicinity.

2.4.7 Section 2.2.3 of the Scoping Report considers the potential use of explosives, piling and drilling alongside the other potentially noisy construction and operational aspects. The Scottish Ministers advise that the Applicant must undertake underwater noise modelling to assess the impact of all potentially noisy aspects of the Proposed Works on all receptors likely to be susceptible to them, including but not limited to; marine mammals, fish and birds. The Scottish Ministers advise the worst case scenario for underwater noise should be assessed and mitigation proposed. The Scottish Ministers advise that the EIA Report should make clear whether or not blasting is required and in what circumstances.

2.4.8 The Scottish Ministers note the Applicant has acknowledged the Water Framework Directive (“WFD”) and the requirement to ensure that there is no deterioration in the quality of surface or groundwater bodies. The Applicant also acknowledges that the construction and dredging associated with the Proposed Works have the potential to cause changes to the current hydromorphological conditions. The Scottish Ministers advise that there is currently insufficient evidence to determine if there will be an impact on the waterbody status. The Applicant states that the site of the Proposed Works is considered low energy and has an absence of fine sediment however has not provided sufficient evidence of this. The Applicant has not provided information on the material to be used in the construction aspects or the composition of the dredge material, nor has any consideration been given to the impact of blasting. The Applicant must assess the impacts of the Proposed Works on the waterbody status and demonstrate that the Proposed Works will not alter the status of the waterbody. The Scottish Ministers advise the Applicant should consider reviewing the Clearing the Waters for All guidance for England and recommends applying this to the Proposed Works. If you require assistance on how to assess the morphological impacts please get touch with MS-LOT.

Design Envelope

2.4.9 The Scottish Ministers note the Applicant's intention to apply a 'design and build' approach whereby the construction methodology will not be confirmed until a contractor is appointed. Where the details of the Proposed Works cannot be defined precisely, the Applicant must apply a worst case scenario. This has not been set out in the Scoping Report.

2.4.10 The Scottish Ministers advise that the Applicant must make every attempt to narrow the range of options. Where flexibility in the design envelope is required, this must be defined within the EIA Report and the reasons for requiring such flexibility clearly stated. At the time of application, the parameters of the Proposed Works should not be so wide-ranging as to represent effectively different projects. To address any uncertainty, the EIA Report must consider the potential impacts associated with each of the different scenarios. The criteria for selecting the worst case and the most likely scenario, together with the potential impacts arising from these, must also be described. The parameters of the Proposed Works must be clearly and consistently defined in the applications for the marine licences and the accompanying EIA Report.

2.4.11 The Scottish Ministers will determine the applications based on the worst case scenario. The EIA will reduce the degree of design flexibility required and the detail may be further refined in a Construction Method Statement ("CMS") to be submitted to the Scottish Ministers, for their approval, before works commence. Please note however, the information provided in Chapter 7 below regarding multi-stage regulatory approval. The CMS will 'freeze' the design of the project and will be reviewed by the Scottish Ministers to ensure that the worst case scenario described in the EIA Report is not exceeded.

2.4.12 It is a matter for the Applicant, in preparing the EIA Report, to consider whether it is possible to robustly assess a range of impacts resulting from a large number of undecided parameters. If the Proposed Works or any associated activities materially change prior to the submission of the EIA Report, the Applicant may wish to consider requesting a new scoping opinion.

Alternatives

2.4.13 The EIA Regulations require that the EIA Report include ‘a description of the reasonable alternatives (for example in terms of project design, technology, location, size and scale) studied by the Applicant, which are relevant to the proposed works and its specific characteristics, and an indication of the main reasons for selecting the chosen option, including a comparison of the environmental effects’. The Scottish Ministers note that the Applicant’s Scoping Report did not indicate any consideration of alternatives.

2.4.14 For the avoidance of doubt, the Scottish Ministers advise that the EIA Report must include an up to date consideration of the reasonable alternatives studied as the parameters of the Proposed Works have been refined. The Scottish Ministers expect this to comprise a discrete section in the EIA Report that provides details of the reasonable alternatives studied across all aspects of the Proposed Works and the reasoning for the selection of the chosen option(s), including a comparison of the environmental effects.

3. Contents of the EIA Report

3.1 Introduction

3.1.1 This chapter provides the Scottish Ministers' general comments on the approach and content of information to be provided in the Applicant's EIA Report, separate to the comments on the specific receptor topics discussed in Section 5 of this Scoping Opinion.

3.2 EIA Scope

3.2.1 Matters are not scoped out unless specifically addressed and justified by the Applicant and confirmed as being scoped out by the Scottish Ministers. The matters scoped out should be documented and an appropriate justification provided in the EIA report.

3.2.2 The Scoping Report lacks detail in construction methodology and the worst case scenario of the Proposed Works and has not detailed any alternatives for the Proposed Works. Additionally, detailed baseline information has not been included nor specifics of proposed mitigation. The Scoping Report fails to identify all relevant receptors which should have been considered. The Scottish Ministers have therefore been unable to justify scoping out the majority of receptors in their entirety.

3.3 Mitigation and Monitoring

3.3.1 Any embedded mitigation relied upon for the purposes of the assessment should be clearly and accurately explained in detail within the EIA Report. The likely efficacy of the mitigation proposed should be explained with reference to residual effects. The EIA Report must identify and describe any proposed monitoring of significant adverse effects and how the results of such monitoring would be utilised to inform any necessary remedial actions.

3.3.2 It is noted that mitigation and monitoring presented in the SEA has been omitted from the Scoping Report. The Scottish Ministers consider the SEA and input to it from consultees to be relevant and consider that the mitigation should have been included in the Scoping Report. Furthermore, the Scottish Ministers acknowledge that the SEA included aims to undertake landscape revegetation and habitat enhancement as part of the proposed mitigation measures to enhance environmental protection and improve the quality of the environment. These aims were supported by consultees and the Scottish Ministers advise that consideration of biodiversity enhancements be considered in the proposed mitigation measures.

3.3.3 The EIA Report should clearly demonstrate how the Applicant has had regard to the mitigation hierarchy, including giving consideration to the avoidance of key receptors. The Scottish Ministers advise that where the mitigation is envisaged to form part of a management or mitigation plan, the EIA Report must set out these plans or the reliance on these in sufficient detail so the significance of the residual effect can be assessed and evaluated. This should also include identification of any monitoring and remedial actions (if relevant) in the event that predicted residual effects differ to actual monitored outcomes. Commitment to develop plans without sufficient detail is not considered to be suitable mitigation in itself.

3.3.4 The EIA Report must include a table of mitigation which corresponds with the mitigation identified and discussed within the various chapters of the EIA Report and accounts for the representations and advice attached in Appendix I.

3.3.5 Where potential impacts on the environment have been fully investigated but found to be of little or no significance, it is sufficient to validate that part of the assessment by detailing in the EIA Report, the work that has been undertaken, the results, what impact, if any, has been identified and why it is not significant.

3.4 Risks of Major Accidents and/or Disasters

3.4.1 The EIA Report must include a description and assessment of the likely significant effects deriving from the vulnerability of the Proposed Works to major accidents and disasters. The Applicant should make use of appropriate guidance, including the recent Institute of Environmental Management and Assessment (“IEMA”) ‘Major Accidents and Disasters in EIA: A Primer’, to better understand the likelihood of an occurrence and the Proposed Works susceptibility to potential major accidents and hazards. The description and assessment should consider the vulnerability of the Proposed Works to a potential accident or disaster and also the Proposed Works potential to cause an accident or disaster.

3.4.2 The Scottish Ministers advise that existing sources of risk assessment or other relevant studies should be used to establish the baseline rather than collecting survey data and note the IEMA Primer provides further advice on this. This should include the review of the identified hazards from your baseline assessment, the level of risk attributed to the identified hazards and the relevant receptors to be considered.

3.4.3 The assessment must detail how significance has been defined and detail the inclusions and exclusions within the assessment. Any mitigation measures that will be employed to prevent, reduce or control significant effects should be included in the EIA Report.

3.5 Climate and Greenhouse Gases

3.5.1 The Scoping Report proposes that the impact of climate change effects will not be significant and there will be no standalone topic or chapter on climate change in the EIA Report. The Scottish Ministers are however mindful that Greenhouse Gas (“GHG”) emissions from all projects contribute to climate change. In this regard, the Scottish Ministers highlight the IEMA Environmental Impact Assessment Guide “Assessing Greenhouse Gas Emissions And Evaluating Their Significance” (“IEMA GHG Guidance”), which states that “GHG emissions have a combined environmental effect that is approaching a scientifically defined environmental limit, as a such any GHG emissions or reductions from a project might be considered significant.” The Scottish Ministers have considered this together with the Climate Change (Emissions Reduction Targets) (Scotland) Act 2019 and the requirement of the EIA Regulations to assess significant effects from the Proposed Works on climate. The Scottish Ministers therefore advise that the EIA Report must include a GHG Assessment which should be based on a Life Cycle Assessment (“LCA”) approach and note that the IEMA GHG Guidance provides further insight on this matter. The Scottish Ministers highlight however that this should include the pre-construction, construction, operation and decommissioning phases, including consideration of the supply chain as well as benefits beyond the life cycle of the Proposed Works. This view is supported by NatureScot and Royal Society for Protection of Birds (“RSPB”) during the scoping consultation.

4. Consultation

4.1 The Consultation Process

4.1.1 Following receipt of the Scoping Report, the Scottish Ministers, in accordance with the 2017 MW Regulations, initiated a 30 day consultation process, which commenced on 21 April 2021. The following bodies were consulted, those marked in bold provided a response:

- UK Chamber of Shipping
- Crown Estate Scotland
- **Defence Infrastructure Organisation (Ministry of Defence) ("MOD")**
- Fisheries Management Scotland ("FMS")
- Health and Safety Executive
- **Historic Environment Scotland ("HES")**
- Holm Community Council
- Kirkwall Fisheries Office
- Marine Safety Forum
- **Maritime and Coastguard Agency ("MCA")**
- **NatureScot (operating name of Scottish Natural Heritage)**
- **Northern Lighthouse Board ("NLB")**
- Orkney Harbour Authority
- **Orkney Island Council ("OIC")**
- Orkney Marine Planning Partnership
- Orkney Sustainable Fisheries
- **Royal Society for the Protection of Birds**
- **Royal Yachting Association ("RYA")**
- **Scottish Environment Protection Agency ("SEPA")**
- Scottish Fishermen's Federation
- Scottish Fishermen's Organisation
- **Scottish Water**
- Scottish Wildlife Trust
- Visit Scotland
- Whale and Dolphin Conservation

4.1.2 Specific advice was sought from Marine Scotland Science ("MSS"), the Marine Scotland – Marine Analytical Unit ("MAU"), Marine Planning and Policy ("MPP") and Transport Scotland, including Transport Scotland Ports and Harbours ("TS").

4.2 Responses received

4.2.1 From the list above a total of 10 responses were received. Advice was also provided by MSS, MAU and TS. The purpose of the consultation was to seek representations to aid the Scottish Ministers' consideration of which potential effects should be scoped in or out of the EIA Report.

4.2.2 The Scottish Ministers are satisfied that the requirements for consultation have been met in accordance with the 2017 MW Regulations. The chapters below highlight issues which are of particular importance with regards to the EIA Report and any marine licence applications. The representations and advice received are attached in Appendix I and each must be read in full for detailed requirements from individual consultees. In addition, an updated representation from MOD was received and again is attached within Appendix I.

5. Interests to be considered within the EIA Report

5.1 Introduction

5.1.1 This chapter contains the Scottish Ministers' opinion on whether the impacts identified in the Scoping Report are scoped in or out of the EIA Report. The Scottish Ministers advise that the representations from consultees and advice from MAU, MSS and TS must be considered in conjunction with the Scoping Opinion and with the expectation that recommendations and advice as directed through this Scoping Opinion are implemented.

5.2 Water Environment and Coastal Processes

5.2.1 The Applicant's consideration of the potential impacts on the water environment and coastal processes during the construction and operation phases of the Proposed Works is detailed in Sections 4.4 to 4.6 of the Scoping Report. Consideration of whether they should be scoped in or out of further assessment within the EIA Report is detailed in Section 9 of the Scoping Report. The Applicant proposes to undertake qualitative assessment of coastal processes and water quality for both the construction and operational phases in the EIA Report. The Applicant proposes to scope out coastal flood risk. The Applicant defines the water environment as hydrology, hydrogeology and water quality, whilst coastal processes are defined as tides, waves and sediment transport processes. References to the water environment and coastal processes made by the consultees in this chapter should be considered to adopt the same definitions.

5.2.2 The Applicant proposes to consider the impact of the Proposed Works on wave action, tidal current and sediment transportation under the qualitative assessment for coastal processes. The Applicant considers the site of the Proposed Works to have low energy and no significant transport of sediment and therefore does not consider this study area to need fully scoped in. The Scottish Ministers agree with NatureScot that there is not currently enough information on the construction methodology, dredging and deposit of dredged material or the impacts from coastal reconfiguration or coastal processes from the use of explosives to assess the impacts of these activities. The Scottish Ministers therefore consider coastal processes, including full assessment of wave action, tidal current and sediment transportation, must be scoped in and assessed in the EIA Report. This view is supported by representations from NatureScot, OIC and MSS advice. In addition, the Scottish Ministers agree with the OIC's representation regarding further assessment of the sediment proposed to be dredged, the proposed method of deposit of dredged material and associated risks and therefore advise the Applicant to fully consider and address these comments within the EIA Report.

5.2.3 The representations from NatureScot and the OIC recommend that potential impacts on coastal processes, as defined in the Scoping Report, and subsequent impacts on benthic habitats, sensitive habitats – particularly Priority Marine Features ("PMF") and foraging marine birds be assessed for the construction, dredging and deposit of dredged material and impacts from coastal reconfiguration from the deposit and use of explosives aspects of the Proposed Works. The Scottish Ministers agree with NatureScot and the OIC's representation and highlight the OIC's recommendation of undertaking benthic surveys to assist with determining proximity of the Proposed Works to and interactions with potentially sensitive habitat features. The OIC also recommend the use of an existing hydrodynamic model of Scapa Flow to assist with the coastal processes assessment. Benthic habitats and PMF's will be considered further in Chapter 5.10.

5.2.4 The Applicant notes there is potential for significant effects including changes in infiltration rates, flood risk, drainage and contamination of the water environment from spillages, runoff or sediment transfer during both construction and operation phases of the Proposed Works. The Applicant states that the site of the Proposed Works is in a low energy area and there will be limited dredging taking place and therefore proposes to consider the potential impact of dredging on water quality and the production of suspended sediment under a qualitative assessment for the water environment. The Scottish Ministers do not consider a qualitative assessment sufficient to address these potentially significant effects.

5.2.5 The Applicant notes that the development of the Proposed Works has the potential to generate pollutants which could impact water quality and the prevention of pollution during both the construction and operational phases of the Proposed Works will be a key focus of the EIA. The Scottish Ministers agree that the prevention of pollution should be addressed in the EIA Report and are content with the proposed adherence to best practice, the creation of a pollution prevention plan and surface water management plan. However the Scottish Ministers do not consider a qualitative assessment sufficient to address the potential effects on the water environment and therefore this study area must be scoped in for further assessment for all phases of the Proposed Works within the EIA Report. The view is supported by representation from the OIC and MSS. The Scottish Ministers advise that the Applicant must consider the chemistry of the dredge material and the impact dredging such material will have on the water environment.

5.2.6 The Scottish Ministers agree with the OIC that consideration should be given to any planned onsite storage of excavated soils which may pose a risk to the nearby Burn of Deepdale / Button and associated drainage ditches, as well as the marine environment. The Scottish Ministers direct the Applicant to representation from the OIC for further information on this risk.

5.2.7 The Applicant considers that coastal flood risk should be scoped out from both phases of the Proposed Works due to the scale of the Proposed Works having a negligible impact on local sea levels. The Scottish Ministers advise that due to the lack of detail in the specifics of the Proposed Works that flood risk cannot be scoped out. In its representation SEPA referred to previous advice on Flood Risk Assessment provided on the Proposed Works which welcomed the commitment from the Applicant to undertake a detailed Flood Risk Assessment. The Scottish Ministers consider this to form part of SEPA's advice and advises this should be included in EIA Report.

5.2.8 The Scottish Ministers agree with NatureScot that the mitigation measures are not sufficient or appropriate. The Scottish Ministers note that the measures identified in the Scoping Report are limited in detail and it is therefore difficult to provide advice on.

5.2.9 The Scottish Ministers advise that coastal processes and water environment are scoped in for further assessment within the EIA Report for construction and operational phases. The Scottish Ministers advise that coastal processes and water environment are addressed as two separate chapters within the EIA Report. Within the scope of coastal processes the following should be assessed for both construction and operation phases as a minimum; wave action, tidal current and sediment transportation, this should include impacts coastal processes have on benthic habitats. Within the scope of water environment the following should be assessed for both construction and operation phases as a minimum; changes in infiltration rates, flood risk, drainage, contamination of the water environment from spillages, runoff or sediment transfer.

5.3 Ecology

5.3.1 The Applicant's consideration of the potential impacts on ecology during the different phases of the Proposed Works and whether they should be scoped in or out of further assessment within the EIA Report are detailed in Sections 5.3, 5.4, 5.6 and 9 of the Scoping Report. The Applicant has assessed terrestrial habitats and species, birds and marine habitats, fish and mammals under the heading of ecology and proposes the above receptors will be scoped out except for marine mammals and their prey which will be scoped in. The Scottish Ministers will consider individual ecological receptors in the following chapters.

5.3.2 For the avoidance of doubt the Scottish Ministers advise all of the following ecology receptors be scoped in for full assessment in the EIA Report for construction and operational phases, except for otters which may be scoped out if NatureScot's advice is followed. In addition the Scottish Ministers highlight NatureScot's representation regarding monitoring and advise the Applicant to consider the possible requirement of ongoing surveys to monitor impacts of the Proposed Works.

5.4 Designated Sites

5.4.1 The Applicant details the designated sites Orkney Mainland Moors Special Protection Area ("SPA"), the North Orkney proposed SPA ("pSPA") and the Scapa Flow pSPA in the baseline assessment under Section 5.2.1 of the Scoping Report. Consideration of whether these sites should be scoped in or out of further assessment within the EIA Report are detailed under the heading 'Birds' in Sections 5.6.2 and 9 of the Scoping Report. The Scottish Ministers do not agree with the Applicant's proposal to scope birds out of the EIA Report and note that undertaking a HRA to assess any potential likely significant effects on the qualifying species of the North Orkney pSPA and the Scapa Flow pSPA is not sufficient. This chapter will address Designated Sites whilst consideration relating directly to the study of Ornithology will be addressed in Chapter 5.6 below.

5.4.2 The Scottish Ministers agree with representation from NatureScots, RSPB, the OIC and advise that full consideration and assessment of the potential impact of the Proposed Works on the Scapa Flow pSPA, Hoy SPA, Orkney Mainland Moors SPA, Loch of Stenness Special Area of Conservation ("SAC") and Sanday SAC must be fully considered in the EIA Report. The Scottish Ministers direct the Applicant to NatureScot's comments on the potential for significant adverse effects on the Scapa Flow pSPA and the possibility of NatureScot objecting if these concerns are not addressed. The Scottish Ministers therefore direct the Applicant to engage with NatureScot to address these concerns.

5.4.3 The Scottish Ministers agree with the views of NatureScot that there is not enough information to scope Designated Sites out of the EIA Report. The Scottish Ministers therefore advise European Protected Areas must be scoped in for further assessment within the EIA Report for construction and operation phases, including the wider operational phases as detailed by NatureScot. The Scottish Ministers advise that the scoping in of European Protected Areas does not negate the requirement for a full HRA to be submitted as well.

5.5 Sites of Special Scientific Interest

5.5.1 The Applicant has not given consideration to Sites of Special Scientific Interest ("SSSI"). The Scottish Ministers direct the Applicant to representation from NatureScot and advise consideration of SSSI's is addressed as part of the assessment of European Protected Areas for sites covering both designations. Additionally, the Scottish Ministers note Waulkmill SSSI which is not covered by any other site designation and therefore must be considered independently. This view is supported by NatureScot.

5.5.2 The Scottish Ministers advise that SSSI are scoped in for further assessment within the EIA Report for construction and operational phases.

5.6 Ornithology

5.6.1 The Applicant considers the potential significant effects on birds in Sections 5.3 and 5.4 and considers whether birds should be included in the EIA Report in Sections 5.6.2 and 9 of the Scoping Report. The Applicant proposes to scope birds out of the EIA Report but undertake a HRA to assess any potential likely significant effects on the qualifying species of the North Orkney pSPA and the Scapa Flow pSPA. The Scottish Ministers do not consider this to be sufficient. This chapter will address Ornithology whilst consideration relating to Designated Sites is addressed in Chapter 5.4 above.

5.6.2 The Scottish Ministers highlight representation from NatureScot, RSPB, the OIC and advice from MSS who consider there to be potential for impact on a number of SPA’s and pSPAs designated for marine bird species. The Scottish Ministers agree with the views of NatureScot and consider there not to be enough detail in the Scoping Report regarding bird surveys and proposed survey timings. The Scottish Ministers advise the Applicant to fully consider representation from NatureScot and MSS advice regarding bird surveys and advise that the Applicant must engage with NatureScot to ensure methodologies are appropriate prior to survey work being undertaken.

5.6.3 The Scottish Ministers advise that Ornithology is scoped in for further assessment within the EIA Report for site investigation, construction and operational phases.

5.7 Otter

5.7.1 The Applicant considers otters in Sections 5.5.1 and 5.6.1 of the Scoping Report under ‘Terrestrial Habitats and Species’. The Applicant proposes scoping terrestrial habitats and species out. This Scoping Opinion will only address the otter aspect of terrestrial habitats and species.

5.7.2 The Scottish Ministers are content with the proposal to scope otters out from further assessment in the EIA Report on the basis that the Applicant will undertake a pre-construction otter survey. The Scottish Ministers advise the Applicant to review and adhere to NatureScot and OIC’s comments on otters and to refer to NatureScot’s website for further information on requirements.

5.8 Marine Mammals – Cetaceans

5.8.1 The Applicant's consideration of potential impacts on marine mammals during different stages of the Proposed Works are detailed in Sections 5.3 and 5.4 and proposed mitigation in Section 5.5.3, consideration of whether to scope in marine mammals is found in Sections 5.6.3 and 9 of the Scoping Report. The Applicant proposes to scope in marine mammals and their prey for further assessment in the EIA Report for the construction phase only. This chapter will deal with cetaceans only. Seals and marine mammals prey will be dealt with in Chapters 5.9, 5.12 and 5.14 below.

5.8.2 The Scottish Ministers agree with the Applicant's proposal to scope in marine mammals and their prey for the construction phase. The Scottish Ministers however do not agree with the proposal to scope marine mammals and their prey out for the operational phase. The Scottish Ministers refer to representations from NatureScot and MSS advice regarding which cetacean species should be scoped in for further assessment within the EIA Report and advise there not to be enough evidence provided to only scope in the cetacean species listed in the Scoping Report. The Scottish Ministers highlight representation from the OIC that details potential impacts on cetacean species due to the location and nature of the Proposed Works, including the possibility of panic, confusion, temporary disorientation and potential for stranding due to noise disturbance in a semi-enclosed area such at the site of the Proposed Works. The Scottish Ministers therefore agree with representation from NatureScot that consideration of all cetacean species listed by NatureScot in its representation should be fully considered in the EIA Report.

5.8.3 The Scottish Ministers recommend using available information to assess baseline density estimates to inform the baseline study of presence / absence, abundance and other relevant ecological data and refer the Applicant to the MSS advice and recommendations of publications to assist in an accurate baseline study.

5.8.4 The Scottish Ministers agree with the representation from NatureScot regarding the potential impact on cetaceans from underwater noise and advise full implementation of the advice provided by MSS regarding underwater noise modelling. In addition, the Scottish Ministers advise the EIA Report must consider the impact from construction activities, including vibropiling, use of explosives, and impact piling if there is any potential that impact piling will be required, and the Applicant must adhere to the MSS advice regarding the undertaking of a quantitative assessment to assess the underwater noise, the results of which should be used to develop a mitigation plan. The Scottish Ministers advise the Applicant to consider the MSS advice regarding mitigation plans and implement it into the EIA Report and recommend the Applicant engage with both NatureScot and MSS for further advice on noise modelling techniques.

5.8.5 The Scottish Ministers consider vessel presence should be scoped in for construction and operational phases for further assessment in the EIA Report. In addition, careful consideration should be given to minimising vessel presence at the site of the Proposed Works to reduce disturbance to marine mammals. The Scottish Ministers recommend adopting a vessel management plan.

5.8.6 The Scottish Ministers agree with NatureScot's recommendation that the following should be scoped in for further assessment in the EIA Report for site investigation, construction (including dredge and deposit of material) and operational phases; a full assessment of any potential impacts on cetaceans, underwater noise and vessel presence. Furthermore, the Scottish Ministers alert the Applicant to the potential requirement for a licence to disturb European Protected Species.

5.9 Marine Mammals – Seal

5.9.1 The Applicant considers seals under the heading 'Marine Mammals' in Section 5.2.3 and the potential impact upon seals during different stages of the Proposed Works are detailed in Sections 5.3 and 5.4, proposed mitigation in Section 5.5.3 and consideration of whether to scope in marine mammals in Section 5.6.3 and Section 9 of the Scoping Report. The Scottish Ministers agree with the Applicants proposal to scope seals in for further consideration within the EIA Report during the construction phase however do not agree with the proposal to scope seals out of consideration for the operational phase.

5.9.2 The Scottish Ministers direct the Applicant to the representations from NatureScot, the OIC and MSS advice in relation to impacts for seals and advise that these must be fully addressed. The Scottish Ministers highlight representation from NatureScot and MSS regarding the proximity of the Proposed Works to the Sanday SAC, designated for harbour seals, and note the site also falls within a harbour seal conservation area. The OIC confirm there are a number of designated and non-designated but well known haul out areas in the vicinity of the Proposed Works. Additionally, the Scottish Ministers draw attention to the serious decline in harbour seal numbers around Scotland in recent years. The OIC add that both grey and harbour seals are susceptible to disturbance, especially during pupping season. The Scottish Ministers agree with views of the OIC and NatureScot and advise careful consideration be applied to address the decline of harbour seals and the importance of not subjecting them to additional pressures. Additionally the Scottish Ministers direct the Applicant to representations from NatureScot and the OIC regarding noise modelling and advise the Applicant to contact NatureScot for further advise on modelling and mitigation.

5.9.3 The Scottish Ministers advise that there are likely to be impacts on both grey and harbour seals arising from the Proposed Works and therefore seals must be scoped in for further assessment in the EIA Report for site investigation, construction and operational phases.

5.10 Benthic Ecology, Intertidal and Subtidal Habitats and Priority Marine Features

5.10.1 The Scottish Ministers do not consider that sufficient information has been given to benthic ecology, intertidal and subtidal habitats and PMF’s. The Applicant briefly considers potential impacts on benthic communities in Sections 5.3 and 5.4 of the Scoping Report. The Applicant has referenced intertidal habitats and noted the UK Biodiversity Action Plan / Local Biodiversity Action Plan (“LBAP”) habitat Coastal vegetated shingle but has not included other intertidal habitats. Benthic ecology, intertidal and subtidal habitats and PMF’s have not been addressed further in consideration of whether they should be scoped in or out.

5.10.2 The Scottish Ministers direct the Applicant to the representations from NatureScot, the OIC and MSS in relation to the lack of knowledge of benthic species and habitats present in the vicinity of the Proposed Works and the resulting requirement for survey work to be undertaken and advise that this must be fully addressed by the Applicant. The Scottish Ministers highlight the requirement that particular focus should be given to identifying presence of PMF’s and advise the Applicant that full adherence to the advice on surveying methods and extent provided by NatureScot and MSS must be applied to inform the EIA Report. If further advice is required on video surveying techniques the Applicant should contact NatureScot. For the avoidance of doubt, the Scottish Ministers advise that the Applicant must undertake in-depth surveys of benthic habitats and species in the intertidal and subtidal areas, with a particular focus on PMF’s. The Scottish Ministers refer the Applicant to the Scottish Biodiversity List and Orkney LBAP to assist in identification of intertidal habitats that might be present in the area of the Proposed Works.

5.10.3 The Scottish Ministers advise the Applicant to include consideration of impacts of the Proposed Works detailed in representation from MSS in the assessment of benthic ecology, intertidal and subtidal habitats and PMF’s. This includes an assessment of the permanent loss of benthic habitats and rocky intertidal shoreline, temporary increase in turbidity from dredging and consideration of release of contaminated sediment during dredging. The Scottish Ministers advise that if further clarity is required on the advice provided by MSS and / or on what impacts should be assessed then the Applicant should engage with MSS through MS-LOT. The Scottish Ministers advise the Applicant to adhere to the advice from MSS and include a description and map of the benthic, intertidal and subtidal habitats in the area of the Proposed Works, with particular focus on PMF’s and the Habitats Directive Annex I features.

5.10.4 Further to the consideration of benthic species and habitats in intertidal and subtidal areas, the Scottish Ministers highlight representation from MSS regarding the HMS Royal Oak and recommend the Applicant includes modelling of sediment plumes arising from the dredging aspect of the Proposed Works. The Scottish Ministers advise the Applicant that inclusion of this and whether sediment plumes reach the artificial reef must be assessed to inform the EIA Report. If the sediment plumes reach the artificial reef then the impact of the temporary increase in turbidity must be assessed.

5.10.5 The Scottish Ministers agree with views of the OIC and NatureScot that benthic ecology, intertidal and subtidal habitat and PMF’s be scoped in for further assessment in the EIA Report for construction and operational phases. The Scottish Ministers advise the following impacts be scoped in for further assessment; permanent loss of benthic habitats, rocky intertidal shoreline and subtidal habitats, temporary increase of turbidity from dredging and smothering of benthic species within the distance of sediment plumes, including the potential of these plumes reaching HMS Royal Oak and consideration of the release of contaminated sediment during dredging and impact on surrounding species and habitats. Furthermore, the Scottish Ministers advise that the impact coastal processes have on benthic ecology, as detailed in Chapter 5.2.9, be scoped in for assessment in the EIA Report.

5.11 Basking Shark

5.11.1 The Applicant does not provide any consideration of the impact on basking shark in the Scoping Report. The Scottish Ministers direct the Applicant to representation from NatureScot and the OIC highlight that basking shark are a protected fish species and PMF and are regularly sighted in Scapa Flow. The Scottish Ministers draw the attention to the requirement for a licence to disturb or injure basking sharks and advise that an assessment of the potential impact of the Proposed Works on basking sharks must be assessed.

5.11.2 The Scottish Ministers advise consideration of the OIC’s comment and recommend reviewing the Orkney Wildlife Information and Recording Centre to assist in the baseline survey of basking shark. This information should be used to assess the potential impact on basking shark at all stages of the Proposed Works.

5.11.3 The Scottish Ministers advise that basking shark are scoped in for further assessment in the EIA Report for construction and operational phases.

5.12 Marine Fish Ecology

5.12.1 The Scottish Ministers do not consider that sufficient consideration has been given to the impact of the Proposed Works on marine fish and are unclear exactly which fish are proposed to be considered in the EIA Report. The Scottish Ministers note Section 5.2.4 mentions sea trout and confirms that baseline data on fish will be collated which, along with marine mammals and their prey, will be included in further assessment for the EIA Report. The Scottish Ministers agree with the proposal to undertake baseline data collection on fish and with the inclusion of marine mammal prey for further assessment in the EIA Report for the construction phase.

5.12.2 The Scottish Ministers do not consider that inclusion of marine fish which are prey to marine mammals to be sufficient consideration of marine fish ecology and therefore advise that the Applicant must consider all marine fish for further assessment within the EIA Report. The Scottish Ministers direct the Applicant to representation from MSS regarding inclusion of individual marine fish species, identification of PMF's, consideration of Essential Fish Habitats and consideration of fish spawning and nursery periods. The Scottish Ministers advise that the Applicant must fully address their comments within the EIA Report. In addition, the Scottish Ministers advise consideration be given to the potential negative impacts on marine fish species for both construction and operational phases.

5.12.3 The Scottish Ministers advise that that marine fish ecology is scoped in for further assessment within the EIA Report for construction and operational phases. The Scottish Ministers advise that mitigation measures that are beneficial to fish species should be considered.

5.13 Commercial Fisheries

5.13.1 The Applicant states that there are many commercial sea fish caught in the area of the Proposed Works but has not given further consideration to commercial sea fisheries in the Scoping Report. The Scottish Ministers do not consider there to be sufficient information to scope commercial fisheries out and therefore advise that commercial fisheries be scoped in for further assessment in the EIA Report for construction and operational phases.

5.14 Diadromous Fish

5.14.1 The Scottish Ministers note in Section 5.2.4 the mention of sea trout and confirmation that baseline data on fish will be collated to inform further assessment for the EIA Report. The Scottish Ministers agree with the proposal to undertake baseline data collection on fish and with the inclusion of marine mammal prey for further assessment in the EIA Report for the construction phase. The Scottish Ministers however do not consider this assessment to be sufficient to address impacts of the Proposed Works on diadromous fish.

5.14.2 The Applicant has not given consideration to either salmon or eel which, along with sea trout, are all of high conservation value nationally and internationally. The Scottish Ministers advise that if there is a lack of information on the distribution and abundance of sea trout, salmon and eel in Orkney coastal waters then survey work is required to provide local information. In addition, the Scottish Ministers agree with representation from NatureScot that it is not possible to scope diadromous fish out from further consideration within the EIA Report due to the scale and location and lack of detail provided in the methodology of the Proposed Works.

5.14.3 The Scottish Ministers advise that diadromous fish must be scoped in for further assessment in the EIA Report for construction and operational phases. The Scottish Ministers recommend engaging with Orkney Trout Fishing Association, Fisheries Management Scotland and MSS through MS-LOT for further advice to assist in the assessment of diadromous fish and ensure appropriate surveys will be undertaken.

5.15 Biosecurity – INNS

5.15.1 The Applicant has not considered biosecurity or marine invasive non-native species (mINNS) in the Scoping Report. The Scottish Ministers note that there are currently a number of mINNS present in the area of the Proposed Works and there is high potential for the introduction and spread of mINNS during the construction and operational phases of the Proposed Works. The Scottish Ministers agree with NatureScot and RSPB and consider that biosecurity and mINNS must be scoped in.

5.15.2 The Scottish Ministers highlight representation from NatureScot regarding the existing presence of mINNS and agree with the view that the Proposed Works have the potential to facilitate spread and advise that this must be considered. In addition, the Scottish Ministers direct the Applicant to the MSS comment regarding the potential for colonisation of the proposed quay wall and advise that consideration of vessels bringing in new mINNS should be assessed.

5.15.3 The Scottish Ministers advise that biosecurity and mINNS are scoped in for construction and operational phases of the Proposed Works and advise that site-based biosecurity plans are produced for both phases of the Proposed Works to assist with managing the spread and introduction of mINNS. The Scottish Ministers advise that the potential for introduction of new mINNS and the potential for spreading existing mINNS should both be considered in further assessment within the EIA Report. Measures to avoid and prevent the introduction and mitigation should be included in this assessment. The Scottish Ministers direct the Applicant to NatureScot for advice on biosecurity plans.

5.16 Archaeology and Cultural Heritage

5.16.1 The Applicants consideration of the potential impacts on archaeology and cultural heritage during the different phases of the Proposed Works and whether they should be scoped in or out of the assessment within the EIA Report are detailed in Tables 6.3 and 6.4 of the Scoping Report. The Scottish Ministers are content with the baseline assessment and agree with the receptors and potential impacts for historic environment detailed and scoped in within Table 6.3 of the Scoping Report.

5.16.2 The Scottish Ministers are content with the proposal to scope in the impacts on heritage assets for both phases as well as scoping in the potential for cumulative effects with the Scapa Pier project. Further, the Scottish Ministers agree with the representation from HES which notes the scoping in and further assessment of the potential effects which may affect cultural heritage assets from dredging and propeller scour should enable the identification of potential significant effects on any debris, stray finds or ordnance which has not been previously identified.

5.16.3 The Applicant notes that further assessment needs to be undertaken to assess the impact on cultural heritage. The Scottish Ministers direct the Applicant to the representation from HES regarding the inclusion of all receptors where the Scoping Report has identified further works that need to be undertaken to understand a potential environmental impact. The Scottish Ministers agree with the view of HES and therefore all receptors which require further works to be undertaken must be scoped in for further assessment within the EIA Report. Further, the Scottish Ministers agree with the representation from HES that even if the results from further investigation indicated there would be no impact on archaeological assets or deposits, this should be included within the EIA Report.

5.16.4 The Scottish Ministers advise that the proposed mitigation strategy is not sufficient to scope out any of the historic environment receptors the Applicant has proposed be scoped out with the use of mitigation. This view is agreed by HES. Further, the Scottish Ministers agree that the EIA Report should include robust mitigation measures for cultural heritage aspects that could experience significant impacts from the works. In its response HES notes that a detailed methodology for assessment of effects on the historic environment has not been provided in the Scoping Report but welcomes the use of guidance in the EIA Handbook for drafting it. The Scottish Ministers advise the Applicant to engage with HES for advice on the methodology. The Scottish Ministers encourage the inclusion of Written Schemes of Investigation in the EIA Report and agree with representation from HES regarding the inclusion of a Protocol of Archaeological Discoveries or other mechanism to assess areas of disturbance for archaeological artefacts.

5.16.5 The Scottish Ministers highlight representation from MOD regarding the wreck of HMS Royal Oak which is located approximately 1km to the northwest of the proposed development, and is a designated war grave with a 200m radius exclusion zone around it. MOD highlight that a request has been made for an update to the Protection of Military Remains Act, to extend the exclusion zone to 350 metres. The Scottish Ministers agree with the view of the MOD that the scoping of cultural heritage assets must take into account this extension for the protection of HMS Royal Oak from any disturbance from the Proposed Works.

5.16.6 The Scottish Ministers advise that archaeology and cultural heritage is scoped in for further assessment within the EIA Report for construction and operational phases. The Scottish Ministers advise that the cumulative effect requires to be fully considered and presented clearly within the EIA Report.

5.17 Seascape, Landscape and Visual

5.17.1 The Applicant lists the potentially significant effects on seascape, landscape and visual resources during construction and operational phases in Section 7.3 and 7.4 and 7.6 and whether they will be considered in the EIA Report in Section 9. The Scottish Ministers agree with the Applicants proposal to scope in seascape, landscape and visual resources for further assessment within the EIA Report. In addition the Scottish Ministers provide the following comments for the Applicant to action.

5.17.2 The Scottish Ministers highlight representation from the OIC regarding the lack of an identified zone of theoretical visibility. The Scottish Ministers agree with representation from NatureScot and the OIC that the potential impacts on the Hoy and West Mainland National Scenic Area should be considered and therefore advise that this must be scoped in for further assessment within the EIA Report. Further, the Scottish Ministers highlight the request by the OIC and advise the Applicant to identify the zone of theoretical visibility and consult the planning authority to identify viewpoints and key receptors.

5.17.3 In addition, the Scottish Ministers highlight the representation made by the OIC regarding the inclusion of cumulative effects. The Scottish Ministers advise that the cumulative effect requires to be fully considered and presented clearly within the EIA Report.

5.17.4 The Scottish Ministers advise that seascape, landscape and visual resources are scoped in for further assessment within the EIA Report for construction and operational phases. This must include assessment of potential impacts on the Hoy and West Mainland National Scenic Area and inclusion of cumulative effects.

5.18 Shipping and Navigation

5.18.1 The Applicants consideration of shipping and navigation is detailed in Section 3.3.3 under Accidents and Natural Disasters which the Applicant proposes is scoped out in Section 9. The Scottish Ministers do not consider this an appropriate consideration of shipping and navigation. The Scottish Ministers agree with representation from MCA and advise shipping and navigation must be considered as its own chapter in the EIA Report.

5.18.2 The Scottish Ministers advise that a Navigational Risk Assessment ("NRA") is undertaken. The Scottish Ministers highlight the representation from MCA and agree with the inclusion of sections on 'shipping and navigation' and 'impact on marine users' in the NRA. Similarly, the Scottish Ministers advise consideration should be given to MCA's comments on the NRA particularly that it should be informed through consultation with the Statutory Harbour Authority and other key stakeholders as considered necessary.

5.18.3 Further to the requirement to include the impact on marine users in the NRA, the Scottish Ministers make reference to the National Marine Plan policy GEN 4 Co-existence and advise it be assessed in the NRA or as a separate section in the EIA Report. The Scottish Ministers advise that the assessment determining how the Proposed Works will co-exist with other marine users must take into account the marine users identified by the OIC in its representation. With consideration of the RYA's advice that recreational boating can be scoped out the Scottish Ministers agree with representations from the MCA and OIC and advise that recreational boating must be included through impact on marine users in the NRA or through co-existence and therefore must be considered within the EIA Report. The Scottish Ministers also acknowledge representation from NLB which advises a full response will be provided to the marine licence applications.

5.18.4 In addition, the Scottish Ministers agree with MCA regarding the inclusion of a robust Safety Management System for the operational phase of the Proposed Works. The Scottish Ministers advise consideration of all MCA comments regarding the Safety Management System and the Port Marine Safety Code.

5.18.5 The Scottish Ministers advise that shipping and navigation impacts during the construction and operational phases must be scoped in further assessment within the EIA Report. For the avoidance of doubt, the Scottish Ministers advise that a NRA, with inclusion of the impacts on other marine users, and a Safety Management System must be considered in the EIA Report

5.19 Population and Human Health

5.19.1 The Scottish Ministers agree that the assessment of population and human health can be scoped out of the EIA Report. The Scottish Ministers however advise that air quality, airborne noise and socio-economic impact will be addressed individually in Chapters 5.20, 5.21 and 5.22.

5.20 Air Quality

5.20.1 The Applicants considers the potential impact on air quality in Section 3.3.2 and proposes air quality be scoped out of both phases in Section 9 of the Scoping Report. The Scottish Ministers agree that the assessment of air quality can be scoped out of the EIA Report. The Applicant notes that the Proposed Works have the potential to impact local air quality in a number of ways with the key issues in relation to traffic emissions from the local road network and dust emissions during the construction. The Scottish Ministers are satisfied with the Applicants proposal to address this through a Dust Management Plan for the construction phase to be included in the Construction Environmental Management Plan. The Scottish Ministers advise that if road transport of dredge material is required the Applicant must refer to the advice from Transport Scotland regarding assessments that may be required.

5.20.2 The Scottish Ministers advise that air quality is scoped out of further assessment within the EIA Report for construction and operational phases.

5.21 Airborne Noise

5.21.1 The Applicant considers the potential impact of airborne noise during the construction and the operational phases of the Proposed Works in Section 8.3, 8.4 and 8.5 of the Scoping Report and whether it should be included in the EIA Report in Section 9. The Scottish Ministers agree that the assessment of airborne noise should be scoped in for the operational phase and should be further assessed within the EIA Report. The Applicant states that a construction noise assessment will be deferred until a contractor is identified and an exact construction methodology is confirmed.

5.21.2 The Scottish Ministers do not agree with the Applicants proposal to not undertake a construction noise assessment until a contractor is appointed. If a final construction methodology has not been decided then the Scottish Ministers require a construction noise assessment be scoped in and further assessed within the EIA Report considering the worst case scenario.

5.21.3 The Scottish Ministers agree with representation from the OIC that airborne noise should be assessed for construction and operational phases of the Proposed Works and this should assess impacts on the amenity of local residents and businesses due to noise.

5.21.4 The Scottish Ministers advise that airborne noise is scoped in for further assessment within the EIA Report for construction and operational phases.

5.22 Socio-Economic

5.22.1 The Applicant has not given consideration to socio-economic impacts of the Proposed Works. The Scottish Ministers direct the Applicant to the representations from the OIC together with the MAU advice in relation to impacts for socio-economics and advise that these must be fully addressed. The Scottish Ministers agree with views of the OIC and MAU that there are likely to be social and economic impacts arising from the Proposed Works and therefore advise socio-economic impacts be scoped in for further assessment in the EIA Report.

5.22.2 The Scottish Ministers advise that a full socio-economic impact assessment must be included in the EIA Report and in completing this, direct the Applicant to the principles outlined in the advice from MAU. Similarly, the Scottish Ministers advise consideration of the OIC's comments regarding what should be included in the socio-economic assessment. Furthermore, the Scottish Ministers advise the Applicant to consult with any other marine users and sectors in the vicinity of the Proposed Works, including marine farms, in the area that might be impacted by the Proposed Works.

5.22.3 The Scottish Ministers advise that social and economic impacts during the construction and operational phases must be scoped in further assessment within the EIA Report.

5.23 Cumulative Assessment

5.23.1 The Applicants consideration of cumulative assessment is detailed in Section 3.4 of the Scoping Report. The Applicant proposes to include consideration of cumulative impacts in each chapter for environmental topics within the EIA Report rather that include a standalone section on cumulative assessment. The Scottish Ministers agree with this proposal. Further, the Scottish Ministers highlight representation from the OIC, NatureScot and RSPB regarding cumulative assessment and advise that the Applicant must consider all of these comments when assessing cumulative assessment, including which projects should be included in the assessment and advise the Applicant to engage with the planning authority to ensure all appropriate developments are considered. In addition the Scottish Ministers highlight NatureScots representation regarding the requirement to include cumulative assessment as part of the HRA.

5.23.2 The Scottish Ministers advise that cumulative impacts must be considered in each relevant chapter within the EIA report.

6. Application and EIA Report

6.1 General

6.1.1 The EIA Report must be in accordance with the 2017 MW Regulations and the Scottish Ministers draw your attention in particular to, regulation 6. In accordance with the 2017 MW EIA Regulations, the Scottish Ministers advise that the EIA Report must be based on this Scoping Opinion.

6.1.2 The Scottish Ministers note the need to carry out an assessment under The Conservation (Natural Habitats, &c.) Regulations 1994. This assessment must be coordinated with the EIA in accordance with the 2017 MW Regulations.

6.1.3 A gap analysis template is attached at Appendix II to record the environmental concerns identified during the scoping process. This template should be completed and used to inform the preparation of the EIA Report. As part of the submission of the EIA Report the Scottish Ministers advise that Applicant must provide confirmation of how this Scoping Opinion is reflected in the EIA Report.

7. Multi-Stage Regulatory Approval

7.1 Background

7.1.1 The 2017 MW Regulations contain provisions regulating the assessment of environmental impacts. A multi-stage approval process arises where an approval procedure comprises more than one stage; one stage involving a principal decision and one or more other stages involving implementing decision(s) within the parameters set by the principal decision. While the effects which works may have on the environment must be identified and assessed at the time of the procedure relating to the principal decision, if those effects are not identified or identifiable at the time of the principle decision, assessment must be undertaken at the subsequent stage.

7.1.2 The definition in the 2017 MW Regulations is as follows: "*application for multi-stage regulatory approval" means an application for approval, consent or agreement required by a condition included in a regulatory approval where (in terms of the condition) that approval, consent or agreement must be obtained from the Scottish Ministers before all or part of the works permitted by the regulatory approval may be begun*".

7.1.3 A marine licence, if granted, by the Scottish Ministers for the Proposed Works, may have several conditions attached requiring approvals etc. which fall under this definition, for example the approval of a CMS. When making an application for multi-stage approval the Applicant must satisfy the Scottish Ministers that no significant effects have been identified in addition to those already assessed in the EIA Report.

7.1.4 If during the consideration of information provided in support of an application for multi-stage regulatory approval the Scottish Ministers consider that the works may have significant environmental effects which have not previously been identified in the EIA Report (perhaps due to revised construction methods or updated survey information), then information on such effects and their impacts will be required. This information will fall to be dealt with as additional information under the 2017 MW Regulations, and procedures for consultation, public participation, public notice and decision notice of additional information will apply.

Signed

Anni Mäkelä

21 October 2021
Authorised by the Scottish Ministers to sign in that behalf.

Appendix I: Consultation Responses & Advice

Please refer to separate document provided alongside the Scoping Opinion

Appendix II: Gap Analysis

Applicant to complete:

Consultee	No.	Point for Inclusion	EIA Report Section	Justification
	1			
	2			
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SCAPA DEEP WATER QUAY EIAR

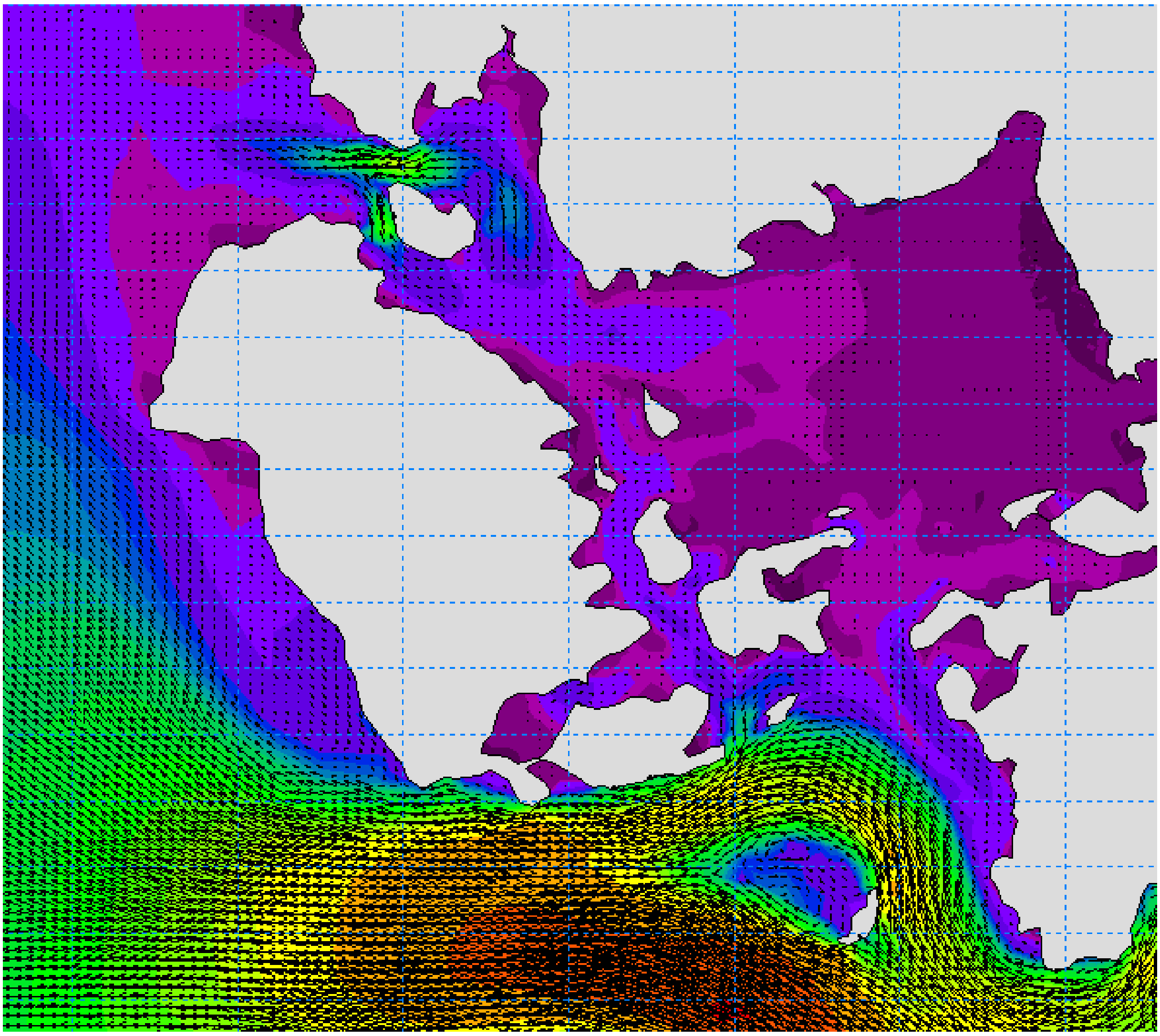
VOLUME 3

TECHNICAL APPENDIX 4

Technical Appendix 4.1	**Coastal Hydrodynamic Modelling Study**
Technical Appendix 4.2	**Significant Wave Height Desktop Study**
Technical Appendix 4.3	**Interpretative Report**
Technical Appendix 4.3.1	**Unexplored Ordnance Survey Report**

TECHNICAL APPENDIX 4.1

Scapa Flow Deep Water Quay
Coastal Hydrodynamic Modelling Study



August 2023

CONTROL SHEET

Client:	Orkney Islands Council Harbour Authority
Project Title:	Scapa Flow Deep Water Quay
Report Title:	Coastal Hydrodynamic Modelling Study
Document number:	13384
Project number:	677674

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EnviroCentre Limited Office Locations:

Glasgow **Edinburgh** **Inverness** **Banchory**

Registered Office: Craighall Business Park 8 Eagle Street Glasgow G4 9XA
Tel 0141 341 5040 info@envirocentre.co.uk www.envirocentre.co.uk

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Contents

Appendices

Figures

Tables

1 INTRODUCTION

1.1 Terms of Reference

EnviroCentre Ltd has been appointed by Orkney Islands Council Harbour Authority (OICHA) to undertake a Coastal Hydrodynamic Modelling Study in support of the Environmental Impact Assessment (EIA) of the proposed new deep water quay at Deepdale Bay, Scapa Flow, Orkney.

1.2 Scope of Report

This study aims to develop a coastal hydrodynamic (HD) model of Scapa Flow, to include Deepdale Bay as well as approaches and surrounding coastal waters. The model will enable simulation and characterisation of tidal flow under pre-development (baseline) and post-development conditions. This report will present details of the baseline coastal conditions at the development site, outline the HD model development, and describe the model simulations and results.

The study will also assess the potential dispersal of sediment plumes from the proposed capital dredging programme. The dredge plume dispersal assessment will involve the use of coupled HD and sediment transport modelling techniques.

1.3 Report Usage

The information and recommendations contained within this report have been prepared in the specific context stated above and should not be utilised in any other context without prior written permission from EnviroCentre Limited.

If this report is to be submitted for regulatory approval more than 12 months following the report date, it is recommended that it is referred to EnviroCentre Limited for review to ensure that any relevant changes in data, best practice, guidance or legislation in the intervening period are integrated into an updated version of the report.

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2 BASELINE CONDITIONS

2.1 Site Location, Existing Condition and Proposed Development

The proposed development site is located at Deepdale Bay, within Scapa Flow, to the south of Kirkwall, Orkney Mainland, as shown in Figure 2-1 and Figure 2-2 below.

The present-day site is undeveloped. The shoreline at the site consists of a rocky intertidal area with stretches of shingle along the upper beach. It lies below steep vegetated slopes, with short sections of vertical rocky cliffs, all less than 15 m high. Beyond the shoreline to the east is a mix of moorland and agricultural fields.

The development of Scapa Deep Water Quay comprises approx. 597m long main quayside berth with general -15m CD water depth, incorporating a 135m quayside pocket with -20m CD water depth. Further north tug (3No.) and pilot boat (2No.) berth approx. 180m long with depths between -6 and -9m CD. Laydown area directly behind quay face approx. 22.85 Hectares. There will also be an access road from the A961 to the site. The main purpose of this facility would be to undertake industrial activities that require both deep-water berthing and a large laydown area.

The proposed development layout is shown in Appendix A.

2.2 Topography and Bathymetry

Topographic and bathymetric survey data is available for the site and surrounds. Bathymetric levels slope from around +3.3 metres relative to Chart Datum (mCD) at the shoreline to around -11mCD at the western boundary of the proposed quay, and -40mCD further out in the centre of Scapa Flow. Bathymetric levels within the modelled extent of the Pentland Firth reach depths below -90mCD. Further information on wider bathymetry and data sources utilised within this modelling study is presented in section 3.3.1 of this report.

2.3 Tidal Water Levels

Tidal water levels at St Mary's, Scapa Flow as presented within the Admiralty tide tables are shown in Table 2-1[1]. The mean tidal range at St Mary's is 2.7m for spring tides and 1.7m for neap tides.

Table 2-1: Tidal water levels at St Mary's Scapa Flow

	Chart Datum (mCD)	Ordnance Datum (mOD)
Highest Astronomical Tide (HAT)	3.8	2.15
Mean High Water Springs (MHWS)	3.3	1.65
Mean High Water Neap (MHWN)	2.6	0.95
Mean Sea Level (MSL)	1.9	0.25
Mean Low Water Neap (MLWN)	1.4	-0.25
Mean Low Water Springs (MLWS)	0.6	-1.05
Lowest Astronomical Tide (LAT)	-0.1	-1.75

*Chart datum correction for Ordnance Datum is -1.65 (relative to OD at Newlyn)

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[1] UK Hydrographic Office, 2023 (Admiralty Tide Tables – Volume 1B)

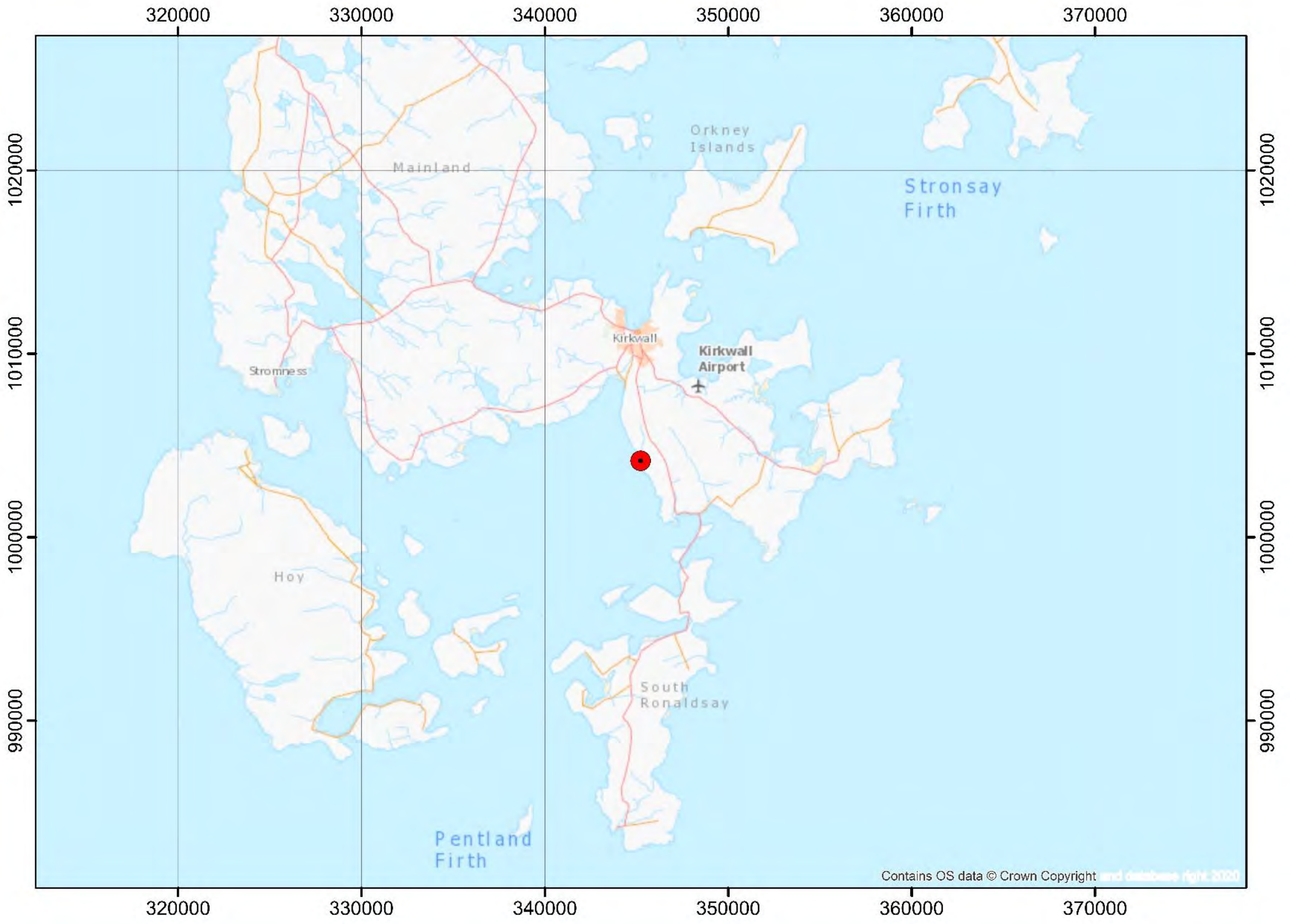

Figure 2-1: Site location shown by red dot

Figure 2-2: Site location within Scapa Flow shown by red dot

Figure 2-3: Satellite imagery of Deepdale Bay (2021)

2.4 Morphology and Geology

Tidal Currents are highest at the southern and western entrances to Scapa Flow, and rapidly dissipate into Scapa Flow, with currents generally weak, particularly so near to Deepdale bay. The relatively narrow openings to Scapa Flow restrict the penetration of swell and waves into Scapa Flow. The wave climate within Scapa Flow is therefore dominated by locally generated wind-waves[2].

Much of the coastline near to Deepdale Bay is fronted by shingle and sand beaches. The European Nature Information System (EUNIS) seabed habitat map shows the dominant seabed habitat around Deepdale Bay to be infralittoral mud and rock with biogenic reef[3]. Rock substrate is shown immediately west of the proposed development location, with gravelly muddy sand substrate located further into Scapa flow [4]. Sediment input to Scapa Flow is limited, with the Churchill Barriers preventing any sediment connectivity from the east. Due to the lack of sediment input, and weak tidal currents, there is therefore little littoral transport other than erosion of existing glacial deposits during extreme events[5].

Analysis of historical coastline alignments show that there have been no major changes to the coastline since 1890 and no significant erosion observed[6].

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[2] Ramsay and Brampton, 2000. Coastal Cells in Scotland: Cell 10 – Orkney.

[3] EUNIS 2017 (https://emodnet.eu/en).

[4] Marine Scotland (https://marinescotland.atkinsgeospatial.com/nmpi/)

[5] Ramsay and Brampton, 2000. Coastal Cells in Scotland: Cell 10 – Orkney.

[6] Dynamic coast online map available at: http://www.dynamiccoast.com/webmap.html

3 HYDRODYNAMIC MODEL DEVELOPMENT

3.1 MIKE 21 Flow Model FM – Hydrodynamic (HD) Module

MIKE 21 Flow Model FM is a modelling package based on a flexible mesh (FM) structure, developed by the Danish Hydraulic Institute (DHI). The modelling system has been developed for applications within oceanographic, coastal and estuarine environments. The Hydrodynamic Module (HD) is the central computational component of the package, solving 2D shallow water equations. The module simulates unsteady flow taking account of bathymetry, sources and external forcing, it consists of continuity, momentum, temperature, salinity and density equations. The latest version of the software, MIKE 2023, has been used within this assessment.

3.2 Model Extent

A HD model has been developed, for which the model extent comprises the coastal waters of Scapa Flow, Hoy Sound, Hoy Mouth, the Sound of Hoxa, the Pentland Firth and North Atlantic as shown in Figure 3-1 below.

Initially the model extent included only the central channel of the Pentland Firth between Orkney and mainland Scotland. However, during the model validation process it was found that this did not sufficiently represent the complex inflow mechanisms into Scapa Flow through the Hoy Sound and the Sound of Hoxa. Expanding the model extents further to the west and east improved the accuracy of the model.

Figure 3-1: MIKE HD model extent (yellow polygon)

3.3 Input Data

3.3.1 Bathymetry

The following bathymetric data has been used within the modelling study:

- UK Hydrographic Office (UKHO) Bathymetric Survey[7]
    - Approaches to Lyness (2007);
    - Flotta (2022);
    - Longhope (2009 – 2010);
    - Scapa Bay 05 (2000 – 2006);
    - Scapa Bay 06 (2000 – 2006);
    - Scapa Flow Area 2a, 2m resolution (2009 – 2010);
    - Scapa Flow Area 2a, 4m resolution (2009 – 2010);
    - Scapa Flow Deepdale (2020 – 2021);
    - Scapa Flow Main Burra, 2m resolution (2009 – 2010).
- European Marine Observation and Data Network (EMODnet) Digital Bathymetry (DTM) - 2020[8]

The datasets have been used to create a combined Digital Terrain Model (DTM) for use within the hydrodynamic model. Snapshots of the DTM with bathymetry displayed relative to Chart Datum are presented in Figure 3-2 and Figure 3-3 below.

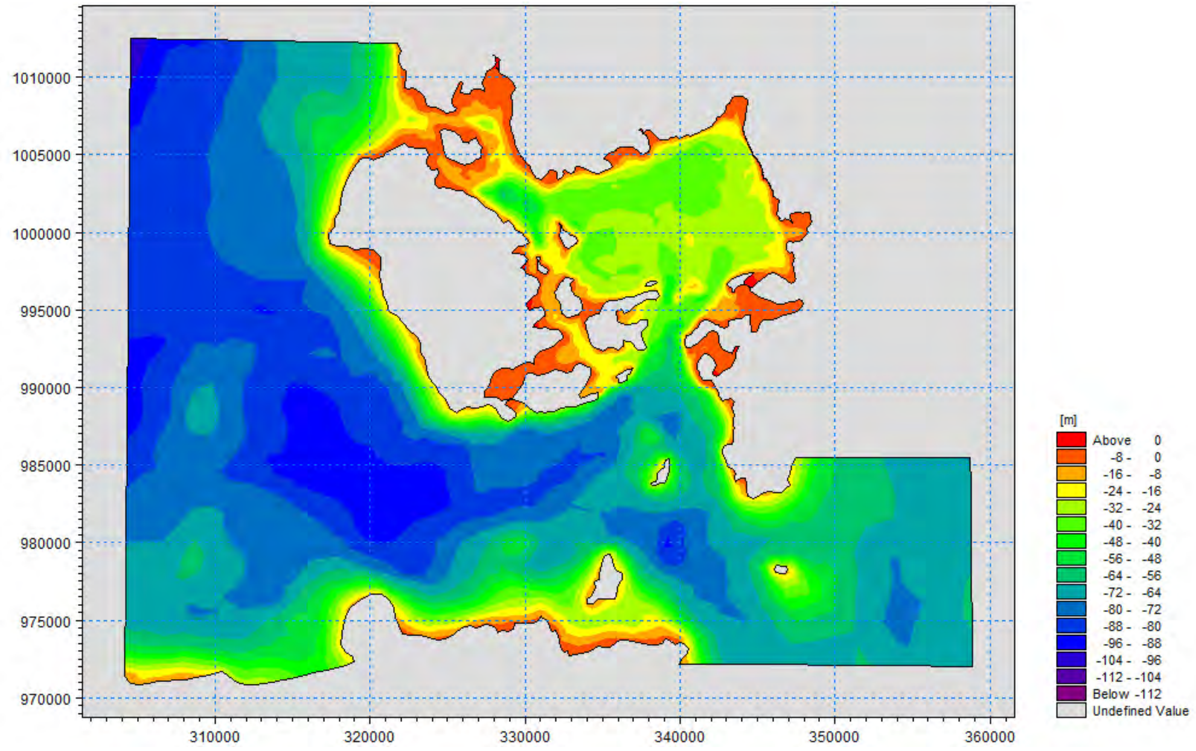

Figure 3-2: Bathymetry across model extent

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[7] Admiralty Maritime Data Solutions: Seabed Mapping Service (https://seabed.admiralty.co.uk/?x=-331303.94&y=8185863.95&z=10.08)

[8] European Marine Observation and Data Network (EMODnet) Bathymetry (https://emodnet.ec.europa.eu/en/bathymetry)

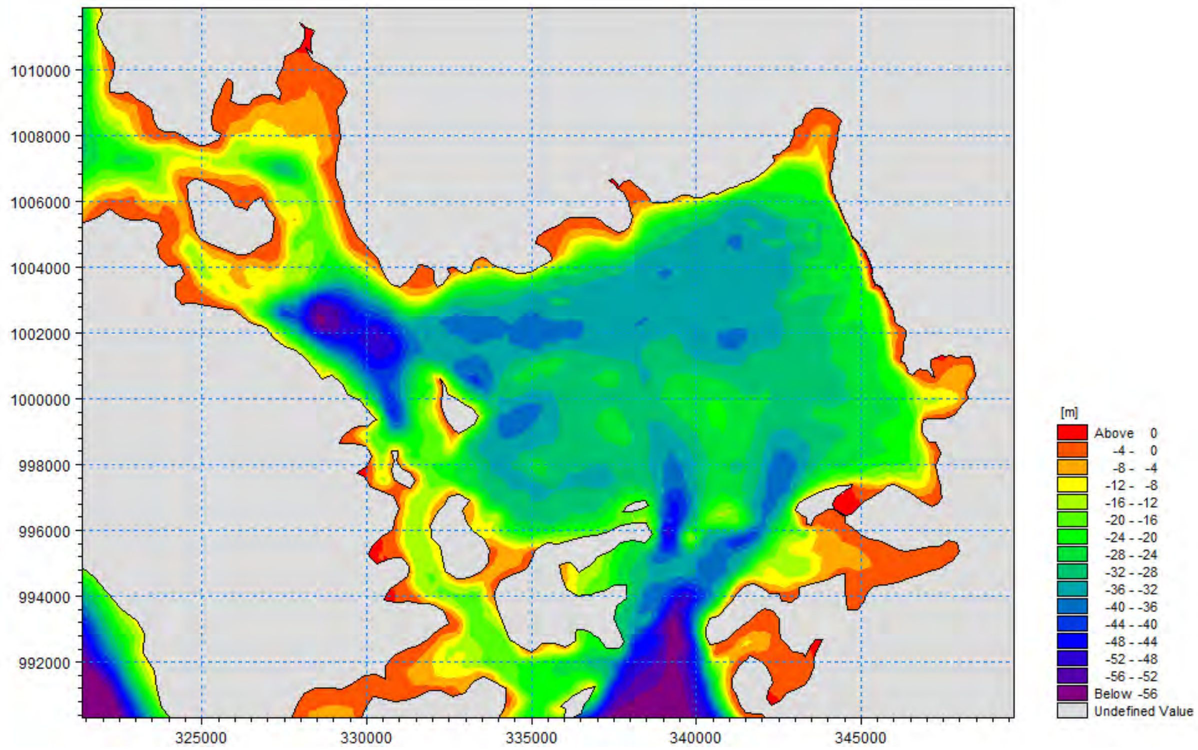

Figure 3-3: Bathymetry within Scapa Flow

3.3.2 Tidal Boundary Conditions

There are five tidal boundaries within the model extent. Two are in the west and north west which extend from the Orkney Mainland to the Scottish Mainland west of Thurso, and three are in the south east, linking the Orkney Mainland to the Scottish Mainland just south of John O'Groats, as shown in Figure 3-4.

Tidal boundary conditions for the HD model have been extracted from the DHI MIKE 21 Global Tide Model. This provides 0.125 x 0.125 degree resolution, 15 minute interval, tidal level data along the open model boundaries.

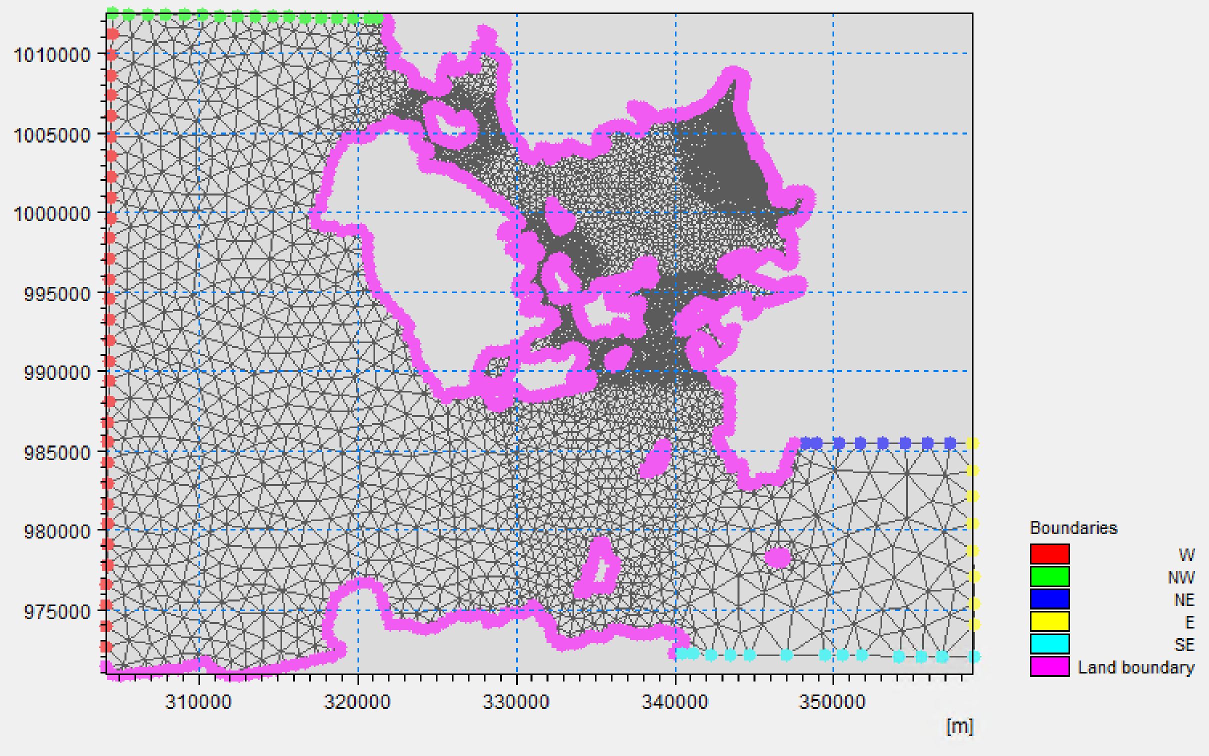

Figure 3-4: HD model boundaries

3.4 Model Mesh

The model utilises a flexible mesh to represent the offshore and coastal areas. The flexible mesh is composed of triangles of varying size and can therefore represent complex coastal alignments or bathymetry accurately.

The baseline model mesh extent and bathymetry are shown in Figure 3-5 below. The mesh has been generated using the bathymetric data described in section 3.3.1. The mesh has progressive refinement in resolution towards Deepdale Bay, becoming finer in the area of interest, as shown in Figure 3-6 and Figure 3-7. Finer mesh regions have also been used to represent areas near the Hoy Sound and Sound of Hoxa, where narrow channels and small islands influence coastal inflows into Scapa Flow. Key characteristics of the baseline mesh are summarised in Table 3-1.

Table 3-1: Baseline HD mesh characteristics

Mesh Characteristic	Value
Number of elements	46,424
Number of nodes	23,990
Min. Z level (mCD)	-100.59
Max. Z level (mCD)	+2.04
Max triangular area at Deepdale	75m^2 (approx. 8.5m resolution)

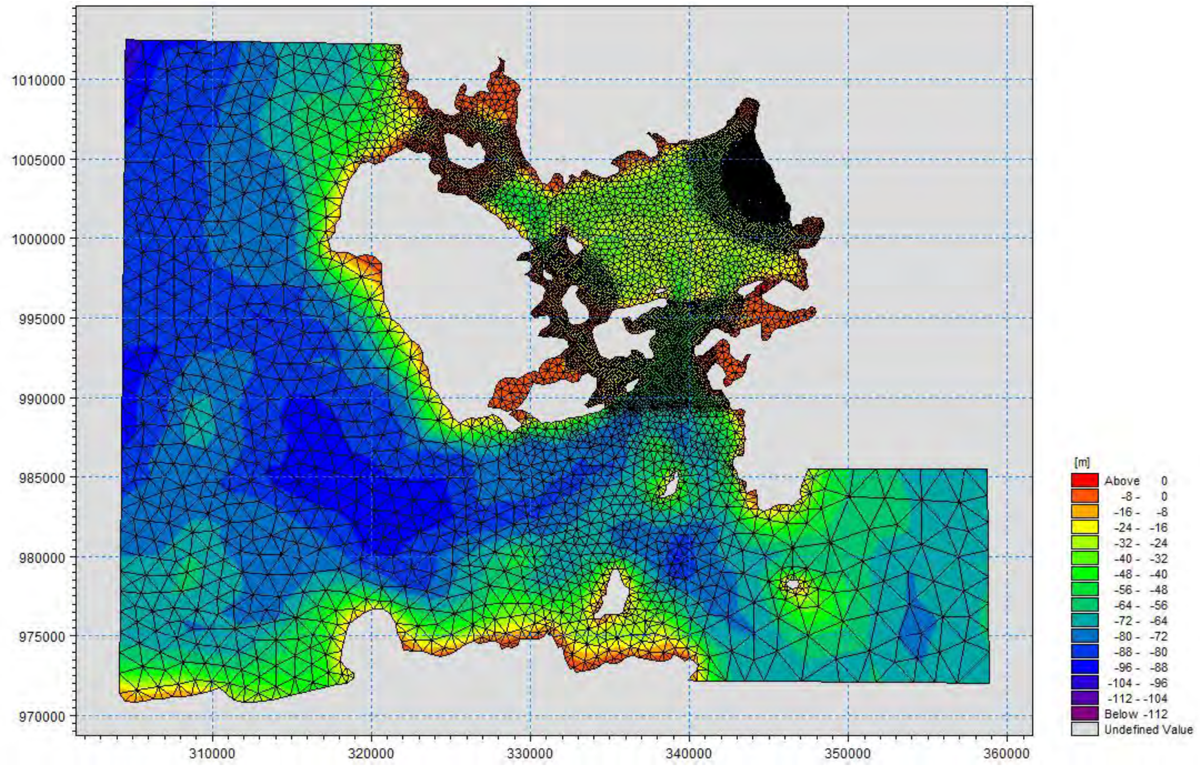

Figure 3-5: Baseline HD model mesh full extent

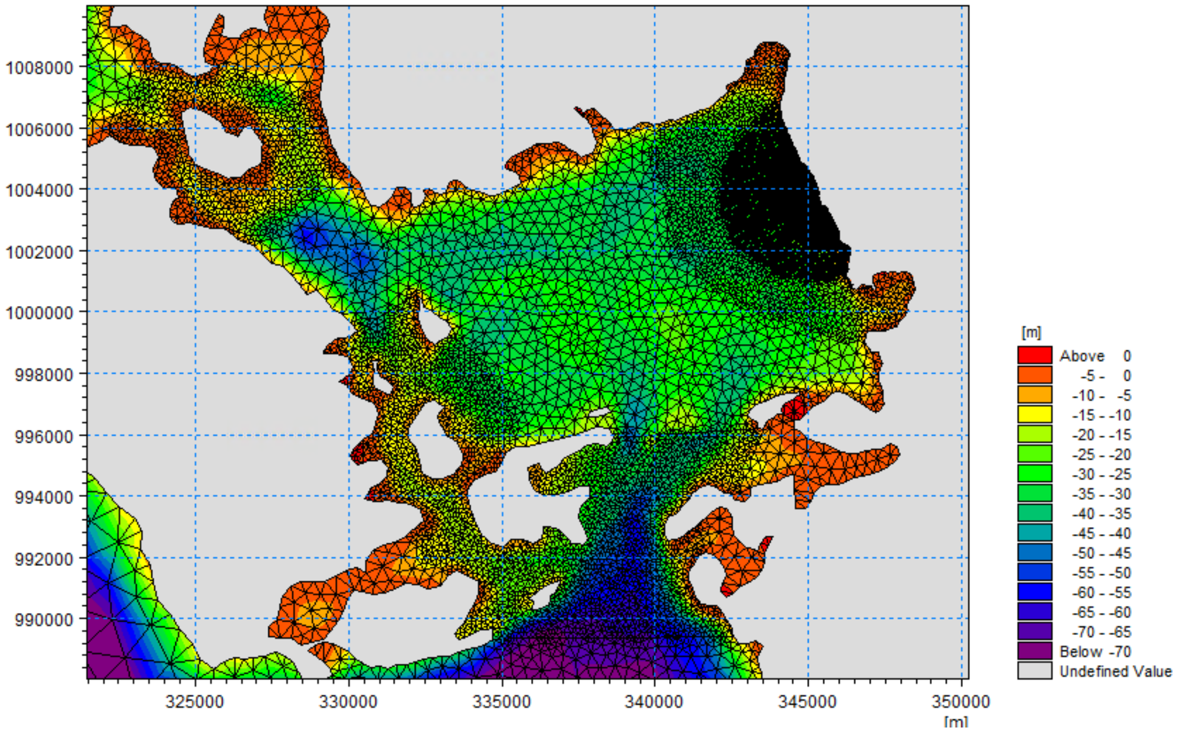

Figure 3-6: Baseline HD model mesh Scapa Flow

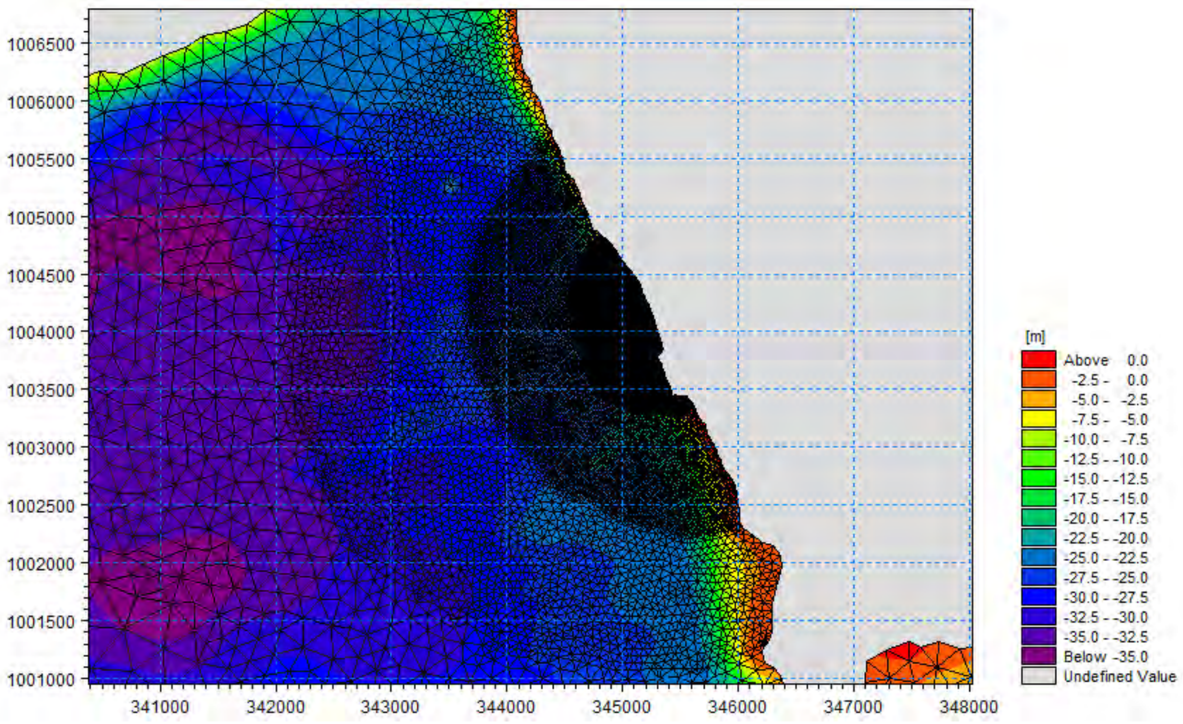

Figure 3-7: Baseline HD model mesh Deepdale Bay

A post-development version of the HD model mesh has been generated to include the proposed development footprint, as shown in Figure 3-8. The bathymetry for the post-development mesh was also updated to include the proposed dredge pockets. The proposed development layout is shown in Appendix A.

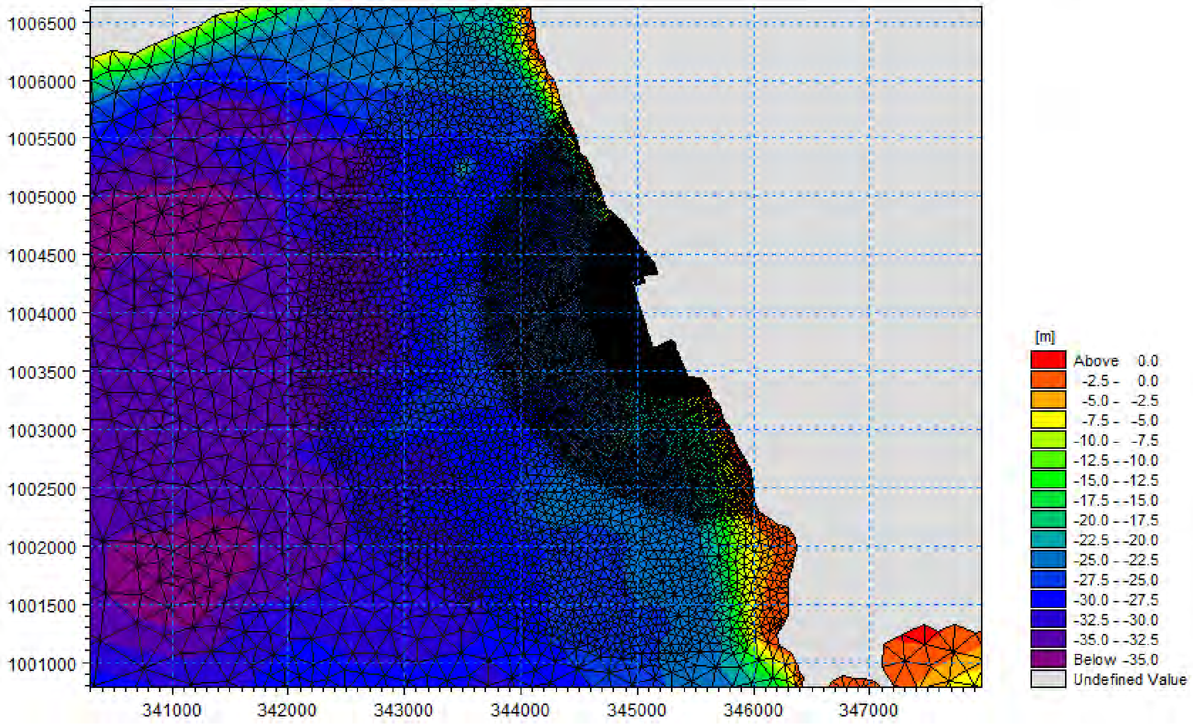

Figure 3-8: Post-development HD model mesh Deepdale Bay

3.5 Model Setup

Further details of the MIKE 21 FM HD model setup are provided below:

- For each model simulation the modelled extent includes the entire mesh as described in section 3.4;
- Open boundary time-varying tidal water level conditions have been derived from the DHI MIKE 21 Global Tide Model as described in section 3.3.2;
- Further model parameters are detailed below:
    - Simulation time-step interval: 300s
    - Model solution technique: Higher order shallow water equations
    - Model solution time-step: Minimum (0.01s) Maximum (30s)
    - Drying depth: 0.02m
    - Wetting depth: 0.1m
    - Bed resistance: 28.8m$^{(1/3)}$/s

A wind forcing sensitivity simulations were undertaken using wind data extracted from the COSMO Reanalysis 6km (CREA6) nonhydrostatic limited-area atmospheric prediction model via the DHI Metocean data portal[9]. For the sensitivity simulations the wind forcing data was applied as varying in time and constant across the model domain.

The modelling has been undertaken with the following computing specification:

- Dell Precision 5820 Tower:
    - 64GB RAM;
    - Utilising 14 Cores – Intel Xeon CPU (2.5GHz);
    - Windows 10 Pro 64-bit operating system.

3.6 Model Outputs

The MIKE 21 FM HD model simulations have been setup to produce results as both point and area outputs. The outputs include the following key parameters:

- Water surface elevation;
- Current speed;
- Current direction; and
- Bed shear stress

The area outputs are generated for the whole model extent, whilst point outputs have been generated at 20 identified locations within the model extent as detailed in Table 3-2. The locations of point outputs are situated within the immediate vicinity of Deepdale bay and the proposed development including the capital dredge pockets. Points are also situated out into the wider Scapa flow Area with a point at St Marys Bay to provide reference with Admiralty tide predictions. Point output locations are shown in Figure 3-9 and Figure 3-10.

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[9] https://www.metocean-on-demand.com/metadata/waterdata-dataset-Europe_CREA6_V2

Table 3-2: HD Model point output locations

Point Output Location	Easting	Northing
Point 1	345014	1003771
Point 2	345123	1003631
Point 3	345064	1003833
Point 4	345013	1004005
Point 5	344962	1004173
Point 6	344925	1004296
Point 7	344949	1003980
Point 8	344896	1004149
Point 9	344859	1004287
Point 10	345065	1003566
Point 11	345154	1003560
Point 12	345248	1003594
Point 13	344914	1004381
Point 14	345028	1004417
Point 15	345180	1003110
Point 16	344363	1003771
Point 17	344586	1004687
Point 21	343093	1005047
Point 22	344343	1002099
Point 23	347449	1000234

Figure 3-9: HD model point output locations

Figure 3-10: HD model point output locations local to development site

3.7 Model Simulations

The key model simulations undertaken using the MIKE 21 FM HD model are presented in Table 3-3.

Table 3-3: HD model simulations

HD Model Simulation	Description
Scapa FM HD 16	Baseline HD model simulating existing (pre-development) conditions. Run for January 2022 tidal cycle, including spring and neap tides.
Scapa FM HD 17	Baseline HD model with wind forcing simulating existing (pre-development) conditions. Run for January 2022 tidal cycle, including spring and neap tides.
Scapa FM HD 19	Post-development HD model simulating conditions with proposed development in place. Run for January 2022 tidal cycle, including spring and neap tides.
Scapa FM HD 20	Post-development HD model with wind forcing simulating conditions with proposed development in place. Run for January 2022 tidal cycle, including spring and neap tides.

3.8 Model Validation

Validation of the model has been undertaken through comparison of baseline modelled tidal levels with Admiralty tide predictions (UKHO, 2022) for the same tide, at St Mary’s. This comparison highlights that the model predicts levels within 0.05m of the Admiralty predicted levels.

Additionally, tidal current speeds predicted by the baseline model have been compared to annotated tidal stream speeds on UKHO hydrographic charts for Scapa Flow and surrounds, with model peak current speed predictions lying within the published range of current speed.

Given the results of the above validation exercise the model is therefore considered to perform well.

4 HYDRODYNAMIC MODEL RESULTS

A summary of the results from the existing (baseline) model run (FM HD 16) are presented in Section 4.1, whilst a summary of results from the post-development model run (FM HD 18) are presented in Section 4.2, along with comparative analysis versus the baseline model results. Appendix B contains tabulated model results under existing and post-development conditions for key tidal states, with relative change between both scenarios also tabulated. Appendix C contains graphical comparisons between existing and post-development results for the point output locations identified in Figure 3-9.

4.1 Existing (Baseline) Conditions

Model run FM HD 16 simulates existing (baseline) tidal conditions within Scapa Flow including at Deepdale Bay and surrounds from 1 January 2022 until 17 January 2022, capturing a full spring and neap tide cycle. The following sub-sections present the results of this simulation split by key outputs, tidal water surface elevation, tidal currents, and bed shear stress. Tabulated results are presented in Appendix B.

4.1.1 Tidal Water Surface Elevation

Tidal water surface elevation predictions relative to chart datum at point output locations 4 and 16 (see Figure 3-10) are presented in Figure 4-1 for the full FM HD 16 run duration. Review of these figures highlights that the same levels are predicted at both point output locations. The figures show a semi-diurnal tidal curve, with two high tides and two low tides each day, as is the case around the UK.

The highest predicted tidal elevation is +3.55mCD during a spring tide on 4th January 2022, with a lowest tidal elevation prediction of +0.42mCD on the same day. These values are within 0.05m and 0.02m of the corresponding Admiralty Tide Tables[10] predictions respectively for the same tide. Neap tides are also present within the simulated tidal curve. A neap high tide elevation of +2.54mCD is predicted on 11th January 2022, with a corresponding low tide elevation of +1.39mCD. Therefore the largest simulated spring tidal range at Deepdale Bay is 3.13m and with a simulated neap tidal range of 1.15m. Comparison with the mean tidal ranges for St Mary's outlined in section 2.3, highlights that the simulated tidal curve includes spring tides larger, and neap tides smaller, than the mean spring and neap tides.

Figure 4-2 presents spatial plots of predicted tidal water surface elevation across the HD model extent for key phases of a spring tide, whilst Figure 4-3 presents the corresponding plots for a neap tide. Review of these figures shows the spatial variation across the model extent, highlighting the progression of the tidal wave approximately from north-west to south-east during the flood tide, and in reverse during the ebb tide.

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[10] UK Hydrographic Office, 2022 (Admiralty Tide Tables – Volume 1B)

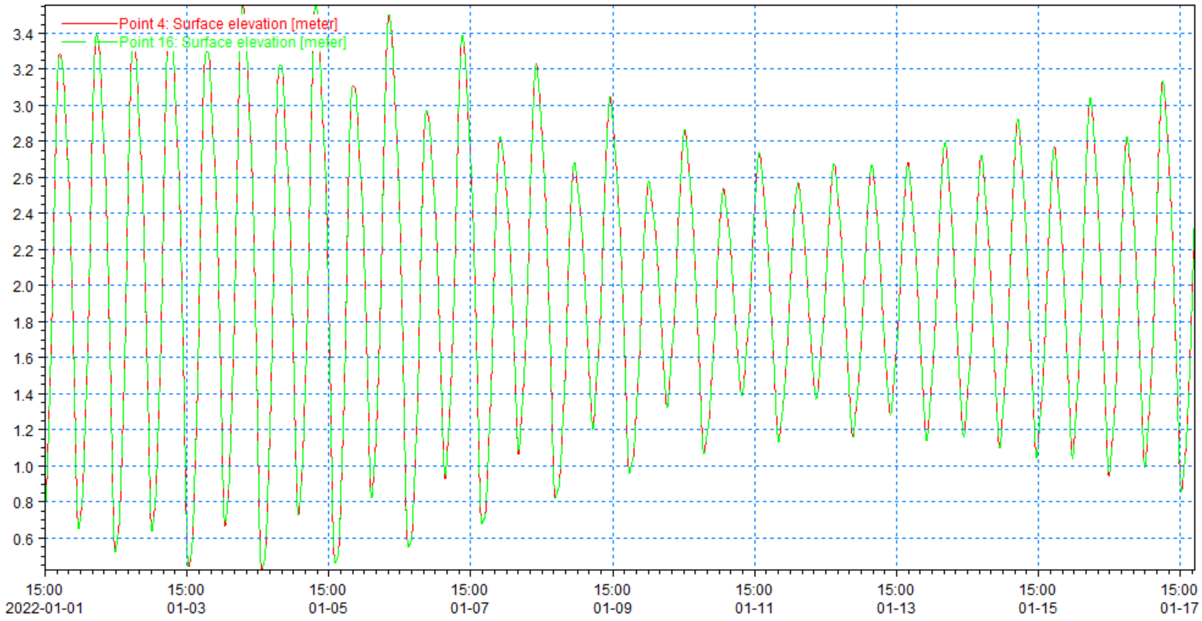
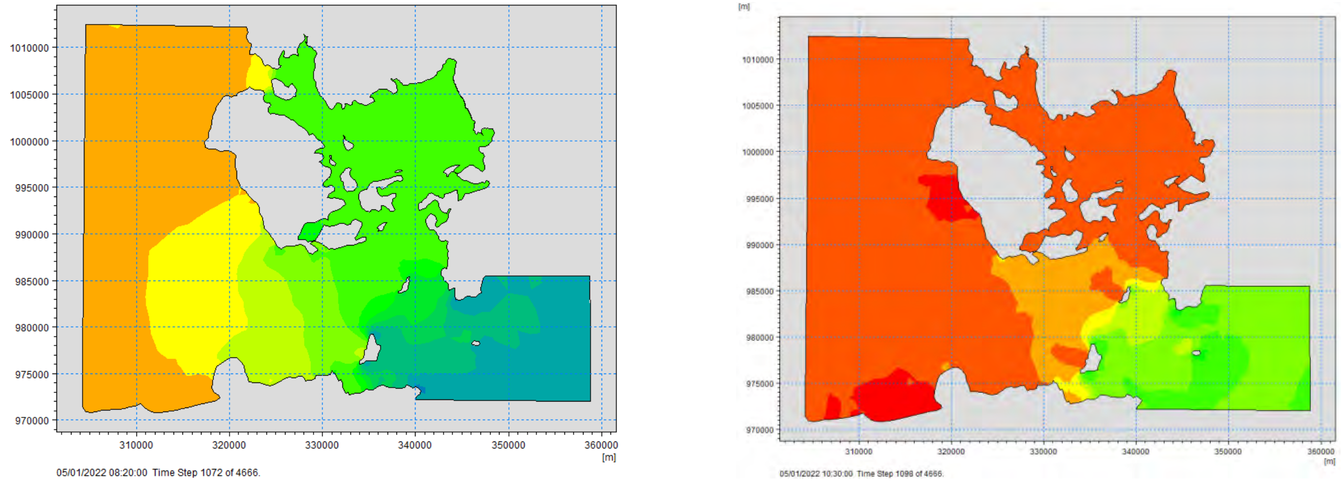


Figure 4-1: FM HD 16 water surface elevation predictions at points 4 and 16 for run duration.

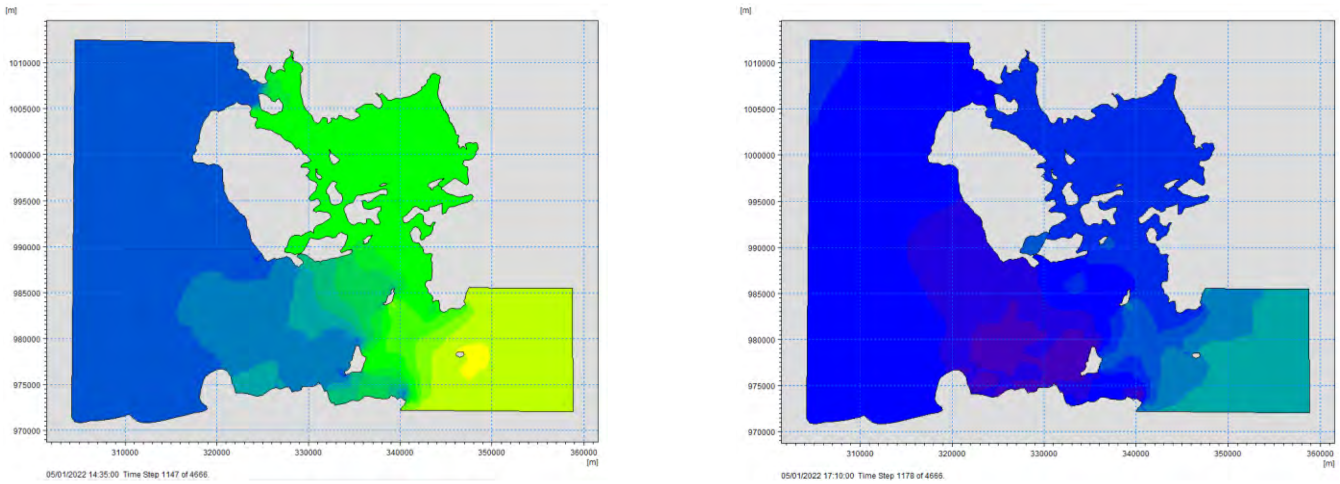
(A) Surface Elevation – Mid Spring Flood Tide

(B) Surface Elevation – High Water Spring Tide



(C) Surface Elevation – Mid Spring Ebb Tide

(D) Surface Elevation – Low Water Spring Tide



Surface elevation [m]

- 🟥 Above 3.75
- 🟧 3.50 - 3.75
- 🟧 3.25 - 3.50
- 🟨 3.00 - 3.25
- 🟩 2.75 - 3.00
- 🟩 2.50 - 2.75
- 🟩 2.25 - 2.50
- 🟩 2.00 - 2.25
- 🟩 1.75 - 2.00
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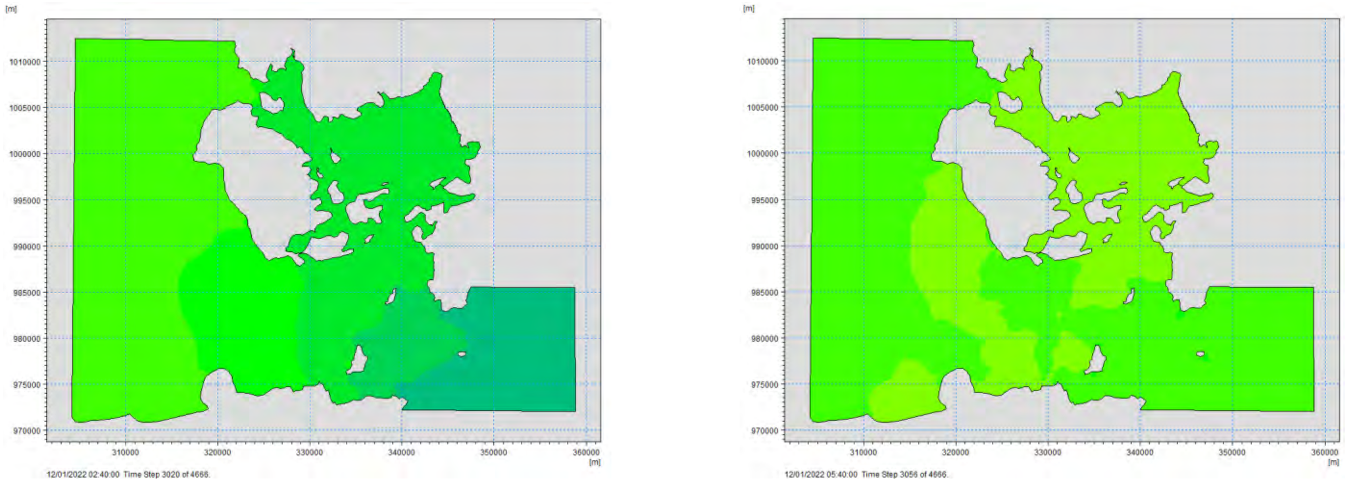
- 🟦 0.50 - 0.75
- 🟦 0.25 - 0.50
- 🟦 0.00 - 0.25
- 🟦 -0.25 - 0.00
- 🟪 -0.50 - -0.25
- 🟪 -0.75 - -0.50
- 🟪 Below -0.75
- ⬜ Undefined Value

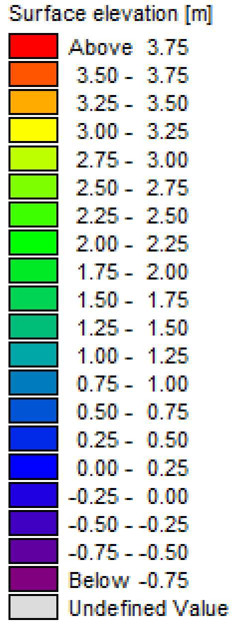
Relative to Chart Datum

Figure 4-2: FM HD 16 water surface elevation (A) mid-flood (B) high (C) mid-ebb (D) low spring tide



(A) Surface Elevation – Mid Neap Flood Tide

(B) Surface Elevation – High Water Neap Tide



Relative to Chart Datum

(C) Surface Elevation – Mid Neap Ebb Tide

(D) Surface Elevation – Low Water Neap Tide

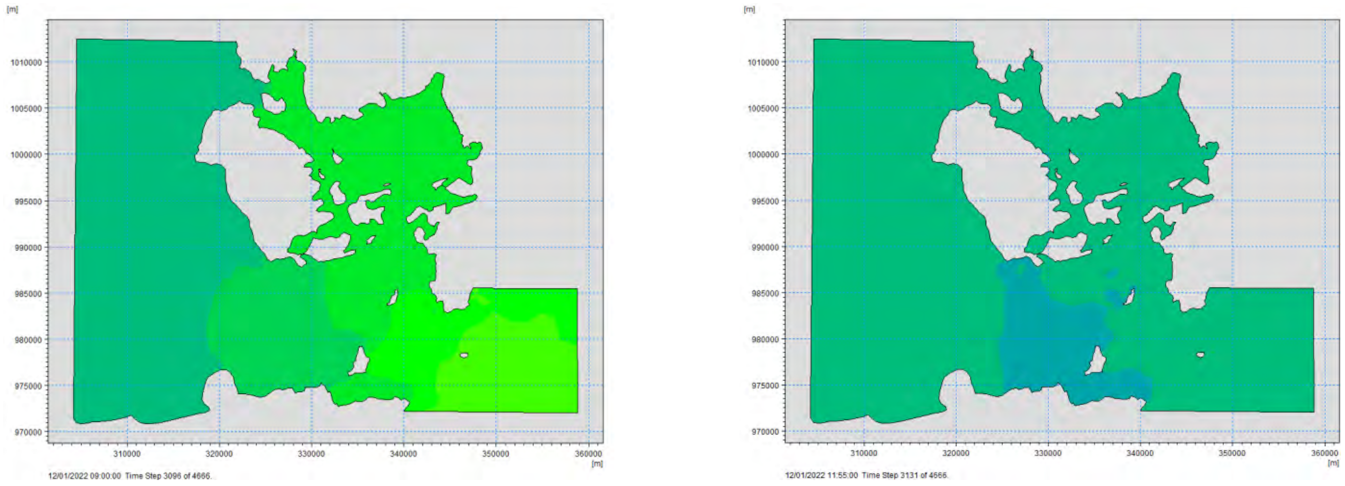


Figure 4-3: FM HD 16 water surface elevation (A) mid-flood (B) high (C) mid-ebb (D) low neap tide

4.1.2 Tidal Currents

Tidal current speed predictions for point output locations 4, 16 and 22 are presented in Figure 4-4 for the full FM HD 16 run duration including the spring and neap tide cycle, and in Figure 4-5 for a selected spring tidal cycle. Review of these figures highlights the relatively weak currents (<0.03m/s) present in throughout locations in Scapa Flow during spring tides.

Figure 4-5 shows the spring tidal current predictions at locations 4, 16 and 22. Review of this figure illustrates the complex and irregular phasing of tidal currents at Deepdale Bay. Whilst all currents are relatively weak, the strongest currents at these particular locations correlate with the incoming peak flood tides, whilst there is not such a clear correlation between tidal phase and current speed during the subsequent ebb tides. In other locations a stronger correlation is observed with the ebb tide. It is considered that due to the complex structure of Scapa Flow, with numerous bays and islands, that local flow patterns and eddies influence the position and speed of currents within Deepdale Bay.

Figure 4-6 presents model extent plots of tidal current speed for mid-flood and ebb conditions, during both spring and neap tides. Review of this figure highlights the spatial variation across the model extent, with the dominant tidal stream within the Pentland Firth travelling north-west to south-east through the model extent, and other focused tidal streams through the narrow channels between islands, for example at the Hoy Sound. Weakest currents are observed to occur the sheltered regions of Scapa Flow, including in the vicinity of the proposed development location of Deepdale Bay.

Figure 4-7 to Figure 4-10 present similar plots focussed on Deepdale Bay and surrounds, with current vector arrows shown to indicate tidal stream direction. Current vectors highlight the direction of the flood tide, circulating generally from north-west to south-east through Scapa Flow and parallel to the shore in the vicinity of Deepdale Bay, and the ebb tide circulating in the opposite direction. The figures further highlight the low current speeds within Scapa Flow, with slightly higher currents observed further out into the bay than at the nearshore locations. Figure 4-11 presents a residual current speed plot comparison between mid-ebb and mid-flood spring tidal currents in the vicinity of Deepdale Bay. Review of this figure highlights the marginal dominance of ebb currents, with the exception of the nearshore area where there is little difference observed.

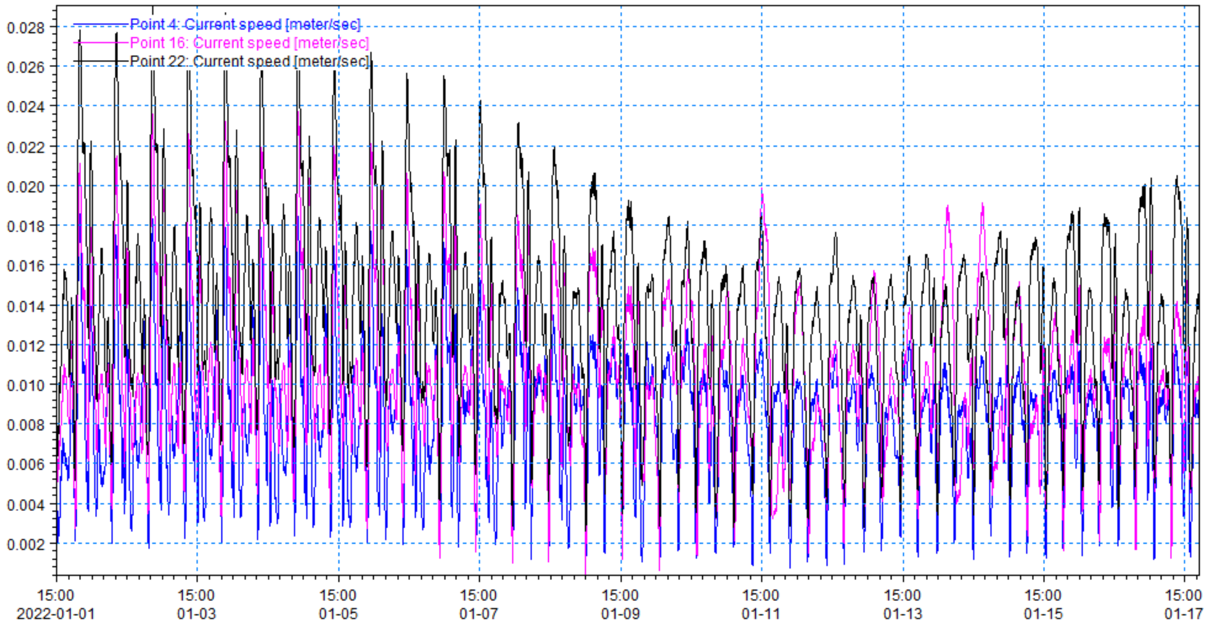


Figure 4-4: FM HD 16 current speed predictions at points 4, 16 and 22 for spring and neap cycle

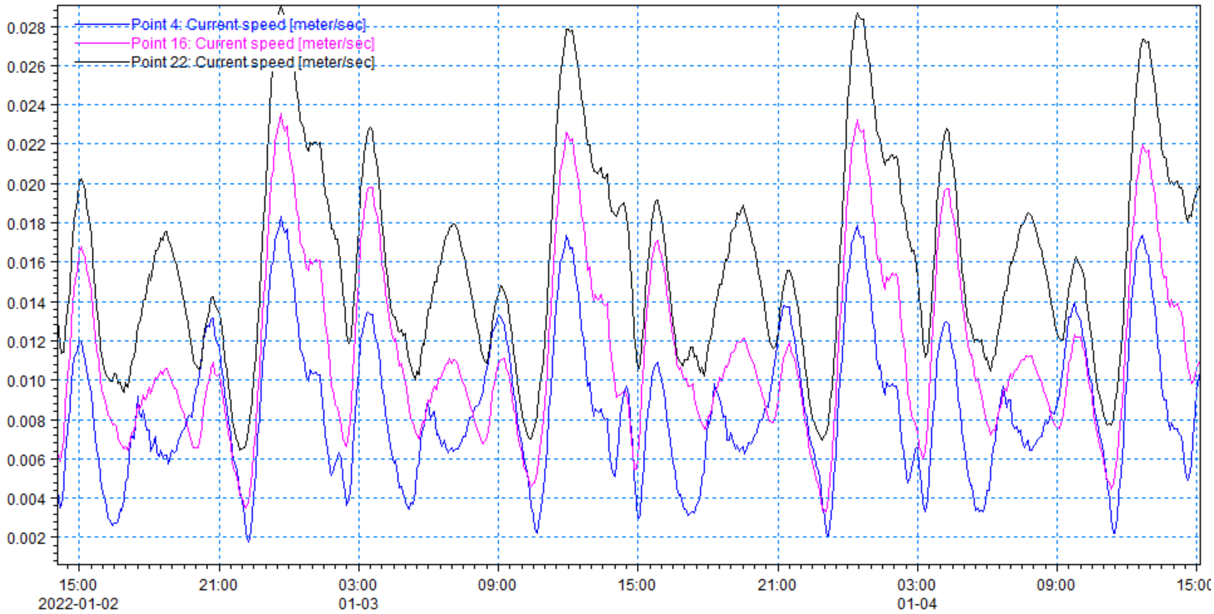
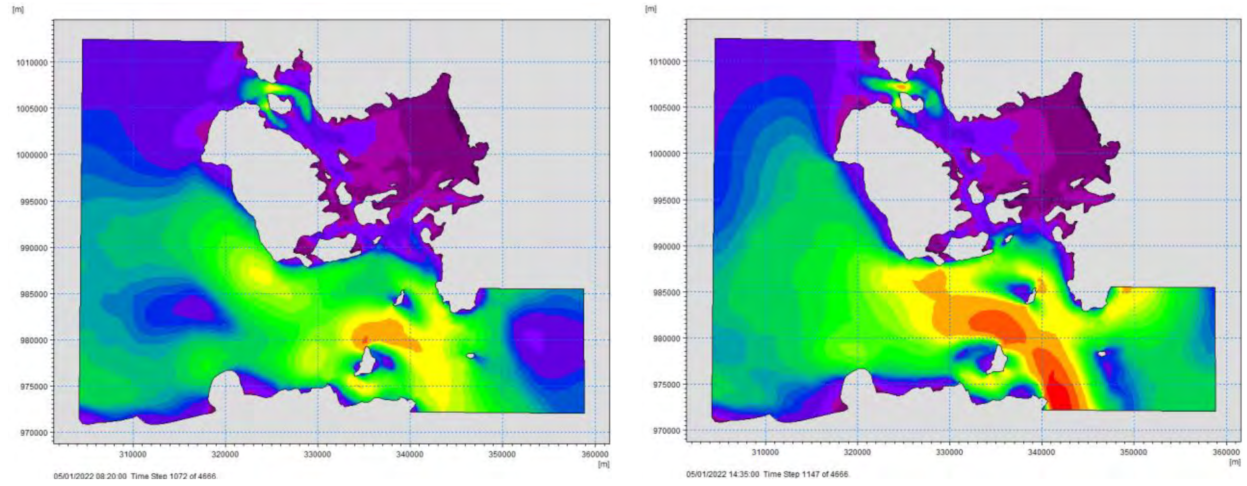
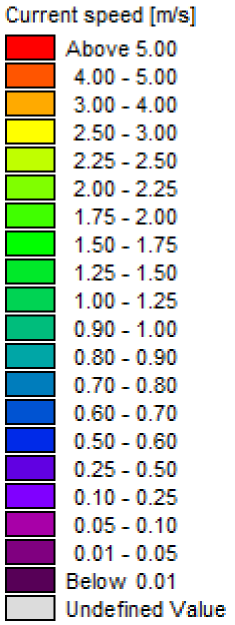


Figure 4-5: FM HD 16 current speed predictions for points 4, 16, 22 for spring tide

(A) Current Speed – Mid Spring Flood Tide

(B) Current Speed – Mid Spring Ebb Tide





(C) Current Speed – Mid Neap Flood Tide

(D) Current Speed – Mid Neap Ebb Tide

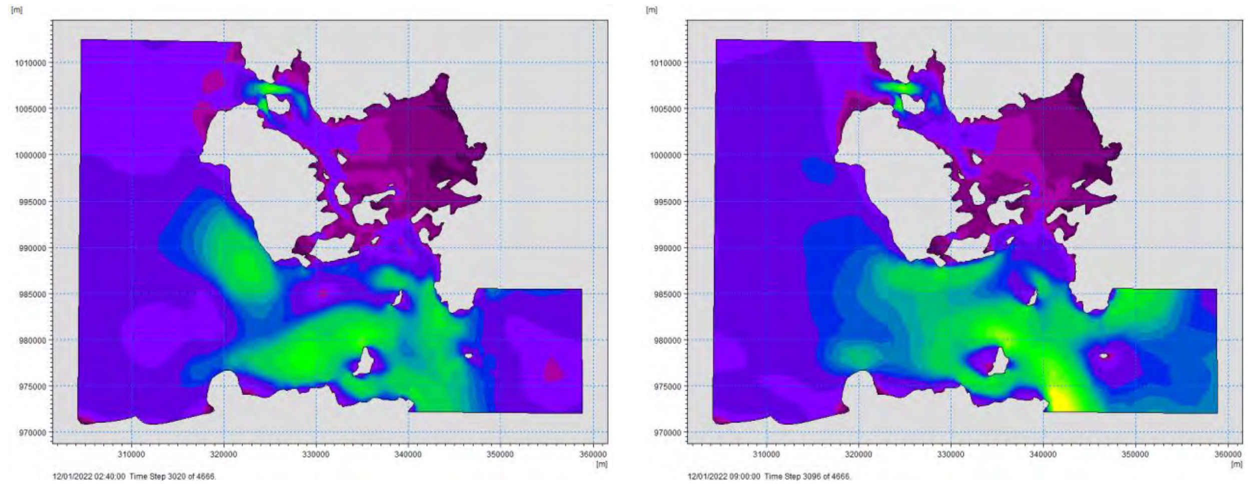


Figure 4-6: FM HD 16 current speed (A) mid-flood spring (B) mid-ebb spring (C) mid-flood neap (D) mid-ebb neap tide

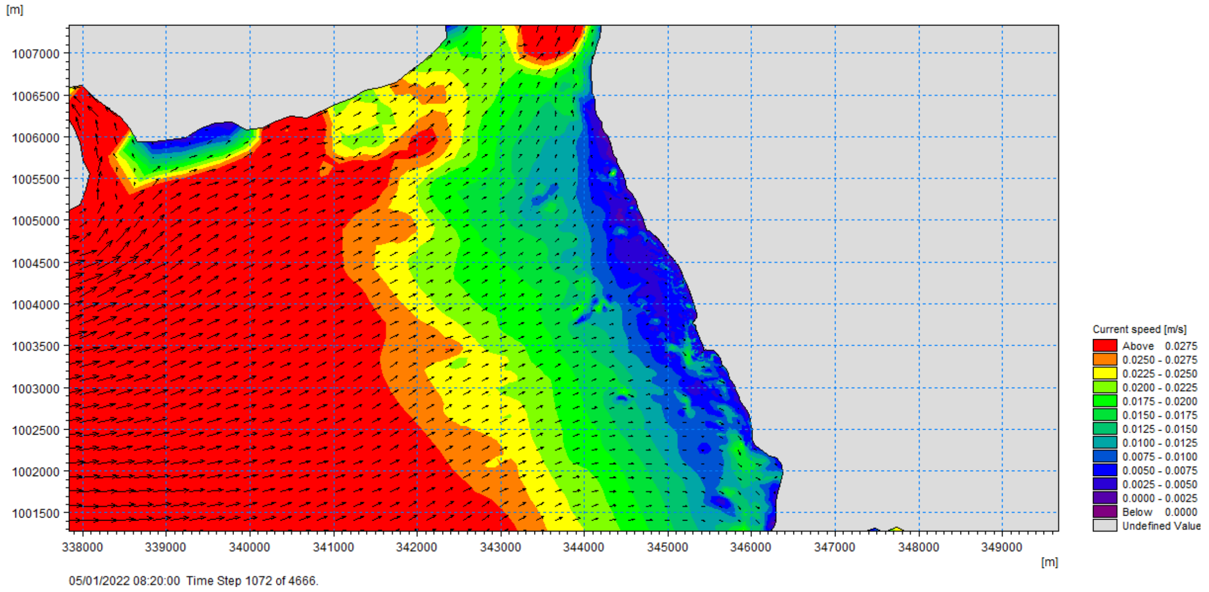


Figure 4-7: FM HD 16 Deepdale Bay and surrounds current speed mid-flood spring tide

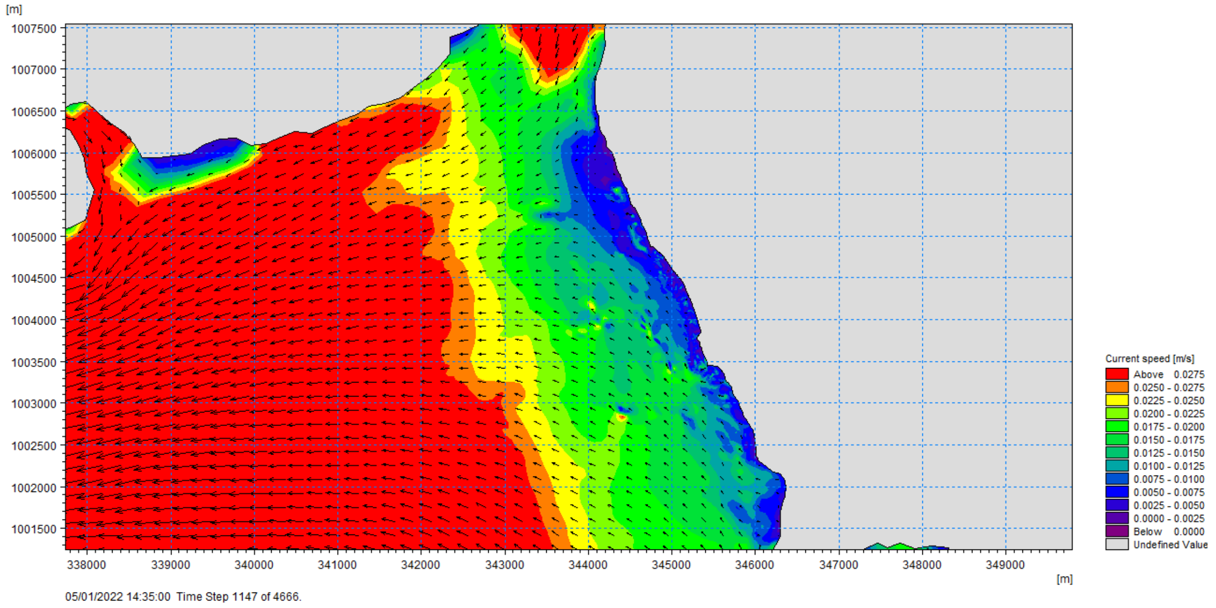


Figure 4-8: FM HD 16 Deepdale Bay and surrounds current speed mid-ebb spring tide

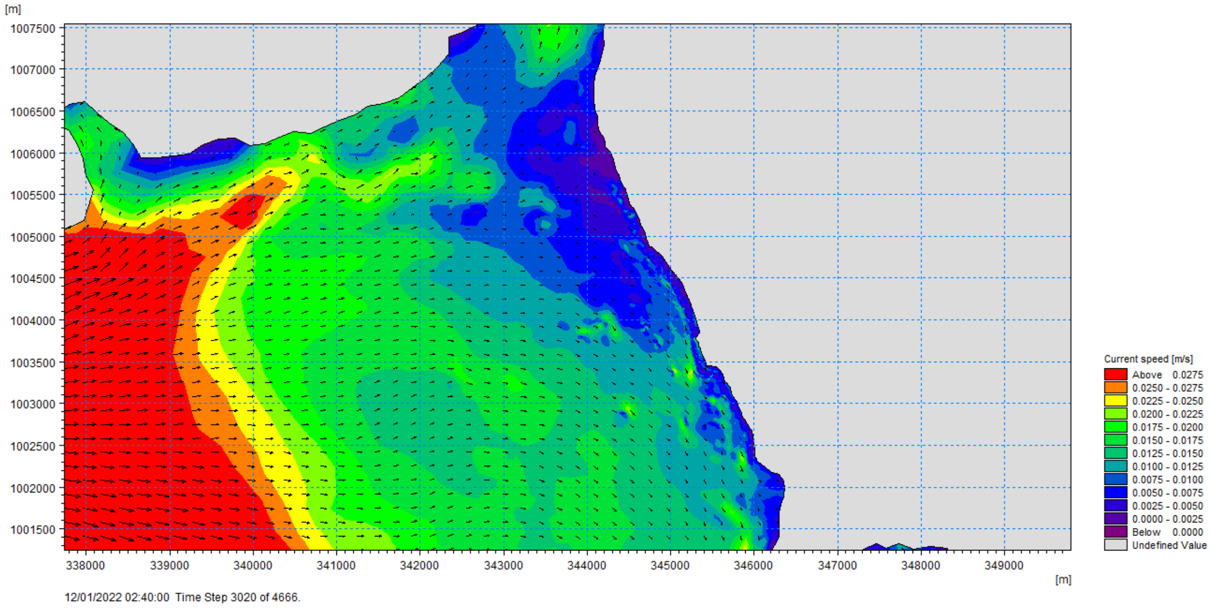


Figure 4-9: FM HD 16 Deepdale Bay and surrounds current speed mid-flood neap tide

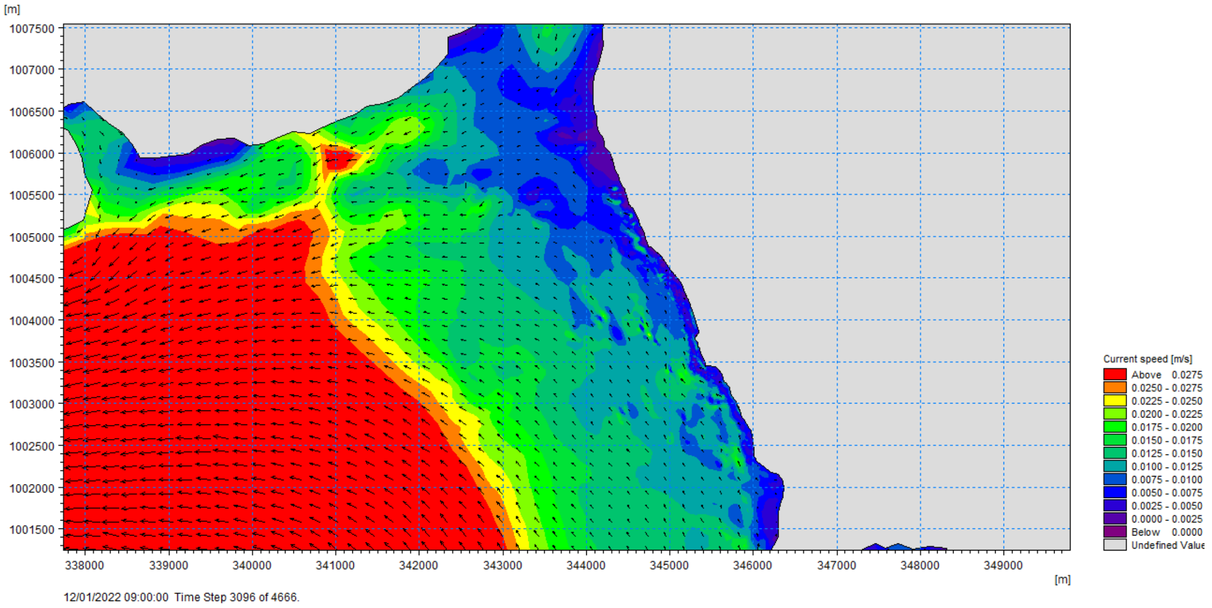


Figure 4-10: FM HD 16 Deepdale Bay and surrounds current speed mid-ebb neap tide

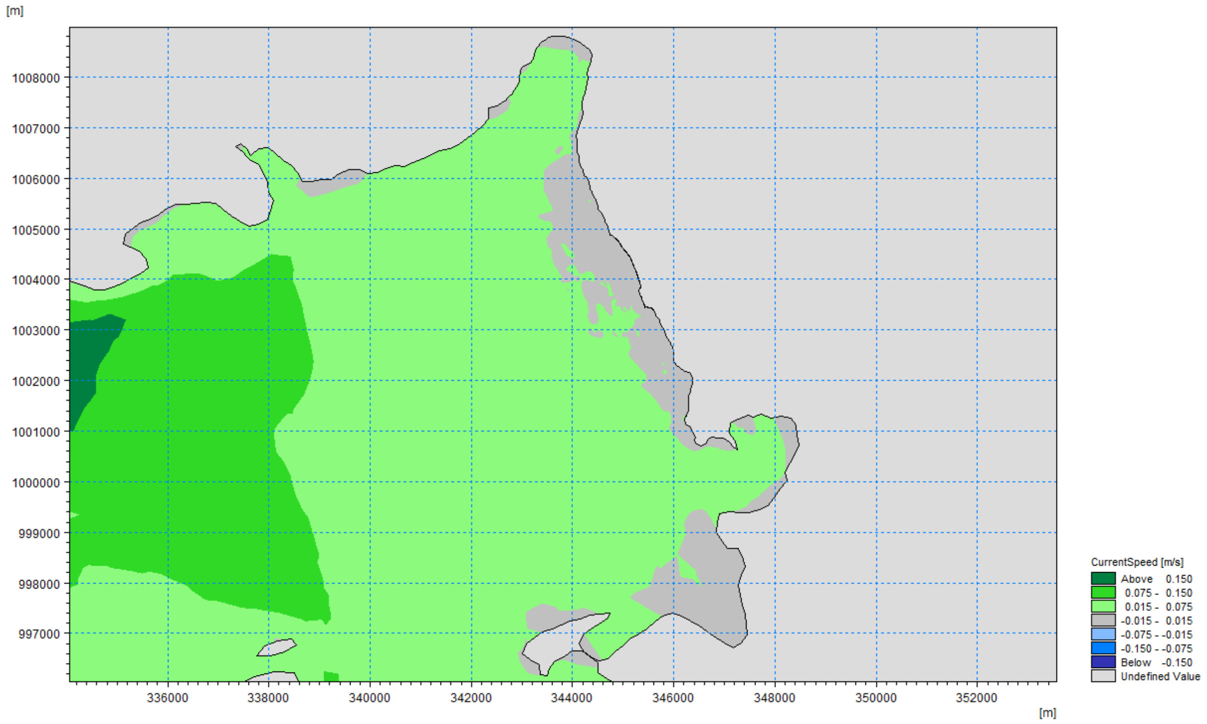


Figure 4-11: FM HD 16 spring tide residual current speed (mid-ebb minus mid-flood)

4.1.3 Bed Shear Stress

Figure 4-12 presents model predictions of bed shear stress during the spring and neap tidal cycle for point output locations 2, 4, 6, 7, 9 and 10 around the proposed development and Deepdale Bay. All locations show generally low bed shear stress, as would be anticipated with the weak tidal currents observed. Peak bed shear stress predictions are around 0.003 N/m^2 during spring tides.

Figure 4-13 shows bed shear stress alongside current speed for location 4. Review of this figure highlights that bed shear stress is correlated with tidal current speed, with peak shear stress occurring with peak current speeds. The low current speeds and corresponding low bed shear stresses are considered indicative of a low energy environment, given this and the absence of significant sediment inputs, no significant sediment transport by tidal currents predicted in the vicinity of Deepdale Bay.

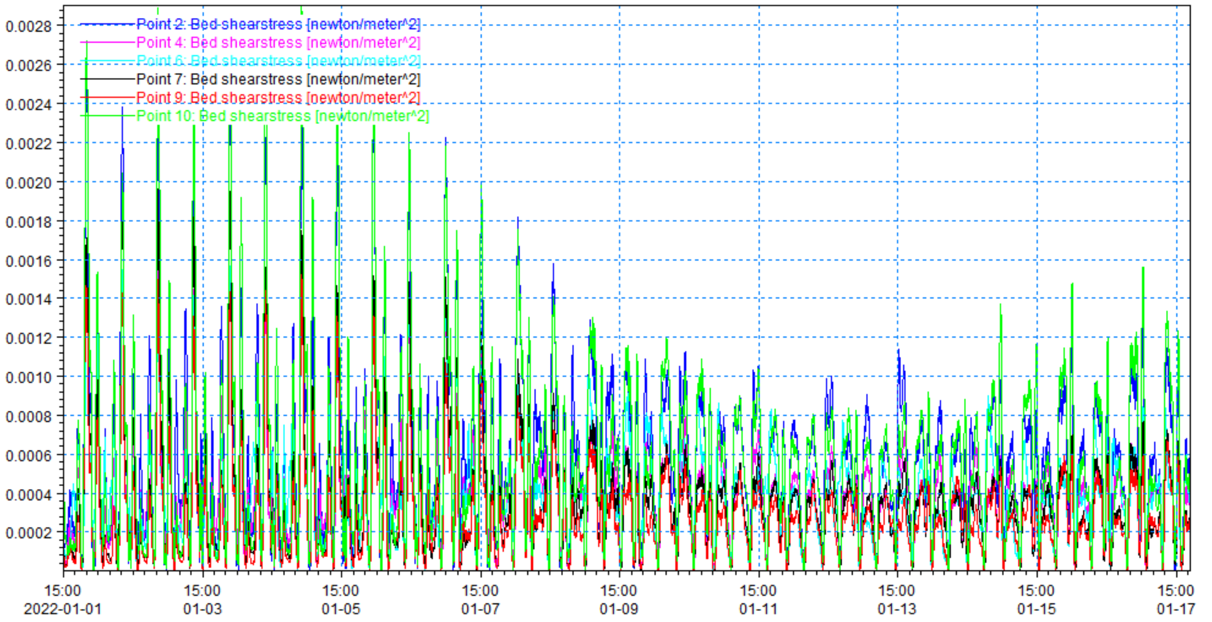


Figure 4-12: FM HD 16 bed shear stress at locations 2, 4, 6, 7, 9 and 10 through spring and neap tidal cycle

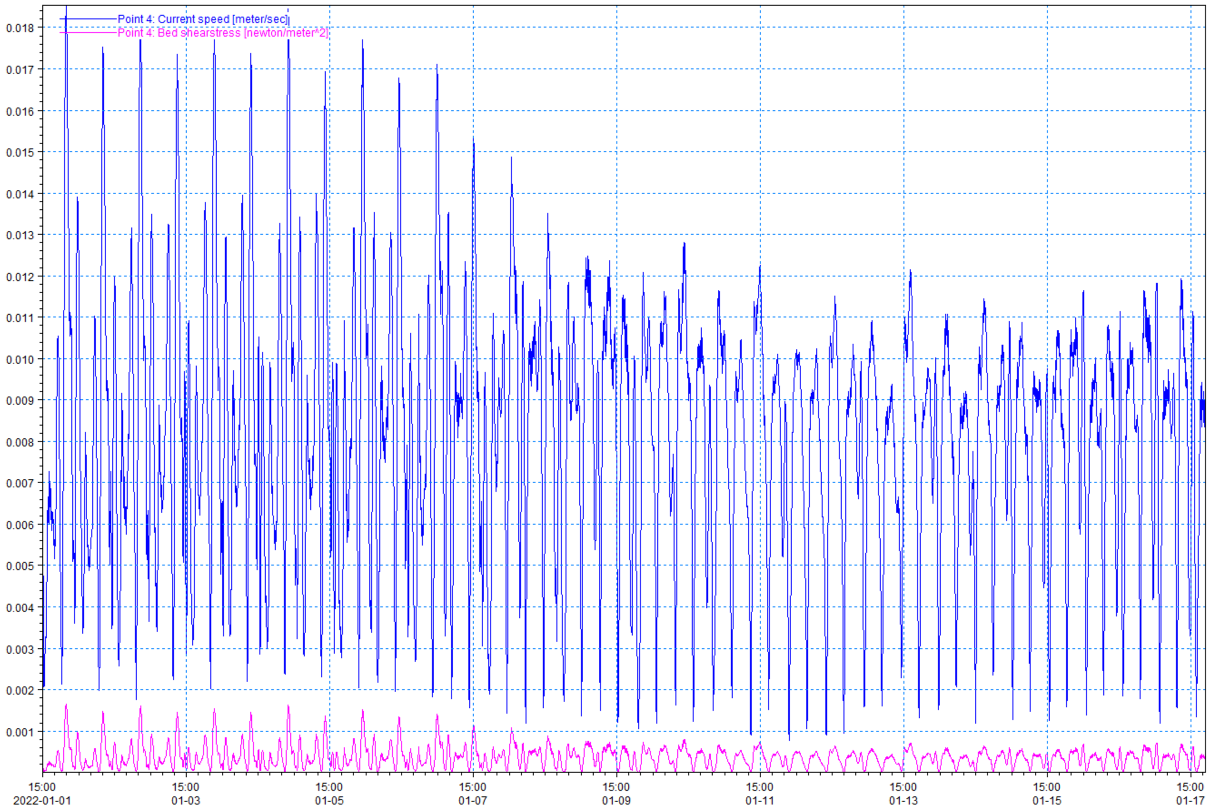


Figure 4-13: FM HD 16 bed shear stress and current speed at location 4

4.1.4 Wind Forcing Sensitivity

Given the low energy environment at Deepdale Bay and within the wider Scapa Flow area, it is considered that wind forcing could have a greater relative influence on current speeds and coastal processes than in more dynamic settings. A wind forcing sensitivity simulation was undertaken using wind data extracted from the COSMO Reanalysis 6km (CREA6) nonhydrostatic limited-area atmospheric prediction model via the DHI Metocean data portal[11]. The wind data used covered the period of January 2018, but is considered representative of general wind conditions in Scapa Flow during that time of year. A rose plot of the data showing wind speed and directional frequency is presented in Figure 4-14. The wind forcing data was applied as varying in time and constant across the model domain. Due to the unpredictability of wind forcing in terms of force, duration and direction, this scenario is only used to assess the model sensitivity to wind forcing. The wind forcing scenario has therefore not been adopted as the baseline case in later assessments.

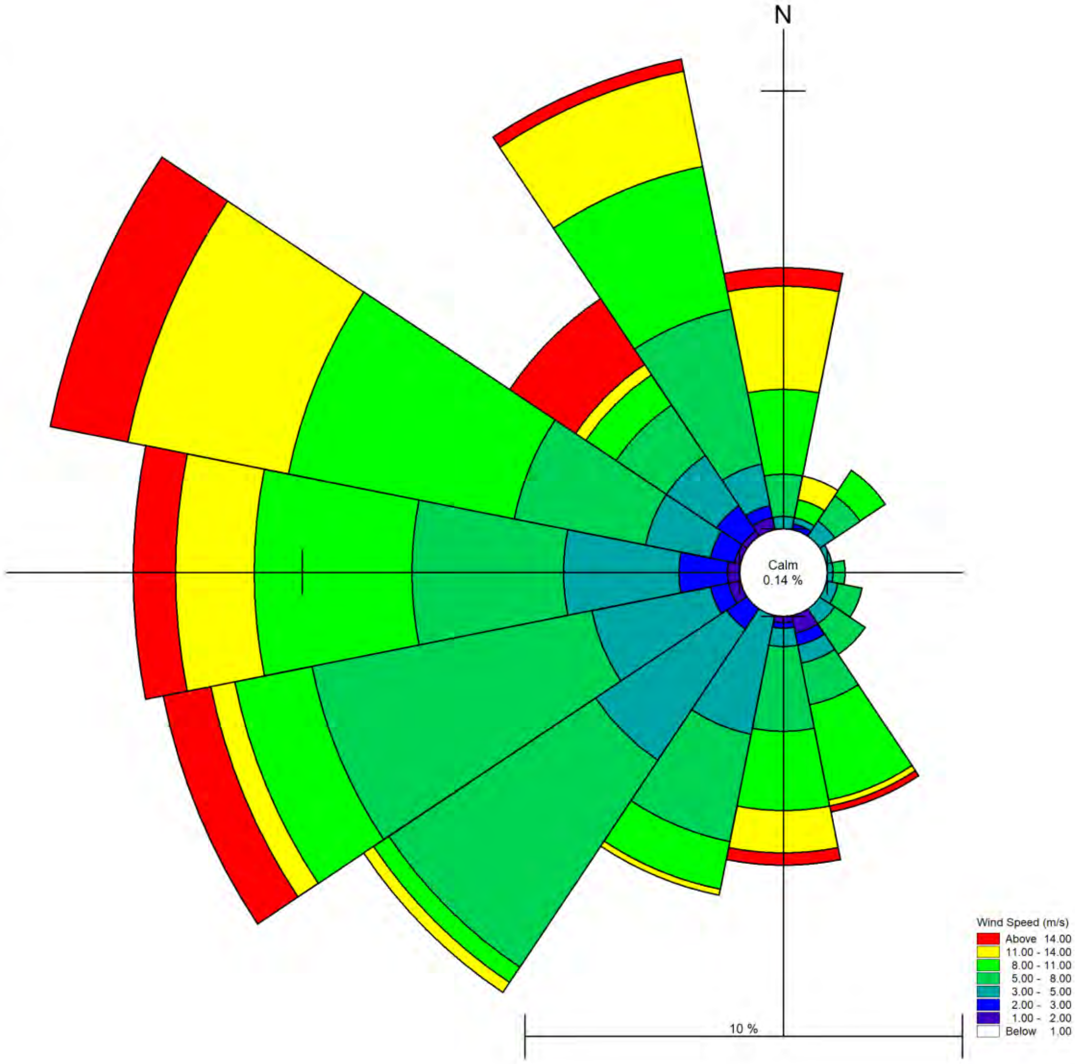


Figure 4-14: Wind rose plot – CREA6 model data (January 2018)

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[11] https://www.metocean-on-demand.com/metadata/waterdata-dataset-Europe_CREA6_V2

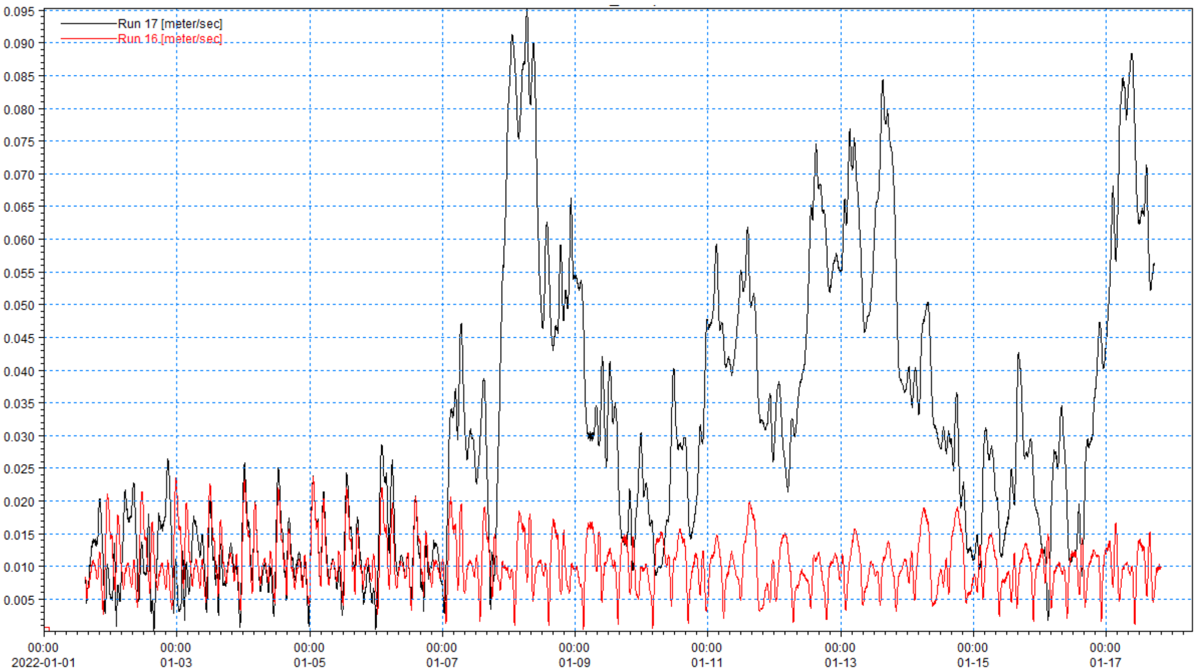


Figure 4-15: FM HD 16 and FM HD 17 current speed at location 16

Figure 4-15 illustrates the predicted current speeds at location 16 for the spring and neap tide cycle, both with (FM HD 17) and without (FM HD 16) wind forcing. The results show how the wind forcing has the potential to both increase and decrease current speeds within Scapa Flow, with peak modelled current speeds increasing from 0.025 m/s to 0.095 m/s. While such predicted relative increases are significant, current speeds within Scapa flow remain generally low in both scenarios, and it should be noted that wind forcing can also impact current direction.

4.2 Post-Development Conditions

Model run FM HD 19 simulates post-development (see Appendix A for proposed development layout) tidal conditions at Deepdale Bay and surrounds. The following sub-sections present the results of this simulation split by key outputs, tidal water surface elevation, tidal currents, and bed shear stress. Comparative analysis versus existing conditions (FM HD 16) is also presented through these sections. Tabulated results and comparisons are presented in Appendix B, whilst result comparisons are presented in graphical form in Appendix C.

4.2.1 Tidal Water Surface Elevation

Tidal water surface elevation predictions relative to chart datum at point output locations 4 and 16 (see Figure 3-9) are presented in Figure 4-16 for the spring and neap tidal cycle. Review of these figures highlights that the same levels are predicted at both point output locations, as per the results for FM HD 16 under existing conditions.

Figure 4-17 presents a comparison of the full model run tidal curves for existing (FM HD 16) and post-development (FM HD 19) conditions at point output location 4. This highlights that no significant change is observed in surface elevation predictions between the two model runs. Further comparative analysis presented in Table 2, Appendix B, and within figures in Appendix C, confirms this to be the case across the study area.

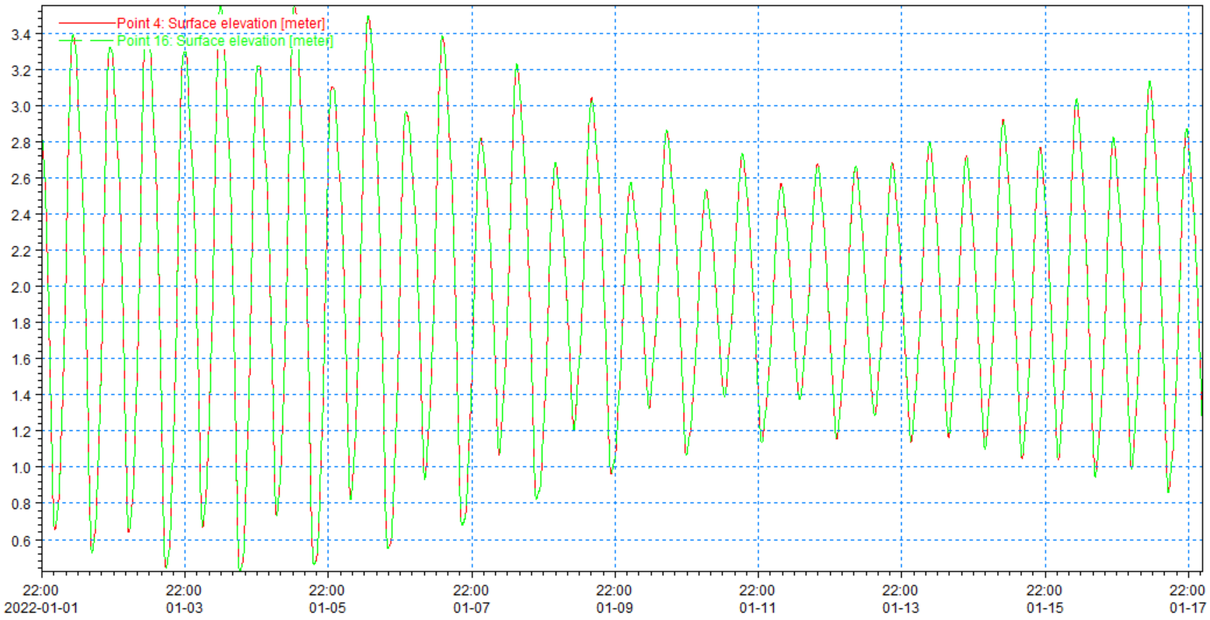
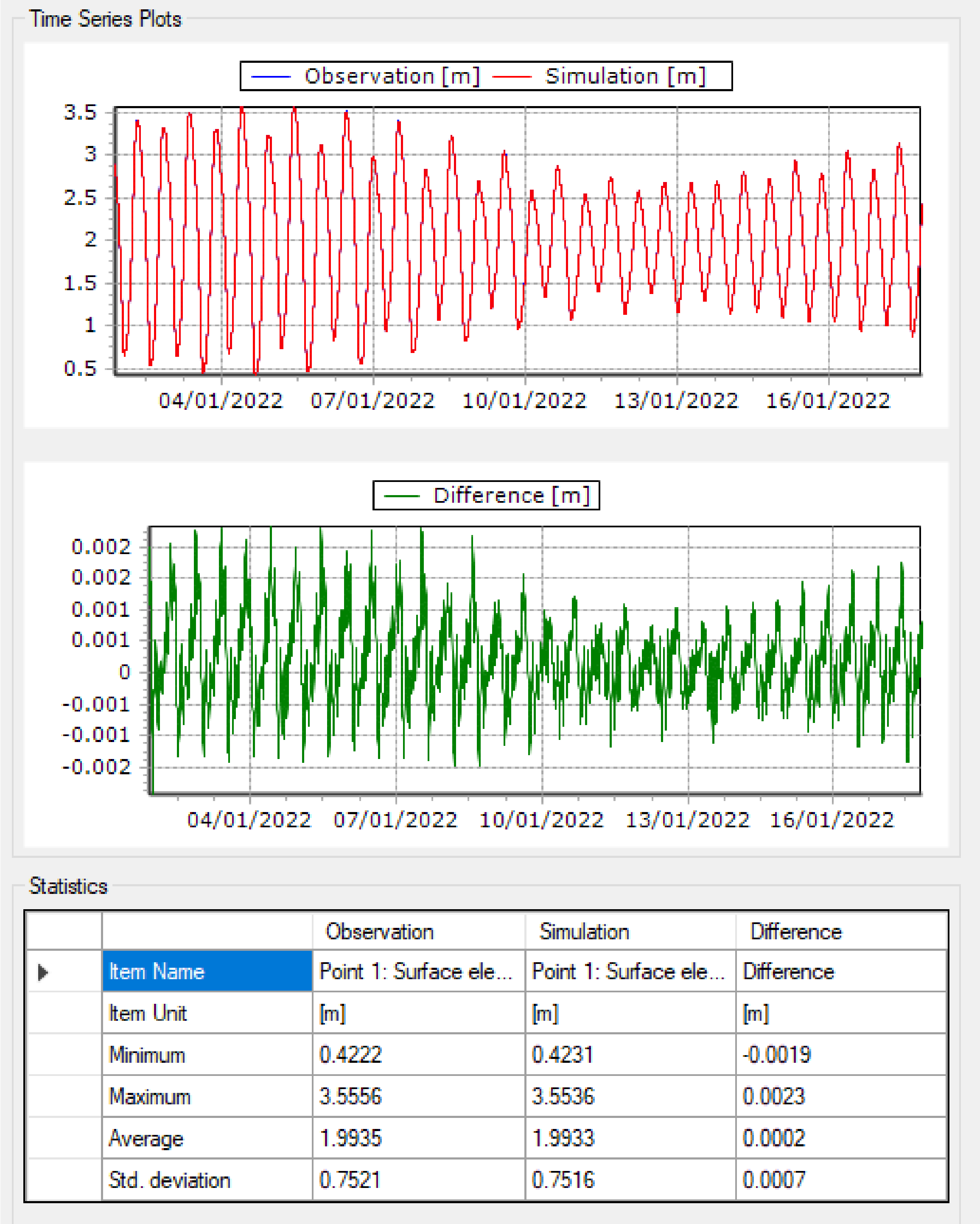


Figure 4-16: FM HD 19 water surface elevation predictions at points 4 and 16 for spring and neap tidal cycle



	Observation	Simulation	Difference
Item Name	Point 1: Surface ele...	Point 1: Surface ele...	Difference
Item Unit	[m]	[m]	[m]
Minimum	0.4222	0.4231	-0.0019
Maximum	3.5556	3.5536	0.0023
Average	1.9935	1.9933	0.0002
Std. deviation	0.7521	0.7516	0.0007

Figure 4-17: Comparison of FM HD 16 & FM HD 19 water surface elevation predictions at point 4

4.2.2 Tidal Currents

Tidal current speed predictions for point output locations 4, 16 and 22 are presented in Figure 4-18 for the spring and neap tidal cycle and in Figure 4-19 for the spring tide cycle. Review of these figures highlights the relatively weak currents (<0.32 m/s) present throughout locations in Scapa Flow.

Whilst there is an identifiable increase in current speed at location 4 adjacent to the proposed development when compared with the existing conditions, the change is not considered significant in the local context, and values remain generally low. Comparison of post-development results with baseline values (Figure 4-4) shows increase in current speed at location 4 both on the spring and the neap tide, with peak current speed during the neap tide cycle increasing from approximately 0.012 m/s to 0.032 m/s. Point 4 is located in close proximity to the new quay, and within the dredging envelop, and it is predicted that the proposed development is locally influencing the position of tidal currents at this location.

Comparative analysis of predicted current speeds across the point output locations is presented in Table 2, Appendix B, and in graphical form in Appendix C. Review of this analysis highlights that minor changes in peak current speed are predicted at point output locations in the immediate vicinity of the proposed development (<0.02 m/s change), with no change observed in the wider surrounds.

Figure 4-20 and Figure 4-21 present plots of predicted post-development current speed at Deepdale Bay during mid-flood and mid-ebb spring tides respectively. These plots show interpolated current vectors highlighting the direction of tidal flow during these tidal states. Review of these plots highlights the localised impact on current direction resulting from the new deep water quay construction. Marginally higher current speeds and associated eddies are noted forming around the proposed dredge pocket, as highlighted by review of the time series data from point 4.

Figure 4-22 and Figure 4-23 present plots of current speed differential between existing (FM HD 16) conditions and post-development (FM HD 19) conditions, for mid-flood and mid-ebb spring tides respectively. Review of these figures highlights the localised spatial pattern of development impact on tidal current speed during each tidal state. Negative values equate to current speed increases in these plots, and a minor increase in current speed post-development is observed in close proximity to the quay face, particularly within the -20mCD dredge pocket, during both flood and ebb tides. During the ebb tide the area of increase extends slightly further north in the direction of flow, along the quay. It is considered that the proposed development concentrates and re-directs flows resulting in the slight increase observed. No significant impact on current speeds is predicted within the wider surrounds.

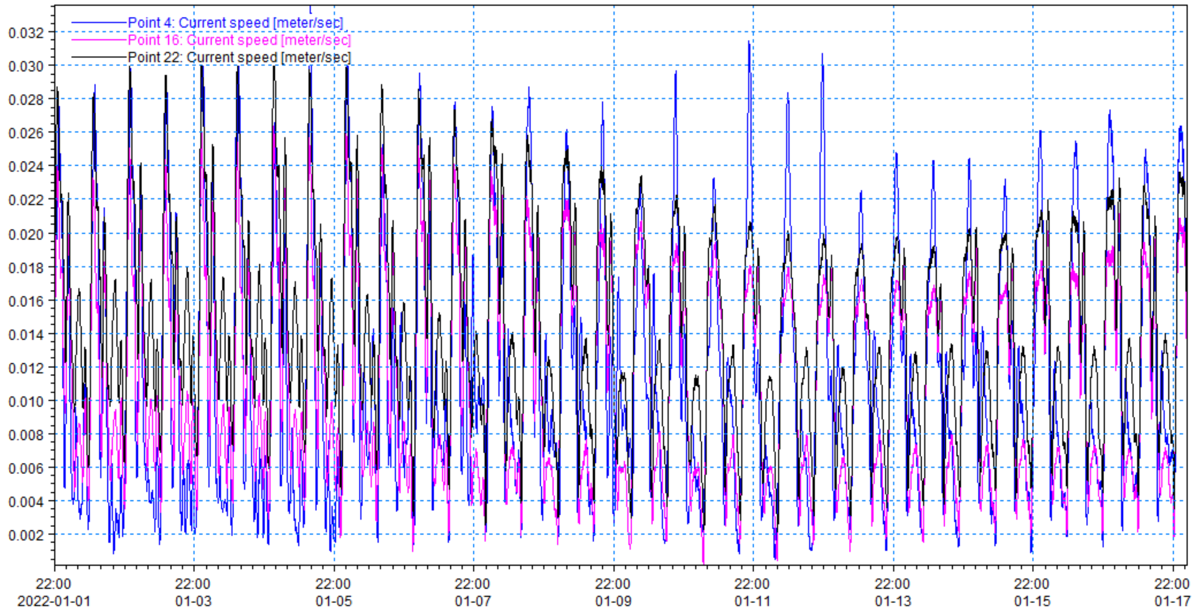


Figure 4-18: FM HD 19 current speed predictions at points 4, 16 and 22 for spring and neap tides

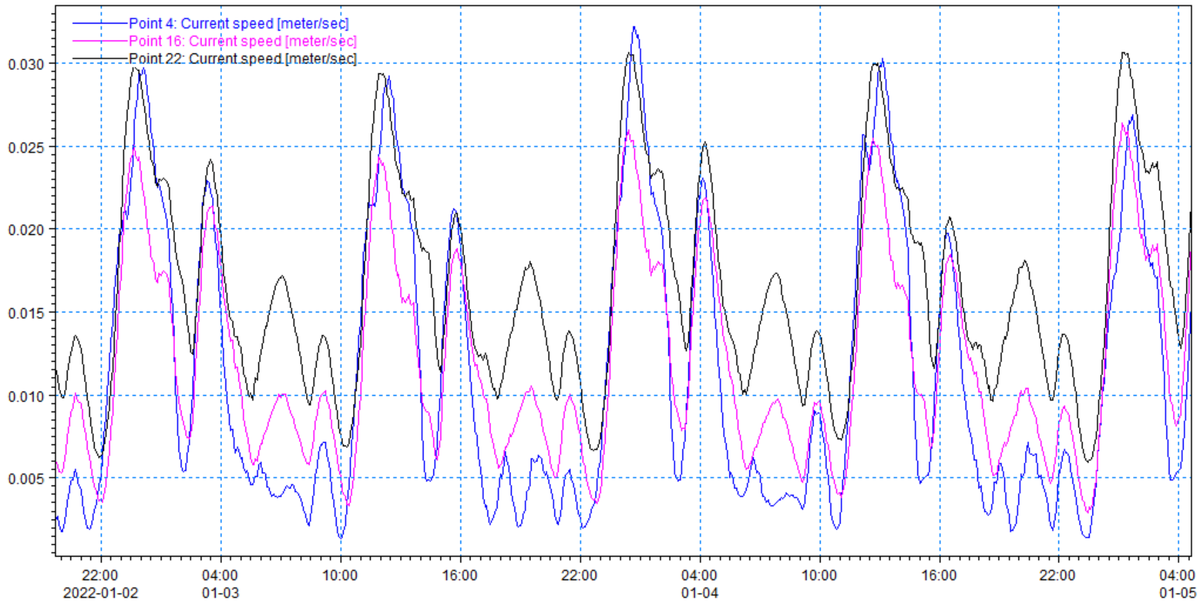


Figure 4-19: FM HD 19 current speed predictions for points 4, 16, 22 for spring tide

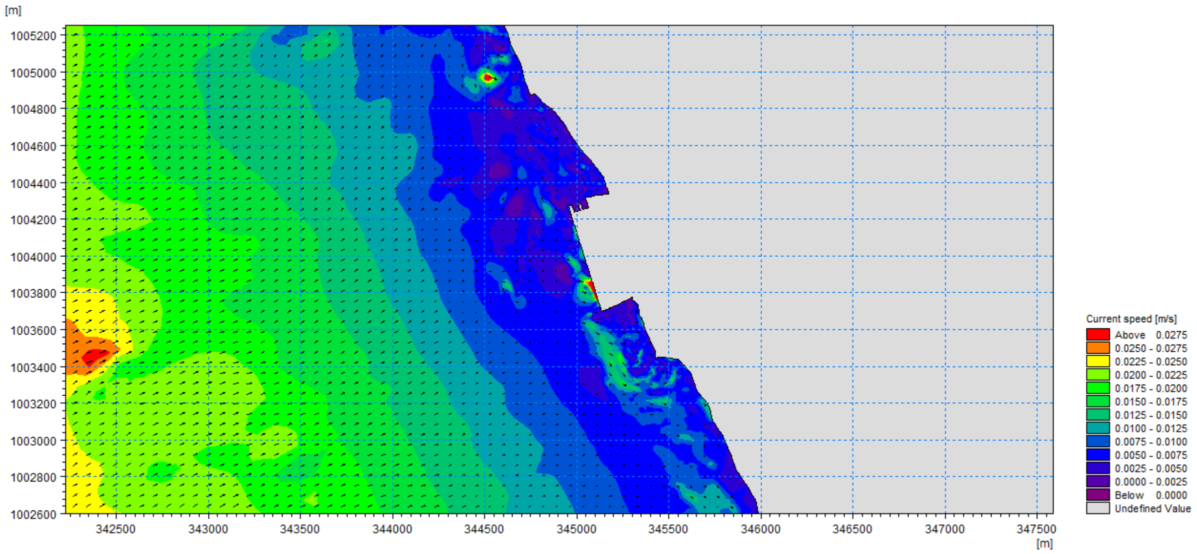


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Figure 4-20: FM HD 19 current speed at Deepdale Bay during mid-flood spring tide

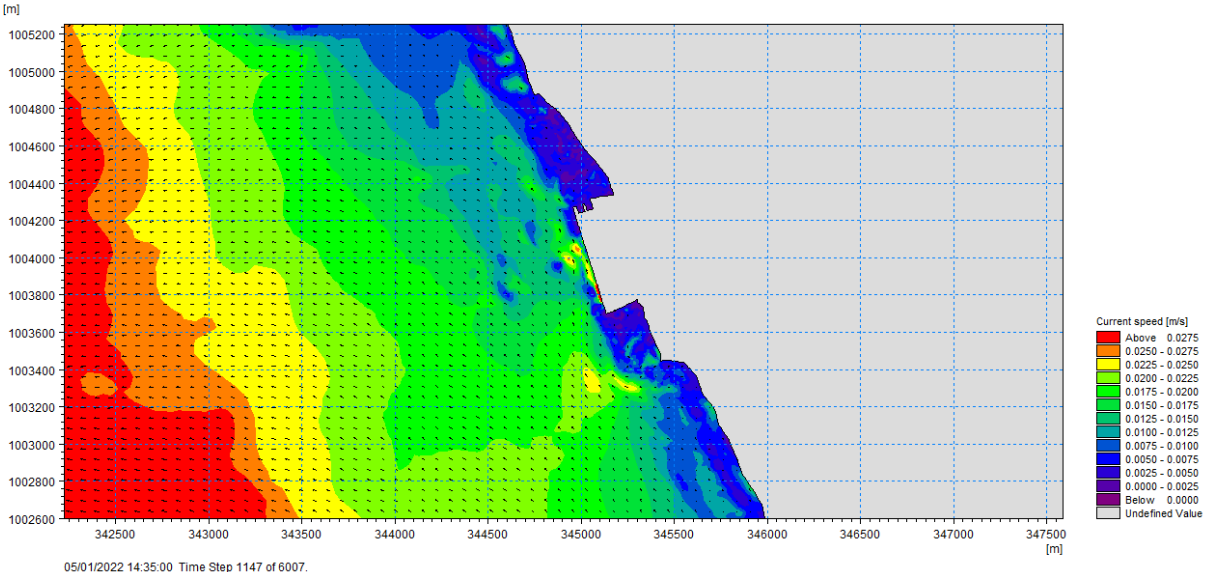

Figure 4-21: FM HD 19 current speed at Deepdale Bay during mid-ebb spring tide

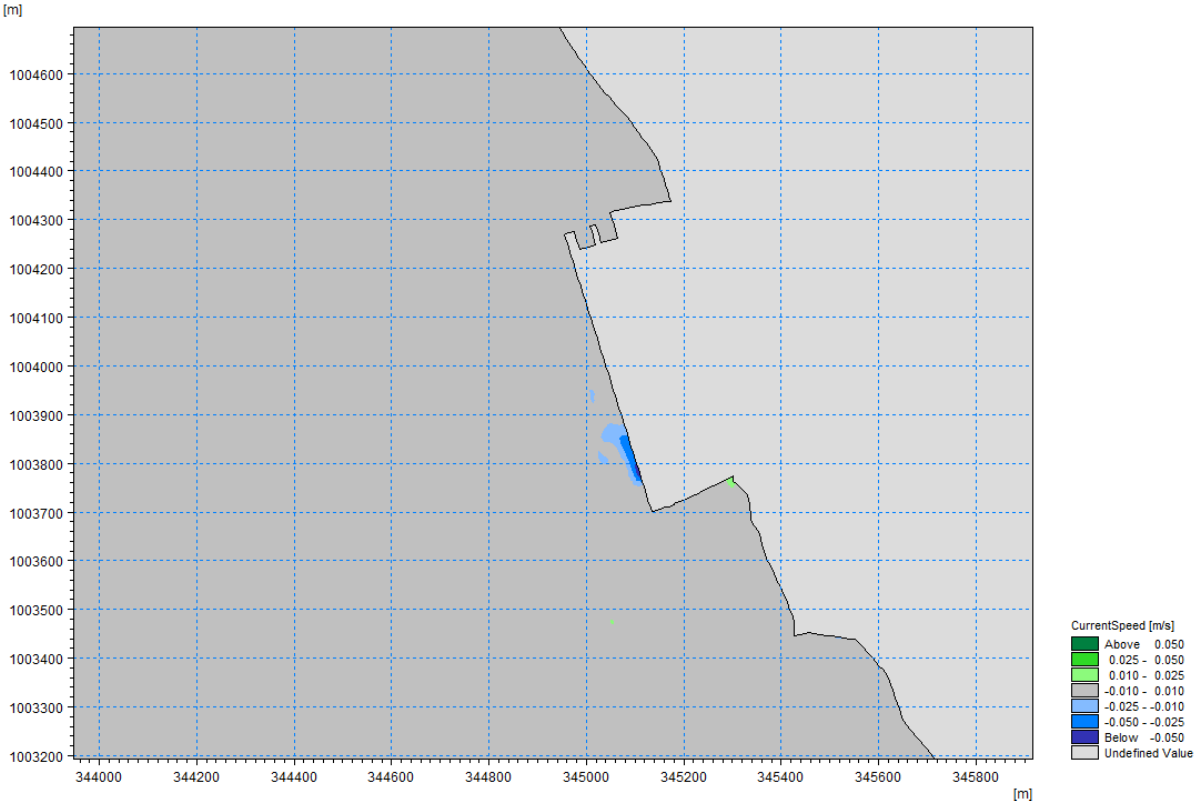

Figure 4-22: Baseline (FM HD 16) versus Post-development (FM HD 19) current speed differential – spring flood tide

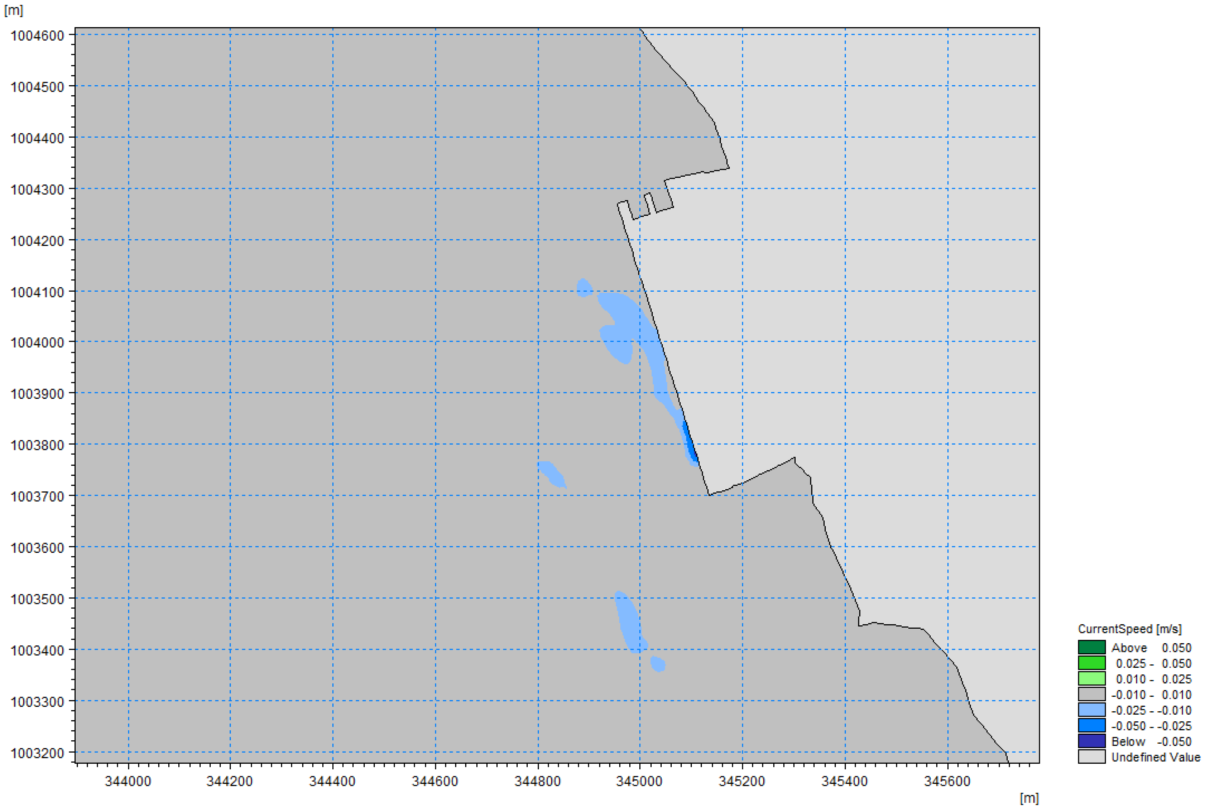

Figure 4-23: Baseline (FM HD 16) versus Post-development (FM HD 19) current speed differential – spring ebb tide

4.2.3 Bed Shear Stress

Figure 4-24 presents post-development model predictions of bed shear stress during the spring and neap tidal cycle for point output locations 2, 4, 6, 7, 9 and 10 around the proposed development and Deepdale Bay. As per existing conditions, all locations show generally low bed shear stress, as would be anticipated with the weak tidal currents observed. Peak bed shear stress predictions are around 0.005 N/m^2 during spring tides.

Whilst there is an identifiable increase in bed shear stress for locations adjacent to the proposed development when compared with the existing conditions, the change is not considered significant in the local context, and values remain generally low. The localised changes are visible when reviewing outputs for points 4 and 7. Figure 4-25 shows bed shear stress alongside current speed for location 4. Review of this figure shows that bed shear stress remains correlated with tidal current speeds despite local increases in shear stress post-development.

Despite local increases, in the post-development scenario it remains the case that the low current speeds and corresponding low bed shear stresses observed are considered comparable in magnitude to pre-development character, and indicative of a low energy environment.

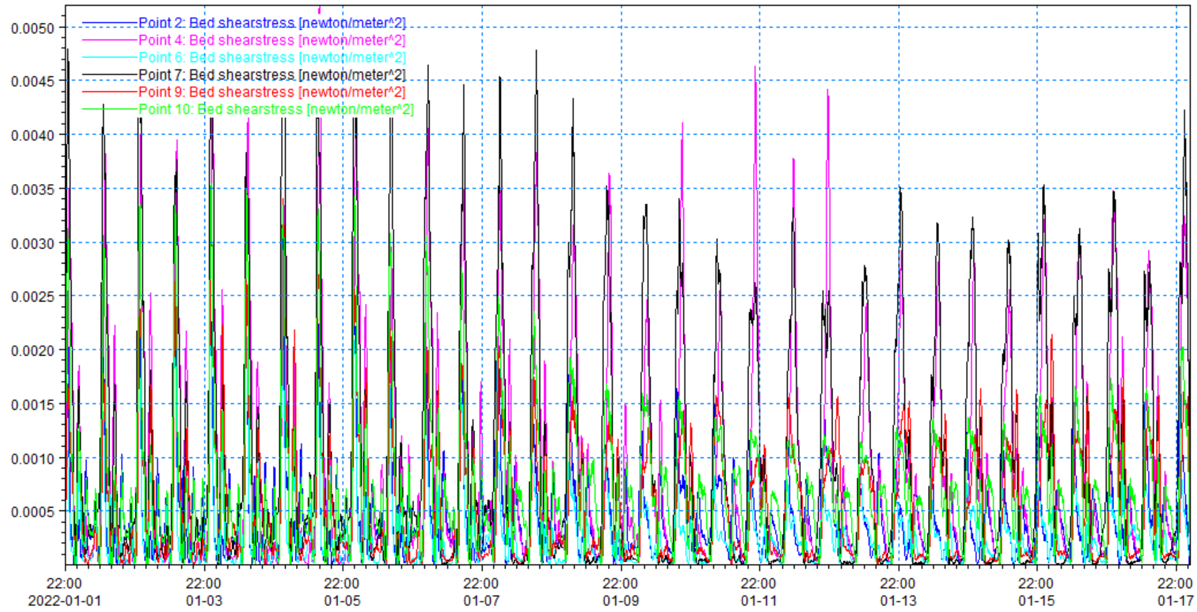

Figure 4-24: FM HD 19 bed shear stress at locations 2, 4, 6, 7, 9 and 10 through spring and neap tidal cycle

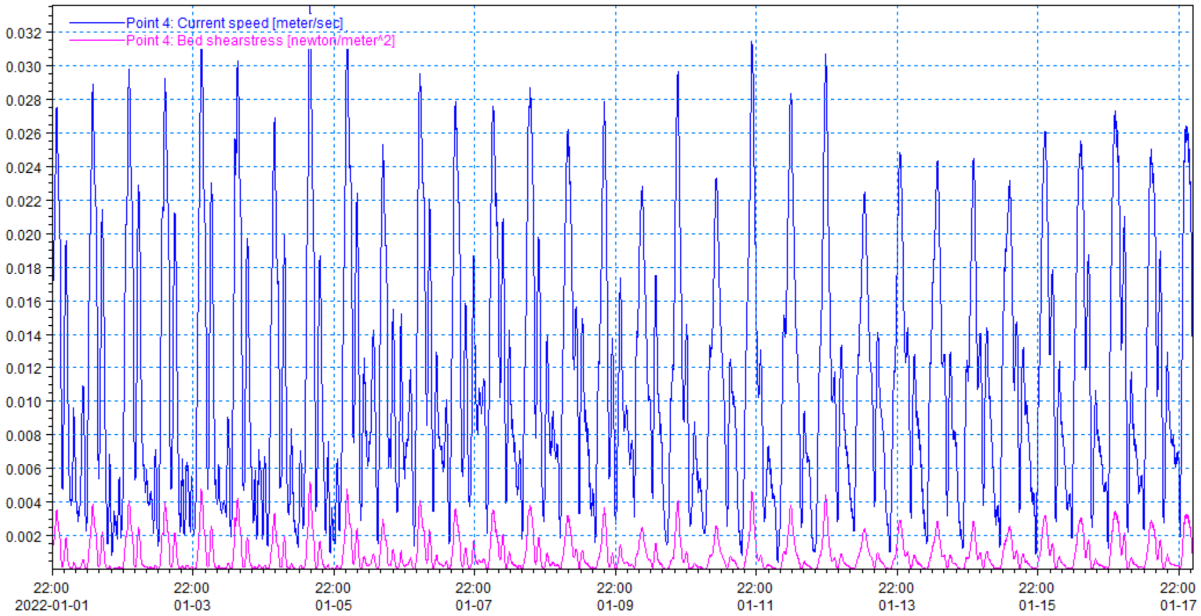

Figure 4-25: FM HD 19 bed shear stress and current speed at location 4

4.2.4 Wind Forcing Sensitivity

A wind forcing sensitivity simulation was undertaken using the post-development model and wind data as described in section 4.1.4. The wind forcing data was again applied as varying in time and constant across the model domain.

Figure 4-26 illustrates the post development current speeds at location 16 for the spring and neap tide cycle, both with and without wind forcing. Figure 4-27 shows the outputs for the same simulations at location 4, adjacent to the proposed development and dredging pocket. As is the case in the existing scenario, the results show how the wind forcing has the potential to increase current speeds within Scapa Flow, with peak current spends increasing from approximately 0.03 m/s to 0.095 m/s. While the relative increase is significant, current speeds within Scapa flow remain generally low.

Due to the unpredictability of wind forcing in terms of force, duration and direction, this scenario is only used to assess the model sensitivity to wind forcing. The wind forcing scenario has not been adopted as the design case in assessments and comparisons.

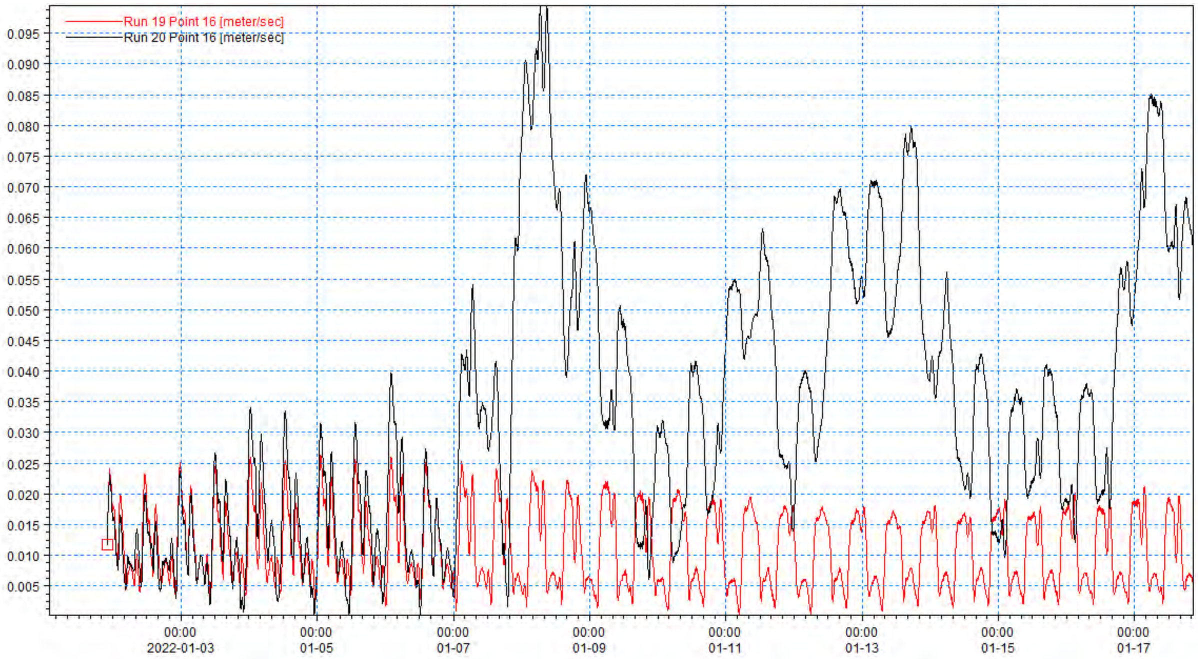

Figure 4-26: FM HD 19 and FM HD 20 current speed at location 16

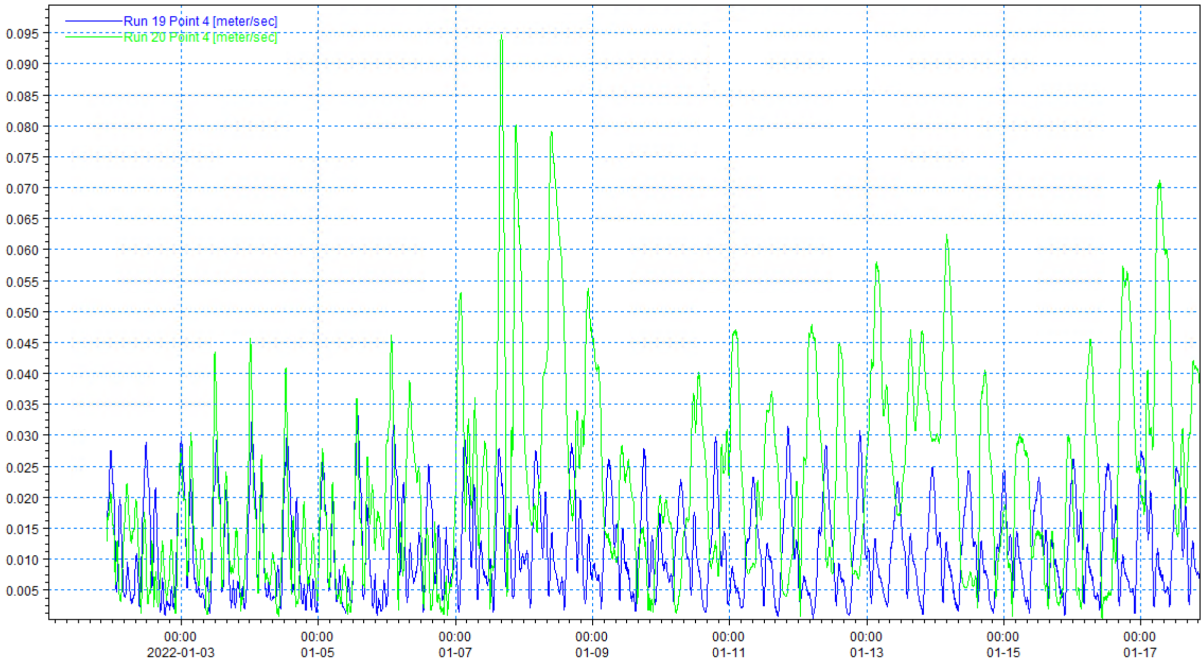

Figure 4-27: FM HD 19 and FM HD 20 current speed at location 4

5 DREDGE PLUME DISPERSAL MODEL

5.1 Context

5.1.1 Proposed Development Dredge

Dredging is required to facilitate the development of Scapa Deep Water Quay. The proposed harbour facility will include approx. 597m long main quayside berth with general -15m CD water depth, incorporating a 135m quayside pocket with -20m CD water depth. Further north tug (3No.) and pilot boat (2No.) berth approx. 180m long with depths between -6 and -9m CD. The proposed dredge budget is estimated at a total of 174,000m^3 across all three phase areas. The proposed dredge campaign would be undertaken by back-hoe dredger, with 24/7 operation over an estimated duration of just over 14 weeks. Dredging would take place following construction of the proposed quay walls. The dredge arisings are to be re-used predominantly as infill material within the proposed development footprint.

The proposed development layout, including dredge pocket locations and extents, are detailed in Appendix A.

5.1.2 Dredge Budget Character

The dredge budget has been assessed through site investigation, including borehole and washprobe sampling, to consist predominantly of sand with silt and gravel content. The average proportion of the dredge budget classified within the various identified particle sizes is presented in Table 5-1 below.

Table 5-1: Summary of dredge budget particle size data

Sediment Type (Grain Size)	Percentage of Dredge Budget
Silt and Clay (<0.063mm)	23.3%
Sand (> 0.063mm and <2mm)	59.7%
Gravel (>2mm)	17.0%

5.2 Dredge Dispersal Model Development

5.2.1 MIKE 21 Mud Transport (MT) Module

To simulate sediment plume dispersal from the proposed dredge campaign, the MIKE 21 Mud Transport (MT) module has been utilised. The mud transport module simulates the erosion and deposition of mud or sand/mud mixtures. It can be coupled with the MIKE 21 HD module, as described in section 3.1, to assess the dispersion of spilled sediment from a dredger by tidal forcing.

Amongst the key features of the MIKE 21 MT module are:

- Multiple sediment fractions;
- Multiple bed layers;
- Flocculation;
- Hindered settling;
- Inclusion of non-cohesive sediments;

- Consolidation; and
- Capability to simulate morphological update of the seabed.

As MIKE 21 is a two-dimensional (depth-averaged) flow model, the simulation of the transport of material is averaged over depth.

5.2.2 MT Module Settings

A summary of the configuration of the general settings within the MT module for the dredge dispersal simulations is presented in Table 5-2 below. The assumed parameters of the dredge applied within the MT simulations are outlined in Table 5-3.

Table 5-2: General settings applied to MIKE 21 MT module

Setting	Description/Value	
Number of fractions	3 fractions: 1. Clay and silt 2. Sand 3. Gravel	
Number of bed layers	1	
Hydrodynamic conditions	2-dimensional flow from HD model (see chapters 3 and 4)	
Solution technique	Higher order	
Simulation period	105 days	
Output time interval	15 minutes	
Settling velocity	Fraction 1: Clay and silt	0.0007m/s
	Fraction 2: Sand	0.0395m/s
	Fraction 3: Gravel	0.0933m/s
Critical shear stress	Fraction 1: Clay and silt	0.136N/m^2
	Fraction 2: Sand	0.211N/m^2
	Fraction 3: Gravel	0.360N/m^2
Flocculation	Calculations included	
Wave forcing	Not included	
Dispersion	Scaled eddy viscosity formulation	
Initial conditions	Layer 1: No bed thickness	
Morphological update	Not included	

Table 5-3: Assumed parameters of dredge applied to MIKE 21 MT module

Variable	Quantity	Comments
Total dredge volume	174,000m^3	All 3 dredge phases
Dredger type	Backhoe	Nordic Giant or similar
Dredge campaign duration	102 days	24 hours operation
Dredge rate	1,694m^3/day	Assumed constant
Dredge sediment composition	Fraction 1 – 23.3%	Clay and silt
	Fraction 2 – 59.7%	Sand
	Fraction 3 – 17.0%	Gravel
Density of material	1,800kg/m^3	Assumed constant
Spill rate	5%	The proportion of dredged material lost to water column
Dredger path	-	As per Figure 5-1

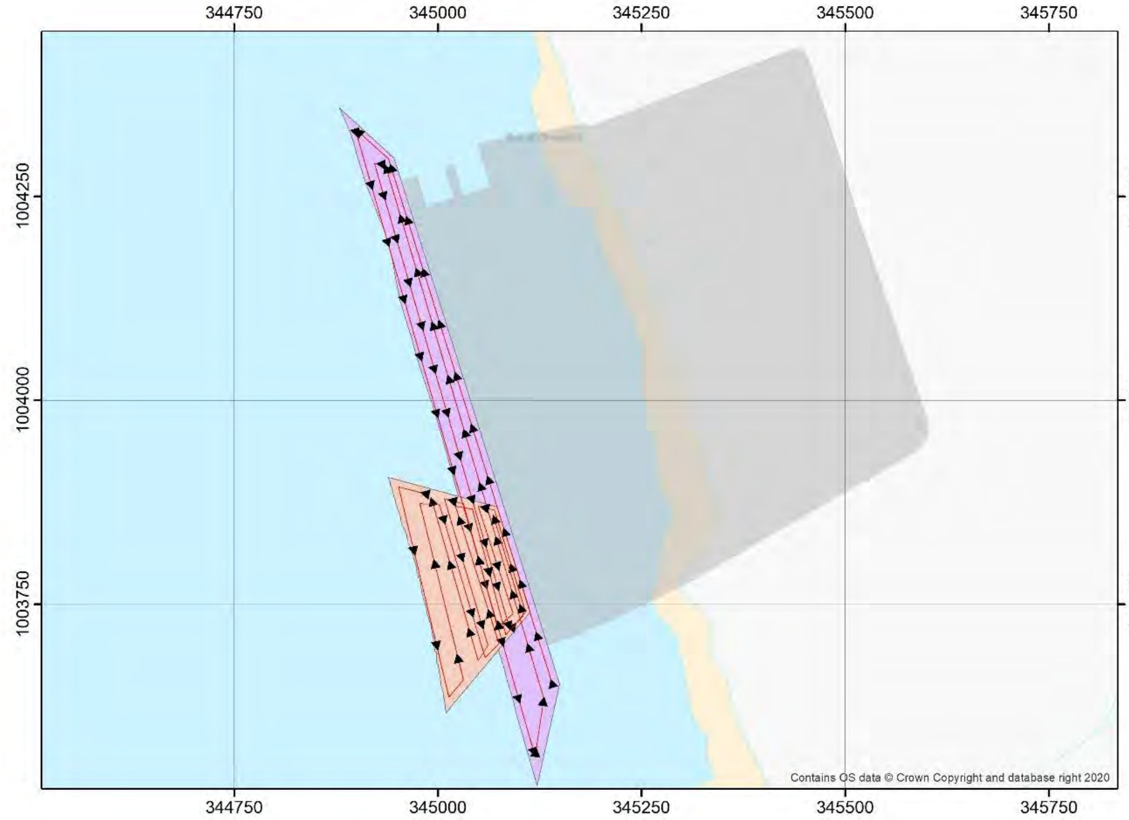

Figure 5-1: Assumed dredger path (red line with arrows) through dredge pockets for whole of dredge campaign

5.2.3 HD Module Settings

The HD module has been setup as described in Chapter 3, and specifically Section 3.5. A new version of the model mesh has been generated combining the post-development model mesh with the baseline bathymetry. This is considered reflective of the likely conditions at the commencement of the dredge campaign, and a conservative setup for assessing dredge plume dispersal.

5.2.4 Model Outputs

The MIKE 21 FM HD MT model simulations have been setup to produce results as both point and area outputs. The HD module outputs are as per those described in Section 3.6. The MT module outputs include the following key parameters:

- Total suspended solids (TSS);
- Bed thickness change; and
- Total net deposition accumulation.

The area outputs are generated for the whole model extent, whilst point outputs have been generated at 12 identified locations within the model extent as detailed in Table 5-4 and shown in Figure 5-2. The locations of point outputs are situated within the immediate vicinity of Deepdale Bay and the proposed development including one within the capital dredge pocket (Point 5), and one within the Westerbister fish farm extent (Point 12).

Table 5-4: MT module point output locations

Point Output Location	Easting	Northing
Point 1	344500	1004600
Point 2	344000	1004200
Point 3	344500	1003400
Point 4	345000	1003000
Point 5	345000	1003800
Point 6	344342	1002099
Point 7	345000	1001200
Point 8	342000	1003000
Point 9	342000	1005500
Point 10	344000	1006000
Point 11	346000	1002000
Point 12	345237	1002729

Figure 5-2: MT module point output locations

5.2.5 Model Simulations

The key MIKE 21 FM HD MT model simulations are described in Table 5-5. Simulations 2 and 4 have been run utilising the computing hardware specified in Section 3.6. Due to the length of required simulation, and the associated computational effort required, simulation 3 has been run utilising the DHI cloud simulation facility, with a PC including 64 CPU.

Table 5-5: MIKE 21 FM HD MT model simulations

Simulation	Description
Scapa FM HD MT Dredge 2	Initial 8 days of dredge campaign, model mesh includes pre-dredge bathymetry with development footprint. Run for January 2022 tidal cycle, with no wind forcing.
Scapa FM HD MT Dredge 3	Full dredge campaign, model mesh includes pre-dredge bathymetry with development footprint. Run for January to April 2022 tidal cycle, with no wind forcing.
Scapa FM HD MT Dredge 4	Wind forcing sensitivity scenario. Initial 8 days of dredge campaign, model mesh includes pre-dredge bathymetry with development footprint. Run for January 2022 tidal cycle, with wind forcing.

5.3 Dredge Dispersal Model Results

5.3.1 Dredge Plume Dispersal – Initial Days of Campaign

As outlined in Table 5-5, simulation Scapa FM HD MT Dredge 2 includes the first 8 days of the proposed dredge campaign, simulated with a January 2022 tidal cycle, and no consideration of wind forcing on hydrodynamics.

Due to the low current speeds present within the vicinity of the dredge, only clay and silt particles from the finest fraction (1) enter suspension to form a plume, whilst sands and gravel fractions immediately fall out of suspension to deposit within the dredge extent. Figure 5-3 presents the total suspended solids concentrations within the dredge plume following 8 days of the dredge campaign. Review of this figure highlights that the highest concentrations (0.0075 – 0.002 kg/m^3) of TSS occur within, and immediately adjacent to, the dredge pockets. TSS concentrations can be seen to rapidly reduce away from the dredge extents. The spatial extent of the plume is relatively restricted, however fingers of lower concentration TSS observed extending to the north-west along shore, highlight the marginal residual dominance of the ebb tide in that direction.

Figure 5-4 presents the total deposition thickness following 8 days of the dredge campaign. Review of this figure highlights that measurable thickness of deposition is limited to the immediate dredge footprint, primarily consisting of sands and gravels, with maximum deposit thickness of 0.015m. Figure 5-5 presents the total net deposition accumulation following 8 days of the dredge campaign. Review of this figure highlights that deposition accumulation primarily occurs within the immediate dredge extent (maximum accumulation ~8,000g/m^2), with accumulation rapidly decreasing away from this area.

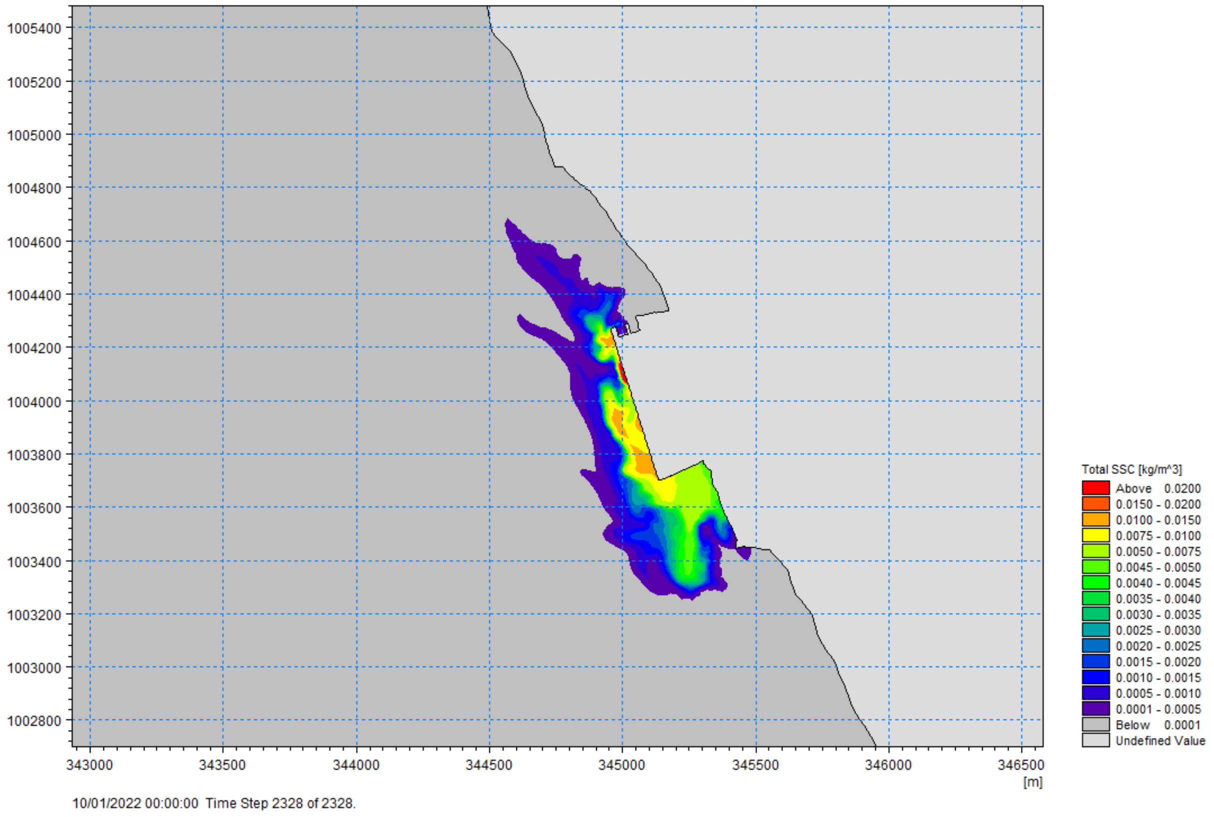

Figure 5-3: FM HD MT Dredge 2 – plume TSS following 8 days of dredge

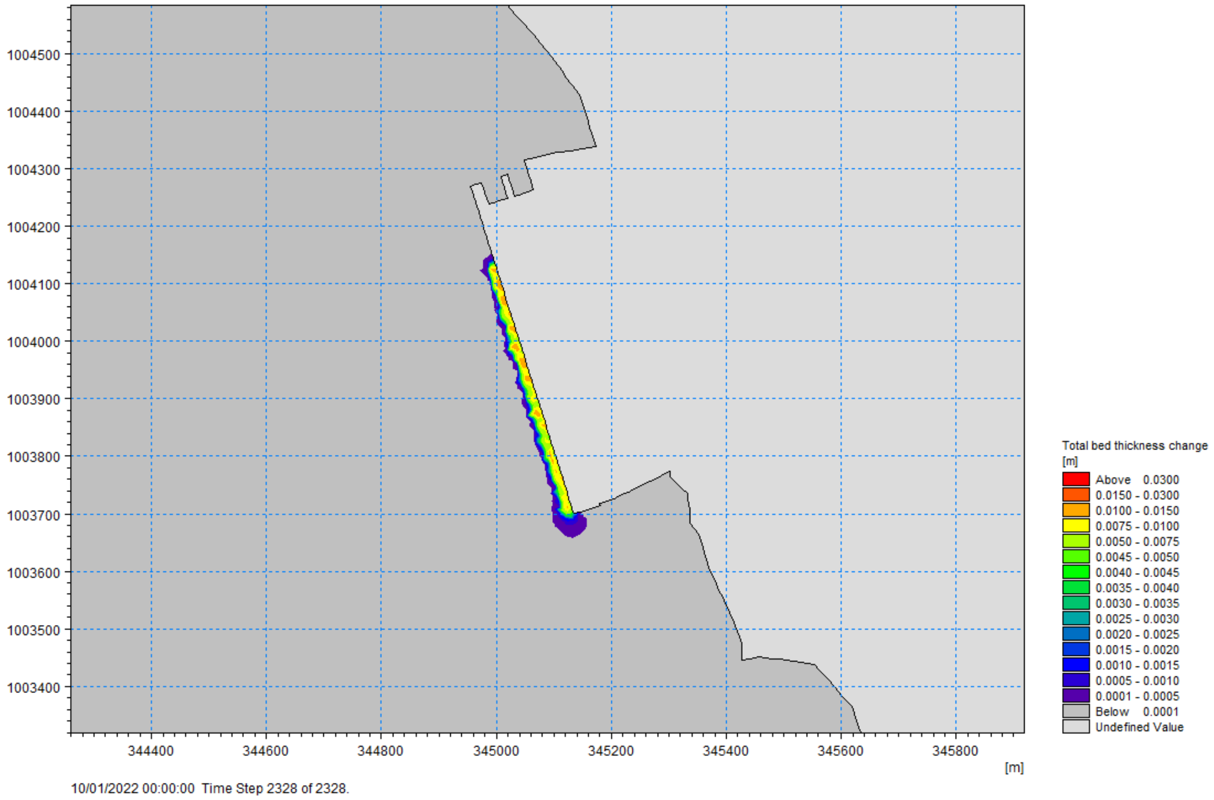

Figure 5-4: FM HD MT Dredge 2 – deposition thickness following 8 days of dredge

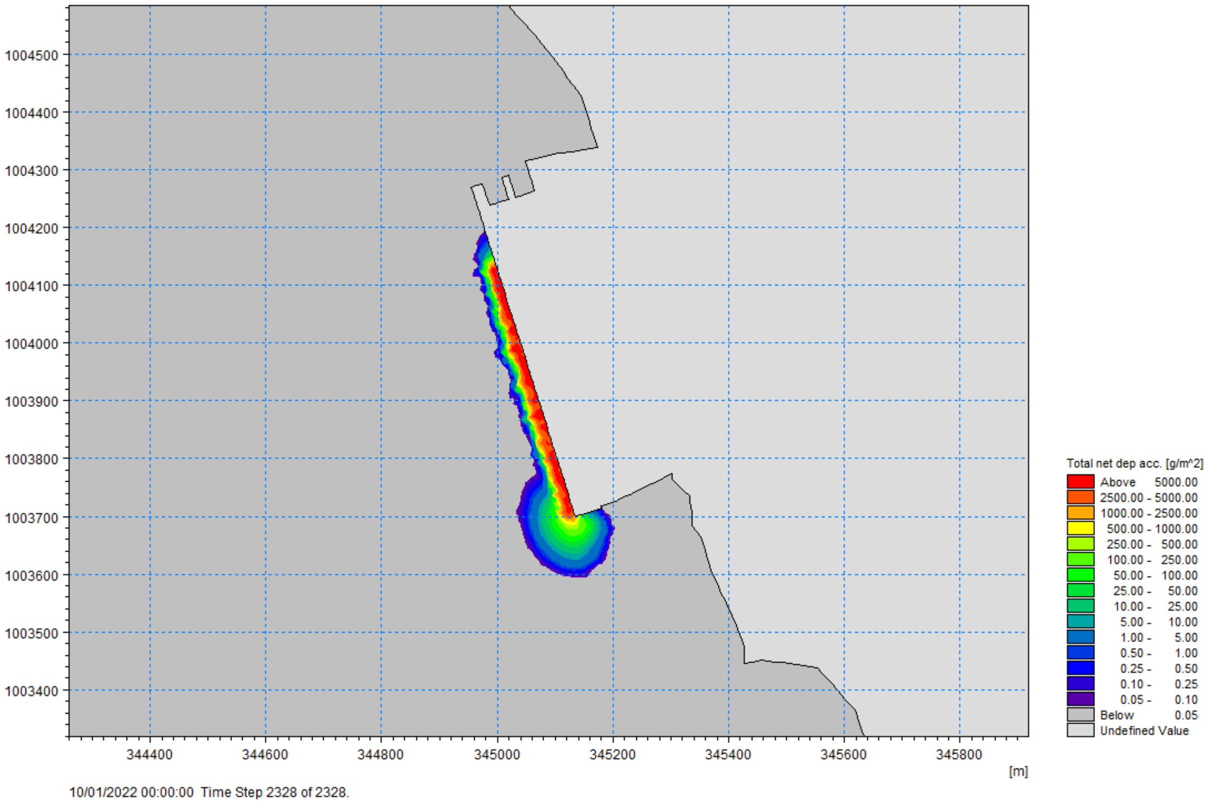

Figure 5-5: FM HD MT Dredge 2 – total net deposition accumulation following 8 days of dredge

5.3.2 Dredge Plume Dispersal – Full Campaign Duration

As outlined in Table 5-5, simulation Scapa FM HD MT Dredge 3 includes the full duration of the proposed dredge campaign, simulated with a January to April 2022 tidal cycle, and no consideration of wind forcing on hydrodynamics.

As described in section 5.3.1, due to the low current speeds present within the vicinity of the dredge, only clay and silt particles from the finest fraction (1) enter suspension to form a plume, whilst sands and gravel fractions immediately fall out of suspension to deposit within the dredge extent. Figure 5-6 presents the total suspended solids concentrations within the dredge plume at the end of the dredge campaign. Review of this figure highlights that the highest concentrations (0.0075 – 0.002 kg/m^3) of TSS occur within, and immediately adjacent to, the dredge pockets. TSS concentrations can be seen to rapidly reduce away from the dredge extents. The spatial extent of the plume, extending to the north-west along shore, highlights the marginal residual dominance of the ebb tide in that direction. Further westwards nearshore spread of very low concentration plume (<0.0005 kg/m^3) is also observed.

Figure 5-7 presents the total suspended solids concentrations within the dredge plume at the end of the simulation, 3 days after completion of dredging. Review of this figure versus Figure 5-6 highlights the reduction in plume extent, and reduction in observed TSS concentrations, over the 3 days since completion of dredging. Figure 5-8 presents a time-series of TSS concentrations at point output locations 1 (north of dredge zone), 5 (within dredge zone) and 12 (within Westerbister fish farm). Review of this figure highlights that point 5 exhibits higher relative TSS concentrations than point 1, and also generally longer duration of higher TSS concentrations throughout the dredge campaign. Point 12 within the fish farm does not return any significant TSS concentrations throughout the dredge campaign duration.

Figure 5-9 presents the statistical maximum TSS concentration across the full simulation. A similar pattern is observed to those described above, with highest TSS concentrations present within the dredge extent, and immediate surrounds, rapidly decreasing with distance away from the dredge zone. The dredge plume can again be observed to extend north-west along shore, with weaker concentrations of TSS observed extending further west into Scapa Flow within the nearshore zone.

Figure 5-11 presents the statistical mean TSS concentration across the full simulation. Review of this figure again highlights a similar pattern of plume dispersal as observed in previous figures. Highest mean TSS values within the dredge extent are <0.015 kg/m^3, whilst plume extents and concentrations are generally reduced in comparison to previous figures.

Figure 5-12 presents the total deposition thickness at the end of the simulation, following completion of the dredge campaign. Review of this figure highlights that measurable thickness of deposition is limited to the immediate dredge footprint, primarily consisting of sands and gravels, with maximum deposit thickness of 0.03m. Figure 5-13 presents the total net deposition accumulation at the end of the simulation, following completion of the dredge campaign. Review of this figure highlights that deposition accumulation primarily occurs within the immediate dredge extent (maximum accumulation ~30,000 g/m^2), with accumulation rapidly decreasing away from this area.

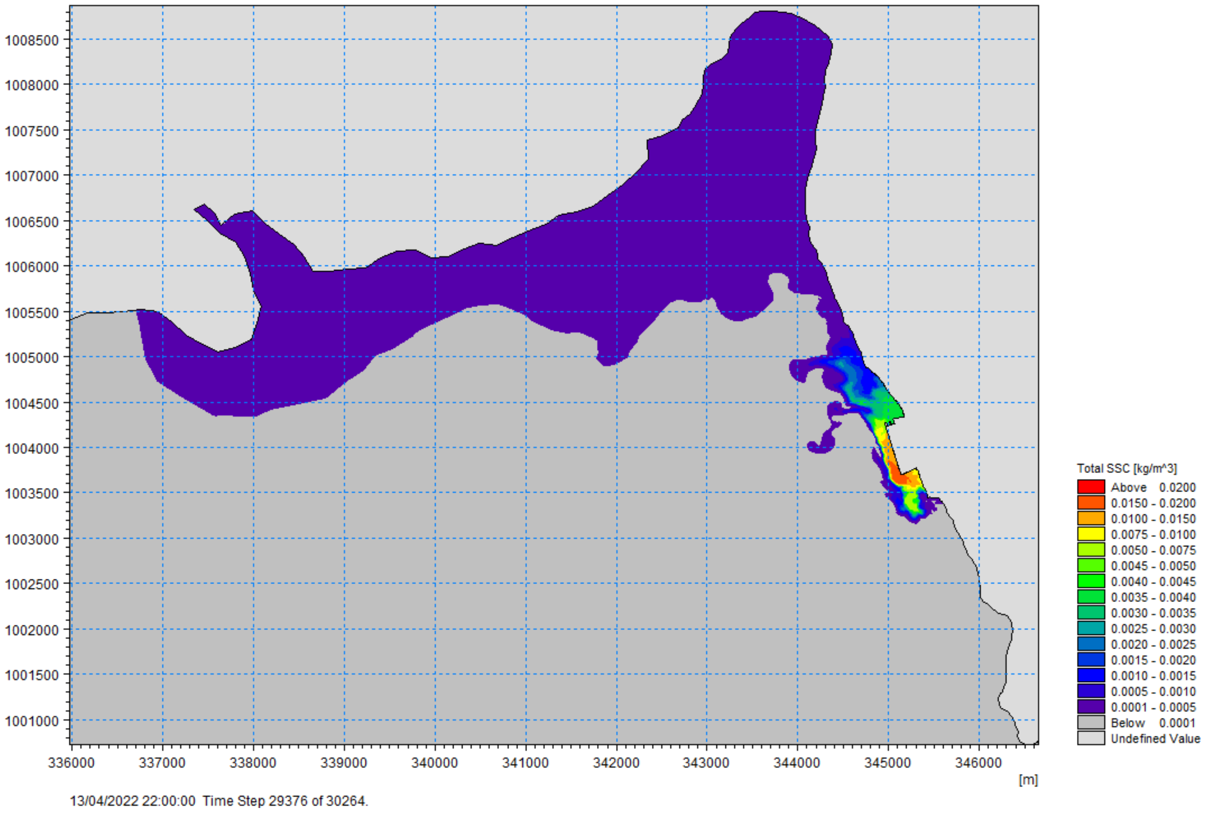

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Figure 5-6: FM HD MT Dredge 3 – plume TSS at end of dredge campaign

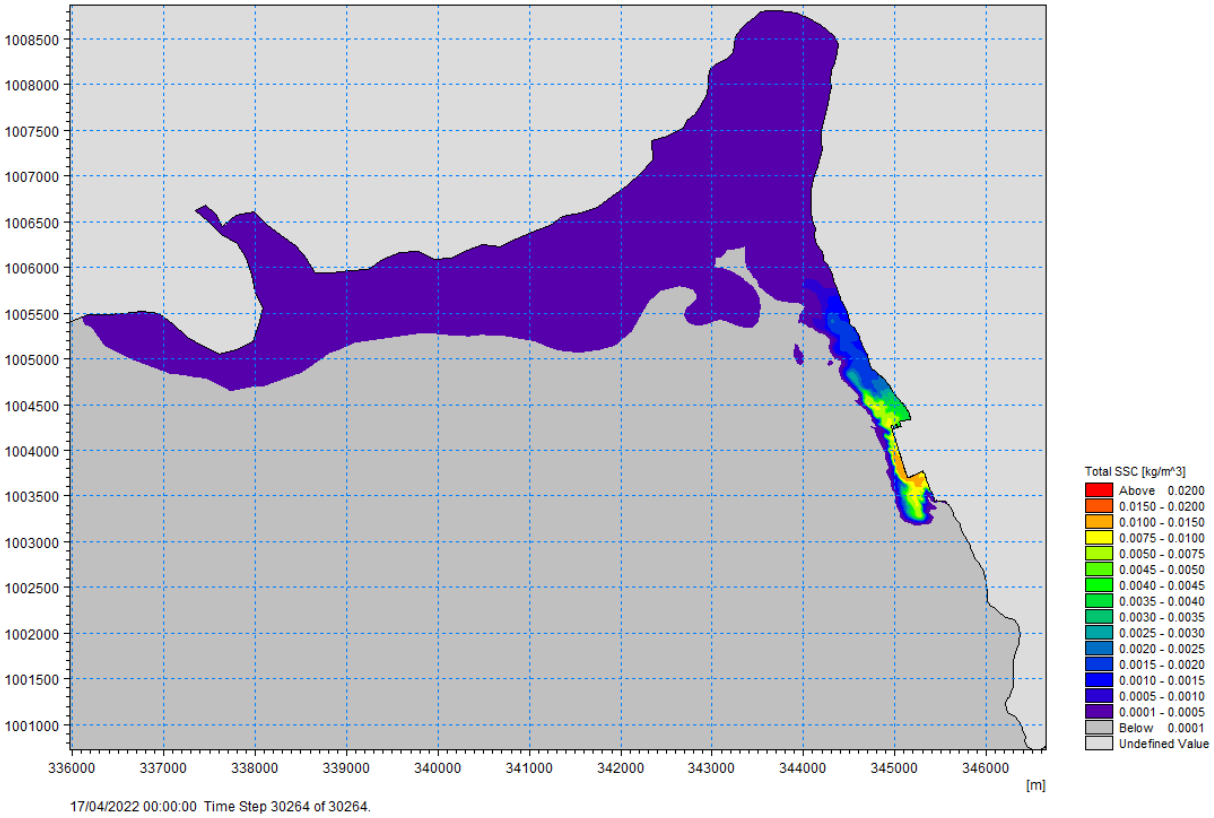

Figure 5-7: FM HD MT Dredge 3 – plume TSS at end of simulation

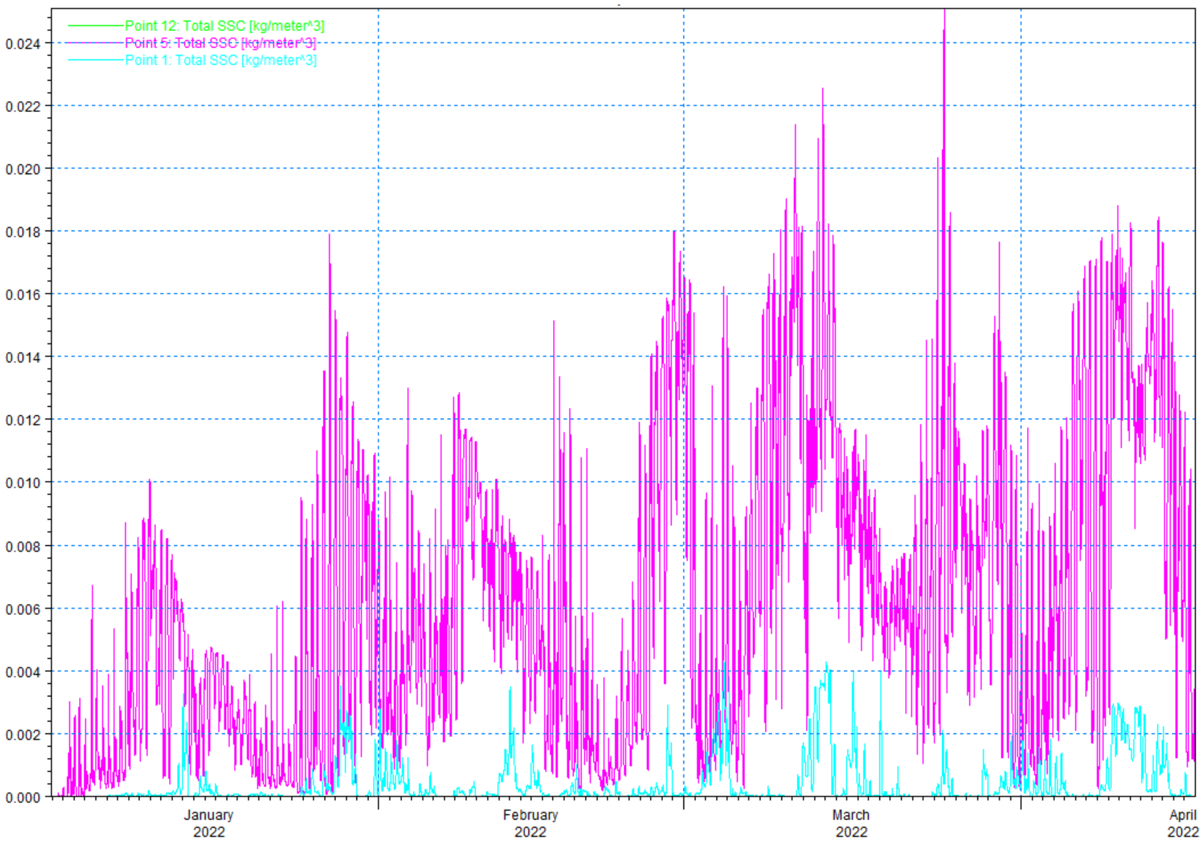

Figure 5-8: FM HD MT Dredge 3 – time-series TSS concentration (kg/m^3) at locations 1, 5 & 12

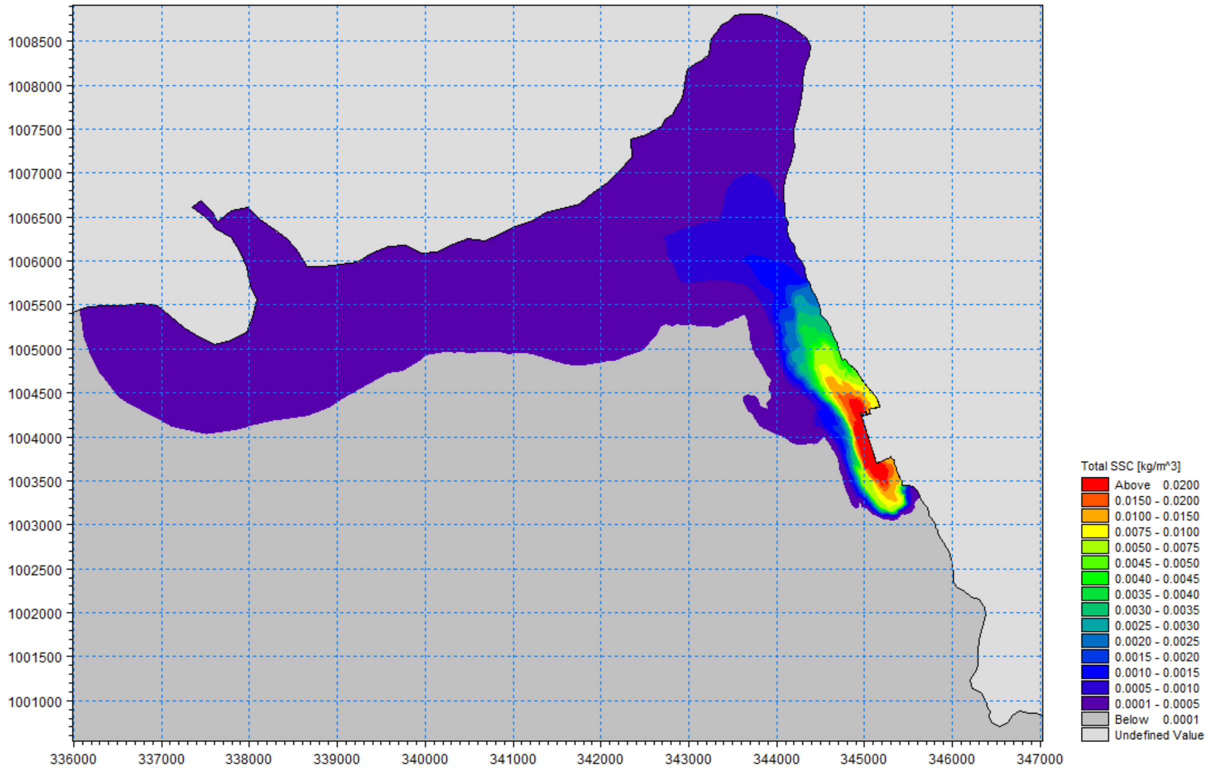

Figure 5-9: FM HD MT Dredge 3 – statistical maximum plume TSS (full dredge campaign)

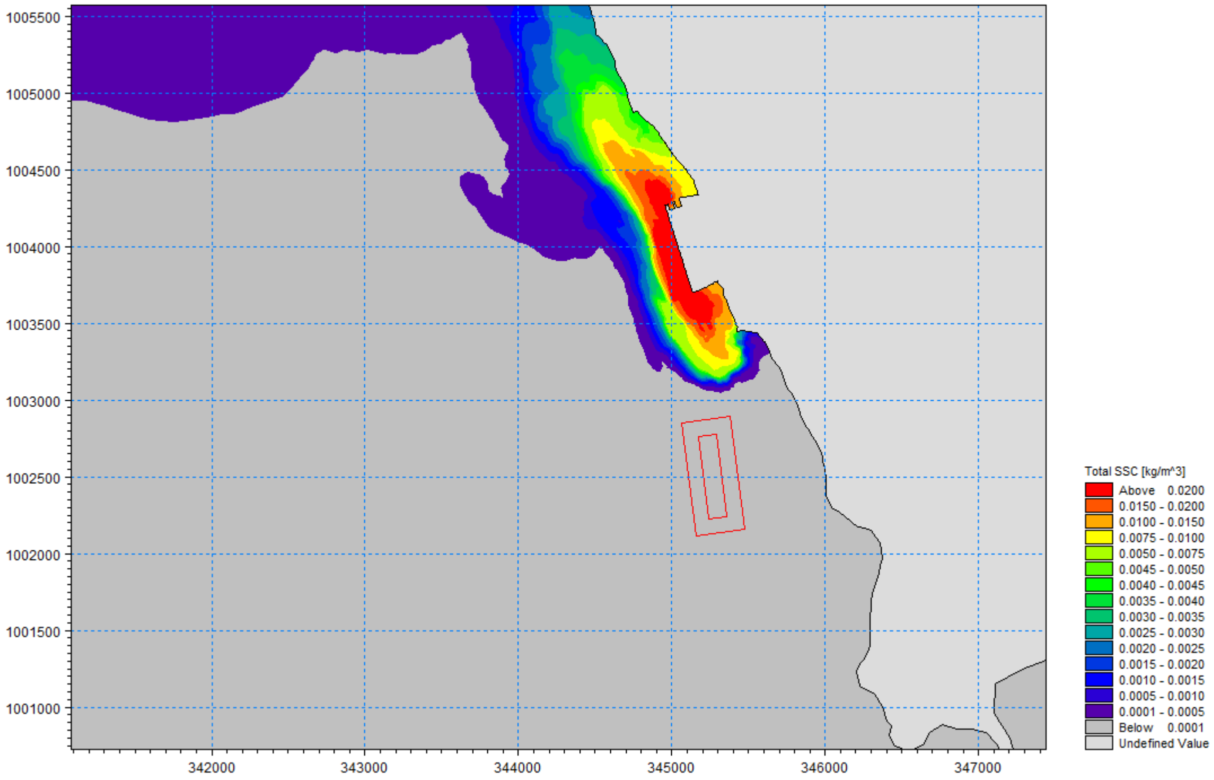

Figure 5-10: FM HD MT Dredge 3 – statistical maximum plume TSS (full dredge campaign zoom view Westerbister Fish Farm (red polygons))

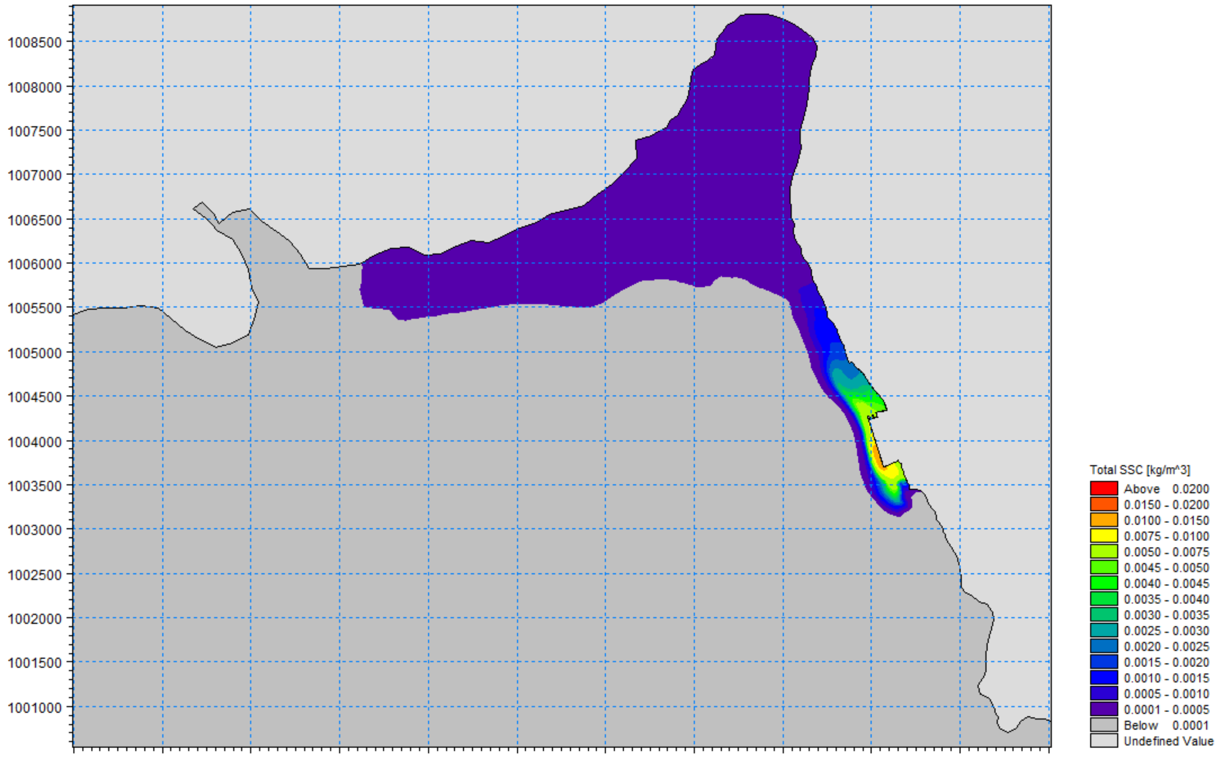

Figure 5-11: FM HD MT Dredge 3 – statistical mean plume TSS (full dredge campaign)

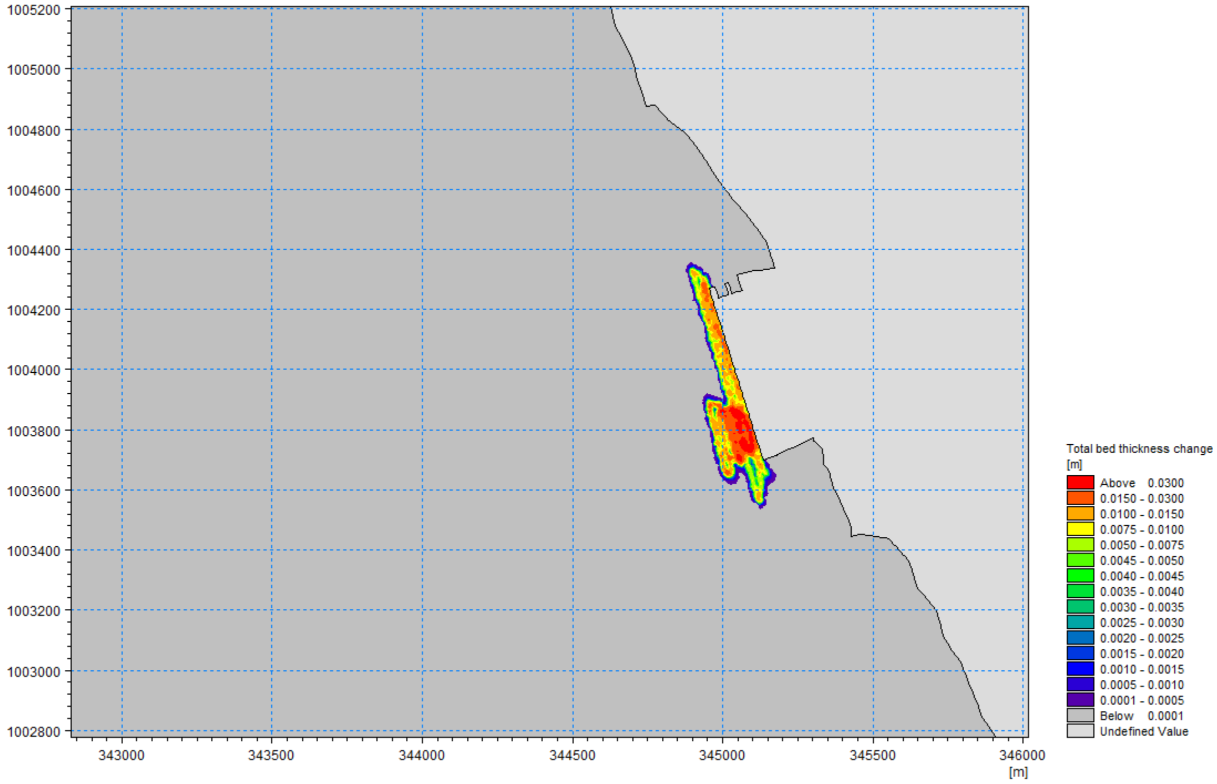

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Figure 5-12: FM HD MT Dredge 3 – deposition thickness at end of simulation

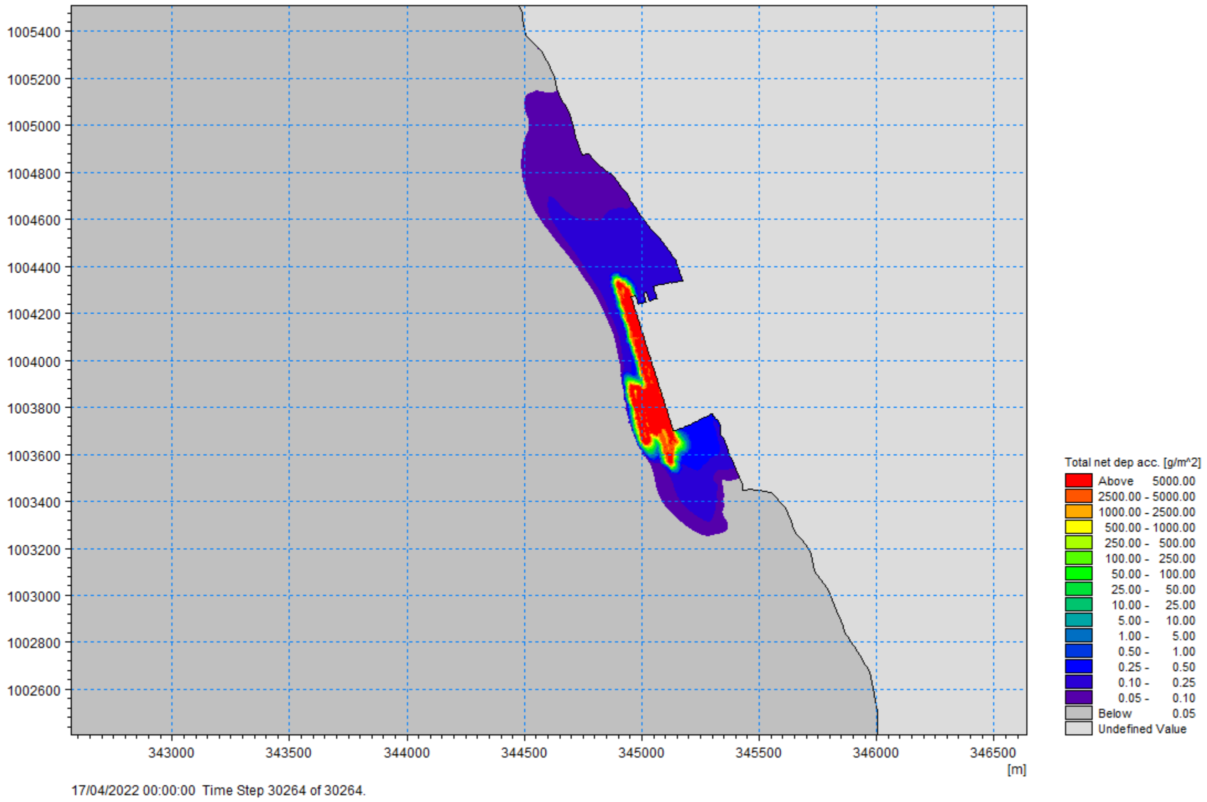


Figure 5-13: FM HD MT Dredge 3 – total net deposition accumulation at end of simulation

5.3.3 Wind Forcing Sensitivity

As outlined in Table 5-5, simulation Scapa FM HD MT Dredge 4 includes the first 8 days of the proposed dredge campaign, simulated with a January 2022 tidal cycle, and including consideration of wind forcing on hydrodynamics, as a model sensitivity scenario. The wind forcing applied in this simulation is constant across the model domain, but varying in time, as described in section 4.1.4. A rose plot showing input wind speed and directional frequency during the simulation period is presented in Figure 5-14, and during the final 50 hours of the simulation in Figure 5-15. Due to the unpredictability of wind forcing in terms of force, duration and direction, this scenario is only used to assess the model sensitivity to wind forcing.

Figure 5-17 and Figure 5-16 present the total suspended solids concentrations within the dredge plume following 8 days of the dredge campaign, with wind forcing included. Comparison of these figures with the results presented in Figure 5-3 highlights the impact of wind forcing on plume extents and placement, as well as observed TSS concentrations. The wind forcing effect on tidal currents acts to reduce the north-western dispersal of the dredge plume, driving the plume towards shore in the east, and extending further along shore to the south-east. Observed TSS concentrations are generally lower than those presented in Figure 5-3, with lower TSS within the dredge pocket, and with values reducing rapidly away from this area.

Figure 5-18 presents a time-series of TSS concentrations at point output locations 1 (north of the dredge zone), 5 (within the dredge zone) and 12 (within the Westerbister fish farm). Review of this figure highlights that point location 5 exhibits the most frequent relative elevations in TSS, and generally highest levels. Point 1 shows less frequent occurrence of elevated TSS, occurring later in the simulation, whilst point 12 shows relatively low (<0.0002 kg/m^3) elevated concentrations of TSS only towards the end of the simulation. The elevation in TSS levels at point 12 is concurrent with prevalence of wind from the north-west and north (Figure 5-15).

Figure 5-19 presents the total deposition thickness following 8 days of the dredge campaign. Review of this figure highlights that, as per simulation FM HD MT Dredge 2, measurable thickness of deposition is limited to the immediate dredge footprint, primarily consisting of sands and gravels, with maximum deposit thickness of 0.015m. Figure 5-20 presents the total net deposition accumulation following 8 days of the dredge campaign. Review of this figure highlights that deposition accumulation primarily occurs within the immediate dredge extent (maximum accumulation ~10,000 g/m^2), with accumulation rapidly decreasing away from this area.

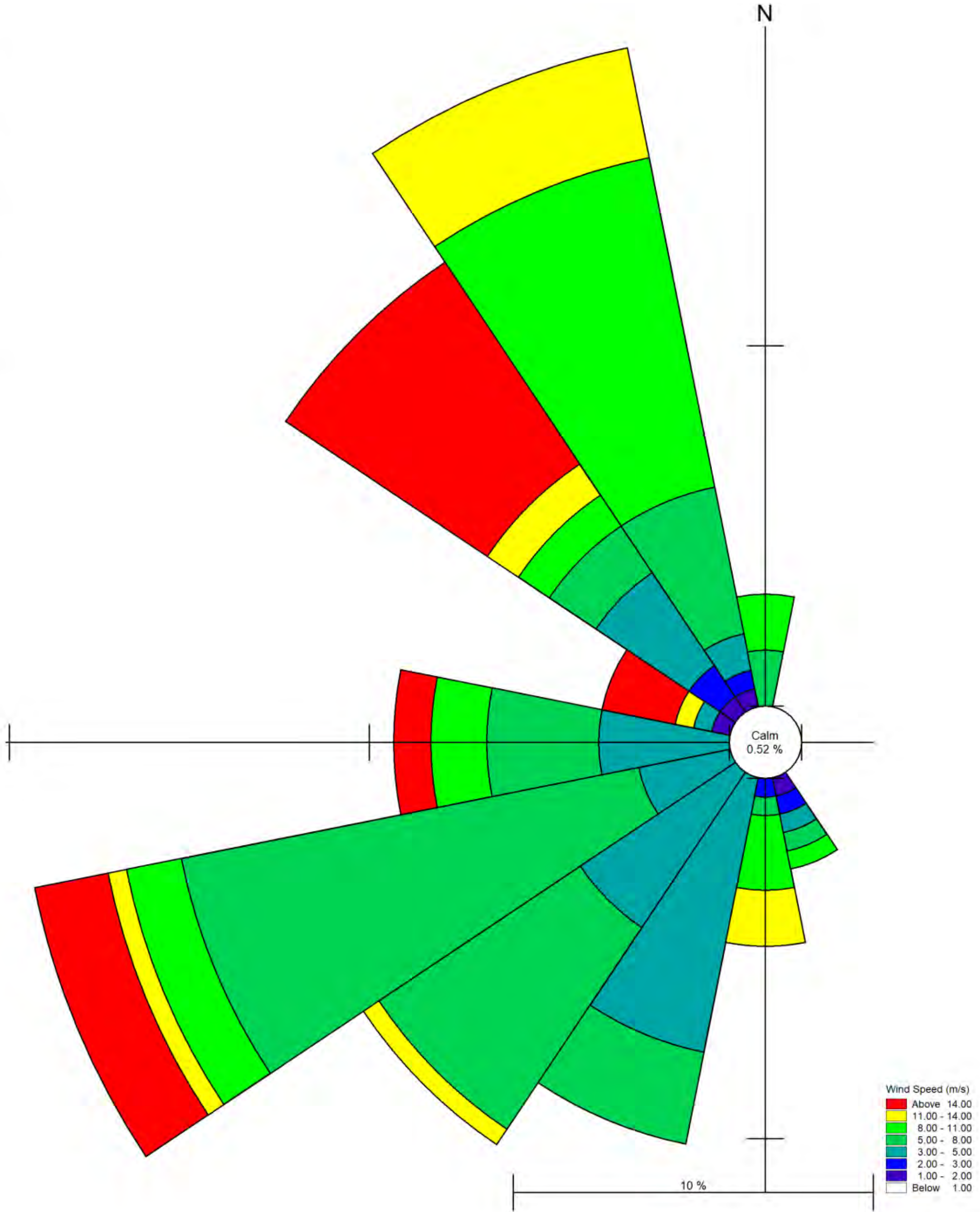


Figure 5-14: Wind rose plot – CREA6 model data for full duration of Scapa FM HD MT Dredge 4

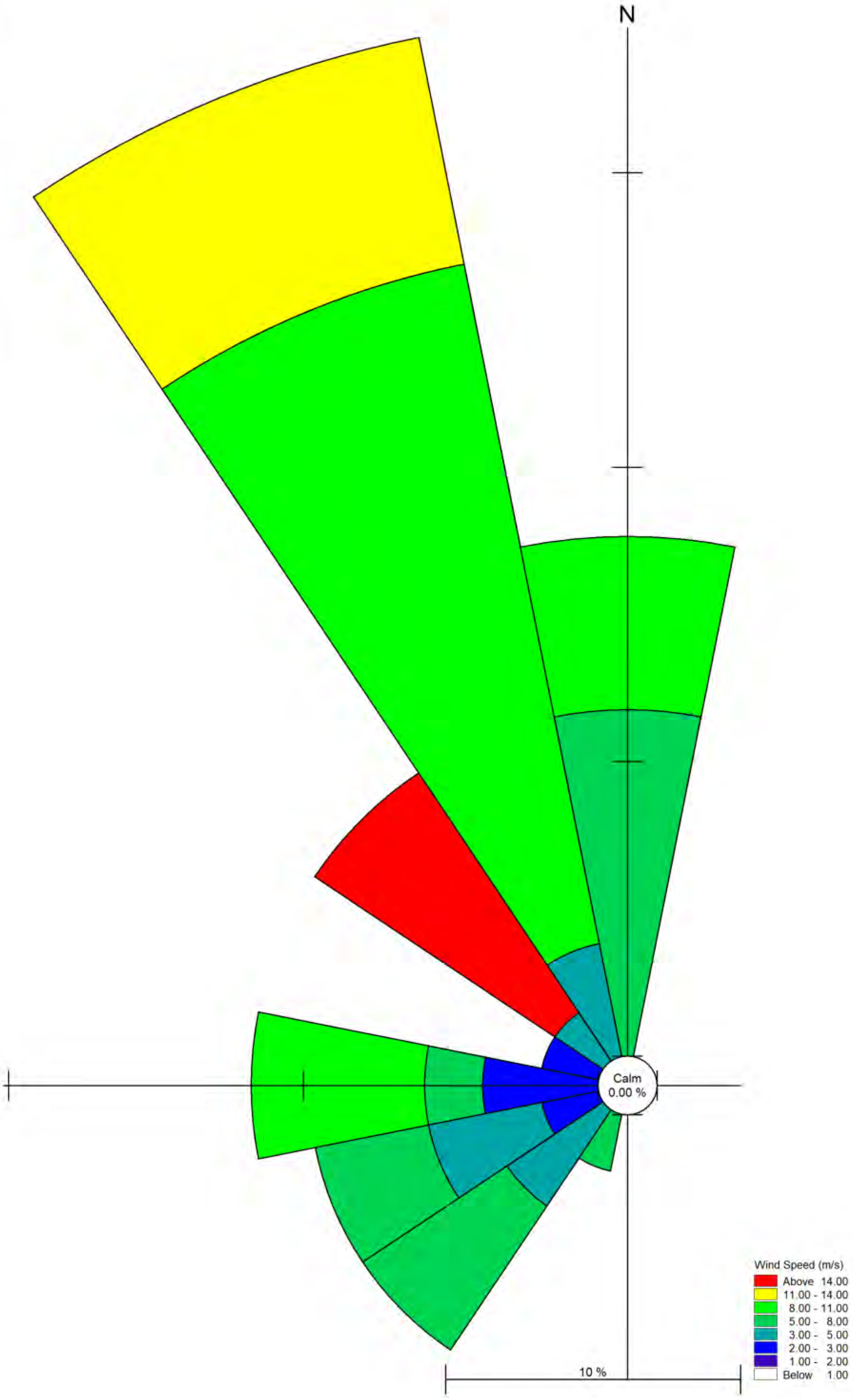


Figure 5-15: Wind rose plot – CREA6 model data for final 50 hours of Scapa FM HD MT Dredge 4

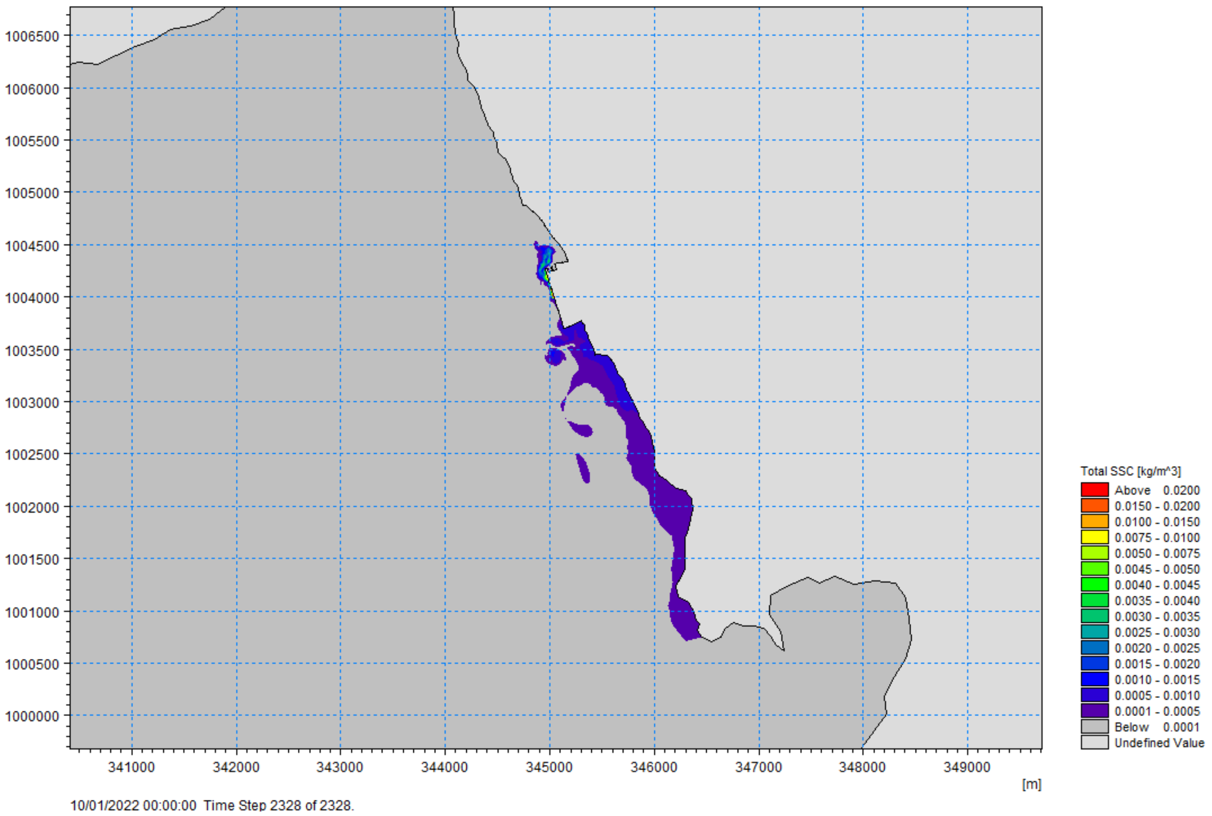
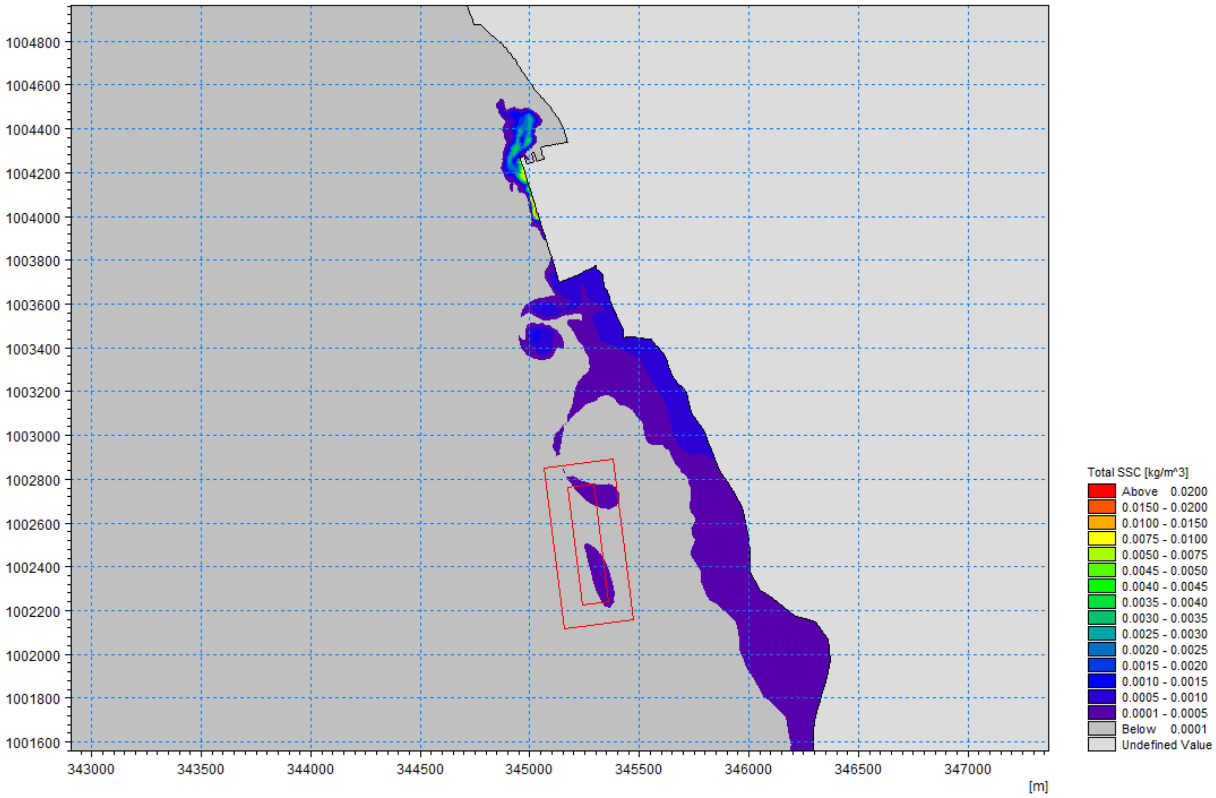


Figure 5-16: FM HD MT Dredge 4 – plume TSS following 8 days of dredge with wind forcing (wider view)



10/01/2022 00:00:00 Time Step 2328 of 2328.

Figure 5-17: FM HD MT Dredge 4 – plume TSS following 8 days of dredge with wind forcing (zoom view Westerbister Fish Farm (red polygons))

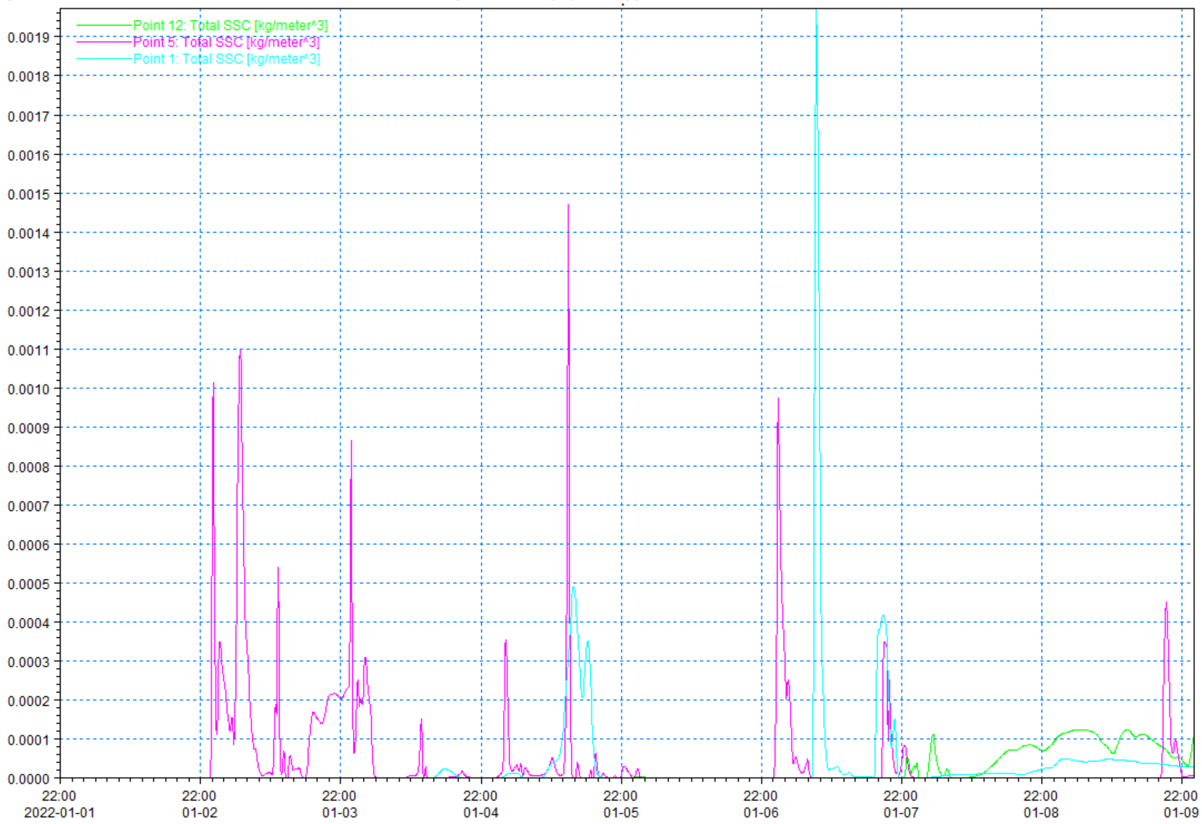


Figure 5-18: FM HD MT Dredge 4 – time-series TSS concentration (kg/m^3) at locations 1, 5 & 12

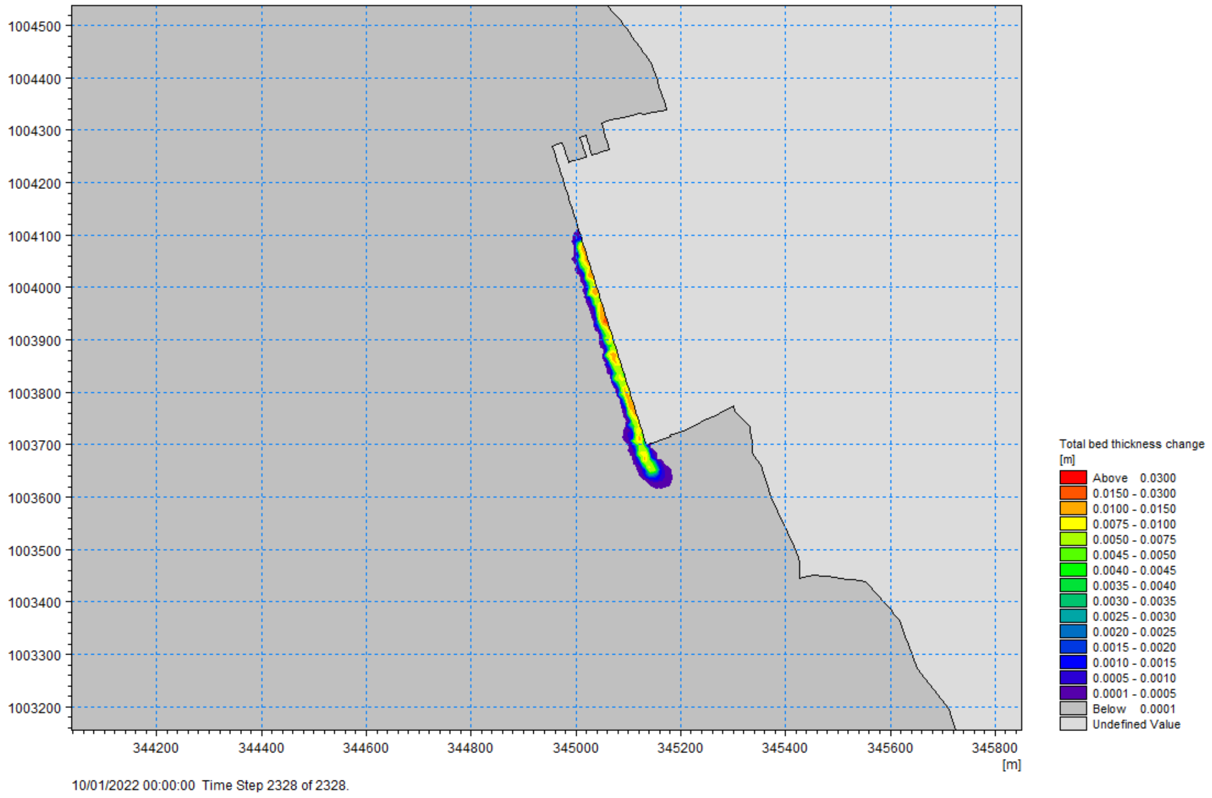


Figure 5-19: FM HD MT Dredge 4 – deposition following 8 days of dredge with wind forcing

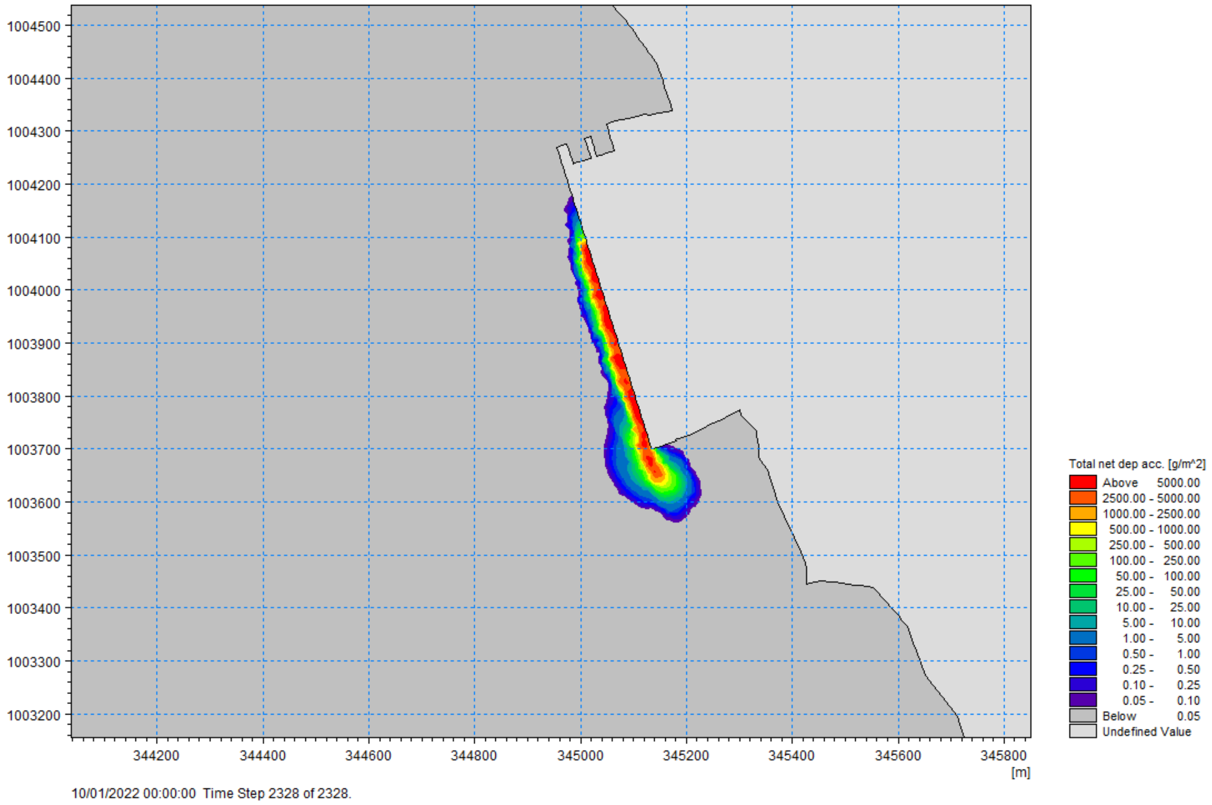


Figure 5-20: FM HD MT Dredge 4 – total net deposition accumulation following 8 days of dredge with wind forcing

6 CONCLUSIONS

A coastal hydrodynamic model has been developed utilising the MIKE by DHI software platform, specifically the MIKE 21 FM HD module. The model extent comprises the coastal waters of Scapa Flow, Scapa Bay, the Hoy Sound, Hoy Mouth, the Sound of Hoxa, the Pentland Firth and North Atlantic.

There are five tidal boundaries within the model extent, with boundary conditions extracted from the DHI MIKE 21 Global Tide Model. UKHO and EMODnet bathymetric survey data have been combined to create a Digital Terrain Model (DTM) for use within the hydrodynamic model. The model utilises a flexible mesh to represent the offshore and coastal areas. The mesh has progressive refinement in resolution towards Deepdale Bay, becoming finer in the area of interest. The mesh has also been refined in locations where complex flow paths influence predictions within Scapa Flow, including around islands, and across the Sound of Hoxa and Hoy Sound. A post-development version of the HD model mesh has been generated to include the proposed development footprint, and associated capital dredge pockets. The model has been run for both existing and post-development conditions, simulating the January 2022 spring and neap tidal cycle. Additional model sensitivity simulations including wind forcing have also been run for both existing and post-development conditions. Validation of the model has been undertaken through comparison of baseline modelled tidal levels with Admiralty tide predictions, and tidal current speeds predicted by the baseline model have been compared to annotated tidal stream speeds on UKHO hydrographic charts. The results of the validation exercise indicate that the model performs well.

The results from the existing (baseline) model run (FM HD 16) and the post-development model run (FM HD 19) have been presented and analysed. Both models predict a semi-diurnal tidal curve, with two high tides and two low tides each day, as is the case around the UK. Tidal elevation predictions are within 0.05m of the corresponding Admiralty Tide Tables predictions for the same tide. The models predict low current speeds and corresponding low bed shear stresses in the vicinity of Deepdale Bay, considered indicative of a low energy environment, with no significant sediment transport by tidal currents predicted.

Comparison of existing and post-development results highlights that no significant change is observed in surface elevation predictions between the two model runs. Comparative analysis of predicted current speeds across the point output locations highlights that minor changes in peak current speed are predicted at point output locations in the immediate vicinity of the proposed development (<0.02m/s change), with no change observed in the wider surrounds. Review of current speed plots highlights that the predicted development impact on tidal current speed is greatest in the vicinity of the -20mCD dredge pocket. Whilst the modelling results presented indicate that the proposed development will produce localised changes in tidal current speeds, it is considered that these variations are insignificant in terms of the wider hydrodynamic regime in and around Deepdale Bay, with predicted changes of very minor scale, and post development speeds of a very similar nature to those observed under existing conditions.

This hydrodynamic modelling study concludes that there will be no significant impact from the proposed development on tidal levels or current speeds.

Additionally, to simulate sediment plume dispersal from the proposed dredge campaign, the MIKE 21 Mud Transport (MT) module has been utilised, in combination with the HD model. Model results show that due to the low current speeds present within the vicinity of the dredge, only clay and silt particles from the finest fraction (1) enter suspension to form a plume, whilst sands and gravel fractions immediately fall out of suspension to deposit within the dredge extent. Highest modelled TSS concentrations are present within the dredge extent, and immediate surrounds, rapidly decreasing with distance away from the dredge zone. The main dredge plume is predicted to extend north-west along shore, with weaker concentrations of TSS predicted to extend further west into Scapa Flow, within the nearshore zone. Model sensitivity scenarios highlight that wind forcing can impact tidal currents and dredge plume dispersal in the vicinity of the proposed development. Wind direction and magnitude will impact the scale and spatial extent of any impact arising from wind forcing.

APPENDICES

A PROPOSED DEVELOPMENT LAYOUT

Chart Datum (Scapa Flow)	Ordnance Datum (Newlyn)	Quay Heights and Tide Data Scapa Deep Water Quay
+7.00m	+5.31m	Quay Edge Level
+3.60m	+1.91m	Mean High Water Spring Tides
+1.69m	0.00m	Ordnance Datum (Newlyn)
+0.70m	-0.99m	Mean Low Water Spring Tides
0.00m	-1.69m	Chart Datum (Scapa Flow)
-5.00m	-6.69m	
-10.00m	-11.69m	
-15.00m	-16.69m	
-20.00m	-21.69m	

ORKNEY ISLANDS COUNCIL
SCAPA DEEP WATER QUAY
PROPOSED SITE LAYOUT
WORKS - FINAL PHASED OPTIONS

20 0 20 40 60 80 100 120 140 160 180 200m

SCALE 1: 2000 at A1

P1	03.02.2023	Preliminary Issue P1 for comment	JJM	
REV	DATE	REVISION	DRN	CHK

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ORKNEY ISLANDS COUNCIL
Harbour Authority

Scapa Deep Water Quay Proposal

Works - Final Phased Option Layout

Arch Henderson
1919

Civil Engineers
Structural Engineers
Architects
CDM Co-ordinators
Geotechnical services
Environmental services

Stewart Building, Lerwick, Shetland. ZE1 0LL.
Tel : 01595 695512
www.arch-henderson.co.uk - email : lerwick@arch-henderson.co.uk

Aberdeen; Dundee; Glasgow; Lerwick; Inverness; Thurso; Stromness; Southampton; Falkland Islands

DRAWN : JJM	DATE : February 2023	CHECKED : APS	APPROVED : APS
SCALE : (A1) As Shown		DRAWING STATUS : Preliminary	
DRAWING No : 212089-SK-030223		REV : P1	

B TABULATED MODEL RESULTS

Table 1: FM HD 16 and FM HD 19 selected point output results for key tidal states

HD Run	Tidal State (Timestep) [Date Time]	Output Location	Surface Elevation (mCD)	Current Speed (m/s)	Current Direction (Radian)	Bed Shear Stress (N/m^2)
16	Mid-Flood Spring (TS 1072) [05/01/22 08:20]	Point 2	2.329	0.006	2.153	0.0002
		Point 4	2.329	0.007	1.968	0.0002
		Point 6	2.329	0.005	2.135	0.0001
		Point 7	2.329	0.005	1.765	0.0001
		Point 9	2.329	0.004	1.735	0.0001
		Point 10	2.329	0.004	2.057	0.0001
		Point 15	2.329	0.007	1.917	0.0002
		Point 16	2.329	0.011	1.187	0.0005
		Point 17	2.329	0.003	1.462	0.0000
		Point 22	2.329	0.018	1.437	0.0013
		Point 23	2.327	0.038	0.948	0.0079
	High Spring (TS 1098) [05/01/22 10:30]	Point 2	3.556	0.016	2.838	0.0012
		Point 4	3.556	0.014	2.647	0.0009
		Point 6	3.556	0.013	2.780	0.0009
		Point 7	3.556	0.012	2.729	0.0007
		Point 9	3.556	0.011	2.636	0.0005
		Point 10	3.556	0.016	2.811	0.0010
		Point 15	3.555	0.015	2.575	0.0009
		Point 16	3.556	0.012	2.557	0.0006
		Point 17	3.556	0.010	2.703	0.0004
		Point 22	3.555	0.017	2.639	0.0011
		Point 23	3.555	0.005	5.270	0.0002
	Mid-Ebb Spring (TS 1147) [05/01/22 14:35]	Point 2	2.126	0.011	5.736	0.0006
		Point 4	2.126	0.008	5.363	0.0003
		Point 6	2.126	0.009	5.197	0.0004
		Point 7	2.126	0.009	5.519	0.0004
		Point 9	2.126	0.009	5.482	0.0003
		Point 10	2.126	0.014	5.673	0.0008
		Point 15	2.126	0.015	5.297	0.0010
		Point 16	2.126	0.014	5.284	0.0008
		Point 17	2.126	0.008	5.337	0.0002
		Point 22	2.126	0.020	5.123	0.0015
		Point 23	2.122	0.032	4.294	0.0060
	Low Spring (TS 1178) [05/01/22 17:10]	Point 2	0.461	0.013	6.079	0.0009
		Point 4	0.461	0.010	5.860	0.0005
		Point 6	0.461	0.009	5.876	0.0004
		Point 7	0.461	0.010	5.940	0.0005
		Point 9	0.461	0.010	5.870	0.0004
		Point 10	0.461	0.016	5.972	0.0012
		Point 15	0.461	0.016	5.625	0.0010
		Point 16	0.461	0.016	5.875	0.0010
		Point 17	0.461	0.009	5.768	0.0003

HD Run	Tidal State (Timestep) [Date Time]	Output Location	Surface Elevation (mCD)	Current Speed (m/s)	Current Direction (Radian)	Bed Shear Stress (N/m²)
		Point 22	0.461	0.017	5.875	0.0012
		Point 23	0.462	0.006	1.890	0.0002
19	Mid-Flood Spring (TS 988) [05/01/22 08:20]	Point 2	2.328	0.008	1.899	0.0003
		Point 4	2.328	0.003	3.494	0.0000
		Point 6	2.328	0.004	1.764	0.0001
		Point 7	2.328	0.009	5.088	0.0003
		Point 9	2.328	0.006	5.517	0.0002
		Point 10	2.328	0.009	1.925	0.0004
		Point 15	2.328	0.007	1.502	0.0002
		Point 16	2.328	0.009	0.915	0.0003
		Point 17	2.328	0.005	6.236	0.0001
		Point 22	2.328	0.017	1.274	0.0011
		Point 23	2.327	0.039	1.067	0.0089
	High Spring (TS 1014) [05/01/22 10:30]	Point 2	3.554	0.011	2.528	0.0006
		Point 4	3.554	0.007	2.639	0.0002
		Point 6	3.554	0.011	3.405	0.0006
		Point 7	3.554	0.014	3.850	0.0009
		Point 9	3.554	0.009	3.372	0.0004
		Point 10	3.554	0.014	2.340	0.0008
		Point 15	3.554	0.011	2.415	0.0005
		Point 16	3.554	0.009	2.614	0.0003
		Point 17	3.554	0.004	2.698	0.0001
		Point 22	3.553	0.014	2.684	0.0007
		Point 23	3.554	0.006	0.601	0.0002
	Mid-Ebb Spring (TS 1063) [05/01/22 14:35]	Point 2	2.128	0.005	5.276	0.0001
		Point 4	2.128	0.023	5.917	0.0025
		Point 6	2.128	0.005	4.499	0.0002
		Point 7	2.128	0.021	6.138	0.0019
		Point 9	2.128	0.015	5.466	0.0010
		Point 10	2.128	0.015	5.637	0.0010
		Point 15	2.128	0.018	5.402	0.0013
		Point 16	2.128	0.017	5.384	0.0012
		Point 17	2.128	0.014	5.443	0.0008
		Point 22	2.127	0.022	5.225	0.0020
		Point 23	2.124	0.034	4.373	0.0067
	Low Spring (TS 1094) [05/01/22 17:10]	Point 2	0.462	0.008	5.637	0.0003
		Point 4	0.462	0.019	5.928	0.0017
		Point 6	0.462	0.014	6.257	0.0010
		Point 7	0.462	0.018	6.102	0.0015
		Point 9	0.462	0.016	5.735	0.0011
		Point 10	0.462	0.013	5.922	0.0008
		Point 15	0.462	0.017	5.644	0.0012
		Point 16	0.462	0.019	5.822	0.0014
		Point 17	0.462	0.015	5.713	0.0010
		Point 22	0.462	0.020	5.882	0.0017
		Point 23	0.463	0.008	3.777	0.0005

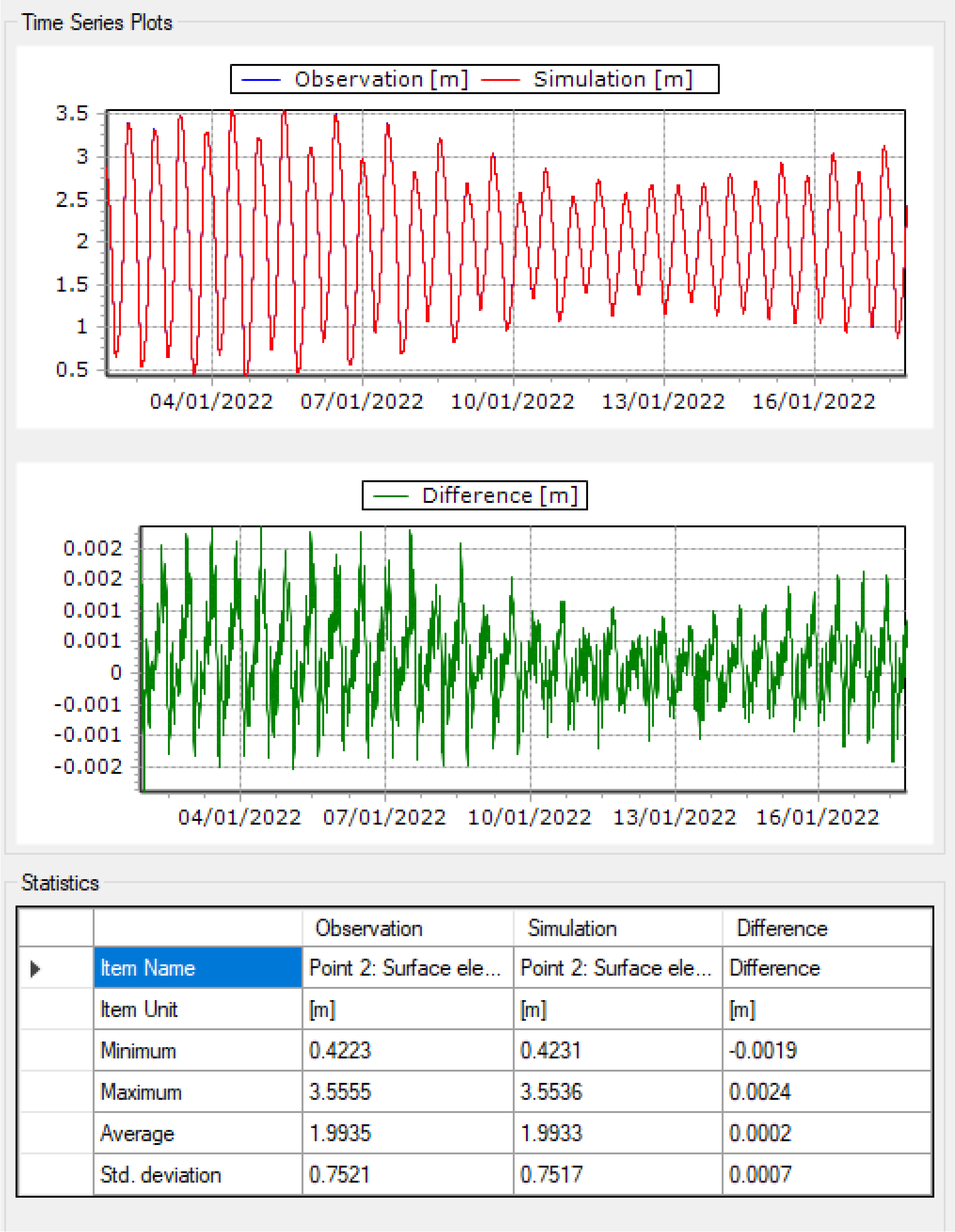
Table 2: Comparison of FM HD 16 and FM HD 19 selected point output results for key tidal states

HD Run Comp.	Tidal State [Date Time]	Output Location	Surface Elevation Difference (m)	Current Speed Difference (m/s)	Bed Shear Stress Difference (N/m^2)
FMHD16 minus FMHD17	Mid-Flood Spring [05/01/22 08:20]	Point 2	0.00	0.00	-0.0001
		Point 4	0.00	0.00	0.0002
		Point 6	0.00	0.00	0.0000
		Point 7	0.00	0.00	-0.0002
		Point 9	0.00	0.00	-0.0001
		Point 10	0.00	-0.01	-0.0003
		Point 15	0.00	0.00	0.0000
		Point 16	0.00	0.00	0.0001
		Point 17	0.00	0.00	-0.0001
		Point 22	0.00	0.00	0.0002
		Point 23	0.00	0.00	-0.0009
	High Spring [05/01/22 10:30]	Point 2	0.00	0.00	0.0007
		Point 4	0.00	0.01	0.0007
		Point 6	0.00	0.00	0.0003
		Point 7	0.00	0.00	-0.0002
		Point 9	0.00	0.00	0.0000
		Point 10	0.00	0.00	0.0002
		Point 15	0.00	0.00	0.0004
		Point 16	0.00	0.00	0.0003
		Point 17	0.00	0.01	0.0003
		Point 22	0.00	0.00	0.0004
		Point 23	0.00	0.00	-0.0001
	Mid-Ebb Spring [05/01/22 14:35]	Point 2	0.00	0.01	0.0005
		Point 4	0.00	-0.02	-0.0022
		Point 6	0.00	0.00	0.0002
		Point 7	0.00	-0.01	-0.0015
		Point 9	0.00	-0.01	-0.0007
		Point 10	0.00	0.00	-0.0001
		Point 15	0.00	0.00	-0.0003
		Point 16	0.00	0.00	-0.0004
		Point 17	0.00	-0.01	-0.0005
		Point 22	0.00	0.00	-0.0005
		Point 23	0.00	0.00	-0.0007
	Low Spring [05/01/22 17:10]	Point 2	0.00	0.01	0.0006
		Point 4	0.00	-0.01	-0.0012
		Point 6	0.00	-0.01	-0.0006
		Point 7	0.00	-0.01	-0.0010
		Point 9	0.00	-0.01	-0.0007
		Point 10	0.00	0.00	0.0004
		Point 15	0.00	0.00	-0.0002
		Point 16	0.00	0.00	-0.0004
		Point 17	0.00	-0.01	-0.0006
		Point 22	0.00	0.00	-0.0005
		Point 23	0.00	0.00	-0.0002

C MODEL RESULTS - GRAPHICAL COMPARISONS

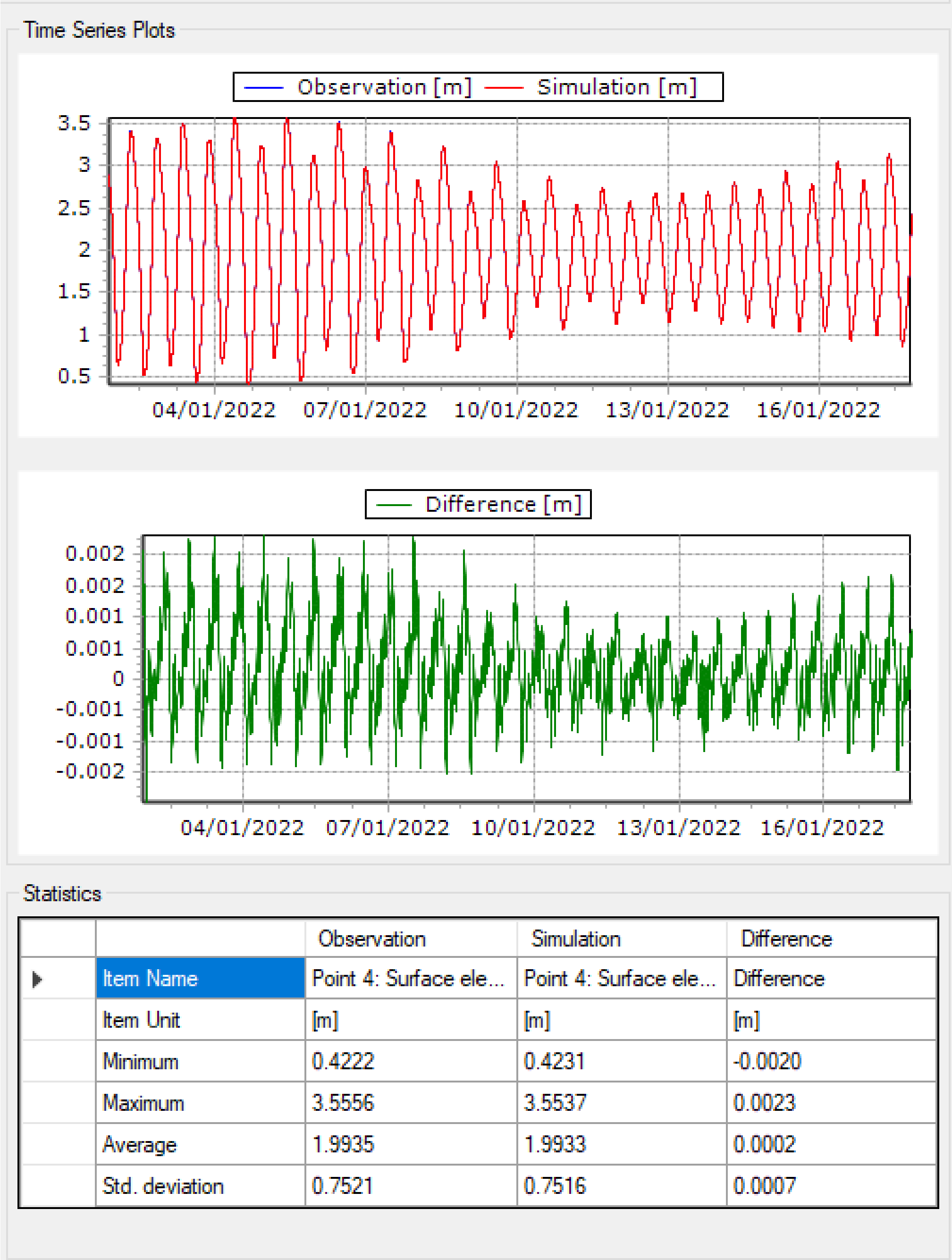
Note: Observation = baseline model [FM HD 16] and Simulation = post-development model [FM HD 19]

<u>Water Surface Elevation</u>

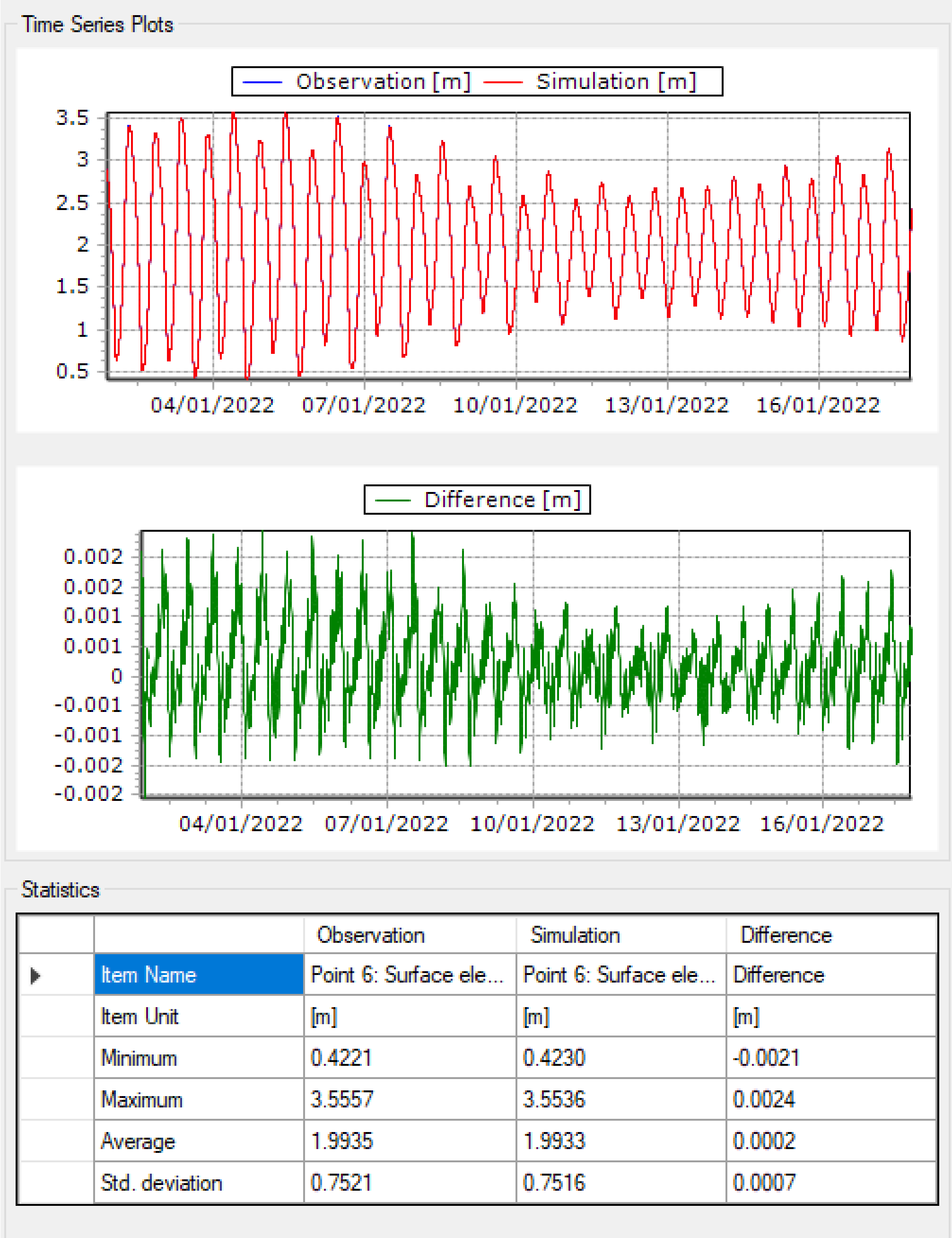


Statistics

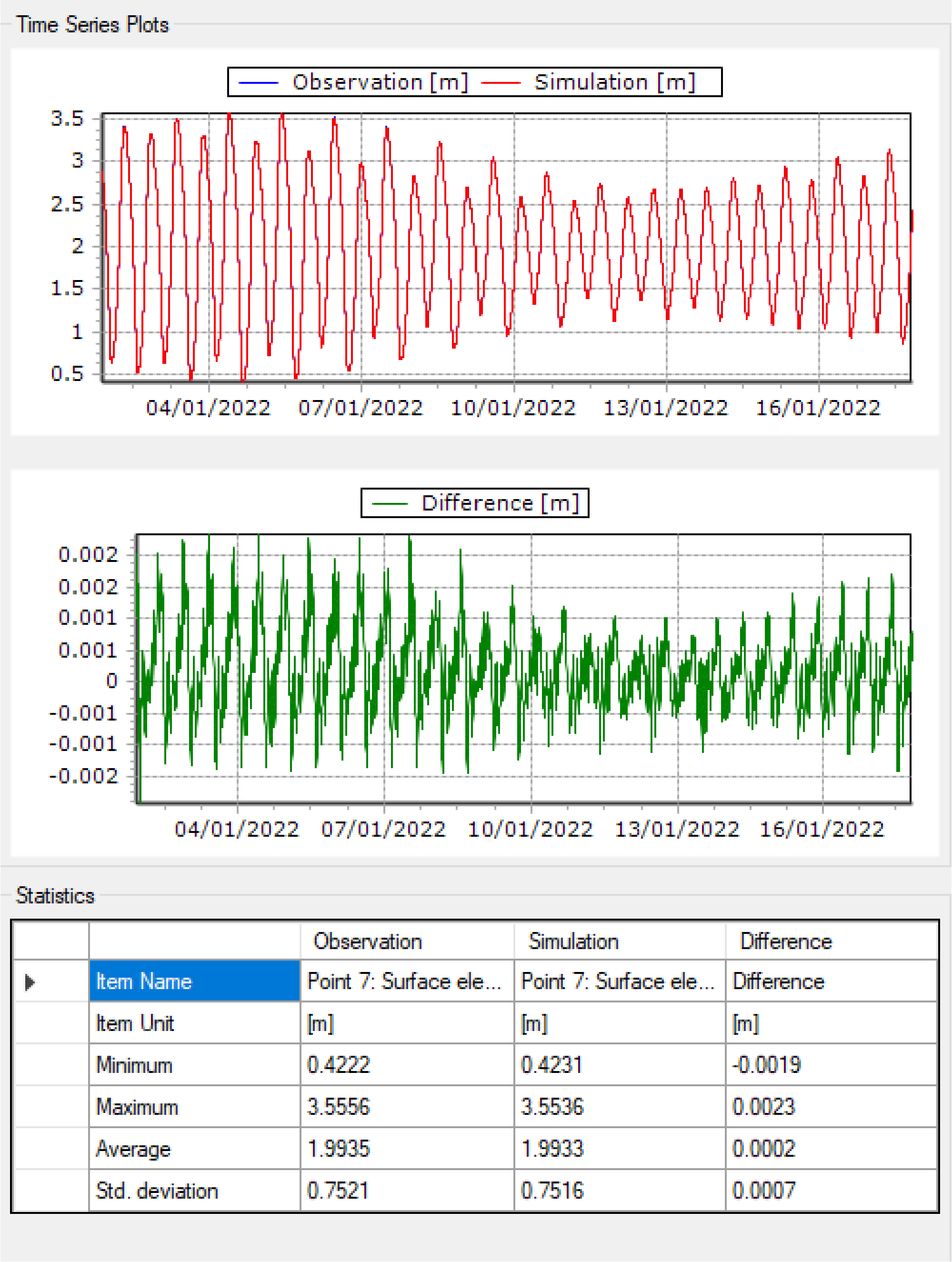
		Observation	Simulation	Difference
▶	Item Name	Point 2: Surface ele...	Point 2: Surface ele...	Difference
	Item Unit	[m]	[m]	[m]
	Minimum	0.4223	0.4231	-0.0019
	Maximum	3.5555	3.5536	0.0024
	Average	1.9935	1.9933	0.0002
	Std. deviation	0.7521	0.7517	0.0007



	Observation	Simulation	Difference
Item Name	Point 4: Surface ele...	Point 4: Surface ele...	Difference
Item Unit	[m]	[m]	[m]
Minimum	0.4222	0.4231	-0.0020
Maximum	3.5556	3.5537	0.0023
Average	1.9935	1.9933	0.0002
Std. deviation	0.7521	0.7516	0.0007

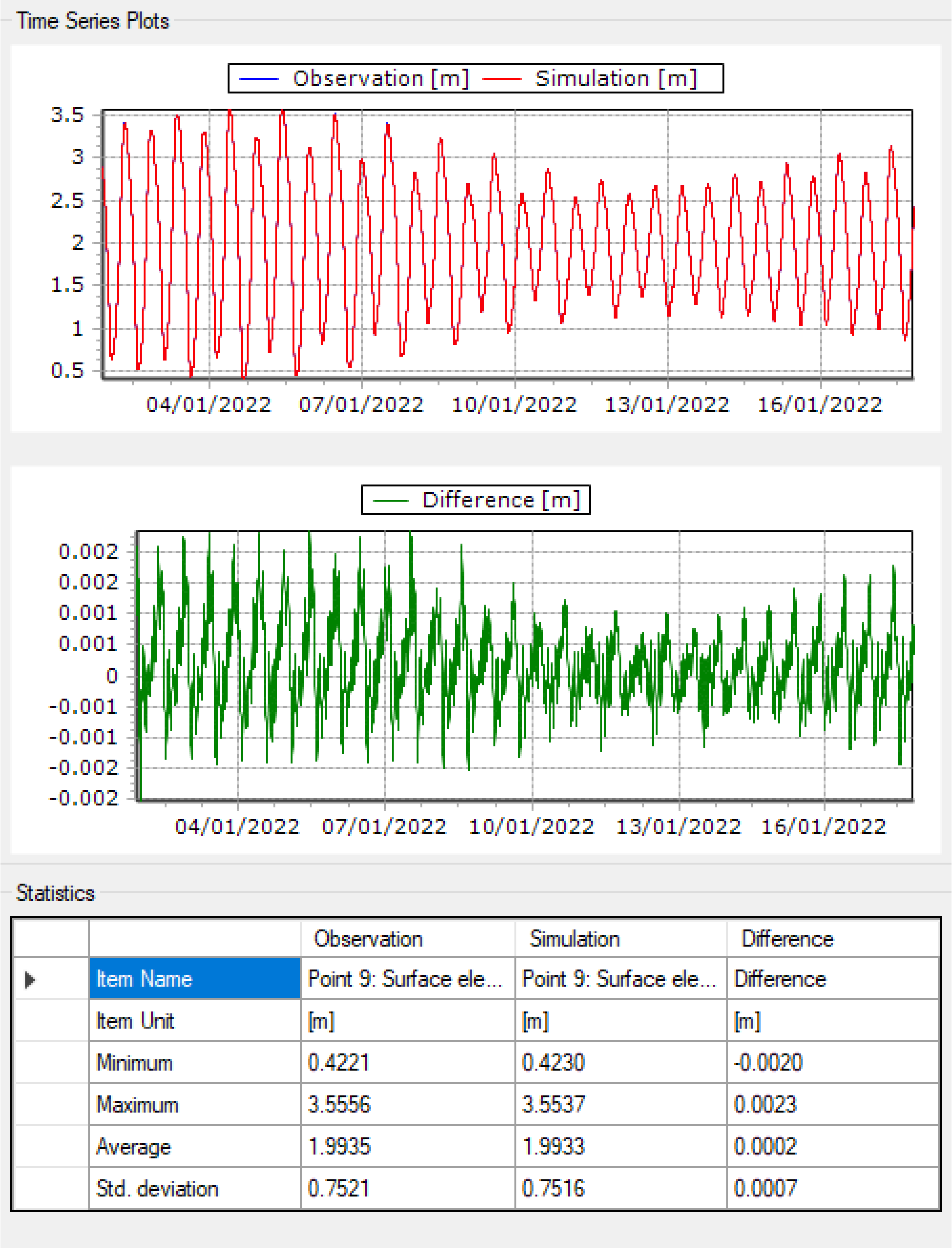


	Observation	Simulation	Difference
Item Name	Point 6: Surface ele...	Point 6: Surface ele...	Difference
Item Unit	[m]	[m]	[m]
Minimum	0.4221	0.4230	-0.0021
Maximum	3.5557	3.5536	0.0024
Average	1.9935	1.9933	0.0002
Std. deviation	0.7521	0.7516	0.0007

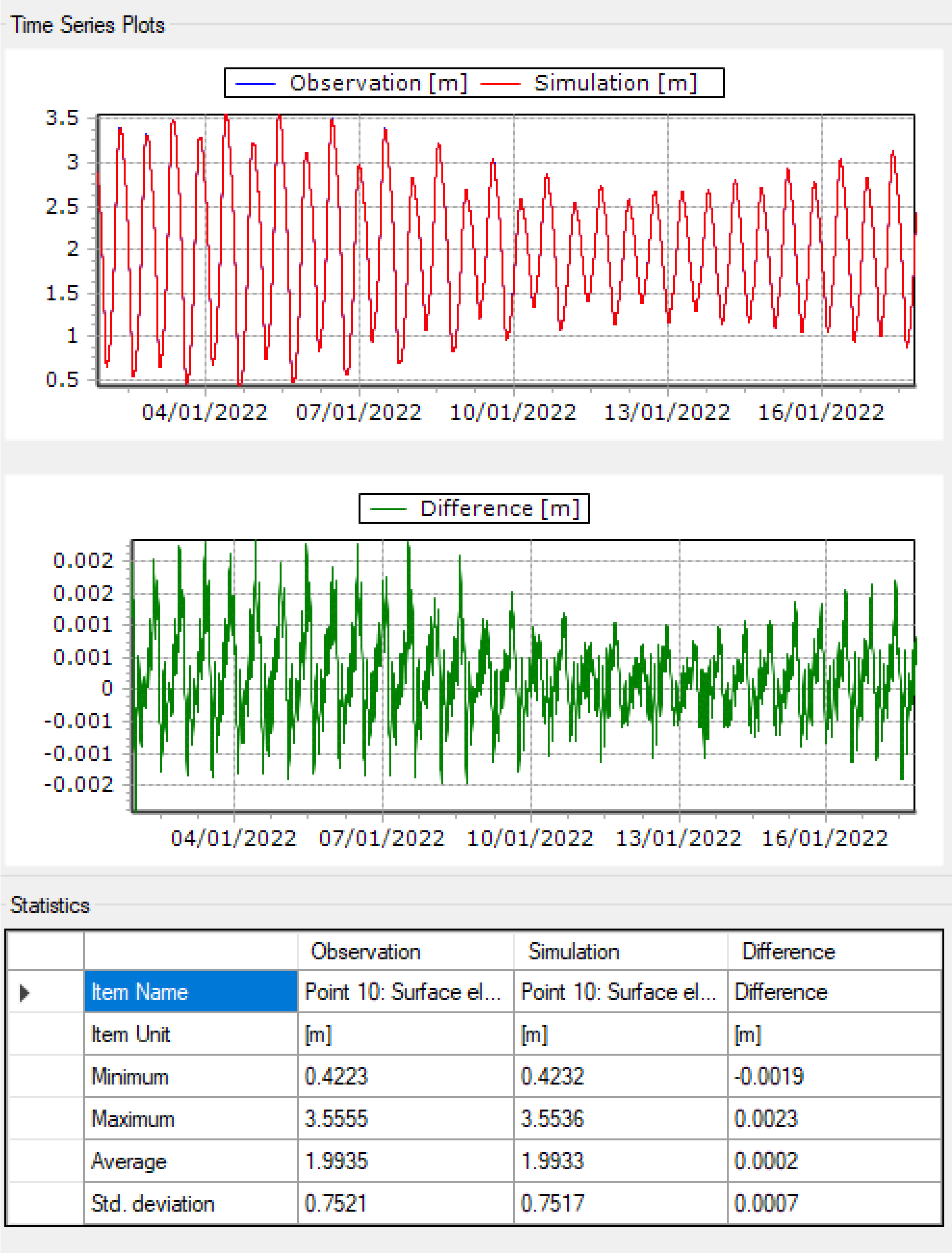


Statistics

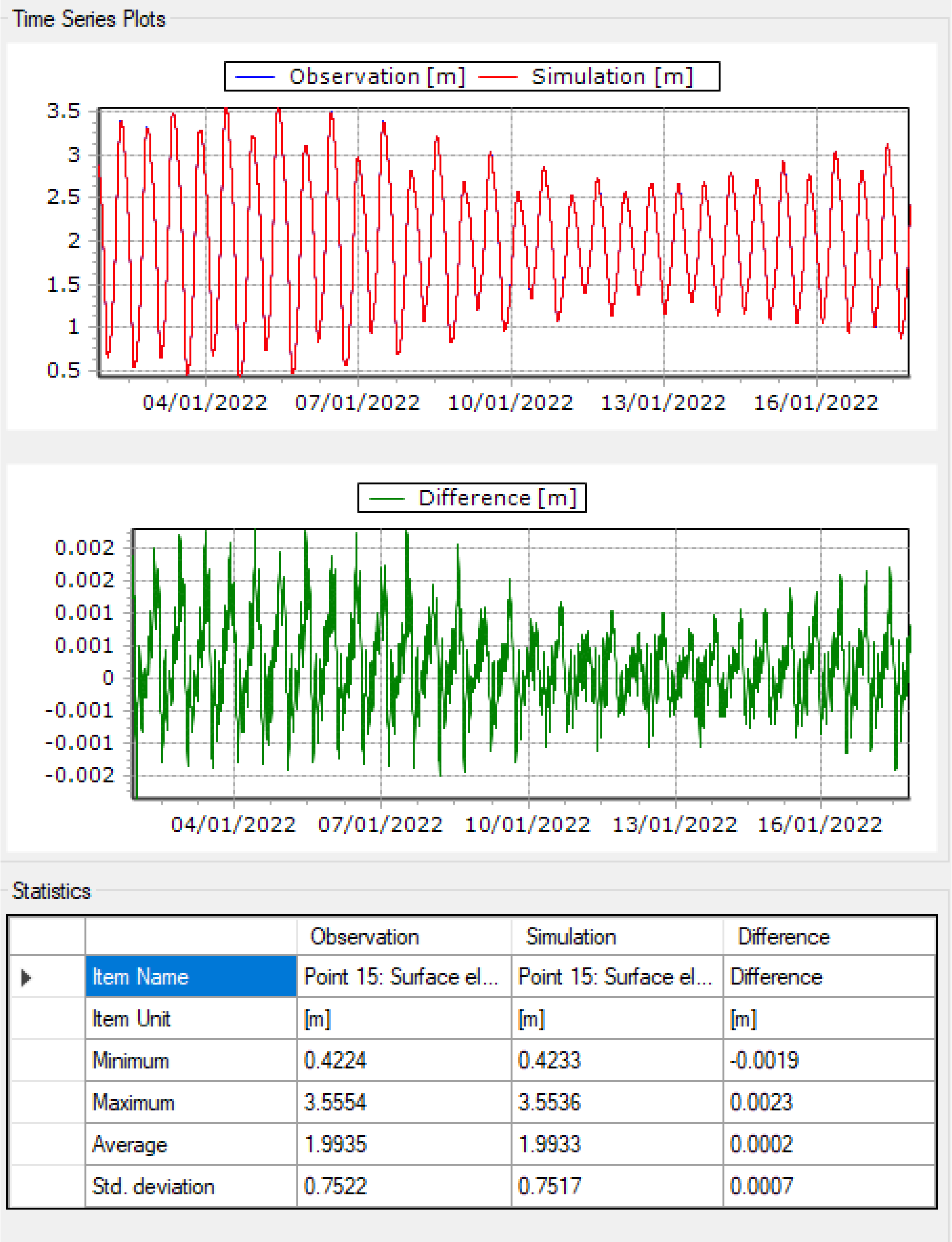
	Observation	Simulation	Difference
Item Name	Point 7: Surface ele...	Point 7: Surface ele...	Difference
Item Unit	[m]	[m]	[m]
Minimum	0.4222	0.4231	-0.0019
Maximum	3.5556	3.5536	0.0023
Average	1.9935	1.9933	0.0002
Std. deviation	0.7521	0.7516	0.0007



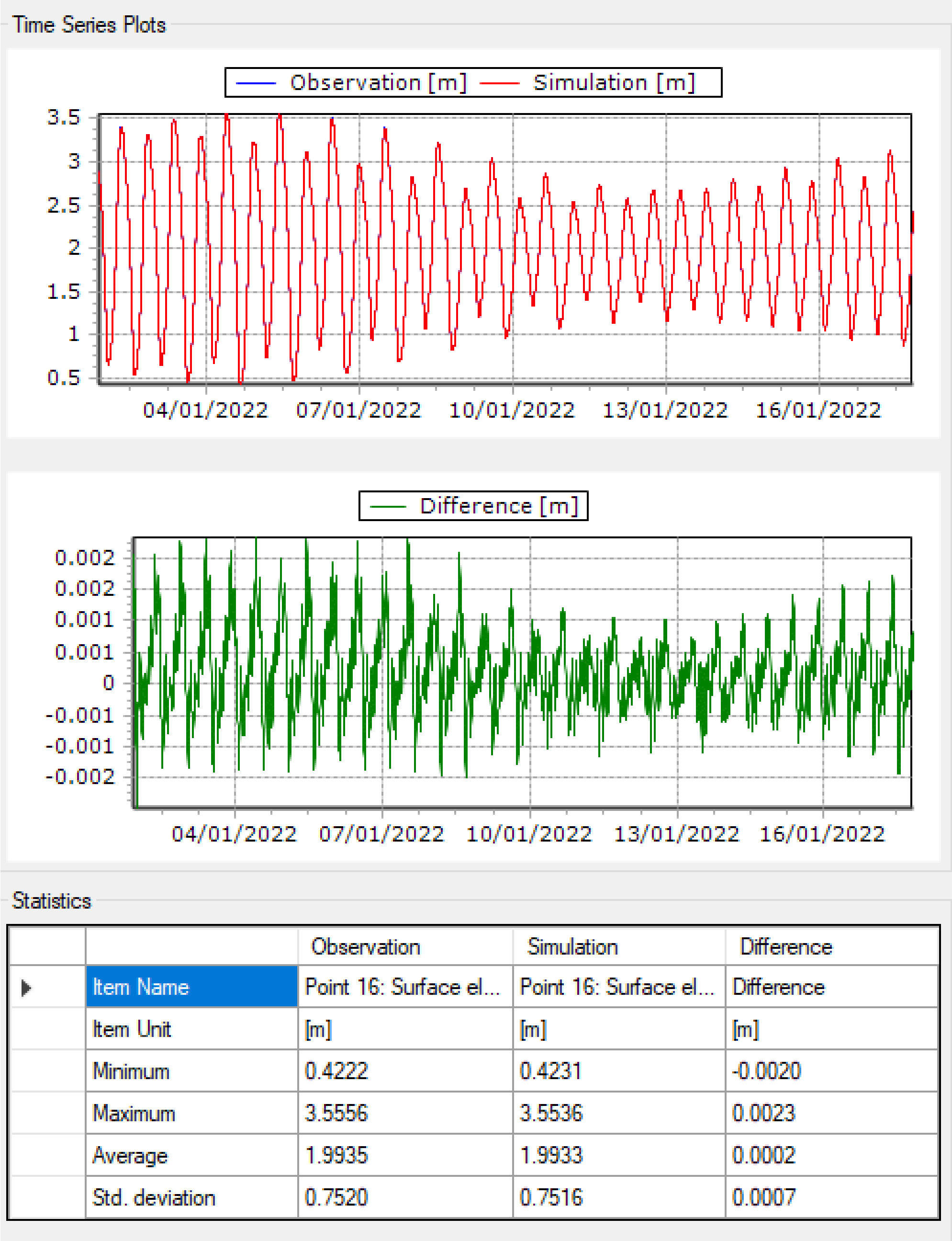
		Observation	Simulation	Difference
▶	Item Name	Point 9: Surface ele...	Point 9: Surface ele...	Difference
	Item Unit	[m]	[m]	[m]
	Minimum	0.4221	0.4230	-0.0020
	Maximum	3.5556	3.5537	0.0023
	Average	1.9935	1.9933	0.0002
	Std. deviation	0.7521	0.7516	0.0007



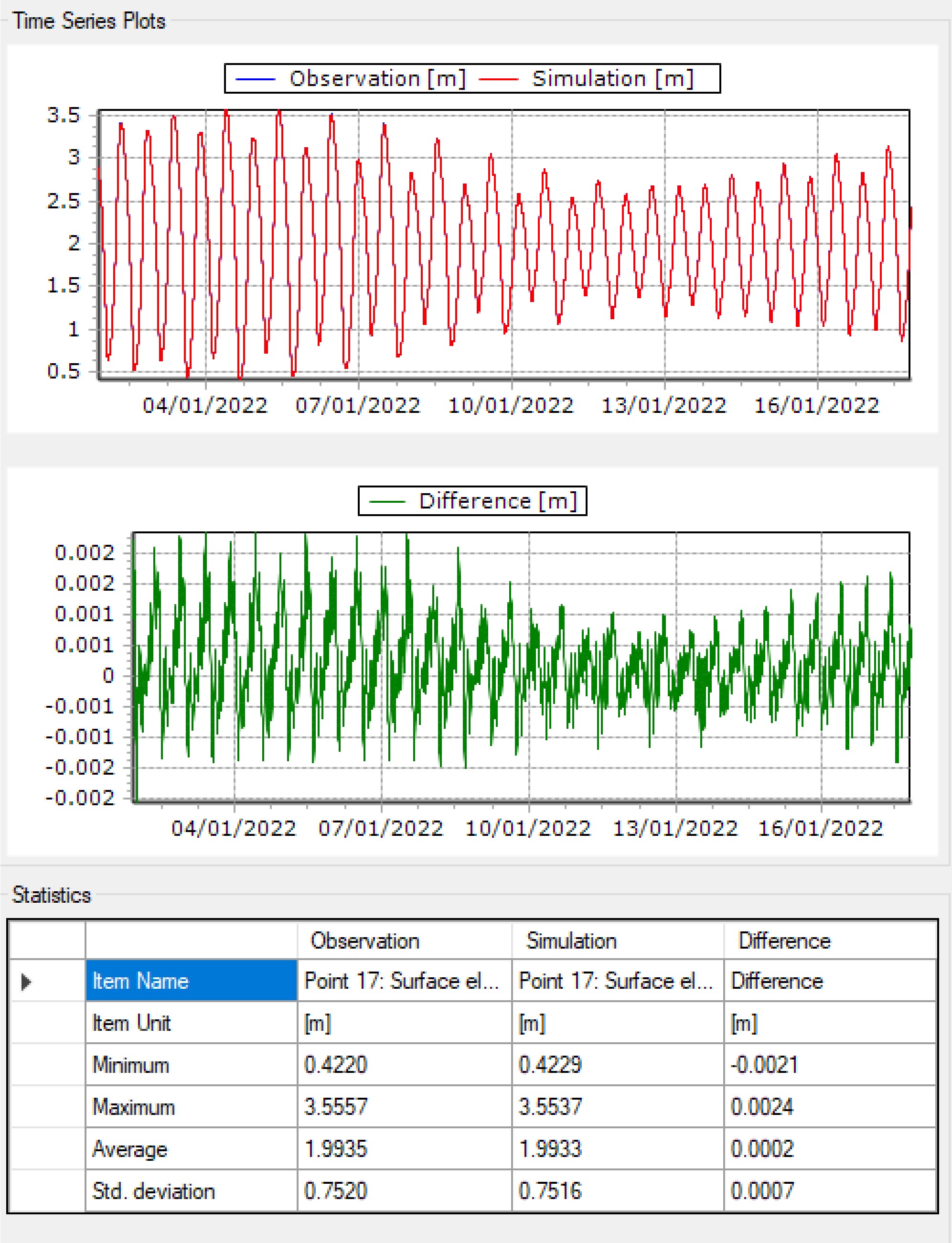
	Observation	Simulation	Difference
Item Name	Point 10: Surface el...	Point 10: Surface el...	Difference
Item Unit	[m]	[m]	[m]
Minimum	0.4223	0.4232	-0.0019
Maximum	3.5555	3.5536	0.0023
Average	1.9935	1.9933	0.0002
Std. deviation	0.7521	0.7517	0.0007



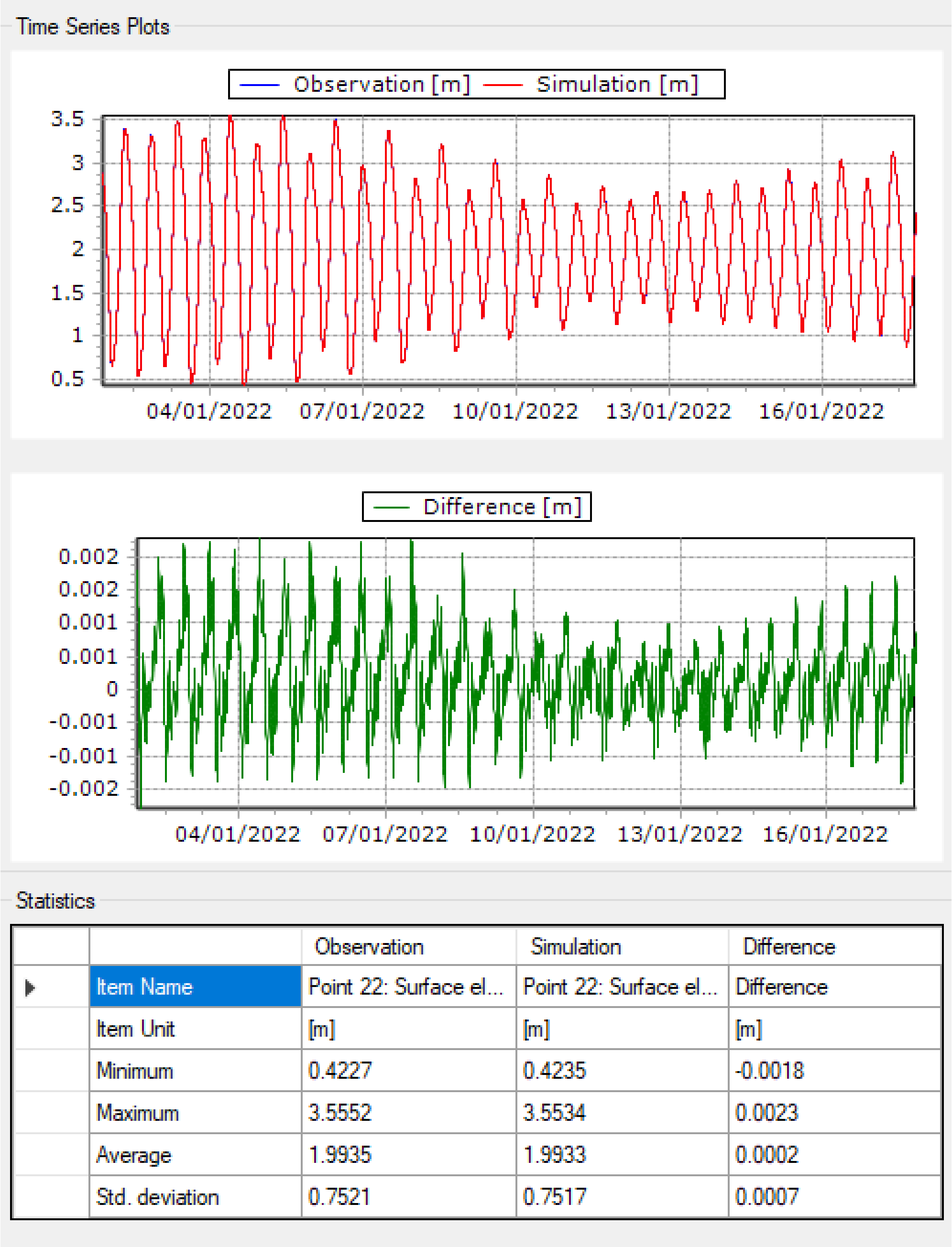
	Observation	Simulation	Difference
Item Name	Point 15: Surface el...	Point 15: Surface el...	Difference
Item Unit	[m]	[m]	[m]
Minimum	0.4224	0.4233	-0.0019
Maximum	3.5554	3.5536	0.0023
Average	1.9935	1.9933	0.0002
Std. deviation	0.7522	0.7517	0.0007



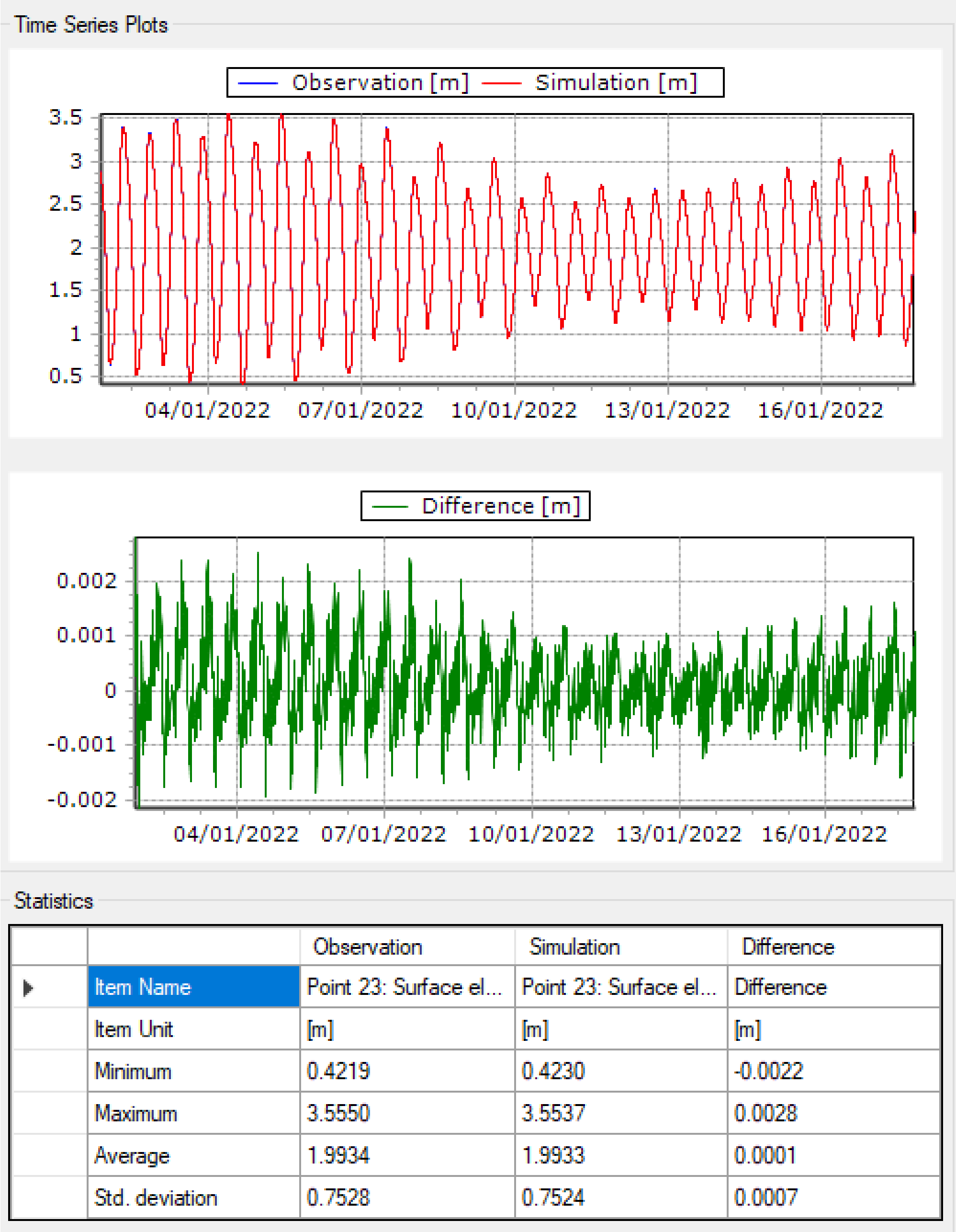
	Observation	Simulation	Difference
Item Name	Point 16: Surface el...	Point 16: Surface el...	Difference
Item Unit	[m]	[m]	[m]
Minimum	0.4222	0.4231	-0.0020
Maximum	3.5556	3.5536	0.0023
Average	1.9935	1.9933	0.0002
Std. deviation	0.7520	0.7516	0.0007



		Observation	Simulation	Difference
▶	Item Name	Point 17: Surface el...	Point 17: Surface el...	Difference
	Item Unit	[m]	[m]	[m]
	Minimum	0.4220	0.4229	-0.0021
	Maximum	3.5557	3.5537	0.0024
	Average	1.9935	1.9933	0.0002
	Std. deviation	0.7520	0.7516	0.0007

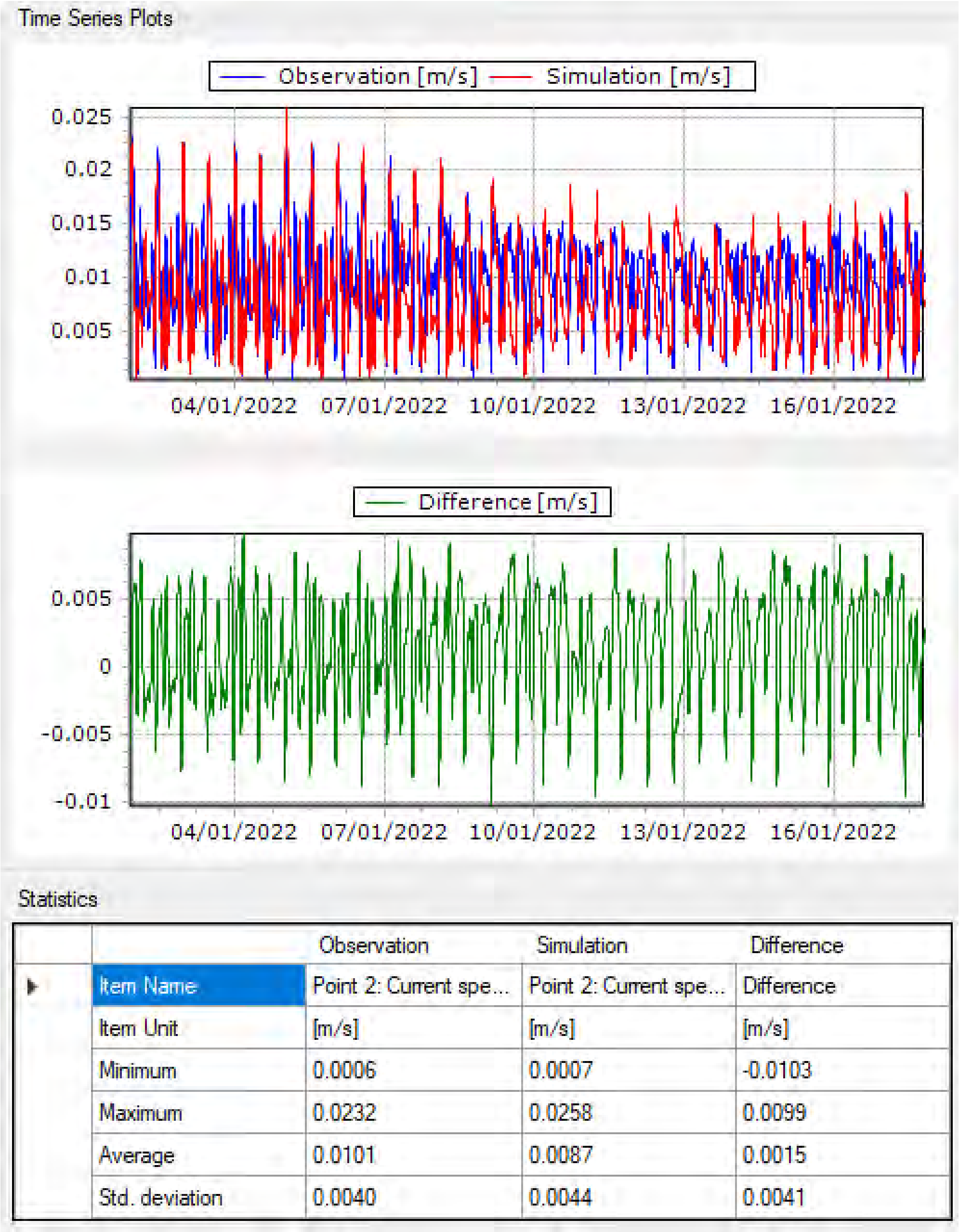


		Observation	Simulation	Difference
▶	Item Name	Point 22: Surface el...	Point 22: Surface el...	Difference
	Item Unit	[m]	[m]	[m]
	Minimum	0.4227	0.4235	-0.0018
	Maximum	3.5552	3.5534	0.0023
	Average	1.9935	1.9933	0.0002
	Std. deviation	0.7521	0.7517	0.0007

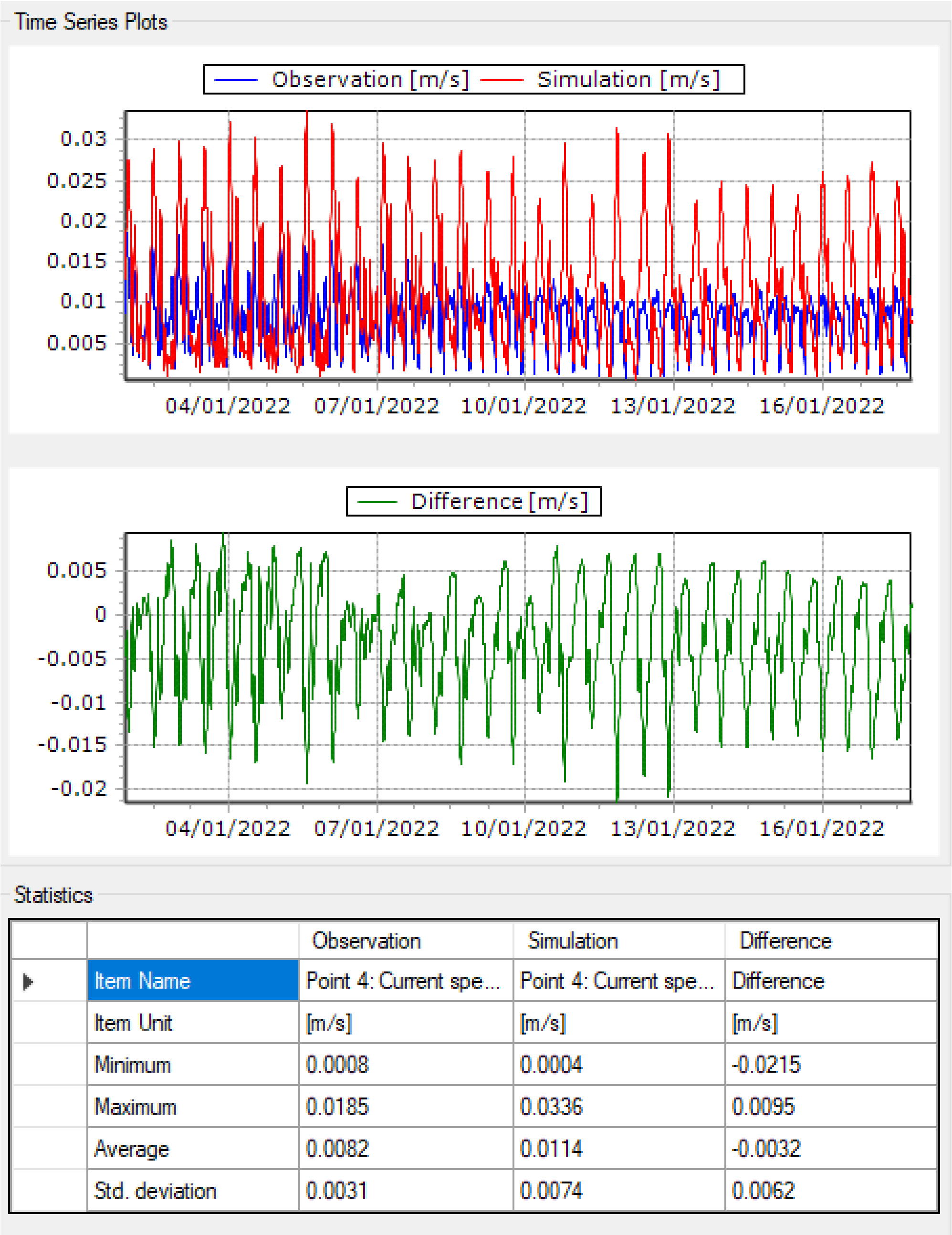


		Observation	Simulation	Difference
▶	Item Name	Point 23: Surface el...	Point 23: Surface el...	Difference
	Item Unit	[m]	[m]	[m]
	Minimum	0.4219	0.4230	-0.0022
	Maximum	3.5550	3.5537	0.0028
	Average	1.9934	1.9933	0.0001
	Std. deviation	0.7528	0.7524	0.0007

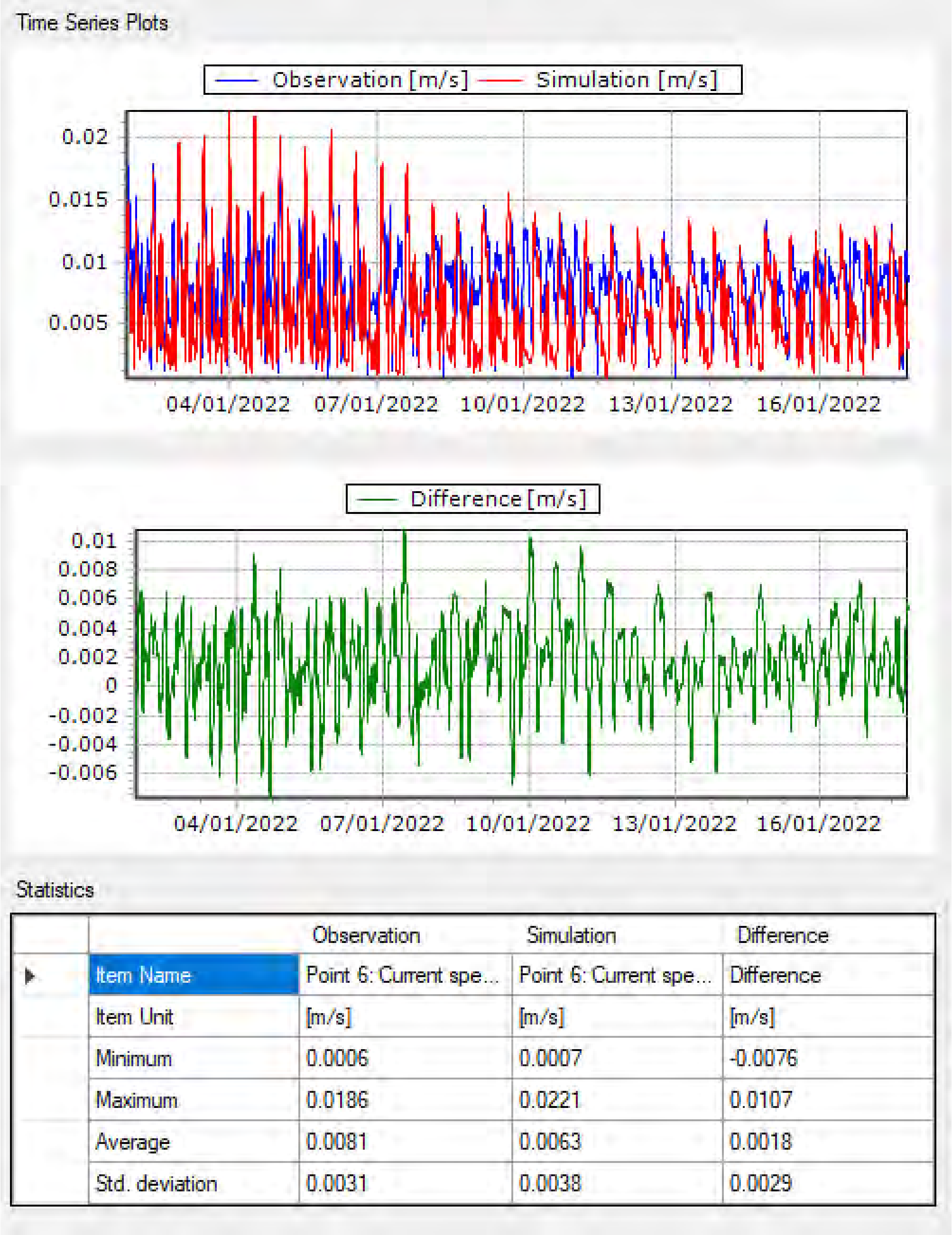
Current Speed



	Observation	Simulation	Difference
Item Name	Point 2: Current spe...	Point 2: Current spe...	Difference
Item Unit	[m/s]	[m/s]	[m/s]
Minimum	0.0006	0.0007	-0.0103
Maximum	0.0232	0.0258	0.0099
Average	0.0101	0.0087	0.0015
Std. deviation	0.0040	0.0044	0.0041

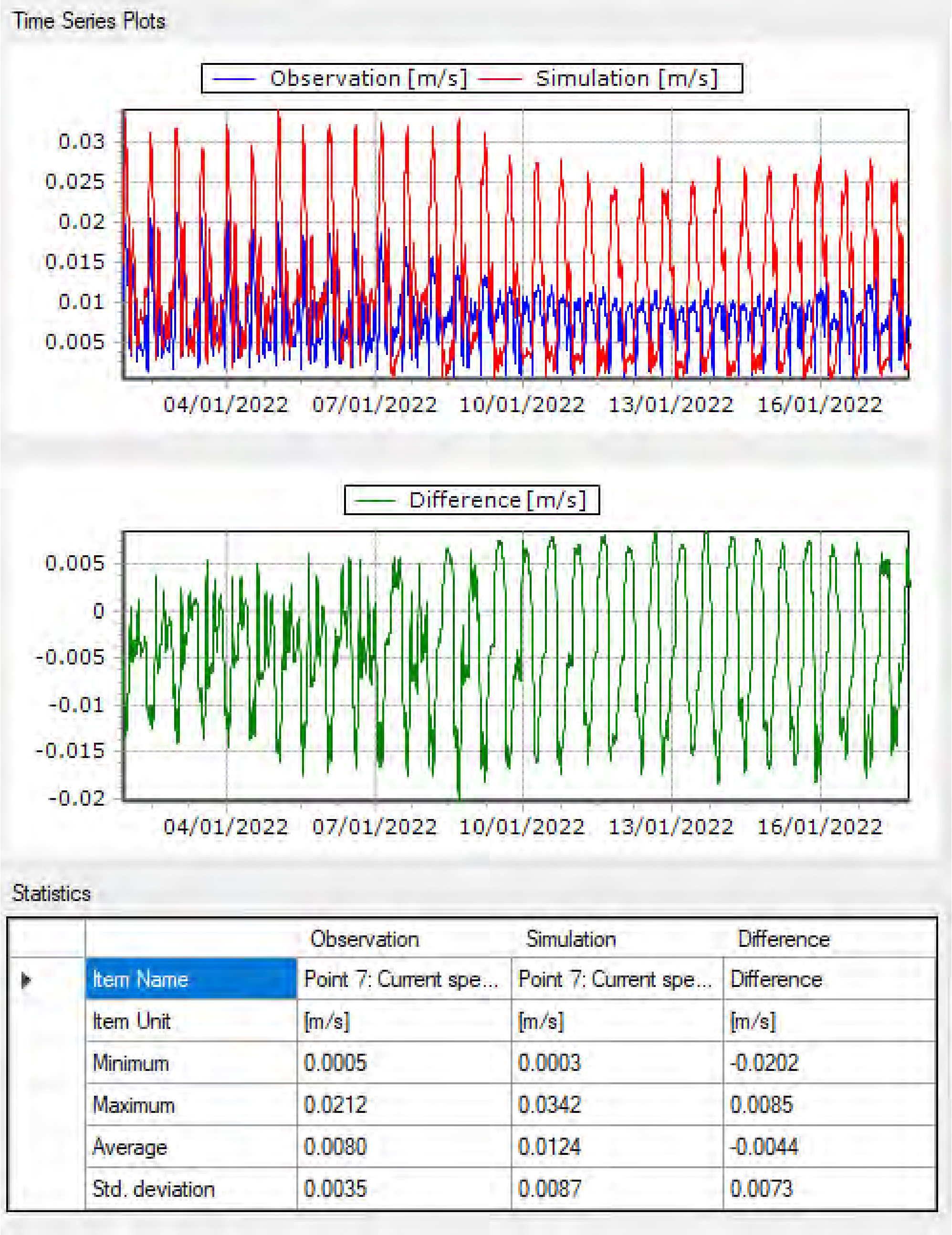


	Observation	Simulation	Difference
Item Name	Point 4: Current spe...	Point 4: Current spe...	Difference
Item Unit	[m/s]	[m/s]	[m/s]
Minimum	0.0008	0.0004	-0.0215
Maximum	0.0185	0.0336	0.0095
Average	0.0082	0.0114	-0.0032
Std. deviation	0.0031	0.0074	0.0062

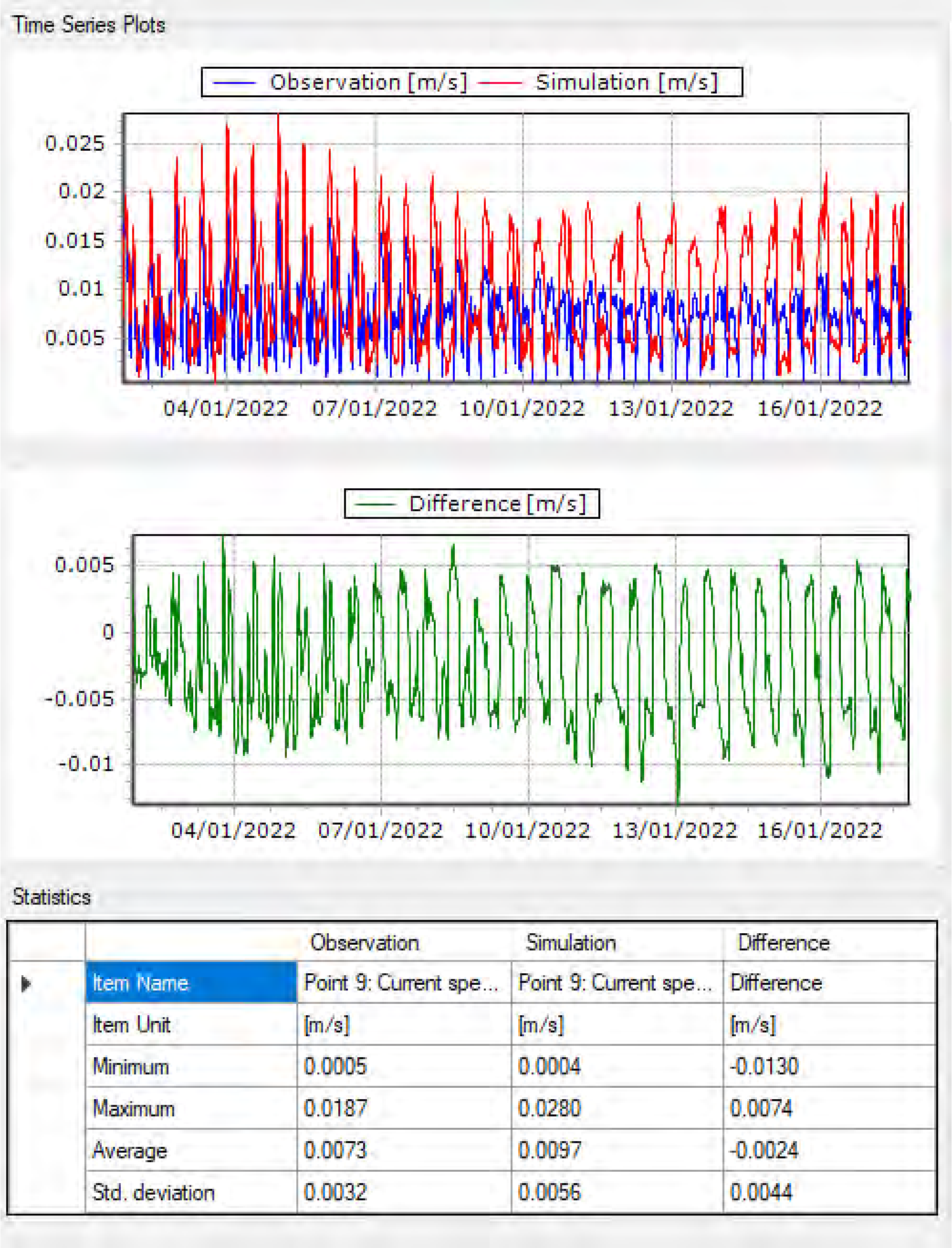

Time Series Plots

Statistics

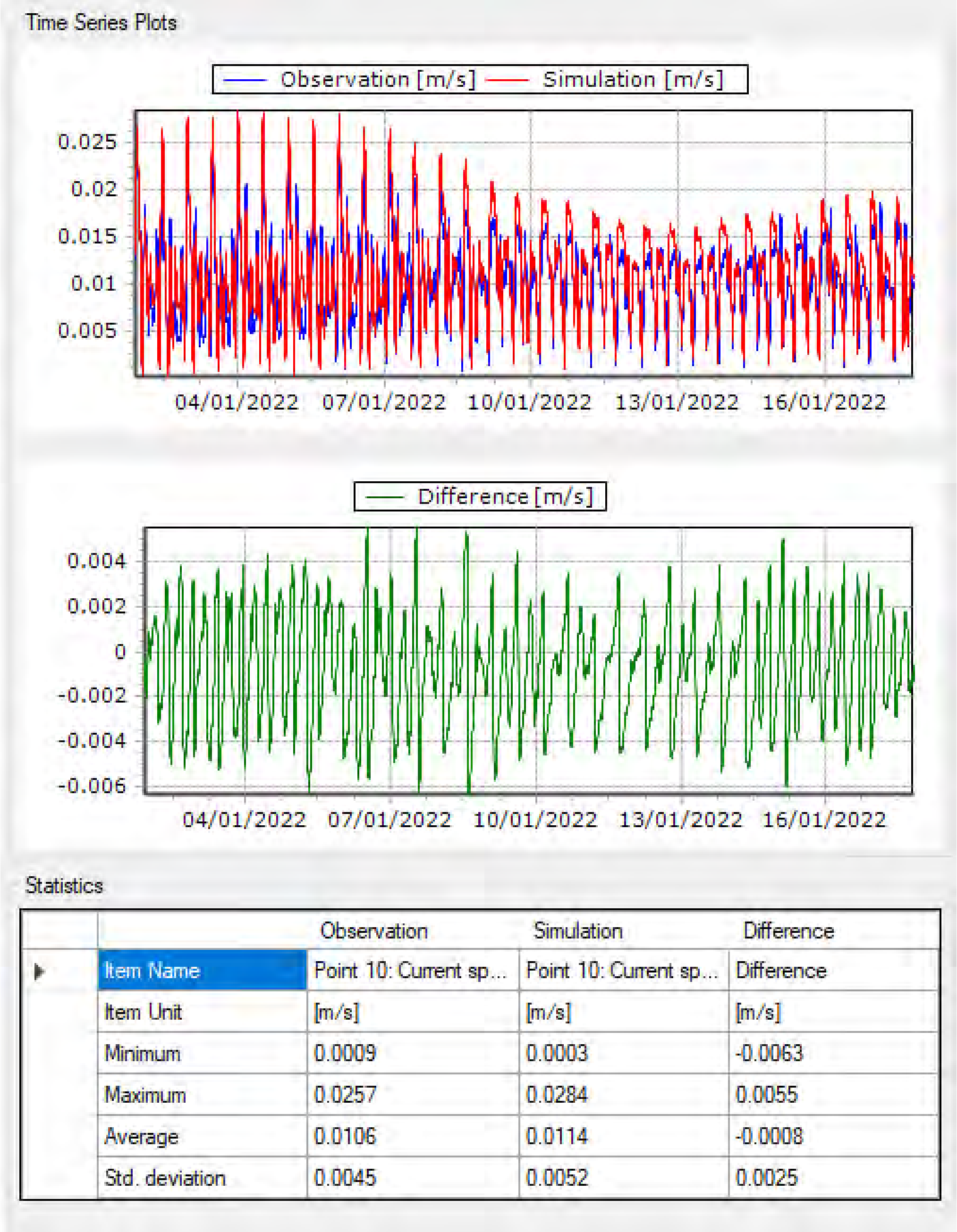
		Observation	Simulation	Difference
▶	Item Name	Point 6: Current spe...	Point 6: Current spe...	Difference
	Item Unit	[m/s]	[m/s]	[m/s]
	Minimum	0.0006	0.0007	-0.0076
	Maximum	0.0186	0.0221	0.0107
	Average	0.0081	0.0063	0.0018
	Std. deviation	0.0031	0.0038	0.0029



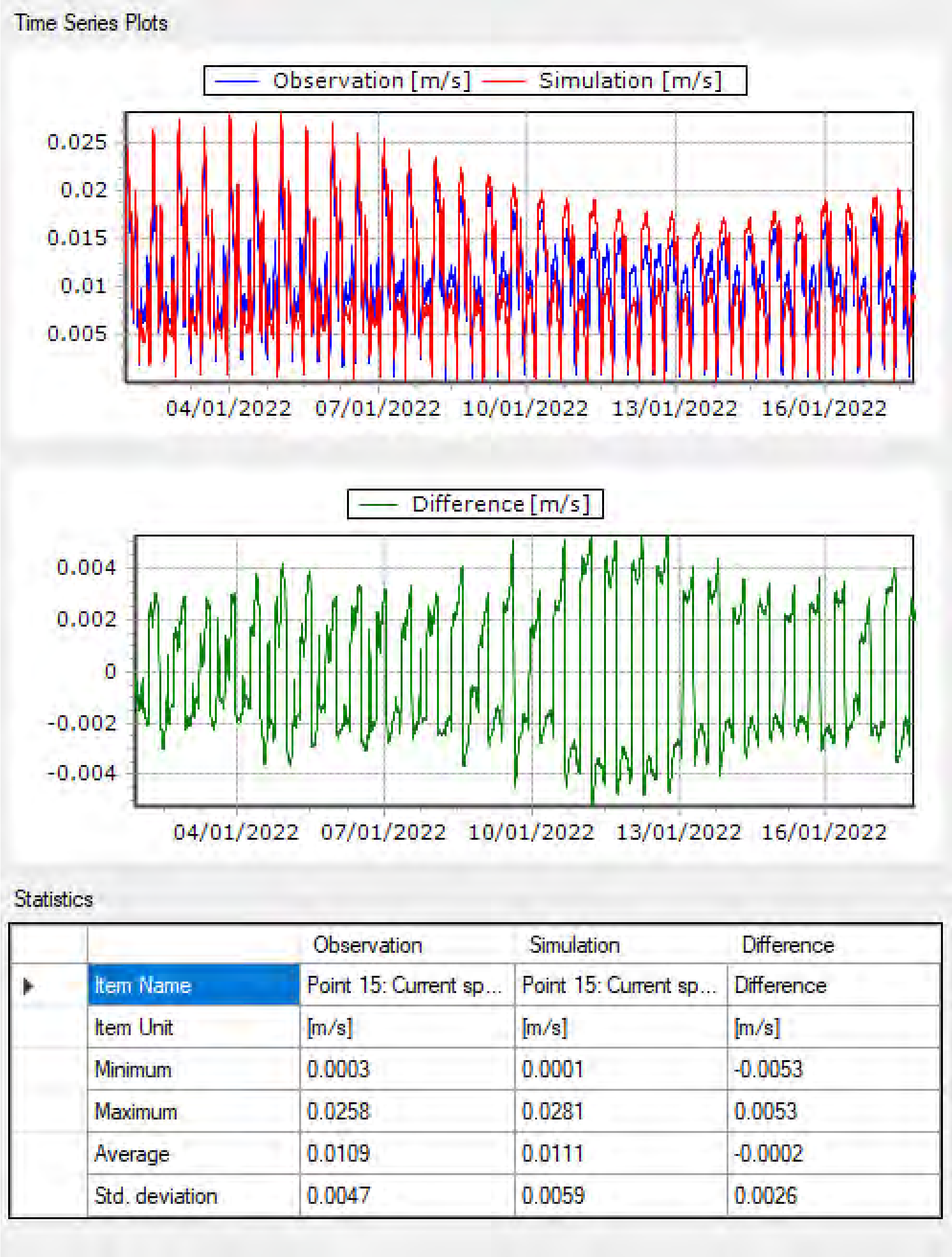
	Observation	Simulation	Difference
Item Name	Point 7: Current spe...	Point 7: Current spe...	Difference
Item Unit	[m/s]	[m/s]	[m/s]
Minimum	0.0005	0.0003	-0.0202
Maximum	0.0212	0.0342	0.0085
Average	0.0080	0.0124	-0.0044
Std. deviation	0.0035	0.0087	0.0073



	Observation	Simulation	Difference
Item Name	Point 9: Current spe...	Point 9: Current spe...	Difference
Item Unit	[m/s]	[m/s]	[m/s]
Minimum	0.0005	0.0004	-0.0130
Maximum	0.0187	0.0280	0.0074
Average	0.0073	0.0097	-0.0024
Std. deviation	0.0032	0.0056	0.0044

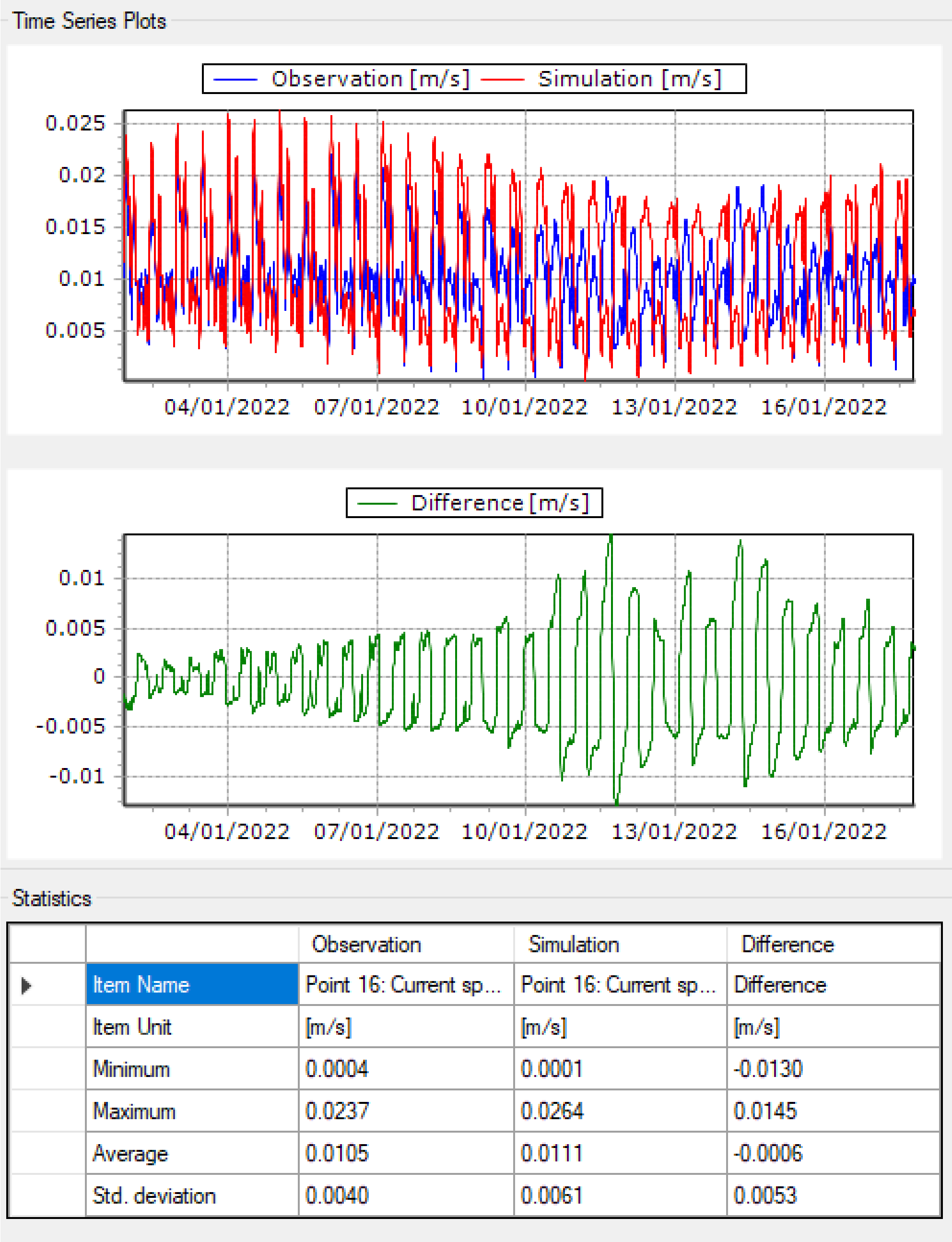


	Observation	Simulation	Difference
Item Name	Point 10: Current sp...	Point 10: Current sp...	Difference
Item Unit	[m/s]	[m/s]	[m/s]
Minimum	0.0009	0.0003	-0.0063
Maximum	0.0257	0.0284	0.0055
Average	0.0106	0.0114	-0.0008
Std. deviation	0.0045	0.0052	0.0025

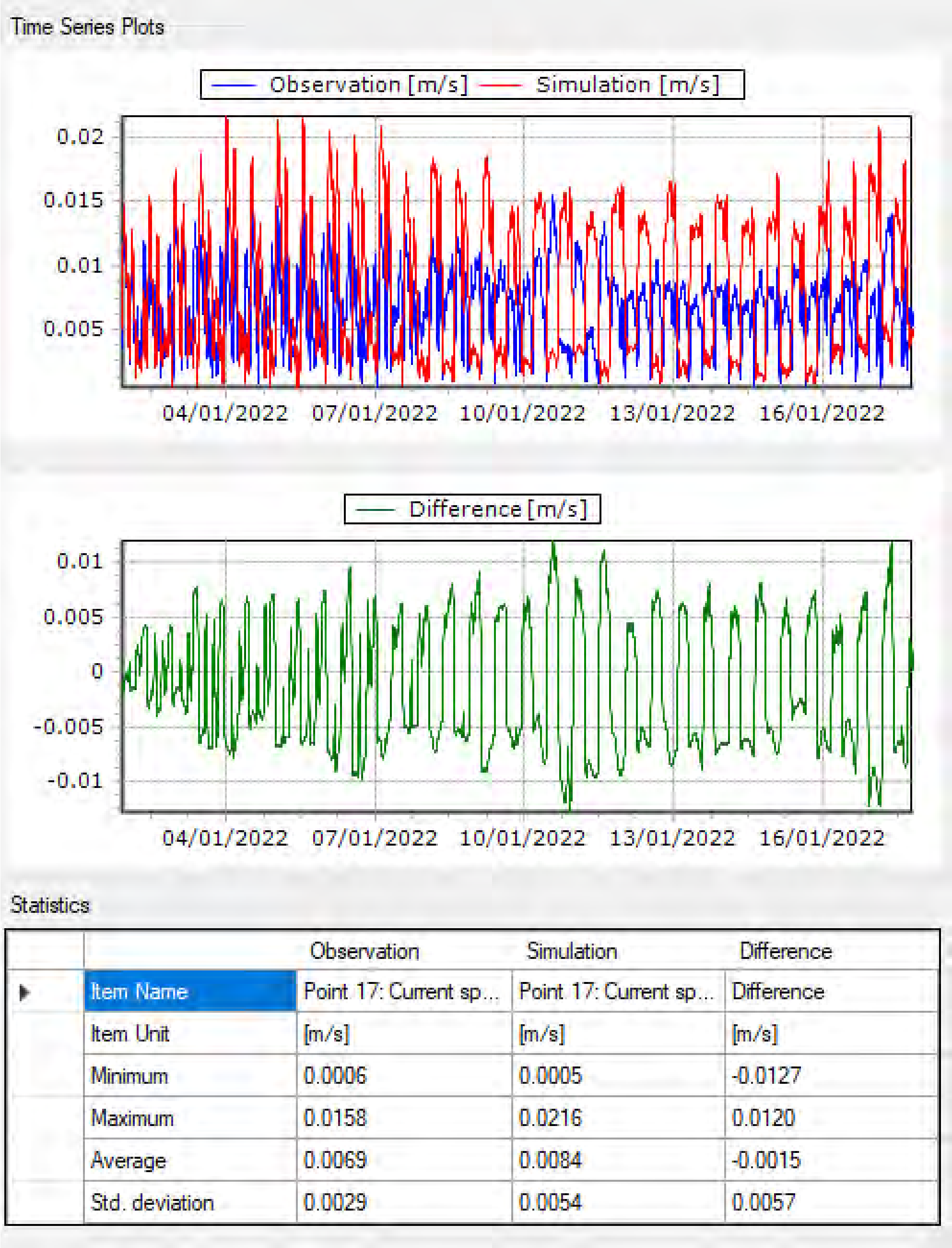


Statistics

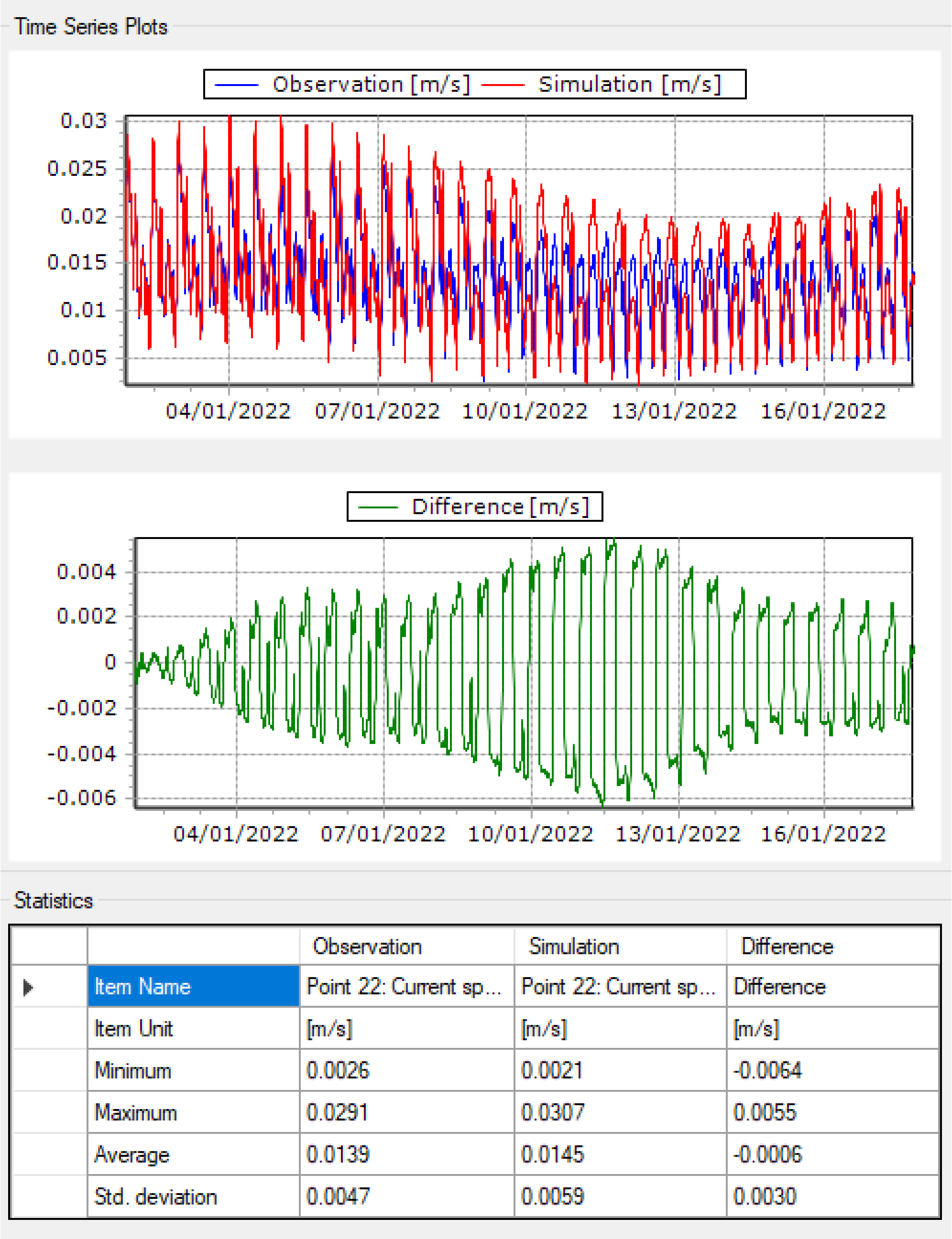
	Observation	Simulation	Difference
Item Name	Point 15: Current sp...	Point 15: Current sp...	Difference
Item Unit	[m/s]	[m/s]	[m/s]
Minimum	0.0003	0.0001	-0.0053
Maximum	0.0258	0.0281	0.0053
Average	0.0109	0.0111	-0.0002
Std. deviation	0.0047	0.0059	0.0026



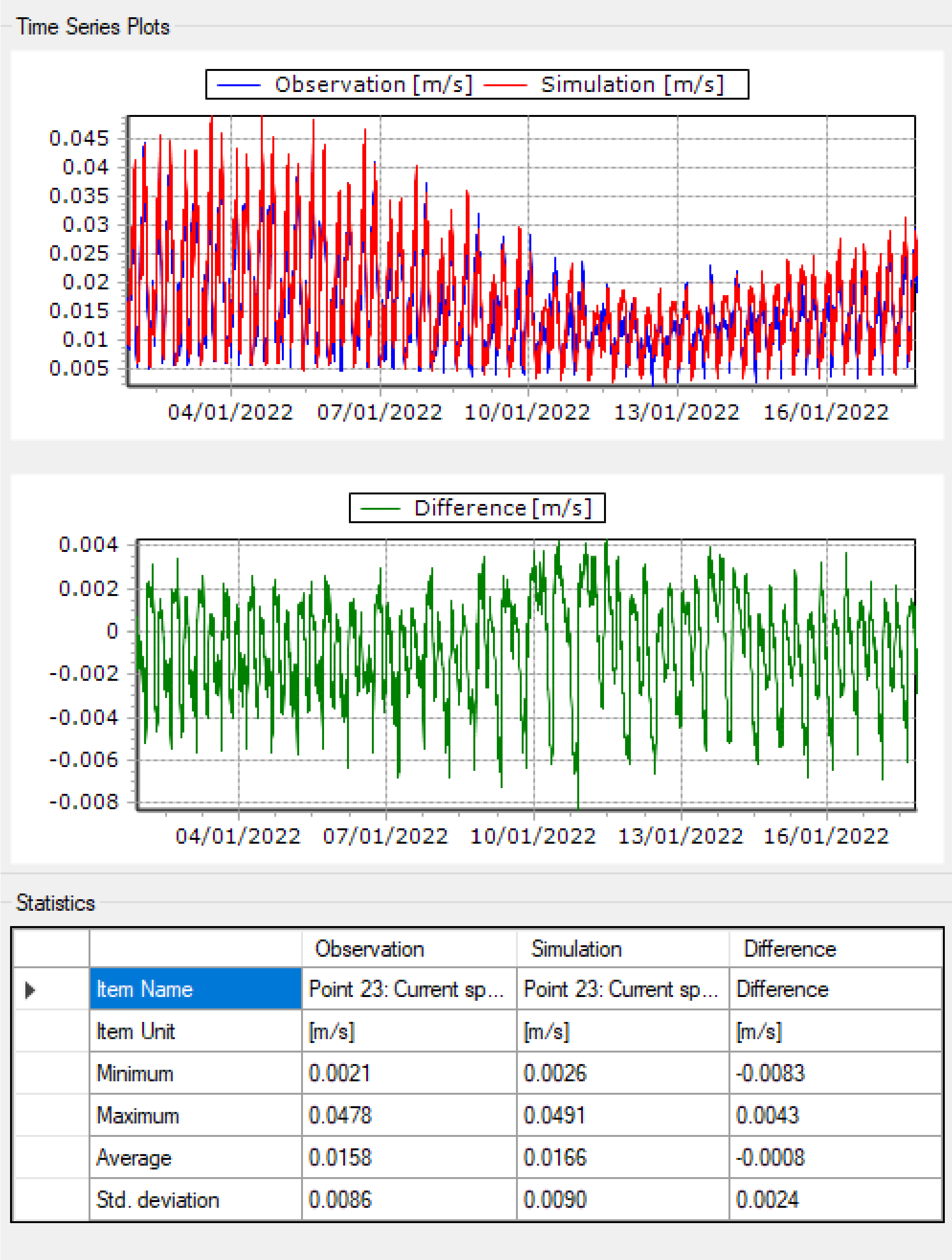
	Observation	Simulation	Difference
Item Name	Point 16: Current sp...	Point 16: Current sp...	Difference
Item Unit	[m/s]	[m/s]	[m/s]
Minimum	0.0004	0.0001	-0.0130
Maximum	0.0237	0.0264	0.0145
Average	0.0105	0.0111	-0.0006
Std. deviation	0.0040	0.0061	0.0053



	Observation	Simulation	Difference
Item Name	Point 17: Current sp...	Point 17: Current sp...	Difference
Item Unit	[m/s]	[m/s]	[m/s]
Minimum	0.0006	0.0005	-0.0127
Maximum	0.0158	0.0216	0.0120
Average	0.0069	0.0084	-0.0015
Std. deviation	0.0029	0.0054	0.0057

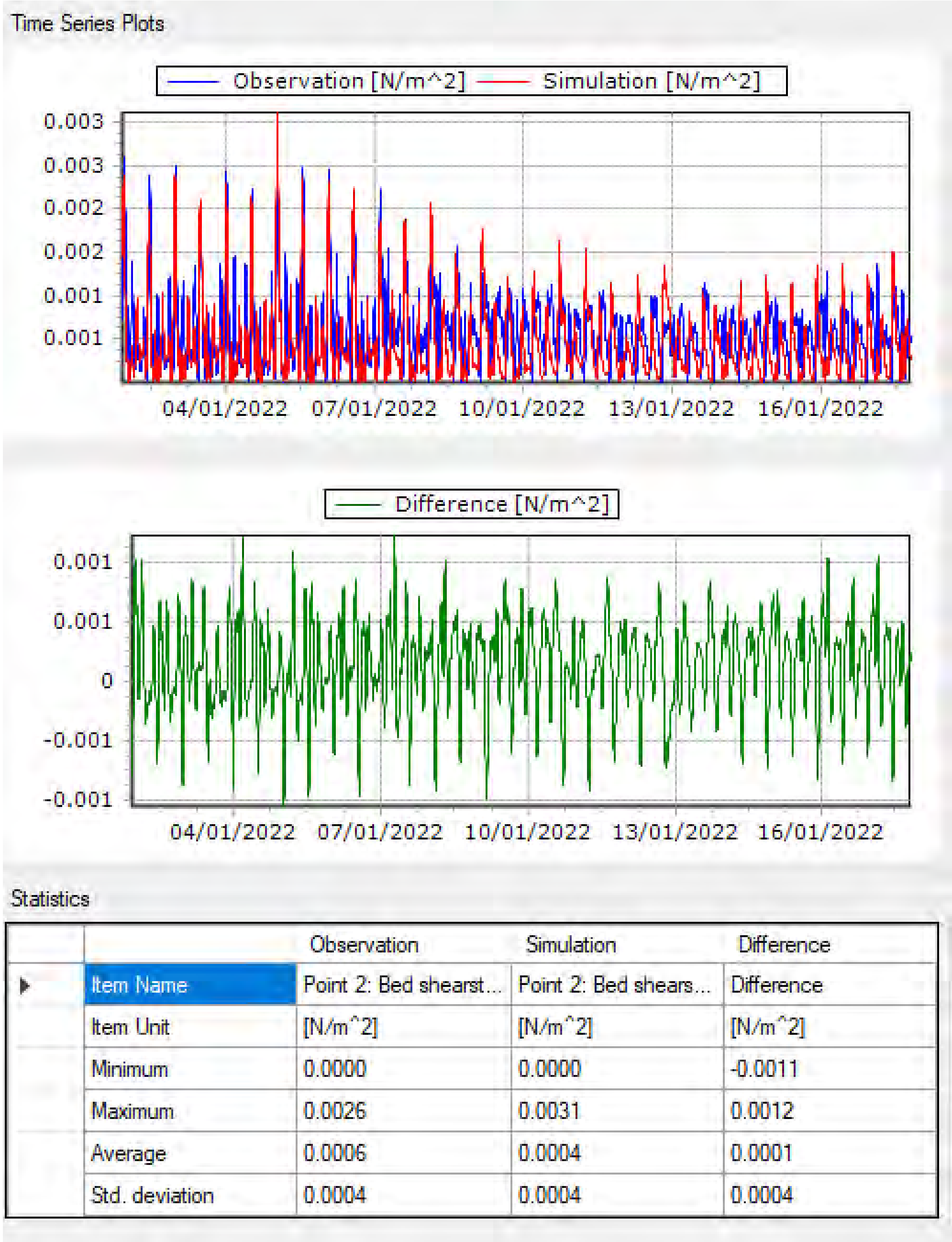


	Observation	Simulation	Difference
Item Name	Point 22: Current sp...	Point 22: Current sp...	Difference
Item Unit	[m/s]	[m/s]	[m/s]
Minimum	0.0026	0.0021	-0.0064
Maximum	0.0291	0.0307	0.0055
Average	0.0139	0.0145	-0.0006
Std. deviation	0.0047	0.0059	0.0030



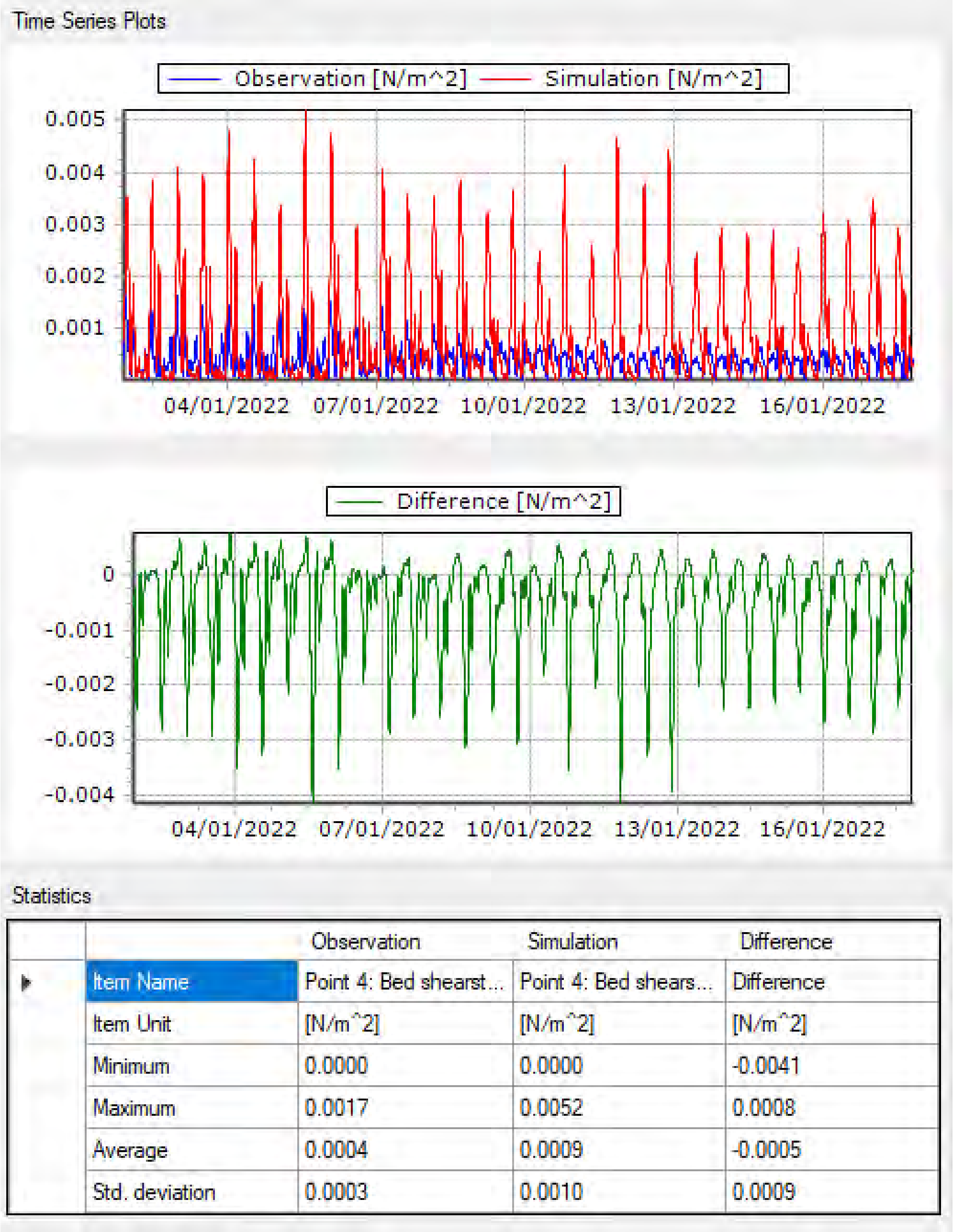
	Observation	Simulation	Difference
Item Name	Point 23: Current sp...	Point 23: Current sp...	Difference
Item Unit	[m/s]	[m/s]	[m/s]
Minimum	0.0021	0.0026	-0.0083
Maximum	0.0478	0.0491	0.0043
Average	0.0158	0.0166	-0.0008
Std. deviation	0.0086	0.0090	0.0024

Bed Shear Stress

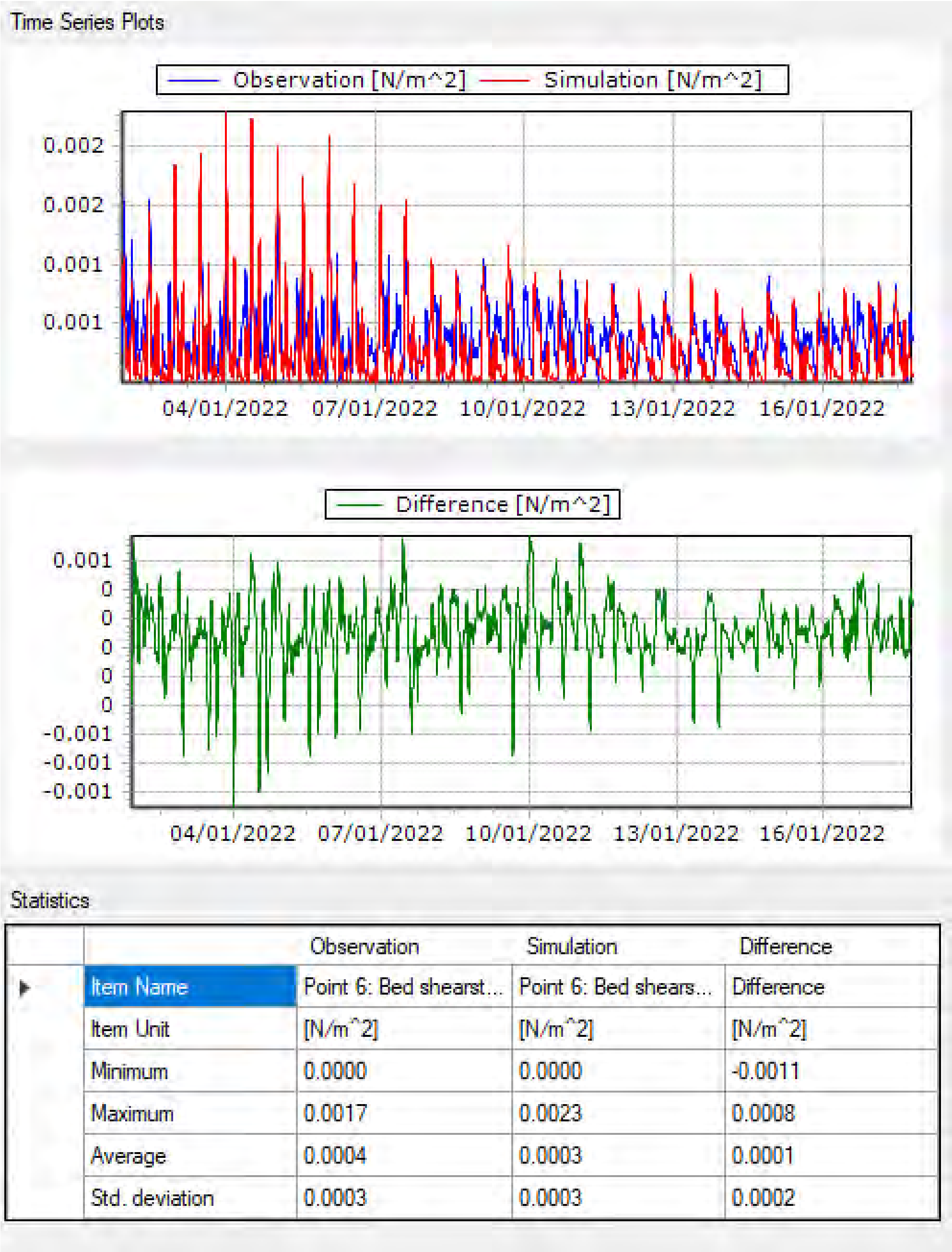


Statistics

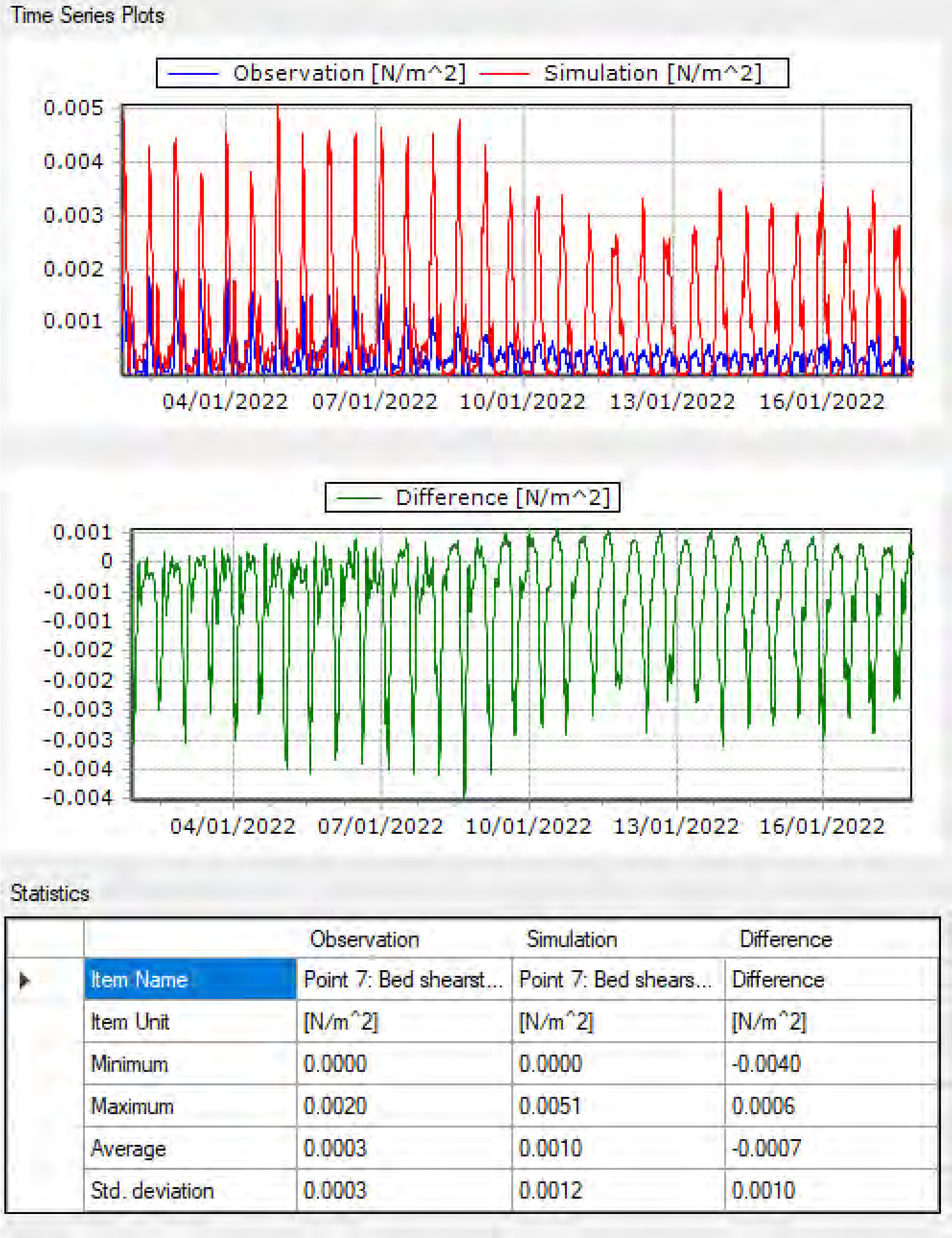
	Observation	Simulation	Difference
Item Name	Point 2: Bed shearst...	Point 2: Bed shears...	Difference
Item Unit	[N/m^2]	[N/m^2]	[N/m^2]
Minimum	0.0000	0.0000	-0.0011
Maximum	0.0026	0.0031	0.0012
Average	0.0006	0.0004	0.0001
Std. deviation	0.0004	0.0004	0.0004



		Observation	Simulation	Difference
▶	Item Name	Point 4: Bed shearst...	Point 4: Bed shears...	Difference
	Item Unit	[N/m^2]	[N/m^2]	[N/m^2]
	Minimum	0.0000	0.0000	-0.0041
	Maximum	0.0017	0.0052	0.0008
	Average	0.0004	0.0009	-0.0005
	Std. deviation	0.0003	0.0010	0.0009



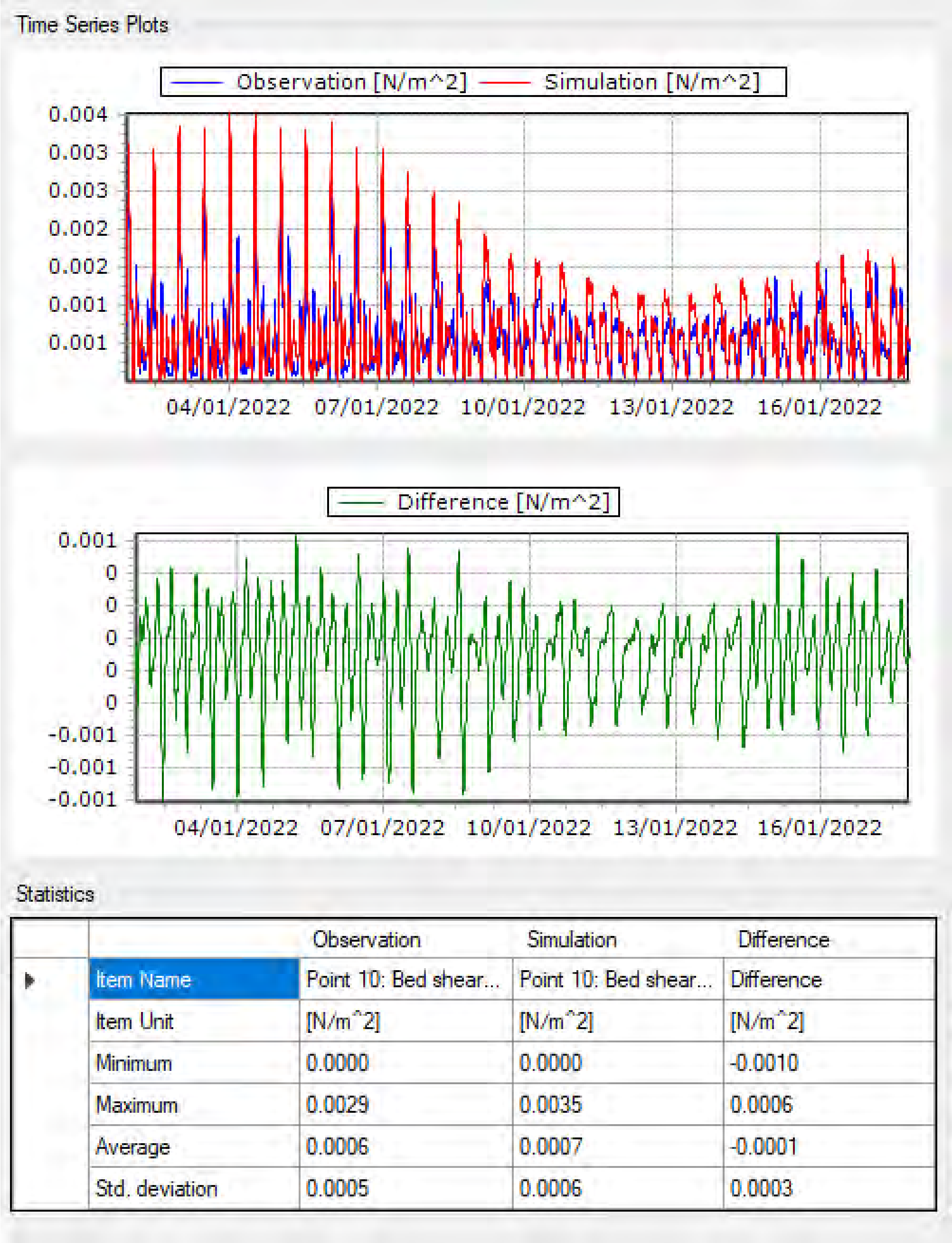
	Observation	Simulation	Difference
Item Name	Point 6: Bed shearst...	Point 6: Bed shears...	Difference
Item Unit	[N/m^2]	[N/m^2]	[N/m^2]
Minimum	0.0000	0.0000	-0.0011
Maximum	0.0017	0.0023	0.0008
Average	0.0004	0.0003	0.0001
Std. deviation	0.0003	0.0003	0.0002



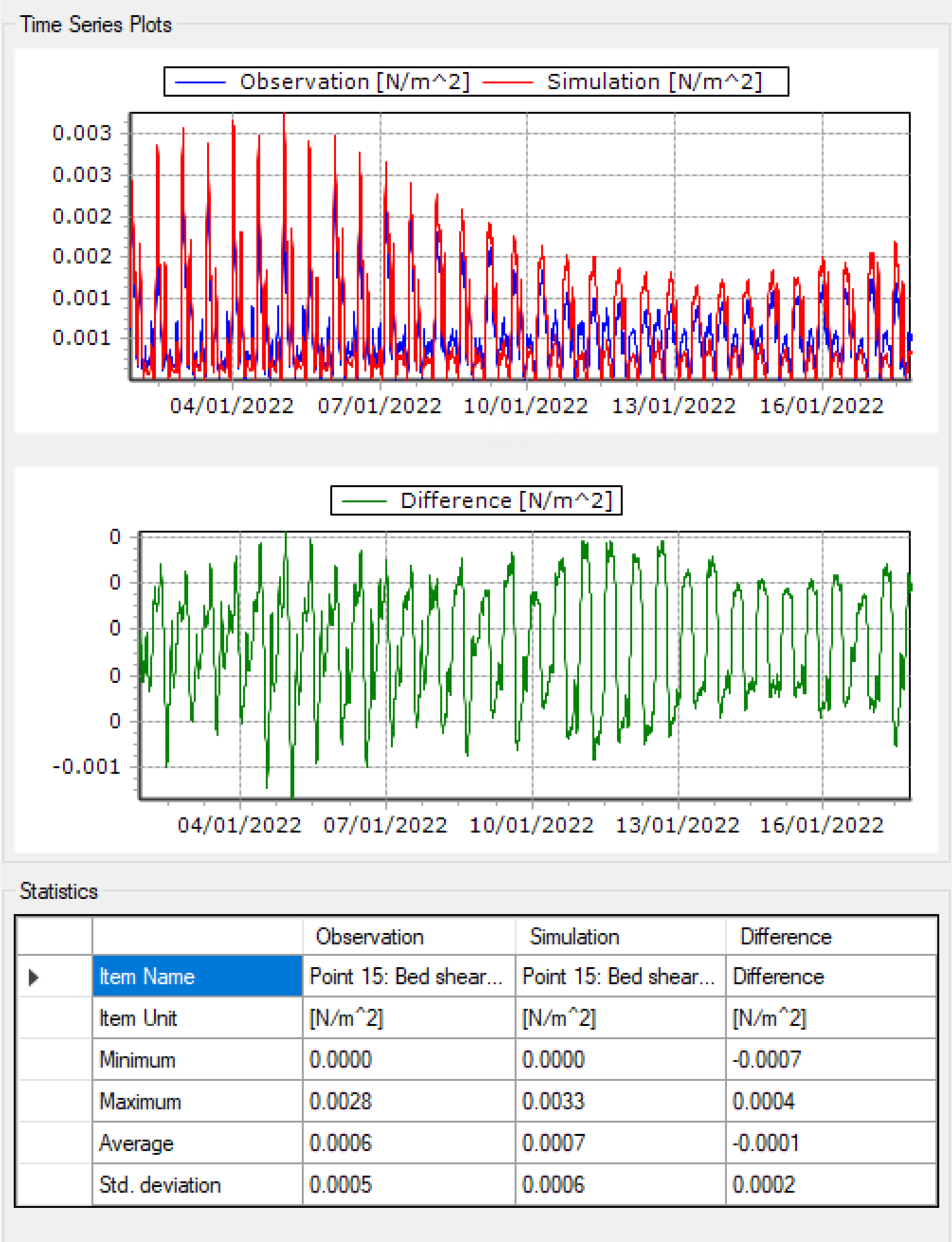
Statistics

	Observation	Simulation	Difference
Item Name	Point 7: Bed shearst...	Point 7: Bed shears...	Difference
Item Unit	[N/m^2]	[N/m^2]	[N/m^2]
Minimum	0.0000	0.0000	-0.0040
Maximum	0.0020	0.0051	0.0006
Average	0.0003	0.0010	-0.0007
Std. deviation	0.0003	0.0012	0.0010

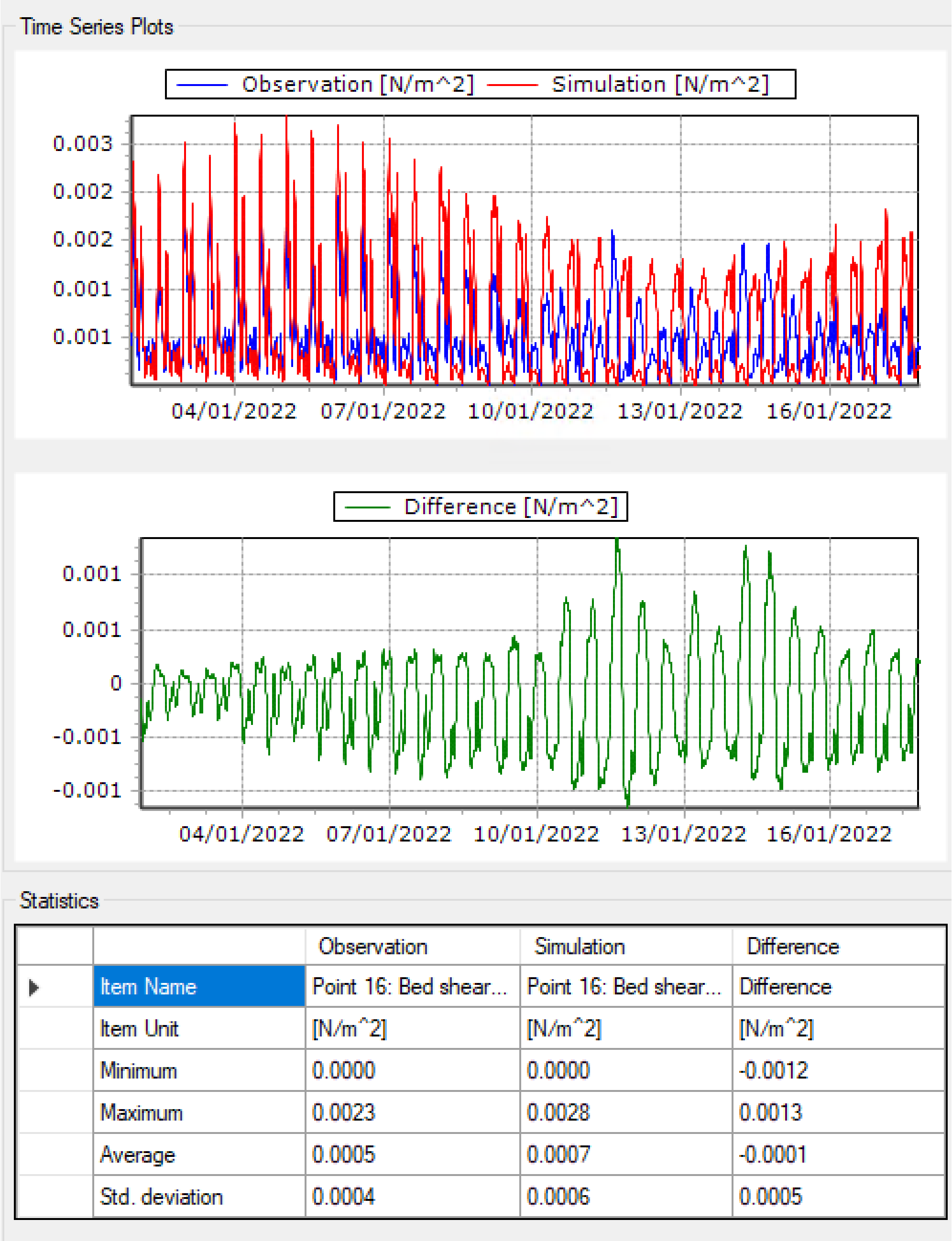
	Observation	Simulation	Difference
Item Name	Point 9: Bed shearst...	Point 9: Bed shears...	Difference
Item Unit	[N/m^2]	[N/m^2]	[N/m^2]
Minimum	0.0000	0.0000	-0.0019
Maximum	0.0015	0.0034	0.0004
Average	0.0003	0.0006	-0.0003
Std. deviation	0.0002	0.0006	0.0004



		Observation	Simulation	Difference
▶	Item Name	Point 10: Bed shear...	Point 10: Bed shear...	Difference
	Item Unit	[N/m^2]	[N/m^2]	[N/m^2]
	Minimum	0.0000	0.0000	-0.0010
	Maximum	0.0029	0.0035	0.0006
	Average	0.0006	0.0007	-0.0001
	Std. deviation	0.0005	0.0006	0.0003

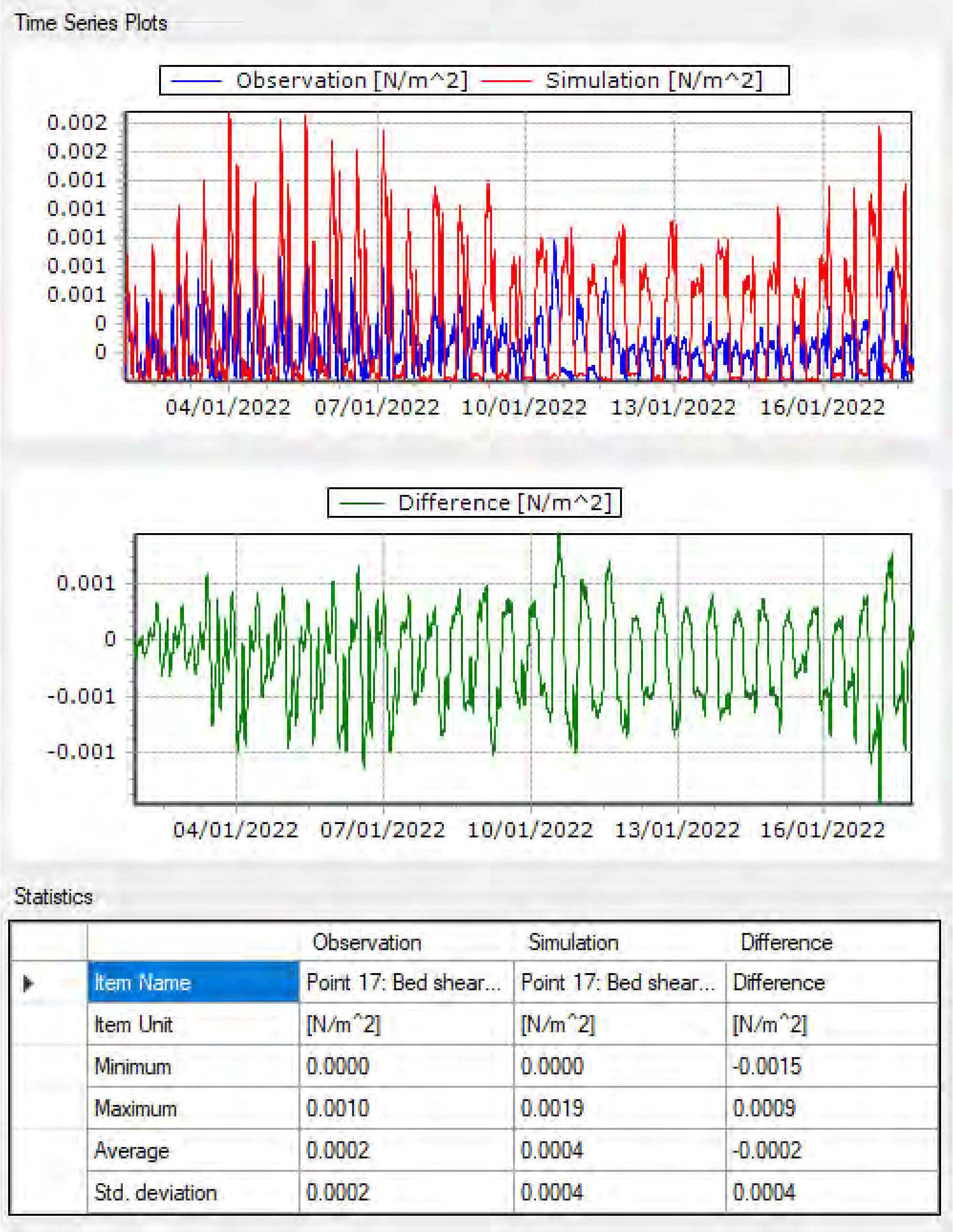


	Observation	Simulation	Difference
Item Name	Point 15: Bed shear...	Point 15: Bed shear...	Difference
Item Unit	[N/m^2]	[N/m^2]	[N/m^2]
Minimum	0.0000	0.0000	-0.0007
Maximum	0.0028	0.0033	0.0004
Average	0.0006	0.0007	-0.0001
Std. deviation	0.0005	0.0006	0.0002

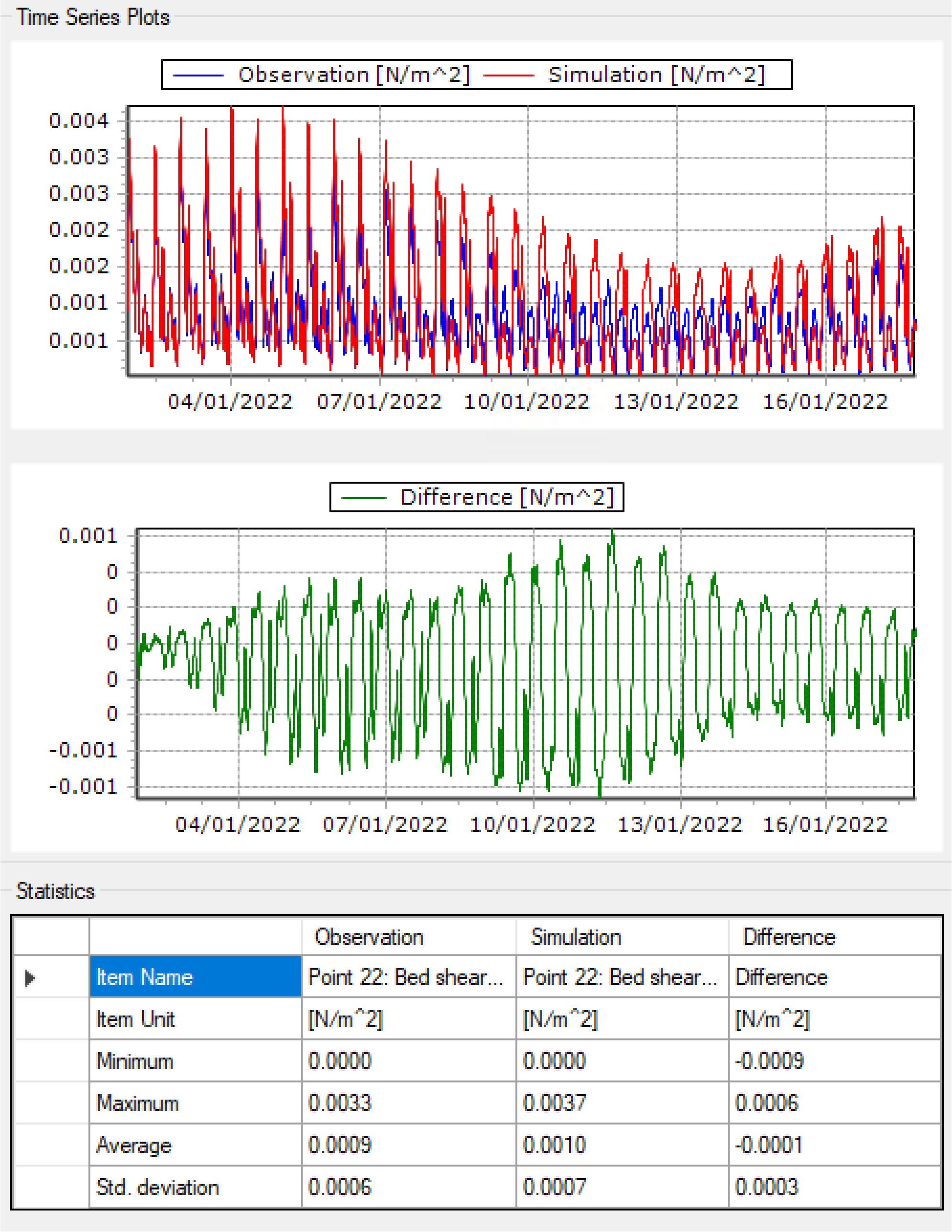


Statistics

		Observation	Simulation	Difference
▶	Item Name	Point 16: Bed shear...	Point 16: Bed shear...	Difference
	Item Unit	[N/m^2]	[N/m^2]	[N/m^2]
	Minimum	0.0000	0.0000	-0.0012
	Maximum	0.0023	0.0028	0.0013
	Average	0.0005	0.0007	-0.0001
	Std. deviation	0.0004	0.0006	0.0005



	Observation	Simulation	Difference
Item Name	Point 17: Bed shear...	Point 17: Bed shear...	Difference
Item Unit	[N/m^2]	[N/m^2]	[N/m^2]
Minimum	0.0000	0.0000	-0.0015
Maximum	0.0010	0.0019	0.0009
Average	0.0002	0.0004	-0.0002
Std. deviation	0.0002	0.0004	0.0004



		Observation	Simulation	Difference
▶	Item Name	Point 22: Bed shear...	Point 22: Bed shear...	Difference
	Item Unit	[N/m^2]	[N/m^2]	[N/m^2]
	Minimum	0.0000	0.0000	-0.0009
	Maximum	0.0033	0.0037	0.0006
	Average	0.0009	0.0010	-0.0001
	Std. deviation	0.0006	0.0007	0.0003

	Observation	Simulation	Difference
Item Name	Point 23: Bed shear...	Point 23: Bed shear...	Difference
Item Unit	[N/m^2]	[N/m^2]	[N/m^2]
Minimum	0.0000	0.0000	-0.0019
Maximum	0.0135	0.0139	0.0011
Average	0.0019	0.0021	-0.0002
Std. deviation	0.0021	0.0023	0.0005

TECHNICAL APPENDIX 4.2

Total Quality. Assured.

ORKNEY ISLANDS COUNCIL

Significant Wave Height Desktop Study

Technical Report - Scapa Deep Water Quay

P2570_R5877_Rev1 | 28 November 2022

Intertek Energy & Water Consultancy Services
Exchange House, Station Road, Liphook, Hampshire GU30 7DW, United Kingdom

DOCUMENT RELEASE FORM

Orkney Islands Council

P2570_R5877_Rev1

Significant Wave Height Desktop Study

Technical Report - Scapa Deep Water Quay

Author/s

Liz Comer

Project Manager	Authoriser
Emma Langley	Richard Dannatt

Rev No	Date	Reason	Author	Checker	Authoriser
Rev 0	23/09/2022	Original release	LCO	KRM	PAT
Rev 1	28/11/2022	Additional wind data QC and model runs	LCO	KRM	RPD

Intertek Energy & Water Consultancy Services is the trading name of Metoc Ltd, a member of the Intertek group of companies.

SUMMARY

INTRODUCTION

Intertek Energy and Water Consultancy Services (Intertek) has been commissioned by Orkney Islands Council (OIC) Harbour Authority to provide a specialist wave consultancy service in relation to the potential developments at Scapa Deep Water Quay (SDWQ), Scapa Flow, and Hatston (Orkney Logistics Base), Kirkwall as these projects move towards Environmental Impact Assessment (EIA), detailed design and construction. As part of this work, Intertek has conducted a desktop study to determine significant wave heights (Hs) and peak wave periods (Tp) at these locations.

This report details the desktop study that Intertek carried out for the potential SDWQ development, specifically investigating incident Hs/Tp at the development site for a selection of extreme wind scenarios, and potential changes to the wave regime resulting from the proposed development. A similar study for Hatston (Orkney Logistics Base) is presented in a separate report (Intertek, 2022).

PURPOSE OF STUDY

The aim of the assessment is to generate wave criteria to support the development phase of the project. As such the modelling aims to generate extreme wave conditions at pertinent locations for the SDWQ development.

The modelling approach employed in this study – a Spectral Wave (SW) Model – generates estimates of wave conditions (such as Hs) as they approach the development site. It includes all pertinent processes that influence waves as they are generated by wind forcing and propagate across Scapa Flow to the site – processes such as wind-wave generation, directional and frequency spreading, refraction, shoaling, bottom dissipation and wave breaking. The model also captures some effects of the development on these waves, such as energy losses as the waves propagate past piers. However, this model does not fully simulate interactions between the incident waves and the development itself – for example, wave diffraction around structures and run-up.

DEVELOPMENT OVERVIEW

The primary area of interest for this study is the Bay of Deepdale, on the east coast of Scapa Flow approximately 6 kilometres (km) south of Kirkwall. At the time of writing there is no quay or harbour within the Bay of Deepdale.

The proposed development at SDWQ will be staggered in three phases but for this study, the SW model has been run to determine the wave field within the area of interest before and after the proposed development. This gives three assessment scenarios:

- Baseline – Baseline before structures added.
- Proposed Development 1 – New solid structures added with solid tubular and sheet pile face (Phase 1 & 2) along with a tubular pile suspended deck (Phase 3) and all associated dredging.
- Proposed Development 2 – New solid structures added with solid tubular and sheet pile face (Phase 1 & 2) and all associated dredging.

MODELLING APPROACH

A MIKE 21 SW model has been developed for Scapa Flow. A linear interpolation technique was adopted to generate the Scapa SW model bathymetry. The model utilises an unstructured mesh of irregular triangular elements, allowing the model resolution to vary throughout the domain. This approach provides the greatest flexibility for addressing environmental conditions throughout the study area. The mesh resolution was optimised during the model development process so as to provide sufficient resolution in the area of the proposed SDWQ development while avoiding onerous computational run times.

It is noted that the area of interest is fetch-limited (<50 km fetch in the longest directions) and so wind-wave growth is the primary driver. For this reason, the fully spectral, quasi-stationary formulation was deemed appropriate. The wind speeds were applied as constants in domain and time, and the uncoupled wind generation formulation was used. The use of a coupled formulation for a spatial scale <100 km may result in an overestimation of the sea surface roughness and thus Hs (Johnson and Kofoed-Hansen, 2000).

In the absence of measured wave data within the model domain, the model was run mostly with default values as input parameters. However, some of these defaults were modified to use parameter values that Intertek has previously derived for calibrated SW models in similar (enclosed) offshore environments. The parameters of relevance were the bottom friction parameter (set to kn=0.02 m) and the white capping dissipation coefficients (set to cdis=4.5 and delta=0.5).

STUDY SUMMARY AND CONCLUSIONS

The potential wave conditions at Bay of Deepdale before and after the proposed SDWQ development have been predicted for a number of scenarios using a spectral wave model. The model results show that the predicted maximum Hs for both the pre- and post-development scenarios is c. 2.6 m and c. 3.4 m respectively, for the 1-in-50 year wind condition from a south-westerly and westerly direction. The maximum Tp is predicted for the same scenarios. This is to be expected as these are the directions with the longest fetch and with a strong extreme wind speed, allowing the waves to build up to the area of interest. The results presented represent a fully developed sea for a constant wind direction, and therefore include a degree of conservatism (as wind speed and direction will vary temporally and spatially on a local scale).

The tables and plots of predicted Hs for the post-development scenarios show that there are areas around the solid quay that are subject to wave sheltering. However, larger wave heights are predicted for locations along the west of the quay. This section of the development is relatively more exposed and rarely subject to wave sheltering and waves can therefore approach unobstructed. It also experiences the deepest water, so waves are less likely to be limited by shoaling or breaking.

In the absence of suitable measured data the SW model predictions have been verified by comparison against estimates of wave height using several empirically-derived wave growth formulations. These comparisons confirm that the model is producing realistic predictions of wave conditions with a slight tendency towards conservatism.

RECOMMENDATIONS

The wave conditions presented in this report are considered suitable for purposes of planning and feasibility. We recommend, however, that they not be used for detailed engineering design without additional analysis and investigation.

CONTENTS

LIST OF TABLES AND FIGURES

Tables

Figures

GLOSSARY

DHI
Danish Hydraulic Institute

EIA
Environmental Impact Assessment

EVA
Extreme Value Analysis

Hs
Significant Wave Height

Intertek
Intertek Energy and Water Consultancy Services

JONSWAP
Joint North Sea Wave Project

MHWS
Mean High Water Springs

MSL
Mean Sea Level

OIC
Orkney Islands Council

OS
Ordnance Survey

SDWQ
Scapa Deep Water Quay

SMB
Sverdrup-Munk-Bretschneider

SW
Spectral Wave

Tp
Peak Wave Period

UKHO
United Kingdom Hydrographic Office

1. INTRODUCTION

1.1 Overview

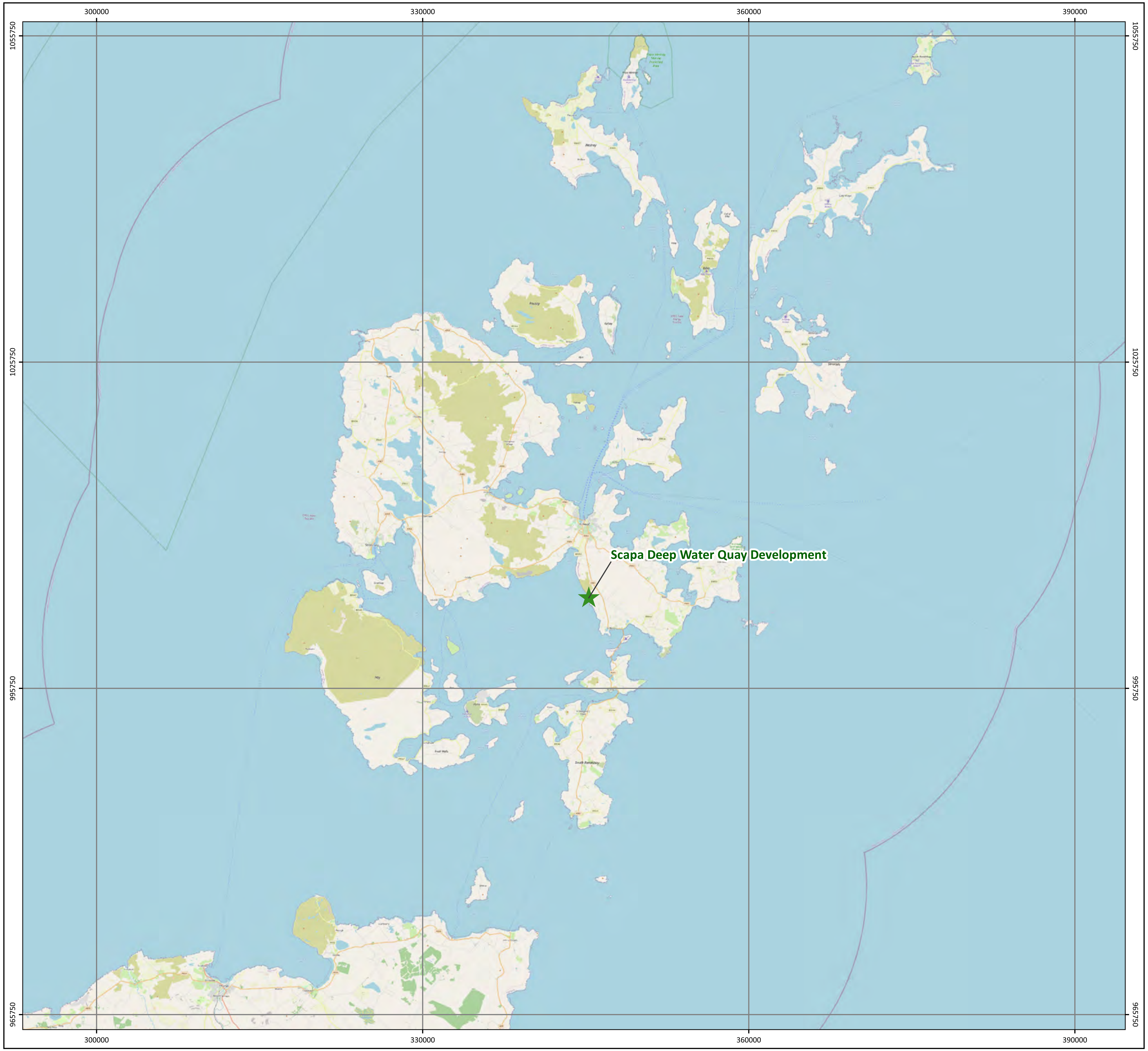
Intertek Energy and Water Consultancy Services (Intertek) has been commissioned by Orkney Islands Council (OIC) Harbour Authority to provide a specialist wave consultancy service in relation to the potential developments at Scapa Deep Water Quay (SDWQ), Scapa Flow, and Hatston (Orkney Logistics Base), Kirkwall as these projects move towards Environmental Impact Assessment (EIA), detailed design and construction. As part of this work, Intertek has conducted a desktop study to determine significant wave heights (Hs) and peak wave periods (Tp) at these locations.

This report details the desktop study that Intertek carried out for the potential SDWQ development, specifically investigating incident Hs/Tp at the development site for a selection of extreme wind scenarios, and potential changes to the wave regime resulting from the proposed development. A similar study for Hatston (Orkney Logistics Base) is presented in a separate report (Intertek, 2022).

1.2 Background and Approach

OIC is looking to improve and expand Orkney's existing harbours and marine assets, to meet the needs of changing markets and position Orkney as a world leading maritime hub. Under the Orkney Harbours Masterplan (OICHA, 2022), the SDWQ development has been proposed, which includes a new multi-user deep water pier and quayside facility with laydown area. The primary area of interest for this study is Bay of Deepdale, on the east coast of Scapa Flow approximately 6 km south of Kirkwall (see Figure 1-1 (Drawing number: P2570-LOC-001-A)). At the time of writing there is no quay or harbour within Bay of Deepdale.

Scapa Flow is an enclosed body of water within the Orkney Islands group, with a harbour area of 324.5 km^2. As it is enclosed it is for the most part not exposed to oceanic wave conditions (swell waves) from the North Atlantic or North Sea, and the predominant wave climate within this water body is fetch-limited wind-generated waves. To provide safe berthing and navigation around the quay it is important that the wave climate under extreme wind conditions is evaluated. The potential Hs at output locations around the proposed quay from wind-generated waves has been investigated through a numerical wave modelling study.



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SIGNIFICANT WAVE HEIGHT DESK TOP STUDY - SCAPA DEEP WATER QUAY

LOCATION OVERVIEW

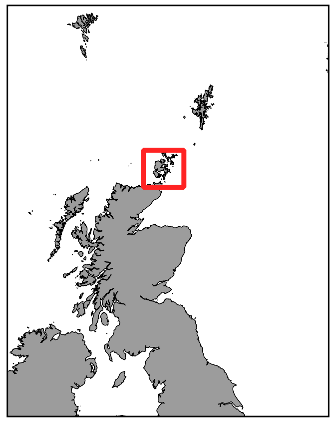
Geographical Overview

Drawing No: P2570-LOC-001 | A

Legend

★ Scapa Deep Water Quay Development

N



NOT TO BE USED FOR NAVIGATION

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File Reference	J:\P2570\Mxd_QGZ\03_LOC \P2570_LOC.qgz
Created By	Lewis Castle
Reviewed By	Emma Langley
Approved By	Emma Langley

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intertek

0 4 8 12 16 km

1.3 Purpose of Study

The aim of the assessment is to generate wave criteria to support the development phase of the project. As such the modelling aims to generate extreme wave conditions at pertinent locations for the SDWQ development.

The modelling approach employed in this study – a Spectral Wave (SW) Model – generates estimates of wave conditions (such as Hs) as they approach the development site. It includes all pertinent processes that influence waves as they are generated by wind forcing and propagate across Scapa Flow to the site – processes such as wind-wave generation, directional and frequency spreading, refraction, shoaling, bottom dissipation and wave breaking. The model also captures some effects of the development on these waves, such as energy losses as the waves propagate past piers. However, this model does not fully simulate interactions between the incident waves and the development itself – for example, wave diffraction around structures, wave reflection off hard surfaces (other than in a simplified fashion), and run-up. To capture such processes within the development area itself, a different model – the Boussinesq Wave Model – would be required. As such, the results of this study are considered suitable for use in project planning and feasibility studies, but are not directly suitable for detailed engineering design (e.g. to derive the forces exerted on structures).

1.4 Development Overview

The proposed SDWQ is described in Section 1.2 and depicted in Figure 1-2 (Drawing number: P2570-LOC-002-A). The proposed development will be undertaken in three phases. For the present study, the SW model has been run to determine the wave field within the area of interest for three assessment scenarios:

- Baseline – Baseline before structures added.
- Proposed Development 1 – New solid structures added with solid tubular and sheet pile face (Phase 1 & 2) along with a tubular pile suspended deck (Phase 3) and all associated dredging.
- Proposed Development 2 – New solid structures added with solid tubular and sheet pile face (Phase 1 & 2) and all associated dredging (Phase 3 suspended deck excluded from this scenario).

SIGNIFICANT WAVE HEIGHT DESK TOP STUDY - SCAPA DEEP WATER QUAY

LOCATION OVERVIEW

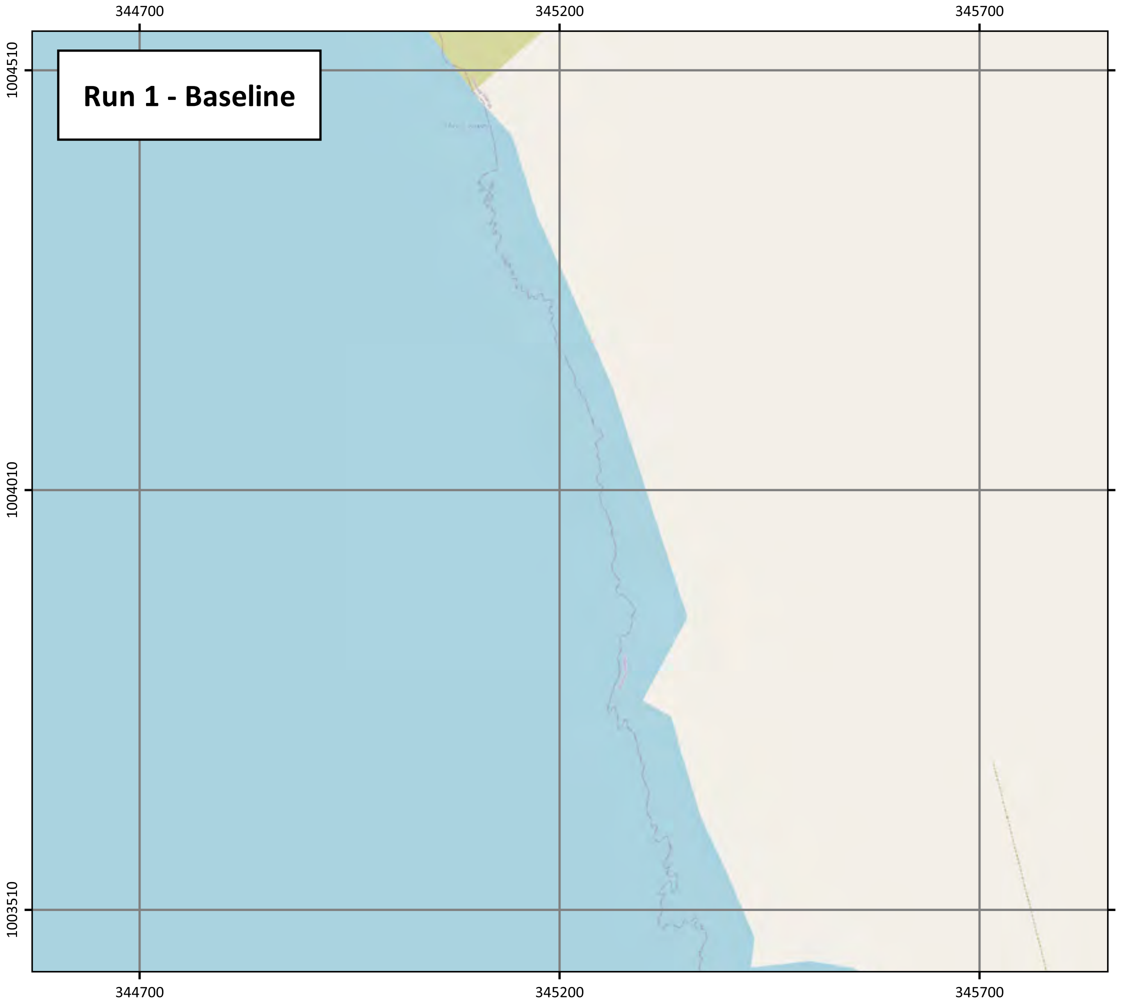
Model Runs

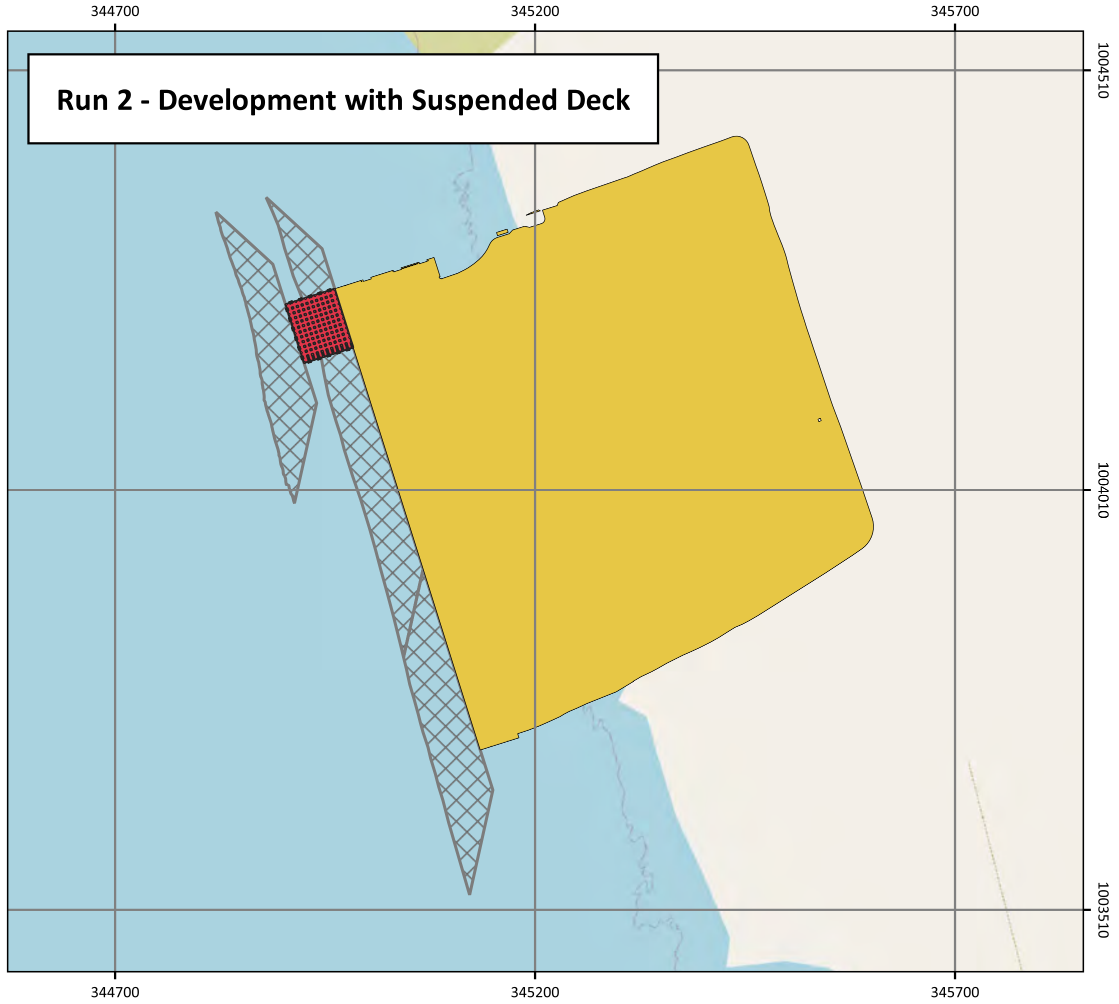
Drawing No: P2570-LOC-002	B

Legend

🟨 Industrial Development Area
🟥 Preliminary Quay (Suspended Deck)
▨ Dredging Area

N


Run 1 - Baseline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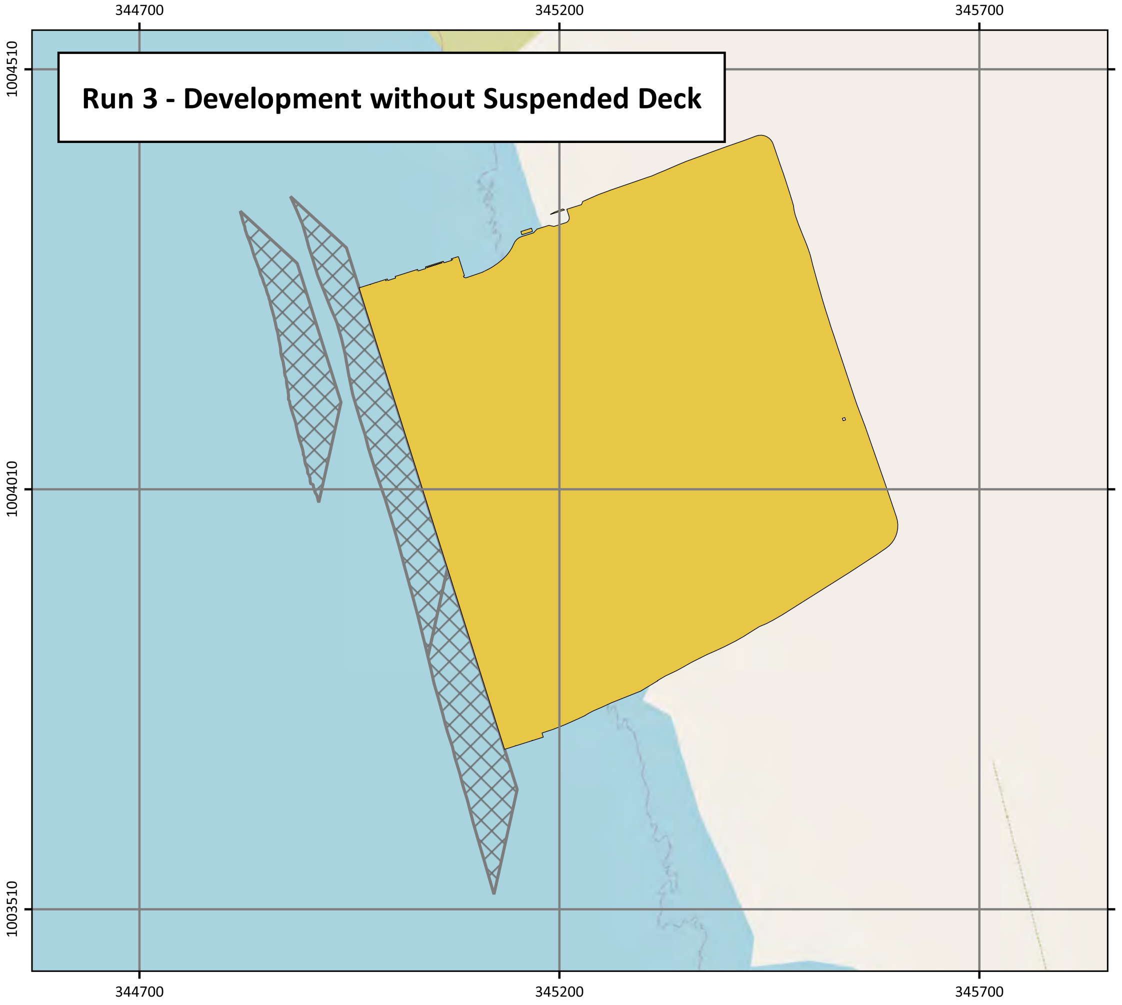
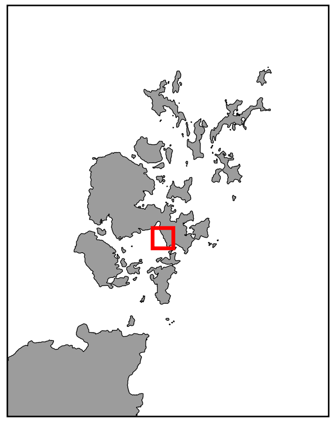

Run 3 - Development without Suspended Deck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Created By	Lewis Castle
Reviewed By	Emma Langley
Approved By	Emma Langley

0 100 200 300 400 m

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2. DATA

2.1 Coordinate System

The following horizontal and vertical coordinate system has been adopted throughout the desktop study:

- ***Horizontal Datum***: British National Grid (OSGB36/EPSG:27700).
- ***Vertical Datum***: Water depth is given as metres below Mean Sea Level (MSL) and as a negative value.

All data provided for SDWQ and the SW model development were converted to MSL at St Mary's using tidal levels given in Admiralty Tide Tables (UKHO, 2016) (Table 2-1).

Table 2-1 Tidal levels and datums for St Mary's

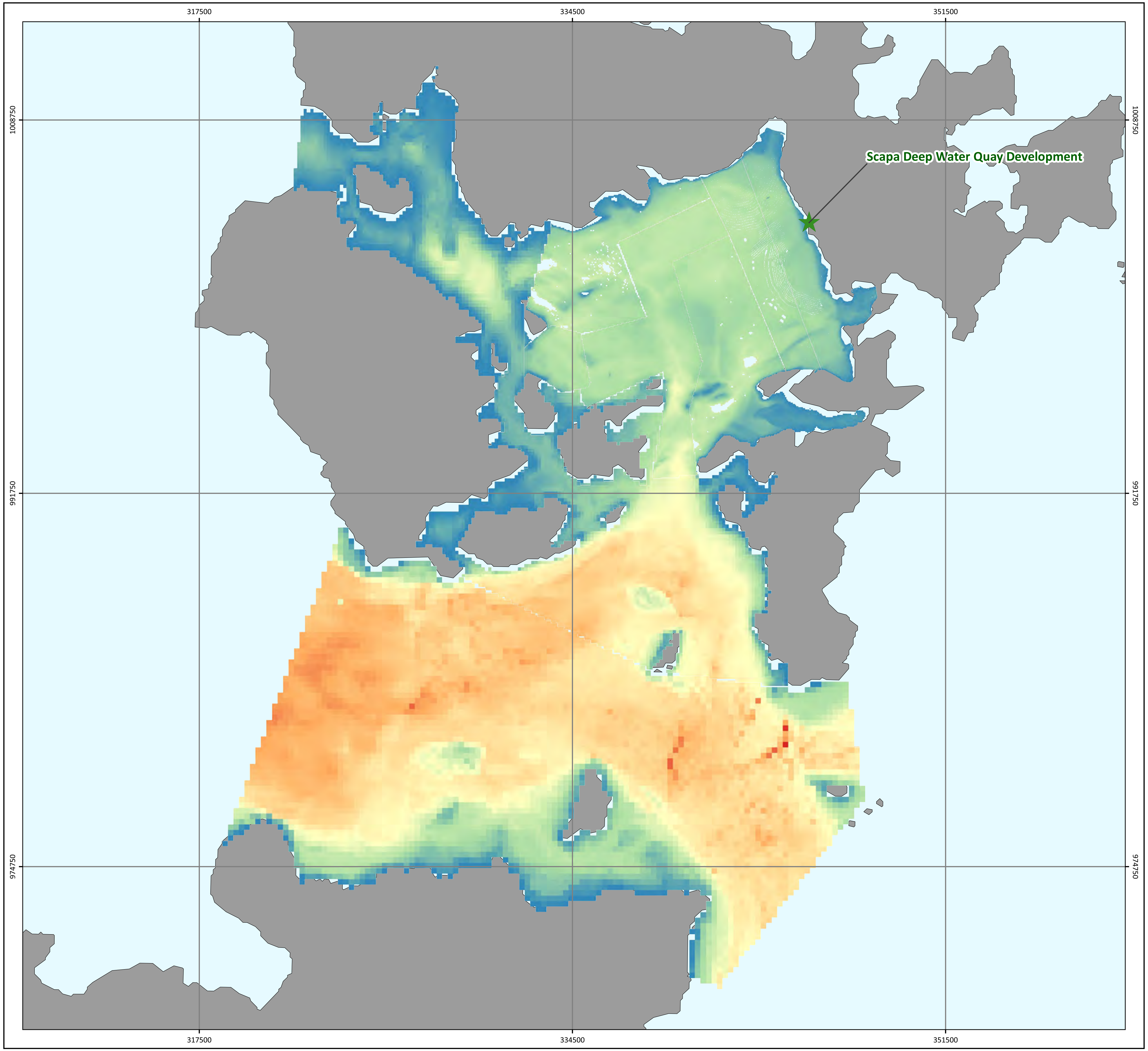
Name	Abbrev.	mMSL St Mary's
Highest Astronomical Tide	HAT	1.87
Mean High Water Springs	MHWS	1.37
Mean High Water Neaps	MHWN	0.67
Mean Sea Level	MSL	0
Ordnance Datum Newlyn	ODN	-0.28
Mean Low Water Neaps	MLWN	-0.53
Mean Low Water Springs	MLWS	-1.33
Chart Datum	CD	-1.93
Lowest Astronomical Tide	LAT	-1.83

2.2 Bathymetry

Bathymetric data are required for the SW model. These data are used to create a representation of the topography of the sea floor. The data have been taken from a number of publicly available sources as detailed below. The primary datasets used to define the SW model bathymetry were the UK Hydrographic Office (UKHO) bathymetry data set covering Scapa Flow and the wider Orkney Islands, and bathymetry data provided by OIC local to the SDWQ development site. Together these datasets provide a high level of detail at a consistent scale across the majority of the study area. This information was also supplemented by EMODnet bathymetry to enable 100% coverage of the SW model domain (EMODnet Bathymetry Consortium, 2018). The land boundary of the model was taken from the Ordnance Survey (OS) Mean High Water Springs (MHWS) polyline. The coverage and resolution of the available data is considered suitable for the purpose of building the Scapa SW model.

For the post-installation scenario, the SW model bathymetry was modified to include areas of proposed dredging as provided by OIC (see Figure 1-2).

All datasets were reduced to a common vertical datum of MSL, using data published by the UKHO (see Table 2-1). The coverage of the bathymetric data used for the SW model construction is shown in Figure 2-1 (Drawing number: P2570-BATH-001-A), together with the extents of the SW model domain.



SIGNIFICANT WAVE HEIGHT DESK TOP STUDY - SCAPA DEEP WATER QUAY

BATHYMETRY

Model Bathymetry

Drawing No: P2570-BATH-001	A

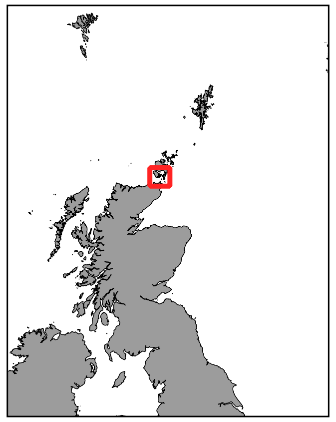
Legend

N

★ Scapa Deep Water Quay Development

Bathymetry (LAT)

🟦 0 m
🟩
🟨
🟧
🟥 -120 m



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Created By	Lewis Castle
Reviewed By	Emma Langley
Approved By	Liz Comer

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0 2 4 6 8 km

2.3 Wind

Wind data were required for the study since extreme wave conditions at the SDWQ development site will be generated by wind fields blowing locally within Scapa Flow itself (rather than by waves propagating in from the North Atlantic or North Sea). As such, the SW model required estimates of extreme wind speeds that would be used to drive wave growth and propagation.

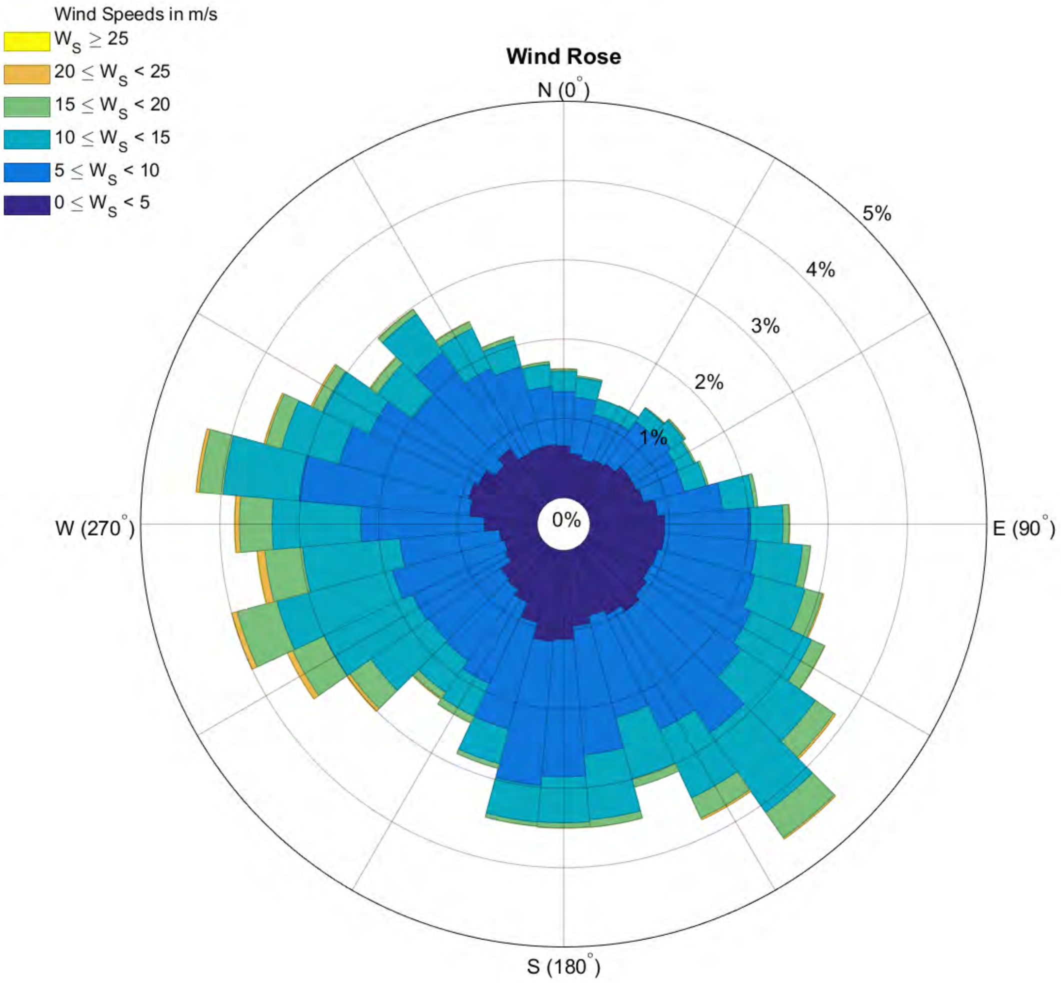
OIC provided 9.75 years of wind speed data (measured approximately 10 m above ground level), in 15-minute averages, for the Barrel of Butter, which is located in the western part of Scapa Flow and is well-suited for defining wind conditions both across Scapa Flow and at the development site. These data were cleaned, removing outliers/spikes from the timeseries. The raw data set as provided was of poor quality with numerous high-speed spikes and associated anomalies. These were removed initially using automated procedures, with the remaining peak wind speeds checked by careful comparison with meteorological records for the days in question, in particular through use of wind and pressure readings recorded at the UK Met Office station at Kirkwall airport and OIC wind speed data at Scapa Pier.

Figure 2-2 shows a wind rose of the cleaned 9.75-year dataset at the Barrel of Butter. The data show a dominance in winds from a west-south-westerly direction with measured wind speeds up to 32.3 m/s. The wind rose indicates an asymmetrical pattern with a secondary lobe from a south-easterly direction.

Table C-1 and Table C-2 in **Error! Reference source not found.** show the percentage frequency of occurrence of wind speed by directional sector, for the all year and March to September periods respectively. These are derived from the cleaned and QC'd Barrel of Butter wind data set. OIC and its contractors have expressed a specific interest in knowing the frequency of occurrence of south-westerly winds exceeding 30 knots (c. 15 m/s) for the period March to September. From Table C-2, and taking south-westerly winds to cover the directional range 195-255°N, the frequency of occurrence is calculated as 1.03% of the period March to September. Since this period represents 214 days of the year, it follows that 30-knot (or greater) south-westerly winds occur for approximately 2.2 days of this period in an average year at Barrel of Butter. Note that these 2.2 days may be split across multiple events.

Table C-3 and Table C-4 show, for all year and March to September respectively, the percentage exceedance of Barrel of Butter wind speeds in 1 m/s bands. Exceedance statistics are given separately for each 15° directional sector and for all directions combined.

Figure 2-2 Barrel of Butter wind rose



3. MODELLING APPROACH

3.1 Modelling Software

The modelling was conducted using the Danish Hydraulic Institute's (DHI) MIKE 21 suite of software. MIKE 21 is an industry standard software suite routinely used around the world for conducting studies in marine, estuarine and fluvial environments. Specifically, the MIKE 21 Spectral Wave (SW) model was used in this study.

MIKE 21 SW can simulate the growth, decay and transformation of wind-generated waves in coastal and offshore areas. Therefore, to assess the potential wave climate at the SDWQ development site, extreme wind conditions were applied uniformly over the model domain for pertinent wind directions and return periods (see Section 4).

The SW model accounts for the following physical processes:

- refraction;
- shoaling;
- bottom dissipation;
- wave breaking;
- wind-wave generation;
- directional spreading;
- frequency spreading;
- wave-current interaction;
- simplified reflection and transmission coefficients at structures.

The SW model is suitable for defining wave conditions across a wide area such as Scapa Flow, including in the shallower coastal waters as waves approach and enter the SDWQ development site. However, the model is not capable of accounting for some wave processes relating to detailed interaction with objects or structures – processes such as wave diffraction, reflection (using a more detailed approach than the simplified approach adopted by the SW model), and run-up. These processes may be important for assessing wave conditions at a high spatial resolution within the area of the SDWQ development. If this level of detail is required, it could be achieved through a follow-on study employing the Boussinesq Wave Model, which would couple with the SW model and allow all desired processes to be simulated.

3.2 Modelling Inputs and Assumptions

A linear interpolation technique was adopted to generate the Scapa SW model bathymetry. Figure 3-1 shows the interpolated bathymetry over the entire model domain whilst Figure 3-2 provides details of the model bathymetry in the vicinity of the study area.

The SW module includes two different formulations for simulating wave growth, propagation and transformation. It is noted that the area of interest is fetch-limited (<50 km fetch in the longest directions) and so wind-wave growth is the primary driver. For this reason, the fully spectral, quasi-stationary formulation was deemed appropriate. The wind speeds were applied as constants in domain and time, and the uncoupled wind generation formulation was used.

In the absence of measured wave data within the model domain, the model was run mostly with default values as input parameters. However, some of these defaults were modified to use parameter values that Intertek has previously derived for calibrated SW models in similar (enclosed) offshore environments. The parameters of relevance were the bottom friction parameter (set to kn=0.02 m) and the white capping dissipation coefficients (set to cdis=4.5 and delta=0.5).

Figure 3-1 Bathymetry in SW model domain – whole domain

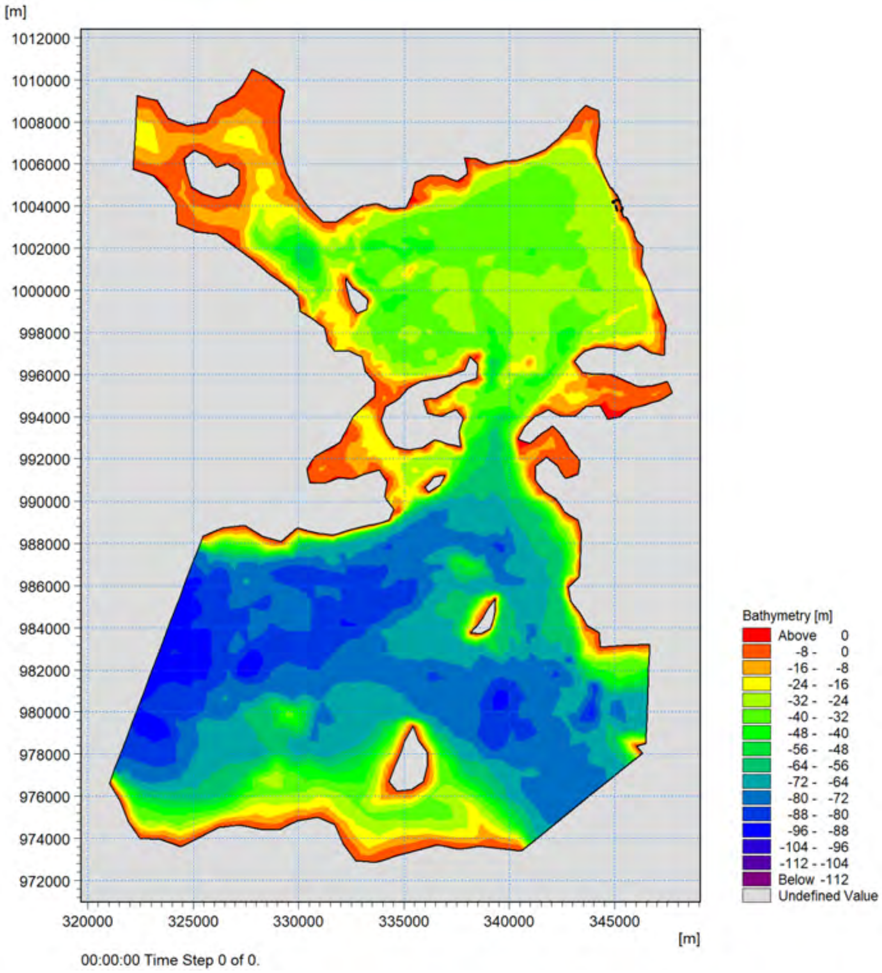
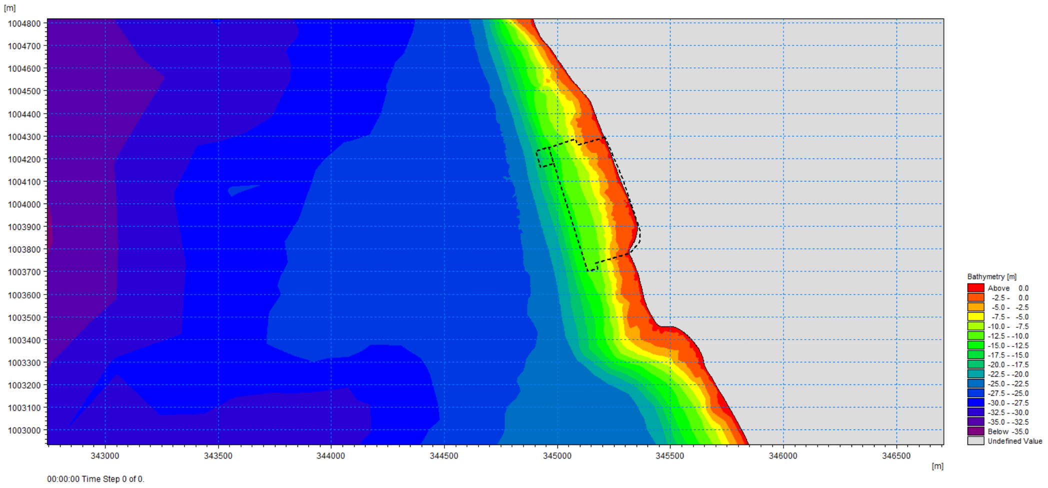


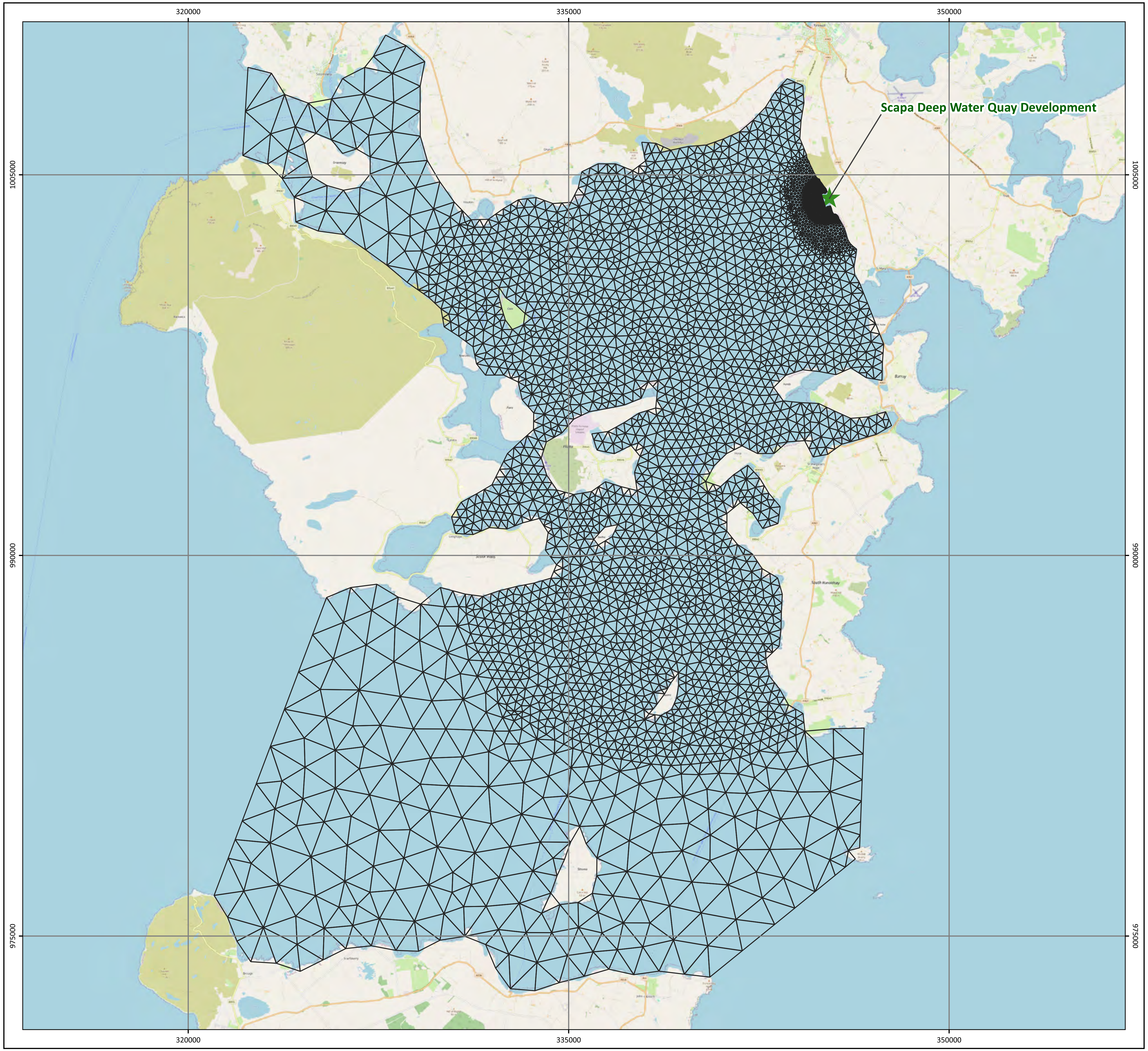
Figure 3-2 Bathymetry in SW model domain – area of interest



3.3 Model Configuration

MIKE 21 SW utilises an unstructured mesh of irregular triangular elements, allowing the model resolution to vary throughout the domain. This approach provides the greatest flexibility for addressing environmental conditions throughout the study area. The mesh resolution was optimised during the model development process so as to provide sufficient resolution in the area of the proposed SDWQ development while avoiding onerous computational run times.

The final model resolution is considered appropriate and robust for undertaking the required study. The resolution near the offshore boundaries is coarser than the area of interest since high resolution is not required here and this approach reduces model run times and potential instabilities. The final Scapa SW model contains approximately 18,000 elements. The spatial resolution within and around the proposed development site is approximately 10 m. Figure 3-3 (Drawing number: P2570-LOC-007-A) shows the model mesh over the entire domain. Figure 3-4 (Drawing number: P2570-LOC-008-A) shows the model mesh near to the study area for both the pre- and post-development scenarios.



SIGNIFICANT WAVE HEIGHT DESK TOP STUDY - SCAPA DEEP WATER QUAY

LOCATION OVERVIEW

Model Mesh

Drawing No: P2570-LOC-007	A

Legend

★ Scapa Deep Water Quay Development

☐ Model Mesh

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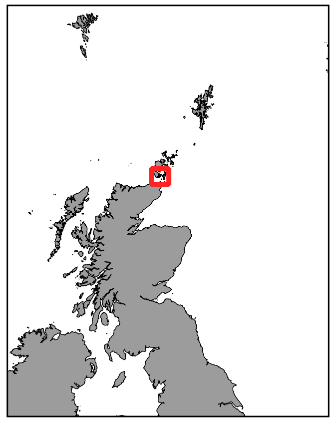

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Created By	Lewis Castle
Reviewed By	Emma Kilbane
Approved By	Emma Langley

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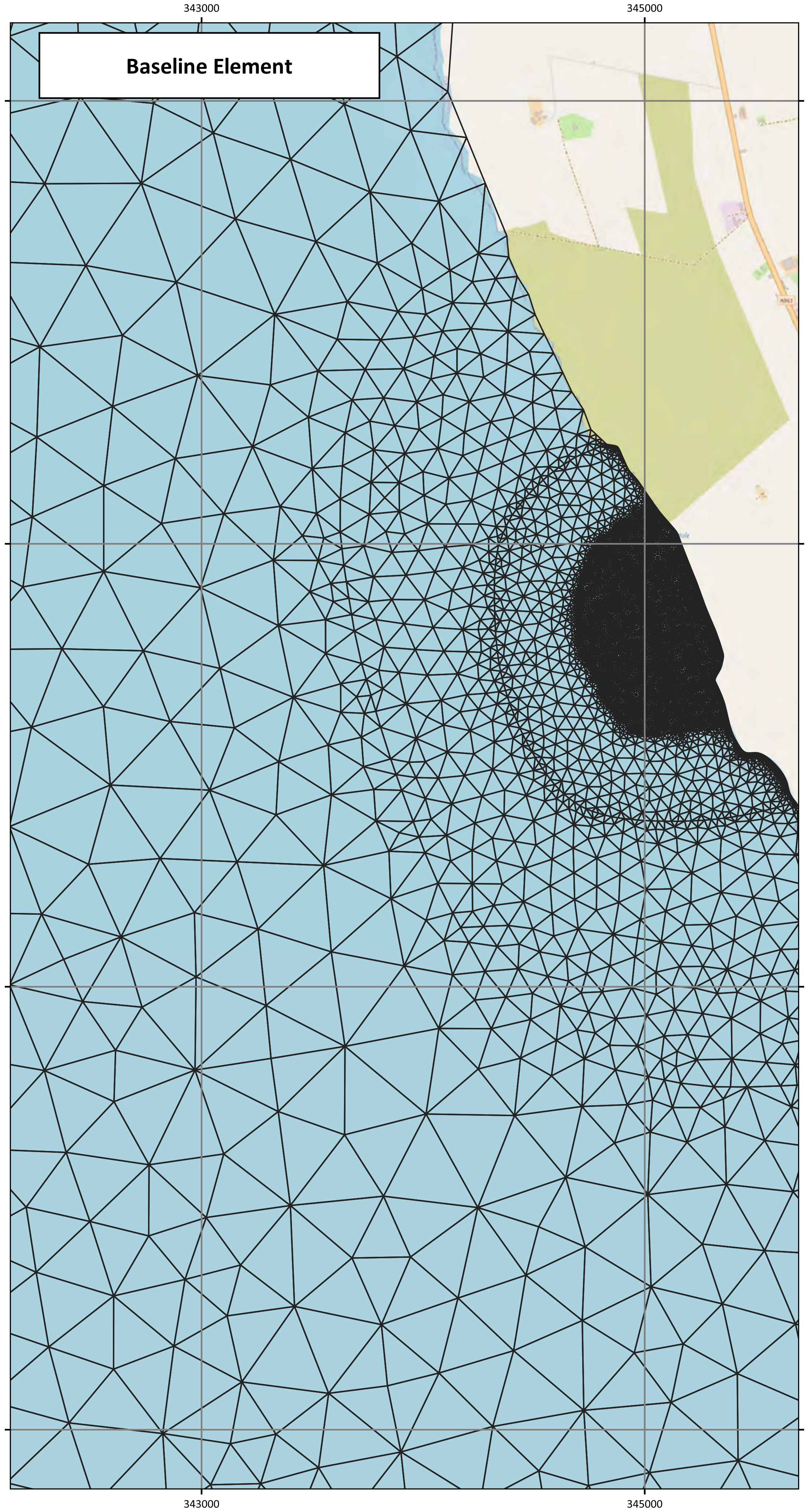

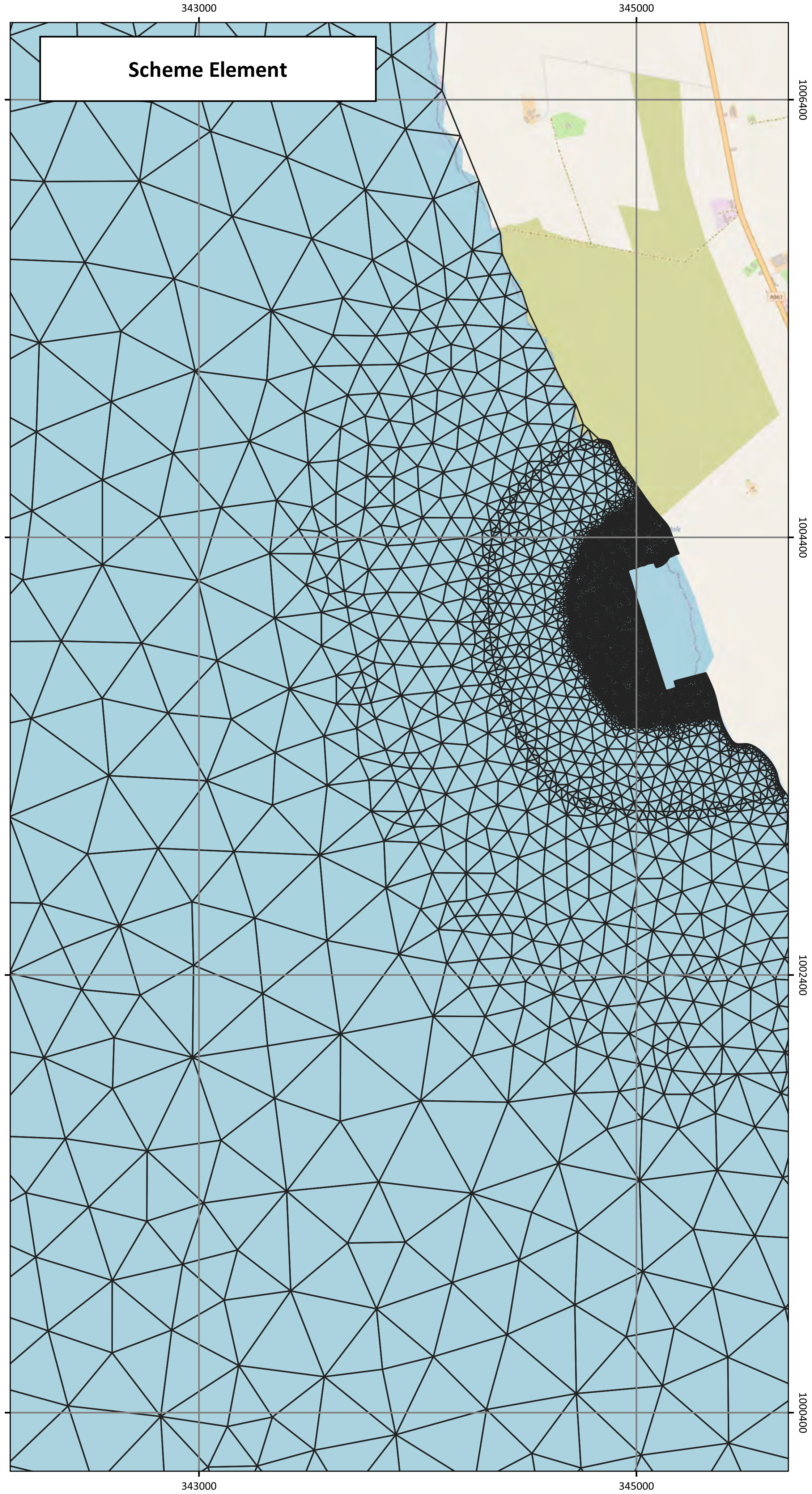

SIGNIFICANT WAVE HEIGHT DESK TOP STUDY - SCAPA DEEP WATER QUAY

LOCATION OVERVIEW

Model Mesh at Development

Drawing No: P2570-LOC-008	A

Legend

▭ Model Mesh

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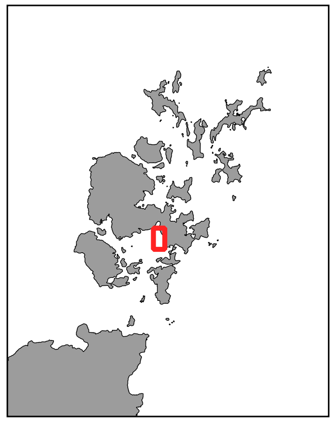

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Created By	Lewis Castle
Reviewed By	Emma Kilbane
Approved By	Emma Langley

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0 0.2 0.4 0.6 0.8 km

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3.4 Model Validation

No suitable measured wave data have been identified within Scapa Flow with which to validate the SW model outputs.

The SW model has been run using calibration parameters previously derived by Intertek for wave models in similar environments (see Section 3.2), but this does not inherently mean that these parameters are suitable for Scapa Flow. Therefore, additional validation of the model outputs was undertaken using standard oceanographic techniques.

Specifically, Intertek estimated extreme waves using wave growth formulas derived from past empirical studies. A number of different approaches and formulations were considered, including the Joint North Sea Wave Project (JONSWAP) method, Sverdrup-Munk-Bretschneider (SMB) wave growth algorithms, and US Coastal Engineering Manual estimates for shallow water waves. These approaches all consider wave growth as a function of:

- wind speed (see Sections 3.5 and 4)
- available fetch (calculated from OS coastline data);
- limiting water depth (taken from the bathymetry data and SW model bathymetry).

In the past, Intertek has found that the JONSWAP approach may underestimate extreme waves but the SMB approach and US Coastal Engineering Manual shallow water estimates are dependable. As such, more weight has been placed on the predictions of these last two techniques.

The model validation results are somewhat complex to interpret and are therefore not presented in this report, although we would be happy to expand on this issue if required. In brief, however, the validation exercise has demonstrated that the SW model predictions are within the range of wave heights that would be expected based on empirically-derived growth formulations. If anything, the model predictions have a slight tendency to err on the conservative side (the predicted Hs is slightly higher than the growth formulations calculate). This gives confidence that the model results are appropriate for use in planning and feasibility studies for the proposed SDWQ development.

3.5 Model Scenarios

The following scenarios have been modelled for both the baseline and development schemes:

- Wind conditions: 1-in-1, 1-in-10 and 1-in-50 year return period, 15 knots (7.7 m/s) and 30 knots (15.4 m/s).
- Wind directional sectors (direction from): south, southwest, west and northwest.

This equates to 60 run scenarios (3 scheme scenarios x 5 wind conditions x 4 wind directions). The modelling was limited to the four selected wind directions as waves from other wind directions would propagate away from the primary area of interest. The selected wind scenarios represent a range of extreme conditions, and the waves generated by these winds will be of use in planning and feasibility studies for the proposed SDWQ development.

All models are run assuming a water level of MHWS, as per the UKHO tidal levels for St. Mary's (see Table 2-1). This ensures the greatest wave heights at the development site since they will be least affected by interaction with the seabed (and resultant energy losses).

4. EXTREME VALUE ANALYSIS

4.1 Approach

Wind data are required in the SW model in order to provide the energy to generate, grow and propagate waves. Without forcing winds, modelled wave heights would steadily decrease through energy losses resulting in an under-prediction of wave heights in the area of interest.

Two of the required wind scenarios (15 knot and 30 knot speeds) were pre-defined by OIC. The other three scenarios required winds speeds with return periods of 1, 10 and 50 years to be derived. This was achieved through Extreme Value Analysis (EVA).

A cumulative frequency analysis was conducted on the directional wind data based on the occurrence of wind speed (ws) in bins of 0.2 m/s. A cumulative frequency table was produced, and percentage exceedance derived.

To derive wind speed for the 1-in-1, 1-in-10 and 1-in-50 year scenarios an EVA was conducted based on the cumulative frequency distribution. Intertek's in-house EVA software adopts a parametric frequency analysis approach by fitting a theoretical probability distribution to the dataset. A Weibull probability distribution (using the least squares method) was fitted to the data, with an R-squared value ranging from 0.98 to 0.99. This is a standard analytical technique that has been widely used for many decades to derive metocean criteria for the offshore industry.

See Appendix D for the summary directional EVA plots.

4.2 Output

Based on the approach described, Table 4-1 shows the results of the EVA for the 9¾-year Barrel of Butter data set. The highest return period wind speed is from a westerly direction. Each scenario was run within the Scapa SW model for both the baseline (pre-development) and post-installation scenarios. These speeds represent hourly-average wind speeds at a standard reference height of 10 m above surface.

Table 4-1 Extreme wind speeds (m/s) – hourly average at 10 m height

Directional sector	**Return Period (years)**		
	1-in-1	**1-in-10**	**1-in-50**
South	22.36	25.77	27.93
Southwest	23.96	27.47	29.64
West	26.57	30.05	32.23
Northwest	21.60	25.08	27.25

5. SPECTRAL WAVE MODEL PREDICTIONS

5.1 Significant Wave Height (Hs)

OIC provided output locations around the area of interest (see **Error! Reference source not found.** in Appendix A). For these output locations, the predicted Hs for each wind speed condition for the four directional sectors are presented in Table 5-1 to Table 5-4.

Table 5-1 Predicted Hs (m) for a southerly wind direction

Output Location	Baseline (Pre-development)					Scheme 1 (Post-development with suspended decking)					Scheme 2 (Post-development without suspended decking)				
	15 kts	30 kts	1:1	1:10	1:50	15 kts	30 kts	1:1	1:10	1:50	15 kts	30 kts	1:1	1:10	1:50
WV-01	0.31	0.80	1.34	1.53	1.70	0.33	0.84	1.34	1.62	1.81	0.33	0.84	1.34	1.62	1.81
WV-02	0.32	0.89	1.52	1.73	1.93	0.39	1.09	1.74	2.09	2.32	0.39	1.09	1.74	2.09	2.32
WV-03	0.32	0.91	1.58	1.81	2.02	0.34	0.96	1.58	1.92	2.14	0.34	0.96	1.58	1.92	2.14
WV-04	0.32	0.92	1.58	1.81	2.02	0.44	1.19	1.93	2.34	2.61	0.43	1.19	1.93	2.34	2.61
WV-05	0.33	0.92	1.59	1.82	2.03	0.42	1.15	1.86	2.26	2.52	0.42	1.15	1.86	2.26	2.52
WV-06	0.33	0.93	1.60	1.83	2.05	0.47	1.28	2.08	2.53	2.82	0.47	1.28	2.08	2.53	2.82
WV-07	0.33	0.93	1.61	1.84	2.06	0.42	1.13	1.83	2.22	2.48	0.42	1.13	1.83	2.22	2.48
WV-08	0.33	0.94	1.62	1.85	2.06	0.46	1.25	2.03	2.46	2.74	0.46	1.25	2.03	2.46	2.74
WV-09	0.33	0.94	1.62	1.86	2.07	0.46	1.26	2.04	2.48	2.76	0.46	1.26	2.04	2.48	2.76
WV-10	0.34	0.94	1.63	1.87	2.08	0.47	1.28	2.08	2.53	2.83	0.47	1.28	2.09	2.54	2.83
WV-11	0.34	0.96	1.67	1.92	2.14	0.45	1.22	1.97	2.39	2.67	0.45	1.22	1.98	2.40	2.68
WV-12	0.34	0.96	1.66	1.91	2.13	0.45	1.24	2.02	2.46	2.75	0.46	1.26	2.05	2.48	2.77
WV-13	0.34	0.95	1.64	1.88	2.09	0.32	0.98	1.68	2.08	2.34	0.44	1.18	1.91	2.32	2.58
WV-14	0.34	0.96	1.67	1.92	2.14	0.39	1.10	1.82	2.24	2.51	0.44	1.18	1.93	2.34	2.61
WV-15	0.34	0.97	1.68	1.94	2.17	0.39	1.09	1.80	2.20	2.46	0.42	1.15	1.87	2.27	2.53
WV-16	0.34	0.95	1.64	1.88	2.09	0.30	0.90	1.54	1.91	2.15	0.39	1.08	1.75	2.13	2.37
WV-17	0.34	0.93	1.59	1.82	2.02	0.13	0.36	0.61	0.75	0.85	0.16	0.42	0.67	0.82	0.92
WV-18	0.33	0.88	1.47	1.68	1.87	0.08	0.21	0.35	0.43	0.49	0.09	0.22	0.36	0.44	0.50

For winds from a southerly direction, the WV-15 observation point is predicted to experience the largest wave conditions with a maximum Hs of 2.17 m for a 1-in-50 year return period wind, for the pre-development scenario (Table 5-1). Post-development, WV-10 is predicted to experience the largest wave conditions with a maximum Hs of 2.83 m for a 1-in-50 year return period wind. WV-01, WV-02 and WV-18 are predicted to experience the lowest waves pre-development and WV-01, WV-17 and WV-18 post-development. The observation point (WV-01) located to the south of the development is predicted to experience only a small increase in Hs post-development, with points to the north of the development (WV-17 and WV-18) decreasing in Hs under southerly wind conditions.

Table 5-2 Predicted Hs (m) for a south-westerly wind direction

Output Location	**Baseline (Pre-development)**					**Scheme 1 (Post-development with suspended decking)**					**Scheme 2 (Post-development without suspended decking)**				
	15 kts	**30 kts**	**1:1**	**1:10**	**1:50**	**15 kts**	**30 kts**	**1:1**	**1:10**	**1:50**	**15 kts**	**30 kts**	**1:1**	**1:10**	**1:50**
WV-01	0.36	0.91	1.61	1.96	2.18	0.37	0.90	1.58	1.96	2.19	0.37	0.90	1.58	1.96	2.19
WV-02	0.37	0.99	1.75	2.12	2.36	0.45	1.14	1.95	2.37	2.64	0.45	1.14	1.95	2.37	2.64
WV-03	0.37	1.00	1.79	2.17	2.42	0.40	1.05	1.85	2.28	2.54	0.40	1.05	1.85	2.28	2.54
WV-04	0.37	1.01	1.80	2.17	2.42	0.50	1.34	2.36	2.90	3.24	0.50	1.34	2.36	2.90	3.24
WV-05	0.38	1.01	1.81	2.18	2.43	0.49	1.30	2.28	2.81	3.13	0.49	1.30	2.28	2.80	3.13
WV-06	0.38	1.02	1.82	2.19	2.44	0.54	1.41	2.49	3.06	3.41	0.54	1.41	2.49	3.06	3.41
WV-07	0.38	1.02	1.83	2.21	2.46	0.48	1.30	2.29	2.81	3.13	0.48	1.30	2.28	2.81	3.13
WV-08	0.38	1.03	1.83	2.21	2.46	0.53	1.38	2.43	2.98	3.31	0.53	1.38	2.43	2.98	3.31
WV-09	0.38	1.03	1.84	2.22	2.47	0.53	1.39	2.43	2.99	3.32	0.53	1.39	2.44	2.99	3.33
WV-10	0.38	1.03	1.85	2.23	2.48	0.54	1.40	2.47	3.04	3.39	0.54	1.41	2.49	3.06	3.41
WV-11	0.38	1.04	1.88	2.28	2.55	0.51	1.33	2.34	2.87	3.20	0.52	1.34	2.35	2.88	3.21
WV-12	0.38	1.04	1.88	2.27	2.54	0.52	1.33	2.35	2.89	3.22	0.53	1.36	2.39	2.93	3.26
WV-13	0.38	1.04	1.86	2.24	2.49	0.37	1.08	2.02	2.53	2.85	0.50	1.31	2.29	2.80	3.12
WV-14	0.39	1.05	1.89	2.28	2.55	0.44	1.18	2.12	2.63	2.93	0.50	1.27	2.23	2.73	3.04
WV-15	0.39	1.05	1.90	2.30	2.57	0.44	1.16	2.07	2.55	2.84	0.48	1.22	2.13	2.61	2.90
WV-16	0.39	1.04	1.86	2.24	2.49	0.35	1.03	1.89	2.35	2.63	0.45	1.16	2.04	2.50	2.78
WV-17	0.38	1.03	1.81	2.17	2.42	0.16	0.61	1.13	1.41	1.59	0.19	0.65	1.17	1.45	1.62
WV-18	0.38	0.97	1.70	2.05	2.29	0.12	0.48	0.88	1.10	1.23	0.12	0.48	0.88	1.09	1.23

For winds from a south-westerly direction, the observation points located to the west of the area of interest (WV-04 to WV-15) are predicted to experience the highest Hs for the post-development scenarios, with a maximum Hs of c.3.4 m (WV-06 and WV-10) for a 1-in-50 year return period wind (Table 5-2). This is an increase of up to c.1 m on the pre-development scenario. At observation points WV-17 and WV-18 the model indicates a decrease in Hs of approximately 1.0 m post-development for the 1-in-50 year wind.

Table 5-3 Predicted Hs (m) for a westerly wind direction

Output Location	Baseline (Pre-development)					Scheme 1 (Post-development with suspended decking)					Scheme 2 (Post-development without suspended decking)				
	15 kts	30 kts	1:1	1:10	1:50	15 kts	30 kts	1:1	1:10	1:50	15 kts	30 kts	1:1	1:10	1:50
WV-01	0.31	0.84	1.80	2.16	2.39	0.25	0.66	1.44	1.74	1.94	0.25	0.66	1.44	1.74	1.94
WV-02	0.31	0.89	1.89	2.25	2.51	0.30	0.82	1.73	2.07	2.30	0.30	0.82	1.72	2.06	2.30
WV-03	0.31	0.89	1.91	2.29	2.54	0.32	0.92	1.99	2.38	2.65	0.32	0.92	1.99	2.38	2.65
WV-04	0.31	0.89	1.91	2.28	2.54	0.42	1.18	2.53	3.04	3.38	0.42	1.18	2.53	3.04	3.38
WV-05	0.31	0.89	1.91	2.29	2.54	0.41	1.17	2.51	3.01	3.34	0.41	1.17	2.51	3.00	3.34
WV-06	0.31	0.89	1.91	2.29	2.55	0.41	1.17	2.52	3.02	3.37	0.41	1.17	2.52	3.02	3.37
WV-07	0.30	0.89	1.91	2.29	2.55	0.42	1.21	2.57	3.07	3.41	0.42	1.21	2.57	3.07	3.41
WV-08	0.30	0.89	1.91	2.28	2.54	0.41	1.17	2.51	3.01	3.35	0.41	1.17	2.51	3.01	3.36
WV-09	0.30	0.89	1.91	2.28	2.54	0.41	1.16	2.50	3.01	3.35	0.41	1.18	2.52	3.03	3.38
WV-10	0.30	0.89	1.91	2.28	2.55	0.40	1.14	2.48	2.98	3.32	0.42	1.20	2.56	3.06	3.41
WV-11	0.30	0.89	1.93	2.32	2.59	0.39	1.10	2.39	2.87	3.20	0.40	1.12	2.41	2.89	3.22
WV-12	0.30	0.89	1.93	2.31	2.58	0.36	1.03	2.26	2.72	3.04	0.38	1.09	2.33	2.79	3.11
WV-13	0.30	0.89	1.91	2.29	2.55	0.27	0.89	2.12	2.60	2.93	0.40	1.14	2.44	2.92	3.25
WV-14	0.30	0.89	1.93	2.31	2.58	0.31	0.93	2.08	2.52	2.82	0.35	1.00	2.16	2.60	2.90
WV-15	0.30	0.89	1.93	2.32	2.59	0.31	0.91	2.00	2.42	2.71	0.33	0.93	2.04	2.45	2.74
WV-16	0.30	0.88	1.90	2.28	2.54	0.30	0.91	2.00	2.41	2.70	0.32	0.95	2.05	2.46	2.75
WV-17	0.30	0.88	1.87	2.23	2.48	0.27	0.86	1.83	2.19	2.43	0.28	0.87	1.85	2.20	2.45
WV-18	0.30	0.85	1.79	2.14	2.39	0.24	0.74	1.54	1.83	2.03	0.24	0.74	1.54	1.83	2.03

Wind from a westerly direction produces fairly consistent Hs at all assessment locations for the pre-development scenario, as shown in Table 5-3. Post-development, the highest predicted Hs is at output locations west of the development (WV-04 to WV-13). The 1-in-50 year return period wind produces the maximum Hs of approximately 2.6 m in the pre-development scenario and 3.4 m in the post-development scenarios. The observation points located to the south (WV-01 and WV-02) and north (WV-17 and WV-18) of the development are predicted to have a decrease in Hs post-development for westerly winds.

Table 5-4 Predicted Hs (m) for a north-westerly wind direction

Output Location	Baseline (Pre-development)					Scheme 1 (Post-development with suspended decking)					Scheme 2 (Post-development without suspended decking)				
	15 kts	30 kts	1:1	1:10	1:50	15 kts	30 kts	1:1	1:10	1:50	15 kts	30 kts	1:1	1:10	1:50
WV-01	0.10	0.64	1.04	1.29	1.45	0.11	0.35	0.51	0.64	0.73	0.11	0.35	0.51	0.64	0.73
WV-02	0.10	0.67	1.12	1.39	1.57	0.12	0.48	0.74	0.91	1.03	0.12	0.48	0.74	0.91	1.03
WV-03	0.10	0.67	1.14	1.42	1.60	0.11	0.70	1.18	1.48	1.68	0.11	0.70	1.19	1.48	1.68
WV-04	0.10	0.67	1.13	1.41	1.59	0.16	0.84	1.40	1.74	1.97	0.16	0.84	1.40	1.74	1.97
WV-05	0.10	0.66	1.13	1.40	1.58	0.14	0.87	1.45	1.81	2.05	0.14	0.87	1.45	1.81	2.05
WV-06	0.10	0.66	1.12	1.39	1.58	0.15	0.82	1.36	1.70	1.93	0.15	0.82	1.37	1.71	1.93
WV-07	0.10	0.65	1.11	1.38	1.57	0.14	0.88	1.47	1.83	2.07	0.14	0.88	1.48	1.84	2.09
WV-08	0.10	0.65	1.11	1.37	1.56	0.15	0.82	1.38	1.72	1.96	0.15	0.84	1.41	1.75	1.99
WV-09	0.10	0.64	1.10	1.36	1.55	0.15	0.80	1.34	1.68	1.91	0.15	0.84	1.41	1.75	1.98
WV-10	0.10	0.64	1.09	1.36	1.54	0.15	0.74	1.23	1.55	1.77	0.15	0.83	1.38	1.71	1.94
WV-11	0.10	0.64	1.11	1.38	1.57	0.15	0.75	1.26	1.57	1.79	0.15	0.78	1.29	1.61	1.82
WV-12	0.10	0.64	1.10	1.37	1.55	0.14	0.69	1.19	1.49	1.70	0.14	0.75	1.26	1.57	1.78
WV-13	0.10	0.63	1.08	1.35	1.53	0.09	0.59	1.07	1.38	1.60	0.14	0.81	1.37	1.70	1.93
WV-14	0.10	0.63	1.09	1.36	1.54	0.11	0.65	1.13	1.41	1.61	0.14	0.69	1.17	1.46	1.66
WV-15	0.09	0.63	1.09	1.36	1.54	0.11	0.64	1.12	1.39	1.59	0.12	0.65	1.13	1.41	1.60
WV-16	0.10	0.63	1.08	1.34	1.52	0.10	0.66	1.15	1.44	1.63	0.12	0.68	1.18	1.46	1.66
WV-17	0.10	0.62	1.06	1.31	1.48	0.05	0.70	1.24	1.53	1.73	0.07	0.71	1.24	1.54	1.74
WV-18	0.10	0.60	1.00	1.23	1.40	0.03	0.62	1.07	1.31	1.48	0.03	0.62	1.07	1.31	1.48

For winds from a north-westerly direction, the predicted Hs is fairly consistent at all assessment locations for the pre-development scenario (Table 5-2). Post-development, observation points to the west of the area of interest (WV-04 to WV-13) are predicted to experience the highest wave conditions with a maximum Hs of c.2.1 m (WV-07) for a 1-in-50 year return period wind condition. Observation points WV01 and WV-02 are predicted to decrease in Hs post-development.

Comparison of all wind directions modelled, in Table 5-1 to Table 5-4, indicates that winds from a south-westerly and westerly direction will generate the highest wave conditions, with the lowest from the north-westerly direction. There are predicted increases in Hs of up to c.1.0 m in the west of the area of interest post-development (1-in-50 year wind condition). Hs is also predicted to decrease by 1 m or more (for the 1-in-50 year wind) for locations in the lee of the solid quay structure under given wind conditions.

Error! Reference source not found. to **Error! Reference source not found.** show contours of the predicted significant wave climate across the study site for each of the modelled baseline (**Error! Reference source not found.** to **Error! Reference source not found.**), development 1 (**Error! Reference source not found.** to **Error! Reference source not found.**) and development 2 (**Error! Reference source not found.** to **Error! Reference source not found.**) scenarios.

5.2 Peak Wave Period (Tp)

Error! Reference source not found. to **Error! Reference source not found.** in Appendix **Error! Reference source not found.** show the peak wave periods predicted by the wave modelling. Notably, all peak wave periods are less than 6.0 seconds and waves from a southerly and south-westerly direction give the highest peak wave periods.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Study Summary and Conclusions

The potential wave conditions at Bay of Deepdale before and after the proposed SDWQ development have been predicted for a number of scenarios using a spectral wave model. The model results show that the predicted maximum Hs for the pre- and post-development scenarios is c.2.6 m and c.3.4 m respectively, for the 1-in-50 year wind condition from south-westerly and westerly directions. The maximum Tp is predicted for the same scenarios. This is to be expected as these are the directions with the longest fetch and with a strong extreme wind speed, allowing the waves to build up to the area of interest. The results presented represent a fully developed sea for a constant wind direction, and therefore include a degree of conservatism (as wind speed and direction will vary temporally and spatially on a local scale).

The tables and plots of predicted Hs for the post-development scenarios show that there are areas around the solid quay that are subject to wave sheltering. However, larger wave heights are predicted for locations along the west of the quay. This section of the development is relatively more exposed and rarely subject to wave sheltering and waves can therefore approach unobstructed. It also experiences the deepest water, so waves are less likely to be limited by shoaling or breaking.

In the absence of suitable measured data the SW model predictions have been verified by comparison against estimates of wave height using several empirically-derived wave growth formulations. These comparisons confirm that the model is producing realistic predictions of wave conditions with perhaps a slight tendency towards conservatism.

6.2 Study Recommendations

The wave conditions presented in this report are considered suitable for purposes of planning and feasibility. We recommend, however, that they not be used for detailed engineering design without additional analysis and investigation. Two issues are of particular note:

1. The SW model has not been validated against measured data. It has been run using calibration parameters successfully derived for other areas, and it has been verified against wave height independently calculated from empirically-derived wave growth formulations. Both of these factors give some confidence that the model predictions are reliable, but additional analysis – and ideally, comparison against measured wave data – would increase robustness in the calculated extreme wave conditions.
2. The SW model includes many important wave processes but does not simulate all processes that would affect waves in close proximity to a development, such as diffraction, reflection (other than in a simplified fashion) and run-up. OIC has highlighted the requirement for a more in-depth assessment of wave behaviour around the development, in particular with regard to the representation of wave reflection in the vicinity of development. This is not possible within the MIKE 21 SW model as it does not include a complex treatment of wave reflection and subsequent wave-wave interaction. To fully evaluate these processes, if required, Intertek would recommend undertaking a Boussinesq wave model assessment to supplement the SW modelling.

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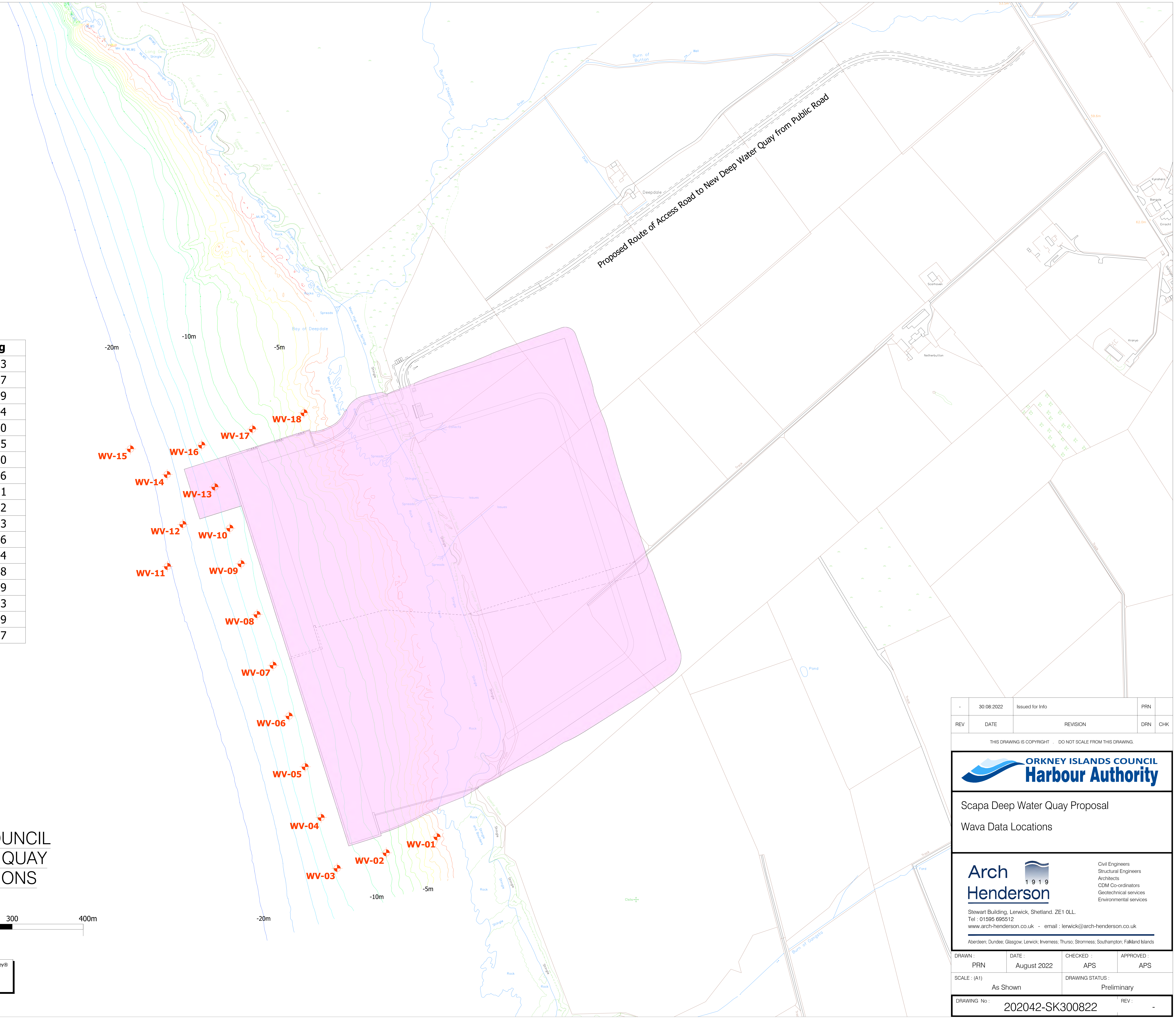
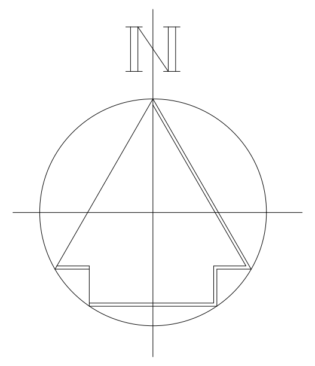
APPENDIX A

Output Locations

Chart Datum (Scapa Flow)	Ordnance Datum (Newlyn)	Quay Heights and Tide Data Scapa Deep Water Quay
+7.00m	+5.31m	Quay Edge Level
+3.60m	+1.91m	Mean High Water Spring Tides
+1.69m	0.00m	Ordnance Datum (Newlyn)
+0.70m	-0.99m	Mean Low Water Spring Tides
0.00m	-1.69m	Chart Datum (Scapa Flow)
-5.00m	-6.69m	
-10.00m	-11.69m	
-15.00m	-16.69m	
-20.00m	-21.69m	

Data Location	Easting	Northing
WV-01	345258.9	1003713.3
WV-02	345187.4	1003690.7
WV-03	345118.3	1003668.9
WV-04	345095.7	1003740.4
WV-05	345073.2	1003812.0
WV-06	345050.6	1003883.5
WV-07	345028.1	1003955.0
WV-08	345005.5	1004026.6
WV-09	344983.0	1004098.1
WV-10	344967.2	1004148.2
WV-11	344879.3	1004094.3
WV-12	344901.0	1004153.6
WV-13	344946.1	1004206.4
WV-14	344878.9	1004223.8
WV-15	344827.1	1004259.9
WV-16	344927.5	1004265.3
WV-17	344999.0	1004287.9
WV-18	345071.6	1004310.7





ORKNEY ISLANDS COUNCIL
SCAPA DEEP WATER QUAY
WAVE DATA LOCATIONS

Scale 1: 2500

25 0 25 50 75 100 200 300 400m

SCALE 1:2500 at A1

REV	DATE	REVISION	DRN	CHK
-	30:08:2022	Issued for Info	PRN	

ORKNEY ISLANDS COUNCIL
Harbour Authority

Scapa Deep Water Quay Proposal

Wava Data Locations

Arch Henderson 1919
Civil Engineers
Structural Engineers
Architects
CDM Co-ordinators
Geotechnical services
Environmental services
Stewart Building, Lerwick, Shetland. ZE1 0LL.
Tel : 01595 695512
www.arch-henderson.co.uk - email : lerwick@arch-henderson.co.uk
Aberdeen; Dundee; Glasgow; Lerwick; Inverness; Thurso; Stromness; Southampton; Falkland Islands

DRAWN :	DATE :	CHECKED :	APPROVED :
PRN	August 2022	APS	APS

SCALE : (A1) As Shown

DRAWING STATUS : Preliminary

DRAWING No : 202042-SK300822

REV : -

APPENDIX B

Percentage Frequency of Wind Occurrence and Exceedance

Table B-1 Percentage frequency of occurrence – Barrel of Butter wind dataset, all year

	Wind direction (°N, from)																							
Wind speed (m/s)	**0 - <15**	**15 - <30**	**30 - <45**	**45 - <60**	**60 - <75**	**75 - <90**	**90 - <105**	**105 - <120**	**120 - <135**	**135 - <150**	**150 - <165**	**165 - <180**	**180 - <195**	**195 - <210**	**210 - <225**	**225 - <240**	**240 - <255**	**255 - <270**	**270 - <285**	**285 - <300**	**300 - <315**	**315 - <330**	**330 - <345**	**345 - <360**	**Total**
0 - <1	0.05	0.05	0.06	0.05	0.06	0.05	0.06	0.05	0.07	0.07	0.06	0.05	0.06	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	1.26
1 - <2	0.16	0.16	0.17	0.17	0.19	0.21	0.22	0.22	0.22	0.21	0.20	0.20	0.19	0.18	0.17	0.15	0.14	0.14	0.16	0.16	0.16	0.14	0.12	0.16	4.18
2 - <3	0.21	0.17	0.19	0.24	0.25	0.30	0.30	0.30	0.32	0.33	0.30	0.33	0.33	0.29	0.24	0.20	0.13	0.17	0.23	0.25	0.24	0.22	0.21	0.20	5.96
3 - <4	0.21	0.19	0.23	0.27	0.30	0.36	0.41	0.38	0.37	0.43	0.36	0.45	0.52	0.37	0.29	0.23	0.14	0.19	0.32	0.40	0.30	0.30	0.26	0.27	7.55
4 - <5	0.25	0.21	0.23	0.28	0.25	0.39	0.42	0.37	0.39	0.47	0.38	0.46	0.63	0.43	0.29	0.26	0.21	0.25	0.45	0.49	0.39	0.45	0.36	0.33	8.63
5 - <6	0.27	0.24	0.24	0.26	0.23	0.36	0.41	0.40	0.45	0.54	0.37	0.47	0.61	0.48	0.33	0.30	0.28	0.32	0.56	0.58	0.41	0.48	0.36	0.27	9.24
6 - <7	0.25	0.22	0.24	0.23	0.19	0.31	0.38	0.44	0.49	0.60	0.40	0.51	0.66	0.44	0.35	0.34	0.36	0.38	0.68	0.57	0.45	0.46	0.37	0.24	9.54
7 - <8	0.21	0.15	0.19	0.18	0.15	0.29	0.35	0.42	0.47	0.58	0.44	0.53	0.57	0.40	0.35	0.36	0.40	0.38	0.68	0.47	0.44	0.45	0.33	0.19	9.00
8 - <9	0.18	0.13	0.15	0.14	0.13	0.25	0.33	0.33	0.41	0.53	0.43	0.51	0.49	0.34	0.35	0.37	0.49	0.41	0.60	0.45	0.39	0.38	0.28	0.19	8.26
9 - <10	0.16	0.10	0.12	0.12	0.11	0.15	0.25	0.32	0.40	0.47	0.41	0.46	0.39	0.28	0.30	0.41	0.55	0.45	0.53	0.39	0.33	0.35	0.25	0.17	7.46
10 - <11	0.13	0.10	0.10	0.08	0.09	0.15	0.23	0.30	0.42	0.44	0.36	0.37	0.26	0.20	0.21	0.39	0.54	0.45	0.49	0.34	0.28	0.33	0.23	0.15	6.64
11 - <12	0.09	0.08	0.09	0.11	0.10	0.13	0.19	0.26	0.37	0.39	0.29	0.28	0.18	0.15	0.18	0.36	0.49	0.40	0.35	0.26	0.22	0.22	0.15	0.10	5.42
12 - <13	0.08	0.06	0.06	0.08	0.10	0.13	0.15	0.21	0.33	0.35	0.24	0.22	0.13	0.13	0.14	0.29	0.44	0.35	0.30	0.20	0.17	0.17	0.10	0.07	4.47
13 - <14	0.06	0.05	0.04	0.04	0.07	0.09	0.14	0.14	0.26	0.33	0.18	0.17	0.10	0.12	0.11	0.24	0.36	0.32	0.21	0.15	0.12	0.11	0.07	0.05	3.49
14 - <15	0.03	0.02	0.03	0.02	0.04	0.09	0.10	0.11	0.24	0.27	0.13	0.10	0.07	0.09	0.08	0.23	0.30	0.26	0.17	0.12	0.10	0.07	0.05	0.03	2.75
15 - <16	0.02	0.00	0.01	0.01	0.02	0.04	0.05	0.08	0.16	0.18	0.09	0.05	0.04	0.05	0.06	0.18	0.24	0.21	0.15	0.09	0.07	0.04	0.03	0.02	1.90
16 - <17	0.01	0.00	0.00	0.01	0.01	0.02	0.03	0.09	0.09	0.14	0.06	0.04	0.02	0.02	0.04	0.14	0.19	0.17	0.13	0.08	0.04	0.03	0.02	0.01	1.41
17 - <18	0.01	0.00	0.00	0.00	0.01	0.00	0.03	0.07	0.07	0.11	0.04	0.02	0.01	0.02	0.02	0.10	0.14	0.13	0.10	0.06	0.03	0.02	0.02	0.01	1.03
18 - <19	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.04	0.04	0.08	0.03	0.01	0.00	0.01	0.01	0.08	0.10	0.11	0.07	0.03	0.02	0.01	0.01	0.00	0.71
19 - <20	0.00		0.00	0.00	0.00	0.01	0.02	0.02	0.02	0.04	0.01	0.01	0.00	0.00	0.01	0.05	0.06	0.08	0.04	0.02	0.02	0.01	0.01	0.00	0.43
20 - <21	0.00		0.00	0.00		0.00	0.01	0.02	0.01	0.03	0.00	0.00	0.00	0.00	0.00	0.03	0.04	0.05	0.03	0.01	0.01	0.01	0.01	0.00	0.29

	Wind direction (°N, from)																							
Wind speed (m/s)	**0 - <15**	**15 - <30**	**30 - <45**	**45 - <60**	**60 - <75**	**75 - <90**	**90 - <105**	**105 - <120**	**120 - <135**	**135 - <150**	**150 - <165**	**165 - <180**	**180 - <195**	**195 - <210**	**210 - <225**	**225 - <240**	**240 - <255**	**255 - <270**	**270 - <285**	**285 - <300**	**300 - <315**	**315 - <330**	**330 - <345**	**345 - <360**	**Total**
21 - <22	0.00		0.00	0.00		0.00		0.00	0.01	0.01	0.00	0.00		0.00	0.00	0.02	0.03	0.03	0.02	0.01	0.01	0.00	0.00	0.00	0.16
22 - <23	0.00		0.00	0.00				0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.10
23 - <24									0.00	0.00	0.00	0.00	0.00		0.00	0.01	0.02	0.01	0.01	0.00	0.00	0.00		0.00	0.06
24 - <25									0.00	0.00	0.00		0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00			0.03
25 - <26											0.00				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			0.01
26 - <27																0.00	0.00	0.00	0.00	0.00					0.01
27 - <28												0.00				0.00		0.00	0.00						0.00
28 - <29																0.00		0.00	0.00						0.00
29 - <30																		0.00	0.00						0.00
30 - <31																		0.00							0.00
31- <32												0.00						0.00							0.00
32- <33																		0.00							0.00
Total	2.37	1.94	2.14	2.31	2.29	3.35	4.09	4.57	5.64	6.62	4.78	5.24	5.26	4.07	3.59	4.80	5.72	5.34	6.34	5.20	4.22	4.32	3.27	2.53	100.00

Note: 0.00 indicates >0% and <0.005%

Table B-2 Percentage frequency of occurrence – Barrel of Butter wind dataset, March to September

	Wind direction (°N, from)																								
Wind speed (m/s)	**0 - <15**	**15 - <30**	**30 - <45**	**45 - <60**	**60 - <75**	**75 - <90**	**90 - <105**	**105 - <120**	**120 - <135**	**135 - <150**	**150 - <165**	**165 - <180**	**180 - <195**	**195 - <210**	**210 - <225**	**225 - <240**	**240 - <255**	**255 - <270**	**270 - <285**	**285 - <300**	**300 - <315**	**315 - <330**	**330 - <345**	**345 - <360**	**Total**
0 - <1	0.06	0.06	0.08	0.06	0.08	0.07	0.08	0.08	0.10	0.09	0.08	0.07	0.07	0.06	0.07	0.06	0.05	0.05	0.06	0.05	0.06	0.06	0.05	0.07	1.62
1 - <2	0.16	0.20	0.22	0.23	0.26	0.30	0.31	0.31	0.31	0.27	0.25	0.23	0.22	0.20	0.19	0.17	0.17	0.17	0.20	0.17	0.18	0.14	0.13	0.17	5.16
2 - <3	0.24	0.22	0.26	0.35	0.36	0.43	0.43	0.42	0.44	0.44	0.37	0.35	0.35	0.30	0.22	0.18	0.16	0.22	0.30	0.29	0.26	0.23	0.19	0.22	7.23
3 - <4	0.23	0.24	0.30	0.38	0.43	0.52	0.58	0.52	0.51	0.56	0.41	0.48	0.49	0.36	0.26	0.23	0.16	0.25	0.42	0.51	0.34	0.29	0.25	0.26	9.01
4 - <5	0.30	0.25	0.30	0.39	0.35	0.57	0.62	0.50	0.50	0.61	0.43	0.45	0.52	0.37	0.25	0.26	0.25	0.32	0.64	0.65	0.45	0.47	0.35	0.33	10.12
5 - <6	0.33	0.29	0.32	0.33	0.27	0.51	0.55	0.52	0.55	0.69	0.36	0.38	0.42	0.37	0.29	0.28	0.33	0.41	0.83	0.78	0.46	0.48	0.36	0.27	10.39
6 - <7	0.32	0.27	0.32	0.27	0.21	0.43	0.45	0.56	0.57	0.81	0.36	0.36	0.39	0.31	0.29	0.32	0.41	0.46	0.98	0.76	0.49	0.46	0.38	0.27	10.45
7 - <8	0.27	0.18	0.26	0.21	0.18	0.38	0.42	0.53	0.52	0.75	0.38	0.31	0.29	0.27	0.29	0.36	0.44	0.43	0.98	0.62	0.45	0.41	0.34	0.23	9.49
8 - <9	0.22	0.14	0.20	0.15	0.16	0.30	0.40	0.39	0.43	0.65	0.31	0.28	0.23	0.21	0.29	0.39	0.51	0.44	0.82	0.54	0.39	0.34	0.26	0.25	8.28
9 - <10	0.21	0.11	0.15	0.11	0.12	0.17	0.28	0.35	0.40	0.50	0.24	0.25	0.16	0.16	0.24	0.42	0.62	0.48	0.67	0.43	0.32	0.32	0.22	0.22	7.14
10 - <11	0.16	0.09	0.11	0.07	0.10	0.18	0.26	0.32	0.36	0.40	0.20	0.17	0.10	0.10	0.14	0.38	0.57	0.47	0.60	0.39	0.25	0.30	0.19	0.17	6.09
11 - <12	0.10	0.07	0.08	0.12	0.09	0.15	0.18	0.24	0.30	0.32	0.13	0.11	0.06	0.08	0.13	0.36	0.50	0.40	0.38	0.28	0.17	0.18	0.12	0.11	4.66
12 - <13	0.08	0.07	0.06	0.08	0.10	0.12	0.11	0.16	0.26	0.22	0.10	0.07	0.03	0.06	0.09	0.26	0.42	0.32	0.29	0.20	0.14	0.12	0.08	0.07	3.50
13 - <14	0.06	0.04	0.05	0.04	0.06	0.06	0.11	0.09	0.16	0.13	0.06	0.07	0.02	0.03	0.05	0.18	0.31	0.25	0.18	0.14	0.09	0.06	0.05	0.05	2.36
14 - <15	0.03	0.02	0.04	0.01	0.04	0.05	0.07	0.06	0.07	0.07	0.03	0.03	0.01	0.02	0.03	0.17	0.26	0.20	0.15	0.10	0.08	0.05	0.03	0.04	1.66
15 - <16	0.02	0.01	0.01	0.00	0.01	0.01	0.03	0.05	0.04	0.02	0.01	0.01	0.01	0.01	0.03	0.12	0.19	0.12	0.10	0.07	0.06	0.02	0.02	0.02	1.01
16 - <17	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.09	0.02	0.02	0.01	0.00	0.00	0.00	0.01	0.09	0.14	0.05	0.08	0.06	0.03	0.03	0.02	0.00	0.69
17 - <18	0.00			0.00	0.00	0.00	0.01	0.06	0.02	0.01	0.00	0.00	0.00	0.00	0.01	0.07	0.10	0.04	0.07	0.05	0.02	0.02	0.01	0.00	0.50
18 - <19	0.00					0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.04	0.08	0.04	0.04	0.02	0.01	0.01	0.01	0.00	0.29
19 - <20	0.00							0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.03	0.02	0.01	0.01	0.01	0.00	0.00	0.18
20 - <21	0.00					0.00			0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.09

	Wind direction (°N, from)																								
Wind speed (m/s)	**0 - <15**	**15 - <30**	**30 - <45**	**45 - <60**	**60 - <75**	**75 - <90**	**90 - <105**	**105 - <120**	**120 - <135**	**135 - <150**	**150 - <165**	**165 - <180**	**180 - <195**	**195 - <210**	**210 - <225**	**225 - <240**	**240 - <255**	**255 - <270**	**270 - <285**	**285 - <300**	**300 - <315**	**315 - <330**	**330 - <345**	**345 - <360**	**Total**
21 - <22	0.00									0.00	0.00			0.00	0.00	0.00	0.01	0.02	0.00			0.00			0.04
22 - <23										0.00					0.00	0.00	0.01	0.01	0.00						0.03
23 - <24									0.00						0.00	0.00	0.00	0.00							0.01
24 - <25															0.00	0.00	0.00	0.00							0.01
25 - <26																		0.00							0.00
26 - <27																	0.00	0.00							0.00
27 - <28																		0.00							0.00
Total	2.80	2.25	2.77	2.80	2.81	4.26	4.93	5.26	5.55	6.61	3.75	3.63	3.39	2.93	2.88	4.38	5.74	5.21	7.82	6.15	4.26	4.00	3.07	2.75	100.00

Note: 0.00 indicates >0% and <0.005

Table B-3 Percentage frequency of exceedance (by direction sector) – Barrel of Butter wind dataset, all year

	Wind direction (°N, from)																								
Wind speed (m/s)	**0 - <15**	**15 - <30**	**30 - <45**	**45 - <60**	**60 - <75**	**75 - <90**	**90 - <105**	**105 - <120**	**120 - <135**	**135 - <150**	**150 - <165**	**165 - <180**	**180 - <195**	**195 - <210**	**210 - <225**	**225 - <240**	**240 - <255**	**255 - <270**	**270 - <285**	**285 - <300**	**300 - <315**	**315 - <330**	**330 - <345**	**345 - <360**	**Total**
1	97.87	97.39	97.17	97.79	97.58	98.47	98.56	98.84	98.80	98.97	98.71	98.97	98.90	98.71	98.62	98.91	99.27	99.21	99.30	99.19	98.82	98.86	98.56	98.00	98.74
2	91.29	88.97	89.24	90.37	89.47	92.27	93.11	94.06	94.85	95.85	94.60	95.18	95.28	94.28	93.95	95.74	96.82	96.67	96.70	96.21	95.02	95.64	94.92	91.86	94.56
3	82.58	80.18	80.31	79.94	78.58	83.43	85.68	87.46	89.23	90.89	88.35	88.85	88.94	87.06	87.20	91.62	94.48	93.48	93.00	91.40	89.43	90.47	88.56	83.81	88.60
4	73.56	70.45	69.74	68.09	65.36	72.76	75.56	79.17	82.60	84.45	80.86	80.26	79.02	77.84	79.23	86.90	92.06	89.86	88.02	83.68	82.42	83.51	80.63	72.99	81.04
5	62.95	59.89	58.79	55.95	54.39	61.16	65.17	71.09	75.61	77.33	72.87	71.55	67.10	67.28	71.19	81.56	88.35	85.26	80.98	74.26	73.22	73.00	69.73	60.11	72.42
6	51.56	47.68	47.71	44.52	44.43	50.40	55.16	62.37	67.63	69.13	65.05	62.52	55.52	55.47	61.96	75.30	83.43	79.26	72.10	63.13	63.40	61.89	58.61	49.48	63.18
7	41.07	36.14	36.60	34.65	36.02	41.04	45.94	52.79	58.91	60.02	56.62	52.80	43.08	44.66	52.22	68.32	77.17	72.21	61.39	52.25	52.81	51.19	47.42	40.07	53.64
8	32.09	28.21	27.74	26.84	29.38	32.43	37.45	43.65	50.54	51.27	47.30	42.72	32.17	34.71	42.48	60.82	70.13	65.10	50.65	43.11	42.45	40.80	37.28	32.65	44.64
9	24.63	21.41	20.69	20.78	23.57	24.85	29.36	36.32	43.28	43.20	38.26	33.02	22.91	26.27	32.84	53.18	61.63	57.47	41.14	34.49	33.18	32.04	28.85	24.99	36.38
10	17.78	16.18	15.06	15.60	18.95	20.27	23.36	29.38	36.27	36.03	29.74	24.27	15.57	19.33	24.58	44.65	51.95	49.09	32.85	27.00	25.36	23.89	21.13	18.11	28.92
11	12.46	11.27	10.46	12.25	15.14	15.76	17.65	22.77	28.87	29.42	22.27	17.16	10.58	14.39	18.64	36.49	42.48	40.63	25.10	20.36	18.68	16.26	14.08	12.38	22.28
12	8.68	6.91	6.40	7.51	10.79	12.02	13.09	17.15	22.30	23.56	16.28	11.90	7.13	10.82	13.73	28.91	33.87	33.07	19.54	15.32	13.57	11.23	9.64	8.24	16.86
13	5.25	4.02	3.78	4.03	6.61	8.22	9.52	12.63	16.42	18.24	11.25	7.76	4.70	7.60	9.80	22.90	26.25	26.57	14.87	11.39	9.58	7.36	6.54	5.35	12.38
14	2.91	1.70	1.99	2.43	3.74	5.40	6.12	9.51	11.75	13.26	7.43	4.54	2.86	4.75	6.81	18.01	20.04	20.56	11.63	8.44	6.85	4.87	4.49	3.39	8.89
15	1.58	0.47	0.79	1.70	1.88	2.58	3.76	7.08	7.49	9.11	4.79	2.65	1.53	2.63	4.51	13.28	14.83	15.63	8.89	6.20	4.56	3.15	3.00	2.05	6.14
16	0.82	0.23	0.44	1.23	0.95	1.26	2.45	5.33	4.59	6.33	2.97	1.65	0.86	1.44	2.79	9.56	10.66	11.63	6.60	4.42	3.01	2.16	2.05	1.29	4.24
17	0.52	0.05	0.34	0.80	0.69	0.66	1.68	3.26	3.01	4.20	1.75	0.94	0.46	0.86	1.64	6.75	7.32	8.42	4.51	2.86	2.04	1.38	1.32	0.80	2.83
18	0.24	0.02	0.28	0.63	0.30	0.57	1.02	1.64	1.72	2.55	0.96	0.50	0.23	0.40	1.06	4.61	4.88	5.97	2.87	1.78	1.38	0.87	0.81	0.56	1.80
19	0.13		0.25	0.44	0.08	0.40	0.55	0.85	0.93	1.27	0.39	0.26	0.14	0.20	0.70	2.86	3.07	3.95	1.76	1.16	0.96	0.57	0.52	0.46	1.09
20	0.09		0.22	0.37		0.21	0.15	0.45	0.58	0.60	0.18	0.16	0.08	0.11	0.46	1.78	2.00	2.52	1.14	0.78	0.53	0.28	0.28	0.34	0.66
21	0.05		0.18	0.18		0.08		0.08	0.36	0.21	0.08	0.08	0.02	0.04	0.33	1.07	1.33	1.51	0.60	0.50	0.30	0.12	0.12	0.19	0.37

	Wind direction (°N, from)																								
Wind speed (m/s)	**0 - <15**	**15 - <30**	**30 - <45**	**45 - <60**	**60 - <75**	**75 - <90**	**90 - <105**	**105 - <120**	**120 - <135**	**135 - <150**	**150 - <165**	**165 - <180**	**180 - <195**	**195 - <210**	**210 - <225**	**225 - <240**	**240 - <255**	**255 - <270**	**270 - <285**	**285 - <300**	**300 - <315**	**315 - <330**	**330 - <345**	**345 - <360**	**Total**
22	0.01		0.07	0.07				0.01	0.15	0.06	0.05	0.04	0.02	0.02	0.25	0.70	0.81	0.91	0.33	0.35	0.16	0.06	0.01	0.12	0.21
23									0.03	0.03	0.05	0.03	0.01	0.01	0.14	0.44	0.39	0.51	0.21	0.18	0.07	0.03		0.04	0.11
24									0.01	0.00	0.03	0.02	0.01	0.01	0.08	0.22	0.12	0.31	0.12	0.09	0.03	0.01			0.06
25											0.01	0.02			0.03	0.08	0.03	0.19	0.06	0.05	0.01	0.01			0.03
26												0.02				0.05	0.01	0.13	0.03	0.03					0.01
27												0.02				0.02		0.09	0.02						0.01
28												0.01				0.01		0.06	0.01						0.01
29												0.01						0.06	0.00						0.00
30												0.01						0.05							0.00
31												0.01						0.03							0.00
32																		0.01							0.00
33																									

Note: 0.00 indicates >0% and <0.005%

Table B-4 Percentage frequency of exceedance (by direction sector) – Barrel of Butter wind dataset, March to September

	Wind direction (°N, from)																								
Wind speed (m/s)	**0 - <15**	**15 - <30**	**30 - <45**	**45 - <60**	**60 - <75**	**75 - <90**	**90 - <105**	**105 - <120**	**120 - <135**	**135 - <150**	**150 - <165**	**165 - <180**	**180 - <195**	**195 - <210**	**210 - <225**	**225 - <240**	**240 - <255**	**255 - <270**	**270 - <285**	**285 - <300**	**300 - <315**	**315 - <330**	**330 - <345**	**345 - <360**	**Total**
1	97.74	97.40	97.27	97.69	97.23	98.36	98.38	98.56	98.28	98.58	97.77	98.06	97.81	97.93	97.68	98.61	99.12	98.97	99.29	99.18	98.60	98.55	98.25	97.61	98.38
2	91.87	88.74	89.33	89.33	88.05	91.43	92.06	92.74	92.75	94.44	91.11	91.65	91.37	91.20	91.21	94.72	96.14	95.79	96.76	96.36	94.28	94.97	93.99	91.34	93.22
3	83.23	79.00	79.81	77.03	75.20	81.36	83.28	84.79	84.85	87.76	81.28	82.07	81.05	80.95	83.48	90.52	93.34	91.66	92.95	91.58	88.25	89.16	87.72	83.37	85.99
4	75.09	68.27	68.90	63.42	60.02	69.12	71.47	74.85	75.72	79.23	70.25	68.86	66.51	68.64	74.36	85.19	90.57	86.82	87.59	83.32	80.31	81.79	79.43	73.86	76.98
5	64.51	57.27	58.04	49.57	47.74	55.77	58.80	65.28	66.74	70.08	58.69	56.58	51.23	55.97	65.71	79.20	86.28	80.64	79.38	72.73	69.72	70.07	67.94	62.03	66.87
6	52.56	44.38	46.47	37.90	38.25	43.75	47.65	55.34	56.89	59.58	49.08	46.06	38.90	43.23	55.59	72.76	80.58	72.83	68.78	60.01	58.81	58.18	56.16	52.10	56.48
7	41.10	32.35	34.88	28.26	30.73	33.67	38.46	44.65	46.63	47.26	39.51	36.13	27.47	32.47	45.60	65.50	73.49	64.08	56.26	47.61	47.36	46.76	43.84	42.21	46.03
8	31.46	24.47	25.48	20.94	24.22	24.72	29.97	34.67	37.34	35.95	29.44	27.67	18.81	23.26	35.47	57.19	65.81	55.85	43.69	37.49	36.82	36.47	32.90	33.99	36.54
9	23.68	18.26	18.29	15.66	18.54	17.64	21.78	27.29	29.68	26.14	21.18	19.93	12.12	16.15	25.22	48.40	57.01	47.39	33.19	28.74	27.72	27.97	24.45	25.02	28.26
10	16.23	13.40	12.94	11.73	14.33	13.59	16.17	20.60	22.47	18.57	14.79	13.14	7.45	10.83	16.99	38.84	46.28	38.19	24.62	21.67	20.18	19.91	17.18	17.03	21.13
11	10.50	9.46	8.84	9.10	10.84	9.32	10.88	14.51	15.93	12.53	9.39	8.55	4.39	7.30	12.04	30.20	36.34	29.19	16.99	15.33	14.41	12.39	10.90	10.88	15.04
12	7.05	6.21	5.87	4.84	7.50	5.90	7.28	9.97	10.44	7.76	5.93	5.57	2.53	4.73	7.54	21.92	27.61	21.48	12.13	10.75	10.32	7.82	7.12	6.87	10.37
13	4.31	3.27	3.74	1.92	3.90	3.10	4.95	6.93	5.75	4.44	3.34	3.53	1.50	2.62	4.59	16.01	20.35	15.37	8.39	7.43	7.04	4.91	4.67	4.33	6.87
14	2.07	1.44	1.77	0.47	1.93	1.59	2.71	5.16	2.90	2.43	1.78	1.63	0.83	1.48	2.94	12.00	14.90	10.58	6.12	5.18	4.96	3.30	2.98	2.43	4.51
15	0.99	0.49	0.47	0.17	0.58	0.36	1.24	4.11	1.57	1.33	0.85	0.71	0.42	0.73	2.03	8.14	10.41	6.74	4.22	3.59	3.03	2.14	1.92	1.08	2.85
16	0.39	0.21	0.08	0.09	0.13	0.10	0.61	3.09	0.80	0.97	0.54	0.30	0.20	0.32	1.09	5.37	7.02	4.44	2.94	2.38	1.67	1.57	1.24	0.53	1.84
17	0.22			0.02	0.04	0.04	0.29	1.46	0.45	0.66	0.32	0.19	0.15	0.18	0.60	3.43	4.54	3.42	1.94	1.42	0.94	0.82	0.66	0.38	1.15
18	0.11					0.02	0.02	0.30	0.18	0.47	0.22	0.14	0.14	0.14	0.38	1.83	2.85	2.65	1.01	0.66	0.50	0.39	0.26	0.28	0.65
19	0.07					0.01		0.08	0.08	0.30	0.13	0.12	0.11	0.09	0.29	0.92	1.46	1.88	0.47	0.31	0.26	0.25	0.07	0.23	0.36
20	0.06					0.01			0.03	0.14	0.08	0.03	0.03	0.04	0.16	0.48	0.75	1.22	0.22	0.08	0.06	0.08	0.03	0.11	0.18
21	0.02								0.01	0.02	0.01			0.02	0.13	0.29	0.39	0.78	0.09			0.01			0.09

	Wind direction (°N, from)																							
Wind speed (m/s)	**0 - <15**	**15 - <30**	**30 - <45**	**45 - <60**	**60 - <75**	**75 - <90**	**90 - <105**	**105 - <120**	**120 - <135**	**135 - <150**	**150 - <165**	**165 - <180**	**180 - <195**	**195 - <210**	**210 - <225**	**225 - <240**	**240 - <255**	**255 - <270**	**270 - <285**	**285 - <300**	**300 - <315**	**315 - <330**	**330 - <345**	**345 - <360**	**Total**
22									0.01	0.01					0.11	0.18	0.23	0.47	0.05						0.05
23									0.01						0.05	0.11	0.11	0.26							0.03
24															0.04	0.02	0.05	0.19							0.01
25																	0.01	0.11							0.01
26																	0.01	0.07							0.00
27																		0.03							0.00
28																									

Note: 0.00 indicates >0% and <0.005

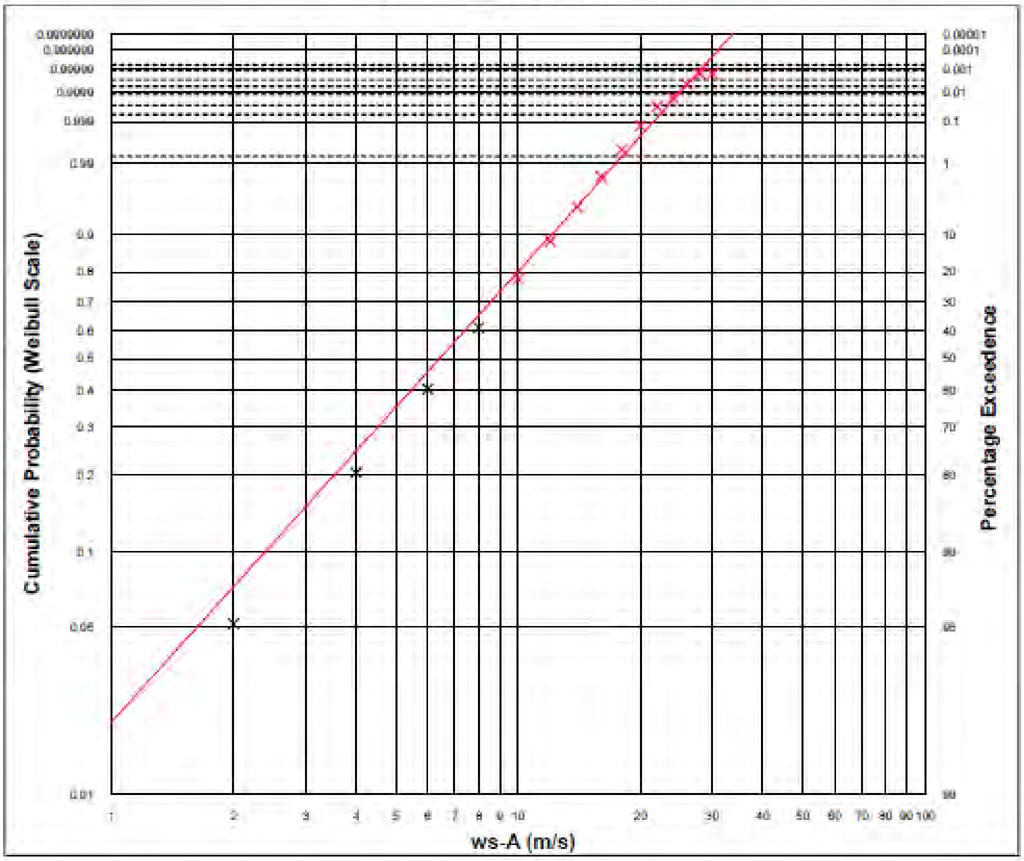
APPENDIX C

Extreme Value Analysis

C.1 EXTREME VALUE ANALYSIS RESULTS – WEIBULL PROBABILITY DISTRIBUTION

Figure C-1 Weibull probability distribution and results – southerly wind

P2570: Scapa Deep Quay



Extrapolations:
(Wind speed, 60 min)

Return period	Cumulative Probability	Extreme value (m/s)
100 yr	0.99999410	28.82
50 yr	0.99998821	27.93
20 yr	0.99997051	26.72
10 yr	0.99994103	25.77
5 yr	0.99988206	24.79
2 yr	0.99970514	23.43
1 yr	0.99941028	22.36
0.0833 yr	0.99292336	18.05

Weibull parameters: A = 0.000 B = 7.777 C = 1.900

Regression line is fitted to the top 25% of the distribution. Fitting technique: least squares method

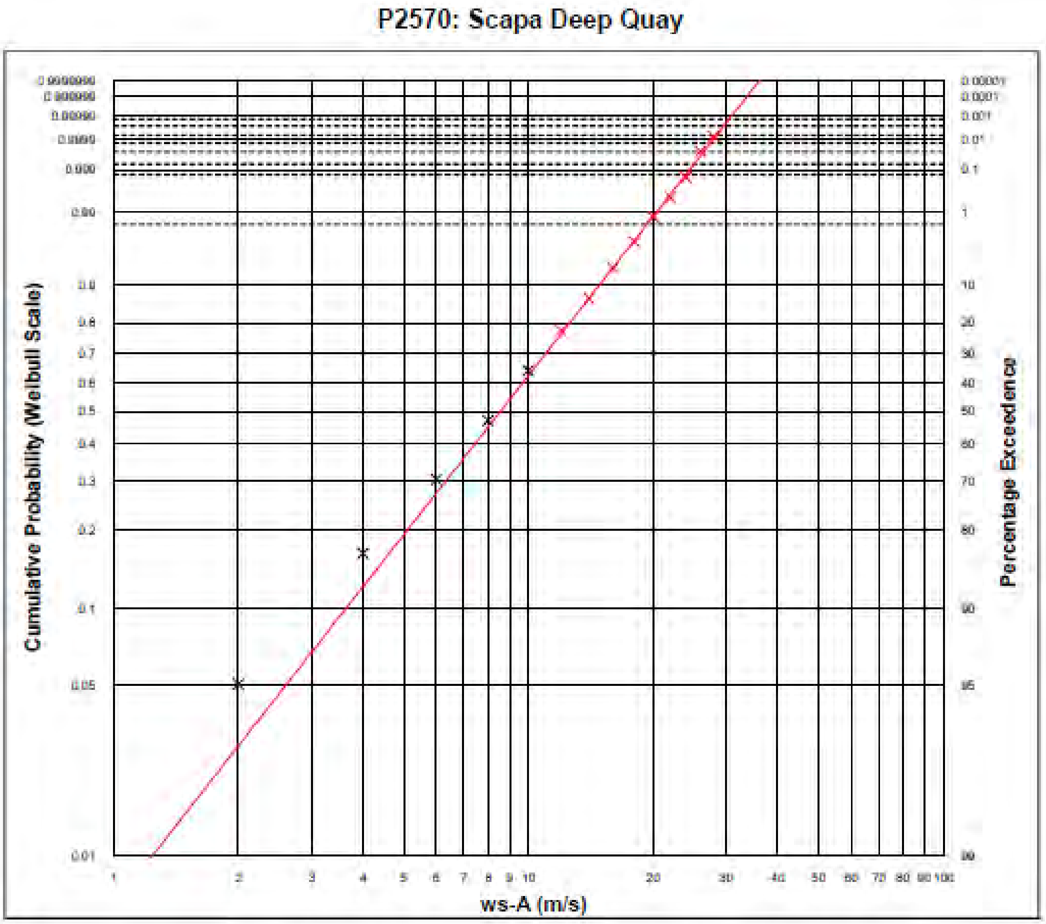
Data interval is 60.0 min

Notes:

1. Data source: Barrel of Butter OIC data
2. Location: 58° 53' N, 03° 7' W
3. Period: 1 April 2012 to 31 December 2021
4. 10 m above surface
5. Wind speed (m/s)
6. Based on 312,676 15-minute data

Weibull Extreme Value Analysis for Barrel of Butter wind observations (Southerly)

Figure C-2 Weibull probability distribution and results – south-westerly wind



Extrapolations:
(Wind speed, 60 min)

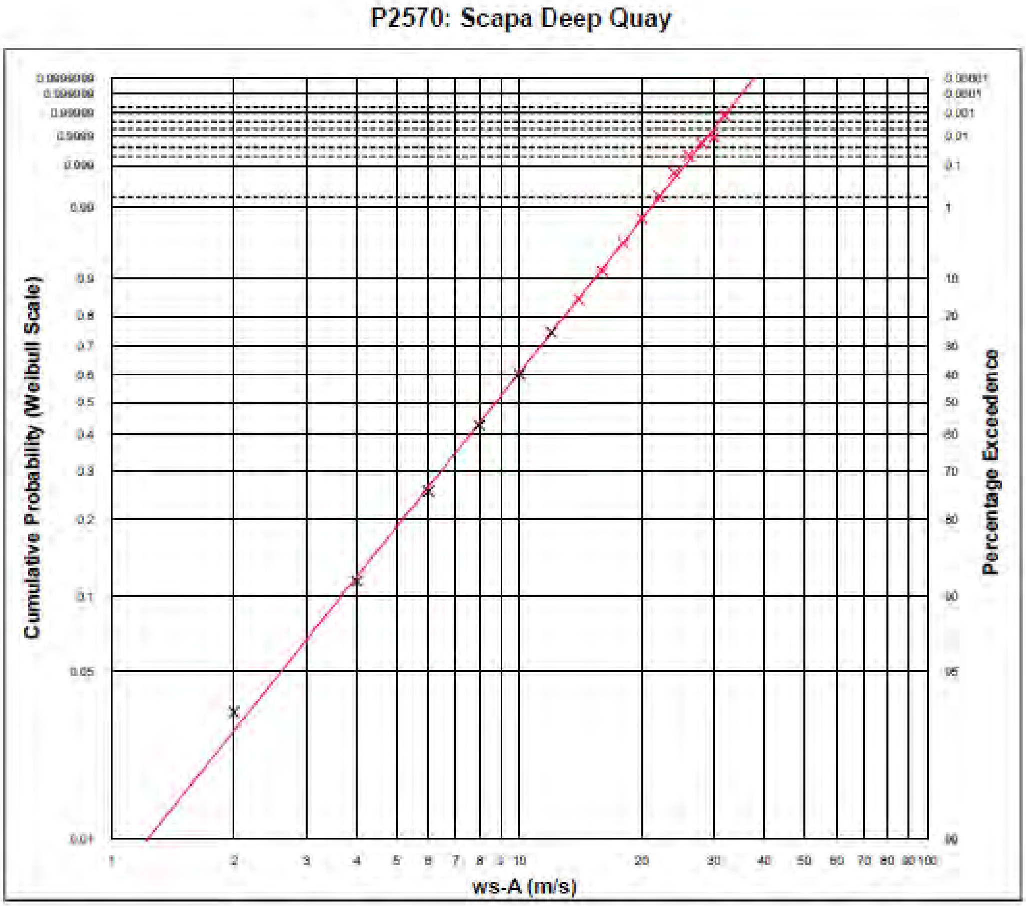
Return period	Cumulative Probability	Extreme value (m/s)
100 yr	0.99998641	30.51
50 yr	0.99997283	29.64
20 yr	0.99993207	28.43
10 yr	0.99986413	27.47
5 yr	0.99972826	26.47
2 yr	0.99932065	25.08
1 yr	0.99864130	23.96
0.0833 yr	0.98369565	19.31

Weibull parameters: A = 0.000 B = 10.123 C = 2.190
Regression line is fitted to the top 25% of the distribution. Fitting technique: least squares method
Data interval is 60.0 min

Notes:
1. Data source: Barrel of Butter OIC data
2. Location: 58° 53' N, 03° 7' W
3. Period: 1 April 2012 to 31 December 2021
4. 10 m above surface
5. Wind speed (m/s)
6. Based on 312,676 15-minute data

Weibull Extreme Value Analysis for Barrel of Butter wind observations (Southwesterly)

Figure C-3 Weibull probability distribution and results – westerly wind



Extrapolations:
(Wind speed, 60 min)

Return period	Cumulative Probability	Extreme value (m/s)
100 yr	0.99999495	33.11
50 yr	0.99998990	32.23
20 yr	0.99997476	31.01
10 yr	0.99994952	30.05
5 yr	0.99989904	29.05
2 yr	0.99974760	27.67
1 yr	0.99949520	26.57
0.0833 yr	0.99394236	22.10

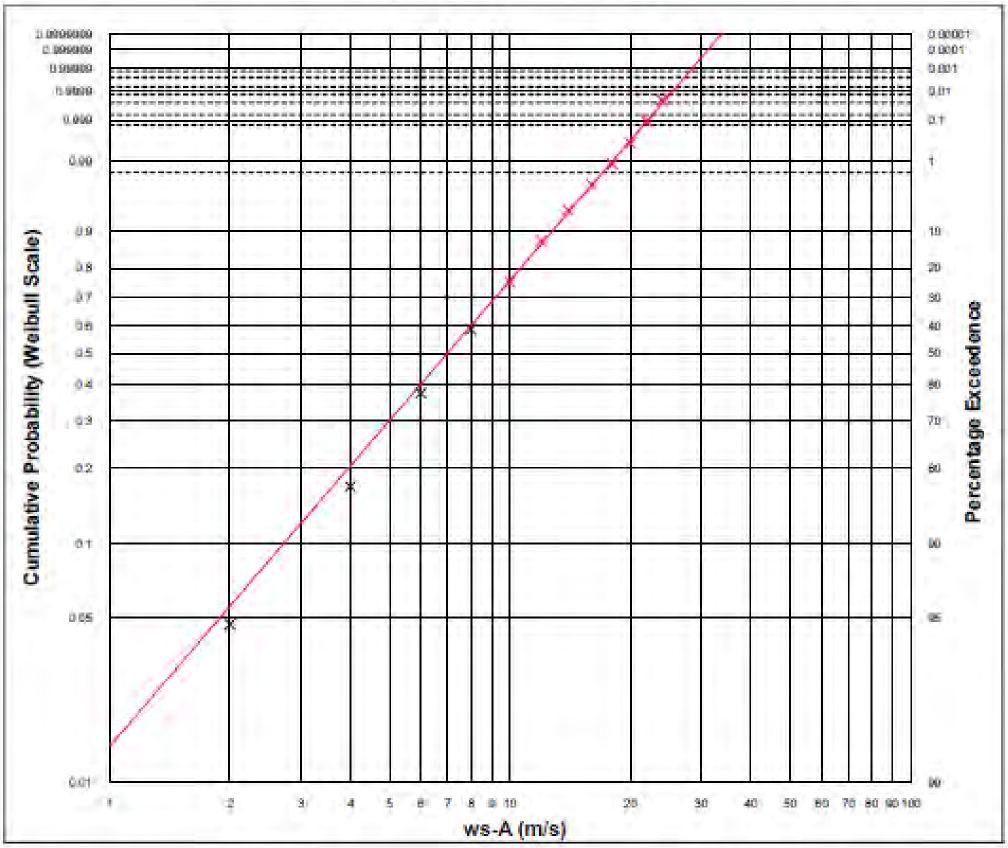
Weibull parameters: A = 0.000 B = 10.370 C = 2.154
Regression line is fitted to the top 25% of the distribution. Fitting technique: least squares method
Data interval is 60.0 min

Notes:
1. Data source: Barrel of Butter OIC data
2. Location: 58° 53' N, 03° 7' W
3. Period: 1 April 2012 to 31 December 2021
4. 10 m above surface
5. Wind speed (m/s)
6. Based on 312,676 15-minute data

Weibull Extreme Value Analysis for Barrel of Butter wind observations (Westerly)

Figure C-4 Weibull probability distribution and results – north-westerly wind

P2570: Scapa Deep Quay



Extrapolations:
(Wind speed, 60 min)

Return period	Cumulative Probability	Extreme value (m/s)
100 yr	0.99998664	28.14
50 yr	0.99997327	27.25
20 yr	0.99993318	26.04
10 yr	0.99986636	25.08
5 yr	0.99973273	24.08
2 yr	0.99933182	22.70
1 yr	0.99866365	21.60
0.0833 yr	0.98396379	17.06

Weibull parameters: A = 0.000 B = 8.380 C = 1.996

Regression line is fitted to the top 25% of the distribution. Fitting technique: least squares method

Data interval is 60.0 min

Notes:

1. Data source: Barrel of Butter OIC data
2. Location: 58° 53' N, 03° 7' W
3. Period: 1 April 2012 to 31 December 2021
4. 10 m above surface
5. Wind speed (m/s)
6. Based on 312,676 15-minute data

Weibull Extreme Value Analysis for Barrel of Butter wind observations (Northwesterly)

APPENDIX D

Additional Results

D.1 SIGNIFICANT WAVE HEIGHT CONTOUR PLOTS – BASELINE

Figure D-1 Model result Hs (m), 15 knots southerly wind direction

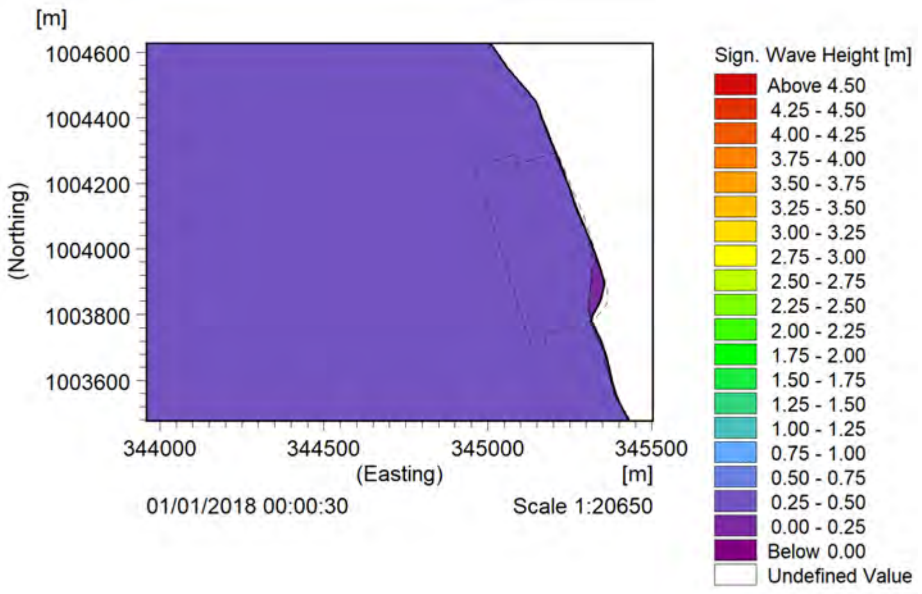


Figure D-2 Model result Hs (m), 15 knots south-westerly wind direction

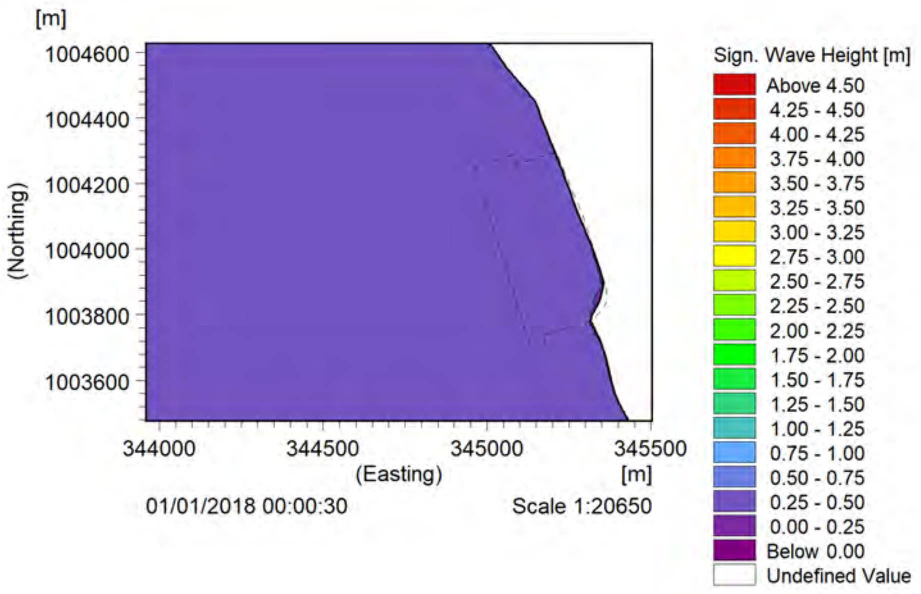


Figure D-3 Model result Hs (m), 15 knots westerly wind direction

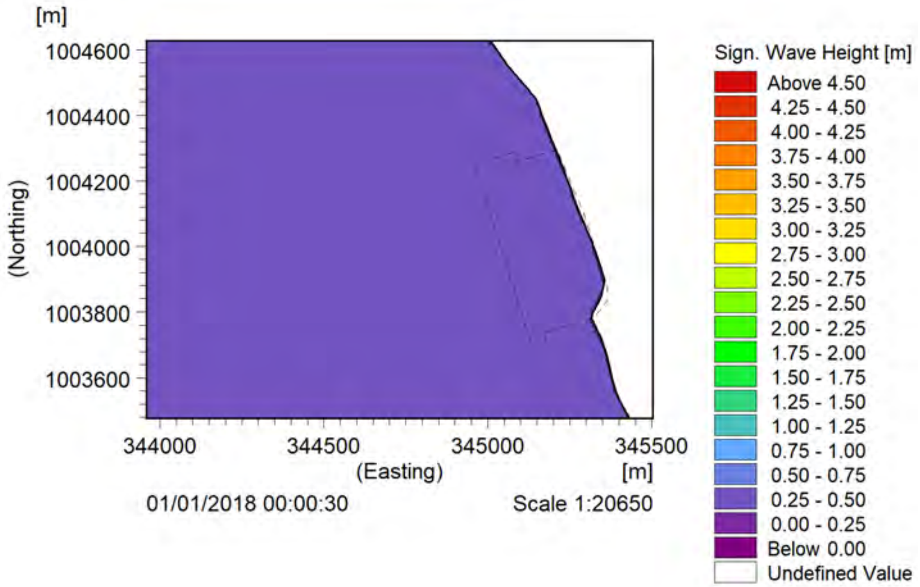


Figure D-4 Model result Hs (m), 15 knots north-westerly wind direction

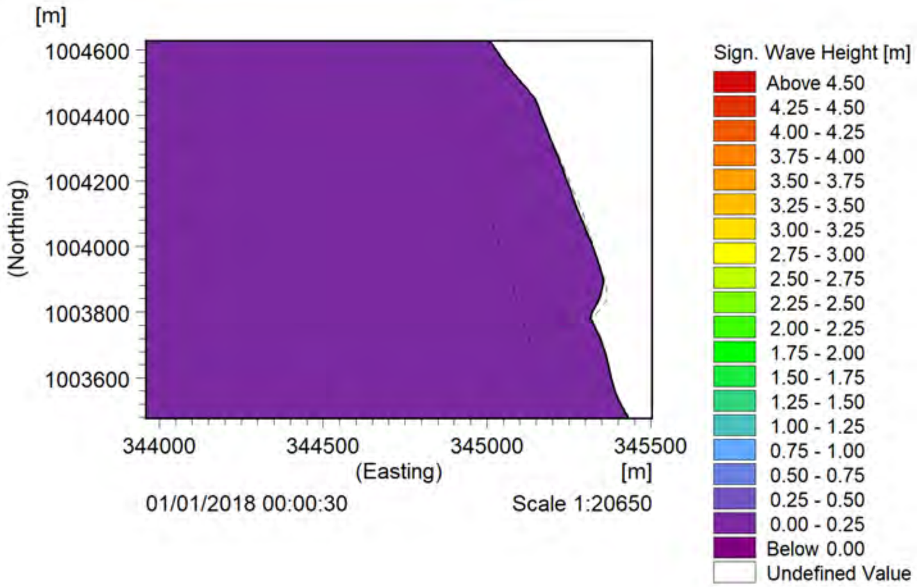


Figure D-5 Model result Hs (m), 30 knots southerly wind direction

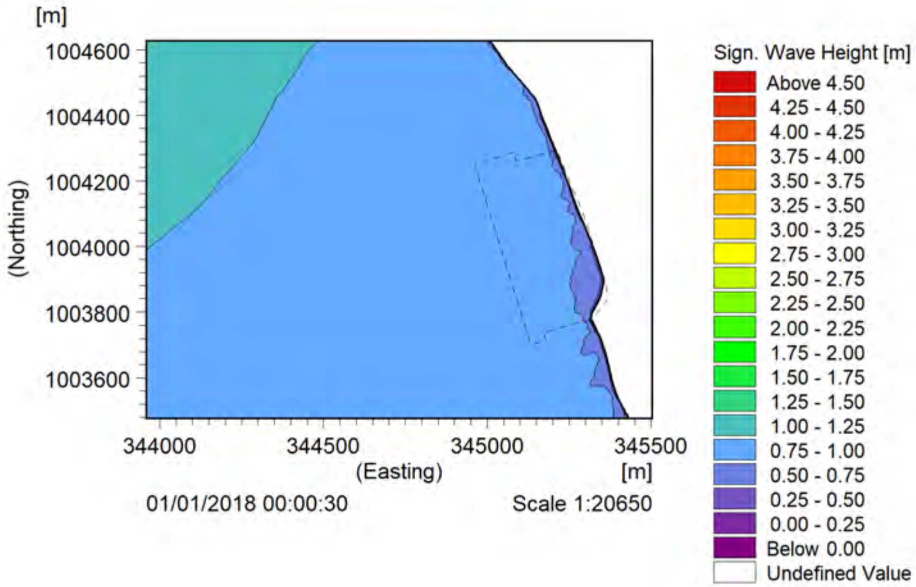


Figure D-6 Model result Hs (m), 30 knots south-westerly wind direction

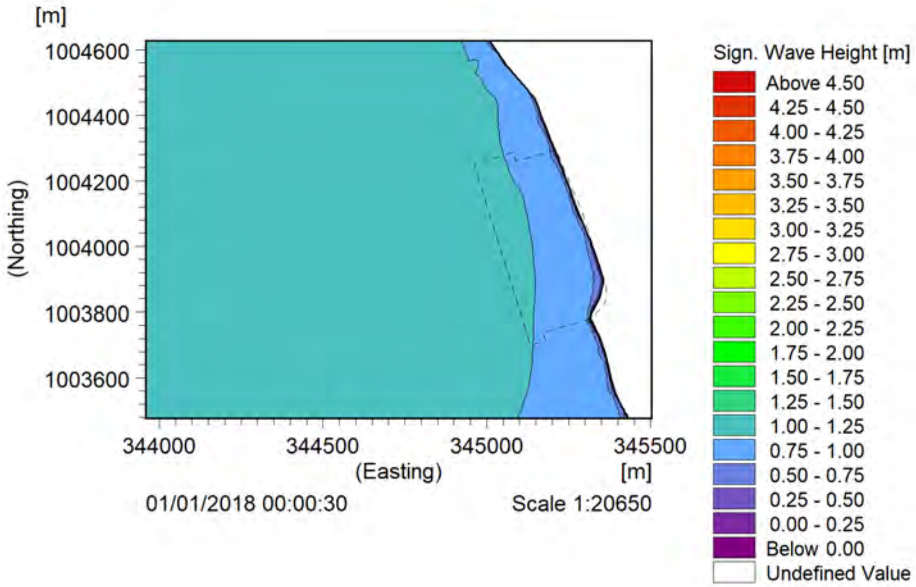


Figure D-7 Model result Hs (m), 30 knots westerly wind direction

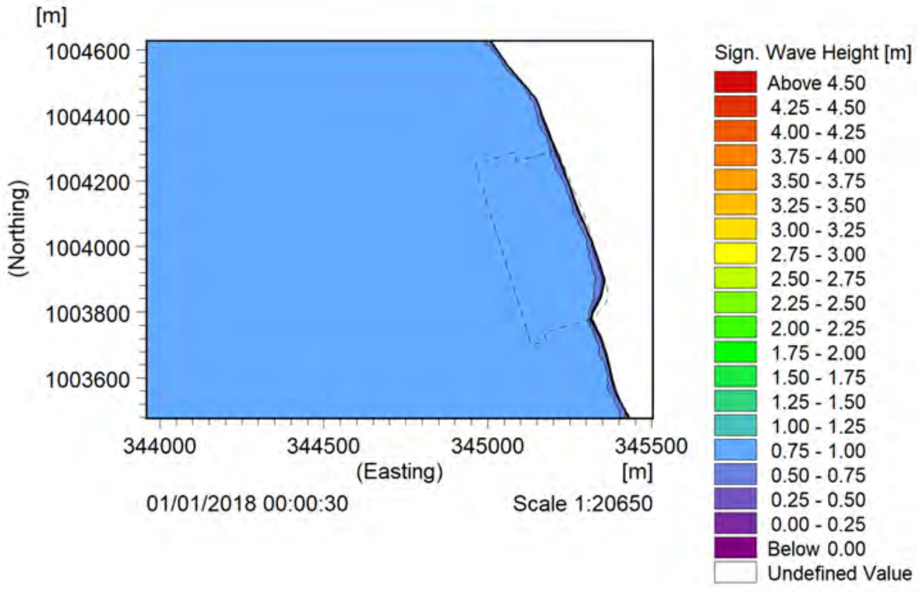


Figure D-8 Model result Hs (m), 30 knots north-westerly wind direction

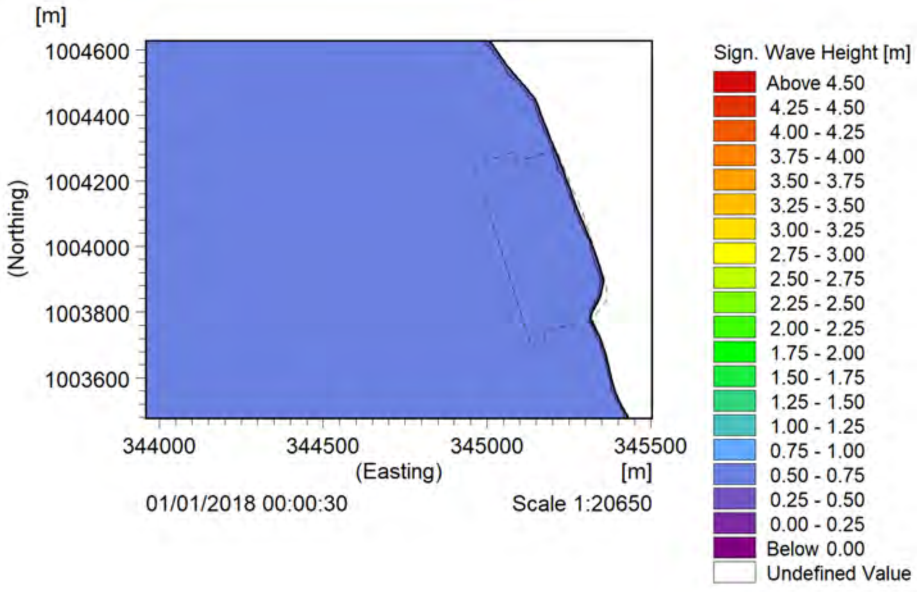


Figure D-9 Model result Hs (m), 1-in-1 year southerly wind direction

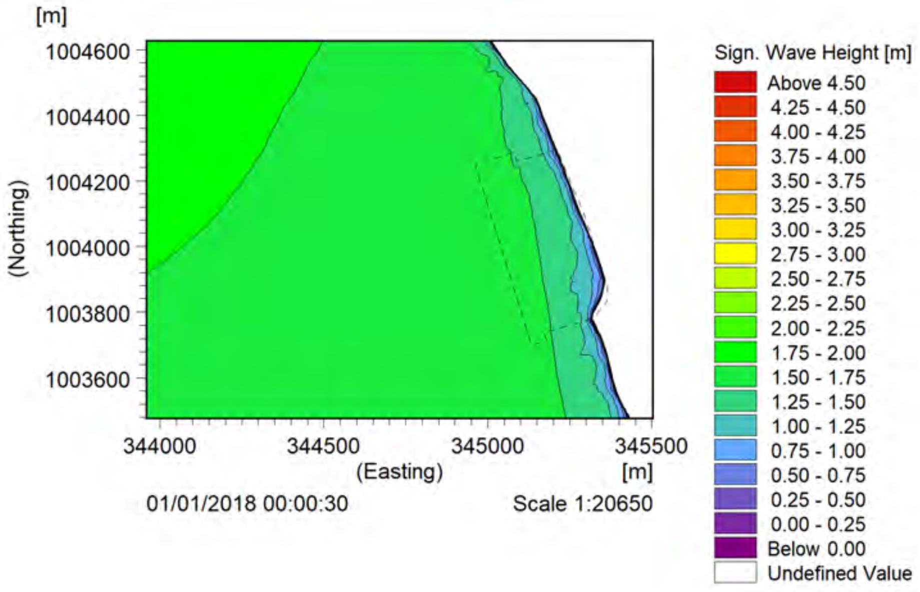


Figure D-10 Model result Hs (m), 1-in-1 year south-westerly wind direction

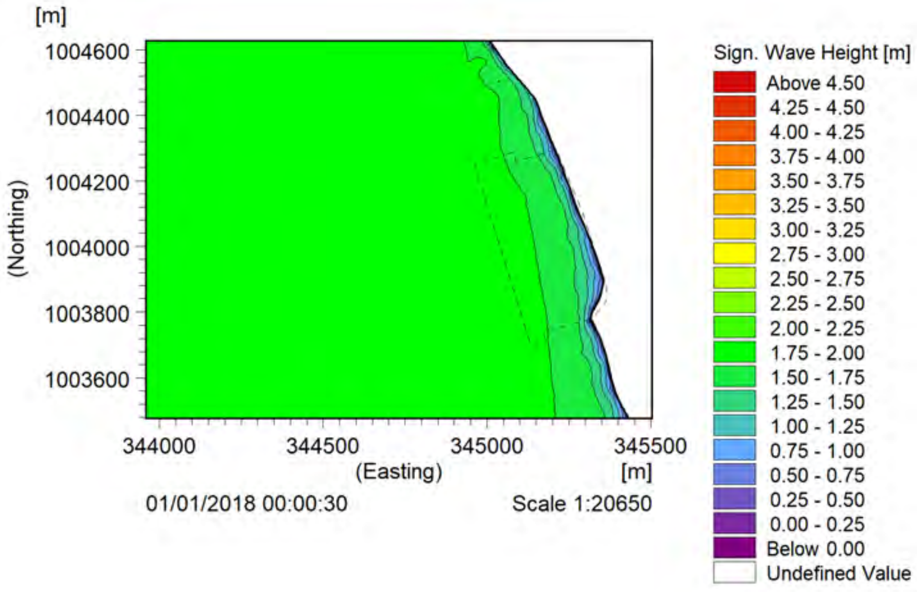


Figure D-11 Model result Hs (m), 1-in-1 year westerly wind direction

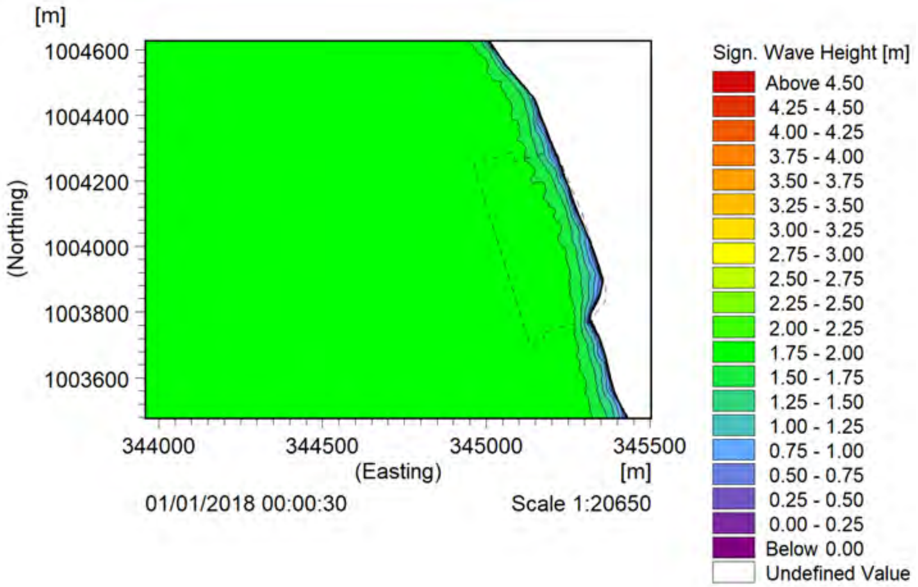


Figure D-12 Model result Hs (m), 1-in-1 year north-westerly wind direction

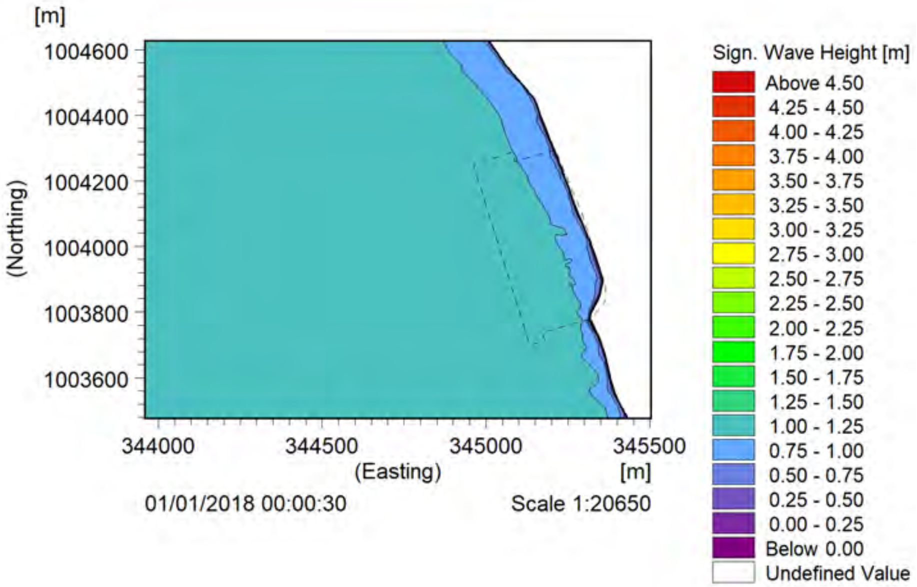


Figure D-13 Model result Hs (m), 1-in-10 year southerly wind direction

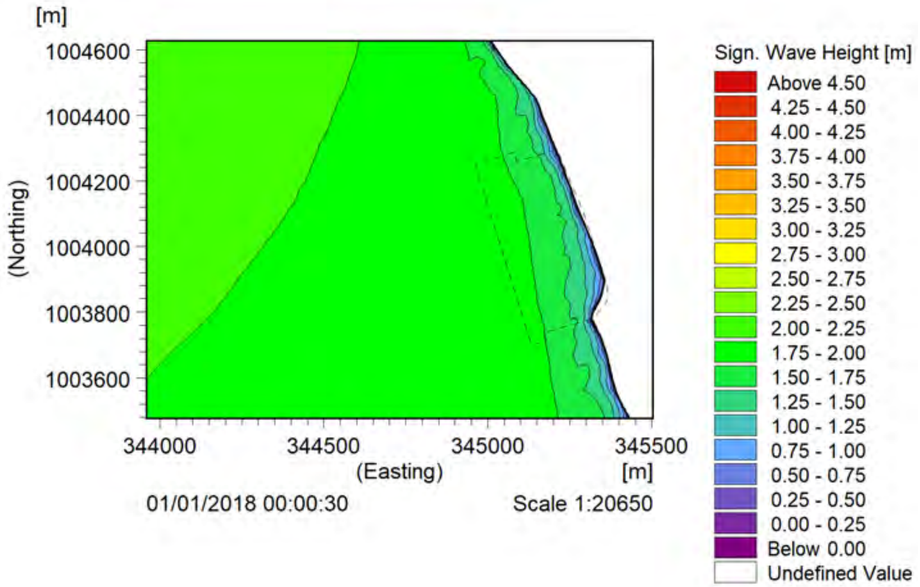


Figure D-14 Model result Hs (m), 1-in-10 year south-westerly wind direction

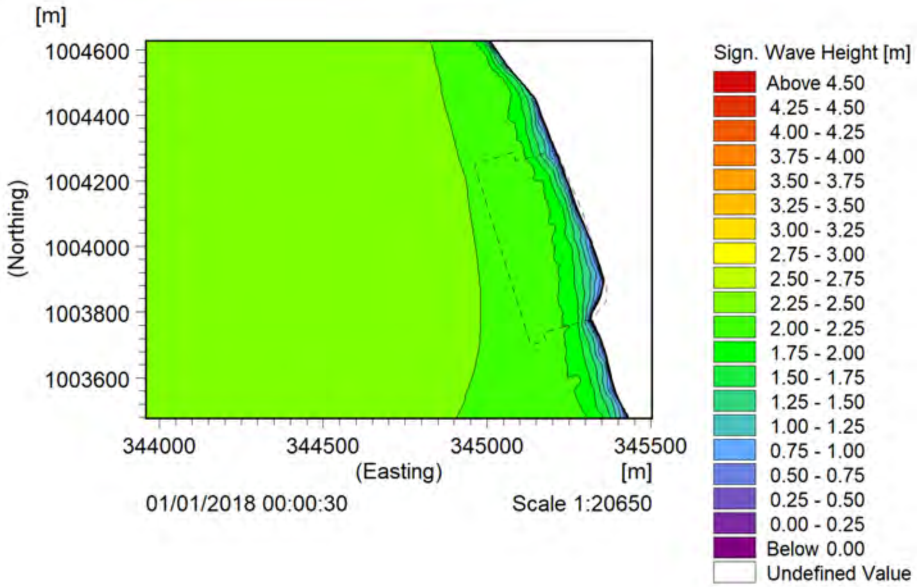


Figure D-15 Model result Hs (m), 1-in-10 year westerly wind direction

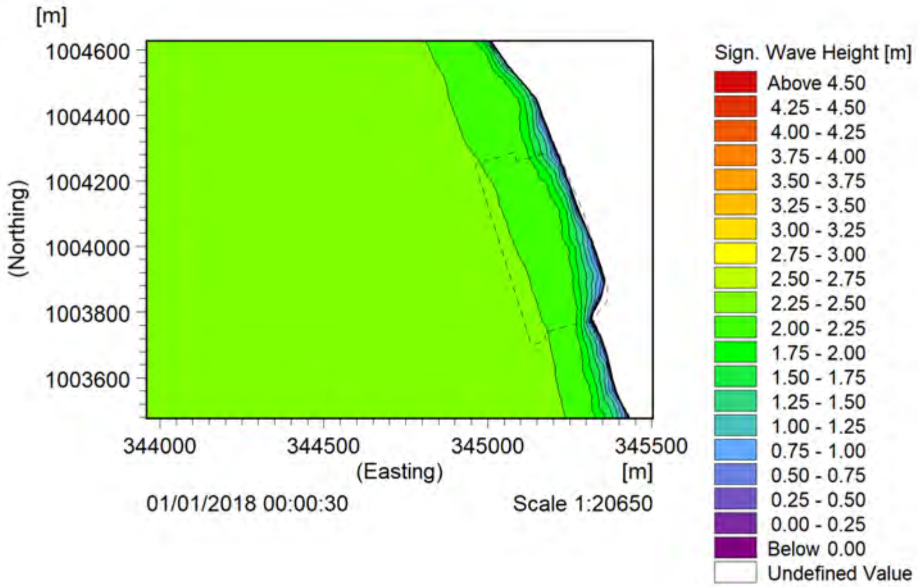


Figure D-16 Model result Hs (m), 1-in-10 year north-westerly wind direction

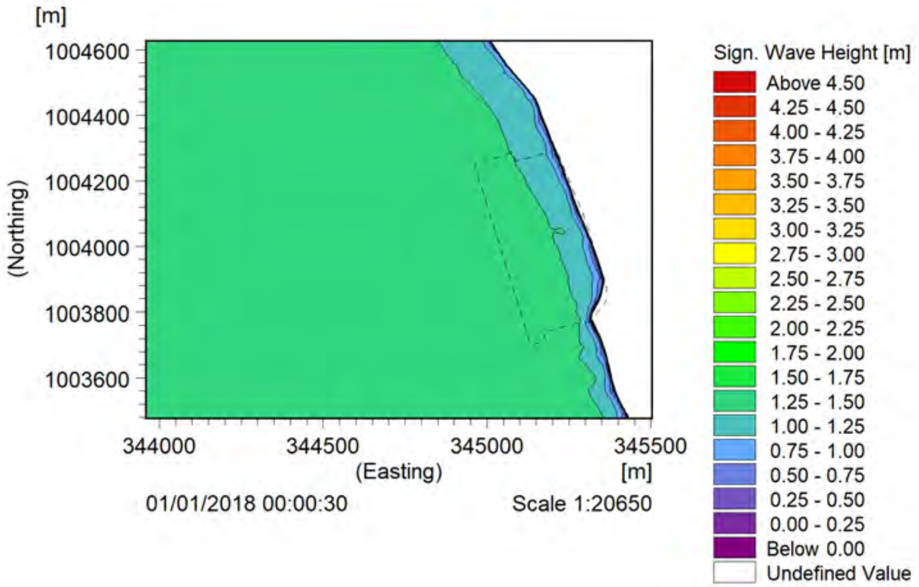


Figure D-17 Model result Hs (m), 1-in-50 year southerly wind direction

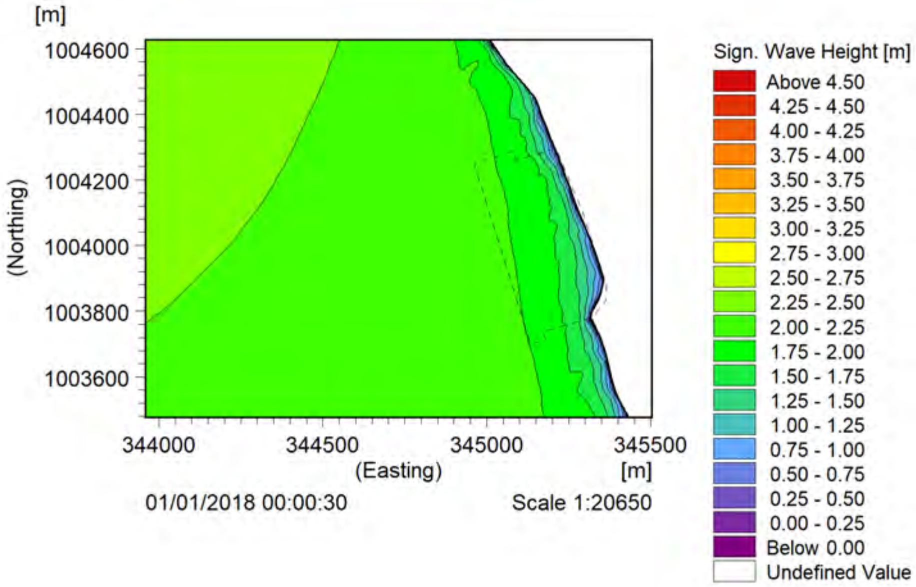


Figure D-18 Model result Hs (m), 1-in-50 year south-westerly wind direction

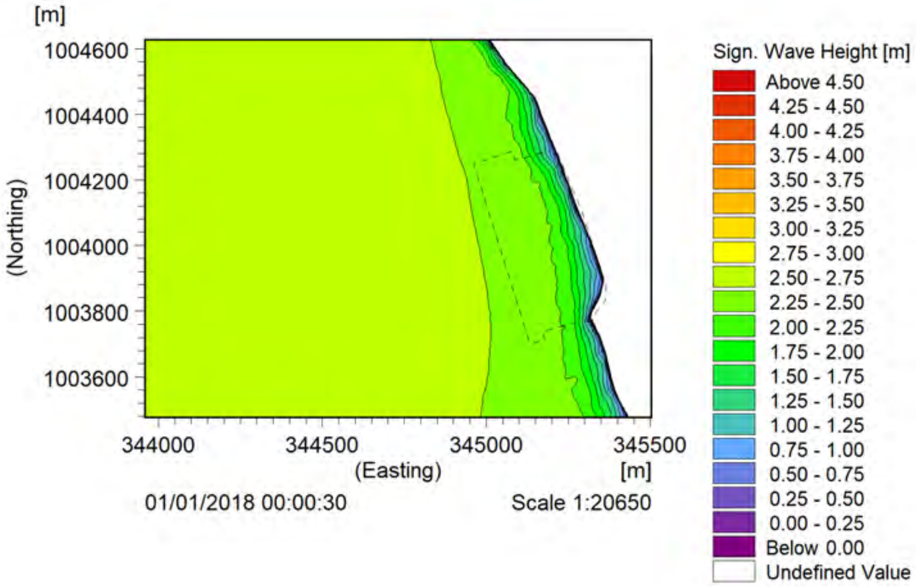


Figure D-19 Model result Hs (m), 1-in-50 year westerly wind direction

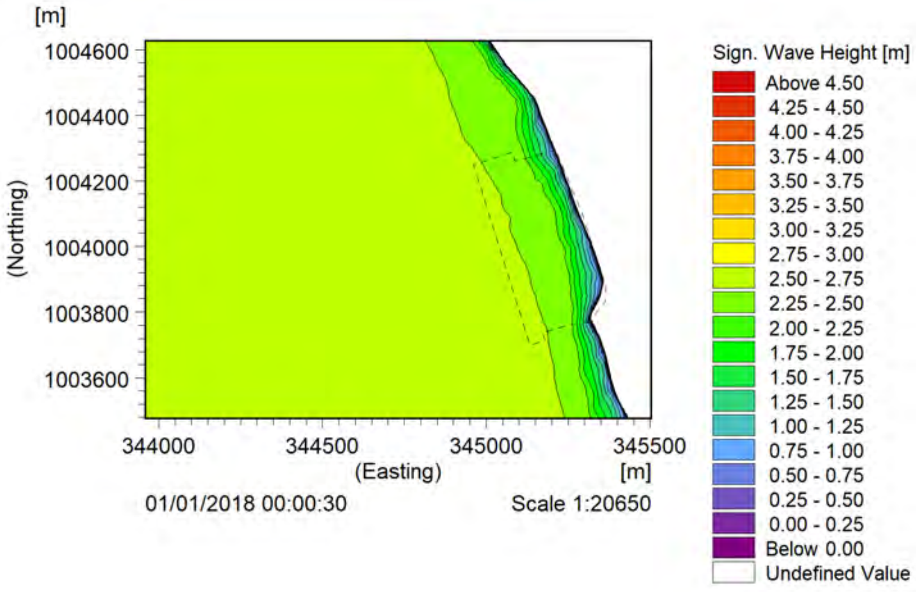
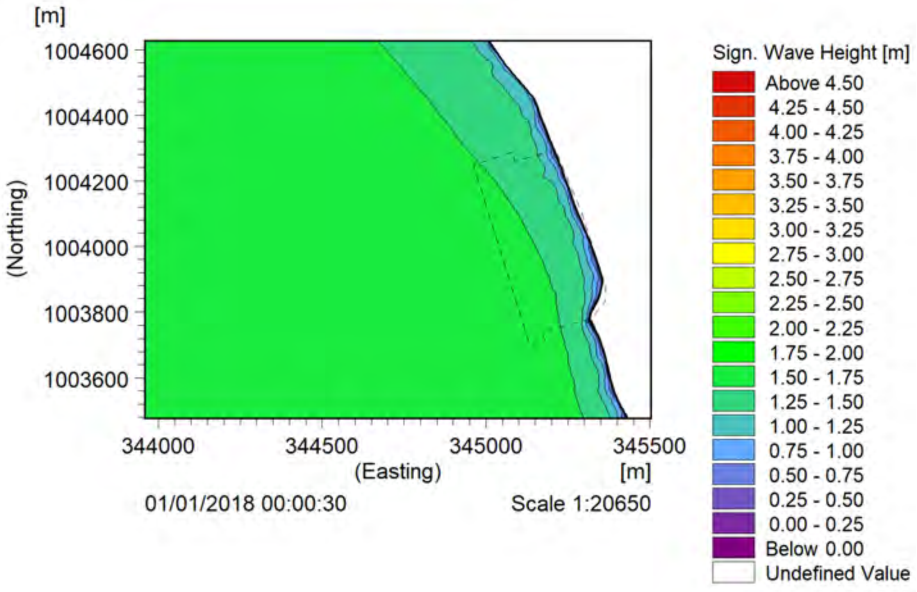


Figure D-20 Model result Hs (m), 1-in-50 year north-westerly wind direction



D.2 SIGNIFICANT WAVE HEIGHT CONTOUR PLOTS – SCHEME 1 (WITH SUSPENDED DECKING)

Figure D-21 Model result Hs (m), 15 knots southerly wind direction

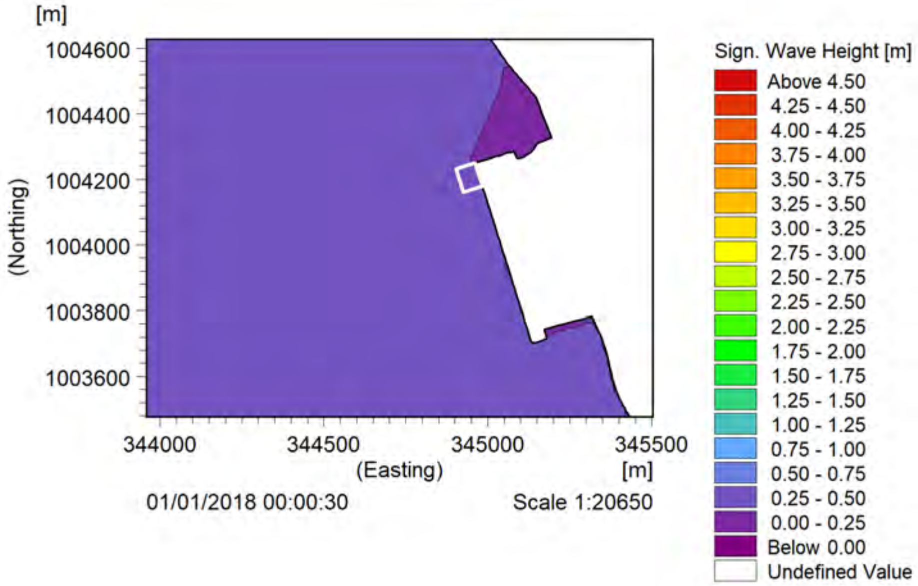


Figure D-22 Model result Hs (m), 15 knots south-westerly wind direction

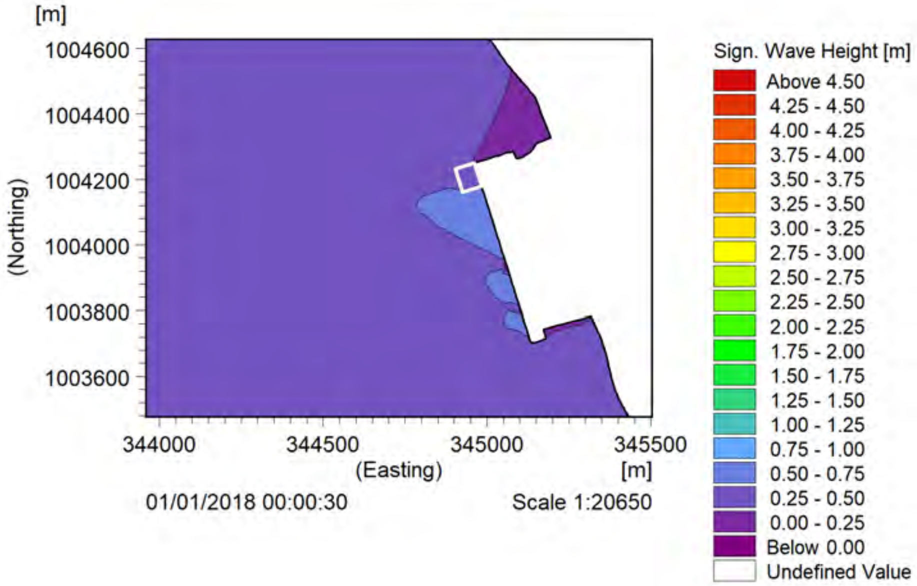


Figure D-23 Model result Hs (m), 15 knots westerly wind direction

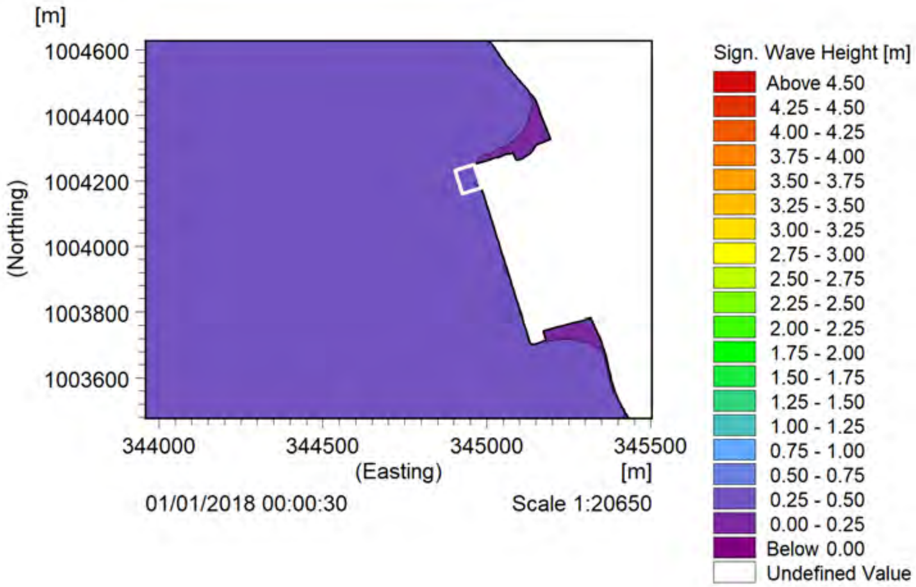


Figure D-24 Model result Hs (m), 15 knots north-westerly wind direction

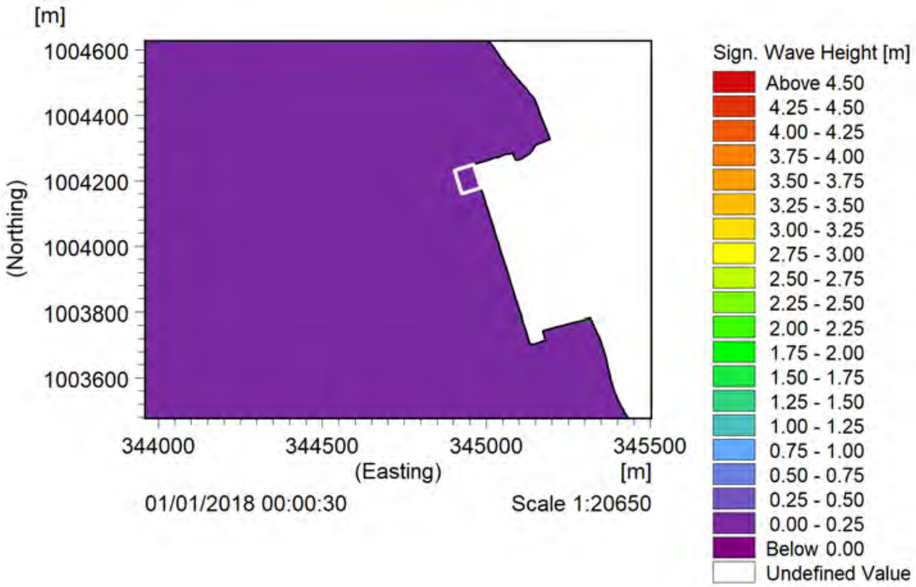


Figure D-25 Model result Hs (m), 30 knots southerly wind direction

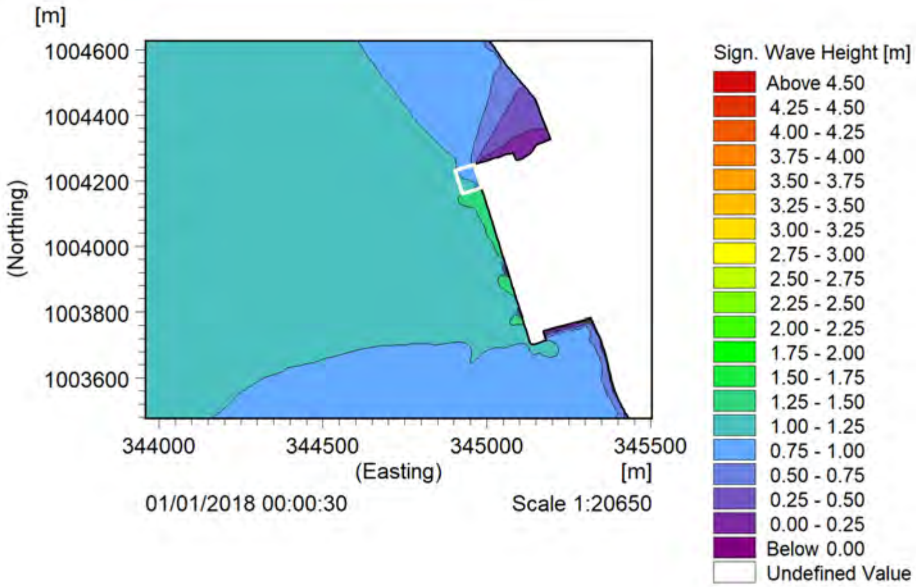


Figure D-26 Model result Hs (m), 30 knots south-westerly wind direction

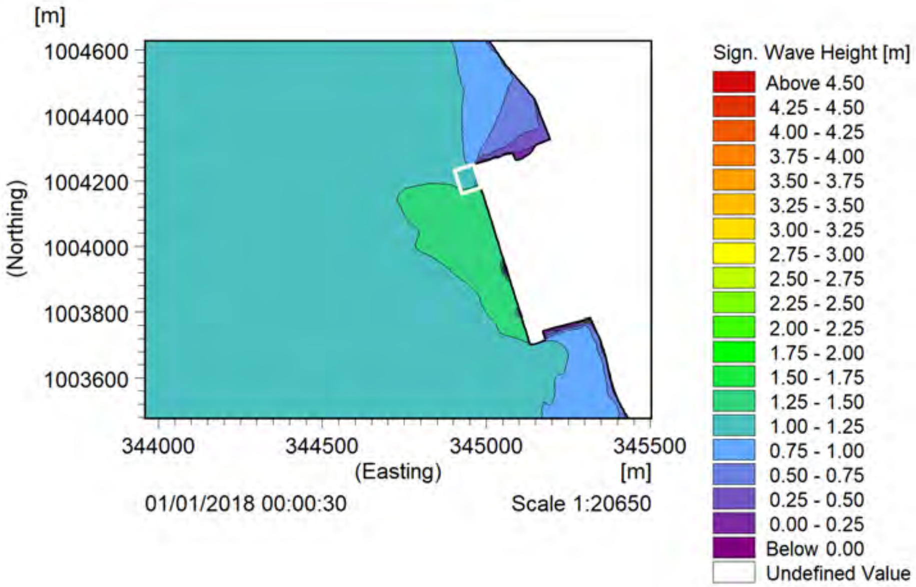


Figure D-27 Model result Hs (m), 30 knots westerly wind direction

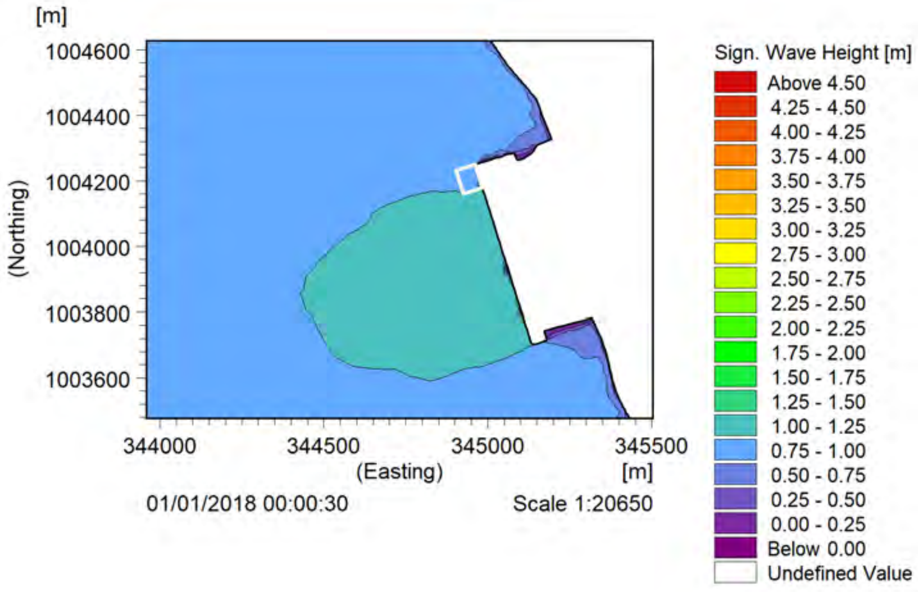


Figure D-28 Model result Hs (m), 30 knots north-westerly wind direction

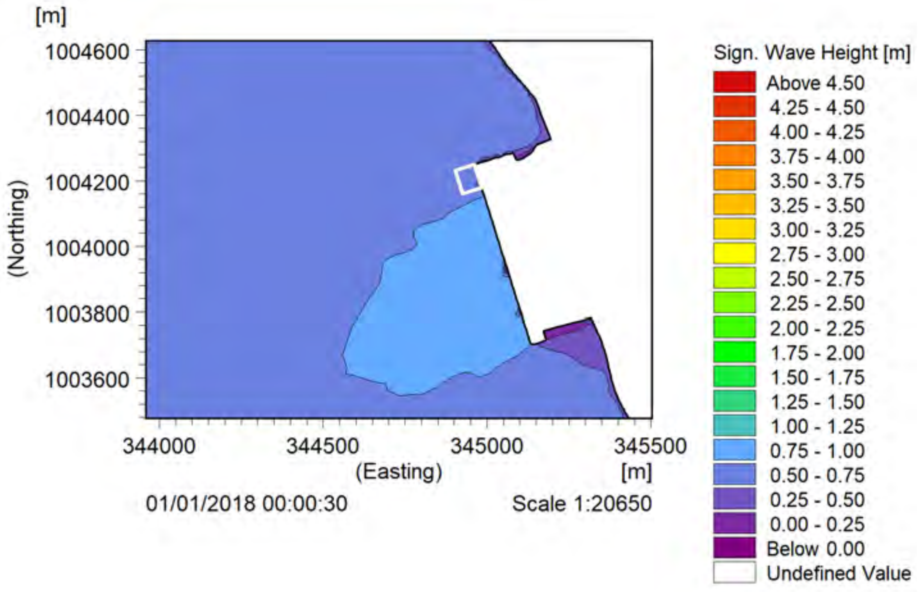


Figure D-29 Model result Hs (m), 1-in-1 year southerly wind direction

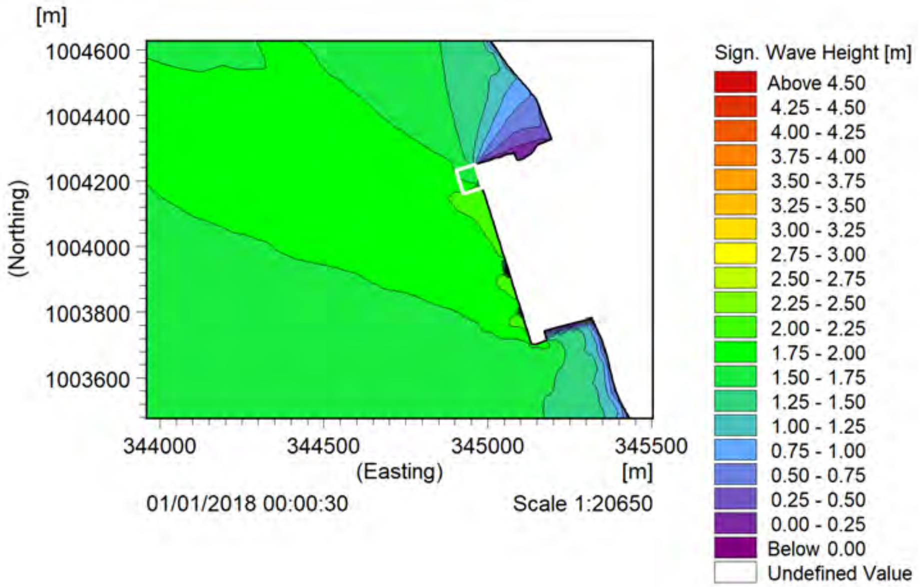


Figure D-30 Model result Hs (m), 1-in-1 year south-westerly wind direction

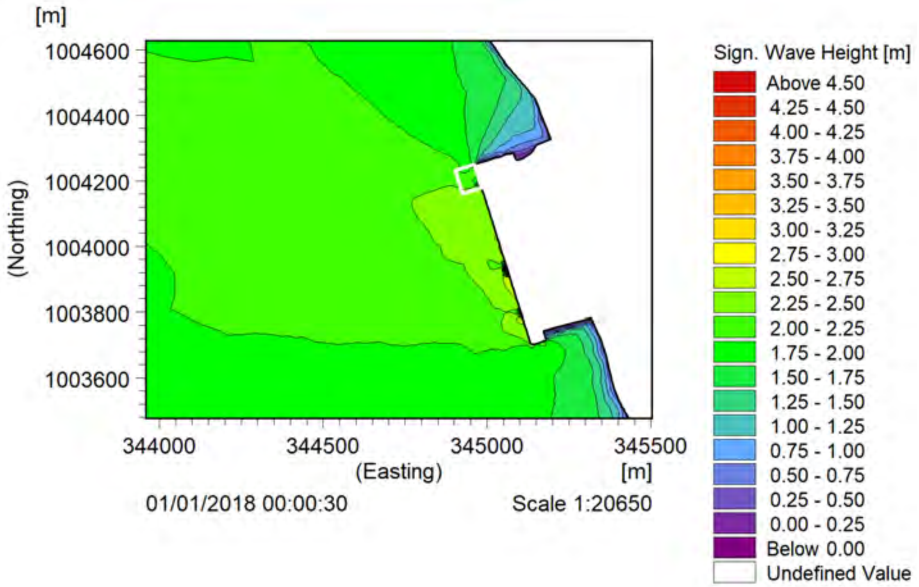


Figure D-31 Model result Hs (m), 1-in-1 year westerly wind direction

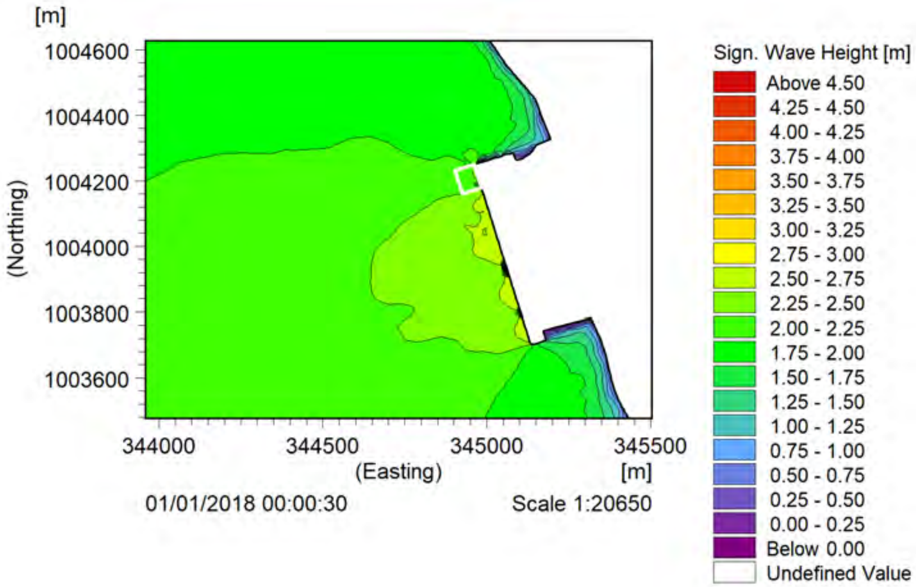


Figure D-32 Model result Hs (m), 1-in-1 year north-westerly wind direction

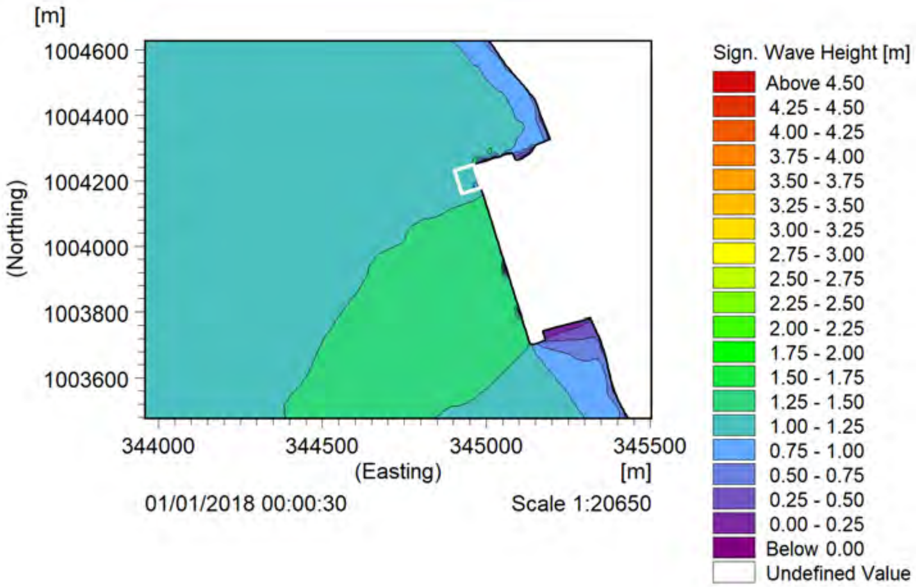


Figure D-33 Model result Hs (m), 1-in-10 year southerly wind direction

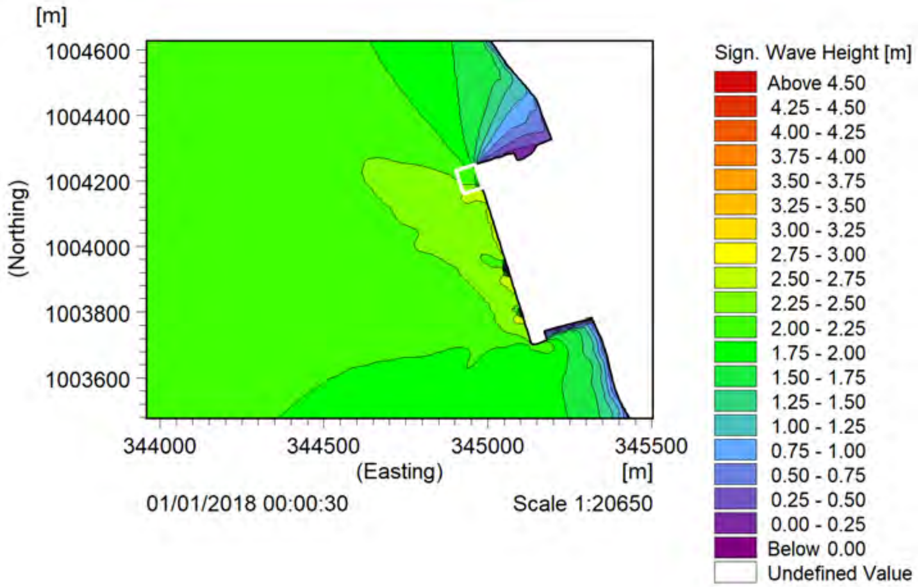


Figure D-34 Model result Hs (m), 1-in-10 year south-westerly wind direction

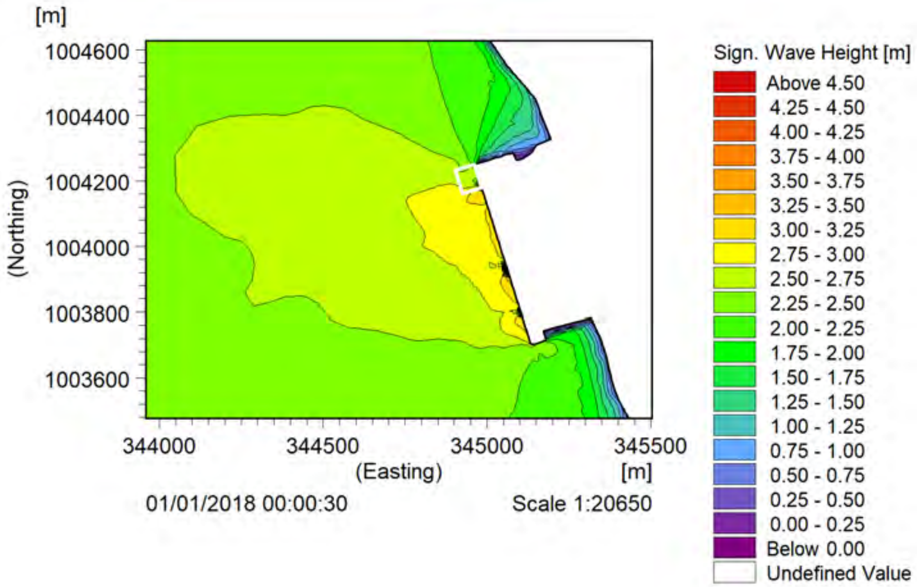


Figure D-35 Model result Hs (m), 1-in-10 year westerly wind direction

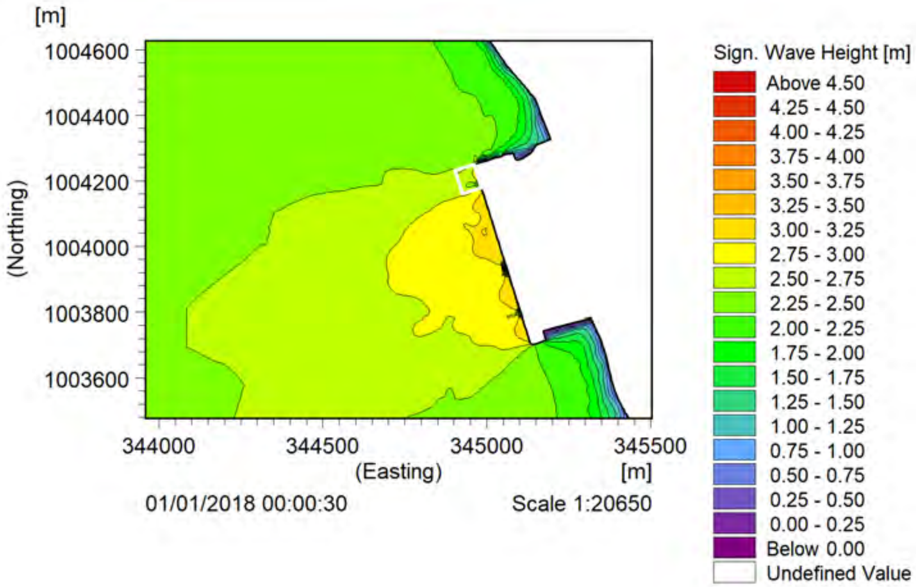


Figure D-36 Model result Hs (m), 1-in-10 year north-westerly wind direction

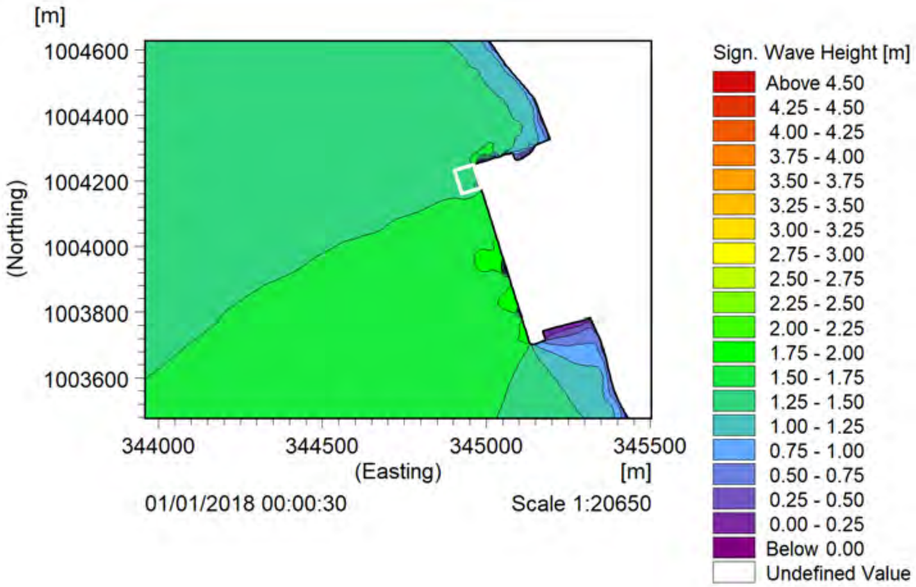


Figure D-37 Model result Hs (m), 1-in-50 year southerly wind direction

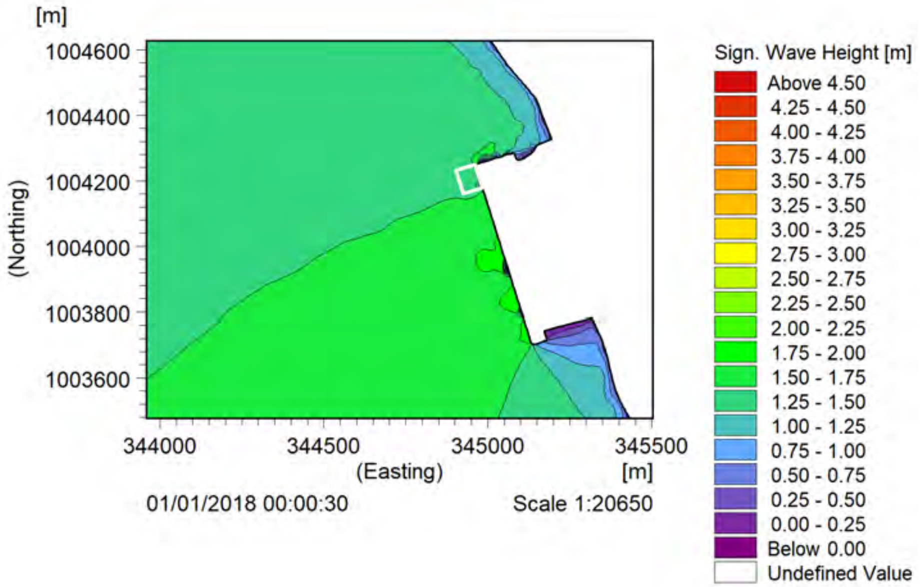


Figure D-38 Model result Hs (m), 1-in-50 year south-westerly wind direction

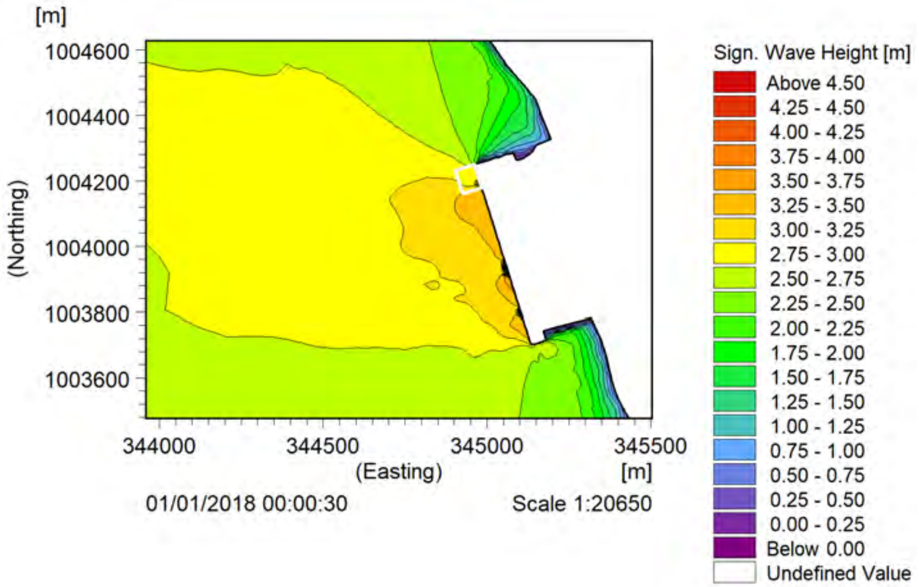


Figure D-39 Model result Hs (m), 1-in-50 year westerly wind direction

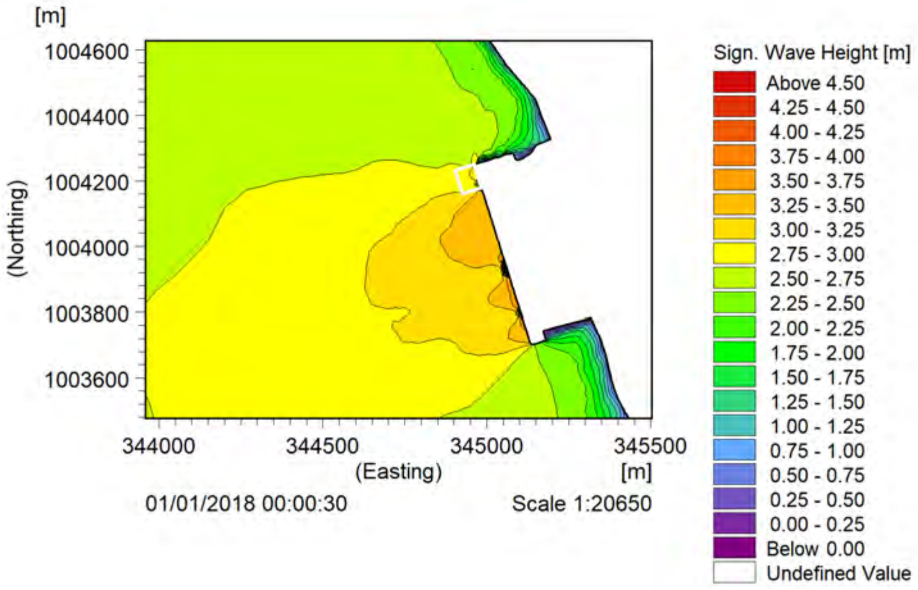
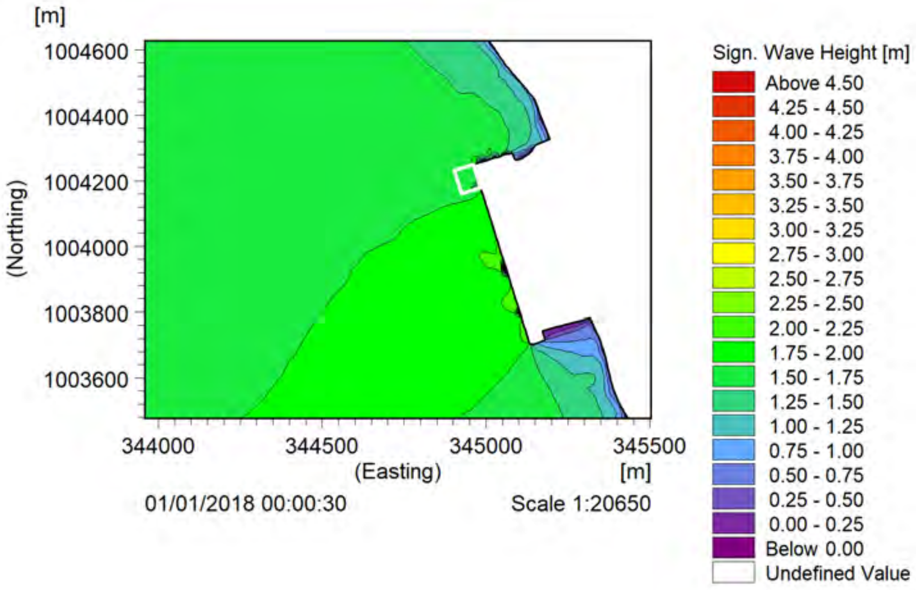


Figure D-40 Model result Hs (m), 1-in-50 year north-westerly wind direction



D.3 SIGNIFICANT WAVE HEIGHT CONTOUR PLOTS – SCHEME 2 (WITHOUT SUSPENDED DECKING)

Figure D-41 Model result Hs (m), 15 knots southerly wind direction

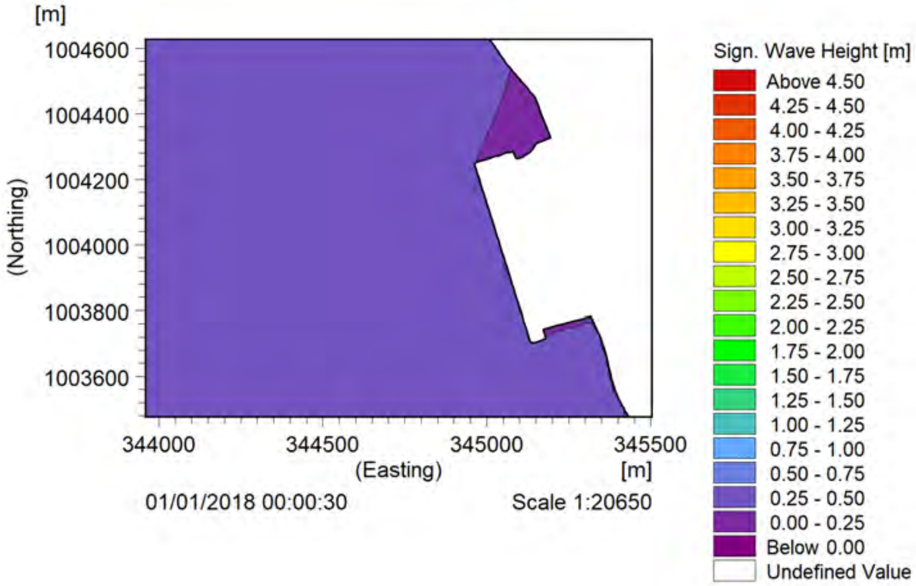


Figure D-42 Model result Hs (m), 15 knots south-westerly wind direction

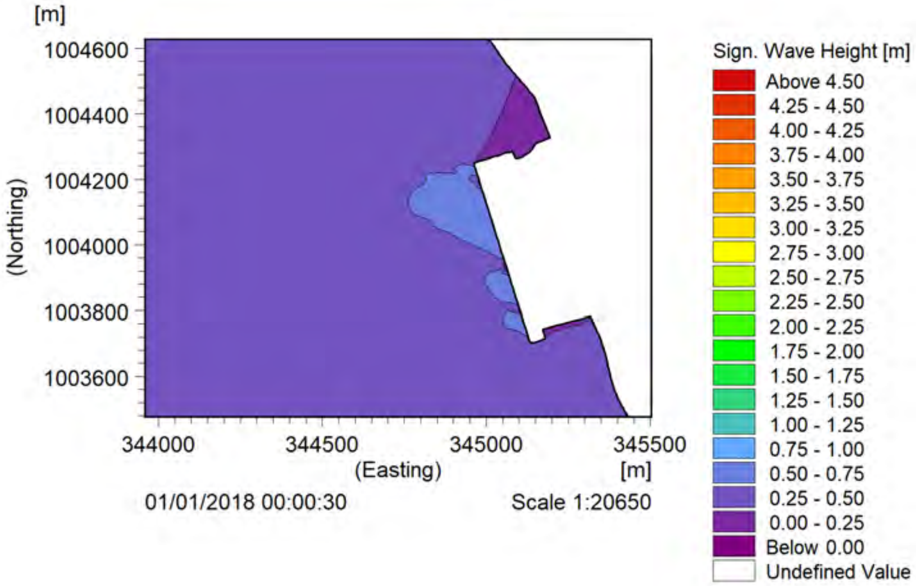


Figure D-43 Model result Hs (m), 15 knots westerly wind direction

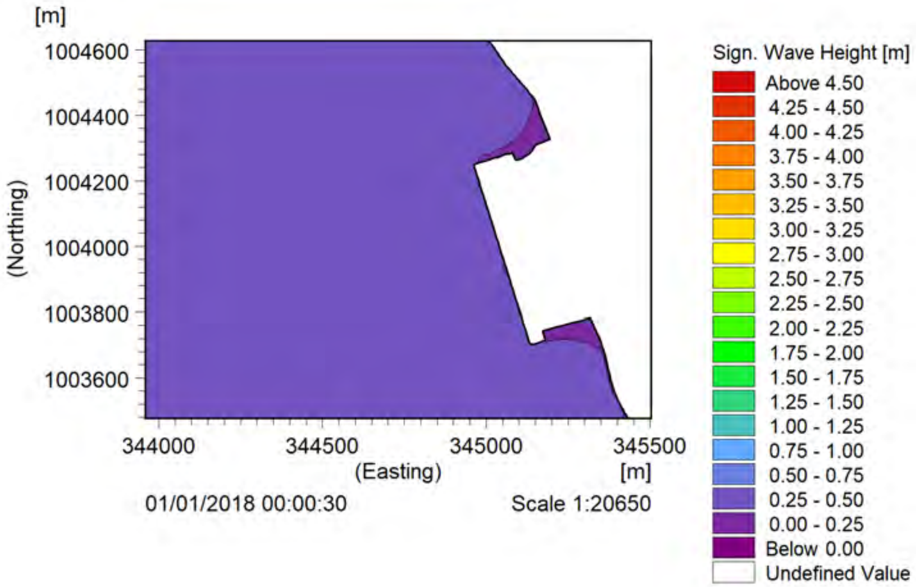


Figure D-44 Model result Hs (m), 15 knots north-westerly wind direction

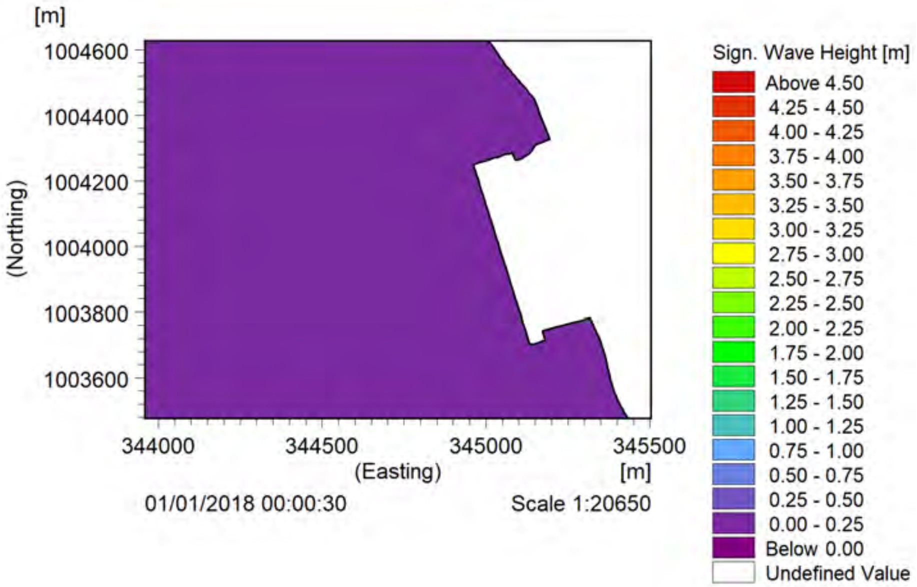


Figure D-45 Model result Hs (m), 30 knots southerly wind direction

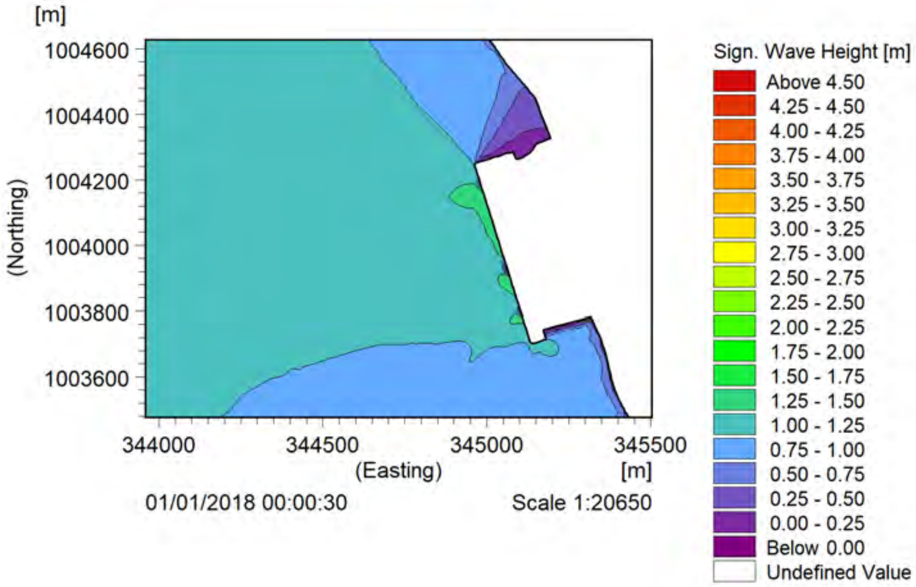


Figure D-46 Model result Hs (m), 30 knots south-westerly wind direction

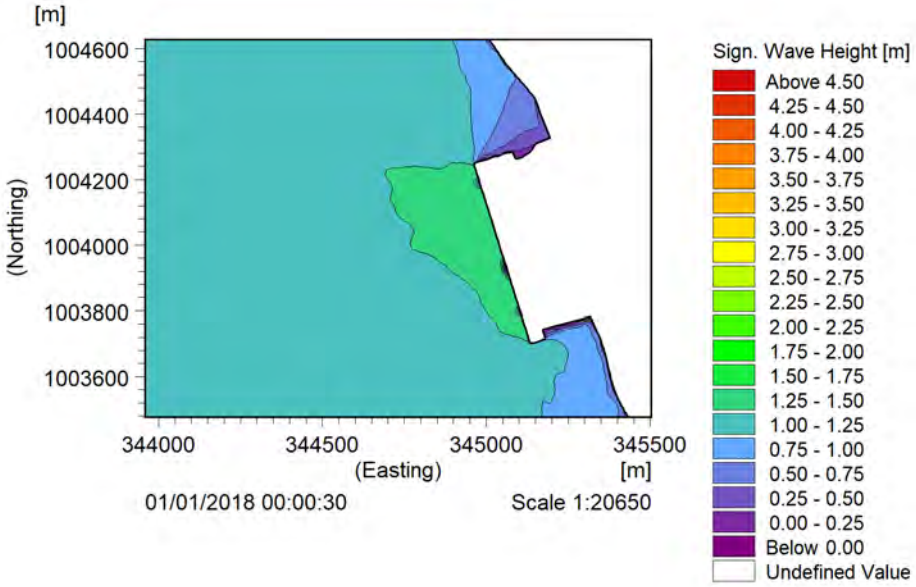


Figure D-47 Model result Hs (m), 30 knots westerly wind direction

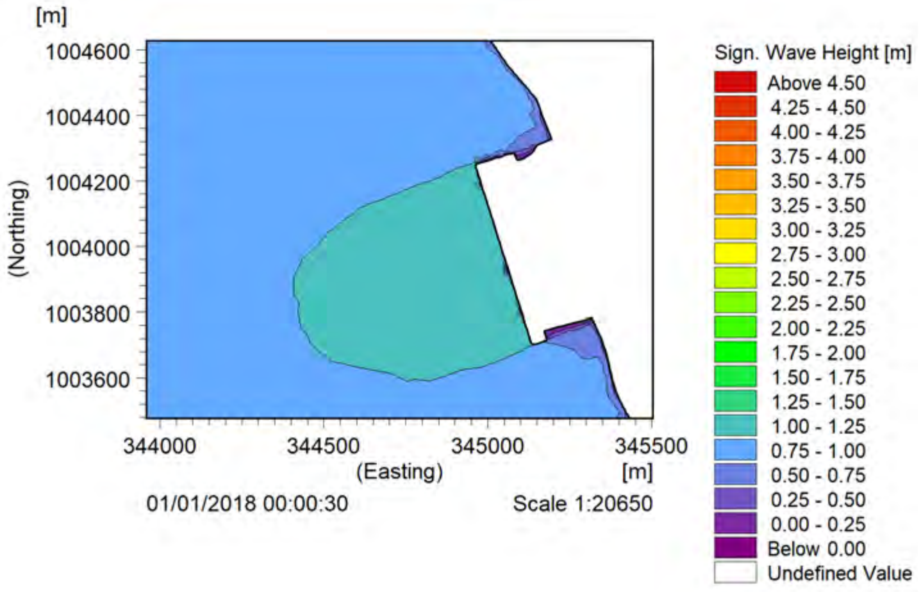


Figure D-48 Model result Hs (m), 30 knots north-westerly wind direction

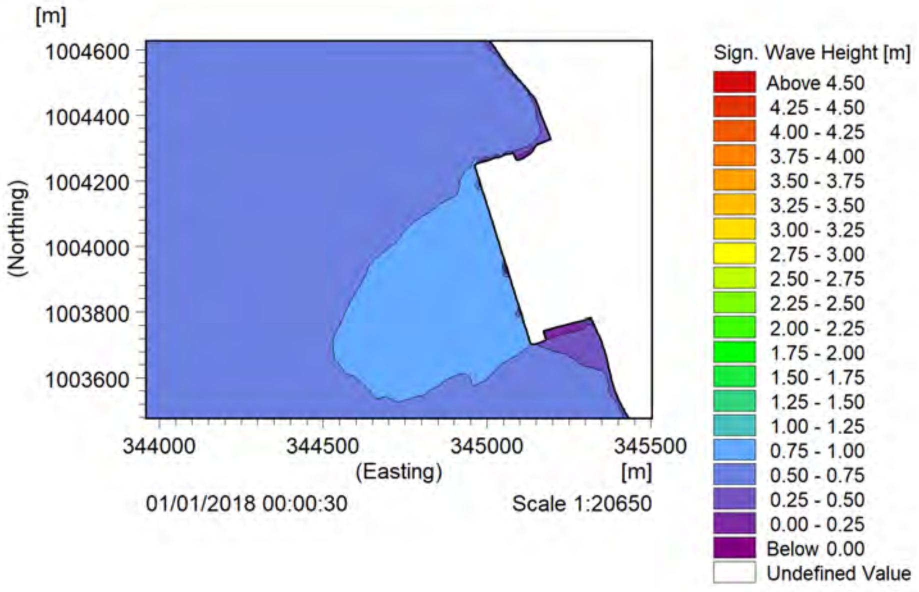


Figure D-49 Model result Hs (m), 1-in-1 year southerly wind direction

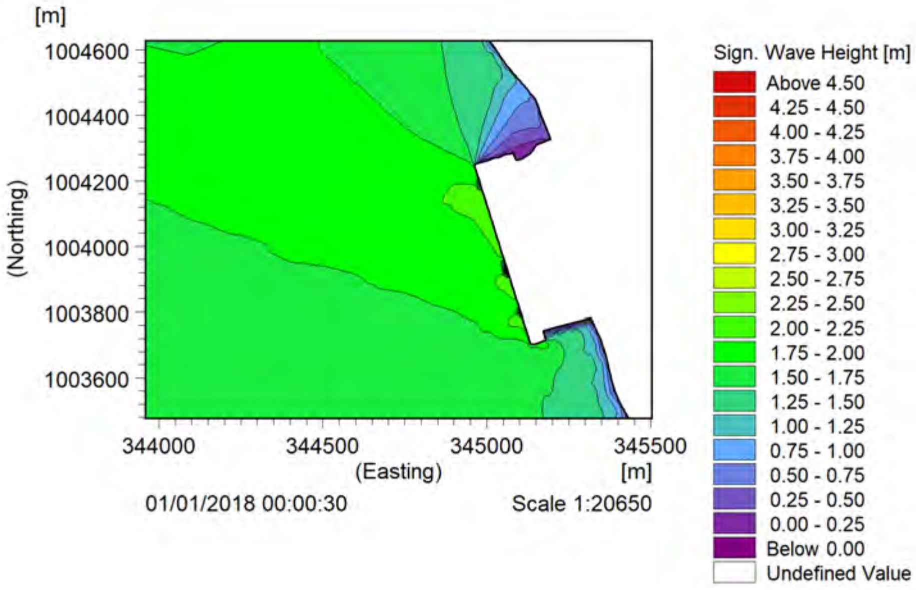


Figure D-50 Model result Hs (m), 1-in-1 year south-westerly wind direction

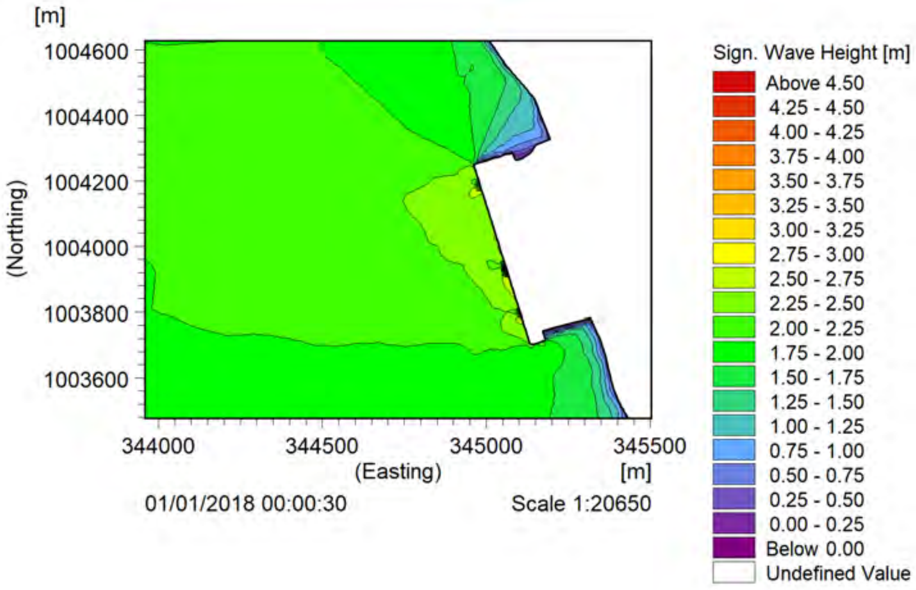


Figure D-51 Model result Hs (m), 1-in-1 year westerly wind direction

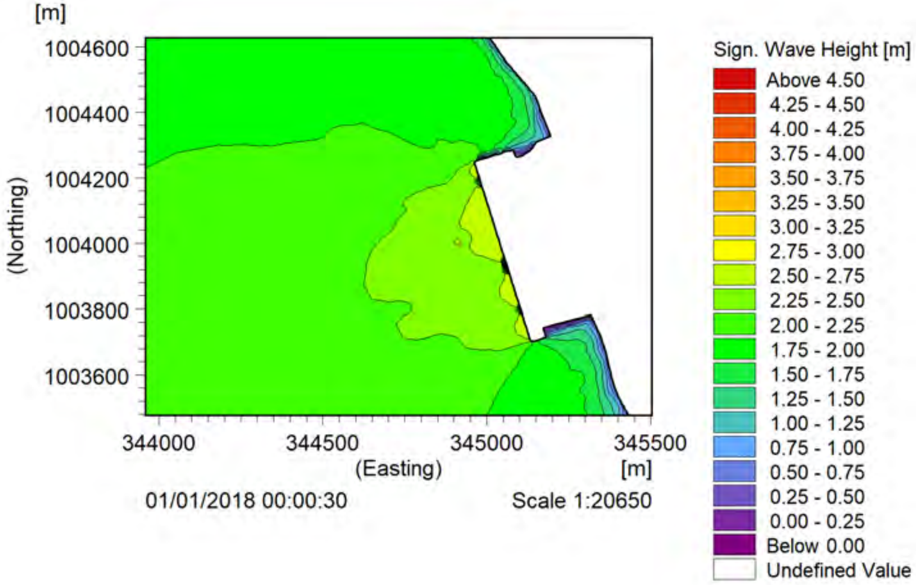


Figure D-52 Model result Hs (m), 1-in-1 year north-westerly wind direction

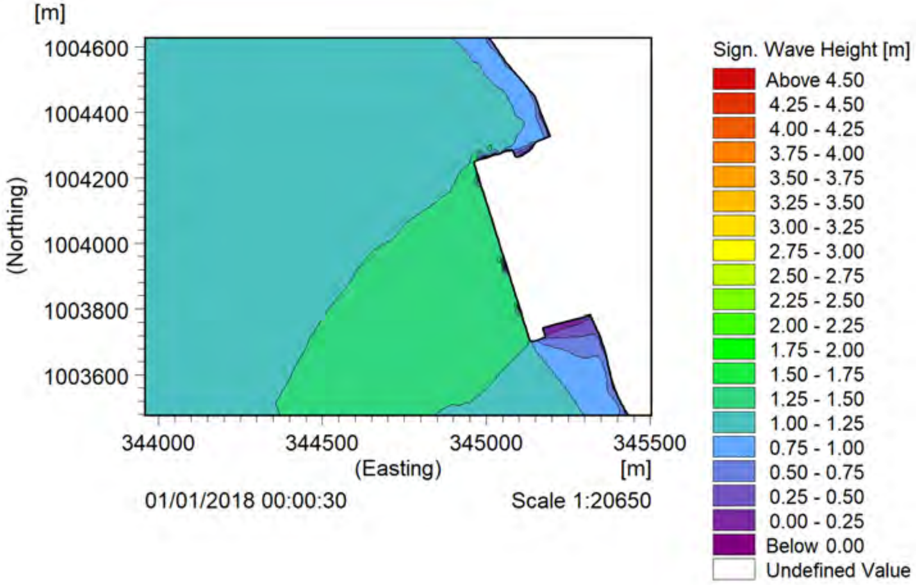


Figure D-53 Model result Hs (m), 1-in-10 year southerly wind direction

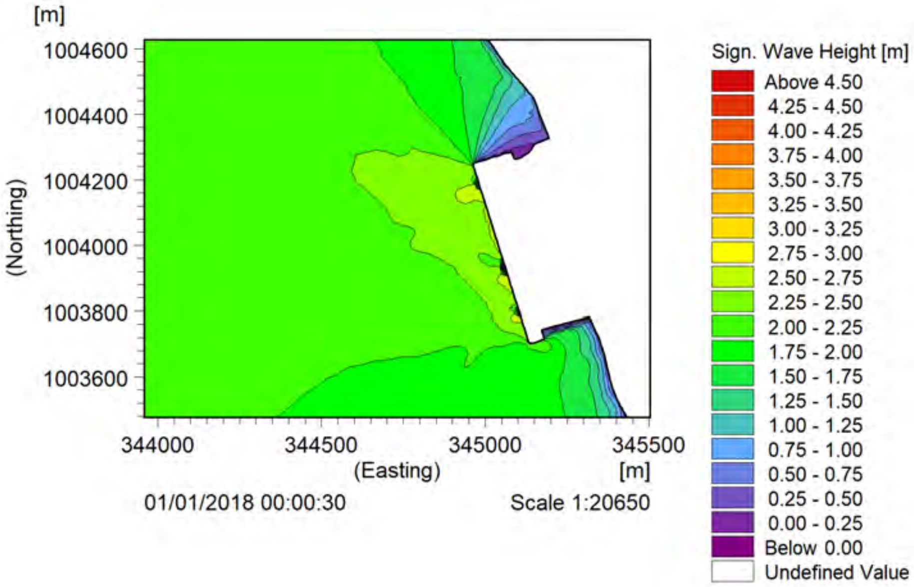


Figure D-54 Model result Hs (m), 1-in-10 year south-westerly wind direction

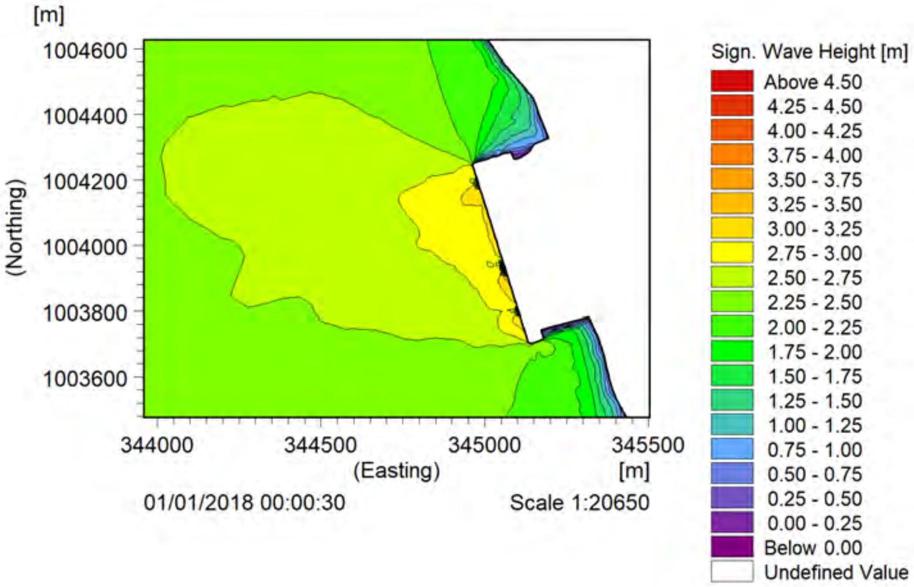


Figure D-55 Model result Hs (m), 1-in-10 year westerly wind direction

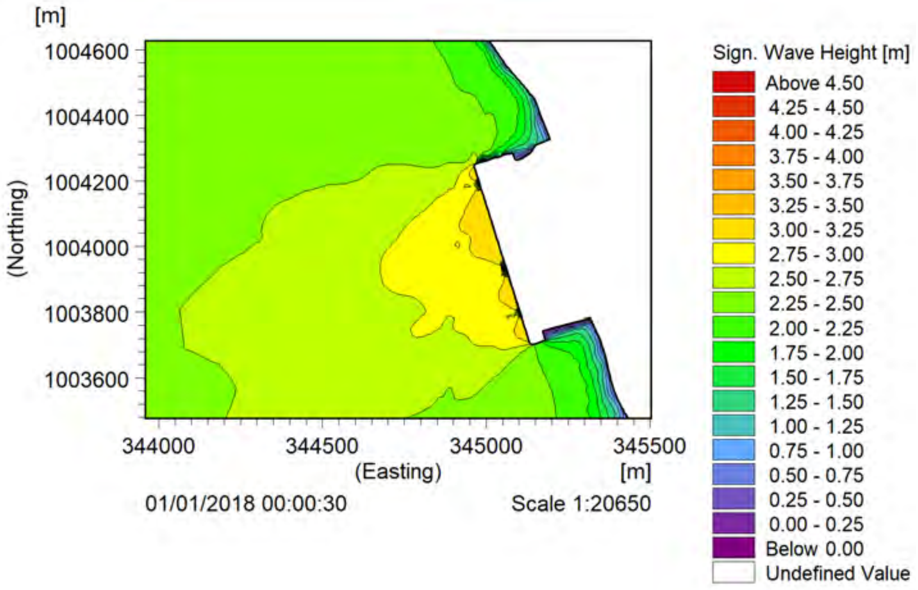


Figure D-56 Model result Hs (m), 1-in-10 year north-westerly wind direction

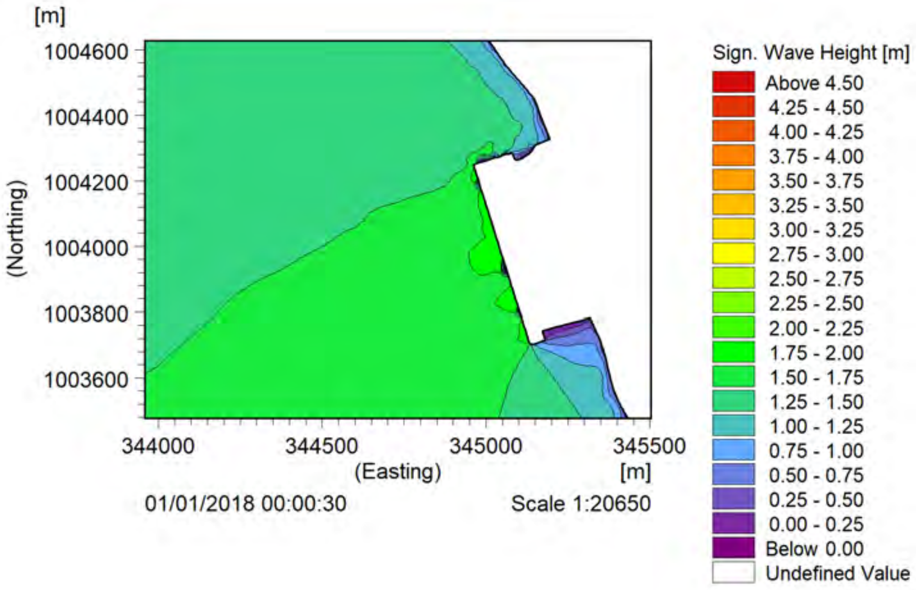


Figure D-57 Model result Hs (m), 1-in-50 year southerly wind direction

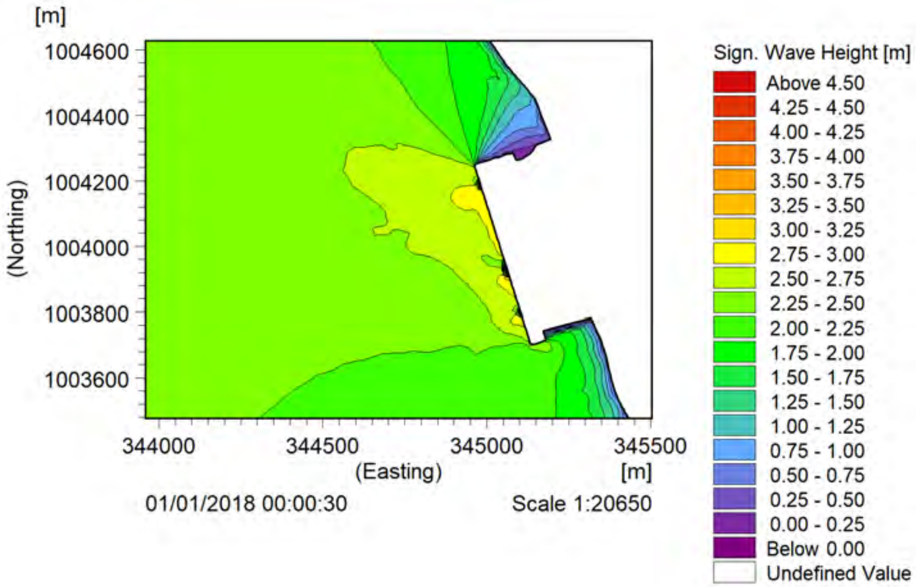


Figure D-58 Model result Hs (m), 1-in-50 year south-westerly wind direction

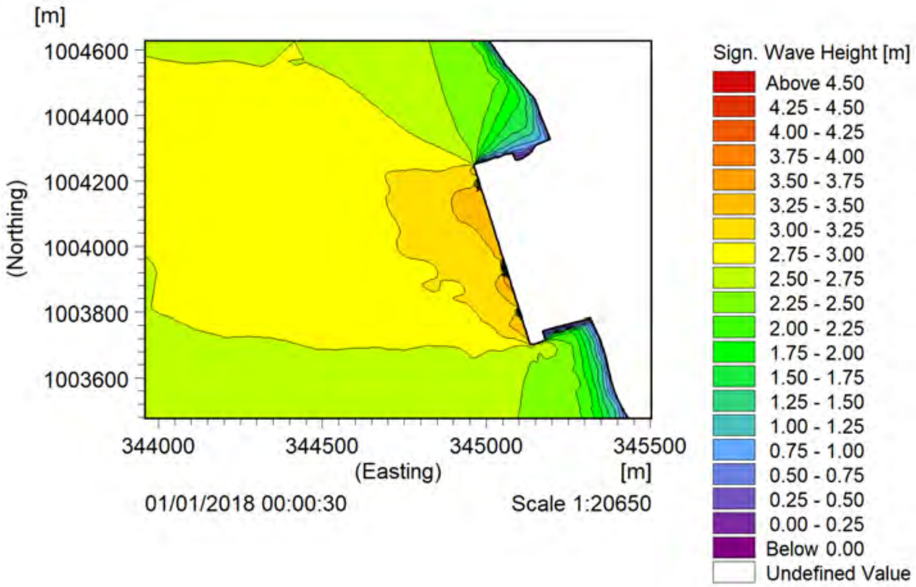


Figure D-59 Model result Hs (m), 1-in-50 year westerly wind direction

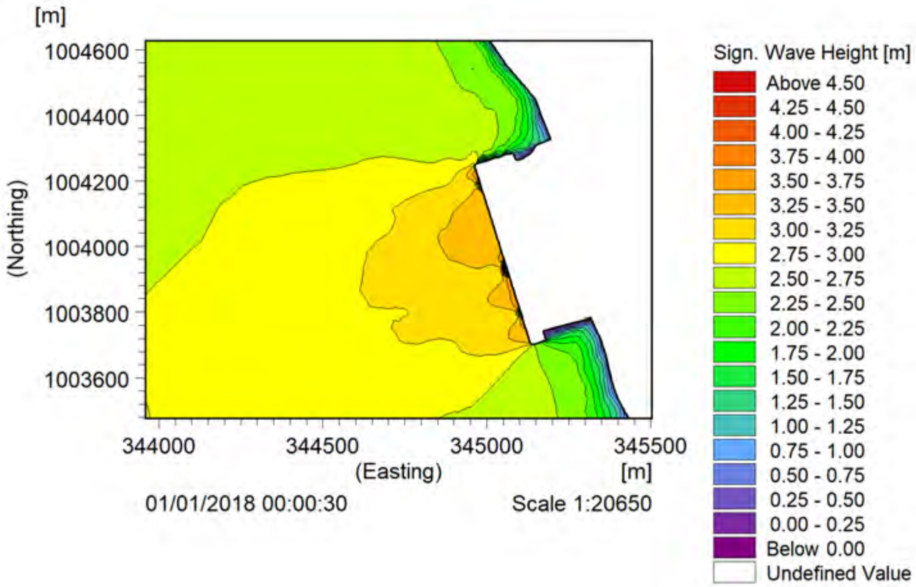
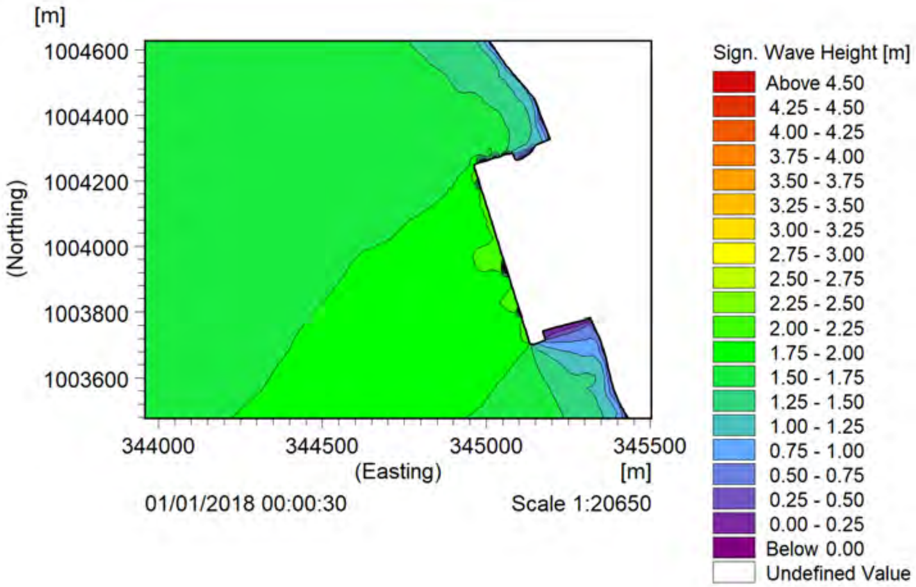


Figure D-60 Model result Hs (m), 1-in-50 year north-westerly wind direction



D.4 PEAK WAVE PERIOD RESULTS TABLES

For the output locations depicted in **Error! Reference source not found.**, the predicted Tp for each wind speed condition for the four directional sectors is presented in **Error! Reference source not found.** to **Error! Reference source not found.**.

Table D-1 Model Result Tp (s), from a southerly wind direction

Output Location	Baseline (Pre-development)					Scheme 1 (Post-development with suspended decking)					Scheme 2 (Post-development without suspended decking)				
	15 kts	30 kts	1:1	1:10	1:50	15 kts	30 kts	1:1	1:10	1:50	15 kts	30 kts	1:1	1:10	1:50
WV-01	2.65	3.92	4.84	5.14	5.36	2.66	3.93	4.78	5.18	5.43	2.66	3.93	4.78	5.18	5.43
WV-02	2.67	3.93	4.78	5.09	5.27	2.67	3.94	4.70	5.08	5.26	2.67	3.94	4.70	5.08	5.26
WV-03	2.67	3.95	4.80	5.10	5.27	2.68	3.96	4.73	5.12	5.29	2.68	3.96	4.73	5.12	5.29
WV-04	2.67	3.96	4.82	5.11	5.28	2.68	3.98	4.77	5.16	5.36	2.68	3.98	4.77	5.16	5.36
WV-05	2.68	3.97	4.84	5.12	5.30	2.69	3.99	4.77	5.16	5.35	2.69	3.99	4.77	5.16	5.35
WV-06	2.68	3.98	4.86	5.14	5.32	2.69	4.01	4.80	5.19	5.41	2.69	4.01	4.80	5.19	5.41
WV-07	2.69	3.99	4.88	5.15	5.34	2.69	4.02	4.81	5.19	5.41	2.69	4.02	4.81	5.19	5.41
WV-08	2.69	4.00	4.89	5.16	5.35	2.70	4.03	4.82	5.20	5.44	2.70	4.03	4.82	5.20	5.44
WV-09	2.69	4.01	4.92	5.17	5.37	2.70	4.05	4.83	5.21	5.47	2.70	4.05	4.83	5.21	5.47
WV-10	2.69	4.02	4.93	5.17	5.39	2.70	4.06	4.85	5.22	5.50	2.70	4.06	4.85	5.22	5.50
WV-11	2.70	4.04	5.00	5.20	5.45	2.70	4.05	4.85	5.22	5.50	2.70	4.05	4.85	5.22	5.49
WV-12	2.70	4.04	4.99	5.20	5.44	2.71	4.07	4.86	5.23	5.52	2.71	4.06	4.86	5.23	5.52
WV-13	2.70	4.04	4.96	5.18	5.41	2.72	4.15	4.87	5.24	5.53	2.71	4.06	4.83	5.20	5.46
WV-14	2.70	4.06	5.02	5.20	5.47	2.71	4.11	4.88	5.24	5.54	2.71	4.07	4.86	5.23	5.52
WV-15	2.70	4.07	5.04	5.22	5.51	2.71	4.11	4.88	5.24	5.55	2.71	4.08	4.86	5.23	5.53
WV-16	2.70	4.05	4.97	5.19	5.43	2.72	4.16	4.89	5.25	5.56	2.71	4.08	4.84	5.21	5.50
WV-17	2.70	4.02	4.93	5.17	5.41	2.75	4.21	5.04	5.42	5.66	2.72	4.11	4.96	5.33	5.59
WV-18	2.69	3.99	4.94	5.19	5.45	2.77	4.32	5.22	5.65	5.87	2.76	4.26	5.17	5.59	5.78

Table D-2 Model Result Tp (s), from a south-westerly wind direction

Output Location	Baseline (Pre-development)					Scheme 1 (Post-development with suspended decking)					Scheme 2 (Post-development without suspended decking)				
	15 kts	30 kts	1:1	1:10	1:50	15 kts	30 kts	1:1	1:10	1:50	15 kts	30 kts	1:1	1:10	1:50
WV-01	2.74	3.92	4.89	5.30	5.55	2.76	3.96	4.92	5.36	5.65	2.76	3.96	4.92	5.36	5.65
WV-02	2.78	3.94	4.87	5.28	5.52	2.80	3.97	4.89	5.31	5.58	2.80	3.97	4.89	5.31	5.58
WV-03	2.79	3.95	4.89	5.29	5.53	2.81	3.96	4.88	5.30	5.55	2.81	3.96	4.88	5.30	5.55
WV-04	2.80	3.96	4.90	5.29	5.54	2.81	3.97	4.89	5.31	5.56	2.81	3.97	4.89	5.31	5.56
WV-05	2.82	3.97	4.92	5.30	5.56	2.83	3.97	4.90	5.31	5.57	2.83	3.97	4.90	5.31	5.57
WV-06	2.84	3.98	4.93	5.31	5.58	2.85	4.00	4.95	5.35	5.63	2.85	4.00	4.95	5.35	5.63
WV-07	2.84	3.98	4.94	5.32	5.59	2.85	3.98	4.91	5.32	5.59	2.85	3.98	4.91	5.32	5.59
WV-08	2.85	3.99	4.95	5.33	5.60	2.86	4.01	4.96	5.36	5.64	2.86	4.01	4.96	5.36	5.64
WV-09	2.86	3.99	4.97	5.33	5.61	2.87	4.01	4.98	5.37	5.65	2.87	4.01	4.98	5.37	5.65
WV-10	2.86	3.99	4.98	5.34	5.62	2.88	4.02	5.00	5.38	5.67	2.88	4.02	4.99	5.38	5.67
WV-11	2.86	4.00	5.01	5.36	5.64	2.87	4.01	4.98	5.37	5.65	2.87	4.01	4.97	5.37	5.65
WV-12	2.87	4.00	5.01	5.36	5.64	2.88	4.04	5.04	5.41	5.69	2.88	4.03	5.03	5.40	5.69
WV-13	2.87	4.00	4.99	5.35	5.63	2.91	4.07	5.03	5.41	5.69	2.88	4.01	4.98	5.37	5.65
WV-14	2.87	4.01	5.02	5.37	5.65	2.90	4.05	5.06	5.43	5.71	2.89	4.03	5.04	5.41	5.69
WV-15	2.87	4.01	5.04	5.38	5.66	2.90	4.06	5.07	5.44	5.71	2.89	4.04	5.06	5.43	5.70
WV-16	2.87	4.00	5.00	5.35	5.64	2.90	4.06	5.05	5.43	5.71	2.89	4.04	5.03	5.41	5.69
WV-17	2.86	3.99	4.97	5.34	5.63	2.73	3.84	4.76	5.20	5.39	2.76	3.86	4.77	5.21	5.39
WV-18	2.85	3.97	4.98	5.35	5.64	1.85	3.56	4.56	4.99	5.19	2.10	3.59	4.58	5.00	5.20

Table D-3 Model Result Tp (s), from a westerly wind direction

Output Location	Baseline (Pre-development)					Scheme 1 (Post-development with suspended decking)					Scheme 2 (Post-development without suspended decking)				
	15 kts	30 kts	1:1	1:10	1:50	15 kts	30 kts	1:1	1:10	1:50	15 kts	30 kts	1:1	1:10	1:50
WV-01	2.27	3.64	4.92	5.30	5.63	2.45	3.73	5.08	5.38	5.74	2.44	3.73	5.08	5.38	5.74
WV-02	2.27	3.64	4.87	5.27	5.56	2.42	3.68	4.94	5.31	5.64	2.42	3.68	4.94	5.31	5.64
WV-03	2.27	3.64	4.88	5.27	5.56	2.36	3.65	4.90	5.28	5.58	2.36	3.65	4.90	5.28	5.58
WV-04	2.26	3.64	4.88	5.27	5.55	2.38	3.66	4.92	5.29	5.59	2.38	3.66	4.92	5.29	5.59
WV-05	2.26	3.64	4.87	5.27	5.54	2.35	3.65	4.90	5.28	5.57	2.35	3.65	4.90	5.28	5.57
WV-06	2.26	3.65	4.88	5.27	5.54	2.38	3.67	4.93	5.30	5.61	2.38	3.67	4.92	5.30	5.60
WV-07	2.26	3.65	4.88	5.27	5.54	2.35	3.65	4.89	5.28	5.56	2.35	3.65	4.89	5.28	5.56
WV-08	2.26	3.65	4.88	5.27	5.54	2.36	3.67	4.92	5.30	5.59	2.36	3.66	4.92	5.30	5.59
WV-09	2.26	3.65	4.88	5.27	5.53	2.35	3.67	4.92	5.30	5.59	2.34	3.66	4.91	5.30	5.59
WV-10	2.26	3.65	4.88	5.28	5.54	2.38	3.68	4.93	5.31	5.61	2.36	3.67	4.92	5.30	5.59
WV-11	2.26	3.65	4.89	5.28	5.55	2.39	3.68	4.95	5.32	5.63	2.37	3.68	4.94	5.31	5.62
WV-12	2.26	3.65	4.89	5.28	5.55	2.38	3.69	4.95	5.32	5.62	2.35	3.67	4.93	5.31	5.60
WV-13	2.26	3.65	4.89	5.28	5.54	2.37	3.71	4.94	5.32	5.63	2.33	3.66	4.90	5.29	5.56
WV-14	2.26	3.65	4.89	5.29	5.55	2.34	3.68	4.96	5.33	5.64	2.37	3.68	4.95	5.32	5.62
WV-15	2.26	3.65	4.90	5.29	5.55	2.33	3.67	4.94	5.32	5.62	2.34	3.67	4.94	5.31	5.61
WV-16	2.26	3.66	4.89	5.28	5.54	2.32	3.66	4.91	5.30	5.59	2.33	3.66	4.91	5.29	5.58
WV-17	2.26	3.65	4.88	5.28	5.55	2.29	3.62	4.83	5.24	5.44	2.30	3.62	4.83	5.24	5.44
WV-18	2.27	3.64	4.90	5.30	5.60	2.27	3.59	4.79	5.21	5.36	2.27	3.59	4.79	5.21	5.36

Table D-4 Model Result Tp (s), from a north-westerly wind direction

Output Location	Baseline (Pre-development)					Scheme 1 (Post-development with suspended decking)					Scheme 2 (Post-development without suspended decking)				
	15 kts	30 kts	1:1	1:10	1:50	15 kts	30 kts	1:1	1:10	1:50	15 kts	30 kts	1:1	1:10	1:50
WV-01	2.15	3.22	3.89	4.26	4.46	2.17	3.77	4.66	5.11	5.35	2.17	3.77	4.66	5.11	5.35
WV-02	2.16	3.24	3.87	4.22	4.37	2.53	3.42	4.12	4.47	4.76	2.53	3.42	4.12	4.47	4.76
WV-03	2.16	3.24	3.87	4.22	4.38	2.16	3.20	3.85	4.20	4.36	2.16	3.20	3.84	4.20	4.36
WV-04	2.15	3.23	3.86	4.21	4.36	2.16	3.26	3.92	4.28	4.48	2.16	3.26	3.92	4.28	4.48
WV-05	2.14	3.22	3.85	4.20	4.34	2.15	3.21	3.88	4.24	4.40	2.15	3.21	3.88	4.24	4.40
WV-06	2.14	3.21	3.84	4.19	4.33	2.15	3.25	3.91	4.26	4.44	2.15	3.25	3.90	4.26	4.43
WV-07	2.13	3.20	3.84	4.19	4.31	2.15	3.22	3.89	4.24	4.39	2.15	3.21	3.88	4.23	4.38
WV-08	2.13	3.19	3.83	4.18	4.30	2.15	3.21	3.87	4.22	4.37	2.15	3.20	3.86	4.21	4.35
WV-09	2.13	3.19	3.83	4.17	4.29	2.14	3.22	3.89	4.24	4.39	2.14	3.20	3.86	4.21	4.35
WV-10	2.12	3.18	3.82	4.16	4.28	2.14	3.27	3.94	4.29	4.45	2.14	3.22	3.88	4.23	4.38
WV-11	2.12	3.18	3.82	4.16	4.28	2.14	3.26	3.91	4.27	4.42	2.14	3.24	3.90	4.26	4.41
WV-12	2.12	3.18	3.82	4.16	4.28	2.14	3.24	3.88	4.24	4.38	2.14	3.22	3.87	4.23	4.36
WV-13	2.12	3.18	3.82	4.15	4.28	2.14	3.24	3.91	4.26	4.39	2.13	3.19	3.86	4.20	4.34
WV-14	2.12	3.18	3.81	4.15	4.27	2.12	3.19	3.83	4.18	4.31	2.13	3.22	3.84	4.18	4.31
WV-15	2.12	3.17	3.80	4.11	4.25	2.12	3.16	3.80	4.11	4.26	2.12	3.17	3.79	4.10	4.25
WV-16	2.12	3.17	3.81	4.13	4.27	2.12	3.16	3.80	4.13	4.27	2.13	3.16	3.81	4.13	4.27
WV-17	2.12	3.17	3.81	4.10	4.26	2.09	2.98	3.67	3.95	4.16	2.10	3.00	3.68	3.96	4.16
WV-18	2.12	3.16	3.79	4.10	4.27	1.85	3.02	3.73	4.00	4.21	1.85	3.03	3.73	4.00	4.21

TECHNICAL APPENDIX 4.3

Scapa Deep Water Quay (DWQ) Marine – Ground Investigation

INTERPRETATIVE REPORT

Client:	Orkney Islands Council
Client's Representative:	Arch Henderson LLP
Report No.:	21-1031
Date:	20th July 2022
Status:	Final for Issue

Causeway Geotech Ltd
8 Drumahiskey Road, Ballymoney
Co. Antrim, N. Ireland, BT53 7QL

+44 (0)28 2766 6640
info@causewaygeotech.com
www.causewaygeotech.com

Registered in Northern Ireland. Company Number: NI610766
Approved: ISO 9001 • ISO 14001 • OHSAS 18001

CONTENTS

Document Control Sheet

Note on: Methods of describing soils and rocks & abbreviations used on exploratory hole logs

APPENDICES

Appendix A	Site and exploratory hole location plans
Appendix B	Borehole logs
Appendix C	Core photographs
Appendix D	Surface sediment sampling log
Appendix E	Geotechnical laboratory test results
Appendix F	Environmental laboratory test results
Appendix G	Marine sediment laboratory results
Appendix H	Geological long sections
Appendix I	Unexploded ordinance survey report
Appendix J	SPT hammer energy measurement report

Document Control Sheet

Report No.:	21-1031 INTERPRETATIVE
Project Title:	Scapa Deep Water Quay (DWQ) Marine - Ground Investigation
Client:	Orkney Islands Council
Client's Representative:	Arch Henderson LLP

Revision:	A01	**Status:**	Final for Issue	**Issue Date:**	20th July 2022

Prepared by:	**Reviewed by:**	**Approved by:**
Joe Gervin Joe Gervin BSc Hons FGS	Neil Haggan BSc(Hons) MSc FGS	Darren O'Mahony BSc MSc MIEI EurGeol PGeo

The works were conducted in accordance with:

UK Specification for Ground Investigation 2nd Edition, published by ICE Publishing (2012)

British Standards Institute (2015) BS 5930:2015+A1:2020, Code of practice for site investigations.

BS EN 1997-2: 2007: Eurocode 7 - Geotechnical design - Part 2 Ground investigation and testing.

Laboratory testing was conducted in accordance with:

British Standards Institute BS 1377:1990 parts 2, 4, 5, 7 and 9

METHODS OF DESCRIBING SOILS AND ROCKS

Soil and rock descriptions are based on the guidance in BS5930:2015+A1:2020, The Code of Practice for Site Investigation.

Abbreviations used on exploratory hole logs	
U	Nominal 100mm diameter undisturbed open tube sample (thick walled sampler).
UT	Nominal 100mm diameter undisturbed open tube sample (thin walled sampler).
P	Nominal 100mm diameter undisturbed piston sample.
B	Bulk disturbed sample.
LB	Large bulk disturbed sample.
D	Small disturbed sample.
C	Core sub-sample (displayed in the Field Records column on the logs).
L	Liner sample from dynamic sampled borehole.
W	Water sample.
ES / EW	Soil sample for environmental testing / Water sample for environmental testing.
SPT (s)	Standard penetration test using a split spoon sampler (small disturbed sample obtained).
SPT (c)	Standard penetration test using 60 degree solid cone.
(x,x/x,x,x,x)	Blows per increment during the standard penetration test. The initial two values relate to the seating drive (150mm) and the remaining four to the 75mm increments of the test length.
(Y for Z/ Y for Z)	Incomplete standard penetration test where the full test length was not achieved. The blows 'X' represent the total blows for the given seating or test length 'Z' (mm).
N=X	SPT blow count 'N' given by the summation of the blows 'X' required to drive the full test length (300mm).
HVP / HVR	In situ hand vane test result (HVP) and vane test residual result (HVR). Results presented in kPa.
V VR	Shear vane test (borehole). Shear strength stated in kPa. V: undisturbed vane shear strength VR: remoulded vane shear strength
Soil consistency description	In cohesive soils, where samples are disturbed and there are no suitable laboratory tests, N values may be used to indicate consistency on borehole logs – a median relationship of Nx5=Cu is used (as set out in Stroud & Butler 1975).
dd-mm-yyyy	Date at the end and start of shifts, shown at the relevant borehole depth. Corresponding casing and water depths shown in the adjacent columns.
▽	Water strike: initial depth of strike.
▼	Water strike: depth water rose to.
Abbreviations relating to rock core – reference Clause 36.4.4 of BS 5930: 2015	
TCR (%)	Total Core Recovery: Ratio of rock/soil core recovered (both solid and non-intact) to the total length of core run.
SCR (%)	Solid Core Recovery: Ratio of solid core to the total length of core run. Solid core has a full diameter, uninterrupted by natural discontinuities, but not necessarily a full circumference and is measured along the core axis between natural fractures.
RQD (%)	Rock Quality Designation: Ratio of total length of solid core pieces greater than 100mm to the total length of core run.
FI	Fracture Index: Number of natural discontinuities per metre over an indicated length of core of similar intensity of fracturing.
NI	Non Intact: Used where the rock material was recovered fragmented, for example as fine to coarse gravel size particles.
AZCL	Assessed zone of core loss: The estimated depth range where core was not recovered.
DIF	Drilling induced fracture: A fracture of non-geological origin brought about by the rock coring.
(xxx/xxx/xxx)	Spacing between discontinuities (minimum/average/maximum) measured in millimetres.

Scapa DWQ Marine

1 AUTHORITY

On the instructions of Arch Henderson LLP, ("the Client's Representative"), acting on the behalf of Orkney Islands Council ("the Client"), a ground investigation was undertaken at the above location to provide geotechnical and environmental information for input to the design and construction of the proposed development of a deep water quay (DWQ) at Scapa Flow.

This report details the work carried out both on site and in the geotechnical and chemical testing laboratories; it contains a description of the site and the works undertaken, the exploratory hole logs and the laboratory test results. A discussion on the recommendations for construction is also provided.

All information given in this report is based upon the ground conditions encountered during the site investigation works, and on the results of the laboratory and field tests performed. However, there may be conditions at the site that have not been taken into account, such as unpredictable soil strata, contaminant concentrations, and water conditions between or below exploratory holes. It should be noted that groundwater levels usually vary due to seasonal and/or other effects and may at times differ to those recorded during the investigation. No responsibility can be taken for conditions not encountered through the scope of work commissioned, for example between exploratory hole points, or beneath the termination depths achieved.

This report was prepared by Causeway Geotech Ltd for the use of the Client and the Client's Representative in response to a particular set of instructions. Any other parties using the information contained in this report do so at their own risk and any duty of care to those parties is excluded.

2 SCOPE

The extent of the investigation, as instructed by the Client's Representative, included boreholes, wash probes, sediment and rock core sampling, environmental sampling, in-situ and laboratory testing, and the preparation of a report on the findings including recommendation for construction.

3 DESCRIPTION OF SITE

As shown on the site location plan in Appendix A, the works were conducted in an area adjacent to the existing coastline at Scapa Flow. The site is approximately 4.5km south of the town of Scapa, stretching from the Bay of Deepdale at the northern end of the works as far as the Burn of Gangsta to the south.

4 SITE OPERATIONS

4.1 Summary of site works

Site operations, which were conducted between 14th January and 2nd April 2022, comprised:

- Eighteen sonic drilled boreholes with rotary follow-on coring
- One surface sediment sample by grab sample
- UXO survey

The exploratory holes and in-situ tests were located as instructed by the Client's Representative, as shown on the exploratory hole location plan in Appendix A.

4.2 Marine Plant

The OCM80 jack-up barge was deployed for twenty-one overwater testing locations. OCM80 is a Combi-float C5 modular jack-up barge in a six-pontoon configuration joined and secured with a simple pinning system; deck size for this project was 12m x 18m. The jack-up barge sits on four 28m spudded legs with associated hydraulic rams and can be operated in both spudded (floating) or jack-up modes.

The barge was contracted and operated through Ocean Crest Marine for the duration of the site works. The overwater boreholes were sunk through an integral moonpool through one of the pontoons which make up the main deck of the jack-up barge.

Ocean Crest Marine also provided the marine support vessel Ocean Battler for all barge moves, and the OCM Fortess to assist with crew transfers, and supply/equipment transfers as required.

4.3 Boreholes

4.3.1 Sonic drilled boreholes

Eighteen boreholes (BH-M01 - BH-M17 and BH-M26) were put to their completion by sonic drilling with rotary coring in bedrock. The boreholes were completed using a Fraste CRS XL Duo rubber-tracked sonic drilling rig.

The UXO survey was referenced to ensure the boreholes were put down at locations clear of unexploded ordinance or other obstructions. Fully cased sonic drilling techniques were employed to advance the boreholes of nominal 177mm diameter to refusal/rockhead after which Geobor-S coring was undertaken with core recovery in both suitable overburden and bedrock strata as required.

Standard penetration tests were carried out in accordance with BS EN 22476-3:2005+A1:2011 at standard depth intervals throughout the overburden using the split spoon sampler (SPT$_{(s)}$) or solid cone attachment (SPT$_{(c)}$). The penetrations are stated for those tests for which the full 150mm seating drive or 300mm test drive was not possible. The N-values provided on the borehole logs are uncorrected and no allowance has been made for energy ratio corrections. The SPT hammer energy measurement report is provided in Appendix J.

The disturbed sonic samples were decanted into bulk bags. Environmental samples were taken at suitable depths as instructed by the Client's Representative. Samples were also recovered for Marine Scotland testing to assist with analysis for disposal of dredged material at sea.

Where coring was carried out within overburden and bedrock strata, Geobor S Coring was used. The core was extracted in up to 1.50m lengths using an SK6L core barrel, which produced core of nominal 102mm diameter, and was placed in single channel wooden core boxes.

The disturbed bulk samples and rock core were then examined by a qualified and experienced Engineering Geologist, thus enabling the production of an engineering log in accordance with BS 5930: 2015: Code of practice for ground investigations.

Appendix B presents the borehole logs, with core photographs presented in Appendix C.

4.3.2 Grab Sample

A single surface sediment sample was taken (WP-M27) using a Van Veen (1L) grab sampler. This was to allow sampling for Marine Scotland testing to assist with analysis for disposal of dredged material at sea.

Appendix D presents the grab sampler log.

4.4 Surveying

The as-built exploratory hole positions were surveyed following completion of site operations by a Site Engineer from Causeway Geotech. Surveying was carried out using a Trimble R10 GPS system employing VRS and real time kinetic (RTK) techniques.

The plan coordinates UK National Grid and ground elevation Newlyn (GB)) at each location are recorded on the individual exploratory hole logs. The exploratory hole plan presented in Appendix A shows these as-built positions.

4.5 UXO Survey

Prior to the intrusive ground investigation an Unexploded Ordinance (UXO) survey was completed by EODEX UK Subsea Limited between 21st October and 04th December.

The Seren Las survey vessel, under the operation of ROVCO Ltd, was used for side scan sonar and magnetic gradiometer surveys. The data was reviewed by EODEX UK and ALARP certification was provided for all site investigation locations.

The EODEX UXO Survey Report is presented in Appendix I.

5 LABORATORY WORK

Upon their receipt in the laboratory, all disturbed samples were carefully examined and accurately described, and their descriptions incorporated into the borehole logs.

5.1 Geotechnical laboratory testing of soils

Laboratory testing of soils comprised:

- **soil classification:** moisture content measurement, Atterberg Limit tests and particle size distribution analysis.
- **direct shear:** shear box tests
- **shear strength** (total stress): unconsolidated undrained triaxial tests
- **soil chemistry:** pH and water-soluble sulphate content

Laboratory testing of soils samples was carried out in accordance with British Standards Institute:
BS 1377, Methods of test for soils for civil engineering purposes; Part 1 (2016), and Parts 2-9 (1990).

The test results are presented in Appendix E.

5.2 Geotechnical laboratory testing of rock

Laboratory testing of rock sub-samples comprised:

- Natural water content of rock
- Schmidt rebound test
- Slake durability
- point load index
- unconfined compressive strength (UCS) tests

Test	Test carried out in accordance with
Natural water content of rock	ISRM (2007) Ulusay R, Hudson JA (eds) The complete ISRM suggested methods for rock characterization, testing and monitoring, 2007
Schmidt rebound test	ASTM D 5873 (Standard Test Method for Determination of Rock Hardness by Rebound Hammer Method).
Slake durability	ISRM (2007) Ulusay R, Hudson JA (eds) The complete ISRM suggested methods for rock characterization, testing and monitoring, 2007
Point load index	ISRM Suggested Methods (1985) Suggested method for determining point-load strength. Int. J. Rock Mech. Min. Sci. Geomech. Abstr. 22, pp. 53–60
Uniaxial compression strength tests	ASTM D7012 - 14

The test results are presented in Appendix E.

5.3 Environmental laboratory testing of soils

Environmental testing, as specified by the Client's Representative was conducted on selected environmental soil samples by Chemtest at its laboratory in Newmarket, Suffolk.

Testing was carried out for a range of determinants, including:

- Metals (As, Cd, Cr, Cu, Hg, Ni, Pb, Zn, Boron)
- Speciated polycyclic aromatic hydrocarbons (PAH)
- TPH total
- Cyanide (total), phenols (total)
- Asbestos screen
- pH, water-soluble sulphate
- organic matter content

Waste acceptance criteria (WAC) testing was carried out on three samples.

Results of environmental laboratory testing are presented in Appendix F.

5.4 Marine Scotland Analysis – Pre-Disposal Dredge Sampling

In addition to geotechnical testing conducted on soils, environmental samples were selected at specified sample locations for chemical testing relating to disposal at sea parameters.

Sampling was carried out in accordance with Marine Scotland's " Pre-disposal Sampling Guidance Version 2 – November 2017.

All borehole derived samples, along with the single grab sample from WP-M27 location, were testing for:

- Metals (As, Cd, Cr, Cu, Hg, Ni, Pb, Zn)
- Particle Size Analysis (PSA)
- Total organic carbon (TOC)
- Asbestos
- Dibutyltin (DBT) and Tributyltin (TBT)
- Polycyclic Aromatic Hydrocarbons (EPA16)
- Total Hydrocarbon Content (THC)
- Polychlorinated Biphenyls (PCB – ICES7)

Testing was conducted to allow assessment of disposal of dredged material at sea.

The dredge analysis test results are included in Appendix G; a summary table showing the Marine Scotland Pre-disposal Sampling Guidance Action Levels has also been included before the SOCOTEC lab results.

6 GROUND CONDITIONS

6.1 General geology of the area

Published geological mapping indicate the superficial deposits at the site comprise Holocene marine deposits and glacial till. These deposits are underlain by Devonian sandstones, siltstones and mudstones.

6.2 Ground types encountered during investigation of the site

A summary of the ground types encountered in the exploratory holes is listed below, in approximate stratigraphic order:

- **Marine deposits:** typically, loose to medium dense gravelly silty sands with shell fragments and occasional cobbles.

- **Glacial Till:** sandy gravelly silty clay, frequently with cobble content, typically stiff in upper horizons, becoming very stiff with increasing depth.

- **Bedrock (Sandstone, Siltstone, mudstone):** rockhead was encountered at various depths below existing seabed level ranging from 0.50m (-9.03mCD) in BH-M17 to 4.90m (-16.12mCD) in borehole BH-M05. Across the works area the depth to rockhead varied between -9.03mCD and -21.45mCD, shallowing as you move east-north-east towards the shoreline.

Representative geological long sections across the site are provided in Appendix H.

7 DISCUSSION

7.1 Proposed construction

It is proposed to construct a new deep-water port (Scapa DWQ) 4km southeast of Scapa Quay. As part of the DWQ development, a large section of the existing hillside east of Scapa Bay will be excavated and placed as fill behind the new quay wall. This report discusses the construction of the ne quay wall and associated structures.

No further details were available to Causeway Geotech at the time of preparing this report and any designs based on the recommendations or conclusions within this report should be completed in accordance with the current design codes, taking into account the variation and the specific details contained within the exploratory holes. Causeway Geotech were commissioned to provide a geotechnical report, and it is outwith our remit to advise on structure design.

7.2 Recommendations for construction

7.2.1 Phase 1 – Proposed Quay Wall

It is proposed to construct a new deep-water port adjacent to the existing coastline. The largest section of the new quay wall and southern section will be built using a combi-wall system comprising 2032mm diameter tubular piles at 3.95m centres and steel sheet piles as the infill members, while the northern sides of the new quay will be comprised of a series of steel sheet piles. Material 'cut' from the adjacent coastline will be used to backfill behind the quay wall. The sea-bed in front of the new quay wall is then proposed to be dredged to -15mCD, from its existing level of ~ -10mCD.

7.2.1.1 Piled Foundations into bedrock

The proposed 2032mm large diameter tubular piles are required to socket a minimum of 4m into bedrock. Based on the findings of the boreholes, depth to bedrock encountered varied across the footprint of the new quay as shown in Table 1 below, indicating that the bedrock is undulating in nature. Pile lengths will therefore vary in length depending on location and depth to competent bedrock.

Table 1 Depths to bedrock encountered as part of the ground investigation

BH ID	Depth to bedrock (CD)	Bedrock Type
BH-MH01	-13.80mCD	SANDSTONE
BH-MH02	-10.48mCD	SANDSTONE
BH-MH03	-16.02mCD	SANDSTONE
BH-MH04	-11.97mCD	SANDSTONE
BH-MH05	-16.72mCD	SANDSTONE
BH-MH06	-13.71mCD	SANDSTONE
BH-MH07	-18.42mCD	SANDSTONE
BH-MH08	-15.31mCD	SANDSTONE
BH-MH09	-15.25mCD	SANDSTONE
BH-MH10	-13.04mCD	SANDSTONE
BH-MH11	-16.41mCD	SANDSTONE
BH-MH12	-12.34mCD	SANDSTONE
BH-MH13	-14.57mCD	SANDSTONE
BH-MH14	-21.43mCD	SANDSTONE
BH-MH15	-20.71mCD	SANDSTONE
BH-MH16	-12.09mCD	SANDSTONE
BH-MH17	-9.53mCD	SANDSTONE
BH-MH26	-17.83mCD	SANDSTONE

Visual inspection and logging of bedrock recovered from the boreholes indicate that bedrock is relatively competent, although there is a weathering profile in the upper 2-3m across the site where the bedrock is significantly weaker than the rest of the rock mass.

Laboratory testing of bedrock (UCS) indicates that the bedrock can be described as “weak” to “strong” or a range from 8 to 97.2MPa and an average of 37MPa, with no obvious trends of increasing strength with depth, as shown in Figure 1 on the following page. It should be noted that UCS testing is generally undertaken on more competent rock samples.

Table 2: Summary of rock strengths resulting from UCS testing

Strength	Ex. Weak	V. Weak	Weak	Med. Strong	Strong	V. Strong
No. of tests	0	0	6	24	3	0
%	0%	0%	18%	73%	9%	0%

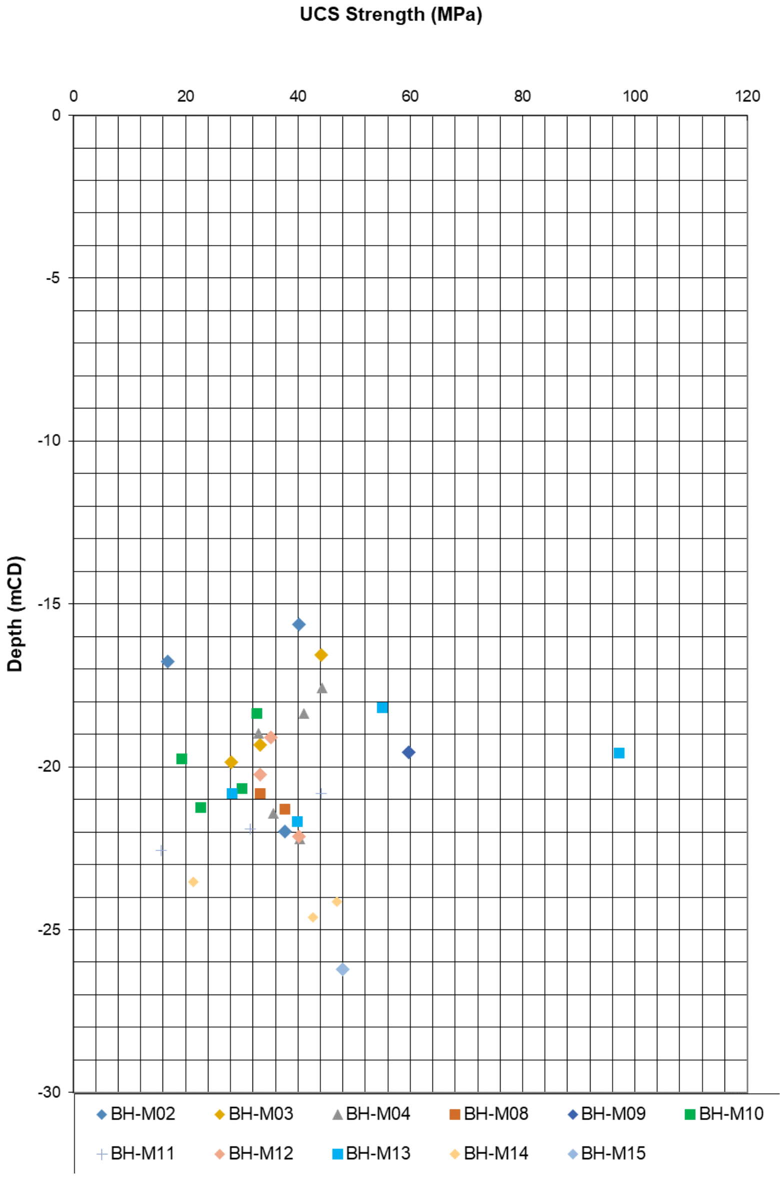


Figure 1 Summary of UCS testing with depth

No UCS testing was instructed in the upper sections of the boreholes undertaken, due to fractured nature of the rock, restricting retrieval of suitable samples, therefore strength of upper bedrock is based on point load correlations below.

Results of point load testing are shown in Figure 2 on the following page, with a range of 0 to 2.8MPa and an average value of 0.75MPa and generally show an increase in strength with depth.

Where no UCS tests have been available and for broadening the existing laboratory result sets, the correlation between Point Load test index Is_{50} and UCS has been used as shown in the following, as per Bienawski, 1975:

$$UCS = k \times Is_{50}$$

Where k is a conversion factor, which depends on the material nature. A conversion factor of k=24 has been applied based on Bieniawski (1975) and Brock and Franklin (1972). Using this correlation between PLT and UCS, a range of strengths from "very weak" to "strong" can be derived for the bedrock tested.

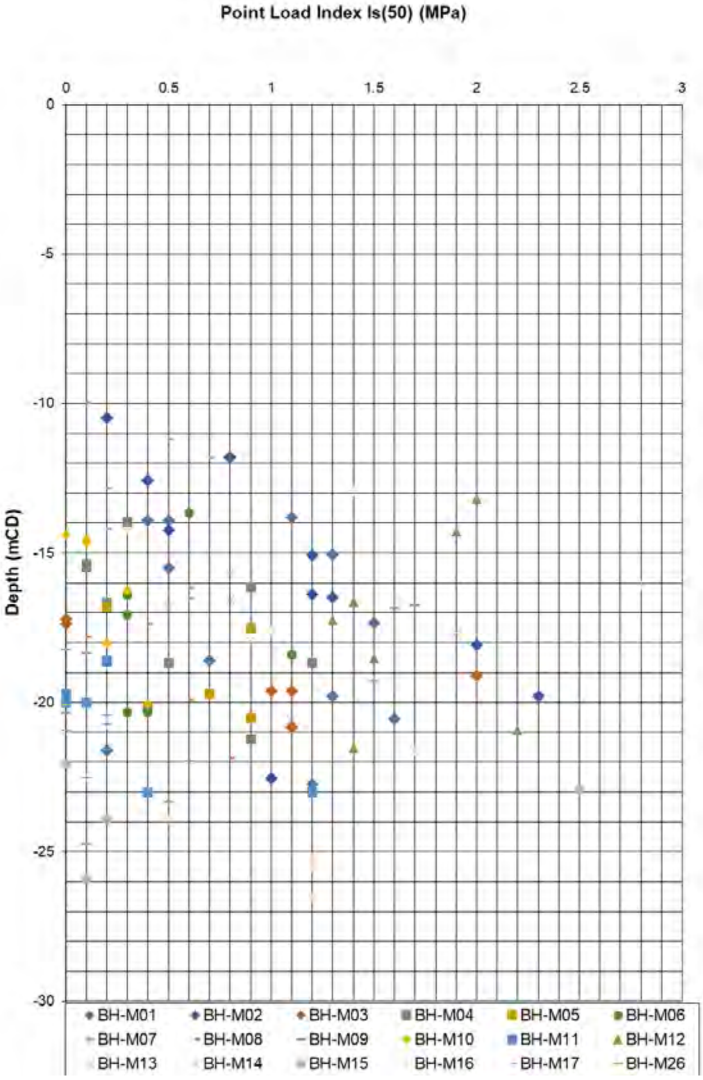


Figure 2 Summary of point load testing with depth

Table 3: Summary of rock strengths resulting from PLT to UCS correlations

Strength	**Ex. Weak**	**V. Weak**	**Weak**	**Med. Strong**	**Strong**	**V. Strong**
No. of tests	10	24	43	32	4	0
%	9%	21%	38%	28%	4%	0%

In all instances, it is recommended that the advice of specialist contractors is sought out at an early stage to ensure the correct methods and pile specifications are selected with regard to the site-specific ground conditions.

The ultimate load capacity of the piles should be determined by the execution of in-situ dynamic load tests.

7.2.1.2 Sheet Piles into Bedrock

In areas where a sheet piled wall is intended to be installed, it is proposed to “fragment” the upper bedrock strata to allow for sheet pile penetration.

Figure 3 below presents an assessment of rock excavatability (after Pettifer and Fookes) based on borehole findings and laboratory testing. It provides an assessment on excavatability using the parameters of point load strength Is(50) and fracture spacing. It can be seen that the “excavation envelope” derived from the point load test data and fracture spacing suggests that the majority of rock can be classified for excavation as hard digging to easy ripping.

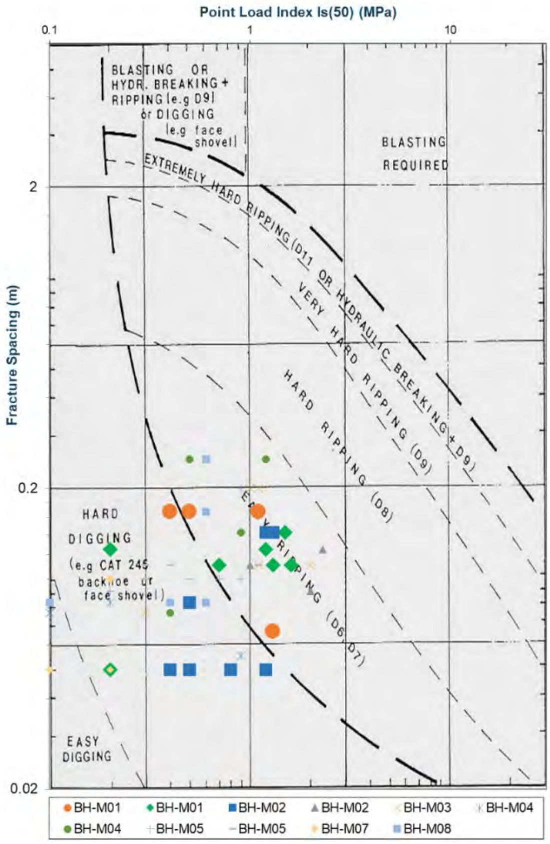


Figure 3 Rock Excavation Chart (after Pettifer and Fookes)

Based on the bedrock information, it will likely not be possible to drive steel sheet piles into the bedrock without some form of pre-treatment in the form of pre-drilling or pre-blasting. At the time of issuing this report, it is proposed to drill a deep hole into competent bedrock, one per pile clutch. Explosive charges will then be placed in each hole and the rock blasted to "fragment" the upper strata to the required depth. Within 24 hours of pre-blasting, reinforced toed piles will then be driven through the blasted rock matrix to required depth.

Based on the findings of the boreholes the upper 3-4m of bedrock encountered can be described as weak to strong, indistinctly thinly laminated sandstone with both horizontal bedding discontinuities (described as indistinctly thinly laminated) and vertical joints, with fracture indices (FI) varying across the site from 3 to >20. It is thought shock blasting using very low powered explosives, would be the most applicable as the blast radius will be limited to a small area around the drill hole. The resulting rock matrix post blasting should in theory resemble a medium dense coarse gravel, and piles should be driven as soon as possible after blasting to obtain the maximum benefits of the fragmented zone before any consolidation occurs.

The type of blasting and type of charge used and spacing of the explosives used, should be designed by specialist drill and blast contractors, using the above information, however it is anticipated that test blasts should be undertaken to determine that the blast design will produce the type of matrix required for driving the piles.

It is recommended that the advice of specialist contractors is sought out at an early stage to ensure the correct methods and pile specifications are selected with regard to the site-specific ground conditions.

7.2.2 Phase 2 - Proposed Dredge Operation

It is proposed to dredge the area immediately adjacent to the new quay wall to a level of approximately -15mCD to allow for larger vessels to utilize the DWQ. Table 4 on the following page lists the depth to sea-bed at each of the borehole locations within the proposed dredge zone, estimated thickness of the overburden marine sediments, and the thickness of bedrock which must be removed to achieve a dredge levels of -15mCD.

It is not known at the time of issuing this reporting what the intent is for the dredged material, but it is likely it will be used in some capacity as infill behind the proposed quay wall.

Generally speaking, the material to be dredged can be described as loose to medium dense sand, stiff clay and weak to medium strong sandstone. It is anticipated that the majority of overburden marine sediments will be easily excavatable by any proposed dredging operation, while some more competent bedrock area, although described as weak to very weak, will likely require some element of drilling and blasting in order to fracture and loosen up the material to allow it to be excavated.

During reclamation works it is advised that any material that has been dredged, is placed and compacted in layers as the operation progresses. Upon loading it is anticipated there will be some compaction of the very soft cohesive and very loose granular marine sediments. The compaction of these layers should be fully observed during the works and any areas of settlement should then receive another layer of compacted granular fill maintaining a level working platform for all plant and machinery.

Table 4 Summary of material to be dredged

Location	Seabed level (mCD)	Depth of overburden to be dredged	Overburden Sediment Description	Depth of Bedrock to be dredged	Strata Description
BH-MH01	-10.10	-3.40	Medium dense SAND	-1.5	Weak SANDSTONE
BH-MH02	-8.78	-1.70	SAND	-4.52	Very weak to weak SANDSTONE
BH-MH03	-10.42	-4.58	Loose to medium dense SAND	-	-
BH-MH04	-8.97	-3.00	Loose SAND/Firm CLAY	-3.03	Medium strong SANDSTONE
BH-MH05	-11.22	-3.78	Loose to medium dense SAND/Stiff CLAY	-	-
BH-MH06	-10.51	-3.20	Loose to medium dense SAND/Firm CLAY	-1.29	Weak SANDSTONE
BH-MH07	-11.32	-3.68	Medium dense SAND/Stiff CLAY	-	-
BH-MH08	-10.31	-4.69	Medium dense SAND/Stiff CLAY	-	-
BH-MH09	-12.25	-2.75	Medium dense SAND/Stiff CLAY	-	-
BH-MH10	-10.05	-2.99	Loose to medium dense SAND/Stiff CLAY	-1.96	Weak SANDSTONE
BH-MH11	-14.41	-0.59	Medium dense SAND	-	-
BH-MH12	-10.84	-1.50	Medium dense SAND	-2.66	Medium strong SANDSTONE
BH-MH13	-11.57	-2.00	Medium dense SAND	-1.43	Weathered SANDSTONE
BH-MH14	-18.13	-	-	-	-
BH-MH15	-17.71	-	-	-	-
BH-MH16	-10.09	-2.00	Loose to medium dense SAND	-2.91	Medium strong SANDSTONE
BH-MH17	-8.53	-1.00	SAND	-5.47	Very weak to weak SANDSTONE
BH-MH26	-14.83	-0.17	Loose to medium dense SAND	-	-

7.2.3 Marine Scotland Analysis

7.2.3.1 Sediment Analysis and Total Organic Content (TOC)

For the purpose of the licensing process and assessment of the physical and chemical analysis, the material grain size is graded into three categories. These are:

- Silt – defined as <63 µm in size;
- Sand – defined as ranging between 63 µm and 2 mm; and
- Gravel – defined as > 2 mm in size.

The results of the laboratory analysis (presented in Appendix G) indicate that:

- At BH-M03 (2.50-3.00m) there is a high contribution of silt (63.9%). This suggests a lower energy environment possibly allowing increased consolidation of the bed
- All other Borehole Locations indicate the sediments are predominantly sand (40.2-82.4%) with contributions (5.5-34.4%) of gravel and (12.1-42.0%) of silt.
- The Total Organic Contents (TOC) of material from all boreholes is generally low (0.05-0.38%).
- The lower silt and TOC is reflected in the high total solid content (76.7-88.4%) indicating a free draining sediment.

7.2.3.2 Contamination Levels

The results of chemical analysis of the samples collected from the borehole locations have been compared to the Marine Scotland chemical guideline Action Levels, administered by MS-LOT (Marine Scotland, 2017). Definitions of the respective Action Levels are provided below:

- **<Action Level 1 (AL1) -** In general, contaminant levels in dredged material below AL1 are likely to be acceptable for disposal at sea.
- **>Action Level 1 (AL1), <Action Level 2 (AL2) -** Dredged material with contaminant levels between AL1 and AL2 may require further consideration before a decision can be made.
- **>Action Level 2 (AL2) -** Dredged material with contaminant levels above AL2 is generally considered unsuitable for disposal at sea.

7.2.3.2.1 Metals and Organotins

Analysis of the trace metals and organotins (presented in Appendix G) showed that:

- At BH-M01 (2.50-3.00m) there was a marginal exceedance of AL1 for Arsenic. The exceedance was about 16% of the concentration interval between AL1 and AL2 for Arsenic.
- At BH-M03 (2.50-3.00m) there was a marginal exceedance of AL1 for Arsenic, and an exceedance of AL1 for Copper. The exceedance was about 2% of the concentration interval between AL1 and AL2 for Arsenic, and 20% of the concentration interval between AL1 and AL2 for Copper.

- At BH-M11 (2.50-3.00m) there was a marginal exceedance of AL1 for Arsenic. The exceedance was about 16% of the concentration interval between AL1 and AL2 for Arsenic.
- At BH-M13 (2.50-3.00m) there was a marginal exceedance of AL1 for Copper. The exceedance was about 6% of the concentration interval between AL1 and AL2 for Copper
- At all other Borehole Locations there was no contamination with all concentrations of the individual metals below AL1.
- All Borehole Locations recorded organotin concentrations below AL1.

From experience elsewhere, such small levels and number of exceedances of AL1 are not usually a concern with respect to sea disposal.

7.2.3.2.2 Polyaromatic Hydrocarbons (PAH) and Organohalogens

Analysis of the PAH and Organohalogens (presented in Appendix G) showed that:

- All Borehole Locations recorded PAH concentrations below AL1.
- All Borehole Locations recorded organohalogen concentrations below AL1.

With no exceedances of AL1 there will be no issues with respect to sea disposal.

7.2.4 Soil aggressivity

An assessment of the Aggressive Chemical Environment for Concrete (ACEC) was undertaken through reference to the Building Research Establishment (BRE) Special Digest 1 (2017).

As noted by BRE Special Digest 1, sulphates in the soil and groundwater are the chemical agents most likely to attack concrete. The extent to which sulphates affect concrete is linked to their concentrations, the type of ground, the presence of groundwater, the type of concrete and the form of construction in which concrete is used.

BRE Special Digest 1 identifies four different categories of site which require specific procedures for investigation for aggressive ground conditions:

- Sites not subjected to previous industrial development and not perceived as containing pyrite;
- Sites not subjected to previous industrial development and perceived as containing pyrite;
- Brownfield sites not perceived as containing pyrite;
- Brownfield sites perceived as containing pyrite.

For the purposes of this report the site was classified as not having been subject to previous industrial development and not perceived as containing pyrite.

The results of chemical tests (pH and water-soluble sulphate contents) on soil samples indicate Design Sulphate Class DS-2 and ACEC Class AC-1s – reference Table C1 of BRE Special Digest 1 (Building Research Establishment, 2005). The Special Digest does not require any measures to protect underground concrete elements greater that 140mm thick.

8 REFERENCES

BS EN 1997-2: 2007: Eurocode 7 - Geotechnical design - Part 2 Ground investigation and testing. British Standards Institution.

BS 5930: 2015+A1:2020: Code of practice for ground investigations. British Standards Institution.

BS EN ISO 14688-1:2018: Geotechnical investigation and testing. Identification and classification of soil. Part 1 Identification and description.

BS EN ISO 14688-2:2018: Geotechnical investigation and testing. Identification and classification of soil. Part 2 Principles for a classification.

BS 1377: 1990: Methods of test for soils for civil engineering purposes. British Standards Institution.

BS EN ISO 14689-1:2018: Geotechnical investigation and testing. Identification and classification of rock. Identification and description.

BS EN ISO 22476-3:2005+A1:2011: Geotechnical investigation and testing. Field testing. Standard penetration test.

Building Research Establishment (2005) BRE Special Digest 1, Concrete in aggressive ground.

Pre-disposal Sampling Guidance Version 2 – November 2017

Guidance on the Classification and Assessment of Waste (1st edition) Technical Guidance WM3 (2015) Environment Agency.

APPENDIX A

SITE LOCATION PLAN AND EXPLORATORY HOLE PLAN

Project No.:	21-1031	**Client:**	Orkney Islands Council
Project Name:	Scapa Deep Water Quay & Hatston Pier Development - Marine GI	**Client's Representative:**	Arch Henderson LLP

Legend Key

Title:
Site Location Plan

Last Revised:	**Scale:**
06/04/2022	1:40000

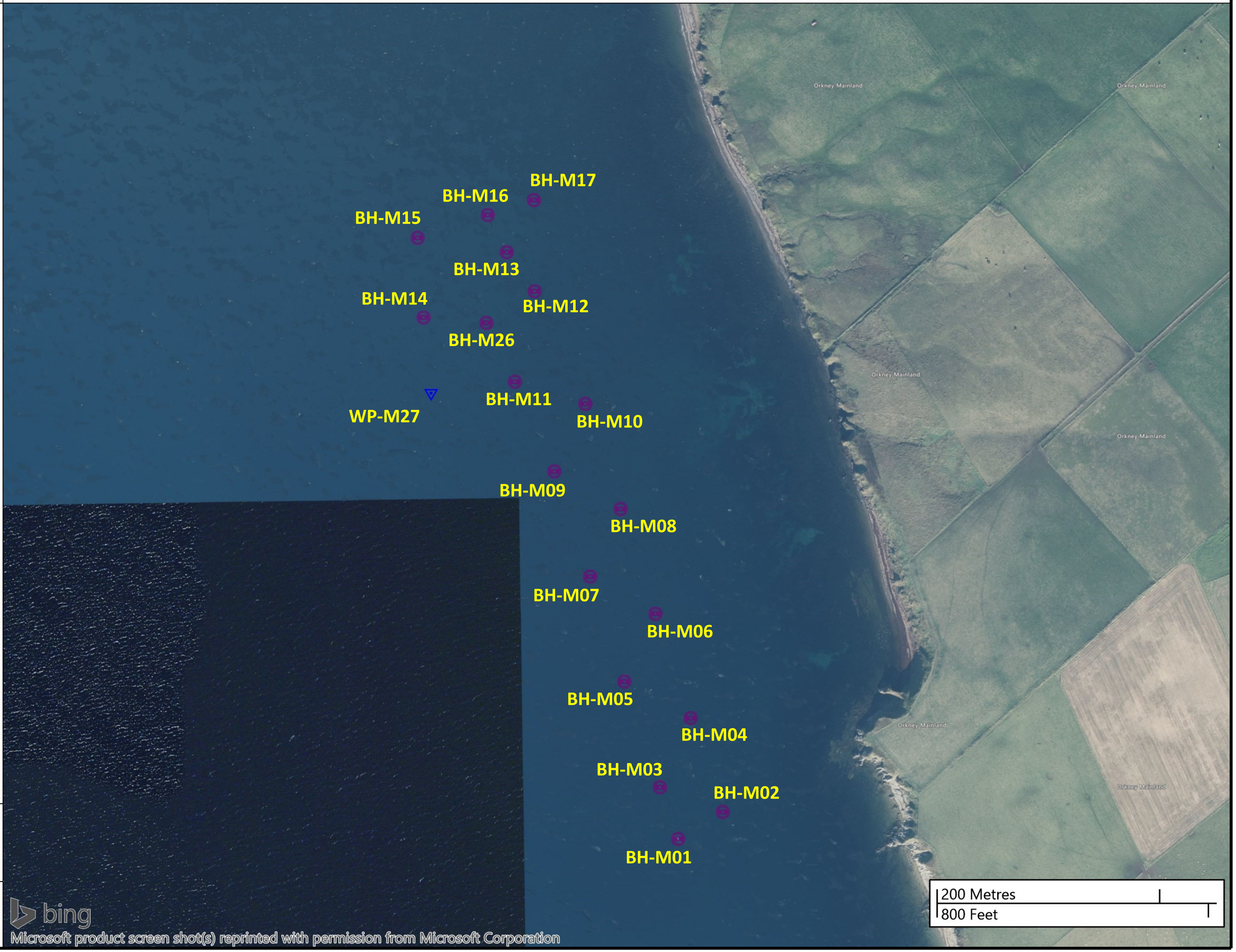
CAUSEWAY GEOTECH

Project No.:	21-1031	**Client:**	Orkney Islands Council
Project Name:	Scapa Deep Water Quay & Hatston Pier Development - Marine GI	**Client's Representative:**	Arch Henderson LLP

Legend Key

▽ Grab Sample - WP

◎ Sonic Drilling + Rotary Coring - BH



Microsoft product screen shot(s) reprinted with permission from Microsoft Corporation

Title:

Site Location Plan

Last Revised:	**Scale:**
06/04/2022	1:5000

CAUSEWAY GEOTECH

APPENDIX B

BOREHOLE LOGS

CAUSEWAY GEOTECH

Project No. **21-1031**	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI **Client:** Orkney Islands Council **Client's Rep:** Arch Henderson LLP		**Borehole ID** **BH-M01**

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	345139.28 E 1003689.78 N
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	12.80	

Final Depth: 12.80 m	**Start Date:** 14/01/2022	**Driller:** MJ/KW	Sheet 1 of 2 Scale: 1:50
Elevation: -10.10 mCD	**End Date:** 15/01/2022	**Logger:** JG+RC	FINAL

Depth (m)	Sample / Tests	Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mCD	Depth (m)	Description
0.00 - 0.50	ES9	Marine Scotland - SS1									Medium dense grey slightly gravelly silty fine to medium SAND with shell fragments (up to 5mm). Gravel is subangular to subrounded fine of various lithologies.
0.50	ES1										
0.50 - 1.50	B4										
1.00 - 1.50	ES10	Marine Scotland - SS2									
1.50	D7										
1.50 - 2.50	B5										
1.50 - 1.95	SPT (S)	N=18 (1,1/3,4,5,6) Hammer SN = 1353					1.50				
2.00	ES2										
2.50 - 3.00	B6								-12.60	2.50	Orangish brown thinly laminated slightly gravelly silty fine to medium SAND. Gravel is angular fine to medium of various lithologies.
2.50 - 3.00	ES11	Marine Scotland - SS3									
3.00	D8						3.00		-13.10	3.00 (0.40)	Dark grey clayey slightly gravelly fine to coarse SAND. Gravel is angular fine to coarse of sandstone.
3.00	ES3										
3.00 - 3.45	SPT(S) N=30 (4,6/7,7,8,8) Hammer SN = 1353		100	19	19				-13.50	3.40 (0.30)	Possible weathered SANDSTONE recovered as light orangish grey clayey gravelly fine to coarse sand. Gravel is angular fine to coarse of sandstone.
3.70	C1								-13.80	3.70	Weak (locally medium strong) indistinctly thinly laminated fine grained light brownish orange and whitish grey SANDSTONE. Partially weathered: reduced strength and much closer fracture spacing. Discontinuities: 1. 0 to 20 degree joints closely spaced (50/110/250) planar, rough, unstained and clean. 2. 55 to 75 degree joints from 4.50m to 4.80m, 5.10m to 5.20m, 5.20m to 5.30m and 6.90m tom 7.00m, planar, rough, unstained and clean.
3.80						6					
3.80	C2		100	85	47	15					
4.95	C3										
5.30										(3.30)	
5.40	C4					12					
5.60	C5		97	81	33	16					
6.80											
									-17.10	7.00	Medium strong (locally weak) indistinctly thinly laminated fine grained light brownish orange and whitish grey SANDSTONE. Partially weathered: slightly reduced strength, closer fracture spacing occasional heavy dark orangish brown discolouration and occasional clay infill. Discontinuities: 1. 0 to 20 degree joints closely spaced (30/140/300) planar, rough, occasional clay infill on joint surfaces up to 40mm deep. 2. 55 to 75 degree joints from 8.60m to 8.90m, 9.50m to 9.60m and 10.30m to 10.40m, planar, rough and occasional heavy dark orangish brown staining on joint surfaces up to 40mm deep.
7.10	C6		100	93	53	7					
7.25	C7										
8.30											
8.50	C8		100	79	27						

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 19.00m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
3.00	177
12.80	150

Water Added

From (m)	To (m)

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH	**Project No.** 21-1031	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI **Client:** Orkney Islands Council **Client's Rep:** Arch Henderson LLP	**Borehole ID** BH-M01

Method	Plant Used	Top (m)	Base (m)	Coordinates
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	345139.28 E
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	12.80	1003689.78 N

Final Depth:	12.80 m	**Start Date:**	14/01/2022	**Driller:**	MJ/KW	Sheet 2 of 2 Scale: 1:50
Elevation:	-10.10 mCD	**End Date:**	15/01/2022	**Logger:**	JG+RC	FINAL

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mCD	Depth (m)	Legend	Description	Water	Backfill
9.70	C9										Medium strong (locally weak) indistinctly thinly laminated fine grained light brownish orange and whitish grey SANDSTONE. Partially weathered: slightly reduced strength, closer fracture spacing occasional heavy dark orangish brown discolouration and occasional clay infill. Discontinuities: 1. 0 to 20 degree joints closely spaced (30/140/300) planar, rough, occasional clay infill on joint surfaces up to 40mm deep. 2. 55 to 75 degree joints from 8.60m to 8.90m, 9.50m to 9.60m and 10.30m to 10.40m, planar, rough and occasional heavy dark orangish brown staining on joint surfaces up to 40mm deep. *11.00m to 11.30m: AZCL - Probable bed of extremely weak sandstone washed out during drilling.*		
9.80		83	75	37	9								
10.45	C10												
10.75	C11												
					AZCL				(5.80)				
11.30		100	97	67	8								
11.50	C12												
12.50	C13												
12.65	C14												
12.80								-22.90	12.80		End of Borehole at 12.80m		

Water Strikes				Chiselling Details		
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)	From (m)	To (m)	Time (hh:mm)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 19.00m
All elevations/reduced levels given in mCD

Casing Details		Water Added	
To (m)	Diam (mm)	From (m)	To (m)
3.00	177		
12.80	150		

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH	**Project No.** **21-1031**	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI **Client:** Orkney Islands Council **Client's Rep:** Arch Henderson LLP	**Borehole ID** **BH-M02**

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	1.20	345180.32 E 1003713.59 N
Rotary Coring	Fraste Duo CXL Rotosonic	1.20	14.00	

Final Depth:	14.00 m	**Start Date:**	20/01/2022	**Driller:**	KW	Sheet 1 of 2 Scale: 1:50
Elevation:	-8.78 mCD	**End Date:**	20/01/2022	**Logger:**	JG+RC	FINAL

Depth (m)	Sample / Tests
0.00 - 0.70	B2
0.50	ES1
0.70 - 1.00	B3
1.00 - 1.20	B4
1.70	C1
2.00	
2.00	C2
3.00	C3
3.20	C4
3.50	
3.80	C5
5.00	
5.45	C6
6.30	C7
6.50	
6.85	C8
7.60	C9
7.70	C10
8.00	
8.00	C11
9.00	C12

Field Records

TCR	SCR	RQD	FI
75	18	0	AZCL NI
100	71	23	14 >20
41	25	0	AZCL
97	74	26	20
100	95	63	7
100	90	79	11

Level mCD	Depth (m)	Description
		Grey very gravelly silty fine to coarse SAND with shell fragments (up to 5mm). Gravel is subangular to subrounded fine to coarse of various lithologies.
-9.48	0.70	Orangish brown thinly laminated silty fine to medium SAND.
-9.78	1.00	Yellowish brown fine to medium SAND.
-9.98	1.20 (0.50)	Dark brownish grey clayey slightly gravelly fine to coarse SAND. Gravel is subrounded fine to coarse of mixed lithologies. *1.20m to 1.40m: AZCL - Probable bed of sand and gravel washed out during drilling.*
-10.48	1.70 (1.20)	Very weak thinly laminated fine grained light brownish yellow and brownish white SANDSTONE. Partially weathered: reduced strength and much closer fracture spacing. Discontinuities: 1. 5 to 15 degree bedding fractures closely spaced (10/65/200) planar, smooth, unstained and clean. 2. 55 to 65 degree joints from 2.35m to 2.55m and 2.80m to 2.90m, undulating, rough, unstained and clean.
-11.68	2.90 (2.10)	Weak indistinctly thinly laminated fine grained light brownish grey and light brownish yellow SANDSTONE. Partially weathered: slightly reduced strength, much closer fracture spacing and occasional heavy brownish black discolouration on fracture surfaces. Discontinuities: 1. 0 to 20 degree bedding fractures, closely spaced (10/75/200) planar, smooth, unstained, clean. 2. 55 to 65 degree joints from 3.30m to 3.50m, 3.60m to 3.70m and 3.80m to 3.90m, undulating, rough, occasional heavy brow black staining on joint surfaces up to 0.5mm deep and clean. *4.10m to 5.00m: AZCL - Probable bed of extremely weak sandstone washed out during drilling.*
-13.78	5.00 (1.35)	Weak (locally medium strong) indistinctly thickly laminated fine grained dark brownish yellow SANDSTONE. Partially weathered: slightly reduced strength, much closer fracture spacing and occasional heavy dark orangish brown discolouration on fracture surfaces. Discontinuities: 1. 0 to 15 degree bedding fractures very closely spaced (10/50/150)m planar, smooth, occasional heavy dark orangish brown staining on fracture surfaces up to 40mm deep.
-15.13	6.35	Medium strong (locally weak) indistinctly thinly laminated fine grained light greyish orange and light brownish orange SANDSTONE. Partially weathered: slightly reduced strength, closer fracture spacing and occasional heavy dark orangish brown discolouration on fracture surfaces. Discontinuities: 1. 0 to 15 degree bedding fractures, closely spaced (10/150/500) planar, smooth, occasional heavy dark orangish brown staining on fracture surfaces up to 100mm deep. 2. 25 to 45 degree joints medium spaced (200/470/1500) planar, smooth, occasional heavy dark orangish brown staining on joint surfaces up to 5mm deep. 3. 65 to 75 degree joint from 11.40m to 11.65m, planar, rough, heavy dark brown staining on joint surface., 10mm deep.

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 19.60m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
1.20	177
14.00	150

Water Added

From (m)	To (m)

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L		Terminated at scheduled depth	29/06/2022

AGS

Project No.	Project Name: Scapa Deep Water Quay & Hatston Pier Development - Marine GI	Borehole ID
21-1031	**Client:** Orkney Islands Council	BH-M02
	Client's Rep: Arch Henderson LLP	

Method	Plant Used	Top (m)	Base (m)	Coordinates
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	1.20	345180.32 E
Rotary Coring	Fraste Duo CXL Rotosonic	1.20	14.00	1003713.59 N

Final Depth: 14.00 m	**Start Date:** 20/01/2022	**Driller:** KW	Sheet 2 of 2 Scale: 1:50
Elevation: -8.78 mCD	**End Date:** 20/01/2022	**Logger:** JG+RC	FINAL

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mCD	Depth (m)	Legend	Description	Water	Backfill
9.30	C13										Medium strong (locally weak) indistinctly thinly laminated fine grained light greyish orange and light brownish orange SANDSTONE. Partially weathered: slightly reduced strength, closer fracture spacing and occasional heavy dark orangish brown discolouration on fracture surfaces. Discontinuities: 1. 0 to 15 degree bedding fractures, closely spaced (10/150/500) planar, smooth, occasional heavy dark orangish brown staining on fracture surfaces up to 100mm deep. 2. 25 to 45 degree joints medium spaced (200/470/1500) planar, smooth, occasional heavy dark orangish brown staining on joint surfaces up to 5mm deep. 3. 65 to 75 degree joint from 11.40m to 11.65m, planar, rough, heavy dark brown staining on joint surface., 10mm deep. *9.50m to 9.70m: AZCL - Probable bed of extremely weak sandstone washed out during drilling.*		
9.50		80	53	34	AZCL 13 20				(7.65)				
11.00													
11.00	C14	96	82	62	8								
12.50		100	97	45	>20 9								
13.20	C15												
13.75	C16												
14.00								-22.78	14.00		End of Borehole at 14.00m		

Water Strikes				Chiselling Details		
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)	From (m)	To (m)	Time (hh:mm)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 19.60m
All elevations/reduced levels given in mCD

Casing Details		Water Added	
To (m)	Diam (mm)	From (m)	To (m)
1.20	177		
14.00	150		

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L		Terminated at scheduled depth	29/06/2022

CAUSEWAY GEOTECH

Project No. **21-1031**	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI **Client:** Orkney Islands Council **Client's Rep:** Arch Henderson LLP	**Borehole ID** **BH-M03**

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	4.50	345123.20 E 1003736.66 N
Rotary Coring	Fraste Duo CXL Rotosonic	4.50	11.90	

Final Depth: 11.90 m	**Start Date:** 24/01/2022	**Driller:** MJ	Sheet 1 of 2	Scale: 1:50
Elevation: -10.42 mCD	**End Date:** 25/01/2022	**Logger:** JG+RC	FINAL	

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)
0.00 - 0.50	ES11	Marine Scotland - SS1		
0.00 - 1.50	B5			
0.50	ES1			
1.00	ES2			
1.00 - 1.50	ES12	Marine Scotland - SS2		
1.50	D8			
1.50 - 3.00	B6			
1.50 - 1.95	SPT (S)	N=10 (1,0/2,2,3,3) Hammer SN = 1353	1.50	
2.00	ES3			
2.50 - 3.00	ES13	Marine Scotland - SS3		
3.00	D9			
3.00	ES4			
3.00 - 4.30	B7			
3.00 - 3.45	SPT (S)	N=18 (3,4/4,5,4,5) Hammer SN = 1353	3.00	
4.50	D10		4.50	
4.50 - 4.95	SPT(S) N=32 (5,6/7,7,8,10) Hammer SN = 1353			
4.70	C1			
5.90				
6.15	C3			
6.80	C4			
6.95	C5			
7.40				
8.70	C6			
8.90				
8.90	C7			
9.20	C8			

Core run (m)	TCR	SCR	RQD	FI
4.50 - 5.90	96	16	13	
5.90 - 7.40	100	89	56	8
7.40 - 8.90	97	77	33	9
8.90 - 9.20				

Level mCD	Depth (m)	Description
-13.42	3.00	Loose to medium dense grey slightly gravelly silty fine to coarse SAND with shell fragments (up to 5mm). Gravel is subangular to subrounded fine of various lithologies.
-14.72	4.30	Medium dense grey slightly gravelly silty fine to coarse SAND with shell fragments (up to 3mm). Gravel is subrounded to rounded fine of various lithologies.
-15.22	(0.50) 4.80	Stiff yellowish brown very sandy silty CLAY. Sand is fine to medium.
-16.02	(0.80) 5.60	Very stiff light yellowish grey sandy slightly gravelly silty CLAY. Sand is fine to medium. Gravel is angular fine to coarse of sandstone. (Possible weathered bedrock)
-19.12	(3.10) 8.70	Medium strong (locally weak) indistinctly thinly laminated fine grained light yellowish grey SANDSTONE. Partially weathered: slightly reduced strength, closer fracture spacing and occasional heavy dark orangish brown discolouration on fracture surfaces. Discontinuities: 1. 10 to 20 degree bedding fractures medium spaced (20/220/400) planar, rough, occasional heavy dark orangish brown staining on fracture surfaces up to 2mm deep. 2. 65 to 75 degree joints from 7.40m to 8.30m and 8.30m to 8.70m, planar, rough, occasional heavy dark orangish brown staining on joint surfaces up to 0.5mm.
		Medium strong (locally weak) indistinctly thinly laminated fine grained light orangish grey SANDSTONE. Partially weathered: slightly reduced strength. Discontinuities: 1. 10 to 20 degree bedding fractures, medium spaced (20/210/400) planar, rough, unstained and clean.

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Casing Details

To (m)	Diam (mm)
4.50	177
11.90	150

Water Added

From (m)	To (m)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 18.60m
All elevations/reduced levels given in mCD

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH

Project No. 21-1031	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI **Client:** Orkney Islands Council **Client's Rep:** Arch Henderson LLP	**Borehole ID** BH-M03

Method	Plant Used	Top (m)	Base (m)	Coordinates
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	4.50	345123.20 E 1003736.66 N
Rotary Coring	Fraste Duo CXL Rotosonic	4.50	11.90	

Final Depth: 11.90 m	**Start Date:** 24/01/2022	**Driller:** MJ	Sheet 2 of 2 Scale: 1:50
Elevation: -10.42 mCD	**End Date:** 25/01/2022	**Logger:** JG+RC	FINAL

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mCD	Depth (m)	Legend	Description	Water	Backfill
9.45	C9												
9.80	C10	95	95	79	5				(1.70)		Medium strong (locally weak) indistinctly thinly laminated fine grained light orangish grey SANDSTONE. Partially weathered: slightly reduced strength. Discontinuities: 1. 10 to 20 degree bedding fractures, medium spaced (20/210/400) planar, rough, unstained and clean.		
10.40								-20.82	10.40				
10.40	C11	100	83	31	9				(1.50)		Medium strong indistinctly thinly laminated fine grained dark greyish orange SANDSTONE. Partially weathered: slightly reduced strength and closer fracture spacing. Discontinuities: 1. 5 to 15 degree bedding fractures closely spaced (10/100/500) planar, rough, unstained and clean. 2. 55 to 65 degree joints from 11.10m to 11.25m and 11.70m to 11.90m, planar, rough, unstained and clean.		
11.50	C12												
11.90								-22.32	11.90		End of Borehole at 11.90m		

Water Strikes			
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Chiselling Details		
From (m)	To (m)	Time (hh:mm)

Casing Details		Water Added	
To (m)	Diam (mm)	From (m)	To (m)
4.50	177		
11.90	150		

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 18.60m
All elevations/reduced levels given in mCD

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

Project No. **21-1031**	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI **Client:** Orkney Islands Council **Client's Rep:** Arch Henderson LLP		**Borehole ID** **BH-M04**

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	345152.16 E 1003798.70 N
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	13.50	

Final Depth: 13.50 m	**Start Date:** 04/03/2022	**Driller:** MJ	Sheet 1 of 2 Scale: 1:50
Elevation: -8.97 mCD	**End Date:** 05/03/2022	**Logger:** NP+RC	FINAL

Depth (m)	Sample / Tests	Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mCD	Depth (m)	Description
0.00 - 0.50	ES5	Marine Scotland - SS1									Loose to medium dense grey very gravelly silty fine to coarse SAND with shell fragments (up to 5mm). Gravel is subangular fine to medium of various lithologies.
0.00 - 1.50	B8										
0.50	ES1										
1.00	ES2										
1.00 - 1.50	ES6	Marine Scotland - SS2									
1.50	D10								-10.47	1.50	Very stiff grey slightly sandy slightly gravelly silty CLAY. Sand is fine to coarse. Gravel is subangular fine to coarse of various lithologies.
1.50 - 3.00	B9										
1.50 - 1.95	SPT (S)	N=10 (1,1/2,2,3,3) Hammer SN = 1353					1.50				
2.00	ES3										
2.50 - 3.00	ES7	Marine Scotland - SS3									
									-11.87	2.90	Weathered SANDSTONE recovered as: white and orange fine to medium sand.
3.00	D11		58	9	9	AZCL	3.00		-11.97	3.00	Weathered SANDSTONE recovered as firm light brownish yellow very sandy gravelly clay. Sand is fine to coarse. Gravel is subangular fine to coarse of sandstone. *3.00m to 3.55m: AZCL - Disturbance due to SPT has lead to subsequent wash out of material.*
3.00	ES4										
3.00 - 3.45	SPT(S) N=48 (5,8/9,9,10,20) Hammer SN = 1353									(1.10)	
3.70	C1					NI					
						11			-13.07	4.10	Medium strong (locally weak) indistinctly thinly laminated fine grained light brownish yellow and whitish grey SANDSTONE. Partially weathered: reduced strength, much closer fracture spacing and occasional clay infill on fracture surfaces. Discontinuities: 1. 0 to 15 degree bedding fractures, closely spaced (10/150/300) planar, rough, unstained and occasional clay infill on fracture surfaces up to 20mm thick. 2. 65 to 75 degree joints from 3.55m to 3.85m, planar, rough, unstained , clay infill on joint surfaces up to 20mm thick.
										(0.40)	
4.50			100	89	30				-13.47	4.50	Medium strong (locally weak) indistinctly thinly laminated fine grained light yellowish and brown and whitish grey SANDSTONE. Partially weathered: slightly reduced strength, much closer fracture spacing and occasional heavy dark orangish brown discolouration on fracture surface. Discontinuities: 1. 10 to 25 degree bedding fractures clsoely spaced (10/120/250) planar, rough, occasional heavy dark ornagish brown staining in fracture surfaces up to 20mm thick.
5.00	C2					13					
						>20				(2.70)	
6.00			87	73	29						
6.00	C3					18					
6.40	C4										
6.50	C5										
6.90	C6										
7.20	C7								-16.17	7.20	Medium strong indistinctly thinly laminated fine grained whitish grey SANDSTONE. Partially weathered: slightly reduced strength, closer fracture spacing, occasional light brownish orange discolouration on fracture surfaces and occasional clay infill on fracture surfaces. Discontinuities: 1. 0 to 20 degree bedding fractures, medium spaced (30/210/550) planar rough, occasional light brownish orange staining on fracture surfaces up to 0.5mm deep and occasional clay infill up to 30mm thick. 2. 55 to 75 degree joints from 7.50m to 7.70m, 8.20m to 8.40m and 10.50m to 10.80m, planar, rough, occasional light brownish orange staining on joint surfaces up to 0.5mm deep. *7.30m to 7.50m: AZCL - Probable bed of extremely weak sandstone washed out during drilling.*
						AZCL					
7.50			100	89	58	12					
7.70	C8										
8.60	C9										
9.00											

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 16.10m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
3.00	177
13.50	150

Water Added

From (m)	To (m)

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH	**Project No.** **21-1031**	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI		**Borehole ID** **BH-M04**
		Client: Orkney Islands Council		
		Client's Rep: Arch Henderson LLP		

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	345152.16 E 1003798.70 N
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	13.50	

Final Depth:	13.50 m	**Start Date:**	04/03/2022	**Driller:**	MJ	Sheet 2 of 2 Scale: 1:50
Elevation:	-8.97 mCD	**End Date:**	05/03/2022	**Logger:**	NP+RC	FINAL

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mCD	Depth (m)	Legend	Description	Water	Backfill
9.40	C10										Medium strong indistinctly thinly laminated fine grained whitish grey SANDSTONE. Partially weathered: slightly reduced strength, closer fracture spacing, occasional light brownish orange discolouration on fracture surfaces and occasional clay infill on fracture surfaces. Discontinuities: 1. 0 to 20 degree bedding fractures, medium spaced (30/210/550) planar rough, occasional light brownish orange staining on fracture surfaces up to 0.5mm deep and occasional clay infill up to 30mm thick. 2. 55 to 75 degree joints from 7.50m to 7.70m, 8.20m to 8.40m and 10.50m to 10.80m, planar, rough, occasional light brownish orange staining on joint surfaces up to 0.5mm deep. *10.80m to 10.95m: Very weak indistinctly thinly laminated light greyish green MUDSTONE.*		
9.70	C11				4								
10.00	C12	100	100	100									
10.50													
11.20	C13	97	87	55	13				(6.30)				
12.00													
12.25	C14												
12.45	C15	100	91	77	7								
13.25	C16												
13.50								-22.47	13.50		End of Borehole at 13.50m		

9.5 10.0 10.5 11.0 11.5 12.0 12.5 13.0 13.5 14.0 14.5 15.0 15.5 16.0 16.5 17.0 17.5 18.0 18.5

TCR SCR RQD FI

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Chiselling Details

From (m)	To (m)	Time (hh:mm)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 16.10m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
3.00	177
13.50	150

Water Added

From (m)	To (m)

Core Barrel	**Flush Type**	**Termination Reason**	**Last Updated**
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH	**Project No.** **21-1031**	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI		**Borehole ID** **BH-M05**
		Client: Orkney Islands Council		
		Client's Rep: Arch Henderson LLP		

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	4.50	345092.93 E 1003832.55 N
Rotary Coring	Fraste Duo CXL Rotosonic	4.50	10.80	

Final Depth: 10.80 m	**Start Date:** 05/03/2022	**Driller:** MJ	Sheet 1 of 2 Scale: 1:50
Elevation: -11.22 mCD	**End Date:** 06/03/2022	**Logger:** NP+EM	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)
0.00 - 0.50	ES5	Marine Scotland - SS1		
0.00 - 1.50	B8			
0.50	ES1			
1.00	ES2			
1.00 - 1.50	ES6	Marine Scotland - SS2		
1.50	D11			
1.50 - 3.00	B9			
1.50 - 1.95	SPT (S)	N=23 (2,5/5,6,6,6) Hammer SN = 1353	1.50	
2.00	ES3			
2.50 - 3.00	ES7	Marine Scotland - SS3		
3.00	D12			
3.00	ES4			
3.00 - 4.50	B10			
3.00 - 3.45	SPT (S)	N=26 (5,6/6,6,7,7) Hammer SN = 1353	3.00	
4.50	D13		4.50	
4.50 - 4.87	SPT(S) N=50 (8,8/50 for 220mm) Hammer SN = 1353			
5.60	C1			
5.90	C2			
6.00				
6.30	C3			
7.50				
7.50	C4			
8.50	C5			
9.00				
9.30	C6			

TCR	SCR	RQD	FI
60	46	23	AZCL
			11
100	90	53	5
			18
100	94	26	10

Level mCD	Depth (m)	Description
		Loose to medium dense greyish brown gravelly silty fine to coarse SAND with shell fragments (up to 5mm). Gravel is subangular fine to medium of various lithologies.
-13.72	2.50	Stiff grey slightly sandy slightly gravelly silty CLAY. Sand is fine to coarse.. Gravel is subangular fine to medium of various lithologies and shell fragments (up to 4mm).
-15.72	4.50 (1.00)	Very stiff brown slightly sandy very gravelly CLAY with high cobble content. Sand is fine to coarse. Gravel is subangular fine to coarse of sandstone. Cobbles are subangular of sandstone and mudstone. *4.50m to 5.00m: AZCL - Disturbance due to SPT has lead to subsequent wash out of material.*
-16.72	5.50 (1.90)	Weak indistinctly thinly laminated well cemented SANDSTONE. Partially weathered: slightly reduced strength, slightly closer fracture spacing with discolouration and clay deposits on some fracture surfaces. Discontinuities: 1. 35 to 25 degree bedding fractures, medium spaced (150/408/450) slightly undulating, rough with strong patchy brown and orangish brown staining on some fracture surfaces. 2. 0 to 5 degree joint at 6.50m, planar, rough, clean. 3. 60 to 80 degree joint at 6.70m to 7.05m, slightly undulating, rough with strong dark brown staining and patchy greyish white clay deposists (up to 4mm thick) on joint surface.
-18.62	7.40 (1.45)	Weak thinly laminated light orangish brown medium grained moderately cemented SANDSTONE. Partially weathered: reduced strength, slightly closer fracture spacing with discolouration and clay deposits on fracture surfaces. Discontinuities: 1. 20 to 30 degree bedding fractures closely spaced (80/161/200) plana, rough with patchy orangish brown staining on few fracture surfaces and light orange clay deposits (up to 3mm thick) on most fracture surfaces. 2. 70 to 80 degree joint at 8.20m to 8.33m, planar, smooth to rough, clean.
-20.07	8.85	Weak (locally medium strong) thinly laminated light orangish brown medium grained well cemented SANDSTONE. Partially weathered: closer fracture spacing with discolouration and clay deposits on fracture surfaces.

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 18.0m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
4.50	177
10.80	150

Water Added

From (m)	To (m)

Core Barrel	**Flush Type**	**Termination Reason**	**Last Updated**
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH

Project No.	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI		**Borehole ID**
21-1031	**Client:**	Orkney Islands Council	**BH-M05**
	Client's Rep:	Arch Henderson LLP	

Method	Plant Used	Top (m)	Base (m)	Coordinates
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	4.50	345092.93 E 1003832.55 N
Rotary Coring	Fraste Duo CXL Rotosonic	4.50	10.80	

Final Depth:	10.80 m	**Start Date:**	05/03/2022	**Driller:**	MJ	Sheet 2 of 2 Scale: 1:50
Elevation:	-11.22 mCD	**End Date:**	06/03/2022	**Logger:**	NP+EM	FINAL

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mCD	Depth (m)	Legend	Description	Water	Backfill
		100	96	26					(1.95)		Weak (locally medium strong) thinly laminated light orangish brown medium grained well cemented SANDSTONE. Partially weathered: closer fracture spacing with discolouration and clay deposits on fracture surfaces. 1. 20 to 30 degree bedding fractures closely spaced (560/162/300) planar, rough, with occasional patchy dark brown discolouration on some fracture surfaces and occasional patchy light greyish white clay deposits (up to 3mm thick) on some fracture surfaces. 2. 50 to 60 degree joint at 9.15m to 9.40m and 9.90m to 10.05m, slightly undulating rough with patchy dark brown discolouration on joint surface. *9.70m to 9.85m: Bed of extremely weak sandstone*		
10.50													
10.50	C7	100	83	50									
10.60	C8							-22.02	10.80				
10.80													
											End of Borehole at 10.80m		
		TCR	SCR	RQD	FI								

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Chiselling Details

From (m)	To (m)	Time (hh:mm)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 18.0m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
4.50	177
10.80	150

Water Added

From (m)	To (m)

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH	**Project No.** **21-1031**	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI **Client:** Orkney Islands Council **Client's Rep:** Arch Henderson LLP	**Borehole ID** **BH-M06**

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	345121.94 E
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	12.00	1003893.44 N

Final Depth: 12.00 m	**Start Date:** 06/03/2022	**Driller:** MJ	Sheet 1 of 2 Scale: 1:50
Elevation: -10.51 mCD	**End Date:** 07/03/2022	**Logger:** NP+RC	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)
0.00 - 0.50	ES5	Marine Scotland - SS1		
0.00 - 1.50	B8			
0.50	ES1			
1.00	ES2			
1.00 - 1.50	ES6	Marine Scotland - SS2		
1.50	D10			
1.50 - 3.00	B9			
1.50 - 1.95	SPT (S)	N=11 (1,2/2,3,3,3) Hammer SN = 1353	1.50	
2.00	ES3			
2.50 - 3.00	ES7	Marine Scotland - SS3		
3.00	D11		3.00	
3.00	ES4			
3.00 - 3.45	SPT(S) N=32 (7,7/7,8,8,9) Hammer SN = 1353			
3.15	C1			
3.30	C2			
4.50				
4.70	C3			
5.90	C4			
6.00				
6.30	C5			
6.55	C6			
7.50				
7.90	C7			
9.00				

Core run (m)	TCR	SCR	RQD	FI
3.00 - 4.50	84			6
4.50 - 6.00	94			10
6.00 - 7.50	88			
7.50 - 9.00	94			9

Level mCD	Depth (m)	Description
		Loose to medium dense grey slightly gravelly silty fine to coarse SAND with shell fragments (up to 4mm). Gravel is subangular fine to medium.
-12.01	1.50	Very stiff grey slightly sandy slightly gravelly silty CLAY. Sand is fine to coarse. Gravel is subangular fine to medium of various lithologies.
-13.71	3.20 (8.80)	Weak (locally medium strong) indistinctly thinly laminated fine grained orangish grey SANDSTONE. Partially weathered: reduced strength, much closer fracture spacing, occasional heavy dark orangish brown discolouration on fracture surfaces and occasional sandy clay infill on fracture surfaces. Discontinuities: 1. 5 to 20 degree bedding fractures, closely spaced (10/125/300) planar, smooth, occasional heavy dark orangish brown staining on fracture surfaces up to 1mm deep and occasional sandy clay infill on fracture surfaces up to 30mm thick. 2. 65 to 75 degree joints from 3.10m to 4.10m, 5.20m to 5.50m to 5.60m, 6.30m to 6.50m, 6.80m to 6.90m, 7.60m to 8.00m, 8.20m to 8.80m, 9.00m ti 9.40m, undulating, smooth and occasional heavy dark orangish brown staining on joint surfaces up to 1mm thick.

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Casing Details

To (m)	Diam (mm)
3.00	177
12.00	150

Water Added

From (m)	To (m)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 17.00m
All elevations/reduced levels given in mCD

Core Barrel	**Flush Type**	**Termination Reason**	**Last Updated**
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH

Project No.	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI		**Borehole ID**
21-1031	**Client:**	Orkney Islands Council	**BH-M06**
	Client's Rep:	Arch Henderson LLP	

Method	Plant Used	Top (m)	Base (m)
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	12.00

Coordinates
345121.94 E
1003893.44 N

Final Depth: 12.00 m	**Start Date:** 06/03/2022	**Driller:** MJ	Sheet 2 of 2 Scale: 1:50
Elevation: -10.51 mCD	**End Date:** 07/03/2022	**Logger:** NP+RC	FINAL

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mCD	Depth (m)	Legend	Description	Water	Backfill
		100									Weak (locally medium strong) indistinctly thinly laminated fine grained orangish grey SANDSTONE. Partially weathered: reduced strength, much closer fracture spacing, occasional heavy dark orangish brown discolouration on fracture surfaces and occasional sandy clay infill on fracture surfaces. Discontinuities: 1. 5 to 20 degree bedding fractures, closely spaced (10/125/300) planar, smooth, occasional heavy dark orangish brown staining on fracture surfaces up to 1mm deep and occasional sandy clay infill on fracture surfaces up to 30mm thick. 2. 65 to 75 degree joints from 3.10m to 4.10m, 5.20m to 5.50m to 5.60m, 6.30m to 6.50m, 6.80m to 6.90m, 7.60m to 8.00m, 8.20m to 8.80m, 9.00m ti 9.40m, undulating, smooth and occasional heavy dark orangish brown staining on joint surfaces up to 1mm thick. *10.50m: Firm sandy clay infill on joint surfaces up to 50mm deep.* *11.25m to 12.00m: AZCL - Lower half of core run unable to be retrieved from base of borehole due to fractured nature of material.*		
9.80	C8				7								
10.50		51			>20								
10.50	C9												
					AZCL								
12.00								-22.51	12.00		End of Borehole at 12.00m		

9.5
10.0
10.5
11.0
11.5
12.0
12.5
13.0
13.5
14.0
14.5
15.0
15.5
16.0
16.5
17.0
17.5
18.0
18.5

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Chiselling Details

From (m)	To (m)	Time (hh:mm)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 17.00m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
3.00	177
12.00	150

Water Added

From (m)	To (m)

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH	**Project No.** **21-1031**	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI **Client:** Orkney Islands Council **Client's Rep:** Arch Henderson LLP	**Borehole ID** **BH-M07**

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	4.50	345062.99 E 1003927.90 N
Rotary Coring	Fraste Duo CXL Rotosonic	4.50	12.00	

Final Depth: 12.00 m	**Start Date:** 07/03/2022	**Driller:** MJ	Sheet 1 of 2 Scale: 1:50
Elevation: -11.32 mCD	**End Date:** 09/03/2022	**Logger:** RC+NP	FINAL

Depth (m)	**Sample / Tests**	**Field Records**	**Casing Depth (m)**	**Water Depth (m)**
0.00 - 0.50	ES5	Marine Scotland - SS1		
0.00 - 1.50	B8			
0.50	ES1			
1.00	ES2			
1.00 - 1.50	ES6	Marine Scotland - SS2		
1.50	D11			
1.50 - 3.00	B9			
1.50 - 1.95	SPT (C)	N=20 (3,4/4,5,5,6) Hammer SN = 1353	1.50	
2.00	ES3			
2.50 - 3.00	ES7	Marine Scotland - SS3		
3.00	D12			
3.00	ES4			
3.00 - 4.50	B10			
3.00 - 3.45	SPT (S)	N=26 (5,6/6,7,6,7) Hammer SN = 1353	3.00	
4.50	D13		4.50	
4.50 - 4.93	SPT(S) N=50 (8,9/50 for 280mm) Hammer SN = 1353			
6.00			6.00	
6.00 - 6.40	SPT(C) N=50 (9,12/50 for 245mm) Hammer SN = 1353			
7.45	C1			
7.50				
8.20	C2			
8.60	C3			
9.00				
9.10	C4			
9.30	C5			

TCR	**SCR**	**RQD**	**FI**
33	0	0	AZCL
60	9	0	AZCL
			>20
80	28	0	>20
			10
			AZCL

Level mCD	**Depth (m)**	**Description**
		Medium dense grey gravelly silty fine to coarse SAND with shell fragments (up to 5mm). Gravel is subangular fine to medium of various lithologies.
-13.82	2.50	Medium dense grey very gravelly silty fine to coarse SAND. Gravel is subangular fine of various lithologies.
-14.72	3.40	Stiff to very stiff brownish grey sandy gravelly silty CLAY. Sand is fine to coarse. Gravel is subangular fine to coarse of various lithologies.
-15.42	4.10	Very stiff dark greyish brown slightly sandy gravelly CLAY with medium cobble content. Sand is fine to coarse. Gravel is angular to subangular fine to coarse of sandstone and mudstone. Cobbles are of mudstone. *4.50m to 5.50m: AZCL - Disturbance due to SPT has lead to subsequent wash out of material.* *6.00m to 6.50m: AZCL - Disturbance due to SPT has lead to subsequent wash out of material.*
	(3.00)	Weak indistinctly thinly laminated fine grained moderately cemented light orangish grey SANDSTONE. Partially weathered: reduced strength, much closer fracture spacing, occasional light brownish orange discolouration on fracture surfaces and occasional sandy clay infill on fracture surfaces. Discontinuities: 1. 5 to 20 degree bedding fractures closely spaced (10/70/100) planar, rough, occasional light brownish orange staining on fracture surfaces up to 1mm deep and occasional sandy clay infill up to 10mm thick. 2. 65 to 75 degree joints from 6.50m to 6.80m, 7.50m to 7.60m and 7.60m to 7.90m, undulating, rough, occasional light brownish orange staining and occasional sandy clay infill up to 3mm thick.
-18.42	7.10	Very weak (locally weak) indistinctly thinly laminated fine grained moderately cemented light greyish orange SANDSTONE. Partially weathered: reduced strength, closer fracture spacing and frequent heavy brownish orange discolouration on fracture surfaces. Discontinuities: 1. 5 to 20 degree bedding fractures closely spaced (30/130/450), planar, rough and frequent heavy light brownish orange staining up to the entire diameter of core. 2. 25 to 45 degree joints medium spaced (150/290/700) planar, rough and frequent heavy light brownish orange staining up to entire diameter of core. 3. 65 to 75 degree joints from 8.20m to 8.50m, 10.10m to 10.50m and 10.70m to 11.00m, undulating, rough and frequent heavy light brownish orange staining up to entire diameter of core. *8.65m to 9.00m: AZCL - Probable bed of extremely weak sandstone washed out during drilling.*
	(1.10)	
-19.52	8.20	

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 22.00m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
4.50	177
12.00	150

Water Added

From (m)	To (m)

Core Barrel	**Flush Type**	**Termination Reason**	**Last Updated**
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH

Project No. 21-1031	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI		**Borehole ID** BH-M07
	Client: Orkney Islands Council		
	Client's Rep: Arch Henderson LLP		

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	4.50	345062.99 E 1003927.90 N
Rotary Coring	Fraste Duo CXL Rotosonic	4.50	12.00	

Final Depth:	12.00 m	**Start Date:**	07/03/2022	**Driller:**	MJ
Elevation:	-11.32 mCD	**End Date:**	09/03/2022	**Logger:**	RC+NP

Sheet 2 of 2
Scale: 1:50
FINAL

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mCD	Depth (m)	Legend	Description	Water	Backfill
9.40	C6	93	59	24	10						Very weak (locally weak) indistinctly thinly laminated fine grained moderately cemented light greyish orange SANDSTONE. Partially weathered: reduced strength, closer fracture spacing and frequent heavy brownish orange discolouration on fracture surfaces. Discontinuities: 1. 5 to 20 degree bedding fractures closely spaced (30/130/450), planar, rough and frequent heavy light brownish orange staining up to the entire diameter of core. 2. 25 to 45 degree joints medium spaced (150/290/700) planar, rough and frequent heavy light brownish orange staining up to entire diameter of core. 3. 65 to 75 degree joints from 8.20m to 8.50m, 10.10m to 10.50m and 10.70m to 11.00m, undulating, rough and frequent heavy light brownish orange staining up to entire diameter of core. *11.30m to 12.00m: AZCL - Lower half of core run unable to be retrieved from base of borehole due to fractured nature of material.*		
10.50		53	0	0	>20				(3.80)				
11.20	C7				AZCL								
12.00								-23.32	12.00		End of Borehole at 12.00m		

TCR SCR RQD FI

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Chiselling Details

From (m)	To (m)	Time (hh:mm)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 22.00m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
4.50	177
12.00	150

Water Added

From (m)	To (m)

Core Barrel	**Flush Type**	**Termination Reason**	**Last Updated**
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH	**Project No.** **21-1031**	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI **Client:** Orkney Islands Council **Client's Rep:** Arch Henderson LLP	**Borehole ID** **BH-M08**

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	345091.71 E 1003988.52 N
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	12.00	

Final Depth: 12.00 m	**Start Date:** 22/03/2022	**Driller:** MJ	Sheet 1 of 2 Scale: 1:50
Elevation: -10.31 mCD	**End Date:** 23/03/2022	**Logger:** NP+EM	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)
0.00 - 1.50	B5			
0.50	ES1			
1.00	ES2			
1.50	D7			
1.50 - 3.00	B6			
1.50 - 1.95	SPT (S)	N=15 (2,2/4,3,4,4) Hammer SN = 1353	1.50	
2.00	ES3			
3.00	D8		3.00	
3.00	ES4			
3.00 - 3.45	SPT(S) N=30 (6,7/7,7,8,8) Hammer SN = 1353			
4.50			4.50	
4.50	D9			
4.50 - 4.65	SPT(S) N=50 (25 for 90mm/50 for 60mm) Hammer SN = 1353			
4.90	C1			
5.85	C2			
6.00				
6.20	C3			
6.90	C4			
7.05	C5			
7.50				
7.50	C6			
9.00				

Run (m)	TCR	SCR	RQD
3.00 - 4.50	26		
4.50 - 6.00	76	60	26
6.00 - 7.50	83	63	30
7.50 - 9.00	100	25	16

FI
AZCL
AZCL
6
12
AZCL
12
NI

Level mCD	Depth (m)	Description
		Medium dense grey very gravelly silty fine to coarse SAND with shell fragments (up to 9mm). Gravel is subangular fine to coarse of various lithologies.
-11.81	1.50	Stiff to very stiff brownish grey slightly sandy slightly gravelly silty CLAY with low cobble content. Sand is fine to coarse. Gravel is subangular fine to medium of various lithologies. Cobbles are subangular.
-13.31	3.00 (2.00)	Very stiff dark greyish brown slightly sandy slightly gravelly CLAY with medium cobble content. Sand is fine to coarse. Gravel is subangular fine to coarse of various lithologies. Cobbles are subrounded of mudstone. *3.00m to 4.10m: AZCL - Disturbance due to SPT has lead to subsequent wash out of material.* *4.50m to 4.90m: AZCL - Disturbance due to SPT has lead to subsequent wash out of material.*
-15.31	5.00 (4.30)	Weak (locally medium strong) thinly laminated light orangish brown fine to medium grained moderately cemented SANDSTONE. Partially weathered: slightly reduced strength, slightly closer fracture spacing, with clay deposits on fracture surfaces. Discontinuities: 1. 10 to 20 degree bedding fractures, medium spaced (110/407/500), planar, rough, with patchy light orangish brown clay deposits (<1mm thick) on few fracture surfaces. 2. 60 to 90 degree joint at 5.50m to 5.80m, undulating, rough with patchy light greyish white clay deposits on joint surface. 3. Possible 90 degree joint at 6.30m to 7.10m, probably undulating, rough with orangish brown patchy staining on joint surface, otherwise clean. 4. 45 degree joint at 5.85m, slightly undulating, rough, clean. *7.20m to 7.50m: AZCL - Probable bed of extremely weak sandstone washed out during drilling.*
-19.61	9.30	

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Casing Details

To (m)	Diam (mm)
3.00	177
12.00	150

Water Added

From (m)	To (m)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 16.50m
All elevations/reduced levels given in mCD

Core Barrel	**Flush Type**	**Termination Reason**	**Last Updated**
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH	Project No.	Project Name: Scapa Deep Water Quay & Hatston Pier Development - Marine GI	Borehole ID
	21-1031	Client: Orkney Islands Council	BH-M08
		Client's Rep: Arch Henderson LLP	

Method	Plant Used	Top (m)	Base (m)	Coordinates				Sheet 2 of 2
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	345091.71 E 1003988.52 N	Final Depth: 12.00 m	Start Date: 22/03/2022	Driller: MJ	Scale: 1:50
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	12.00		Elevation: -10.31 mCD	End Date: 23/03/2022	Logger: NP+EM	FINAL

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mCD	Depth (m)	Legend	Description	Water	Backfill
9.35	C7										Medium strong (locally weak) thickly laminated light orangish brown medium grained well cemented SANDSTONE. Partially weathered: much closer fracture spacing, slightly reduced strength with discolouration and clay deposits on fracture surfaces. Discontinuities: 1. 15 to 25 degree bedding fractures, closely spaced (40/166/800) planar, rough with patchy brown clay deposits and orangish brown staining on fractures surfaces and fracture staining. 2. 70 to 90 degree joint at 8.10m to 9.00m, and 9.90m to 10.30m, undulating, rough with patchy faint orangish brow staining on joint surfaces, otherwise clean. 3. 50 to 60 degree joint at 7.70m to 7.80m, 11.75m to 12.00m, slightly undulating, rough, clean.		
9.60	C8												
9.80	C9	100	87	46									
10.50													
10.50	C10				4				(2.70)				
11.00	C11												
		100	95	65									
11.55	C12												
12.00								-22.31	12.00		End of Borehole at 12.00m		
		TCR	SCR	RQD	FI								

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Chiselling Details

From (m)	To (m)	Time (hh:mm)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 16.50m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
3.00	177
12.00	150

Water Added

From (m)	To (m)

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH	Project No.	Project Name: Scapa Deep Water Quay & Hatston Pier Development - Marine GI	Borehole ID
	21-1031	Client: Orkney Islands Council	BH-M09
		Client's Rep: Arch Henderson LLP	

Method	Plant Used	Top (m)	Base (m)	Coordinates
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	345032.04 E 1004023.35 N
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	10.50	

Final Depth:	10.50 m	Start Date:	23/03/2022	Driller:	MJ	Sheet 1 of 2 Scale: 1:50
Elevation:	-12.25 mCD	End Date:	24/03/2022	Logger:	RC+NP	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)
0.00 - 0.50	ES5	Marine Scotland - SS1		
0.00 - 1.50	B8			
0.50	ES1			
1.00	ES2			
1.00 - 1.50	ES6	Marine Scotland - SS2		
1.50	D10			
1.50 - 3.00	B9			
1.50 - 1.95	SPT (S)	N=15 (2,3/3,4,4,4) Hammer SN = 1353	1.50	
2.00	ES3			
2.50 - 3.00	ES7	Marine Scotland - SS3		
3.00	D11		3.00	
3.00	ES4			
3.00 - 3.45	SPT(S) N=34 (6,7/8,8,9,9) Hammer SN = 1353			
4.50				
4.50	C1			
4.60	C2			
5.10	C3			
6.00				
6.10	C4			
6.90	C5			
7.30	C6			
7.50				
8.10	C7			
9.00				

Core run (m)	TCR	SCR	RQD	FI
3.00 - 4.50	27	3	0	AZCL >20
4.50 - 6.00	53	20	0	>20 AZCL
6.00 - 7.50	100	89	55	10
7.50 - 9.00	100	61	12	12 20
9.00 -				

Level mCD	Depth (m)	Description
-14.75	2.50	Medium dense grey very gravelly silty fine to coarse SAND with shell fragments (up to 8mm). Gravel is subangular fine to medium of various lithologies.
-15.25	3.00	Stiff to very stiff brownish grey sandy gravelly silty CLAY. Sand is fine to coarse. Gravel is subangular fine to coarse of sandstone and mudstone.
-18.25	(3.00) 6.00	Medium strong (locally weak) indistinctly thinly laminated fine grained, moderately cemented SANDSTONE. Partially weathered: reduced strength, much closer fracture spacing and occasional heavy brownish black discolouration on fracture surfaces. Discontinuities: 1. 5 to 20 degree bedding fractures, closely spaced (10/65/100) planar, rough and occasional heavy brownish black staining on fracture surfaces up to 10mm deep. 2. 65 to 75 degree joints from 3.00m to 3.30m and 4.70m to 5.00m,. undulating, rough and occasional heavy brownish black staining on joint surfaces up to 1mm deep. *3.00m to 4.10m: AZCL - Disturbance due to SPT has lead to subsequent wash out of material.* *5.30m to 6.00m: AZCL - Probable bed of extremely weak sandstone washed out during drilling.*
	(4.50)	Medium strong to strong (locally weak) indistinctly thinly laminated fine grained moderately cemented light orangish grey SANDSTONE. Partially weathered: slightly reduced strength, closer fracture spacing, occasional heavy brownish ornate discolouration on fracture surfaces and occasional sandy clay infill on fracture surfaces. Discontinuities: 1. 5 to 25 degree bedding fractures closely spaced (20/140/300) planar, rough, occasional heavy brownish orange staining on fracture surfaces up to 1mm deep and occasional sandy clay infill on fracture surfaces up to 40mm thick. 2. 25 to 45 degree joints medium spaced (200/500/1000) planar, rough and frequent heavy brownish orange staining on joint surfaces up to 2mm deep. 3. 65 to 75 degree joints from 7.50m to 7.80m, 7.80m to 8.00m, 8.40m to 8.50m, 9.50m to 9.40m and 9.90m to 10.50m, undulating, rough and occasional light brownish orange staining up to 0.5mm deep.

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 19.00m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
3.00	177
10.50	150

Water Added

From (m)	To (m)

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH

Project No.	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI		**Borehole ID**
21-1031	**Client:**	Orkney Islands Council	**BH-M09**
	Client's Rep:	Arch Henderson LLP	

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	345032.04 E 1004023.35 N
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	10.50	

Final Depth:	10.50 m	**Start Date:**	23/03/2022	**Driller:**	MJ	Sheet 2 of 2 Scale: 1:50
Elevation:	-12.25 mCD	**End Date:**	24/03/2022	**Logger:**	RC+NP	FINAL

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mCD	Depth (m)	Legend	Description	Water	Backfill
9.50	C8									⁘	Medium strong to strong (locally weak) indistinctly thinly laminated fine grained moderately cemented light orangish grey SANDSTONE. Partially weathered: slightly reduced strength, closer fracture spacing, occasional heavy brownish ornate discolouration on fracture surfaces and occasional sandy clay infill on fracture surfaces. Discontinuities: 1. 5 to 25 degree bedding fractures closely spaced (20/140/300) planar, rough, occasional heavy brownish orange staining on fracture surfaces up to 1mm deep and occasional sandy clay infill on fracture surfaces up to 40mm thick. 2. 25 to 45 degree joints medium spaced (200/500/1000) planar, rough and frequent heavy brownish orange staining on joint surfaces up to 2mm deep. 3. 65 to 75 degree joints from 7.50m to 7.80m, 7.80m to 8.00m, 8.40m to 8.50m, 9.50m to 9.40m and 9.90m to 10.50m, undulating, rough and occasional light brownish orange staining up to 0.5mm deep.		▓
9.70	C9												
		100	56	26	14								
10.50								-22.75	10.50		End of Borehole at 10.50m		
		TCR	SCR	RQD	FI								

9.5 10.0 10.5 11.0 11.5 12.0 12.5 13.0 13.5 14.0 14.5 15.0 15.5 16.0 16.5 17.0 17.5 18.0 18.5

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Chiselling Details

From (m)	To (m)	Time (hh:mm)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 19.00m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
3.00	177
10.50	150

Water Added

From (m)	To (m)

Core Barrel	**Flush Type**	**Termination Reason**	**Last Updated**
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH	**Project No.** **21-1031**	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI **Client:** Orkney Islands Council **Client's Rep:** Arch Henderson LLP	**Borehole ID** **BH-M10**

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	345061.10 E
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	12.00	1004083.93 N

Final Depth: 12.00 m	**Start Date:** 24/03/2022	**Driller:** MJ	Sheet 1 of 2 Scale: 1:50
Elevation: -10.05 mCD	**End Date:** 25/03/2022	**Logger:** NP+RC	FINAL

Depth (m)	**Sample / Tests**	**Field Records**	**Casing Depth (m)**	**Water Depth (m)**
0.00 - 1.50	B5			
0.50	ES1			
1.00	ES2			
1.50	D7			
1.50 - 3.00	B6			
1.50 - 1.95	SPT (S)	N=10 (1,1/2,2,3,3) Hammer SN = 1353	1.50	
2.00	ES3			
3.00	D8		3.00	
3.00	ES4			
3.00 - 3.42	SPT(S) N=50 (6,7/50 for 275mm) Hammer SN = 1353			
4.35	C1			
4.50				
4.50	C2			
4.60	C3			
6.00				
6.20	C4			
7.30	C5			
7.50				
7.95	C6			
8.30	C7			
9.00				

TCR	**SCR**	**RQD**	**FI**
67	17	0	AZCL 12
100	57	0	13
100	78	21	9
100	85	55	13

Level mCD	**Depth (m)**	**Description**
		Loose to medium dense grey very gravelly silty fine to coarse SAND with shell fragments (up to 11mm). Gravel is subangular fine to medium of various lithologies.
-11.54	1.50	Stiff to very stiff brownish grey slightly gravelly very sandy silty CLAY. Sand is fine to coarse. Gravel is subangular fine to medium of various lithologies.
-12.54	2.50	Highly weathered brown SANDSTONE. (Drillers description)
-12.90	2.85	Light brown and orangish brown banded SANDSTONE (Driller's description)
-13.04	3.00 (0.80)	Weathered SANDSTONE recovered as: stiff dark greyish orange very sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular fine to coarse of sandstone. *3.00m to 3.50m: AZCL - Disturbance due to SPT has lead to subsequent wash out of material.*
-13.84	3.80 (1.15)	Weak thinly laminated fine grained greyish orange SANDSTONE. Partially weathered: significantly reduced strength, closer fracture spacing, frequent heavy dark brownish orange discolouration on fracture surfaces. Discontinuities: 1. 5 to 20 degree bedding fractures closely spaced (20/165/250) planar rough, frequent heacy dark brownish orange staining up to whole diameter of core deep and frequent, light greenish grey sandy clay infill on fracture surfaces.
-15.00	4.95 (2.75)	Weak indistinctly thinly laminated fine grained dark yellowish grey SANDSTONE. Partially weathered: reduced strength, much closer fracture spacing and occasional heavy brownish black discolouration on fracture surfaces and occasional sandy clay infill on fracture surfaces. Discontinuities: 1. 5 to 25 degree bedding fractures closely spaced (10/110/350) planar, rough, occasional orangish brown staining up to full diameter of core an occasional brownish black staining up to 0.5mm deep and occasional sandy clay infill up to 10mm thick. 2. 65 to 75 degree joints from 4.95m to 5.05m, 5.05m to 5.45m, 5.90m to 6.20m, 6.30m to 6.70m and 6.80m to 7.35m, undulating, rough and frequent heavy brownish black staining up to 1mm deep.
-17.74	7.70	Medium strong (locally weak) indistinctly thinly laminated fine grained light yellowish grey SANDSTONE. Partially weathered: slightly reduced strength, closer fracture spacing and occasional brownish black and brownish orange discolouration on fracture surfaces. Discontinuities: 1. 5 to 15 degree bedding fractures closely spaced (30/190/400) planar, rough and occasional heavy brownish black staining up to 1mm deep. 2. 45 to 55 degree joints at 9.20m, 10.00m and 11.70m, planar, rough and occasional brownish black staining up to 10mm deep. 3. 65 to 75 degree joints from 7.70m to 7.80m, 7.90m to 8.05m, 8.60m to 9.00m and 9.00m to 9.50m, undulating, rough and frequent heavy brownish black and orangish brown staining on joint surfaces up to 3mm deep.

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 17.00m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
3.00	177
12.00	150

Water Added

From (m)	To (m)

Core Barrel	**Flush Type**	**Termination Reason**	**Last Updated**
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH	**Project No.** **21-1031**	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI **Client:** Orkney Islands Council **Client's Rep:** Arch Henderson LLP	**Borehole ID** **BH-M10**

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	345061.10 E
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	12.00	1004083.93 N

Final Depth: 12.00 m	**Start Date:** 24/03/2022	**Driller:** MJ	Sheet 2 of 2 Scale: 1:50
Elevation: -10.05 mCD	**End Date:** 25/03/2022	**Logger:** NP+RC	FINAL

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mCD	Depth (m)	Legend	Description	Water	Backfill
9.70	C8	85	65	32							Medium strong (locally weak) indistinctly thinly laminated fine grained light yellowish grey SANDSTONE. Partially weathered: slightly reduced strength, closer fracture spacing and occasional brownish black and brownish orange discolouration on fracture surfaces. Discontinuities: 1. 5 to 15 degree bedding fractures closely spaced (30/190/400) planar, rough and occasional heavy brownish black staining up to 1mm deep. 2. 45 to 55 degree joints at 9.20m, 10.00m and 11.70m, planar, rough and occasional brownish black staining up to 10mm deep. 3. 65 to 75 degree joints from 7.70m to 7.80m, 7.90m to 8.05m, 8.60m to 9.00m and 9.00m to 9.50m, undulating, rough and frequent heavy brownish black and orangish brown staining on joint surfaces up to 3mm deep.		
10.00	C9												
10.50					3								
10.60	C10	100	90	81					(4.30)				
11.20	C11												
12.00								-22.04	12.00		End of Borehole at 12.00m		

Water Strikes				**Chiselling Details**		
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)	From (m)	To (m)	Time (hh:mm)

Casing Details		**Water Added**	
To (m)	Diam (mm)	From (m)	To (m)
3.00	177		
12.00	150		

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 17.00m
All elevations/reduced levels given in mCD

Core Barrel	**Flush Type**	**Termination Reason**	**Last Updated**
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH

Project No. 21-1031	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI		**Borehole ID** BH-M11
	Client: Orkney Islands Council		
	Client's Rep: Arch Henderson LLP		

Method	Plant Used	Top (m)	Base (m)	Coordinates
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	344997.29 E 1004104.77 N
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	9.00	

Final Depth: 9.00 m	**Start Date:** 26/03/2022	**Driller:** MJ	Sheet 1 of 2 Scale: 1:50
Elevation: -14.41 mCD	**End Date:** 27/03/2022	**Logger:** NP	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)
0.00 - 0.50	ES5	Marine Scotland - SS1		
0.00 - 1.50	B8			
0.50	ES1			
1.00	ES2			
1.00 - 1.50	ES6	Marine Scotland - SS2		
1.50	D10			
1.50 - 3.00	B9			
1.50 - 1.95	SPT (S)	N=16 (2,3/3,4,4,5) Hammer SN = 1353	1.50	
2.00	ES3			
2.50 - 3.00	ES7	Marine Scotland - SS3		
3.00	D11		3.00	
3.00	ES4			
3.00 - 3.29	SPT(S) N=50 (6,8/50 for 140mm) Hammer SN = 1353			
4.20	C1			
4.50				
5.30	C2			
5.60	C3			
6.00				
6.40	C4			
7.30	C5			
7.50				
7.50	C6			
8.15	C7			
8.60	C8			
9.00				

Core run (m)	TCR	SCR	RQD
3.00 - 4.50	30	0	0
4.50 - 6.00	100	72	40
6.00 - 7.50	100	97	55
7.50 - 9.00	100	100	34

Depth (m)	FI
3.00 - 4.10	AZCL
4.10 - 4.50	12
4.50 - 5.10	>20
5.10 - 6.20	3
6.20 - 9.00	5

Level mCD	Depth (m)
-16.41	2.00
	(2.10)
-18.51	4.10
	(0.40)
-18.91	4.50
	(0.25)
-19.16	4.75
	(0.35)
-19.51	5.10
	(1.10)
-20.61	6.20
	(2.80)
-23.41	9.00

Description

Medium dense grey very gravelly silty fine to coarse SAND with shell fragments (up to 6mm). Gravel is subangular fine to medium of various lithologies.

Highly weathered white SANDSTONE recovered as sandy subangular fine to coarse gravel and subangular cobbles.

3.00m to 4.10m: AZCL - Disturbance due to SPT has lead to subsequent wash out of material.

Very weak, probably thinly laminated, medium grained, well cemented, light orangish brown SANDSTONE.

Very weak, thinly laminated, fine grained, poorly cemented, light brown highly fractured SANDSTONE. Partially weathered, reduced strength, much closer fracture spacing with pervasive orangish brown discolouration, closed.
Discontinuities:
1. 10 to 15 degree bedding fractures, very thinly spaced (5/40/60), planar, smooth, with pervasive light brown staining on fracture surfaces.
2. 80 to85 degree joints, probably very closely spaced, undulating, smooth.

Weak, thinly bedded, medium grained, moderately well cemented, orangish brown SANDSTONE. Partially weathered, reduced strength, close fracture spacing with pervasive orangish brown discolouration.
Discontinuities:
1. 10 to 15 degree bedding fractures, thinly spaced (30/85/95), planar, rough, with orangish brown staining on fracture surfaces.
2. 60 degree joint at 4.80m to 4.90m, undulating, smooth, with orangish brown fine sand deposits and orangish brown staining on joint surfaces.
3. 70 to 80 degree joint at 4.90m to 5.10m, undulating, rough, with pervasive orangish brown staining on joint surfaces.

Extremely weak, probably very thinly laminated, orangish brown and greenish grey MUDSTONE. Highly weathered, highly reduced strength, pervasive greenish grey discolouration from 5.20m to 6.05m
Discontinuities:
1. 5 degree bedding fracture at 5.60m, planar, smooth, with pervasive greenish grey staining on fracture surfaces.
2. 70 degree joints at 5.15m to 5.25m and 5.20m to 5.40m, planar, smooth, with pervasive greenish grey staining on joint surfaces.

Medium strong (locally weak), thinly laminated to thinly bedded, fine grained, well cemented, light orangish brown SANDSTONE. Partially weathered, slightly closer fracture spacing with occasional orangish brown discolouration.
Discontinuities:
1. 10 to 25 degree bedding fractures, medium spaced (100/345/800), planar, rough, with dark orangish brown staining on some fracture surfaces.

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Casing Details

To (m)	Diam (mm)
3.00	177
9.00	150

Water Added

From (m)	To (m)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 20.20m
All elevations/reduced levels given in mCD

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH

Project No.	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI		**Borehole ID**
21-1031	**Client:**	Orkney Islands Council	**BH-M11**
	Client's Rep:	Arch Henderson LLP	

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	344997.29 E
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	9.00	1004104.77 N

Final Depth:	9.00 m	**Start Date:**	26/03/2022	**Driller:**	MJ	Sheet 2 of 2 Scale: 1:50
Elevation:	-14.41 mCD	**End Date:**	27/03/2022	**Logger:**	NP	FINAL

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mCD	Depth (m)	Legend	Description	Water	Backfill
											Medium strong (locally weak), thinly laminated to thinly bedded, fine grained, well cemented, light orangish brown SANDSTONE. Partially weathered, slightly closer fracture spacing with occasional orangish brown discolouration. Discontinuities: 1. 10 to 25 degree bedding fractures, medium spaced (100/345/800), planar, rough, with dark orangish brown staining on some fracture surfaces. 2. 25 degree joint at 8.00m to 8.05m, planar, smooth. 3. 65 to 75 degree joints at 6.90m to 7.20m, 8.10m to 8.25m and 8.50m to 8.65m, slightly undulating, rough, with dark brown staining on 6.90m to 7.20m joint surfaces penetrating to the base of the strata. *8.25m to 8.65m: 65 to 75 degree probably closely spaced incipient joints.*		
											End of Borehole at 9.00m		
		TCR	SCR	RQD	FI								

9.5
10.0
10.5
11.0
11.5
12.0
12.5
13.0
13.5
14.0
14.5
15.0
15.5
16.0
16.5
17.0
17.5
18.0
18.5

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Chiselling Details

From (m)	To (m)	Time (hh:mm)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 20.20m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
3.00	177
9.00	150

Water Added

From (m)	To (m)

Core Barrel	**Flush Type**
SK6L	Polymer

Termination Reason

Terminated at scheduled depth

Last Updated

29/06/2022

AGS

Project No. 21-1031	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI	**Borehole ID** BH-M12	
	Client: Orkney Islands Council		
	Client's Rep: Arch Henderson LLP		

Method	Plant Used	Top (m)	Base (m)	Coordinates
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	1.50	345016.39 E 1004186.20 N
Rotary Coring	Fraste Duo CXL Rotosonic	1.50	12.00	

Final Depth:	12.00 m	**Start Date:**	27/03/2022	**Driller:**	MJ	Sheet 1 of 2 Scale: 1:50
Elevation:	-10.84 mCD	**End Date:**	28/03/2022	**Logger:**	EM+NP	FINAL

Depth (m)	Sample / Tests	Field Records
0.00 - 1.50	B3	
0.50	ES1	
1.00	ES2	
1.50	D4	
1.50 - 1.95	SPT(S) N=38 (6,7/7,9,10,12) Hammer SN = 1353	
2.35	C1	
2.75	C2	
3.00		
3.00	C3	
3.45	C4	
4.50		
4.80	C5	
5.80	C6	
6.00		
6.40	C7	
7.50		
7.70	C9	
8.25	C10	
9.00		

Run	TCR	SCR	RQD	FI
1.50 - 3.00	50	30	15	AZCL 6
3.00 - 4.50	100	85	38	16
4.50 - 6.00	100	82	42	7
6.00 - 7.50	100	86	38	NI 5
7.50 - 9.00	100	96	83	4

Casing Depth (m): 1.50

Level mCD	Depth (m)	Description
-11.34	0.50	Medium dense grey very gravelly very silty fine to coarse SAND with shell fragments (up to 5mm). Gravel is subangular fine to coarse of various lithologies.
-12.34	1.50	Highly weathered brown SANDSTONE recovered as subangular fine to coarse gravel and subangular cobbles.
-15.24	4.40 (2.90)	Medium strong indistinctly thinly laminated light creamy brown fine grained moderately cemented SANDSTONE. Partially weathered: closer fracture spacing, slightly reduced strength with sandy clay deposits and discolouration on fracture surfaces. Discontinuities: 1. 30 to 40 degree bedding fractures closely spaced (40/93/150) planar, rough with patchy orangish brown sandy clay deposits (1mm thick) on rare surfaces and strong patchy orangish brown staining on most fracture surfaces. 2. 75 to 85 degree joint at 3.20m to 3.45m, planar, rough with patchy brown staining on joint surface. 3. 50 to 60 degree joint at 3.80m to 4.00m, planar, rough with orangish brown staining on joint surface. *1.50m to 2.25m: AZCL - Disturbance due to SPT has lead to subsequent wash out of material.*
	(7.60)	Medium strong (locally weak) thickly laminated light greyish white fine grained moderately cemented SANDSTONE. Partially weathered: closer fracture spacing, slightly reduced strength with discolouration and clay deposits and clay infill on fracture surfaces. Discontinuities: 1. 5 to 15 degree bedding fractures medium spaced (85/400/650) planar, rough with strong orangish brown staining on most fracture surfaces, patchy black staining on few fracture surfaces and patchy orangish brown sandy clay deposits (up to 5mm thick) on some fracture surfaces. 2. 50 to 60 degree joints at 5.10m to 5.40m, 5.60m to 5.80m, 6.60m to 6.95m, 7.50m to 7.70m, 8.10m to 8.25m, 8.50m to 8.65m, 10.70m to 10.85m, 10.95m to 11.15m, planar, rough with strong orangish brown staining on most joint surfaces, patchy black staining on few surfaces and occasional patchy light brown clay deposits on few surfaces. 3. 80 to 90 degree joint at 5.35m to 5.60m, 6.40m to 6.90m, 8.60m to 8.90m, planar to slightly undulating rough with orangish brown staining and black staining on some fracture surfaces. *7.50m to 7.60m: Light grey and orangish brown gravelly clay infill.*

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 16.30m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
1.50	177
12.00	150

Water Added

From (m)	To (m)

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

CAUSEWAY GEOTECH	Project No.	Project Name: Scapa Deep Water Quay & Hatston Pier Development - Marine GI	Borehole ID
	21-1031	Client: Orkney Islands Council	BH-M12
		Client's Rep: Arch Henderson LLP	

Method	Plant Used	Top (m)	Base (m)	Coordinates
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	1.50	345016.39 E
Rotary Coring	Fraste Duo CXL Rotosonic	1.50	12.00	1004186.20 N

Final Depth: 12.00 m	**Start Date:** 27/03/2022	**Driller:** MJ	Sheet 2 of 2 Scale: 1:50
Elevation: -10.84 mCD	**End Date:** 28/03/2022	**Logger:** EM+NP	FINAL

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mCD	Depth (m)	Legend	Description	Water	Backfill
9.40	C11	100	84	40							Medium strong (locally weak) thickly laminated light greyish white fine grained moderately cemented SANDSTONE. Partially weathered: closer fracture spacing, slightly reduced strength with discolouration and clay deposits and clay infill on fracture surfaces. Discontinuities: 1. 5 to 15 degree bedding fractures medium spaced (85/400/650) planar, rough with strong orangish brown staining on most fracture surfaces, patchy black staining on few fracture surfaces and patchy orangish brown sandy clay deposits (up to 5mm thick) on some fracture surfaces. 2. 50 to 60 degree joints at 5.10m to 5.40m, 5.60m to 5.80m, 6.60m to 6.95m, 7.50m to 7.70m, 8.10m to 8.25m, 8.50m to 8.65m, 10.70m to 10.85m, 10.95m to 11.15m, planar, rough with strong orangish brown staining on most joint surfaces, patchy black staining on few surfaces and occasional patchy light brown clay deposits on few surfaces. 3. 80 to 90 degree joint at 5.35m to 5.60m, 6.40m to 6.90m, 8.60m to 8.90m, planar to slightly undulating rough with orangish brown staining and black staining on some fracture surfaces.		
10.10	C12				11								
10.50		93	81	73									
10.70	C13												
11.30	C14				4								
12.00								-22.84	12.00				

End of Borehole at 12.00m

Water Strikes				Chiselling Details		
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)	From (m)	To (m)	Time (hh:mm)

Casing Details		Water Added	
To (m)	Diam (mm)	From (m)	To (m)
1.50	177		
12.00	150		

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 16.30m
All elevations/reduced levels given in mCD

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH	**Project No.** **21-1031**	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI **Client:** Orkney Islands Council **Client's Rep:** Arch Henderson LLP	**Borehole ID** **BH-M13**

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	344991.90 E 1004221.83 N
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	10.50	

Final Depth: 10.50 m	**Start Date:** 28/03/2022	**Driller:** MJ	Sheet 1 of 2 Scale: 1:50
Elevation: -11.57 mCD	**End Date:** 29/03/2022	**Logger:** NP	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)
0.00 - 0.50	ES5	Marine Scotland - SS1		
0.00 - 1.50	B8			
0.50	ES1			
1.00	ES2			
1.00 - 1.50	ES6	Marine Scotland - SS2		
1.50	D10			
1.50 - 3.00	B9			
1.50 - 1.95	SPT (S)	N=13 (1,2/3,3,3,4) Hammer SN = 1353	1.50	
2.00	ES3			
2.50 - 3.00	ES7	Marine Scotland - SS3		
3.00	D11		3.00	
3.00	ES4			
3.00 - 3.44	SPT(S) N=50 (6,8/50 for 290mm) Hammer SN = 1353			
4.10	C1			
4.50				
5.00	C2			
5.20	C3			
5.25	C4			
6.00				
6.10	C5			
6.60	C6			
7.50				
8.00	C7			
9.00				
9.00	C8			
9.25	C9			

Core run (m)	TCR	SCR	RQD	FI
3.00 - 4.50	40	0	0	AZCL NI
4.50 - 6.00	95	70	16	9 >20
6.00 - 7.50	97	97	53	6
7.50 - 9.00	96	80	33	
9.00 -				

Level mCD	Depth (m)	Description
		Medium dense light grey gravelly silty fine to coarse SAND with shell fragments (up to 7mm). Gravel is subangular fine to coarse of various lithologies. *1.50m to 2.00m: Very silty from 1.50m*
-13.57	2.00	Highly weathered brown SANDSTONE recovered as subangular coarse gravel and subangular cobbles.
-14.57	3.00 (1.50)	Weathered SANDSTONE recovered as subangular medium to coarse gravel and subangular cobbles. *3.00m to 3.90m: AZCL - Disturbance due to SPT has lead to subsequent wash out of material.*
-16.07	4.50 (0.65)	Weak light brown indistinctly thinly bedded well cemented fine grained SANDSTONE. Partially weathered: slightly reduced strength slightly closer fracture spacing with dark orangish brown discolouration. Discontinuities: 1. Probable 5 to 15 degree bedding fractures, medium spaced (40/160/215) undulating, smooth. 2. 70 to 75 degree joints at 4.55m to 4.80m, 4.80m to 5.00m, undulating, rough with dark orangish brown staining on joint surfaces, penetrating up to 3mm from joint surfaces.
-16.72	5.15 (0.75)	Weak (locally medium strong) light orangish brown thickly laminated poorly cemented fine grained SANDSTONE. Partially weathered: slightly reduced strength, closer fracture spacing with orangish brown discolouration. Discontinuities: 1. 0 to 5 degree bedding fractures, very closely spaced (20/50/180) planar, smooth, with orangish brown staining on some fracture surfaces. 2. 40 to 45 degree joint at 5.15m to 5.20m, an 5.50m to 5.55m planar, smooth. 3. 70 to 90 degree joints at 5.65m to 5.90m, undulating, rough with orangish brown staining on joint surfaces penetrating up to 3mm from joint surfaces.
-17.47	5.90 (4.60)	Medium strong to strong light orangish brown indistinctly thinly bedded moderately, well cemented fine grained SANDSTONE. Partially weathered: slightly reduced strength, slightly closer fracture spacing with localised pervasive orangish brown discolouration. Discontinuities: 1. 15 to 25 degree bedding fractures, medium spaced (40/350/820) planar, smooth with orangish brown staining on joint surfaces, locally penetrating up to 6mm fracture surfaces. 2. 50 to 70 degree joints, probably medium spaced, planar and undulating with orangish brown staining on joint surfaces, locally penetrating up to 5mm from joint surface. *8.50m to 9.00m: Dark orangish brown staining on fracture surfaces.*

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 18.00m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
3.00	177
10.50	150

Water Added

From (m)	To (m)

Core Barrel	**Flush Type**	**Termination Reason**	**Last Updated**
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

Project No. **21-1031**	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI		**Borehole ID** **BH-M13**
	Client: Orkney Islands Council		
	Client's Rep: Arch Henderson LLP		

Method	**Plant Used**	**Top (m)**	**Base (m)**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	10.50

Coordinates
344991.90 E
1004221.83 N

Final Depth: 10.50 m	**Start Date:** 28/03/2022	**Driller:** MJ	Sheet 2 of 2 Scale: 1:50
Elevation: -11.57 mCD	**End Date:** 29/03/2022	**Logger:** NP	FINAL

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mCD	Depth (m)	Legend	Description	Water	Backfill
		100	96	59							Medium strong to strong light orangish brown indistinctly thinly bedded moderately, well cemented fine grained SANDSTONE. Partially weathered: slightly reduced strength, slightly closer fracture spacing with localised pervasive orangish brown discolouration. Discontinuities: 1. 15 to 25 degree bedding fractures, medium spaced (40/350/820) planar, smooth with orangish brown staining on joint surfaces, locally penetrating up to 6mm fracture surfaces. 2. 50 to 70 degree joints, probably medium spaced, planar and undulating with orangish brown staining on joint surfaces, locally penetrating up to 5mm from joint surface.		
10.10	C10												
10.50								-22.07	10.50		End of Borehole at 10.50m		

9.5 10.0 10.5 11.0 11.5 12.0 12.5 13.0 13.5 14.0 14.5 15.0 15.5 16.0 16.5 17.0 17.5 18.0 18.5

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Chiselling Details

From (m)	To (m)	Time (hh:mm)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 18.00m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
3.00	177
10.50	150

Water Added

From (m)	To (m)

Core Barrel	**Flush Type**	**Termination Reason**	**Last Updated**
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

CAUSEWAY GEOTECH	**Project No.** **21-1031**	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI **Client:** Orkney Islands Council **Client's Rep:** Arch Henderson LLP	**Borehole ID** **BH-M14**

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	344915.81 E 1004164.01 N
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	9.00	

Final Depth:	9.00 m	**Start Date:**	29/03/2022	**Driller:**	MJ	Sheet 1 of 2 Scale: 1:50
Elevation:	-18.13 mCD	**End Date:**	30/03/2022	**Logger:**	EM+NP	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)	TCR	SCR	RQD	FI	Level mCD	Depth (m)	Description
0.00 - 0.50	ES5	Marine Scotland - SS1									Medium dense grey gravelly silty fine to coarse SAND with shell fragments (up to 9mm) and unfragmented gastropod shells (up to 19mm). Gravel is subangular fine to medium of various lithologies.
0.00 - 1.50	B8										
0.50	ES1										
1.00	ES2										
1.00 - 1.50	ES6	Marine Scotland - SS2									
1.50	D10										
1.50 - 3.00	B9										
1.50 - 1.95	SPT (S)	N=11 (1,1/2,2,3,4) Hammer SN = 1353	1.50								
2.00	ES3										
2.50 - 3.00	ES7	Marine Scotland - SS3									
3.00	D11		3.00		100	63	23		-21.13	3.00 (0.30)	Greyish brown subrounded fine to coarse GRAVEL of sandstone with high cobble content. Cobbles are subrounded of sandstone.
3.00	ES4										
3.00 - 3.45	SPT(S) N=28 (3,4/6,6,7,9) Hammer SN = 1353								-21.43	3.30	Weak thinly laminated light brown fine grained well cemented SANDSTONE. Partially weathered: slightly closer fractures spacing, slightly reduced strength with discolouration and clay deposits on fracture surfaces. Discontinuities: 1. 30 to 40 degree bedding fractures closely spaced (30/92/120) planar, smooth with patchy orangish brown staining on occasional surfaces and patchy light brown sandy clay deposits (<1mm thick) on most fracture surfaces. 2. 60 to 70 degree joint at 3.65m to 3.80m, undulating, rough with patchy brown andy clay deposits (up to 2mm thick) and patchy faint dark brown discolouration joint surface.
3.50	C1							11		(1.10)	
3.70	C2										
									-22.53	4.40	Weak thinly laminated orangish brown fine grained medium cemented SANDSTONE. Partially weathered: reduced strength with clay deposits. Discontinuities: 1. 30 to 40 degree bedding fractures very closely spaced (10/28/80) slightly undulating, rough with frequent patchy light grey clay deposits (up to 4mm thick) on most fracture surface.
4.50					100	88	43	>20		(0.35)	
								7	-22.88	4.75 (1.25)	Weak indistinctly thickly laminated light brown fine grained medium cemented SANDSTONE. Partially weathered; slightly closer fractures spacing with clay deposits and discolouration. Discontinuities: 1. 25 to 35 degree bedding fractures closely spaced (30/150/230) undulating, rough with patchy brown clay deposits (<2mm thick) on some fracture surfaces. 2. 0 to 5 degree joint at 4.85m, slightly undulating, rough with patchy light brown clay deposits (<1mm thick) on joint surface. 3. 80 to 85 degree joint at 5.20m to 5.30m planar, rough with patchy light brown clay deposits (<1mm thick) on joint surface.
5.40	C3										
5.80	C4										
6.00					100	98	84	2	-24.13	6.00 (1.40)	Medium strong thinly laminated light grey fine grained well cemented SANDSTONE. Partially weathered: slightly closer fracture spacing. Discolouration on fracture surfaces. Discontinuities: 1. 20 to 30 degree bedding fractures closely spaced (10/200/800) planar, rough with pervasive, orangish brown staining penetrating from fracture surfaces and patchy dark reddish brown discolouration on some fracture surfaces, otherwise clean.
6.00	C5										
6.50	C6										
7.05	C7										
7.40	C8							16	-25.53	7.40 (1.60)	Weak (locally medium strong) thinly laminated light brown fine
7.50					100	92	51				
8.40	C9							7			
9.00									-27.13	9.00	

Water Strikes			
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Casing Details		**Water Added**	
To (m)	Diam (mm)	From (m)	To (m)
3.00	177		
9.00	150		

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 25.00m
All elevations/reduced levels given in mCD

Core Barrel	**Flush Type**	**Termination Reason**	**Last Updated**
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH	**Project No.** **21-1031**	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI **Client:** Orkney Islands Council **Client's Rep:** Arch Henderson LLP	**Borehole ID** **BH-M14**

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	344915.81 E
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	9.00	1004164.01 N

Final Depth: 9.00 m	**Start Date:** 29/03/2022	**Driller:** MJ	Sheet 2 of 2 Scale: 1:50
Elevation: -18.13 mCD	**End Date:** 30/03/2022	**Logger:** EM+NP	FINAL

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mCD	Depth (m)	Legend	Description	Water	Backfill
											Weak (locally medium strong) thinly laminated light brown fine grained moderately cemented SANDSTONE. Partially weathered: much closer fracture spacing with discolouration and clay deposits on fracture surfaces. Discontinuities: 1. 0 to 10 degree bedding fractures, closely spaced (5/80/180) planar, smooth with orangish brown staining on some fracture surfaces and light brown sandy clay deposits (up to 20mm thick) on fracture surfaces. *8.40m: Black staining on fracture surface.* *8.70m to 8.72m: Light brown sandy clay infill.*		
											End of Borehole at 9.00m		
		TCR	SCR	RQD	FI								

9.5
10.0
10.5
11.0
11.5
12.0
12.5
13.0
13.5
14.0
14.5
15.0
15.5
16.0
16.5
17.0
17.5
18.0
18.5

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Chiselling Details

From (m)	To (m)	Time (hh:mm)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 25.00m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
3.00	177
9.00	150

Water Added

From (m)	To (m)

Core Barrel	**Flush Type**	**Termination Reason**	**Last Updated**
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH

Project No. 21-1031	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI **Client:** Orkney Islands Council **Client's Rep:** Arch Henderson LLP	**Borehole ID** BH-M15

Method	Plant Used	Top (m)	Base (m)	Coordinates
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	344911.66 E 1004235.99 N
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	9.00	

Final Depth: 9.00 m	**Start Date:** 30/03/2022	**Driller:** MJ	Sheet 1 of 2 Scale: 1:50
Elevation: -17.71 mCD	**End Date:** 31/03/2022	**Logger:** NP	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)
0.00 - 0.50	ES5	Marine Scotland - SS1		
0.00 - 1.50	B8			
0.50	ES1			
1.00	ES2			
1.00 - 1.50	ES6	Marine Scotland - SS2		
1.50	D10			
1.50 - 3.00	B9			
1.50 - 1.95	SPT (S)	N=11 (1,1/2,3,3,3) Hammer SN = 1353	1.50	
2.00	ES3			
2.50 - 3.00	ES7	Marine Scotland - SS3		
3.00	D11		3.00	
3.00	ES4			
3.00 - 3.45	SPT(S) N=34 (4,6/8,8,9,9) Hammer SN = 1353			
4.35	C1			
4.50				
5.20	C2			
5.40	C3			
6.00				
6.20	C4			
7.50				
8.20	C5			
8.50	C6			
9.00				

Core run (m)	TCR	SCR	RQD
3.00 - 4.50	33	0	0
4.50 - 6.00	100	73	0
6.00 - 7.50	100	92	0
7.50 - 9.00	100	95	19

FI
AZCL
NI
11
15
>20
14

Level mCD	Depth (m)	Thickness
-19.21	1.50	
-20.71	3.00	(1.40)
-22.11	4.40	(0.10)
-22.21	4.50	(1.80)
-24.01	6.30	(0.60)
-24.61	6.90	(0.50)
-25.11	7.40	(0.50)
-25.61	7.90	(1.10)
-26.71	9.00	

Description

Loose to medium dense grey very gravelly silty fine to coarse SAND with shell fragments (up to 8mm) and unfragmented articulated brachiopod shells (up to 31mm). Gravel is subangular fine to medium of various lithologies.

Medium dense grey gravelly silty fine to coarse SAND with low cobble content and shell fragments (up to 7mm) and unfragmented gastropod shells (up to 12mm). Gravel is subangular fine to medium of various lithologies. Cobbles are subrounded of sandstone.

Weathered SANDSTONE recovered as subangular fine to coarse gravel of sandstone with low cobble content. Cobbles are subangular of sandstone.

3.00m to 4.10m: AZCL - Disturbance due to SPT has lead to subsequent wash out of material.

Highly weathered SANDSTONE recovered as silty fine sand.

Medium strong light orangish brown indistinctly thinly bedded fine grained moderately well cemented SANDSTONE. Partially weathered: slightly reduced strength, closer fracture spacing with orangish brown discolouration.
Discontinuities:
1. 5 to 15 degree bedding fractures, closely spaced (40/90/220), planar, smooth with patchy dark orangish brown staining on fracture surfaces ad light brown patchy clay deposits on some fracture surfaces.
2. 70 to 90 degree joint at 4.50m to 5.00m, 5.03m to 5.35m, 5.35m to 5.65m, 5.70m to 6.15, and 6.15m to 6.30m, undulating, smooth with dark orangish brown staining, penetrating up to 5mm from joint surfaces and patchy light brown clay deposits on some joint surfaces.

Weak light brown mottled orangish brown indistinctly thinly bedded partly cemented fine grained SANDSTONE. Partially weathered: slightly reduced strength, slightly closer fracture spacing with dark orangish brown discolouration.
Discontinuities:
1. 15 to 20 degree bedding fractures, closely spaced 930/85/110) planar, smooth with patchy dark orangish brown staining on joint surfaces and occasional light brown clay deposits on joint surfaces.
2. 80 to 85 degree joints at 6.30m to 6.70m and 6.35m to 6.70m, undulating, smooth with patchy dark orangish brown staining on joint surfaces and occasional light brown clay deposits on joint surfaces.
2. 80 to 85 degree joints at 6.30m to 6.70m and 6.35m to 6.70m, undulating, smooth with patchy dark orangish brown staining on joint surfaces.

Medium strong orangish brown very thinly bedded poorly cemented fine grained SANDSTONE. Partially weathered: reduced strength, closer fracture spacing with pervasive orangish brown discolouration.
Discontinuities:
1. 15 to 20 degree bedding fracture, very closely spaced (10/25/70) planar, smooth with pervasive orangish brown staining on fracture surfaces.
2. 85 to 90 degree joints at 6.90m to 7.25m and 7.05m to 7.40m,

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 24.00m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
3.00	177
9.00	150

Water Added

From (m)	To (m)

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH	**Project No.** **21-1031**	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI **Client:** Orkney Islands Council **Client's Rep:** Arch Henderson LLP	**Borehole ID** **BH-M15**

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	344911.66 E 1004235.99 N
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	9.00	

Final Depth: 9.00 m	**Start Date:** 30/03/2022	**Driller:** MJ	Sheet 2 of 2 Scale: 1:50
Elevation: -17.71 mCD	**End Date:** 31/03/2022	**Logger:** NP	FINAL

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mCD	Depth (m)	Legend	Description	Water	Backfill
					11						Medium strong orangish brown very thinly bedded poorly cemented fine grained SANDSTONE. Partially weathered: reduced strength, closer fracture spacing with pervasive orangish brown discolouration. Discontinuities: 1. 15 to 20 degree bedding fracture, very closely spaced (10/25/70) planar, smooth with pervasive orangish brown staining on fracture surfaces. 2. 85 to 90 degree joints at 6.90m to 7.25m and 7.05m to 7.40m, undulating, smooth with dark orangish brown staining on joint surfaces. *7.25m: Thick light brown soft clay infill on 15 degree bedding fracture.*		
											Medium strong light brown indistinctly thinly bedded well cemented fine grained SANDSTONE. Partially weathered: slightly reduced strength, slightly closer fracture spacing with patchy orangish brown discolouration. Discontinuities: 1. 5 to 15 degree bedding fractures, closely spaced (50/70/120) planar, smooth, with patchy orangish brown staining on fracture surfaces.		
											Medium strong (locally weak) light orangish brown indistinctly thinly bedded very well cemented fine grained SANDSTONE. Partially weathered: slightly reduced strength, slightly closer fracture spacing with localised orangish brown and greenish grey discolouration. Discontinuities: 1. 15 to 25 degree bedding fractures, closely spaced (30/110/350) planar, smooth with patchy orangish brown staining on fracture surfaces. 2. 70 to 80 degree joints at 8.25m to 8.34m and 8.80m to 9.00m, undulating, rough with orangish brown staining on joint surfaces, penetrating up to 7mm from joint surface. *8.15m to 8.25m: Weak thickly laminated orangish brown and greenish grey poorly cemented sandstone.*		
											End of Borehole at 9.00m		
		TCR	SCR	RQD	FI								

9.5 · 10.0 · 10.5 · 11.0 · 11.5 · 12.0 · 12.5 · 13.0 · 13.5 · 14.0 · 14.5 · 15.0 · 15.5 · 16.0 · 16.5 · 17.0 · 17.5 · 18.0 · 18.5

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Chiselling Details

From (m)	To (m)	Time (hh:mm)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 24.00m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
3.00	177
9.00	150

Water Added

From (m)	To (m)

Core Barrel	**Flush Type**	**Termination Reason**	**Last Updated**
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH	**Project No.** **21-1031**	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI **Client:** Orkney Islands Council **Client's Rep:** Arch Henderson LLP	**Borehole ID** **BH-M16**

Method	Plant Used	Top (m)	Base (m)	Coordinates
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	2.00	344975.43 E
Rotary Coring	Fraste Duo CXL Rotosonic	2.00	8.00	1004255.73 N

Final Depth:	8.00 m	**Start Date:**	02/04/2022	**Driller:**	KW	Sheet 1 of 1 Scale: 1:50
Elevation:	-10.09 mCD	**End Date:**	02/04/2022	**Logger:**	RC +TMcA	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)
0.00 - 0.50	ES3	Marine Scotland - SS1		
0.00 - 1.00	B5			
0.50	ES1			
1.00	ES2			
1.00 - 1.50	B6			
1.00 - 1.50	ES4	Marine Scotland - SS2		
1.50	D7			
1.50 - 1.95	SPT (S)	N=14 (2,4/3,3,4,4) Hammer SN = 1353	1.50	
2.00	C1			
2.85	C2			
3.00	D8		3.00	
3.00 - 3.45	SPT(S) N=34 (4,5/8,9,8,9) Hammer SN = 1353			
3.50				
4.10	C3			
5.00				
6.00	C4			
6.50				
7.30	C5			
7.50	C6			
7.75	C7			
8.00				

TCR	SCR	RQD	FI
100	38	13	>20
100	65	19	14
100	63	9	
100	62	29	17
			9

Level mCD	Depth (m)	Description
		Loose to medium dense grey slightly gravelly silty fine to coarse SAND with shell fragments (up to 5mm) and unfragmented articulated brachiopod shells (up to 25mm). Gravel is subangular fine of various lithologies.
-11.89	1.80	Weathered yellowish white banded SANDSTONE. (Drillers description)
-12.09	2.00	Medium strong (locally weak) indistinctly thinly laminated fine grained light yellowish grey SANDSTONE. Partially weathered: reduced strength, closer fracture spacing. occasional light brownish orange discolouration on fracture surfaces and occasional sandy clay infill on fracture surfaces. Discontinuities: 1. 5 to 25 degree bedding fractures closely spaced (10/115/300), planar, rough, occasional light brownish orange staining up to 1mm deep and occasional sandy clay infill on fracture surfaces up to 1mm thick. 2. 25 to 45 degree joints at 2.60m to 2.80m, 3.00m, 3.30m to 4.30m and 4.70m, planar, rough and staining on joint surfaces up to 1mm deep. 3. 65 to 75 degree joints from 2.30m to 2.60m, 3.10m to 3.50m, 3.80m to 4.10m, 4.10m to 4.40m, undulating, rough ad occasional light brownish orange staining on joint surfaces up to 1mm deep.
	(4.30)	
-16.39	6.30	Weak (locally medium strong) indistinctly thinly laminated fine grained dark yellowish grey SANDSTONE. Partially weathered: reduced strength, closer fracture spacing and frequent heavy brownish orange discolouration on fracture surfaces. Discontinuities: 1. 5 to 25 degree bedding fractures closely spaced (10/130/350) planar, rough and frequent heavy brownish orange staining up to 10mm deep. 2. 65 to 75 degree joints from 6.70m to 6.85m and 7.10m to 7.50m, undulating, rough and frequent heavy brownish orange staining up to 1mm deep.
	(1.70)	
-18.09	8.00	End of Borehole at 8.00m

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 16.50m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
2.00	177
8.00	150

Water Added

From (m)	To (m)

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH	**Project No.** **21-1031**	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI **Client:** Orkney Islands Council **Client's Rep:** Arch Henderson LLP	**Borehole ID** **BH-M17**

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	1.00	345017.31 E 1004268.57 N
Rotary Coring	Fraste Duo CXL Rotosonic	1.00	7.00	

Final Depth:	7.00 m	**Start Date:** 01/04/2022	**Driller:** KW	Sheet 1 of 1 Scale: 1:50
Elevation:	-8.53 mCD	**End Date:** 01/04/2022	**Logger:** NP +TMcA	FINAL

Depth (m)	Sample / Tests	Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mCD	Depth (m)	Legend	Description	Water	Backfill
0.00 - 0.50	B3											Grey very gravelly silty fine to coarse SAND with shell fragments (up to 3mm). Gravel is subangular fine to medium of various lithologies.		
0.00 - 0.50	ES2	Marine Scotland - SS1												
0.50	ES1								-9.03	0.50		Weathered yellowish white banded SANDSTONE. (Drillers description)		
1.00	C1					NI			-9.53	1.00 (0.45)		Highly weathered SANDSTONE recovered as orangish brown gravelly fine to coarse SAND with low cobble content. Gravel is subangular fine to coarse. Cobbles are subangular.		
1.45	C2		100	12	8	>20			-9.98	1.45		Weak (locally very weak) indistinctly thinly bedded light orangish brown moderately well cemented fine grained SANDSTONE. Partially weathered: slightly reduced strength, closer fracture spacing with orangish brown discolouration. Discontinuities: 1. 15 to 20 degree bedding fractures, medium spaced (70/205/310) planar, smooth with dark orangish brown staining on fracture surfaces, penetrating up to 3mm from fracture surfaces, light brown clay deposits on some fracture surfaces. 2. 55 to 65 degree joints, widely spaced (120/1118/1550) planar and undulating, smooth, with dark orangish brown staining on joint surfaces. 3. 75 to 85 degree joints at 1.65m to 2.00m, 1.90m to 2.25m, 2.25m to 2.95m, 3.50m to 4.70m and 4.60m to 5.15m, undulating, smooth with dark orangish brown staining on joint surfaces, penetrating 3m from joint surface.		
2.50														
2.65	C3													
2.80	C4													
3.30	C5		100	59	0									
4.00														
4.15	C6									(5.55)				
4.30	C7		100	30	0	10								
5.50						14								
5.65	C8													
			65	0	0	AZCL						*6.10m to 7.00m: AZCL - Lower section of core run unable to be retrieved from base of borehole due to fractured nature of material.*		
7.00									-15.53	7.00		End of Borehole at 7.00m		

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 15.00m
All elevations/reduced levels given in mCD

Casing Details		**Water Added**	
To (m)	Diam (mm)	From (m)	To (m)
1.00	177		
7.00	150		

Core Barrel	**Flush Type**	**Termination Reason**	**Last Updated**
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH	Project No.	Project Name: Scapa Deep Water Quay & Hatston Pier Development - Marine GI	Borehole ID
	21-1031	Client: Orkney Islands Council	BH-M26
		Client's Rep: Arch Henderson LLP	

Method	Plant Used	Top (m)	Base (m)	Coordinates
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	344972.76 E 1004158.34 N
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	10.50	

Final Depth:	10.50 m	Start Date:	31/03/2022	Driller:	MJ	Sheet 1 of 2 Scale: 1:50
Elevation:	-14.83 mCD	End Date:	01/04/2022	Logger:	NP+RC	FINAL

Depth (m)	Sample / Tests	Field Records	Casing Depth (m)	Water Depth (m)
0.00 - 1.50	B5			
0.50	ES1			
1.00	ES2			
1.50	D7			
1.50 - 3.00	B6			
1.50 - 1.95	SPT (S)	N=17 (3,4/4,3,5,5) Hammer SN = 1353	1.50	
2.00	ES3			
3.00	D8		3.00	
3.00	ES4			
3.00 - 3.45	SPT(S) N=27 (5,5/6,6,7,8) Hammer SN = 1353			
3.40	C1			
3.60	C2			
4.45	C3			
4.50				
5.25	C4			
6.00				
6.10	C5			
6.60	C6			
7.50				
8.50	C7			
9.00				
9.20	C8			

Core run (m)	TCR	SCR	RQD
3.00 - 4.50	100	6	0
4.50 - 6.00	61	5	0
6.00 - 7.50	100	17	0
7.50 - 9.00	100	19	0
9.00 -			

FI
>20
AZCL
19
>20
17

Level mCD	Depth (m)	Description
		Loose grey gravelly silty fine to coarse SAND with shell fragments (up to 3mm). Gravel is subangular fine to medium of various lithologies.
-16.03	1.20	Medium dense grey very gravelly silty fine to coarse SAND with shell fragments (up to 4mm). Gravel is subangular fine to medium of various lithologies.
-17.33	2.50	Highly weathered orangish brown SANDSTONE. (Drillers Description)
-17.83	3.00	Weak (locally medium strong) indistinctly thinly bedded fine grained light orangish grey SANDSTONE. Partially weathered: reduced strength, much closer fracture spacing, occasional light brownish orange discolouration on fracture surfaces and frequent sandy clay infill on fracture surfaces. Discontinuities: 1. 5 to 20 degree bedding closely spaced (10/90/150) planar, smooth, occasional light brownish ornate staining up to 2m deep and frequent sandy clay infill on fracture surfaces up to 50mm thick. 2. 65 to 75 degree joints from 4.20m to 4.50m, 4.50m to 5.00m and 6.00m to 6.20m, planar, smooth and occasional light brownish orange staining up to 2mm deep. *5.40m to 6.00m: AZCL - Probable bed of extremely weak sandstone washed out during drilling.*
	(3.20)	
-21.03	6.20	Weak indistinctly thinly laminated fine grained light orangish grey SANDSTONE. Partially weathered: reduced strength, much closer fractures spacing and frequent heavy dark brownish orange discolouration on fracture surfaces. Discontinuities: 1. 10 to 25 degree bedding fractures, closely spaced (10/90/200) planar, rough and frequent heavy dark brownish orange staining up to 30mm deep. 2. 45 to 55 degree joints closely spaced (50/180/450) planar, rough and frequent heavy dark brownish orange staining up to 50mm deep. 3. 65 to 75 degree joints from 7.50m to 7.80m and 7.90m to 8.00m, planar, rough and frequent heavy dark brownish orange staining up to 50mm deep.
	(1.80)	
-22.83	8.00	Weak (locally medium strong) indistinctly thinly laminated fine grained light orangish grey SANDSTONE. Partially weathered: slightly reduced strength, much closer fracture spacing and occasional heavy dark brownish orange discolouration on fracture surfaces. Discontinuities: 1. 15 to 25 degree bedding fractures, medium spaced (50/22/350) planar rough and occasional heavy dark brownish orange staining up to 0.5mm deep. 2. 65 to 75 degree joints from 8.00m to 8.40m, 8.40m to 8.80m and 9.30m to 9.70m, planar, rough and occasional dark brownish orange staining up to 0.5mm deep.
	(2.50)	

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Casing Details

To (m)	Diam (mm)
3.00	177
10.50	150

Water Added

From (m)	To (m)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 21.20m
All elevations/reduced levels given in mCD

Core Barrel	Flush Type	Termination Reason	Last Updated
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY GEOTECH	**Project No.** **21-1031**	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI **Client:** Orkney Islands Council **Client's Rep:** Arch Henderson LLP		**Borehole ID** **BH-M26**

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Sonic Drilling	Fraste Duo CXL Rotosonic	0.00	3.00	344972.76 E 1004158.34 N
Rotary Coring	Fraste Duo CXL Rotosonic	3.00	10.50	

Final Depth:	10.50 m	**Start Date:**	31/03/2022	**Driller:**	MJ	Sheet 2 of 2 Scale: 1:50
Elevation:	-14.83 mCD	**End Date:**	01/04/2022	**Logger:**	NP+RC	FINAL

Depth (m)	Samples / Field Records	TCR	SCR	RQD	FI	Casing Depth (m)	Water Depth (m)	Level mCD	Depth (m)	Legend	Description	Water	Backfill
9.90	C9	71	25	0						⁚⁚⁚	Weak (locally medium strong) indistinctly thinly laminated fine grained light orangish grey SANDSTONE. Partially weathered: slightly reduced strength, much closer fracture spacing and occasional heavy dark brownish orange discolouration on fracture surfaces. Discontinuities: 1. 15 to 25 degree bedding fractures, medium spaced (50/22/350) planar rough and occasional heavy dark brownish orange staining up to 0.5mm deep. 2. 65 to 75 degree joints from 8.00m to 8.40m, 8.40m to 8.80m and 9.30m to 9.70m, planar, rough and occasional dark brownish orange staining up to 0.5mm deep. *10.00m to 10.50m: AZCL - Lower section of core run unable to be retrieved from base of borehole due to fractured nature of material.*		▩
					AZCL								
10.50								-25.33	10.50		End of Borehole at 10.50m		

Depth scale: 9.5, 10.0, 10.5, 11.0, 11.5, 12.0, 12.5, 13.0, 13.5, 14.0, 14.5, 15.0, 15.5, 16.0, 16.5, 17.0, 17.5, 18.0, 18.5

TCR SCR RQD FI

Water Strikes

Struck at (m)	Casing to (m)	Time (min)	Rose to (m)

Chiselling Details

From (m)	To (m)	Time (hh:mm)

Remarks

Marine Borehole drilled off OCM 80 jack-up barge
Deck to Bed = 21.20m
All elevations/reduced levels given in mCD

Casing Details

To (m)	Diam (mm)
3.00	177
10.50	150

Water Added

From (m)	To (m)

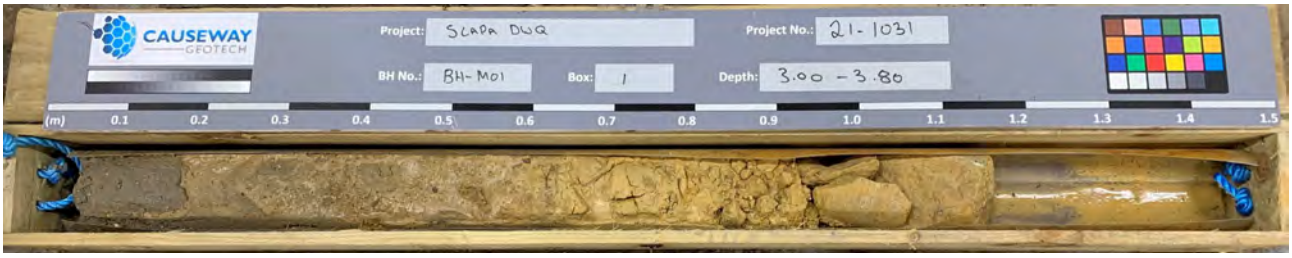
Core Barrel	**Flush Type**	**Termination Reason**	**Last Updated**
SK6L	Polymer	Terminated at scheduled depth	29/06/2022

AGS

CAUSEWAY
GEOTECH

APPENDIX C

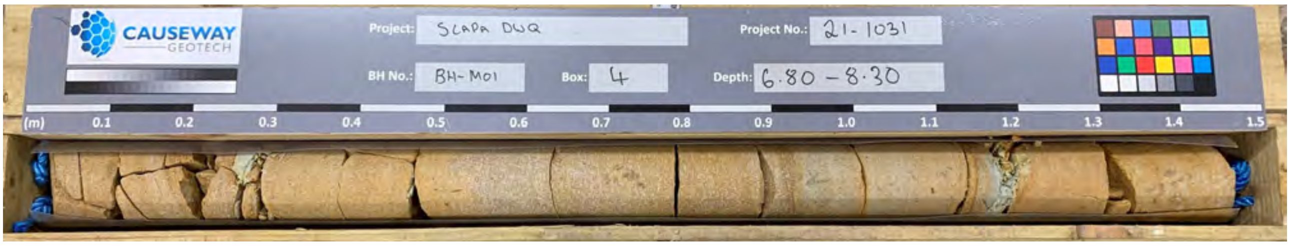
CORE PHOTOGRAPHS



BH-M01 Box 1 3.00-3.80m

BH-M01 Box 2 3.80-5.30m

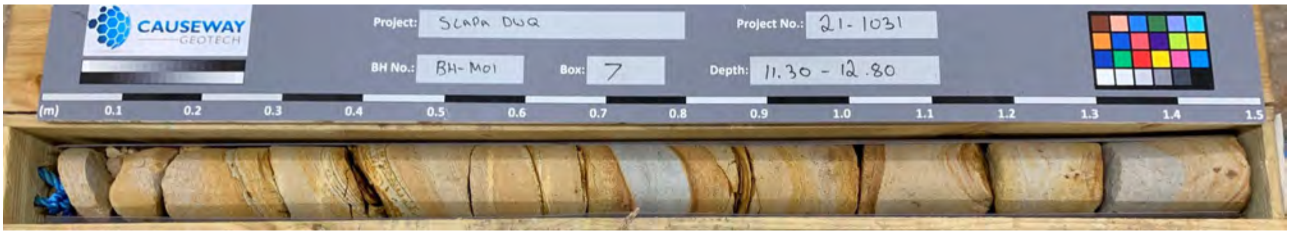
BH-M01 Box 3 5.30-6.80m



BH-M01 Box 4 6.80-8.30m

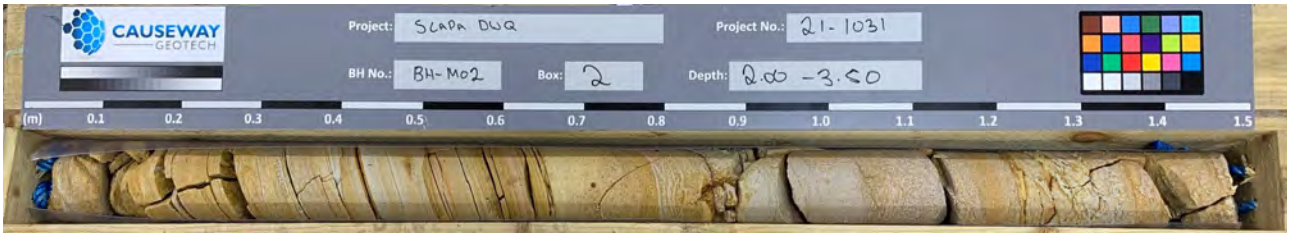
BH-M01 Box 5 8.30-9.80m

BH-M01 Box 6 9.80-11.30m

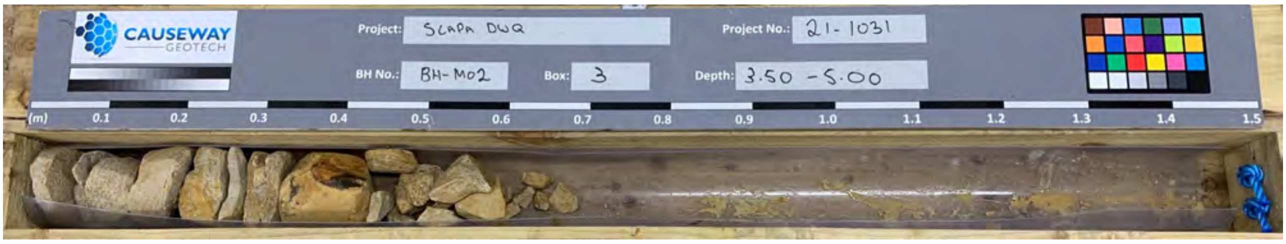


BH-M01 Box 7 11.30-12.80m

BH-M02 Box 1 1.20-2.00m



BH-M02 Box 2 2.00-3.50m



BH-M02 Box 3 3.50-5.00m

BH-M02 Box 4 5.00-6.50m

BH-M02 Box 5 6.50-8.00m

BH-M02 Box 6 8.00-9.50m

BH-M02 Box 7 9.50-11.00m

BH-M02 Box 8 11.00-12.50m

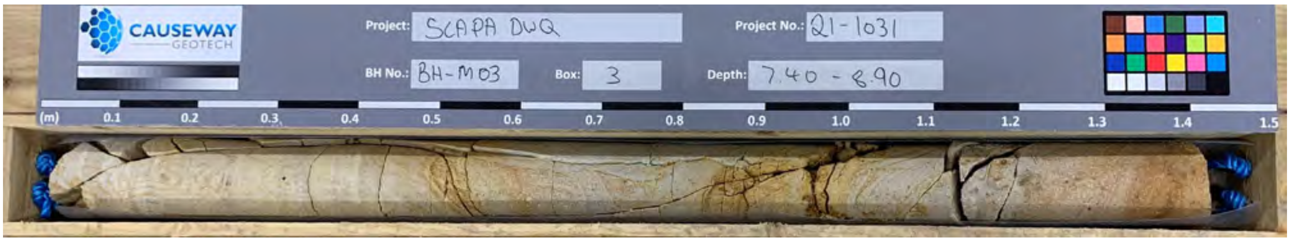
BH-M02 Box 9 12.50-14.00m

Project: SCAPA DWQ
Project No.: 21-1031
BH No.: BH-M03
Box: 1
Depth: 4.50 – 5.90

BH-M03 Box 1 4.50-5.90m

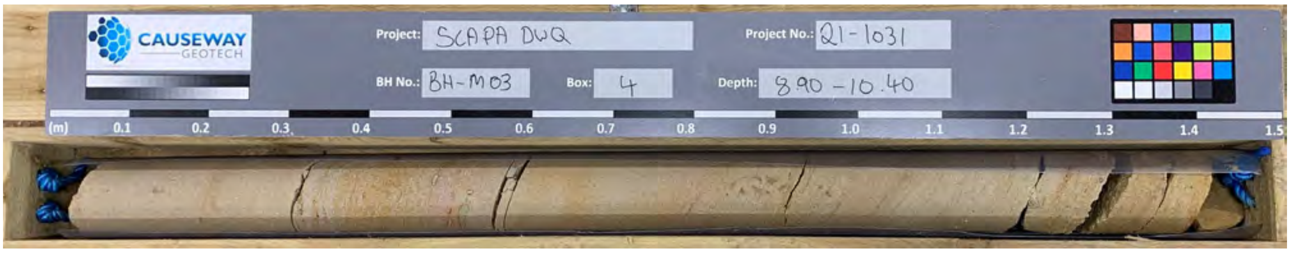
Project: SCAPA DWQ
Project No.: 21-1031
BH No.: BH-M03
Box: 2
Depth: 5.90 - 7.40

BH-M03 Box 2 5.90-7.40m



Project: SCAPA DWQ
Project No.: 21-1031
BH No.: BH-M03
Box: 3
Depth: 7.40 - 8.90

BH-M03 Box 3 7.40-8.90m

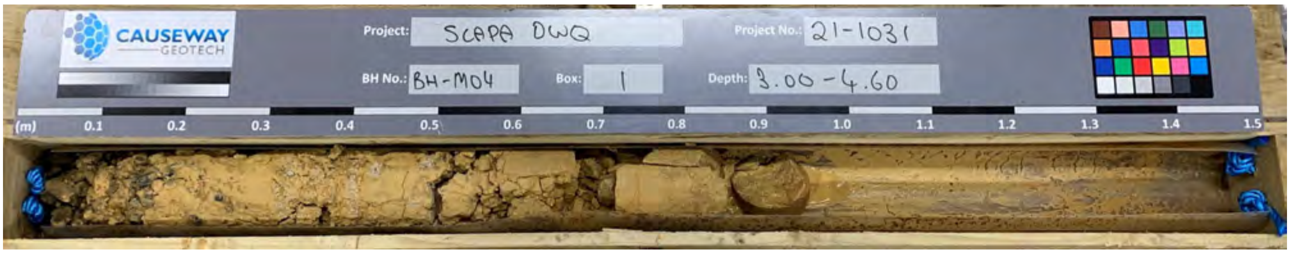


Project: SCAPA DWQ
Project No.: 21-1031
BH No.: BH-M03
Box: 4
Depth: 8.90 - 10.40

BH-M03 Box 4 8.90-10.40m

Project: SCAPA DWQ
Project No.: 21-1031
BH No.: BH-M03
Box: 5
Depth: 10.40 - 11.90

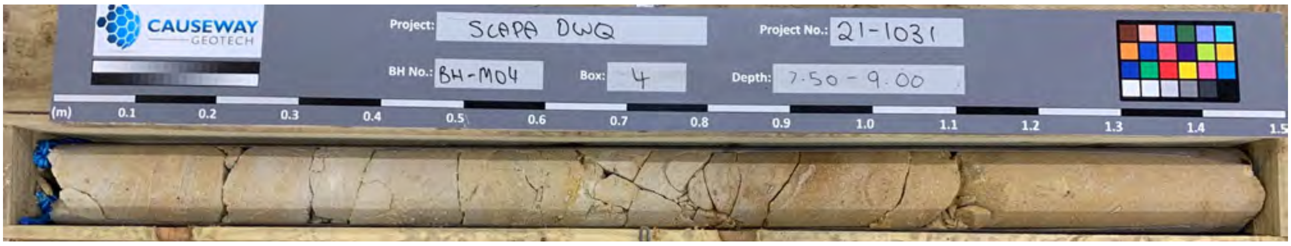
BH-M03 Box 5 10.40-11.90m



BH-M04 Box 1 3.00-4.50m

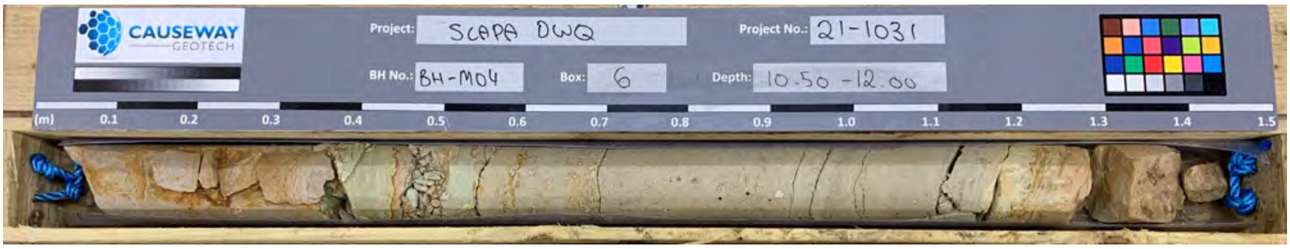
BH-M04 Box 2 4.50-6.00m

BH-M04 Box 3 6.00-7.50m

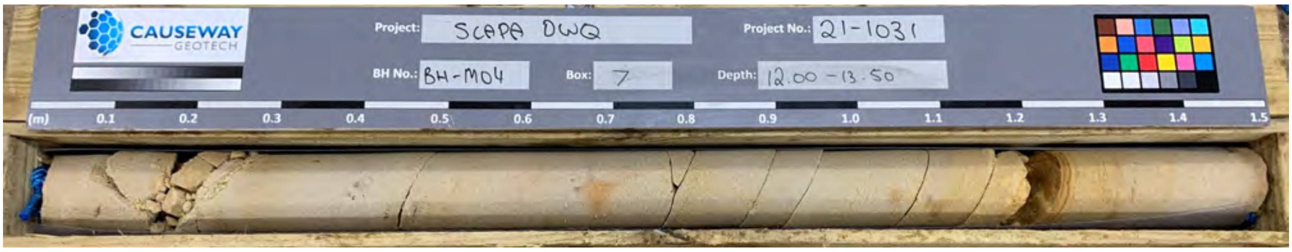


BH-M04 Box 4 7.50-9.00m

BH-M04 Box 5 9.00-10.50m



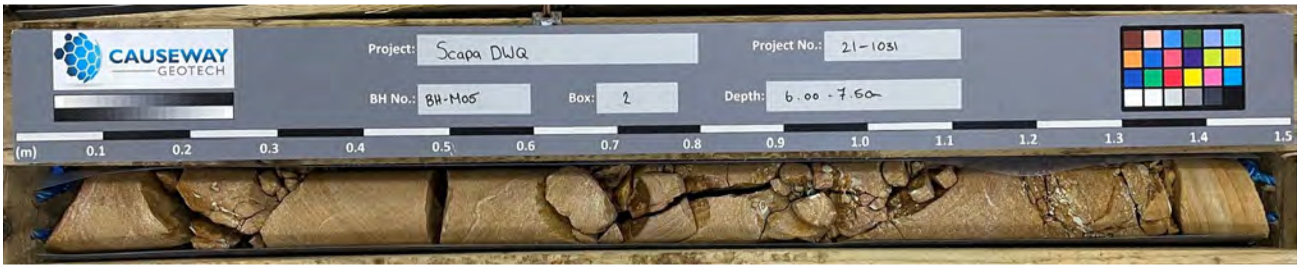
BH-M04 Box 6 10.50-12.00m



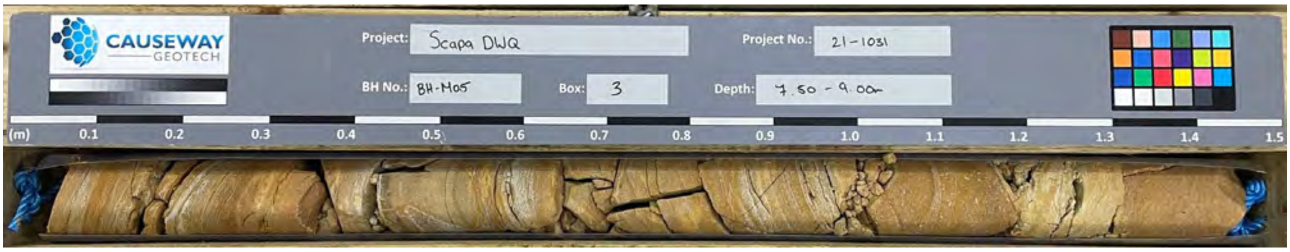
BH-M04 Box 7 12.00-13.50m


Project: Scapa DWQ
Project No.: 21-1031
BH No.: BH-M05
Box: 1
Depth: 4.50 - 6.00m

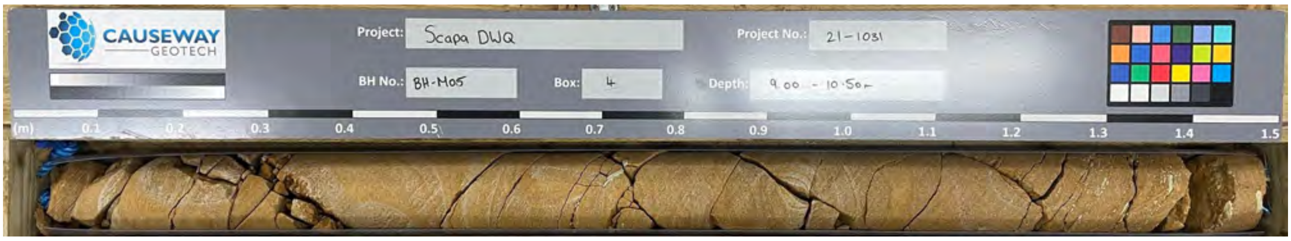
BH-M05 Box 1 4.50-6.00m


Project: Scapa DWQ
Project No.: 21-1031
BH No.: BH-M05
Box: 2
Depth: 6.00 - 7.50m

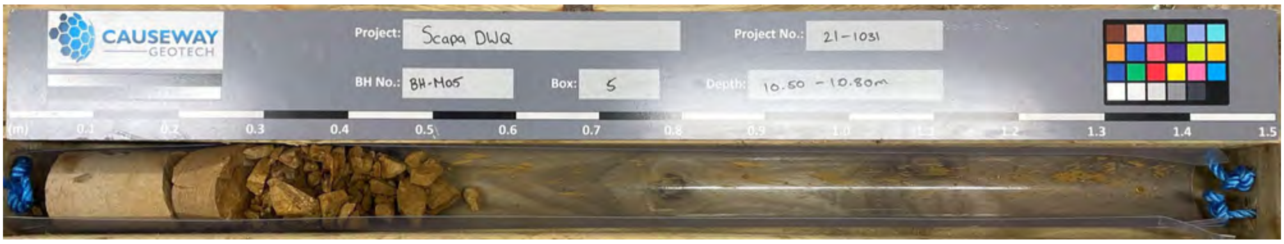
BH-M05 Box 2 6.00-7.50m


Project: Scapa DWQ
Project No.: 21-1031
BH No.: BH-M05
Box: 3
Depth: 7.50 - 9.00m

BH-M05 Box 3 7.50-9.00m

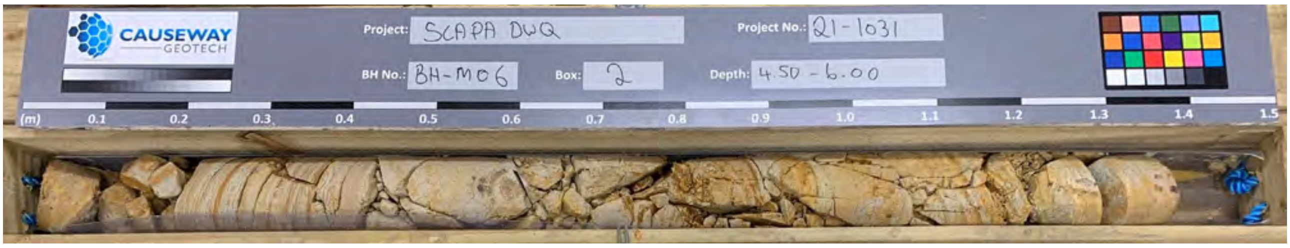

Project: Scapa DWQ
Project No.: 21-1031
BH No.: BH-M05
Box: 4
Depth: 9.00 - 10.50m

BH-M05 Box 4 9.00-10.50m

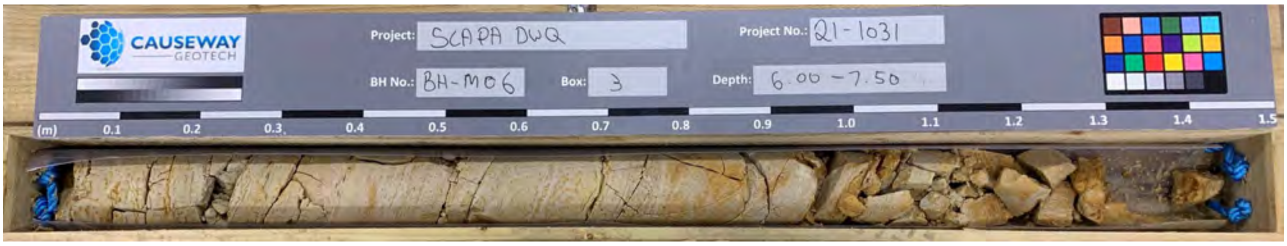

Project: Scapa DWQ
Project No.: 21-1031
BH No.: BH-M05
Box: 5
Depth: 10.50 - 10.80m

BH-M05 Box 5 10.50-10.80m

BH-M06 Box 1 3.00-4.50m



BH-M06 Box 2 4.50-6.00m

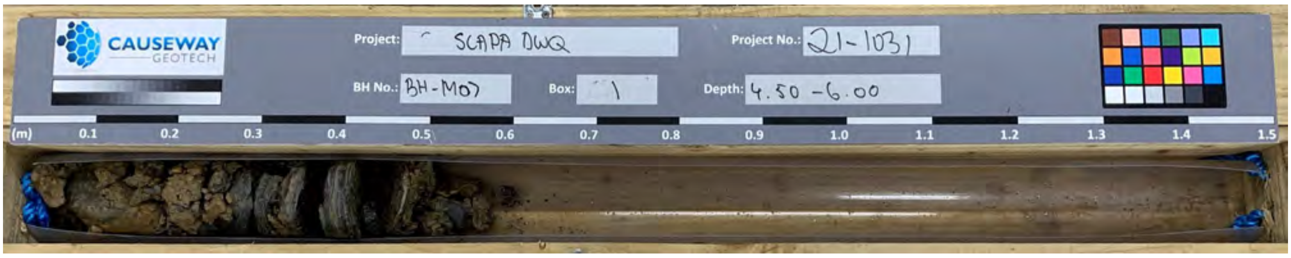


BH-M06 Box 3 6.00-7.50m

BH-M06 Box 4 7.50-9.00m

BH-M06 Box 5 9.00-10.50m

BH-M06 Box 6 10.50-12.00m



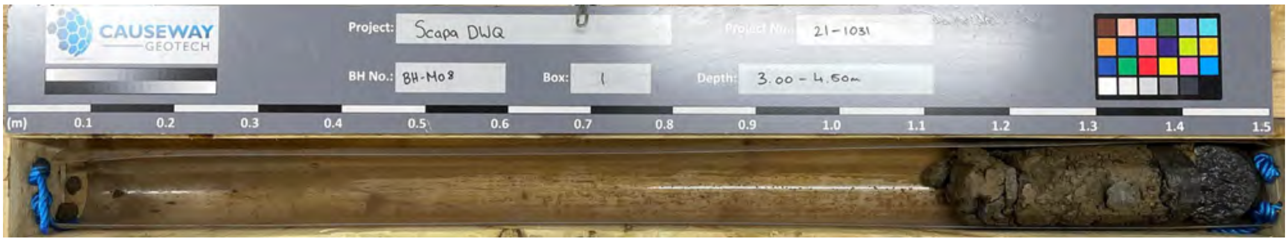
BH-M07 Box 1 4.50-6.00m

BH-M07 Box 2 6.00-7.50m

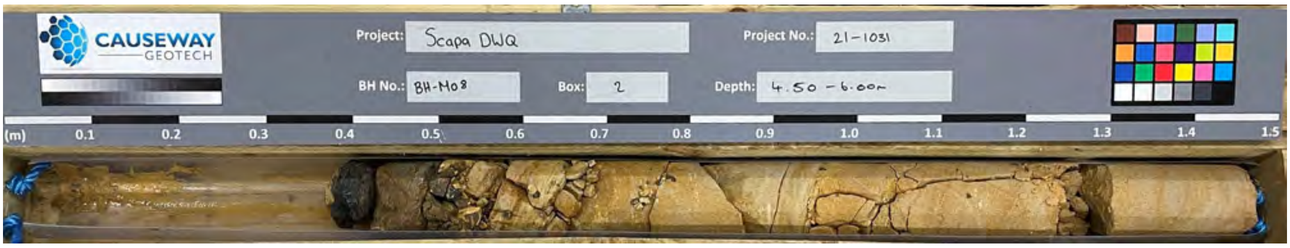
BH-M07 Box 3 7.50-9.00m

BH-M07 Box 4 9.00-10.50m

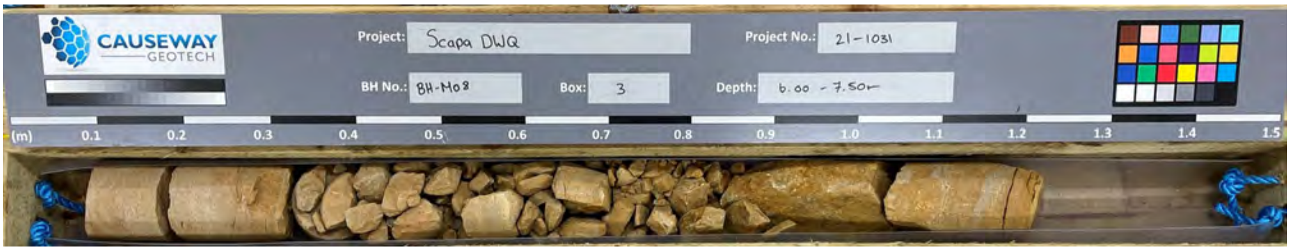
BH-M07 Box 5 10.50-12.00m



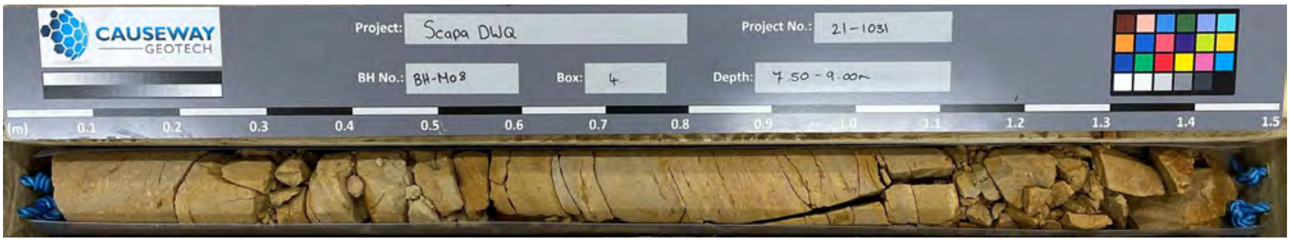
BH-M08 Box 1 3.00-4.50m



BH-M08 Box 2 4.50-6.00m

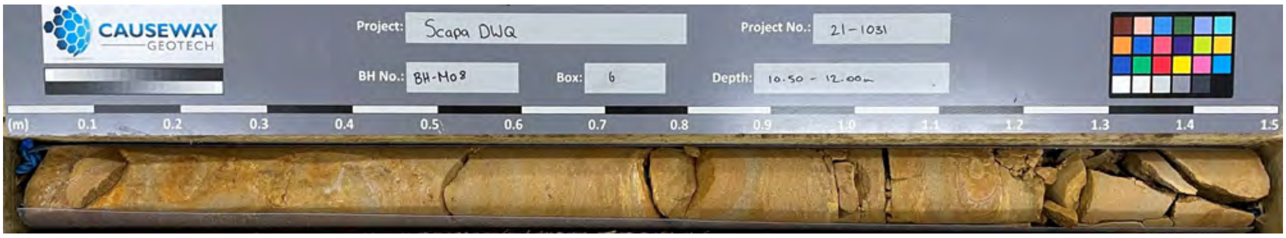


BH-M08 Box 3 6.00-7.50m

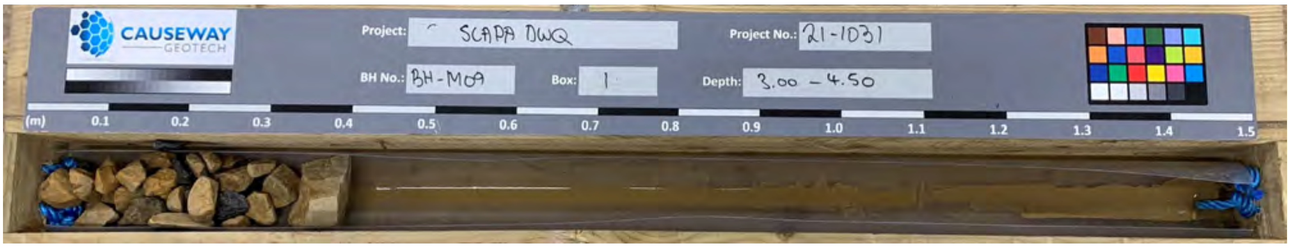


BH-M08 Box 4 7.50-9.00m

BH-M08 Box 5 9.00-10.50m



BH-M08 Box 6 10.50-12.00m



BH-M09 Box 1 3.00-4.50m

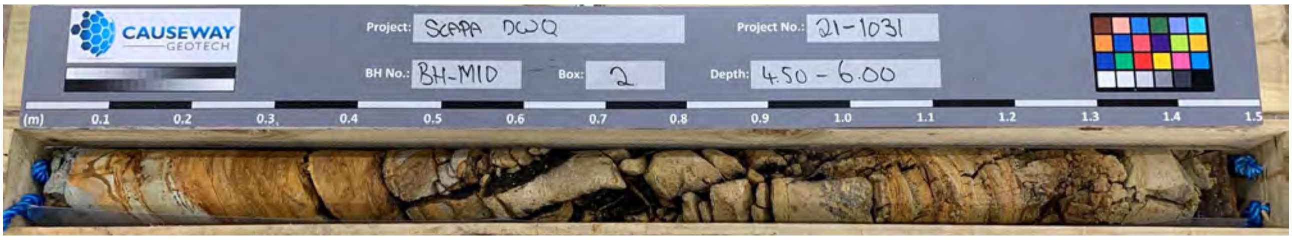
BH-M09 Box 2 4.50-6.00m

BH-M09 Box 3 6.00-7.50m

BH-M09 Box 4 7.50-9.00m

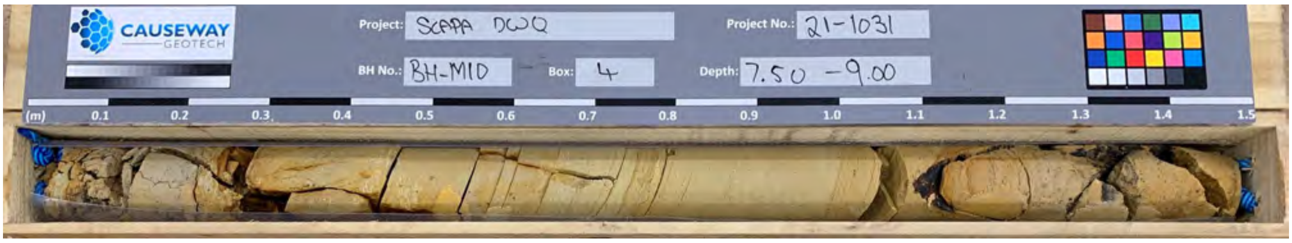
BH-M09 Box 5 9.00-10.50m

BH-M10 Box 1 3.00-4.50m



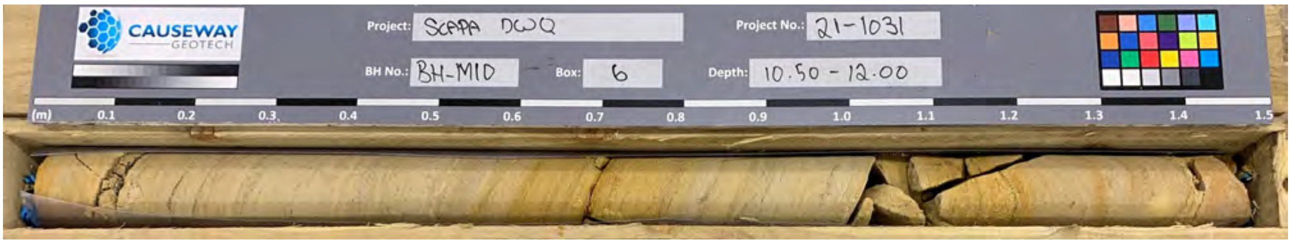
BH-M10 Box 2 4.50-6.00m

BH-M10 Box 3 6.00-7.50m



BH-M10 Box 4 7.50-9.00m

BH-M10 Box 5 9.00-10.50m

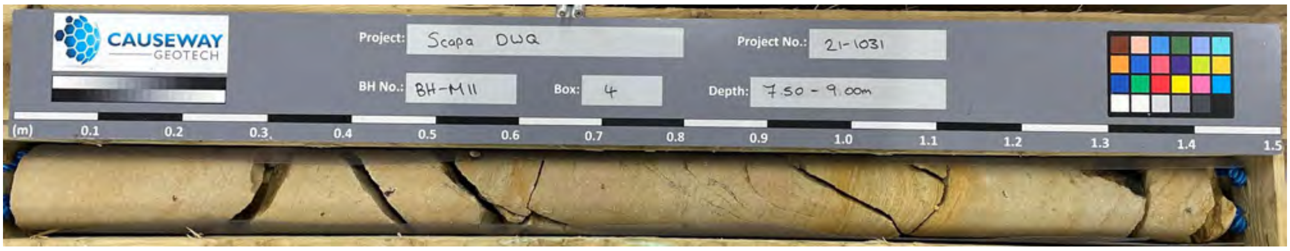


BH-M10 Box 6 10.50-12.00m

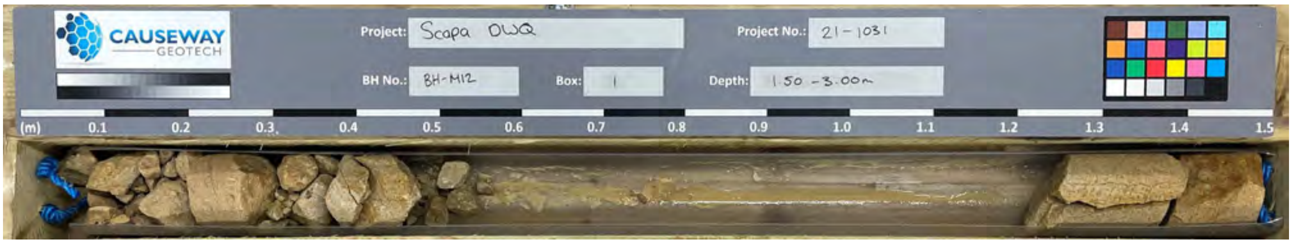
BH-M11 Box 1 3.00-4.50m

BH-M11 Box 2 4.50-6.00m

BH-M11 Box 3 6.00-7.50m



BH-M11 Box 4 7.50-9.00m

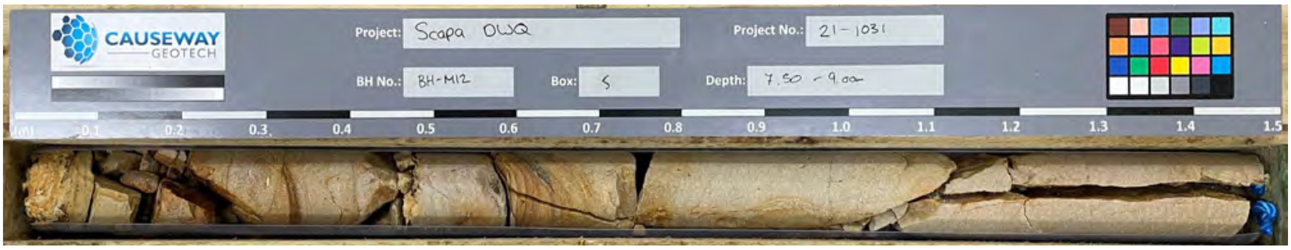


BH-M12 Box 1 1.50-3.00m

BH-M12 Box 2 3.00-4.50m

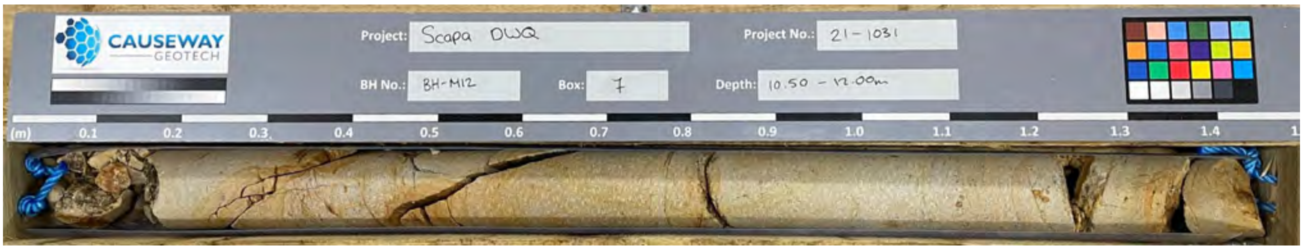
BH-M12 Box 3 4.50-6.00m

BH-M12 Box 4 6.00-7.50m

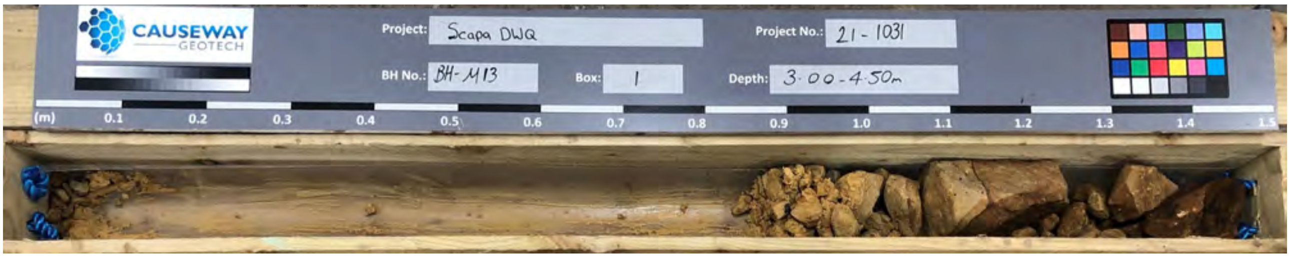


BH-M12 Box 5 7.50-9.00m

BH-M12 Box 6 9.00-10.50m



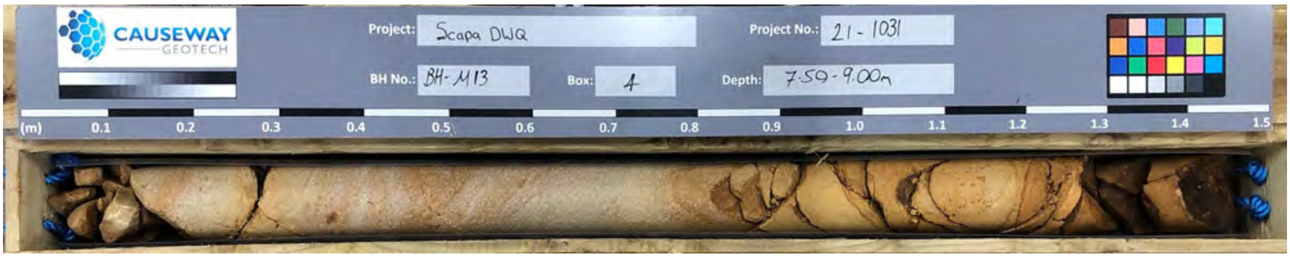
BH-M12 Box 7 10.50-12.00m



BH-M13 Box 1 3.00-4.50m

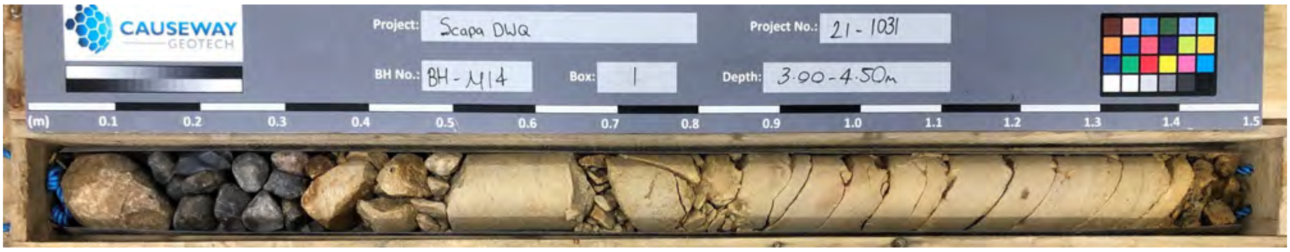
BH-M13 Box 2 4.50-6.00m

BH-M13 Box 3 6.00-7.50m

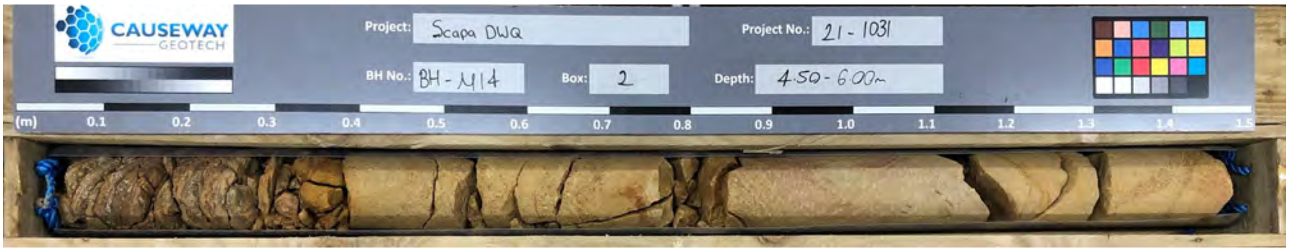


BH-M13 Box 4 7.50-9.00m

BH-M13 Box 5 9.00-10.50m

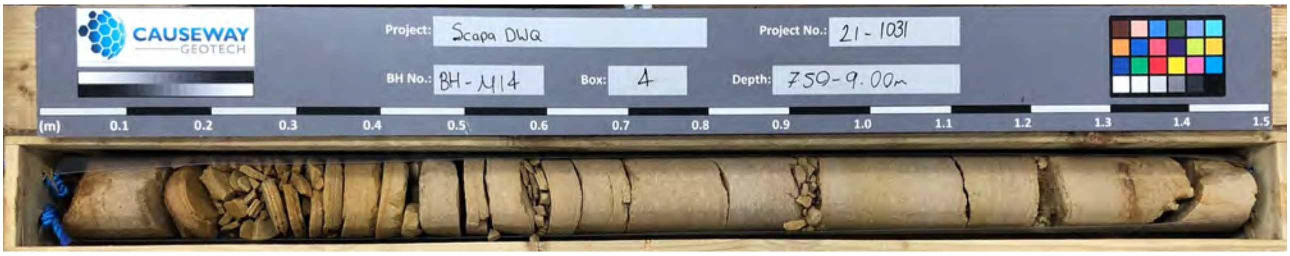


BH-M14 Box 1 3.00-4.50m

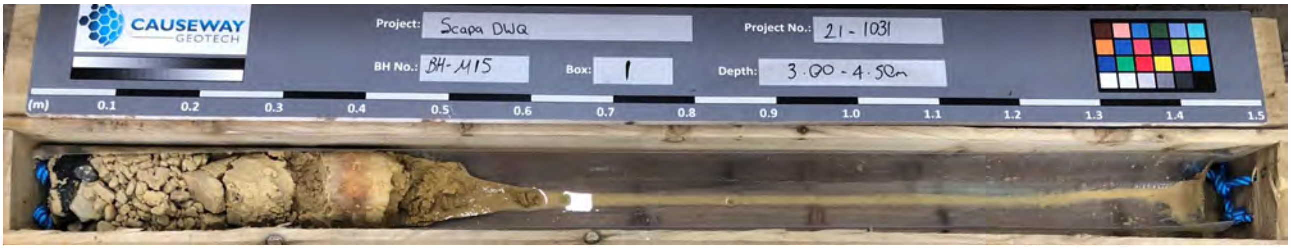


BH-M14 Box 2 4.50-6.00m

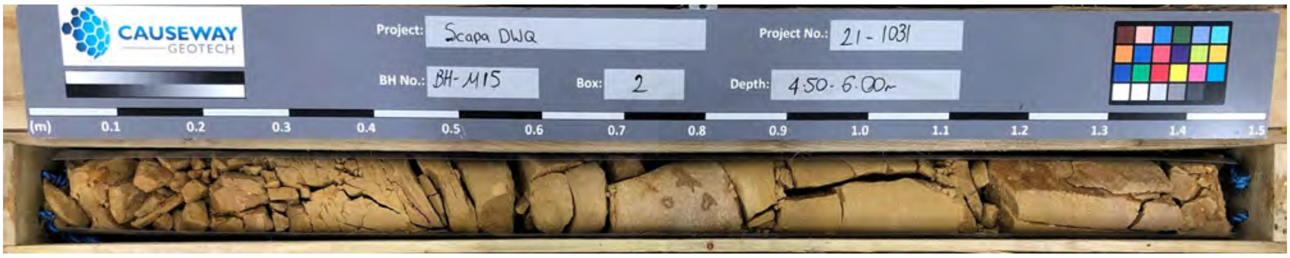
BH-M14 Box 3 6.00-7.50m



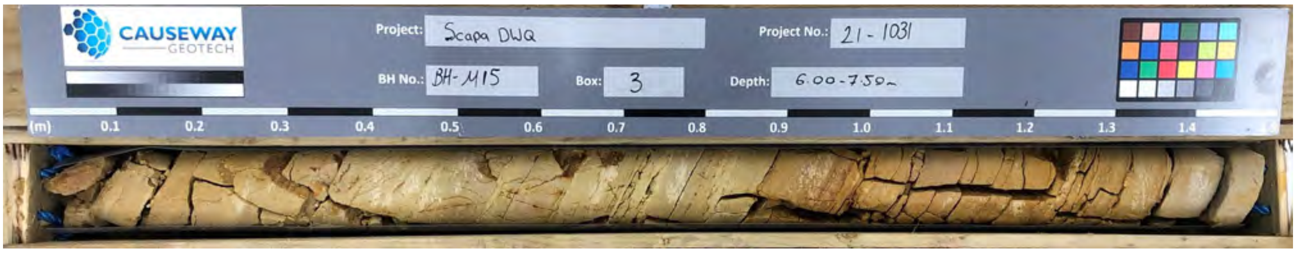
BH-M14 Box 4 7.50-9.00m



BH-M15 Box 1 3.00-4.50m



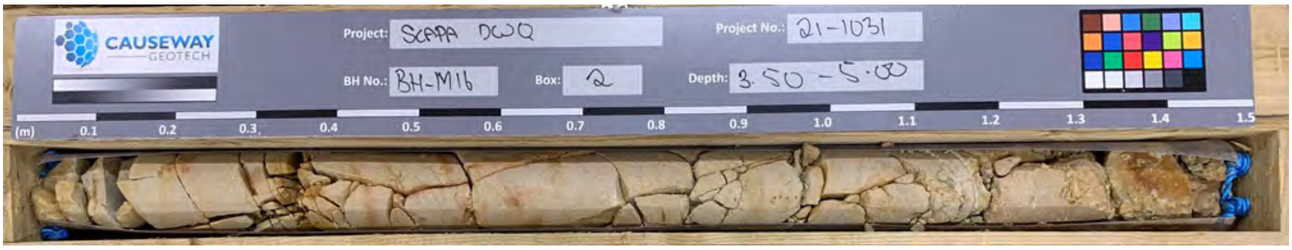
BH-M15 Box 2 4.50-6.00m



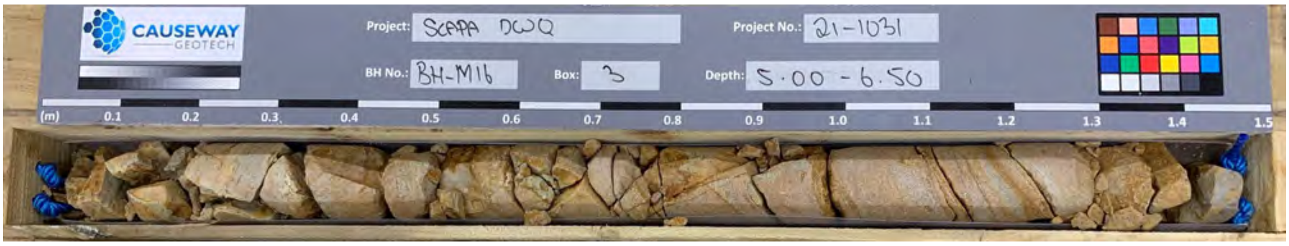
BH-M15 Box 3 6.00-7.50m

BH-M15 Box 4 7.50-9.00m

BH-M16 Box 1 2.00-3.50m

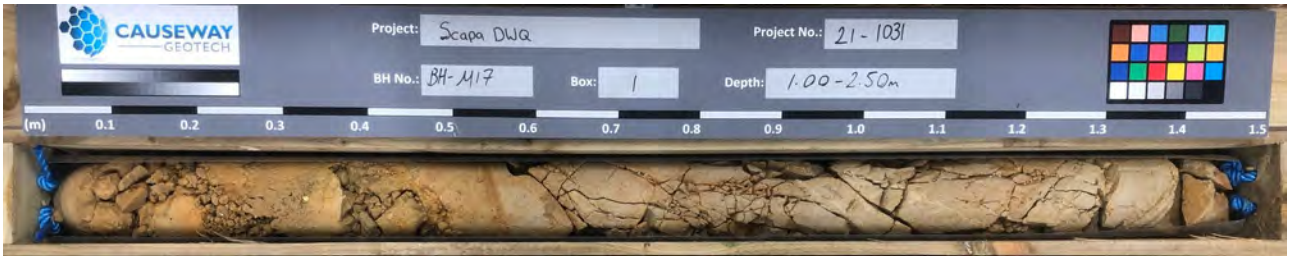


BH-M16 Box 2 3.50-5.00m

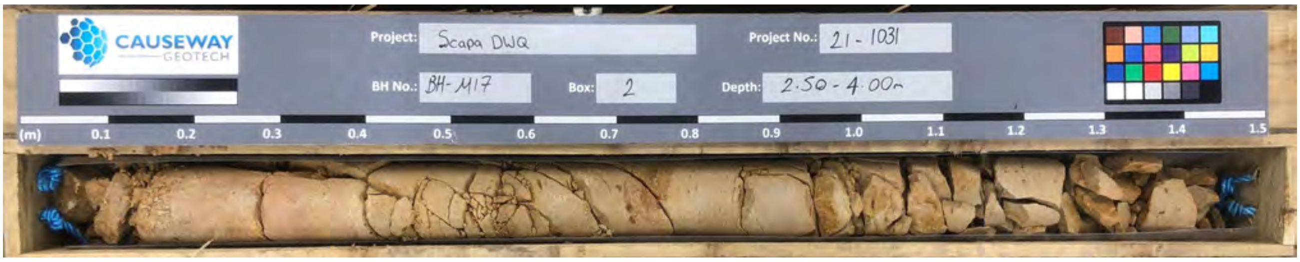


BH-M16 Box 3 5.00-6.50m

BH-M16 Box 4 6.50-8.00m

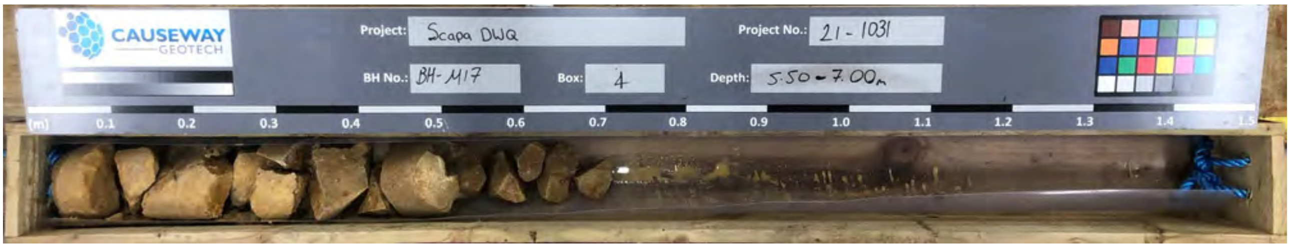


BH-M17 Box 1 1.00-2.50m



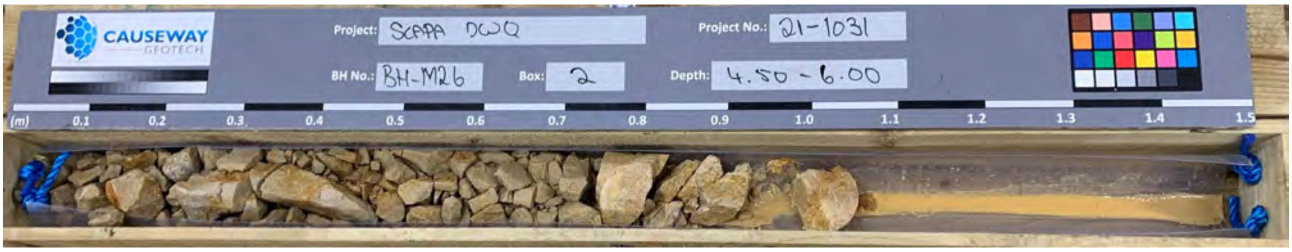
BH-M17 Box 2 2.50-4.00m

BH-M17 Box 3 4.00-5.50m

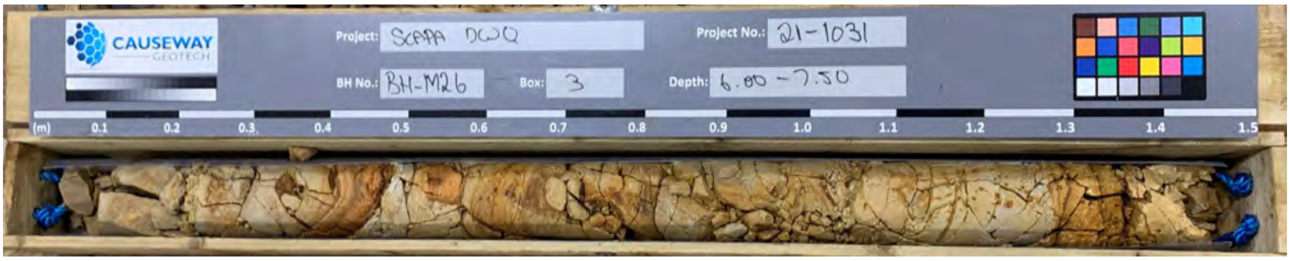


BH-M17 Box 4 5.50-7.00m

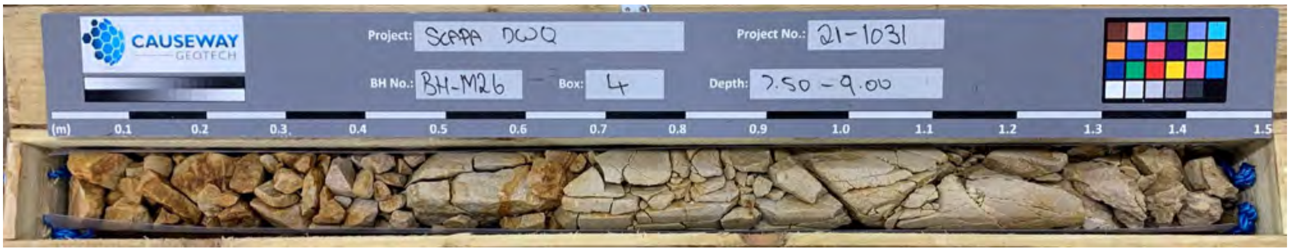
BH-M26 Box 1 3.00-4.50m



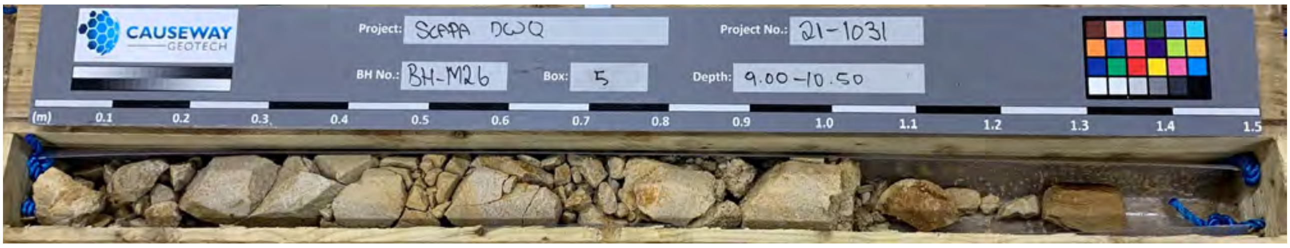
BH-M26 Box 2 4.50-6.00m



BH-M26 Box 3 6.00-7.50m



BH-M26 Box 4 7.50-9.00m



BH-M26 Box 5 9.00-10.50m

APPENDIX D

WASH PROBE LOG

CAUSEWAY GEOTECH	**Project No.** **21-1031**	**Project Name:** Scapa Deep Water Quay & Hatston Pier Development - Marine GI **Client:** Orkney Islands Council **Client's Rep:** Arch Henderson LLP	**Borehole ID** **WP-M27**

Method	**Plant Used**	**Top (m)**	**Base (m)**	**Coordinates**
Grab Sample	Van Veen Sampler (1L)	0.00	0.15	344921.23 E 1004094.11 N

Final Depth:	0.15 m	**Start Date:** 31/03/2022	**Driller:** NP	Sheet 1 of 1 Scale: 1:50
Elevation:	-18.20 mCD	**End Date:** 31/03/2022	**Logger:** NP	FINAL

Depth (m)	**Sample / Tests**	**Field Records**	**Casing Depth (m)**	**Water Depth (m)**	**Level mCD**	**Depth (m)**	**Legend**	**Description**	**Water**	**Backfill**
0.00 - 0.15	ES1	Marine Scotland - SS1			-18.35	0.15	▨	Grey gravelly silty fine to coarse SAND with shell fragments (up to 4mm). Gravel is subangular fine to medium.		
								End of Borehole at 0.15m		

0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0

Water Strikes				**Casing Details**	
Struck at (m)	Casing to (m)	Time (min)	Rose to (m)	To (m)	Diameter

Remarks

Marine grab sample at location of WP-M27 taken from OCM Fortess

Termination Reason	**Last Updated**
Terminated at scheduled depth	10/06/2022

AGS

CAUSEWAY
GEOTECH

APPENDIX E

GEOTECHNICAL LABORATORY TEST RESULTS

CAUSEWAY GEOTECH

HEAD OFFICE
Causeway Geotech Ltd
8 Drumahiskey Road
Ballymoney
Co. Antrim, N. Ireland, BT53 7QL
NI: +44 (0)28 276 66640
Registered in Northern Ireland.
Company Number: NI610766

REGIONAL OFFICE
Causeway Geotech (IRL) Ltd
Unit 1 Fingal House
Stephenstown Industrial Estate
Balbriggan, Co Dublin, Ireland, K32 VR66
ROI: +353 (0)1 526 7465
Registered in Ireland.
Company Number: 633786

www.causewaygeotech.com

SOIL AND ROCK SAMPLE ANALYSIS
LABORATORY TEST REPORT

25 April 2022

Project Name:	Scapa Deep Water Quay - Marine GI
Project No.:	21-1031
Client:	Orkney Islands Council
Engineer:	Arch Henderson LLP

We are pleased to attach the results of laboratory testing carried out for the above project. This memo and its attachments constitute a report of the results of tests as detailed in the Contents page(s). This testing was performed between 04/04/2022 and 25/04/2022.

The attached results complete the testing requested and we would therefore wish to confirm that samples will be retained without charge for a period of 28 days from the above date after which they will be appropriately disposed of unless we receive written instructions to the contrary prior to that date.

We trust our report meets with your approval but if you have any queries or require additional information, please do not hesitate to contact the undersigned.

Stephen Watson

Stephen Watson

Laboratory Manager

Signed for and on behalf of Causeway Geotech Ltd

Project Name: Scapa Deep Water Quay - Marine GI

Report Reference: Schedule 5 - 8

The table below details the tests carried out, the specifications used, and the number of tests included in this report. The results contained in this report relate to the sample(s) as received

Tests marked with* in this report are not United Kingdom Accreditation Service (UKAS) accredited and are not included in Causeway Geotech Limited's scope of UKAS Accreditation Schedule of Tests. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation.

Material tested	Type of test/Properties measured/Range of measurement	Standard specifications	No. of results included in the report
SOIL	Moisture Content of Soil	BS 1377-2: 1990: Cl 3.2	21
SOIL	Liquid and Plastic Limits of soil-1 point cone penetrometer method	BS 1377-2: 1990: Cl 4.4, 5.3 & 5.4	21
SOIL	Particle size distribution - wet sieving	BS 1377-2: 1990: Cl 9.2	28
SOIL	Particle size distribution - sedimentation hydrometer method	BS 1377-2: 1990: Cl 9.5	12
SOIL	Direct Shear Test using 60mm Small Shearbox (up to 3 days)	BS EN ISO 17892-10:2018	7
	Extra over days (more than initial 3 days)		2

SUB-CONTRACTED TESTS

In agreement with Client, the following tests were conducted by an approved sub-contractor. All sub-contracting laboratories used are UKAS accredited.

Material tested	Type of test/Properties measured/Range of measurement	Standard specifications	No. of results included in the report
SOIL – Subcontracted to Eurofins Chemtest Ltd *(UKAS 2183)*	pH Value of Soil		19
SOIL – Subcontracted to Eurofins Chemtest Ltd *(UKAS 2183)*	Sulphate Content water extract		19

Summary of Classification Test Results

Project No.	Project Name
21-1031	Scapa Deep Water Quay - Marine GI

Hole No.	Sample Ref	Sample Top	Sample Base	Sample Type	Soil Description	Density bulk Mg/m3	Density dry Mg/m3	*w* %	Passing 425µm %	LL %	PL %	PI %	Particle density Mg/m3	Casagrande Classification
BH-M01	7	1.50		D	Brownish grey slightly gravelly slightly silty fine to coarse SAND.			18.0	68	24 -1pt	NP			
BH-M02	2	0.00	0.70	B	Brownish grey gravelly silty fine to coarse SAND.			17.0	53	22 -1pt	NP			
BH-M03	6	1.50	3.00	B	Brownish grey slightly gravelly slightly silty fine to coarse SAND.			17.0	80	23 -1pt	NP			
BH-M04	10	1.50		D	Brownish grey sandy slightly gravelly silty CLAY.			13.0	61	23 -1pt	12	11		CL
BH-M04	11	3.00		D	Brownish grey sandy slightly gravelly silty CLAY.			10.0	90	23 -1pt	13	10		CL
BH-M05	11	1.50		D	Brownish grey slightly gravelly slightly silty fine to coarse SAND.			18.0	66	22 -1pt	NP			
BH-M06	10	1.50		D	Brownish grey sandy slightly gravelly silty CLAY			16.0	63	28 -1pt	14	14		CL
BH-M06	11	3.00		D	Brownish grey sandy slightly gravelly silty CLAY			14.0	66	21 -1pt	14	7		CL
BH-M07	11	1.50		D	Brownish grey slightly gravelly slightly silty fine to coarse SAND.			20.0	59	25 -1pt	NP			
BH-M07	12	3.00		D	Brownish grey slightly gravelly slightly silty fine to coarse SAND.			18.0	75	23 -1pt	NP			
BH-M08	7	1.50		D	Brownish grey sandy slightly gravelly silty CLAY.			18.0	51	21 -1pt	NP			
BH-M08	8	3.00		D	Brownish grey sandy slightly gravelly silty CLAY.			14.0	61	28 -1pt	15	13		CL

All tests performed in accordance with BS1377:1990 unless specified otherwise

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Key

Density test	Liquid Limit	Particle density
Linear measurement unless :	4pt cone unless :	sp - small pyknometer
wd - water displacement	cas - Casagrande method	gj - gas jar
wi - immersion in water	1pt - single point test	

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Summary of Classification Test Results

Project No.	Project Name
21-1031	Scapa Deep Water Quay - Marine GI

Hole No.	Sample				Soil Description	Density bulk	Density dry	*w*	Passing 425µm	LL	PL	PI	Particle density	Casagrande Classification
	Ref	Top	Base	Type		Mg/m3		%	%	%	%	%	Mg/m3	
BH-M09	10	1.50		D	Brownish grey slightly gravelly slightly silty fine to coarse SAND.			18.0	48	21 -1pt	NP			
BH-M09	11	3.00		D	Brownish grey slightly gravelly slightly silty fine to coarse SAND.			18.0	76	26 -1pt	NP			
BH-M10	7	1.50		D	Brownish grey slightly gravelly clayey fine to coarse SAND.			12.0	74	21 -1pt	13	8		CL
BH-M11	10	1.50		D	Brownish grey slightly gravelly clayey fine to coarse SAND.			12.0	55	23 -1pt	12	11		CL
BH-M12	3	0.00	1.50	B	Brownish grey slightly gravelly silty fine to coarse SAND.			13.0	61	21 -1pt	NP			
BH-M13	10	1.50		D	Brownish grey slightly gravelly silty fine to coarse SAND.			15.0	52	22 -1pt	17	5		ML
BH-M14	10	1.50		D	Brownish grey slightly gravelly slightly silty fine to coarse SAND.			15.0	71	25 -1pt	NP			
BH-M15	10	1.50		D	Brownish grey slightly gravelly slightly silty fine to coarse SAND.			18.0	67	22 -1pt	NP			
BH-M16	7	1.50		D	Brownish grey slightly gravelly slightly silty fine to coarse SAND.			16.0	84	26 -1pt	NP			

All tests performed in accordance with BS1377:1990 unless specified otherwise

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Key

Density test	Liquid Limit	Particle density
Linear measurement unless :	4pt cone unless :	sp - small pyknometer
wd - water displacement	cas - Casagrande method	gj - gas jar
wi - immersion in water	1pt - single point test	

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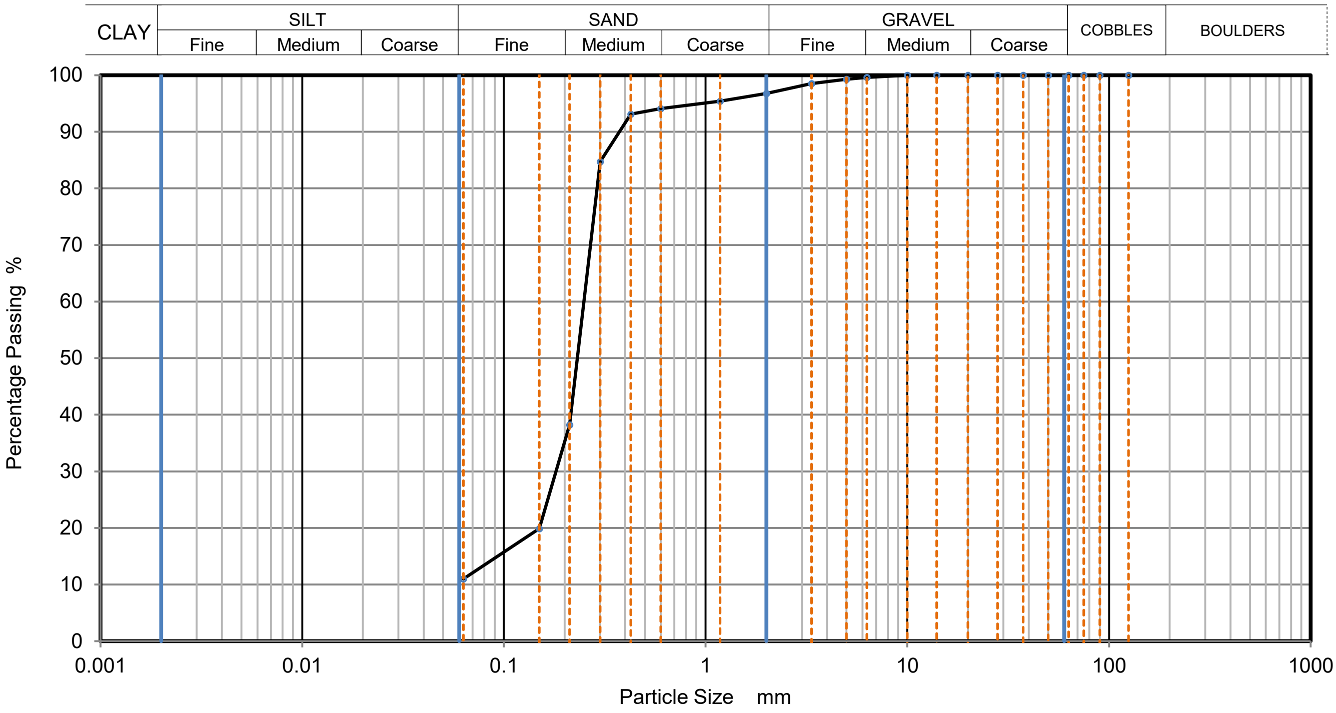
CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**	Job Ref	**21-1031**
		Borehole/Pit No.	BH-M01
Site Name	Scapa Deep Water Quay - Marine GI	Sample No.	4
Soil Description	Brownish grey slightly gravelly slightly silty fine to coarse SAND.	Depth, m	0.50
Specimen Reference	4 / Specimen Depth / 0.5 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2	KeyLAB ID	Caus2022030410



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	100		
5	99		
3.35	99		
2	97		
1.18	95		
0.6	94		
0.425	93		
0.3	85		
0.212	38		
0.15	20		
0.063	11		

Dry Mass of sample, g	228

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	3.2
Sand	85.8
Fines <0.063mm	11.0

Grading Analysis	
D100 mm	
D60 mm	0.25
D30 mm	0.182
D10 mm	
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

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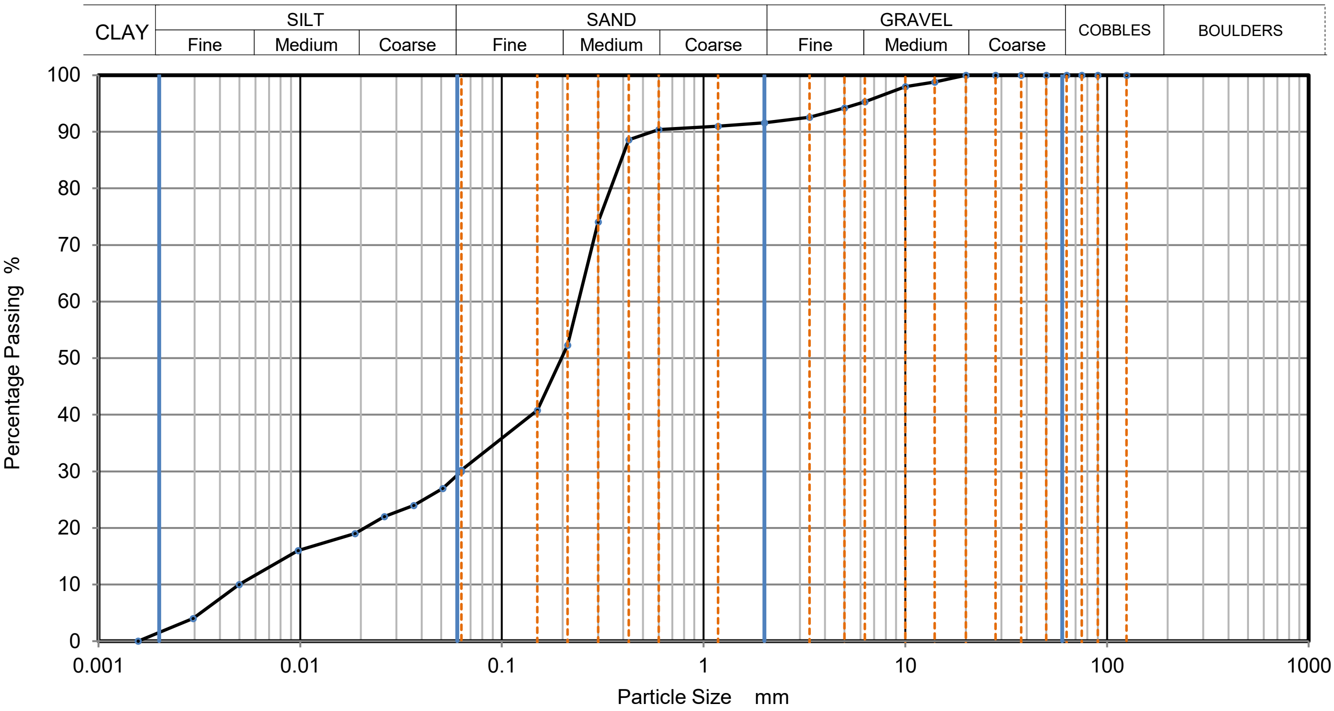
PARTICLE SIZE DISTRIBUTION

		Job Ref	**21-1031**
		Borehole/Pit No.	BH-M01
Site Name	Scapa Deep Water Quay - Marine GI	Sample No.	6
Soil Description	Brownish grey sandy slightly gravelly clayey SILT.	Depth, m	2.50
Specimen Reference	4 Specimen Depth 2.5 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5	KeyLAB ID	Caus2022030412



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	30
90	100	0.05097	27
75	100	0.03649	24
63	100	0.02611	22
50	100	0.01868	19
37.5	100	0.00976	16
28	100	0.00499	10
20	100	0.00294	4
14	99	0.00157	0
10	98		
6.3	95		
5	94		
3.35	93		
2	92		
1.18	91		
0.6	90	Particle density	(assumed)
0.425	89	2.65	Mg/m3
0.3	74		
0.212	52		
0.15	41		
0.063	30		

Dry Mass of sample, g	501

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	8.4
Sand	61.3
Silt	28.6
Clay	1.7

Grading Analysis		
D100	mm	
D60	mm	0.24
D30	mm	0.062
D10	mm	0.00496
Uniformity Coefficient		48
Curvature Coefficient		3.2

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

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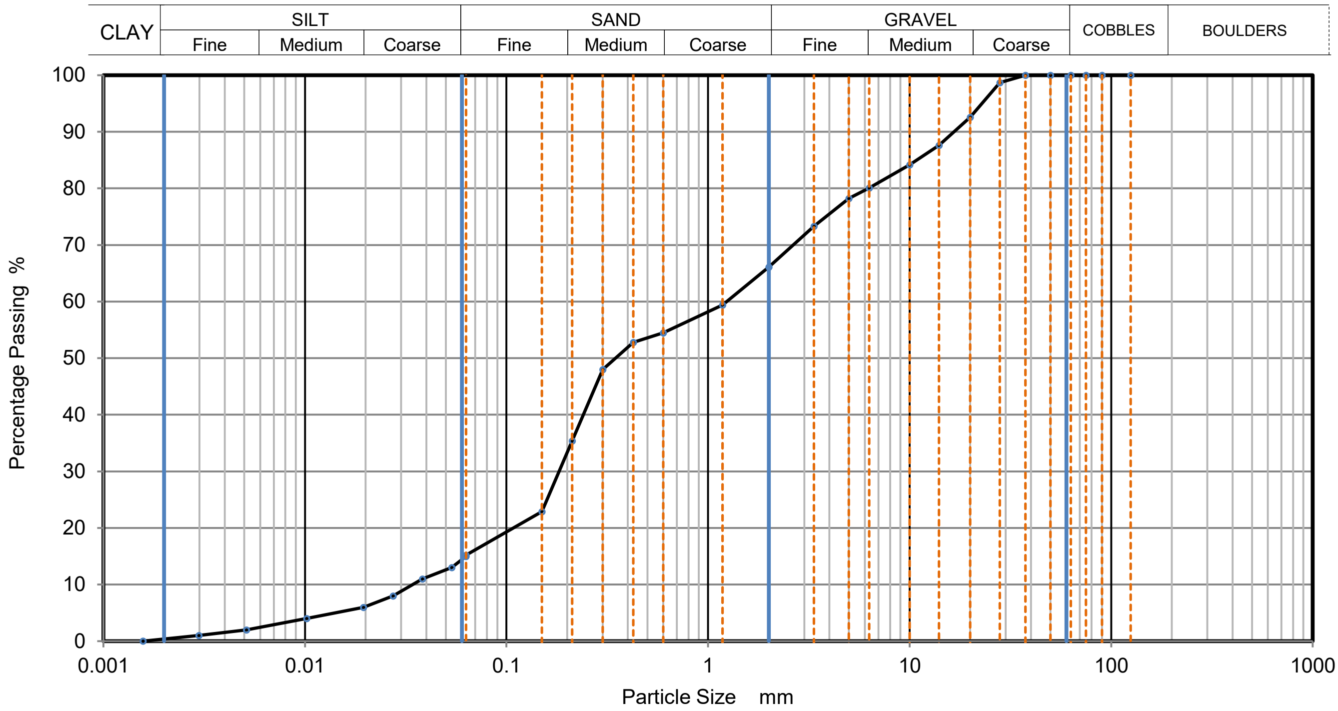
CAUSEWAY GEOTECH

PARTICLE SIZE DISTRIBUTION

				Job Ref	**21-1031**
				Borehole/Pit No.	BH-M02
Site Name	Scapa Deep Water Quay - Marine GI			Sample No.	2
Soil Description	Brownish grey gravelly silty fine to coarse SAND.			Depth, m	0.00
Specimen Reference	11	Specimen Depth	0 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2022030413



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	15
90	100	0.05345	13
75	100	0.03822	11
63	100	0.02732	8
50	100	0.01953	6
37.5	100	0.01019	4
28	99	0.00512	2
20	93	0.00297	1
14	88	0.00157	0
10	84		
6.3	80		
5	78		
3.35	73		
2	66		
1.18	59		
0.6	55	Particle density	(assumed)
0.425	53	2.65	Mg/m3
0.3	48		
0.212	35		
0.15	23		
0.063	15		

Dry Mass of sample, g	2660

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	33.9
Sand	50.9
Silt	14.8
Clay	0.4

Grading Analysis	
D100 mm	
D60 mm	1.23
D30 mm	0.183
D10 mm	0.0355
Uniformity Coefficient	35
Curvature Coefficient	0.76

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

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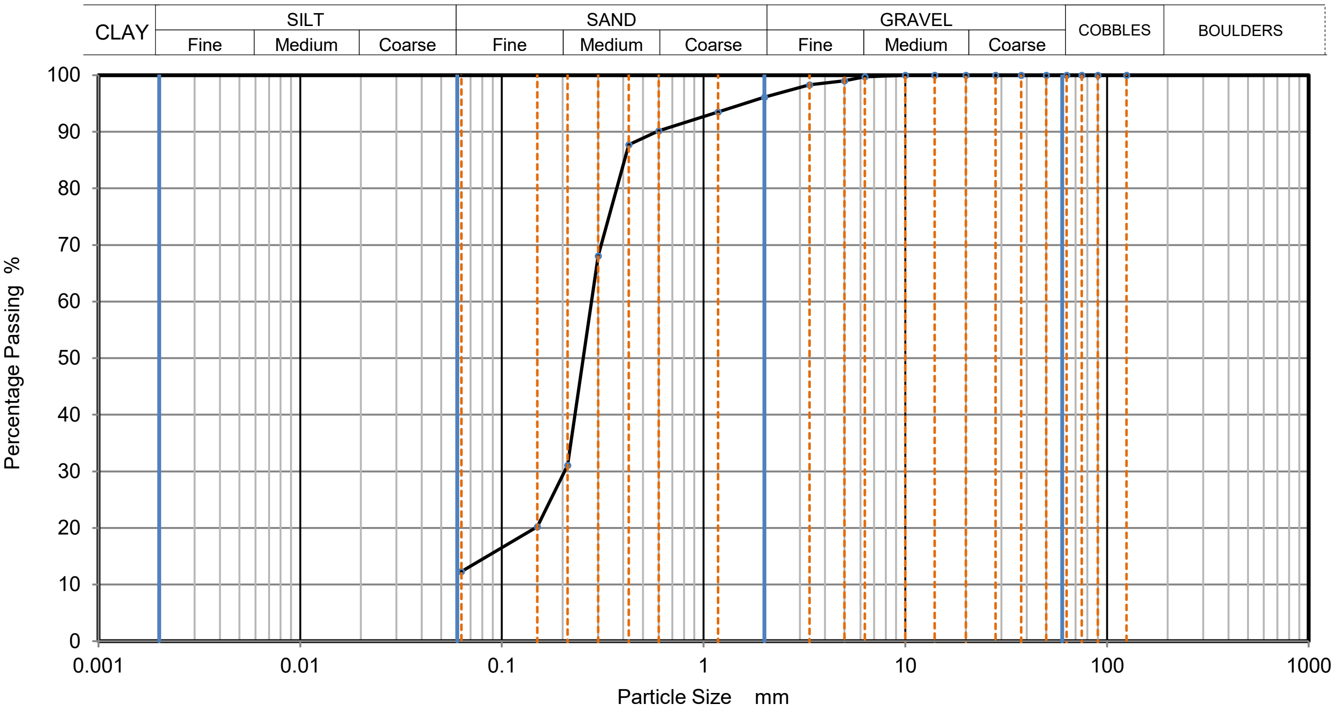
CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**	Job Ref	**21-1031**
		Borehole/Pit No.	BH-M03
Site Name	Scapa Deep Water Quay - Marine GI	Sample No.	6
Soil Description	Brownish grey slightly gravelly slightly silty fine to coarse SAND.	Depth, m	1.50
Specimen Reference	10 Specimen Depth 1.5 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2	KeyLAB ID	Caus2022030414



Sieving		**Sedimentation**	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	100		
5	99		
3.35	98		
2	96		
1.18	94		
0.6	90		
0.425	88		
0.3	68		
0.212	31		
0.15	20		
0.063	12		

Dry Mass of sample, g	207

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	3.9
Sand	83.8
Fines <0.063mm	12.0

Grading Analysis	
D100 mm	
D60 mm	0.278
D30 mm	0.205
D10 mm	
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

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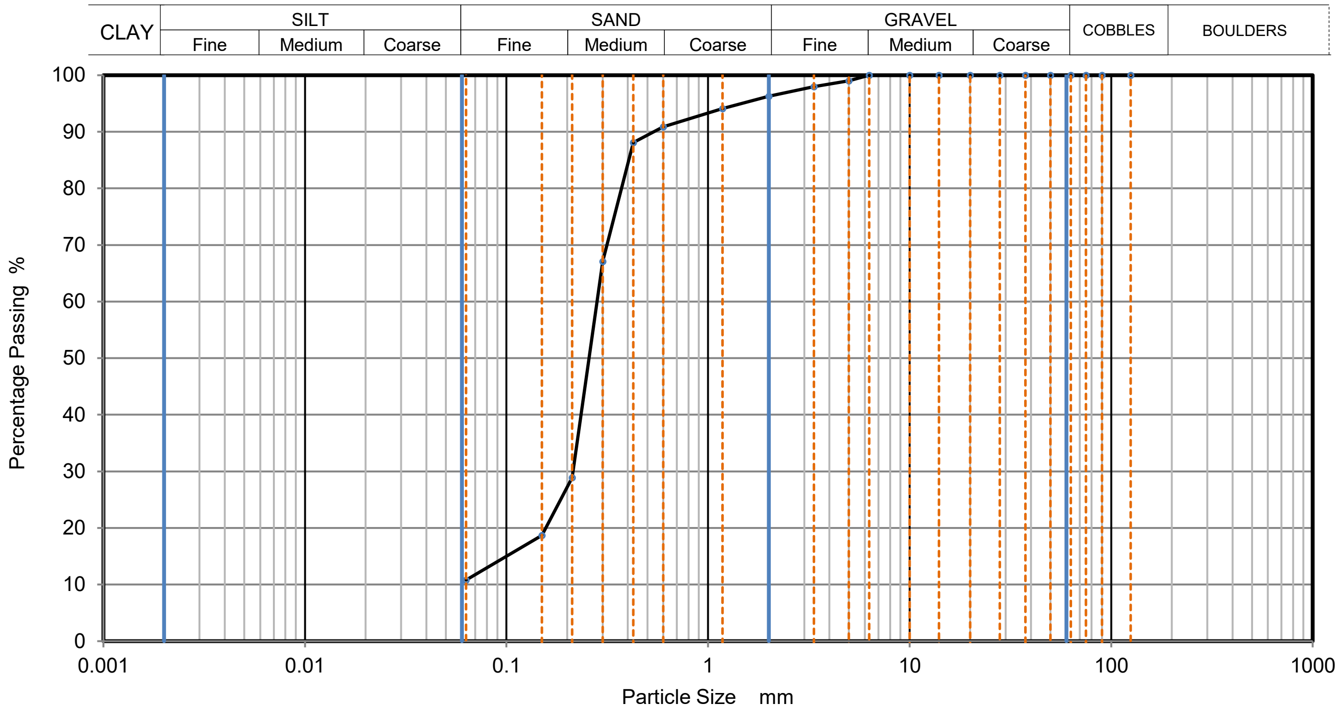
CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**	Job Ref	**21-1031**
		Borehole/Pit No.	BH-M03
Site Name	Scapa Deep Water Quay - Marine GI	Sample No.	7
Soil Description	Brownish grey slightly gravelly slightly silty fine to coarse SAND.	Depth, m	3.00
Specimen Reference	4 / Specimen Depth / 3 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2	KeyLAB ID	Caus2022030415



Sieving		**Sedimentation**	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	100		
5	99		
3.35	98		
2	96		
1.18	94		
0.6	91		
0.425	88		
0.3	67		
0.212	29		
0.15	19		
0.063	11		

Dry Mass of sample, g	210

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	3.7
Sand	85.5
Fines <0.063mm	11.0

Grading Analysis	
D100 mm	
D60 mm	0.281
D30 mm	0.214
D10 mm	
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

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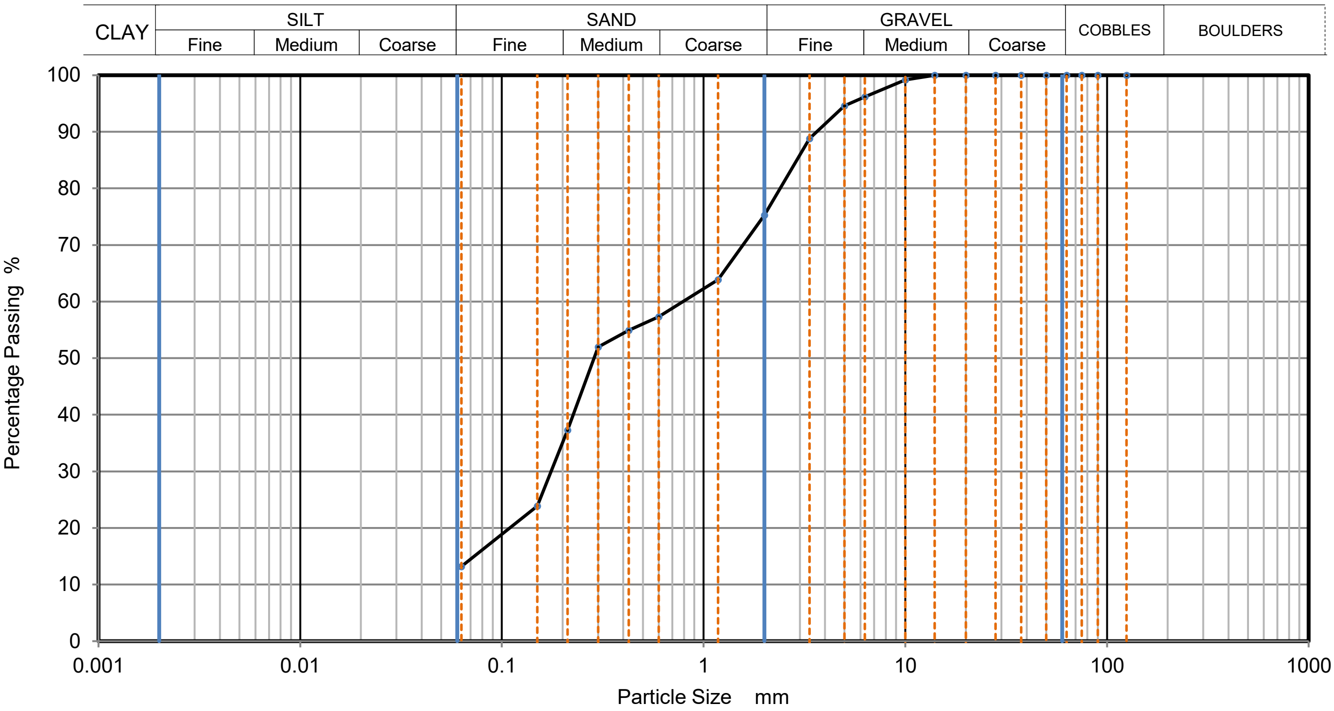
PARTICLE SIZE DISTRIBUTION

CAUSEWAY GEOTECH		Job Ref	**21-1031**
		Borehole/Pit No.	BH-M04
Site Name	Scapa Deep Water Quay - Marine GI	Sample No.	8
Soil Description	Brownish grey slightly gravelly slightly silty fine to coarse SAND.	Depth, m	0.00
Specimen Reference	3 / Specimen Depth 0 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2	KeyLAB ID	Caus202204077



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	99		
6.3	96		
5	95		
3.35	89		
2	75		
1.18	64		
0.6	57		
0.425	55		
0.3	52		
0.212	37		
0.15	24		
0.063	13		

Dry Mass of sample, g: 216

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	24.7
Sand	62.1
Fines <0.063mm	13.0

Grading Analysis	
D100 mm	
D60 mm	0.79
D30 mm	0.176
D10 mm	
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

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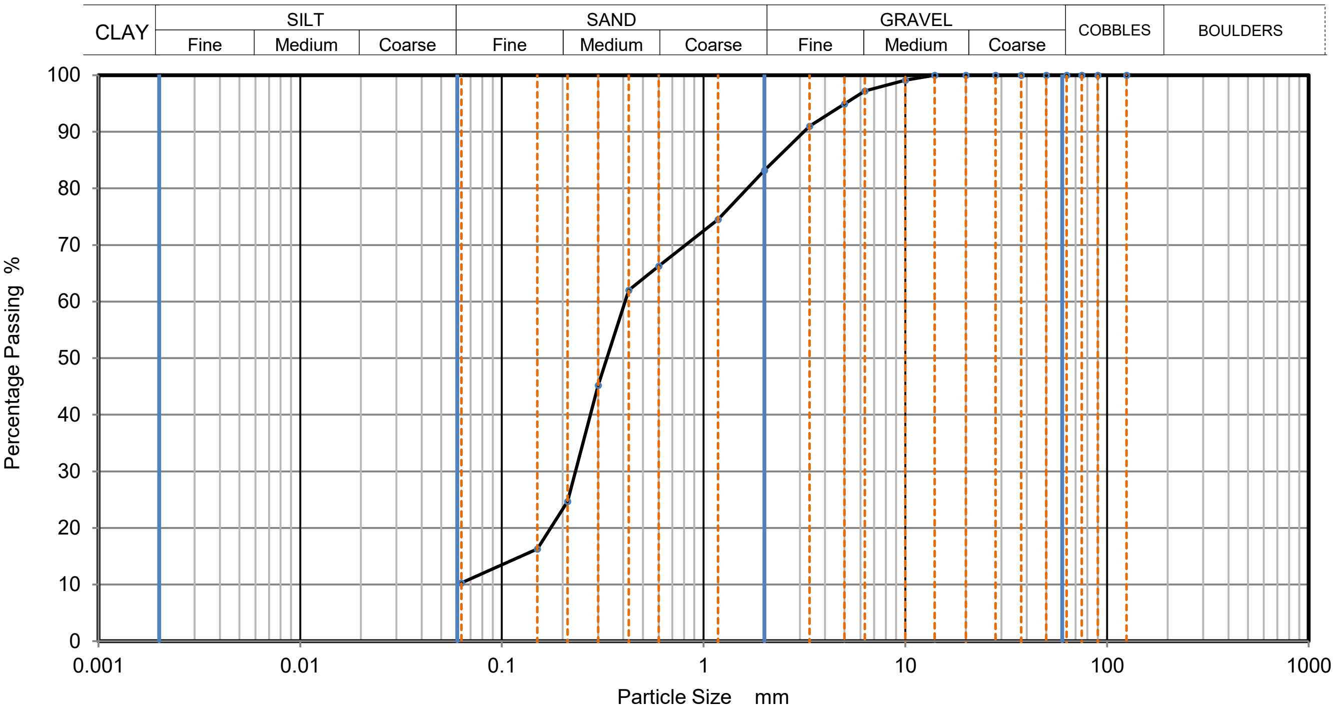
CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**	Job Ref	**21-1031**
		Borehole/Pit No.	BH-M05
Site Name	Scapa Deep Water Quay - Marine GI	Sample No.	8
Soil Description	Brownish grey slightly gravelly slightly silty fine to coarse SAND.	Depth, m	0.00
Specimen Reference	2 Specimen Depth 0 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2	KeyLAB ID	Caus2022040710



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	99		
6.3	97		
5	95		
3.35	91		
2	83		
1.18	75		
0.6	66		
0.425	62		
0.3	45		
0.212	25		
0.15	16		
0.063	10		

Dry Mass of sample, g	211

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	16.8
Sand	72.8
Fines <0.063mm	10.0

Grading Analysis		
D100	mm	
D60	mm	0.408
D30	mm	0.232
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

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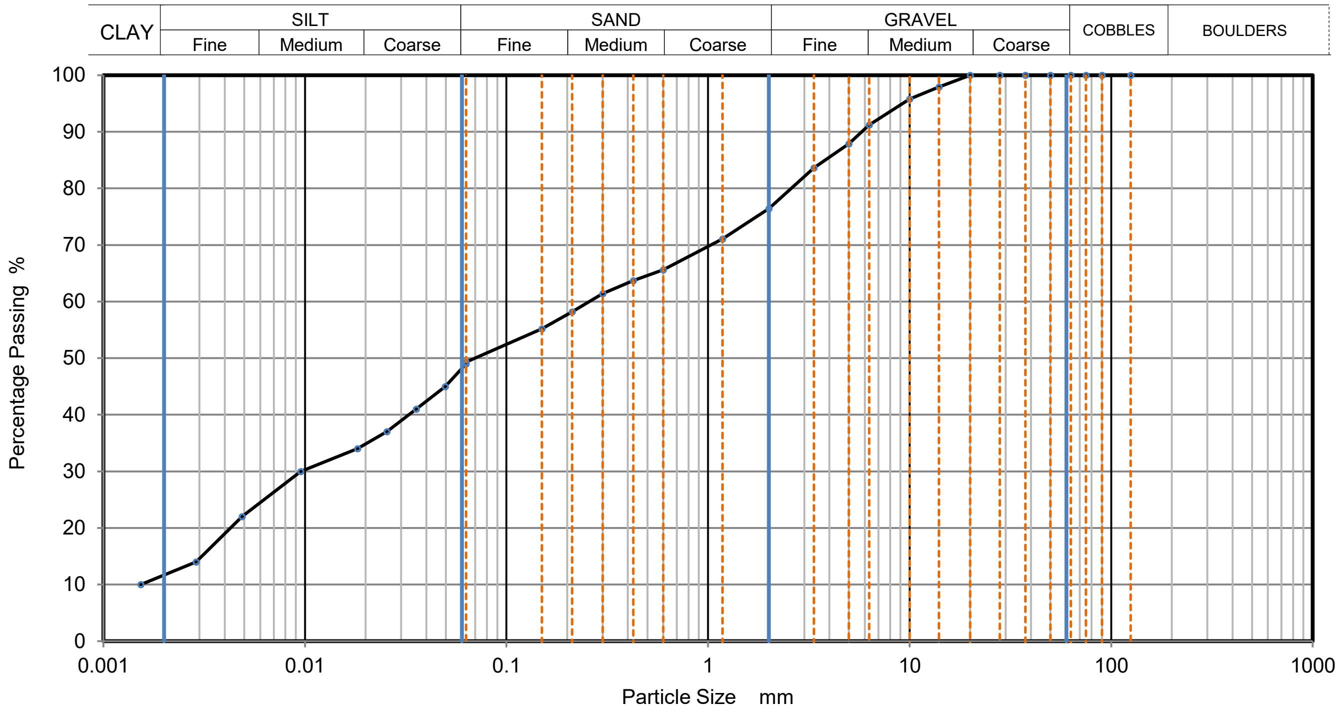
CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**		Job Ref	**21-1031**
			Borehole/Pit No.	BH-M05
Site Name	Scapa Deep Water Quay - Marine GI		Sample No.	10
Soil Description	Brownish grey sandy slightly gravelly silty CLAY.		Depth, m	3.00
Specimen Reference	2	Specimen Depth	3 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5		KeyLAB ID	Caus2022040712



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	49
90	100	0.04969	45
75	100	0.03559	41
63	100	0.02549	37
50	100	0.01824	34
37.5	100	0.00953	30
28	100	0.00488	22
20	100	0.00288	14
14	98	0.00153	10
10	96		
6.3	91		
5	88		
3.35	84		
2	76		
1.18	71		
0.6	66	Particle density	(assumed)
0.425	64	2.65	Mg/m3
0.3	61		
0.212	58		
0.15	55		
0.063	49		

Dry Mass of sample, g	213

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	23.6
Sand	27.2
Silt	37.7
Clay	11.5

Grading Analysis		
D100	mm	
D60	mm	0.257
D30	mm	0.0102
D10	mm	0.00157
Uniformity Coefficient		160
Curvature Coefficient		0.26

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

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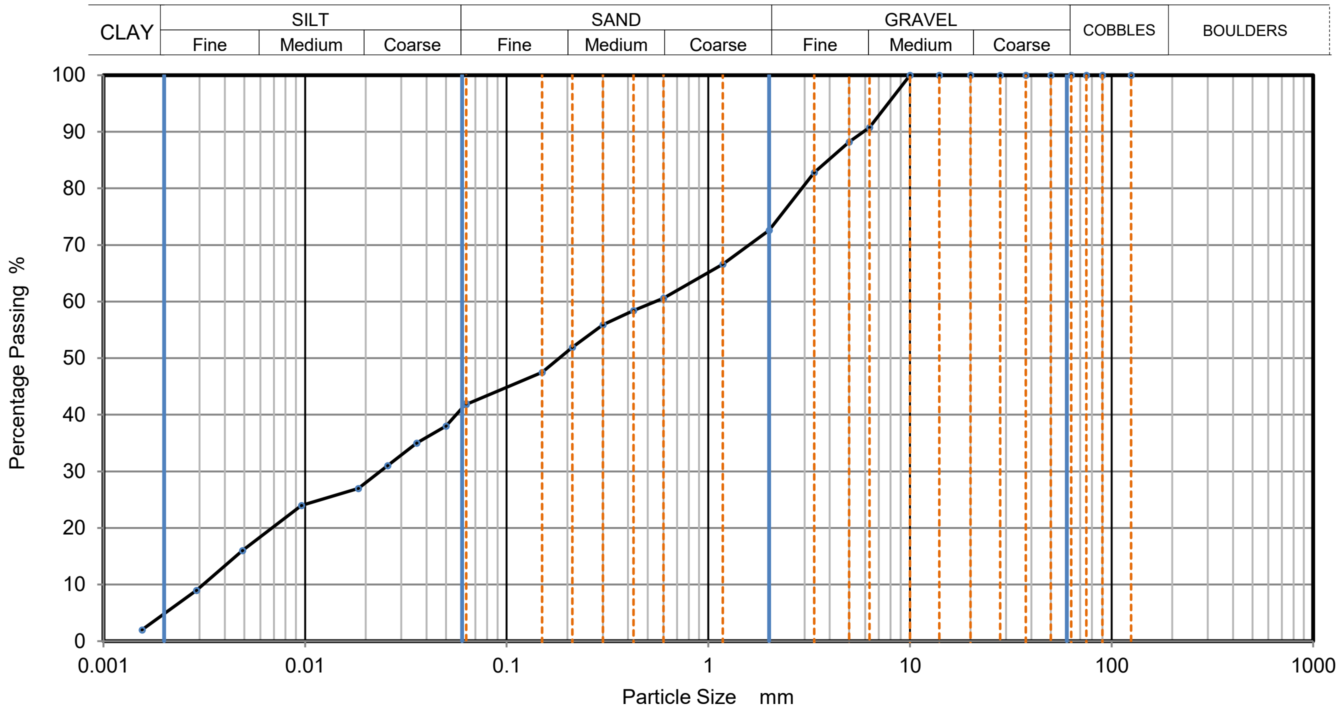
CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**21-1031**
				Borehole/Pit No.	BH-M06
Site Name	Scapa Deep Water Quay - Marine GI			Sample No.	9
Soil Description	Brownish grey sandy slightly gravelly silty CLAY			Depth, m	1.50
Specimen Reference	2	Specimen Depth	1.5 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2022040714



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	42
90	100	0.05002	38
75	100	0.03581	35
63	100	0.02563	31
50	100	0.01834	27
37.5	100	0.00958	24
28	100	0.00490	16
20	100	0.00289	9
14	100	0.00155	2
10	100		
6.3	91		
5	88		
3.35	83		
2	73		
1.18	67		
0.6	61	Particle density	(assumed)
0.425	58	2.65	Mg/m3
0.3	56		
0.212	52		
0.15	48		
0.063	42		

Dry Mass of sample, g	206

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	27.4
Sand	30.8
Silt	37.0
Clay	4.8

Grading Analysis		
D100	mm	
D60	mm	0.546
D30	mm	0.0236
D10	mm	0.00309
Uniformity Coefficient		180
Curvature Coefficient		0.33

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

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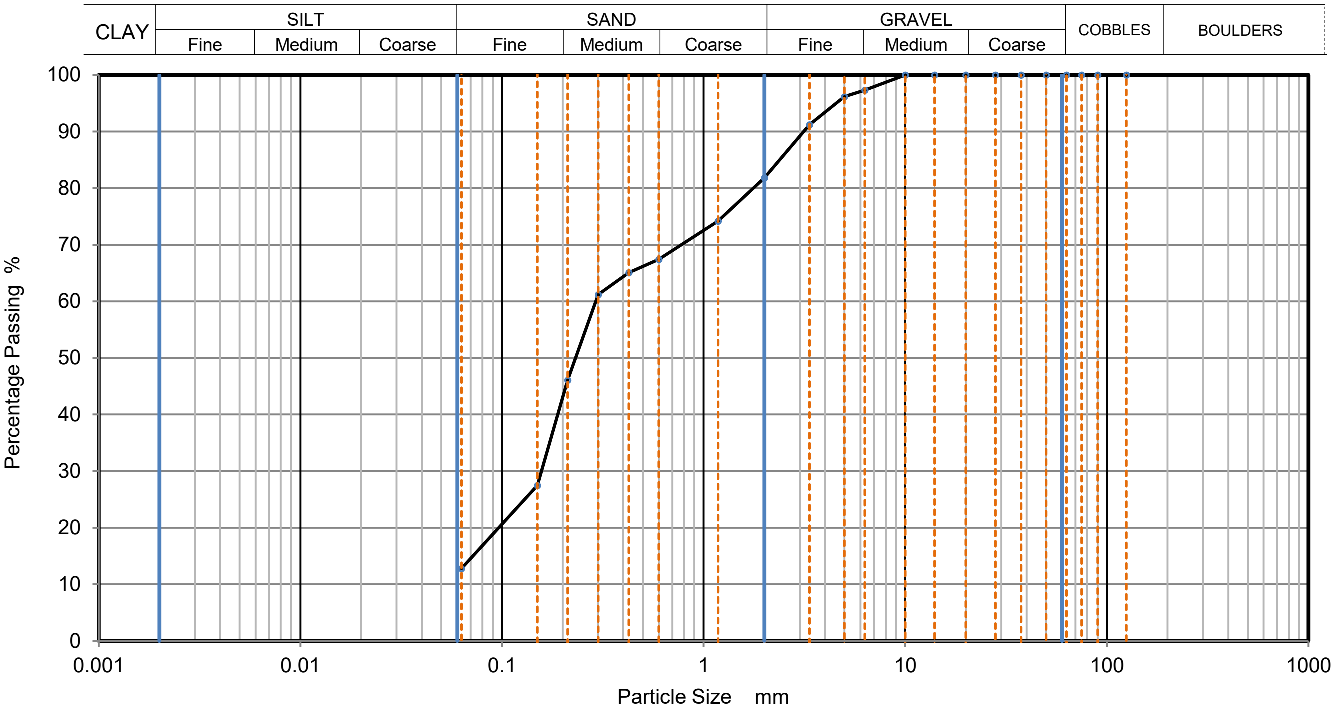
CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**	Job Ref	**21-1031**
		Borehole/Pit No.	BH-M07
Site Name	Scapa Deep Water Quay - Marine GI	Sample No.	8
Soil Description	Brownish grey slightly gravelly slightly silty fine to coarse SAND.	Depth, m	0.00
Specimen Reference	2 — Specimen Depth — 0 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2	KeyLAB ID	Caus2022040717



Sieving		**Sedimentation**	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	97		
5	96		
3.35	91		
2	82		
1.18	74		
0.6	67		
0.425	65		
0.3	61		
0.212	46		
0.15	28		
0.063	13		

Dry Mass of sample, g	212

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	18.2
Sand	69.0
Fines <0.063mm	13.0

Grading Analysis	
D100 mm	
D60 mm	0.292
D30 mm	0.157
D10 mm	
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

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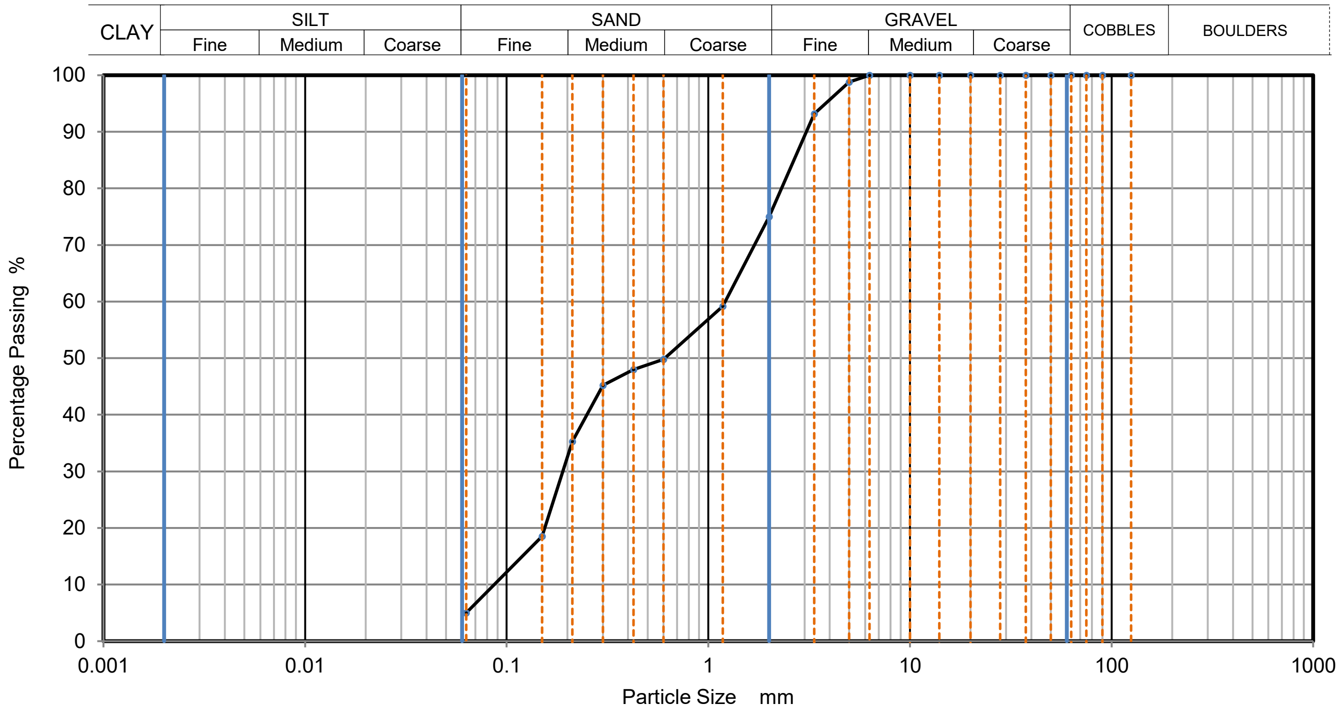
CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**	Job Ref	**21-1031**
		Borehole/Pit No.	BH-M07
Site Name	Scapa Deep Water Quay - Marine GI	Sample No.	10
Soil Description	Brownish grey slightly gravelly slightly silty fine to coarse SAND.	Depth, m	3.00
Specimen Reference	2 Specimen Depth 3 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2	KeyLAB ID	Caus2022040720



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	100		
5	99		
3.35	93		
2	75		
1.18	59		
0.6	50		
0.425	48		
0.3	45		
0.212	35		
0.15	19		
0.063	5		

Dry Mass of sample, g	201

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	25.0
Sand	70.0
Fines <0.063mm	5.0

Grading Analysis	
D100 mm	
D60 mm	1.21
D30 mm	0.19
D10 mm	0.087
Uniformity Coefficient	14
Curvature Coefficient	0.34

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

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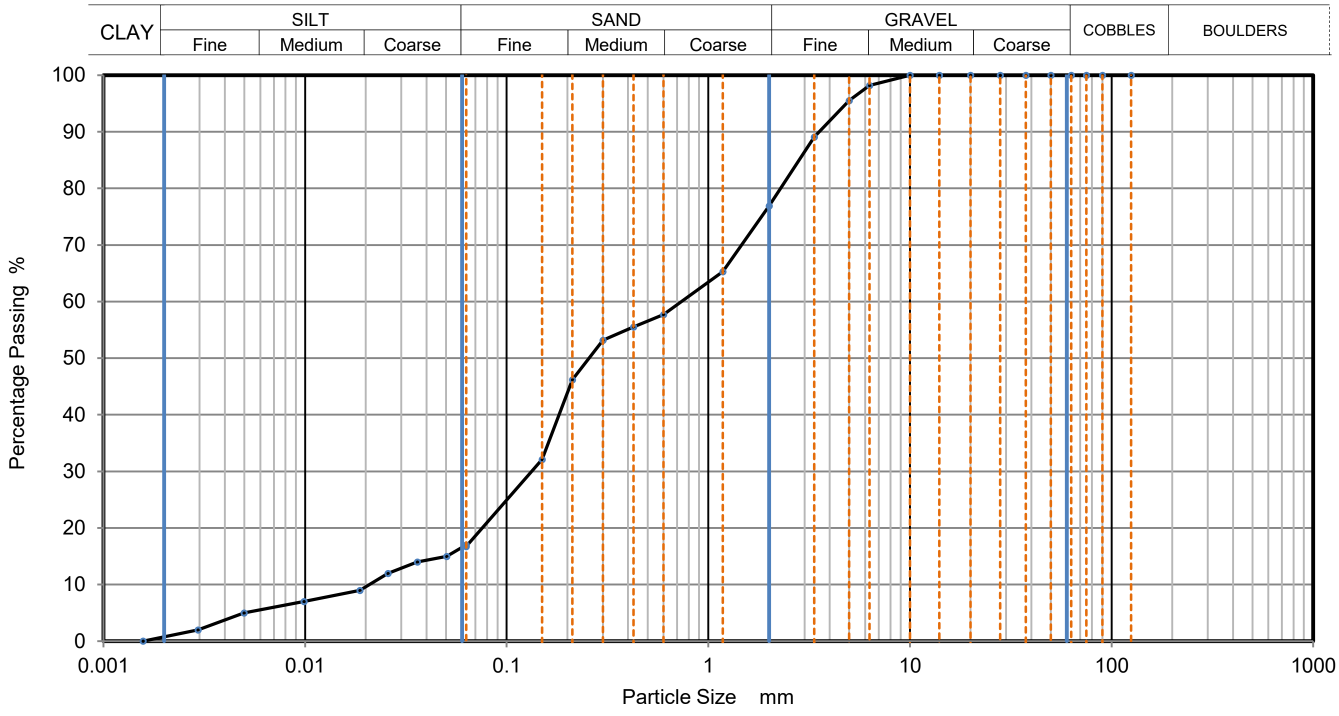
CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**21-1031**
				Borehole/Pit No.	BH-M08
Site Name	Scapa Deep Water Quay - Marine GI			Sample No.	5
Soil Description	Brownish grey slightly gravelly silty fine to coarse SAND.			Depth, m	0.00
Specimen Reference	3	Specimen Depth	0 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2022040721



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	17
90	100	0.05033	15
75	100	0.03604	14
63	100	0.02580	12
50	100	0.01868	9
37.5	100	0.00987	7
28	100	0.00499	5
20	100	0.00294	2
14	100	0.00157	0
10	100		
6.3	98		
5	96		
3.35	89		
2	77		
1.18	65		
0.6	58	Particle density	(assumed)
0.425	56	2.65	Mg/m3
0.3	53		
0.212	46		
0.15	32		
0.063	17		

Dry Mass of sample, g	251

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	23.1
Sand	60.2
Silt	15.9
Clay	0.8

Grading Analysis	
D100 mm	
D60 mm	0.736
D30 mm	0.134
D10 mm	0.0199
Uniformity Coefficient	37
Curvature Coefficient	1.2

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

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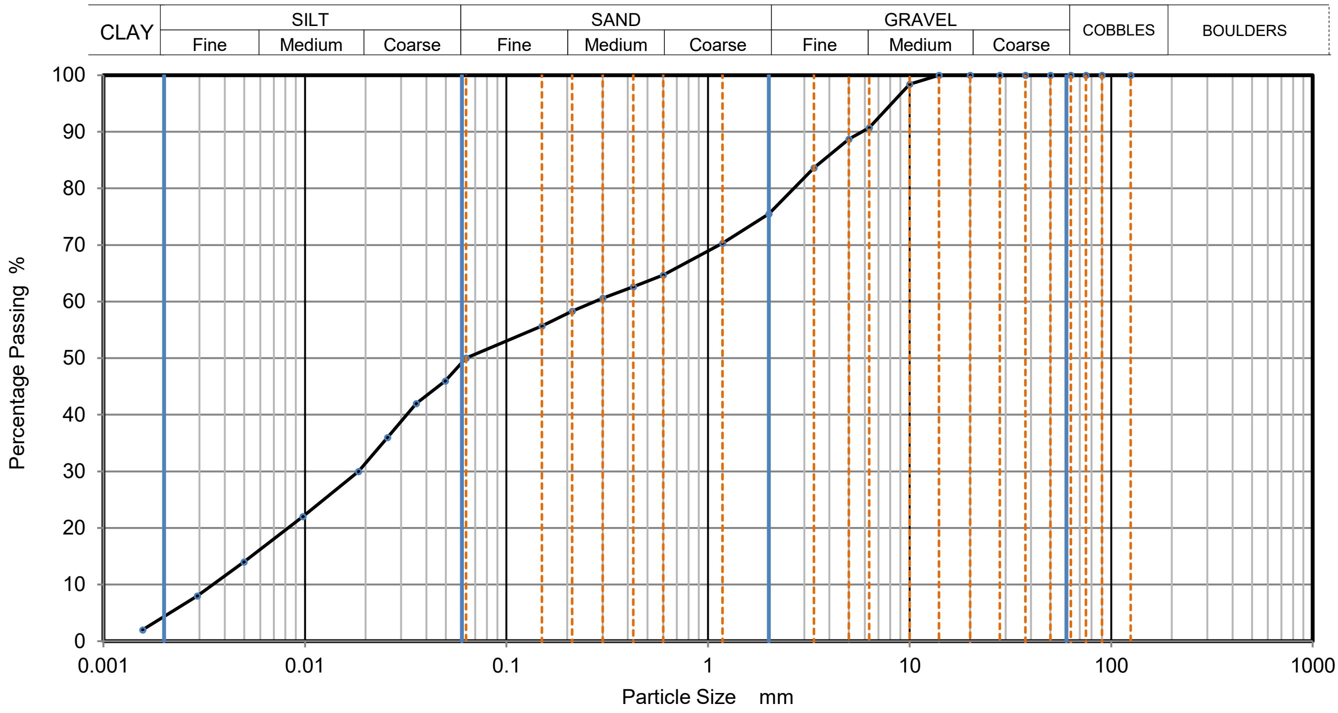
CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**21-1031**
				Borehole/Pit No.	BH-M08
Site Name	Scapa Deep Water Quay - Marine GI			Sample No.	6
Soil Description	Brownish grey sandy slightly gravelly silty CLAY.			Depth, m	1.50
Specimen Reference	2	Specimen Depth	1.5 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2022040723



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	50
90	100	0.04969	46
75	100	0.03559	42
63	100	0.02564	36
50	100	0.01846	30
37.5	100	0.00976	22
28	100	0.00499	14
20	100	0.00293	8
14	100	0.00156	2
10	98		
6.3	91		
5	89		
3.35	84		
2	76		
1.18	70		
0.6	65	Particle density	(assumed)
0.425	63	2.65	Mg/m3
0.3	61		
0.212	58		
0.15	56		
0.063	50		

Dry Mass of sample, g	204

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	24.5
Sand	25.5
Silt	45.6
Clay	4.4

Grading Analysis	
D100 mm	
D60 mm	0.274
D30 mm	
D10 mm	0.0035
Uniformity Coefficient	78
Curvature Coefficient	

Remarks

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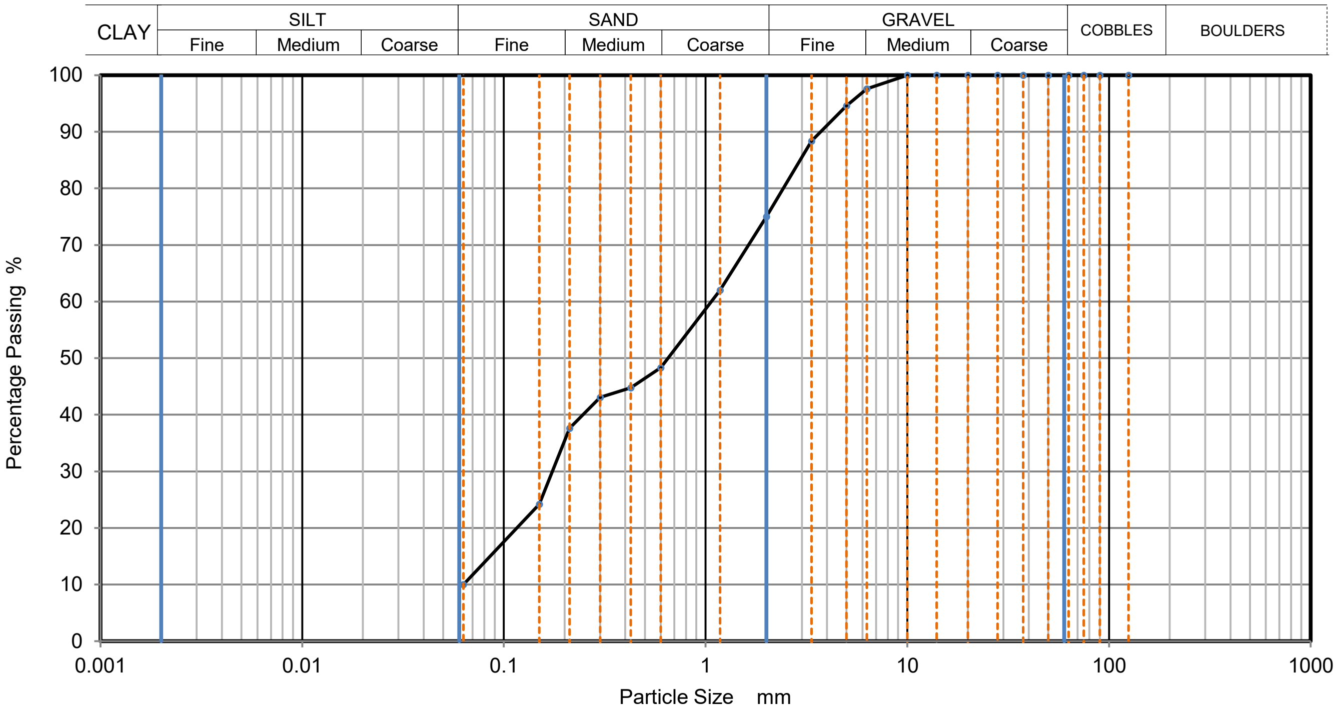
CAUSEWAY GEOTECH

PARTICLE SIZE DISTRIBUTION

		Job Ref	**21-1031**
		Borehole/Pit No.	BH-M09
Site Name	Scapa Deep Water Quay - Marine GI	Sample No.	8
Soil Description	Brownish grey slightly gravelly slightly silty fine to coarse SAND.	Depth, m	0.00
Specimen Reference	2 Specimen Depth 0 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2	KeyLAB ID	Caus2022040725



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	98		
5	95		
3.35	88		
2	75		
1.18	62		
0.6	48		
0.425	45		
0.3	43		
0.212	38		
0.15	24		
0.063	10		

Dry Mass of sample, g	214

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	25.0
Sand	65.0
Fines <0.063mm	10.0

Grading Analysis	
D100 mm	
D60 mm	1.07
D30 mm	0.174
D10 mm	
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

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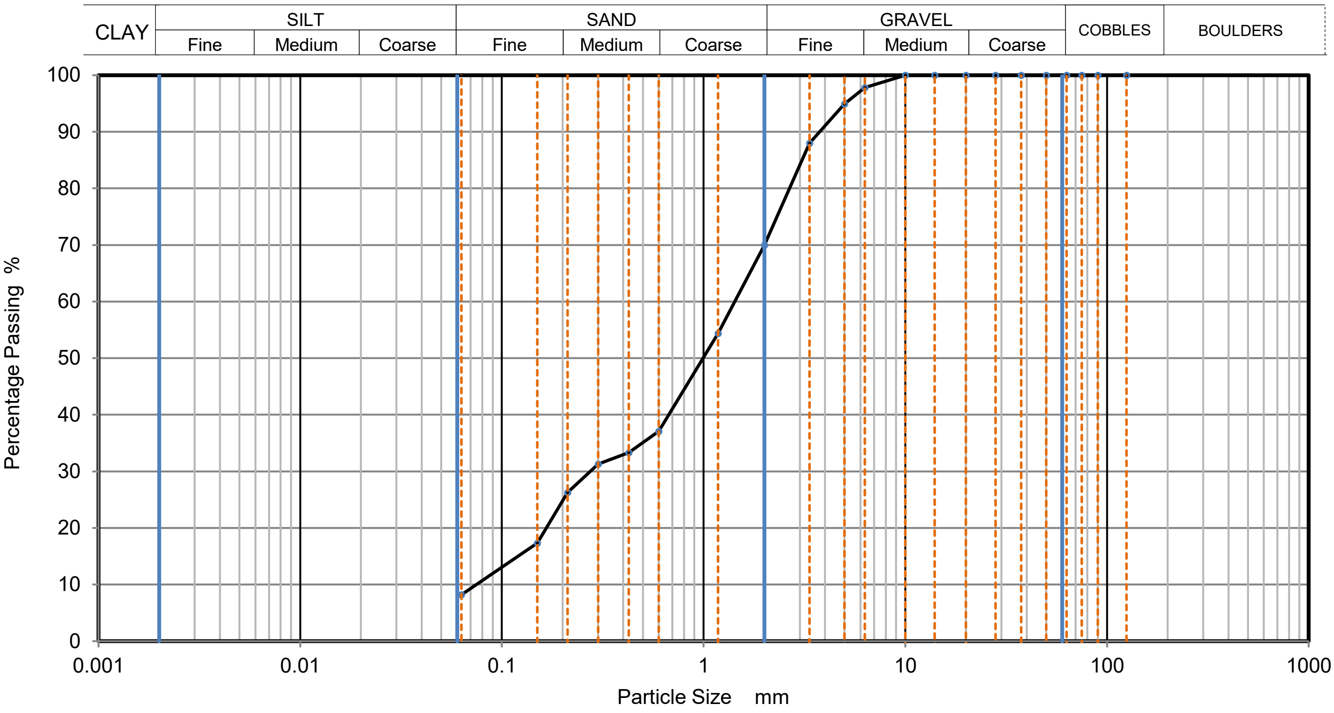
CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**	Job Ref	**21-1031**
		Borehole/Pit No.	BH-M09
Site Name	Scapa Deep Water Quay - Marine GI	Sample No.	9
Soil Description	Brownish grey slightly gravelly slightly silty fine to coarse SAND.	Depth, m	1.50
Specimen Reference	2 Specimen Depth 1.5 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2	KeyLAB ID	Caus2022040727



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	98		
5	95		
3.35	88		
2	70		
1.18	54		
0.6	37		
0.425	33		
0.3	31		
0.212	26		
0.15	17		
0.063	8		

Dry Mass of sample, g	202

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	30.0
Sand	61.9
Fines <0.063mm	8.0

Grading Analysis	
D100 mm	
D60 mm	1.43
D30 mm	0.275
D10 mm	0.075
Uniformity Coefficient	19
Curvature Coefficient	0.71

Remarks

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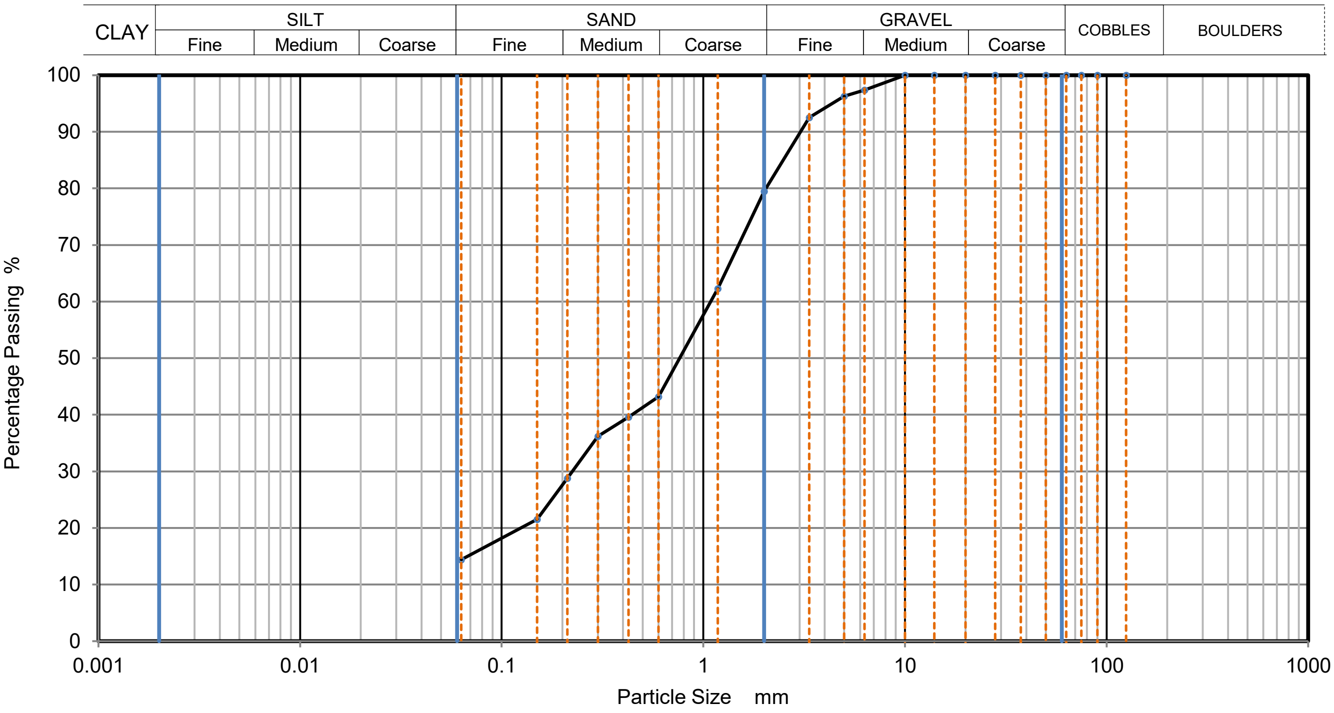
CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**21-1031**
				Borehole/Pit No.	BH-M10
Site Name	Scapa Deep Water Quay - Marine GI			Sample No.	5
Soil Description	Brownish grey slightly gravelly slightly silty fine to coarse SAND.			Depth, m	0.00
Specimen Reference	3	Specimen Depth	0 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	Caus2022040729



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	97		
5	96		
3.35	93		
2	80		
1.18	62		
0.6	43		
0.425	40		
0.3	36		
0.212	29		
0.15	22		
0.063	14		

Dry Mass of sample, g	212

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	20.5
Sand	65.1
Fines <0.063mm	14.0

Grading Analysis		
D100	mm	
D60	mm	1.09
D30	mm	0.225
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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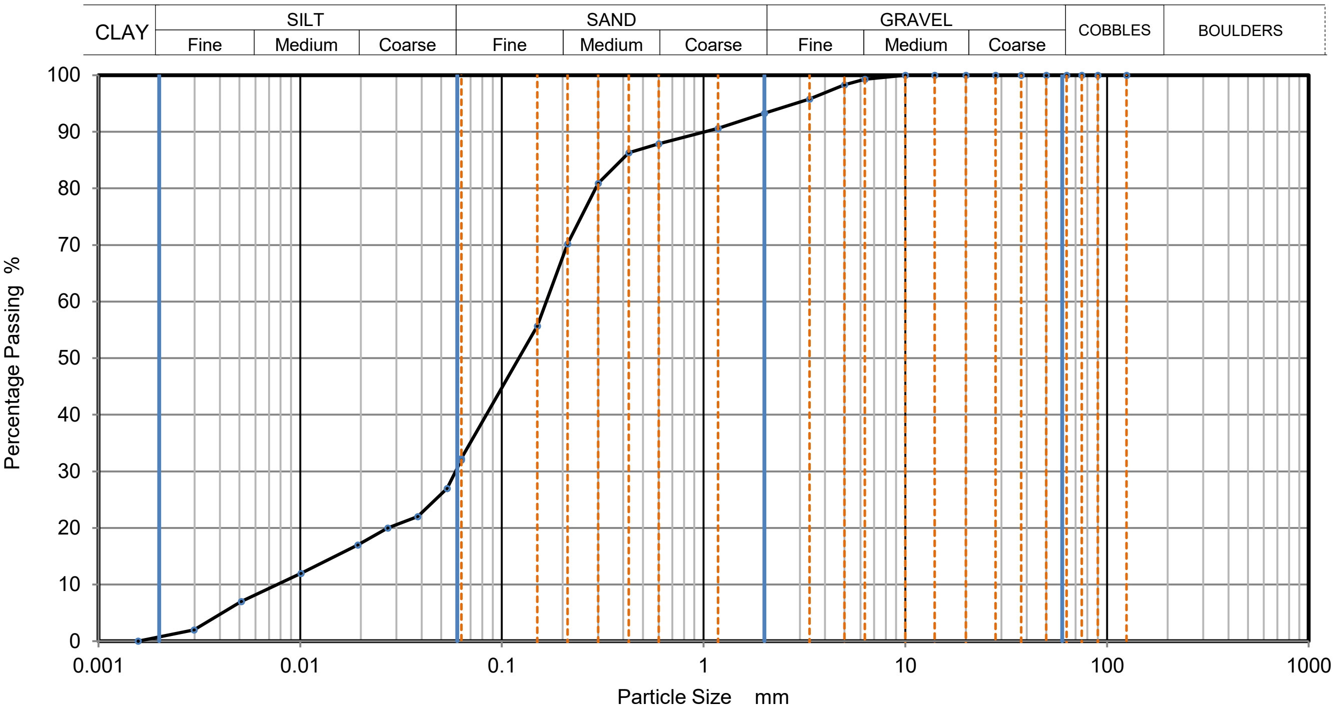
CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**	Job Ref	**21-1031**
		Borehole/Pit No.	BH-M10
Site Name	Scapa Deep Water Quay - Marine GI	Sample No.	6
Soil Description	Brownish grey slightly gravelly clayey fine to coarse SAND.	Depth, m	1.50
Specimen Reference	2 Specimen Depth 1.5 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5	KeyLAB ID	Caus2022040730



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	32
90	100	0.05345	27
75	100	0.03822	22
63	100	0.02717	20
50	100	0.01932	17
37.5	100	0.01008	12
28	100	0.00509	7
20	100	0.00297	2
14	100	0.00157	0
10	100		
6.3	99		
5	98		
3.35	96		
2	93		
1.18	91		
0.6	88	Particle density	(assumed)
0.425	86	2.65	Mg/m3
0.3	81		
0.212	70		
0.15	56		
0.063	32		

Dry Mass of sample, g	211

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	6.7
Sand	60.9
Silt	31.5
Clay	0.9

Grading Analysis		
D100	mm	
D60	mm	0.166
D30	mm	0.0584
D10	mm	0.00723
Uniformity Coefficient		23
Curvature Coefficient		2.8

Remarks

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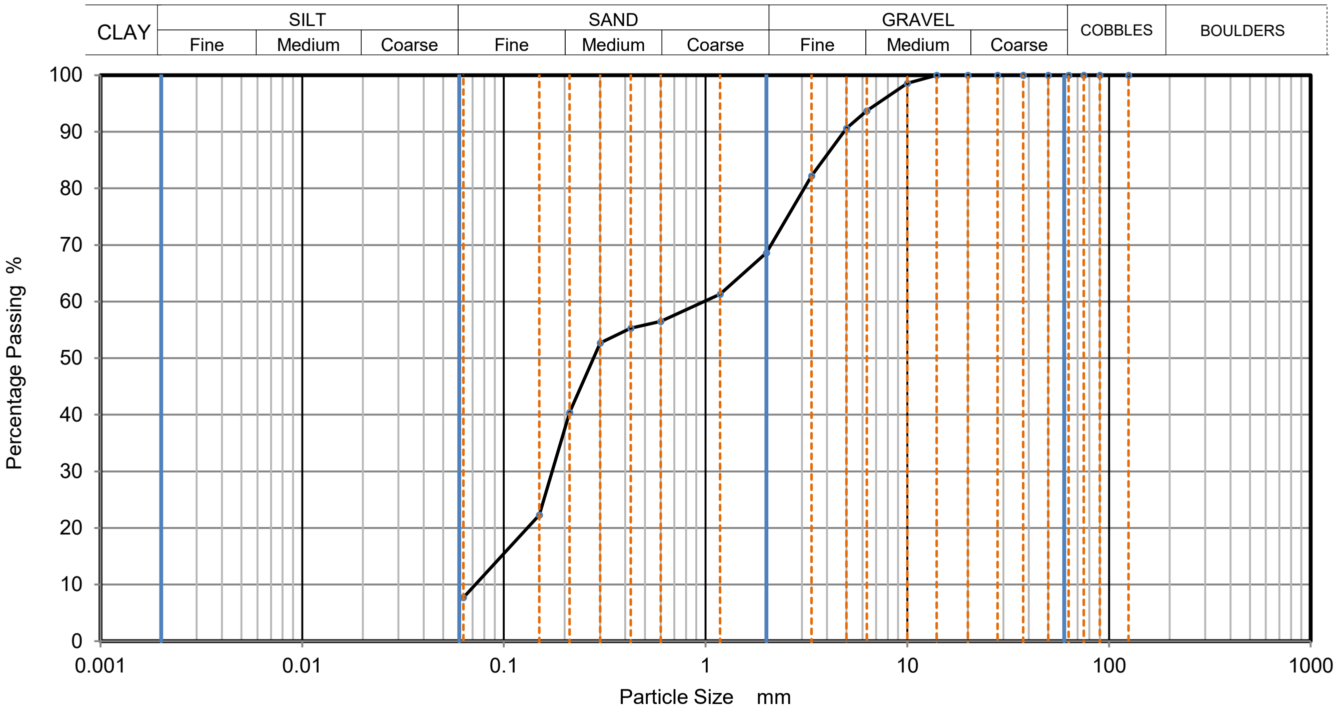
CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**	Job Ref	**21-1031**
		Borehole/Pit No.	BH-M11
Site Name	Scapa Deep Water Quay - Marine GI	Sample No.	8
Soil Description	Brownish grey slightly gravelly slightly silty fine to coarse SAND.	Depth, m	0.00
Specimen Reference	2 Specimen Depth 0 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2	KeyLAB ID	Caus2022040732



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	99		
6.3	94		
5	91		
3.35	82		
2	69		
1.18	61		
0.6	57		
0.425	55		
0.3	53		
0.212	40		
0.15	22		
0.063	8		

Dry Mass of sample, g	204

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	31.4
Sand	60.9
Fines <0.063mm	8.0

Grading Analysis		
D100	mm	
D60	mm	0.977
D30	mm	0.174
D10	mm	0.0723
Uniformity Coefficient		14
Curvature Coefficient		0.43

Remarks

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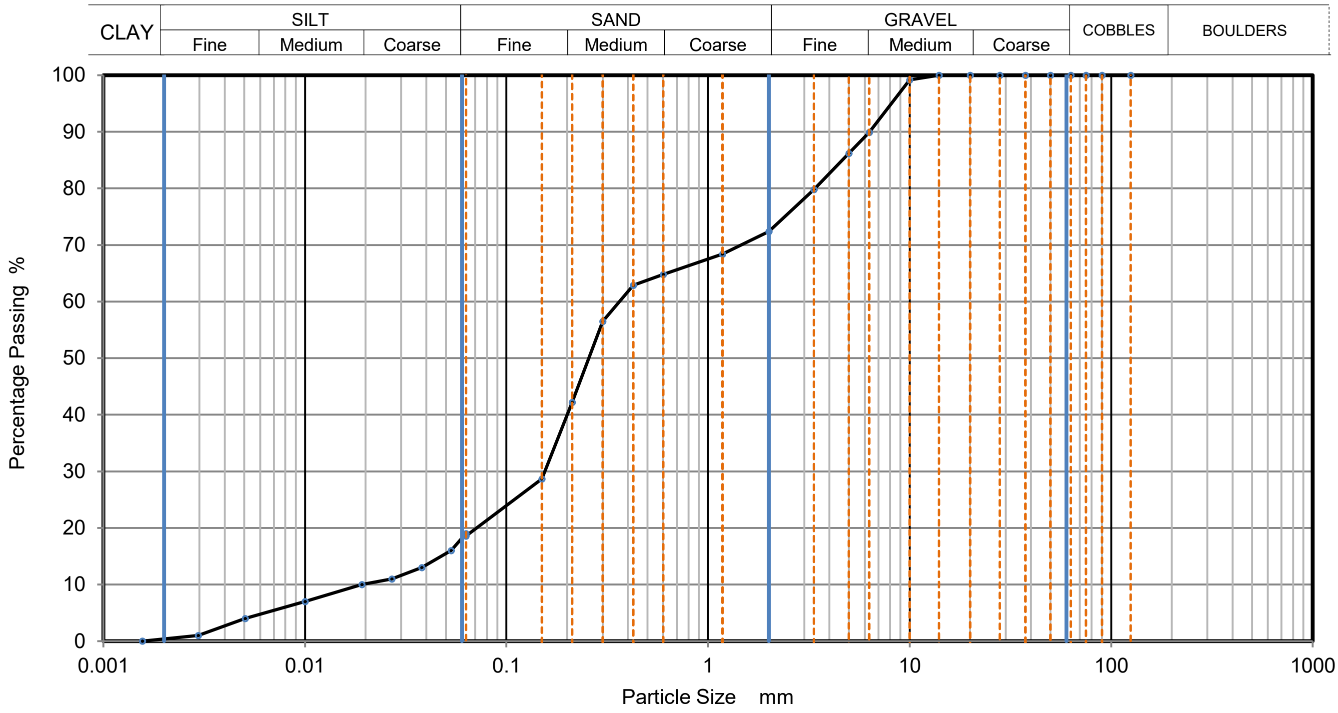
CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**21-1031**
				Borehole/Pit No.	BH-M11
Site Name	Scapa Deep Water Quay - Marine GI			Sample No.	9
Soil Description	Brownish grey slightly gravelly clayey fine to coarse SAND.			Depth, m	1.50
Specimen Reference	2	Specimen Depth	1.5 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2022040734



Sieving		**Sedimentation**	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	19
90	100	0.05308	16
75	100	0.03795	13
63	100	0.02698	11
50	100	0.01918	10
37.5	100	0.01001	7
28	100	0.00506	4
20	100	0.00295	1
14	100	0.00156	0
10	99		
6.3	90		
5	86		
3.35	80		
2	72		
1.18	68		
0.6	65	Particle density	(assumed)
0.425	63	2.65	Mg/m3
0.3	57		
0.212	42		
0.15	29		
0.063	19		

Dry Mass of sample, g	209

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	27.6
Sand	53.8
Silt	18.0
Clay	0.6

Grading Analysis		
D100	mm	
D60	mm	0.362
D30	mm	0.155
D10	mm	0.0191
Uniformity Coefficient		19
Curvature Coefficient		3.5

Remarks

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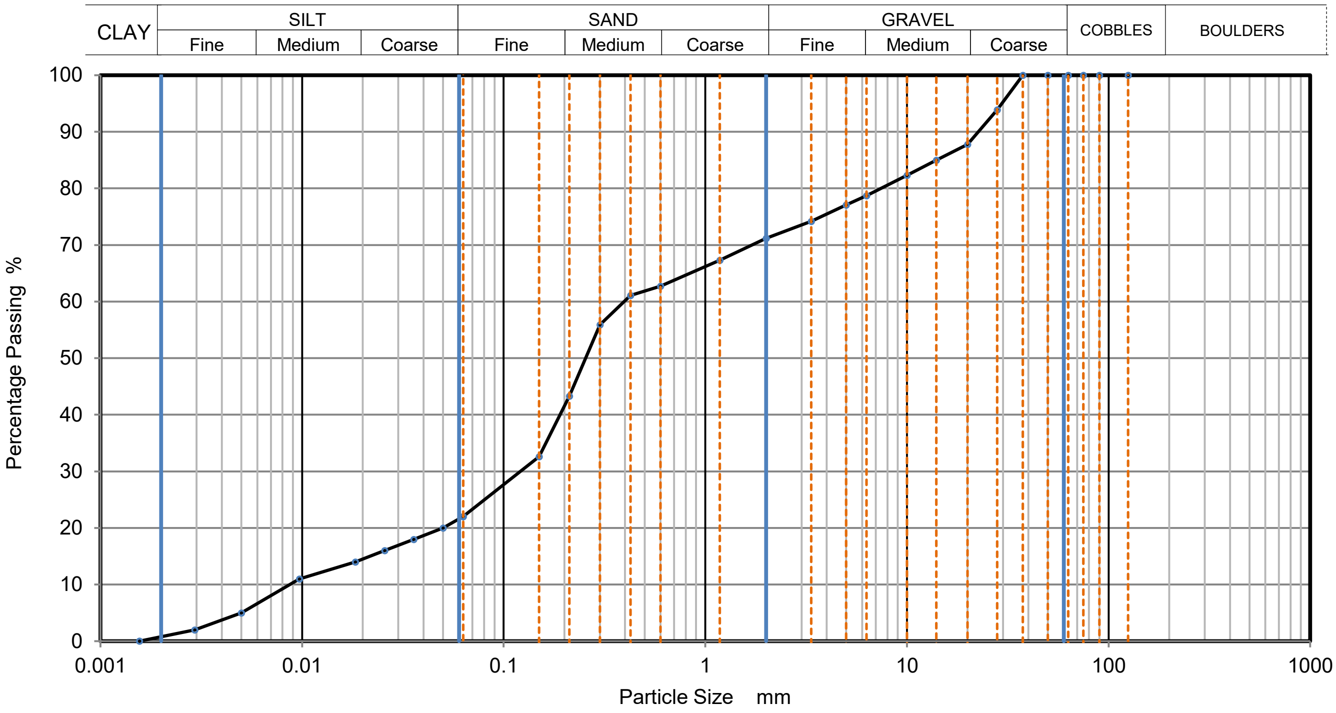
CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**	Job Ref	**21-1031**
		Borehole/Pit No.	BH-M12
Site Name	Scapa Deep Water Quay - Marine GI	Sample No.	3
Soil Description	Brownish grey slightly gravelly silty fine to coarse SAND.	Depth, m	0.00
Specimen Reference	5 Specimen Depth 0 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5	KeyLAB ID	Caus2022040735



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	22
90	100	0.05002	20
75	100	0.03581	18
63	100	0.02563	16
50	100	0.01834	14
37.5	100	0.00969	11
28	94	0.00501	5
20	88	0.00293	2
14	85	0.00156	0
10	82		
6.3	79		
5	77		
3.35	74		
2	71		
1.18	67		
0.6	63	Particle density	(assumed)
0.425	61	2.65	Mg/m3
0.3	56		
0.212	43		
0.15	33		
0.063	22		

Dry Mass of sample, g	2476

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	28.8
Sand	49.1
Silt	21.3
Clay	0.8

Grading Analysis	
D100 mm	
D60 mm	0.394
D30 mm	0.121
D10 mm	0.00913
Uniformity Coefficient	43
Curvature Coefficient	4.1

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

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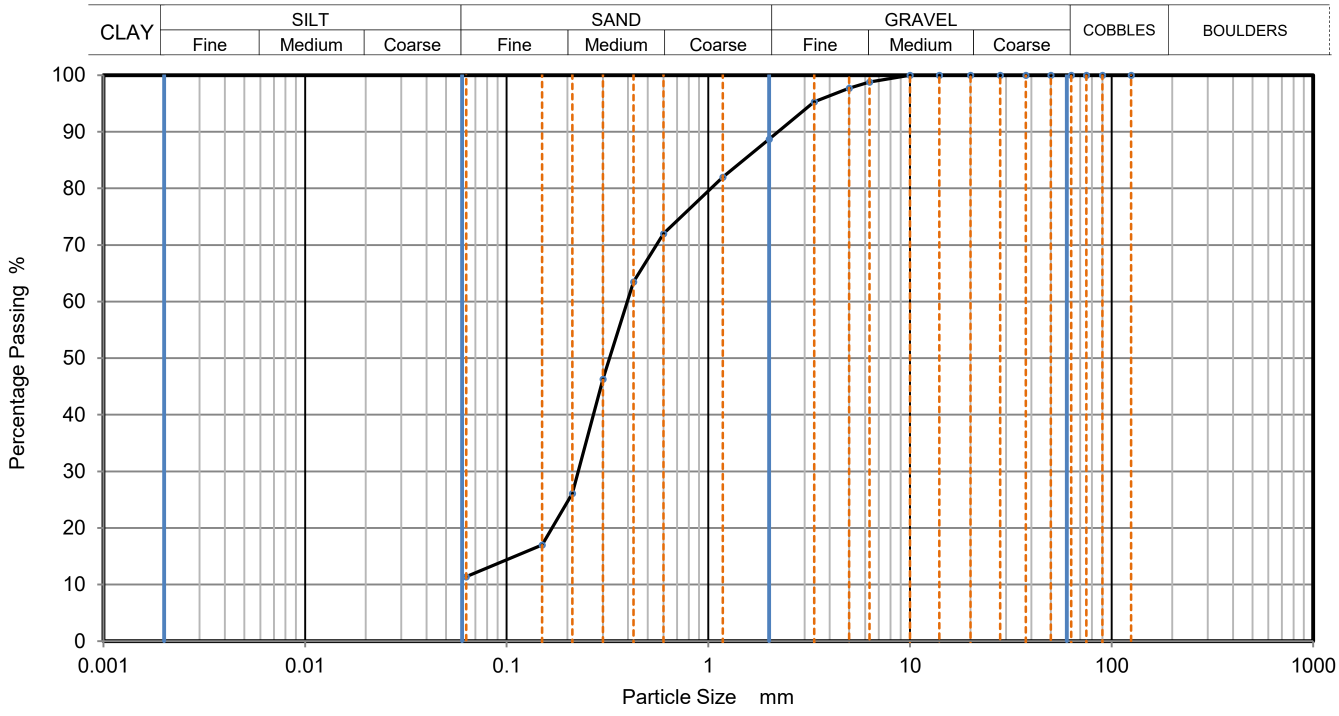
CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**	Job Ref	**21-1031**
		Borehole/Pit No.	BH-M13
Site Name	Scapa Deep Water Quay - Marine GI	Sample No.	8
Soil Description	Brownish grey slightly gravelly slightly silty fine to coarse SAND.	Depth, m	0.00
Specimen Reference	3 / Specimen Depth: 0 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2	KeyLAB ID	Caus2022040736



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	99		
5	98		
3.35	95		
2	89		
1.18	82		
0.6	72		
0.425	64		
0.3	46		
0.212	26		
0.15	17		
0.063	11		

Dry Mass of sample, g	251

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	11.3
Sand	77.3
Fines <0.063mm	11.0

Grading Analysis	
D100 mm	
D60 mm	0.396
D30 mm	0.227
D10 mm	
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

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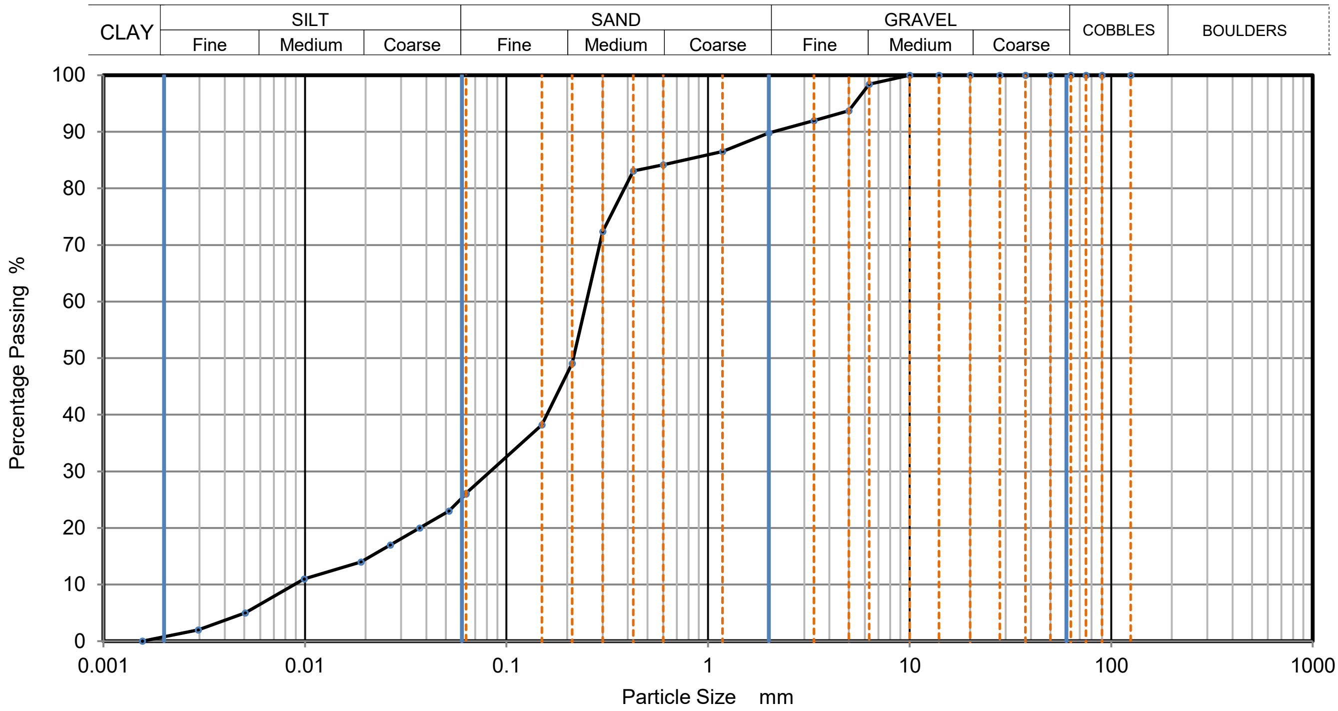
CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**	Job Ref	**21-1031**
		Borehole/Pit No.	BH-M13
Site Name	Scapa Deep Water Quay - Marine GI	Sample No.	9
Soil Description	Brownish grey slightly gravelly silty fine to coarse SAND.	Depth, m	1.50
Specimen Reference	2 Specimen Depth 1.5 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5	KeyLAB ID	Caus2022040737



Sieving		**Sedimentation**	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	26
90	100	0.05188	23
75	100	0.03711	20
63	100	0.02654	17
50	100	0.01897	14
37.5	100	0.00990	11
28	100	0.00506	5
20	100	0.00295	2
14	100	0.00156	0
10	100		
6.3	98		
5	94		
3.35	92		
2	90		
1.18	87		
0.6	84	Particle density	(assumed)
0.425	83	2.65	Mg/m3
0.3	72		
0.212	49		
0.15	38		
0.063	26		

Dry Mass of sample, g	223

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	10.2
Sand	63.6
Silt	25.6
Clay	0.6

Grading Analysis		
D100	mm	
D60	mm	0.249
D30	mm	0.0832
D10	mm	0.00913
Uniformity Coefficient		27
Curvature Coefficient		3

Remarks

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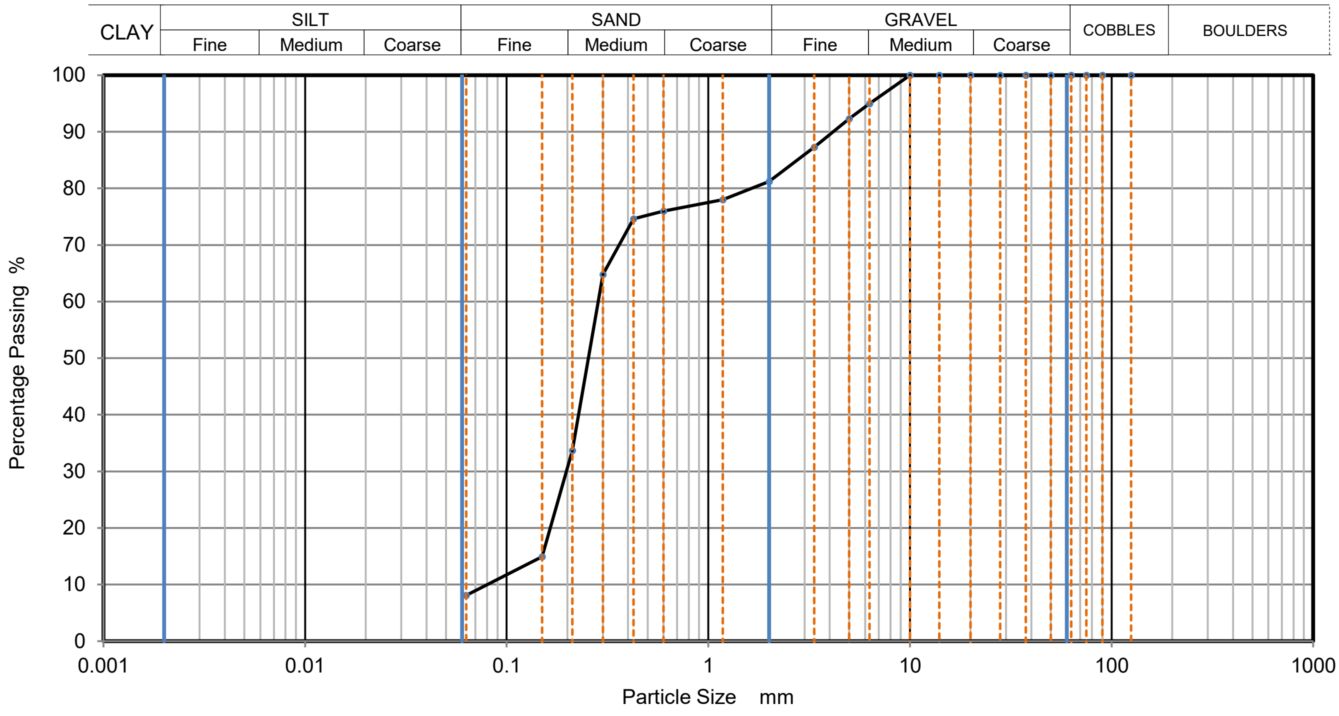
CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**	Job Ref	**21-1031**
		Borehole/Pit No.	BH-M14
Site Name	Scapa Deep Water Quay - Marine GI	Sample No.	9
Soil Description	Brownish grey slightly gravelly slightly silty fine to coarse SAND.	Depth, m	1.50
Specimen Reference	2 Specimen Depth 1.5 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2	KeyLAB ID	Caus2022040739



Sieving		**Sedimentation**	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	95		
5	92		
3.35	87		
2	81		
1.18	78		
0.6	76		
0.425	75		
0.3	65		
0.212	34		
0.15	15		
0.063	8		

Dry Mass of sample, g	208

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	18.8
Sand	73.1
Fines <0.063mm	8.0

Grading Analysis		
D100	mm	
D60	mm	0.284
D30	mm	0.198
D10	mm	0.0801
Uniformity Coefficient		3.5
Curvature Coefficient		1.7

Remarks

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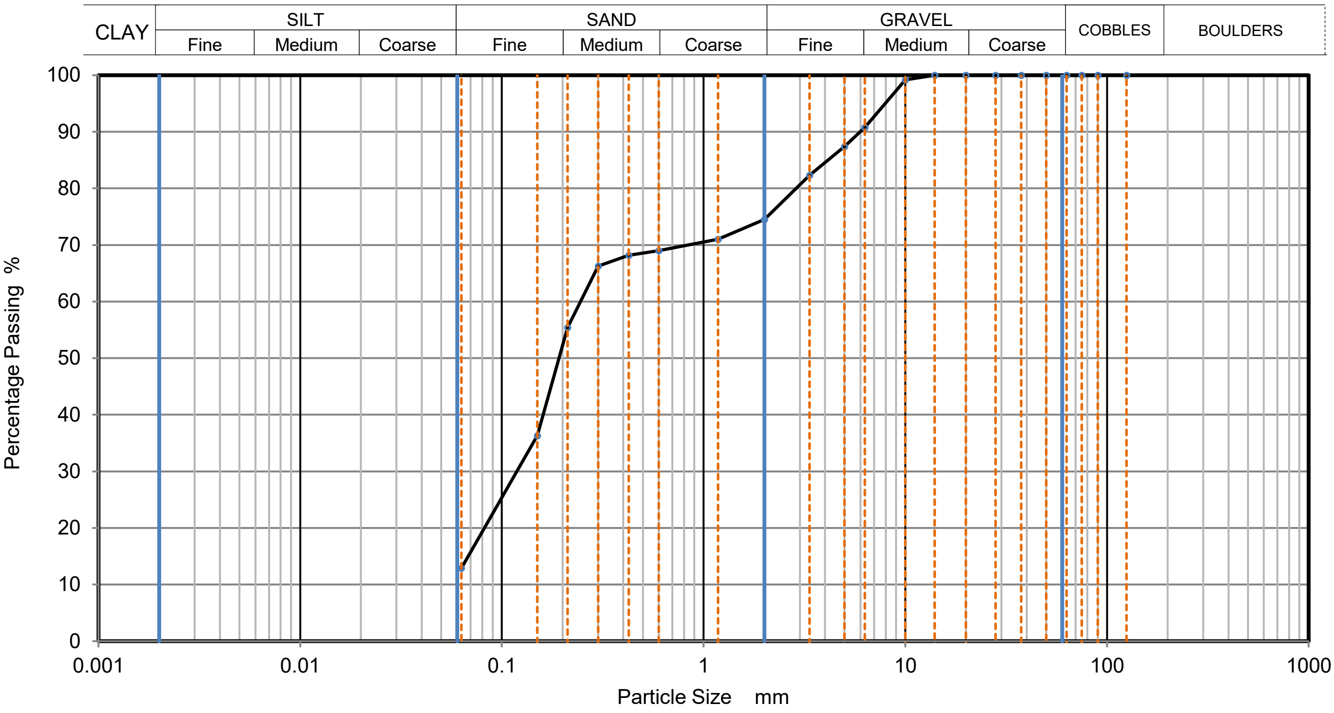
CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**21-1031**
				Borehole/Pit No.	BH-M15
Site Name	Scapa Deep Water Quay - Marine GI			Sample No.	8
Soil Description	Brownish grey slightly gravelly slightly silty fine to coarse SAND.			Depth, m	0.00
Specimen Reference	2	Specimen Depth	0 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	Caus2022040741



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	99		
6.3	91		
5	87		
3.35	82		
2	75		
1.18	71		
0.6	69		
0.425	68		
0.3	66		
0.212	55		
0.15	36		
0.063	13		

Dry Mass of sample, g	209

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	25.5
Sand	61.6
Fines <0.063mm	13.0

Grading Analysis		
D100	mm	
D60	mm	0.246
D30	mm	0.119
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

Approved
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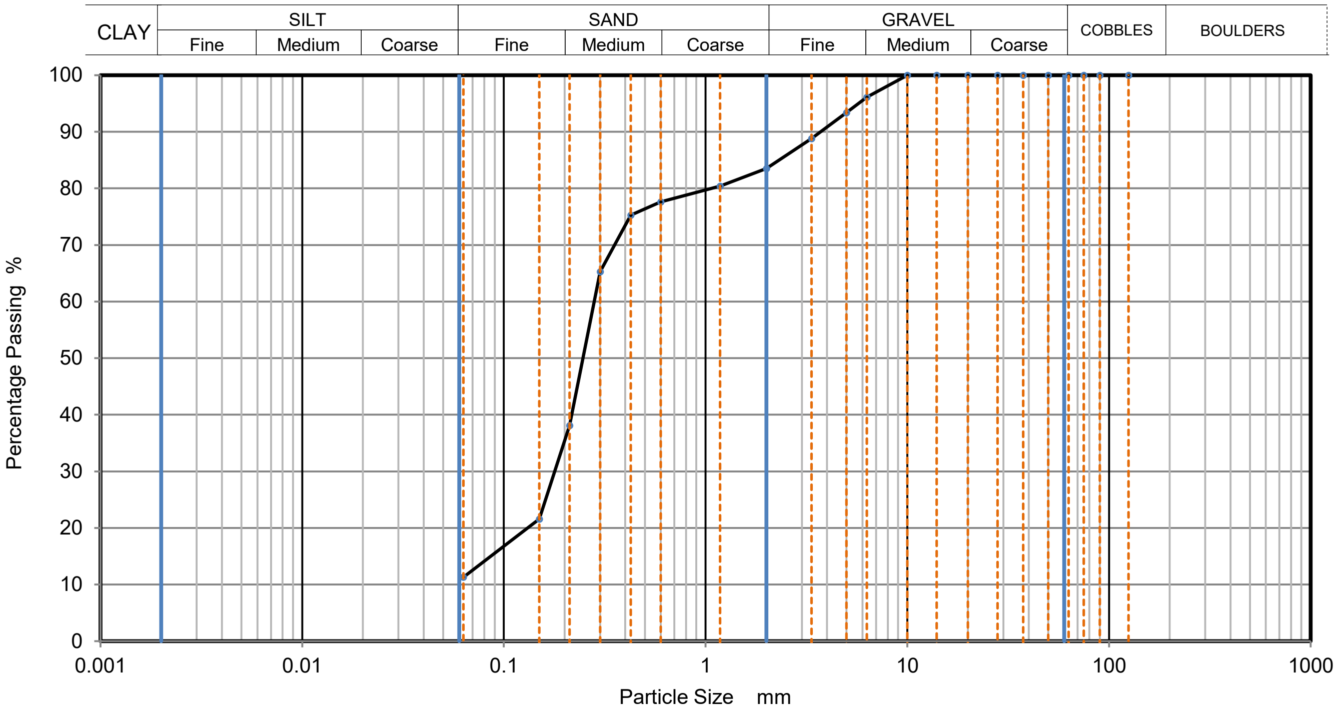
UKAS TESTING 10122

CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**	Job Ref	**21-1031**
		Borehole/Pit No.	BH-M15
Site Name	Scapa Deep Water Quay - Marine GI	Sample No.	9
Soil Description	Brownish grey slightly gravelly slightly silty fine to coarse SAND.	Depth, m	1.50
Specimen Reference	2 Specimen Depth 1.5 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2	KeyLAB ID	Caus2022040743



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	96		
5	93		
3.35	89		
2	84		
1.18	80		
0.6	78		
0.425	75		
0.3	65		
0.212	38		
0.15	22		
0.063	11		

Dry Mass of sample, g	216

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	16.5
Sand	72.2
Fines <0.063mm	11.0

Grading Analysis	
D100 mm	
D60 mm	0.28
D30 mm	0.179
D10 mm	
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

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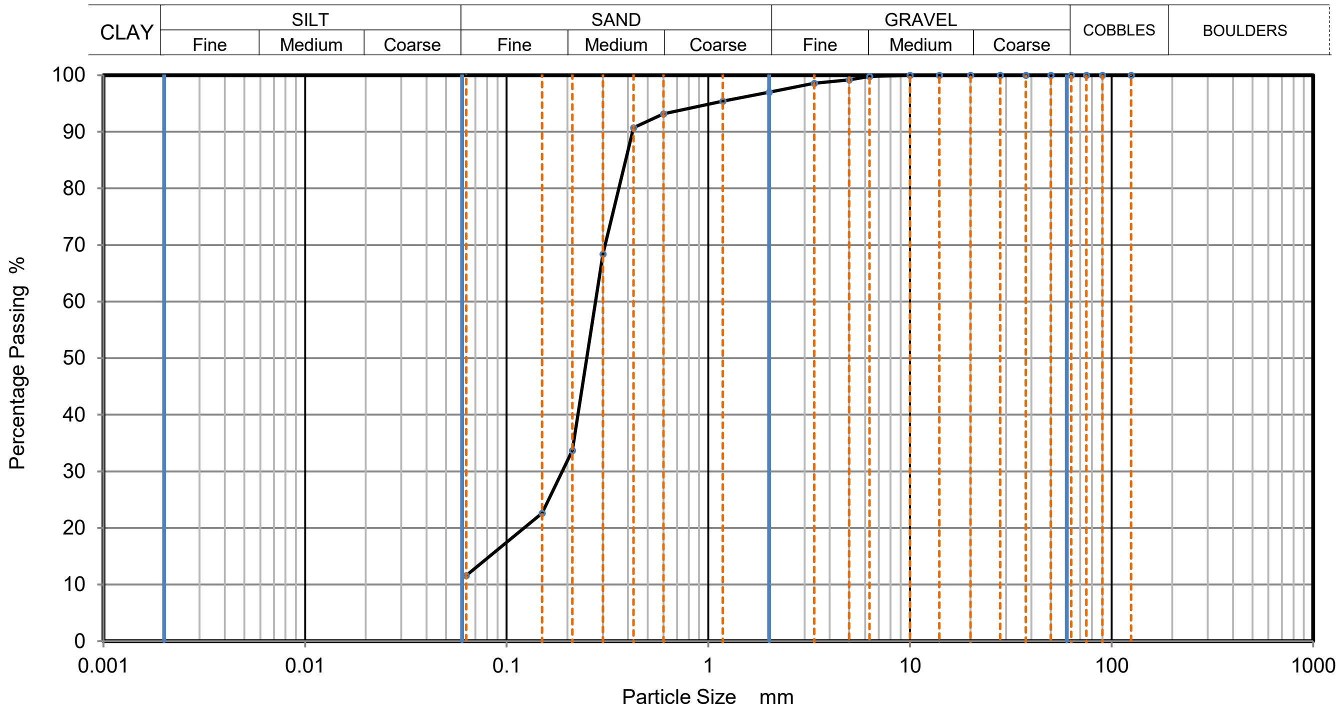
CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**	Job Ref	**21-1031**
		Borehole/Pit No.	BH-M16
Site Name	Scapa Deep Water Quay - Marine GI	Sample No.	5
Soil Description	Brownish grey slightly gravelly slightly silty fine to coarse SAND.	Depth, m	0.00
Specimen Reference	2 | Specimen Depth | 0 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2	KeyLAB ID	Caus2022040744



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	100		
5	99		
3.35	99		
2	97		
1.18	95		
0.6	93		
0.425	91		
0.3	68		
0.212	34		
0.15	23		
0.063	12		

Dry Mass of sample, g	209

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	3.0
Sand	85.4
Fines <0.063mm	12.0

Grading Analysis	
D100 mm	
D60 mm	0.276
D30 mm	0.189
D10 mm	
Uniformity Coefficient	
Curvature Coefficient	

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

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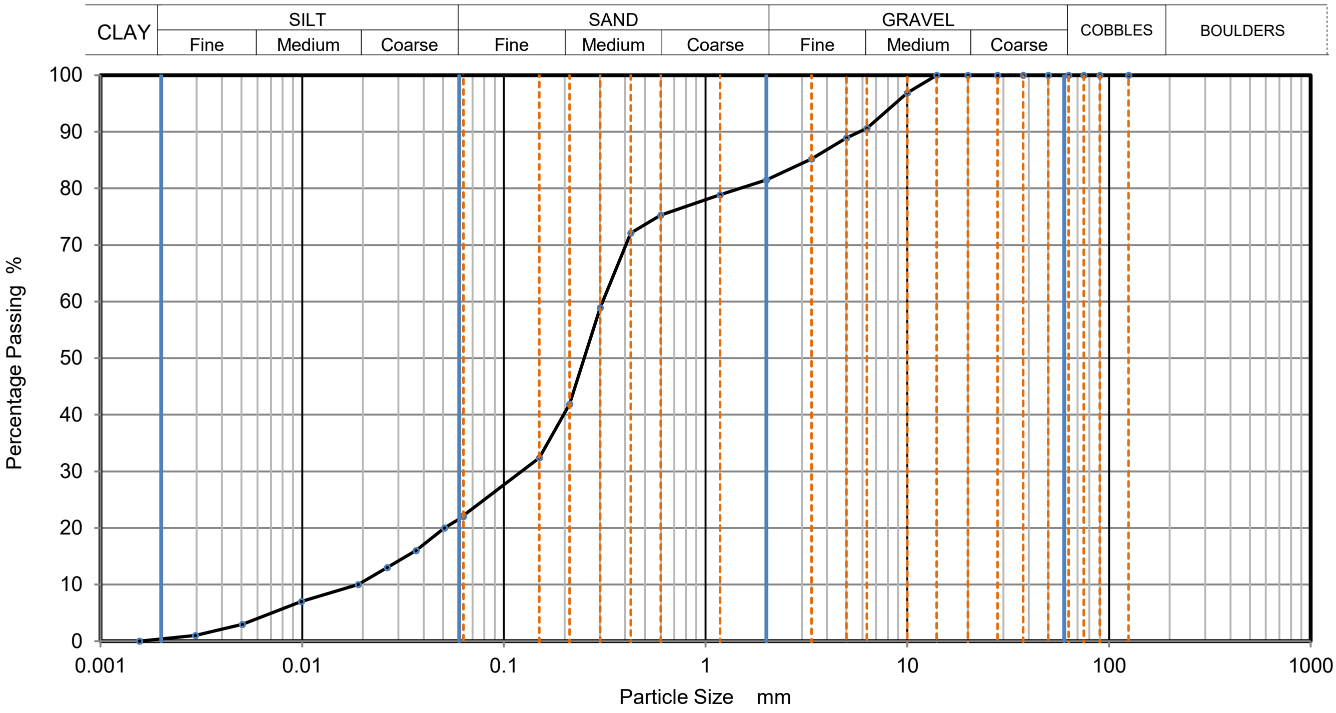
CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**	Job Ref	**21-1031**
		Borehole/Pit No.	BH-M17
Site Name	Scapa Deep Water Quay - Marine GI	Sample No.	3
Soil Description	Brownish grey slightly gravelly silty fine to coarse SAND.	Depth, m	0.00
Specimen Reference	2 Specimen Depth 0 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5	KeyLAB ID	Caus2022040746



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	22
90	100	0.05065	20
75	100	0.03668	16
63	100	0.02639	13
50	100	0.01897	10
37.5	100	0.00990	7
28	100	0.00506	3
20	100	0.00295	1
14	100	0.00156	0
10	97		
6.3	91		
5	89		
3.35	85		
2	82		
1.18	79		
0.6	75	Particle density	(assumed)
0.425	72	2.65	Mg/m3
0.3	59		
0.212	42		
0.15	32		
0.063	22		

Dry Mass of sample, g	209

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	18.5
Sand	59.4
Silt	21.7
Clay	0.4

Grading Analysis		
D100	mm	
D60	mm	0.309
D30	mm	0.123
D10	mm	0.02
Uniformity Coefficient		15
Curvature Coefficient		2.4

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

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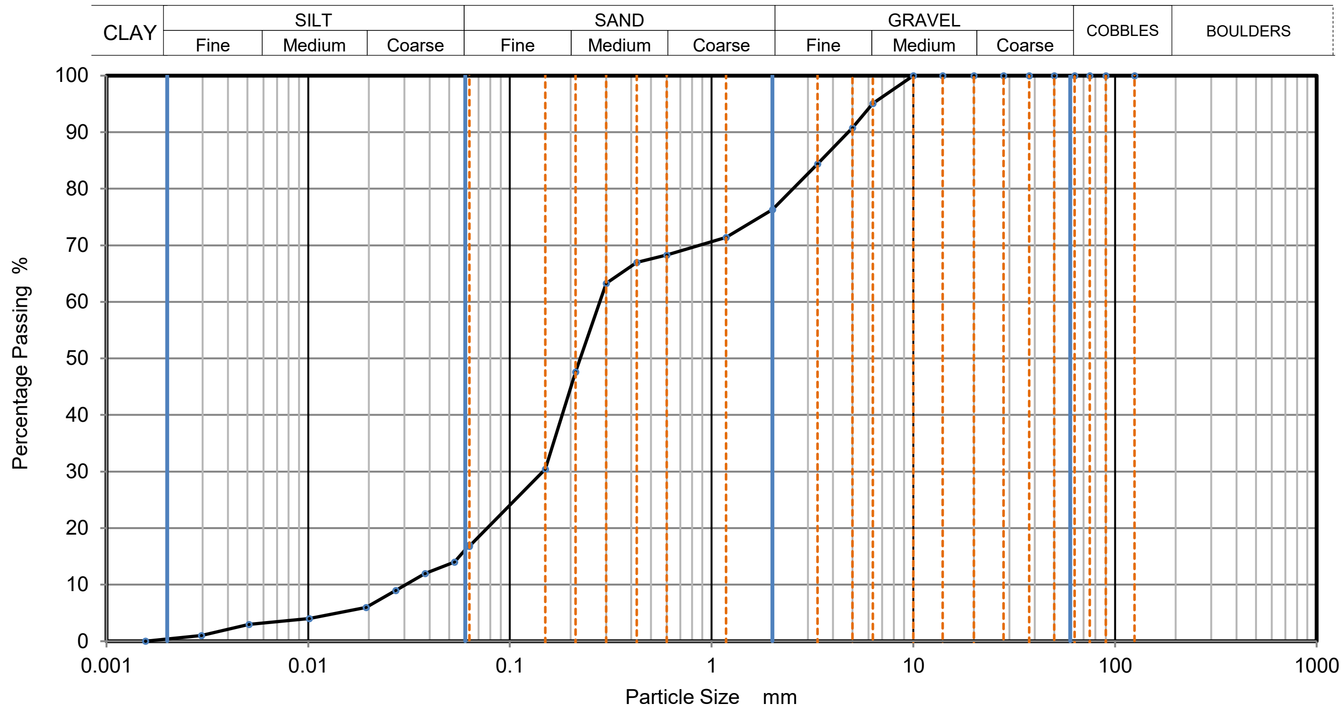
CAUSEWAY GEOTECH	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**21-1031**
				Borehole/Pit No.	BH-M26
Site Name	Scapa Deep Water Quay - Marine GI			Sample No.	6
Soil Description	Brownish grey slightly gravelly silty fine to coarse SAND.			Depth, m	1.50
Specimen Reference	2	Specimen Depth	1.5 m	Sample Type	B
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5			KeyLAB ID	Caus2022040747



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	17
90	100	0.05308	14
75	100	0.03795	12
63	100	0.02713	9
50	100	0.01938	6
37.5	100	0.01011	4
28	100	0.00508	3
20	100	0.00295	1
14	100	0.00156	0
10	100		
6.3	95		
5	91		
3.35	84		
2	76		
1.18	71		
0.6	68	Particle density	(assumed)
0.425	67	2.65	Mg/m3
0.3	63		
0.212	48		
0.15	30		
0.063	17		

Dry Mass of sample, g	215

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	23.7
Sand	59.5
Silt	16.3
Clay	0.5

Grading Analysis		
D100	mm	
D60	mm	0.279
D30	mm	0.147
D10	mm	0.0307
Uniformity Coefficient		9.1
Curvature Coefficient		2.5

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

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LAB 05R - Version 5

10122

Direct Shear Test BS EN ISO 17892-10:2018

Project Number	21-1031	Project	Scapa Deep Water Quay - Marine GI	
Location Number	BH-M02	Sample Reference	2	
Depth (m)	0.00	Sample Submerged?	Yes	~~No~~
Sample Type	B	Particle Density (Mg/m^3)	2.65	Assumed
Description	Brownish grey gravelly silty fine to coarse SAND.			
Sample Preparation	Sample is recompacted using material passing 2mm test sieve			

Stage	**1**	**2**	**3**
Initial Conditions			
Height (mm)	20.0	20.0	20.0
Diameter (mm)	60.0	60.0	60.0
Water Content (%)	21.0	21.0	21.0
Bulk Density (Mg/m^3)	2.06	2.04	2.06
Dry Density (Mg/m^3)	1.71	1.69	1.71
Voids Ratio	0.550	0.566	0.550
Consolidation			
Normal Pressure (kPa)	7.5	15	30
Vertical Displacement (mm)	0.047	0.193	0.225
Shearing			
Rate of Strain (mm/min)	0.600	0.600	0.600
Peak Shear Stress (kPa)	14.4	28.0	31.7
Hoz Displacement (mm)	10.2	10.2	10.2
Hoz Displacement at Peak Shear Stress (mm)	1.737	8.283	1.803
Final Conditions			
Water Content (%)	21.0	21.0	21.0
Dry Density (Mg/m^3)	1.65	1.69	1.70
Voids Ratio	0.579	0.555	0.564

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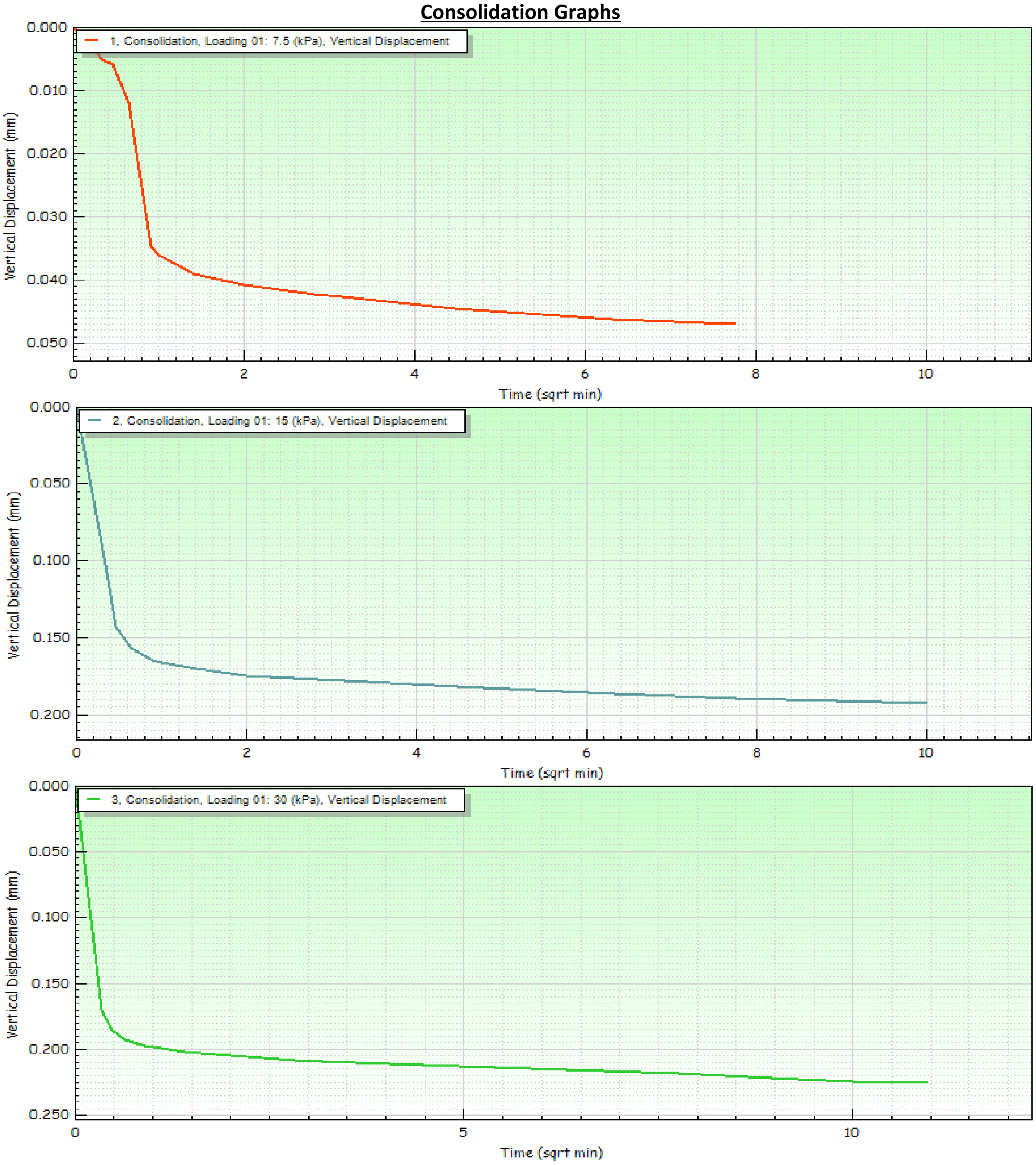
CAUSEWAY GEOTECH

Tested	**Approved**
Aaron Nutt	**Joseph Nicholl**

Lab Sheet Reference : LAB25R - Version 4

Direct Shear Test	**BS EN ISO 17892-10:2018**		
Project Number	21-1031	Project	Scapa Deep Water Quay - Marine GI
Location Number	BH-M02	Sample Reference	2
Depth (m)	0.00	Sample Submerged?	Yes ~~No~~
Sample Type	B	Particle Density (Mg/m^3)	2.65 Assumed

Consolidation Graphs

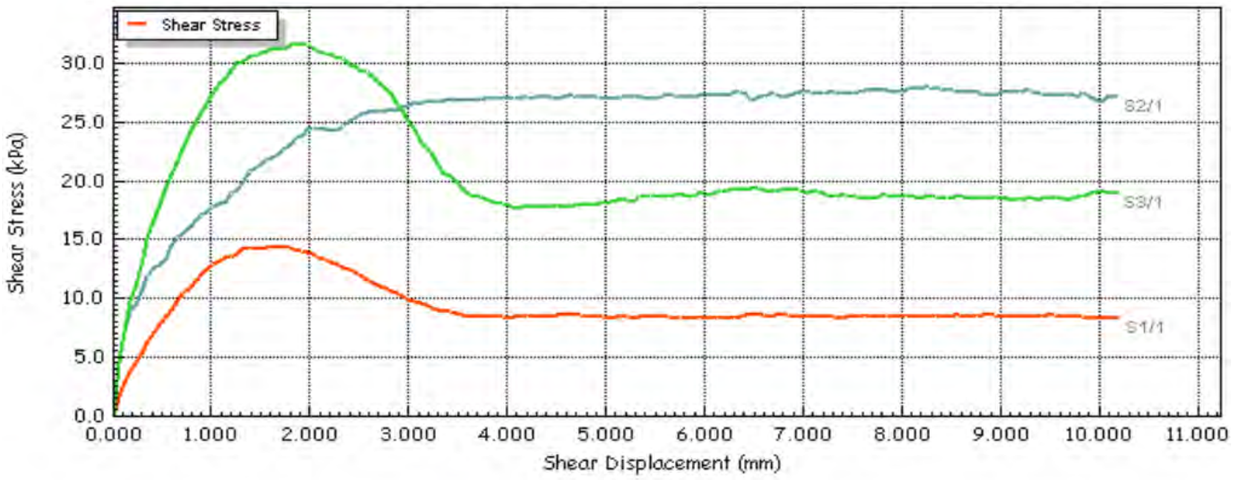


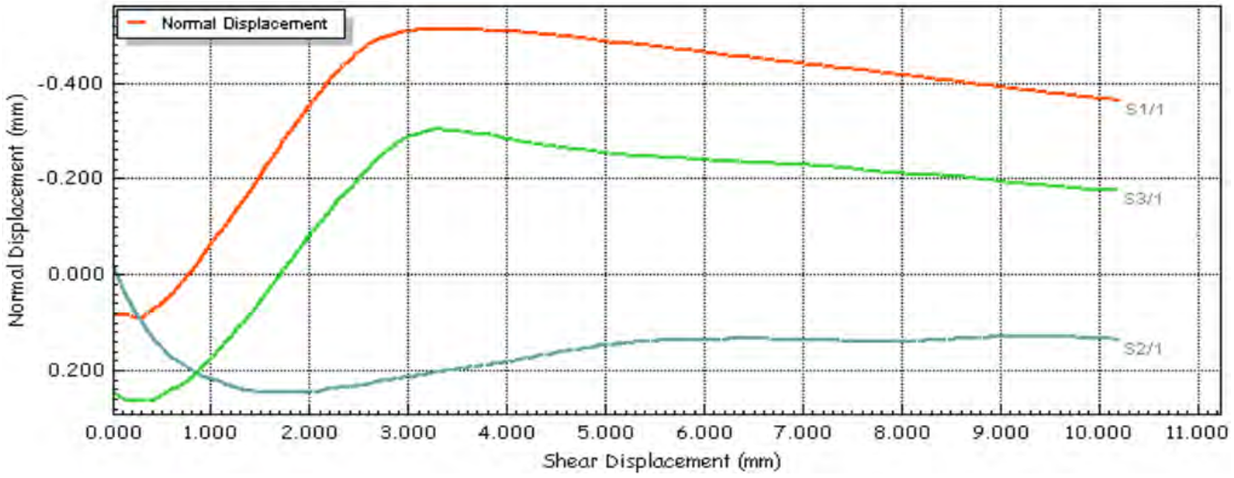
UKAS TESTING 10122 CAUSEWAY GEOTECH	**Tested**	**Approved**
	Aaron Nutt	**Joseph Nicholl**

Lab Sheet Reference : LAB25R - Version 4

Direct Shear Test BS EN ISO 17892-10:2018				
Project Number	21-1031	Project	Scapa Deep Water Quay - Marine GI	
Location Number	BH-M02	Sample Reference	2	
Depth (m)	0.00	Sample Submerged?	Yes	~~No~~
Sample Type	B	Particle Density (Mg/m^3)	2.65	Assumed

Shear Stage



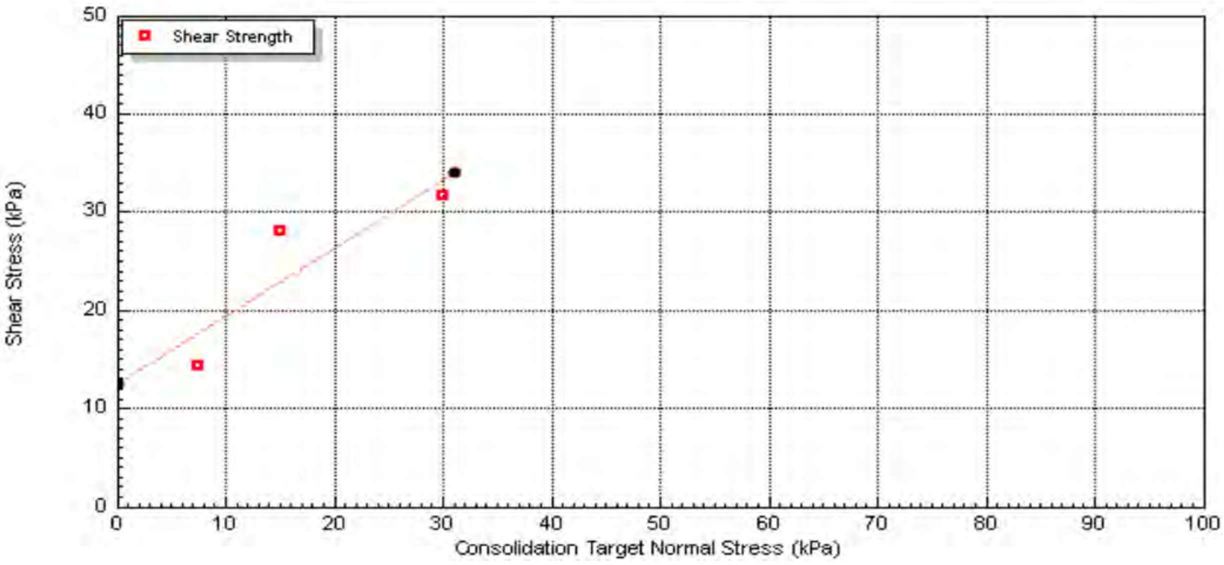


10122	**Tested**	**Approved**
	Aaron Nutt	**Joseph Nicholl**

Lab Sheet Reference : LAB25R - Version 4

Direct Shear Test BS EN ISO 17892-10:2018				
Project Number	21-1031	Project	Scapa Deep Water Quay - Marine GI	
Location Number	BH-M02	Sample Reference	2	
Depth (m)	0.00	Sample Submerged?	Yes	~~No~~
Sample Type	B	Particle Density (Mg/m^3)	2.65	Assumed

	Stage	1	2	3
Envelope Failure Results				
Apparent Cohesion (kPa)		13		
Angle of Shearing Resistance (°)		34.5		



	Tested	Approved
UKAS TESTING 10122 CAUSEWAY GEOTECH	Aaron Nutt	Joseph Nicholl

Lab Sheet Reference : LAB25R - Version 4

Direct Shear Test BS EN ISO 17892-10:2018

Project Number	21-1031	Project	Scapa Deep Water Quay - Marine GI	
Location Number	BH-M04	Sample Reference	8	
Depth (m)	0.00	Sample Submerged?	Yes	~~No~~
Sample Type	B	Particle Density (Mg/m^3)	2.65	Assumed
Description	Brownish grey slightly gravelly slightly silty fine to coarse SAND.			
Sample Preparation	Sample is recompacted using material passing 2mm test sieve			

Stage	**1**	**2**	**3**
Initial Conditions			
Height (mm)	20.0	20.0	20.0
Diameter (mm)	60.0	60.0	60.0
Water Content (%)	17.0	17.0	17.0
Bulk Density (Mg/m^3)	2.01	2.03	1.99
Dry Density (Mg/m^3)	1.71	1.72	1.69
Voids Ratio	0.552	0.536	0.566
Consolidation			
Normal Pressure (kPa)	15	30	60
Vertical Displacement (mm)	0.098	0.187	0.249
Shearing			
Rate of Strain (mm/min)	0.600	0.600	0.600
Peak Shear Stress (kPa)	20.5	43.3	55.4
Hoz Displacement (mm)	10.2	10.2	10.2
Hoz Displacement at Peak Shear Stress (mm)	1.383	1.563	1.677
Final Conditions			
Water Content (%)	20.0	20.0	21.0
Dry Density (Mg/m^3)	1.68	1.65	1.68
Voids Ratio	0.558	0.540	0.560

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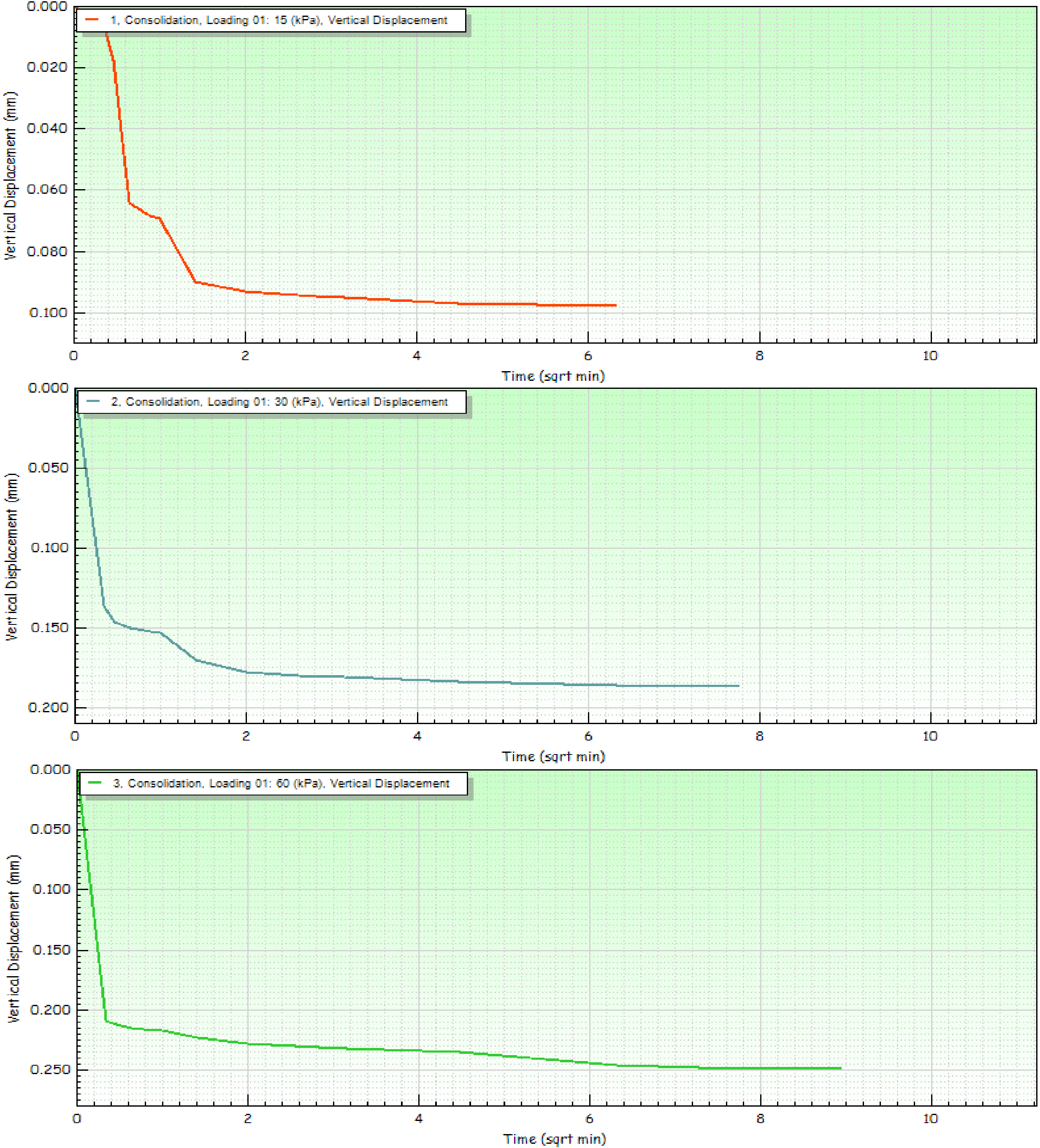
Lab Sheet Reference : LAB25R - Version 4

Direct Shear Test BS EN ISO 17892-10:2018				
Project Number	21-1031	Project	Scapa Deep Water Quay - Marine GI	
Location Number	BH-M04	Sample Reference	8	
Depth (m)	0.00	Sample Submerged?	Yes	~~No~~
Sample Type	B	Particle Density (Mg/m^3)	2.65	Assumed

Consolidation Graphs



UKAS TESTING 10122 CAUSEWAY GEOTECH	**Tested**	**Approved**
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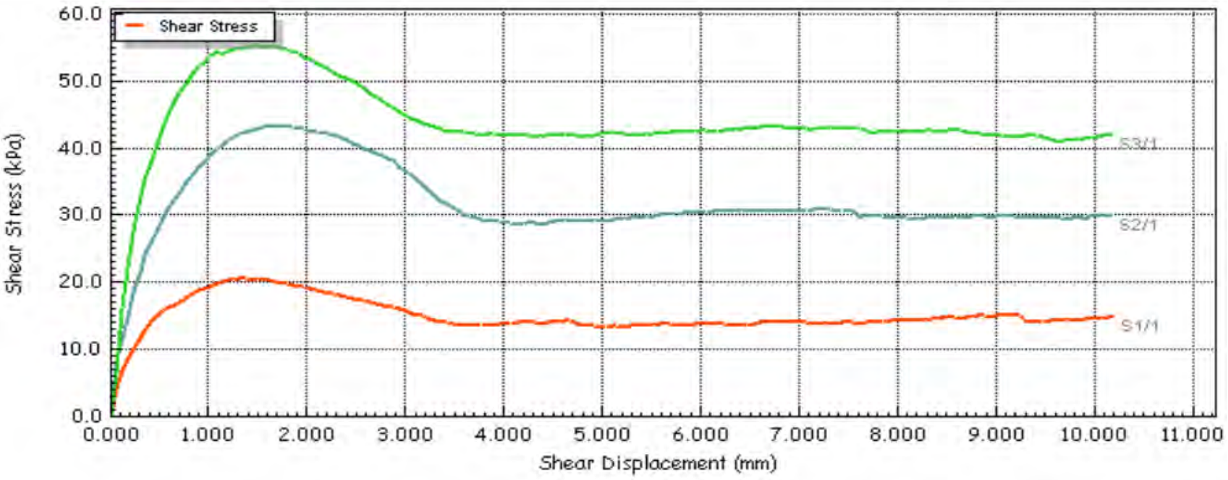
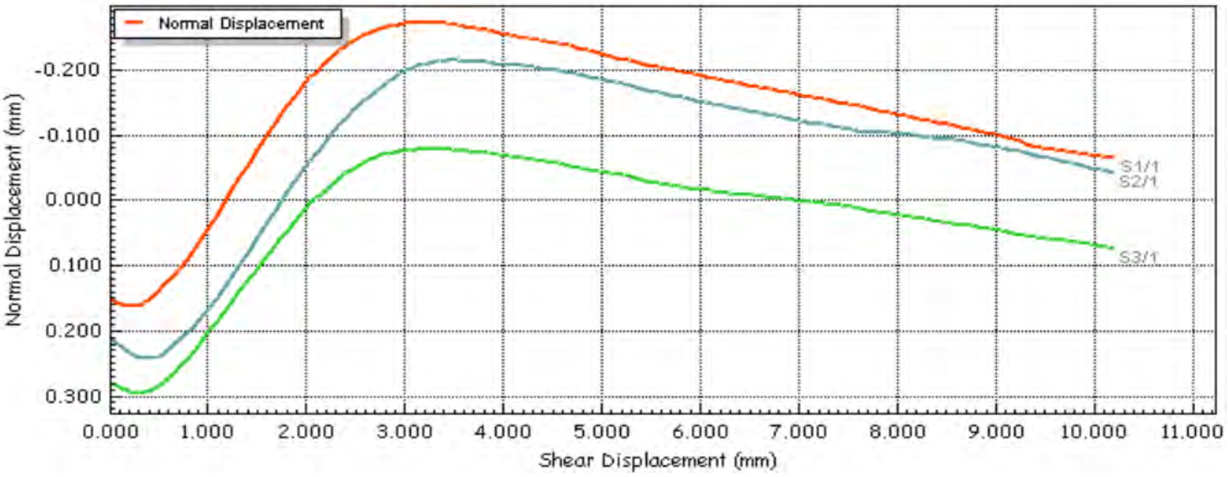
Lab Sheet Reference : LAB25R - Version 4

Direct Shear Test BS EN ISO 17892-10:2018

Project Number	21-1031	Project	Scapa Deep Water Quay - Marine GI	
Location Number	BH-M04	Sample Reference	8	
Depth (m)	0.00	Sample Submerged?	Yes	~~No~~
Sample Type	B	Particle Density (Mg/m^3)	2.65	Assumed

Shear Stage





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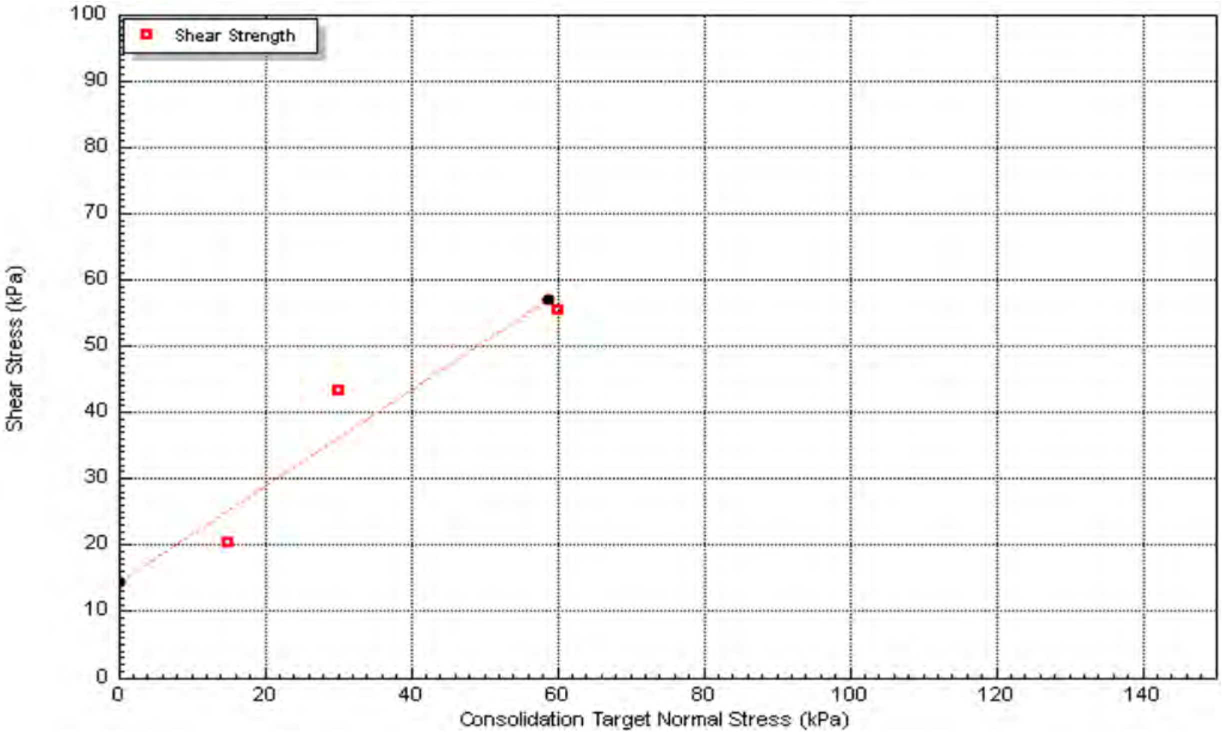
Lab Sheet Reference : LAB25R - Version 4

Direct Shear Test BS EN ISO 17892-10:2018				
Project Number	21-1031	Project	Scapa Deep Water Quay - Marine GI	
Location Number	BH-M04	Sample Reference	8	
Depth (m)	0.00	Sample Submerged?	Yes	~~No~~
Sample Type	B	Particle Density (Mg/m^3)	2.65	Assumed

Stage	1	2	3
Envelope Failure Results			
Apparent Cohesion (kPa)	14		
Angle of Shearing Resistance (°)	36.0		



	Tested	Approved
10122	Aaron Nutt	Joseph Nicholl

Lab Sheet Reference : LAB25R - Version 4

Direct Shear Test BS EN ISO 17892-10:2018

Project Number	21-1031	Project	Scapa Deep Water Quay - Marine GI	
Location Number	BH-M06	Sample Reference	8	
Depth (m)	0.00	Sample Submerged?	Yes	~~No~~
Sample Type	B	Particle Density (Mg/m^3)	2.65	Assumed
Description	Brownish grey slightly gravelly slightly silty fine to coarse SAND.			
Sample Preparation	Sample is recompacted using material passing 2mm test sieve			

Stage	1	2	3
Initial Conditions			
Height (mm)	20.0	20.0	20.0
Diameter (mm)	60.0	60.0	60.0
Water Content (%)	19.0	19.0	19.0
Bulk Density (Mg/m^3)	2.03	2.02	2.08
Dry Density (Mg/m^3)	1.71	1.70	1.75
Voids Ratio	0.552	0.560	0.516
Consolidation			
Normal Pressure (kPa)	15	30	60
Vertical Displacement (mm)	0.058	0.238	0.420
Shearing			
Rate of Strain (mm/min)	0.600	0.600	0.600
Peak Shear Stress (kPa)	18.9	41.0	59.8
Hoz Displacement (mm)	10.2	10.2	10.2
Hoz Displacement at Peak Shear Stress (mm)	1.617	2.163	1.917
Final Conditions			
Water Content (%)	22.0	22.0	22.0
Dry Density (Mg/m^3)	1.64	1.67	1.77
Voids Ratio	0.562	0.562	0.505

10122

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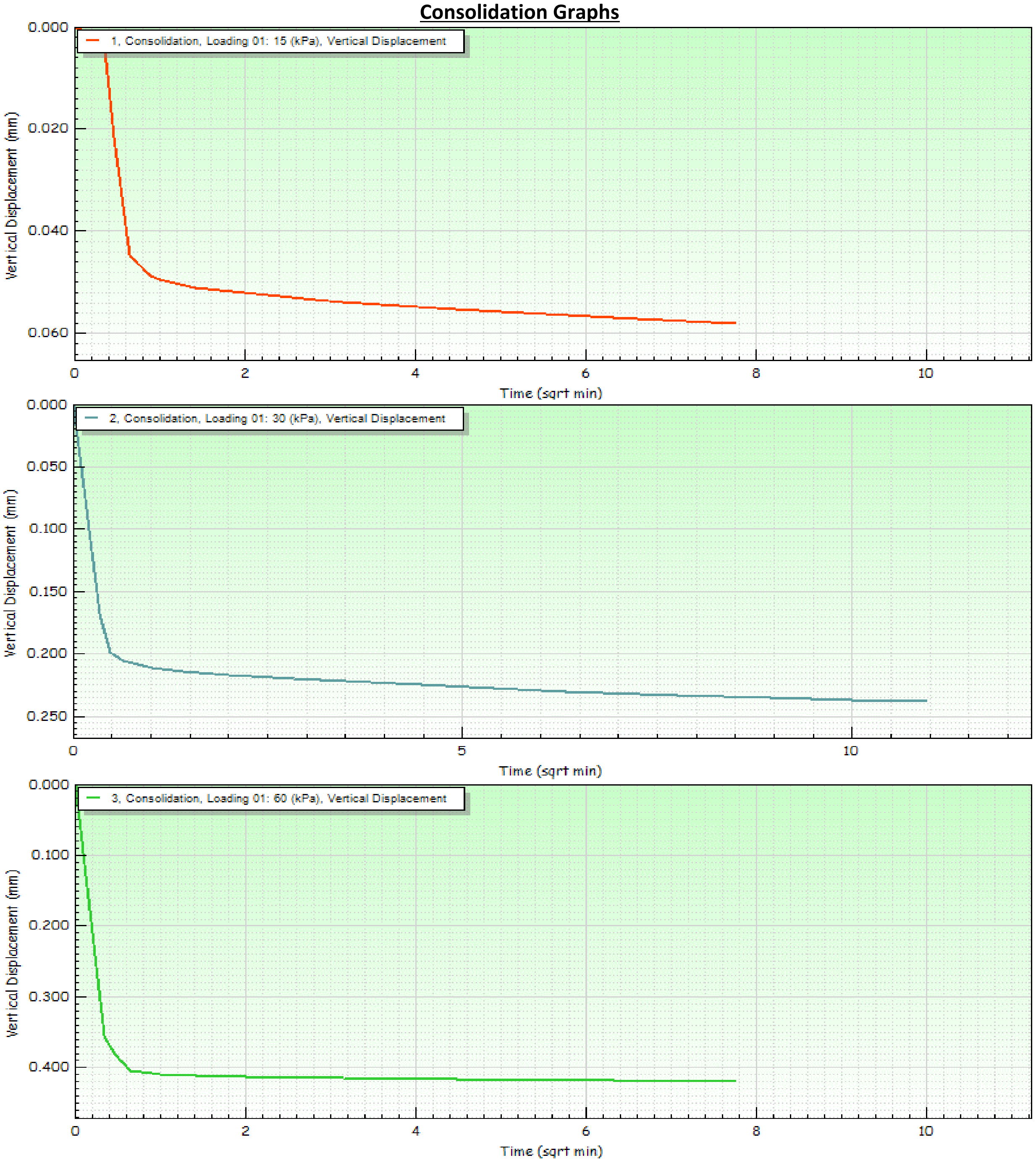
Lab Sheet Reference : LAB25R - Version 4

Direct Shear Test BS EN ISO 17892-10:2018				
Project Number	21-1031	Project	Scapa Deep Water Quay - Marine GI	
Location Number	BH-M06	Sample Reference	8	
Depth (m)	0.00	Sample Submerged?	Yes	~~No~~
Sample Type	B	Particle Density (Mg/m^3)	2.65	Assumed

Consolidation Graphs



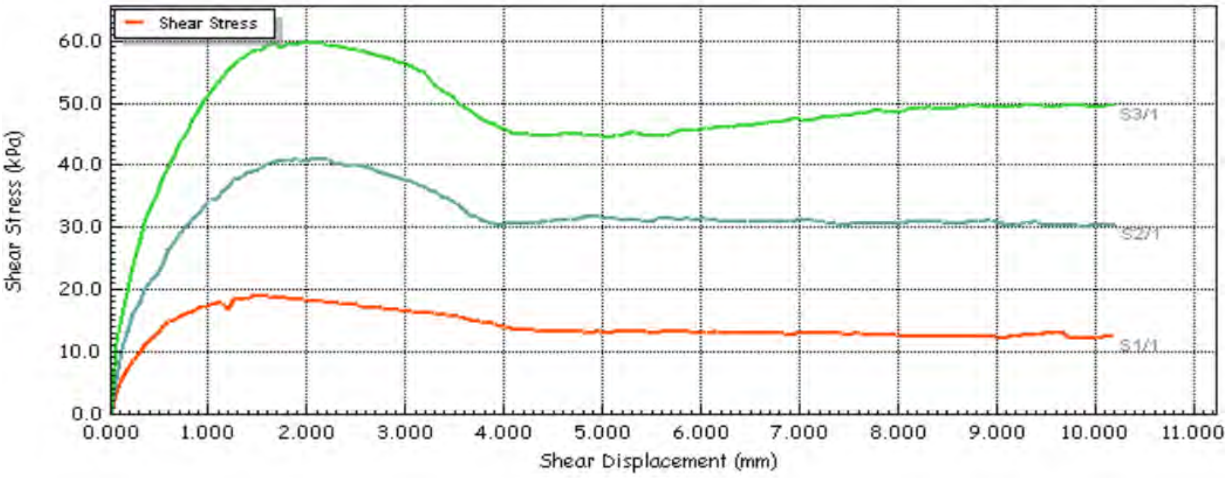
	Tested	Approved
UKAS TESTING 10122 CAUSEWAY GEOTECH	Aaron Nutt	Joseph Nicholl

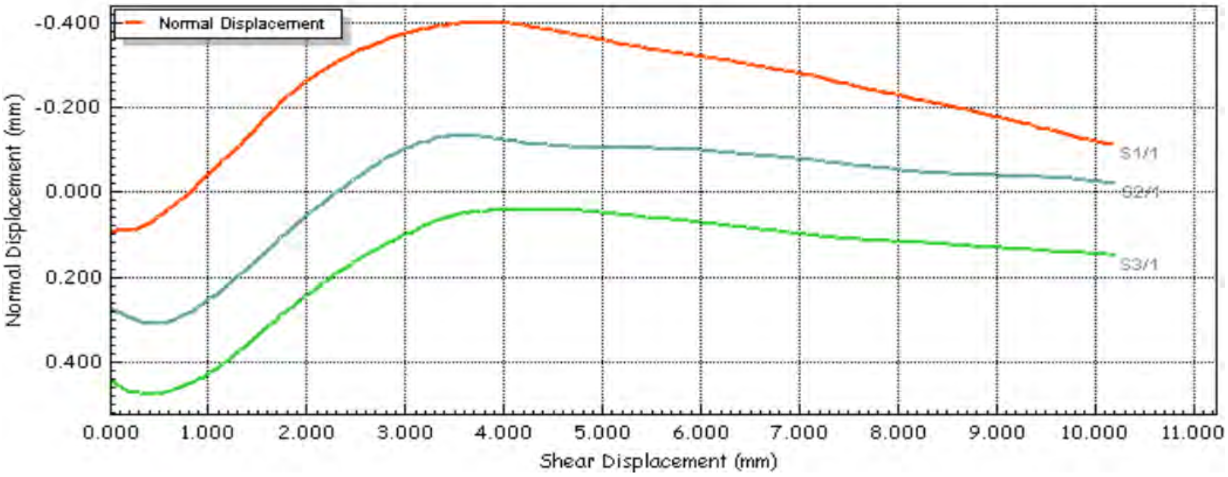
Lab Sheet Reference : LAB25R - Version 4

Direct Shear Test BS EN ISO 17892-10:2018

Project Number	21-1031	Project	Scapa Deep Water Quay - Marine GI	
Location Number	BH-M06	Sample Reference	8	
Depth (m)	0.00	Sample Submerged?	Yes	~~No~~
Sample Type	B	Particle Density (Mg/m^3)	2.65	Assumed

Shear Stage



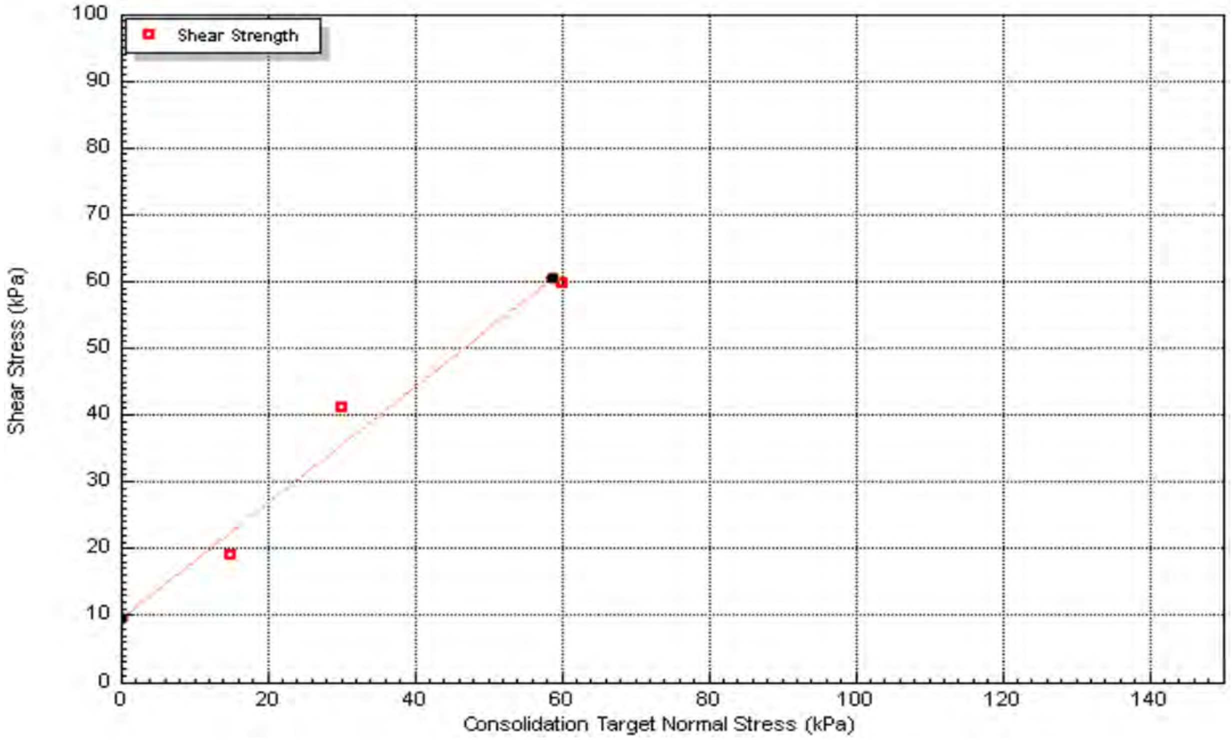


UKAS TESTING 10122 CAUSEWAY GEOTECH	**Tested**	**Approved**
	Aaron Nutt	**Joseph Nicholl**

Lab Sheet Reference : LAB25R - Version 4

Direct Shear Test BS EN ISO 17892-10:2018				
Project Number	21-1031	Project	Scapa Deep Water Quay - Marine GI	
Location Number	BH-M06	Sample Reference	8	
Depth (m)	0.00	Sample Submerged?	Yes	~~No~~
Sample Type	B	Particle Density (Mg/m^3)	2.65	Assumed

Stage	1	2	3
Envelope Failure Results			
Apparent Cohesion (kPa)	9		
Angle of Shearing Resistance (°)	41.0		



10122	Tested	Approved
	Aaron Nutt	Joseph Nicholl

Lab Sheet Reference : LAB25R - Version 4

Direct Shear Test BS EN ISO 17892-10:2018

Project Number	21-1031	Project	Scapa Deep Water Quay - Marine GI	
Location Number	BH-M08	Sample Reference	5	
Depth (m)	0.00	Sample Submerged?	Yes	~~No~~
Sample Type	B	Particle Density (Mg/m^3)	2.65	Assumed
Description	Brownish grey slightly gravelly silty fine to coarse SAND.			
Sample Preparation	Sample is recompacted using material passing 2mm test sieve			

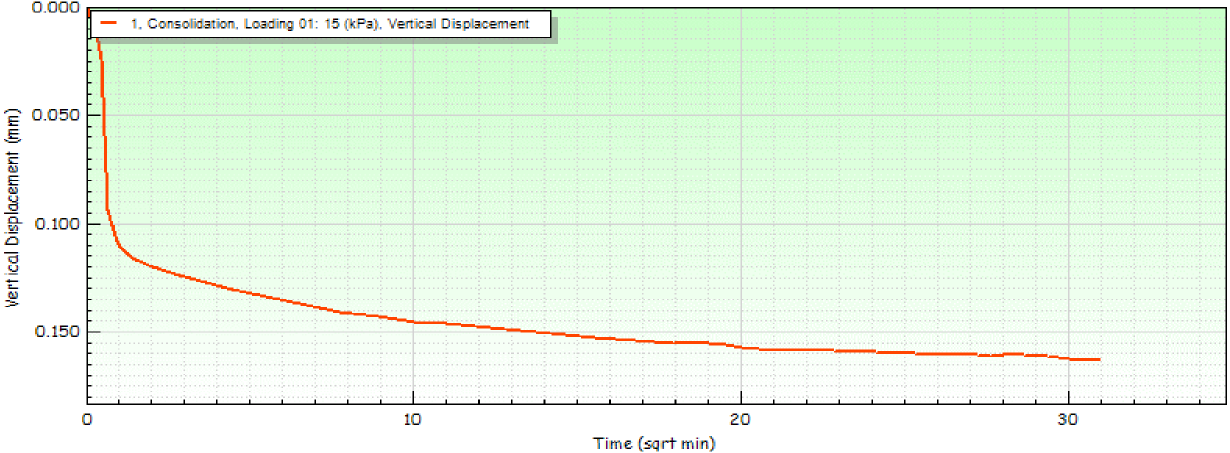
Stage	**1**	**2**	**3**
Initial Conditions			
Height (mm)	20.0	20.0	20.0
Diameter (mm)	60.0	60.0	60.0
Water Content (%)	16.0	16.0	16.0
Bulk Density (Mg/m^3)	2.07	2.10	2.12
Dry Density (Mg/m^3)	1.79	1.81	1.83
Voids Ratio	0.482	0.463	0.449
Consolidation			
Normal Pressure (kPa)	15	30	60
Vertical Displacement (mm)	0.163	0.287	0.512
Shearing			
Rate of Strain (mm/min)	0.067	0.067	0.067
Peak Shear Stress (kPa)	21.4	44.4	58.0
Hoz Displacement (mm)	10.2	10.2	10.2
Hoz Displacement at Peak Shear Stress (mm)	1.563	1.863	1.503
Final Conditions			
Water Content (%)	18.0	18.0	18.0
Dry Density (Mg/m^3)	1.78	1.80	1.88
Voids Ratio	0.491	0.462	0.428

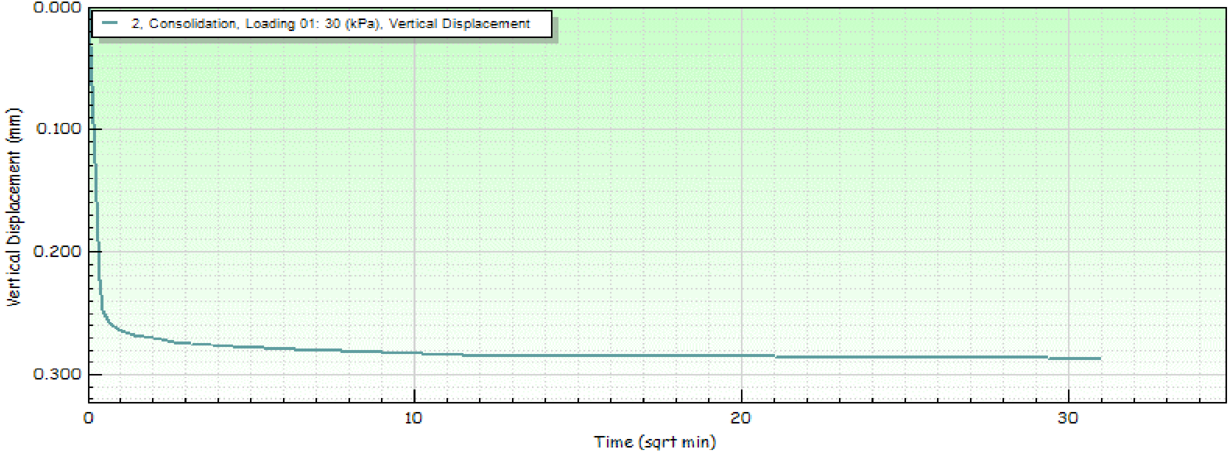
UKAS TESTING 10122	**Tested**	**Approved**
CAUSEWAY GEOTECH	**Aaron Nutt**	**Joseph Nicholl**

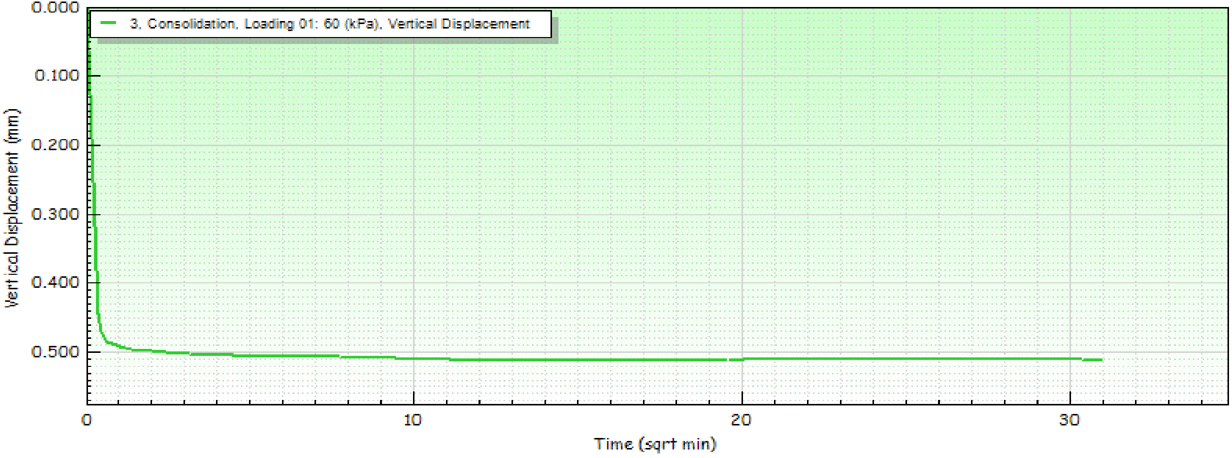
Lab Sheet Reference : LAB25R - Version 4

Direct Shear Test BS EN ISO 17892-10:2018				
Project Number	21-1031	Project	Scapa Deep Water Quay - Marine GI	
Location Number	BH-M08	Sample Reference	5	
Depth (m)	0.00	Sample Submerged?	Yes	~~No~~
Sample Type	B	Particle Density (Mg/m^3)	2.65	Assumed

Consolidation Graphs





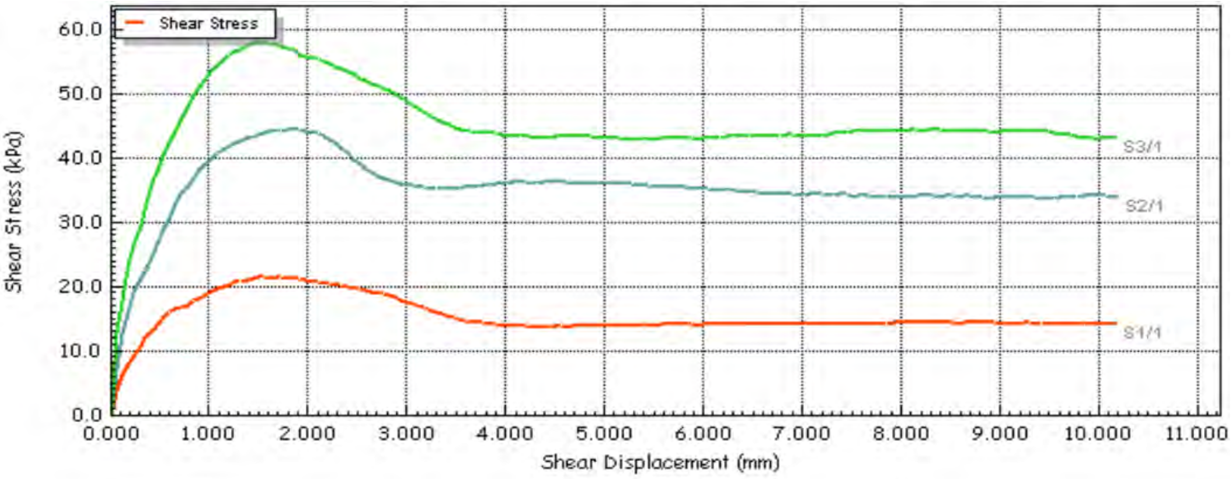


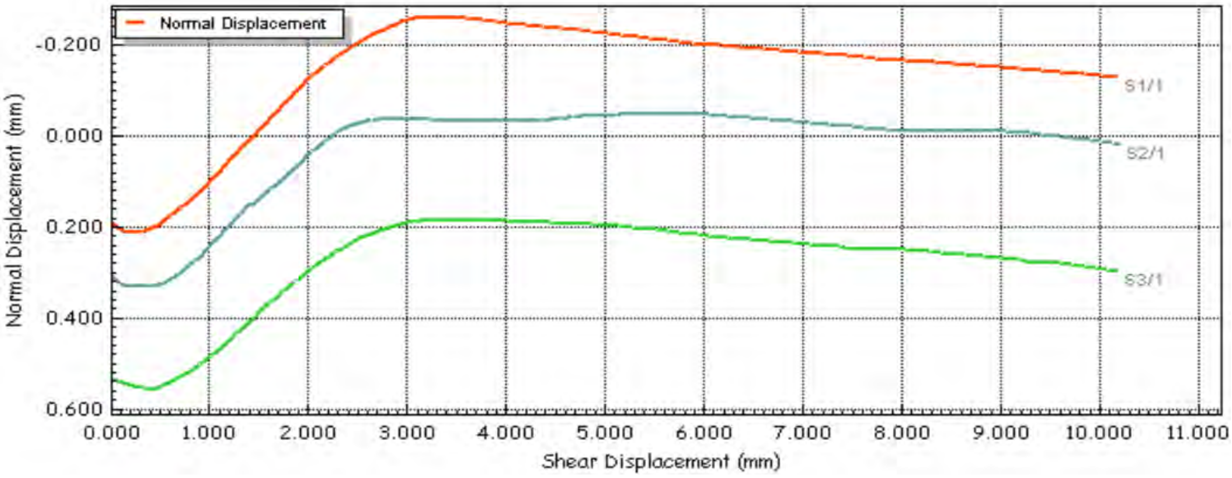
UKAS TESTING 10122 — CAUSEWAY GEOTECH	**Tested**	**Approved**
	Aaron Nutt	**Joseph Nicholl**

Lab Sheet Reference : LAB25R - Version 4

Direct Shear Test BS EN ISO 17892-10:2018				
Project Number	21-1031	Project	Scapa Deep Water Quay - Marine GI	
Location Number	BH-M08	Sample Reference	5	
Depth (m)	0.00	Sample Submerged?	Yes	~~No~~
Sample Type	B	Particle Density (Mg/m^3)	2.65	Assumed

Shear Stage



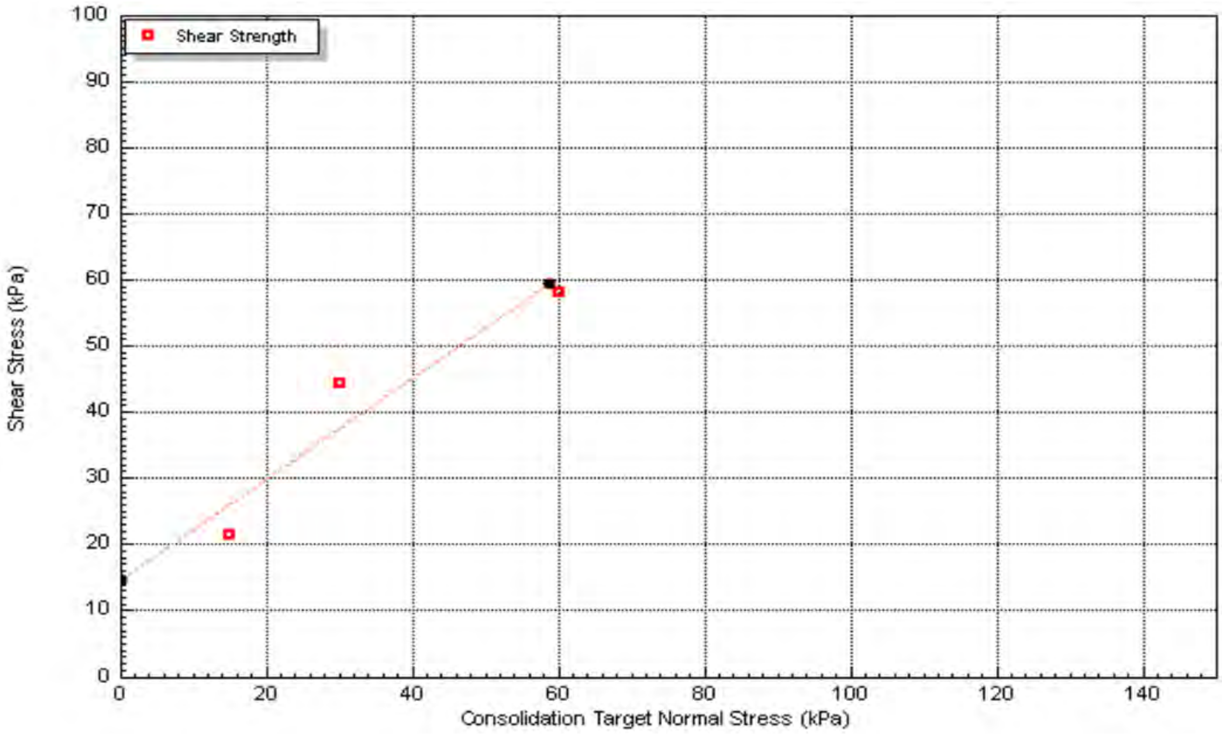


UKAS TESTING 10122 CAUSEWAY GEOTECH	Tested	Approved
	Aaron Nutt	Joseph Nicholl

Lab Sheet Reference : LAB25R - Version 4

Direct Shear Test BS EN ISO 17892-10:2018				
Project Number	21-1031	Project	Scapa Deep Water Quay - Marine GI	
Location Number	BH-M08	Sample Reference	5	
Depth (m)	0.00	Sample Submerged?	Yes	~~No~~
Sample Type	B	Particle Density (Mg/m^3)	2.65	Assumed

Stage	1	2	3
Envelope Failure Results			
Apparent Cohesion (kPa)	15		
Angle of Shearing Resistance (°)	37.5		



10122	**Tested**	**Approved**
	Aaron Nutt	**Joseph Nicholl**

Lab Sheet Reference : LAB25R - Version 4

Direct Shear Test BS EN ISO 17892-10:2018

Project Number	21-1031	Project	Scapa Deep Water Quay - Marine GI	
Location Number	BH-M10	Sample Reference	5	
Depth (m)	0.00	Sample Submerged?	Yes	~~No~~
Sample Type	B	Particle Density (Mg/m^3)	2.65	Assumed
Description	Brownish grey slightly gravelly slightly silty fine to coarse SAND.			
Sample Preparation	Sample is recompacted using material passing 2mm test sieve			

Stage	1	2	3
Initial Conditions			
Height (mm)	20.0	20.0	20.0
Diameter (mm)	60.0	60.0	60.0
Water Content (%)	13.0	13.0	13.0
Bulk Density (Mg/m^3)	2.20	2.26	2.26
Dry Density (Mg/m^3)	1.94	1.99	1.99
Voids Ratio	0.364	0.329	0.329
Consolidation			
Normal Pressure (kPa)	15	30	60
Vertical Displacement (mm)	0.504	0.369	0.549
Shearing			
Rate of Strain (mm/min)	0.600	0.600	0.600
Peak Shear Stress (kPa)	24.9	43.1	67.2
Hoz Displacement (mm)	10.2	10.2	10.2
Hoz Displacement at Peak Shear Stress (mm)	1.683	2.337	1.983
Final Conditions			
Water Content (%)	15.0	15.0	15.0
Dry Density (Mg/m^3)	1.98	1.99	2.02
Voids Ratio	0.355	0.335	0.313

UKAS TESTING
10122

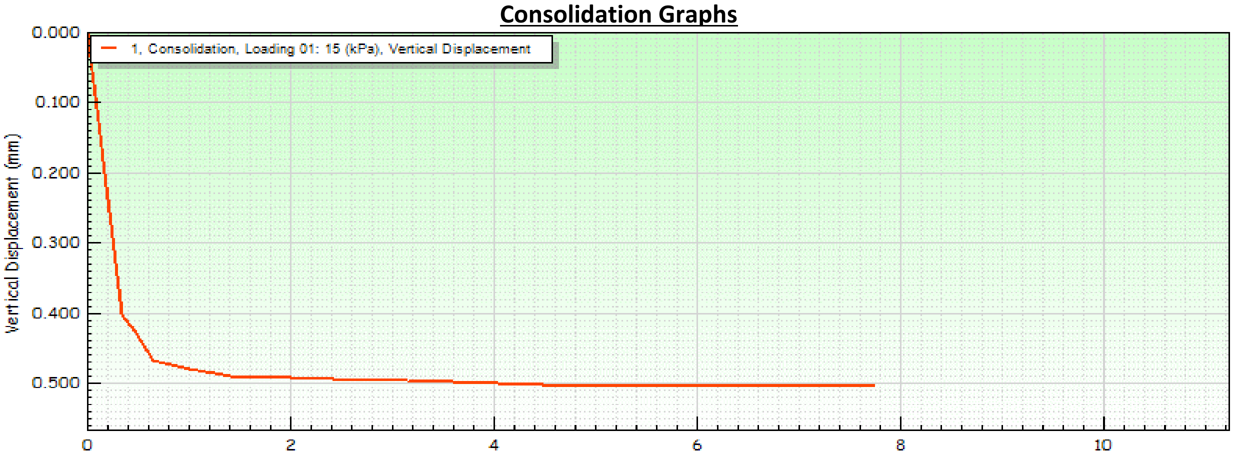
CAUSEWAY GEOTECH

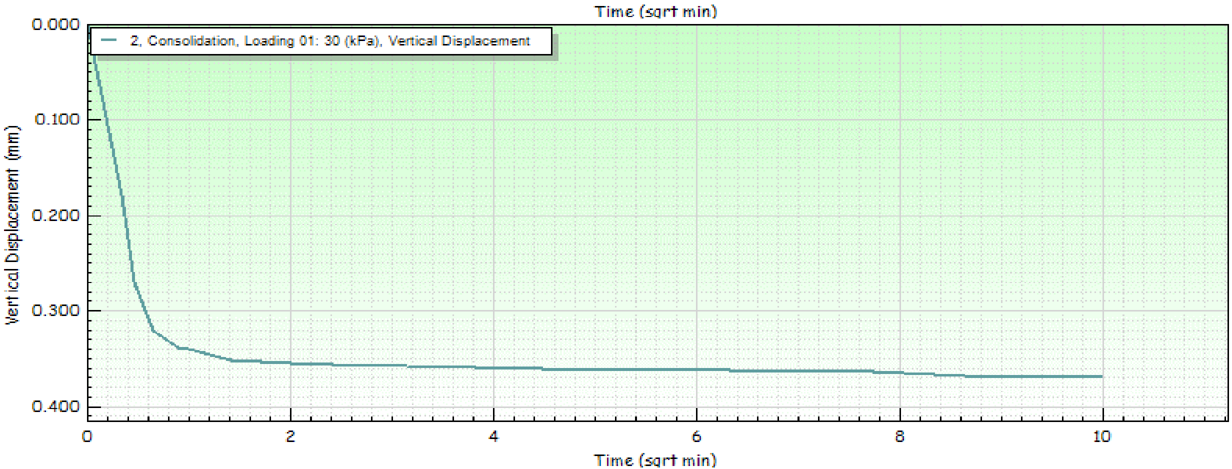
Tested	Approved
Aaron Nutt	Joseph Nicholl

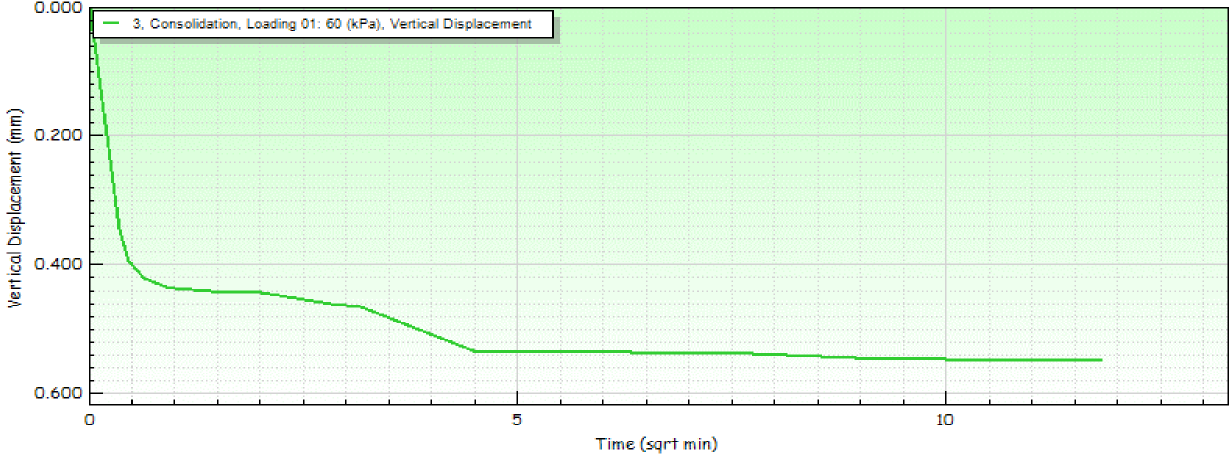
Lab Sheet Reference : LAB25R - Version 4

Direct Shear Test BS EN ISO 17892-10:2018				
Project Number	21-1031	Project	Scapa Deep Water Quay - Marine GI	
Location Number	BH-M10	Sample Reference	5	
Depth (m)	0.00	Sample Submerged?	Yes	~~No~~
Sample Type	B	Particle Density (Mg/m^3)	2.65	Assumed

Consolidation Graphs





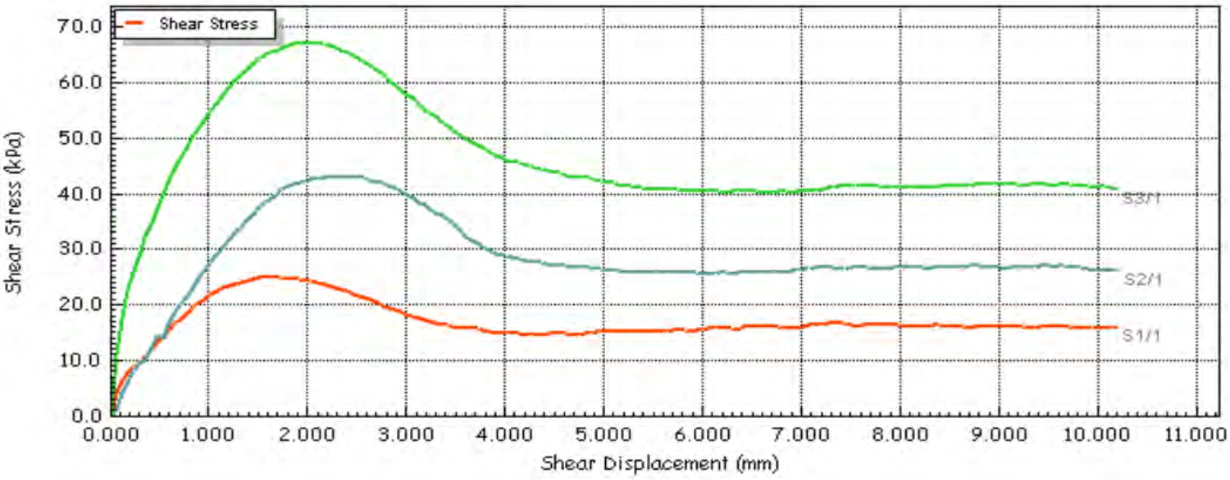


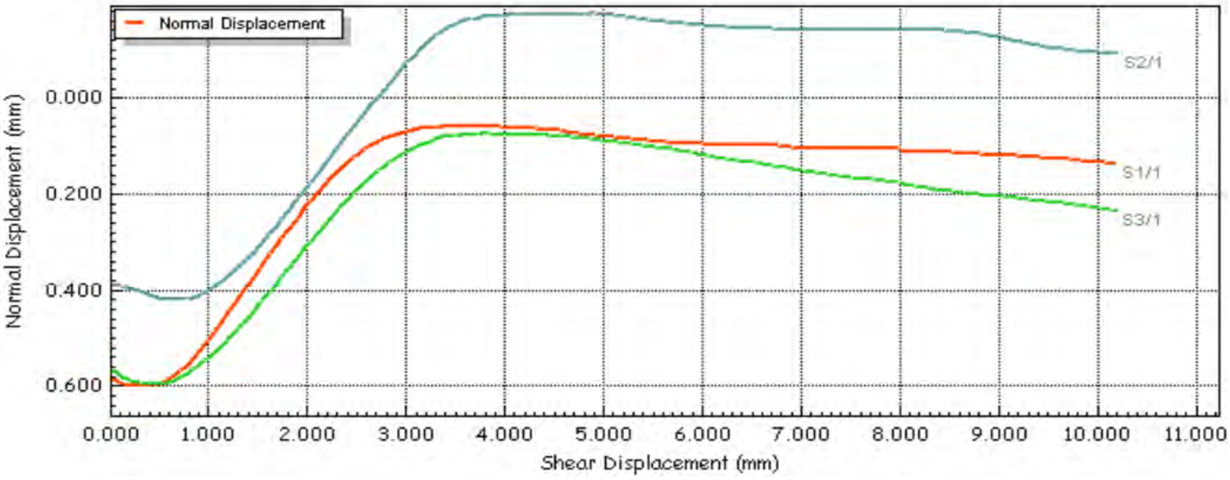
UKAS TESTING 10122	CAUSEWAY GEOTECH	Tested	Approved
		Aaron Nutt	Joseph Nicholl

Lab Sheet Reference : LAB25R - Version 4

Direct Shear Test BS EN ISO 17892-10:2018				
Project Number	21-1031	Project	Scapa Deep Water Quay - Marine GI	
Location Number	BH-M10	Sample Reference	5	
Depth (m)	0.00	Sample Submerged?	Yes	~~No~~
Sample Type	B	Particle Density (Mg/m^3)	2.65	Assumed

Shear Stage



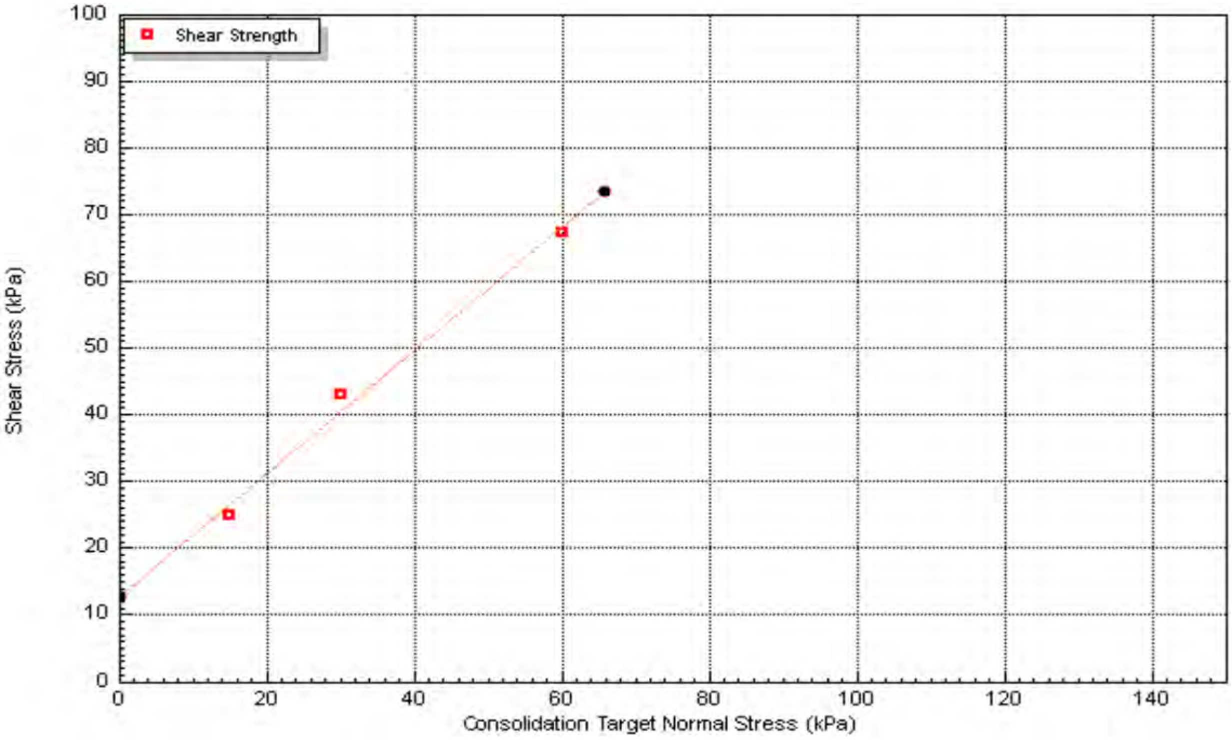


	Tested	Approved
UKAS TESTING 10122	Aaron Nutt	Joseph Nicholl

Lab Sheet Reference : LAB25R - Version 4

Direct Shear Test BS EN ISO 17892-10:2018				
Project Number	21-1031	Project	Scapa Deep Water Quay - Marine GI	
Location Number	BH-M10	Sample Reference	5	
Depth (m)	0.00	Sample Submerged?	Yes	~~No~~
Sample Type	B	Particle Density (Mg/m^3)	2.65	Assumed

Stage	1	2	3
Envelope Failure Results			
Apparent Cohesion (kPa)	13		
Angle of Shearing Resistance (°)	42.5		



UKAS TESTING 10122	Tested	Approved
CAUSEWAY GEOTECH	Aaron Nutt	Joseph Nicholl

Lab Sheet Reference : LAB25R - Version 4

Direct Shear Test BS EN ISO 17892-10:2018

Project Number	21-1031	Project	Scapa Deep Water Quay - Marine GI
Location Number	BH-M12	Sample Reference	3
Depth (m)	0.00	Sample Submerged?	Yes ~~No~~
Sample Type	B	Particle Density (Mg/m^3)	2.65 Assumed
Description	Brownish grey slightly gravelly silty fine to coarse SAND.		
Sample Preparation	Sample is recompacted using material passing 2mm test sieve		

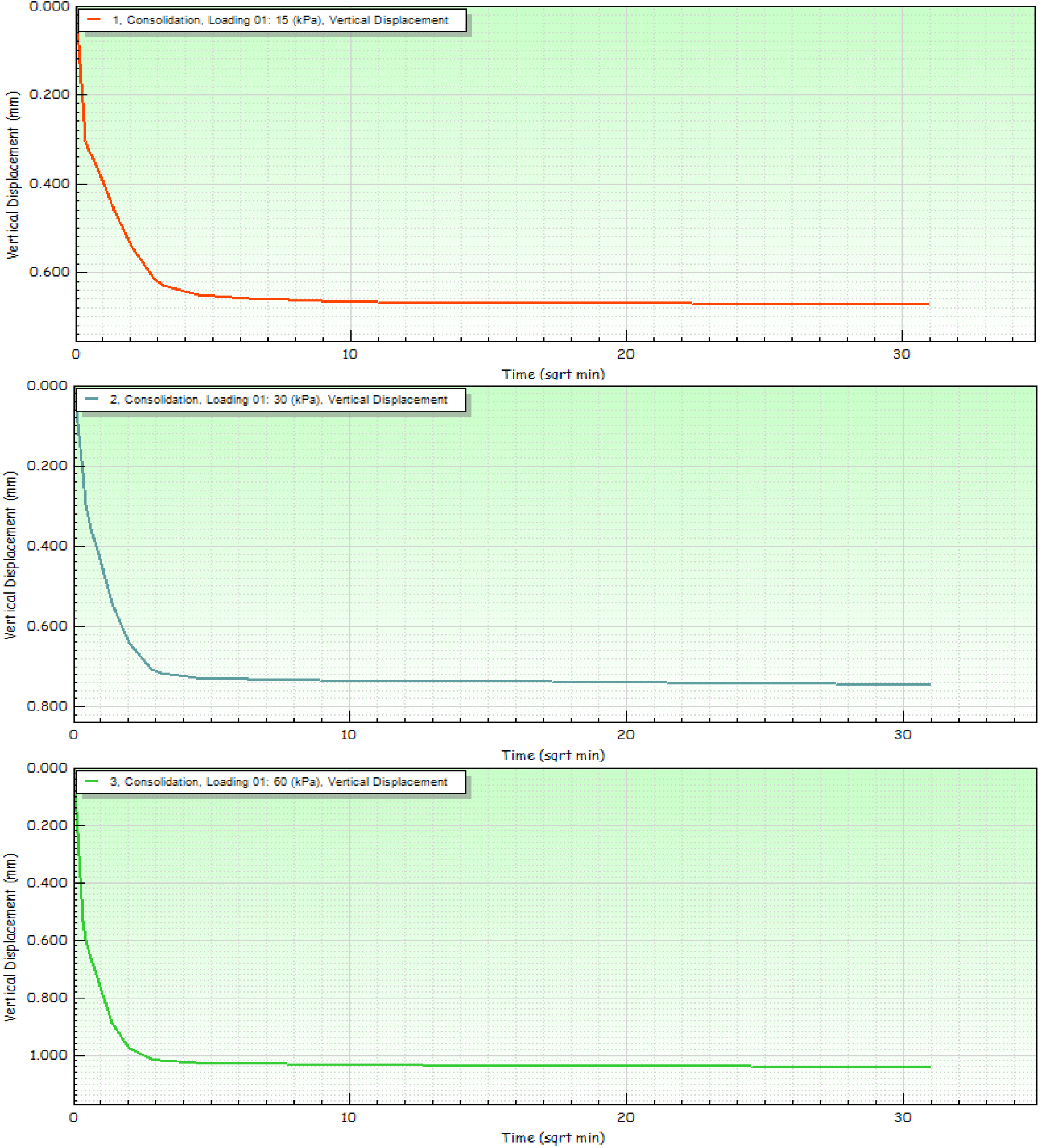
Stage	**1**	**2**	**3**
Initial Conditions			
Height (mm)	20.0	20.0	20.0
Diameter (mm)	60.0	60.0	60.0
Water Content (%)	13.0	13.0	13.0
Bulk Density (Mg/m^3)	2.20	2.21	2.19
Dry Density (Mg/m^3)	1.94	1.95	1.93
Voids Ratio	0.362	0.358	0.371
Consolidation			
Normal Pressure (kPa)	15	30	60
Vertical Displacement (mm)	0.672	0.746	1.043
Shearing			
Rate of Strain (mm/min)	0.085	0.085	0.085
Peak Shear Stress (kPa)	21.2	40.6	62.0
Hoz Displacement (mm)	10.2	10.2	10.2
Hoz Displacement at Peak Shear Stress (mm)	1.803	2.937	2.223
Final Conditions			
Water Content (%)	15.0	14.0	14.0
Dry Density (Mg/m^3)	2.02	2.04	2.13
Voids Ratio	0.342	0.329	0.296

	Tested	**Approved**
UKAS TESTING 10122	**Aaron Nutt**	**Joseph Nicholl**

Lab Sheet Reference : LAB25R - Version 4

Direct Shear Test		BS EN ISO 17892-10:2018		
Project Number	21-1031	Project	Scapa Deep Water Quay - Marine GI	
Location Number	BH-M12	Sample Reference	3	
Depth (m)	0.00	Sample Submerged?	Yes	~~No~~
Sample Type	B	Particle Density (Mg/m^3)	2.65	Assumed

Consolidation Graphs

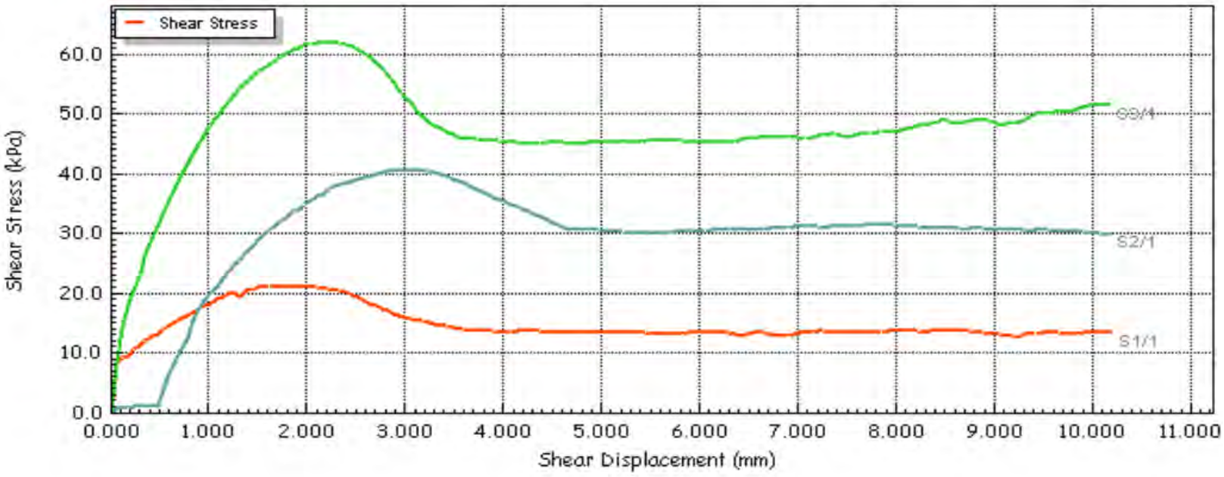


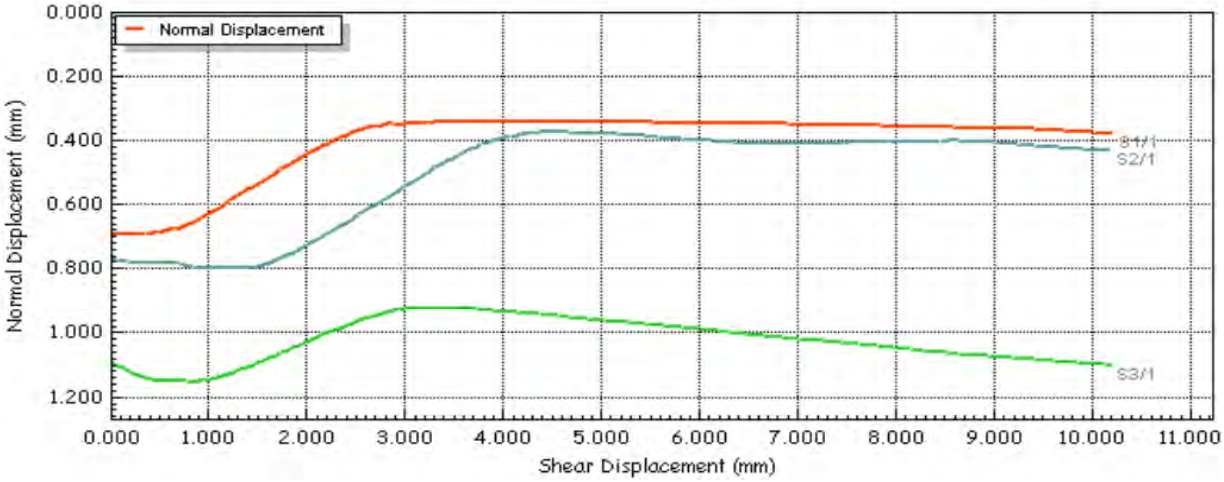
	Tested	**Approved**
10122	**Aaron Nutt**	**Joseph Nicholl**

Lab Sheet Reference : LAB25R - Version 4

Direct Shear Test BS EN ISO 17892-10:2018				
Project Number	21-1031	Project	Scapa Deep Water Quay - Marine GI	
Location Number	BH-M12	Sample Reference	3	
Depth (m)	0.00	Sample Submerged?	Yes	~~No~~
Sample Type	B	Particle Density (Mg/m^3)	2.65	Assumed

Shear Stage



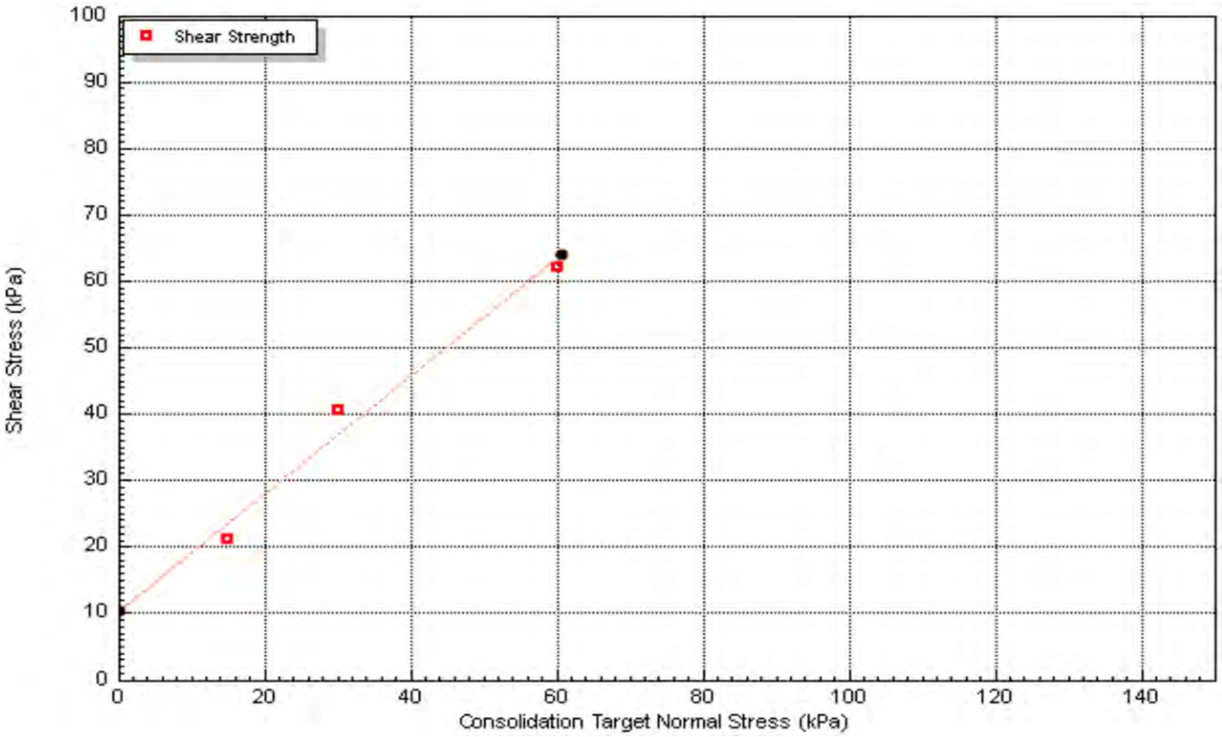


	Tested	Approved
UKAS TESTING 10122 CAUSEWAY GEOTECH	Aaron Nutt	Joseph Nicholl

Lab Sheet Reference : LAB25R - Version 4

Direct Shear Test BS EN ISO 17892-10:2018				
Project Number	21-1031	Project	Scapa Deep Water Quay - Marine GI	
Location Number	BH-M12	Sample Reference	3	
Depth (m)	0.00	Sample Submerged?	Yes	~~No~~
Sample Type	B	Particle Density (Mg/m^3)	2.65	Assumed

Stage	1	2	3
Envelope Failure Results			
Apparent Cohesion (kPa)	10		
Angle of Shearing Resistance (°)	41.5		



	Tested	Approved
10122	Aaron Nutt	Joseph Nicholl

Lab Sheet Reference : LAB25R - Version 4

Direct Shear Test BS EN ISO 17892-10:2018

Project Number	21-1031	Project	Scapa Deep Water Quay - Marine GI	
Location Number	BH-M13	Sample Reference	8	
Depth (m)	0.00	Sample Submerged?	Yes	~~No~~
Sample Type	B	Particle Density (Mg/m^3)	2.65	Assumed
Description	Brownish grey slightly gravelly slightly silty fine to coarse SAND.			
Sample Preparation	Sample is recompacted using material passing 2mm test sieve			

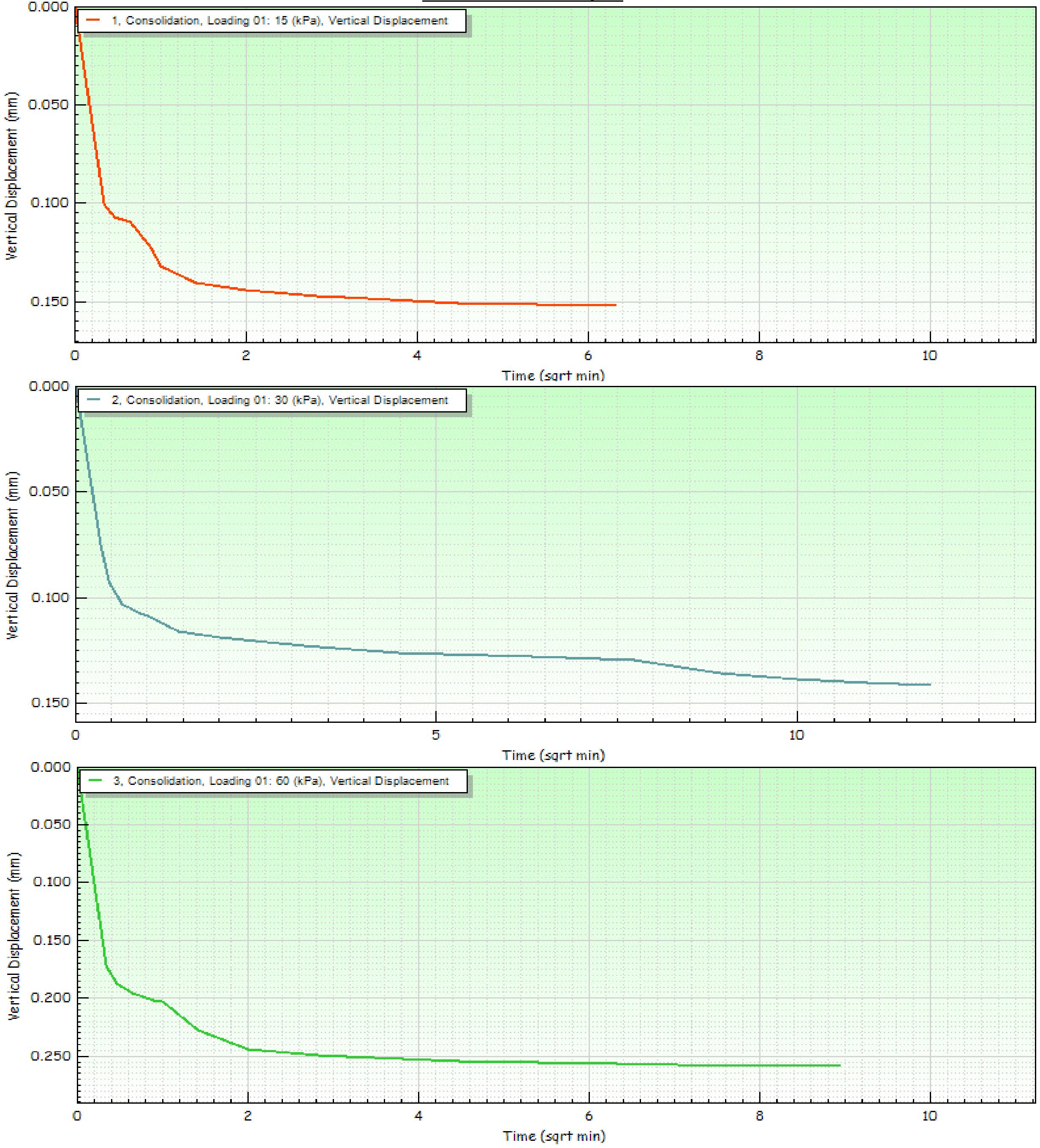
Stage	**1**	**2**	**3**
Initial Conditions			
Height (mm)	20.0	20.0	20.0
Diameter (mm)	60.0	60.0	60.0
Water Content (%)	21.0	21.0	21.0
Bulk Density (Mg/m^3)	2.02	2.01	2.04
Dry Density (Mg/m^3)	1.67	1.66	1.69
Voids Ratio	0.584	0.594	0.567
Consolidation			
Normal Pressure (kPa)	15	30	60
Vertical Displacement (mm)	0.152	0.141	0.259
Shearing			
Rate of Strain (mm/min)	0.600	0.600	0.600
Peak Shear Stress (kPa)	22.6	37.3	60.9
Hoz Displacement (mm)	10.2	10.2	10.2
Hoz Displacement at Peak Shear Stress (mm)	1.977	2.403	2.577
Final Conditions			
Water Content (%)	23.0	23.0	23.0
Dry Density (Mg/m^3)	1.65	1.66	1.69
Voids Ratio	0.601	0.599	0.572

UKAS TESTING 10122 CAUSEWAY GEOTECH	**Tested**	**Approved**
	Aaron Nutt	**Joseph Nicholl**

Lab Sheet Reference : LAB25R - Version 4

Direct Shear Test BS EN ISO 17892-10:2018				
Project Number	21-1031	Project	Scapa Deep Water Quay - Marine GI	
Location Number	BH-M13	Sample Reference	8	
Depth (m)	0.00	Sample Submerged?	Yes	~~No~~
Sample Type	B	Particle Density (Mg/m^3)	2.65	Assumed

Consolidation Graphs

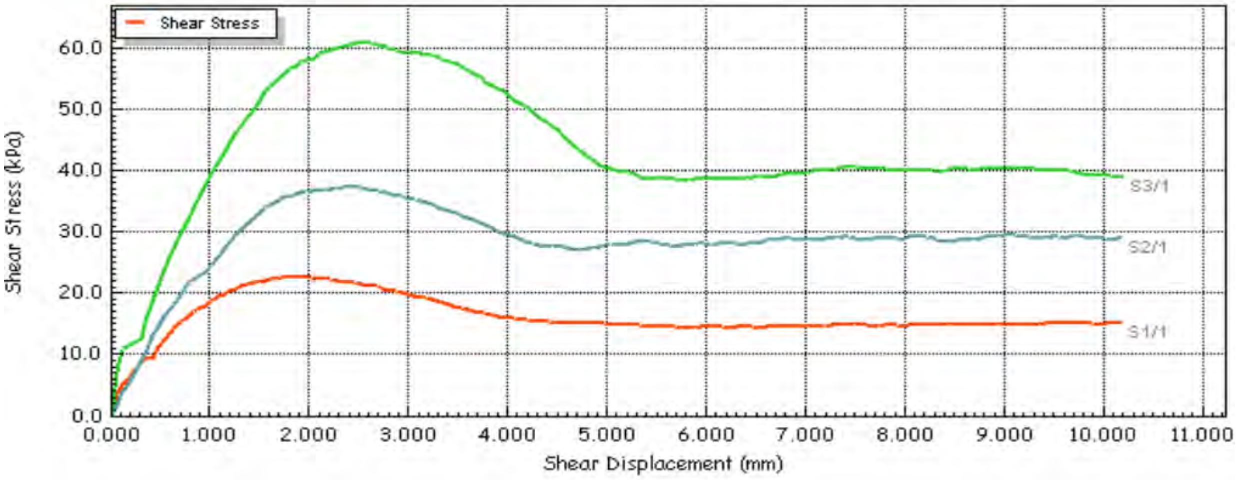


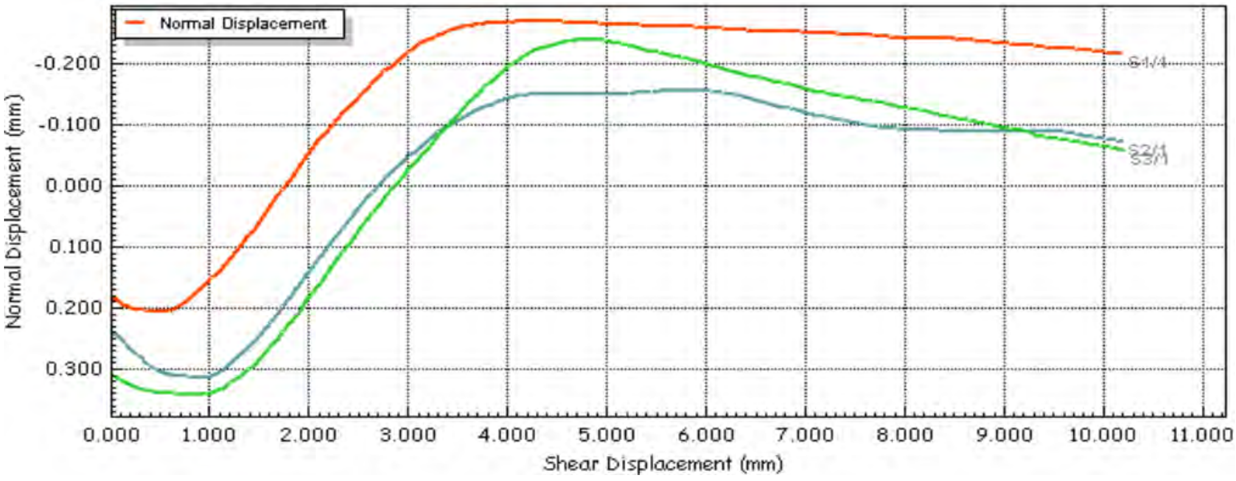
		Tested	Approved
UKAS TESTING 10122	CAUSEWAY GEOTECH	Aaron Nutt	Joseph Nicholl

Lab Sheet Reference : LAB25R - Version 4

Direct Shear Test BS EN ISO 17892-10:2018				
Project Number	21-1031	Project	Scapa Deep Water Quay - Marine GI	
Location Number	BH-M13	Sample Reference	8	
Depth (m)	0.00	Sample Submerged?	Yes	~~No~~
Sample Type	B	Particle Density (Mg/m^3)	2.65	Assumed

Shear Stage



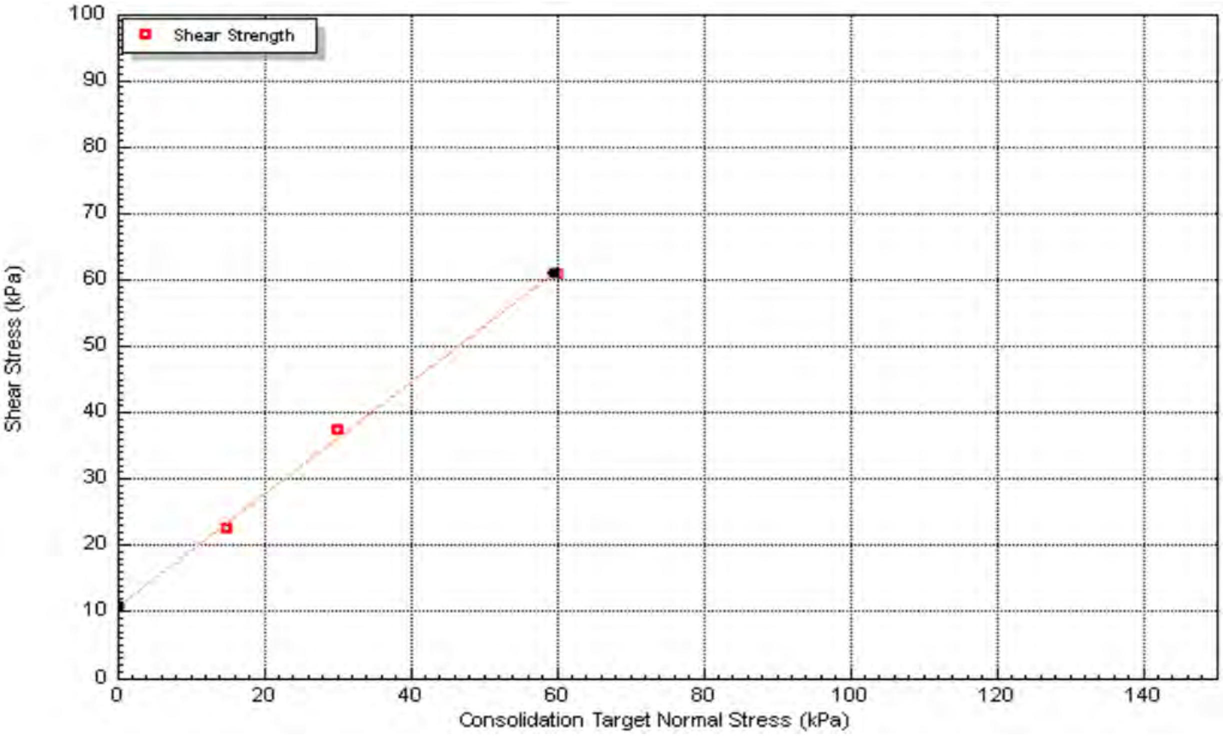


UKAS TESTING 10122 CAUSEWAY GEOTECH	**Tested**	**Approved**
	Aaron Nutt	**Joseph Nicholl**

Lab Sheet Reference : LAB25R - Version 4

Direct Shear Test BS EN ISO 17892-10:2018				
Project Number	21-1031	Project	Scapa Deep Water Quay - Marine GI	
Location Number	BH-M13	Sample Reference	8	
Depth (m)	0.00	Sample Submerged?	Yes	~~No~~
Sample Type	B	Particle Density (Mg/m^3)	2.65	Assumed

Stage	1	2	3
Envelope Failure Results			
Apparent Cohesion (kPa)	11		
Angle of Shearing Resistance (°)	40.0		



UKAS TESTING 10122	Tested	Approved
CAUSEWAY GEOTECH	Aaron Nutt	Joseph Nicholl

Lab Sheet Reference : LAB25R - Version 4

UKAS
TESTING
2183

eurofins
Chemtest
Eurofins Chemtest Ltd
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

Final Report

Report No.:	22-13839-1		
Initial Date of Issue:	19-Apr-2022		
Client	Causeway Geotech Ltd		
Client Address:	8 Drumahiskey Road Balnamore Ballymoney County Antrim BT53 7QL		
Contact(s):	Carin Cornwall Colm Hurley Darren O'Mahony Gabriella Horan Joe Gervin John Cameron Lucy Newland Martin Gardiner Matthew Gilbert Neil Haggan Paul Dunlop Sean Ross Stephen Franey Stephen Watson Stuart Abraham Thomas McAllister		
Project	21-1031 Scapa Deep Water Quay		
Quotation No.:		**Date Received:**	12-Apr-2022
Order No.:		**Date Instructed:**	12-Apr-2022
No. of Samples:	19		
Turnaround (Wkdays):	7	**Results Due:**	22-Apr-2022
Date Approved:	19-Apr-2022		

Approved By:

Details: Stuart Henderson, Technical Manager

Results - Soil

Project: 21-1031 Scapa Deep Water Quay

Client: Causeway Geotech Ltd	**Chemtest Job No.:**				22-13839	22-13839	22-13839	22-13839	22-13839	22-13839	22-13839	22-13839	22-13839
Quotation No.:	**Chemtest Sample ID.:**				1410229	1410230	1410231	1410232	1410233	1410234	1410235	1410236	1410237
Order No.:	Client Sample Ref.:				7	2	6	10	11	10	11	12	7
	Sample Location:				BH-M01	BH-M02	BH-M03	BH-M04	BH-M05	BH-M06	BH-M07	BH-M07	BH-M08
	Sample Type:				SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
	Top Depth (m):				1.50	0.00	1.50	1.50	1.50	1.50	1.50	3.00	1.50
	Date Sampled:				11-Apr-2022	11-Apr-2022	11-Apr-2022	11-Apr-2022	11-Apr-2022	11-Apr-2022	11-Apr-2022	11-Apr-2022	11-Apr-2022
Determinand	**Accred.**	**SOP**	**Units**	**LOD**									
Moisture	N	2030	%	0.020	16	12	13	13	14	14	15	13	12
pH	U	2010		4.0	8.5	8.5	8.7	8.5	8.5	8.4	8.5	8.6	8.4
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	0.76	0.17	0.21	0.72	0.36	0.54	0.41	0.25	0.39

Results - Soil

Project: 21-1031 Scapa Deep Water Quay

Client: Causeway Geotech Ltd				**Chemtest Job No.:**	22-13839	22-13839	22-13839	22-13839	22-13839	22-13839	22-13839	22-13839	22-13839
Quotation No.:				**Chemtest Sample ID.:**	1410238	1410239	1410240	1410241	1410242	1410243	1410244	1410245	1410246
Order No.:				Client Sample Ref.:	8	10	11	7	10	3	10	10	10
				Sample Location:	BH-M08	BH-M09	BH-M09	BH-M10	BH-M11	BH-M12	BH-M13	BH-M14	BH-M15
				Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
				Top Depth (m):	3.00	1.50	3.00	1.50	1.50	0.00	1.50	1.50	1.50
				Date Sampled:	11-Apr-2022	11-Apr-2022	11-Apr-2022	11-Apr-2022	11-Apr-2022	11-Apr-2022	11-Apr-2022	11-Apr-2022	11-Apr-2022
Determinand	**Accred.**	**SOP**	**Units**	**LOD**									
Moisture	N	2030	%	0.020	10	14	8.7	12	12	12	13	14	15
pH	U	2010		4.0	8.5	8.3	8.6	8.5	8.6	8.6	8.6	8.4	8.5
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	0.12	0.50	0.34	0.16	0.40	0.38	0.30	0.36	0.39

Results - Soil

Project: 21-1031 Scapa Deep Water Quay

Client: Causeway Geotech Ltd	**Chemtest Job No.:**				22-13839
Quotation No.:	**Chemtest Sample ID.:**				1410247
Order No.:	Client Sample Ref.:				7
	Sample Location:				BH-M16
	Sample Type:				SOIL
	Top Depth (m):				1.50
	Date Sampled:				11-Apr-2022
Determinand	**Accred.**	**SOP**	**Units**	**LOD**	
Moisture	N	2030	%	0.020	13
pH	U	2010		4.0	8.2
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	0.36

Test Methods

SOP	Title	Parameters included	Method summary
2010	pH Value of Soils	pH	pH Meter
2030	Moisture and Stone Content of Soils(Requirement of MCERTS)	Moisture content	Determination of moisture content of soil as a percentage of its as received mass obtained at <37°C.
2040	Soil Description(Requirement of MCERTS)	Soil description	As received soil is described based upon BS5930
2120	Water Soluble Boron, Sulphate, Magnesium & Chromium	Boron; Sulphate; Magnesium; Chromium	Aqueous extraction / ICP-OES

Report Information

Key	
U	UKAS accredited
M	MCERTS and UKAS accredited
N	Unaccredited
S	This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
SN	This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
T	This analysis has been subcontracted to an unaccredited laboratory
I/S	Insufficient Sample
U/S	Unsuitable Sample
N/E	not evaluated
<	"less than"
>	"greater than"
SOP	Standard operating procedure
LOD	Limit of detection

Comments or interpretations are beyond the scope of UKAS accreditation
The results relate only to the items tested
Uncertainty of measurement for the determinands tested are available upon request
None of the results in this report have been recovery corrected
All results are expressed on a dry weight basis

The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols

For all other tests the samples were dried at < 37°C prior to analysis
All Asbestos testing is performed at the indicated laboratory
Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

A - Date of sampling not supplied
B - Sample age exceeds stability time (sampling to extraction)
C - Sample not received in appropriate containers
D - Broken Container
E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

Sample Retention and Disposal

All soil samples will be retained for a period of 30 days from the date of receipt
All water samples will be retained for 14 days from the date of receipt
Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:
customerservices@chemtest.com

CAUSEWAY GEOTECH

HEAD OFFICE
Causeway Geotech Ltd
8 Drumahiskey Road
Ballymoney
Co. Antrim, N. Ireland, BT53 7QL
NI: +44 (0)28 276 66640
Registered in Northern Ireland.
Company Number: NI610766

REGIONAL OFFICE
Causeway Geotech (IRL) Ltd
Unit 1 Fingal House
Stephenstown Industrial Estate
Balbriggan, Co Dublin, Ireland, K32 VR66
ROI: +353 (0)1 526 7465
Registered in Ireland.
Company Number: 633786

www.causewaygeotech.com

SOIL AND ROCK SAMPLE ANALYSIS LABORATORY TEST REPORT

10 June 2022

Project Name:	Scapa Deep Water Quay - Marine GI
Project No.:	21-1031
Client:	Orkney Islands Council
Engineer:	Arch Henderson Consulting Engineers

We are pleased to attach the results of laboratory testing carried out for the above project. This memo and its attachments constitute a report of the results of tests as detailed in the Contents page(s). This testing was performed between 04/05/2022 and 08/06/2022.

The attached results complete the testing requested and we would therefore wish to confirm that samples will be retained without charge for a period of 28 days from the above date after which they will be appropriately disposed of unless we receive written instructions to the contrary prior to that date.

We trust our report meets with your approval but if you have any queries or require additional information, please do not hesitate to contact the undersigned.

Stephen Watson

Stephen Watson

Laboratory Manager

Signed for and on behalf of Causeway Geotech Ltd

Project Name: Scapa Deep Water Quay - Marine GI

Report Reference: Rock Schedule 2

The table below details the tests carried out, the specifications used, and the number of tests included in this report. The results contained in this report relate to the sample(s) as received

Tests marked with* in this report are not United Kingdom Accreditation Service (UKAS) accredited and are not included in Causeway Geotech Limited's scope of UKAS Accreditation Schedule of Tests. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation.

Material tested	Type of test/Properties measured/Range of measurement	Standard specifications	No. of results included in the report
SOIL	Moisture Content of Soil	BS 1377-2: 1990: Cl 3.2	1
SOIL	Liquid and Plastic Limits of soil-1 point cone penetrometer method	BS 1377-2: 1990: Cl 4.4, 5.3 & 5.4	1
SOIL	Particle size distribution - wet sieving	BS 1377-2: 1990: Cl 9.2	1
SOIL	Particle size distribution - sedimentation hydrometer method	BS 1377-2: 1990: Cl 9.5	1
SOIL	Undrained shear strength – triaxial compression without measurement of pore pressure (loads from 0.12 to 24 kN)	BS 1377-7: 1990: Cl 8	1
ROCK	Point load index	ISRM Commission on Testing Methods. Suggested Method for Determining Point Load Strength 1985	113

SUB-CONTRACTED TESTS

In agreement with Client, the following tests were conducted by an approved sub-contractor. All sub-contracting laboratories used are UKAS accredited.

Material tested	Type of test/Properties measured/Range of measurement	Standard specifications	No. of results included in the report
ROCK – subcontracted to MATtest Limited *(UKAS 2643)*	Natural Water Content of Rock	Tested in accordance with ISRM (2007)	43
ROCK – subcontracted to MATtest Limited *(UKAS 2643)*	Uniaxial Compressive Strength (UCS)	ASTM D7012 - 14	33
ROCK – subcontracted to MATtest Limited *(UKAS 2643)*	Schmidt Rebound Hardness Test		18
ROCK – subcontracted to MATtest Limited *(UKAS 2643)*	Slake Durability	Tested in accordance with ISRM (2007)	7

Summary of Classification Test Results

Project No.	Project Name
21-1031	Scapa Deep Water Quay - Marine GI

Hole No.	Sample				Soil Description	Density Mg/m3		*w* %	Passing 425µm %	LL %	PL %	PI %	Particle density Mg/m3	Casagrande Classification
	Ref	Top	Base	Type		bulk	dry							
BH-M03	1	4.70		C	Greyish brown sandy silty CLAY.			11.0	99	27 -1pt	16	11		CL

All tests performed in accordance with BS1377:1990 unless specified otherwise

LAB 01R Version 5

Key

Density test	Liquid Limit	Particle density
Linear measurement unless :	4pt cone unless :	sp - small pyknometer
wd - water displacement	cas - Casagrande method	gj - gas jar
wi - immersion in water	1pt - single point test	

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31/05/2022

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Stephen.Watson

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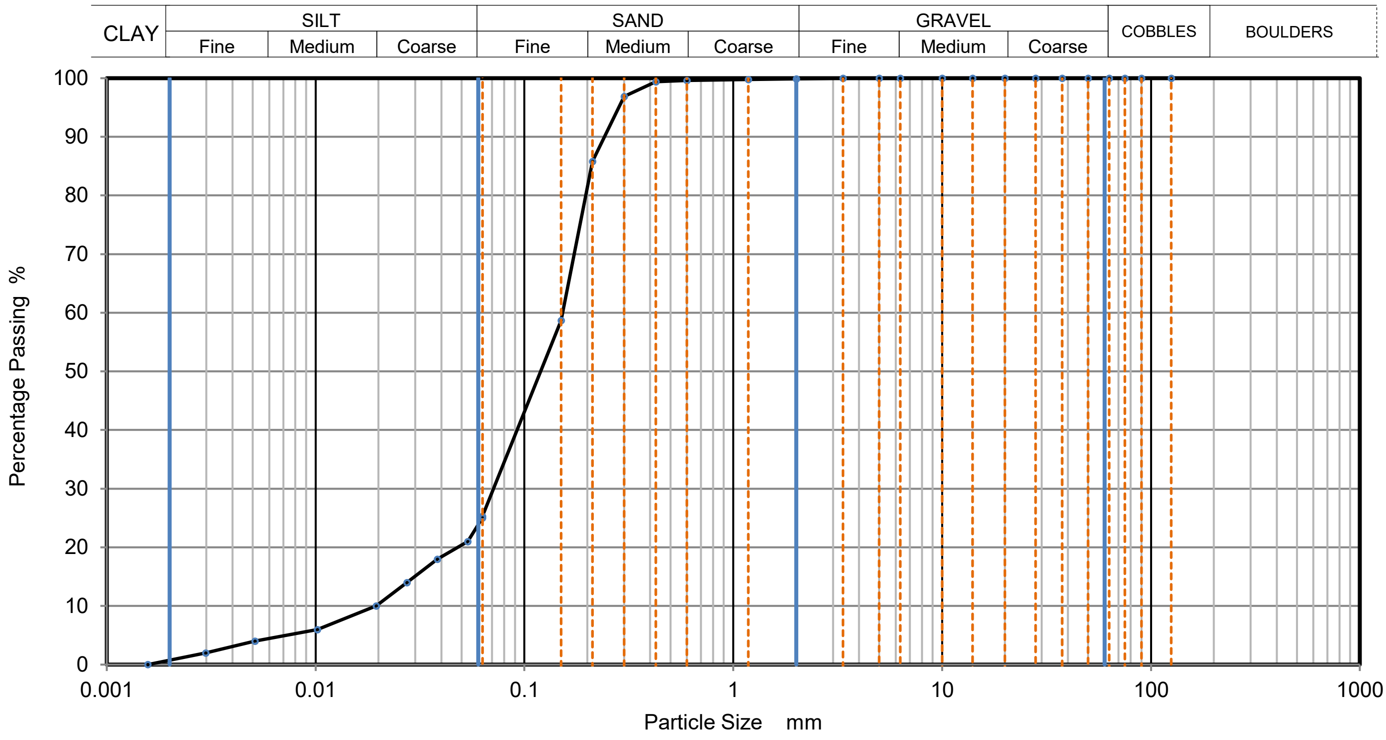
CAUSEWAY GEOTECH

PARTICLE SIZE DISTRIBUTION

		Job Ref	**21-1031**
		Borehole/Pit No.	BH-M03
Site Name	Scapa Deep Water Quay - Marine GI	Sample No.	1
Soil Description	Greyish brown clayey fine to coarse SAND.	Depth, m	4.70
Specimen Reference	3 Specimen Depth 4.7 m	Sample Type	C
Test Method	BS1377:Part 2:1990, clauses 9.2 and 9.5	KeyLAB ID	Caus202205050



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.06300	25
90	100	0.05345	21
75	100	0.03822	18
63	100	0.02732	14
50	100	0.01953	10
37.5	100	0.01019	6
28	100	0.00512	4
20	100	0.00297	2
14	100	0.00157	0
10	100		
6.3	100		
5	100		
3.35	100		
2	100		
1.18	100		
0.6	100	Particle density	(assumed)
0.425	99	2.65	Mg/m3
0.3	97		
0.212	86		
0.15	59		
0.063	25		

Dry Mass of sample, g	206

Sample Proportions	% dry mass
Cobbles	0.0
Gravel	0.1
Sand	74.6
Silt	24.6
Clay	0.7

Grading Analysis		
D100	mm	
D60	mm	0.153
D30	mm	0.0712
D10	mm	0.02
Uniformity Coefficient		7.6
Curvature Coefficient		1.7

Remarks

Preparation and testing in accordance with BS1377-2 :1990 unless noted below

Approved	
Stephen.Watson	

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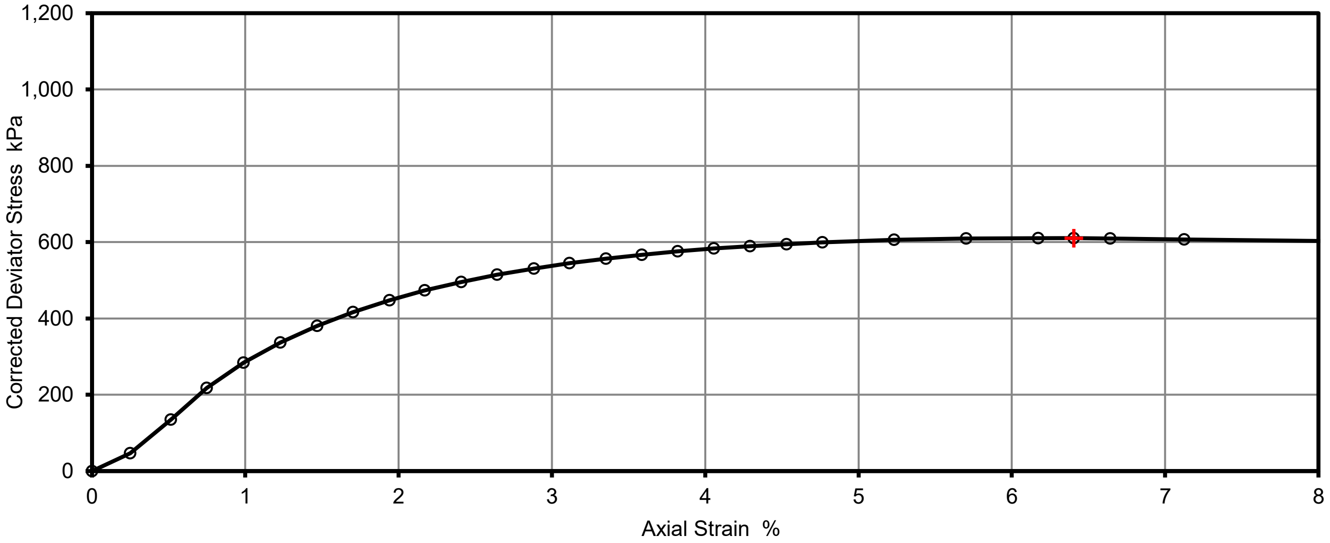
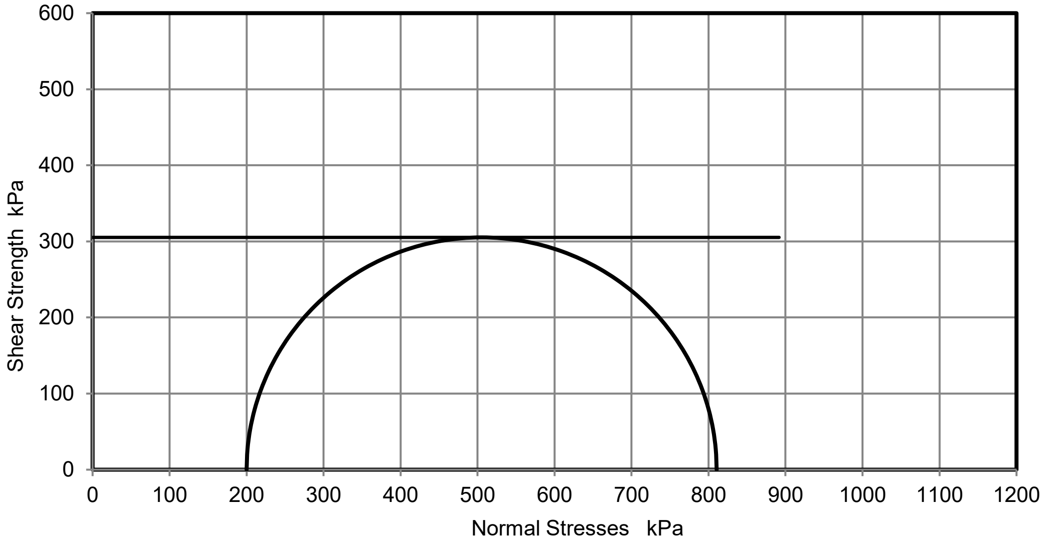
CAUSEWAY GEOTECH	**Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen**			Job Ref	21-1031
				Borehole/Pit No.	BH-M03
Site Name	Scapa Deep Water Quay - Marine GI			Sample No.	1
Soil Description	Greyish brown clayey fine to coarse SAND.			Depth	4.70
Specimen Reference	1	Specimen Depth	4.75 m	Sample Type	C
Specimen Description	Greyish brown clayey fine to coarse SAND.			KeyLAB ID	Caus202205050
Test Method	BS1377 : Part 7 : 1990, clause 8, single specimen			Date of test	10/05/2022

Sample Condition		UNDISTURBED	
Test Number		1	
Length		210.0	mm
Diameter		106.3	mm
Bulk Density		2.00	Mg/m3
Moisture Content		11	%
Dry Density		1.81	Mg/m3
Rate of Strain		3.0	%/min
Cell Pressure		200	kPa
At failure	Axial Strain	6.4	%
	Deviator Stress, (σ1 - σ3)f	611	kPa
	Undrained Shear Strength, cu	305	kPa ½(σ1 - σ3)f
	Mode of Failure	Compound	

Deviator Stress v Axial Strain



Mohr Circles



Deviator stress corrected for area change and membrane effects

Mohr circles and their interpretation is not covered by BS1377.
This is provided for information only.

Remarks	Approved	Printed
	Stephen.Watson	31/05/2022 12:25

UKAS TESTING 10122

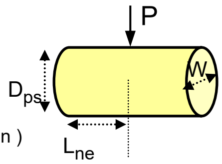
Point Load Strength Index Tests
Summary of Results

Project No.	Project Name
21-1031	Scapa Deep Water Quay - Marine GI

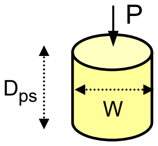
Borehole No.	Sample			Specimen		Rock Type	Test Type see ISRM		Failure Valid (Y/N)	Dimensions				Force P	Equivalent diameter, De	Point Load Strength Index		Remarks (including water content if measured)
	Depth m	Ref.	Type	Ref.	Depth m		Type (D, A, I, B)	Direction (L, P or U)		Lne mm	W mm	Dps mm	Dps' mm	kN	mm	Is MPa	Is(50) MPa	
BH-M01	3.70	1	C	3	3.70	SANDSTONE	A	U	YES		101.3	78.0	76.0	8.2	99.0	0.8	1.1	
BH-M01	3.80	2	C	1	3.80	SANDSTONE	A	U	YES		101.2	52.0	49.0	2.4	79.5	0.4	0.5	
BH-M01	3.80	2	C	2	3.85	SANDSTONE	A	U	YES		101.3	63.0	61.0	2.6	88.7	0.3	0.4	
BH-M01	4.95	3	C	3	4.95	SANDSTONE	I	U	YES	76.7	50.0	77.0	72.0	5.0	67.7	1.1	1.3	
BH-M01	5.40	4	C	3	5.40	SANDSTONE	A	U	YES		100.8	82.0	80.0	3.4	101.3	0.3	0.5	
BH-M01	7.25	7	C	3	7.25	SANDSTONE	A	U	YES		101.0	95.0	93.0	12.5	109.4	1.0	1.5	
BH-M01	8.50	8	C	3	8.50	SANDSTONE	A	U	YES		100.9	89.0	87.0	5.7	105.7	0.5	0.7	
BH-M01	9.70	9	C	3	9.70	SANDSTONE	A	U	YES		101.0	106.0	103.0	12.0	115.1	0.9	1.3	
BH-M01	10.45	10	C	3	10.45	SANDSTONE	A	U	YES		100.4	85.0	82.0	11.8	102.4	1.1	1.6	
BH-M01	11.50	12	C	3	11.50	SANDSTONE	A	U	YES		100.5	87.0	83.0	1.5	103.1	0.1	0.2	
BH-M01	12.65	14	C	3	12.65	SANDSTONE	A	U	YES		101.0	95.0	93.0	9.8	109.4	0.8	1.2	
BH-M02	1.70	1	C	3	1.70	SANDSTONE	A	U	YES		101.2	65.0	60.0	1.0	87.9	0.1	0.2	
BH-M02	3.00	3	C	3	3.00	SANDSTONE	A	U	YES		101.2	84.0	81.0	6.4	102.2	0.6	0.8	
BH-M02	3.80	5	C	3	3.80	SANDSTONE	A	U	YES		100.9	111.0	107.0	3.9	117.2	0.3	0.4	
BH-M02	5.45	6	C	3	5.45	SANDSTONE	A	U	YES		100.6	104.0	102.0	4.8	114.3	0.4	0.5	
BH-M02	6.30	7	C	3	6.30	SANDSTONE	A	U	YES		101.1	88.0	86.0	9.3	105.2	0.8	1.2	
BH-M02	7.60	9	C	3	7.60	SANDSTONE	A	U	YES		101.0	60.0	66.0	7.9	92.1	0.9	1.2	
BH-M02	7.70	10	C	3	7.70	SANDSTONE	A	U	YES		101.1	84.0	82.0	9.9	102.7	0.9	1.3	

Test Type
D - Diametral, A - Axial, I - Irregular Lump, B - Block
Direction
L - parallel to planes of weakness
P - perpendicular to planes of weakness
U - unknown or random
Dimensions
Dps - Distance between platens (platen separation)
Dps' - at failure (see ISRM note 6)
Lne - Length from platens to nearest free end
W - Width of shortest dimension perpendicular to load, P

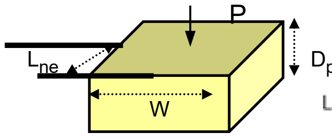
Diametral

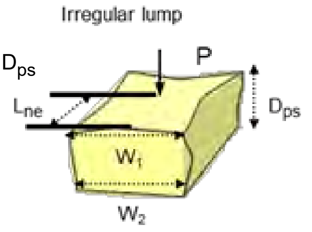


Axial



Block





Test performed in accordance with ISRM Suggested Methods : 2007, unless noted otherwise

Detailed legend for test and dimensions, based on ISRM, is shown above.

Size factor, F = (De/50)0.45 for all tests.

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Approved By
Stephen.Watson

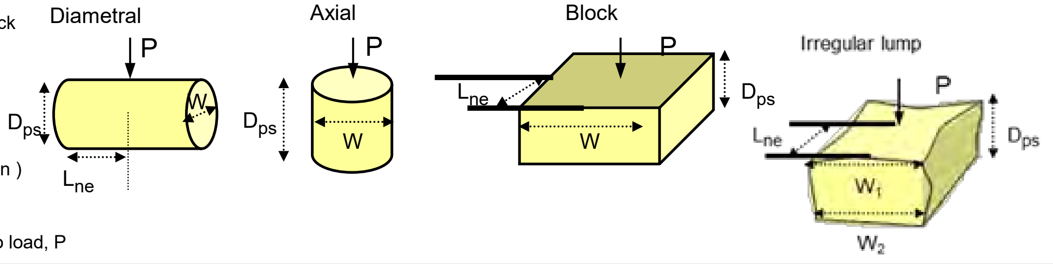
10122

Point Load Strength Index Tests
Summary of Results

Project No.	Project Name
21-1031	Scapa Deep Water Quay - Marine GI

Borehole No.	Sample			Specimen		Rock Type	Test Type see ISRM		Failure Valid (Y/N)	Dimensions				Force P	Equivalent diameter, De	Point Load Strength Index		Remarks (including water content if measured)
	Depth m	Ref.	Type	Ref.	Depth m		Type (D, A, I, B)	Direction (L, P or U)		Lne mm	W mm	Dps mm	Dps' mm	kN	mm	Is MPa	Is(50) MPa	
BH-M02	9.30	13	C	3	9.30	SANDSTONE	A	U	YES		101.0	68.0	63.0	12.2	90.0	1.5	2.0	
BH-M02	11.00	14	C	3	11.00	SANDSTONE	A	U	YES		100.9	105.0	99.0	20.1	112.8	1.6	2.3	
BH-M02	13.75	16	C	3	13.75	SANDSTONE	A	U	YES		101.2	87.5	85.0	7.9	104.7	0.7	1.0	
BH-M03	6.80	4	C	3	6.80	SANDSTONE	A	U	YES		101.1	96.0	93.0	0.1	109.4	0.0	0.0	
BH-M03	6.95	5	C	3	6.95	SANDSTONE	A	U	YES		100.2	66.0	61.0	0.2	88.2	0.0	0.0	
BH-M03	8.70	6	C	3	8.70	SANDSTONE	A	U	YES		101.3	96.0	92.0	17.1	108.9	1.4	2.0	
BH-M03	9.20	8	C	4	9.20	SANDSTONE	A	U	YES		101.3	99.0	96.0	8.6	111.3	0.7	1.0	
BH-M03	9.20	8	C	5	9.25	SANDSTONE	D	U	YES	79.7	101.2	101.2	99.0	8.0	100.1	0.8	1.1	
BH-M03	10.40	11	C	3	10.40	SANDSTONE	A	U	YES		101.2	97.0	95.0	9.3	110.6	0.8	1.1	
BH-M04	5.00	2	C	3	5.00	SANDSTONE	A	U	YES		101.4	78.0	77.0	2.3	99.7	0.2	0.3	
BH-M04	6.40	4	C	3	6.40	SANDSTONE	I	U	YES	47.3	78.2	82.0	74.0	0.6	85.8	0.1	0.1	
BH-M04	6.50	5	C	3	6.50	SANDSTONE	A	U	YES		100.0	43.0	41.0	0.3	72.3	0.1	0.1	
BH-M04	7.20	7	C	3	7.20	SANDSTONE	A	U	YES		101.2	111.0	106.0	8.7	116.9	0.6	0.9	
BH-M04	7.70	8	C	3	7.70	SANDSTONE	A	U	YES		101.2	100.0	95.0	2.0	110.6	0.2	0.2	
BH-M04	9.70	11	C	4	9.70	SANDSTONE	A	U	YES		101.2	75.0	73.0	3.2	97.0	0.3	0.5	
BH-M04	9.70	11	C	5	9.75	SANDSTONE	D	U	YES	148.3	101.2	101.2	99.0	8.6	100.1	0.9	1.2	
BH-M04	11.20	13	C	3	11.20	SANDSTONE	A	U	YES		101.0	91.0	86.0	3.3	105.2	0.3	0.4	
BH-M04	12.25	14	C	3	12.25	SANDSTONE	A	U	YES		101.0	88.0	85.0	7.1	104.6	0.6	0.9	

Test Type
D - Diametral, A - Axial, I - Irregular Lump, B - Block
Direction
L - parallel to planes of weakness
P - perpendicular to planes of weakness
U - unknown or random
Dimensions
Dps - Distance between platens (platen separation)
Dps' - at failure (see ISRM note 6)
Lne - Length from platens to nearest free end
W - Width of shortest dimension perpendicular to load, P



Test performed in accordance with ISRM Suggested Methods : 2007, unless noted otherwise

Detailed legend for test and dimensions, based on ISRM, is shown above.

Size factor, F = (De/50)0.45 for all tests.

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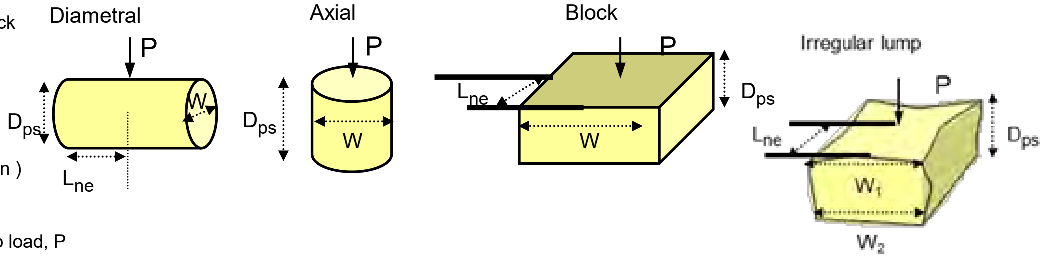
Point Load Strength Index Tests
Summary of Results

Project No.	Project Name
21-1031	Scapa Deep Water Quay - Marine GI

Borehole No.	Sample			Specimen		Rock Type	Test Type see ISRM		Failure Valid (Y/N)	Dimensions				Force P	Equivalent diameter, De	Point Load Strength Index		Remarks (including water content if measured)
	Depth m	Ref.	Type	Ref.	Depth m		Type (D, A, I, B)	Direction (L, P or U)		Lne mm	W mm	Dps mm	Dps' mm	kN	mm	Is MPa	Is(50) MPa	
BH-M05	5.60	1	C	3	5.60	SANDSTONE	A	U	YES		100.4	109.0	104.0	1.6	115.3	0.1	0.2	
BH-M05	6.30	3	C	3	6.30	SANDSTONE	A	U	YES		100.9	95.0	92.0	7.9	108.7	0.7	0.9	
BH-M05	8.50	5	C	3	8.50	SANDSTONE	A	U	YES		101.2	86.0	84.0	5.4	104.0	0.5	0.7	
BH-M05	9.30	6	C	3	9.30	SANDSTONE	A	U	YES		101.1	91.0	96.0	7.7	111.2	0.6	0.9	
BH-M05	10.50	7	C	3	10.50	SANDSTONE	A	U	YES		101.1	88.0	84.0	3.9	104.0	0.4	0.5	
BH-M06	3.15	1	C	3	3.15	SANDSTONE	I	U	YES	64.3	70.0	44.0	43.0	2.2	61.9	0.6	0.6	
BH-M06	5.90	4	C	3	5.90	SANDSTONE	A	U	YES		100.2	69.0	66.0	1.8	91.8	0.2	0.3	
BH-M06	6.55	6	C	3	6.55	SANDSTONE	A	U	YES		100.8	65.0	60.0	1.7	87.8	0.2	0.3	
BH-M06	7.90	7	C	3	7.90	SANDSTONE	I	U	YES	84.2	75.4	84.0	82.0	6.9	88.7	0.9	1.1	
BH-M06	9.80	8	C	4	9.80	SANDSTONE	A	U	YES		101.1	71.0	68.0	1.8	93.6	0.2	0.3	
BH-M06	9.80	8	C	5	9.85	SANDSTONE	D	U	YES	97.3	101.1	101.1	99.0	2.7	100.0	0.3	0.4	
BH-M07	7.45	1	C	3	7.45	SANDSTONE	I	U	YES	63.4	78.1	37.0	35.0	0.7	59.0	0.2	0.2	
BH-M07	8.60	3	C	3	8.60	SANDSTONE	I	U	YES	67.2	43.7	56.0	54.0	0.2	54.8	0.1	0.1	
BH-M07	9.10	4	C	3	9.10	SANDSTONE	A	U	YES		101.0	84.0	81.0	1.3	102.1	0.1	0.2	
BH-M07	9.40	6	C	3	9.40	SANDSTONE	A	U	YES		101.3	70.0	66.0	1.0	92.3	0.1	0.2	
BH-M07	11.20	7	C	3	11.20	SANDSTONE	I	U	YES	72.9	83.2	66.0	49.0	0.4	72.0	0.1	0.1	
BH-M08	5.85	2	C	3	5.85	SANDSTONE	A	U	YES		100.8	64.0	61.0	3.7	88.5	0.5	0.6	
BH-M08	6.20	3	C	3	6.20	SANDSTONE	A	U	YES		101.0	99.0	98.0	5.3	112.3	0.4	0.6	

Test Type
D - Diametral, A - Axial, I - Irregular Lump, B - Block
Direction
L - parallel to planes of weakness
P - perpendicular to planes of weakness
U - unknown or random
Dimensions
Dps - Distance between platens (platen separation)
Dps' - at failure (see ISRM note 6)
Lne - Length from platens to nearest free end
W - Width of shortest dimension perpendicular to load, P



Test performed in accordance with ISRM Suggested Methods : 2007, unless noted otherwise

Detailed legend for test and dimensions, based on ISRM, is shown above.

Size factor, F = (De/50)0.45 for all tests.

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Stephen.Watson

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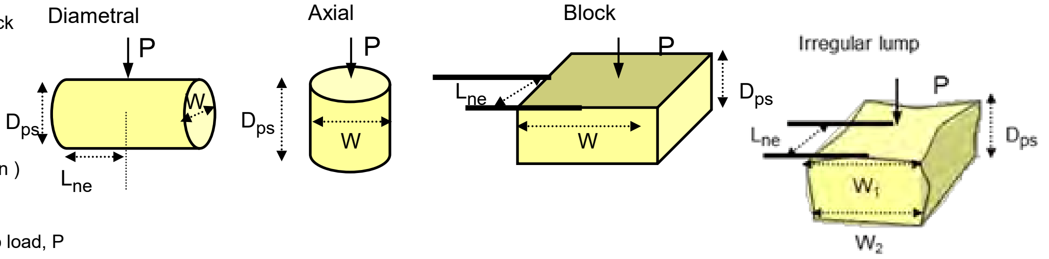
Point Load Strength Index Tests
Summary of Results

Project No.	Project Name
21-1031	Scapa Deep Water Quay - Marine GI

Borehole No.	Sample			Specimen		Rock Type	Test Type see ISRM		Failure Valid (Y/N)	Dimensions				Force P	Equivalent diameter, De	Point Load Strength Index		Remarks (including water content if measured)
	Depth m	Ref.	Type	Ref.	Depth m		Type (D, A, I, B)	Direction (L, P or U)		Lne mm	W mm	Dps mm	Dps' mm	kN	mm	Is MPa	Is(50) MPa	
BH-M08	7.05	5	C	3	7.05	SANDSTONE	A	U	YES		101.1	86.0	83.0	3.4	103.4	0.3	0.4	
BH-M08	7.50	6	C	3	7.50	SANDSTONE	A	U	YES		100.6	99.0	91.0	1.1	108.0	0.1	0.1	
BH-M08	9.60	8	C	3	9.60	SANDSTONE	A	U	YES		101.1	81.0	79.0	4.7	100.8	0.5	0.6	
BH-M08	9.80	9	C	3	9.80	SANDSTONE	A	U	YES		100.7	75.0	73.0	2.5	96.7	0.3	0.4	
BH-M08	11.55	12	C	3	11.55	SANDSTONE	A	U	YES		101.2	77.0	75.0	5.8	98.3	0.6	0.8	
BH-M09	4.50	1	C	3	4.50	SANDSTONE	A	U	YES		101.2	33.0	29.0	5.8	61.1	1.6	1.7	
BH-M09	4.60	2	C	3	4.60	SANDSTONE	A	U	YES		101.3	103.0	100.0	14.1	113.6	1.1	1.6	
BH-M09	6.10	4	C	3	6.10	SANDSTONE	A	U	YES		101.1	62.0	57.0	0.3	85.7	0.0	0.1	
BH-M09	8.10	7	C	3	8.10	SANDSTONE	A	U	YES		101.7	93.0	71.0	0.2	95.9	0.0	0.0	
BH-M09	9.70	9	C	3	9.70	SANDSTONE	I	U	YES	92.7	84.5	58.0	56.0	2.8	77.6	0.5	0.6	
BH-M10	4.35	1	C	3	4.35	SANDSTONE	A	U	YES		100.9	72.0	69.0	0.3	94.2	0.0	0.0	
BH-M10	4.50	2	C	3	4.50	SANDSTONE	A	U	YES		101.0	64.0	55.0	0.8	84.1	0.1	0.1	
BH-M10	4.60	3	C	3	4.60	SANDSTONE	A	U	YES		101.0	79.0	74.0	0.5	97.6	0.1	0.1	
BH-M10	6.20	4	C	3	6.20	SANDSTONE	A	U	YES		101.0	90.0	81.0	2.6	102.1	0.2	0.3	
BH-M10	7.95	6	C	3	7.95	SANDSTONE	A	U	YES		100.9	92.0	88.0	1.6	106.3	0.1	0.2	
BH-M10	10.00	9	C	3	10.00	SANDSTONE	A	U	YES		101.1	70.0	67.0	2.9	92.9	0.3	0.4	
BH-M11	4.20	1	C	3	4.20	SANDSTONE	A	U	YES		101.5	95.0	84.0	1.6	104.2	0.1	0.2	
BH-M11	5.30	2	C	3	5.30	MUDSTONE	A	U	YES		101.0	25.0	23.0	0.1	54.4	0.0	0.0	

Test Type
D - Diametral, A - Axial, I - Irregular Lump, B - Block
Direction
L - parallel to planes of weakness
P - perpendicular to planes of weakness
U - unknown or random
Dimensions
Dps - Distance between platens (platen separation)
Dps' - at failure (see ISRM note 6)
Lne - Length from platens to nearest free end
W - Width of shortest dimension perpendicular to load, P



Test performed in accordance with ISRM Suggested Methods : 2007, unless noted otherwise

Detailed legend for test and dimensions, based on ISRM, is shown above.

Size factor, F = (De/50)0.45 for all tests.

LAB 17R - Version 5

Date Printed	Approved By
06/10/2022 00:00	Stephen.Watson

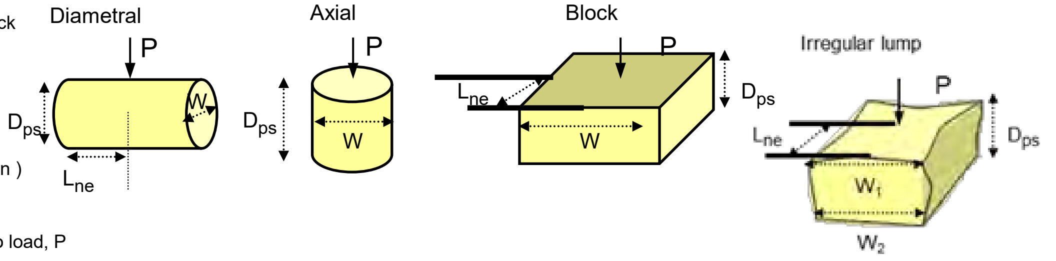
10122

Point Load Strength Index Tests
Summary of Results

Project No.	Project Name
21-1031	Scapa Deep Water Quay - Marine GI

Borehole No.	Sample			Specimen		Rock Type	Test Type see ISRM		Failure Valid (Y/N)	Dimensions				Force P	Equivalent diameter, De	Point Load Strength Index		Remarks (including water content if measured)
	Depth m	Ref.	Type	Ref.	Depth m		Type (D, A, I, B)	Direction (L, P or U)		Lne mm	W mm	Dps mm	Dps' mm	kN	mm	Is MPa	Is(50) MPa	
BH-M11	5.60	3	C	1	5.60	MUDSTONE	A	U	YES		101.7	90.0	76.0	0.2	99.2	0.0	0.0	
BH-M11	5.60	3	C	2	5.65	MUDSTONE	A	U	YES		99.8	81.0	70.0	0.6	94.3	0.1	0.1	
BH-M11	8.60	8	C	4	8.60	SANDSTONE	A	U	YES		101.1	102.0	98.0	3.4	112.3	0.3	0.4	
BH-M11	8.60	8	C	5	8.65	SANDSTONE	D	U	YES	134.2	101.1	101.1	97.0	8.7	99.0	0.9	1.2	
BH-M12	2.35	1	C	3	2.35	SANDSTONE	A	U	YES		101.3	97.0	91.0	16.2	108.3	1.4	2.0	
BH-M12	3.45	4	C	3	3.45	SANDSTONE	A	U	YES		100.7	89.0	87.0	15.3	105.6	1.4	1.9	
BH-M12	5.80	6	C	3	5.80	SANDSTONE	A	U	YES		101.2	79.0	77.0	10.0	99.6	1.0	1.4	
BH-M12	6.40	7	C	3	6.40	SANDSTONE	A	U	YES		101.2	84.0	82.0	9.7	102.8	0.9	1.3	
BH-M12	7.70	9	C	3	7.70	SANDSTONE	A	U	YES		101.0	84.0	82.0	11.3	102.7	1.1	1.5	
BH-M12	10.10	12	C	3	10.10	SANDSTONE	A	U	YES		101.2	71.0	67.0	14.1	92.9	1.6	2.2	
BH-M12	10.70	13	C	3	10.70	SANDSTONE	A	U	YES		100.8	89.0	87.0	11.2	105.7	1.0	1.4	
BH-M13	4.10	1	C	3	4.10	SANDSTONE	A	U	YES		100.9	106.0	103.0	7.7	115.0	0.6	0.8	
BH-M13	5.00	2	C	3	5.00	SANDSTONE	A	U	YES		101.3	95.0	93.0	7.1	109.5	0.6	0.8	
BH-M13	5.25	4	C	3	5.25	SANDSTONE	A	U	YES		101.0	43.0	41.0	2.1	72.6	0.4	0.5	
BH-M13	6.10	5	C	3	6.10	SANDSTONE	A	U	YES		101.1	85.0	80.0	14.0	101.5	1.4	1.9	
BH-M13	9.00	8	C	3	9.00	SANDSTONE	A	U	YES		101.1	96.0	92.0	9.5	108.8	0.8	1.1	
BH-M14	3.50	1	C	3	3.50	SANDSTONE	A	U	YES		100.6	94.0	92.0	14.0	108.6	1.2	1.7	
BH-M14	5.80	4	C	3	5.80	SANDSTONE	A	U	YES		100.8	82.0	76.0	3.4	98.8	0.3	0.5	

Test Type
D - Diametral, A - Axial, I - Irregular Lump, B - Block
Direction
L - parallel to planes of weakness
P - perpendicular to planes of weakness
U - unknown or random
Dimensions
Dps - Distance between platens (platen separation)
Dps' - at failure (see ISRM note 6)
Lne - Length from platens to nearest free end
W - Width of shortest dimension perpendicular to load, P



Test performed in accordance with ISRM Suggested Methods : 2007, unless noted otherwise

Detailed legend for test and dimensions, based on ISRM, is shown above.

Size factor, F = (De/50)0.45 for all tests.

LAB 17R - Version 5

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06/10/2022 00:00	Stephen.Watson

10122

CAUSEWAY GEOTECH

Point Load Strength Index Tests
Summary of Results

Project No.	Project Name
21-1031	Scapa Deep Water Quay - Marine GI

Borehole No.	Sample			Specimen		Rock Type	Test Type see ISRM		Failure Valid (Y/N)	Dimensions				Force P	Equivalent diameter, De	Point Load Strength Index		Remarks (including water content if measured)
	Depth m	Ref.	Type	Ref.	Depth m		Type (D, A, I, B)	Direction (L, P or U)		Lne mm	W mm	Dps mm	Dps' mm	kN	mm	Is MPa	Is(50) MPa	
BH-M14	7.05	7	C	3	7.05	SANDSTONE	A	U	YES		100.9	87.0	85.0	9.3	104.5	0.9	1.2	
BH-M14	7.40	8	C	3	7.40	SANDSTONE	A	U	YES		101.1	89.0	87.0	9.8	105.8	0.9	1.2	
BH-M14	8.40	9	C	3	8.40	SANDSTONE	A	U	YES		101.4	94.0	92.0	10.4	109.0	0.9	1.2	
BH-M15	4.35	1	C	3	4.35	SANDSTONE	I	U	YES	37.4	70.8	52.0	41.0	0.1	60.8	0.0	0.0	
BH-M15	5.20	2	C	3	5.20	SANDSTONE	A	U	YES		101.6	91.0	86.0	20.2	105.5	1.8	2.5	
BH-M15	6.20	4	C	3	6.20	SANDSTONE	I	U	YES	84.1	80.8	86.0	84.0	1.0	93.0	0.1	0.2	
BH-M15	8.20	5	C	3	8.20	SANDSTONE	A	U	YES		99.7	101.0	92.0	0.5	108.1	0.0	0.1	
BH-M16	2.85	2	C	3	2.85	SANDSTONE	A	U	YES		101.1	84.0	82.0	10.7	102.7	1.0	1.4	
BH-M16	4.10	3	C	3	4.10	SANDSTONE	I	U	YES	93.4	77.6	87.0	86.0	1.9	92.2	0.2	0.3	
BH-M16	6.00	4	C	3	6.00	SANDSTONE	A	U	YES		100.8	92.0	90.0	22.6	107.5	2.0	2.8	
BH-M16	7.50	6	C	3	7.50	SANDSTONE	I	U	YES	91.7	78.0	50.0	49.0	4.3	69.7	0.9	1.0	
BH-M16	7.75	7	C	3	7.75	SANDSTONE	A	U	YES		100.9	103.0	99.0	7.9	112.8	0.6	0.9	
BH-M17	1.45	2	C	3	1.45	SANDSTONE	A	U	YES		100.8	41.0	37.0	0.3	68.9	0.1	0.1	
BH-M17	2.65	3	C	3	2.65	SANDSTONE	A	U	YES		101.2	31.0	29.0	1.7	61.1	0.5	0.5	
BH-M17	3.30	5	C	3	3.30	SANDSTONE	A	U	YES		101.2	46.0	44.0	3.5	75.3	0.6	0.7	
BH-M17	4.30	7	C	3	4.30	SANDSTONE	A	U	YES		100.9	48.0	47.0	1.2	77.7	0.2	0.2	
BH-M17	5.65	8	C	3	5.65	SANDSTONE	I	U	YES	75.4	62.5	55.0	51.0	0.9	63.7	0.2	0.2	
BH-M26	3.40	1	C	3	3.40	SANDSTONE	A	U	YES		100.5	68.0	31.0	0.1	63.0	0.0	0.0	

Test Type
D - Diametral, A - Axial, I - Irregular Lump, B - Block
Direction
L - parallel to planes of weakness
P - perpendicular to planes of weakness
U - unknown or random
Dimensions
Dps - Distance between platens (platen separation)
Dps' - at failure (see ISRM note 6)
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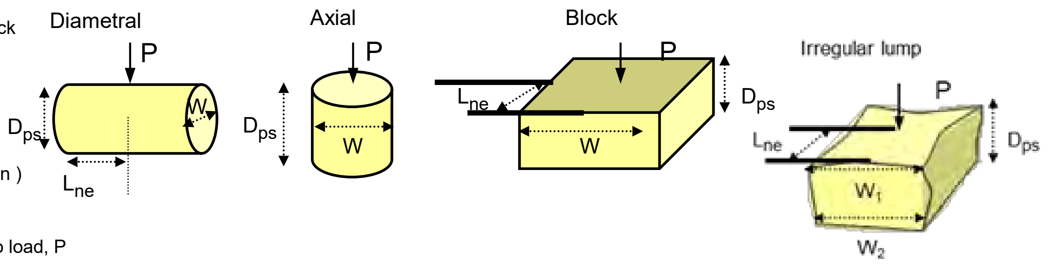

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Size factor, F = (De/50)0.45 for all tests.

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Stephen.Watson

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CAUSEWAY GEOTECH

Point Load Strength Index Tests
Summary of Results

Project No.	Project Name
21-1031	Scapa Deep Water Quay - Marine GI

Borehole No.	Sample			Specimen		Rock Type	Test Type see ISRM		Failure Valid (Y/N)	Dimensions				Force P	Equivalent diameter, De	Point Load Strength Index		Remarks (including water content if measured)
	Depth m	Ref.	Type	Ref.	Depth m		Type (D, A, I, B)	Direction (L, P or U)		Lne mm	W mm	Dps mm	Dps' mm	kN	mm	Is MPa	Is(50) MPa	
BH-M26	4.45	3	C	3	4.45	SANDSTONE	I	U	YES	43.2	72.7	48.0	44.0	5.5	63.8	1.4	1.5	
BH-M26	5.25	4	C	3	5.25	SANDSTONE	A	U	YES		101.0	56.0	51.0	0.2	81.0	0.0	0.0	
BH-M26	6.10	5	C	3	6.10	SANDSTONE	I	U	YES	45.8	55.2	60.0	58.0	0.1	63.8	0.0	0.0	
BH-M26	8.50	7	C	3	8.50	SANDSTONE	I	U	YES	91.4	80.9	52.0	50.0	2.3	71.7	0.4	0.5	
BH-M26	9.90	9	C	3	9.90	SANDSTONE	A	U	YES		101.4	92.0	89.0	0.7	107.2	0.1	0.1	

Test Type
D - Diametral, A - Axial, I - Irregular Lump, B - Block
Direction
L - parallel to planes of weakness
P - perpendicular to planes of weakness
U - unknown or random
Dimensions
Dps - Distance between platens (platen separation)
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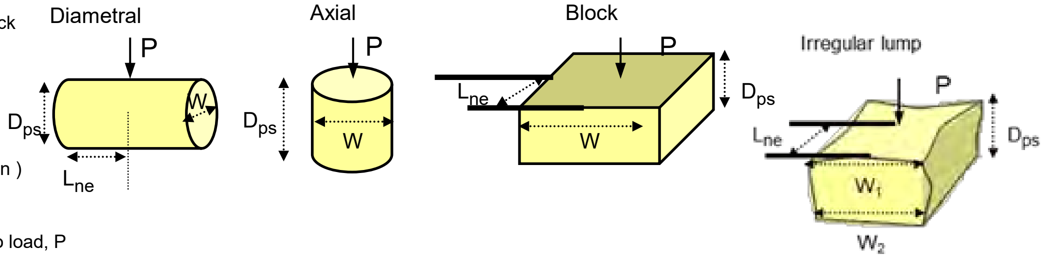

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LAB 17R - Version 5

Date Printed

06/10/2022 00:00

Approved By

Stephen.Watson

UKAS TESTING
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MATtest Limited
materials testing & consultancy

LABORATORY TEST CERTIFICATE

10 Queenslie Point
Queenslie Industrial Estate
120 Stepps Road
Glasgow
G33 3NQ

Tel: 0141 774 4032

email: info@mattest.org
Website: www.mattest.org

Certificate No : **22/538 - 01**

To : **Stephen Watson**

Client : **Causeway Geotech Limited**
8 Drumahiskey Road
Ballymoney
Co. Antrim
BT53 7QL

LABORATORY TESTING OF ROCK

Introduction

We refer to samples taken from Scapa DWQ & Hatston Pier Development and delivered to our laboratory on 05th May 2022.

Material & Source

Sample Reference : See Report Plates

Sampled By : Client

Sampling Certificate : Not Supplied

Location : See Report Plates

Description : Rock Cores

Date Sampled : Not Supplied

Date Tested : 05th May 2022 Onwards

Source : 21-1031 - Scapa DWQ & Hatston Pier Development

Test Results

As Detailed On Page 2 to Page 20 inclusive

Comments

The results contained in this report relate to the sample(s) as received
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
This report should not be reproduced except in full without the written approval of the laboratory
All remaining samples for this project will be disposed of 28 days after issue of this test certificate

Remarks

Approved for Issue

T McLelland (Director)

Date 08/06/2022

BOREHOLE	SAMPLE	DEPTH (m)	WATER CONTENT (%)	BULK DENSITY (Mg/m^3)	DRY DENSITY (Mg/m^3)
BH-M01	C2	3.80-4.20	7.3	-	-
BH-M01	C6	7.10-7.25	6.7	-	-
BH-M01	C11	10.75-10.95	4.2	-	-
BH-M02	C4	3.20-3.40	8.2	-	-
BH-M02	C11	8.00-8.30	4.6	2.40	2.29
BH-M02	C15	13.20-13.45	5.3	2.33	2.21
BH-M03	C3	6.15-6.50	6.0	2.32	2.19
BH-M03	C9	9.45-9.80	8.3	2.30	2.12
BH-M04	C1	3.70-3.85	5.5	-	-
BH-M04	C3	6.00-6.20	5.7	-	-
BH-M04	C9	8.60-9.00	6.5	2.31	2.17
BH-M05	C2	5.90-6.00	4.7	-	-
BH-M05	C8	10.60-10.80	5.1	-	-
BH-M06	C2	3.30-4.50	1.1	-	-
BH-M06	C5	6.30-6.50	6.9	-	-
BH-M06	C9	10.50-10.80	7.1	-	-
BH-M07	C5	9.30-9.40	6.0	-	-
BH-M08	C1	4.90-5.85	1.6	-	-
BH-M08	C4	6.90-7.05	4.9	-	-
BH-M08	C7	9.35-9.50	6.5	-	-
BH-M08	C10	10.50-11.00	3.8	2.35	2.26
BH-M09	C3	5.10-5.30	2.8	-	-
BH-M09	C8	9.50-9.70	5.5	-	-

Tested in accordance with ISRM (2007)

SUMMARY OF WATER CONTENT AND DENSITY TEST RESULTS

BOREHOLE	SAMPLE	DEPTH (m)	WATER CONTENT (%)	BULK DENSITY (Mg/m^3)	DRY DENSITY (Mg/m^3)
BH-M10	C7	8.30-8.55	6.1	2.27	2.14
BH-M11	C3	5.60-6.00	5.5	-	-
BH-M11	C7	8.15-8.45	6.6	2.29	2.15
BH-M12	C2	2.75-3.00	2.7	-	-
BH-M12	C5	4.80-5.00	3.6	-	-
BH-M12	C11	9.40-9.80	2.4	2.29	2.24
BH-M12	C14	11.30-11.70	2.7	2.39	2.33
BH-M13	C3	5.20-5.25	5.0	-	-
BH-M13	C6	6.60-7.10	2.4	2.30	2.25
BH-M13	C10	10.10-10.50	3.9	2.42	2.33
BH-M14	C3	5.40-5.70	4.9	2.40	2.29
BH-M14	C5	6.00-6.30	5.1	2.33	2.22
BH-M15	C3	5.40-5.60	9.1	-	-
BH-M15	C6	8.50-8.80	4.9	2.35	2.24
BH-M16	C1	2.00-3.50	2.4	-	-
BH-M16	C5	7.30-7.50	4.6	-	-
BH-M17	C1	1.00-2.50	2.1	-	-
BH-M17	C6	4.15-4.30	3.0	-	-
BH-M26	C2	3.60-3.85	6.2	-	-
BH-M26	C6	6.60-6.80	5.6	-	-

Tested in accordance with ISRM (2007)

SUMMARY OF WATER CONTENT AND DENSITY TEST RESULTS

BOREHOLE	SAMPLE	DEPTH (m)	SLAKING FLUID	FLUID TEMPERATURE (°C)	APPEARANCE OF FRAGMENTS RETAINED IN THE DRUM (see notes)	APPEARANCE OF MATERIAL PASSING THROUGH THE DRUM (see notes)	SLAKE DURABILITY INDEX (%)
BH-M02	C2	2.00-3.00	Water	20 ± 2	R2	P2	61.6
BH-M06	C2	3.30-4.50	Water	20 ± 2	R1	P2	88.7
BH-M08	C1	4.90-5.85	Water	20 ± 2	R1	P2	62.8
BH-M12	C3	3.00-4.50	Water	20 ± 2	R1	P2	93.7
BH-M14	C2	3.70-4.50	Water	20 ± 2	R1	P2	83.4
BH-M16	C1	2.00-3.50	Water	20 ± 2	R1	P2	93.1
BH-M17	C1	1.00-2.50	Water	20 ± 2	R1	P2	78.4

Notes

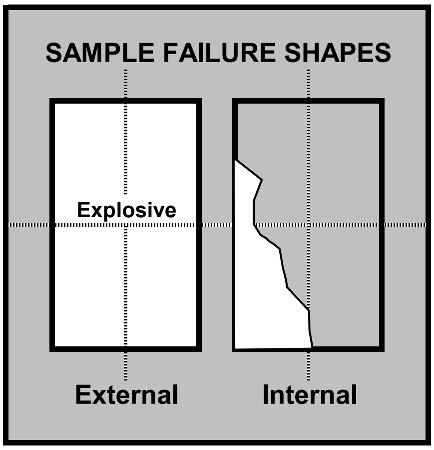
Appearance of fragments retained in the drum
R1. Retained pieces remain virtually unchanged
R2. Retained fragments consist of small and large pieces
R3. Retained fragments are mainly small pieces

Appearance of material passing through the drum
P1. Passing material consists of mainly coarse sand sized particles
P2. Passing material ranges from fine to coarse sand sized particles
P3. Passing material consists of mainly clay / silt sized particles

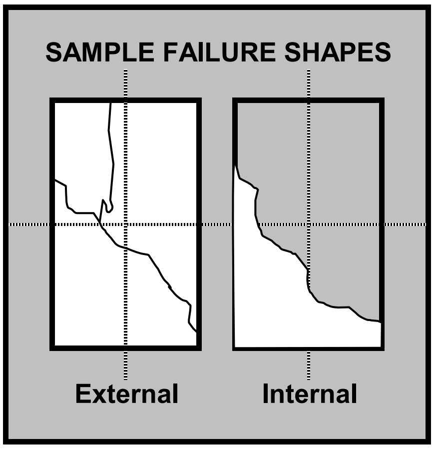
Tested in accordance with ISRM (2007)

SUMMARY OF SLAKE DURABILITY INDEX (SECOND CYCLE)

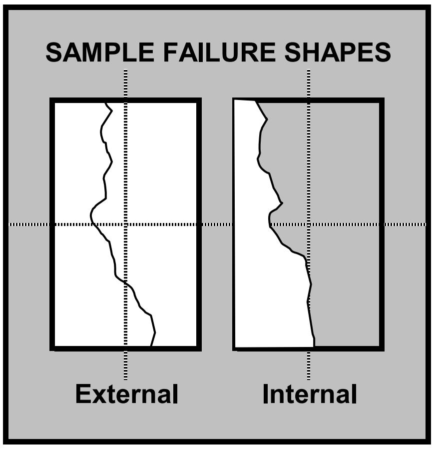
BOREHOLE		**BH-M02**
SAMPLE		**C8**
DEPTH	m	**6.85-7.30**
SAMPLE DIAMETER	mm	**101.60**
SAMPLE HEIGHT	mm	**210.41**
TEST CONDITION		**As Received**
RATE OF LOADING	kN/s	**0.6**
TEST DURATION	min.sec	**8.40**
DATE OF TESTING		**06/06/2022**
LOAD FRAME USED		**2000kN**
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		**Unknown**
FAILURE LOAD	kN	**326.1**
UNCONFINED COMPRESSIVE STRENGTH	MPa	**40.2**
WATER CONTENT (ISRM Suggested Methods)	%	**4.4**
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.36**
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.26**



BOREHOLE		**BH-M02**
SAMPLE		**C11**
DEPTH	m	**8.00-8.30**
SAMPLE DIAMETER	mm	**101.60**
SAMPLE HEIGHT	mm	**207.88**
TEST CONDITION		**As Received**
RATE OF LOADING	kN/s	**0.9**
TEST DURATION	min.sec	**2.49**
DATE OF TESTING		**06/06/2022**
LOAD FRAME USED		**2000kN**
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		**Unknown**
FAILURE LOAD	kN	**136.1**
UNCONFINED COMPRESSIVE STRENGTH	MPa	**16.8**
WATER CONTENT (ISRM Suggested Methods)	%	**4.6**
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.40**
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.29**



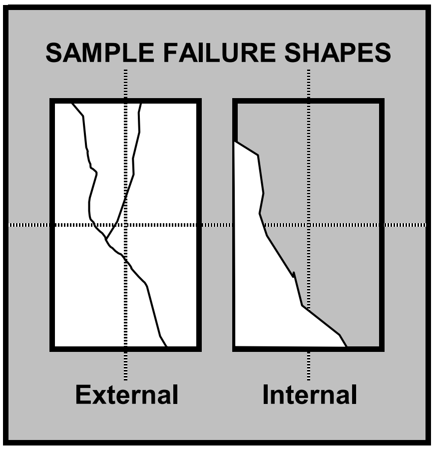
BOREHOLE		**BH-M02**
SAMPLE		**C15**
DEPTH	m	**13.20-13.45**
SAMPLE DIAMETER	mm	**101.51**
SAMPLE HEIGHT	mm	**201.90**
TEST CONDITION		**As Received**
RATE OF LOADING	kN/s	**1.1**
TEST DURATION	min.sec	**4.50**
DATE OF TESTING		**06/06/2022**
LOAD FRAME USED		**2000kN**
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		**Unknown**
FAILURE LOAD	kN	**305.0**
UNCONFINED COMPRESSIVE STRENGTH	MPa	**37.7**
WATER CONTENT (ISRM Suggested Methods)	%	**5.3**
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.33**
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.21**



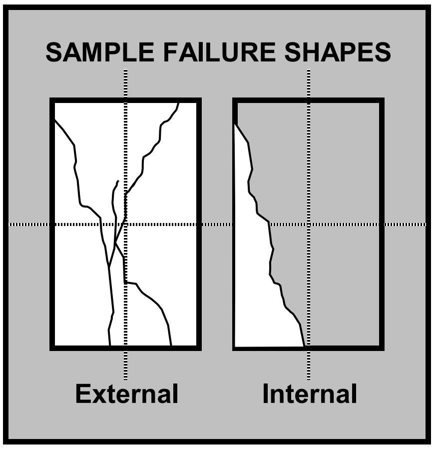
Tested in accordance with ASTM D7012 - 14

SUMMARY OF UNCONFINED COMPRESSIVE STRENGTH

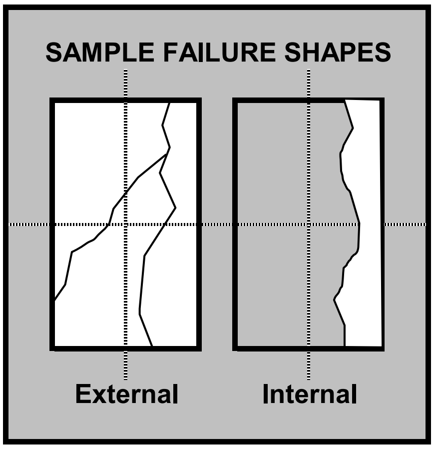
BOREHOLE		**BH-M03**
SAMPLE		**C3**
DEPTH	m	**6.15-6.50**
SAMPLE DIAMETER	mm	**101.47**
SAMPLE HEIGHT	mm	**213.41**
TEST CONDITION		**As Received**
RATE OF LOADING	kN/s	**1.0**
TEST DURATION	min.sec	**6.23**
DATE OF TESTING		**06/06/2022**
LOAD FRAME USED		**2000kN**
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		**Unknown**
FAILURE LOAD	kN	**357.4**
UNCONFINED COMPRESSIVE STRENGTH	MPa	**44.2**
WATER CONTENT (ISRM Suggested Methods)	%	**6.0**
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.32**
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.19**



BOREHOLE		**BH-M03**
SAMPLE		**C7**
DEPTH	m	**8.90-9.20**
SAMPLE DIAMETER	mm	**101.59**
SAMPLE HEIGHT	mm	**211.41**
TEST CONDITION		**As Received**
RATE OF LOADING	kN/s	**1.0**
TEST DURATION	min.sec	**4.46**
DATE OF TESTING		**06/06/2022**
LOAD FRAME USED		**2000kN**
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		**Unknown**
FAILURE LOAD	kN	**269.7**
UNCONFINED COMPRESSIVE STRENGTH	MPa	**33.3**
WATER CONTENT (ISRM Suggested Methods)	%	**6.5**
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.31**
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.17**



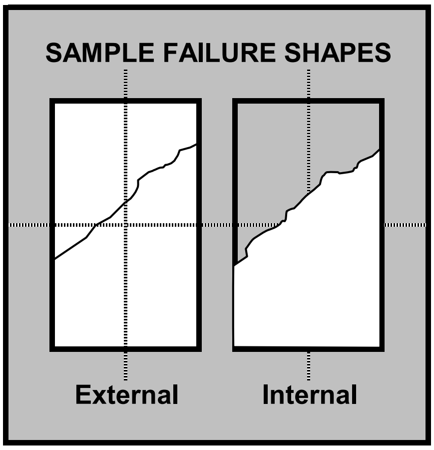
BOREHOLE		**BH-M03**
SAMPLE		**C9**
DEPTH	m	**9.45-9.80**
SAMPLE DIAMETER	mm	**101.61**
SAMPLE HEIGHT	mm	**209.90**
TEST CONDITION		**As Received**
RATE OF LOADING	kN/s	**0.9**
TEST DURATION	min.sec	**4.08**
DATE OF TESTING		**06/06/2022**
LOAD FRAME USED		**2000kN**
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		**Unknown**
FAILURE LOAD	kN	**228.3**
UNCONFINED COMPRESSIVE STRENGTH	MPa	**28.2**
WATER CONTENT (ISRM Suggested Methods)	%	**8.3**
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.30**
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.12**



Tested in accordance with ASTM D7012 - 14

SUMMARY OF UNCONFINED COMPRESSIVE STRENGTH

BOREHOLE		BH-M03
SAMPLE		C10
DEPTH	m	9.80-10.10
SAMPLE DIAMETER	mm	101.59
SAMPLE HEIGHT	mm	210.13
TEST CONDITION		As Received
RATE OF LOADING	kN/s	0.5
TEST DURATION	min.sec	2.25
DATE OF TESTING		06/06/2022
LOAD FRAME USED		2000kN
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		Unknown
FAILURE LOAD	kN	65.1
UNCONFINED COMPRESSIVE STRENGTH	MPa	8.0
WATER CONTENT (ISRM Suggested Methods)	%	6.9
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	2.31
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	2.17



BOREHOLE		
SAMPLE		
DEPTH	m	
SAMPLE DIAMETER	mm	
SAMPLE HEIGHT	mm	
TEST CONDITION		
RATE OF LOADING	kN/s	
TEST DURATION	min.sec	
DATE OF TESTING		
LOAD FRAME USED		
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		
FAILURE LOAD	kN	
UNCONFINED COMPRESSIVE STRENGTH	MPa	
WATER CONTENT (ISRM Suggested Methods)	%	
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	

SAMPLE FAILURE SHAPES

External Internal

BOREHOLE		
SAMPLE		
DEPTH	m	
SAMPLE DIAMETER	mm	
SAMPLE HEIGHT	mm	
TEST CONDITION		
RATE OF LOADING	kN/s	
TEST DURATION	min.sec	
DATE OF TESTING		
LOAD FRAME USED		
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		
FAILURE LOAD	kN	
UNCONFINED COMPRESSIVE STRENGTH	MPa	
WATER CONTENT (ISRM Suggested Methods)	%	
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	

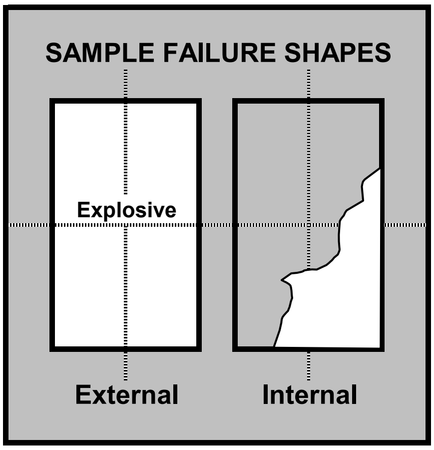
SAMPLE FAILURE SHAPES

External Internal

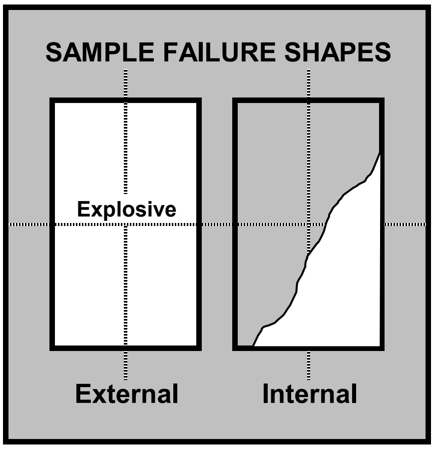
Tested in accordance with ASTM D7012 - 14

SUMMARY OF UNCONFINED COMPRESSIVE STRENGTH

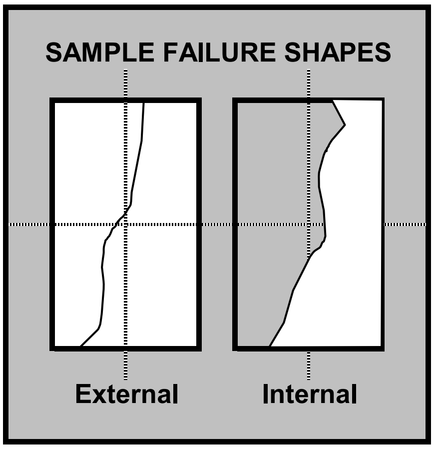
BOREHOLE		**BH-M04**
SAMPLE		**C9**
DEPTH	m	**8.60-9.00**
SAMPLE DIAMETER	mm	**101.56**
SAMPLE HEIGHT	mm	**209.19**
TEST CONDITION		**As Received**
RATE OF LOADING	kN/s	**1.0**
TEST DURATION	min.sec	**6.19**
DATE OF TESTING		**06/06/2022**
LOAD FRAME USED		**2000kN**
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		**Unknown**
FAILURE LOAD	kN	**359.1**
UNCONFINED COMPRESSIVE STRENGTH	MPa	**44.3**
WATER CONTENT (ISRM Suggested Methods)	%	**6.5**
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.31**
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.17**



BOREHOLE		**BH-M04**
SAMPLE		**C10**
DEPTH	m	**9.40-9.70**
SAMPLE DIAMETER	mm	**101.51**
SAMPLE HEIGHT	mm	**207.43**
TEST CONDITION		**As Received**
RATE OF LOADING	kN/s	**0.9**
TEST DURATION	min.sec	**6.10**
DATE OF TESTING		**06/06/2022**
LOAD FRAME USED		**2000kN**
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		**Unknown**
FAILURE LOAD	kN	**332.7**
UNCONFINED COMPRESSIVE STRENGTH	MPa	**41.1**
WATER CONTENT (ISRM Suggested Methods)	%	**7.1**
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.35**
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.19**



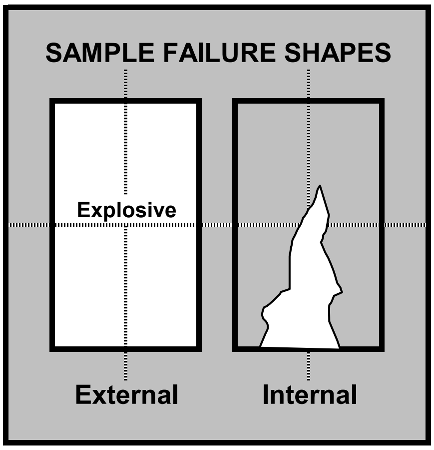
BOREHOLE		**BH-M04**
SAMPLE		**C12**
DEPTH	m	**10.00-10.50**
SAMPLE DIAMETER	mm	**101.60**
SAMPLE HEIGHT	mm	**211.15**
TEST CONDITION		**As Received**
RATE OF LOADING	kN/s	**1.0**
TEST DURATION	min.sec	**4.39**
DATE OF TESTING		**06/06/2022**
LOAD FRAME USED		**2000kN**
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		**Unknown**
FAILURE LOAD	kN	**267.2**
UNCONFINED COMPRESSIVE STRENGTH	MPa	**33.0**
WATER CONTENT (ISRM Suggested Methods)	%	**5.5**
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.33**
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.21**



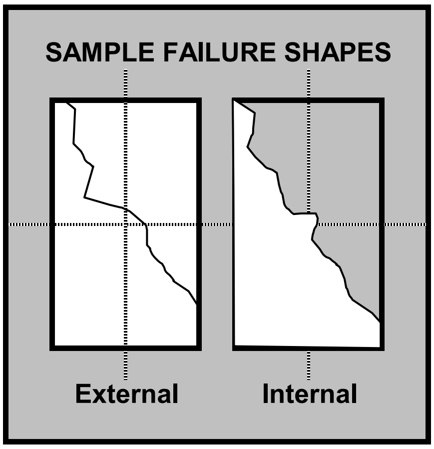
Tested in accordance with ASTM D7012 - 14

SUMMARY OF UNCONFINED COMPRESSIVE STRENGTH

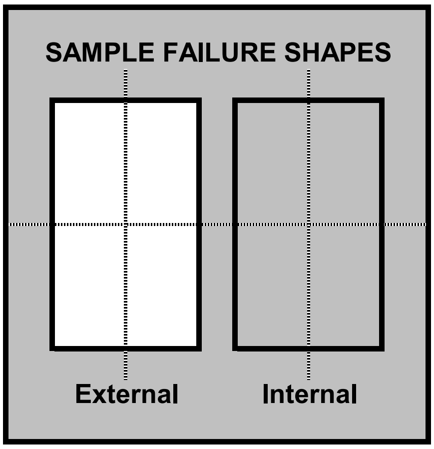
BOREHOLE		**BH-M04**
SAMPLE		**C15**
DEPTH	m	**12.45-12.75**
SAMPLE DIAMETER	mm	**101.68**
SAMPLE HEIGHT	mm	**211.61**
TEST CONDITION		**As Received**
RATE OF LOADING	kN/s	**0.9**
TEST DURATION	min.sec	**5.10**
DATE OF TESTING		**06/06/2022**
LOAD FRAME USED		**2000kN**
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		**Unknown**
FAILURE LOAD	kN	**288.9**
UNCONFINED COMPRESSIVE STRENGTH	MPa	**35.6**
WATER CONTENT (ISRM Suggested Methods)	%	**6.2**
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.31**
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.17**



BOREHOLE		**BH-M04**
SAMPLE		**C16**
DEPTH	m	**13.25-13.50**
SAMPLE DIAMETER	mm	**101.80**
SAMPLE HEIGHT	mm	**206.91**
TEST CONDITION		**As Received**
RATE OF LOADING	kN/s	**1.0**
TEST DURATION	min.sec	**5.48**
DATE OF TESTING		**06/06/2022**
LOAD FRAME USED		**2000kN**
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		**Unknown**
FAILURE LOAD	kN	**327.9**
UNCONFINED COMPRESSIVE STRENGTH	MPa	**40.3**
WATER CONTENT (ISRM Suggested Methods)	%	**5.1**
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.36**
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.25**



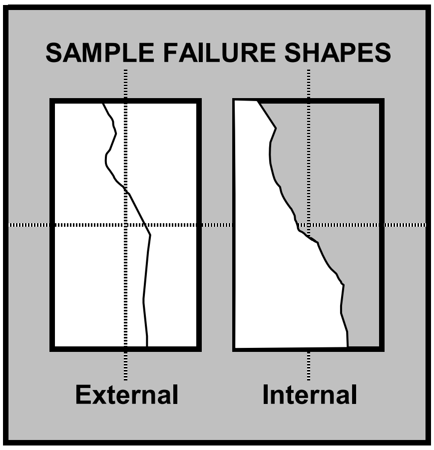
BOREHOLE		
SAMPLE		
DEPTH	m	
SAMPLE DIAMETER	mm	
SAMPLE HEIGHT	mm	
TEST CONDITION		
RATE OF LOADING	kN/s	
TEST DURATION	min.sec	
DATE OF TESTING		
LOAD FRAME USED		
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		
FAILURE LOAD	kN	
UNCONFINED COMPRESSIVE STRENGTH	MPa	
WATER CONTENT (ISRM Suggested Methods)	%	
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	



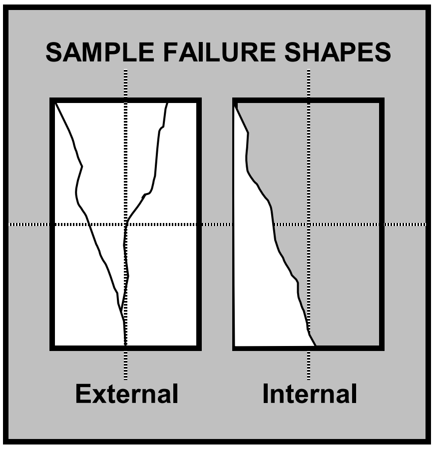
Tested in accordance with ASTM D7012 - 14

SUMMARY OF UNCONFINED COMPRESSIVE STRENGTH

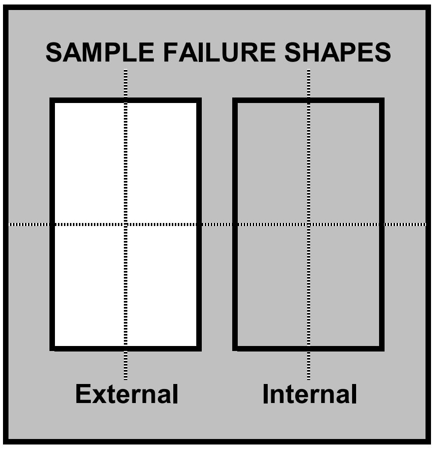
BOREHOLE		**BH-M08**
SAMPLE		**C10**
DEPTH	m	**10.50-11.00**
SAMPLE DIAMETER	mm	**101.61**
SAMPLE HEIGHT	mm	**207.67**
TEST CONDITION		**As Received**
RATE OF LOADING	kN/s	**0.9**
TEST DURATION	min.sec	**5.00**
DATE OF TESTING		**06/06/2022**
LOAD FRAME USED		**2000kN**
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		**Unknown**
FAILURE LOAD	kN	**269.1**
UNCONFINED COMPRESSIVE STRENGTH	MPa	**33.2**
WATER CONTENT (ISRM Suggested Methods)	%	**3.8**
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.35**
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.27**



BOREHOLE		**BH-M08**
SAMPLE		**C11**
DEPTH	m	**11.00-11.25**
SAMPLE DIAMETER	mm	**101.48**
SAMPLE HEIGHT	mm	**199.54**
TEST CONDITION		**As Received**
RATE OF LOADING	kN/s	**1.0**
TEST DURATION	min.sec	**5.30**
DATE OF TESTING		**06/06/2022**
LOAD FRAME USED		**2000kN**
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		**Unknown**
FAILURE LOAD	kN	**304.6**
UNCONFINED COMPRESSIVE STRENGTH	MPa	**37.7**
WATER CONTENT (ISRM Suggested Methods)	%	**4.3**
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.39**
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.29**



BOREHOLE		
SAMPLE		
DEPTH	m	
SAMPLE DIAMETER	mm	
SAMPLE HEIGHT	mm	
TEST CONDITION		
RATE OF LOADING	kN/s	
TEST DURATION	min.sec	
DATE OF TESTING		
LOAD FRAME USED		
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		
FAILURE LOAD	kN	
UNCONFINED COMPRESSIVE STRENGTH	MPa	
WATER CONTENT (ISRM Suggested Methods)	%	
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	

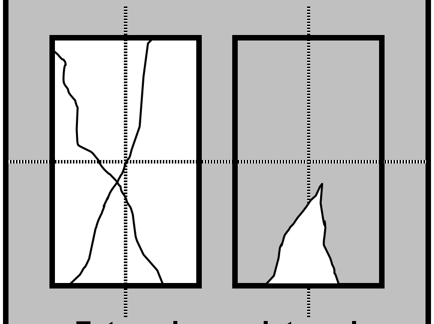


Tested in accordance with ASTM D7012 - 14

SUMMARY OF UNCONFINED COMPRESSIVE STRENGTH

BOREHOLE		**BH-M09**
SAMPLE		**C6**
DEPTH	m	**7.30-7.50**
SAMPLE DIAMETER	mm	**101.52**
SAMPLE HEIGHT	mm	**201.51**
TEST CONDITION		**As Received**
RATE OF LOADING	kN/s	**1.0**
TEST DURATION	min.sec	**8.22**
DATE OF TESTING		**06/06/2022**
LOAD FRAME USED		**2000kN**
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		**Unknown**
FAILURE LOAD	kN	**482.9**
UNCONFINED COMPRESSIVE STRENGTH	MPa	**59.7**
WATER CONTENT (ISRM Suggested Methods)	%	**6.7**
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.36**
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.21**

SAMPLE FAILURE SHAPES



External **Internal**

BOREHOLE		
SAMPLE		
DEPTH	m	
SAMPLE DIAMETER	mm	
SAMPLE HEIGHT	mm	
TEST CONDITION		
RATE OF LOADING	kN/s	
TEST DURATION	min.sec	
DATE OF TESTING		
LOAD FRAME USED		
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		
FAILURE LOAD	kN	
UNCONFINED COMPRESSIVE STRENGTH	MPa	
WATER CONTENT (ISRM Suggested Methods)	%	
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	

SAMPLE FAILURE SHAPES

External **Internal**

BOREHOLE		
SAMPLE		
DEPTH	m	
SAMPLE DIAMETER	mm	
SAMPLE HEIGHT	mm	
TEST CONDITION		
RATE OF LOADING	kN/s	
TEST DURATION	min.sec	
DATE OF TESTING		
LOAD FRAME USED		
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		
FAILURE LOAD	kN	
UNCONFINED COMPRESSIVE STRENGTH	MPa	
WATER CONTENT (ISRM Suggested Methods)	%	
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	

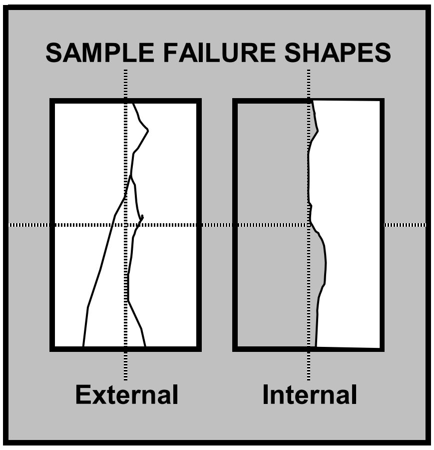
SAMPLE FAILURE SHAPES

External **Internal**

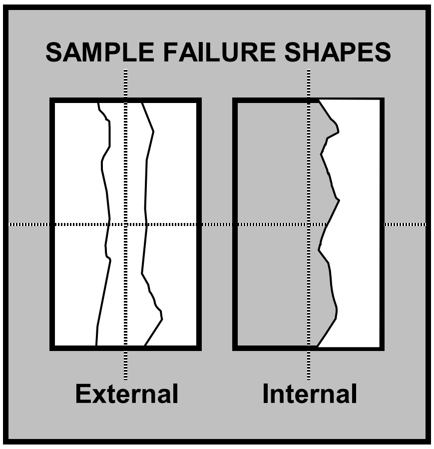
Tested in accordance with ASTM D7012 - 14

SUMMARY OF UNCONFINED COMPRESSIVE STRENGTH

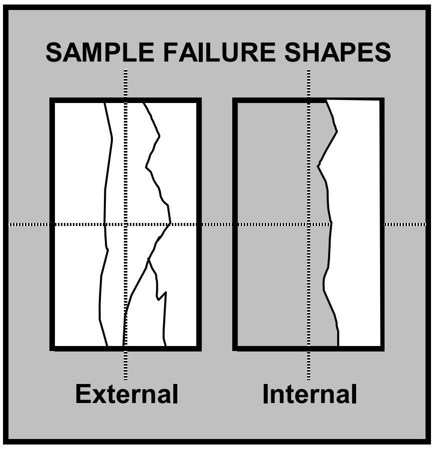
BOREHOLE		**BH-M10**
SAMPLE		**C7**
DEPTH	m	**8.30-8.55**
SAMPLE DIAMETER	mm	**101.50**
SAMPLE HEIGHT	mm	**202.50**
TEST CONDITION		**As Received**
RATE OF LOADING	kN/s	**1.0**
TEST DURATION	min.sec	**4.35**
DATE OF TESTING		**06/06/2022**
LOAD FRAME USED		**2000kN**
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		**Unknown**
FAILURE LOAD	kN	**263.7**
UNCONFINED COMPRESSIVE STRENGTH	MPa	**32.6**
WATER CONTENT (ISRM Suggested Methods)	%	**6.1**
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.27**
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.14**



BOREHOLE		**BH-M10**
SAMPLE		**C8**
DEPTH	m	**9.70-10.00**
SAMPLE DIAMETER	mm	**101.31**
SAMPLE HEIGHT	mm	**201.79**
TEST CONDITION		**As Received**
RATE OF LOADING	kN/s	**1.0**
TEST DURATION	min.sec	**2.49**
DATE OF TESTING		**06/06/2022**
LOAD FRAME USED		**2000kN**
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		**Unknown**
FAILURE LOAD	kN	**155.9**
UNCONFINED COMPRESSIVE STRENGTH	MPa	**19.3**
WATER CONTENT (ISRM Suggested Methods)	%	**7.6**
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.32**
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.16**



BOREHOLE		**BH-M10**
SAMPLE		**C10**
DEPTH	m	**10.60-11.20**
SAMPLE DIAMETER	mm	**101.52**
SAMPLE HEIGHT	mm	**206.79**
TEST CONDITION		**As Received**
RATE OF LOADING	kN/s	**1.0**
TEST DURATION	min.sec	**4.15**
DATE OF TESTING		**06/06/2022**
LOAD FRAME USED		**2000kN**
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		**Unknown**
FAILURE LOAD	kN	**242.1**
UNCONFINED COMPRESSIVE STRENGTH	MPa	**29.9**
WATER CONTENT (ISRM Suggested Methods)	%	**4.3**
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.26**
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.17**

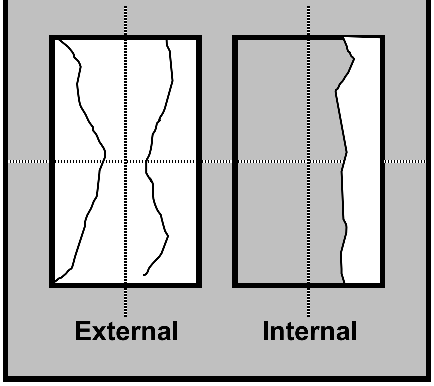


Tested in accordance with ASTM D7012 - 14

SUMMARY OF UNCONFINED COMPRESSIVE STRENGTH

BOREHOLE		**BH-M10**
SAMPLE		**C11**
DEPTH	m	**11.20-11.55**
SAMPLE DIAMETER	mm	**101.62**
SAMPLE HEIGHT	mm	**207.34**
TEST CONDITION		**As Received**
RATE OF LOADING	kN/s	**0.9**
TEST DURATION	min.sec	**3.24**
DATE OF TESTING		**06/06/2022**
LOAD FRAME USED		**2000kN**
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		**Unknown**
FAILURE LOAD	kN	**182.9**
UNCONFINED COMPRESSIVE STRENGTH	MPa	**22.6**
WATER CONTENT (ISRM Suggested Methods)	%	**7.2**
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.33**
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.17**

SAMPLE FAILURE SHAPES



BOREHOLE		
SAMPLE		
DEPTH	m	
SAMPLE DIAMETER	mm	
SAMPLE HEIGHT	mm	
TEST CONDITION		
RATE OF LOADING	kN/s	
TEST DURATION	min.sec	
DATE OF TESTING		
LOAD FRAME USED		
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		
FAILURE LOAD	kN	
UNCONFINED COMPRESSIVE STRENGTH	MPa	
WATER CONTENT (ISRM Suggested Methods)	%	
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	

SAMPLE FAILURE SHAPES

External Internal

BOREHOLE		
SAMPLE		
DEPTH	m	
SAMPLE DIAMETER	mm	
SAMPLE HEIGHT	mm	
TEST CONDITION		
RATE OF LOADING	kN/s	
TEST DURATION	min.sec	
DATE OF TESTING		
LOAD FRAME USED		
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		
FAILURE LOAD	kN	
UNCONFINED COMPRESSIVE STRENGTH	MPa	
WATER CONTENT (ISRM Suggested Methods)	%	
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	

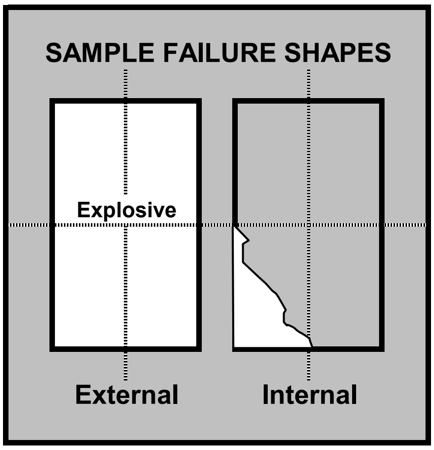
SAMPLE FAILURE SHAPES

External Internal

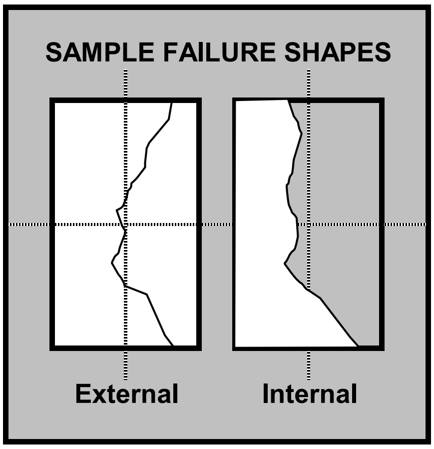
Tested in accordance with ASTM D7012 - 14

SUMMARY OF UNCONFINED COMPRESSIVE STRENGTH

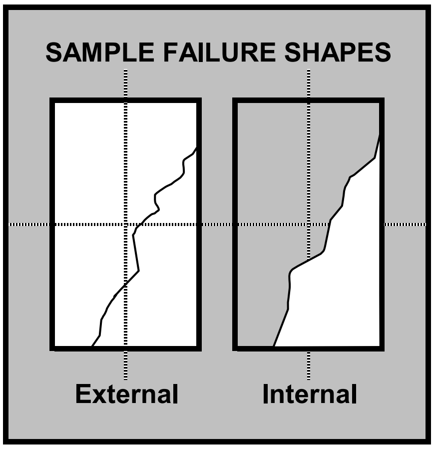
BOREHOLE		**BH-M11**
SAMPLE		**C4**
DEPTH	m	**6.40-6.80**
SAMPLE DIAMETER	mm	**101.60**
SAMPLE HEIGHT	mm	**210.18**
TEST CONDITION		**As Received**
RATE OF LOADING	kN/s	**1.0**
TEST DURATION	min.sec	**6.20**
DATE OF TESTING		**06/06/2022**
LOAD FRAME USED		**2000kN**
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		**Unknown**
FAILURE LOAD	kN	**358.6**
UNCONFINED COMPRESSIVE STRENGTH	MPa	**44.2**
WATER CONTENT (ISRM Suggested Methods)	%	**2.6**
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.25**
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.19**



BOREHOLE		**BH-M11**
SAMPLE		**C6**
DEPTH	m	**7.50-7.75**
SAMPLE DIAMETER	mm	**101.51**
SAMPLE HEIGHT	mm	**201.44**
TEST CONDITION		**As Received**
RATE OF LOADING	kN/s	**1.0**
TEST DURATION	min.sec	**4.32**
DATE OF TESTING		**06/06/2022**
LOAD FRAME USED		**2000kN**
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		**Unknown**
FAILURE LOAD	kN	**255.3**
UNCONFINED COMPRESSIVE STRENGTH	MPa	**31.5**
WATER CONTENT (ISRM Suggested Methods)	%	**4.8**
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.33**
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.22**



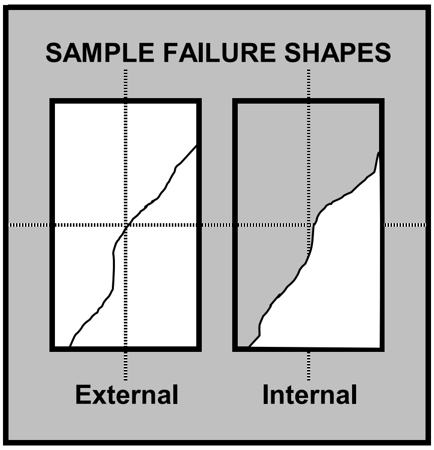
BOREHOLE		**BH-M11**
SAMPLE		**C7**
DEPTH	m	**8.15-8.45**
SAMPLE DIAMETER	mm	**101.53**
SAMPLE HEIGHT	mm	**200.18**
TEST CONDITION		**As Received**
RATE OF LOADING	kN/s	**1.0**
TEST DURATION	min.sec	**2.20**
DATE OF TESTING		**06/06/2022**
LOAD FRAME USED		**2000kN**
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		**Unknown**
FAILURE LOAD	kN	**126.2**
UNCONFINED COMPRESSIVE STRENGTH	MPa	**15.6**
WATER CONTENT (ISRM Suggested Methods)	%	**6.6**
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.29**
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.15**



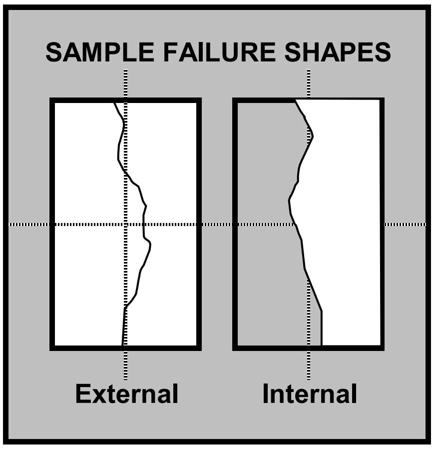
Tested in accordance with ASTM D7012 - 14

SUMMARY OF UNCONFINED COMPRESSIVE STRENGTH

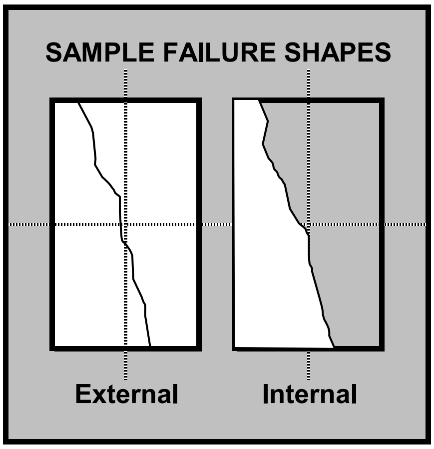
BOREHOLE		**BH-M12**
SAMPLE		**C10**
DEPTH	m	**8.25-8.55**
SAMPLE DIAMETER	mm	**101.80**
SAMPLE HEIGHT	mm	**200.89**
TEST CONDITION		**As Received**
RATE OF LOADING	kN/s	**1.0**
TEST DURATION	min.sec	**4.56**
DATE OF TESTING		**06/06/2022**
LOAD FRAME USED		**2000kN**
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		**Unknown**
FAILURE LOAD	kN	**286.5**
UNCONFINED COMPRESSIVE STRENGTH	MPa	**35.2**
WATER CONTENT (ISRM Suggested Methods)	%	**4.1**
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.37**
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.27**



BOREHOLE		**BH-M12**
SAMPLE		**C11**
DEPTH	m	**9.40-9.80**
SAMPLE DIAMETER	mm	**101.51**
SAMPLE HEIGHT	mm	**207.04**
TEST CONDITION		**As Received**
RATE OF LOADING	kN/s	**1.0**
TEST DURATION	min.sec	**4.51**
DATE OF TESTING		**06/06/2022**
LOAD FRAME USED		**2000kN**
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		**Unknown**
FAILURE LOAD	kN	**269.1**
UNCONFINED COMPRESSIVE STRENGTH	MPa	**33.3**
WATER CONTENT (ISRM Suggested Methods)	%	**2.4**
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.29**
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.24**



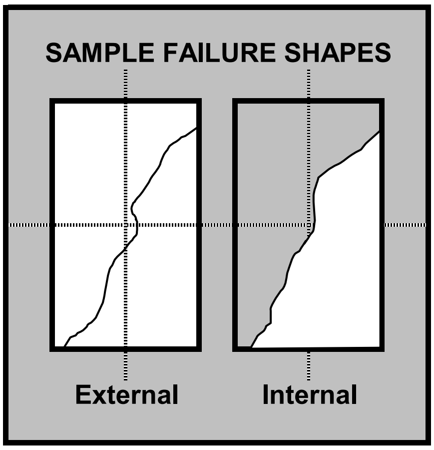
BOREHOLE		**BH-M12**
SAMPLE		**C14**
DEPTH	m	**11.30-11.70**
SAMPLE DIAMETER	mm	**101.61**
SAMPLE HEIGHT	mm	**209.54**
TEST CONDITION		**As Received**
RATE OF LOADING	kN/s	**1.0**
TEST DURATION	min.sec	**5.51**
DATE OF TESTING		**06/06/2022**
LOAD FRAME USED		**2000kN**
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		**Unknown**
FAILURE LOAD	kN	**326.1**
UNCONFINED COMPRESSIVE STRENGTH	MPa	**40.2**
WATER CONTENT (ISRM Suggested Methods)	%	**2.7**
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.39**
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.33**



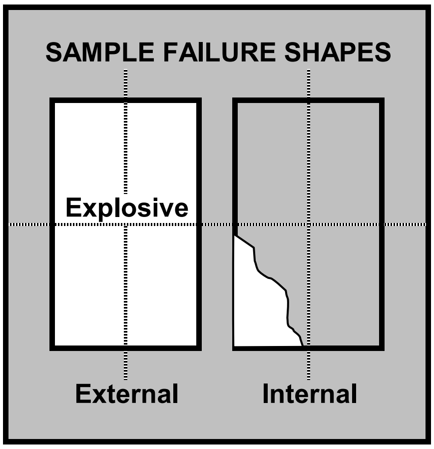
Tested in accordance with ASTM D7012 - 14

SUMMARY OF UNCONFINED COMPRESSIVE STRENGTH

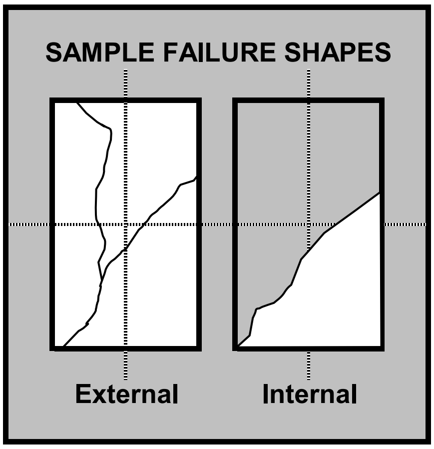
BOREHOLE		**BH-M13**
SAMPLE		**C6**
DEPTH	m	**6.60-7.10**
SAMPLE DIAMETER	mm	**101.53**
SAMPLE HEIGHT	mm	**209.25**
TEST CONDITION		**As Received**
RATE OF LOADING	kN/s	**1.0**
TEST DURATION	min.sec	**7.42**
DATE OF TESTING		**06/06/2022**
LOAD FRAME USED		**2000kN**
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		**Unknown**
FAILURE LOAD	kN	**444.5**
UNCONFINED COMPRESSIVE STRENGTH	MPa	**54.9**
WATER CONTENT (ISRM Suggested Methods)	%	**2.4**
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.30**
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.25**



BOREHOLE		**BH-M13**
SAMPLE		**C7**
DEPTH	m	**8.00-8.40**
SAMPLE DIAMETER	mm	**101.51**
SAMPLE HEIGHT	mm	**206.41**
TEST CONDITION		**As Received**
RATE OF LOADING	kN/s	**0.9**
TEST DURATION	min.sec	**14.06**
DATE OF TESTING		**06/06/2022**
LOAD FRAME USED		**2000kN**
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		**Unknown**
FAILURE LOAD	kN	**786.8**
UNCONFINED COMPRESSIVE STRENGTH	MPa	**97.2**
WATER CONTENT (ISRM Suggested Methods)	%	**4.2**
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.45**
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.36**



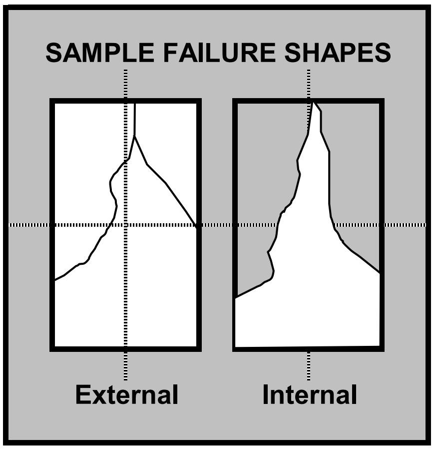
BOREHOLE		**BH-M13**
SAMPLE		**C9**
DEPTH	m	**9.25-9.50**
SAMPLE DIAMETER	mm	**101.62**
SAMPLE HEIGHT	mm	**206.17**
TEST CONDITION		**As Received**
RATE OF LOADING	kN/s	**1.1**
TEST DURATION	min.sec	**3.37**
DATE OF TESTING		**06/06/2022**
LOAD FRAME USED		**2000kN**
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		**Unknown**
FAILURE LOAD	kN	**228.7**
UNCONFINED COMPRESSIVE STRENGTH	MPa	**28.2**
WATER CONTENT (ISRM Suggested Methods)	%	**6.1**
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.37**
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.24**



Tested in accordance with ASTM D7012 - 14

SUMMARY OF UNCONFINED COMPRESSIVE STRENGTH

BOREHOLE		**BH-M13**
SAMPLE		**C10**
DEPTH	m	**10.10-10.50**
SAMPLE DIAMETER	mm	**101.60**
SAMPLE HEIGHT	mm	**203.24**
TEST CONDITION		**As Received**
RATE OF LOADING	kN/s	**1.0**
TEST DURATION	min.sec	**5.41**
DATE OF TESTING		**06/06/2022**
LOAD FRAME USED		**2000kN**
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		**Unknown**
FAILURE LOAD	kN	**322.5**
UNCONFINED COMPRESSIVE STRENGTH	MPa	**39.8**
WATER CONTENT (ISRM Suggested Methods)	%	**3.9**
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.42**
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.33**



BOREHOLE		
SAMPLE		
DEPTH	m	
SAMPLE DIAMETER	mm	
SAMPLE HEIGHT	mm	
TEST CONDITION		
RATE OF LOADING	kN/s	
TEST DURATION	min.sec	
DATE OF TESTING		
LOAD FRAME USED		
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		
FAILURE LOAD	kN	
UNCONFINED COMPRESSIVE STRENGTH	MPa	
WATER CONTENT (ISRM Suggested Methods)	%	
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	

SAMPLE FAILURE SHAPES

External Internal

BOREHOLE		
SAMPLE		
DEPTH	m	
SAMPLE DIAMETER	mm	
SAMPLE HEIGHT	mm	
TEST CONDITION		
RATE OF LOADING	kN/s	
TEST DURATION	min.sec	
DATE OF TESTING		
LOAD FRAME USED		
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		
FAILURE LOAD	kN	
UNCONFINED COMPRESSIVE STRENGTH	MPa	
WATER CONTENT (ISRM Suggested Methods)	%	
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	

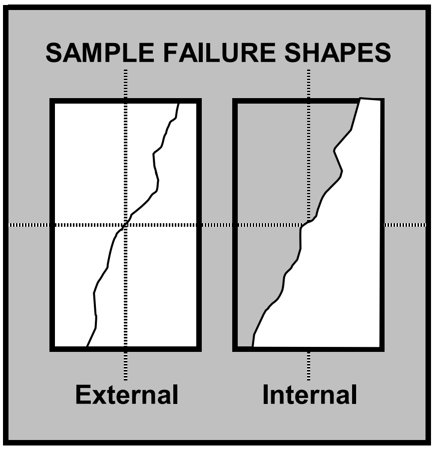
SAMPLE FAILURE SHAPES

External Internal

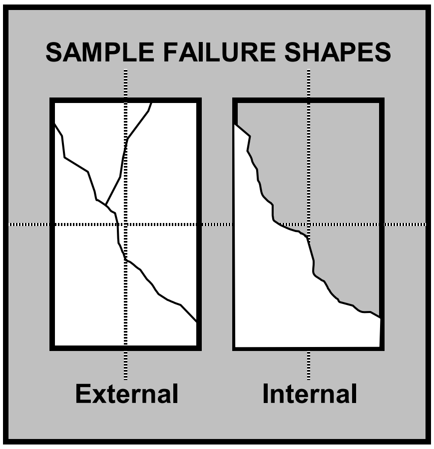
Tested in accordance with ASTM D7012 - 14

SUMMARY OF UNCONFINED COMPRESSIVE STRENGTH

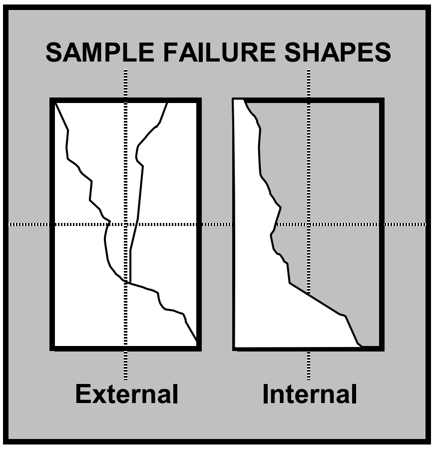
BOREHOLE		**BH-M14**
SAMPLE		**C3**
DEPTH	m	**5.40-5.70**
SAMPLE DIAMETER	mm	**101.51**
SAMPLE HEIGHT	mm	**200.72**
TEST CONDITION		**As Received**
RATE OF LOADING	kN/s	**0.9**
TEST DURATION	min.sec	**3.05**
DATE OF TESTING		**06/06/2022**
LOAD FRAME USED		**2000kN**
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		**Unknown**
FAILURE LOAD	kN	**172.7**
UNCONFINED COMPRESSIVE STRENGTH	MPa	**21.3**
WATER CONTENT (ISRM Suggested Methods)	%	**4.9**
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.40**
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.28**


SAMPLE FAILURE SHAPES

BOREHOLE		**BH-M14**
SAMPLE		**C5**
DEPTH	m	**6.00-6.30**
SAMPLE DIAMETER	mm	**101.49**
SAMPLE HEIGHT	mm	**209.51**
TEST CONDITION		**As Received**
RATE OF LOADING	kN/s	**1.0**
TEST DURATION	min.sec	**6.37**
DATE OF TESTING		**06/06/2022**
LOAD FRAME USED		**2000kN**
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		**Unknown**
FAILURE LOAD	kN	**380.2**
UNCONFINED COMPRESSIVE STRENGTH	MPa	**47.0**
WATER CONTENT (ISRM Suggested Methods)	%	**5.1**
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.33**
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.22**


SAMPLE FAILURE SHAPES

BOREHOLE		**BH-M14**
SAMPLE		**C6**
DEPTH	m	**6.50-6.80**
SAMPLE DIAMETER	mm	**101.51**
SAMPLE HEIGHT	mm	**208.11**
TEST CONDITION		**As Received**
RATE OF LOADING	kN/s	**0.9**
TEST DURATION	min.sec	**6.06**
DATE OF TESTING		**06/06/2022**
LOAD FRAME USED		**2000kN**
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		**Unknown**
FAILURE LOAD	kN	**345.4**
UNCONFINED COMPRESSIVE STRENGTH	MPa	**42.7**
WATER CONTENT (ISRM Suggested Methods)	%	**4.0**
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.41**
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.32**

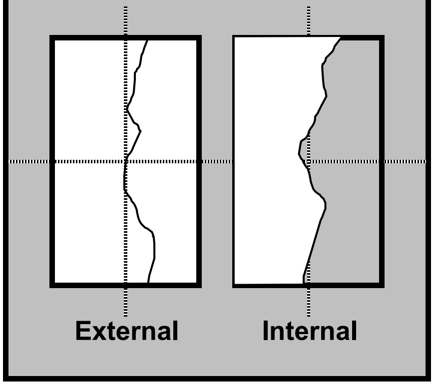

SAMPLE FAILURE SHAPES

Tested in accordance with ASTM D7012 - 14

SUMMARY OF UNCONFINED COMPRESSIVE STRENGTH

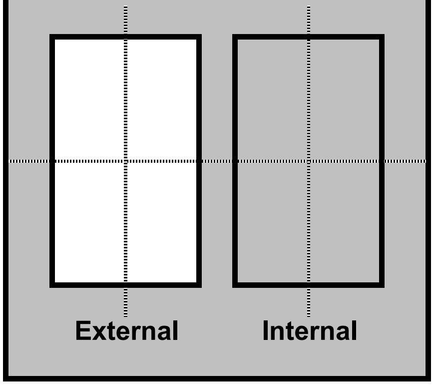
BOREHOLE		**BH-M15**
SAMPLE		**C6**
DEPTH	m	**8.50-8.80**
SAMPLE DIAMETER	mm	**101.51**
SAMPLE HEIGHT	mm	**205.49**
TEST CONDITION		**As Received**
RATE OF LOADING	kN/s	**1.0**
TEST DURATION	min.sec	**6.45**
DATE OF TESTING		**06/06/2022**
LOAD FRAME USED		**2000kN**
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		**Unknown**
FAILURE LOAD	kN	**387.4**
UNCONFINED COMPRESSIVE STRENGTH	MPa	**47.9**
WATER CONTENT (ISRM Suggested Methods)	%	**4.9**
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.35**
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	**2.24**

SAMPLE FAILURE SHAPES



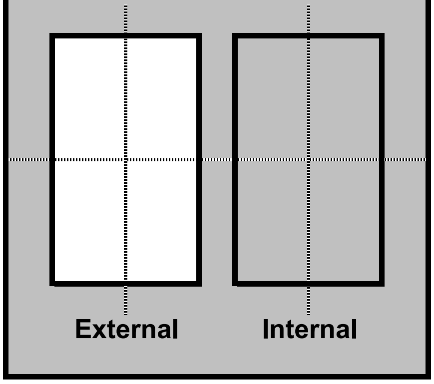
BOREHOLE		
SAMPLE		
DEPTH	m	
SAMPLE DIAMETER	mm	
SAMPLE HEIGHT	mm	
TEST CONDITION		
RATE OF LOADING	kN/s	
TEST DURATION	min.sec	
DATE OF TESTING		
LOAD FRAME USED		
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		
FAILURE LOAD	kN	
UNCONFINED COMPRESSIVE STRENGTH	MPa	
WATER CONTENT (ISRM Suggested Methods)	%	
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	

SAMPLE FAILURE SHAPES



BOREHOLE		
SAMPLE		
DEPTH	m	
SAMPLE DIAMETER	mm	
SAMPLE HEIGHT	mm	
TEST CONDITION		
RATE OF LOADING	kN/s	
TEST DURATION	min.sec	
DATE OF TESTING		
LOAD FRAME USED		
LOAD DIRECTION WITH RESPECT TO LITHOLOGY		
FAILURE LOAD	kN	
UNCONFINED COMPRESSIVE STRENGTH	MPa	
WATER CONTENT (ISRM Suggested Methods)	%	
BULK DENSITY (ISRM Suggested Methods)	Mg/m^3	
DRY DENSITY (ISRM Suggested Methods)	Mg/m^3	

SAMPLE FAILURE SHAPES



Tested in accordance with ASTM D7012 - 14

SUMMARY OF UNCONFINED COMPRESSIVE STRENGTH

BOREHOLE	SAMPLE	DEPTH (m)	SCHMIDT REBOUND HARDNESS (N/mm^2)
BH-M01	C5	5.60-5.75	42
BH-M01	C13	12.50-12.65	40
BH-M02	C4	3.20-3.40	36
BH-M02	C12	9.00-9.15	50
BH-M03	C12	11.50-11.75	30
BH-M04	C6	6.90-7.00	<10
BH-M05	C4	7.50-7.60	14
BH-M06	C3	4.70-4.90	12
BH-M07	C2	8.20-8.30	16
BH-M08	C1	4.90-5.85	26
BH-M09	C5	6.90-7.10	44
BH-M10	C5	7.30-7.50	<10
BH-M11	C5	7.30-7.50	54
BH-M12	C2	2.75-3.00	40
BH-M15	C3	5.40-5.60	22
BH-M16	C5	7.30-7.50	28
BH-M17	C4	2.80-2.90	24
BH-M26	C8	9.20-9.40	32

SUMMARY OF SCHMIDT REBOUND HARDNESS TEST

LABORATORY RESTRICTION REPORT

Project Reference	21-1031	To Position	Neil Haggan Project Manager
Project Name	Scapa Deep Water Quay & Hatson Pier Development - Marine GI	From Position	Joseph Nicholl Laboratory Quality Manager
TR reference	21-1031 / R02		

The following sample(s) and test(s) are restricted as detailed below. Could you please complete the "Required Action" column and return the completed form to the laboratory.

Hole Number	Sample			Test Type	Reason for Restriction	Required Action
	Number	Depth (m)	Type			
BH-M03	2	5.60-5.80	C	PL	No intact core to test	CANCEL
BH-M04	1	3.70-3.85	C	PL	No intact core to test	CANCEL
BH-M01	2	3.80-4.20	C	UCS	Insufficient intact sample	2 PL's in lieu
BH-M02	9	7.60-8.00	C	UCS	Insufficient intact sample	2 PL's in lieu
BH-M03	4	6.80-7.45	C	UCS	Insufficient intact sample	2 PL's in lieu
BH-M04	4	6.40-6.70	C	UCS	Insufficient intact sample	2 PL's in lieu
BH-M10	2	4.50-4.80	C	UCS	Insufficient intact sample	2 PL's in lieu
BH-M11	3	5.60-6.00	C	UCS	Insufficient intact sample	2 PL's in lieu
BH-M12	8	7.15-7.50	C	UCS	Sample badly fractured / No intact section	CANCEL
BH-M13	3	5.20-5.50	C	UCS	Insufficient intact sample	1 PL in lieu
BH-M14	7	7.05-7.50	C	UCS	Insufficient intact sample	2 PL's in lieu

For electronic reporting a form of electronic signature or printed name is acceptable

Laboratory Signature Joseph Nicholl	Project Manager Signature Neil Haggan
Date 05 May 2022	Date 07 June 2022

APPENDIX F

ENVIRONMENTAL LABORATORY TEST RESULTS

UKAS
TESTING
2183

mCERTS
THE ENVIRONMENT AGENCY'S MONITORING CERTIFICATION SCHEME

eurofins
Chemtest
Eurofins Chemtest Ltd
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

Final Report

Report No.:	21-45620-1		
Initial Date of Issue:	10-Jan-2022		
Client	Causeway Geotech Ltd		
Client Address:	8 Drumahiskey Road Balnamore Ballymoney County Antrim BT53 7QL		
Contact(s):	Neil Haggan Thomas McAllister		
Project	21-1031 Scapa DWQ		
Quotation No.:	Q21-26202	**Date Received:**	24-Dec-2021
Order No.:		**Date Instructed:**	24-Dec-2021
No. of Samples:	1		
Turnaround (Wkdays):	9	**Results Due:**	10-Jan-2022
Date Approved:	10-Jan-2022		
Approved By:			
Details:	Stuart Henderson, Technical Manager		

Results - Leachate

Project: 21-1031 Scapa DWQ

Client: Causeway Geotech Ltd					**Chemtest Job No.:**	21-45620
Quotation No.: Q21-26202					**Chemtest Sample ID.:**	1346906
Order No.:					Client Sample Ref.:	2
					Sample Location:	BH-M52
					Sample Type:	SOIL
					Top Depth (m):	0.60
					Date Sampled:	18-Dec-2021
Determinand	**Accred.**	**SOP**	**Type**	**Units**	**LOD**	
Electrical Conductivity	U	1020	10:1	µS/cm	1.0	770

Results - Soil

Project: 21-1031 Scapa DWQ

Client: Causeway Geotech Ltd	**Chemtest Job No.:**				21-45620
Quotation No.: Q21-26202	**Chemtest Sample ID.:**				1346906
Order No.:	Client Sample Ref.:				2
	Sample Location:				BH-M52
	Sample Type:				SOIL
	Top Depth (m):				0.60
	Date Sampled:				18-Dec-2021
	Asbestos Lab:				DURHAM
Determinand	**Accred.**	**SOP**	**Units**	**LOD**	
ACM Type	U	2192		N/A	-
Asbestos Identification	U	2192		N/A	No Asbestos Detected
Moisture	N	2030	%	0.020	12
Soil Colour	N	2040		N/A	Brown
Other Material	N	2040		N/A	Stones
Soil Texture	N	2040		N/A	Sand
pH	M	2010		4.0	8.8
Boron (Hot Water Soluble)	M	2120	mg/kg	0.40	2.8
Sulphate (2:1 Water Soluble) as SO4	M	2120	g/l	0.010	0.29
Cyanide (Total)	M	2300	mg/kg	0.50	2.6
Arsenic	M	2450	mg/kg	1.0	33
Cadmium	M	2450	mg/kg	0.10	< 0.10
Chromium	M	2450	mg/kg	1.0	50
Copper	M	2450	mg/kg	0.50	21
Mercury	M	2450	mg/kg	0.10	< 0.10
Nickel	M	2450	mg/kg	0.50	47
Lead	M	2450	mg/kg	0.50	10
Zinc	M	2450	mg/kg	0.50	54
Organic Matter	M	2625	%	0.40	0.69
Total TPH >C6-C40	M	2670	mg/kg	10	< 10
Naphthalene	M	2800	mg/kg	0.10	< 0.10
Acenaphthylene	N	2800	mg/kg	0.10	< 0.10
Acenaphthene	M	2800	mg/kg	0.10	< 0.10
Fluorene	M	2800	mg/kg	0.10	< 0.10
Phenanthrene	M	2800	mg/kg	0.10	< 0.10
Anthracene	M	2800	mg/kg	0.10	< 0.10
Fluoranthene	M	2800	mg/kg	0.10	< 0.10
Pyrene	M	2800	mg/kg	0.10	< 0.10
Benzo[a]anthracene	M	2800	mg/kg	0.10	< 0.10
Chrysene	M	2800	mg/kg	0.10	< 0.10
Benzo[b]fluoranthene	M	2800	mg/kg	0.10	< 0.10
Benzo[k]fluoranthene	M	2800	mg/kg	0.10	< 0.10
Benzo[a]pyrene	M	2800	mg/kg	0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	M	2800	mg/kg	0.10	< 0.10
Dibenz(a,h)Anthracene	N	2800	mg/kg	0.10	< 0.10
Benzo[g,h,i]perylene	M	2800	mg/kg	0.10	< 0.10
Total Of 16 PAH's	N	2800	mg/kg	2.0	< 2.0

Results - Soil

Project: 21-1031 Scapa DWQ

Client: Causeway Geotech Ltd	**Chemtest Job No.:**				21-45620
Quotation No.: Q21-26202	**Chemtest Sample ID.:**				1346906
Order No.:	Client Sample Ref.:				2
	Sample Location:				BH-M52
	Sample Type:				SOIL
	Top Depth (m):				0.60
	Date Sampled:				18-Dec-2021
	Asbestos Lab:				DURHAM
Determinand	**Accred.**	**SOP**	**Units**	**LOD**	
Total Phenols	M	2920	mg/kg	0.10	< 0.10

Results - Single Stage WAC

Chemtest Job No:	21-45620				**Landfill Waste Acceptance Criteria Limits**		
Chemtest Sample ID:	1346906						
Sample Ref:	2				**Inert Waste Landfill**	**Stable, Non-reactive hazardous waste in non-hazardous Landfill**	**Hazardous Waste Landfill**
Sample ID:							
Sample Location:	BH-M52						
Top Depth(m):	0.60						
Bottom Depth(m):							
Sampling Date:	18-Dec-2021						
Determinand	**SOP**	**Accred.**	**Units**				
Total Organic Carbon	2625	M	%	0.40	3	5	6
Loss on Ignition					--	--	10
Total BTEX	2760	M	mg/kg	< 0.010	6	--	--
Total PCBs (7 Congeners)	2815	M	mg/kg	< 0.10	1	--	--
TPH Total WAC	2670	M	mg/kg	< 10	500	--	--
Total (Of 17) PAH's	2700	N	mg/kg	< 2.0	100	--	--
pH					--	>6	--
Acid Neutralisation Capacity					--	To evaluate	To evaluate
Eluate Analysis			**10:1 Eluate mg/l**	**10:1 Eluate mg/kg**	**Limit values for compliance leaching test using BS EN 12457 at L/S 10 l/kg**		
Arsenic	1455	U	0.0015	0.015	0.5	2	25
Barium	1455	U	0.023	0.23	20	100	300
Cadmium	1455	U	< 0.00011	< 0.00011	0.04	1	5
Chromium	1455	U	< 0.0005	< 0.0005	0.5	10	70
Copper	1455	U	0.0009	0.0089	2	50	100
Mercury	1455	U	< 0.00005	< 0.00005	0.01	0.2	2
Molybdenum	1455	U	0.012	0.12	0.5	10	30
Nickel	1455	U	0.0006	0.0057	0.4	10	40
Lead	1455	U	< 0.0005	< 0.0005	0.5	10	50
Antimony	1455	U	0.0022	0.022	0.06	0.7	5
Selenium	1455	U	< 0.0005	< 0.0005	0.1	0.5	7
Zinc	1455	U	< 0.003	< 0.003	4	50	200
Chloride	1220	U	220	2200	800	15000	25000
Fluoride	1220	U	0.33	3.3	10	150	500
Sulphate	1220	U	44	440	1000	20000	50000
Total Dissolved Solids	1020	N	500	5000	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.30	1	-	-
Dissolved Organic Carbon	1610	U	3.0	< 50	500	800	1000

Solid Information	
Dry mass of test portion/kg	0.090
Moisture (%)	12

Waste Acceptance Criteria

Landfill WAC analysis (specifically leaching test results) must not be used for hazardous waste classification purposes. This analysis is only applicable for hazardous waste landfill acceptance and does not give any indication as to whether a waste may be hazardous or non-hazardous.

Test Methods

SOP	Title	Parameters included	Method summary
1020	Electrical Conductivity and Total Dissolved Solids (TDS) in Waters	Electrical Conductivity and Total Dissolved Solids (TDS) in Waters	Conductivity Meter
1220	Anions, Alkalinity & Ammonium in Waters	Fluoride; Chloride; Nitrite; Nitrate; Total; Oxidisable Nitrogen (TON); Sulfate; Phosphate; Alkalinity; Ammonium	Automated colorimetric analysis using 'Aquakem 600' Discrete Analyser.
1455	Metals in Waters by ICP-MS	Metals, including: Antimony; Arsenic; Barium; Beryllium; Boron; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Tin; Vanadium; Zinc	Filtration of samples followed by direct determination by inductively coupled plasma mass spectrometry (ICP-MS).
1610	Total/Dissolved Organic Carbon in Waters	Organic Carbon	TOC Analyser using Catalytic Oxidation
1920	Phenols in Waters by HPLC	Phenolic compounds including: Phenol, Cresols, Xylenols, Trimethylphenols Note: Chlorophenols are excluded.	Determination by High Performance Liquid Chromatography (HPLC) using electrochemical detection.
2010	pH Value of Soils	pH	pH Meter
2030	Moisture and Stone Content of Soils(Requirement of MCERTS)	Moisture content	Determination of moisture content of soil as a percentage of its as received mass obtained at <37°C.
2040	Soil Description(Requirement of MCERTS)	Soil description	As received soil is described based upon BS5930
2120	Water Soluble Boron, Sulphate, Magnesium & Chromium	Boron; Sulphate; Magnesium; Chromium	Aqueous extraction / ICP-OES
2192	Asbestos	Asbestos	Polarised light microscopy / Gravimetry
2300	Cyanides & Thiocyanate in Soils	Free (or easy liberatable) Cyanide; total Cyanide; complex Cyanide; Thiocyanate	Allkaline extraction followed by colorimetric determination using Automated Flow Injection Analyser.
2450	Acid Soluble Metals in Soils	Metals, including: Arsenic; Barium; Beryllium; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Vanadium; Zinc	Acid digestion followed by determination of metals in extract by ICP-MS.
2625	Total Organic Carbon in Soils	Total organic Carbon (TOC)	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.
2670	Total Petroleum Hydrocarbons (TPH) in Soils by GC-FID	TPH (C6–C40); optional carbon banding, e.g. 3-band – GRO, DRO & LRO*TPH C8–C40	Dichloromethane extraction / GC-FID
2700	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Soil by GC-FID	Acenaphthene; Acenaphthylene; Anthracene; Benzo[a]Anthracene; Benzo[a]Pyrene; Benzo[b]Fluoranthene; Benzo[ghi]Perylene; Benzo[k]Fluoranthene; Chrysene; Dibenz[ah]Anthracene; Fluoranthene; Fluorene; Indeno[123cd]Pyrene; Naphthalene; Phenanthrene; Pyrene	Dichloromethane extraction / GC-FID (GC-FID detection is non-selective and can be subject to interference from co-eluting compounds)
2760	Volatile Organic Compounds (VOCs) in Soils by Headspace GC-MS	Volatile organic compounds, including BTEX and halogenated Aliphatic/Aromatics.(cf. USEPA Method 8260)*please refer to UKAS schedule	Automated headspace gas chromatographic (GC) analysis of a soil sample, as received, with mass spectrometric (MS) detection of volatile organic compounds.
2800	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Soil by GC-MS	Acenaphthene*; Acenaphthylene; Anthracene*; Benzo[a]Anthracene*; Benzo[a]Pyrene*; Benzo[b]Fluoranthene*; Benzo[ghi]Perylene*; Benzo[k]Fluoranthene; Chrysene*; Dibenz[ah]Anthracene; Fluoranthene*; Fluorene*; Indeno[123cd]Pyrene*; Naphthalene*; Phenanthrene*; Pyrene*	Dichloromethane extraction / GC-MS
2815	Polychlorinated Biphenyls (PCB) ICES7Congeners in Soils by GC-MS	ICES7 PCB congeners	Acetone/Hexane extraction / GC-MS

Test Methods

SOP	Title	Parameters included	Method summary
2920	Phenols in Soils by HPLC	Phenolic compounds including Resorcinol, Phenol, Methylphenols, Dimethylphenols, 1-Naphthol and TrimethylphenolsNote: chlorophenols are excluded.	60:40 methanol/water mixture extraction, followed by HPLC determination using electrochemical detection.
640	Characterisation of Waste (Leaching C10)	Waste material including soil, sludges and granular waste	ComplianceTest for Leaching of Granular Waste Material and Sludge

Report Information

Key	
U	UKAS accredited
M	MCERTS and UKAS accredited
N	Unaccredited
S	This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
SN	This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
T	This analysis has been subcontracted to an unaccredited laboratory
I/S	Insufficient Sample
U/S	Unsuitable Sample
N/E	not evaluated
<	"less than"
>	"greater than"
SOP	Standard operating procedure
LOD	Limit of detection

Comments or interpretations are beyond the scope of UKAS accreditation
The results relate only to the items tested
Uncertainty of measurement for the determinands tested are available upon request
None of the results in this report have been recovery corrected
All results are expressed on a dry weight basis

The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols

For all other tests the samples were dried at < 37°C prior to analysis
All Asbestos testing is performed at the indicated laboratory
Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

A - Date of sampling not supplied
B - Sample age exceeds stability time (sampling to extraction)
C - Sample not received in appropriate containers
D - Broken Container
E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

Sample Retention and Disposal

All soil samples will be retained for a period of 30 days from the date of receipt
All water samples will be retained for 14 days from the date of receipt
Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:
customerservices@chemtest.com

Chemtest
Eurofins Chemtest Ltd
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

Final Report

Report No.: 22-03590-1

Initial Date of Issue: 10-Feb-2022

Client Causeway Geotech Ltd

Client Address:
8 Drumahiskey Road
Balnamore
Ballymoney
County Antrim
BT53 7QL

Contact(s):
Carin Cornwall
Colm Hurley
Darren O'Mahony
Gabriella Horan
Joe Gervin
John Cameron
Lucy Newland
Martin Gardiner
Matthew Gilbert
Michelle Gaffney
Neil Haggan
Paul Dunlop
Sean Ross
Stephen Franey
Stephen Watson
Stuart Abraham
Thomas McAllist

Project 21-1031 Scapa DWQ - Marine

Quotation No.: Q21-26202

Date Received: 01-Feb-2022

Order No.:

Date Instructed: 02-Feb-2022

No. of Samples: 1

Turnaround (Wkdays): 7

Results Due: 10-Feb-2022

Date Approved: 10-Feb-2022

Approved By:

Details: Stuart Henderson, Technical Manager

Results - Soil

Project: 21-1031 Scapa DWQ - Marine

Client: Causeway Geotech Ltd	**Chemtest Job No.:**	22-03590
Quotation No.: Q21-26202	**Chemtest Sample ID.:**	1363487
Order No.:	Client Sample Ref.:	2
	Sample Location:	BH-M03
	Sample Type:	SOIL
	Top Depth (m):	1.00
	Date Sampled:	25-Jan-2022
	Asbestos Lab:	COVENTRY

Determinand	**Accred.**	**SOP**	**Units**	**LOD**	
ACM Type	U	2192		N/A	-
Asbestos Identification	U	2192		N/A	No Asbestos Detected
Moisture	N	2030	%	0.020	15
Soil Colour	N	2040		N/A	Brown
Other Material	N	2040		N/A	None
Soil Texture	N	2040		N/A	Sand
pH	M	2010		4.0	9.0
Sulphate (2:1 Water Soluble) as SO4	M	2120	g/l	0.010	0.51
Cyanide (Total)	M	2300	mg/kg	0.50	< 0.50
Organic Matter	M	2625	%	0.40	1.0
Total TPH >C6-C40	M	2670	mg/kg	10	< 10
Naphthalene	M	2800	mg/kg	0.10	< 0.10
Acenaphthylene	N	2800	mg/kg	0.10	< 0.10
Acenaphthene	M	2800	mg/kg	0.10	< 0.10
Fluorene	M	2800	mg/kg	0.10	< 0.10
Phenanthrene	M	2800	mg/kg	0.10	0.42
Anthracene	M	2800	mg/kg	0.10	0.26
Fluoranthene	M	2800	mg/kg	0.10	1.2
Pyrene	M	2800	mg/kg	0.10	0.89
Benzo[a]anthracene	M	2800	mg/kg	0.10	0.93
Chrysene	M	2800	mg/kg	0.10	0.86
Benzo[b]fluoranthene	M	2800	mg/kg	0.10	0.98
Benzo[k]fluoranthene	M	2800	mg/kg	0.10	0.55
Benzo[a]pyrene	M	2800	mg/kg	0.10	0.86
Indeno(1,2,3-c,d)Pyrene	M	2800	mg/kg	0.10	< 0.10
Dibenz(a,h)Anthracene	N	2800	mg/kg	0.10	< 0.10
Benzo[g,h,i]perylene	M	2800	mg/kg	0.10	< 0.10
Total Of 16 PAH's	N	2800	mg/kg	2.0	7.0
Total Phenols	M	2920	mg/kg	0.10	< 0.10

Results - Single Stage WAC

					Landfill Waste Acceptance Criteria Limits		
Chemtest Job No:	22-03590				Inert Waste Landfill	Stable, Non-reactive hazardous waste in non-hazardous Landfill	Hazardous Waste Landfill
Chemtest Sample ID:	1363487						
Sample Ref:	2						
Sample ID:							
Sample Location:	BH-M03						
Top Depth(m):	1.00						
Bottom Depth(m):							
Sampling Date:	25-Jan-2022						
Determinand	**SOP**	**Accred.**	**Units**				
Total Organic Carbon	2625	M	%	0.59	3	5	6
Loss on Ignition					--	--	10
Total BTEX	2760	M	mg/kg	< 0.010	6	--	--
Total PCBs (7 congeners)					1	--	--
TPH Total WAC	2670	M	mg/kg	< 10	500	--	--
Total (Of 17) PAH's	2700	N	mg/kg	< 2.0	100	--	--
pH					--	>6	--
Acid Neutralisation Capacity					--	To evaluate	To evaluate
Eluate Analysis			**10:1 Eluate mg/l**	**10:1 Eluate mg/kg**	**Limit values for compliance leaching test using BS EN 12457 at L/S 10 l/kg**		
Arsenic	1455	U		U/S	0.5	2	25
Barium	1455	U	0.079		20	100	300
Cadmium					0.04	1	5
Chromium					0.5	10	70
Copper					2	50	100
Mercury					0.01	0.2	2
Molybdenum					0.5	10	30
Nickel	1455	U		U/S	0.4	10	40
Lead	1455	U		U/S	0.5	10	50
Antimony	1455	U	0.0028		0.06	0.7	5
Selenium					0.1	0.5	7
Zinc	1455	U	< 0.003		4	50	200
Chloride	1220	U	410	4100	800	15000	25000
Fluoride	1220	U	0.99	9.9	10	150	500
Sulphate	1220	U	78	780	1000	20000	50000
Total Dissolved Solids	1020	N	960	9600	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.30	1	-	-
Dissolved Organic Carbon	1610	U	12	120	500	800	1000

Solid Information	
Dry mass of test portion/kg	0.090
Moisture (%)	15

Waste Acceptance Criteria

Landfill WAC analysis (specifically leaching test results) must not be used for hazardous waste classification purposes. This analysis is only applicable for hazardous waste landfill acceptance and does not give any indication as to whether a waste may be hazardous or non-hazardous.

Test Methods

SOP	Title	Parameters included	Method summary
1020	Electrical Conductivity and Total Dissolved Solids (TDS) in Waters	Electrical Conductivity and Total Dissolved Solids (TDS) in Waters	Conductivity Meter
1220	Anions, Alkalinity & Ammonium in Waters	Fluoride; Chloride; Nitrite; Nitrate; Total; Oxidisable Nitrogen (TON); Sulfate; Phosphate; Alkalinity; Ammonium	Automated colorimetric analysis using 'Aquakem 600' Discrete Analyser.
1455	Metals in Waters by ICP-MS	Metals, including: Antimony; Arsenic; Barium; Beryllium; Boron; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Tin; Vanadium; Zinc	Filtration of samples followed by direct determination by inductively coupled plasma mass spectrometry (ICP-MS).
1610	Total/Dissolved Organic Carbon in Waters	Organic Carbon	TOC Analyser using Catalytic Oxidation
1920	Phenols in Waters by HPLC	Phenolic compounds including: Phenol, Cresols, Xylenols, Trimethylphenols Note: Chlorophenols are excluded.	Determination by High Performance Liquid Chromatography (HPLC) using electrochemical detection.
2010	pH Value of Soils	pH	pH Meter
2030	Moisture and Stone Content of Soils(Requirement of MCERTS)	Moisture content	Determination of moisture content of soil as a percentage of its as received mass obtained at <37°C.
2040	Soil Description(Requirement of MCERTS)	Soil description	As received soil is described based upon BS5930
2120	Water Soluble Boron, Sulphate, Magnesium & Chromium	Boron; Sulphate; Magnesium; Chromium	Aqueous extraction / ICP-OES
2192	Asbestos	Asbestos	Polarised light microscopy / Gravimetry
2300	Cyanides & Thiocyanate in Soils	Free (or easy liberatable) Cyanide; total Cyanide; complex Cyanide; Thiocyanate	Allkaline extraction followed by colorimetric determination using Automated Flow Injection Analyser.
2450	Acid Soluble Metals in Soils	Metals, including: Arsenic; Barium; Beryllium; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Vanadium; Zinc	Acid digestion followed by determination of metals in extract by ICP-MS.
2625	Total Organic Carbon in Soils	Total organic Carbon (TOC)	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.
2670	Total Petroleum Hydrocarbons (TPH) in Soils by GC-FID	TPH (C6–C40); optional carbon banding, e.g. 3-band – GRO, DRO & LRO*TPH C8–C40	Dichloromethane extraction / GC-FID
2700	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Soil by GC-FID	Acenaphthene; Acenaphthylene; Anthracene; Benzo[a]Anthracene; Benzo[a]Pyrene; Benzo[b]Fluoranthene; Benzo[ghi]Perylene; Benzo[k]Fluoranthene; Chrysene; Dibenz[ah]Anthracene; Fluoranthene; Fluorene; Indeno[123cd]Pyrene; Naphthalene; Phenanthrene; Pyrene	Dichloromethane extraction / GC-FID (GC-FID detection is non-selective and can be subject to interference from co-eluting compounds)
2760	Volatile Organic Compounds (VOCs) in Soils by Headspace GC-MS	Volatile organic compounds, including BTEX and halogenated Aliphatic/Aromatics.(cf. USEPA Method 8260)*please refer to UKAS schedule	Automated headspace gas chromatographic (GC) analysis of a soil sample, as received, with mass spectrometric (MS) detection of volatile organic compounds.
2800	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Soil by GC-MS	Acenaphthene*; Acenaphthylene; Anthracene*; Benzo[a]Anthracene*; Benzo[a]Pyrene*; Benzo[b]Fluoranthene*; Benzo[ghi]Perylene*; Benzo[k]Fluoranthene; Chrysene*; Dibenz[ah]Anthracene; Fluoranthene*; Fluorene*; Indeno[123cd]Pyrene*; Naphthalene*; Phenanthrene*; Pyrene*	Dichloromethane extraction / GC-MS
2815	Polychlorinated Biphenyls (PCB) ICES7Congeners in Soils by GC-MS	ICES7 PCB congeners	Acetone/Hexane extraction / GC-MS

Test Methods

SOP	Title	Parameters included	Method summary
2920	Phenols in Soils by HPLC	Phenolic compounds including Resorcinol, Phenol, Methylphenols, Dimethylphenols, 1-Naphthol and TrimethylphenolsNote: chlorophenols are excluded.	60:40 methanol/water mixture extraction, followed by HPLC determination using electrochemical detection.
640	Characterisation of Waste (Leaching C10)	Waste material including soil, sludges and granular waste	ComplianceTest for Leaching of Granular Waste Material and Sludge

Report Information

Key	
U	UKAS accredited
M	MCERTS and UKAS accredited
N	Unaccredited
S	This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
SN	This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
T	This analysis has been subcontracted to an unaccredited laboratory
I/S	Insufficient Sample
U/S	Unsuitable Sample
N/E	not evaluated
<	"less than"
>	"greater than"
SOP	Standard operating procedure
LOD	Limit of detection

Comments or interpretations are beyond the scope of UKAS accreditation
The results relate only to the items tested
Uncertainty of measurement for the determinands tested are available upon request
None of the results in this report have been recovery corrected
All results are expressed on a dry weight basis

The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols

For all other tests the samples were dried at < 37°C prior to analysis
All Asbestos testing is performed at the indicated laboratory
Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

A - Date of sampling not supplied
B - Sample age exceeds stability time (sampling to extraction)
C - Sample not received in appropriate containers
D - Broken Container
E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

Sample Retention and Disposal

All soil samples will be retained for a period of 30 days from the date of receipt
All water samples will be retained for 14 days from the date of receipt
Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:
customerservices@chemtest.com

UKAS TESTING 2183

Eurofins Chemtest Ltd
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

Final Report

Report No.: 22-13660-1

Initial Date of Issue: 22-Apr-2022

Client Causeway Geotech Ltd

Client Address:
8 Drumahiskey Road
Balnamore
Ballymoney
County Antrim
BT53 7QL

Contact(s):
Carin Cornwall
Colm Hurley
Darren O'Mahony
Gabriella Horan
Joe Gervin
John Cameron
Lucy Newland
Martin Gardiner
Matthew Gilbert
Neil Haggan
Paul Dunlop
Sean Ross
Stephen Franey
Stephen Watson
Stuart Abraham
Thomas McAllister

Project 21-1031 Scapa DWG & Hatston Pier Development - Marine GI

Quotation No.: Q21-26202

Date Received: 11-Apr-2022

Order No.:

Date Instructed: 12-Apr-2022

No. of Samples: 1

Turnaround (Wkdays): 7

Results Due: 22-Apr-2022

Date Approved: 22-Apr-2022

Approved By:

Details: Stuart Henderson, Technical Manager

Results - Soil

Project: 21-1031 Scapa DWG & Hatston Pier Development - Marine GI

Client: Causeway Geotech Ltd				**Chemtest Job No.:**	22-13660
Quotation No.: Q21-26202				**Chemtest Sample ID.:**	1409557
Order No.:				Client Sample Ref.:	3
				Sample Location:	BH-M09
				Sample Type:	SOIL
				Top Depth (m):	2.00
				Date Sampled:	24-Mar-2022
				Asbestos Lab:	NEW-ASB
Determinand	**Accred.**	**SOP**	**Units**	**LOD**	
ACM Type	U	2192		N/A	-
Asbestos Identification	U	2192		N/A	No Asbestos Detected
Moisture	N	2030	%	0.020	18
Soil Colour	N	2040		N/A	Brown
Other Material	N	2040		N/A	Stones
Soil Texture	N	2040		N/A	Sand
pH	M	2010		4.0	8.2
Boron (Hot Water Soluble)	M	2120	mg/kg	0.40	< 0.40
Sulphate (2:1 Water Soluble) as SO4	M	2120	g/l	0.010	< 0.010
Cyanide (Total)	M	2300	mg/kg	0.50	[B] < 0.50
Arsenic	M	2450	mg/kg	1.0	9.2
Cadmium	M	2450	mg/kg	0.10	< 0.10
Chromium	M	2450	mg/kg	1.0	4.4
Copper	M	2450	mg/kg	0.50	3.0
Mercury	M	2450	mg/kg	0.10	< 0.10
Nickel	M	2450	mg/kg	0.50	8.9
Lead	M	2450	mg/kg	0.50	3.6
Zinc	M	2450	mg/kg	0.50	2.5
Organic Matter	M	2625	%	0.40	< 0.40
Total TPH >C6-C40	M	2670	mg/kg	10	[B] < 10
Naphthalene	M	2800	mg/kg	0.10	< 0.10
Acenaphthylene	N	2800	mg/kg	0.10	< 0.10
Acenaphthene	M	2800	mg/kg	0.10	< 0.10
Fluorene	M	2800	mg/kg	0.10	< 0.10
Phenanthrene	M	2800	mg/kg	0.10	< 0.10
Anthracene	M	2800	mg/kg	0.10	< 0.10
Fluoranthene	M	2800	mg/kg	0.10	< 0.10
Pyrene	M	2800	mg/kg	0.10	< 0.10
Benzo[a]anthracene	M	2800	mg/kg	0.10	< 0.10
Chrysene	M	2800	mg/kg	0.10	< 0.10
Benzo[b]fluoranthene	M	2800	mg/kg	0.10	< 0.10
Benzo[k]fluoranthene	M	2800	mg/kg	0.10	< 0.10
Benzo[a]pyrene	M	2800	mg/kg	0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	M	2800	mg/kg	0.10	< 0.10
Dibenz(a,h)Anthracene	N	2800	mg/kg	0.10	< 0.10
Benzo[g,h,i]perylene	M	2800	mg/kg	0.10	< 0.10

Results - Soil

Project: 21-1031 Scapa DWG & Hatston Pier Development - Marine GI

Client: Causeway Geotech Ltd	**Chemtest Job No.:**				22-13660
Quotation No.: Q21-26202	**Chemtest Sample ID.:**				1409557
Order No.:	Client Sample Ref.:				3
	Sample Location:				BH-M09
	Sample Type:				SOIL
	Top Depth (m):				2.00
	Date Sampled:				24-Mar-2022
	Asbestos Lab:				NEW-ASB
Determinand	**Accred.**	**SOP**	**Units**	**LOD**	
Total Of 16 PAH's	N	2800	mg/kg	2.0	< 2.0
Total Phenols	M	2920	mg/kg	0.10	< 0.10

Results - Single Stage WAC

Chemtest Job No:	22-13660				**Landfill Waste Acceptance Criteria Limits**		
Chemtest Sample ID:	1409557						
Sample Ref:	3				**Inert Waste Landfill**	**Stable, Non-reactive hazardous waste in non-hazardous Landfill**	**Hazardous Waste Landfill**
Sample ID:							
Sample Location:	BH-M09						
Top Depth(m):	2.00						
Bottom Depth(m):							
Sampling Date:	24-Mar-2022						
Determinand	**SOP**	**Accred.**	**Units**				
Total Organic Carbon	2625	M	%	< 0.20	3	5	6
Loss on Ignition					--	--	10
Total BTEX	2760	M	mg/kg	[B] < 0.010	6	--	--
Total PCBs (7 Congeners)	2815	M	mg/kg	< 0.10	1	--	--
TPH Total WAC	2670	M	mg/kg	[B] < 10	500	--	--
Total (Of 17) PAH's	2700	N	mg/kg	< 2.0	100	--	--
pH					--	>6	--
Acid Neutralisation Capacity					--	To evaluate	To evaluate
Eluate Analysis			**10:1 Eluate mg/l**	**10:1 Eluate mg/kg**	**Limit values for compliance leaching test using BS EN 12457 at L/S 10 l/kg**		
Arsenic	1455	U	0.0026	0.026	0.5	2	25
Barium	1455	U	0.13	1.3	20	100	300
Cadmium	1455	U	< 0.00011	< 0.00011	0.04	1	5
Chromium	1455	U	0.0040	0.040	0.5	10	70
Copper	1455	U	0.0023	0.023	2	50	100
Mercury	1455	U	< 0.00005	< 0.00005	0.01	0.2	2
Molybdenum	1455	U	0.0035	0.035	0.5	10	30
Nickel	1455	U	0.0029	0.029	0.4	10	40
Lead	1455	U	< 0.0005	< 0.0005	0.5	10	50
Antimony	1455	U	0.0015	0.015	0.06	0.7	5
Selenium	1455	U	0.0013	0.013	0.1	0.5	7
Zinc	1455	U	0.003	0.028	4	50	200
Chloride	1220	U	360	3600	800	15000	25000
Fluoride	1220	U	0.17	1.7	10	150	500
Sulphate	1220	U	63	630	1000	20000	50000
Total Dissolved Solids	1020	N	790	7800	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.30	1	-	-
Dissolved Organic Carbon	1610	U	< 2.5	< 50	500	800	1000

Solid Information	
Dry mass of test portion/kg	0.090
Moisture (%)	18

Waste Acceptance Criteria

Landfill WAC analysis (specifically leaching test results) must not be used for hazardous waste classification purposes. This analysis is only applicable for hazardous waste landfill acceptance and does not give any indication as to whether a waste may be hazardous or non-hazardous.

Deviations

In accordance with UKAS Policy on Deviating Samples TPS 63. Chemtest have a procedure to ensure 'upon receipt of each sample a competent laboratory shall assess whether the sample is suitable with regard to the requested test(s)'. This policy and the respective holding times applied, can be supplied upon request.The reason a sample is declared as deviating is detailed below. Where applicable the analysis remains UKAS/MCERTs accredited but the results may be compromised.

Sample:	Sample Ref:	Sample ID:	Sample Location:	Sampled Date:	Deviation Code(s):	Containers Received:
1409557	3		BH-M09	24-Mar-2022	B	Amber Glass 250ml
1409557	3		BH-M09	24-Mar-2022	B	Amber Glass 60ml
1409557	3		BH-M09	24-Mar-2022	B	Plastic Tub 500g

Test Methods

SOP	Title	Parameters included	Method summary
1020	Electrical Conductivity and Total Dissolved Solids (TDS) in Waters	Electrical Conductivity and Total Dissolved Solids (TDS) in Waters	Conductivity Meter
1220	Anions, Alkalinity & Ammonium in Waters	Fluoride; Chloride; Nitrite; Nitrate; Total; Oxidisable Nitrogen (TON); Sulfate; Phosphate; Alkalinity; Ammonium	Automated colorimetric analysis using 'Aquakem 600' Discrete Analyser.
1455	Metals in Waters by ICP-MS	Metals, including: Antimony; Arsenic; Barium; Beryllium; Boron; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Tin; Vanadium; Zinc	Filtration of samples followed by direct determination by inductively coupled plasma mass spectrometry (ICP-MS).
1610	Total/Dissolved Organic Carbon in Waters	Organic Carbon	TOC Analyser using Catalytic Oxidation
1920	Phenols in Waters by HPLC	Phenolic compounds including: Phenol, Cresols, Xylenols, Trimethylphenols Note: Chlorophenols are excluded.	Determination by High Performance Liquid Chromatography (HPLC) using electrochemical detection.
2010	pH Value of Soils	pH	pH Meter
2030	Moisture and Stone Content of Soils(Requirement of MCERTS)	Moisture content	Determination of moisture content of soil as a percentage of its as received mass obtained at <37°C.
2040	Soil Description(Requirement of MCERTS)	Soil description	As received soil is described based upon BS5930
2120	Water Soluble Boron, Sulphate, Magnesium & Chromium	Boron; Sulphate; Magnesium; Chromium	Aqueous extraction / ICP-OES
2192	Asbestos	Asbestos	Polarised light microscopy / Gravimetry
2300	Cyanides & Thiocyanate in Soils	Free (or easy liberatable) Cyanide; total Cyanide; complex Cyanide; Thiocyanate	Allkaline extraction followed by colorimetric determination using Automated Flow Injection Analyser.
2450	Acid Soluble Metals in Soils	Metals, including: Arsenic; Barium; Beryllium; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Vanadium; Zinc	Acid digestion followed by determination of metals in extract by ICP-MS.
2625	Total Organic Carbon in Soils	Total organic Carbon (TOC)	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.
2670	Total Petroleum Hydrocarbons (TPH) in Soils by GC-FID	TPH (C6–C40); optional carbon banding, e.g. 3-band – GRO, DRO & LRO*TPH C8–C40	Dichloromethane extraction / GC-FID
2700	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Soil by GC-FID	Acenaphthene; Acenaphthylene; Anthracene; Benzo[a]Anthracene; Benzo[a]Pyrene; Benzo[b]Fluoranthene; Benzo[ghi]Perylene; Benzo[k]Fluoranthene; Chrysene; Dibenz[ah]Anthracene; Fluoranthene; Fluorene; Indeno[123cd]Pyrene; Naphthalene; Phenanthrene; Pyrene	Dichloromethane extraction / GC-FID (GC-FID detection is non-selective and can be subject to interference from co-eluting compounds)
2760	Volatile Organic Compounds (VOCs) in Soils by Headspace GC-MS	Volatile organic compounds, including BTEX and halogenated Aliphatic/Aromatics.(cf. USEPA Method 8260)*please refer to UKAS schedule	Automated headspace gas chromatographic (GC) analysis of a soil sample, as received, with mass spectrometric (MS) detection of volatile organic compounds.
2800	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Soil by GC-MS	Acenaphthene*; Acenaphthylene; Anthracene*; Benzo[a]Anthracene*; Benzo[a]Pyrene*; Benzo[b]Fluoranthene*; Benzo[ghi]Perylene*; Benzo[k]Fluoranthene; Chrysene*; Dibenz[ah]Anthracene; Fluoranthene*; Fluorene*; Indeno[123cd]Pyrene*; Naphthalene*; Phenanthrene*; Pyrene*	Dichloromethane extraction / GC-MS
2815	Polychlorinated Biphenyls (PCB) ICES7Congeners in Soils by GC-MS	ICES7 PCB congeners	Acetone/Hexane extraction / GC-MS

Test Methods

SOP	Title	Parameters included	Method summary
2920	Phenols in Soils by HPLC	Phenolic compounds including Resorcinol, Phenol, Methylphenols, Dimethylphenols, 1-Naphthol and TrimethylphenolsNote: chlorophenols are excluded.	60:40 methanol/water mixture extraction, followed by HPLC determination using electrochemical detection.
640	Characterisation of Waste (Leaching C10)	Waste material including soil, sludges and granular waste	ComplianceTest for Leaching of Granular Waste Material and Sludge

Report Information

Key	
U	UKAS accredited
M	MCERTS and UKAS accredited
N	Unaccredited
S	This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
SN	This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
T	This analysis has been subcontracted to an unaccredited laboratory
I/S	Insufficient Sample
U/S	Unsuitable Sample
N/E	not evaluated
<	"less than"
>	"greater than"
SOP	Standard operating procedure
LOD	Limit of detection

Comments or interpretations are beyond the scope of UKAS accreditation

The results relate only to the items tested

Uncertainty of measurement for the determinands tested are available upon request

None of the results in this report have been recovery corrected

All results are expressed on a dry weight basis

The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols

For all other tests the samples were dried at < 37°C prior to analysis

All Asbestos testing is performed at the indicated laboratory

Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

A - Date of sampling not supplied
B - Sample age exceeds stability time (sampling to extraction)
C - Sample not received in appropriate containers
D - Broken Container
E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

Sample Retention and Disposal

All soil samples will be retained for a period of 30 days from the date of receipt

All water samples will be retained for 14 days from the date of receipt

Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:
customerservices@chemtest.com

Eurofins Chemtest Ltd
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

Final Report

Report No.: 22-13684-1

Initial Date of Issue: 21-Apr-2022

Client Causeway Geotech Ltd

Client Address:
8 Drumahiskey Road
Balnamore
Ballymoney
County Antrim
BT53 7QL

Contact(s):
Carin Cornwall
Colm Hurley
Darren O'Mahony
Gabriella Horan
Joe Gervin
John Cameron
Lucy Newland
Martin Gardiner
Matthew Gilbert
Neil Haggan
Paul Dunlop
Sean Ross
Stephen Franey
Stephen Watson
Stuart Abraham
Thomas McAllister

Project 21-1031 Scapa DWQ & Hatson Pier Development - Marine GI

Quotation No.: Q21-26202 **Date Received:** 11-Apr-2022

Order No.: **Date Instructed:** 12-Apr-2022

No. of Samples: 1

Turnaround (Wkdays): 7 **Results Due:** 22-Apr-2022

Date Approved: 21-Apr-2022

Approved By:

Details: Stuart Henderson, Technical Manager

Results - Soil

Project: 21-1031 Scapa DWQ & Hatson Pier Development - Marine GI

Client: Causeway Geotech Ltd	**Chemtest Job No.:**				22-13684
Quotation No.: Q21-26202	**Chemtest Sample ID.:**				1409665
Order No.:	Client Sample Ref.:				1
	Sample Location:				BH-M15
	Sample Type:				SOIL
	Top Depth (m):				0.50
	Date Sampled:				31-Mar-2022
	Asbestos Lab:				NEW-ASB
Determinand	**Accred.**	**SOP**	**Units**	**LOD**	
ACM Type	U	2192		N/A	-
Asbestos Identification	U	2192		N/A	No Asbestos Detected
Moisture	N	2030	%	0.020	20
Soil Colour	N	2040		N/A	Brown
Other Material	N	2040		N/A	Stones and shell
Soil Texture	N	2040		N/A	Sand
pH	U	2010		4.0	8.4
Boron (Hot Water Soluble)	U	2120	mg/kg	0.40	4.0
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	0.47
Cyanide (Total)	U	2300	mg/kg	0.50	< 0.50
Arsenic	U	2450	mg/kg	1.0	9.0
Cadmium	U	2450	mg/kg	0.10	< 0.10
Chromium	U	2450	mg/kg	1.0	6.3
Copper	U	2450	mg/kg	0.50	< 0.50
Mercury	U	2450	mg/kg	0.10	< 0.10
Nickel	U	2450	mg/kg	0.50	4.4
Lead	U	2450	mg/kg	0.50	0.77
Zinc	U	2450	mg/kg	0.50	4.6
Organic Matter	U	2625	%	0.40	< 0.40
Total TPH >C6-C40	U	2670	mg/kg	10	< 10
Naphthalene	U	2800	mg/kg	0.10	< 0.10
Acenaphthylene	N	2800	mg/kg	0.10	< 0.10
Acenaphthene	U	2800	mg/kg	0.10	< 0.10
Fluorene	U	2800	mg/kg	0.10	< 0.10
Phenanthrene	U	2800	mg/kg	0.10	< 0.10
Anthracene	U	2800	mg/kg	0.10	< 0.10
Fluoranthene	U	2800	mg/kg	0.10	< 0.10
Pyrene	U	2800	mg/kg	0.10	< 0.10
Benzo[a]anthracene	U	2800	mg/kg	0.10	< 0.10
Chrysene	U	2800	mg/kg	0.10	< 0.10
Benzo[b]fluoranthene	U	2800	mg/kg	0.10	< 0.10
Benzo[k]fluoranthene	U	2800	mg/kg	0.10	< 0.10
Benzo[a]pyrene	U	2800	mg/kg	0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	U	2800	mg/kg	0.10	< 0.10
Dibenz(a,h)Anthracene	N	2800	mg/kg	0.10	< 0.10

Results - Soil

Project: 21-1031 Scapa DWQ & Hatson Pier Development - Marine GI

Client: Causeway Geotech Ltd	**Chemtest Job No.:**				22-13684
Quotation No.: Q21-26202	**Chemtest Sample ID.:**				1409665
Order No.:	Client Sample Ref.:				1
	Sample Location:				BH-M15
	Sample Type:				SOIL
	Top Depth (m):				0.50
	Date Sampled:				31-Mar-2022
	Asbestos Lab:				NEW-ASB
Determinand	**Accred.**	**SOP**	**Units**	**LOD**	
Benzo[g,h,i]perylene	U	2800	mg/kg	0.10	< 0.10
Total Of 16 PAH's	N	2800	mg/kg	2.0	< 2.0
Total Phenols	U	2920	mg/kg	0.10	< 0.10

Results - Single Stage WAC

Chemtest Job No:	22-13684				**Landfill Waste Acceptance Criteria Limits**		
Chemtest Sample ID:	1409665						
Sample Ref:	1				**Inert Waste Landfill**	**Stable, Non-reactive hazardous waste in non-hazardous Landfill**	**Hazardous Waste Landfill**
Sample ID:							
Sample Location:	BH-M15						
Top Depth(m):	0.50						
Bottom Depth(m):							
Sampling Date:	31-Mar-2022						
Determinand	**SOP**	**Accred.**	**Units**				
Total Organic Carbon	2625	U	%	< 0.20	3	5	6
Loss on Ignition					--	--	10
Total BTEX	2760	U	mg/kg	< 0.010	6	--	--
Total PCBs (7 Congeners)	2815	U	mg/kg	< 0.10	1	--	--
TPH Total WAC	2670	U	mg/kg	< 10	500	--	--
Total (Of 17) PAH's	2700	N	mg/kg	< 2.0	100	--	--
pH					--	>6	--
Acid Neutralisation Capacity					--	To evaluate	To evaluate
Eluate Analysis			**10:1 Eluate mg/l**	**10:1 Eluate mg/kg**	**Limit values for compliance leaching test using BS EN 12457 at L/S 10 l/kg**		
Arsenic	1455	U	0.0031	0.030	0.5	2	25
Barium	1455	U	0.077	0.76	20	100	300
Cadmium	1455	U	< 0.00011	< 0.00011	0.04	1	5
Chromium	1455	U	0.0040	0.040	0.5	10	70
Copper	1455	U	0.0019	0.019	2	50	100
Mercury	1455	U	< 0.00005	< 0.00005	0.01	0.2	2
Molybdenum	1455	U	0.0056	0.056	0.5	10	30
Nickel	1455	U	0.0029	0.029	0.4	10	40
Lead	1455	U	< 0.0005	< 0.0005	0.5	10	50
Antimony	1455	U	0.0013	0.013	0.06	0.7	5
Selenium	1455	U	0.0008	0.0082	0.1	0.5	7
Zinc	1455	U	< 0.003	< 0.003	4	50	200
Chloride	1220	U	290	2900	800	15000	25000
Fluoride	1220	U	0.094	< 1.0	10	150	500
Sulphate	1220	U	50	500	1000	20000	50000
Total Dissolved Solids	1020	N	670	6700	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.30	1	-	-
Dissolved Organic Carbon	1610	U	< 2.5	< 50	500	800	1000

Solid Information	
Dry mass of test portion/kg	0.090
Moisture (%)	20

Waste Acceptance Criteria

Landfill WAC analysis (specifically leaching test results) must not be used for hazardous waste classification purposes. This analysis is only applicable for hazardous waste landfill acceptance and does not give any indication as to whether a waste may be hazardous or non-hazardous.

Test Methods

SOP	Title	Parameters included	Method summary
1020	Electrical Conductivity and Total Dissolved Solids (TDS) in Waters	Electrical Conductivity and Total Dissolved Solids (TDS) in Waters	Conductivity Meter
1220	Anions, Alkalinity & Ammonium in Waters	Fluoride; Chloride; Nitrite; Nitrate; Total; Oxidisable Nitrogen (TON); Sulfate; Phosphate; Alkalinity; Ammonium	Automated colorimetric analysis using 'Aquakem 600' Discrete Analyser.
1455	Metals in Waters by ICP-MS	Metals, including: Antimony; Arsenic; Barium; Beryllium; Boron; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Tin; Vanadium; Zinc	Filtration of samples followed by direct determination by inductively coupled plasma mass spectrometry (ICP-MS).
1610	Total/Dissolved Organic Carbon in Waters	Organic Carbon	TOC Analyser using Catalytic Oxidation
1920	Phenols in Waters by HPLC	Phenolic compounds including: Phenol, Cresols, Xylenols, Trimethylphenols Note: Chlorophenols are excluded.	Determination by High Performance Liquid Chromatography (HPLC) using electrochemical detection.
2010	pH Value of Soils	pH	pH Meter
2030	Moisture and Stone Content of Soils(Requirement of MCERTS)	Moisture content	Determination of moisture content of soil as a percentage of its as received mass obtained at <37°C.
2040	Soil Description(Requirement of MCERTS)	Soil description	As received soil is described based upon BS5930
2120	Water Soluble Boron, Sulphate, Magnesium & Chromium	Boron; Sulphate; Magnesium; Chromium	Aqueous extraction / ICP-OES
2192	Asbestos	Asbestos	Polarised light microscopy / Gravimetry
2300	Cyanides & Thiocyanate in Soils	Free (or easy liberatable) Cyanide; total Cyanide; complex Cyanide; Thiocyanate	Allkaline extraction followed by colorimetric determination using Automated Flow Injection Analyser.
2450	Acid Soluble Metals in Soils	Metals, including: Arsenic; Barium; Beryllium; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Vanadium; Zinc	Acid digestion followed by determination of metals in extract by ICP-MS.
2625	Total Organic Carbon in Soils	Total organic Carbon (TOC)	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.
2670	Total Petroleum Hydrocarbons (TPH) in Soils by GC-FID	TPH (C6–C40); optional carbon banding, e.g. 3-band – GRO, DRO & LRO*TPH C8–C40	Dichloromethane extraction / GC-FID
2700	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Soil by GC-FID	Acenaphthene; Acenaphthylene; Anthracene; Benzo[a]Anthracene; Benzo[a]Pyrene; Benzo[b]Fluoranthene; Benzo[ghi]Perylene; Benzo[k]Fluoranthene; Chrysene; Dibenz[ah]Anthracene; Fluoranthene; Fluorene; Indeno[123cd]Pyrene; Naphthalene; Phenanthrene; Pyrene	Dichloromethane extraction / GC-FID (GC-FID detection is non-selective and can be subject to interference from co-eluting compounds)
2760	Volatile Organic Compounds (VOCs) in Soils by Headspace GC-MS	Volatile organic compounds, including BTEX and halogenated Aliphatic/Aromatics.(cf. USEPA Method 8260)*please refer to UKAS schedule	Automated headspace gas chromatographic (GC) analysis of a soil sample, as received, with mass spectrometric (MS) detection of volatile organic compounds.
2800	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Soil by GC-MS	Acenaphthene*; Acenaphthylene; Anthracene*; Benzo[a]Anthracene*; Benzo[a]Pyrene*; Benzo[b]Fluoranthene*; Benzo[ghi]Perylene*; Benzo[k]Fluoranthene; Chrysene*; Dibenz[ah]Anthracene; Fluoranthene*; Fluorene*; Indeno[123cd]Pyrene*; Naphthalene*; Phenanthrene*; Pyrene*	Dichloromethane extraction / GC-MS
2815	Polychlorinated Biphenyls (PCB) ICES7Congeners in Soils by GC-MS	ICES7 PCB congeners	Acetone/Hexane extraction / GC-MS

Test Methods

SOP	Title	Parameters included	Method summary
2920	Phenols in Soils by HPLC	Phenolic compounds including Resorcinol, Phenol, Methylphenols, Dimethylphenols, 1-Naphthol and TrimethylphenolsNote: chlorophenols are excluded.	60:40 methanol/water mixture extraction, followed by HPLC determination using electrochemical detection.
640	Characterisation of Waste (Leaching C10)	Waste material including soil, sludges and granular waste	ComplianceTest for Leaching of Granular Waste Material and Sludge

Report Information

Key	
U	UKAS accredited
M	MCERTS and UKAS accredited
N	Unaccredited
S	This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
SN	This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
T	This analysis has been subcontracted to an unaccredited laboratory
I/S	Insufficient Sample
U/S	Unsuitable Sample
N/E	not evaluated
<	"less than"
>	"greater than"
SOP	Standard operating procedure
LOD	Limit of detection

Comments or interpretations are beyond the scope of UKAS accreditation

The results relate only to the items tested

Uncertainty of measurement for the determinands tested are available upon request

None of the results in this report have been recovery corrected

All results are expressed on a dry weight basis

The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols

For all other tests the samples were dried at < 37°C prior to analysis

All Asbestos testing is performed at the indicated laboratory

Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

A - Date of sampling not supplied
B - Sample age exceeds stability time (sampling to extraction)
C - Sample not received in appropriate containers
D - Broken Container
E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

Sample Retention and Disposal

All soil samples will be retained for a period of 30 days from the date of receipt
All water samples will be retained for 14 days from the date of receipt
Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:
customerservices@chemtest.com

APPENDIX G

MARINE SEDIMENT LABORATORY RESULTS

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR01357	
Issue Version	1	
Customer	Causeway Geotech Ltd, 8 Drumahiskey Road, Ballymoney, Co. Antrim, BT53 7QL	
Customer Reference	Scapa Flow Marine Scotland Sediment Testing	
Date Sampled	04-05-Mar-2022	
Date Received	16-Mar-22	
Date Reported	12-Apr-22	
Condition of samples	Cold	Satisfactory

Authorised by:	Marya Hubbard
Position:	Laboratory Manager

Any additional opinions or interpretations found in this report, are outside the scope of UKAS accreditation.

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR01357
Issue Version	1
Customer Reference	Scapa Flow Marine Scotland Sediment Testing

		Units	%	%	%	%	%	Mg/m3
		Method No	ASC/SOP/303	ASC/SOP/303	SUB_01*	SUB_01*	SUB_01*	SOCOTEC Doncaster*
		Limit of Detection	0.2	0.2	N/A	N/A	N/A	N/A
		Accreditation	UKAS	UKAS	N	N	N	N
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**Total Moisture @ 120°C**	**Total Solids**	**Gravel (>2mm)**	**Sand (63-2000 µm)**	**Silt (<63 µm)**	**Particle Density**
BH-M04 (SS1) 0.00-0.50m	MAR01357.1	Sediment	15.6	84.4	14.1	69.1	16.8	2.66
BH-M04 (SS2) 1.00-1.50m	MAR01357.2	Sediment	13.3	86.7	14.2	66.6	19.2	2.72
BH-M04 (SS3) 2.50-3.00m	MAR01357.3	Sediment	13.3	86.7	20.0	65.8	14.2	2.67
BH-M05 (SS1) 0.00-0.50m	MAR01357.4	Sediment	12.7	87.3	15.1	59.5	25.4	2.73
BH-M05 (SS2) 1.00-1.50m	MAR01357.5	Sediment	12.9	87.1	14.2	69.6	16.2	2.72
BH-M05 (SS3) 2.50-3.00m	MAR01357.6	Sediment	21.0	79.0	10.9	72.6	16.5	2.54
Reference Material (% Recovery)			N/A	N/A	N/A	N/A	N/A	N/A
QC Blank			N/A	N/A	N/A	N/A	N/A	N/A

* See Report Notes

NAIIS - No Asbestos Identified In Sample

Certificate of Analysis

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Test Report ID MAR01357
Issue Version 1
Customer Reference Scapa Flow Marine Scotland Sediment Testing

		Units	N/A	% M/M
		Method No	SUB_02*	WSLM59*
		Limit of Detection	N/A	0.02
		Accreditation	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**Asbestos**	**TOC**
BH-M04 (SS1) 0.00-0.50m	MAR01357.1	Sediment	NAIIS	0.26
BH-M04 (SS2) 1.00-1.50m	MAR01357.2	Sediment	NAIIS	0.21
BH-M04 (SS3) 2.50-3.00m	MAR01357.3	Sediment	NAIIS	0.23
BH-M05 (SS1) 0.00-0.50m	MAR01357.4	Sediment	NAIIS	0.22
BH-M05 (SS2) 1.00-1.50m	MAR01357.5	Sediment	NAIIS	0.25
BH-M05 (SS3) 2.50-3.00m	MAR01357.6	Sediment	NAIIS	0.27
		Reference Material (% Recovery)	N/A	105
		QC Blank	N/A	<0.02

* See Report Notes
NAIIS - No Asbestos Identified In Sample

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID MAR01357
Issue Version 1
Customer Reference Scapa Flow Marine Scotland Sediment Testing

		Units	mg/Kg (Dry Weight)							
		Method No	ICPMSS*							
		Limit of Detection	0.5	0.04	0.5	0.5	0.01	0.5	0.5	2
		Accreditation	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Mercury**	**Nickel**	**Lead**	**Zinc**
BH-M04 (SS1) 0.00-0.50m	MAR01357.1	Sediment	24.6	0.29	51.4	40.0	0.12	31.8	50.7	161
BH-M04 (SS2) 1.00-1.50m	MAR01357.2	Sediment	23.8	0.19	34.5	18.4	0.04	27.4	25.8	80.8
BH-M04 (SS3) 2.50-3.00m	MAR01357.3	Sediment	19.9	0.32	36.5	21.4	0.03	29.0	23.5	82.1
BH-M05 (SS1) 0.00-0.50m	MAR01357.4	Sediment	16.6	0.17	27.8	11.9	<0.01	18.6	12.8	46.6
BH-M05 (SS2) 1.00-1.50m	MAR01357.5	Sediment	14.5	0.11	24.6	9.9	<0.01	16.3	10.2	45.8
BH-M05 (SS3) 2.50-3.00m	MAR01357.6	Sediment	11.7	0.15	23.3	10.3	<0.01	15.7	8.9	36.7
Certified Reference Material SETOC 774 (% Recovery)			107	105	109	108	101	107	103	103
QC Blank			<0.5	<0.04	<0.5	<0.5	<0.01	<0.5	<0.5	<2

* See Report Notes

Certificate of Analysis

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Test Report ID MAR01357
Issue Version 1

Customer Reference Scapa Flow Marine Scotland Sediment Testing

		Units	µg/Kg (Dry Weight)	
		Method No	ASC/SOP/301	
		Limit of Detection	1	1
		Accreditation	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**Dibutyltin (DBT)**	**Tributyltin (TBT)**
BH-M04 (SS1) 0.00-0.50m	MAR01357.1	Sediment	<5	<5
BH-M04 (SS2) 1.00-1.50m	MAR01357.2	Sediment	<5	<5
BH-M04 (SS3) 2.50-3.00m	MAR01357.3	Sediment	<5	<5
BH-M05 (SS1) 0.00-0.50m	MAR01357.4	Sediment	<5	<5
BH-M05 (SS2) 1.00-1.50m	MAR01357.5	Sediment	<5	<5
BH-M05 (SS3) 2.50-3.00m	MAR01357.6	Sediment	<5	<5
Certified Reference Material QSP076MS (% Recovery)			93	104
QC Blank			<1	<1

* See Report Notes

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Test Report ID	MAR01357
Issue Version	1
Customer Reference	Scapa Flow Marine Scotland Sediment Testing

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304
		Limit of Detection	1	1	1	1	1	1
		Accreditation	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**ACENAPTH**	**ACENAPHY**	**ANTHRACN**	**BAA**	**BAP**	**BBF**
BH-M04 (SS1) 0.00-0.50m	MAR01357.1	Sediment	<1	<1	<1	<1	<1	1.83
BH-M04 (SS2) 1.00-1.50m	MAR01357.2	Sediment	<1	<1	<1	<1	<1	1.45
BH-M04 (SS3) 2.50-3.00m	MAR01357.3	Sediment	<1	<1	<1	<1	<1	1.65
BH-M05 (SS1) 0.00-0.50m	MAR01357.4	Sediment	<1	<1	<1	<1	<1	1.70
BH-M05 (SS2) 1.00-1.50m	MAR01357.5	Sediment	<1	<1	<1	<1	<1	1.84
BH-M05 (SS3) 2.50-3.00m	MAR01357.6	Sediment	1.34	1.16	1.92	4.94	5.71	6.87
Certified Reference Material Quasimeme QPH105MS (% Recovery)			88	127	97	89	91	73
QC Blank			<1	<1	<1	<1	<1	<1

For full analyte name see method summaries

~ Indicates result is for an In-house Reference Material as no Certified Reference Materials are avaliable.

As the method uses surrogate standards to correct for losses, the RM results are reported as percentage trueness, not recovery.

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Test Report ID MAR01357
Issue Version 1
Customer Reference Scapa Flow Marine Scotland Sediment Testing

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304
		Limit of Detection	1	1	1	1	1	1
		Accreditation	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**BENZGHIP**	**BKF**	**CHRYSENE**	**DBENZAH**	**FLUORANT**	**FLUORENE**
BH-M04 (SS1) 0.00-0.50m	MAR01357.1	Sediment	1.75	<1	4.43	<1	1.74	<1
BH-M04 (SS2) 1.00-1.50m	MAR01357.2	Sediment	1.45	<1	3.83	<1	1.79	<1
BH-M04 (SS3) 2.50-3.00m	MAR01357.3	Sediment	1.44	<1	3.09	<1	1.23	<1
BH-M05 (SS1) 0.00-0.50m	MAR01357.4	Sediment	1.07	<1	3.22	<1	1.08	<1
BH-M05 (SS2) 1.00-1.50m	MAR01357.5	Sediment	1.30	<1	2.09	<1	1.54	<1
BH-M05 (SS3) 2.50-3.00m	MAR01357.6	Sediment	5.15	3.05	7.67	1.28	9.94	1.77
Certified Reference Material Quasimeme QPH105MS (% Recovery)			96	99	90	96	98	86
QC Blank			<1	<1	<1	<1	<1	<1

For full analyte name see method summaries
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Issue Version 1
Customer Reference Scapa Flow Marine Scotland Sediment Testing

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/306
		Limit of Detection	1	1	1	1	100
		Accreditation	UKAS	UKAS	UKAS	N	N
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**INDPYR**	**NAPTH**	**PHENANT**	**PYRENE**	**THC**
BH-M04 (SS1) 0.00-0.50m	MAR01357.1	Sediment	<1	1.38	3.60	2.88	59900
BH-M04 (SS2) 1.00-1.50m	MAR01357.2	Sediment	<1	1.38	4.48	2.64	46800
BH-M04 (SS3) 2.50-3.00m	MAR01357.3	Sediment	<1	1.43	2.81	3.06	123000
BH-M05 (SS1) 0.00-0.50m	MAR01357.4	Sediment	<1	1.28	1.10	3.05	42200
BH-M05 (SS2) 1.00-1.50m	MAR01357.5	Sediment	<1	1.22	1.14	1.78	20200
BH-M05 (SS3) 2.50-3.00m	MAR01357.6	Sediment	4.20	4.02	6.67	9.32	23600
Certified Reference Material Quasimeme QPH105MS (% Recovery)			90	103	94	101	92~
QC Blank			<1	<1	<1	<1	<1

For full analyte name see method summaries
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As the method uses surrogate standards to correct for losses, the RM results are reported as percentage trueness, not recovery.

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Test Report ID MAR01357
Issue Version 1
Customer Reference Scapa Flow Marine Scotland Sediment Testing

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302
		Limit of Detection	0.08	0.08	0.08	0.08	0.08	0.08	0.08
		Accreditation	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**PCB28**	**PCB52**	**PCB101**	**PCB118**	**PCB138**	**PCB153**	**PCB180**
BH-M04 (SS1) 0.00-0.50m	MAR01357.1	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M04 (SS2) 1.00-1.50m	MAR01357.2	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M04 (SS3) 2.50-3.00m	MAR01357.3	Sediment	<0.08	0.12	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M05 (SS1) 0.00-0.50m	MAR01357.4	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M05 (SS2) 1.00-1.50m	MAR01357.5	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M05 (SS3) 2.50-3.00m	MAR01357.6	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Certified Reference Material Quasimeme QOR143MS (% Recovery)			79	103	96	108	98	101	91
QC Blank			<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08

For full analyte name see method summaries

~ Indicates result is for an In-house Reference Material as no Certified Reference Materials are avaliable.

REPORT NOTES

Method Code	Sample ID	The following information should be taken into consideration when using the data contained within this report
WSLM59*	MAR01357.1-6	Analysis was conducted by an internal SOCOTEC laboratory. UKAS accredited analysis by this laboratory is under UKAS number 1252.
ICPMSS*	MAR01357.1-6	Analysis was conducted by an internal SOCOTEC laboratory. UKAS accredited analysis by this laboratory is under UKAS number 1252.
SOCOTEC Doncaster*	MAR01357.1-6	Analysis was conducted by an internal SOCOTEC laboratory.
SUB_01*	MAR01357.1-6	Analysis was conducted by an approved subcontracted laboratory.
SUB_02*	MAR01357.1-6	Analysis was conducted by an approved subcontracted laboratory.
ASC/SOP/301	MAR01357.1-6	The matrix of this sample has been found to interfere with the result for this test. The sample has therefore been diluted, but in doing so, the detection limit for this test has been elevated.
ASC/SOP/303/304	MAR01357.1-6	Chrysene is known to coelute with Triphenylene and these peaks can not be resolved. It is believed Triphenylene is present in these samples therefore it is suggested that the Chrysene results should be taken as a Chrysene (inc. Triphenylene).This should be taken into consideration when utilising the data.

DEVIATING SAMPLE STATEMENT

Deviation Code	Deviation Definition	Sample ID	Deviation Details. The following information should be taken into consideration when using the data contained within this report
D1	Holding Time Exceeded	N/A	N/A
D2	Handling Time Exceeded	N/A	N/A
D3	Sample Contaminated through Damaged Packaging	N/A	N/A
D4	Sample Contaminated through Sampling	N/A	N/A
D5	Inappropriate Container/Packaging	N/A	N/A
D6	Damaged in Transit	N/A	N/A
D7	Insufficient Quantity of Sample	N/A	N/A
D8	Inappropriate Headspace	N/A	N/A
D9	Retained at Incorrect Temperature	N/A	N/A
D10	Lack of Date & Time of Sampling	N/A	N/A
D11	Insufficient Sample Details	N/A	N/A
D12	Sample integrity compromised or not suitable for analysis	N/A	N/A

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR01357
Issue Version	1
Customer Reference	Scapa Flow Marine Scotland Sediment Testing

Method	Sample and Fraction Size	Method Summary
Total Solids	Wet Sediment	Calculation (100%-Moisture Content).Moisture content determined by drying a portion of the sample at 120°C to constant weight.
Particle Size Analysis	Wet Sediment	Wet and dry sieving followed by laser diffraction analysis.
Total Organic Carbon (TOC)	Air dried and ground	Carbonate removal and sulphurous acid/combustion at 1600°C/NDIR.
Metals	Air dried and seived to <63µm	Aqua-regia extraction followed by ICP analysis.
Organotins	Wet Sediment	Solvent extraction and derivatisation followed by GC-MS analysis.
Polyaromatic Hydrocarbons (PAH)	Wet Sediment	Solvent extraction and clean up followed by GC-MS analysis.
Total Hydrocarbon Content (THC)	Wet Sediment	Solvent extraction and clean up followed by GC-FID analysis.
Polychlorinated Biphenyls (PCBs)	Air dried and seived to <2mm	Solvent extraction and clean up followed by GC-MS-MS analysis.

Analyte Definitions

Analyte Abbreviation	Full Analyte name	Analyte Abbreviation	Full Analyte name	Analyte Abbreviation	Full Analyte name
ACENAPTH	Acenaphthene	C2N	C2-naphthalenes	THC	Total Hydrocarbon Content
ACENAPHY	Acenaphthylene	C3N	C3-naphthalenes	AHCH	alpha-Hexachlorcyclohexane
ANTHRACN	Anthracene	CHRYSENE	Chrysene	BHCH	beta-Hexachlorcyclohexane
BAA	Benzo[a]anthracene	DBENZAH	Dibenzo[ah]anthracene	GHCH	gamma-Hexachlorcyclohexane
BAP	Benzo[a]pyrene	FLUORANT	Fluoranthene	DIELDRIN	Dieldrin
BBF	Benzo[b]fluoranthene	FLUORENE	Fluorene	HCB	Hexachlorobenzene
BEP	Benzo[e]pyrene	INDPYR	Indeno[1,2,3-cd]pyrene	DDD	p,p'-Dichlorodiphenyldichloroethane
BENZGHIP	Benzo[ghi]perylene	NAPTH	Naphthalene	DDE	p,p'-Dichlorodiphenyldichloroethylene
BKF	Benzo[k]fluoranthene	PERYLENE	Perylene	DDT	p,p'-Dichlorodiphenyltrichloroethane
C1N	C1-naphthalenes	PHENANT	Phenanthrene		
C1PHEN	C1-phenanthrene	PYRENE	Pyrene		

Applicant Information

Applicant:	
Description of dredging:	
Total amount to be dredged (wet tonnes)	

Sample Details & Physical Properties

Explanatory Notes:
An example of a 'Dredge area' is: 'Dock A, Harbour X'
Provide description of the dredge area and the latitude and longitude co-oridnates (WGS84) for each sample location. Co-ordinates taken from GPS equipment should be set to WGS84.
Note for sample depth that the seabed is 0 metres.
Gravel is defined as >2mm, **Sand** is defined as >63um<2mm, **Silt** is deinfed as <63um).

Sample information:

Sample ID	Dredge area	Latitude	Longitude	Type of sample	Sample depth (m)	Total solids (%)	Gravel (%)	Sand (%)	Silt (%)	TOC (%)	Specific gravity	Asbestos
MAR01357.1	BH-M04 (SS1) 0.0-0.5m	58°55.076'N	002°57.248'W	Core	0.00-0.50m	84.4	14.1	69.1	16.8	0.26	2.66	No
MAR01357.2	BH-M04 (SS2) 1.0-1.5m	58°55.076'N	002°57.248'W	Core	1.00-1.50m	86.7	14.2	66.6	19.2	0.21	2.72	No
MAR01357.3	BH-M04 (SS3) 2.5-3.0m	58°55.076'N	002°57.248'W	Core	2.50-3.00m	86.7	20	65.8	14.2	0.23	2.67	No
MAR01357.4	BH-M05 (SS1) 0.0-0.5m	58°55.094'N	002°57.310'W	Core	0.00-0.50m	87.3	15.1	59.5	25.4	0.22	2.73	No
MAR01357.5	BH-M05 (SS2) 1.0-1.5m	58°55.094'N	002°57.310'W	Core	1.00-1.50m	87.1	14.2	69.6	16.2	0.25	2.72	No
MAR01357.6	BH-M05 (SS3) 2.5-3.0m	58°55.094'N	002°57.310'W	Core	2.50-3.00m	79	10.9	72.6	16.5	0.27	2.54	No
		° . 'N	° . 'W									
		° . 'N	° . 'W									
		° . 'N	° . 'W									
		° . 'N	° . 'W									
		° . 'N	° . 'W									
		° . 'N	° . 'W									
		° . 'N	° . 'W									
		° . 'N	° . 'W									
		° . 'N	° . 'W									
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		° . 'N	° . 'W									
		° . 'N	° . 'W									
		° . 'N	° . 'W									

Trace Metals & Organotins

Explanatory Notes:
Results above Action Level 1 will be highlighted in blue and above Action Level 2 in red.

Sample information:

Sample ID	Dredge area	Type of sample	Sample depth (m)	Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Copper (Cu)	Mercury (Hg)	Nickel (Ni)	Lead (Pb)	Zinc (Zn)	Dibutyltin (DBT)	Tributyltin (TBT)
				mg/kg dry weight									
MAR01357.1	BH-M04 (SS1) 0.0-0.5m	Core	0.00-0.50m	24.6	0.29	51.4	40	0.12	31.8	50.7	161	<0.005	<0.005
MAR01357.2	BH-M04 (SS2) 1.0-1.5m	Core	1.00-1.50m	23.8	0.19	34.5	18.4	0.04	27.4	25.8	80.8	<0.005	<0.005
MAR01357.3	BH-M04 (SS3) 2.5-3.0m	Core	2.50-3.00m	19.9	0.32	36.5	21.4	0.03	29	23.5	82.1	<0.005	<0.005
MAR01357.4	BH-M05 (SS1) 0.0-0.5m	Core	0.00-0.50m	16.6	0.17	27.8	11.9	<0.01	18.6	12.8	46.6	<0.005	<0.005
MAR01357.5	BH-M05 (SS2) 1.0-1.5m	Core	1.00-1.50m	14.5	0.11	24.6	9.9	<0.01	16.3	10.2	45.8	<0.005	<0.005
MAR01357.6	BH-M05 (SS3) 2.5-3.0m	Core	2.50-3.00m	11.7	0.15	23.3	10.3	<0.01	15.7	8.9	36.7	<0.005	<0.005
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Polyaromatic Hydrocarbons (PAH)

Explanatory Notes:
Results above Action Level 1 will be highlighted in blue and above Action Level 2 in red.

Definitions:

ACENAPTH	Acenaphthene
ACENAPHY	Acenaphthylene
ANTHRACN	Anthracene
BAA	Benz(a)anthracene
BAP	Benzo(a)pyrene
BBF	Benzo(b)fluoranthene
BEP	Benzo(e)pyrene
BENZGHIP	Benzo(ghi)perylene
BKF	Benzo(K)fluoranthene
C1N	C1-naphthalenes
C1PHEN	C1-phenanthrene
C2N	C2-naphthalenes
C3N	C3-naphthalenes
CHRYSENE	Chrysene
DBENZAH	Diben(ah)anthracene
FLUORANT	Fluoranthene
FLUORENE	Fluorene
INDPYR	Indeno(1,2,3-cd)pyrene
NAPTH	Naphthalene
PERYLENE	Perylene
PHENANT	Phenanthrene
PYRENE	Pyrene
THC	Total Hydrocarbon Content

Sample information:

				µg/kg																						
Sample ID	Dredge area	Type of sample	Sample depth (m)	ACENAPTH	ACENAPHY	ANTHRACN	BAA	BAP	BBF	BEP	BENZGHIP	BKF	C1N	C1PHEN	C2N	C3N	CHRYSENE	DBENZAH	FLUORANT	FLUORENE	INDPYR	NAPTH	PERYLENE	PHENANT	PYRENE	THC
MAR01357.1	BH-M04 (SS1) 0.0-0.5m	Core	0.00-0.50m	<1	<1	<1	<1	<1	1.83		1.75	<1					4.43	<1	1.74	<1	<1	1.38		3.6	2.88	59900
MAR01357.2	BH-M04 (SS2) 1.0-1.5m	Core	1.00-1.50m	<1	<1	<1	<1	<1	1.45		1.45	<1					3.83	<1	1.79	<1	<1	1.38		4.48	2.64	46800
MAR01357.3	BH-M04 (SS3) 2.5-3.0m	Core	2.50-3.00m	<1	<1	<1	<1	<1	1.65		1.44	<1					3.09	<1	1.23	<1	<1	1.43		2.81	3.06	123000
MAR01357.4	BH-M05 (SS1) 0.0-0.5m	Core	0.00-0.50m	<1	<1	<1	<1	<1	1.7		1.07	<1					3.22	<1	1.08	<1	<1	1.28		1.1	3.05	42200
MAR01357.5	BH-M05 (SS2) 1.0-1.5m	Core	1.00-1.50m	<1	<1	<1	<1	<1	1.84		1.3	<1					2.09	<1	1.54	<1	<1	1.22		1.14	1.78	20200
MAR01357.6	BH-M05 (SS3) 2.5-3.0m	Core	2.50-3.00m	1.34	1.16	1.92	4.94	5.71	6.87		5.15	3.05					7.67	1.28	9.94	1.77	4.2	4.02		6.67	9.32	23600
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Organohalogens

Explanatory Notes:
Results above Action Level 1 will be highlighted in blue and above Action Level 2 in red.
ICES7 is the sum of PCB 28,52,101,138,153,180 and 118.

Definitions:

AHCH	alpha-Hexachlorcyclohexane
BHCH	beta-Hexachlorcyclohexane
GHCH	gamma-Hexachlorcyclohexane
DIELDRIN	Dieldrin
HCB	Hexachlorobenzene
PPDDE	p,p'-Dichorodiphenyldicloroethylene
PPDDT	p,p'-Dichorodiphenyltrichloroethane
PPTDE	p,p'-Dichorodiphenyldicloroethane

Sample information:

Sample ID	Dredge area	Type of sample	Sample depth (m)	PCB28	PCB52	PCB101	PCB118	PCB138	PCB153	PCB18	PCB105	PCB110	PCB128	PCB141	PCB149	PCB151	PCB156	PCB158	PCB170	PCB180	PCB183	PCB187	PCB194	PCB31	PCB44	PCB47	PCB49	PCB66	ICES7
				µg/kg																									
MAR01357.1	BH-M04 (SS1) 0.0-0.5m	Core	0.00-0.50m	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08											<0.08									0.56
MAR01357.2	BH-M04 (SS2) 1.0-1.5m	Core	1.00-1.50m	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08											<0.08									0.56
MAR01357.3	BH-M04 (SS3) 2.5-3.0m	Core	2.50-3.00m	<0.08	0.12	<0.08	<0.08	<0.08	<0.08											<0.08									0.6
MAR01357.4	BH-M05 (SS1) 0.0-0.5m	Core	0.00-0.50m	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08											<0.08									0.56
MAR01357.5	BH-M05 (SS2) 1.0-1.5m	Core	1.00-1.50m	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08											<0.08									0.56
MAR01357.6	BH-M05 (SS3) 2.5-3.0m	Core	2.50-3.00m	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08											<0.08									0.56
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PR Details

Total amount to be dredged (wet tonnes)

Explanatory Notes:
The values entered for each determinand should be an average wet weight concentration from all the samples representing the material to be disposed to sea. They should be entered in the units stated in the Unit of measurement column in the table below.
Results above Action Level 1 will be highlighted in blue and above Action Level 2 in red.

Average for the total dredge area:

Sample ID	Unit of measurement	
Total Solids	%	85.2
Gravel	%	14.8
Sand	%	67.2
Silt	%	18.1
Arsenic (As)	mg/kg	15.7
Cadmium (Cd)		0.17
Chromium (Cr)		27.9
Copper (Cu)		15.8
Mercury (Hg)		0.03
Nickel (Ni)		19.5
Lead (Pb)		18.6
Zinc (Zn)		63.9
Dibutyltin (DBT)		<0.005
Tributyltin (TBT)		<0.005
Acenapth	µg/kg	1.01
Acenapthylene		1
Anthracn		1.09
BAA		1.48
BAP		1.59
BBF		2.12
BEP		
Benzghip		1.7
BKF		1.24
C1N		
C1PHEN		
C2N		
C3N		
Chrysene		3.41
Debenzah		1
Flurant		2.38
Fluorene		1.07
Indypr		1.39
napth		1.49
perylene		
phenant		2.77
pyrene		3.16
THC		45167
PCB28		<0.08
PCB52		<0.08
PCB101		<0.08
PCB118		<0.08
PCB138		<0.08
PCB153		<0.08
PCB18		
PCB105		
PCB110		
PCB128		
PCB141		
PCB149		
PCB151		
PCB156		
PCB158		
PCB170		
PCB180		<0.08
PCB183		
PCB187		
PCB194		
PCB31		
PCB44		
PCB47		
PCB49		
PCB66		
ICES7		0.48
AHCH		
BHCH		
GHCH		
DIELDRIN		
HCB		
DDE		
DDT		
TDE		
BDE100		
BDE138		
BDE153		
BDE154		
BDE17		
BDE183		
BDE209		
BDE28		
BDE47		
BDE66		
BDE85		
BDE99		

Comments:

Laboratory Details

Explanatory Notes:
Please complete a separate worksheet for each laboratory (e.g. complete 'Laboartory_1' worksheet for 1 laboratory and complete 'Laboartory_2' worksheet for a second laboratory). If there are more than 3 laboratories then please contact MS-L

Laboratory 1 Details:

Laboratory name:	SOCOTEC
Year:	2022

LabRefMat	**Q1**	Does the laboratory carrying out the analyses undertake the analysis of blank samples and laboratory reference materials with each batch of samples of waste and other material dumped in the maritime area that is analysed by that laboratory?	Yes
CompAnal	**Q2**	Does the laboratory carrying out the analyses undertake periodic comparative analysis of laboratory reference materials and certified reference materials	Yes
QAQC	**Q3**	Does the laboratory carrying out the analyses undertake the compilation of quality control charts based upon the data resulting from the analyses of the laboratory reference materials and certified reference materials, and the use of those quality control charts to monitor analytical performance in relation to all samples of dumped wastes or other materials?	Yes
InterlabCaleb	**Q4**	Does the laboratory carrying out the analyses undertake periodic participation in interlaboratory comparison exercises, including, where possible, international comparison exercises?	Yes
InternatCaleb	**Q5**	Does the laboratory carrying out the analyses undertake periodic participation in national and, where possible, international laboratory proficiency schemes?	Yes
SpikedSamples	**Q6**	If the answer to questions 4 or 5 is 'Yes' then does the laboratory analyse samples of substances which are provided by the organisers of the scheme?	Yes
BlindSamples	**Q7**	If the answer to questions 4 or 5 is 'Yes' then does the laboratory confirm that the composition of those samples is not disclosed in advance?	Yes
Ranking	**Q8**	If the answer to questions 4 or 5 is 'Yes' then does the laboratory confirm that the results of the scheme for each participating laboratory are made available to all participating laboratories?	Yes
FracAnal	**Q9**	Enter the size fraction that is analysed i.e. Whole or less than 63µm etc.	<63um(metals)
GranMeth	**Q10**	PSA method	Distribution by wet & dry sieving and laser detraction
OCMeth	**Q11**	Organic Carbon method	Carbonate removal and sulfurous acid/combustion at 1600°C/NDIR,
MetExtrType	**Q12**	Method of extraction used for metal analysis	Aquaregia
MethOfDetMetals	**Q13**	Method of detection used for metal analysis	ICP-MS
PAHExtrType	**Q14**	Method of extraction used for poly aromatic hydrocarbon analysis	Methanol/DCM solvent extraction with silica clean up and copper clean up stages
MethOfDetPAH	**Q15**	Method of detection used for poly aromatic hydrocarbons analysis	GCMS
OHExtrType	**Q16**	Method of extraction used for organohalogens inc PCBs, pesticides, flame retardants etc analysis	Ultrasonic acetone/hexane solvent extraction
MethOfDetOH	**Q17**	Method of detection used for organohalogens inc PCBs, pesticides, flame retardants etc analysis	GCMSMS
OTExtrType	**Q18**	Method of extraction used for organotin analysis	Derivatisation and solvent extraction
MethOfDetOT	**Q19**	Method of detection used for organotin analysis	GCMS

		LOD/LOQ	Precision (%)	Recovery (%)
mg/kg	Hg	0.015	4.2	101
	As	0.5	2.7	107
	Cd	0.04	3.6	105
	Cu	0.5	2.9	108
	Pb	0.5	3	103
	Zn	2	2.6	103
	Cr	0.5	3.1	109
	Ni	0.5	3.6	107
	TBT	0.001	12.62	104
	DBT	0.001	12.62	93
µg/kg	PCB28	0.08	12.56	79
	PCB31			
	PCB44			
	PCB47			
	PCB49			
	PCB52	0.08	6.999	103
	PCB66			
	PCB101	0.08	8.43	96
	PCB105			
	PCB110			
	PCB118	0.08	14.61	108
	PCB128			
	PCB138+163	0.08	12.93	98
	PCB141			
	PCB149			
	PCB151			
	PCB153	0.08	7.41	101
	PCB156			
	PCB158			
	PCB170			
	PCB180	0.08	9.85	91
	PCB183			
	PCB187			
	PCB194			
	DDE			
	DDT			
	DDD			
	Dieldrin			
	Lindane			
	HCB			
	BDE17			
	BDE28			
	BDE47			
	BDE66			
	BDE85			
	BDE99			
	BDE100			
	BDE138			
	BDE153			
	BDE154			
	BDE183			
	BDE209			
	ACENAPTH	1	6.68	88
	ACENAPHY	1	7.74	127
	ANTHRACN	1	4.95	97
	BAA	1	9.8	89
	BAP	1	9.07	91
	BBF	1	8.44	73
	BENZGHIP	1	13.46	96
	BEP			
	BKF	1	8.9	99
	C1N			
	C1PHEN			
	C2N			
	C3N			
	CHRYSENE	1	7.87	90
	DBENZAH	1	19.23	96
	FLUORENE	1	5.25	86
	FLUORANT	1	4.36	98
	INDPYR	1	17.1	90
	NAPTH	1	3.02	103
	PERYLENE			
	PHENANT	1	5.41	94
	PYRENE	1	4.29	101
	THC	100	N/A	92

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR1394	
Issue Version	1	
Customer	Causeway Geotech Ltd, 8 Drumahiskey Road, Ballymoney, Co. Antrim, BT53 7QL	
Customer Reference	Scapa Flow Marie Scotland Sediment Testing	
Date Sampled	23-Mar- 02-Apr-2022	
Date Received	11-Apr-22	
Date Reported	09-May-22	
Condition of samples	Cold	Satisfactory

Authorised by: Marya Hubbard

Position: Laboratory Manager

Any additional opinions or interpretations found in this report, are outside the scope of UKAS accreditation.

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID MAR1394
Issue Version 1
Customer Reference Scapa Flow Marie Scotland Sediment Testing

		Units	%	%	%	%	%	Mg/m3
		Method No	ASC/SOP/303	ASC/SOP/303	SUB_01*	SUB_01*	SUB_01*	SOCOTEC Doncaster*
		Limit of Detection	0.2	0.2	N/A	N/A	N/A	N/A
		Accreditation	UKAS	UKAS	N	N	N	N
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**Total Moisture @ 120°C**	**Total Solids**	**Gravel (>2mm)**	**Sand (63-2000 µm)**	**Silt (<63 µm)**	**Particle Density**
BH-M01 (SS1) 0.00-0.50m	MAR1394.01	Sediment	16.3	83.7	7.6	73.8	18.6	2.72
BH-M01 (SS2) 1.00-1.50m	MAR1394.02	Sediment	14.6	85.4	5.5	82.4	12.1	2.69
BH-M01 (SS3) 2.50-3.00m	MAR1394.03	Sediment	11.6	88.4	10.1	47.9	42.0	2.66
BH-M03 (SS1) 0.00-0.50m	MAR1394.04	Sediment	14.3	85.7	8.3	64.6	27.0	2.71
BH-M03 (SS2) 1.00-1.50m	MAR1394.05	Sediment	13.8	86.2	11.0	53.1	35.9	2.74
BH-M03 (SS3) 2.50-3.00m	MAR1394.06	Sediment	14.3	85.7	10.4	25.8	63.9	Not Amenable*
BH-M07 (SS1) 0.00-0.50m	MAR1394.07	Sediment	16.1	83.9	20.9	57.8	21.2	2.51
BH-M07 (SS2) 1.00-1.50m	MAR1394.08	Sediment	18.7	81.3	19.1	60.9	20.0	Not Amenable*
BH-M07 (SS3) 2.50-3.00m	MAR1394.09	Sediment	14.3	85.7	17.6	67.8	14.6	Not Amenable*
BH-M09 (SS1) 0.00-0.50m	MAR1394.10	Sediment	23.0	77.0	23.5	52.9	23.6	0.72
BH-M09 (SS2) 1.00-1.50m	MAR1394.11	Sediment	17.5	82.5	11.6	64.9	23.5	2.76
BH-M09 (SS3) 2.50-3.00m	MAR1394.12	Sediment	12.7	87.3	25.2	54.2	20.7	Not Amenable*
BH-M11 (SS1) 0.00-0.50m	MAR1394.13	Sediment	12.9	87.1	17.8	65.2	17.0	2.69
BH-M11 (SS2) 1.00-1.50m	MAR1394.14	Sediment	13.1	86.9	8.7	61.9	29.4	2.70
BH-M11 (SS3) 2.50-3.00m	MAR1394.15	Sediment	12.6	87.4	20.0	45.3	34.7	Not Amenable*
BH-M13 (SS1) 0.00-0.50m	MAR1394.16	Sediment	19.3	80.7	9.3	75.3	15.4	Not Amenable*
BH-M13 (SS2) 1.00-1.50m	MAR1394.17	Sediment	17.1	82.9	10.3	59.4	30.3	2.71
BH-M13 (SS3) 2.50-3.00m	MAR1394.18	Sediment	12.0	88.0	20.8	40.2	39.0	2.69
BH-M14 (SS1) 0.00-0.50m	MAR1394.19	Sediment	17.9	82.1	22.9	61.9	15.2	Not Amenable*
BH-M14 (SS2) 1.00-1.50m	MAR1394.20	Sediment	23.3	76.7	20.6	63.8	15.6	Not Amenable*
BH-M14 (SS3) 2.50-3.00m	MAR1394.21	Sediment	16.0	84.0	19.9	63.2	16.8	2.66
BH-M15 (SS1) 0.00-0.50m	MAR1394.22	Sediment	20.3	79.7	34.4	47.8	17.9	2.72
BH-M15 (SS2) 1.00-1.50m	MAR1394.23	Sediment	17.2	82.8	28.6	48.8	22.5	2.68
BH-M15 (SS3) 2.50-3.00m	MAR1394.24	Sediment	15.5	84.5	32.4	50.2	17.3	2.71
WP-M27 (SS1) 0.00-0.15m	MAR1394.25	Sediment	22.4	77.6	21.5	57.5	21.0	2.66
BH-M16 (SS1) 0.00-0.50m	MAR1394.26	Sediment	16.5	83.5	27.4	51.7	20.9	2.69
BH-M16 (SS2) 1.00-1.50m	MAR1394.27	Sediment	13.3	86.7	30.4	51.8	17.8	Not Amenable*
BH-M17 (SS1) 0.00-0.50m	MAR1394.28	Sediment	12.2	87.8	20.1	42.9	37.1	2.71
Reference Material (% Recovery)			N/A	N/A	N/A	N/A	N/A	N/A
QC Blank			N/A	N/A	N/A	N/A	N/A	N/A

* See Report Notes
NAIIS - No Asbestos Identified In Sample

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR1394
Issue Version	1
Customer Reference	Scapa Flow Marie Scotland Sediment Testing

		Units	N/A	% M/M
		Method No	SUB_02*	WSLM59*
		Limit of Detection	N/A	0.02
		Accreditation	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**Asbestos**	**TOC**
BH-M01 (SS1) 0.00-0.50m	MAR1394.01	Sediment	NAIIS	0.22
BH-M01 (SS2) 1.00-1.50m	MAR1394.02	Sediment	NAIIS	0.17
BH-M01 (SS3) 2.50-3.00m	MAR1394.03	Sediment	NAIIS	0.05
BH-M03 (SS1) 0.00-0.50m	MAR1394.04	Sediment	NAIIS	0.26
BH-M03 (SS2) 1.00-1.50m	MAR1394.05	Sediment	NAIIS	0.18
BH-M03 (SS3) 2.50-3.00m	MAR1394.06	Sediment	NAIIS	0.07
BH-M07 (SS1) 0.00-0.50m	MAR1394.07	Sediment	NAIIS	0.17
BH-M07 (SS2) 1.00-1.50m	MAR1394.08	Sediment	NAIIS	0.25
BH-M07 (SS3) 2.50-3.00m	MAR1394.09	Sediment	NAIIS	0.15
BH-M09 (SS1) 0.00-0.50m	MAR1394.10	Sediment	NAIIS	0.27
BH-M09 (SS2) 1.00-1.50m	MAR1394.11	Sediment	NAIIS	0.25
BH-M09 (SS3) 2.50-3.00m	MAR1394.12	Sediment	NAIIS	0.21
BH-M11 (SS1) 0.00-0.50m	MAR1394.13	Sediment	NAIIS	0.17
BH-M11 (SS2) 1.00-1.50m	MAR1394.14	Sediment	NAIIS	0.23
BH-M11 (SS3) 2.50-3.00m	MAR1394.15	Sediment	NAIIS	0.13
BH-M13 (SS1) 0.00-0.50m	MAR1394.16	Sediment	NAIIS	0.30
BH-M13 (SS2) 1.00-1.50m	MAR1394.17	Sediment	NAIIS	0.28
BH-M13 (SS3) 2.50-3.00m	MAR1394.18	Sediment	NAIIS	0.05
BH-M14 (SS1) 0.00-0.50m	MAR1394.19	Sediment	NAIIS	0.27
BH-M14 (SS2) 1.00-1.50m	MAR1394.20	Sediment	NAIIS	0.23
BH-M14 (SS3) 2.50-3.00m	MAR1394.21	Sediment	NAIIS	0.17
BH-M15 (SS1) 0.00-0.50m	MAR1394.22	Sediment	NAIIS	0.38
BH-M15 (SS2) 1.00-1.50m	MAR1394.23	Sediment	NAIIS	0.36
BH-M15 (SS3) 2.50-3.00m	MAR1394.24	Sediment	NAIIS	0.26
WP-M27 (SS1) 0.00-0.15m	MAR1394.25	Sediment	NAIIS	0.28
BH-M16 (SS1) 0.00-0.50m	MAR1394.26	Sediment	NAIIS	0.24
BH-M16 (SS2) 1.00-1.50m	MAR1394.27	Sediment	NAIIS	0.28
BH-M17 (SS1) 0.00-0.50m	MAR1394.28	Sediment	NAIIS	0.24
Reference Material (% Recovery)			N/A	95
QC Blank			N/A	<0.02

* See Report Notes

NAIIS - No Asbestos Identified In Sample

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR1394
Issue Version	1
Customer Reference	Scapa Flow Marie Scotland Sediment Testing

		Units	mg/Kg (Dry Weight)							
		Method No	ICPMSS*							
		Limit of Detection	0.5	0.04	0.5	0.5	0.01	0.5	0.5	2
		Accreditation	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Mercury**	**Nickel**	**Lead**	**Zinc**
BH-M01 (SS1) 0.00-0.50m	MAR1394.01	Sediment	3.5	0.07	6.8	5.5	0.02	4.8	4.7	13.8
BH-M01 (SS2) 1.00-1.50m	MAR1394.02	Sediment	3.7	0.10	6.9	5.4	0.01	4.7	3.5	11.4
BH-M01 (SS3) 2.50-3.00m	MAR1394.03	Sediment	27.8	0.07	8.3	8.4	0.09	3.2	7.6	15.5
BH-M03 (SS1) 0.00-0.50m	MAR1394.04	Sediment	7.9	0.14	10.6	8.1	<0.01	8.7	5.6	19.0
BH-M03 (SS2) 1.00-1.50m	MAR1394.05	Sediment	19.5	0.11	14.6	12.6	0.02	16.1	10.8	32.4
BH-M03 (SS3) 2.50-3.00m	MAR1394.06	Sediment	21.0	0.11	13.1	84.1	0.03	11.4	10.3	18.6
BH-M07 (SS1) 0.00-0.50m	MAR1394.07	Sediment	10.4	0.07	14.9	12.4	<0.01	14.1	12.4	32.5
BH-M07 (SS2) 1.00-1.50m	MAR1394.08	Sediment	4.1	0.06	8.1	5.7	<0.01	6.8	4.9	12.6
BH-M07 (SS3) 2.50-3.00m	MAR1394.09	Sediment	5.1	0.05	7.8	8.2	<0.01	7.6	5.2	21.0
BH-M09 (SS1) 0.00-0.50m	MAR1394.10	Sediment	13.3	0.07	11.2	6.9	<0.01	8.9	7.2	15.6
BH-M09 (SS2) 1.00-1.50m	MAR1394.11	Sediment	12.6	0.09	11.8	7.3	<0.01	9.1	8.1	16.5
BH-M09 (SS3) 2.50-3.00m	MAR1394.12	Sediment	19.6	0.13	26.1	14.7	0.05	22.9	15.5	46.3
BH-M11 (SS1) 0.00-0.50m	MAR1394.13	Sediment	19.0	0.15	27.4	15	0.02	24.2	17.7	47.3
BH-M11 (SS2) 1.00-1.50m	MAR1394.14	Sediment	17.9	0.10	17.6	8.0	0.01	11.4	9.8	21.9
BH-M11 (SS3) 2.50-3.00m	MAR1394.15	Sediment	27.8	0.16	14.9	21.6	0.03	20.6	15.4	46.8
BH-M13 (SS1) 0.00-0.50m	MAR1394.16	Sediment	9.2	0.10	11.1	9.5	0.01	10.8	7.0	21.8
BH-M13 (SS2) 1.00-1.50m	MAR1394.17	Sediment	5.2	0.09	10.1	5.9	<0.01	8.0	5.0	15.0
BH-M13 (SS3) 2.50-3.00m	MAR1394.18	Sediment	4.9	0.31	11.6	46.4	0.13	8.3	16.6	15.8
BH-M14 (SS1) 0.00-0.50m	MAR1394.19	Sediment	7.1	0.15	14.8	18.3	0.04	12.2	10.6	26.6
BH-M14 (SS2) 1.00-1.50m	MAR1394.20	Sediment	6.8	0.13	13.1	8.9	0.02	10.7	7.5	23.6
BH-M14 (SS3) 2.50-3.00m	MAR1394.21	Sediment	7.2	0.15	12.7	10.1	0.03	10.5	9.3	39.7
BH-M15 (SS1) 0.00-0.50m	MAR1394.22	Sediment	5.1	0.10	9.7	6.2	0.01	7.7	5.6	17.4
BH-M15 (SS2) 1.00-1.50m	MAR1394.23	Sediment	5.7	0.08	10.3	6.0	<0.01	8.8	5.5	17.0
BH-M15 (SS3) 2.50-3.00m	MAR1394.24	Sediment	9.3	0.11	16.6	10.0	<0.01	14.5	9.1	27.2
WP-M27 (SS1) 0.00-0.15m	MAR1394.25	Sediment	6.2	0.10	11.2	8.0	<0.01	9.9	6.4	24.3
BH-M16 (SS1) 0.00-0.50m	MAR1394.26	Sediment	10.0	0.17	16.0	8.6	0.01	13.6	8.9	29.0
BH-M16 (SS2) 1.00-1.50m	MAR1394.27	Sediment	11.3	0.14	19.7	11.7	0.01	16.3	11.5	33.6
BH-M17 (SS1) 0.00-0.50m	MAR1394.28	Sediment	7.6	0.07	6.4	7.1	0.02	5.1	23.6	9.1
Certified Reference Material SETOC 774 (% Recovery)			99	96	93	97	90	99	93	98
QC Blank			<0.5	<0.04	<0.5	<0.5	<0.01	<0.5	<0.5	<2

* See Report Notes

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR1394
Issue Version	1
Customer Reference	Scapa Flow Marie Scotland Sediment Testing

		Units	µg/Kg (Dry Weight)	
		Method No	ASC/SOP/301	
		Limit of Detection	1	1
		Accreditation	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**Dibutyltin (DBT)**	**Tributyltin (TBT)**
BH-M01 (SS1) 0.00-0.50m	MAR1394.01	Sediment	<1	<1
BH-M01 (SS2) 1.00-1.50m	MAR1394.02	Sediment	<1	<1
BH-M01 (SS3) 2.50-3.00m	MAR1394.03	Sediment	<1	<1
BH-M03 (SS1) 0.00-0.50m	MAR1394.04	Sediment	<1	<1
BH-M03 (SS2) 1.00-1.50m	MAR1394.05	Sediment	<1	<1
BH-M03 (SS3) 2.50-3.00m	MAR1394.06	Sediment	<1	<1
BH-M07 (SS1) 0.00-0.50m	MAR1394.07	Sediment	<5	<5
BH-M07 (SS2) 1.00-1.50m	MAR1394.08	Sediment	<5	<5
BH-M07 (SS3) 2.50-3.00m	MAR1394.09	Sediment	<5	<5
Certified Reference Material QSP076MS(% Recovery)			51	56
QC Blank			<1	<1

* See Report Notes

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR1394
Issue Version	1
Customer Reference	Scapa Flow Marie Scotland Sediment Testing

		Units	µg/Kg (Dry Weight)	
		Method No	ASC/SOP/301	
		Limit of Detection	1	1
		Accreditation	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**Dibutyltin (DBT)**	**Tributyltin (TBT)**
BH-M09 (SS1) 0.00-0.50m	MAR1394.10	Sediment	<5	<5
BH-M09 (SS2) 1.00-1.50m	MAR1394.11	Sediment	<5	<5
BH-M09 (SS3) 2.50-3.00m	MAR1394.12	Sediment	<5	<5
BH-M11 (SS1) 0.00-0.50m	MAR1394.13	Sediment	<5	<5
BH-M11 (SS2) 1.00-1.50m	MAR1394.14	Sediment	<5	<5
BH-M11 (SS3) 2.50-3.00m	MAR1394.15	Sediment	<5	<5
BH-M13 (SS1) 0.00-0.50m	MAR1394.16	Sediment	<5	<5
BH-M13 (SS2) 1.00-1.50m	MAR1394.17	Sediment	<5	<5
BH-M13 (SS3) 2.50-3.00m	MAR1394.18	Sediment	<5	<5
Certified Reference Material QSP076MS (% Recovery)			85	60
QC Blank			<1	<1

* See Report Notes

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR1394
Issue Version	1
Customer Reference	Scapa Flow Marie Scotland Sediment Testing

		Units	µg/Kg (Dry Weight)	
		Method No	ASC/SOP/301	
		Limit of Detection	1	1
		Accreditation	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**Dibutyltin (DBT)**	**Tributyltin (TBT)**
BH-M14 (SS1) 0.00-0.50m	MAR1394.19	Sediment	<5	<5
BH-M14 (SS2) 1.00-1.50m	MAR1394.20	Sediment	<5	<5
BH-M14 (SS3) 2.50-3.00m	MAR1394.21	Sediment	<1	<1
BH-M15 (SS1) 0.00-0.50m	MAR1394.22	Sediment	<5	<5
BH-M15 (SS2) 1.00-1.50m	MAR1394.23	Sediment	<5	<5
BH-M15 (SS3) 2.50-3.00m	MAR1394.24	Sediment	<5	<5
WP-M27 (SS1) 0.00-0.15m	MAR1394.25	Sediment	<5	<5
BH-M16 (SS1) 0.00-0.50m	MAR1394.26	Sediment	<5	<5
BH-M16 (SS2) 1.00-1.50m	MAR1394.27	Sediment	<5	<5
BH-M17 (SS1) 0.00-0.50m	MAR1394.28	Sediment	<5	<5
Certified Reference Material QSP077MS (% Recovery)			116	169
QC Blank			<1	<1

* See Report Notes

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR1394
Issue Version	1
Customer Reference	Scapa Flow Marie Scotland Sediment Testing

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304
		Limit of Detection	1	1	1	1	1	1
		Accreditation	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**ACENAPTH**	**ACENAPHY**	**ANTHRACN**	**BAA**	**BAP**	**BBF**
BH-M01 (SS1) 0.00-0.50m	MAR1394.01	Sediment	<1	<1	<1	<1	<1	1.46
BH-M01 (SS2) 1.00-1.50m	MAR1394.02	Sediment	<1	<1	<1	<1	<1	1.13
BH-M01 (SS3) 2.50-3.00m	MAR1394.03	Sediment	<1	<1	<1	<1	<1	<1
BH-M03 (SS1) 0.00-0.50m	MAR1394.04	Sediment	<1	<1	<1	<1	<1	1.57
BH-M03 (SS2) 1.00-1.50m	MAR1394.05	Sediment	<1	<1	<1	<1	<1	1.72
BH-M03 (SS3) 2.50-3.00m	MAR1394.06	Sediment	<1	<1	<1	<1	<1	<1
BH-M07 (SS1) 0.00-0.50m	MAR1394.07	Sediment	<1	<1	<1	<1	<1	1.15
BH-M07 (SS2) 1.00-1.50m	MAR1394.08	Sediment	<1	<1	<1	<1	<1	1.65
BH-M07 (SS3) 2.50-3.00m	MAR1394.09	Sediment	<1	<1	<1	<1	<1	<1
BH-M09 (SS1) 0.00-0.50m	MAR1394.10	Sediment	<1	<1	<1	<1	<1	1.21
BH-M09 (SS2) 1.00-1.50m	MAR1394.11	Sediment	<1	<1	<1	<1	<1	1.85
BH-M09 (SS3) 2.50-3.00m	MAR1394.12	Sediment	<1	<1	<1	<1	<1	2.19
BH-M11 (SS1) 0.00-0.50m	MAR1394.13	Sediment	<1	<1	<1	<1	<1	1.07
BH-M11 (SS2) 1.00-1.50m	MAR1394.14	Sediment	<1	<1	<1	1.27	<1	2.86
Certified Reference Material Quasimeme QPH105MS (% Recovery)			82	140	90	81	86	70
QC Blank			<1	<1	<1	<1	<1	<1

For full analyte name see method summaries

~ Indicates result is for an In-house Reference Material as no Certified Reference Materials are avaliable.

As the method uses surrogate standards to correct for losses, the RM results are reported as percentage trueness, not recovery.

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR1394
Issue Version	1
Customer Reference	Scapa Flow Marie Scotland Sediment Testing

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304
		Limit of Detection	1	1	1	1	1	1
		Accreditation	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**BENZGHIP**	**BKF**	**CHRYSENE**	**DBENZAH**	**FLUORANT**	**FLUORENE**
BH-M01 (SS1) 0.00-0.50m	MAR1394.01	Sediment	<1	<1	3.02	<1	<1	<1
BH-M01 (SS2) 1.00-1.50m	MAR1394.02	Sediment	<1	<1	2.60	<1	<1	<1
BH-M01 (SS3) 2.50-3.00m	MAR1394.03	Sediment	<1	<1	<1	<1	<1	<1
BH-M03 (SS1) 0.00-0.50m	MAR1394.04	Sediment	1.47	<1	3.81	<1	1.52	<1
BH-M03 (SS2) 1.00-1.50m	MAR1394.05	Sediment	1.67	<1	3.00	<1	1.66	<1
BH-M03 (SS3) 2.50-3.00m	MAR1394.06	Sediment	1.38	<1	1.33	<1	<1	<1
BH-M07 (SS1) 0.00-0.50m	MAR1394.07	Sediment	1.27	<1	3.40	<1	1.11	<1
BH-M07 (SS2) 1.00-1.50m	MAR1394.08	Sediment	1.61	<1	2.37	<1	1.33	<1
BH-M07 (SS3) 2.50-3.00m	MAR1394.09	Sediment	<1	<1	1.06	<1	<1	<1
BH-M09 (SS1) 0.00-0.50m	MAR1394.10	Sediment	1.02	<1	2.62	<1	1.05	<1
BH-M09 (SS2) 1.00-1.50m	MAR1394.11	Sediment	1.16	<1	4.04	<1	1.42	<1
BH-M09 (SS3) 2.50-3.00m	MAR1394.12	Sediment	1.25	<1	4.79	<1	1.52	<1
BH-M11 (SS1) 0.00-0.50m	MAR1394.13	Sediment	1.16	<1	3.71	<1	1.06	<1
BH-M11 (SS2) 1.00-1.50m	MAR1394.14	Sediment	1.76	<1	7.46	<1	2.16	<1
Certified Reference Material Quasimeme QPH105MS (% Recovery)			100	85	80	87	82	87
QC Blank			<1	<1	<1	<1	<1	<1

For full analyte name see method summaries

~ Indicates result is for an In-house Reference Material as no Certified Reference Materials are avaliable.

As the method uses surrogate standards to correct for losses, the RM results are reported as percentage trueness, not recovery.

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID MAR1394
Issue Version 1
Customer Reference Scapa Flow Marie Scotland Sediment Testing

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/306
		Limit of Detection	1	1	1	1	100
		Accreditation	UKAS	UKAS	UKAS	UKAS	N
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**INDPYR**	**NAPTH**	**PHENANT**	**PYRENE**	**THC**
BH-M01 (SS1) 0.00-0.50m	MAR1394.01	Sediment	<1	<1	<1	2.02	8680
BH-M01 (SS2) 1.00-1.50m	MAR1394.02	Sediment	<1	<1	<1	1.71	10600
BH-M01 (SS3) 2.50-3.00m	MAR1394.03	Sediment	<1	<1	<1	<1	2580
BH-M03 (SS1) 0.00-0.50m	MAR1394.04	Sediment	<1	<1	1.61	1.98	40900
BH-M03 (SS2) 1.00-1.50m	MAR1394.05	Sediment	1.08	<1	1.85	2.12	25300
BH-M03 (SS3) 2.50-3.00m	MAR1394.06	Sediment	<1	<1	<1	<1	34400
BH-M07 (SS1) 0.00-0.50m	MAR1394.07	Sediment	<1	<1	1.66	2.18	13200
BH-M07 (SS2) 1.00-1.50m	MAR1394.08	Sediment	1.04	<1	1.66	1.96	12000
BH-M07 (SS3) 2.50-3.00m	MAR1394.09	Sediment	<1	<1	<1	<1	9730
BH-M09 (SS1) 0.00-0.50m	MAR1394.10	Sediment	<1	<1	<1	1.80	9760
BH-M09 (SS2) 1.00-1.50m	MAR1394.11	Sediment	<1	<1	1.20	2.49	21200
BH-M09 (SS3) 2.50-3.00m	MAR1394.12	Sediment	<1	<1	1.57	2.90	36500
BH-M11 (SS1) 0.00-0.50m	MAR1394.13	Sediment	<1	<1	1.29	2.07	14000
BH-M11 (SS2) 1.00-1.50m	MAR1394.14	Sediment	1.10	<1	1.76	3.55	16100
Certified Reference Material Quasimeme QPH105MS (% Recovery)			88	100	85	88	98~
QC Blank			<1	<1	<1	<1	<100

For full analyte name see method summaries
~ Indicates result is for an In-house Reference Material as no Certified Reference Materials are avaliable.
As the method uses surrogate standards to correct for losses, the RM results are reported as percentage trueness, not recovery.

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR1394
Issue Version	1
Customer Reference	Scapa Flow Marie Scotland Sediment Testing

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304
		Limit of Detection	1	1	1	1	1	1
		Accreditation	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**ACENAPTH**	**ACENAPHY**	**ANTHRACN**	**BAA**	**BAP**	**BBF**
BH-M11 (SS3) 2.50-3.00m	MAR1394.15	Sediment	<1	<1	<1	<1	<1	<1
BH-M13 (SS1) 0.00-0.50m	MAR1394.16	Sediment	<1	<1	<1	<1	<1	2.22
BH-M13 (SS2) 1.00-1.50m	MAR1394.17	Sediment	<1	<1	<1	<1	<1	1.53
BH-M13 (SS3) 2.50-3.00m	MAR1394.18	Sediment	<1	<1	<1	<1	<1	<1
BH-M14 (SS1) 0.00-0.50m	MAR1394.19	Sediment	<1	<1	<1	<1	<1	<1
BH-M14 (SS2) 1.00-1.50m	MAR1394.20	Sediment	<1	<1	<1	<1	1.03	2.34
BH-M14 (SS3) 2.50-3.00m	MAR1394.21	Sediment	<1	<1	<1	<1	<1	1.59
BH-M15 (SS1) 0.00-0.50m	MAR1394.22	Sediment	<1	<1	<1	<1	<1	<1
BH-M15 (SS2) 1.00-1.50m	MAR1394.23	Sediment	<1	<1	<1	<1	<1	<1
BH-M15 (SS3) 2.50-3.00m	MAR1394.24	Sediment	<1	<1	<1	<1	<1	<1
WP-M27 (SS1) 0.00-0.15m	MAR1394.25	Sediment	<1	<1	<1	1.16	1.36	2.35
BH-M16 (SS1) 0.00-0.50m	MAR1394.26	Sediment	<1	<1	1.61	5.26	4.78	4.94
BH-M16 (SS2) 1.00-1.50m	MAR1394.27	Sediment	<1	<1	<1	<1	<1	<1
BH-M17 (SS1) 0.00-0.50m	MAR1394.28	Sediment	<1	<1	<1	<1	<1	<1
Certified Reference Material Quasimeme QPH105MS (% Recovery)			81	113	92	76	78	66
QC Blank			<1	<1	<1	<1	<1	<1

For full analyte name see method summaries

~ Indicates result is for an In-house Reference Material as no Certified Reference Materials are avaliable.

As the method uses surrogate standards to correct for losses, the RM results are reported as percentage trueness, not recovery.

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR1394
Issue Version	1
Customer Reference	Scapa Flow Marie Scotland Sediment Testing

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304
		Limit of Detection	1	1	1	1	1	1
		Accreditation	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**BENZGHIP**	**BKF**	**CHRYSENE**	**DBENZAH**	**FLUORANT**	**FLUORENE**
BH-M11 (SS3) 2.50-3.00m	MAR1394.15	Sediment	<1	<1	<1	<1	<1	<1
BH-M13 (SS1) 0.00-0.50m	MAR1394.16	Sediment	1.53	<1	2.97	<1	1.59	<1
BH-M13 (SS2) 1.00-1.50m	MAR1394.17	Sediment	1.27	<1	2.73	<1	1.26	<1
BH-M13 (SS3) 2.50-3.00m	MAR1394.18	Sediment	<1	<1	<1	<1	<1	<1
BH-M14 (SS1) 0.00-0.50m	MAR1394.19	Sediment	<1	<1	1.67	<1	<1	<1
BH-M14 (SS2) 1.00-1.50m	MAR1394.20	Sediment	2.32	1.43	2.07	<1	2.05	<1
BH-M14 (SS3) 2.50-3.00m	MAR1394.21	Sediment	1.26	<1	1.83	<1	1.45	<1
BH-M15 (SS1) 0.00-0.50m	MAR1394.22	Sediment	<1	<1	1.37	<1	<1	<1
BH-M15 (SS2) 1.00-1.50m	MAR1394.23	Sediment	<1	<1	1.60	<1	<1	<1
BH-M15 (SS3) 2.50-3.00m	MAR1394.24	Sediment	<1	<1	1.78	<1	<1	<1
WP-M27 (SS1) 0.00-0.15m	MAR1394.25	Sediment	2.47	1.33	2.57	<1	2.69	<1
BH-M16 (SS1) 0.00-0.50m	MAR1394.26	Sediment	3.94	2.89	6.88	<1	11.4	<1
BH-M16 (SS2) 1.00-1.50m	MAR1394.27	Sediment	<1	<1	1.71	<1	<1	<1
BH-M17 (SS1) 0.00-0.50m	MAR1394.28	Sediment	<1	<1	<1	<1	<1	<1
Certified Reference Material Quasimeme QPH105MS (% Recovery)			83	85	78	74	83	80
QC Blank			<1	<1	<1	<1	<1	<1

For full analyte name see method summaries

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Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID MAR1394
Issue Version 1
Customer Reference Scapa Flow Marie Scotland Sediment Testing

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/306
		Limit of Detection	1	1	1	1	100
		Accreditation	UKAS	UKAS	UKAS	UKAS	N
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**INDPYR**	**NAPTH**	**PHENANT**	**PYRENE**	**THC**
BH-M11 (SS3) 2.50-3.00m	MAR1394.15	Sediment	<1	<1	<1	<1	38900
BH-M13 (SS1) 0.00-0.50m	MAR1394.16	Sediment	1.19	<1	1.07	1.96	21500
BH-M13 (SS2) 1.00-1.50m	MAR1394.17	Sediment	<1	<1	<1	1.81	15500
BH-M13 (SS3) 2.50-3.00m	MAR1394.18	Sediment	<1	<1	<1	<1	3830
BH-M14 (SS1) 0.00-0.50m	MAR1394.19	Sediment	<1	<1	2.96	1.33	9280
BH-M14 (SS2) 1.00-1.50m	MAR1394.20	Sediment	1.93	<1	1.15	2.60	14200
BH-M14 (SS3) 2.50-3.00m	MAR1394.21	Sediment	<1	<1	<1	1.89	18600
BH-M15 (SS1) 0.00-0.50m	MAR1394.22	Sediment	<1	<1	<1	<1	8150
BH-M15 (SS2) 1.00-1.50m	MAR1394.23	Sediment	<1	<1	<1	1.03	8230
BH-M15 (SS3) 2.50-3.00m	MAR1394.24	Sediment	<1	<1	<1	1.31	11700
WP-M27 (SS1) 0.00-0.15m	MAR1394.25	Sediment	2.23	<1	1.55	3.18	17400
BH-M16 (SS1) 0.00-0.50m	MAR1394.26	Sediment	3.09	<1	4.15	10.6	11200
BH-M16 (SS2) 1.00-1.50m	MAR1394.27	Sediment	<1	<1	1.48	1.08	13500
BH-M17 (SS1) 0.00-0.50m	MAR1394.28	Sediment	<1	<1	<1	<1	7090
Certified Reference Material Quasimeme QPH105MS (% Recovery)			76	93	90	87	100~
QC Blank			<1	<1	<1	<1	<100

For full analyte name see method summaries
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Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR1394
Issue Version	1
Customer Reference	Scapa Flow Marie Scotland Sediment Testing

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302
		Limit of Detection	0.08	0.08	0.08	0.08	0.08	0.08	0.08
		Accreditation	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**PCB28**	**PCB52**	**PCB101**	**PCB118**	**PCB138**	**PCB153**	**PCB180**
BH-M01 (SS1) 0.00-0.50m	MAR1394.01	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M01 (SS2) 1.00-1.50m	MAR1394.02	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M01 (SS3) 2.50-3.00m	MAR1394.03	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M03 (SS1) 0.00-0.50m	MAR1394.04	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M03 (SS2) 1.00-1.50m	MAR1394.05	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M03 (SS3) 2.50-3.00m	MAR1394.06	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M07 (SS1) 0.00-0.50m	MAR1394.07	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M07 (SS2) 1.00-1.50m	MAR1394.08	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M07 (SS3) 2.50-3.00m	MAR1394.09	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M09 (SS1) 0.00-0.50m	MAR1394.10	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M09 (SS2) 1.00-1.50m	MAR1394.11	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M09 (SS3) 2.50-3.00m	MAR1394.12	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M11 (SS1) 0.00-0.50m	MAR1394.13	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M11 (SS2) 1.00-1.50m	MAR1394.14	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M11 (SS3) 2.50-3.00m	MAR1394.15	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M13 (SS1) 0.00-0.50m	MAR1394.16	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M13 (SS2) 1.00-1.50m	MAR1394.17	Sediment	<0.08	<0.08	<0.08	<0.08	0.13	0.22	<0.08
BH-M13 (SS3) 2.50-3.00m	MAR1394.18	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M14 (SS1) 0.00-0.50m	MAR1394.19	Sediment	0.21	0.26	0.28	0.31	0.30	0.29	0.34
Certified Reference Material Quasimeme QOR145MS (% Recovery)			103~	87	96~	96~	98~	97~	96~
QC Blank			<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08

For full analyte name see method summaries

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Certificate of Analysis

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Test Report ID MAR1394
Issue Version 1
Customer Reference Scapa Flow Marie Scotland Sediment Testing

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)
		Method No	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302
		Limit of Detection	0.08	0.08	0.08	0.08	0.08	0.08	0.08
		Accreditation	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS	UKAS
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**PCB28**	**PCB52**	**PCB101**	**PCB118**	**PCB138**	**PCB153**	**PCB180**
BH-M14 (SS2) 1.00-1.50m	MAR1394.20	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M14 (SS3) 2.50-3.00m	MAR1394.21	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M15 (SS1) 0.00-0.50m	MAR1394.22	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M15 (SS2) 1.00-1.50m	MAR1394.23	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M15 (SS3) 2.50-3.00m	MAR1394.24	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
WP-M27 (SS1) 0.00-0.15m	MAR1394.25	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M16 (SS1) 0.00-0.50m	MAR1394.26	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M16 (SS2) 1.00-1.50m	MAR1394.27	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
BH-M17 (SS1) 0.00-0.50m	MAR1394.28	Sediment	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Certified Reference Material Quasimeme QOR145MS (% Recovery)			97~	87	98~	88	97~	98~	98~
QC Blank			<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08

For full analyte name see method summaries
~ Indicates result is for an In-house Reference Material as no Certified Reference Materials are avaliable.

Certificate of Analysis

Issuing Laboratory SOCOTEC, Marine Department, Advanced Chemistry and Research, Etwall House, Bretby Business Park, Ashby Road, Burton-upon-Trent DE15 0YZ

Test Report ID	MAR1394
Issue Version	1
Customer Reference	Scapa Flow Marie Scotland Sediment Testing

REPORT NOTES

Method Code	Sample ID	The following information should be taken into consideration when using the data contained within this report
WSLM59*	MAR1394.01-28	Analysis was conducted by an internal SOCOTEC laboratory. UKAS accredited analysis by this laboratory is under UKAS number 1252.
ICPMSS*	MAR1394.01-28	Analysis was conducted by an internal SOCOTEC laboratory. UKAS accredited analysis by this laboratory is under UKAS number 1252.
SOCOTEC Doncaster*	MAR1394.01-28	Analysis was conducted by an internal SOCOTEC laboratory.
SOCOTEC Doncaster*	MAR1394.006, 08, 09, 12, 15, 16, 19, 20, 27	Unsuitable to test due to Gravel and Shell content.
SUB_01*	MAR1394.01-28	Analysis was conducted by an approved subcontracted laboratory.
SUB_02*	MAR1394.01-28	Analysis was conducted by an approved subcontracted laboratory.
ASC/SOP/301	MAR194.07-20, 22-28	The matrix of this sample has been found to interfere with the result for this test. The sample has therefore been diluted, but in doing so, the detection limit for this test has been elevated.
ASC/SOP/303/304	MAR1394.01-28	Chrysene is known to coelute with Triphenylene and these peaks can not be resolved. It is believed Triphenylene is present in these samples therefore it is suggested that the Chrysene results should be taken as a Chrysene (inc. Triphenylene).This should be taken into consideration when utilising the data.

DEVIATING SAMPLE STATEMENT

Deviation Code	Deviation Definition	Sample ID	Deviation Details. The following information should be taken into consideration when using the data contained within this report
D1	Holding Time Exceeded	N/A	N/A
D2	Sample Contaminated through Damaged Packaging	N/A	N/A
D3	Sample Contaminated through Sampling	N/A	N/A
D4	Inappropriate Container/Packaging	N/A	N/A
D5	Damaged in Transit	N/A	N/A
D6	Insufficient Quantity of Sample	N/A	N/A
D7	Inappropriate Headspace	N/A	N/A
D8	Retained at Incorrect Temperature	N/A	N/A
D9	Lack of Date & Time of Sampling	N/A	N/A
D10	Insufficient Sample Details	N/A	N/A
D11	Sample integrity compromised or not suitable for analysis	N/A	N/A

Certificate of Analysis

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Test Report ID	MAR1394
Issue Version	1
Customer Reference	Scapa Flow Marie Scotland Sediment Testing

Method	Sample and Fraction Size	Method Summary
Total Solids	Wet Sediment	Calculation (100%-Moisture Content).Moisture content determined by drying a portion of the sample at 120°C to constant weight.
Particle Size Analysis	Wet Sediment	Wet and dry sieving followed by laser diffraction analysis.
Total Organic Carbon (TOC)	Air dried and ground	Carbonate removal and sulphurous acid/combustion at 1600°C/NDIR.
Metals	Air dried and seived to <63µm	Aqua-regia extraction followed by ICP analysis.
Organotins	Wet Sediment	Solvent extraction and derivatisation followed by GC-MS analysis.
Polyaromatic Hydrocarbons (PAH)	Wet Sediment	Solvent extraction and clean up followed by GC-MS analysis.
Total Hydrocarbon Content (THC)	Wet Sediment	Solvent extraction and clean up followed by GC-FID analysis.
Polychlorinated Biphenyls (PCBs)	Air dried and seived to <2mm	Solvent extraction and clean up followed by GC-MS-MS analysis.
Organochlorine Pesticides (OCPs)	Air dried and seived to <2mm	Solvent extraction and clean up followed by GC-MS-MS analysis.

Analyte Definitions

Analyte Abbreviation	Full Analyte name	Analyte Abbreviation	Full Analyte name	Analyte Abbreviation	Full Analyte name
ACENAPTH	Acenaphthene	C2N	C2-naphthalenes	THC	Total Hydrocarbon Content
ACENAPHY	Acenaphthylene	C3N	C3-naphthalenes	AHCH	alpha-Hexachlorcyclohexane
ANTHRACN	Anthracene	CHRYSENE	Chrysene	BHCH	beta-Hexachlorcyclohexane
BAA	Benzo[a]anthracene	DBENZAH	Dibenzo[ah]anthracene	GHCH	gamma-Hexachlorcyclohexane
BAP	Benzo[a]pyrene	FLUORANT	Fluoranthene	DIELDRIN	Dieldrin
BBF	Benzo[b]fluoranthene	FLUORENE	Fluorene	HCB	Hexachlorobenzene
BEP	Benzo[e]pyrene	INDPYR	Indeno[1,2,3-cd]pyrene	DDD	p,p'-Dichlorodiphenyldichloroethane
BENZGHIP	Benzo[ghi]perylene	NAPTH	Naphthalene	DDE	p,p'-Dichlorodiphenyldichloroethylene
BKF	Benzo[k]fluoranthene	PERYLENE	Perylene	DDT	p,p'-Dichlorodiphenyltrichloroethane
C1N	C1-naphthalenes	PHENANT	Phenanthrene		
C1PHEN	C1-phenanthrene	PYRENE	Pyrene		

Applicant Information

Applicant:	
Description of dredging:	
Total amount to be dredged (wet tonnes)	

Sample Details & Physical Properties

Explanatory Notes:
An example of a 'Dredge area' is: 'Dock A, Harbour X'
Provide description of the dredge area and the latitude and longitude co-oridnates (WGS84) for each sample location. Co-ordinates taken from GPS equipment should be set to WGS84.
Note for sample depth that the seabed is 0 metres.
Gravel is defined as >2mm, **Sand** is defined as >63um<2mm, **Silt** is deinfed as <63um).

Sample information:

Sample ID	Dredge area	Latitude										Longitude											Type of sample	Sample depth (m)	Total solids (%)	Gravel (%)	Sand (%)	Silt (%)	TOC (%)	Specific gravity	Asbestos
MAR1394.01	BH-M01 (SS1) 0.0-0.5m	5	8	°	5	5	.	0	1	7	'N	0	0	2	°	5	7	.	2	6	0	'W	Core	0.00-0.50	83.7	7.6	73.8	18.6	0.22	2.72	No
MAR1394.02	BH-M01 (SS2) 1.0-1.5m	5	8	°	5	5	.	0	1	7	'N	0	0	2	°	5	7	.	2	6	0	'W	Core	1.00-1.50	85.4	5.5	82.4	12.1	0.17	2.69	No
MAR1394.03	BH-M01 (SS3) 2.5-3.0m	5	8	°	5	5	.	0	1	7	'N	0	0	2	°	5	7	.	2	6	0	'W	Core	2.50-3.00	88.4	10.1	47.9	42	0.05	2.66	No
MAR1394.04	BH-M03 (SS1) 0.0-0.5m	5	8	°	5	5	.	0	4	3	'N	0	0	2	°	5	7	.	2	7	7	'W	Core	0.00-0.50	85.7	8.3	64.6	27	0.26	2.71	No
MAR1394.05	BH-M03 (SS2) 1.0-1.5m	5	8	°	5	5	.	0	4	3	'N	0	0	2	°	5	7	.	2	7	7	'W	Core	1.00-1.50	86.2	11	53.1	35.9	0.18	2.74	No
MAR1394.06	BH-M03 (SS3) 2.5-3.0m	5	8	°	5	5	.	0	4	3	'N	0	0	2	°	5	7	.	2	7	7	'W	Core	2.50-3.00	85.7	10.4	25.8	63.9	0.07		No
MAR1394.07	BH-M07 (SS1) 0.0-0.5m	5	8	°	5	5	.	1	4	6	'N	0	0	2	°	5	7	.	3	4	2	'W	Core	0.00-0.50	83.9	20.9	57.8	21.2	0.17	2.51	No
MAR1394.08	BH-M07 (SS2) 1.0-1.5m	5	8	°	5	5	.	1	4	6	'N	0	0	2	°	5	7	.	3	4	2	'W	Core	1.00-1.50	81.3	19.1	60.9	20	0.25		No
MAR1394.09	BH-M07 (SS3) 2.5-3.0m	5	8	°	5	5	.	1	4	6	'N	0	0	2	°	5	7	.	3	4	2	'W	Core	2.50-3.00	85.7	17.6	67.8	14.6	0.15		No
MAR1394.10	BH-M09 (SS1) 0.0-0.5m	5	8	°	5	5	.	1	9	7	'N	0	0	2	°	5	7	.	3	7	6	'W	Core	0.00-0.50	77	23.5	52.9	23.6	0.27	0.72	No
MAR1394.11	BH-M09 (SS2) 1.0-1.5m	5	8	°	5	5	.	1	9	7	'N	0	0	2	°	5	7	.	3	7	6	'W	Core	1.00-1.50	82.5	11.6	64.9	23.5	0.25	2.76	No
MAR1394.12	BH-M09 (SS3) 2.5-3.0m	5	8	°	5	5	.	1	9	7	'N	0	0	2	°	5	7	.	3	7	6	'W	Core	2.50-3.00	87.3	25.2	54.2	20.7	0.21		No
MAR1394.13	BH-M11 (SS1) 0.0-0.5m	5	8	°	5	5	.	2	3	8	'N	0	0	2	°	5	7	.	4	1	3	'W	Core	0.00-0.50	87.1	17.8	65.2	17	0.17	2.69	No
MAR1394.14	BH-M11 (SS2) 1.0-1.5m	5	8	°	5	5	.	2	3	8	'N	0	0	2	°	5	7	.	4	1	3	'W	Core	1.00-1.50	86.9	8.7	61.9	29.4	0.23	2.7	No
MAR1394.15	BH-M11 (SS3) 2.5-3.0m	5	8	°	5	5	.	2	3	8	'N	0	0	2	°	5	7	.	4	1	3	'W	Core	2.50-3.00	87.4	20	45.3	34.7	0.13		No
MAR1394.16	BH-M13 (SS1) 0.0-0.5m	5	8	°	5	5	.	3	0	3	'N	0	0	2	°	5	7	.	4	2	1	'W	Core	0.00-0.50	80.7	9.3	75.3	15.4	0.3		No
MAR1394.17	BH-M13 (SS2) 1.0-1.5m	5	8	°	5	5	.	3	0	3	'N	0	0	2	°	5	7	.	4	2	1	'W	Core	1.00-1.50	82.9	10.3	59.4	30.3	0.28	2.71	No
MAR1394.18	BH-M13 (SS3) 2.5-3.0m	5	8	°	5	5	.	3	0	3	'N	0	0	2	°	5	7	.	4	2	1	'W	Core	2.50-3.00	88	20.8	40.2	39	0.05	2.69	No
MAR1394.19	BH-M14 (SS1) 0.0-0.5m	5	8	°	5	5	.	2	7	2	'N	0	0	2	°	5	7	.	4	9	9	'W	Core	0.00-0.50	82.1	22.9	61.9	15.2	0.27		No
MAR1394.20	BH-M14 (SS2) 1.0-1.5m	5	8	°	5	5	.	2	7	2	'N	0	0	2	°	5	7	.	4	9	9	'W	Core	1.00-1.50	76.7	20.6	63.8	15.6	0.23		No
MAR1394.21	BH-M14 (SS3) 2.5-3.0m	5	8	°	5	5	.	2	7	2	'N	0	0	2	°	5	7	.	4	9	9	'W	Core	2.50-3.00	84	19.9	63.2	16.8	0.17	2.66	No
MAR1394.22	BH-M15 (SS1) 0.0-0.5m	5	8	°	5	5	.	3	1	0	'N	0	0	2	°	5	7	.	5	0	5	'W	Core	0.00-0.50	79.7	34.4	47.8	17.9	0.38	2.72	No
MAR1394.23	BH-M15 (SS2) 1.0-1.5m	5	8	°	5	5	.	3	1	0	'N	0	0	2	°	5	7	.	5	0	5	'W	Core	1.00-1.50	82.8	28.6	48.8	22.5	0.36	2.68	No
MAR1394.24	BH-M15 (SS3) 2.5-3.0m	5	8	°	5	5	.	3	1	0	'N	0	0	2	°	5	7	.	5	0	5	'W	Core	2.50-3.00	84.5	32.4	50.2	17.3	0.26	2.71	No
MAR1394.25	WP-M27 (SS1) 0.0-0.15m	5	8	°	5	5	.	2	3	4	'N	0	0	2	°	5	7	.	4	9	2	'W	Grab	0.00-0.15	77.6	21.5	57.5	21	0.28	2.66	No
				°			.				'N				°			.				'W									
				°			.				'N				°			.				'W									
MAR1394.26	BH-M16 (SS1) 0.0-0.5m	5	8	°	5	5	.	3	2	2	'N	0	0	2	°	5	7	.	4	3	8	'W	Core	0.00-0.50	83.5	27.4	51.7	20.9	0.24	2.69	No
MAR1394.27	BH-M16 (SS2) 1.0-1.5m	5	8	°	5	5	.	3	2	2	'N	0	0	2	°	5	7	.	4	3	8	'W	Core	1.00-1.50	86.7	30.4	51.8	17.8	0.28		No
MAR1394.28	BH-M17 (SS1) 0.0-0.5m	5	8	°	5	5	.	3	2	9	'N	0	0	2	°	5	7	.	3	9	5	'W	Core	0.00-0.50	87.8	20.1	42.9	37.1	0.24	2.71	No

Trace Metals & Organotins

Explanatory Notes:
Results above Action Level 1 will be highlighted in blue and above Action Level 2 in red.

Sample information:

Sample ID	Dredge area	Type of sample	Sample depth (m)	Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Copper (Cu)	Mercury (Hg)	Nickel (Ni)	Lead (Pb)	Zinc (Zn)	Dibutyltin (DBT)	Tributyltin (TBT)
				mg/kg dry weight									
MAR1394.01	BH-M01 (SS1) 0.0-0.5m	Core	0.00-0.50	3.5	0.07	6.8	5.5	0.02	4.8	4.7	13.8	<1	<1
MAR1394.02	BH-M01 (SS2) 1.0-1.5m	Core	1.00-1.50	3.7	0.1	6.9	5.4	0.01	4.7	3.5	11.4	<1	<1
MAR1394.03	BH-M01 (SS3) 2.5-3.0m	Core	2.50-3.00	27.8	0.07	8.3	8.4	0.09	3.2	7.6	15.5	<1	<1
MAR1394.04	BH-M03 (SS1) 0.0-0.5m	Core	0.00-0.50	7.9	0.14	10.6	8.1	<0.01	8.7	5.6	19	<1	<1
MAR1394.05	BH-M03 (SS2) 1.0-1.5m	Core	1.00-1.50	19.5	0.11	14.6	12.6	0.02	16.1	10.8	32.4	<1	<1
MAR1394.06	BH-M03 (SS3) 2.5-3.0m	Core	2.50-3.00	21	0.11	13.1	84.1	0.03	11.4	10.3	18.6	<1	<1
MAR1394.07	BH-M07 (SS1) 0.0-0.5m	Core	0.00-0.50	10.4	0.07	14.9	12.4	<0.01	14.1	12.4	32.5	<5	<5
MAR1394.08	BH-M07 (SS2) 1.0-1.5m	Core	1.00-1.50	4.1	0.06	8.1	5.7	<0.01	6.8	4.9	12.6	<5	<5
MAR1394.09	BH-M07 (SS3) 2.5-3.0m	Core	2.50-3.00	5.1	0.05	7.8	8.2	<0.01	7.6	5.2	21	<5	<5
MAR1394.10	BH-M09 (SS1) 0.0-0.5m	Core	0.00-0.50	13.3	0.07	11.2	6.9	<0.01	8.9	7.2	15.6	<5	<5
MAR1394.11	BH-M09 (SS2) 1.0-1.5m	Core	1.00-1.50	12.6	0.09	11.8	7.3	<0.01	9.1	8.1	16.5	<5	<5
MAR1394.12	BH-M09 (SS3) 2.5-3.0m	Core	2.50-3.00	19.6	0.13	26.1	14.7	0.05	22.9	15.5	46.3	<5	<5
MAR1394.13	BH-M11 (SS1) 0.0-0.5m	Core	0.00-0.50	19	0.15	27.4	15	0.02	24.2	17.7	47.3	<5	<5
MAR1394.14	BH-M11 (SS2) 1.0-1.5m	Core	1.00-1.50	17.9	0.1	17.6	8	0.01	11.4	9.8	21.9	<5	<5
MAR1394.15	BH-M11 (SS3) 2.5-3.0m	Core	2.50-3.00	27.8	0.16	14.9	21.6	0.03	20.6	15.4	46.8	<5	<5
MAR1394.16	BH-M13 (SS1) 0.0-0.5m	Core	0.00-0.50	9.2	0.1	11.1	9.5	0.01	10.8	7	21.8	<5	<5
MAR1394.17	BH-M13 (SS2) 1.0-1.5m	Core	1.00-1.50	5.2	0.09	10.1	5.9	<0.01	8	5	15	<5	<5
MAR1394.18	BH-M13 (SS3) 2.5-3.0m	Core	2.50-3.00	4.9	0.31	11.6	46.4	0.13	8.3	16.6	15.8	<5	<5
MAR1394.19	BH-M14 (SS1) 0.0-0.5m	Core	0.00-0.50	7.1	0.15	14.8	18.3	0.04	12.2	10.6	26.6	<5	<5
MAR1394.20	BH-M14 (SS2) 1.0-1.5m	Core	1.00-1.50	6.8	0.13	13.1	8.9	0.02	10.7	7.5	23.6	<5	<5
MAR1394.21	BH-M14 (SS3) 2.5-3.0m	Core	2.50-3.00	7.2	0.15	12.7	10.1	0.03	10.5	9.3	39.7	<1	<1
MAR1394.22	BH-M15 (SS1) 0.0-0.5m	Core	0.00-0.50	5.1	0.1	9.7	6.2	0.01	7.7	5.6	17.4	<5	<5
MAR1394.23	BH-M15 (SS2) 1.0-1.5m	Core	1.00-1.50	5.7	0.08	10.3	6	<0.01	8.8	5.5	17	<5	<5
MAR1394.24	BH-M15 (SS3) 2.5-3.0m	Core	2.50-3.00	9.3	0.11	16.6	10	<0.01	14.5	9.1	27.2	<5	<5
MAR1394.25	WP-M27 (SS1) 0.0-0.15m	Grab	0.00-0.15	6.2	0.1	11.2	8	<0.01	9.9	6.4	24.3	<5	<5
0	0	0	0										
0	0	0	0										
MAR1394.26	BH-M16 (SS1) 0.0-0.5m	Core	0.00-0.50	10	0.17	16	8.6	0.01	13.6	8.9	29	<5	<5
MAR1394.27	BH-M16 (SS2) 1.0-1.5m	Core	1.00-1.50	11.3	0.14	19.7	11.7	0.01	16.3	11.5	33.6	<5	<5
MAR1394.28	BH-M17 (SS1) 0.0-0.5m	Core	0.00-0.50	7.6	0.07	6.4	7.1	0.02	5.1	23.6	9.1	<5	<5

Polyaromatic Hydrocarbons (PAH)

Explanatory Notes:
Results above Action Level 1 will be highlighted in blue and above Action Level 2 in red.

Definitions:

ACENAPTH	Acenaphthene
ACENAPHY	Acenaphthylene
ANTHRACN	Anthracene
BAA	Benz(a)anthracene
BAP	Benzo(a)pyrene
BBF	Benzo(b)fluoranthene
BEP	Benzo(e)pyrene
BENZGHIP	Benzo(ghi)perylene
BKF	Benzo(K)fluoranthene
C1N	C1-naphthalenes
C1PHEN	C1-phenanthrene
C2N	C2-naphthalenes
C3N	C3-naphthalenes
CHRYSENE	Chrysene
DBENZAH	Diben(ah)anthracene
FLUORANT	Fluoranthene
FLUORENE	Fluorene
INDPYR	Indeno(1,2,3-cd)pyrene
NAPTH	Naphthalene
PERYLENE	Perylene
PHENANT	Phenanthrene
PYRENE	Pyrene
THC	Total Hydrocarbon Conten

Sample information:

Sample ID	Dredge area	Type of sample	Sample depth (m)	µg/kg																						
				ACENAPTH	ACENAPHY	ANTHRACN	BAA	BAP	BBF	BEP	BENZGHIP	BKF	C1N	C1PHEN	C2N	C3N	CHRYSENE	DBENZAH	FLUORANT	FLUORENE	INDPYR	NAPTH	PERYLENE	PHENANT	PYRENE	THC
MAR1394.01	BH-M01 (SS1) 0.0-0.5m	Core	0.00-0.50	<1	<1	<1	<1	<1	1.46		<1	<1					3.02	<1	<1	<1	<1	<1		<1	2.02	8680
MAR1394.02	BH-M01 (SS2) 1.0-1.5m	Core	1.00-1.50	<1	<1	<1	<1	<1	1.13		<1	<1					2.6	<1	<1	<1	<1	<1		<1	1.71	10600
MAR1394.03	BH-M01 (SS3) 2.5-3.0m	Core	2.50-3.00	<1	<1	<1	<1	<1	<1		<1	<1					<1	<1	<1	<1	<1	<1		<1	<1	2580
MAR1394.04	BH-M03 (SS1) 0.0-0.5m	Core	0.00-0.50	<1	<1	<1	<1	<1	1.57		1.47	<1					3.81	<1	1.52	<1	<1	<1		1.61	1.98	40900
MAR1394.05	BH-M03 (SS2) 1.0-1.5m	Core	1.00-1.50	<1	<1	<1	<1	<1	1.72		1.67	<1					3	<1	1.66	<1	1.08	<1		1.85	2.12	25300
MAR1394.06	BH-M03 (SS3) 2.5-3.0m	Core	2.50-3.00	<1	<1	<1	<1	<1	<1		1.38	<1					1.33	<1	<1	<1	<1	<1		<1	<1	34400
MAR1394.07	BH-M07 (SS1) 0.0-0.5m	Core	0.00-0.50	<1	<1	<1	<1	<1	1.15		1.27	<1					3.4	<1	1.11	<1	<1	<1		1.66	2.18	13200
MAR1394.08	BH-M07 (SS2) 1.0-1.5m	Core	1.00-1.50	<1	<1	<1	<1	<1	1.65		1.61	<1					2.37	<1	1.33	<1	1.04	<1		1.66	1.96	12000
MAR1394.09	BH-M07 (SS3) 2.5-3.0m	Core	2.50-3.00	<1	<1	<1	<1	<1	<1		<1	<1					1.06	<1	<1	<1	<1	<1		<1	<1	9730
MAR1394.10	BH-M09 (SS1) 0.0-0.5m	Core	0.00-0.50	<1	<1	<1	<1	<1	1.21		1.02	<1					2.62	<1	1.05	<1	<1	<1		<1	1.8	9760
MAR1394.11	BH-M09 (SS2) 1.0-1.5m	Core	1.00-1.50	<1	<1	<1	<1	<1	1.85		1.16	<1					4.04	<1	1.42	<1	<1	<1		1.2	2.49	21200
MAR1394.12	BH-M09 (SS3) 2.5-3.0m	Core	2.50-3.00	<1	<1	<1	<1	<1	2.19		1.25	<1					4.79	<1	1.52	<1	<1	<1		1.57	2.9	36500
MAR1394.13	BH-M11 (SS1) 0.0-0.5m	Core	0.00-0.50	<1	<1	<1	<1	<1	1.07		1.16	<1					3.71	<1	1.06	<1	<1	<1		1.29	2.07	14000
MAR1394.14	BH-M11 (SS2) 1.0-1.5m	Core	1.00-1.50	<1	<1	<1	1.27	<1	2.86		1.76	<1					7.46	<1	2.16	<1	1.1	<1		1.76	3.55	16100
MAR1394.15	BH-M11 (SS3) 2.5-3.0m	Core	2.50-3.00	<1	<1	<1	<1	<1	<1		<1	<1					<1	<1	<1	<1	<1	<1		<1	<1	38900
MAR1394.16	BH-M13 (SS1) 0.0-0.5m	Core	0.00-0.50	<1	<1	<1	<1	<1	2.22		1.53	<1					2.97	<1	1.59	<1	1.19	<1		1.07	1.96	21500
MAR1394.17	BH-M13 (SS2) 1.0-1.5m	Core	1.00-1.50	<1	<1	<1	<1	<1	1.53		1.27	<1					2.73	<1	1.26	<1	<1	<1		<1	1.81	15500
MAR1394.18	BH-M13 (SS3) 2.5-3.0m	Core	2.50-3.00	<1	<1	<1	<1	<1	<1		<1	<1					<1	<1	<1	<1	<1	<1		<1	<1	3830
MAR1394.19	BH-M14 (SS1) 0.0-0.5m	Core	0.00-0.50	<1	<1	<1	<1	<1	<1		<1	<1					1.67	<1	<1	<1	<1	<1		2.96	1.33	9280
MAR1394.20	BH-M14 (SS2) 1.0-1.5m	Core	1.00-1.50	<1	<1	<1	<1	1.03	2.34		2.32	1.43					2.07	<1	2.05	<1	1.93	<1		1.15	2.6	14200
MAR1394.21	BH-M14 (SS3) 2.5-3.0m	Core	2.50-3.00	<1	<1	<1	<1	<1	1.59		1.26	<1					1.83	<1	1.45	<1	<1	<1		<1	1.89	18600
MAR1394.22	BH-M15 (SS1) 0.0-0.5m	Core	0.00-0.50	<1	<1	<1	<1	<1	<1		<1	<1					1.37	<1	<1	<1	<1	<1		<1	<1	8150
MAR1394.23	BH-M15 (SS2) 1.0-1.5m	Core	1.00-1.50	<1	<1	<1	<1	<1	<1		<1	<1					1.6	<1	<1	<1	<1	<1		<1	1.03	8230
MAR1394.24	BH-M15 (SS3) 2.5-3.0m	Core	2.50-3.00	<1	<1	<1	<1	<1	<1		<1	<1					1.78	<1	<1	<1	<1	<1		<1	1.31	11700
MAR1394.25	WP-M27 (SS1) 0.0-0.15m	Grab	0.00-0.15	<1	<1	<1	1.16	1.36	2.35		2.47	1.33					2.57	<1	2.69	<1	2.23	<1		1.55	3.18	17400
0	0	0	0																							
0	0	0	0																							
MAR1394.26	BH-M16 (SS1) 0.0-0.5m	Core	0.00-0.50	<1	<1	1.61	5.26	4.78	4.94		3.94	2.89					6.88	<1	11.4	<1	3.09	<1		4.15	10.6	11200
MAR1394.27	BH-M16 (SS2) 1.0-1.5m	Core	1.00-1.50	<1	<1	<1	<1	<1	<1		<1	<1					1.71	<1	<1	<1	<1	<1		1.48	1.08	13500
MAR1394.28	BH-M17 (SS1) 0.0-0.5m	Core	0.00-0.50	<1	<1	<1	<1	<1	<1		<1	<1					<1	<1	<1	<1	<1	<1		<1	<1	7090

Organohalogens

Explanatory Notes:
Results above Action Level 1 will be highlighted in blue and above Action Level 2 in red.
ICES7 is the sum of PCB 28,52,101,138,153,180 and 118.

Definitions:

AHCH	alpha-Hexachlorcyclohexane
BHCH	beta-Hexachlorcyclohexane
GHCH	gamma-Hexachlorcyclohexane
DIELDRIN	Dieldrin
HCB	Hexachlorobenzene
PPDDE	p,p'-Dichorodiphenyldicloroethylene
PPDDT	p,p'-Dichorodiphenyltrichloroethane
PPTDE	p,p'-Dichorodiphenyldicloroethan

Sample information:

Sample ID	Dredge area	Type of sample	Sample depth (m)	PCB28	PCB52	PCB101	PCB118	PCB138	PCB153	PCB18	PCB105	PCB110	PCB128	PCB141	PCB149	PCB151	PCB156	PCB158	PCB170	PCB180	PCB183	PCB187	PCB194	PCB31	PCB44	PCB47	PCB49	PCB66	ICES7
				µg/kg																									
MAR1394.01	BH-M01 (SS1) 0.0-0.5m	Core	0.00-0.50	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08											<0.08									0.56
MAR1394.02	BH-M01 (SS2) 1.0-1.5m	Core	1.00-1.50	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08											<0.08									0.56
MAR1394.03	BH-M01 (SS3) 2.5-3.0m	Core	2.50-3.00	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08											<0.08									0.56
MAR1394.04	BH-M03 (SS1) 0.0-0.5m	Core	0.00-0.50	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08											<0.08									0.56
MAR1394.05	BH-M03 (SS2) 1.0-1.5m	Core	1.00-1.50	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08											<0.08									0.56
MAR1394.06	BH-M03 (SS3) 2.5-3.0m	Core	2.50-3.00	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08											<0.08									0.56
MAR1394.07	BH-M07 (SS1) 0.0-0.5m	Core	0.00-0.50	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08											<0.08									0.56
MAR1394.08	BH-M07 (SS2) 1.0-1.5m	Core	1.00-1.50	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08											<0.08									0.56
MAR1394.09	BH-M07 (SS3) 2.5-3.0m	Core	2.50-3.00	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08											<0.08									0.56
MAR1394.10	BH-M09 (SS1) 0.0-0.5m	Core	0.00-0.50	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08											<0.08									0.56
MAR1394.11	BH-M09 (SS2) 1.0-1.5m	Core	1.00-1.50	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08											<0.08									0.56
MAR1394.12	BH-M09 (SS3) 2.5-3.0m	Core	2.50-3.00	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08											<0.08									0.56
MAR1394.13	BH-M11 (SS1) 0.0-0.5m	Core	0.00-0.50	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08											<0.08									0.56
MAR1394.14	BH-M11 (SS2) 1.0-1.5m	Core	1.00-1.50	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08											<0.08									0.56
MAR1394.15	BH-M11 (SS3) 2.5-3.0m	Core	2.50-3.00	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08											<0.08									0.56
MAR1394.16	BH-M13 (SS1) 0.0-0.5m	Core	0.00-0.50	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08											<0.08									0.56
MAR1394.17	BH-M13 (SS2) 1.0-1.5m	Core	1.00-1.50	<0.08	<0.08	<0.08	<0.08	0.13	0.22											<0.08									0.75
MAR1394.18	BH-M13 (SS3) 2.5-3.0m	Core	2.50-3.00	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08											<0.08									0.56
MAR1394.19	BH-M14 (SS1) 0.0-0.5m	Core	0.00-0.50	0.21	0.26	0.28	0.31	0.3	0.29											0.34									1.99
MAR1394.20	BH-M14 (SS2) 1.0-1.5m	Core	1.00-1.50	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08											<0.08									0.56
MAR1394.21	BH-M14 (SS3) 2.5-3.0m	Core	2.50-3.00	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08											<0.08									0.56
MAR1394.22	BH-M15 (SS1) 0.0-0.5m	Core	0.00-0.50	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08											<0.08									0.56
MAR1394.23	BH-M15 (SS2) 1.0-1.5m	Core	1.00-1.50	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08											<0.08									0.56
MAR1394.24	BH-M15 (SS3) 2.5-3.0m	Core	2.50-3.00	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08											<0.08									0.56
MAR1394.25	WP-M27 (SS1) 0.0-0.15m	Grab	0.00-0.15	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08											<0.08									0.56
0	0	0	0																										
0	0	0	0																										
MAR1394.26	BH-M16 (SS1) 0.0-0.5m	Core	0.00-0.50	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08											<0.08									0.56
MAR1394.27	BH-M16 (SS2) 1.0-1.5m	Core	1.00-1.50	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08											<0.08									0.56
MAR1394.28	BH-M17 (SS1) 0.0-0.5m	Core	0.00-0.50	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08											<0.08									0.56

PR Details

Total amount to be dredged (wet tonnes)

Explanatory Notes:
The values entered for each determinand should be an average wet weight concentration from all the samples representing the material to be disposed to sea. They should be entered in the units stated in the Unit of measurement column in the table below.
Results above Action Level 1 will be highlighted in blue and above Action Level 2 in red.

Average for the total dredge area:

Sample ID	Unit of measurement	
Total Solids	%	84
Gravel	%	18.4
Sand	%	56.9
Silt	%	24.7
Arsenic (As)	mg/kg	9.3
Cadmium (Cd)		0.09
Chromium (Cr)		10.7
Copper (Cu)		11.4
Mercury (Hg)		0.02
Nickel (Ni)		9.2
Lead (Pb)		7.9
Zinc (Zn)		19.9
Dibutyltin (DBT)		<0.005
Tributyltin (TBT)		<0.005
Acenapth	µg/kg	<1
Acenapthylene		<1
Anthracn		1.01
BAA		1.12
BAP		1.11
BBF		1.37
BEP		
Benzghip		1.22
BKF		1.06
C1N		
C1PHEN		
C2N		
C3N		
Chrysene		2.25
Debenzah		<1
Flurant		1.46
Fluorene		<1
Indypr		1.1
napth		<1
perylene		
phenant		1.25
pyrene		1.79
THC		13674
PCB28		<0.08
PCB52		<0.08
PCB101		<0.08
PCB118		<0.08
PCB138		<0.08
PCB153		0.08
PCB18		
PCB105		
PCB110		
PCB128		
PCB141		
PCB149		
PCB151		
PCB156		
PCB158		
PCB170		
PCB180		<0.08
PCB183		
PCB187		
PCB194		
PCB31		
PCB44		
PCB47		
PCB49		
PCB66		
ICES7		0.51
AHCH		
BHCH		
GHCH		
DIELDRIN		
HCB		
DDE		
DDT		
TDE		
BDE100		
BDE138		
BDE153		
BDE154		
BDE17		
BDE183		
BDE209		
BDE28		
BDE47		
BDE66		
BDE85		
BDE99		

Comments:

Laboratory Details

Explanatory Notes:
Please complete a separate worksheet for each laboratory (e.g. complete 'Laboartory_1' worksheet for 1 laboratory and complete 'Laboartory_2' worksheet for a second laboratory). If there are more than 3 laboratories then please contact MS-LOT.

Laboratory 1 Details:

Laboratory name	SOCOTEC
Year:	2022

LabRefMat	**Q1**	Does the laboratory carrying out the analyses undertake the analysis of blank samples and laboratory reference materials with each batch of samples of waste and other material dumped in the maritime area that is analysed by that laboratory?	Yes
CompAnal	**Q2**	Does the laboratory carrying out the analyses undertake periodic comparative analysis of laboratory reference materials and certified reference materials?	Yes
QAQC	**Q3**	Does the laboratory carrying out the analyses undertake the compilation of quality control charts based upon the data resulting from the analyses of the laboratory reference materials and certified reference materials, and the use of those quality control charts to monitor analytical performance in relation to all samples of dumped wastes or other materials?	Yes
InterlabCaleb	**Q4**	Does the laboratory carrying out the analyses undertake periodic participation in interlaboratory comparison exercises, including, where possible, international comparison exercises?	Yes
InternatCaleb	**Q5**	Does the laboratory carrying out the analyses undertake periodic participation in national and, where possible, international laboratory proficiency schemes?	Yes
SpikedSamples	**Q6**	If the answer to questions 4 or 5 is 'Yes' then does the laboratory analyse samples of substances which are provided by the organisers of the scheme?	Yes
BlindSamples	**Q7**	If the answer to questions 4 or 5 is 'Yes' then does the laboratory confirm that the composition of those samples is not disclosed in advance?	Yes
Ranking	**Q8**	If the answer to questions 4 or 5 is 'Yes' then does the laboratory confirm that the results of the scheme for each participating laboratory are made available to all participating laboratories?	Yes
FracAnal	**Q9**	Enter the size fraction that is analysed i.e. Whole or less than 63µm etc.	<63um(metals)
GranMeth	**Q10**	PSA method	Distribution by wet & dry sieving and laser detraction
OCMeth	**Q11**	Organic Carbon method	Carbonate removal and sulfurous acid/combustion at 1600°C/NDIR,
MetExtrType	**Q12**	Method of extraction used for metal analysis	Aquaregia
MethOfDetMetals	**Q13**	Method of detection used for metal analysis	ICP-MS
PAHExtrType	**Q14**	Method of extraction used for poly aromatic hydrocarbon analysis	Methanol/DCM solvent extraction with silica clean up and copper clean up stages
MethOfDetPAH	**Q15**	Method of detection used for poly aromatic hydrocarbons analysis	GCMS
OHExtrType	**Q16**	Method of extraction used for organohalogens inc PCBs, pesticides, flame retardants etc analysis	Ultrasonic acetone/hexane solvent extraction
MethOfDetOH	**Q17**	Method of detection used for organohalogens inc PCBs, pesticides, flame retardants etc analysis	GCMSMS
OTExtrType	**Q18**	Method of extraction used for organotin analysis	Derivatisation and solvent extraction
MethOfDetOT	**Q19**	Method of detection used for organotin analysis	GCMS

		LOD/LOQ	Precision (%)	Recovery (%)
mg/kg	Hg	0.01	4.2	90
	As	0.5	2.7	99
	Cd	0.04	3.6	96
	Cu	0.5	2.9	97
	Pb	0.5	3	93
	Zn	2	2.6	98
	Cr	0.5	3.1	93
	Ni	0.5	3.6	99
	TBT	0.001	12.62	60
	DBT	0.001	12.62	85
µg/kg	PCB28	0.08	12.56	103
	PCB31			
	PCB44			
	PCB47			
	PCB49			
	PCB52	0.08	6.999	87
	PCB66			
	PCB101	0.08	8.43	96
	PCB105			
	PCB110			
	PCB118	0.08	14.61	96
	PCB128			
	PCB138+163	0.08	12.93	98
	PCB141			
	PCB149			
	PCB151			
	PCB153	0.08	7.41	97
	PCB156			
	PCB158			
	PCB170			
	PCB180	0.08	9.85	96
	PCB183			
	PCB187			
	PCB194			
	DDE			
	DDT			
	DDD			
	Dieldrin			
	Lindane			
	HCB			
	BDE17			
	BDE28			
	BDE47			
	BDE66			
	BDE85			
	BDE99			
	BDE100			
	BDE138			
	BDE153			
	BDE154			
	BDE183			
	BDE209			
	ACENAPTH	1	6.68	82
	ACENAPHY	1	7.74	140
	ANTHRACN	1	4.95	90
	BAA	1	9.8	81
	BAP	1	9.07	86
	BBF	1	8.44	70
	BENZGHIP	1	13.46	100
	BEP			
	BKF	1	8.9	85
	C1N			
	C1PHEN			
	C2N			
	C3N			
	CHRYSENE	1	7.87	80
	DBENZAH	1	19.23	87
	FLUORENE	1	5.25	87
	FLUORANT	1	4.36	82
	INDPYR	1	17.1	88
	NAPTH	1	3.02	100
	PERYLENE			
	PHENANT	1	5.41	85
	PYRENE	1	4.29	88
	THC	100	N/A	98

Marine Scotland
Pre-disposal Sampling Guidance
Version 2 - November 2017

Table 2 Action Levels

Contaminant	Revised AL1 mg/kg dry weight (ppm)	Revised AL2 mg/kg dry weight (ppm)
Arsenic	20	70
Cadmium	0.4	4
Chromium	50	370
Copper	30	300
Mercury	0.25	1.5
Nickel	30	150
Lead	50	400
Zinc	130	600
Tributyltin	0.1	0.5
Polychlorinated Biphenyls	0.02	0.18
Polyaromatic Hydrocarbons		
Acenaphthene	0.1	
Acenaphthylene	0.1	
Anthracene	0.1	
Fluorene	0.1	
Naphthalene	0.1	
Phenanthrene	0.1	
Benzo[a]anthracene	0.1	
Benzo[b]flouranthene	0.1	
Benzo[k]fluoranthene	0.1	
Benzo[a]pyrene	0.1	
Benzo[g,h,i]perylene	0.1	
Dibenzo[a,h]anthracene	0.01	
Chrysene	0.1	
Fluoranthene	0.1	
Pyrene	0.1	
Indeno(1,2,3cd)pyrene	0.1	
Total Hydrocarbons	100	
Booster Biocide and		
Brominated Flame Retardents*		

*Provisional Action Levels for these compounds are subject to further investigation.

Results which exceed the Contaminant Action Levels are highlighted in blue or red, as appropriate, on the following pages

CAUSEWAY
GEOTECH

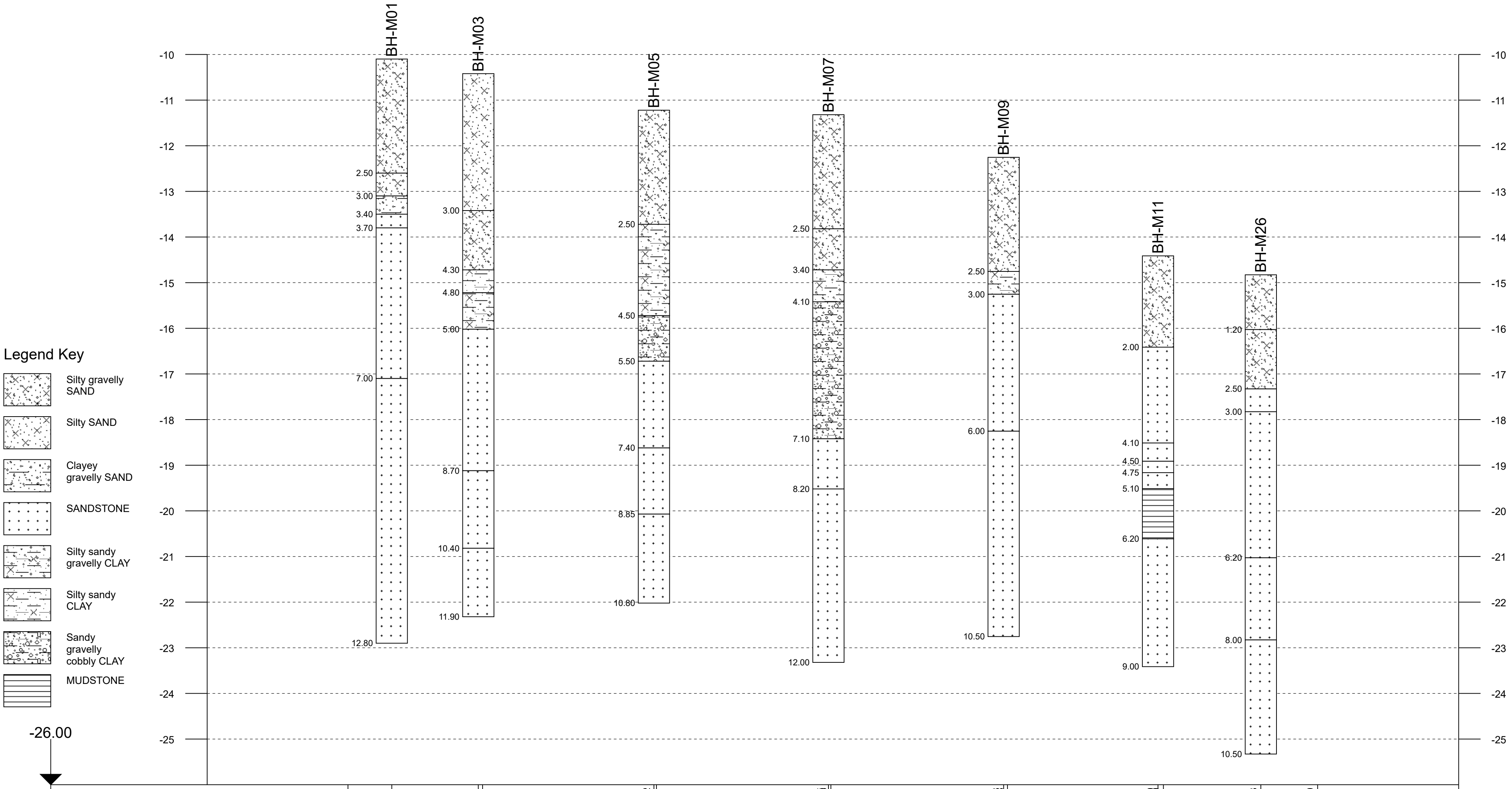
APPENDIX H

GEOLOGICAL LONG SECTIONS

Project Id: 21-1031
Project Title: Scapa Deep Water Quay & Hatston Pier Development - Marine GI
Location: Scapa Flow and Hatston Pier
Client: Orkney Islands Council

Title: Section line 1 - Scapa DWQ Front Alignment BH-L01 to BH-M26
Vertical Scale: 1:123
Horizontal Scale: 1:3217
Engineer: Arch Henderson LLP

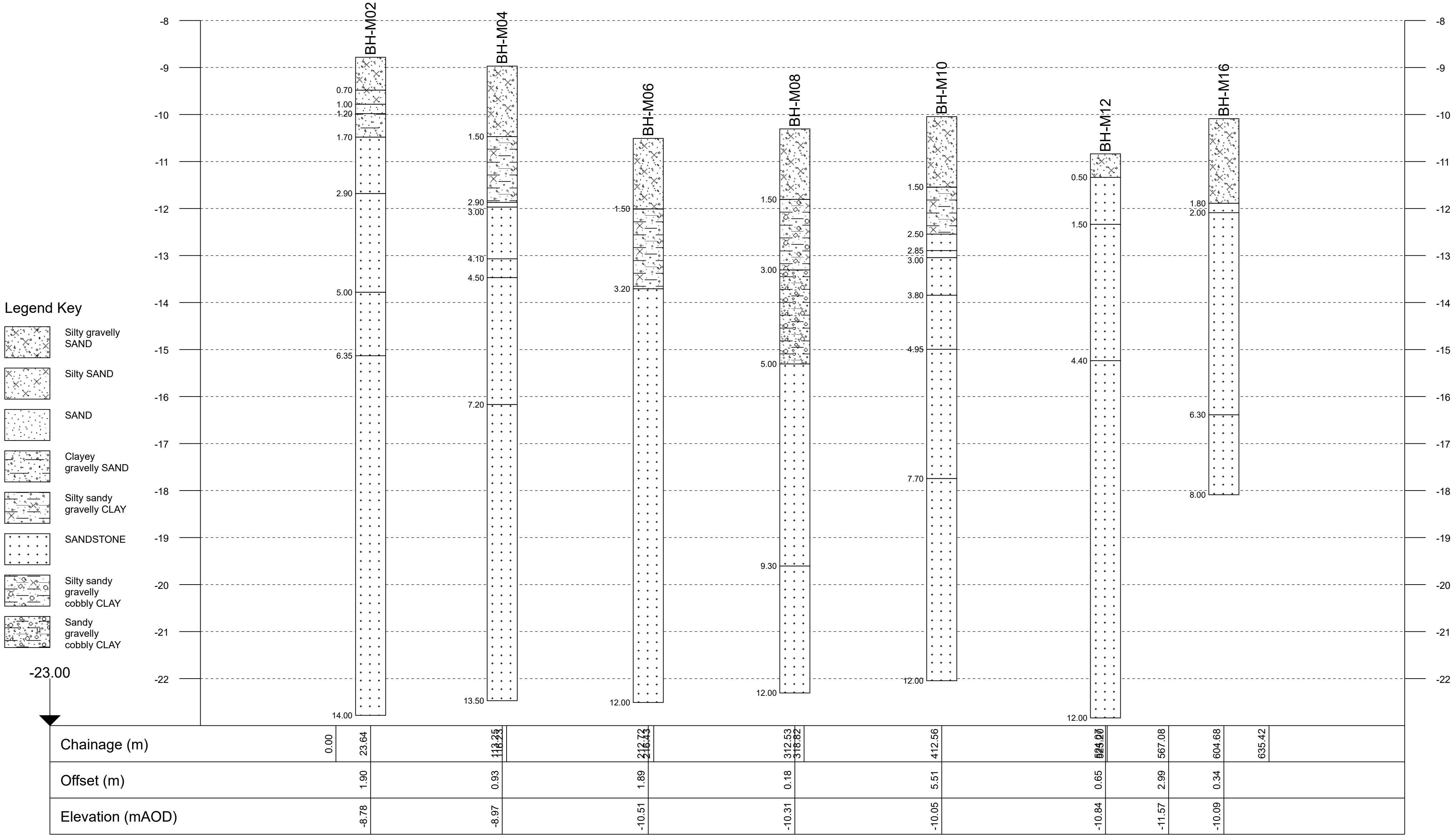
CAUSEWAY GEOTECH



Chainage (m)	0.00	25.09	74.64 77.10	175.32 176.67	276.15 276.55	375.48 377.68	463.89 466.99	522.78	555.30
Offset (m)		2.75	1.84	1.15	1.52	1.57	0.69	0.35	
Elevation (mAOD)		-10.10	-10.42	-11.22	-11.32	-12.25	-14.41	-14.83	

Project Id: 21-1031	Title: Section line 2 - Scapa DWQ Rear Alignment BH-L02 to BH-L16
Project Title: Scapa Deep Water Quay & Hatston Pier Development - Marine GI	Vertical Scale: 1:115
Location: Scapa Flow and Hatston Pier	Horizontal Scale: 1:3681
Client: Orkney Islands Council	Engineer: Arch Henderson LLP

CAUSEWAY GEOTECH



Project Id: 21-1031

Project Title: Scapa Deep Water Quay & Hatston Pier Development - Marine GI

Location: Scapa Flow and Hatston Pier

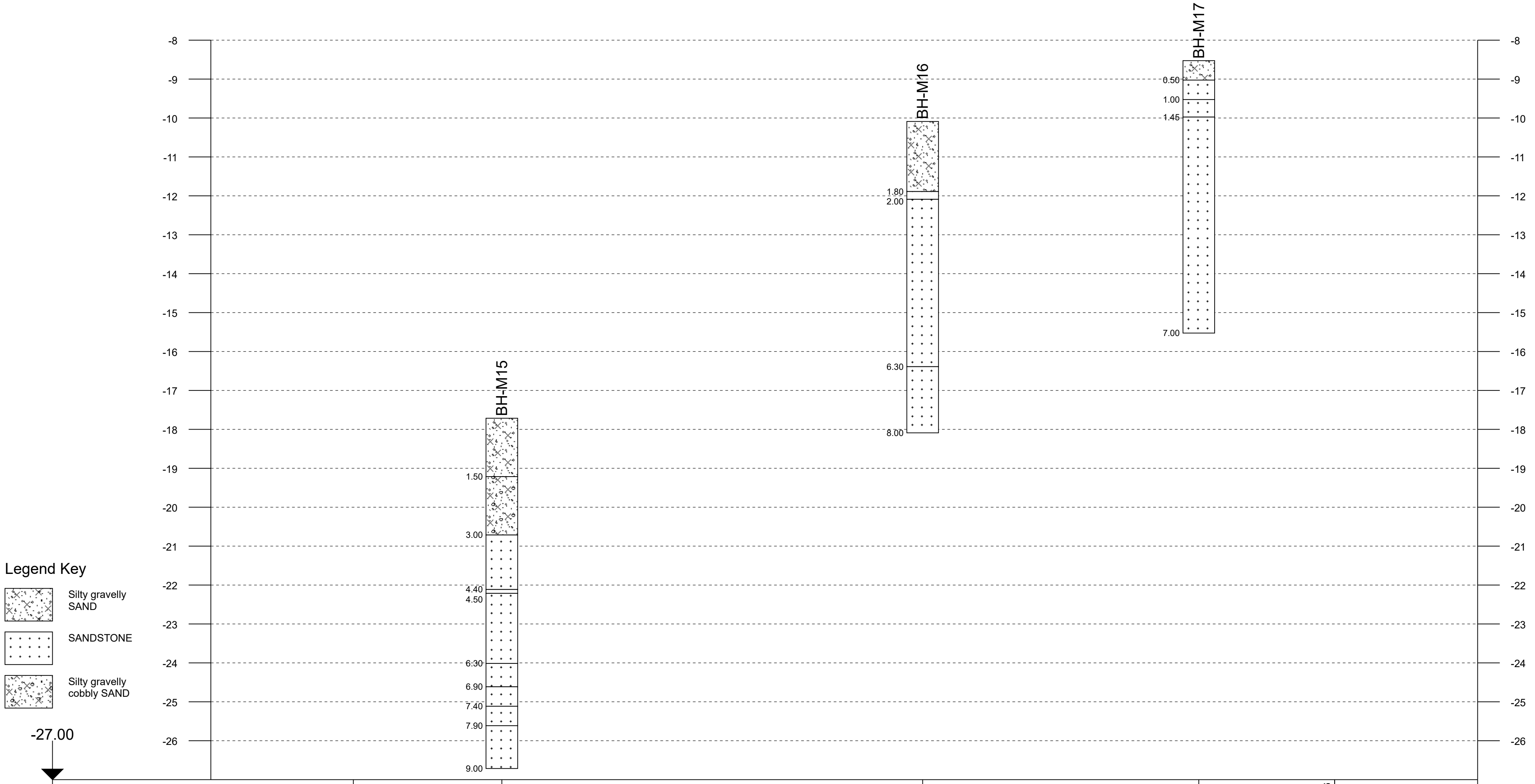
Client: Orkney Islands Council

Title: Section line 3 - Scapa DWQ Cross Section BH-L15 to BH-L17

Vertical Scale: 1:146

Horizontal Scale: 1:902

Engineer: Arch Henderson LLP



Chainage (m)	0.00	23.55	90.31	134.11	155.66
Offset (m)		2.22	1.86	1.75	
Elevation (mAOD)		-17.71	-10.09	-8.53	

APPENDIX I

UNEXPLODED ORDNANCE SURVEY REPORT

APPENDIX J

SPT HAMMER ENERGY MEASUREMENT REPORT

SPT Hammer Energy Test Report

in accordance with BSEN ISO 22476-3:2005

Southern Testing
Unit 11
Charlwood Road
East Grinstead
West Sussex
RH19 2HU

SPT Hammer Ref:	1353
Test Date:	27/09/2021
Report Date:	01/10/2021
File Name:	1353.spt
Test Operator:	NPB

Instrumented Rod Data

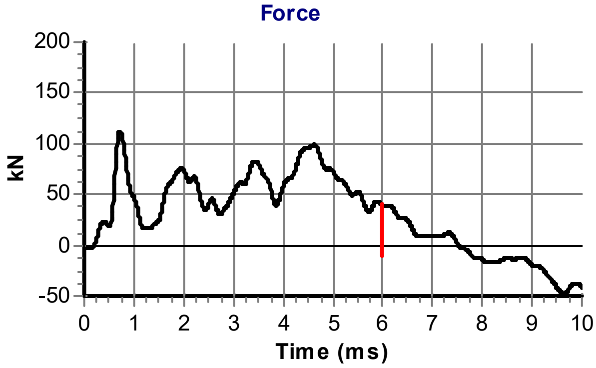
Diameter d_r (mm):	54
Wall Thickness t_r (mm):	6.3
Assumed Modulus E_a (GPa):	208
Accelerometer No.1:	6458
Accelerometer No.2:	9607

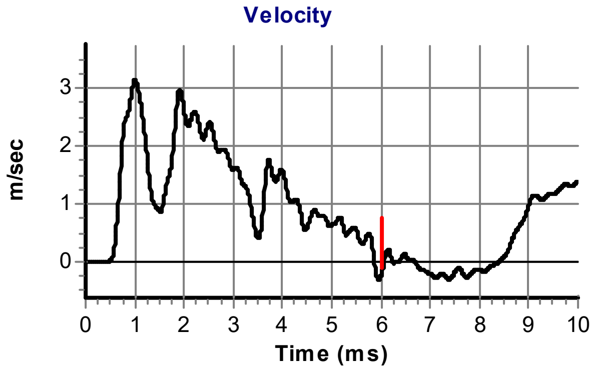
SPT Hammer Information

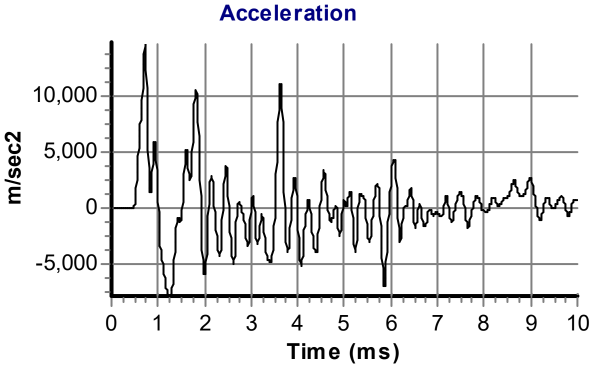
Hammer Mass m (kg):	63.5
Falling Height h (mm):	760
SPT String Length L (m):	11.0

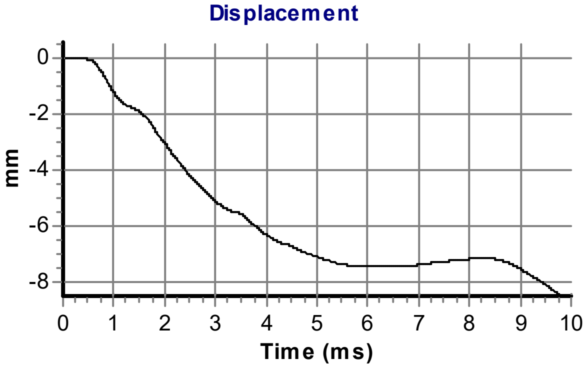
Comments / Location

BALLYMONEY









Calculations

Area of Rod A (mm2):	944
Theoretical Energy E_{theor} (J):	473
Measured Energy E_{meas} (J):	363

Energy Ratio E_r (%): 77

N P Burrows

Signed: N P Burrows
Title: Field Operations Manager

The recommended calibration interval is 12 months

TECHNICAL APPENDIX 4.3.1

APPENDIX I

UNEXPLODED ORDNANCE SURVEY REPORT

EXCELLENCE IN **UXO** RESOLUTION

Report Title	**Orkney UXO Survey Clearance Certification**
Client	Causeway Geotech Limited
Project Name	Scapa Deep Water Quay & Hatston Pier Development Marine Site Investigations
Date	23 December 2021

EODEX UK Subsea Limited
Registered Address: Fourteenth Floor, 33 Cavendish Square, London, W1G 0PW
Company number: 11104658

Document Control

Revision	Date	Issued For	Prepared By	Reviewed By
0	23/12/21	Client review	Hardy Sidhu Gustav Pettersson	Steve Vernon

Document Issue

	Approved By	Approved by
Signature		
Print Name	Steve Vernon MIExpE	Andrew Woollven MIExpE
Date	23 December 2021	23 December 2021

Distribution

Copy No.	Recipient	Format
1	EODEX Office	PDF
2	Causeway Geotech Limited	PDF

Change Control

Revision	Date	Section	Page	Description

CONTENTS

List of Figures:

List of Tables:

1. REFERENCES

1.1. ACRONYMS & ABBREVIATIONS

ALARP	As low as reasonably practicable
BGL	Below ground level
BH	Borehole
BSBL	Below seabed level
CIRIA	Construction Industry Research and Information Association
CRP	Common reference point
cUXO	Confirmed UXO
DBSL	Depth below sea level
(D)GPS	(Differential) Global positioning system
DRA	Detailed risk assessment
DTS	Desktop study
EO	Explosive ordnance
EOD	Explosive ordnance disposal
ITT	Invitation to tender
JUB	Jack-up barge
MSW	Metres of sea water
pUXO	Potential UXO
QASG	QuasiAnalytic signal gradient
RMS	Risk mitigation strategy
SI	Site investigation
SIT	Surrogate item trial
SoW	Scope of work
SSS	Sidescan sonar
TI	Target investigation
TVG	Transvers (magnetic) gradiometer
USBL	Ultra-short baseline (underwater acoustic positioning)
UTM	Universal Transverse Mercator
UXO	Unexploded ordnance
WP	Wash probe

1.2. DOCUMENTS

A. Causeway Geotech email request for proposal dated 22 July 2021.
B. Orkney Islands Council Marine SI Specification document – First Issue dated 16 July 2021.
C. NjordIC UXO Desk Study dated 02 July 2021.
D. EODEX proposal dated 03 August 2021.
E. CIRIA Report C754 – UXO in the marine environment.
F. Rovco Limited: Technical and Commercial Proposal for Provision of Geophysical UXO Survey. Reference: RVC.19010.PR.001, Revision: 03, Issue Date: 11/08/21.
G. Rovco Limited: Seren Las Mobilisation, Calibration and Verification Report. Project No.: 21018R, Revision: A4, Document number: Rovco-21018R-RP-001-A4.
H. Rovco Limited: UXO Geophysical Survey – Field Operations Report. Revision: A1.
I. EODEX: Orkney UXO Survey – HQS Review, Determination of Minimum Threat Items. 8th October 2021, Revision 0.

2. INTRODUCTION

Causeway Geotech Ltd (“Causeway”) were awarded the contract to carry out the Site Investigation (SI) works at two marine sites near to Kirkwall, Orkney. The scope of works was approximately 50 overwater investigation positions conducted from a JUB. A risk of encountering UXO had been identified as described in Reference A.

Causeway requested a proposal and quotation from Eodex UK Subsea Limited (“EODEX”, Reference D) to carry out a UXO survey as a precursor operation prior to the SI works and to provide certification that the UXO risk at the site can be reduced to and maintained at a level which is ALARP.

In the role of a specialist UXO consultant, EODEX assisted the Client to procure and manage the geophysical survey, review the final outcome and finally provide ALARP certification as required for the SI works.

2.1. LOCATION & SURVEY AREAS

The site locations were at Haston Pier, the current ferry terminal berth at the NW approach to Kirkwall and the planned Scapa Deep Water Quay at the Northern end of Scapa Flow.

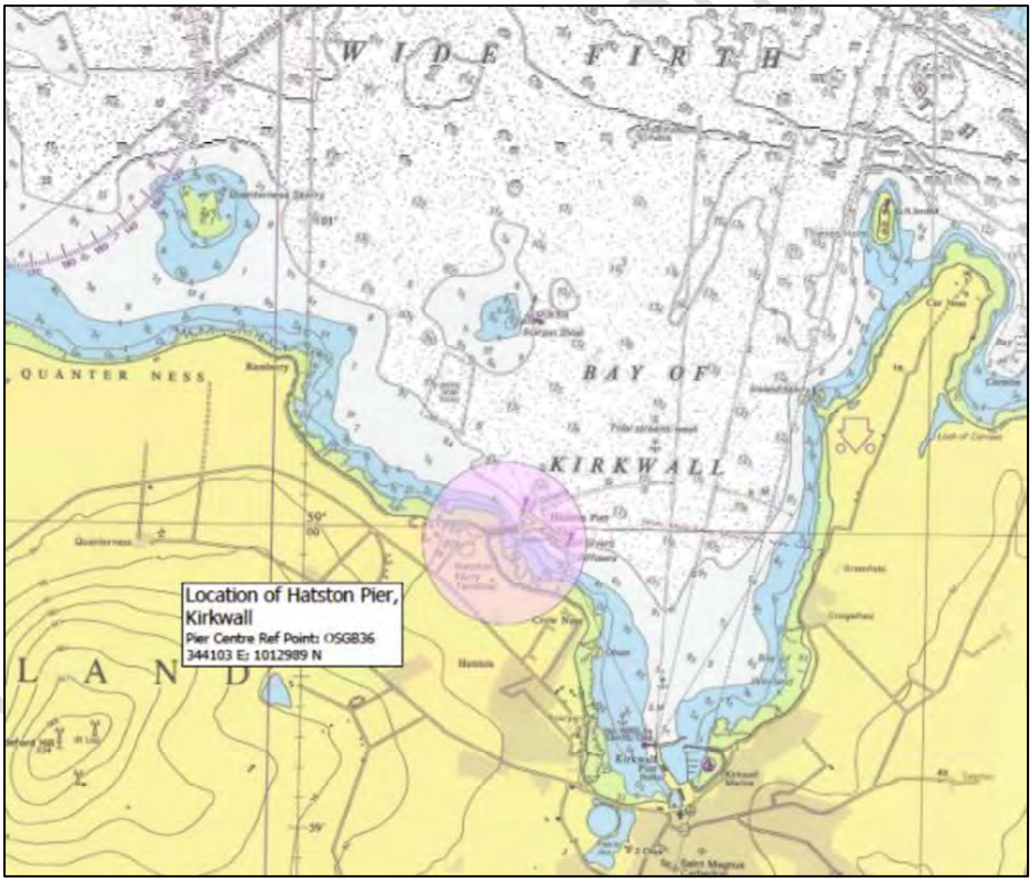


Figure 1: Haston Pier area for UXO survey and ALARP certification

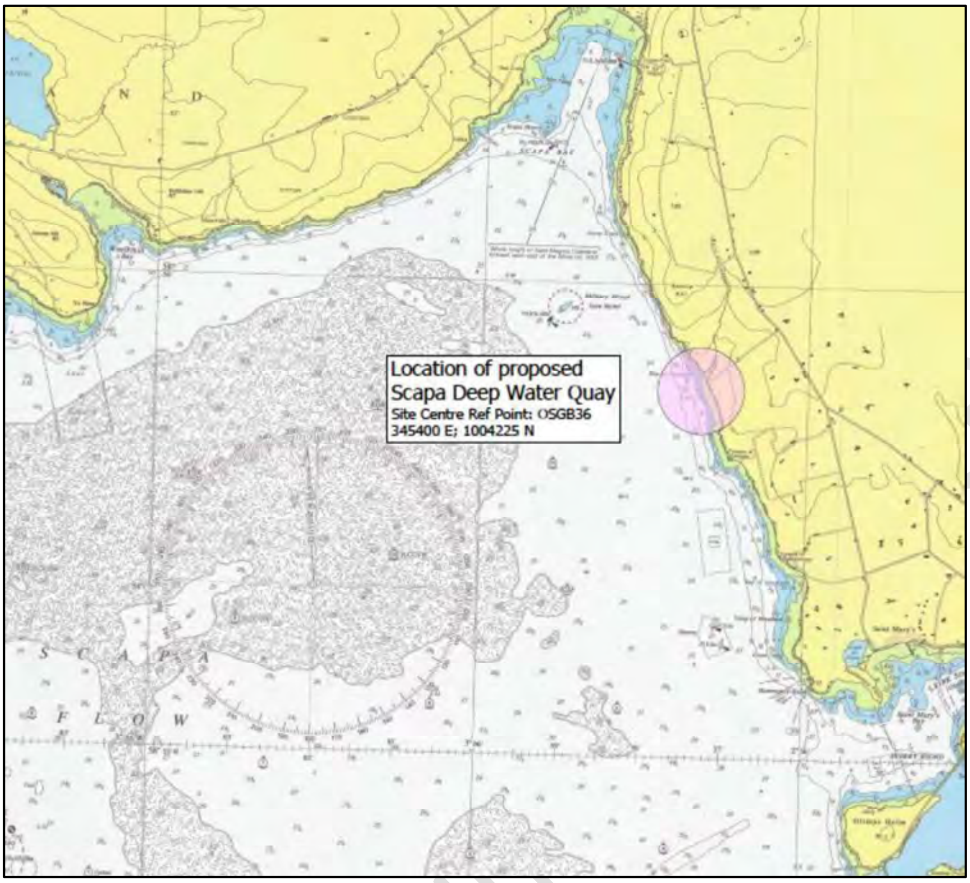


Figure 2: Scapa Deep Water Quay area for UXO survey and ALARP certification

3. SURVEY PROCUREMENT & DELIVERY

3.1. PROCUREMENT

EODEX produced a technical specification and ITT for the geophysical survey (reference document D), as summarised below:

3.1.1. Work Packages

Table 1: Work packages

WP	Title	Activity
1	Pre-Operational Activities	Permits, project plan and kick-off meeting
2	Operations	Mobilisation, survey operations, data processing, interpretation and demobilisation
3	Reporting	Final report

3.1.2. Summary Requirements

Table 2: Summary requirements

Operational hours	Daylight or 12 hours/day
Bathymetry	N/A. Target burial depths to be obtained from gradiometer altimeter measurements
Seafloor imagery	Sidescan sonar
Magnetic	Transverse magnetometer gradiometer
Survey corridor and areas dimensions	Refer to • 1004178-01 (Marine SI) ITT Document Tender Issue (r.2.0) • UP0-308 - HQS Orkney Island_rev0.1 • APPROACHES TO KIRKWALL LOCATION PLAN. 212013- 01 (P1) • SCAPA FLOW LOCATION PLAN. 212013- 10 (P3)
Max. depth of investigation	2 metres.
MAG detection threshold	12.5 kg ferromagnetic weight.

3.1.3. Deliverables

In order to provide final ALARP certification, EODEX specified that the following were to be delivered in order to allow determination of potential UXO targets.

1. Operations Report, including as a minimum:
    - Vessels, manning and survey systems.
    - Method statements for data acquisition, processing, interpretation and QA/QC.
    - Summary and detailed results: text and lists of all contacts, potential UXO items and all features of note.
    - Overview maps of the investigation areas with boundaries, at a suitable scale.
    - Site survey charts showing the survey area limits, sailed track-lines, sonar targets, magnetic targets and potential UXO items.
    - For each ferromagnetic anomaly:
        - GPS and UTM coordinates
        - Position (XY data) with an accuracy of ≤ 1.0 m

  - Water depth (m)
  - Height of the gradiometer array above the seabed
  - Depth of the object beneath the seabed (m)
  - Magnetic field strength (nT)
  - Electromagnetic outputs (mV and/or mV/m)
  - Object dimensions (m)
  - Object mass (kg)
2. Raw and processed data files
3. Optionally, GIS data deliverables if the Client requires these.

As a result of the ITT process, Rovco Limited (“Rovco”) offered a technically compliant proposal (reference document F) that was considered to provide sufficiently detained information so as to allow EODEX to evaluate the sites for the presence of pUXO in order to issue ALARP certification. Causeway contracted Rovco to undertake the geophysical surveys under separate contract to Eodex.

All aspects of the survey mobilisation, tests, calibrations, operations and demobilisation were reported independently by Rovco directly to Causeway (reference documents G and H). EODEX was provided sufficient data to assess the risk of pUXO lying at the sites, to recommend final geotechnical station locations and to finally issue clearance certification for the Hatston Pier and Scapa areas.

3.2. OPERATIONS

3.2.1. Key Personnel

The following key personnel were involved with managing the work:

Table 3: Key personnel

Name	Role	Responsibilities
Steve Vernon	Operations Director	EODEX operations and clearance certification
Hardeep Sidhu	Project Manager	Contract and project management
Gustav Pettersson	On-site Representative	QA/QC during acquisition; final data analyses
Tristan Thorne	Commercial Manager	QA/QC during acquisition

3.2.2. Health, Safety & Environmental

During the course of the survey, Rovco reported various HSE indicators within its DPRs, showing that the operations were conducted in a safe and proper manner. Only one safety observation card of an unsafe condition was submitted; this should be reported within Rovco’s independent final survey report. No safety incidents or issues were reported by or involved the EODEX Representatives.

3.2.3. Survey Control

- Horizontal control: Ordnance Survey National Grid reference system 1936.
- Vertical control: LAT.

4. SURVEY ANALYSES, HATSTON PIER

4.1. SIDESCAN SONAR SURVEY

The acquired sidescan sonar data for Hatston fully covered the 40 x 40 metre boxes, centred on the BH and WP locations, apart for WP-M78, which was added after the survey was carried out. The sidescan sonar data were of good quality, and any lines of marginal or unacceptable quality were re-run. Underwater acoustic positioning of the sidescan sonar towfish was also of an acceptable quality. Sonar contacts were identified and sorted into the following categories: Debris; Boulders; Buoy; Fishing equipment; Possible spoil mound; Rocky outcrop; Sediment mound; Tyre & Unknown.

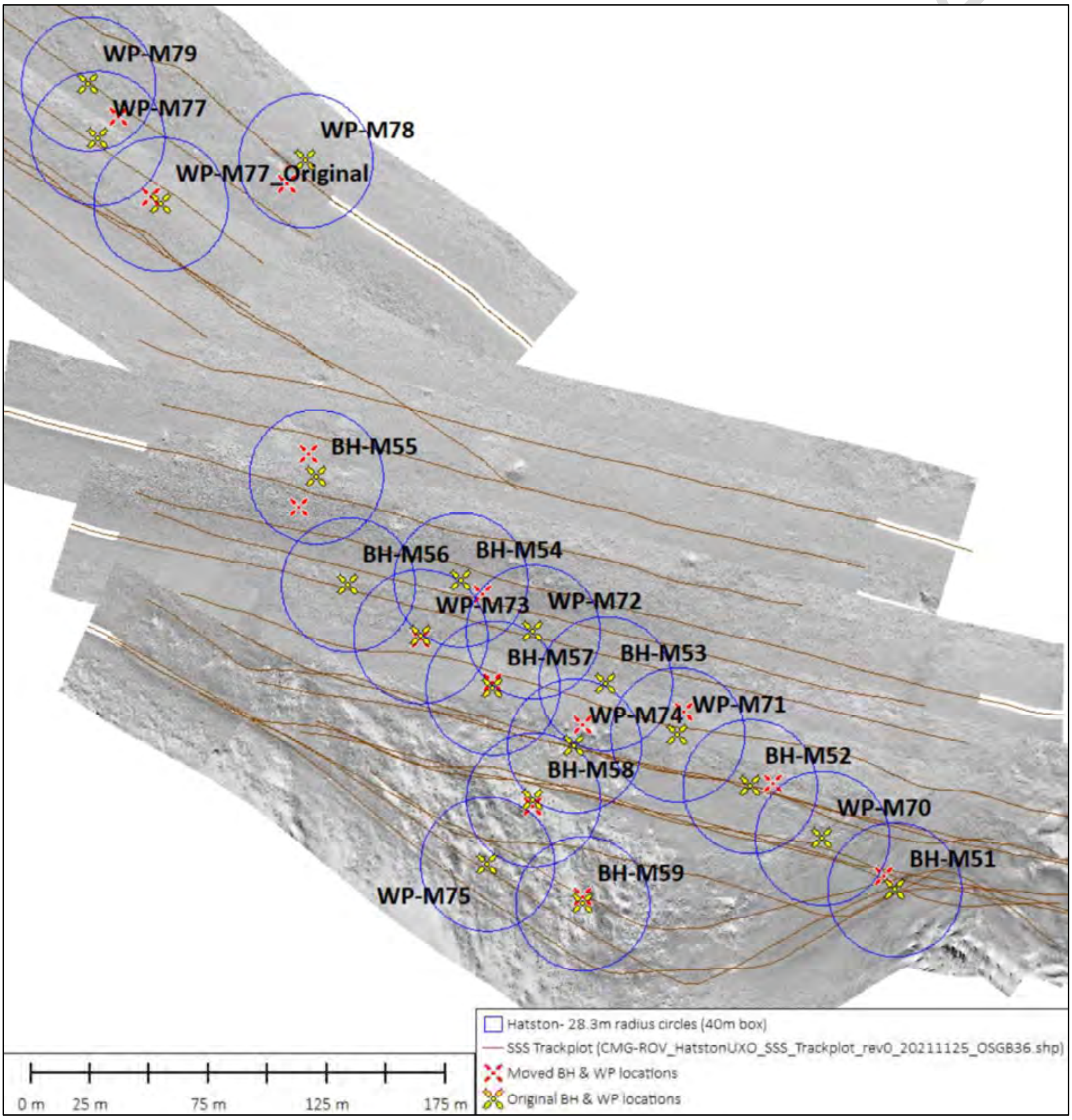


Figure 3: Hatston Pier area with sidescan sonar mosaic and track plot

In the northern section, covering WP-M77 to WP-M79, there was no indication of the two linear features (possibly cables or pipes) that can be seen in the magnetometer data (Figure 10). The positions of these have been overlayed in the sonar mosaic in Figure 4. Within the vicinity of the WP locations, three sonar contacts can possibly be attributed to magnetic anomalies.

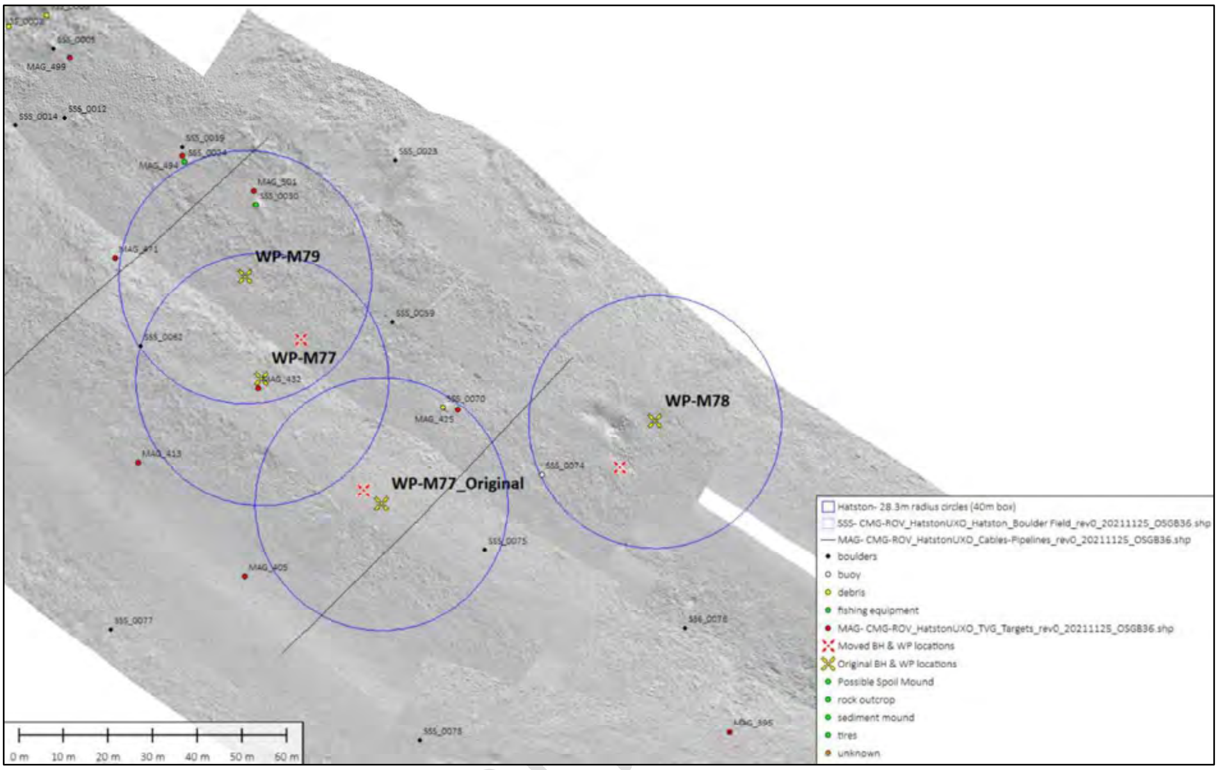


Figure 4: Hatston Pier northern section, sonar and magnetic contacts

In the southern section, there are two further possible pipe or cables features as seen in the magnetometer data (Figure 13), but again, there is no indication of these in the sonar data, indicating they were buried features (highlighted on Figure 5). As seen in Figure 5, a boulder field has been marked out towards the shore. Within this area, Rovco did not pick individual boulders but marked them collectively within a boundary. Within the vicinity of the WP and BH locations eleven sonar contacts could possibly be attributed to magnetic anomalies.

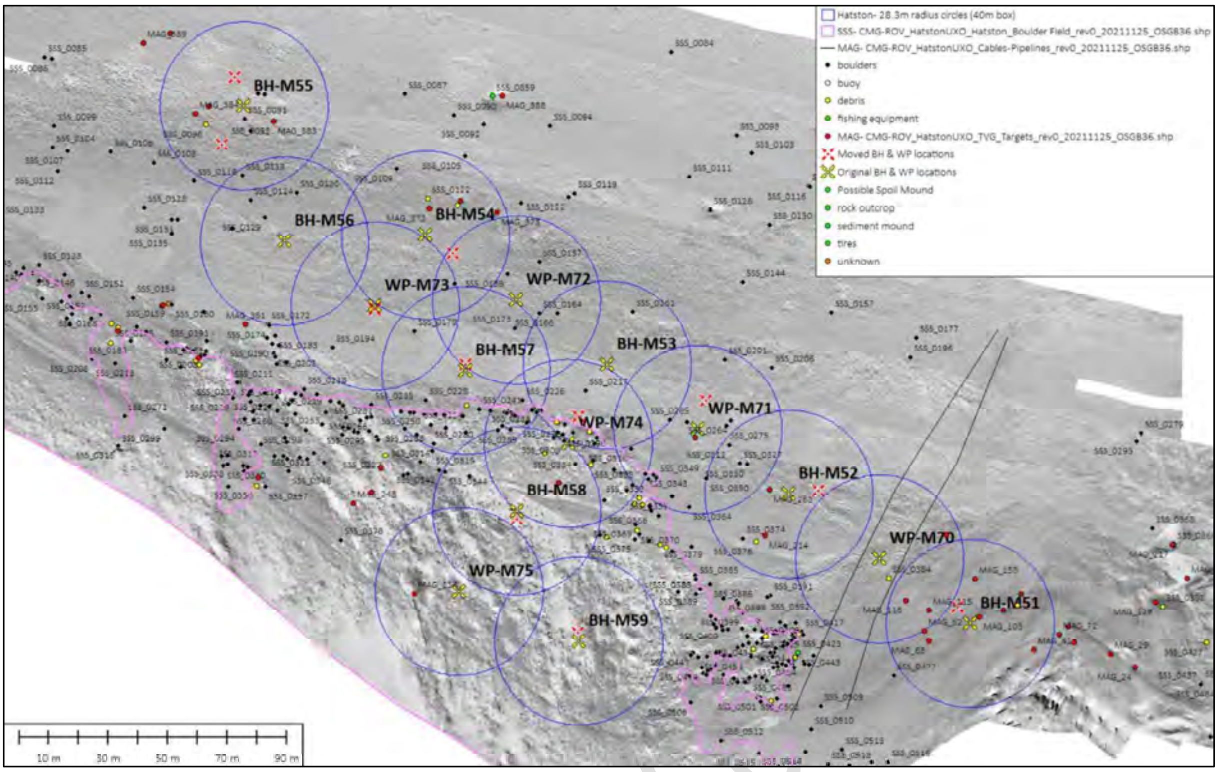


Figure 5: Hatston Pier southern section, sonar and magnetic contacts

4.2. MAGNETIC GRADIOMETER SURVEY

Full coverage, when using a 1.5 m buffer (3 m corridor centred on TVG CRP), was not achieved, and therefore some WP and BH locations have been repositioned so as to be located within an area of full coverage. Figure 6 presents a magnetic data coverage plot with BH-M53 being located in an area of good coverage. This shows a 1.5 m grey buffer zone around the TVG track, overlaying the magnetometer grid shown in blue.

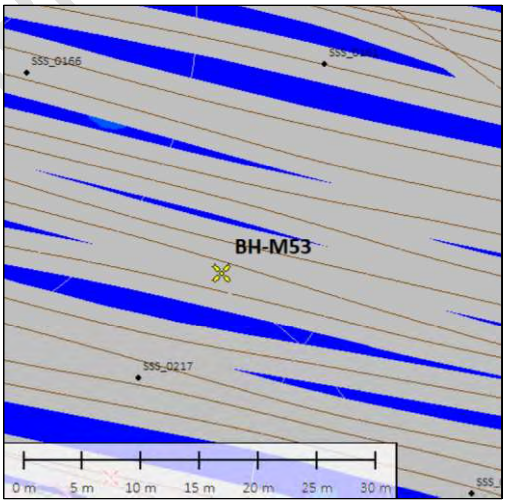


Figure 6: Hatston Pier area – TVG coverage example

The magnetic gradiometer data were of good quality, with low levels of noise, and any data associated with towfish altitudes of greater than 4 m were removed. USBL positioning was dense with no excessive deviations.

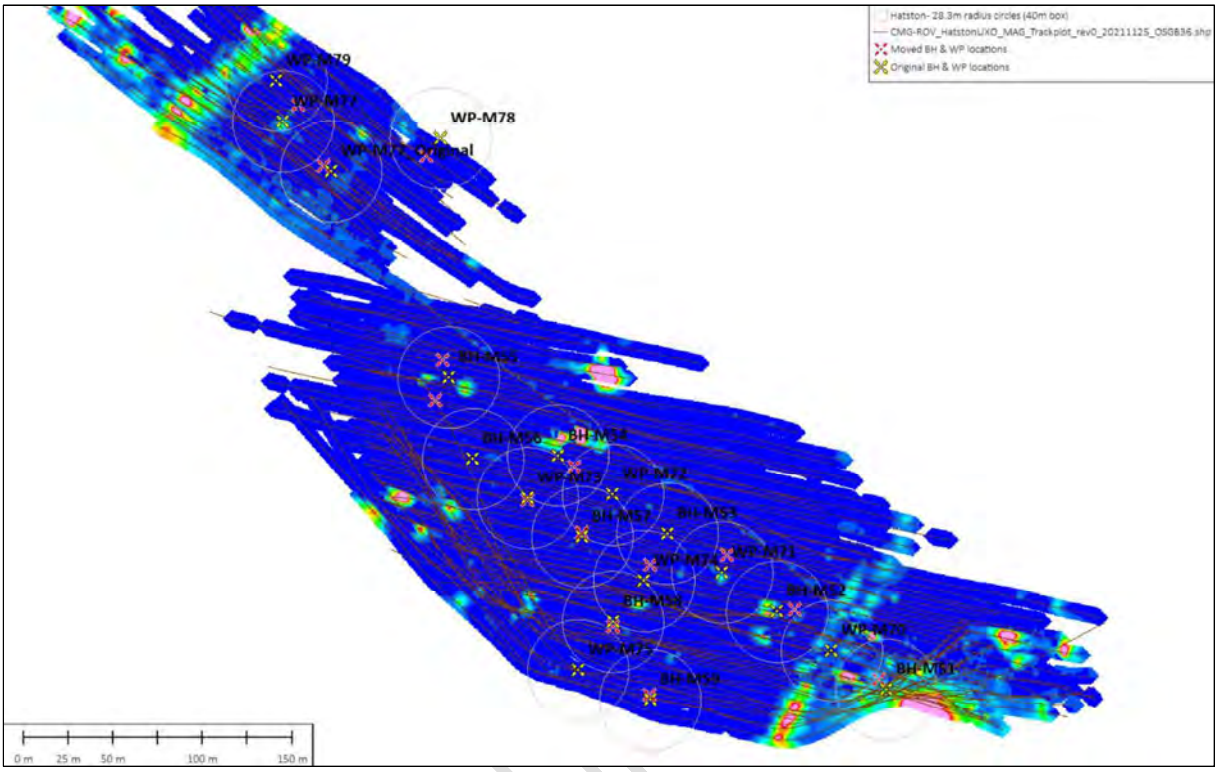


Figure 7: Hatston Pier area – TVG track plot

A horizontal gradient grid is shown in Figure 8. Figure 9, showing the same area with the QuasiAnalytic signal gradient grid, provides a simpler signature that is always positive and allows estimation of horizontal coordinates based on the maximum anomaly position.

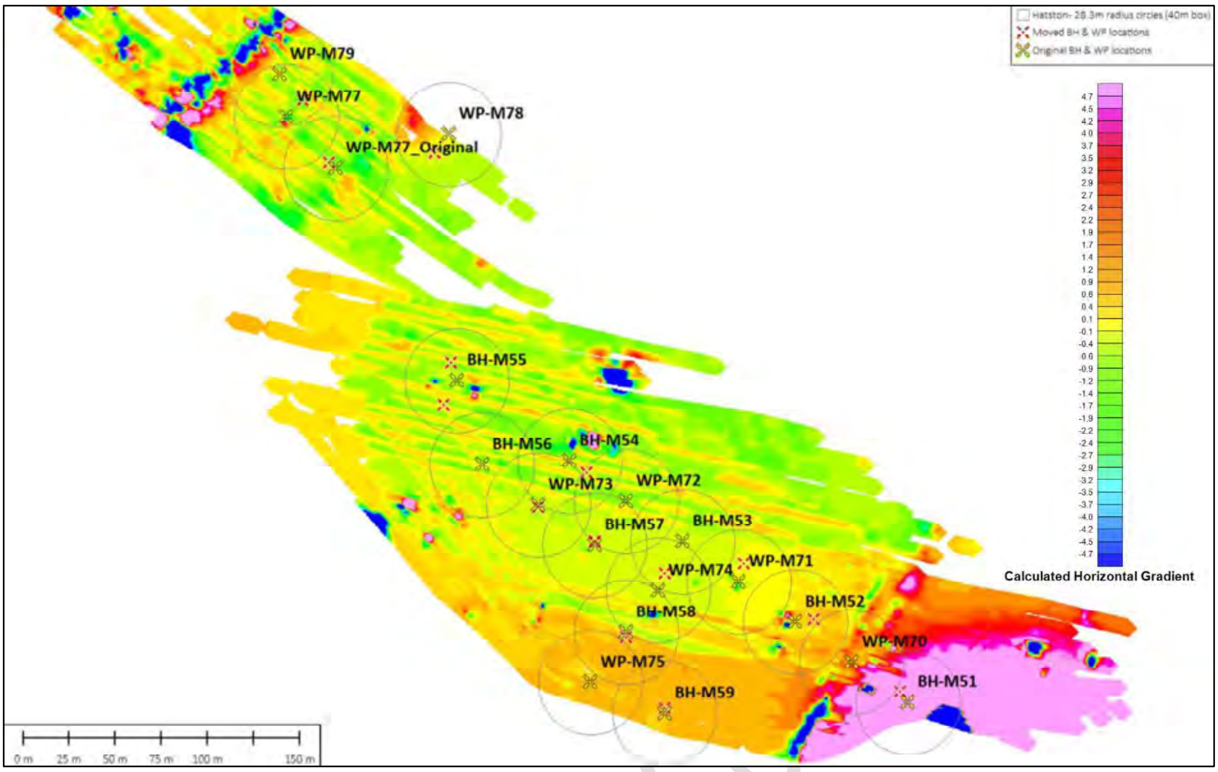


Figure 8: Hatston Pier area, horizontal gradient

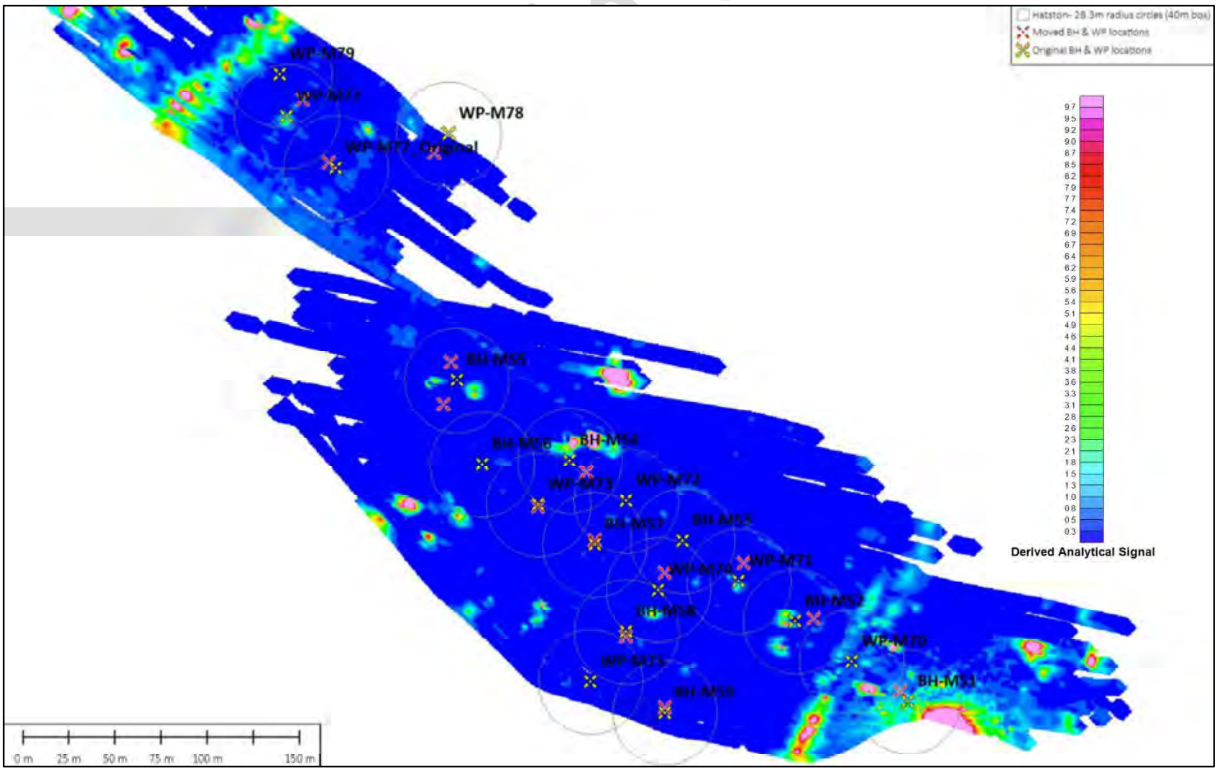


Figure 9: Hatston Pier area, QuasiAnalytic signal gradient

In the northern section, 2 linear features can be seen in the magnetometer data, which could indicate cables or pipelines (Figure 10), but these are not observed in the sidescan sonar data.

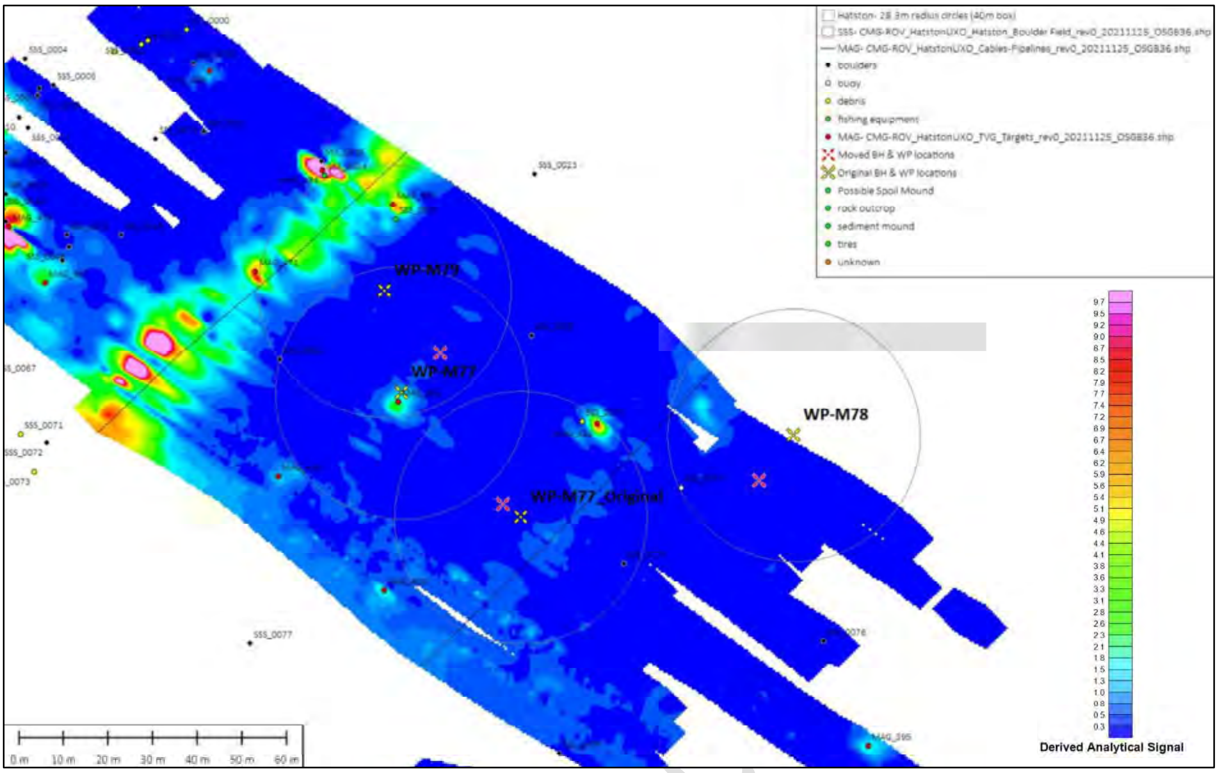


Figure 10: Hatston Pier northern section, QASG, sonar and magnetic targets

In the southern section large magnetic anomalies were observed around the current pier, attributable to vessels or the pier structure itself (Figure 11 and Figure 12). The QuasiAnalytic Signal reduces the influence of the pier within the processed data and allows for identification of potential anomalies that would otherwise be swamped in the horizontal gradient dataset.

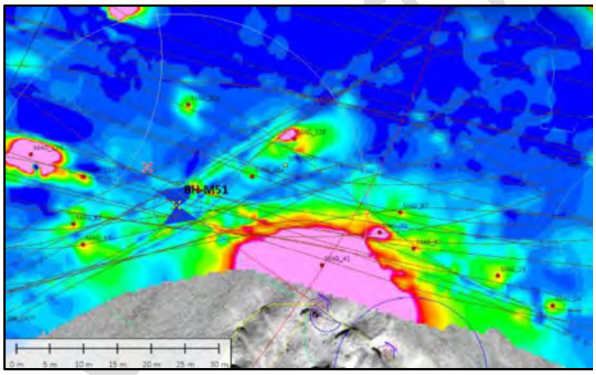


Figure 11: Hatston Pier northwest section, QuasiAnalytic signal gradient

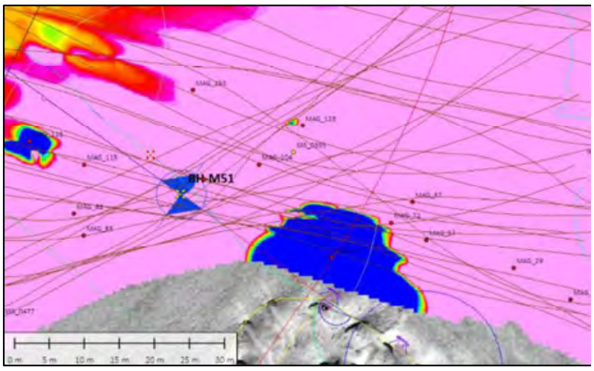


Figure 12: Hatston Pier northwest section, horizontal gradient

A further two linear features (possible cables or pipes) were observed as shown in Figure 13, but were not seen in the sonar data.

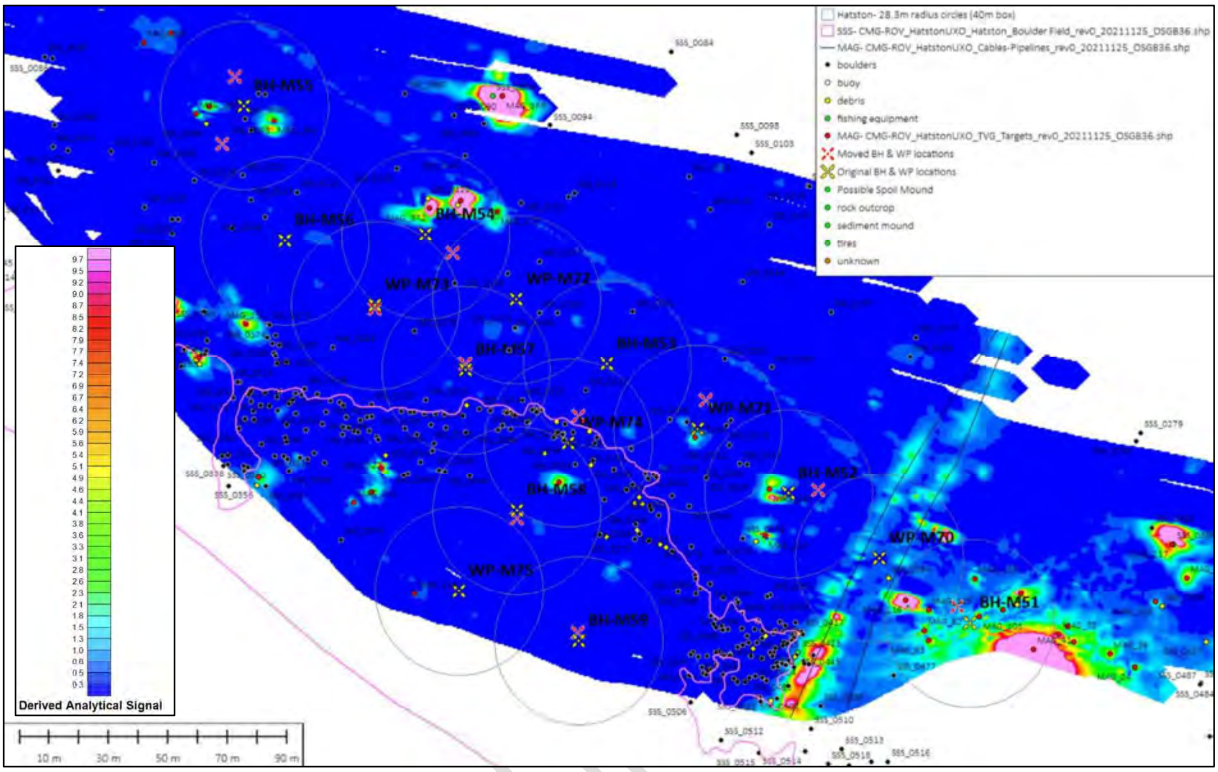


Figure 13: Hatston Pier southern section, QASG, sonar and magnetic targets

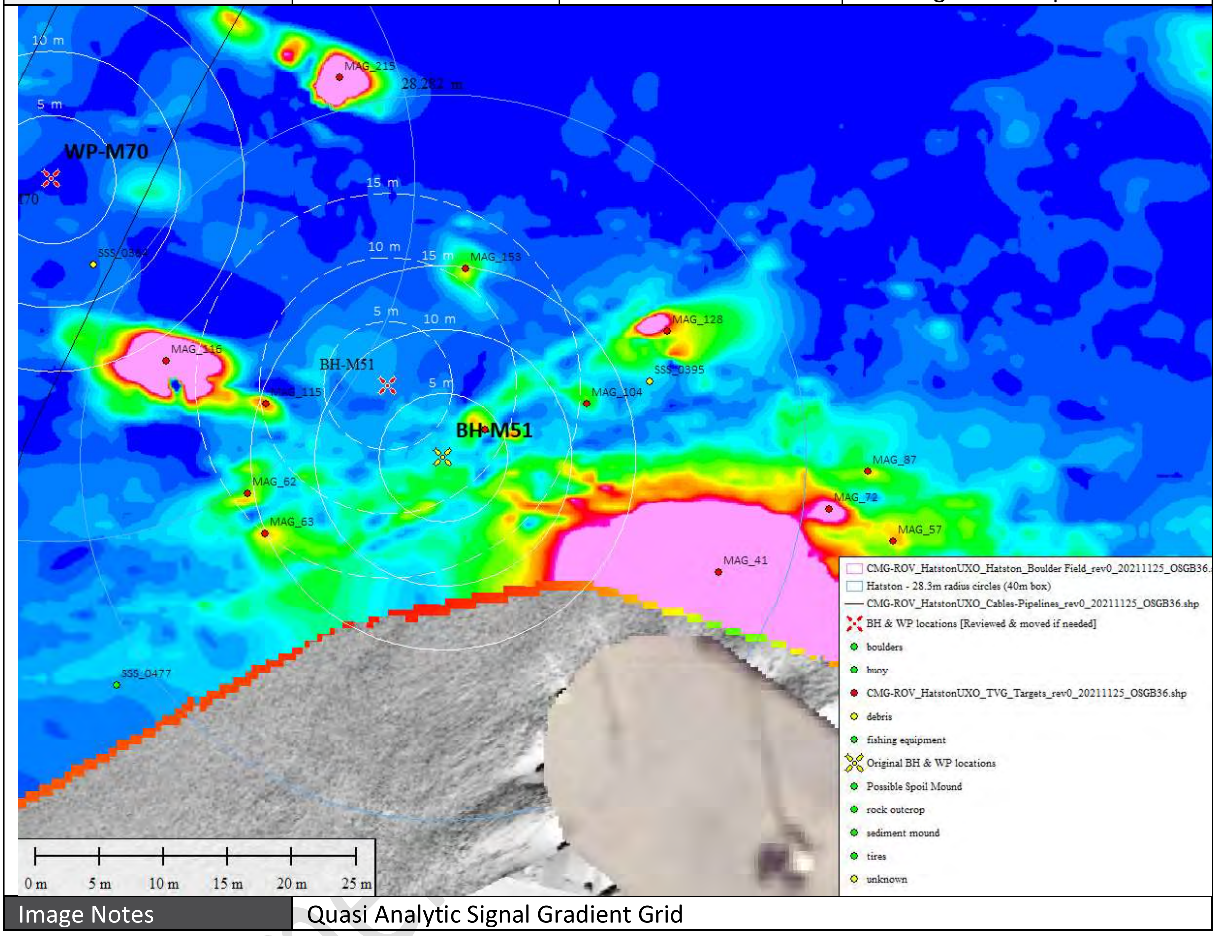
<table>
<tr><th colspan="4">Table 4: Magnetic analysis borehole location BH-M51</th></tr>
<tr><td>Location</td><td colspan="2">BH-M51</td><td>Comments</td></tr>
<tr><td>Position</td><td>Easting</td><td>Northing</td><td rowspan="3">Moved 7 m to the NE to avoid magnetic targets and possible missed targets due to possible masking from the pier</td></tr>
<tr><td>Original (OSGB36)</td><td>343957.8</td><td>1013092.3</td></tr>
<tr><td>New (OSGB36)</td><td>343953.5</td><td>1013097.9</td></tr>
<tr><td colspan="4">
</td></tr>
<tr><td>Image Notes</td><td colspan="3">Quasi Analytic Signal Gradient Grid</td></tr>
</table>

Table 5: Magnetic analysis borehole location BH-M52

Location	BH-M52		Comments
Position	Easting	Northing	Moved 10 m to the east to avoid magnetic target. Possible pipe or cable lying approximately 24 m SE of new position.
Original (OSGB36)	343896.8	1013135.8	
New (OSGB36)	343906.7	1013136.9	

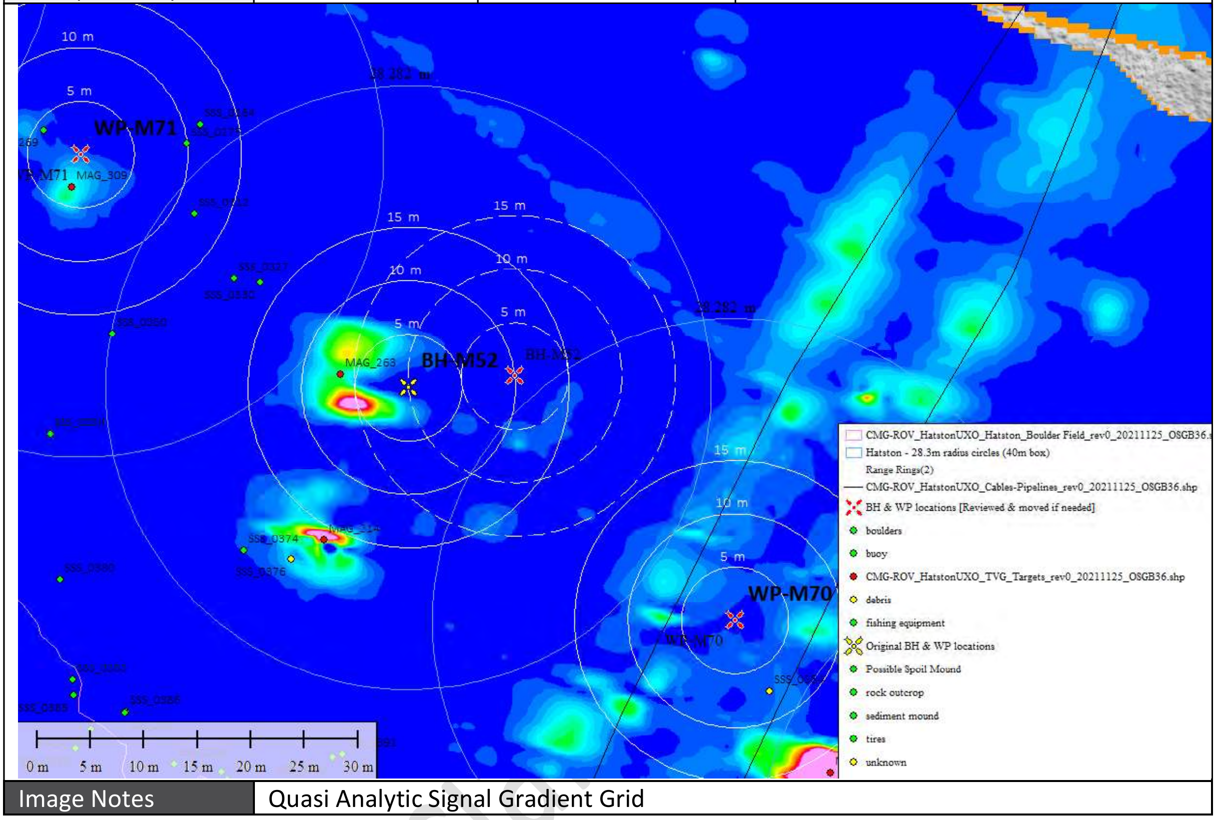


Image Notes	Quasi Analytic Signal Gradient Grid

Table 6: Magnetic analysis borehole location BH-M53			
Location	BH-M53		Comments
Position	Easting	Northing	
Original (OSGB36)	343835.7	1013179.3	
New (OSGB36)	n/a	n/a	

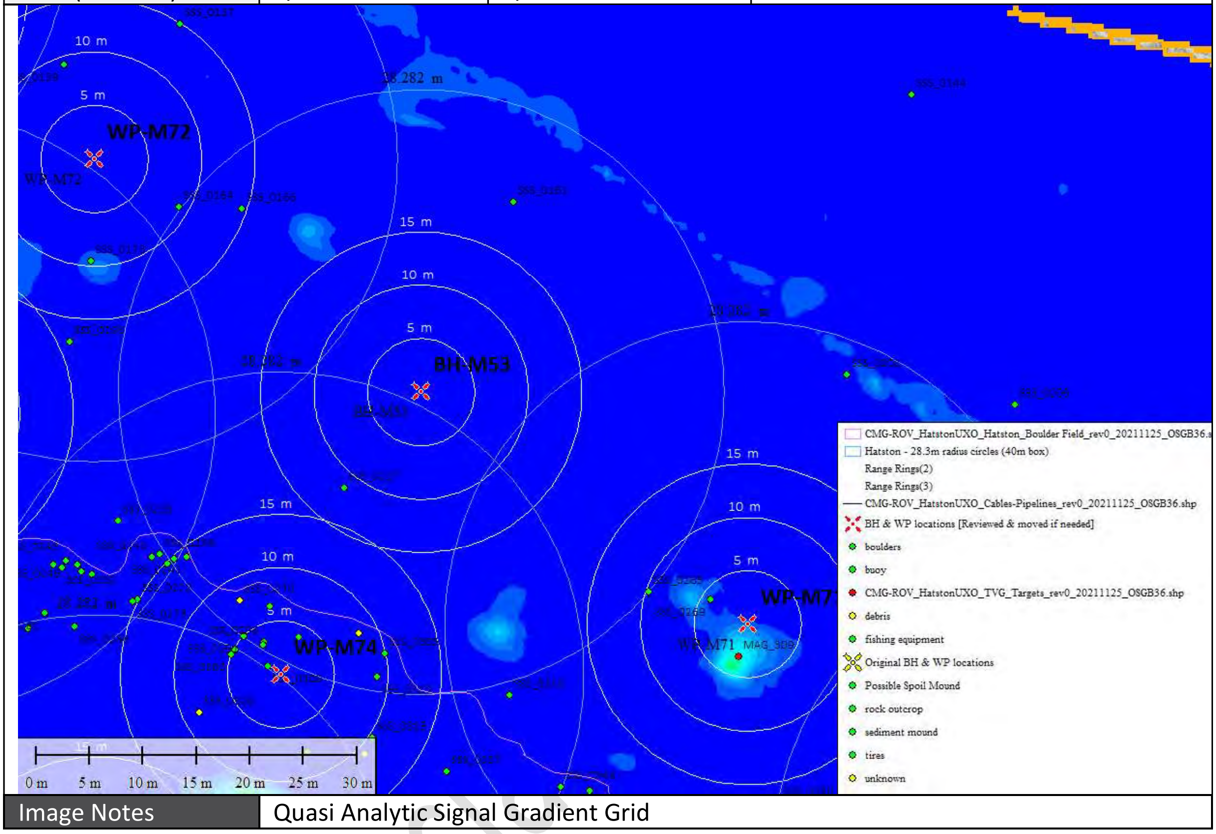



Image Notes	Quasi Analytic Signal Gradient Grid		

Table 7: Magnetic analysis borehole location BH-M54			
Location	BH-M54		Comments
Position	Easting	Northing	Moved 11 m SE to avoid magnetic targets
Original (OSGB36)	343774.6	1013222.9	
New (OSGB36)	343783.9	1013216.7	

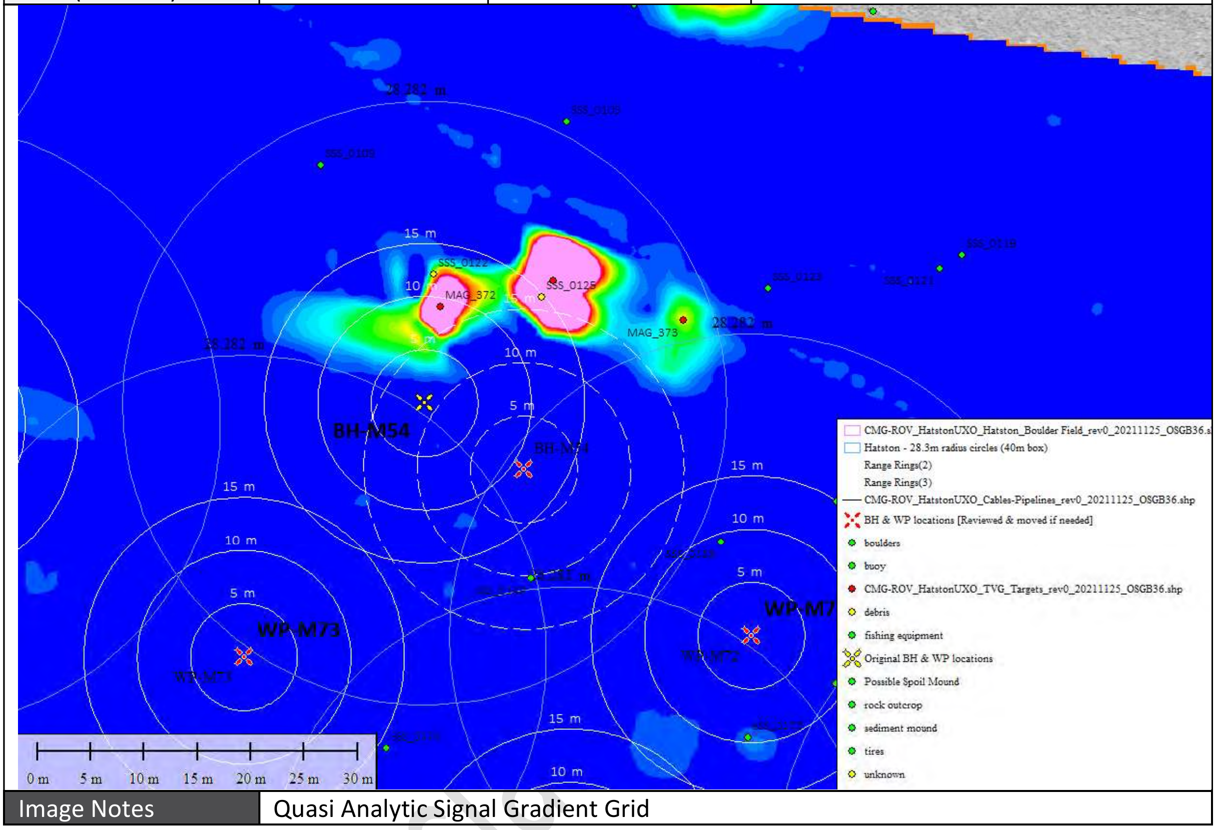



Image Notes	Quasi Analytic Signal Gradient Grid		

Table 8: Magnetic analysis borehole location BH-M55

Location	BH-M55		Comments
Position	Easting	Northing	Two new possible locations: • Moved 10 m NW to avoid magnetic targets. • Moved 15 m SSW to avoid magnetic targets.
Original (OSGB36)	343713.6	1013266.4	
New (OSGB36) - North	343710.6	1013276.1	
New (OSGB36) - South	343706.3	1013253.3	

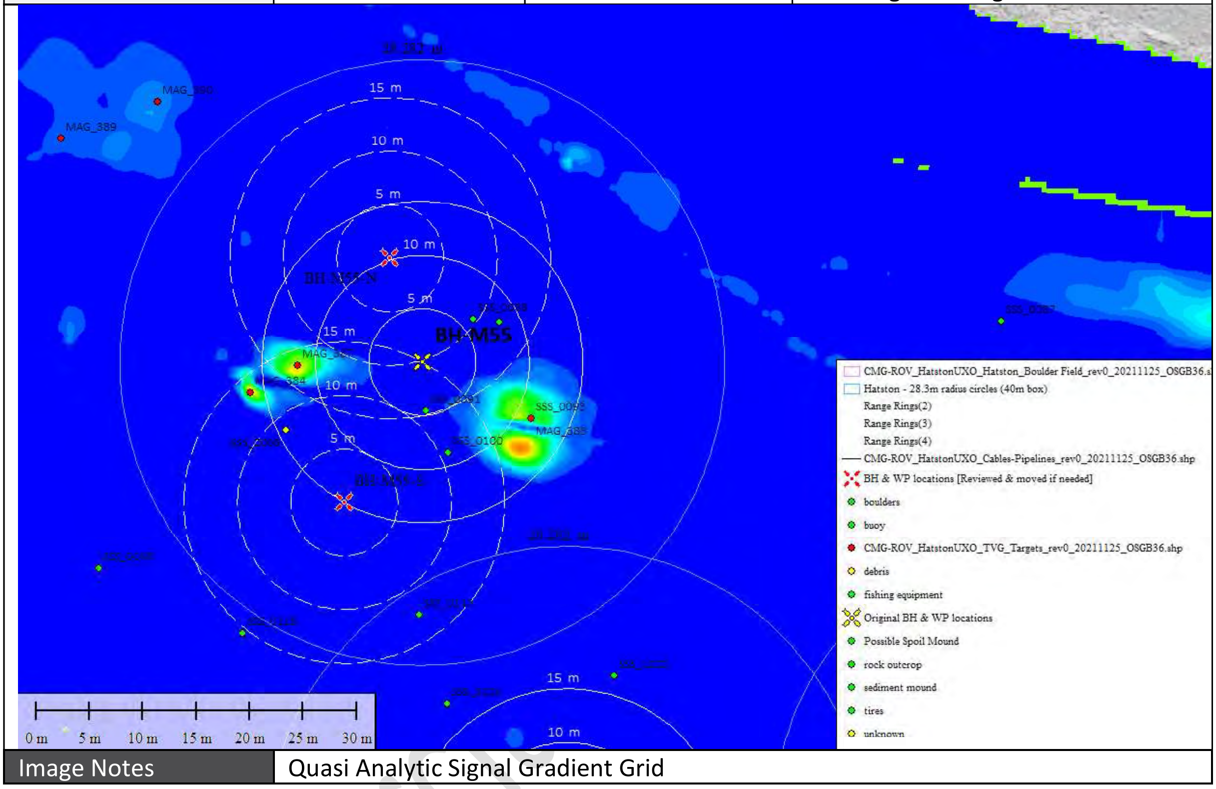



Image Notes	Quasi Analytic Signal Gradient Grid		

Table 9: Magnetic analysis borehole location BH-M56

Location	BH-M56		Comments
Position	Easting	Northing	
Original (OSGB36)	343727.2	1013220.9	
New (OSGB36)	n/a	n/a	

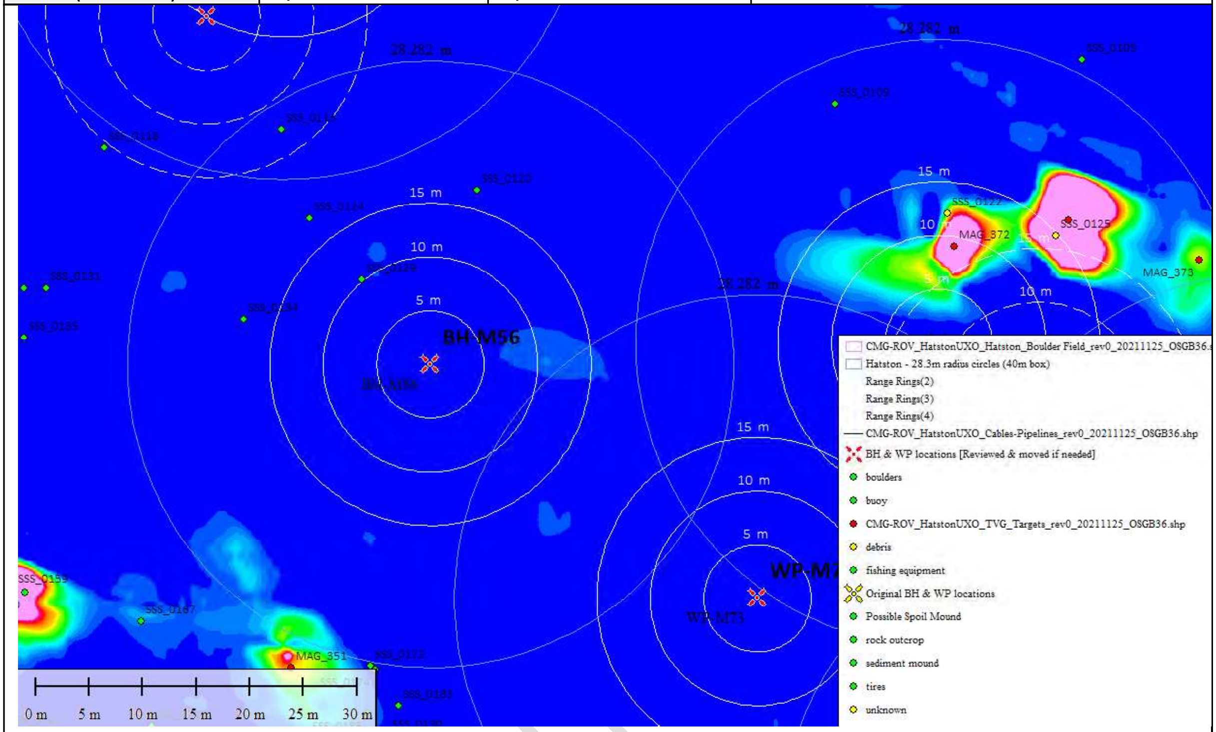


Image Notes	Quasi Analytic Signal Gradient Grid

Table 10: Magnetic analysis borehole location BH-M57

Location	BH-M57		Comments
Position	Easting	Northing	Moved 2 m north into better TVG coverage.
Original (OSGB36)	343788.2	1013177.4	
New (OSGB36)	343788.2	1013179.4	

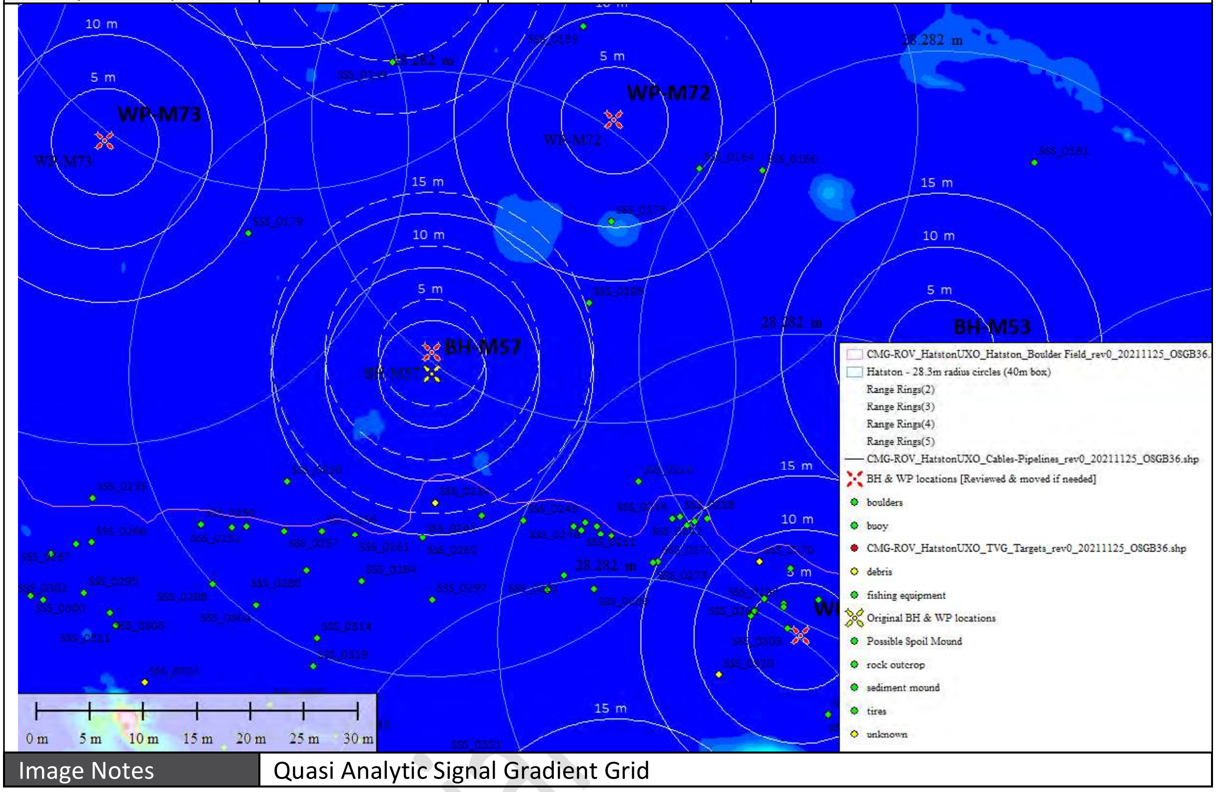



Image Notes	Quasi Analytic Signal Gradient Grid		

Table 11: Magnetic analysis borehole location BH-M58

Location	BH-M58		Comments
Position	Easting	Northing	Moved 2.8 m south into better TVG coverage. Located in a bolder field (most boulders not marked as SSS targets).
Original (OSGB36)	343805.3	1013130.2	
New (OSGB36)	343805.3	1013127.4	

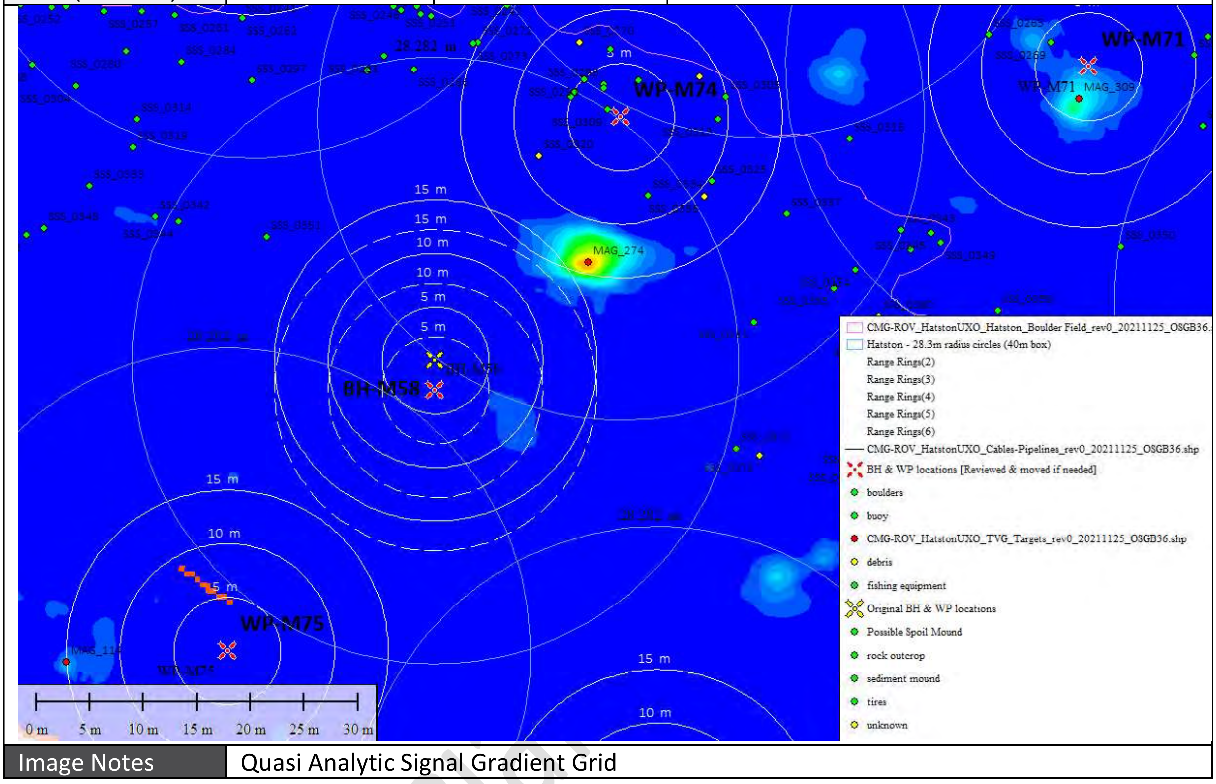



Image Notes	Quasi Analytic Signal Gradient Grid		

Table 12: Magnetic analysis borehole location BH-M59

Location	BH-M59		Comments
Position	Easting	Northing	Moved 2.6 m north into better TVG coverage. Located in a bolder field (most boulders not marked as SSS targets).
Original (OSGB36)	343826.1	1013086.4	
New (OSGB36)	343826.0	1013089.0	

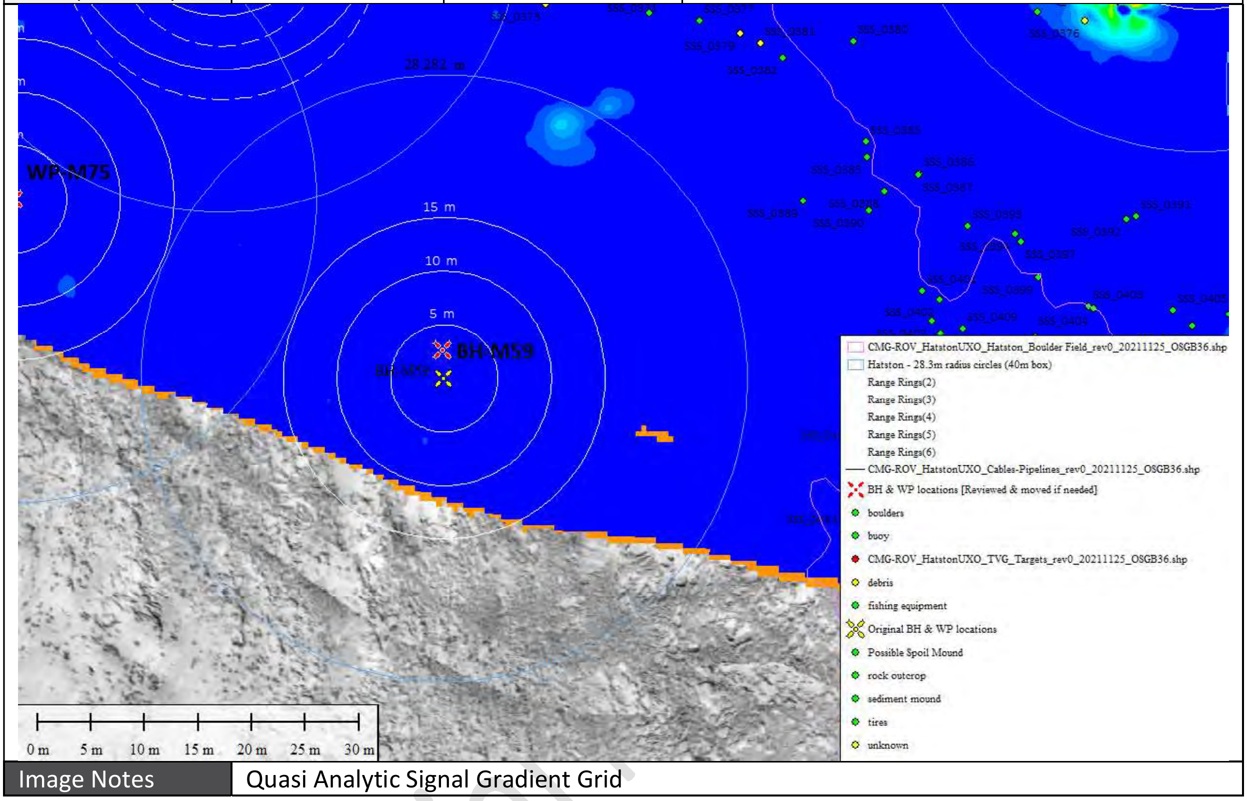



Image Notes	Quasi Analytic Signal Gradient Grid		

Table 13: Magnetic analysis wash probe location WP-M70			
Location	WP-M70		Comments
Position	Easting	Northing	Possible pipe or cable approximately 5 m SE and NW of position. Unknown debris 7.4 m SSE of location, but no magnetic signature.
Original (OSGB36)	343927.3	1013114	
New (OSGB36)	n/a	n/a	

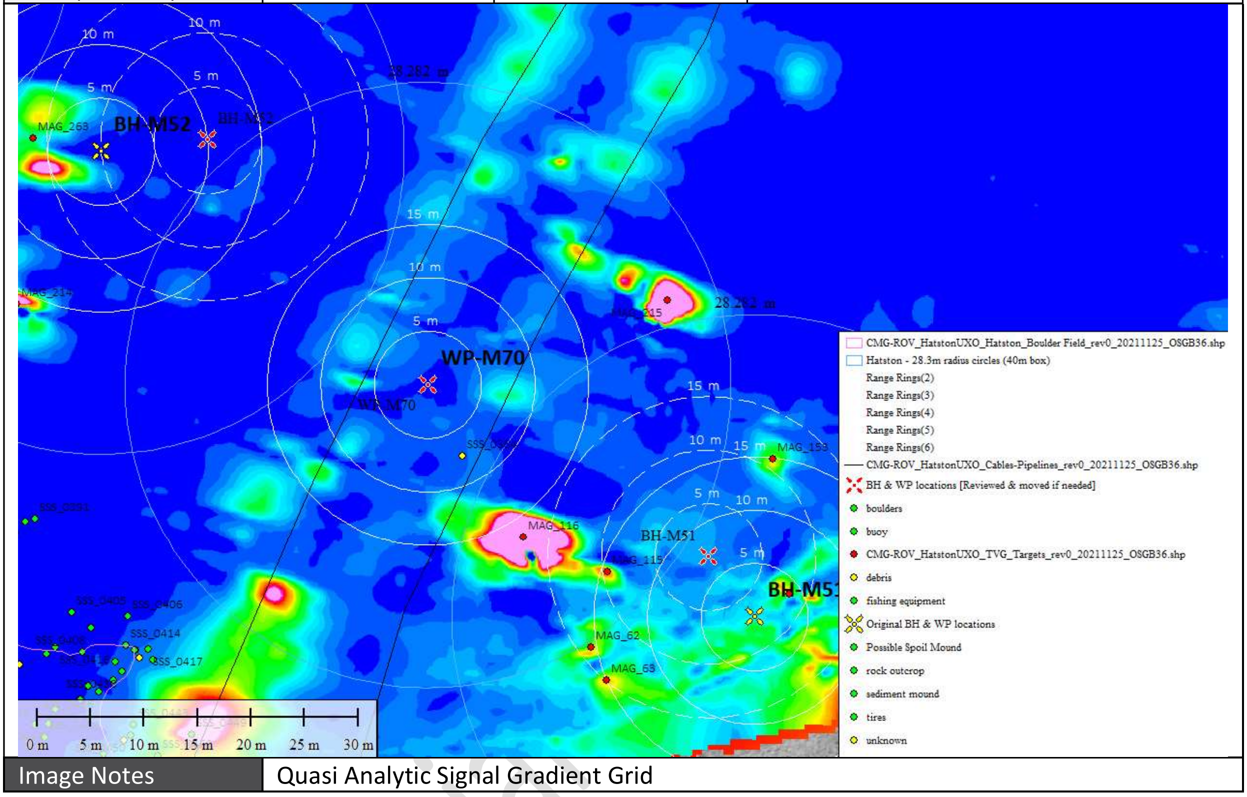



Image Notes	Quasi Analytic Signal Gradient Grid		

Table 14: Magnetic analysis wash probe location WP-M71			
Location	WP-M71		Comments
Position	Easting	Northing	Moved 10 m north.
Original (OSGB36)	343866.2	1013157.6	
New (OSGB36)	343869.0	1013167.2	

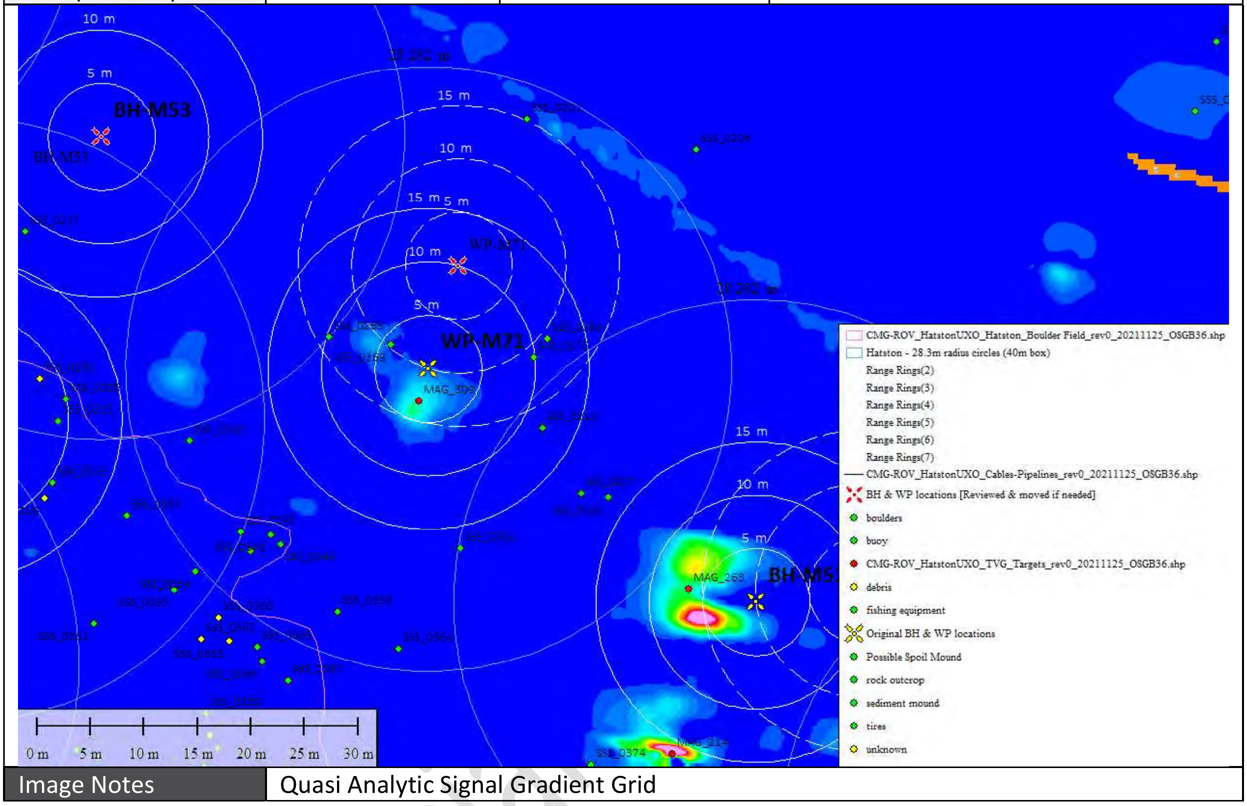



Image Notes	Quasi Analytic Signal Gradient Grid		

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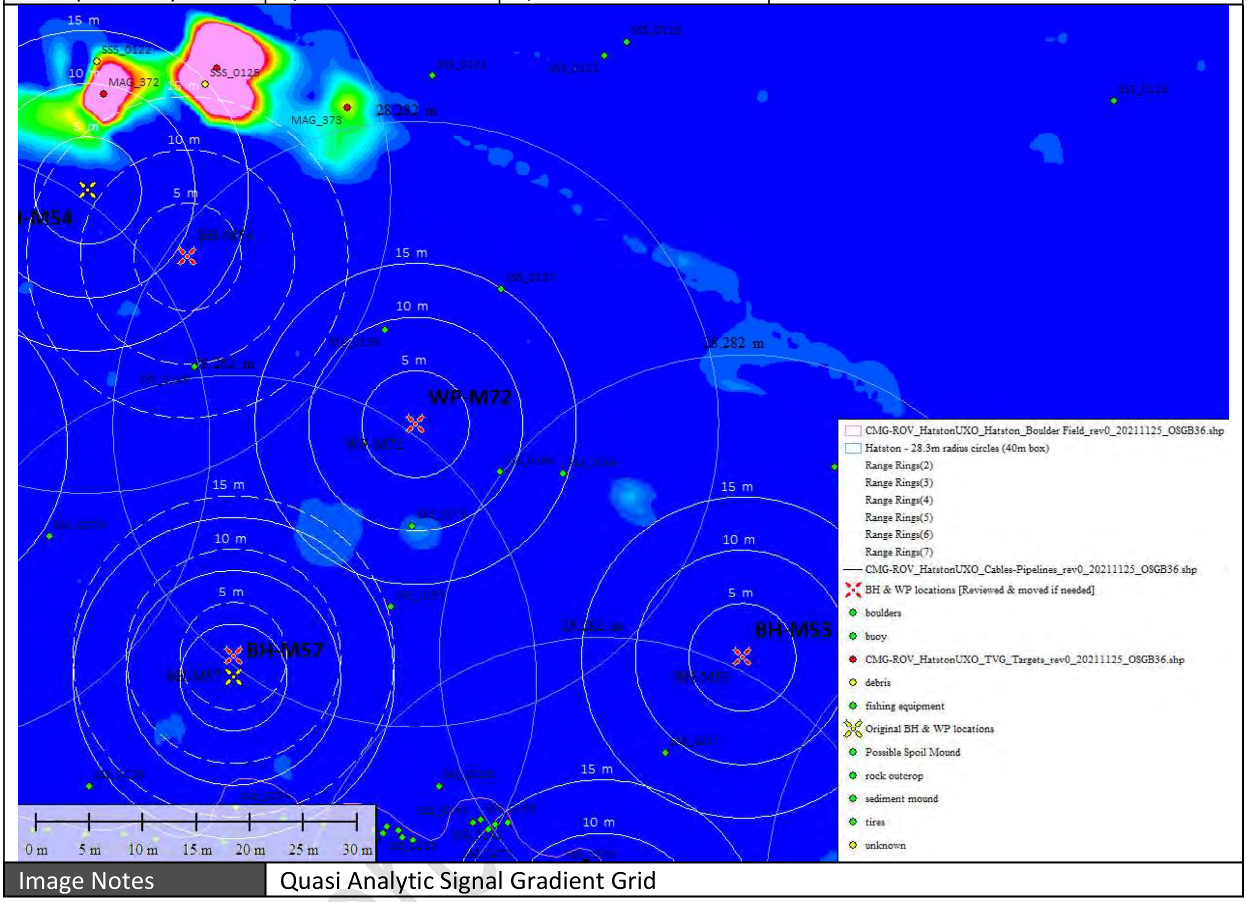
<tr><td>Location</td><td colspan="2">WP-M72</td><td>Comments</td></tr>
<tr><td>Position</td><td>Easting</td><td>Northing</td><td rowspan="3"></td></tr>
<tr><td>Original (OSGB36)</td><td>343805.2</td><td>1013201.1</td></tr>
<tr><td>New (OSGB36)</td><td>n/a</td><td>n/a</td></tr>
<tr><td colspan="4">
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Table 16: Magnetic analysis wash probe location WP-M73			
Location	WP-M73		Comments
Position	Easting	Northing	Moved 1.4 m south into better TVG coverage.
Original (OSGB36)	343757.7	1013199.1	
New (OSGB36)	343757.6	1013198.0	
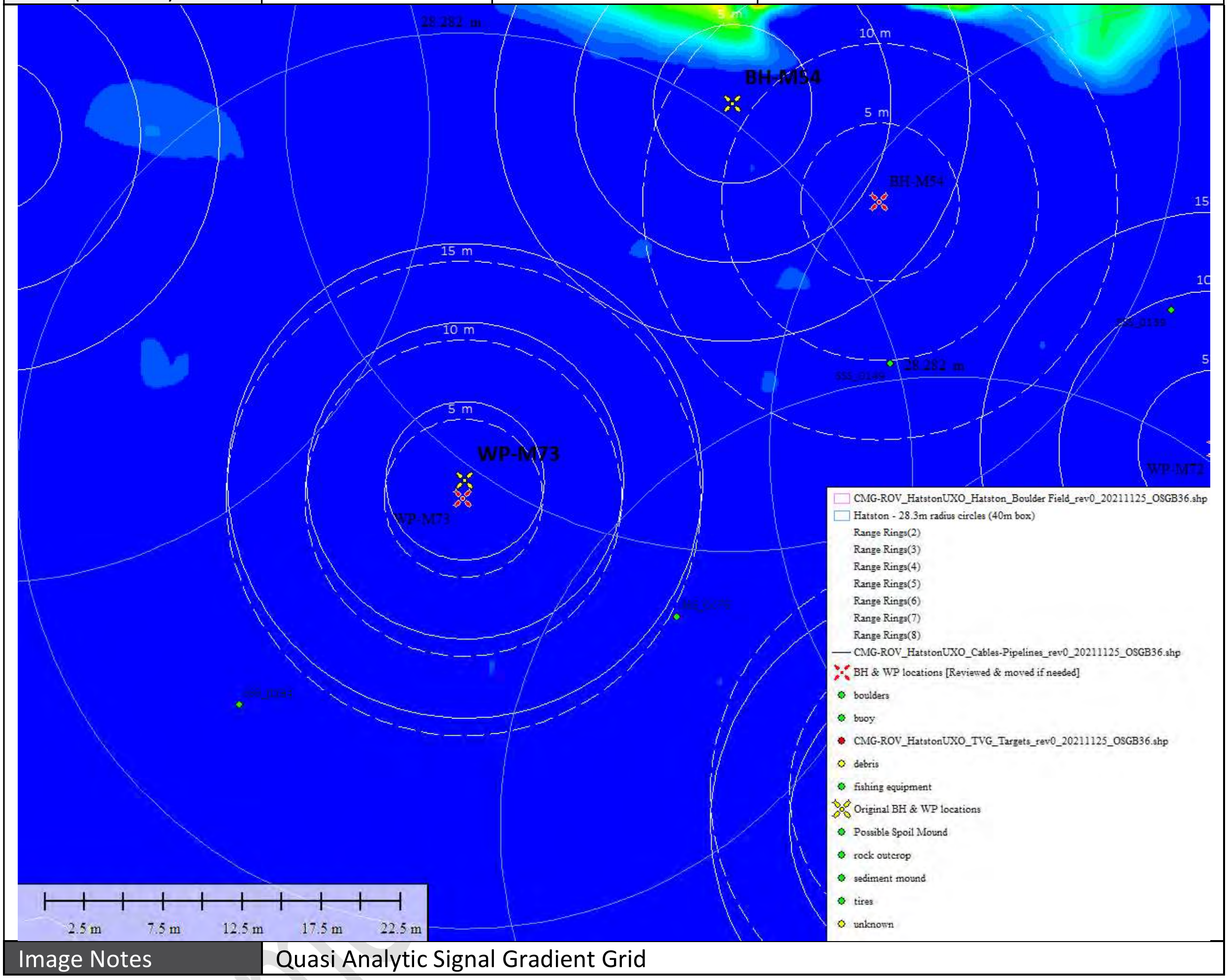			
Image Notes	Quasi Analytic Signal Gradient Grid		

Table 17: Magnetic analysis wash probe location WP-M74			
Location	WP-M74		Comments
Position	Easting	Northing	Moved 9.6 m north to avoid boulder field.
Original (OSGB36)	343822.6	1013152.9	
New (OSGB36)	343826.2	1013161.9	
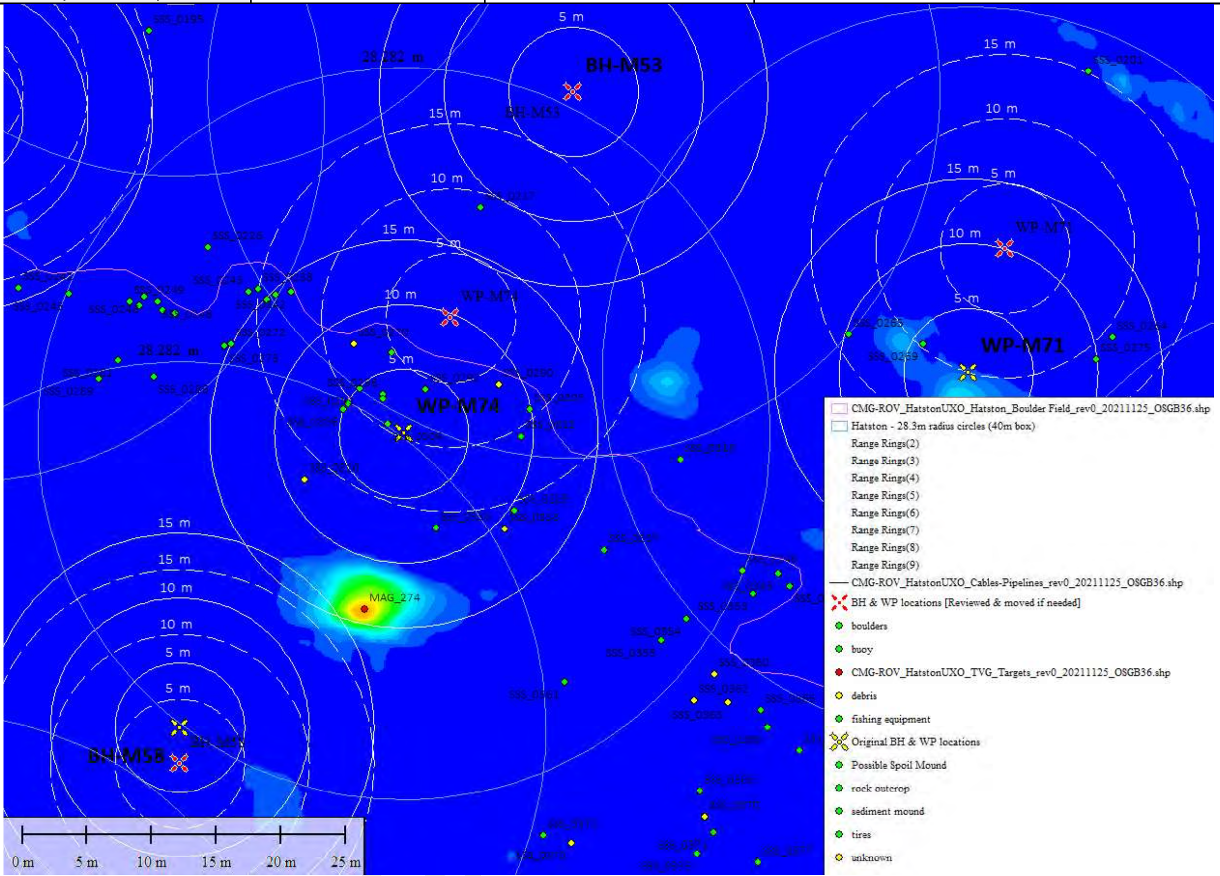			
Image Notes	Quasi Analytic Signal Gradient Grid		

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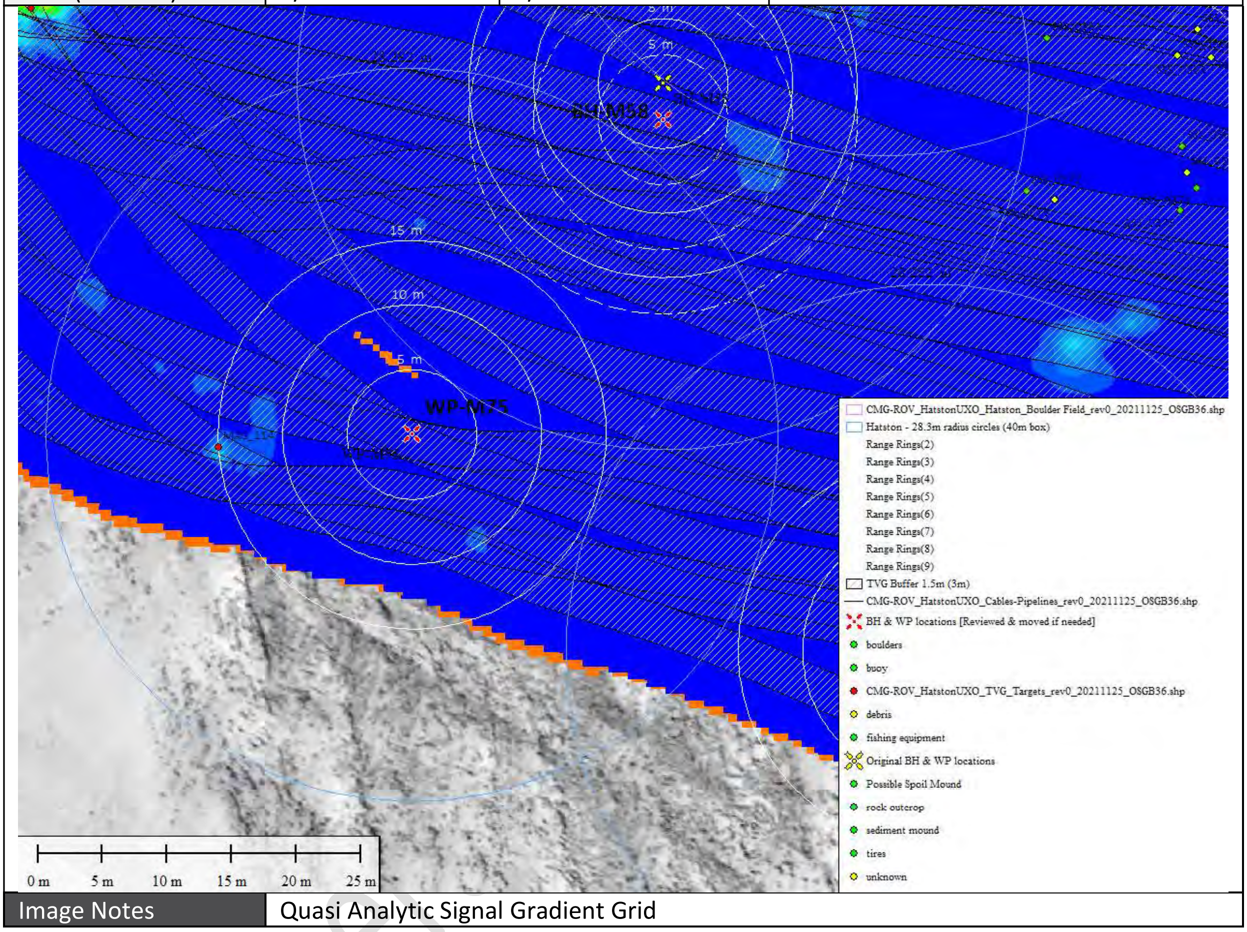
<tr><td>Location</td><td colspan="2">WP-M75</td><td>Comments</td></tr>
<tr><td>Position</td><td>Easting</td><td>Northing</td><td rowspan="3">In boulder field.</td></tr>
<tr><td>Original (OSGB36)</td><td>343785.9</td><td>1013103.1</td></tr>
<tr><td>New (OSGB36)</td><td>n/a</td><td>n/a</td></tr>
<tr><td colspan="4">
</td></tr>
<tr><td>Image Notes</td><td colspan="3">Quasi Analytic Signal Gradient Grid</td></tr>
</table>

Table 19: Magnetic analysis wash probe location WP-M77			
Location	WP-M77		Comments
Position	Easting	Northing	Moved 12.5 m NE to avoid magnetic anomaly at original location and to keep away from possible pipe or cable. Target SSS_0059 has inadequate TVG coverage to determine if it is ferrous or not. Possible pipe or cable to the NW and SE.
Original (OSGB36)	343621.3	1013409.3	
New (OSGB36)	343630.0	1013418.2	

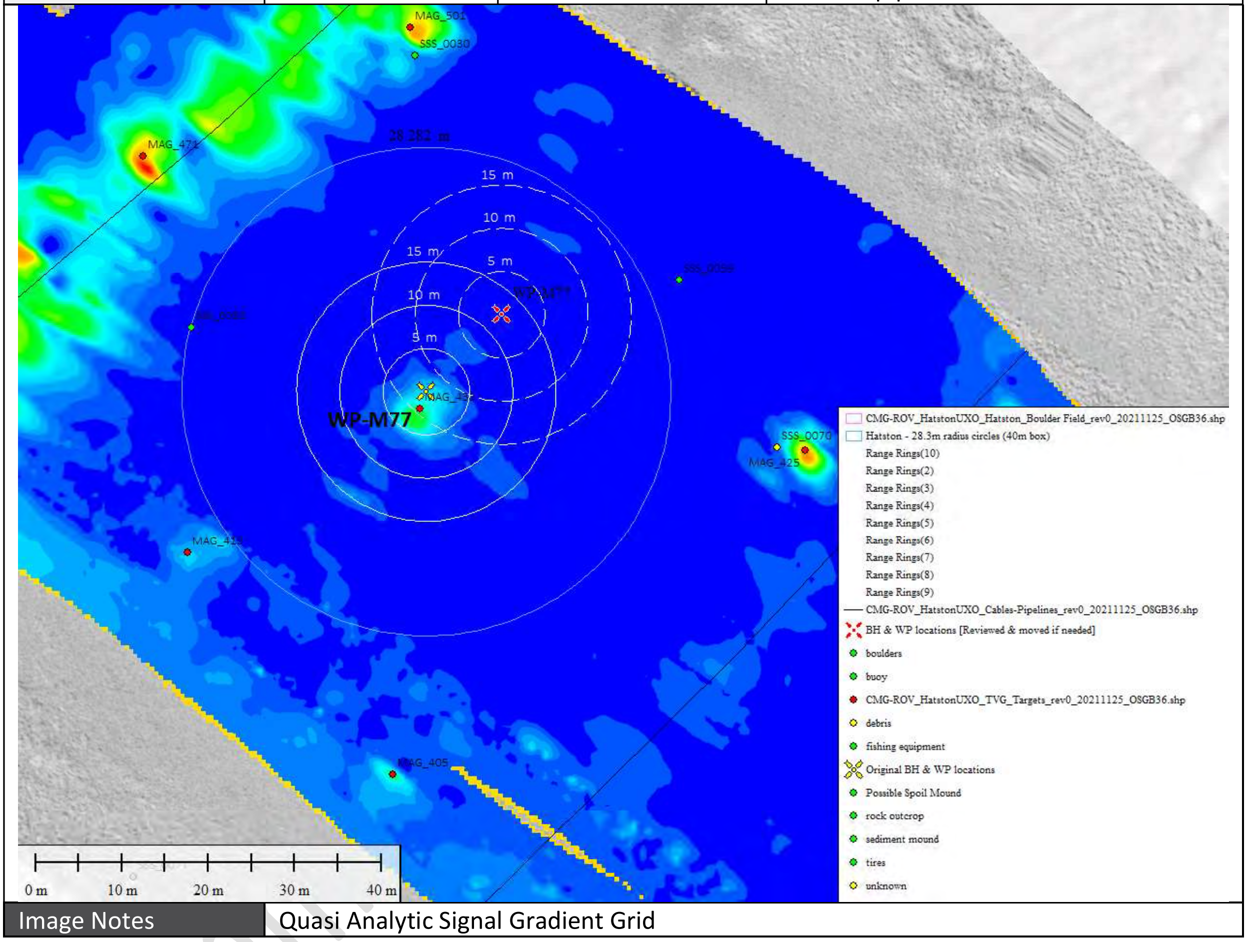



Image Notes	Quasi Analytic Signal Gradient Grid		

Table 20: Magnetic analysis wash probe location WP-M78			
Location	WP-M78		Comments
Position	Easting	Northing	Moved 12.8 m SW into TVG coverage.
Original (OSGB36)	343709.2	1013399.8	
New (OSGB36)	343701.4	1013389.6	

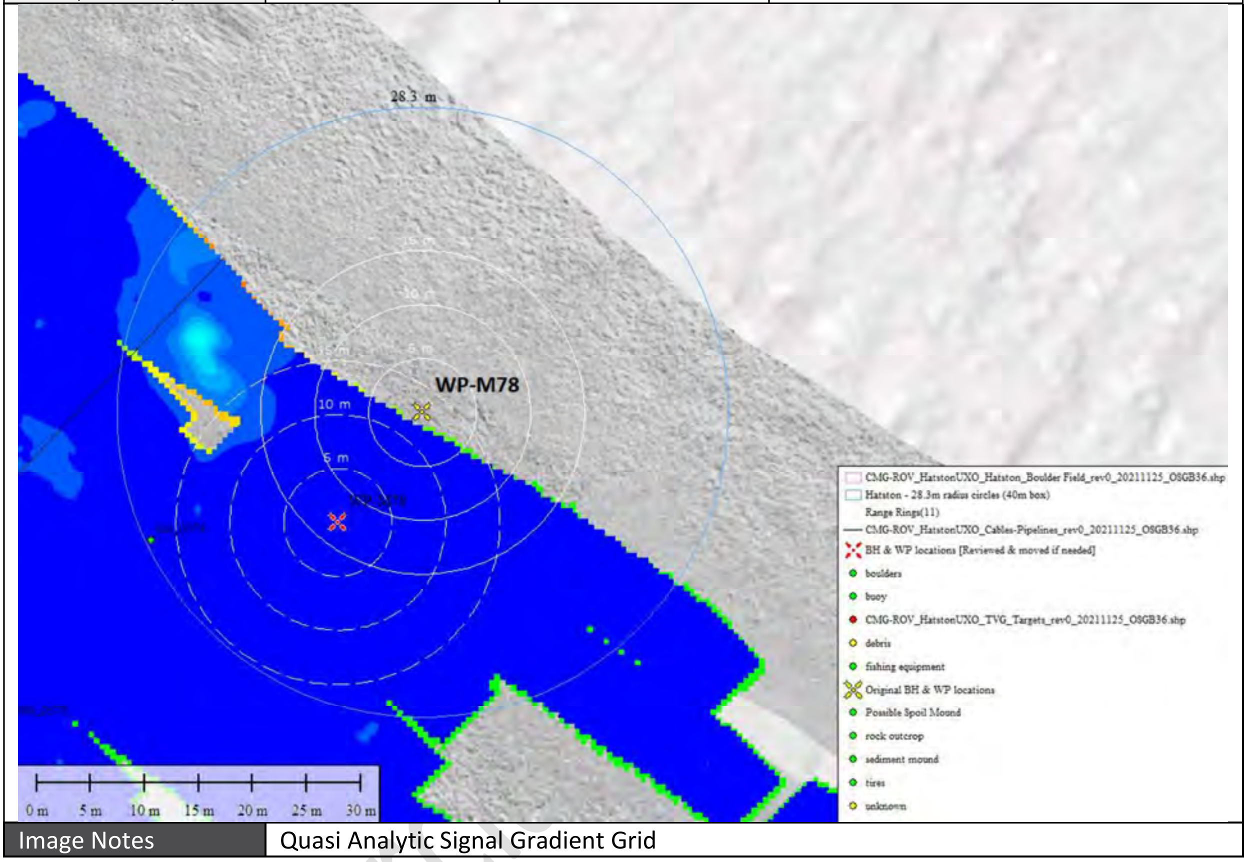



Image Notes	Quasi Analytic Signal Gradient Grid		

Table 21: Magnetic analysis wash probe location WP-M79

Location	WP-M79		Comments
Position	Easting	Northing	Possible pipe or cable 15 m to the NW (high signal intensity so could be an active power cable). Magnetic target just over 15 m to the north.
Original (OSGB36)	343617.5	1013432.2	
New (OSGB36)	n/a	n/a	

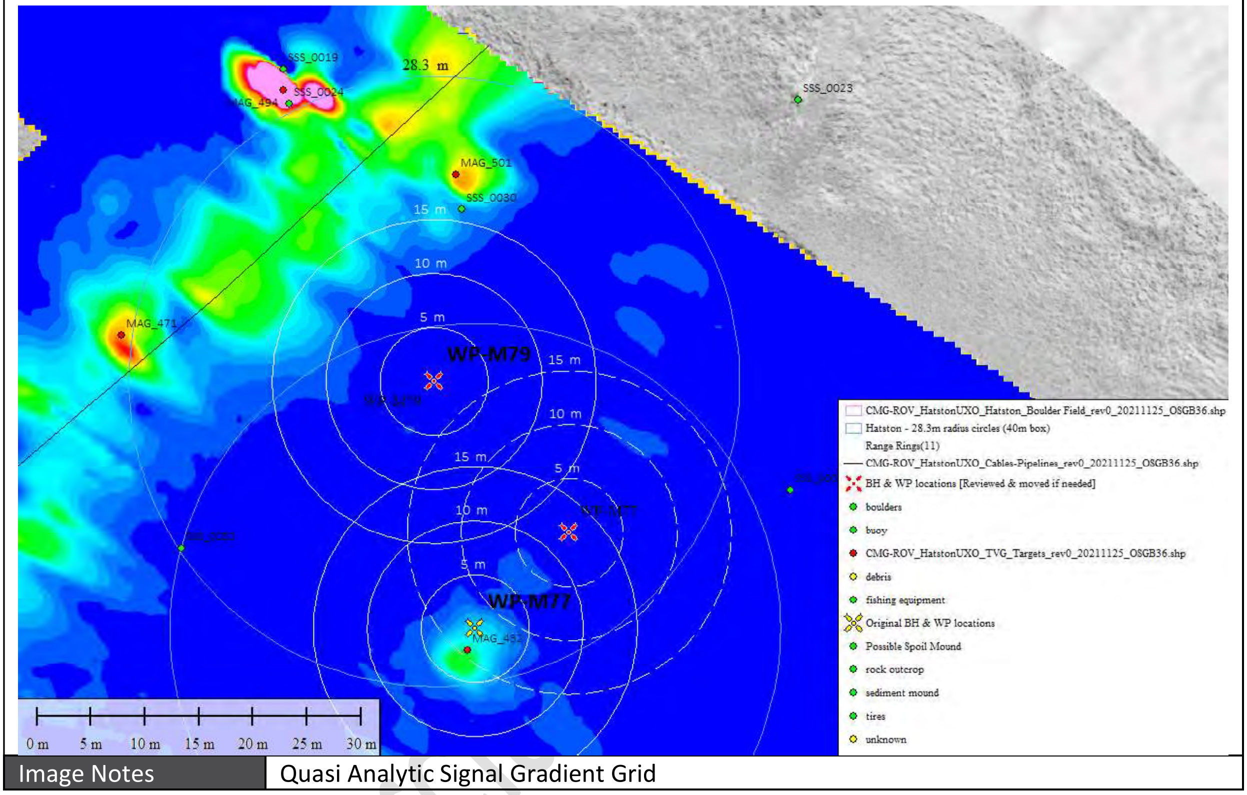


Image Notes	Quasi Analytic Signal Gradient Grid

4.3. RECOMMENDED GEOTECHNICAL LOCATIONS

Table 22: Recommended geotechnical locations, Hatston Pier

	Original locations (OSGB36)		New locations (OSGB36)	
BH & WP ID	Easting	Northing	Easting	Northing
BH-M51	343 957.8	1013 092.3	343 953.5	1013 097.9
BH-M52	343 896.8	1013 135.8	343 906.7	1013 136.9
BH-M53	343 835.7	1013 179.3		
BH-M54	343 774.6	1013 222.9	343 783.9	1013 216.7
BH-M55-N	343 713.6	1013 266.4	343 710.6	1013 276.1
BH-M55-S			343 706.3	1013 253.3
BH-M56	343 727.2	1013 220.9		
BH-M57	343 788.2	1013 177.4	343 788.2	1013 179.4
BH-M58	343 805.3	1013 130.2	343 805.3	1013 127.4
BH-M59	343 826.1	1013 086.4	343 826.0	1013 089.0
WP-M70	343 927.3	1013 114.0		
WP-M71	343 866.2	1013 157.6	343 869.0	1013 167.2
WP-M72	343 805.2	1013 201.1		
WP-M73	343 757.7	1013 199.1	343 757.6	1013 198.0
WP-M74	343 822.6	1013 152.9	343 826.2	1013 161.9
WP-M75	343 785.9	1013 103.1		
WP-M77	343 621.3	1013 409.3	343 630.0	1013 418.2
WP-M78	343 709.2	1013 399.8	343 701.4	1013 389.6
WP-M79	343 617.5	1013 432.2		

5. SURVEY ANALYSES, SCAPA DEEPWATER QUAY

5.1. SIDESCAN SONAR SURVEY

The acquired sidescan sonar data for Scapa Deepwater Quay fully covered the 40 x 40 metre boxes, centred on the BH and WP locations. The sidescan sonar data were generally of good quality. Approximately 5 lines of marginal quality were not re-run due to time and cost restraints. Underwater acoustic positioning of the sidescan sonar towfish was also of an acceptable quality. Sonar contacts were identified and sorted into the following categories: Debris; Boulders; Fishing equipment & Unknown.

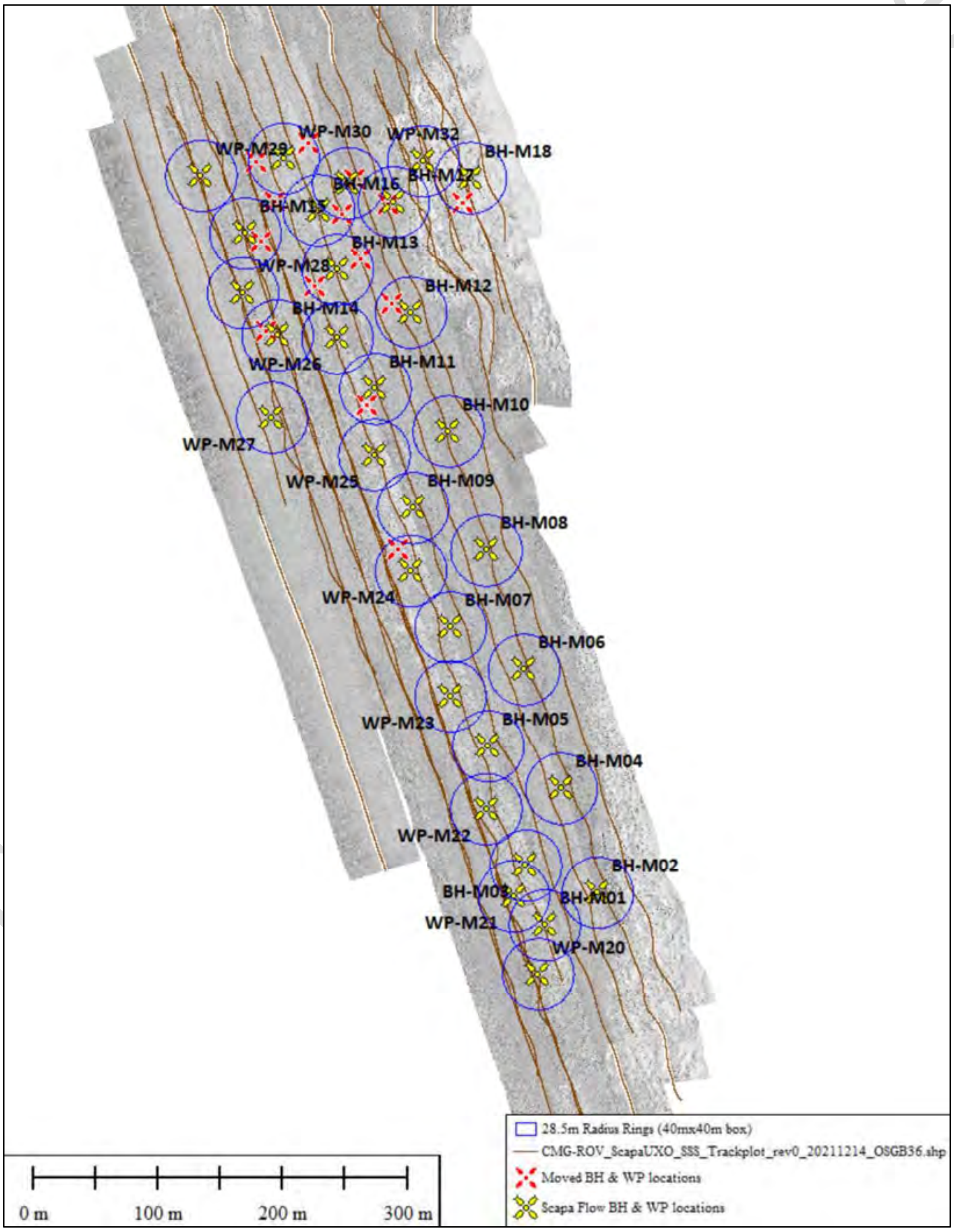


Figure 14: Scapa Deepwater Quay area with sidescan sonar mosaic and track plot

In the northern section, there was an abandoned line of fishing pots within the 40 x 40 metre boxes of BH-M11, 13 and 16, and WP-M26 and 30 (Figure 15).

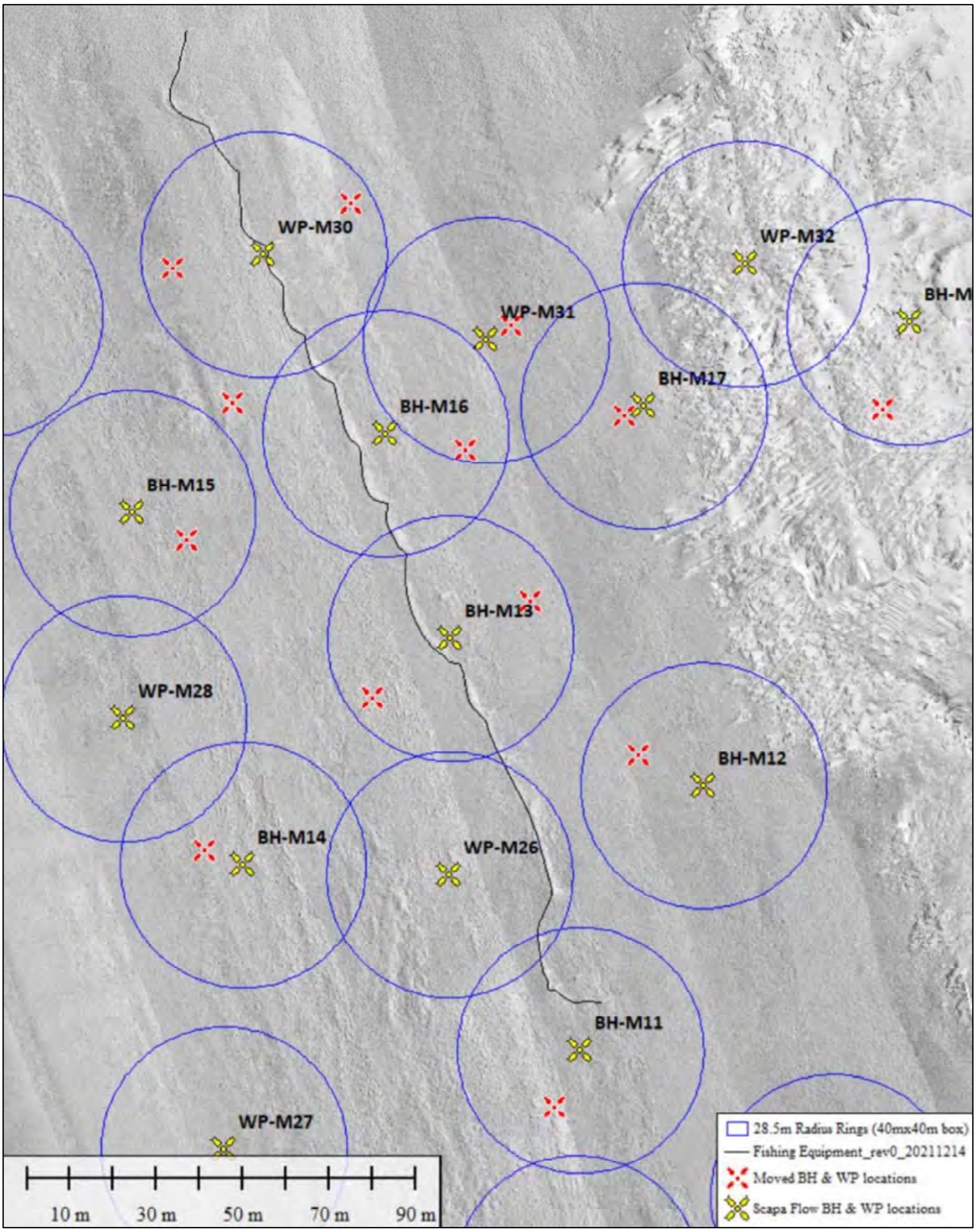


Figure 15: Scapa Deepwater Quay Fishing Pots

As seen in Figure 16, a boulder field has been marked out towards the shore (Eastern side). Within this area, Rovco did not pick individual boulders but marked them collectively within a boundary.

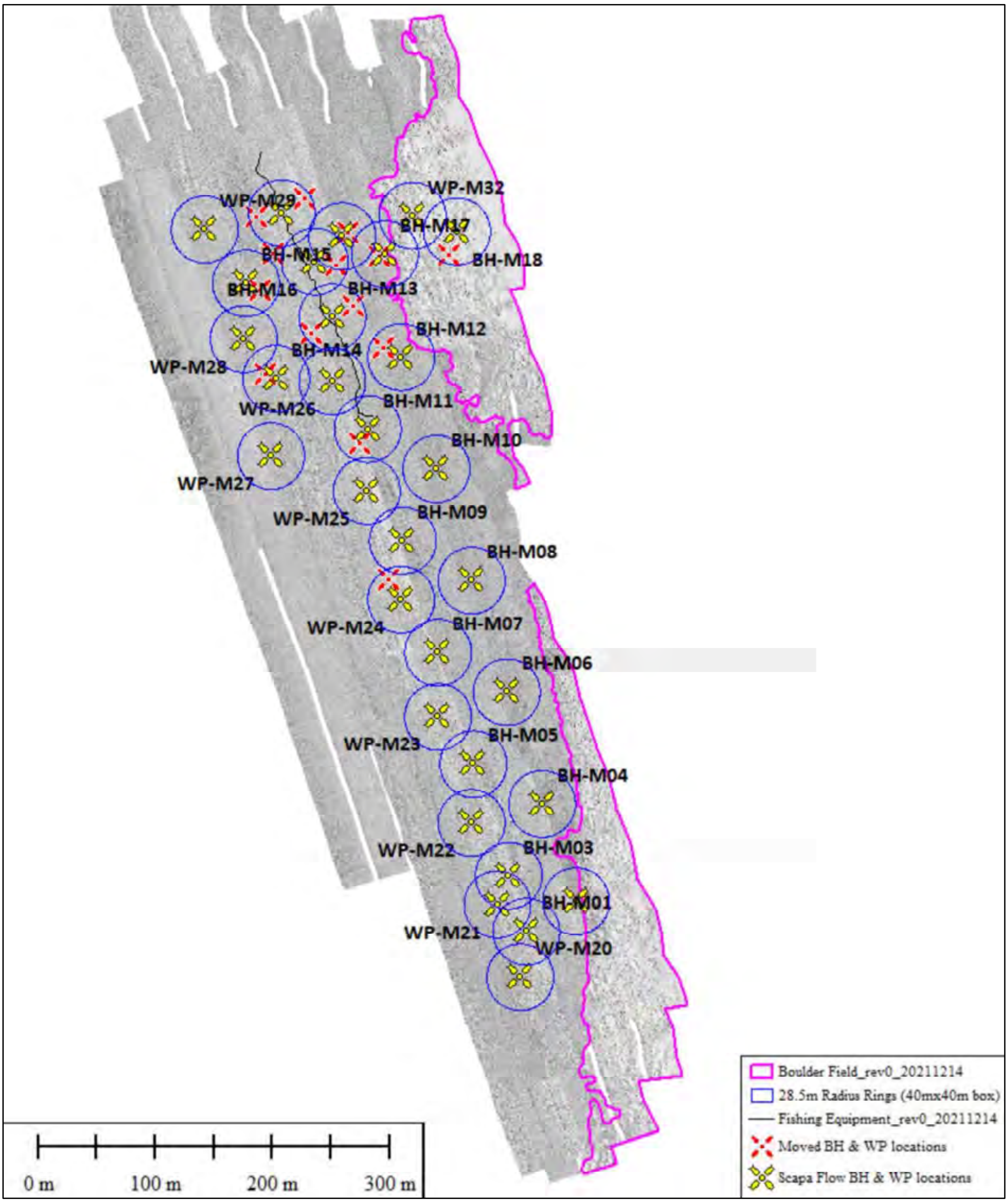


Figure 16: Scapa Deepwater Quay – Boulder Fields (Pink outlines)

Within the vicinity of the WP and BH locations 23 sonar contacts were correlated with magnetic anomalies (Figure 17). Eighteen of these could possibly be attributed to the fishing gear.

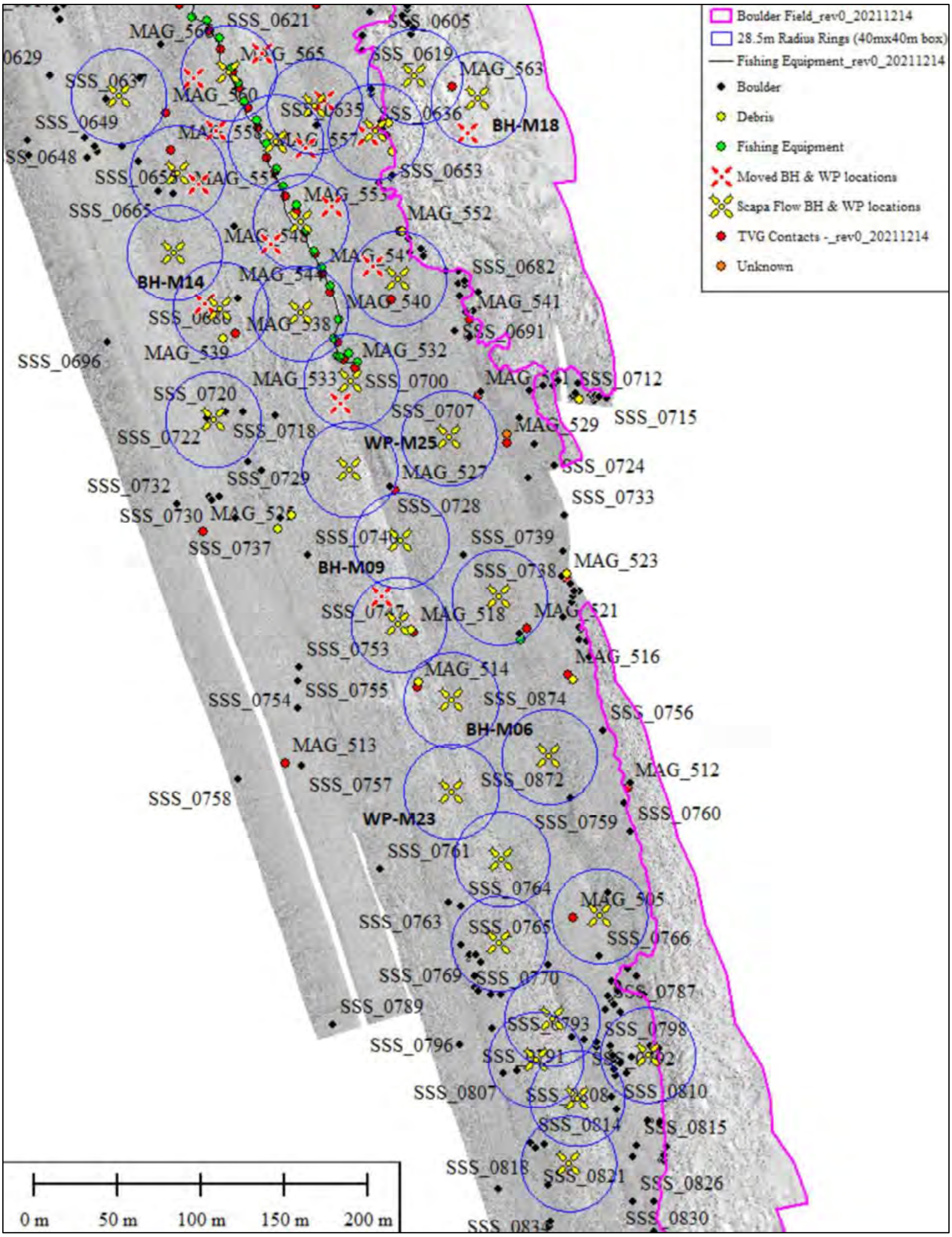


Figure 17: Scapa Deepwater Quay – Sonar and magnetic contacts

5.2. MAGNETIC GRADIOMETER SURVEY

Full coverage, when using a 1.5 m buffer (3 m corridor centred on TVG CRP), was not achieved, and therefore some WP and BH locations have been repositioned so as to be located within an area of full coverage. Figure 18 presents a magnetic data coverage plot with WP-M23 being located in an area of good coverage. This shows a 1.5 m grey buffer zone around the TVG track, overlaying the magnetometer grid shown in blue.

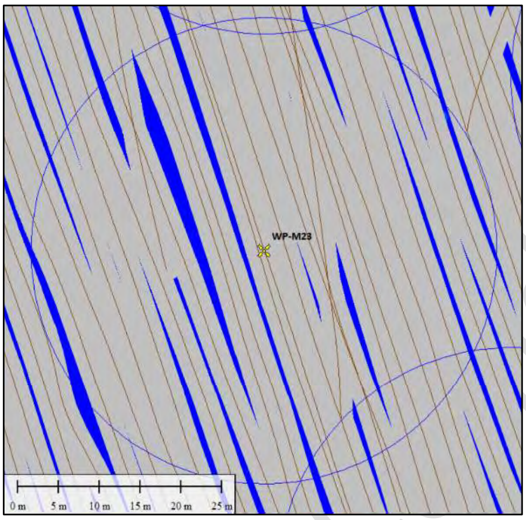


Figure 18: Scapa Deepwater Quay –TVG coverage example

The inshore section of BH-M18 40 x 40 metre box did not get any coverage due to it being too shallow and rocky (Figure 19) to be surveyed.

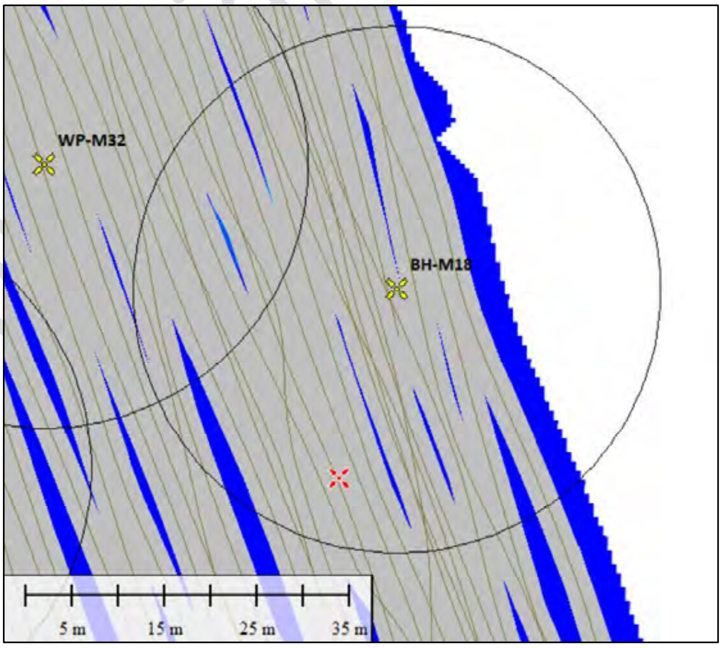


Figure 19: Scapa Deepwater Quay –BH-M18 TVG coverage

The magnetic gradiometer data were of good quality, with low levels of noise, and any data associated with towfish altitudes of greater than 4 m were removed. Underwater acoustic (USBL) positioning was dense with no excessive deviations.

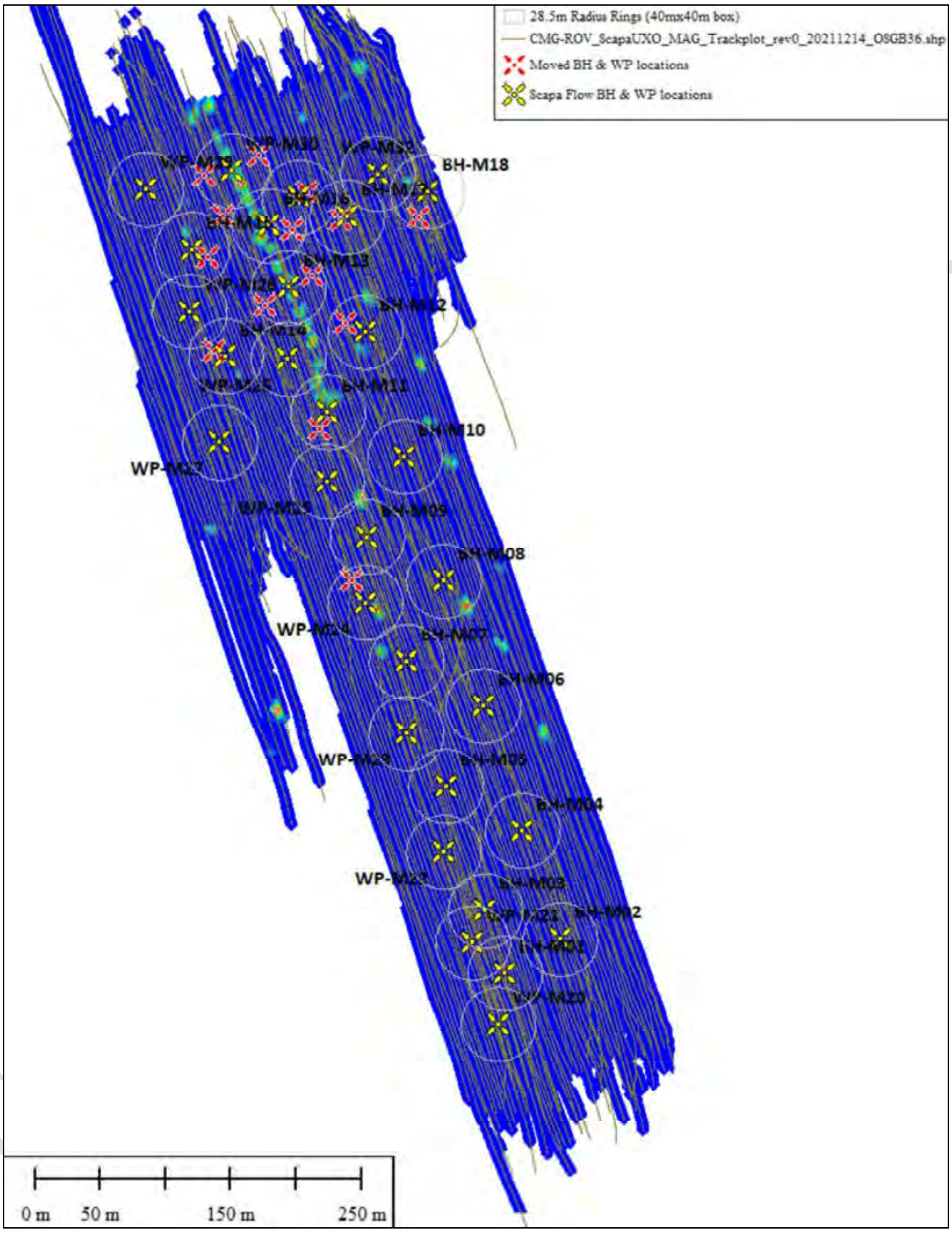


Figure 20: Scapa Deepwater Quay – TVG track plot

A horizontal gradient grid is shown in Figure 21. Figure 22, showing the same area with the QuasiAnalytic signal gradient grid, provides a simpler signature that is always positive and allows estimation of horizontal coordinates based on the maximum anomaly position.

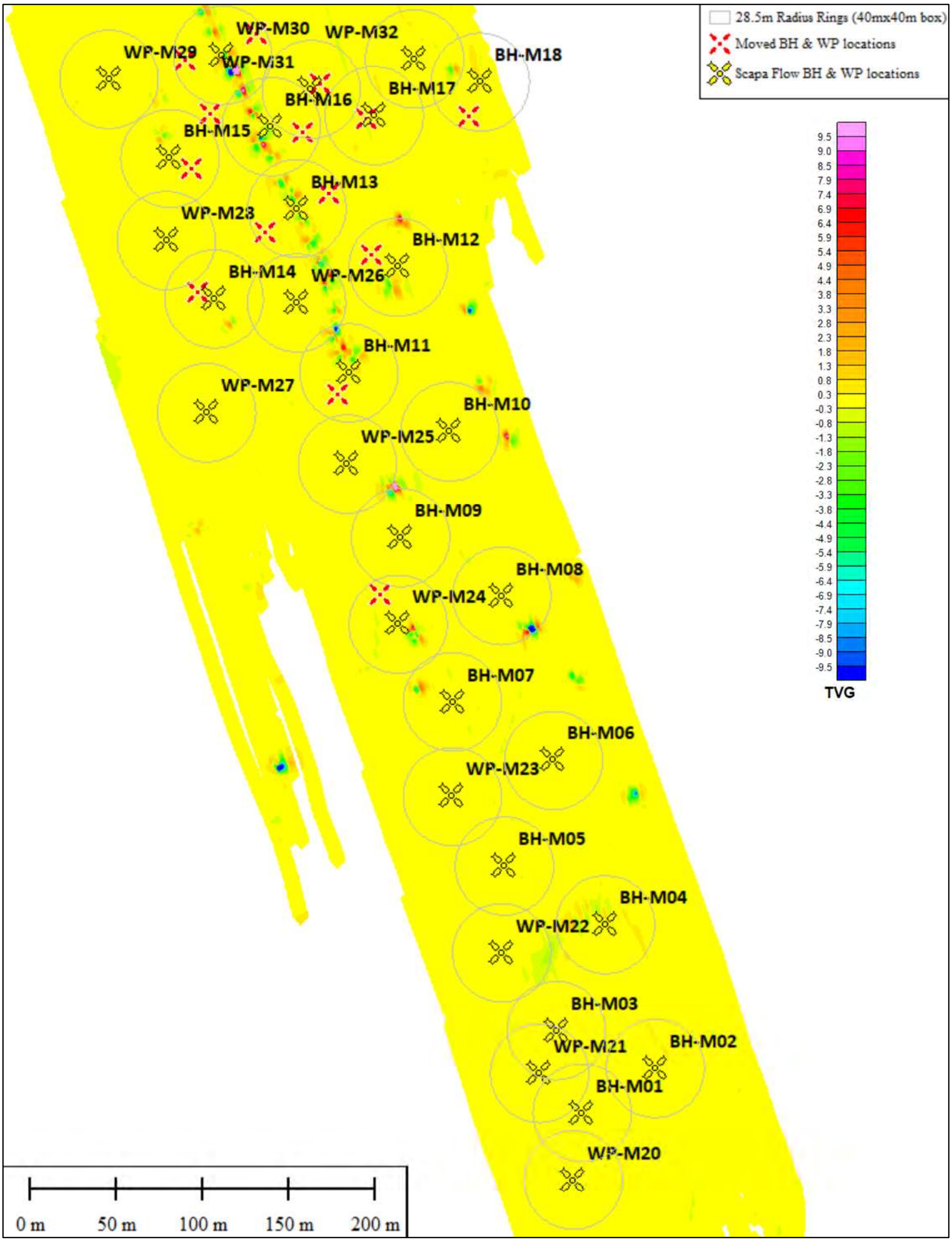


Figure 21: Scapa Deepwater Quay – horizontal gradient

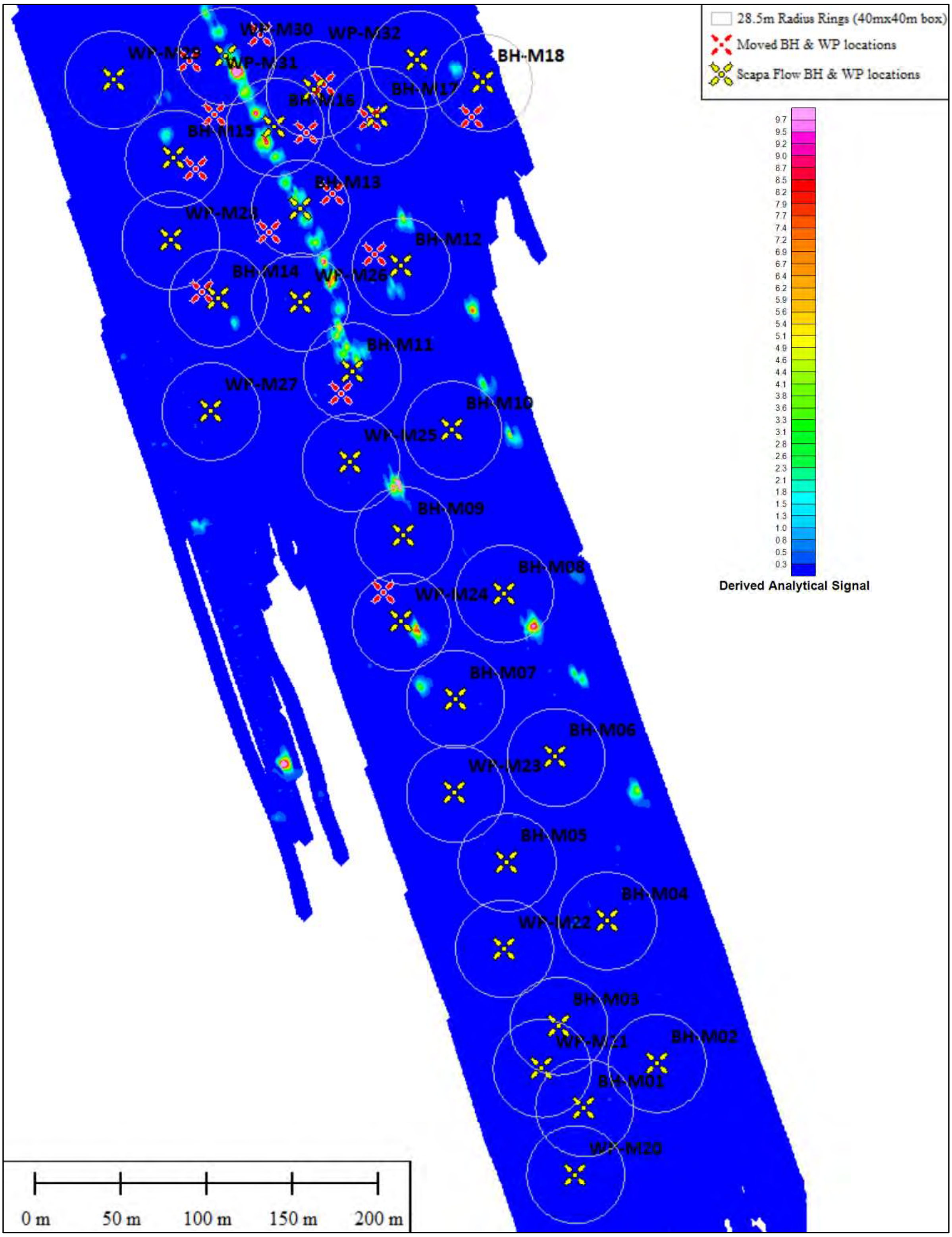


Figure 22: Scapa Deepwater Quay – QuasiAnalytic signal gradient

In the northern section, the line of fishing pots can be seen in the magnetometer data. (Figure 23), as also seen in the sidescan sonar data.

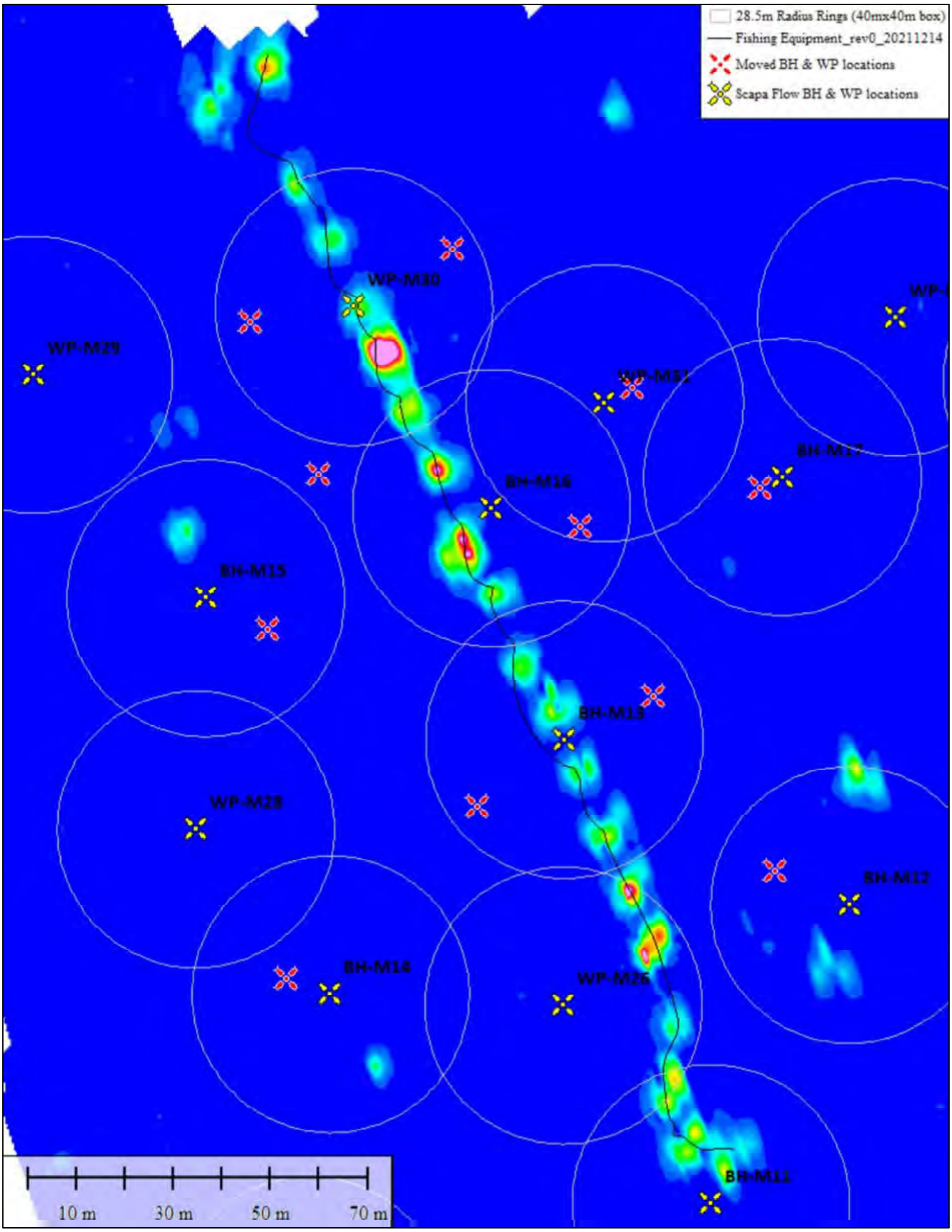


Figure 23: Scapa Deepwater Quay – Fishing pots (QuasiAnalytic signal gradient)

Table 23: Magnetic analysis wash probe location BH-M01			
Location	BH-M01		Comments
Position	Easting	Northing	Possible boulders 21 m to the east.
Original (OSGB36)	345138.2	1003688.9	
New (OSGB36)	n/a	n/a	

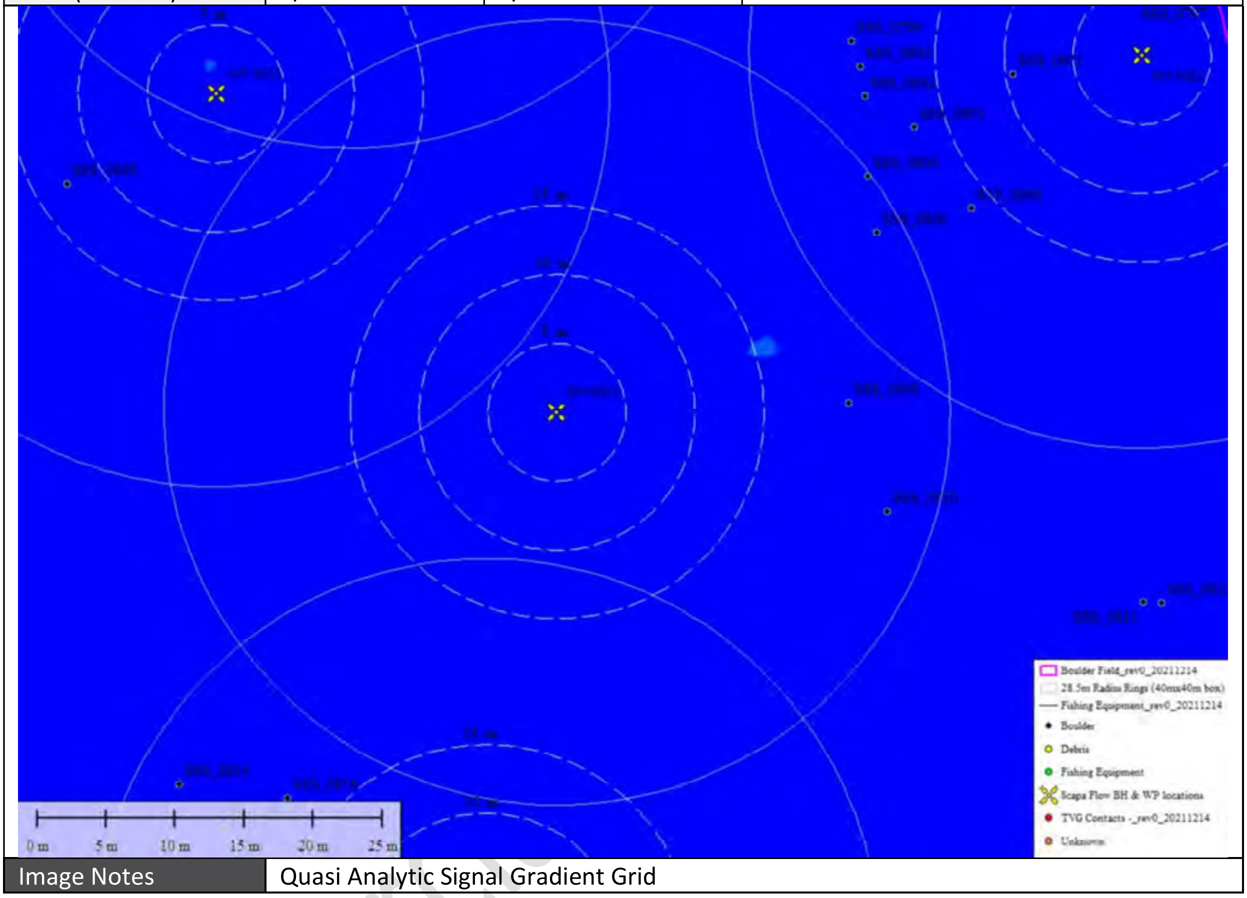



Image Notes	Quasi Analytic Signal Gradient Grid		

Table 24: Magnetic analysis wash probe location BH-M02

Location	BH-M02		Comments
Position	Easting	Northing	
Original (OSGB36)	345180.6	1003714.8	
New (OSGB36)	n/a	n/a	

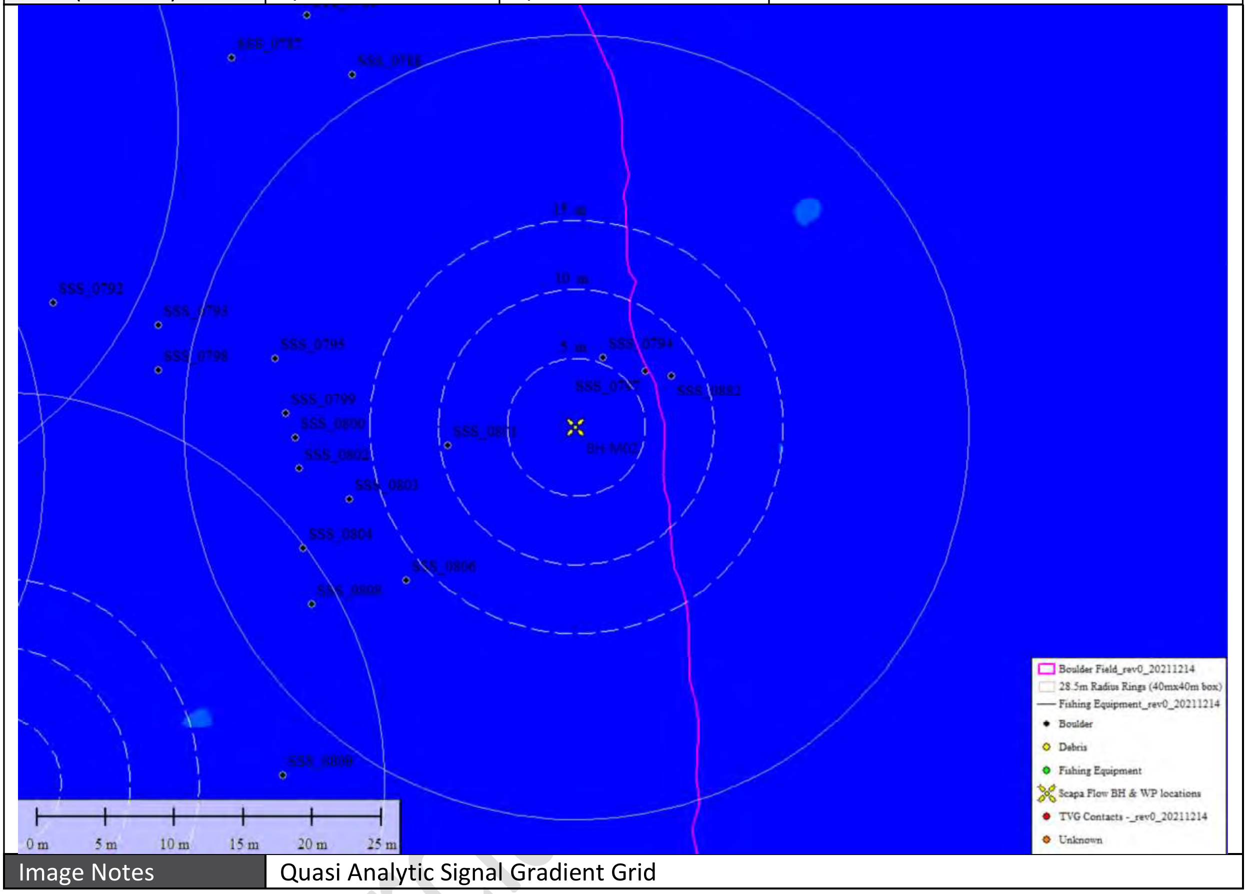


Image Notes	Quasi Analytic Signal Gradient Grid

Table 25: Magnetic analysis wash probe location BH-M03			
Location	BH-M03		Comments
Position	Easting	Northing	
Original (OSGB36)	345123.2	1003736.6	
New (OSGB36)	n/a	n/a	

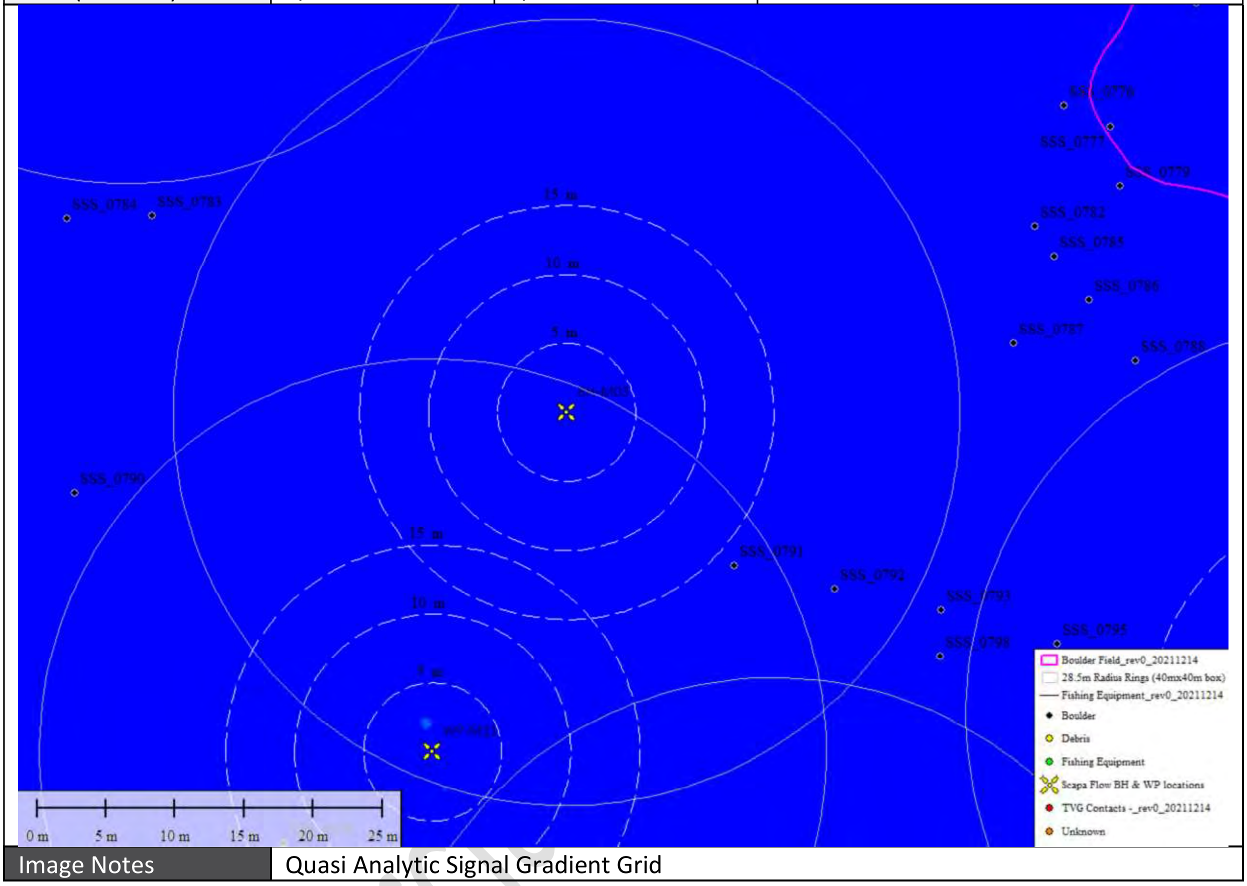



Image Notes	Quasi Analytic Signal Gradient Grid		

Table 26: Magnetic analysis wash probe location BH-M04			
Location	BH-M04		Comments
Position	Easting	Northing	
Original (OSGB36)	345151.7	1003798	
New (OSGB36)	n/a	n/a	

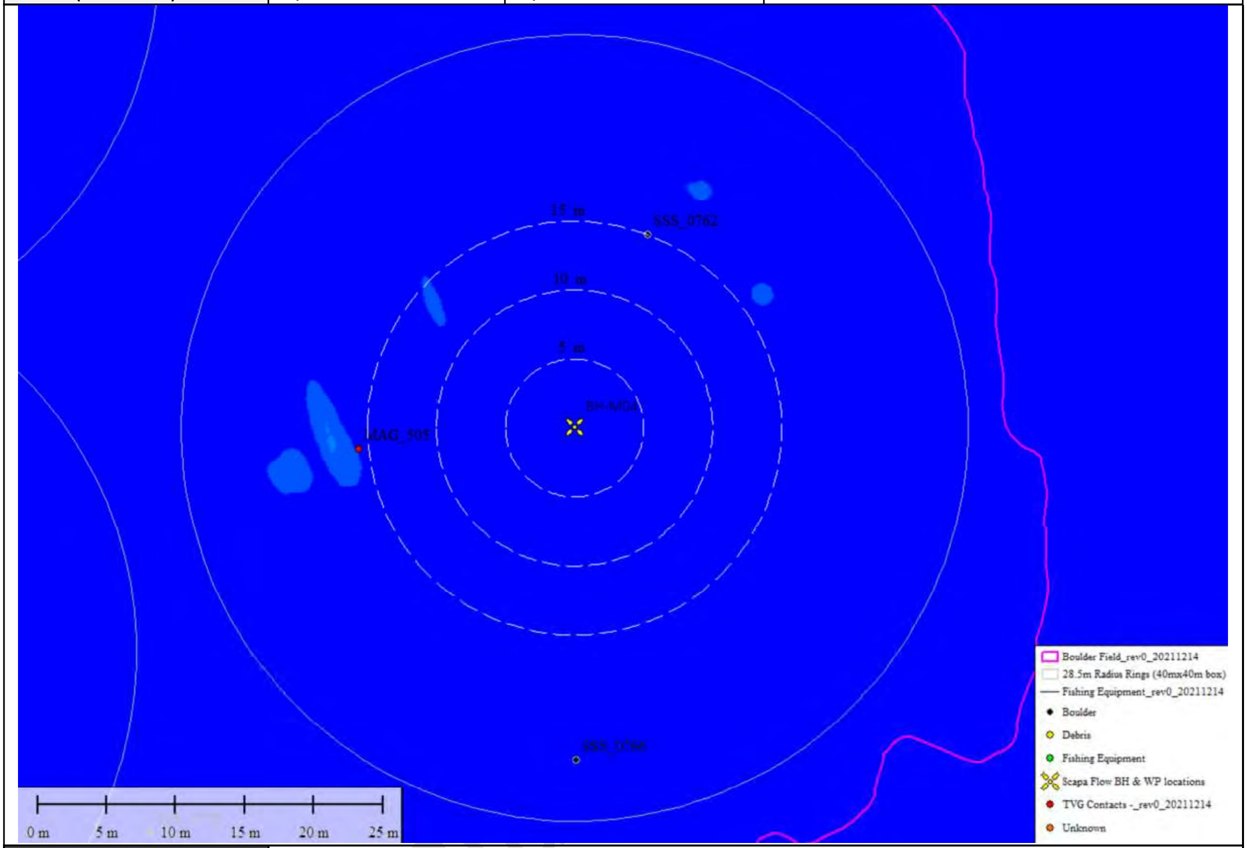



Image Notes	Quasi Analytic Signal Gradient Grid		

Table 27: Magnetic analysis wash probe location BH-M05			
Location	BH-M05		Comments
Position	Easting	Northing	
Original (OSGB36)	345093.1	1003832	
New (OSGB36)	n/a	n/a	

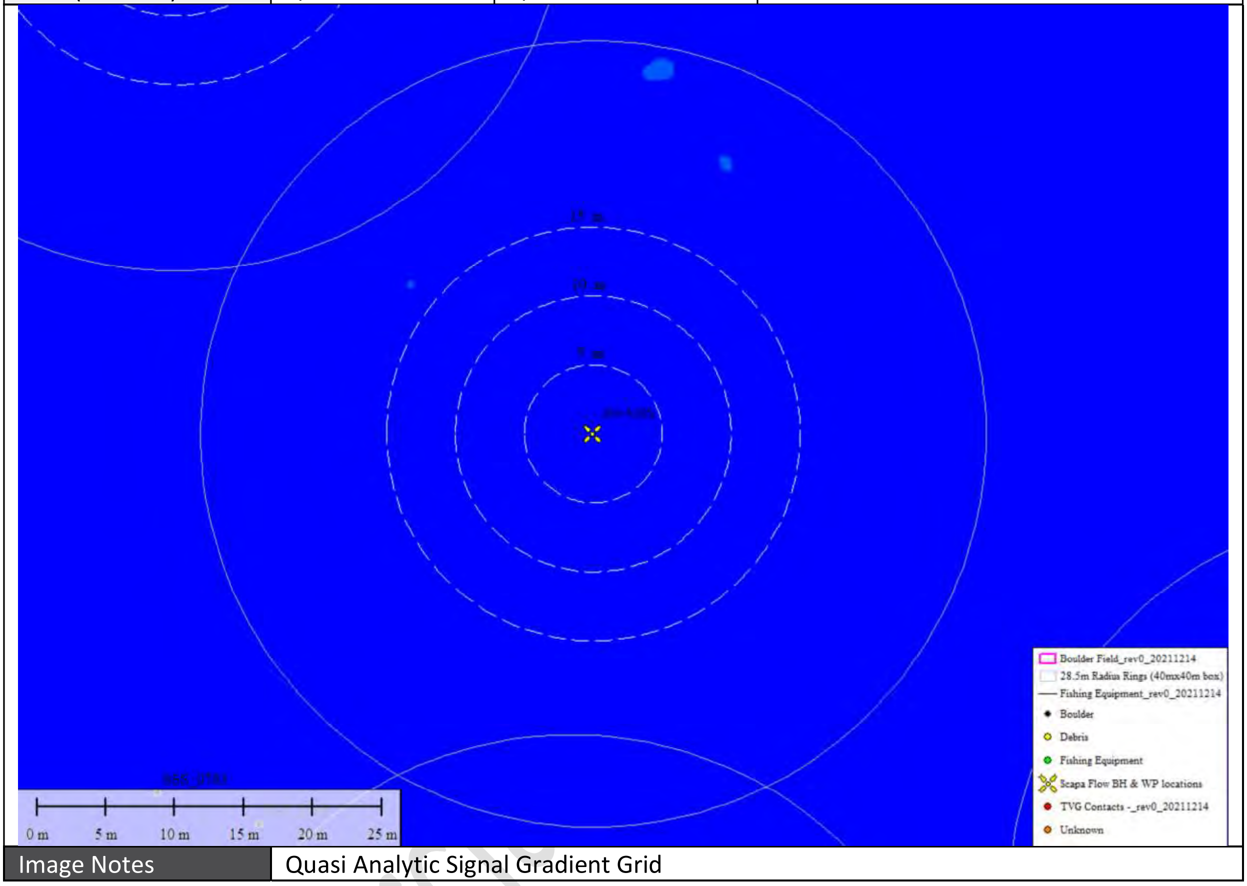



Image Notes	Quasi Analytic Signal Gradient Grid		

Table 28: Magnetic analysis wash probe location BH-M06

Location	BH-M06		Comments
Position	Easting	Northing	
Original (OSGB36)	345121.6	1003893.4	
New (OSGB36)	n/a	n/a	

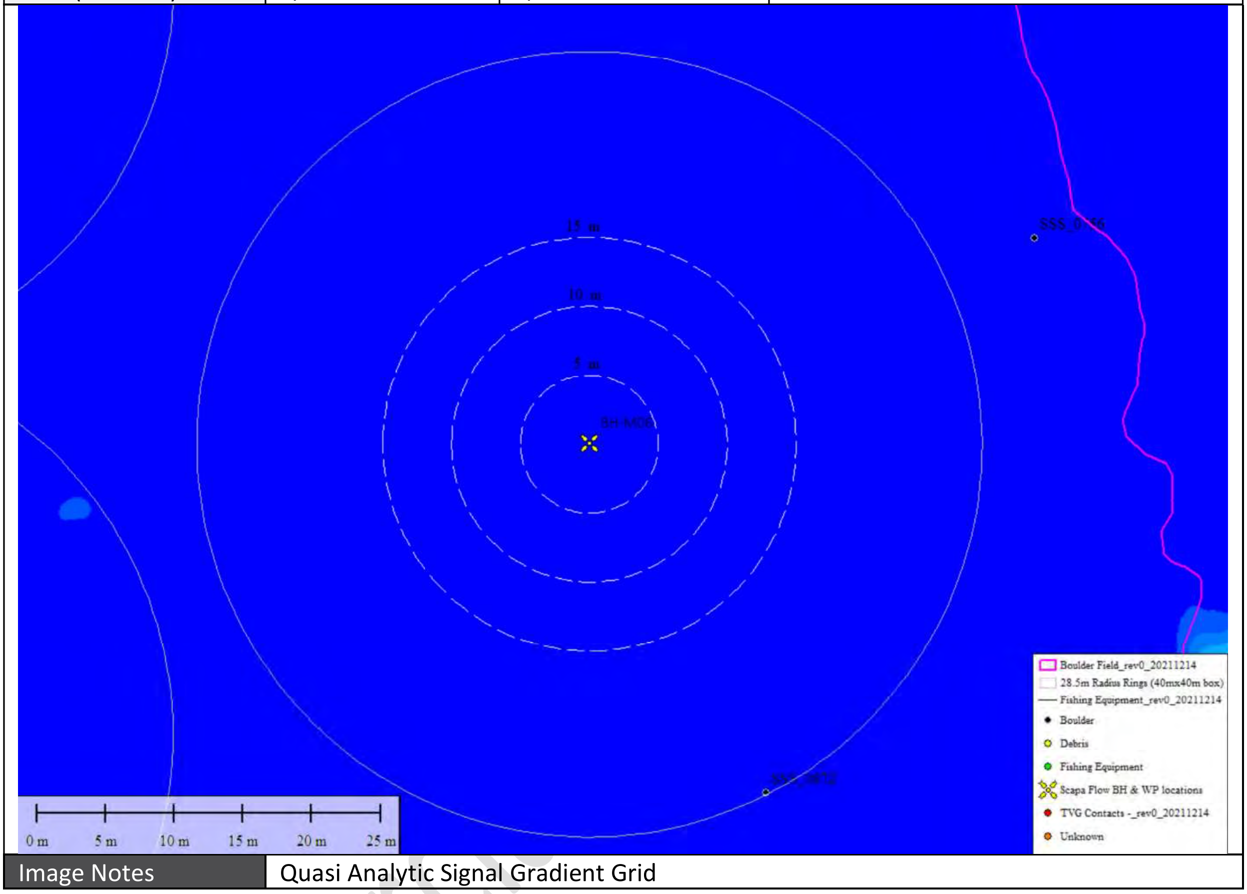


Image Notes	Quasi Analytic Signal Gradient Grid

Table 29: Magnetic analysis wash probe location BH-M07			
Location	BH-M07		Comments
Position	Easting	Northing	Magnetic anomaly 18 m NW of the BH location.
Original (OSGB36)	345063	1003927.3	
New (OSGB36)	n/a	n/a	

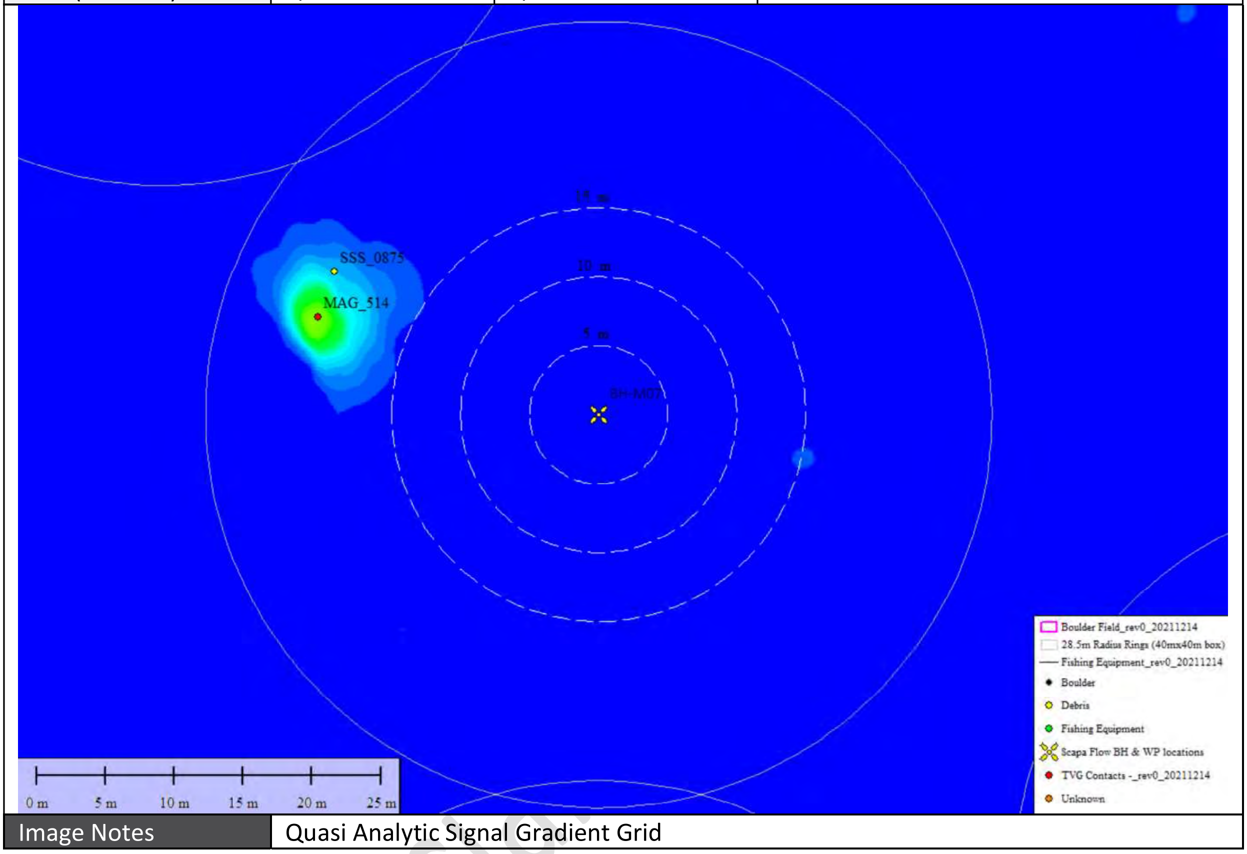



Image Notes	Quasi Analytic Signal Gradient Grid		

Table 30: Magnetic analysis wash probe location BH-M08			
Location	BH-M08		Comments
Position	Easting	Northing	Magnetic anomaly and debris approximately 22 m SE of the BH location.
Original (OSGB36)	345091.6	1003988.8	
New (OSGB36)	n/a	n/a	

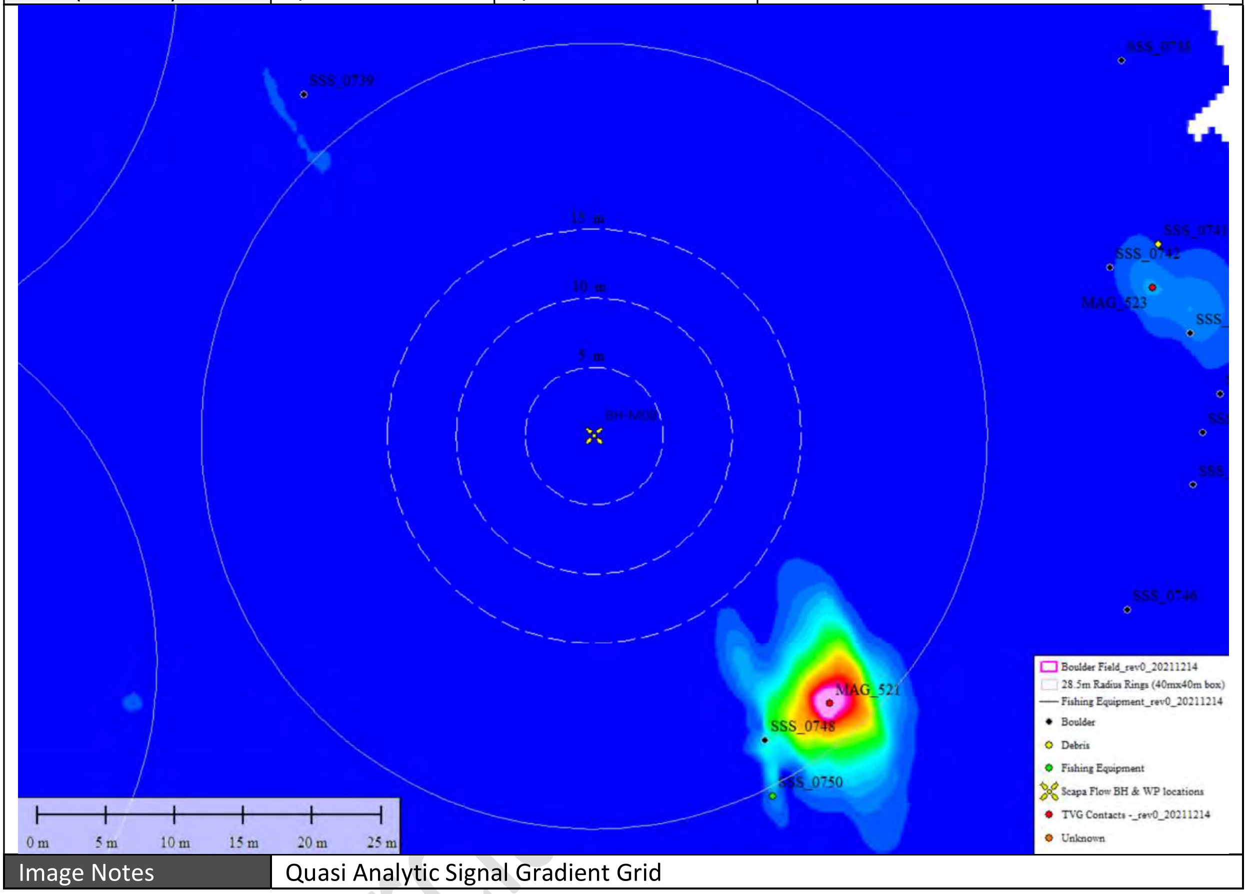



Image Notes	Quasi Analytic Signal Gradient Grid		

Table 31: Magnetic analysis wash probe location BH-M09			
Location	BH-M09		Comments
Position	Easting	Northing	Magnetic anomaly approximately 25 m N of the BH location.
Original (OSGB36)	345032.9	1004022.7	
New (OSGB36)	n/a	n/a	

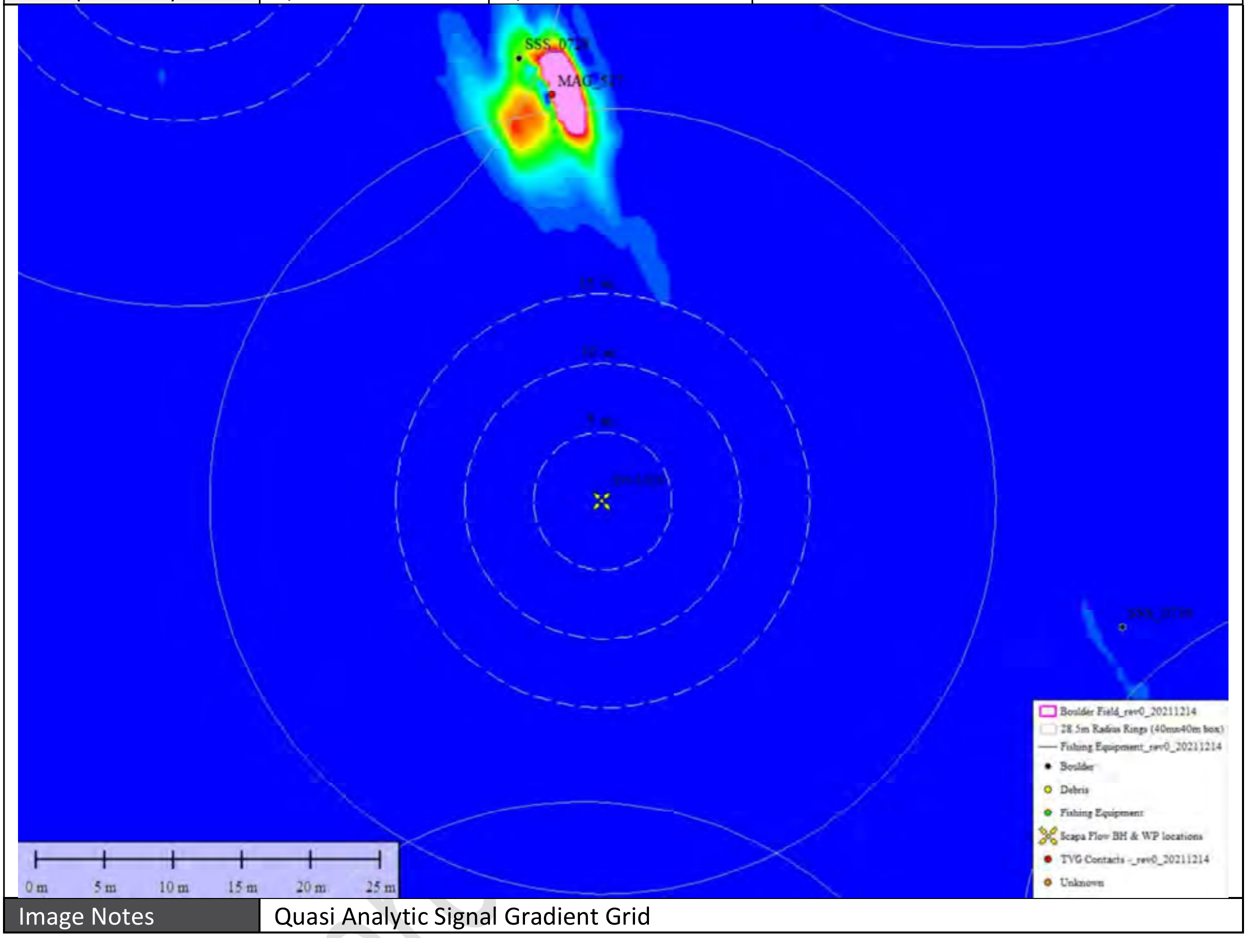


Image Notes	Quasi Analytic Signal Gradient Grid

Table 32: Magnetic analysis wash probe location BH-M10			
Location	BH-M10		Comments
Position	Easting	Northing	
Original (OSGB36)	345061.5	1004084.1	
New (OSGB36)	n/a	n/a	

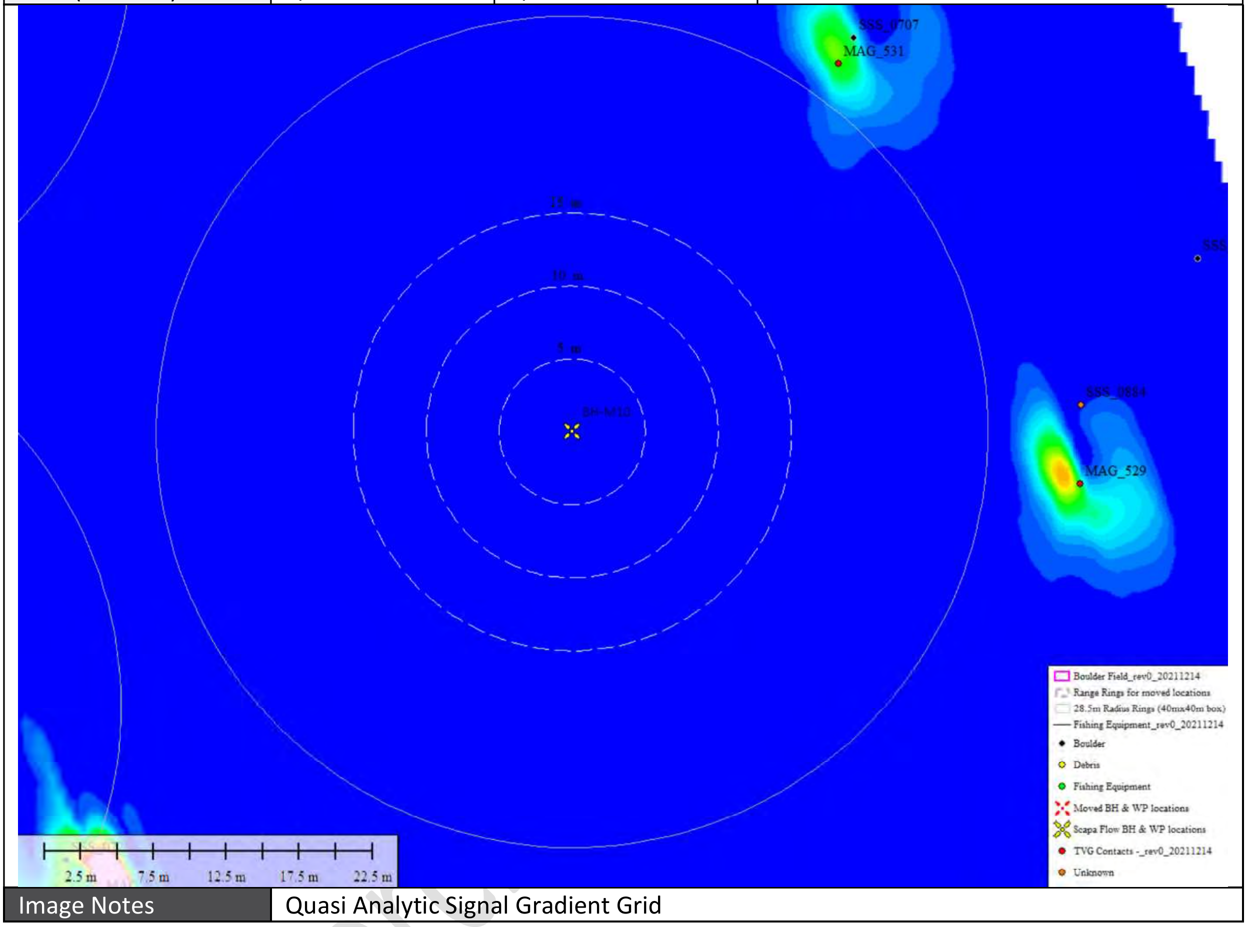


Image Notes	Quasi Analytic Signal Gradient Grid

Table 33: Magnetic analysis wash probe location BH-M11			
Location	BH-M11		Comments
Position	Easting	Northing	Moved away from the magnetic anomalies to the north. These are the fishing pots but could be obscuring other possible targets.
Original (OSGB36)	345002.9	1004118.1	
New (OSGB36)	344997.0	1004104.9	

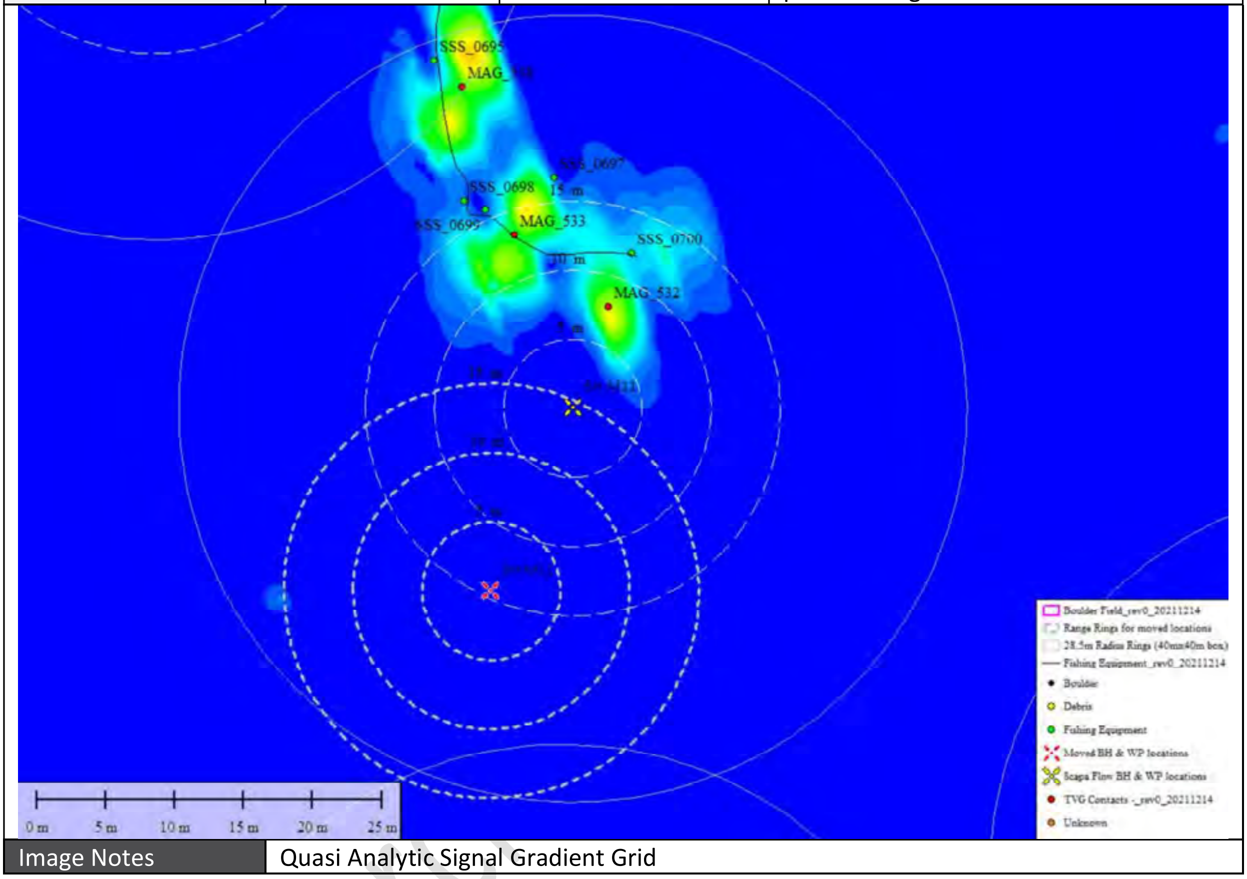



Image Notes	Quasi Analytic Signal Gradient Grid		

Table 34: Magnetic analysis wash probe location BH-M12			
Location	BH-M12		Comments
Position	Easting	Northing	Moved further from southerly magnetic anomaly and away from boulder field. Boulder field to the west of the BH location.
Original (OSGB36)	345031.4	1004179.5	
New (OSGB36)	345016.3	1004186.4	

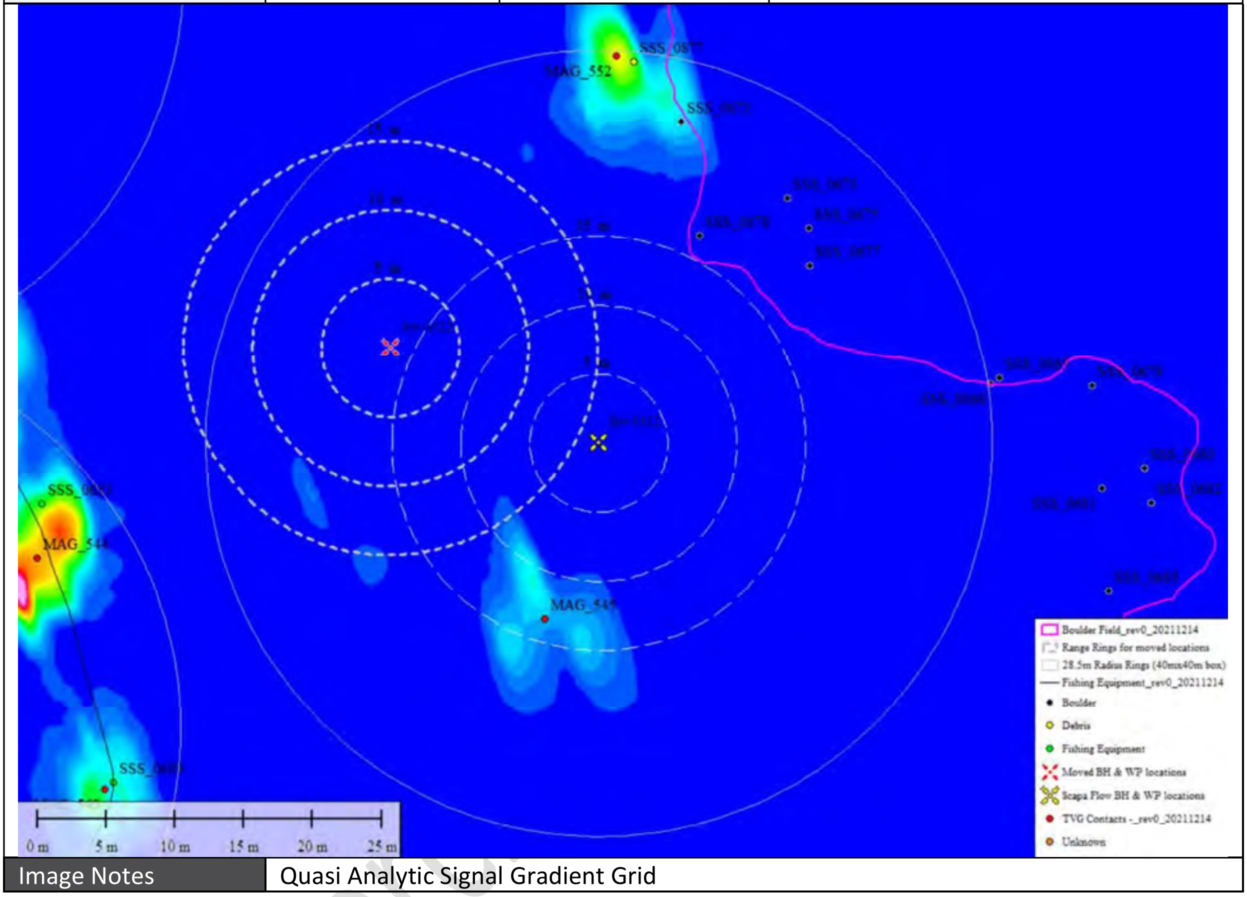



Image Notes	Quasi Analytic Signal Gradient Grid		

Table 35: Magnetic analysis wash probe location BH-M13			
Location	BH-M13		Comments
Position	Easting	Northing	Moved away from fishing pots. Two optional locations.
Original (OSGB36)	344972.8	1004213.5	
New A (OSGB36)	344991.3	1004222.2	
New B (OSGB36)	344954.9	1004199.7	

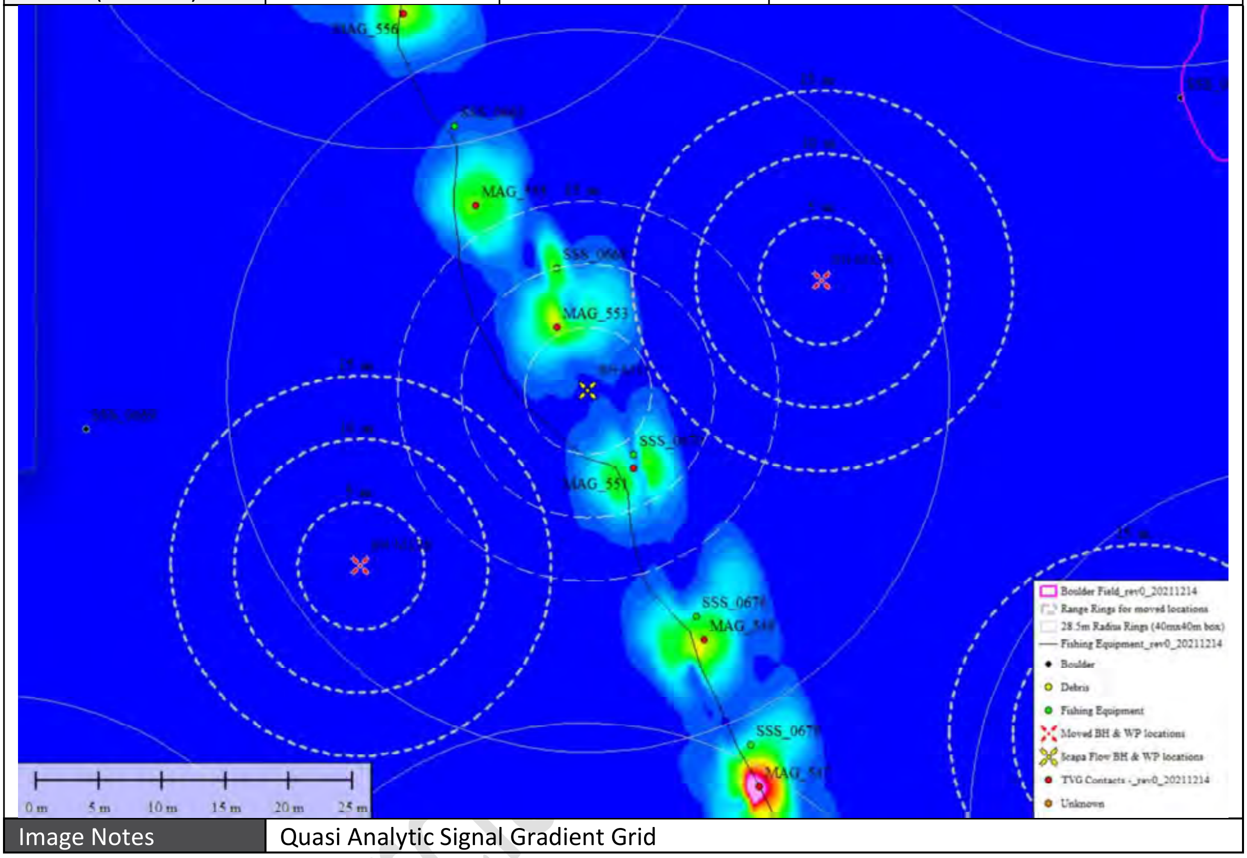



Image Notes	Quasi Analytic Signal Gradient Grid		

Table 36: Magnetic analysis wash probe location BH-M14

Location	BH-M14		Comments
Position	Easting	Northing	Moved further away from magnetic anomaly and debris situated SE of the BH location.
Original (OSGB36)	344924.8	1004161.1	
New (OSGB36)	344915.8	1004164.3	

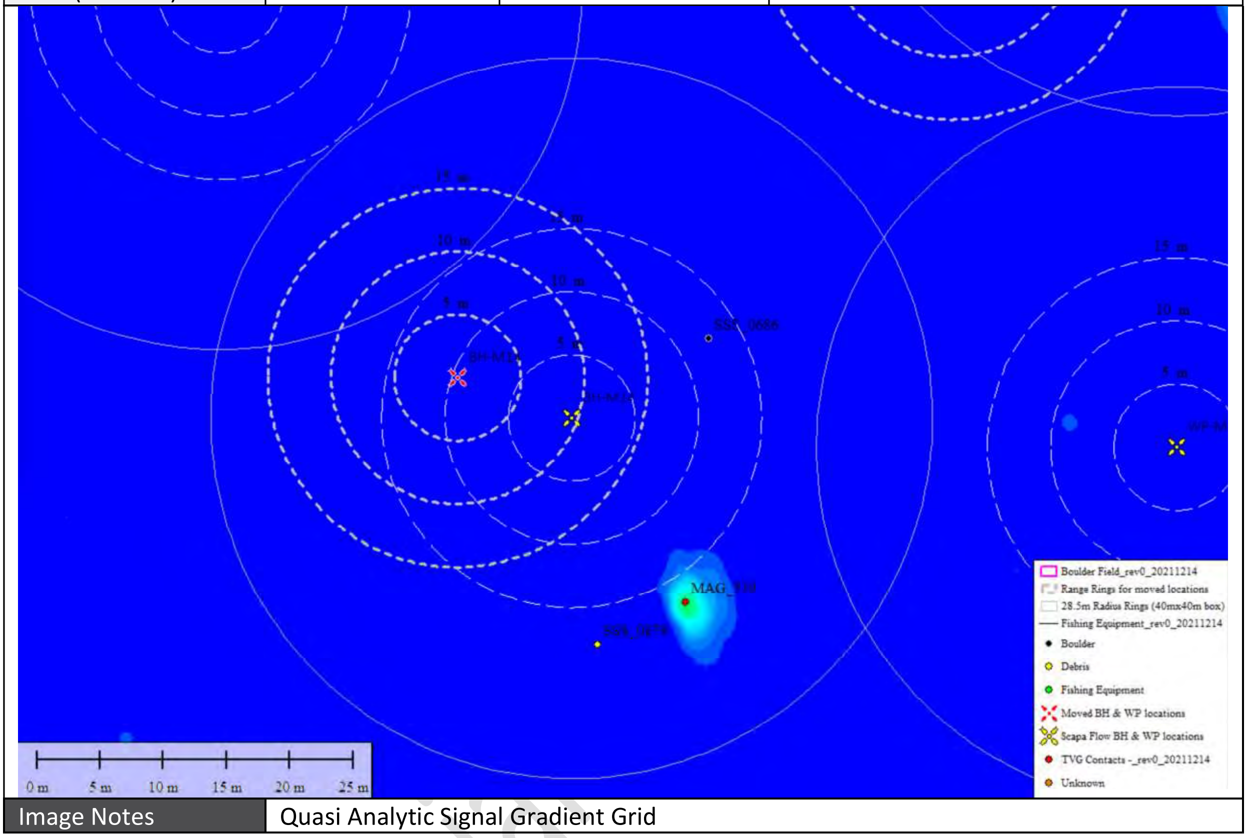



Image Notes	Quasi Analytic Signal Gradient Grid		

Table 37: Magnetic analysis wash probe location BH-M15			
Location	BH-M15		Comments
Position	Easting	Northing	Moved away from magnetic anomaly and into better TVG coverage.
Original (OSGB36)	344899.1	1004242.6	
New (OSGB36)	344911.9	1004236.1	

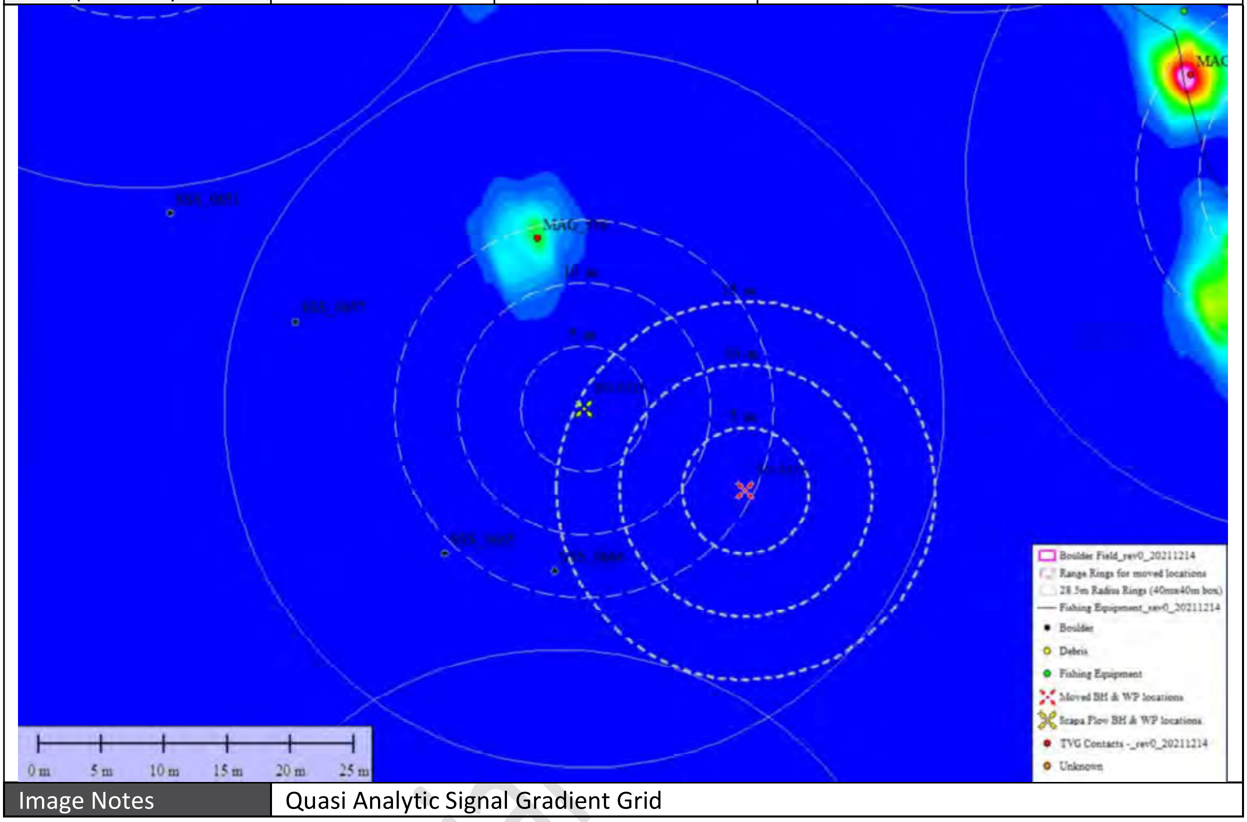



Image Notes	Quasi Analytic Signal Gradient Grid		

Table 38: Magnetic analysis wash probe location BH-M16			
Location	BH-M16		Comments
Position	Easting	Northing	Moved away from fishing pots. Two optional locations.
Original (OSGB36)	344957.8	1004261.1	
New A (OSGB36)	344976.2	1004257.2	
New B (OSGB36)	344922.5	1004267.9	

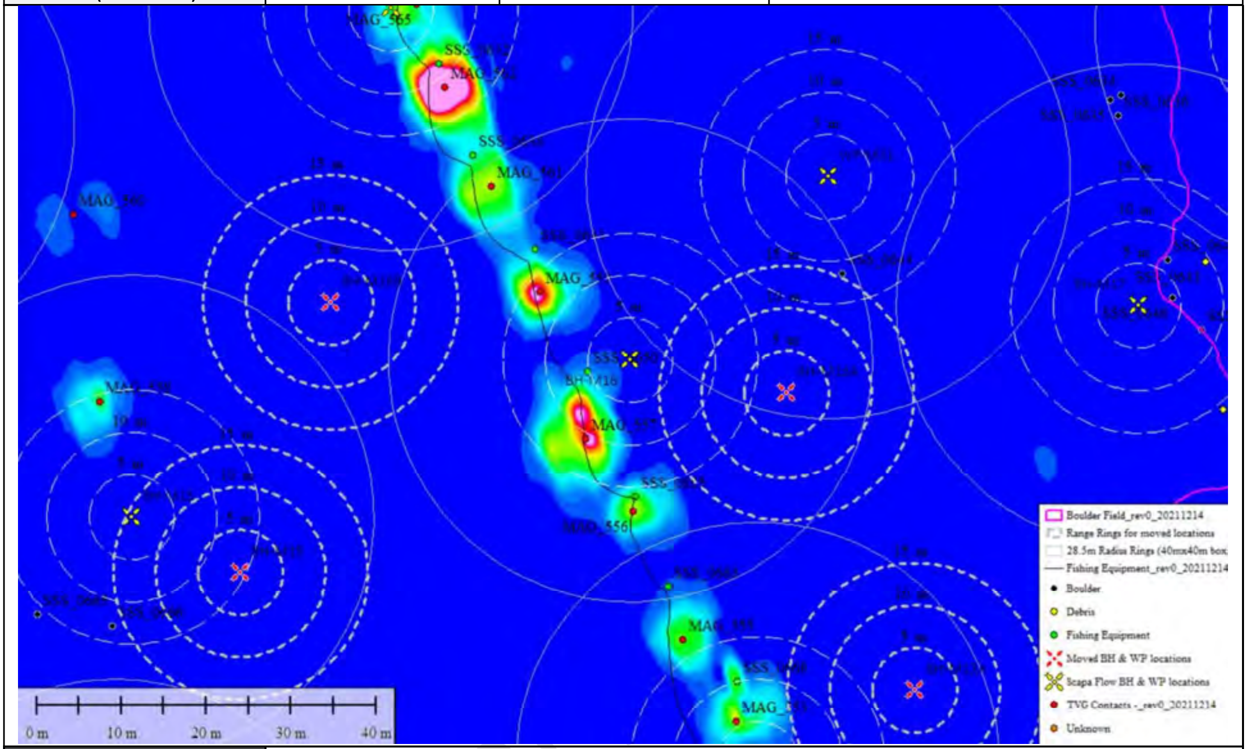



Image Notes	Quasi Analytic Signal Gradient Grid		

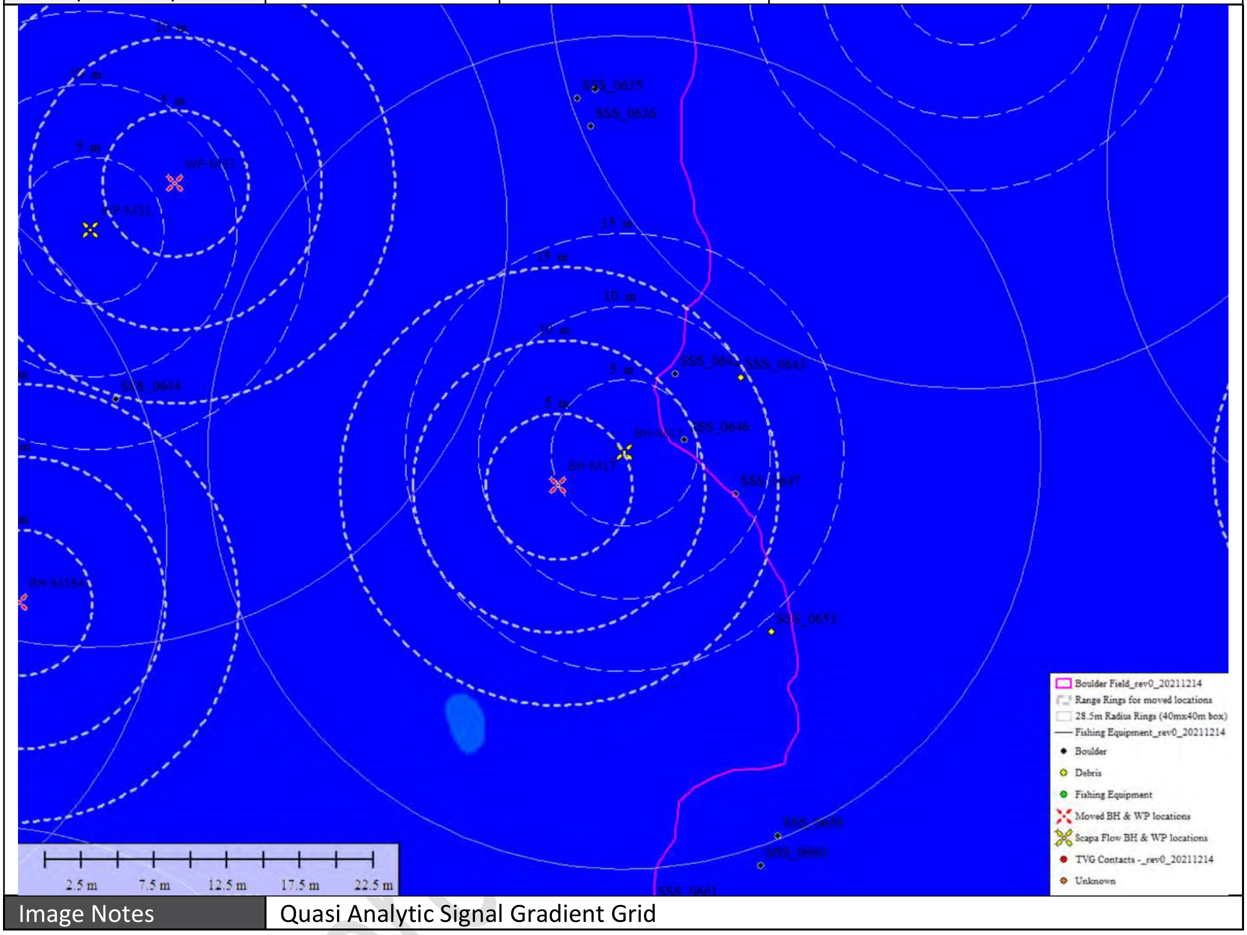
<table>
<tr><th colspan="4">Table 39: Magnetic analysis wash probe location BH-M17</th></tr>
<tr><td>Location</td><td colspan="2">BH-M17</td><td>Comments</td></tr>
<tr><td>Position</td><td>Easting</td><td>Northing</td><td rowspan="3">Moved away from boulder field and debris. Debris is not magnetic so original location could still be acceptable</td></tr>
<tr><td>Original (OSGB36)</td><td>345017.6</td><td>1004267.5</td></tr>
<tr><td>New (OSGB36)</td><td>345013.1</td><td>1004265.2</td></tr>
<tr><td colspan="4"> </td></tr>
<tr><td>Image Notes</td><td colspan="3">Quasi Analytic Signal Gradient Grid</td></tr>
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Table 40: Magnetic analysis wash probe location BH-M18			
Location	BH-M18		Comments
Position	Easting	Northing	Moved away from magnetic anomaly and to better coverage. In the boulder field.
Original (OSGB36)	345079.1	1004286.9	
New (OSGB36)	345072.9	1004266.5	

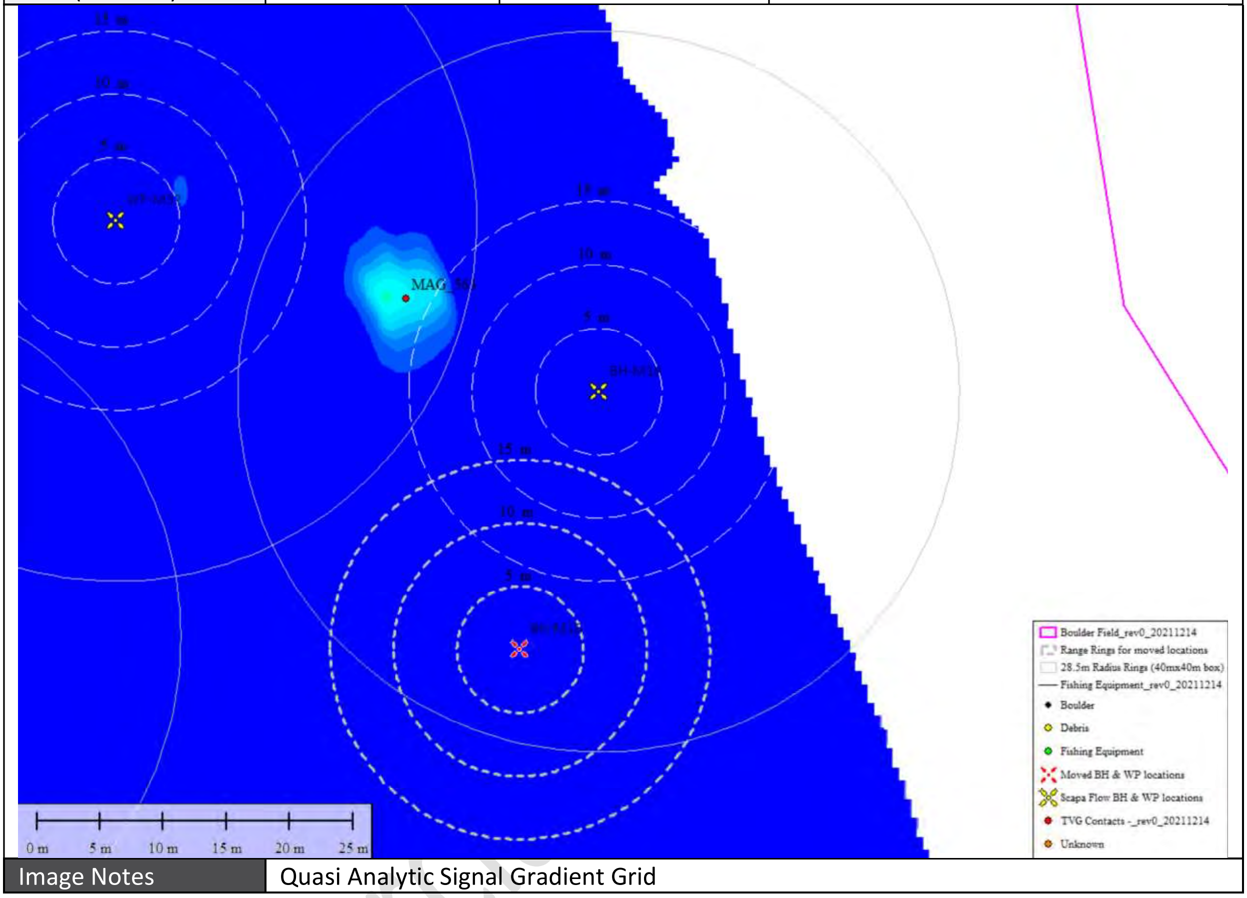



Image Notes	Quasi Analytic Signal Gradient Grid		

Table 41: Magnetic analysis wash probe location WP-M20			
Location	WP-M20		Comments
Position	Easting	Northing	
Original (OSGB36)	345133.1	1003649.8	
New (OSGB36)	n/a	n/a	

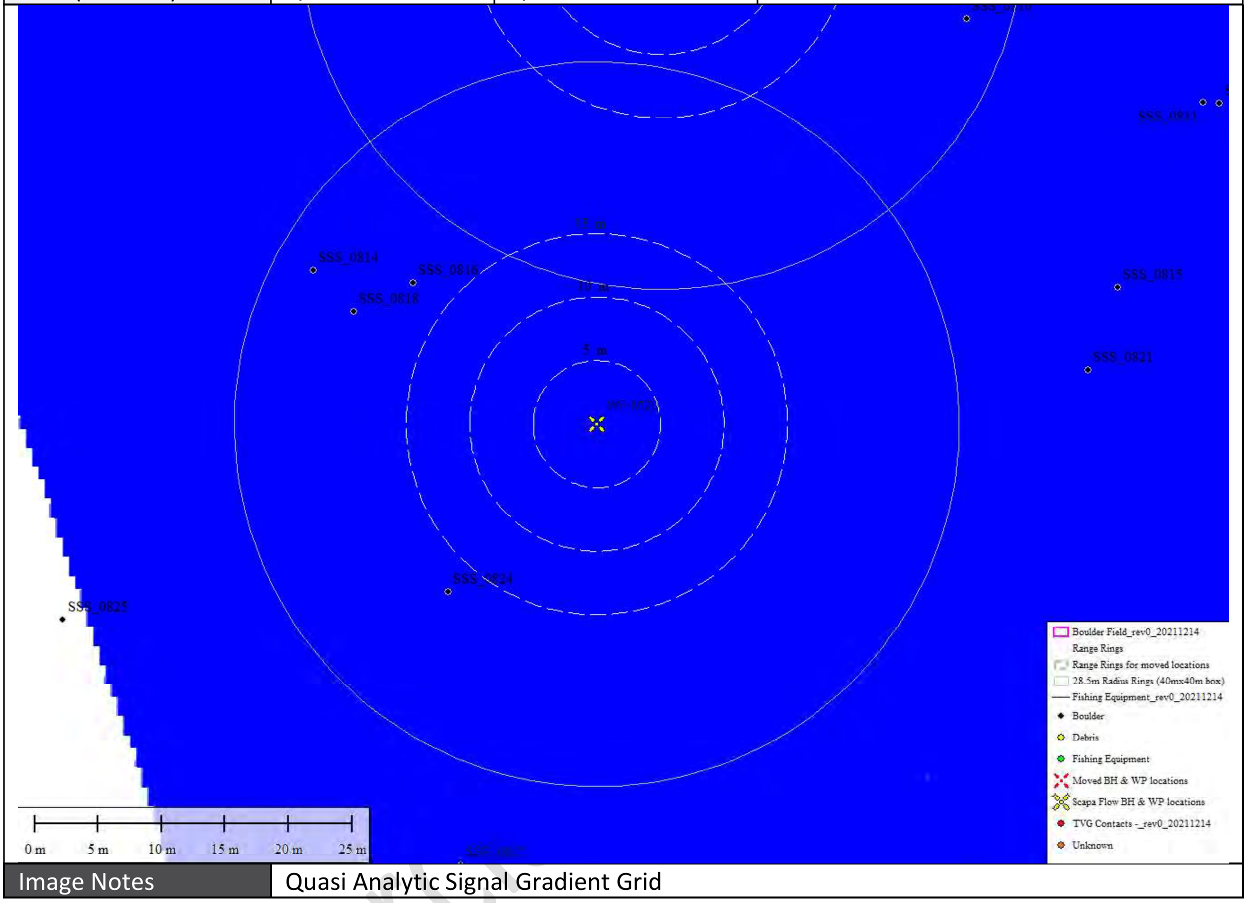



Image Notes	Quasi Analytic Signal Gradient Grid		

Table 42: Magnetic analysis wash probe location WP-M21			
Location	WP-M21		Comments
Position	Easting	Northing	
Original (OSGB36)	345113.5	1003712	
New (OSGB36)	n/a	n/a	

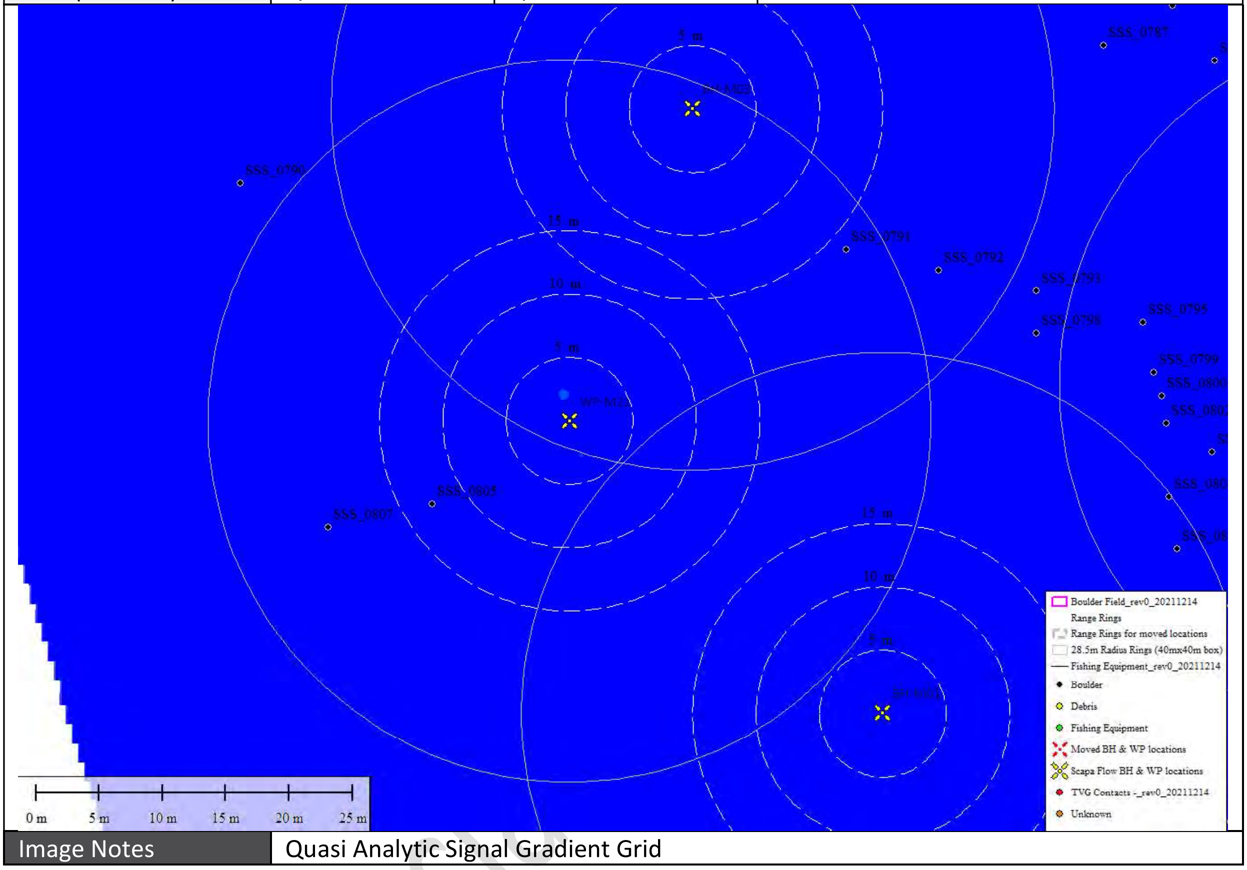
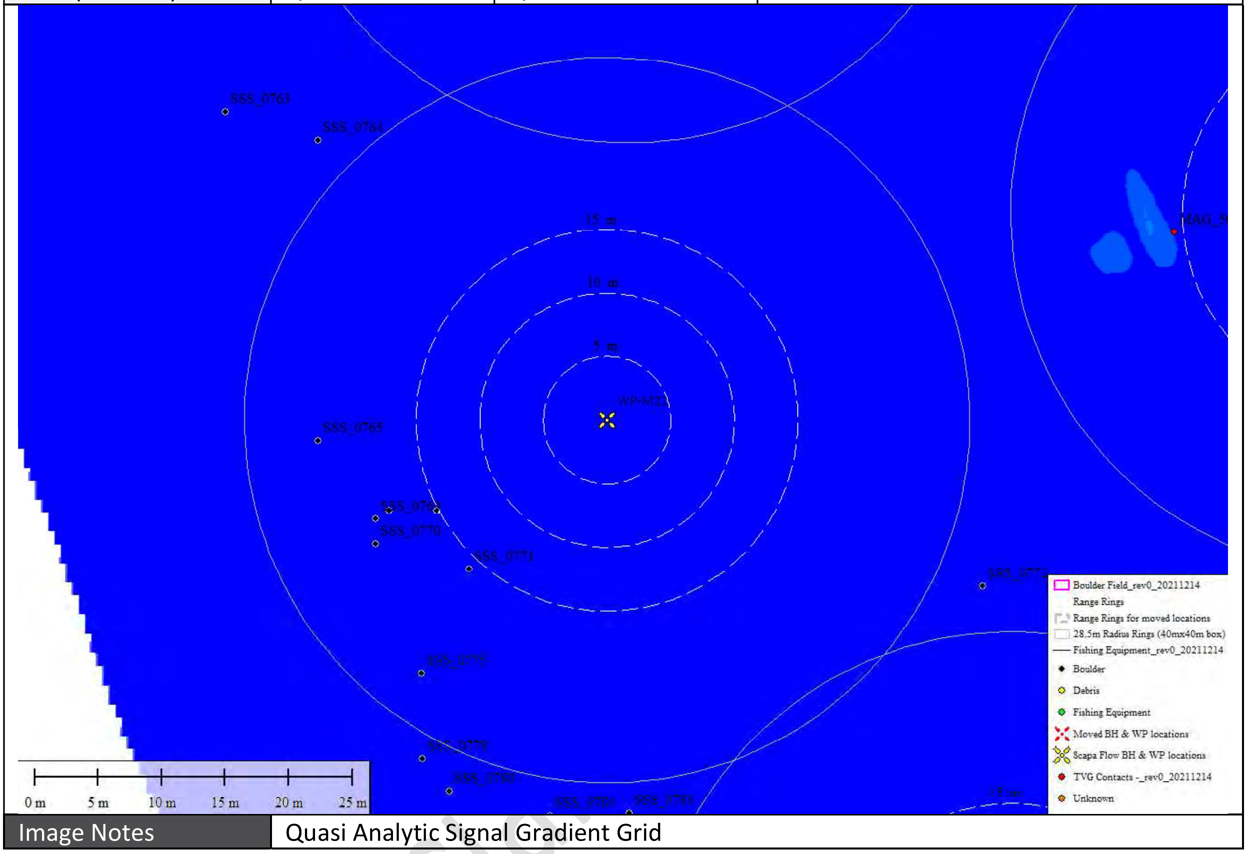



Image Notes	Quasi Analytic Signal Gradient Grid		

<table>
<tr><th colspan="4">Table 43: Magnetic analysis wash probe location WP-M22</th></tr>
<tr><td>Location</td><td colspan="2">WP-M22</td><td>Comments</td></tr>
<tr><td>Position</td><td>Easting</td><td>Northing</td><td rowspan="3"></td></tr>
<tr><td>Original (OSGB36)</td><td>345091.5</td><td>1003781.7</td></tr>
<tr><td>New (OSGB36)</td><td>n/a</td><td>n/a</td></tr>
<tr><td colspan="4">
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<tr><td>Image Notes</td><td colspan="3">Quasi Analytic Signal Gradient Grid</td></tr>
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Table 44: Magnetic analysis wash probe location WP-M23			
Location	WP-M23		Comments
Position	Easting	Northing	
Original (OSGB36)	345062.9	1003872.3	
New (OSGB36)	n/a	n/a	
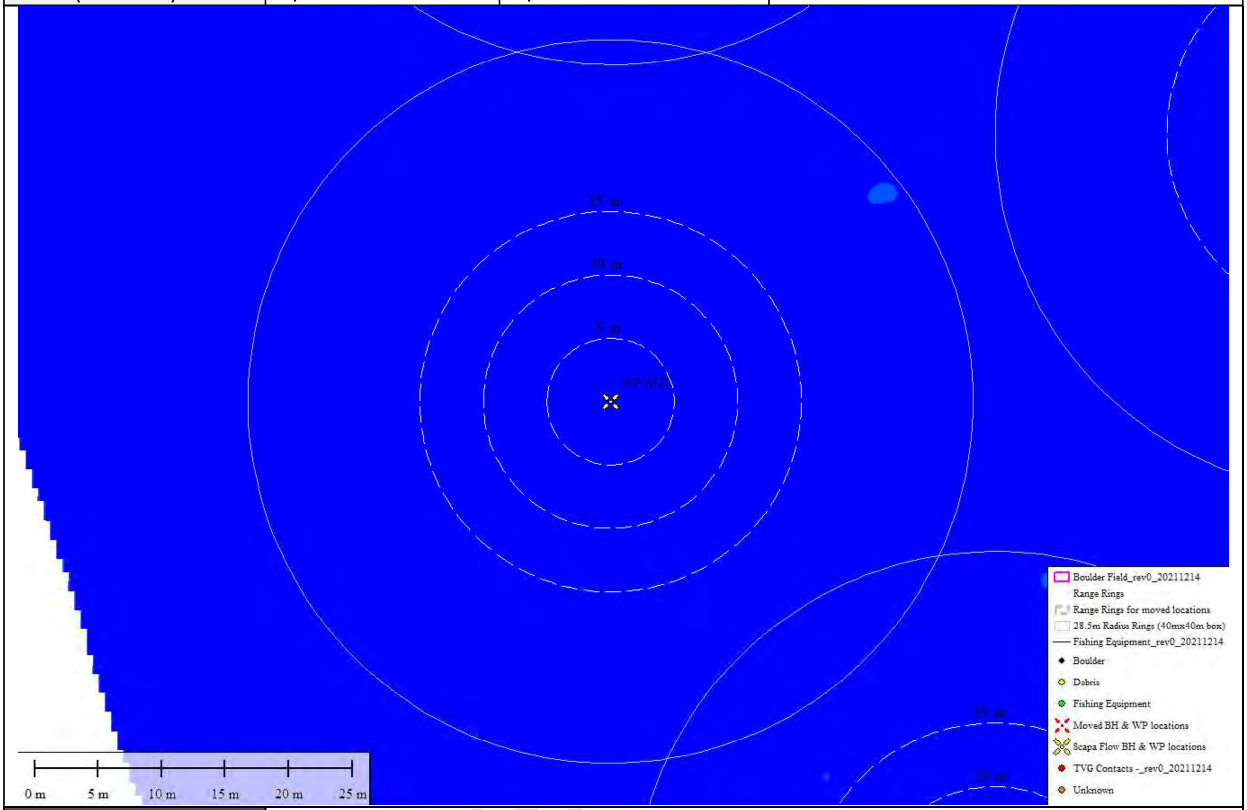			
Image Notes	Quasi Analytic Signal Gradient Grid		

Table 45: Magnetic analysis wash probe location WP-M24			
Location	WP-M24		Comments
Position	Easting	Northing	Moved NNW from magnetic anomaly and associated SSS target.
Original (OSGB36)	345031.4	1003972.4	
New (OSGB36)	345021.2	1003989.3	

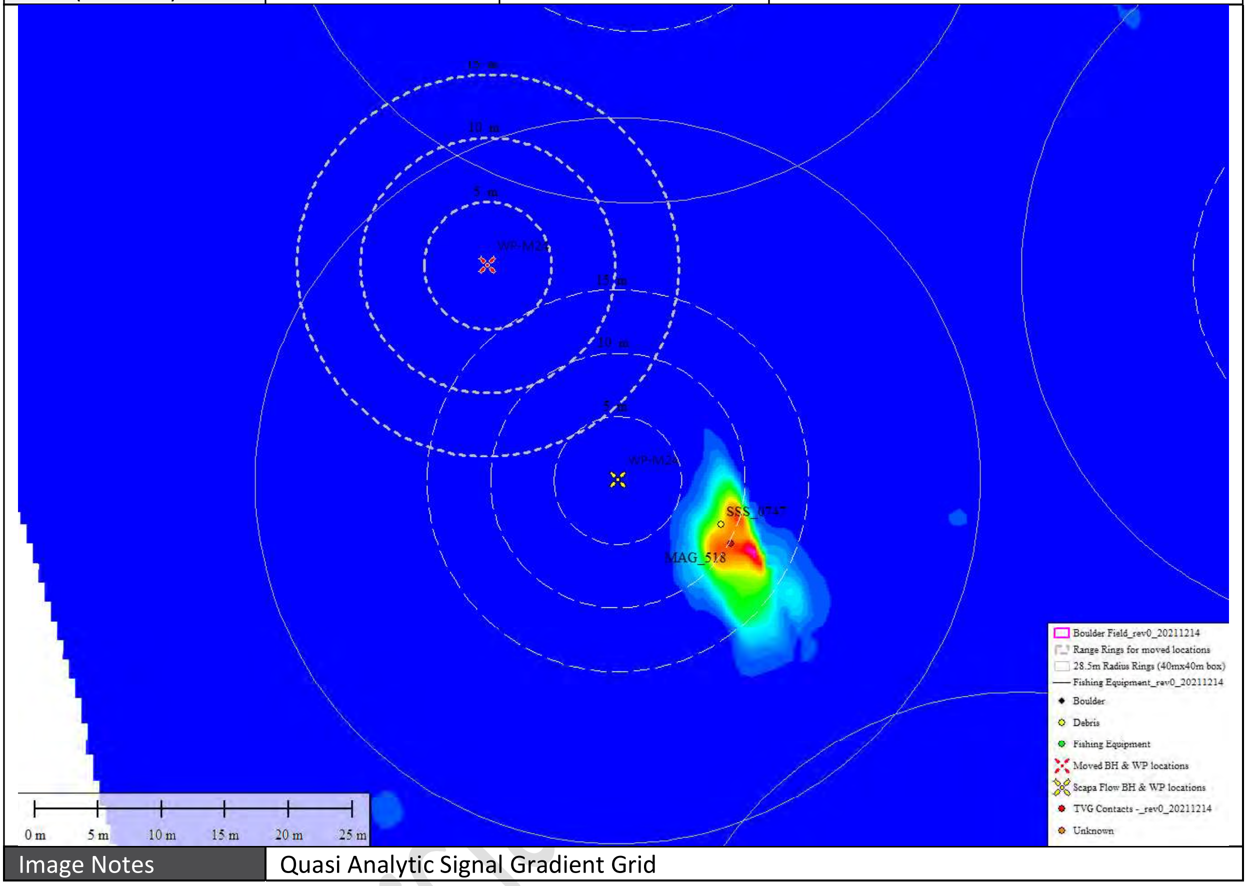

Image Notes	Quasi Analytic Signal Gradient Grid

Table 46: Magnetic analysis wash probe location WP-M25			
Location	WP-M25		Comments
Position	**Easting**	**Northing**	Magnetic anomaly and SSS target 25 m SE of the WP location.
Original (OSGB36)	345002.1	1004065.3	
New (OSGB36)	n/a	n/a	

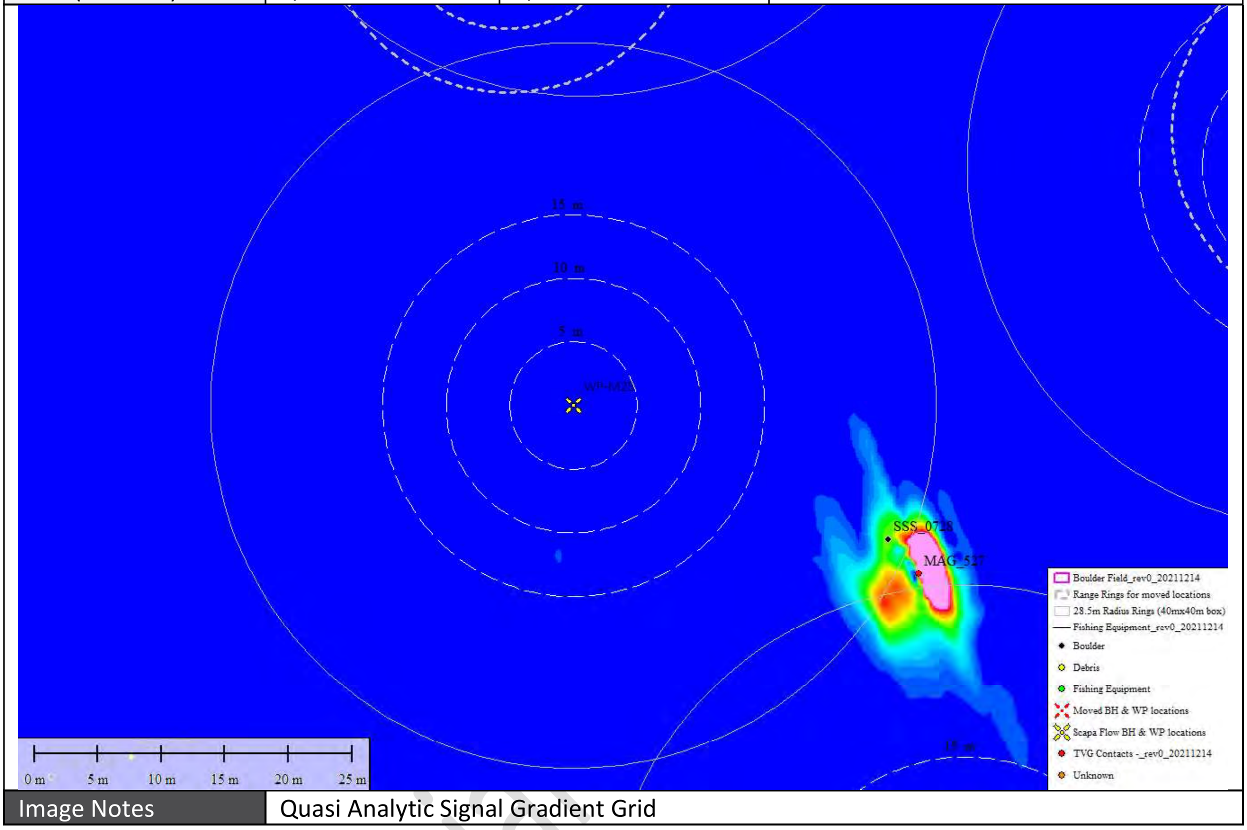

Image Notes	Quasi Analytic Signal Gradient Grid

Table 47: Magnetic analysis wash probe location WP-M26			
Location	WP-M26		Comments
Position	Easting	Northing	Fishing pots 17 m NE of the WP location.
Original (OSGB36)	344972.6	1004158.8	
New (OSGB36)	n/a	n/a	
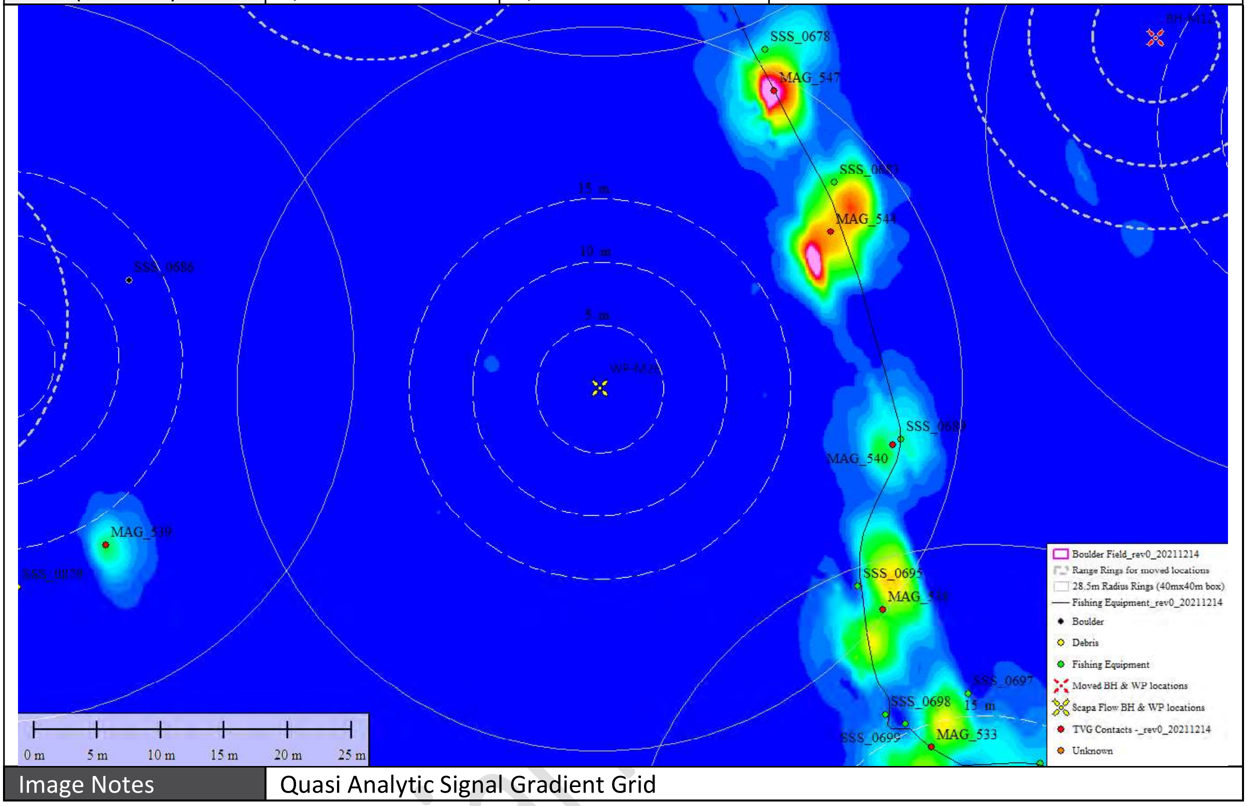			
Image Notes	Quasi Analytic Signal Gradient Grid		

Table 48: Magnetic analysis wash probe location WP-M27			
Location	WP-M27		Comments
Position	Easting	Northing	
Original (OSGB36)	344920.4	1004095.1	
New (OSGB36)	n/a	n/a	
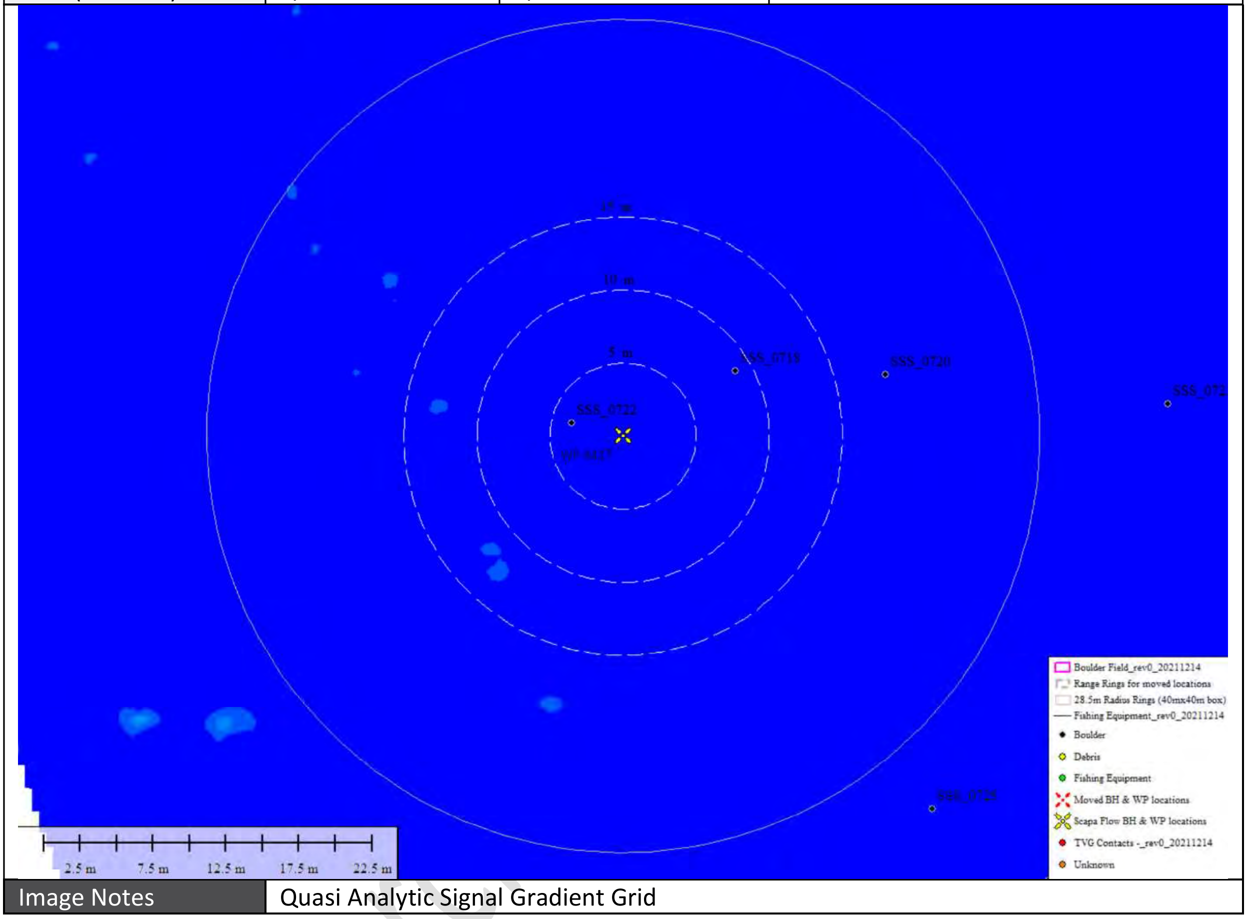			
Image Notes	Quasi Analytic Signal Gradient Grid		

Table 49: Magnetic analysis wash probe location WP-M28

Location	WP-M28		Comments
Position	Easting	Northing	
Original (OSGB36)	344897.1	1004195.0	
New (OSGB36)	n/a	n/a	
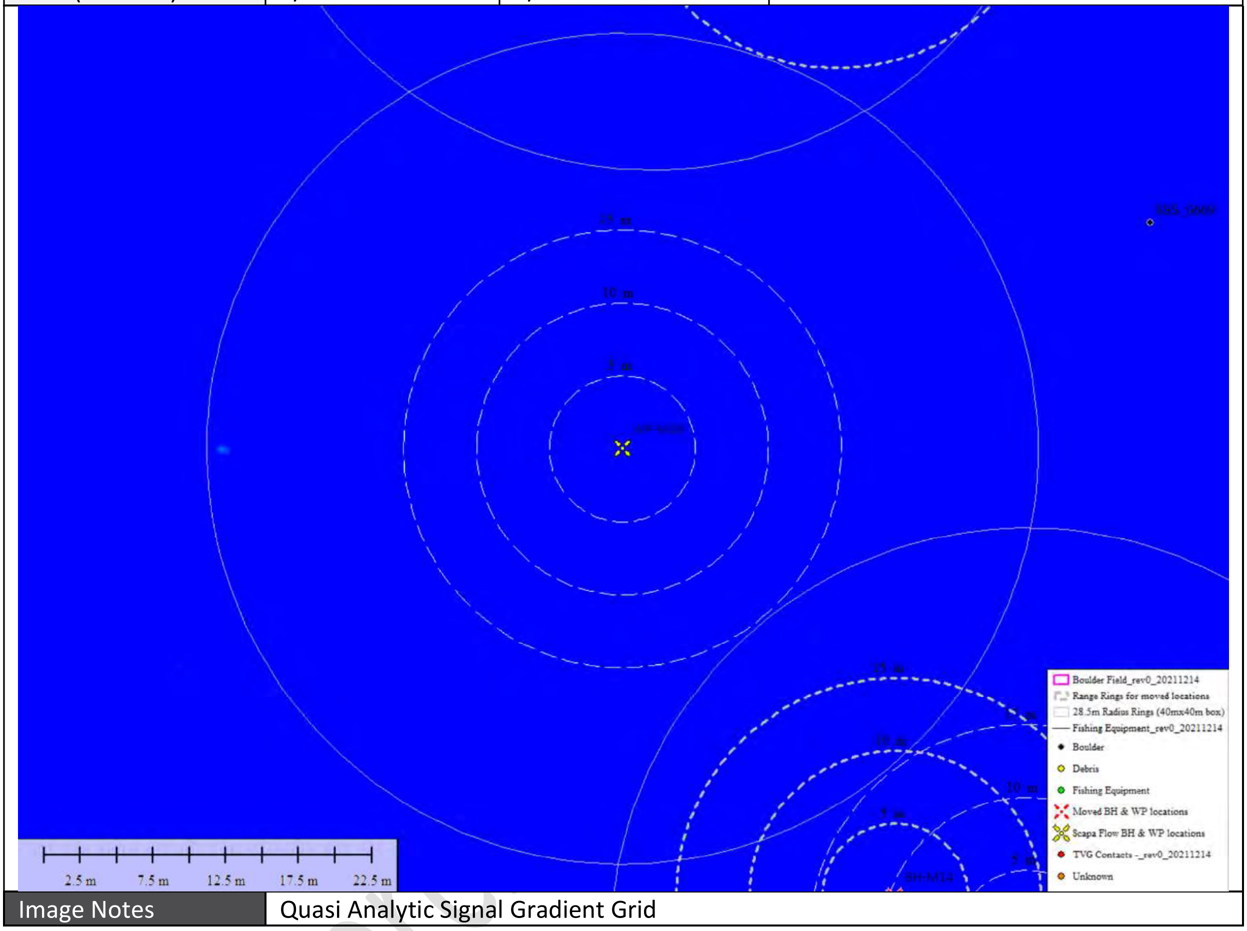			
Image Notes	Quasi Analytic Signal Gradient Grid		

Table 50: Magnetic analysis wash probe location WP-M29			
Location	WP-M29		Comments
Position	Easting	Northing	
Original (OSGB36)	344863.8	1004288.6	
New (OSGB36)	n/a	n/a	
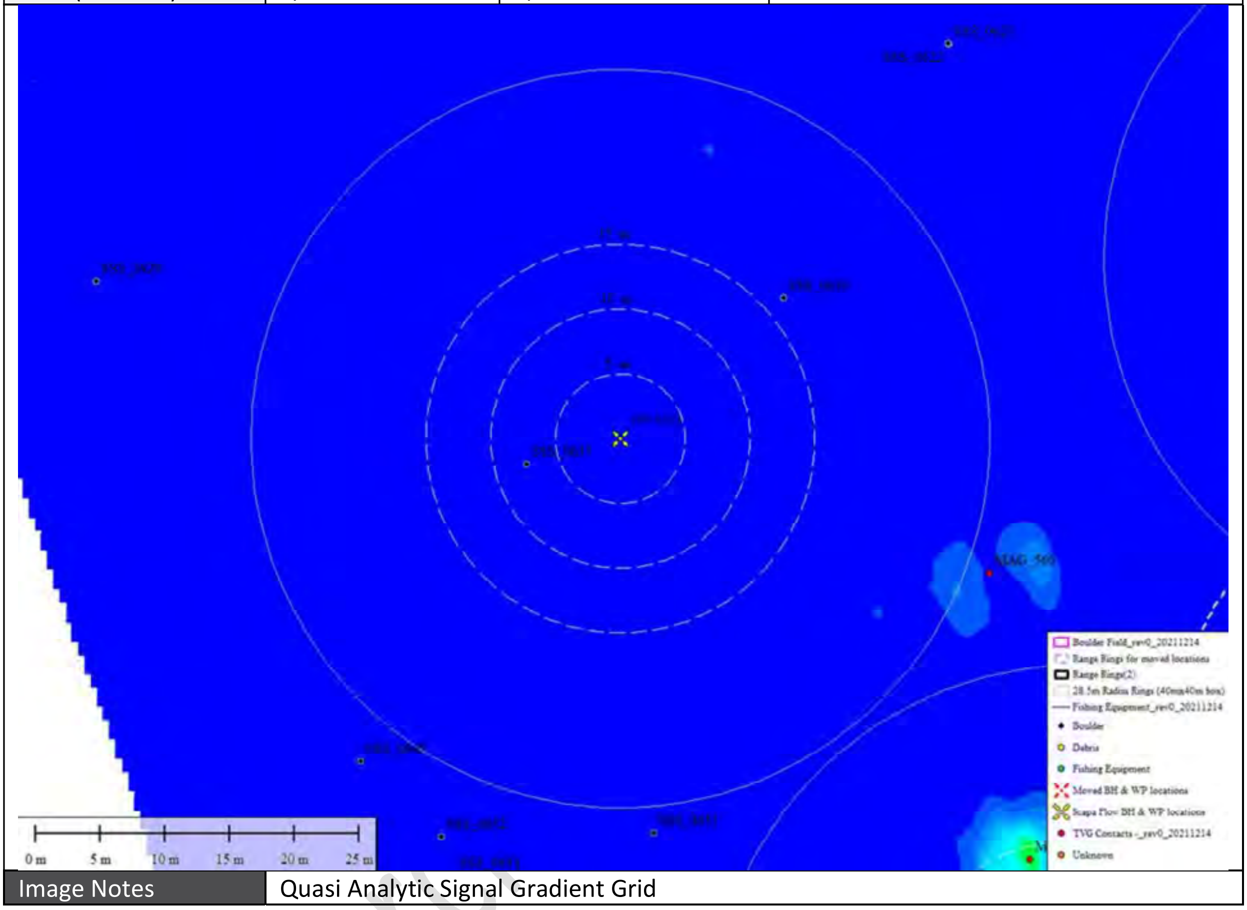			
Image Notes	Quasi Analytic Signal Gradient Grid		

Table 51: Magnetic analysis wash probe location WP-M30			
Location	WP-M30		Comments
Position	Easting	Northing	Moved away from fishing pots. Two optional locations.
Original (OSGB36)	344929.6	1004302.5	
New A (OSGB36)	344949.9	1004314.3	
New B (OSGB36)	344908.5	1004299.3	
Image Notes	Quasi Analytic Signal Gradient Grid		

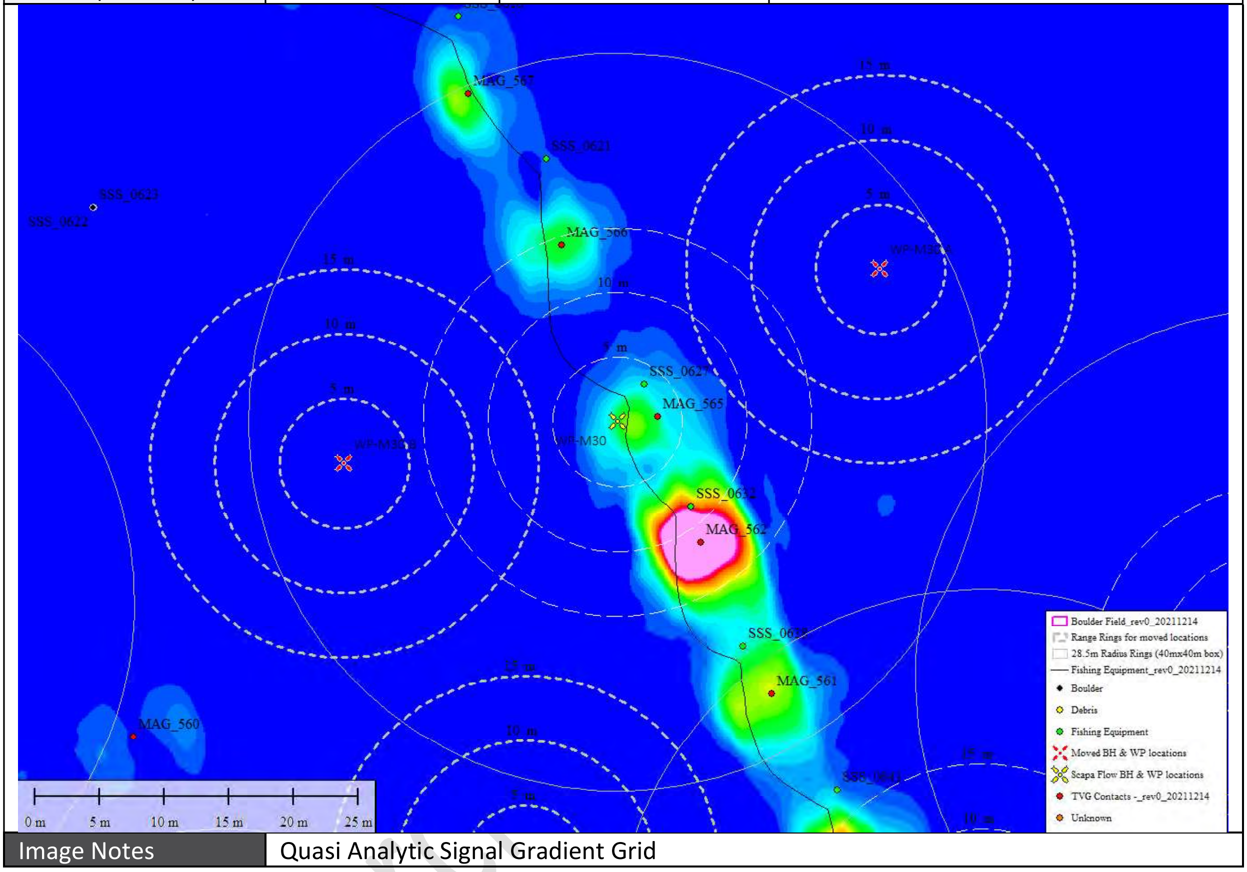

Table 52: Magnetic analysis wash probe location WP-M31			
Location	WP-M31		Comments
Position	Easting	Northing	Moved to better TVG coverage.
Original (OSGB36)	344981.1	1004282.7	
New (OSGB36)	344986.9	1004285.9	
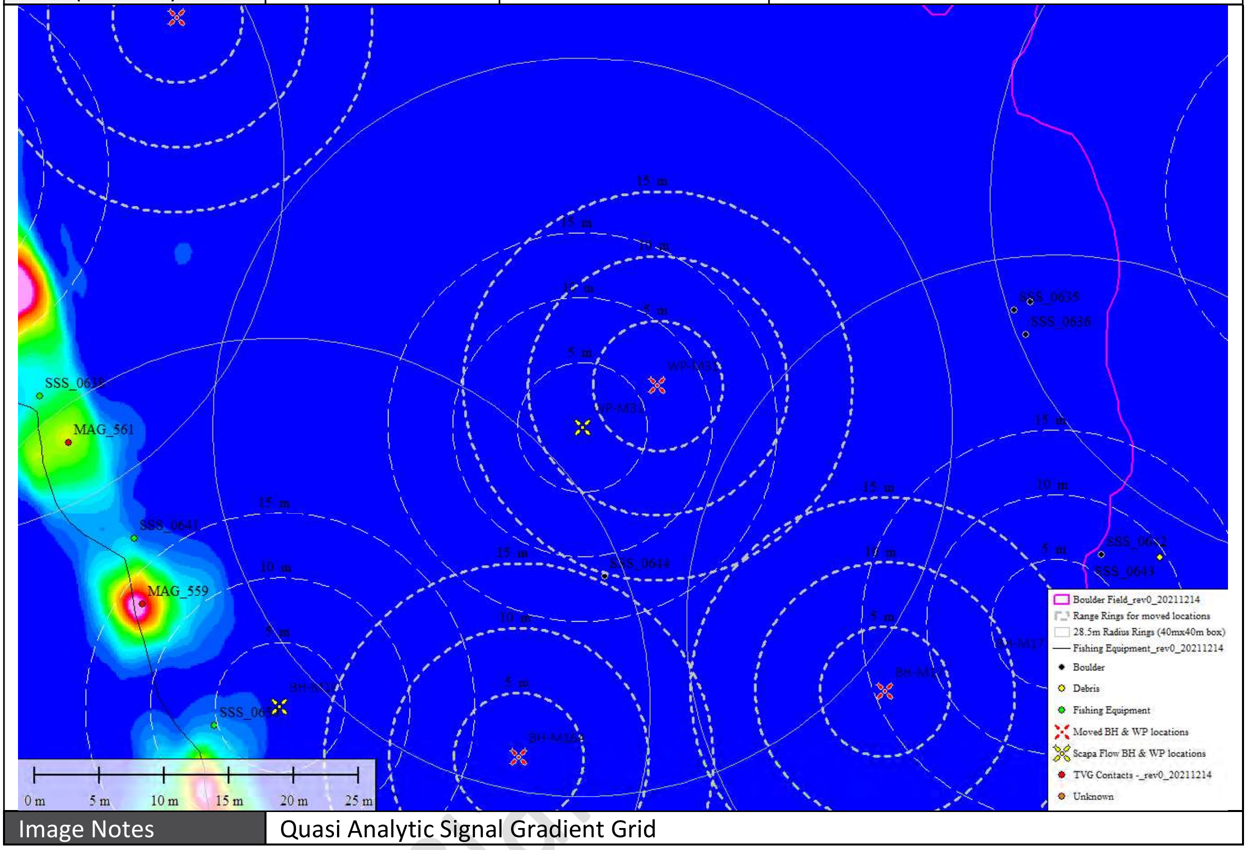			
Image Notes	Quasi Analytic Signal Gradient Grid		

Table 53: Magnetic analysis wash probe location WP-M32

Location	WP-M32		Comments
Position	Easting	Northing	Inside boulder field. Magnetometer anomaly approximately 20 m SE of WP location.
Original (OSGB36)	345041.0	1004300.4	
New (OSGB36)	n/a	n/a	
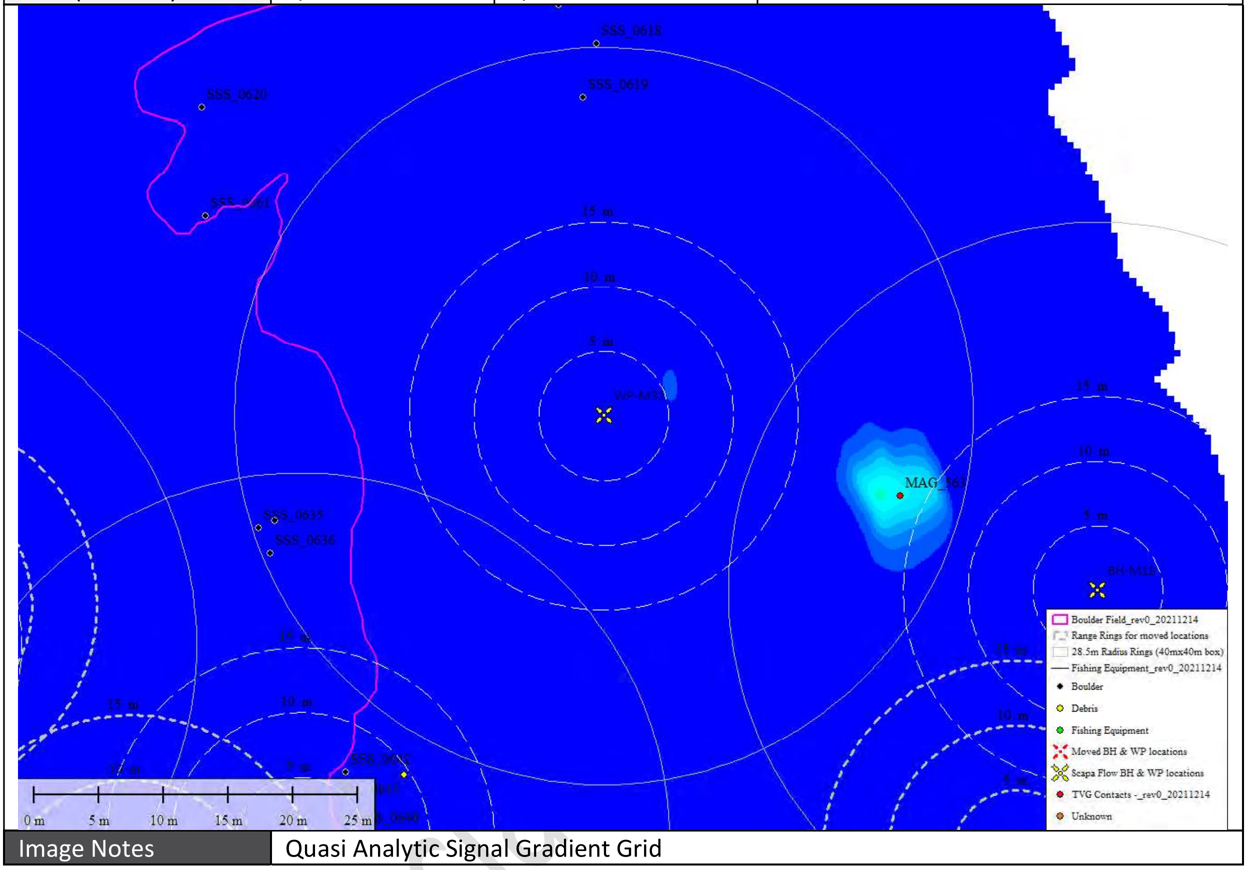			
Image Notes	Quasi Analytic Signal Gradient Grid		

5.3. RECOMMENDED GEOTECHNICAL LOCATIONS

Table 54: Recommended geotechnical locations, Scapa Deep Water Quay

BH & WP ID	Original locations (OSGB36)		New locations (OSGB36)	
	Easting	Northing	Easting	Northing
BH-M01	345 138.2	1003 688.9		
BH-M02	345 180.6	1003 714.8		
BH-M03	345 123.2	1003 736.6		
BH-M04	345 151.7	1003 798.0		
BH-M05	345 093.1	1003 832.0		
BH-M06	345 121.6	1003 893.4		
BH-M07	345 063.0	1003 927.3		
BH-M08	345 091.6	1003 988.8		
BH-M09	345 032.9	1004 022.7		
BH-M10	345 061.5	1004 084.1		
BH-M11	345 002.9	1004 118.1	344997.0	1004104.9
BH-M12	345 031.4	1004 179.5	345016.3	1004186.4
BH-M13 A	344 972.8	1004 213.5	344991.3	1004222.2
BH-M13 B			344954.9	1004199.7
BH-M14	344 924.8	1004 161.1	344915.8	1004164.3
BH-M15	344 899.1	1004 242.6	344911.9	1004236.1
BH-M16 A	344 957.8	1004 261.1	344976.2	1004257.2
BH-M16 B			344922.5	1004267.9
BH-M17	345 017.6	1004 267.5	345013.1	1004265.2
BH-M18	345 079.1	1004 286.9	345072.9	1004266.5
WP-M20	345 133.1	1003 649.8		
WP-M21	345 113.5	1003 712.0		
WP-M22	345 091.5	1003 781.7		
WP-M23	345 062.9	1003 872.3		
WP-M24	345 031.4	1003 972.4	345021.2	1003989.3
WP-M25	345 002.1	1004 065.3		
WP-M26	344 972.6	1004 158.8		
WP-M27	344 920.4	1004 095.1		
WP-M28	344 897.1	1004 195.0		
WP-M29	344 863.8	1004 288.6		
WP-M30 A	344 929.6	1004 302.5	344949.9	1004314.3
WP-M30 B			344908.5	1004299.3
WP-M31	344 981.1	1004 282.7	344986.9	1004285.9
WP-M32	345 041.0	1004 300.4		

6. ALARP STATUS AND CERTIFICATION

An ALARP certificate for the Hatston Pier and Scapa Deep Water Quay areas is hereby given for the surveyed areas and the expected scopes of works to be conducted in these areas. EODEX recommends that Causeway's planned scope of work can continue in accordance with these certificates and this report.

6.1. INTRODUCTION & PURPOSE

An ALARP certificate details how the UXO risk at this project location has been reduced to an acceptable level in accordance with the UK Health and Safety Executive (UK HSE) guidance and Reference D.

ALARP certification does not mean that UXO risk has been completely removed or reduced to zero. To do this for any site on land or at sea would be impractical. A residual risk will always remain, but this is at a level that is as low as reasonably practicable and is therefore able to be carried forward by the parties involved.

6.2. CERTIFIED PROJECT AREA

The ALARP certificate provided is unique to the areas surveyed by Rovco as detailed in Rovco's survey report (reference document H) and analysed by EODEX. No survey was conducted at any location outside those given in the drawings and therefore, liability for any UXO interaction outside of these areas can be accepted.

The proposed geotechnical operational activities have been considered during the risk mitigation processes and preparation of this certificate, which covers the following areas only:

- Area A – Haston Pier
- Area B – Scapa Deep Water Quay

If the scope of work expands to include other works, these may lead to a heightened level of UXO risk which may exceed the ALARP threshold given in this report and further UXO risk mitigation works may be required.

6.3. RISK TOLERANCE AND THE ALARP PRINCIPLE

The concept of reducing risk to 'ALARP lies at the heart of the British health and safety system. It is a key part of the general duties of the Health and Safety at Work etc. Act 1974 and many sets of health and safety regulations that the UK HSE and Local Authorities enforce. In general, any proposed regulatory action (Regulations, ACOPs, guidance, campaigns, etc.) should be based on what is reasonably practicable. In some cases, however, this may not be possible because the Regulations implement a European directive or other international measure that adopt a risk control standard different from 'reasonably practicable' (i.e., different from ALARP).

In most practical situations in the maritime environment, the level of residual risk can statistically never be zero. However, there will be a point at which it is accepted that the costs to achieve an acceptable level of residual risk are proportionate to the residual risks and to expend additional costs would be disproportionate to the residual risks that remain. ALARP may be considered as being achieved at this point.

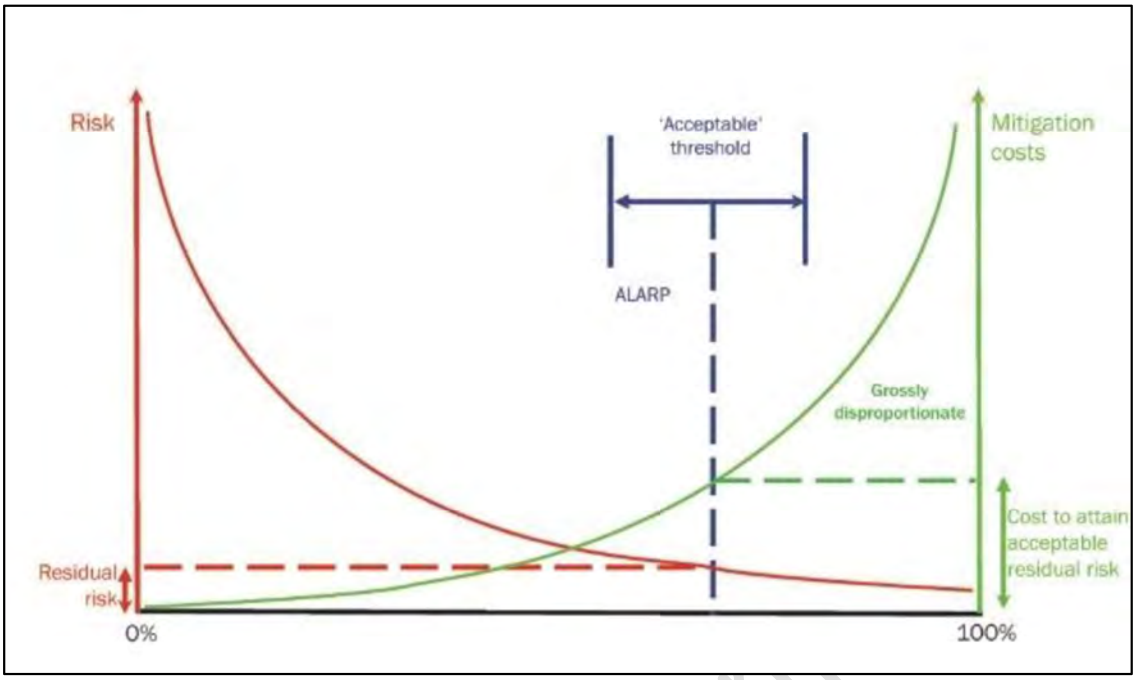

Figure 24: Achieving ALARP status (CIRIA C754)

The number of hazard items in a development area is rarely definitive; the limitations of current survey equipment technology mean that the probability of detection can never be 100% and therefore the probability of encounter cannot be zero. Similarly, the sensitivity and stability of any UXO present is not known and, therefore the probability of detonation cannot be zero.

There will always be a residual level of risk. The level will depend on the mitigation measures put in place.

6.4. UXO RISK ANALYSIS

EODEX were provided with the 3rd Party UXO Threat and Risk Assessment (reference document C) at the project start.

In providing this certification and associated documents EODEX undertook the following activities:

- Preparation of a document (reference I) reviewing the UXO desktop study provided by Causeway (reference document C, to determine the likely UXO threat items and burial.
- Determine UXO detectability and any residual risk to Causeway's scope of works based on the available geophysical data acquired and presented by Rovco (reference document H).

6.5. UXO RISK AT THE PROPOSED SITES

Following these steps, no potential UXO risk was identified, and so the UXO risk in the surveyed areas has been assessed as being ALARP, with no further investigations being required. In arriving at this declaration, EODEX has carefully followed the flow diagram 5.2 (Marine UXO risk management framework) within the CIRIA guidelines (reference document E), where the UXO risk assessment on completion of the survey did not identify any potential UXO risks.

Where no pUXO target was identified, i.e. no magnetic signal was received above the threat level or image detected meeting the sidescan sonar criteria for potential UXO, non-UXO items such as wooden debris or non-ferrous metals may still be buried in the seabed.

6.6. VALIDITY

This certificate and accompanying reports and documents are valid for a period of 1 year from the completion date of the survey. After this period, due consideration shall be given to the amount and scope of works that have taken place and the scope of works outstanding.

Further geophysical survey may be necessary depending on the planned works, weather and hydrographic conditions during the period and any likelihood of additional UXO contamination into the work areas.

SCAPA DEEP WATER QUAY EIAR

VOLUME 3

TECHNICAL APPENDIX 5

Technical Appendix 5.1	**Deepdale Vegetation Survey – 2021**
Technical Appendix 5.2	**Marine Mammal and Fish Baseline**
Technical Appendix 5.3	**Ornithology Technical Report**
Technical Appendix 5.4	**Habitat Mapping Survey**
Technical Appendix 5.5	**Habitats Regulations Appraisal**
Technical Appendix 5.6	**TBC**
Technical Appendix 5.7	**Marine Mammal Protection Plan**
Technical Appendix 5.8	**Otter Survey**

TECHNICAL APPENDIX 5.1

DEEPDALE VEGETATION SURVEY – 2021

Phase 1 and NVC report

Prepared by:

Andrew Upton
FIRTH ECOLOGY
Finstown, Orkney
01856 880176
firth.ecology@btinternet.com

Date: October 2022 – v.3

Summary

- A habitat and vegetation survey was carried out at the proposed location for a deep water quay at Deepdale, Holm, Orkney between July and October 2021.
- Particular attention was paid to the unimproved coastal habitats along and behind the shore.
- Habitats of high conservation value are present within the currently proposed development footprint, including maritime grassland and maritime heath, both of which are Annex 1 and UKBAP priority habitats. There are also numerous tufa-forming springs along the cliffs and sea-banks, which is an Annex 1 priority habitat.
- There does not appear to be any scope for avoidance or mitigation of impacts on the important habitats that lie under the proposed development.

1.1 INTRODUCTION

This report presents the methods and findings of a Phase 1 habitats and National Vegetation Classification (NVC) survey carried out at the proposed deep water quay site at Deepdale, Holm, Orkney during 2021.

The surveys were undertaken by Andrew Upton of Firth Ecology, an experienced local ecological surveyor with more than 15 years' experience of carrying out habitat/vegetation surveys in Orkney and northern Scotland for a variety of proposed developments.

The work was carried out over a number of days from July through to October 2021, alongside a continuing programme of bird fieldwork at the site.

1.2 METHODOLOGY

1.2.1 Survey area and methods

The survey area comprised the shoreline from the mouth of Burn of Deepdale south to the first small headland lying north of Tongue of Gangsta, and inland to the A961 public road.

Phase 1 survey covered the whole of the survey area and habitats were classified in accordance with the JNCC Phase 1 descriptions[1].

NVC survey concentrated on the unimproved habitats along and behind the shoreline. Quadrat samples (2 m x 2 m) were taken in different parts of the maritime grassland area and in patches of maritime heath in order to aid identification of communities and sub-communities and to provide evidence for the classifications made. For all of the unimproved vegetation, the detailed community

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[1] JNCC (2010). Handbook for Phase 1 habitat survey – a technique for environmental audit, 2010 edition. Revised 2016. Available online at:https://data.jncc.gov.uk/data/9578d07b-e018-4c66-9c1b-47110f14df2a/Handbook-Phase1-HabitatSurvey-Revised-2016.pdf. [Accessed 15 June 2021].

descriptions and tables in the NVC series[2, 3, 4], and the subsequent JNCC Guide to British Upland Vegetation[5] have been consulted. In addition, there are gaps within the NVC coverage that have subsequently come to light and new vegetation types have been proposed in a more comprehensive review[6] and additional commentary[7].

Aerial photographs were used to assist in delineating the boundaries of distinct vegetation types.

1.2.2 Limitations of survey

Several of the vegetation types were not straightforward to allocate to NVC classes and showed characteristics of more than one sub-community. The boundaries between these less distinct types were also difficult to pin down, so that some of the boundaries shown on the NVC map (**Map 3**) are approximate only, and others incorporate more than one sub-community with only a descriptive account of their location on the ground.

Certain vegetation types were not covered in the original NVC volumes, but are widespread in Scotland and have been described since, with suggested non-NVC codes. Similar codes have been given to the same type of vegetation here.

Still other types of vegetation found are not covered by the NVC or subsequent guidance at all and have been described here in words, rather than being given a code.

1.3 SURVEY FINDINGS

1.3.1 Site description

Agricultural land slopes down westwards from the public road, then more gently down to the shore, with a relatively narrow strip of unenclosed vegetation on sea-banks and low cliffs above a shingle beach. Immediately to the north lies a block of unploughed heather moorland, through which the Burn of Deepdale runs south-westwards to discharge at the northern end of the survey area. Views of the sea-banks and cliffs are shown in **Figures 1** and **2**.

The enclosed land has been variously improved, with the upper fields closest to the road generally those most recently ploughed and reseeded, and used for grazing and silage. The fields on the flatter land behind the shore have not been ploughed for many years and are used for late summer grazing.

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[2] Rodwell J S (ed) (1991). British Plant Communities Volume 2: Mires and heath. *Cambridge University Press.*

[3] Rodwell J S (ed) (1992). British Plant Communities Volume 3: Grasslands and montane communities. *Cambridge University Press.*

[4] Rodwell J S (ed) (2000). British Plant Communities Volume 5: Maritime communities and vegetation of open habitats. *Cambridge University Press.*

[5] Averis A M, Averis A B G, Birks H J B, Horsfield D, Thompson D B A and Yeo M J M (2004). An Illustrated Guide to British Upland Vegetation. *JNCC, Peterborough.*

[6] Rodwell J S, Dring J C, Averis A B G, Proctor M C F, Malloch A J C, Schaminee J N J and Dargie T C D (2000). Review of coverage of the National Vegetation Classification. *JNCC Report, No. 302. JNCC, Peterborough.*

[7] Averis B and Averis A (2020). Plant Communities Found by Ben and Alison Averis but not described in the UK National Vegetation Classification. Available at: http://www.benandalisonaveris.co.uk/resources/ [Accessed 01 October 2021].

only. Two smaller enclosures along the shore have not been ploughed at all, although they have been grazed in the past.

Figure 1. *View north along the shoreline from just south of the proposal; shows the fully vegetated sea-banks with cliffs at the far end of the shingle beach (near the centre of the proposal).*

The shoreline beyond enclosure is somewhat variably grazed by Rabbits and Greylag Geese, with the occasional stray cow or calf. The geese in particular made an impression in 2021, when a flock of up to several hundred utilised the sea-banks in the northern half of the survey area during their wing-moult period, when flightless adults were present with their growing young.

The Burn of Button is a southern tributary of the Burn of Deepdale and runs across the upper part of the site along a partly natural course; it is mainly open to grazing, but one ditched stretch alongside the main track is not accessible to stock and holds emergent vegetation.

Emerging sub-surface water is a feature near the shore, where there are several marshy areas arising in shallow depressions behind the cliffs; these feed trickles down channels onto the beach with a variety of damp vegetation. Groundwater proper also emerges directly from the cliff faces themselves.

1.3.2 Phase 1 habitats and NVC classes

A summary of the Phase 1 habitat types found within the survey area is provided in Table 1. Those along the shore and in the lowest fields where the development is proposed are also classified according to the NVC or equivalent descriptions. Only the more important and extensive of the vegetation types along the shore have been categorised down to NVC sub-community, otherwise they have been identified to community level only.

Figure 2. *Viewing north from near the centre of the proposal; shows the cliffs with steep vegetated banks above.*

In general, coastal habitats show a well-established zonation as the influence of the sea decreases with distance inland. There is often strandline vegetation at the high-water mark, rock-crevice vegetation on cliffs above the beach, coastal grassland on the cliff-tops and coastal heath behind the grassland. In a natural succession the upper coastal habitats would grade into non-maritime heath or grassland, although very often the zonation is abruptly truncated at the outer fence of improved agriculture. The precise nature and extent of the maritime grassland and heath communities on a coastline depends on latitude and exposure to sea-spray; the Scapa Flow shoreline at Deepdale is much more sheltered than ocean-facing coasts elsewhere in Orkney, so that maritime heath is able to grow to the very edge of the cliffs in places. Two enclosures behind the cliffs at the centre of the site are unploughed and this allows an extension of the zonation inland, beyond the usual narrow unenclosed strip; past grazing has had an influence here.

Further details on each of the NVC or equivalent vegetation types is given following the table, along with a brief note of the extent to which they might be affected by the development as currently proposed. A list of the all the species identified during the survey is given in **Tables E** and **F** in the appendix.

Table 1. List of Phase 1 habitats found within the survey area and NVC communities along the shore

Phase 1 code	Phase 1 habitat	NVC or equivalent code	NVC community/sub-community or equivalent description	Occurrence on site
A2.1	Dense scrub	W23	*Ulex europaeus-Rubus fruticosus* scrub	Two small patches on the cliff-top
B1.1	Unimproved acid grassland	a) U5c b) *not assigned*	a) *Nardus stricta-Galium saxatile* grassland, *Carex panicea-Viola riviniana* sub-community b) -	a) Unploughed enclosure behind the cliffs b) Fragment along double fenceline
B2.2	Semi-improved neutral grassland	a) *not assigned* b) MG5c	a) - b) *Centaurea nigra-Cynosurum cristatus* grassland, *Danthonia decumbens* sub-community	a) Unploughed slopes open to heavy grazing b) Field edge next to unploughed enclosure
B4	Improved grassland	*not assigned*	-	All of the larger enclosed fields
B5	Marshy grassland	a) M23b b) M27 c) M28 d) 'M23Jart' e) 'MCx' f) 'Caltha runnel'	a) *Juncus effusus/acutiflorus-Galium palustre* rush pasture, *Juncus effusus* sub-community b) *Filipendula ulmaria-Angelica sylvestris* mire c) *Filipendula ulmaria-Iris pseudacorus* mire d) *Juncus articulatus* mire e) Neutral small-sedge mire f) *Caltha palustris* runnels	In mosaics behind the cliffs where groundwater emerges; also M27 and M28 alongside the Burn of Deepdale
C1.1	Bracken	U20	*Pteridium aquilinum-Galium saxatile* community	Along west slope of Burn of Deepdale
D1.1	Dry acid heath	H10	*Calluna vulgaris-Erica cinerea* heath	One patch next to the LNCS moorland
E2.3	Bryophyte-dominated spring	Tufa-forming spring	Tufa-forming spring	Scattered along the sea-bank and cliffs
F2.1	Marginal vegetation	*not assigned*	-	Alongside a stretch of ditched burn
H5	Strandline vegetation	SD3	*Tripleurospermum maritimum-Galium aparine* strandline community	Intermittent along the upper shingle
H8.3	Crevice/ledge vegetation	MC2	*Armeria maritima-Ligusticum scoticum* maritime rock-crevice community	Intermittent along the cliffs
H8.4	Coastal grassland	a) MC8c b) MC9d c) MC9e & related	a) *Festuca rubra-Armeria maritima* maritime grassland, *Ligusticum scoticum* sub-community b) *Festuca rubra-Holcus lanatus* maritime grassland, *Primula vulgaris* sub-community c) *Festuca rubra-Holcus lanatus* maritime grassland, *Anthoxanthum odoratum* sub-community	In zonation along the length of the sea-bank and cliffs, from more to less maritime
H8.5	Coastal heathland	a) H7d & related b) H7b & related	a) *Calluna vulgaris-Scilla verna* heath, *Empetrum nigrum* sub-community b) *Calluna vulgaris-Scilla verna* heath, *Viola riviniana* sub-community	Patchily on top of the cliffs and extending back where unploughed

1.3.3 Non-maritime grasslands

B4 Improved grassland

The recently improved fields have very little botanical interest, primarily holding sown Perennial Ryegrass *Lolium perenne* and White Clover *Trifolium repens* and were not investigated. During bird survey work, one field edge where the grass had not yet grown thickly in the dry early summer held a scattering Wild Pansy *Viola tricolor*, presumably arising from the seed bank after reseeding.

These fields will be partially impacted by the development, primarily due to the access road.

The older improved fields down near the shore have a wider range of grasses and common forbs re-established in the sward such as Yorkshire-fog *Holcus lanatus*, Meadow Buttercup *Ranunculus acris* and Daisy *Bellis perennis* but in most places there is little of real interest and they were not investigated in any detail.

Approximately half of the area of these fields will be impacted, since the bulk of the landward quay area will be situated on them.

B2.2 Semi-improved neutral grassland

In places steep slopes within the improved fields have not been ploughed and retain some of their original flora. At the top of the site, the Burn of Button cuts diagonally across one of the upper fields; it has not been ditched and appears to follow a natural course with low banks set back on either side. These were seen to hold colourful patches of Lesser Celandine *Ficaria ficaria* and Primrose *Primula vulgaris* in the early summer, but were not investigated in detail.

These banks are not expected to be impacted.

A broad lower edge of one grazed field holds a wider range of species, with abundant Crested Dog's-tail *Cynosurus cristatus* alongside Sweet Vernal-grass *Anthoxanthum odoratum*, Red Fescue *Festuca rubra*, Ribwort Plantain *Plantago lanceolata*, Yellow Rattle *Rhinanthus minor* and Northern Marsh Orchid *Dactylorhiza purpurella*. This was not investigated in detail, but is likely to represent MG5c *Centaurea nigra-Cynosurus cristatus* grassland, the *Danthonia decumbens* sub-community. It lies immediately behind the unploughed shoreside enclosure, in which the recently ungrazed grassland appears to grade from maritime grassland towards neutral grassland away from the shore (see **1.3.4** below).

This area will be almost wholly lost to the development.

B1.1 Unimproved acid grassland

On one shallow slope within the unploughed enclosures, there is sufficient Mat-grass *Nardus stricta* for the vegetation to be classed as U5 *Nardus stricta-Galium saxatile* grassland. However, it is not strongly acidic and the presence of more mesotrophic species such as Crested Dog's-tail, Ribwort Plantain, Self-heal *Prunella vulgaris*, Meadow Buttercup, Devil's-bit Scabious *Succisa pratensis*, Eyebright *Euphrasia* sp. and damper indicators such as Glaucous Sedge *Carex flacca*, Jointed Rush *Juncus articulatus* and Sneezewort *Achillea ptarmica* points towards U5c, the *Carex panicea-Viola riviniana* sub-community. It is clearly related to the maritime grasslands on either side and, other than the abundance of the Mat-grass, could perhaps be accommodated within them (e.g. in the 'MC9e-related' category – see **1.3.4** below).

This area will be wholly lost to the development.

Within the double fenceline between the buildings of Deepdale and Netherbutton, a fragment of less improved grassland was encountered during bird survey work. It holds Pignut *Conopodium majus*, Sweet Vernal-grass, Yellow Rattle, Ribwort Plantain and Bird's-foot Trefoil *Lotus corniculatus*. The first two of these species indicate that this is an acid grassland, but it was not investigated in any further detail.

This area will not be impacted.

1.3.4 Maritime grasslands

The maritime grassland extends the full length of the shoreline, with a rough zonation of types from the base of the vegetated parts of the cliffs up to the cliff-top and (in a less natural state) some way inland. The maritime grassland complex at Deepdale appears to be a particularly species-rich example compared to that found around much of the Orkney coastline.

MC8c maritime grassland

MC8c F*estuca rubra-Armeria maritima* maritime grassland, the *Ligusticum scoticum* sub-community is the most maritime grassland type identified at Deepdale, growing in a very narrow and intermittent band just above the rocky cliffs, or above the shingle where the sea-bank is vegetated right down to the beach. It is comprised of thick mats of Red Fescue, with frequent clumps of Thrift *Armeria maritima* and occasional plants or patches of Scots Lovage *Ligusticum scoticum*. Its occurrence is too small to be mapped and it is not shown separately on the NVC map; it forms a seaward edge to much of the MC9 grassland on the map.

The majority of the MC8c within the survey area will be lost to the development.

MC9d maritime grassland

Above the fringe of MC8, on the steeper slopes, Red Fescue is still abundant, but less strongly dominant and with a wider variety of associated species. One of the most striking here is Primrose, making colourful displays in the early summer alongside Lesser Celandine, Common Dog-violet *Viola riviniana* and occasional Wild Thyme *Thymus polytrichus* and Common Milkwort *Polygala vulgaris*. This is MC9d *Festuca rubra-Holcus lanatus* maritime grassland, the *Primula vulgaris* sub-community. A characteristic species found patchily here on these slopes is Wood False-brome *Brachypodium sylvaticum*, which is a coastal rather than woodland species in the far north. Three quadrats are shown in **Table A** in the appendix. **Figure 3** Shows this type of vegetation flowering in early summer on a steep, low sea-bank at the north of the site.

The majority of the MC9d within the survey area will be lost to the development.

Figure 3. *Richly flowering MC9d sea-bank at the north of the site, with Primrose, Thrift, Spring Squill, Kidney Vetch, and Daisy; Common Milkwort is also present here, but less obvious in the photo.*

MC9e and 'related' maritime grassland

On the flatter cliff-tops there is a wider range of species again, but with Primrose becoming less common. Maritime species still present are Sea Plantain and occasional Spring Squill *Scilla verna* (but not found in the quadrats) and non-maritime species such as Cat's-ear *Hypochaeris radicata*, Red Clover *Trifolium pratense*, White Clover *Trifolium repens* and Common Mouse-ear *Cerastium fontanum* appear. This is MC9e, the *Anthoxanthum odoratum* sub-community of *Festuca rubra-Holcus lanatus* maritime grassland. The abundance of Sweet Vernal-grass and the high frequencies of Spreading Meadow-grass *Poa humilis* and Sea Plantain are typical of this sub-community. Four quadrats are shown in **Table B** in the appendix.

The majority of the MC9e within the survey area will be lost to the development.

Two smaller enclosures behind the shore are unploughed and the grassland within them appears to grade from the cliff-top MC9e towards less maritime neutral or slightly acidic grassland. The sward has abundant broad-leaved herbs and is most akin to MG5c *Centaurea nigra-Cynosurus* grassland, the *Danthonia decumbens* sub-community but with little Crested Dog's-tail, which is much more abundant in the grazed field adjacent inland (see **1.3.3** above). This grassland is perhaps more difficult to define since, as well as occurring in what appears to be a broad maritime/non-maritime transition, it has almost certainly been derived from grazed out heath rather than an original grassland. In general appearance it is similar to the cliff-tops although the quadrat data (three quadrats shown in **Table C** in the appendix) indicate that any clearly maritime influence has been lost, with no Sea Plantain present. It is considered here to be close to MC9e and is termed 'MC9e-related'. The boundaries between the MC9e proper and 'MC9e-related', and also onward to the MG5c of the adjacent field, are difficult to discern or to draw precisely. For simplicity they have mainly been mapped at the fence lines that separate the unenclosed/enclosed grassland and the ungrazed/grazed grassland. The 'MC9e-related' grassland has been included as a coastal grassland in the vegetation valuation in section **1.4** below.

This area will be almost wholly lost to the development.

The Burn of Deepdale cuts across the edges of two fields near the shore; the steep banks are open to heavy grazing, dunging and poaching – they are nevertheless semi-natural and show patchy coastal influence, with Sea Plantain *Plantago maritima* still present in places and abundant Primrose. They were not investigated in detail.

These banks will not be impacted by the development.

1.3.5 Heathland and scrub

H7d and 'related' maritime heath

Coastal heath is present right up to the edge of the cliffs in places, indicating the less exposed nature of this relatively sheltered coast. Five quadrats were taken in this vegetation, as shown in **Table D** in the appendix. It is clearly a form of H7 *Calluna vulgaris-Scilla verna* heath, although lacking the squill (which was seen nearby) and Wild Thyme from the quadrats. On balance the areas outside of the fence have been classed here as H7d, the *Empetrum nigrum* sub-community, with constant and often abundant Crowberry *Empetrum nigrum* and acid grassland species such as Sweet Vernal-grass and Common Bent *Agrostis capillaris*. However, it also shows some characteristics of H7b, the *Viola riviniana* sub-community, especially the abundance of Bell Heather *Erica cinerea* and the constant presence of Cat's-ear and Glaucous Sedge.

The majority of the H7d within the survey area will be lost to the development.

To the north of the Burn of Deepdale there is a seaward fringe of Crowberry-dominated heath on top of the higher cliff there. This differs from the H7d to the south of the burn in that it has abundant Common Sedge *Carex nigra* growing through the shrubs, with patchy Common Cottongrass *Eriophorum angustifolium*. This does not fit in readily with the NVC categories, although seems clearly related to H7d; similar-looking cliff-top vegetation found elsewhere in Orkney (e.g. on Stronsay) has been termed 'wet Empetrum heath'; here it is classed as 'H7d-related' heath.

This 'H7d-related' heath will not be impacted.

H7b and 'related' maritime heath

Very grassy heath inside the unploughed enclosure was not sampled by quadrat, but had low-growing Heather *Calluna vulgaris* at 50% cover or more with only very occasional plants of Crowberry, Bell Heather and Cross-leaved Heath *Erica tetralix*. It is therefore clearly heath, despite its grassy appearance, and is presumably derived from former grazed-out heath that is now recovering. Where it is contiguous with the heath beyond the fence both Primrose and Common Dog-violet occur, petering out up the slope, and this has been classed as H7b the *Viola riviniana* sub-community, which is typically one of the less maritime H7 sub-communities.

Further away from the shore the violet disappears, but the constant presence of Cat's-ear and Glaucous Sedge indicate that this is close enough to be termed 'H7b-related' heathland and it has been included as a coastal heath for valuation purposes (section **1.4** below).

All of the H7b and related heathland will be lost to the development.

H10 dry heath

There is a small patch of drier-looking heath adjacent to the wider moorland to the north of the site, which has little discernible maritime influence. It is mainly comprised of Heather and Bell Heather, with much less Crowberry. There is a scattering of the lichen *Cladonia portentosa* here. It was not investigated in any detail, but falls within the H10 *Calluna vulgaris-Erica cinerea* community.

This heath will not be impacted.

W23 Gorse scrub

Gorse *Ulex europaeus* is not native to Orkney and the presence of two small patches on the cliff-tops is of little consequence. It was not investigated in detail.

One of these patches will be lost to the development.

1.3.6 Flushed habitats, streamsides and springs

At the Deepdale site, flushed habitats include a variety of rush, sedge and Meadowsweet *Filipendula ulmaria*, dominated vegetation. Sub-surface water emerges at the heads of shallow channels behind the cliffs and these feed, or are associated with, all of these flushed vegetation types.

Alongside burns and trickles Meadowsweet may again by abundant, as well as stands of Yellow Iris *Iris pseudacorus* or strips of wet Marsh-marigold *Caltha palustris* grassland.

Springs and seepages emerge directly from the sea-cliffs and sea-banks, where they appear to be clearly fed by calcareous groundwater, and are tufa-forming and dominated by characteristic mosses.

M23b Soft Rush mire and 'M23Jart' Jointed Rush mire

Rush-dominated vegetation surrounds most of the seepages. Where this is mainly Soft Rush *Juncus effusus* it falls within M23b *Juncus effusus/acutiflorus-Galium palustre* rush pasture, the *Juncus effusus* sub-community. Where Jointed Rush *Juncus articulatus* is the dominant rush, the vegetation is lower-growing and the largest ungrazed example of this is the richest of the flushed habitats, with species such as: Marsh Pennywort *Hydrocotyle vulgaris*, Marsh-marigold, Lesser Spearwort *Ranunculus flammula*, Greater Bird's-foot Trefoil *Lotus pedunculatus*, Sneezewort *Achillea ptarmica* and Star Sedge *Carex echinata*. This vegetation is not included in the NVC, but similar vegetation is found in Orkney[8] and elsewhere[9] and has been termed 'M23Jart'. The flushed areas arising within the improved grassland are grassier and heavily impacted by cattle-grazing, but appear to have been derived from 'M23b'.

All of the Soft Rush and Jointed Rush vegetation will be lost to the development.

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[8] A Upton, pers. obs.

[9] Averis B and Averis A (2020). Plant Communities Found by Ben and Alison Averis but not described in the UK National Vegetation Classification. Available at: http://www.benandalisonaveris.co.uk/resources/ [Accessed 01 October 2021].

‘MCx’ neutral small-sedge mire

In places the flushed vegetation is dominated by Glaucous Sedge, or holds this species in abundance accompanied by prominent Field Horsetail *Equisetum arvense*, Wild Angelica *Angelica sylvestris*, Devil’s-bit Scabious, Compact Rush *Juncus conglomeratus* and Marsh Willowherb *Epilobium palustre*. These sedge mires lack any conspicuous moss layer to indicate their acidic or basic affiliation and fall under a broad neutral sedge-mire heading not defined in the NVC.

All of this sedge-mire will be lost to the development.

M27 Meadowsweet mire, M28 Iris mire and Marsh-marigold runnels

The bulk of this vegetation occurs alongside the lower part of the Burn of Deepdale where it fills the level ground between steep banks set back from the burn. Here there is a mixture of thick stands of Meadowsweet and Iris, with both species interleaved to a considerable extent; the M28 has been delineated on the NVC map where Iris was the visually dominant component. There are few associated species and no sub-communities have been assigned.

These main stands of M27 and M28 will not be impacted.

Where the trickles arising behind the shore run down as runnels across the sea-bank, they are mostly lined with soft muddy ground with a grassy covering of Creeping Bent *Agrostis stolonifera* and sometimes thick Marsh-marigold. Associated species in one such trickle are Glaucous Sedge, Lady’s-smock *Cardamine pratensis*, White Clover, Yorkshire-fog *Holcus lanatus* and Red Fescue. Being such small areas, fed by somewhat differing mire vegetation upstream, there are individual differences between them, but all are marked by an abundance of Marsh-marigold and a general grassiness. This type of wet grassland is not well-covered in the NVC and bears similarities to different non-NVC types in which Marsh-marigold and/or Creeping Bent are abundant. **Figure 4** shows one of these runnels in full flower in early summer.

There are also small patches of Meadowsweet set within the maritime grassland on the cliff-tops and these are probably mainly kept damp by surface or near-surface water and run-off.

All of this wet and damp vegetation will be lost to the development.

Figure 4. *Cliff-top runnel with abundant flowering Marsh-marigold in early summer.*

Tufa-forming springs

More than 20 tufa-forming springs or seepages arise directly from the cliffs or sea-banks, along the full length of the shore where the development is proposed, with an outlying location along the lower course of the burn. These are rather species-poor and variable in their amount of vegetation cover, but include characteristic mosses which can thrive in the calcareous water. No NVC category covers lowland springs of this type, but recent work in Ireland[10] has proposed eight groupings, of which two appear to be present here. These are the Group 1 *Eucladium verticillatum-Pellia endiviifolia* Tufa cascades and Group 4 *Palustriella commutata-Agrostis stolonifera* Springheads. **Figure 5** shows one of these springs at the southern end of the site and four more examples from the centre and north of the site are shown in section **1.5**, Additional Photographs, below.

One of the trickles from the inland springs is also lined with this type of mossy vegetation where it crosses the top of the sea-bank over gravelly rather than muddy ground.

Most of the springs will be lost directly under the development; the four that will not be lost may be affected indirectly due to changes in the adjacent groundwater flow.

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[10] Lyons M D & Kelly D L (2016). Monitoring guidelines for the assessment of petrifying springs in Ireland. Irish Wildlife Manuals, No. 94. National Parks and Wildlife Service, Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs, Ireland. Available online at: https://www.npws.ie/sites/default/files/publications/pdf/IWM94.pdf. [Accessed 13 Jan 2022].

Figure 5. *Tufa-forming spring at the south end of the site; just above the shingle here.*

1.3.7 Shoreline habitats

Two very narrow, intermittent shoreline habitats occur to seaward of the fully vegetated cliff-tops and banks. These are the strandline along the upper shingle and scattered rock-crevice vegetation on the steeper and vertical cliffs. Both are somewhat fragmentary habitats and although accommodated within existing NVC categories here, there are some parts which might be better thought of as ‘related’ to these communities rather than falling entirely within them.

The NVC Review indicated that the number of strandline types in particular could be expanded to cover those dominated by orache *Atriplex* species, as found in one stretch here, but it is all at present accommodated within SD3, the *Tripleurospermum maritimum-Galium aparine* strandline community.
Strandline vegetation will be partially lost under the proposed development.

The cliff vegetation here is rather poor in species, mainly comprising a scattering of Thrift and Sea Plantain with the moss *Schistidium maritimum*. This is clearly related to MC2, the *Armeria maritima-Ligusticum scoticum* maritime rock-crevice community found around northern shores, but at this site the Scots Lovage primarily grows within the lower band of maritime grassland rather than on the cliffs themselves.
The majority of the rock-crevice vegetation within the survey area will be lost under the development.

1.4 IMPORTANCE OF HABITATS AND VEGETATION

1.4.1 Reference lists

The NVC vegetation types at Deepdale fall within broader habitats that have been recognised as important at different regional scales – European, UK, Scottish and Orkney – and have been listed in various biodiversity documents produced by different bodies. These listings are:

- Annex I of the EC Habitats Directive – as habitat types of 'Community Interest' requiring the designation of special areas[11];
- the UK Biodiversity Action Plan, UKBAP – as 'priority' habitats[12], and
- the Scottish Biodiversity List, SBL – including those placed on a 'watching brief'[13].
- the Orkney Local Biodiversity Action Plan – as 'priority' or 'locally important' habitats in Orkney[14].

The definitions within each list are not identical, nevertheless there is broad correspondence. The listed habitats are nested within this hierarchy so that Annex I habitats are also important at each of the more local levels.

1.4.2 Evaluation of habitats and vegetation at Deepdale

The habitats occurring in the Deepdale survey area which qualify as priorities or as important at each of these levels are summarised in Error! Reference source not found..

Map 4 shows the study area vegetation by its relative value within these listings.

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[11] European Council (1922). Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. Available online at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:01992L0043-20130701&from=EN. [Accessed 15 June 2021].

[12] JNCC (2019). UK BAP Priority Habitats. Available online at: https://jncc.gov.uk/our-work/uk-bap-priority-habitats/#list-of-uk-bap-priority-habitats. [Accessed 15 June 2021].

[13] NatureScot (2020). Scottish Biodiversity List. Available online at: https://www.nature.scot/scottish-biodiversity-list. [Accessed 01 October 2021].

[14] The Orkney Local Biodiversity Action Plan (2018). Version 1.3: A targeted action plan for 2018 - 2022. *Prepared by Orkney's Biodiversity Steering Group for The Orkney Environment Partnership.*

Table 2. Vegetation types at Deepdale which are included in legislative and biodiversity lists.

NVC and non-NVC communities	Habitats Directive Annex I	UKBAP Priority list	Scottish Biodiversity List	Orkney LBAP priority and locally important habitats
Tufa-forming spring	***PRIORITY*** Petrifying springs with tufa formation (Cratoneurion)	Included in: Maritime cliff and slopes	Included in: Maritime cliff and slopes	Included in: Base-rich flushes
H10 dry heath	European dry heaths	Upland heathland	Upland heathland	Lowland heath
H7 & related maritime heath	European dry heaths	Maritime cliff and slopes	Maritime cliff and slopes	Maritime heath; *Empetrum* heath
MC8, MC9 & related maritime grassland	Vegetated sea-cliffs of the Atlantic and Baltic coasts	Maritime cliff and slopes	Maritime cliff and slopes	Maritime grassland
MC2 rock crevice vegetation	Vegetated sea-cliffs of the Atlantic and Baltic coasts	Maritime cliff and slopes	Maritime cliff and slopes	Maritime cliff and slopes
SD3 strandline vegetation	Annual vegetation of drift lines	Coastal vegetated shingle	Coastal vegetated shingle	Coastal strandline
M23b, 'M23Jart', M27, M28, 'MCx', 'Caltha runnel'	-	Upland flushes, fens and swamps	Upland flushes, fens and swamps	Wet meadow; marsh
U5	-	-	U5 Acid Grassland	-
MG5c	-	-	-	Species-rich grassland

Some notes may be made on the biodiversity listing categories in **Table 2** as follows:

- Tufa-forming springs are included within differing broader habitats at levels below the Habitats Directive.
- The Annex 1 vegetated sea-cliffs is a very broad habitat and includes the small flushed areas and runnels which cross the cliff-tops, even though these are also defined more closely at the lower UKBAP level.
- The H10 dry heath is regarded as 'lowland' purely in an Orkney context.
- As noted already, the complex of MC9d and MC9e maritime grassland at Deepdale appears to be a particularly species-rich example compared to much of the maritime grassland around Orkney.

- The U5 acid grassland is included in the Scottish Biodiversity List under the heading 'watching brief only' i.e. it is of 'less concern'.

The various listings in **Table 2** give an accepted judgement on the biodiversity value of each habitat, as a whole. This does not necessarily translate to a habitat's importance or value at the site level – for instance strandline is listed at all levels, implying that it is important at up to the European level, but every individual stretch is not treated as internationally important in ecological impact assessment – indeed it is very common on Orkney shores wherever there are deposits of shingle, cobbles or boulders on the upper beach. However, there are other habitats which are much more restricted in extent, particularly tufa-forming springs and the floristically rich maritime grasslands found at Deepdale.

These habitats and their constituent vegetation types may be considered as priorities for biodiversity conservation at the level of the legislation or plan in which they feature. The wordings of the UKBAP objectives clearly imply that a no-net-loss scenario is a prime target for each UKBAP habitat, and they are therefore high conservation priorities wherever they occur. The majority of these habitats are in favourable condition within the Deepdale survey area.

1.4.3 Rare, scarce and declining species

No nationally rare or nationally scarce plant species at a GB level were identified from this survey work.

1.4.4 Groundwater dependent terrestrial ecosystems (GWDTE)

Since the implementation of the EU Water Framework Directive (WFD), SEPA has drawn attention to the requirement to consider habitats that are dependent on groundwater within impact assessments. Such habitats are termed 'groundwater dependent terrestrial ecosystems' (GWDTE) and a list of the relevant NVC communities considered likely to be highly or moderately groundwater dependent has been compiled by SEPA[15]. The occurrence of these communities is detailed in **Table 3** along with information regarding their setting at the study area which indicates the extent to which they occur in situations indicative of potential groundwater dependence.

Map 5 shows the location of potentially groundwater dependent vegetation, based on the NVC classes and SEPA's NVC table.

The approach taken by the Water Framework Directive defines groundwater as the body of water (aquifer) in the underlying rock i.e. it does not appear to include shallow subsurface water in the soil which is separated from the rock aquifer by impermeable soil or subsoil layers.

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[15] SEPA (2017). *Guidance on Assessing the Impacts of Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems.* Land Use Planning System, SEPA Guidance Note 31, Version 3, Issue date: 11/09/2017. Available online at: https://www.sepa.org.uk/media/144266/lups-gu31-guidance-on-assessing-the-impacts-of-development-proposals-on-groundwater-abstractions-and-groundwater-dependent-terrestrial-ecosystems.pdf [Accessed 01 October 2021].

The clearest evidence of groundwater is where springs arise directly from the cliffs and deposit tufa – the high calcium carbonate content of this water can only have been obtained from the influence of underlying bedrock.

The water emerging from the grassland close behind the cliffs is not so obviously calcareous and may therefore be from shallower subsurface layers e.g. through the subsoil or at the subsoil/rock interface, rather than rock aquifer groundwater in the Water Framework Directive sense; however the vegetation associated with it has been regarded here as potentially partially groundwater dependent.

Table 3. Occurrence of SEPA-defined NVC communities likely to be highly or moderately groundwater dependent (depending on the hydrogeological setting). The highlighted row indicates the most clearly groundwater dependent vegetation – all other types are potentially partially groundwater dependent.

NVC community	NVC Community Name (per SEPA's table)	Per SEPA as likely to be highly or moderately groundwater dependent	Occurrence of habitat at the Deepdale site in the context of the hydrogeological setting
M23b	*Juncus effusus/ acutiflorus-Galium palustre* rush pasture	Highly	These flushes are associated with the water emerging from grassland behind the cliffs; as such they may not be connected to 'rock aquifer' groundwater.
'M23Jart'	(treated the same as M23b)	Highly	
M27	*Filipendula ulmaria-Angelica sylvestris* mire	Moderately	The bulk of this vegetation is alongside the lower Burn of Deepdale; most likely kept damp due to surface run-off from the slopes on either side as well as the influence of the burn. The smaller stands linked to the water emerging behind the cliffs may not be connected to 'rock aquifer' groundwater.
M28	*Iris Pseudacorus - Filipendula ulmaria* mire	Moderately	This vegetation is alongside the lower Burn of Deepdale; most likely kept damp due to surface run-off from the slopes on either side as well as the influence of the burn.
'MCx'	(treated as M6)	Highly	These flushes and streamsides are associated with the water emerging from grassland behind the cliffs; as such they may not be connected to 'rock aquifer' groundwater.
'Caltha runnel'	*(treated as MG8)*	Moderately	
Tufa-forming springs	(treated the same as M37 and M38 *Cratoneuron* springs)	Highly	These highly calcareous springs appear to be clearly fed by groundwater emerging from the bedrock.

1.5 ADDITIONAL PHOTOGRAPHS

Figure 6. *Tufa cascade from the top part of the cliff, near the centre of the site. This example with low vegetation cover.*

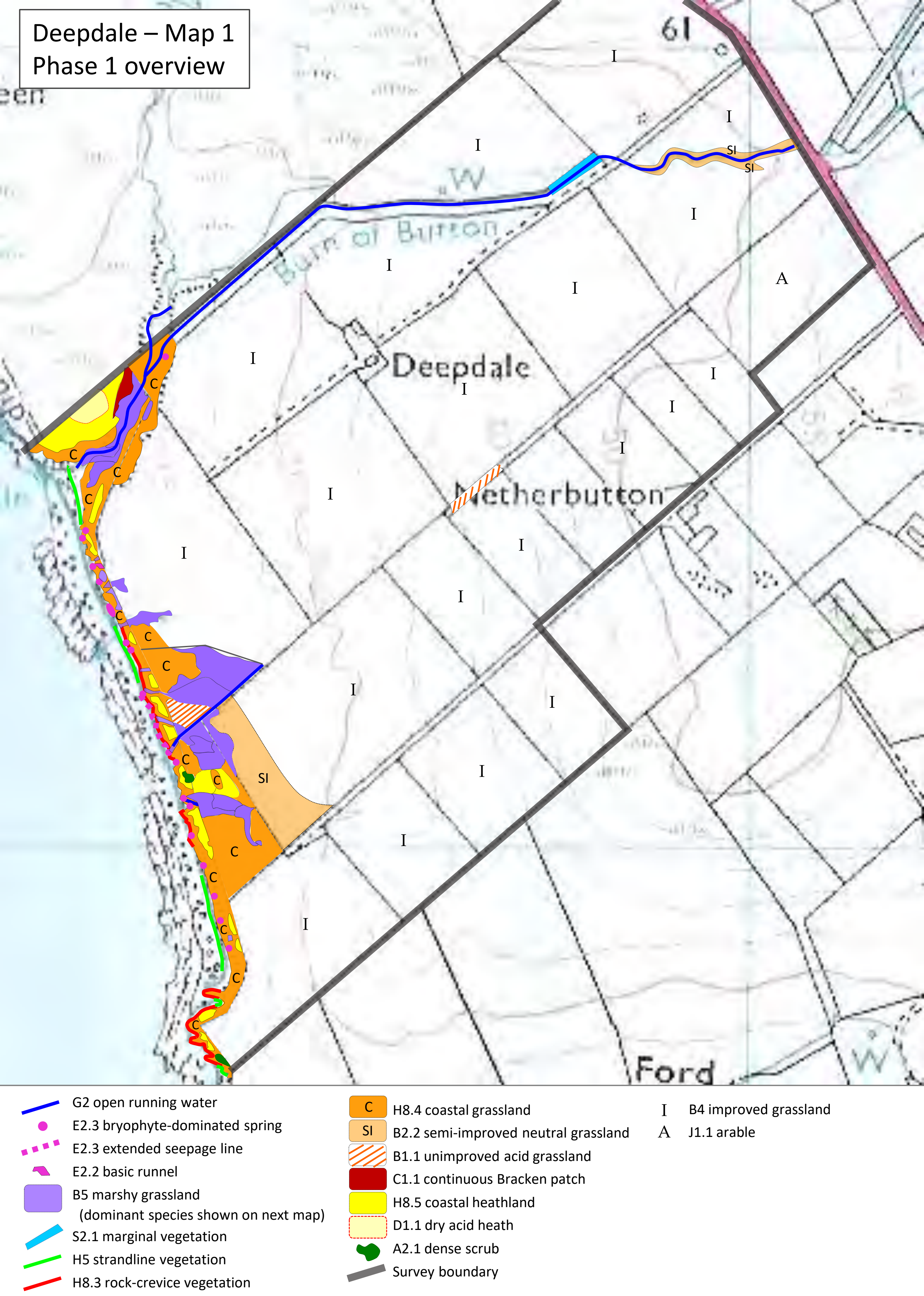
4 SEP 2021

Figure 7. *Well-vegetated tufa spring near the centre of the site, with much Creeping Bent Agrostis stolonifera*.

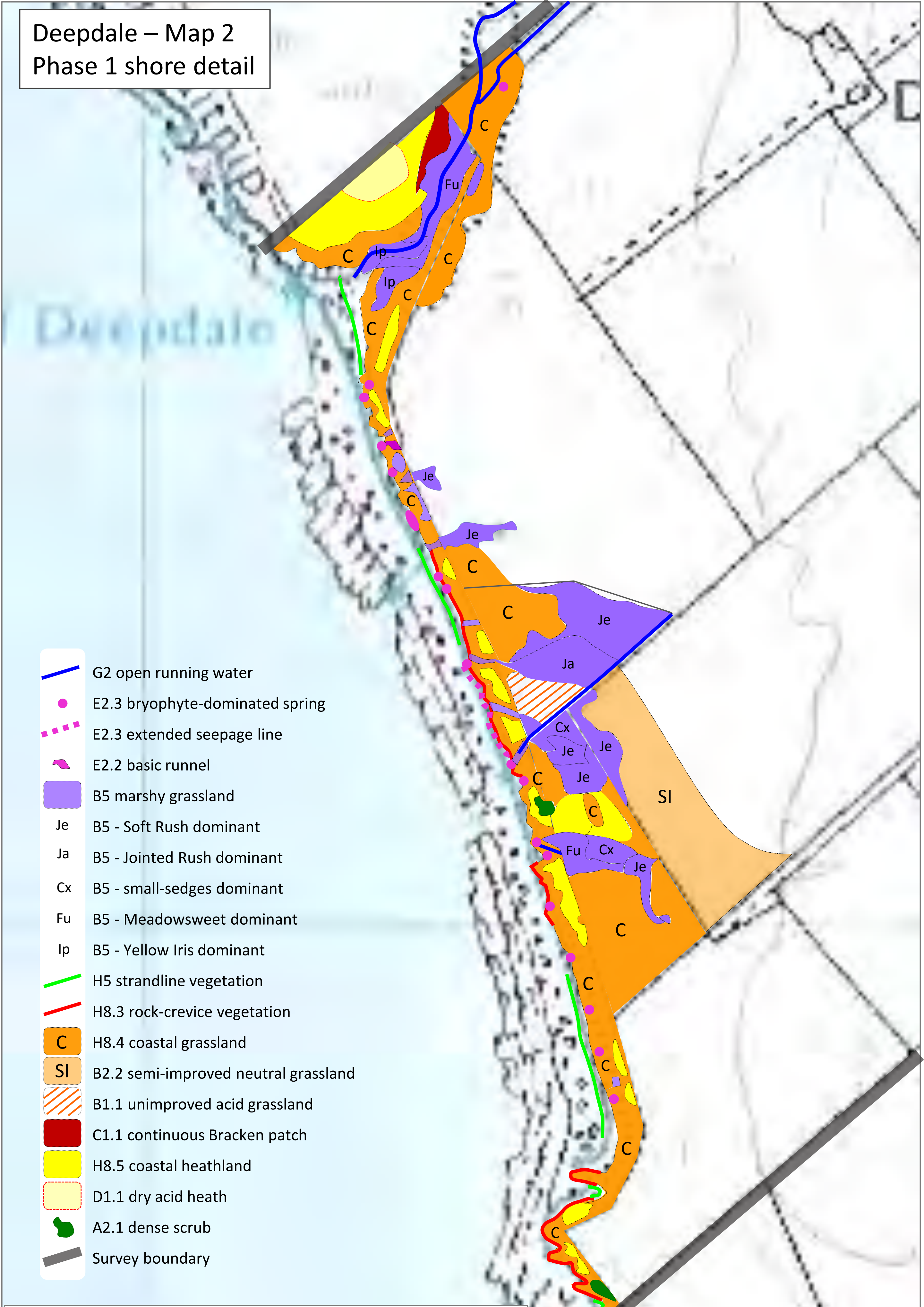
Figure 8. Tufa-forming spring with an algal layer on the rock beneath the mosses – possibly indicating nutrient enrichment.

Figure 9. *Tufa-forming springs emerging at the base of the low sea-banks at the north end of the site; two moss cushions are visible below the edge of the grass at either side of the picture.*

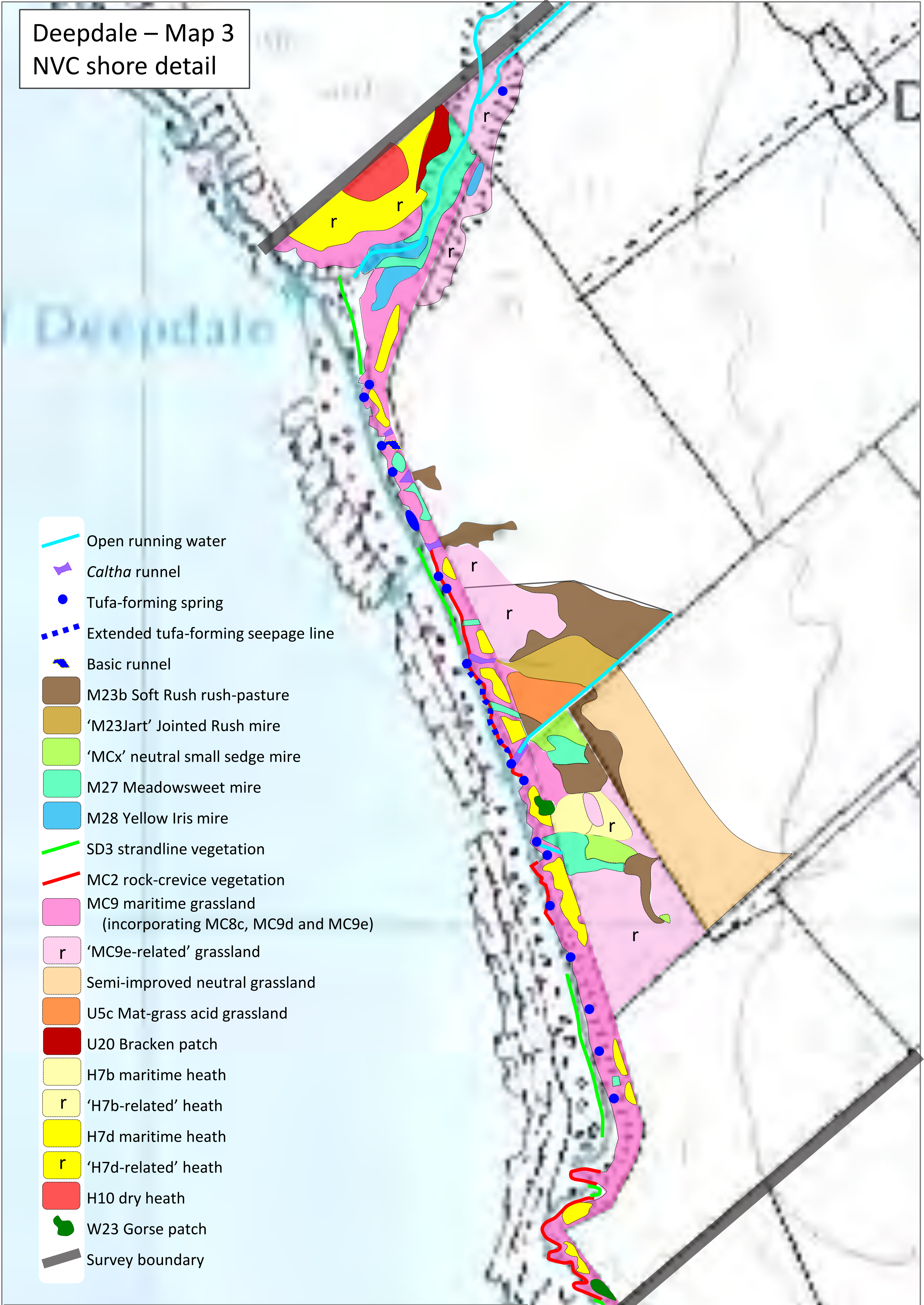
Deepdale – Map 1
Phase 1 overview



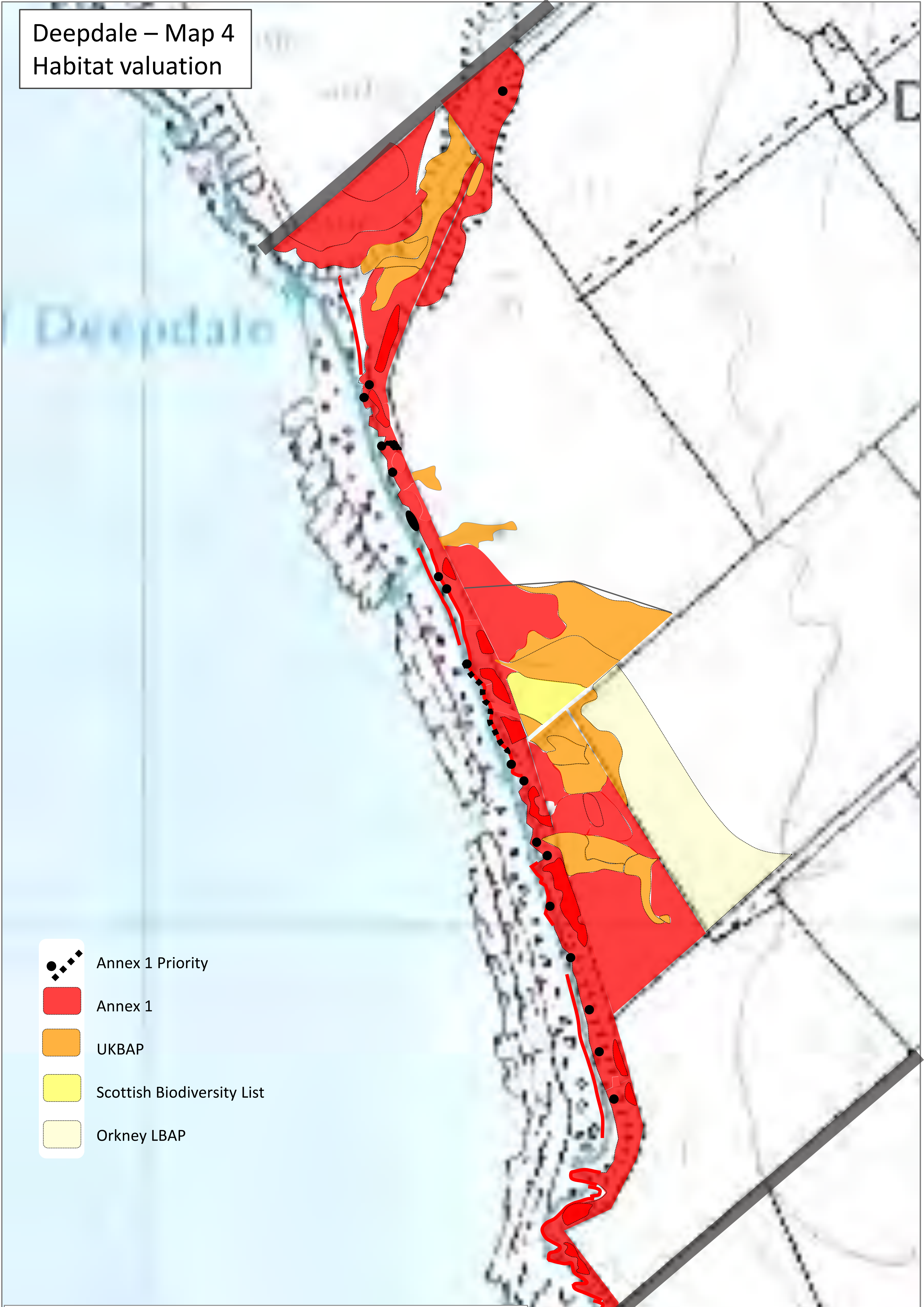
Deepdale – Map 2
Phase 1 shore detail



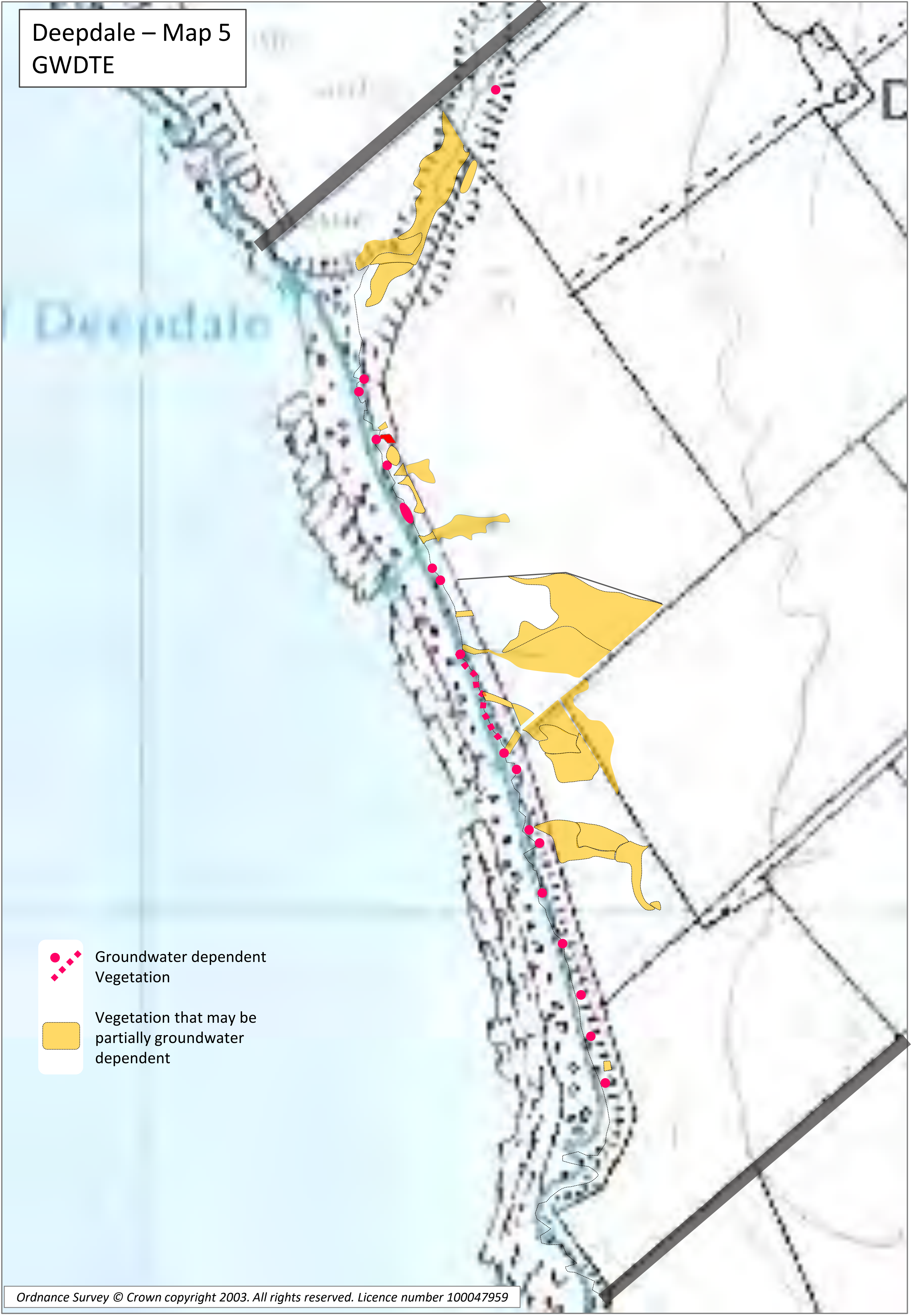
Deepdale – Map 3
NVC shore detail



Deepdale – Map 4
Habitat valuation



Deepdale – Map 5
GWDTE



● ⋰ Groundwater dependent Vegetation

🟨 Vegetation that may be partially groundwater dependent

TECHNICAL APPENDIX 5.2

Scapa Deep Water Quay
Marine Mammal and Fish Baseline

July 2023

CONTROL SHEET

Client: Orkney Island Council Harbour Authority
Project Title: Scapa Deep Water Quay
Report Title: Marine Mammal and Fish Baseline
Document number: 13339
Project number: 674795

Issue Record

Issue	Status	Author	Reviewer	Approver	Issue Date
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EnviroCentre Limited Office Locations:

Glasgow **Edinburgh** **Inverness** **Banchory**

Registered Office: Craighall Business Park 8 Eagle Street Glasgow G4 9XA
Tel 0141 341 5040 info@envirocentre.co.uk www.envirocentre.co.uk

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VAT no. GB 348 6770 57.

EXECUTIVE SUMMARY

EnviroCentre Limited was commissioned by Orkney Island Council Harbour Authority to undertake a marine mammal and fish desk study to inform an Environmental Impact Assessment (EIA) in relation to the development of Scapa Deep Water Quay (SDWQ).

The desk study is required to provide an ecological marine baseline.

The cetacean fauna (whales, dolphins, and porpoises) of Orkney is considered one of the richest in the UK, with favoured localities for sightings off headlands, between sounds of islands in inshore areas, and overfishing banks in offshore regions. Seventeen species of cetacean have been recorded, since 1980, along the coast or in nearshore waters (within 60 km of the coast) of Orkney.

Orkney is a stronghold for breeding grey seals and is part of the North Coast and Orkney Seal Management Unit (SMU). Orkney and North Coast SMU is home to c.4.5% of the UK Harbour seal population.

Basking sharks are listed as endangered on the International Union for Conservation of Nature and Natural Resources (IUCN) Redlist and are afforded. Basking sharks are also Priority Marine Features (PMFs) and have been recorded near Orkney.

Flapper skate listed as critically endangered on the IUCN red list and also PMFs are known to be present in the wider area. There are no records from the site and no observations made during drop down video transects conducted in December 2022. The habitat within the site is considered sub-optimal for egg laying but may be utilized for foraging.

Several PMF fish species, have either been recorded in proximity to the site and/or there is considered to be suitable habitat for nursery or spawning ground within or adjacent to the site.

There are no records of diadromous fish utilising the water courses near the site and a walkover survey to assess habitat found several barriers likely to restrict upstream migration for these species.

A number of active commercial fisheries are present around Scapa Flow. The nearest is Westerbister (500m south west of the SDWQ site) and consists of Atlantic salmon, lumpsucker and wrasse.

The following impacts may occur:

- Noise and vibration generated during construction and future operations may temporarily or permanently impact marine mammals and fish.
- Potential impacts on water quality from pollution events (fuel spills, sediment runoff etc.).
- Removal of benthic habitat for construction of pier.

It has been assessed that the most frequently observed species, and therefore the species considered to be of most concern within the zone of influence of the proposed SDWQ development, are harbour porpoise, Risso’s dolphin, killer whale, white-beaked dolphin, long-finned pilot whale, grey seal, harbour seal, basking sharks, flapper skate, some marine PMFs and commercial fisheries.

Contents

Appendices

Figures

Tables

1 INTRODUCTION

1.1 Terms of Reference

EnviroCentre Limited was commissioned by Orkney Island Council Harbour Authority (OICHA) to undertake a marine mammal and fish desk study to inform an Environmental Impact Assessment (EIA) in relation to the development of Scapa Deep Water Quay (SDWQ), approximately 8km south of Kirkwall at Bay of Deepdale, Scapa Flow. Please see Appendix A: Proposed Site Location and Layout.

1.2 Scope of Study

The aim of this study is to establish which species are likely to present and could be impacted by the proposed development to aid scoping of features to be taken forward for further assessment within the EIA. The objectives were as follows:

- Collate existing data in relation to designated sites, species records, distribution, population counts, habitat use and any other relevant information, to establish which species are likely to be present within the development site and the wider zone of influence of the development.
- Identify potential impacts to marine mammals and fish which could occur as a result of the proposed development.
- Provide a summary of species which are likely to be present and which may be subject to significant impacts.

1.3 Project Overview

The proposed development is located on the southern shore of the Orkney mainland, approximately 8km south of Kirkwall. It is located on the coastline within Scapa Flow, approximately 4km south of the existing Scapa Pier.

It is currently untouched coastline. The intertidal area comprises a rocky shore bordered on the landside by a rock face circa 3m in height. The sub-tidal habitats are largely soft sediments consisting of gravelly mud and sandy mud. There are some kelp and seaweed beds on sublittoral sediment present.

The main purpose of this facility would be to undertake multiple industrial activities that require both deep-water berthing and large laydown area. It is envisaged that the main activity will be the construction/assembly and maintenance of offshore wind turbines. This is also a potential location for the development of a storage and supply hub for future marine fuels. There will also be an access road from the A961 to the site.

It is proposed that the main quay berth depth at the site should be a minimum of minus 15m to CD with a further phased deep water site to between minus 20 and 24m CD to allow for potential future requirements.

In summary, the proposed development contains the following components during each Phase:

Phase 1

- Installation of an access road from the A961 to the site;
- Excavation of current landform along with reclamation of shore to form 12Ha of laydown area bounded by bunds on the north and eastern edges;
- Creation of 450m of berthing by formation of a quay 300m x ~46m wide with a 100m wide section on the northern edge providing water depth of up to -15m CD; and
- Dredging adjacent to the newly formed quay.

Phase 2

- Excavation of current landform along with reclamation of shore to form an additional 6Ha of laydown area to the south of Phase 1 laydown area. The bund on the eastern edge will be extended along the length of the new laydown area and partially along the southern edge;
- Extension of the Phase 1 quay area by 275m x ~46m to the south; and
- Dredging adjacent to the newly formed quay extension to provide -15m CD water depth.

Phase 3

- Dredging on the northern side of the newly formed quay extension to provide -20m CD water depth.

1.4 Report Usage

The information and recommendations contained within this report have been prepared in the specific context stated above and should not be utilised in any other context without prior written permission from EnviroCentre Limited.

If this report is to be submitted for regulatory approval more than 12 months following the report date, it is recommended that it is referred to EnviroCentre Limited for review to ensure that any relevant changes in data, best practice, guidance or legislation in the intervening period are integrated into an updated version of the report.

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2 MARINE MAMMAL AND FISH BASELINE

2.1 Desk Study

In order to anticipate the potential marine mammal and fish ecological sensitivities at the site, a desk study was conducted. The following sources were checked:

- The Joint Nature Conservation Committee (JNCC)[1 & 2];
- Sea Watch Foundation (SWF)[3 & 4];
- NatureScot (NS)[5];
- Whale and Dolphin Conservation (WDC)[6];
- The Hebridean Whale and Dolphin Trust (HWDT) Whale Track[7];
- Orcadian Wildlife (OW)[8];
- Scottish Marine Animal Stranding Scheme (SMASS)[9];
- NS[10];
- Orkney Marine Mammal Research Initiative (OMMRI)[11];
- Marine Scotland (MS) Regional baselines for marine mammal knowledge across the North Sea and Atlantic areas of Scottish waters [12] and appendices[13];
- MS Updated Seal Usage Maps: The Estimated at-sea Distribution of Grey and Harbour Seals[14], which includes data obtained from the Sea Mammal Research Unit at St Andrews University[15];
- Scottish Government Designated Sites: Seal Haul out Sites[16 & 17];

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[1] JNCC Statutory Nature Conservation Agency Protocol for Minimising the Risk of Injury to Marine Mammals from Piling Noise (2010) available at: http://jncc.defra.gov.uk/pdf/JNCC_Guidelines_Piling%20protocol_August%202010.pdf last accessed 12/12/2022

[2] Reid, J B, Evans, P G H, and Northridge, S P. JNCC Atlas of Cetacean Distribution in north-west European waters (2003) available at: http://jncc.defra.gov.uk/page-2713#download last accessed 12/12/2022

[3] Sea Watch Foundation Cetaceans of Orkney available at: https://seawatchfoundation.org.uk/wp-content/uploads/2012/07/Orkney2.pdf last accessed 12/12/2022

[4] Sea Watch Foundation Recent Sightings Orkney available at: https://www.seawatchfoundation.org.uk/recentsightings/ last accessed 12/12/2022

[5] SNH About Scotland's Nature: Marine Mammals available at: https://www.nature.scot/plants-animals-and-fungi/mammals/marine-mammals last accessed 12/12/2022

[6] WDC species guides available at: https://uk.whales.org/whales-dolphins/species-guide/ last accessed 12/12/2022

[7] HWDT sightings data available at: https://whaletrack.hwdt.org/sightings-map/ last accessed 12/12/2022

[8] Orcadian Wildlife information available at: http://orcadianwildlife.co.uk/wPress/cetaceans-in-orkney/ last accessed 12/12/2022

[9] Species reported within a 10km (sea route) from 2001-2020 to Scottish Marine Animal Stranding Scheme (SMASS) available at: https://strandings.org/map/ last accessed 10/04/2023

[10] NatureScot Seals available at: https://www.nature.scot/plants-animals-and-fungi/mammals/marine-mammals/seals last accessed 12/12/2022

[11] Orkney Marine Mammal Research Initiative data request, available at: https://ommri.org/ last accessed 18/05/2023

[12] Marine Scotland Regional baselines for marine mammal knowledge across the North Sea and Atlantic areas of Scottish waters, Scottish Marine and Freshwater Science, Vol 11 No 12, available at: https://data.marine.gov.scot/sites/default/files/Scottish%20Marine%20and%20Freshwater%20Science%20%28SMFS%29%20Vol%2011%20No%2012%20Regional%20baselines%20for%20marine%20mammal%20knowledge%20across%20the%20North%20Sea%20and%20Atlantic%20areas%20of%20Scottish%20waters.pdf

[13] Regional baselines for marine mammal knowledge across the North Sea and Atlantic areas of Scottish waters: Appendix 3 - SCANS surveys Scottish Marine and Freshwater Science Vol 11 No 12, available at: https://data.marine.gov.scot/sites/default/files//Scottish%20Marine%20and%20Freshwater%20Science%20%28SMFS%29%20Vol%2011%20No%2012_%20Regional%20baselines%20for%20marine%20mammal%20knowledge%20across%20the%20North%20Sea%20and%20Atlantic%20areas%20of%20Scottish%20waters%20-%20Appendix%203%20SCANS%20surveys%20%281%29.pdf

[14] Updated Seal Usage Maps: The Estimated at-sea Distribution of Grey and Harbour Seals, Scottish Marine and Freshwater Science, Vol 8 No 25, available at: https://data.marine.gov.scot/sites/default/files//SMFS%200825.pdf

[15] St Andrews Sea Mammal Research Unit, available at: http://www.smru.st-andrews.ac.uk/

[16] Scottish Government seal Haul-out maps available at: http://www.gov.scot/Topics/marine/marine-environment/species/19887/20814/maps last accessed 12/12/2022

[17] Haul Out Maps available at: https://webarchive.nrscotland.gov.uk/20180105052418mp_/http://www.gov.scot/Resource/0045/00454617.pdf last accessed 12/12/2022

- IUCN Red List[18]
- The Shark Trust basking shark sightings[19];
- NatureScot Basking shark satellite tagging project, Commissioned Report[20];
- Orkney Trout Fishing Association (OTFA)[21];
- Orkney Islands Sea Angling Association (OISAA)[22];
- Orkney Skate Trust[23]
- MS Aquaculture – Active Fin-fish Sites (19.12.2022)[24]; and
- Scotland's Aquaculture[25]

2.1.1 Disclaimer

It should be noted that the baseline is limited by the reliability of third party information and the geographical availability of biological and/or ecological records and data. The absence of species from biological records cannot be taken to represent actual absence. Species distribution patterns should be interpreted with caution as they may reflect survey/reporting effort rather than actual distribution.

2.2 Cetaceans

The cetacean fauna (whales, dolphins, and porpoises) of Orkney is considered one of the richest in the UK, with favoured localities for sightings off headlands, between sounds of islands in inshore areas, and over fishing banks in offshore regions. Seventeen species of cetacean have been recorded, since 1980, along the coast or in nearshore waters (within 60 km of the coast) of Orkney. Seven of the seventeen species are thought to be present throughout the year or at least recorded annually as seasonal visitors, which include; minke whale (*Balaenoptera acutorostrata*), long-finned pilot whale (*Globicephala melas*), killer whale (*Orcinus orca*), Risso's dolphin (*Grampus griseus*), white-beaked dolphin (*Lagenorhynchus albirostris*), Atlantic white-sided dolphin (*Lagenorhynchus acutus*) and harbour porpoise (*Phocoena phocoena*).

Unusual cetacean sightings have included fin whale (*Balaenoptera physalus*), humpback whale (*Megaptera novaeangliae*), Sperm whale (*Physeter macrocephalus*), Sowerby's beaked whale (*Mesoplodon bidens*), Cuvier's beaked whale (*Ziphius cavirostris*), Northern bottlenose whale (*Hyperoodon ampullatus*), short-beaked common dolphin (*Delphinus delphis*), Bottlenose dolphin (*Tursiops truncates*), False killer (*Pseudorca crassidens*), and Beluga (*Delphinapterus leucas*).

In addition, three species have been recorded prior to 1980: Blue whale (*Balaenoptera musculus*), Sei whale (*Balaenoptera physalus*), and Narwhal (*Monodon monoceros*).

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[18] IUCN Red List available at: http://www.iucnredlist.org/ last accessed 12/12/2022

[19] The Shark Trust basking shark sightings available at: https://www.sharktrust.org/basking-shark-project last accessed 12/12/2022

[20] Witt, M.J., Doherty, P.D., Godley, B.J. Graham, R.T. Hawkes, L.A. & Henderson, S.M. 2016. Basking shark satellite tagging project: insights into basking shark (Cetorhinus maximus) movement, distribution and behaviour using satellite telemetry. Final Report. Scottish Natural Heritage Commissioned Report No. 908.

[21] Contact with the Orkney Trout Fishing Association to discuss species information (09/01/2023)

[22] Orkney Islands Sea Angling Association list of species, available at: https://www.orkneycommunities.co.uk/anglingorkney/index.asp?pageid=591698, last accessed 27/03/2023

[23] Orkney Skate Trust website available at: https://www.orkneyskatetrust.co.uk/ (accessed 27/06/2023)

[24] MarineScotland Aquaculture – active Fin-fish Sites (19.12.2022), available at: https://marine.gov.scot/maps/1586, last accessed 09/01/2022

[25] Scotland's Aquaculture Site Data, available at: http://aquaculture.scotland.gov.uk/data/site_details_record.aspx?site_id=FS1305, last accessed 09/01/2022

2.2.1 Harbour Porpoise

The harbour porpoise is widely distributed and common throughout the Orkney region. They are a Priority marine feature (PMF)[26] and European Protected Species (EPS). Harbour porpoise are predominantly confined to shelf waters, although sightings have occurred in deep water. Although present throughout the year, most sightings associated with Orkney occur during summer-Autumn (June to October), with peak number of records occurring July-August.

Harbour porpoises eat a variety of fish, cephalopods and crustaceans, determined by local availability. Prey species including herring (*Clupea harengus)*, sprat (*Sprattus sprattus*), pouting (*Trisopterus luscus*), sandeel (*Ammodytes tobianus*), gobies (*Gobiidae*), cod (*Gadus morhua*), saithe (*Pollachius virens*) and whiting (*Merlangius merlangus*)[27].

No sightings of harbour porpoise have been recorded within the development area. 10 records of harbour porpoise have been submitted to SWF in 2022 from Orkney, consisting of 28 individuals, the closest of which being approximately 10km south of the development site, offshore of Hoxa in July. OW also state that each Autumn large numbers gather in Switha Sound to the south of Scapa Flow (approximately 15km south west, via the shortest path). 223 records of harbour porpoise sightings (dead and alive) within 10km radius of SDWQ have been submitted to OMMRI between 2013-2017, with five additional records returned for 2022. Figure 2-1 shows UK harbour porpoise sightings during the SCANS-III surveys [10]. Relatively high densities of porpoises have been reported around Orkney coastlines via data collated from a range of sources by Evans *et al* (2011)[28] and as detailed in Figure 2-2.

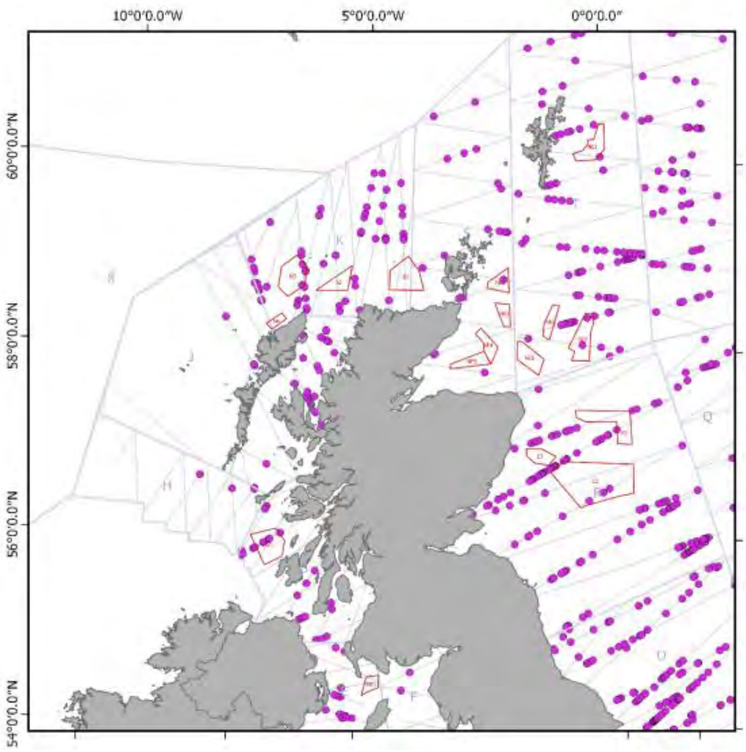

Figure 2-1: Sightings of harbour porpoise seen during the SCANS-III surveys (1994-2016)

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[26] NatureScot Priority Marine Features in Scotland's Sea's List, available at: https://www.nature.scot/doc/priority-marine-features-scotlands-seas-habitats, last accessed 09/01/2023

[27] SWF, harbour Porpoise fact sheet (2020), available at: https://www.seawatchfoundation.org.uk/wp-content/uploads/2020/07/Harbour-Porpoise.pdf

[28] Evans, P.G.H., Baines, M.E. & Coppock, J. (2011).Abundance and behaviour of cetaceans and basking sharks in the Pentland Firth and Orkney Waters. Report by Hebog Environmental Ltd & Sea Watch Foundation. Scottish Natural Heritage Commissioned Report No.419

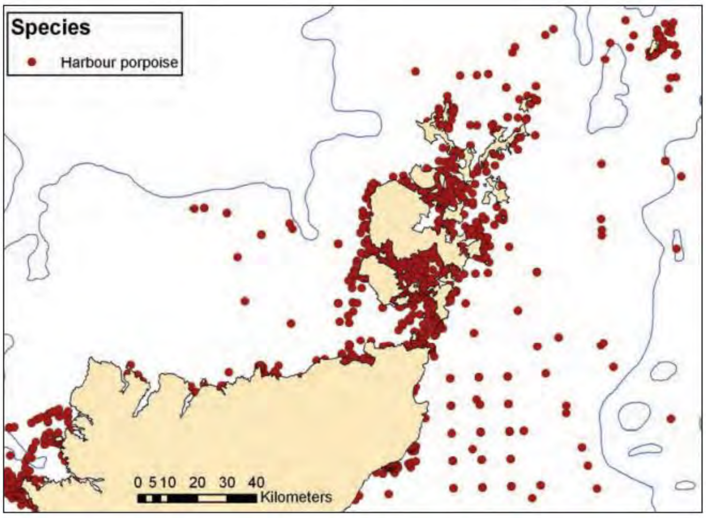

Figure 2-2: Distribution sightings of harbour porpoise (1980-2010)

2.2.2 Risso's Dolphin

Risso's dolphin are PMFs and EPS. Sightings of Risso's dolphin around Orkney are amongst the furthest north in the eastern Atlantic, with most frequent sightings concentrated along the west coasts of Orkney, particularly west mainland and west Hoy, but also off North Ronaldsay and in the Pentland Firth.

Sightings generally occurring between April and November, with peak number of records occurring in August. Strandings have occurred between November and March and individuals have also been observed off north-east Scotland and Shetland in winter, suggesting that the species may be present in the area year-round.

Risso's dolphin predominantly eat cephalopods, specifically octopus (*Octopoda*), cuttlefish (*Sepiida*) and various small squid (*Decapodiformes)*, but will occasionally eat small fish, including cod[29].

No sightings of Risso's dolphin have been recorded within the development area. Since 1st August 2017, three sightings of Risso's dolphin have been recorded via the HWDT Whale Track sightings database, with the closest record approximately 24km south west (via the shortest path). Eight records of Risso's dolphin (38 individuals) off the coast of Orkney, have been submitted to SWF in 2022, with the closest sighting being approximately 10km south (via the shortest path), offshore of Hoxa. 51 records of Risso's dolphin sightings within 10km radius of SDWQ have been submitted to OMMRI between 2013-2017, with 11 additional records returned for 2022. Figure 2-3 shows UK Risso's dolphin sightings during the SCANS-III surveys [10]. Risso's dolphin have been reported to show a coastal distribution via data collated from a range of sources by Evans *et al* (2011)[24], as detailed in Figure 2-4, however this has been suggested to be an artefact of watch effort.

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[29] SWF, Risso's dolphin fact sheet (2020), available at: https://www.seawatchfoundation.org.uk/wp-content/uploads/2020/10/Rissos-Dolphin.pdf

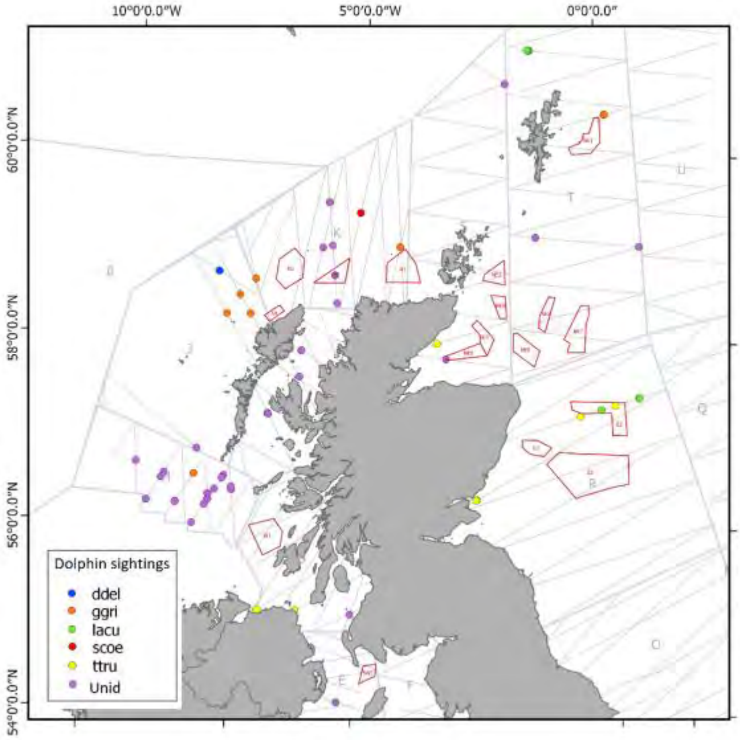

Figure 2-3: Sightings of Risso's dolphin (ggri) seen during the SCANS-III surveys (1994-2016)

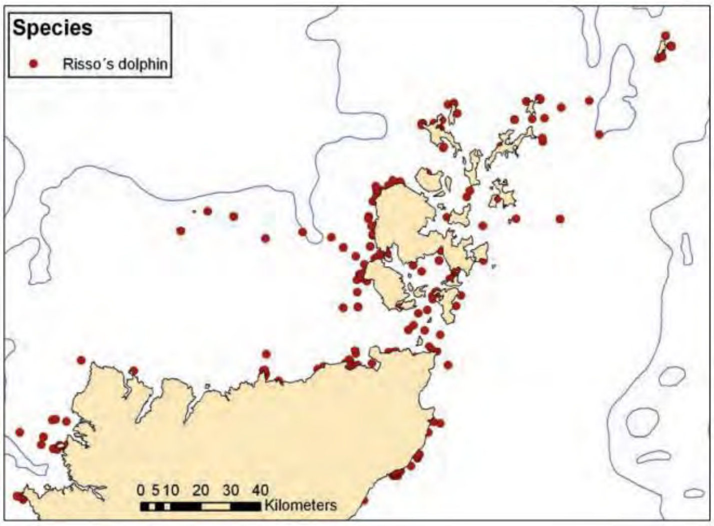

Figure 2-4: Distribution sightings of Risso's dolphin (1980-2010)

2.2.3 Minke Whale

Minke whales are frequently seen in coastal and inshore waters and are widely distributed throughout the North Sea. They are PMFs and EPS. Minke whale are mostly observed along the west and south coasts of Orkney and in the Pentland Firth. The species is deemed widely distributed in small numbers, with most sightings occurring between June and October.

Minke whale are both meso- and bentho-pelagic feeders, with those in the northern hemisphere, mainly taking fish including sandeel, herring, mackerel (*Scombrus scombrus*), sprat, capelin (*Mallotus* *villosus*), cod, whiting, haddock (*Melanogrammus aeglefinus*), but will also take euphausiids and copepods, especially at higher latitudes[30].

No sightings of minke whale have been recorded within the development area. One sighting submitted to SWF of minke whale was recorded approximately 13km south of the proposed development in 2022 (via the shortest path). 50 records of minke whale sightings (dead and alive) within 10km radius of SDWQ have been submitted to OMMRI between 2013-2017, with an additional seven records in 2022. Figure 2-5 shows UK minke whale sightings during the SCANS-III surveys [10]. Sightings records of minke whales in Orkney have also been reported to show a fairly coastal distribution of sightings (offshore sightings also recorded), via data collated from a range of sources by Evans *et al* (2011)[24] as detailed in Figure 2-6. However, it was considered the coastal distribution was likely indicative of surveyor effort rather than reflective of minke whale distribution.

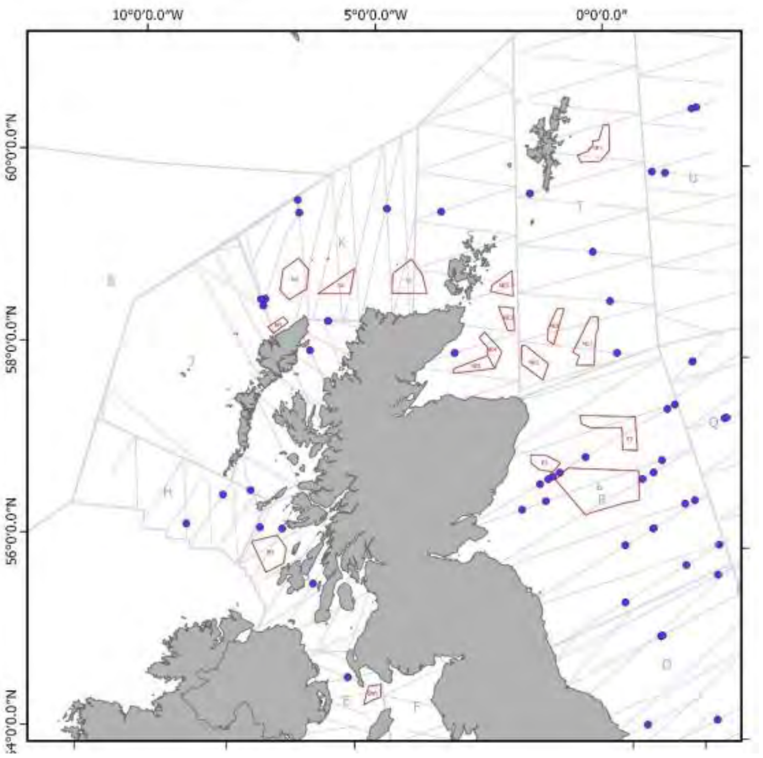

Figure 2-5: Sightings of minke whale seen during the SCANS-III surveys (1994-2016)

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[30] SWF, minke whale fact sheet (2020), available at: https://www.seawatchfoundation.org.uk/wp-content/uploads/2020/07/Minke-Whale.pdf

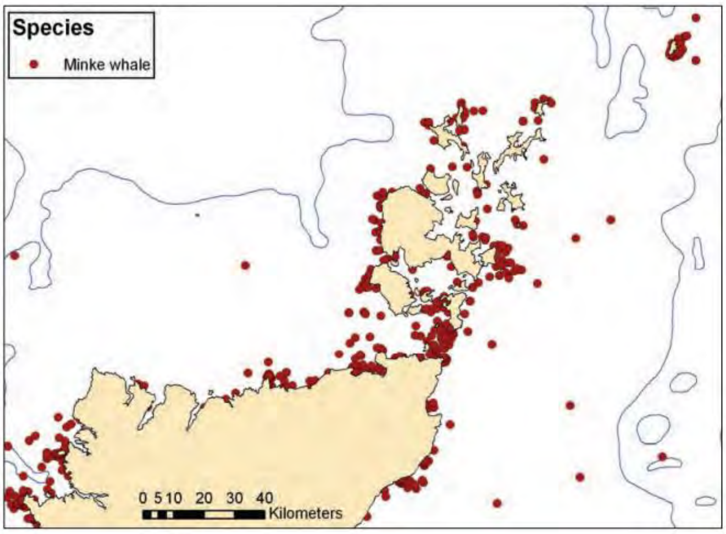

Figure 2-6: Distribution sightings of minke whale (1980-2010)

2.2.4 Long-finned Pilot Whale

Long-finned pilot whale are PMFs and EPS and mainly occur in deep waters (200-3,000 m), although have occasionally been observed in shallower coastal waters around northern Scotland, the northern North Sea and the Channel. Long-finned pilot whales occur in greater numbers to the north of Scotland, with little seasonality in the pattern of sightings. Long-finned pilot whale are infrequently observed in nearshore waters, but sightings have been recorded year-round, with no particular area favoured, although greater sightings are recorded between November and March, when several mass strandings have also occurred.

Long-finned pilot whale are benthic and pelagic feeders, with a diet consisting predominantly of squid, with some fish, including mackerel, hake (*Merluccius hubbsi*), cod, whiting, pollack (*Pollachius pollachius*), scad (*Selar crumenophthalmus*), sea bass (*Dicentrarchus labrax*) and sandeels [31].

No sightings of long-finned pilot whale have been recorded within the development area. One record of long-finned pilot whale, approximately 15km south west of the development site (via the shortest path), offshore of Hoy, was submitted to SWF in 2022. Orkney Council comments to the MSLOT scoping response for Hatston[32] refer to a pod of pilot whales found within Kirkwall Bay, near to the Hatston Pier in May 2019 (approximately 45km from the SDWQ site). Five records of long-finned pilot whale sightings within 10km radius of SDWQ (at Billia Croo and Black Craig, Stromness and Warbeth) have been submitted to OMMRI between 2013-2022. Figure 2-7 shows UK long-finned pilot whale sightings during the SCANS-III surveys [10]. Sightings around the Orkney Isles have been recorded both off-shore and near-shore, via data collated from a range of sources by Evans *et al* (2011)[24], as detailed in Figure 2-8.

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[31] SWF, long-finned pilot whale fact sheet (2020), available at: https://www.seawatchfoundation.org.uk/wp-content/uploads/2020/07/Long-finned-Pilot-Whale.pdf

[32] Marine Scotland – Licensing Operations Team Scoping Opinion Scoping Opinion adopted by the Scottish Ministers under Part 4 of The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017. Orkney Island Council Harbour Authority Expansion of Hatston Pier and Harbour. October 2021

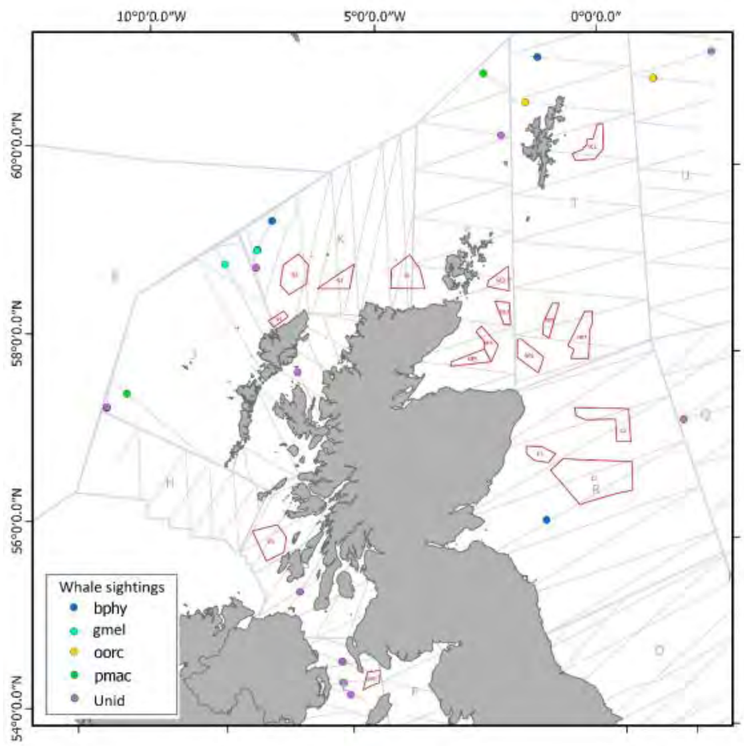

Figure 2-7: Sightings of pilot whale (gmel) seen during the SCANS-III surveys (1994-2016)

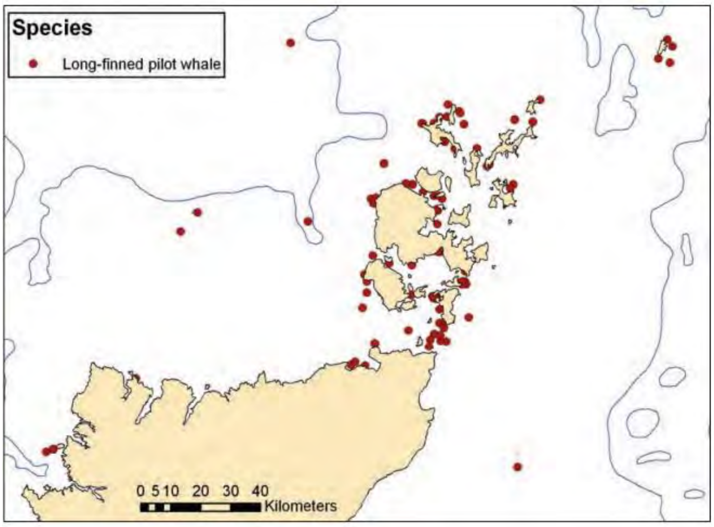

Figure 2-8: Distribution sightings of long-finned pilot whale (1980-2010)

2.2.5 Killer Whale

Although killer whales are uncommon, they are widely distributed in the northern Scottish water and specifically throughout Orkney waters and are PMFs. Killer whales usually first appear in coastal waters around the Northern Isles and Outer Hebrides in May and June, singly or in groups numbering up to 14 individuals, with peak number of records occurring between June and October. Sightings have been reported particularly around Pentland Firth, the Scapa Flow and the North Isles. Pods of up to 150 killer whales have also been observed in the North Sea east of Orkney, closely associated with purse seine fishing activities.

Killer whale use a wide variety of foraging methods and thus have a very variable diet, including fish, such as herring, mackerel, salmon (*Salmo salar*), cod, halibut (*Hippoglossus stenolepis*), squid, rays (*Batoidea*), marine mammals, and occasionally turtles (*Testudines*) and birds[33].

No sightings of killer whale have been recorded within the development area. 10 records of killer whale (43 individuals) off the coast of Orkney, have been submitted to SWF in 2022, with the closest sighting being within Scapa Flow, in proximity to the development site. OW also state killer whale have been sighted in the waters surrounding Orkney. 25 records of killer whale sightings within 10km radius of SDWQ have been submitted to OMMRI between 2013-2022. Figure 2-9 shows UK killer whale sightings during the SCANS-III surveys [10]. Frequent sightings of killer whales around Orkney were reported, via data collated from a range of sources by Evans *et al* (2011)[24], as detailed in Figure 2-10.

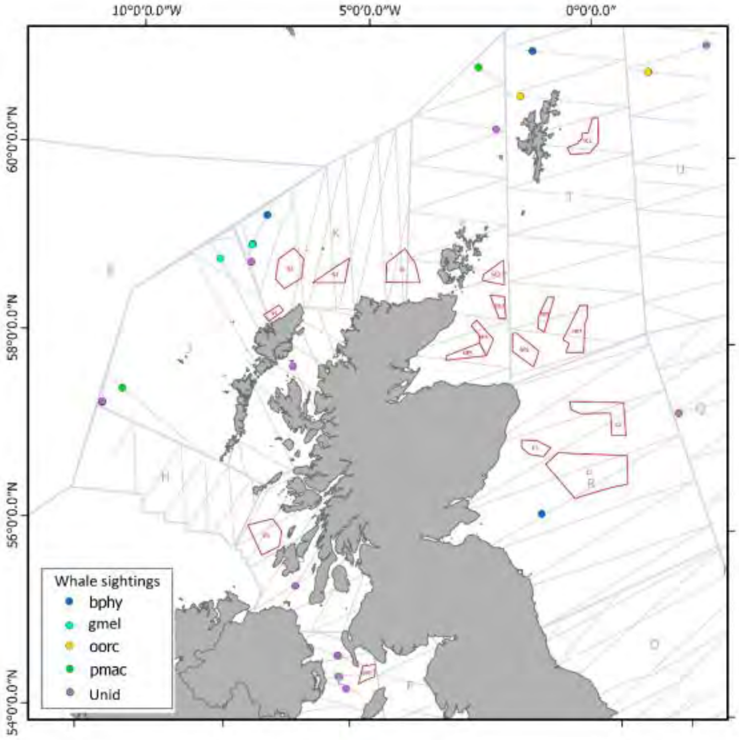

Figure 2-9: Sightings of killer whale (oorc) seen during the SCANS-III surveys (1994-2016)

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[33] SWF, killer whale fact sheet (2020), available at: https://www.seawatchfoundation.org.uk/wp-content/uploads/2021/03/Killer-Whale.pdf

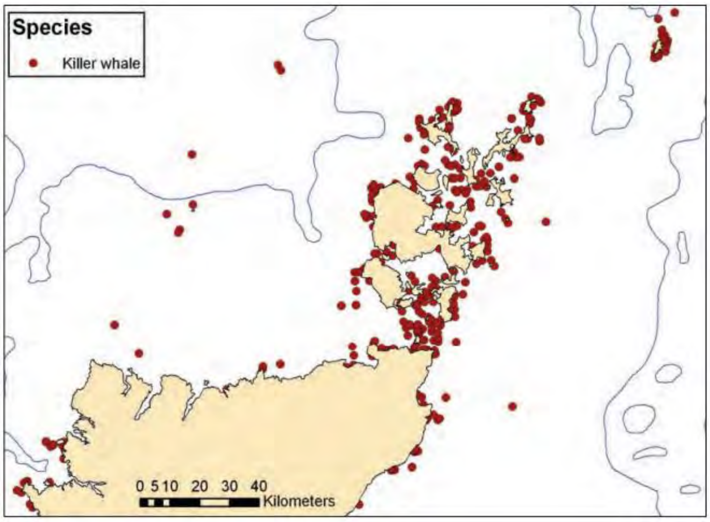

Figure 2-10: Distribution sightings of killer whale (1980-2010)

2.2.6 White-beaked Dolphin

White-beaked dolphin are recorded frequently in the North Sea and are fairly common and widely distributed around Orkney and are PMFs. Although present year-round in near-shore waters, with most sightings occurring offshore in the northern North Sea east and south of Orkney or at either end of the Pentland Firth throughout the year, peak number of records of the species generally occur between June and October.

White-beaked dolphin eat a variety of prey items, including fish (cod, whiting, hake, haddock, sprat, mackerel, herring, scad, and gobies), cephalopods (octopus) and sometimes crustaceans[34].

No sightings of white-beaked dolphin have been recorded within the development area. One sighting submitted to SWF of white-beaked dolphin was recorded approximately 24km west of the proposed development in 2022 (via the shortest path). Six records of white-beaked dolphin sightings within 10km radius of SDWQ (Billia Croo, Stromness) have been submitted to OMMRI between 2013-2022. Figure 2-11 shows UK white-beaked dolphin sightings during the SCANS-III surveys [10]. Fine scale sightings data over 1980-2010 showed a fairly even distribution of coverage of sightings of white-beaked dolphin between inshore and offshore waters, via data collated from a range of sources by Evans *et al* (2011)[24] as detailed in Figure 2-12.

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[34] SWF, white-beaked dolphin fact sheet (2020), available at: https://www.seawatchfoundation.org.uk/wp-content/uploads/2020/07/White-beaked-Dolphin.pdf

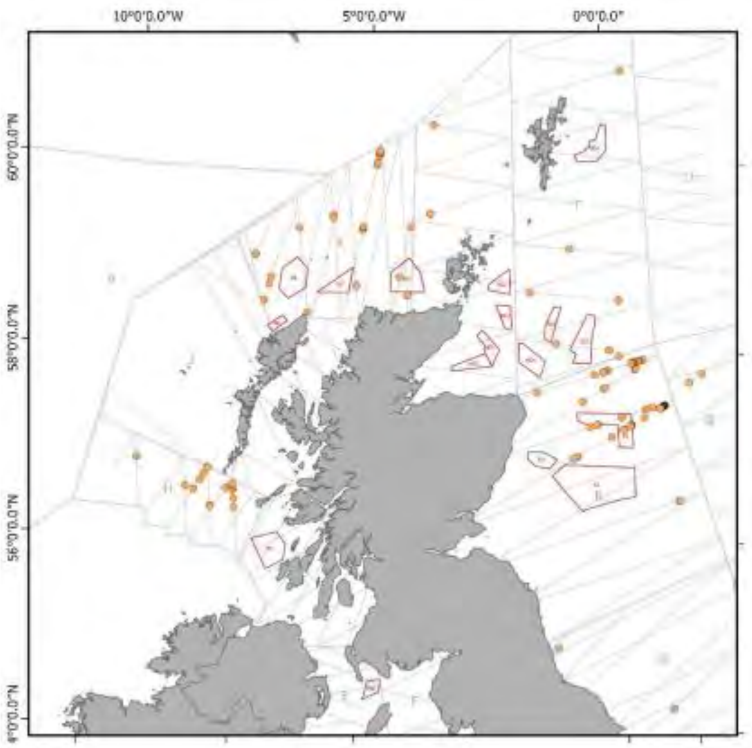

Figure 2-11:Sightings of white-beaked dolphin seen during the SCANS-III surveys (1994-2016)

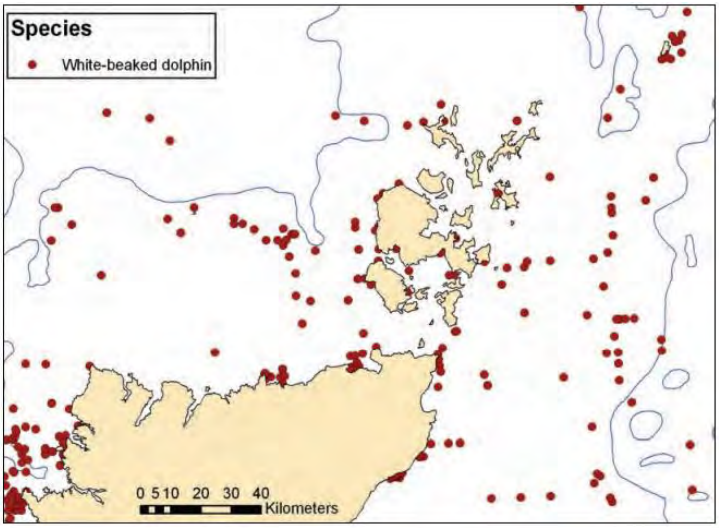

Figure 2-12: Distribution sightings of white-beaked dolphin (1980-2010)

2.2.7 Atlantic White-sided Dolphin

Atlantic white-sided dolphin are predominantly distributed north west of Britain and found in deep waters around the north of Scotland throughout the year and tend to be an infrequent visitor to the nearshore waters of Orkney. Atlantic white-sided dolphin are PMFs. They tend to enter the North Sea mainly in summer, but little is known about seasonal movements. Atlantic white-sided dolphin are most frequently sighted around the waters to the west of Orkney out to Sule Skerry between May and October, with peak number of records occurring in August.

Atlantic white-sided dolphin are pelagic feeders, predominantly eating herring, silver pout (*Gadiculus argenteus*), blue whiting (*Micromesistius poutassou*), scad, lantern fish (*Myctophidae*), Argentine (*Argentina*) and mackerel as well as some squid and shrimps (*Caridea*)[35].

No sightings of Atlantic white-sided dolphin have been recorded within the development area. No records of Atlantic white-sided dolphin were returned from SWF of HWDC, however OW state they are occasionally observed, but usually well offshore. 14 records of Atlantic white-sided dolphin sightings within 10km radius of SDWQ (Billia Croo and Black Craig, Stromness) have been submitted to OMMRI between 2013-2015. Figure 2-13 shows UK Atlantic white-sided dolphin sightings during the SCANS-III surveys [10]. A mainly offshore distribution of Atlantic white-sided dolphins is associated with Orkney, via data collated from a range of sources by Evans *et al* (2011)[24] as detailed in Figure 2-14.

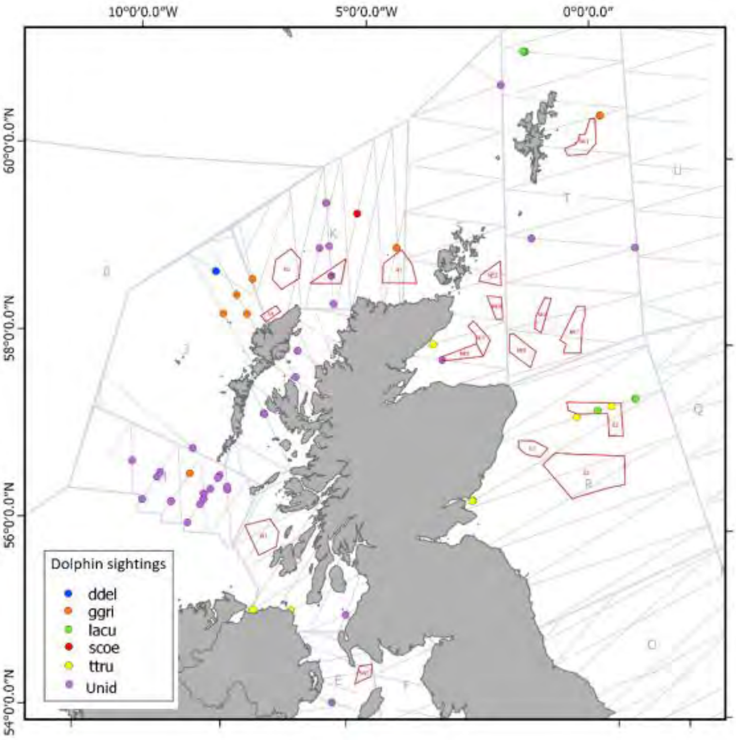

Figure 2-13: Sightings of Atlantic white-sided dolphin (lacu) seen during the SCANS-III surveys (1994-2016)

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[35] SWF, Atlantic white-sided dolphin fact sheet (2020), available at: https://www.seawatchfoundation.org.uk/wp-content/uploads/2020/07/Atlantic-White-sided-Dolphin.pdf

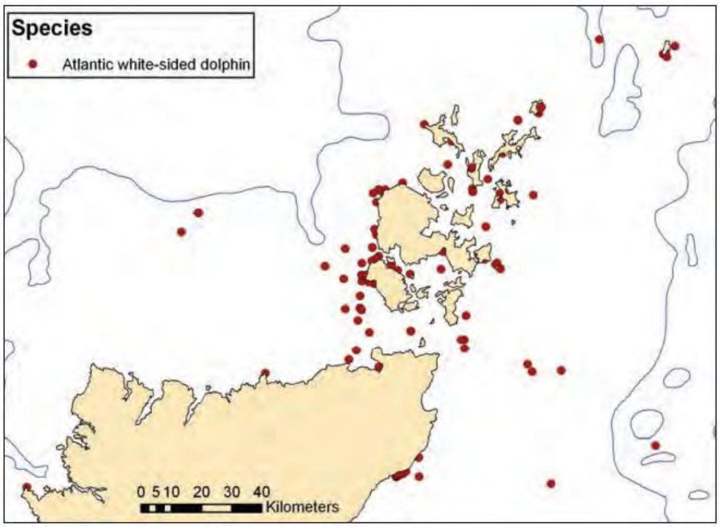

Figure 2-14: Distribution sightings of Atlantic white-sided dolphin (1980-2010)

2.2.8 Sperm Whale

Male sperm whales occur mainly in waters deeper than 200m beyond the shelf break north of Scotland, but they have also been observed in near-shore waters mainly off the Northern Isles of Scotland. Sperm whale are frequently sighted between July and December. Sperm whale are MPFs.

Sperm whale eat a variety of deep sea squid. However, they will also take saithe, monkfish (*Lophius*), halibut, benthic octopus, and crustaceans[36].

No sightings of sperm whale have been recorded within the development area. No records of sperm whale were returned from HWDC, however SWF state that sperm whale are occasionally recorded near Orkney, with most notable records of six sperm whales that remained in Scapa Flow (in proximity to the site) between 22nd February and 25th March in 1993, and eleven sperm whales which were stranded at Backaskaill Bay, Sanday (approximately 70km north, via the shortest sea route) on 7th December 1994, where they died the subsequent morning. OW state that sperm whale have been sighted, in Scapa Flow (within proximity to the development site), however previous reports of sperm whales associated with Scapa Flow suggest accidental occurrences. No records of sperm whale were returned from OMMRI. Figure 2-15 shows UK sperm whale sightings during the SCANS-III surveys [10]. Sightings of sperm whale over a thirty year study period, via data collated from a range of sources by Evans *et al* (2011)[24] around Orkney Isles was low (seven main coastal sightings events between 1993 and 2007) as detailed in Figure 2-16.

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[36] SWF, Atlantic white-sided dolphin fact sheet (2020), available at: https://www.seawatchfoundation.org.uk/wp-content/uploads/2020/07/Sperm-Whale.pdf

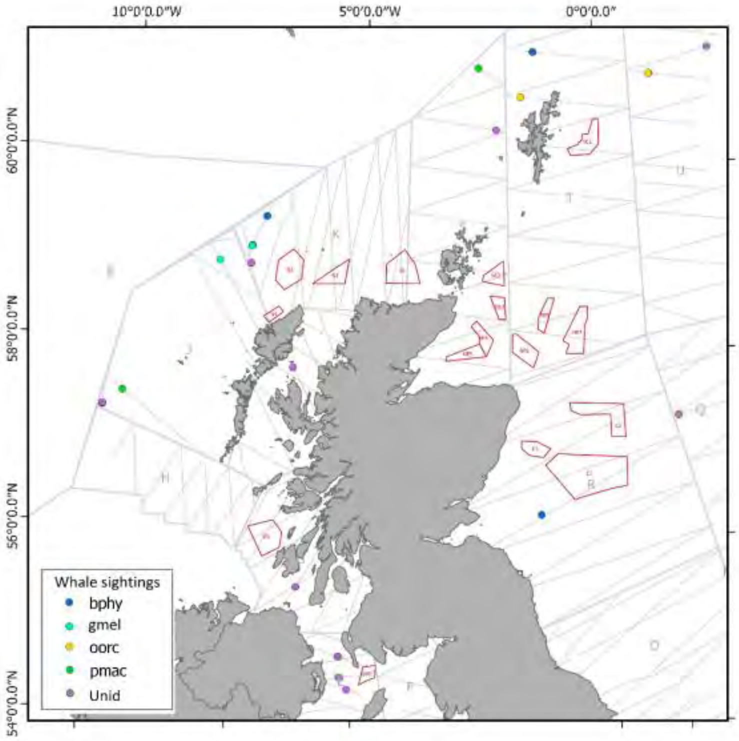

Figure 2-15: Sightings of sperm whale (pmac) seen during the SCANS-III surveys (1994-2016)

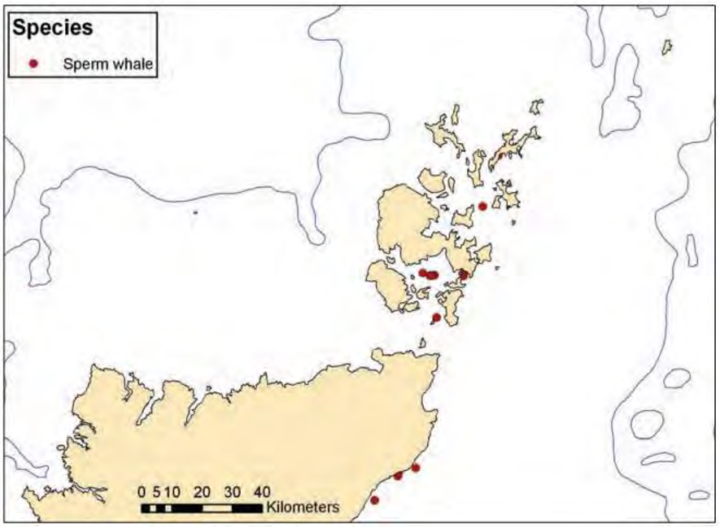

Figure 2-16: Distribution sightings of sperm whale (1980-2010)

2.2.9 Humpback Whale

Humpback whale sightings off Orkney are unusual, with isolated records almost exclusively in waters deeper than 200m. Most sightings are recorded in summer between May and September, which is when small numbers are seen off the continental shelf west and north of Scotland.

Humpback whale eat krill (*Euphausiids*) and various species of small schooling fish, such as herring, sprat, capelin, sandeel and mackerel[37].

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[37] SWF, humpback whale fact sheet (2020), available at: https://www.seawatchfoundation.org.uk/wp-content/uploads/2020/07/Humpback-Whale.pdf

No sightings of humpback whale have been recorded within the development area. One sighting submitted to SWF of humpback whale was recorded approximately 7km north west of the proposed development in 2022 off the shore of Hobbister (Scapa Flow) (via shortest sea route). OW state they are observed annually, mostly in Scapa Flow in proximity to the development site. Two records of humpback whale sightings within 10km radius of SDWQ (Billia Croo and Black Craig, Stromness, approximately 20km north west of the SDWQ site) have been submitted to OMMRI between 2013-2015. Figure 2-17 shows UK humpback whale distribution. Sightings of humpback whales have been infrequently recorded (only 14 sightings in the 30 years), which were mostly clustered around Orkney with no apparent seasonal pattern, via data collated from a range of sources by Evans *et al* (2011)[24] as detailed in Figure 2-18.

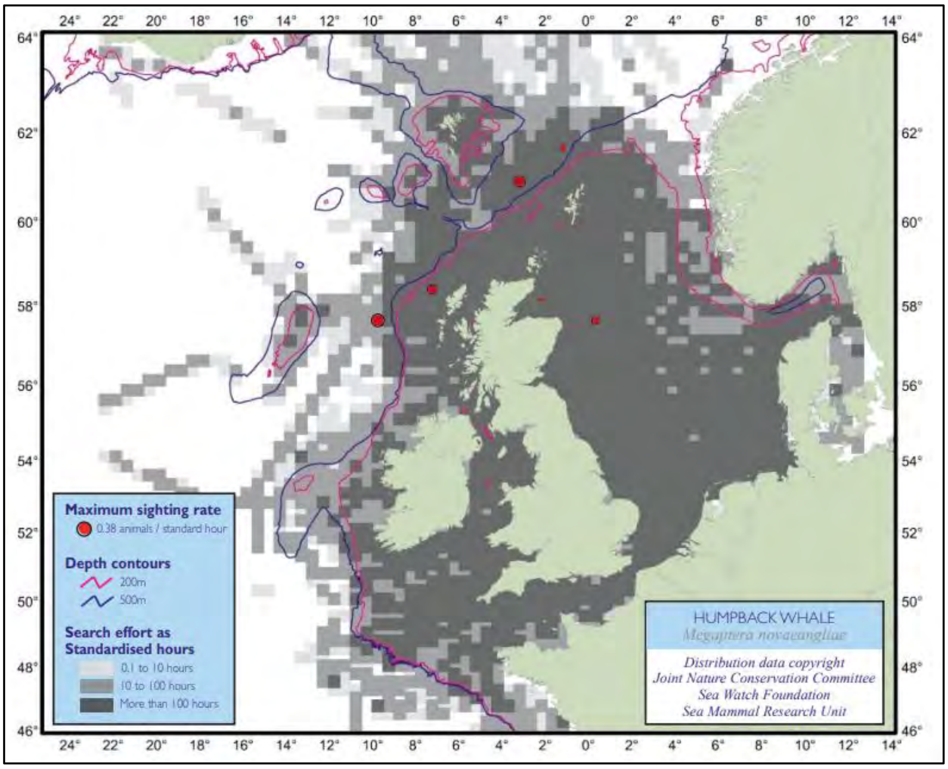

Figure 2-17: JNCC humpback whale distribution map (1979-1997)

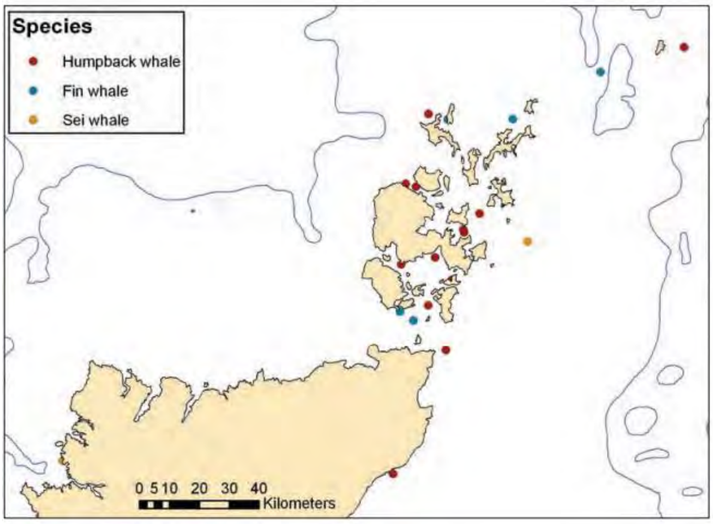

Figure 2-18: Distribution sightings of humpback whale (1980-2010)

2.2.10 Fin Whale

Fin whale are distributed predominantly along or beyond 500m, with fin whale sightings occurring mainly between June and December and peak number of records in northern Britain occur between June and August. Fin whale are MPFs.

Fin whale diet consists predominantly of planktonic crustaceans (particularly *euphausiids*) but will also prey upon small schooling fish including herring, capelin, sandeel, blue whiting, mackerel, and squid[38].

No sightings of fin whale have been recorded within the development area. No records of fin whale were returned from SWF or HWDC, however OW state fine whale have been rarely observed passing Hoxa Head (approximately 13km south of the development site, via shortest sea route) and records of two strandings in Scapa Flow (in proximity to the development site) were recorded in two consecutive years, 2019 and 2020. Two records of fin whale sightings within 10km radius of SDWQ (Billia Croo and Black Craig, Stromness, approximately 20km north west of the SDWQ site) have been submitted to OMMRI in 2022. Figure 2-19 shows UK fin whale sightings during the SCANS-III surveys [10]. Sightings of fin whale are very rare around the Orkney Isles (only four sightings in 30 years), via data collated from a range of sources by Evans *et al* (2011)[24] as detailed in Figure 2-20.

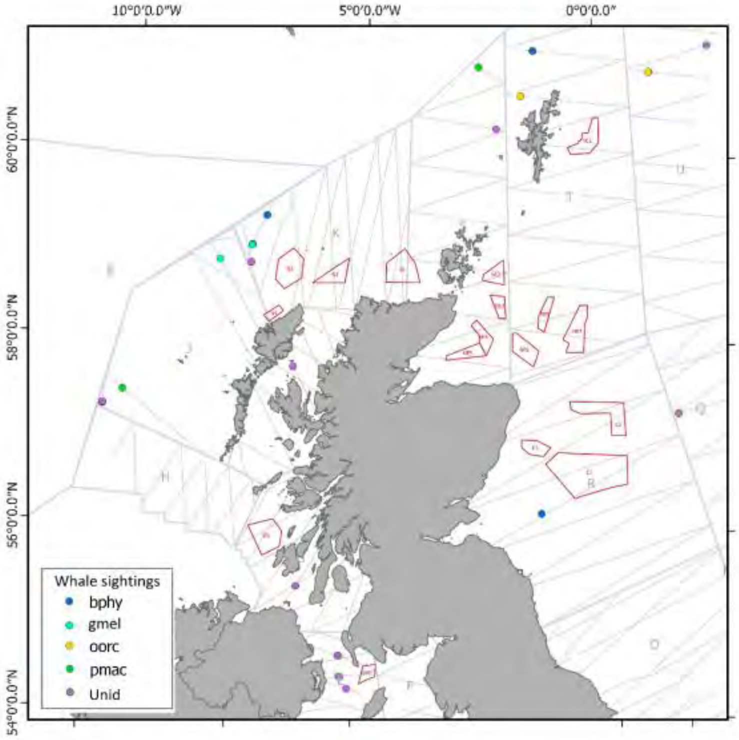

Figure 2-19: Sightings of fin whale (bphy) seen during the SCANS-III surveys (1994-2016)

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[38] SWF, humpback whale fact sheet (2020), available at: https://www.seawatchfoundation.org.uk/wp-content/uploads/2020/07/Fin-Whale.pdf

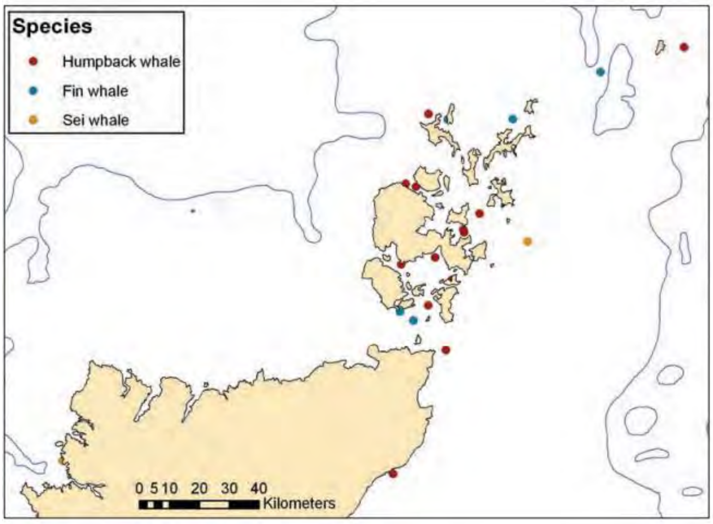

Figure 2-20: Distribution sightings of fin whale (1980-2010)

2.2.11 Sei Whale

Sei whales have mostly been recorded in waters deeper than 200m between the Northern Isles and the Faroes (specifically in proximity to the Faroe-Shetland Channel). Infrequent sightings of sei whale have been reported in coastal waters off Shetland. In general, sightings of sei whale were mainly previously observed in July and August off the Shetland coast.

Sei whale skim the surface waters for patches of copepod, their preferred prey. However, they also feed on *euphausiids*, shoals of fish (e.g. sardine (*Sardina pilchardus*), anchovy (*Engraulidae*)) and where encountered, squid[39].

No records of sei whale were returned from SWF, HWDC, OW or OMMRI. Figure 2-21 shows UK sei whale distribution. Sightings of Sei whale are very rare around the Orkney Isles (only one sighting in 30 years), via data collated from a range of sources by Evans *et al* (2011)[24] as detailed in Figure 2-22.

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[39] SWF, sei whale fact sheet (2020), available at: https://www.seawatchfoundation.org.uk/wp-content/uploads/2020/07/Sei-Whale.pdf

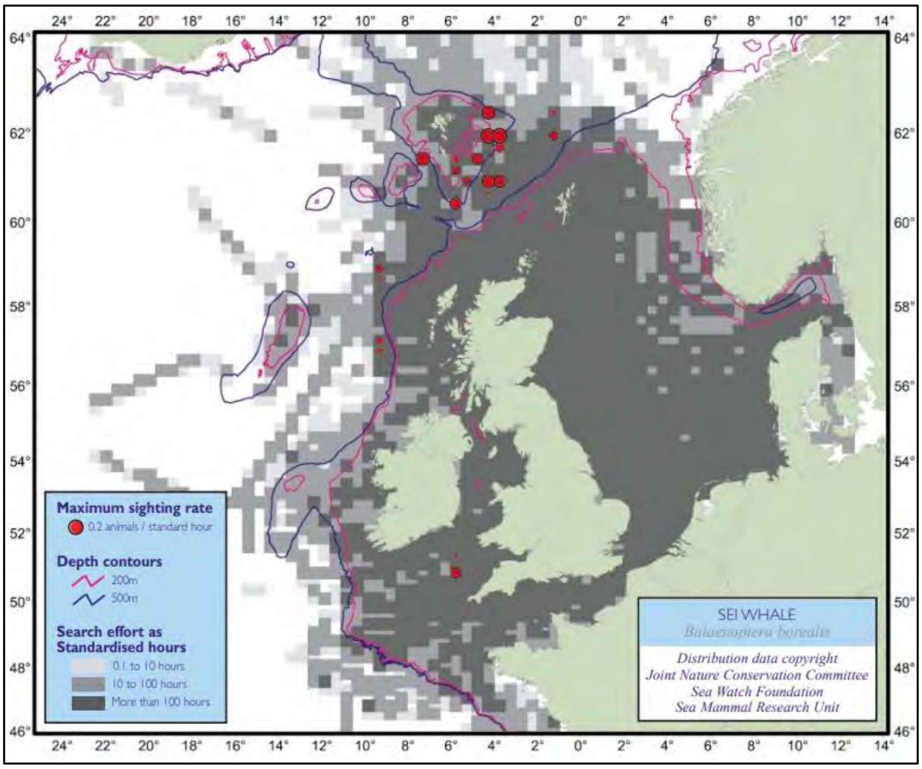

Figure 2-21: JNCC sei whale distribution map (1979-1997)

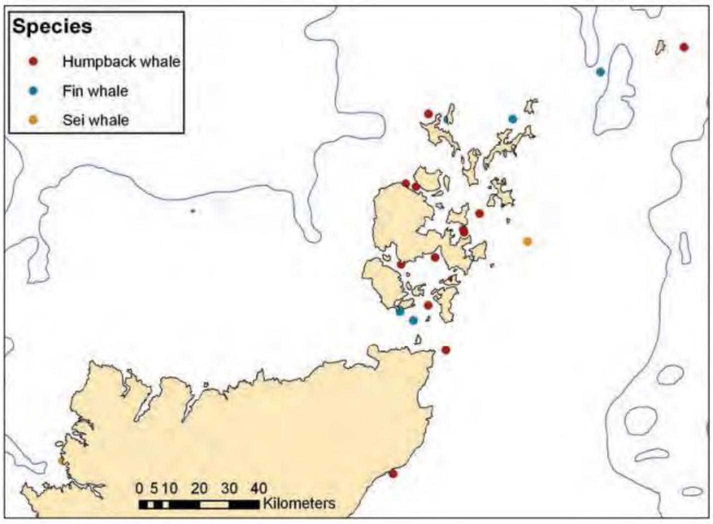

Figure 2-22: Distribution sightings of sei whale (1980-2010)

2.2.12 Striped Dolphin

Striped dolphin are considered rare in UK waters, with the species normal distribution reaching its northern limits at 50° N and most infrequent records reported in the South-west Channel.

Striped dolphin have variable diets and are classed as opportunistic feeders, depending on the region and season. Being meso- and bentho-pelagic feeders, their diet consists of fish (sprat, blue whiting, herring, mackerel, hake, sandeel, lanternfish, and cod), with crustaceans and cephalopods also making up part of their diet[40].

No records of striped dolphin were returned from SWF, HWDC, OW or OMMRI. Figure 2-23 shows UK striped dolphin sightings during the SCANS-III surveys [10]. Only two sightings of striped dolphin as reported over a 30 year study, via data collated from a range of sources by Evans *et al* (2011)[24] as detailed in Figure 2-24, with the closets sighting recorded approximately 11km south of the SDWQ site.

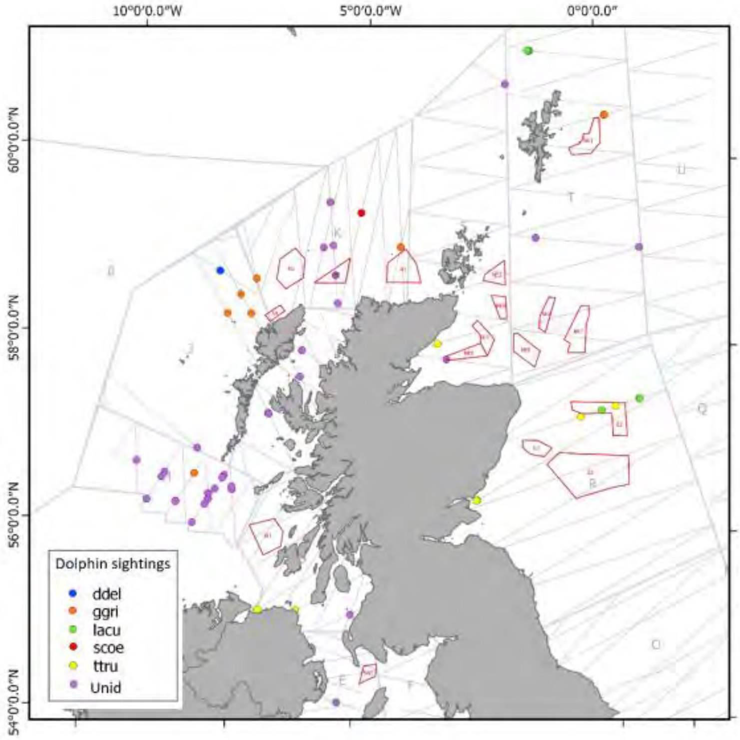

Figure 2-23: Sightings of striped dolphin (scoe) seen during the SCANS-III surveys (1994-2016)

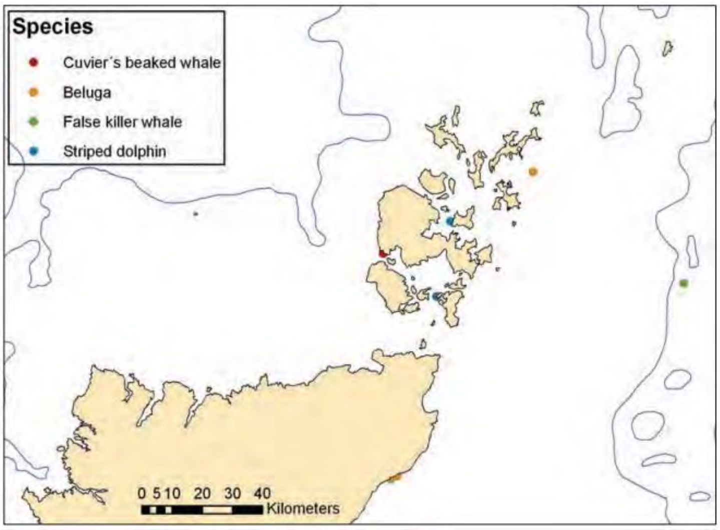

Figure 2-24: Distribution sightings of striped dolphin (1980-2010)

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[40] SWF, striped dolphin fact sheet (2020), available at: https://www.seawatchfoundation.org.uk/wp-content/uploads/2020/07/Striped-Dolphin.pdf

2.2.13 Cuvier’s Beaked Whale

Cuvier’s beaked whales have a preference for deep waters and there have been only six confirmed sightings of this species in British and Irish waters. Previous sightings have occurred east of the Orkney Islands in the northern North Sea in August 1980. From the limited sightings, it has been suggested that there is likely a summer movement of Cuvier’s beaked whale into UK waters between June and September.

Cuvier’s beaked whale eat a variety of deep-sea squid species, but will also prey upon crustaceans and fish[41].

No records of striped dolphin were returned from SWF, HWDC, OW or OMMRI. Figure 2-25 shows UK Cuvier’s beaked whale sightings during the SCANS-III surveys [10]. Only one sighting of a Cuvier’s beaked whale approximately 20km north west of the SDWQ site (via shortest path), as reported over a 30 year study, via data collated from a range of sources by Evans *et al* (2011)[24] as detailed in Figure 2-26.

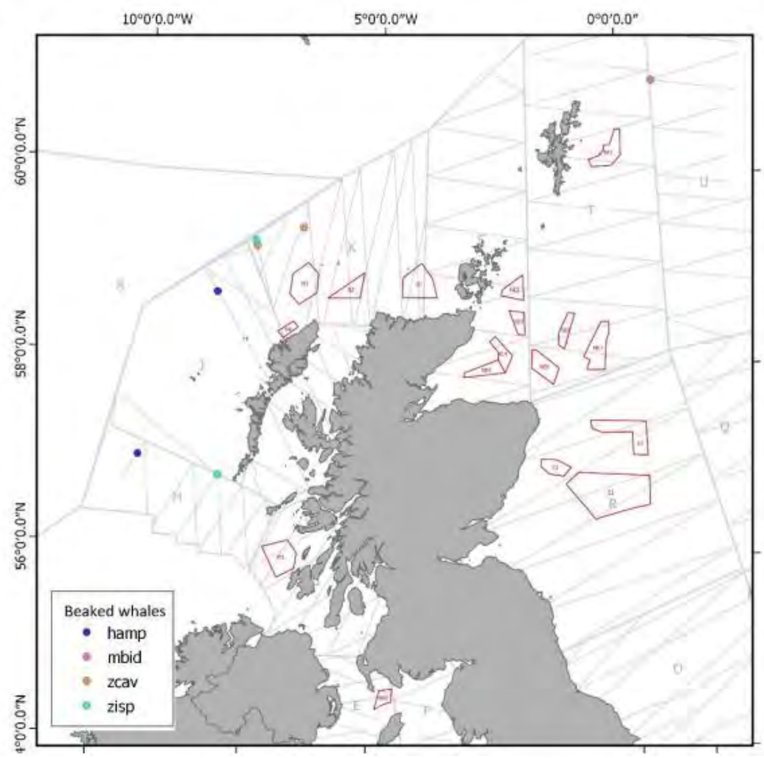

Figure 2-25: Sightings of Cuvier’s beaked whale (zcav) seen during the SCANS-III surveys (1994-2016)

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[41] SWF, Cuvier’s beaked whale fact sheet (2020), available at: https://www.seawatchfoundation.org.uk/wp-content/uploads/2020/07/Cuviers-Beaked-Whale.pdf

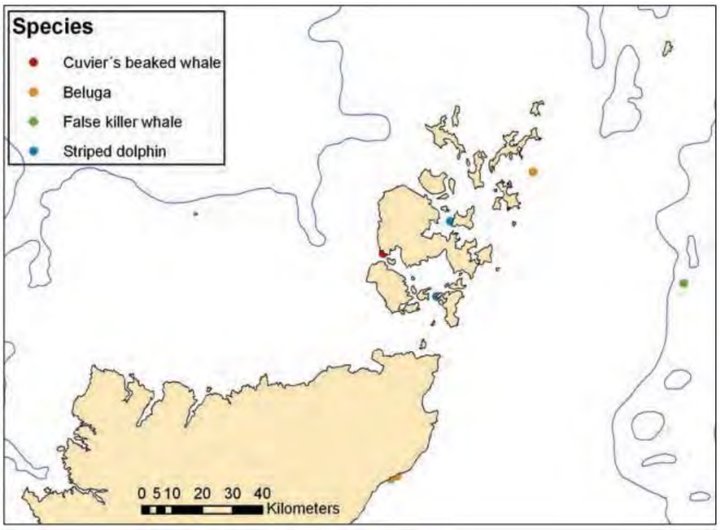

Figure 2-26: Distribution sightings of Cuvier's beaked whale (1980-2010)

2.2.14 Short-beaked Common Dolphin

Short-beaked common dolphin are not strongly associated with Orkney islands and have been rarely recorded in the area since 1980, but are MPFs. In North Atlantic waters, short-beaked common dolphins are predominantly found in continental shelf waters, notably in the Celtic Sea and Western Approaches to the Channel.

Short-beaked common dolphin are opportunistic feeders, with their diet being very varied, but predominantly small schooling fish are preferred, with species depend upon region, including hake, horse mackerel (*Trachurus trachurus*), mackerel, sprat, sardine, anchovy, Norway pout (*Trisopterus esmarkii*), cod, scad, sandeel, herring, whiting and blue whiting. Squid is also taken depending on local availability[42].

No sightings of short-beaked common dolphin have been recorded within the development area. No records of short-beaked common dolphin through SWF or HWDT have been submitted within proximity to Orkney, however they have been rarely observed by OW. 15 records of short-beaked common dolphin sightings (dead and alive) within 10km radius of SDWQ have been submitted to OMMRI between 2013-2022. Figure 2-27 shows UK common dolphin sightings during the SCANS-III surveys [10]. Infrequent coastal sightings of common dolphins along the Orkney Isles have been recorded via data collated from a range of sources by Evans *et al* (2011)[24] as detailed in Figure 2-28.

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[42] SWF, short-beaked common dolphin fact sheet (2020), available at: https://www.seawatchfoundation.org.uk/wp-content/uploads/2020/07/Common-Dolphin.pdf

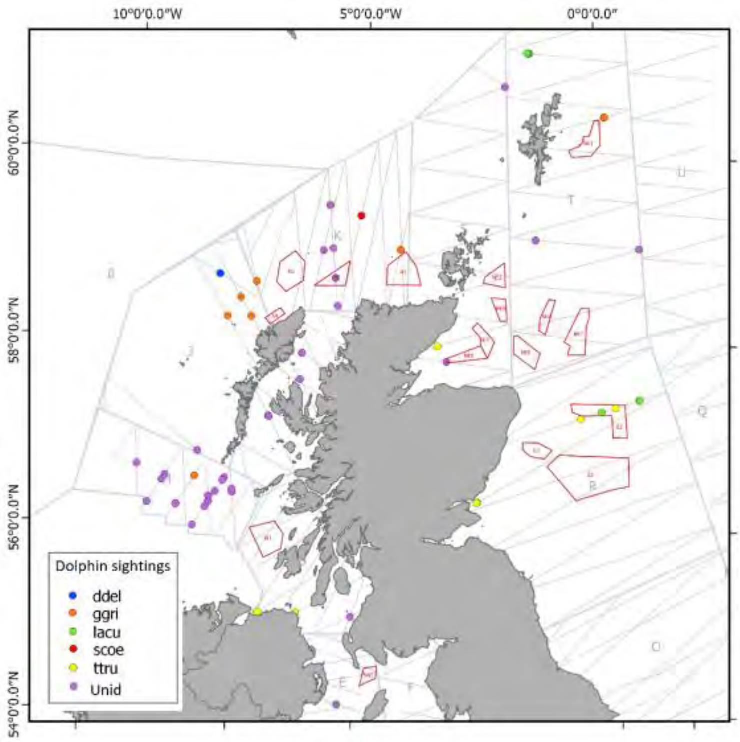

Figure 2-27: Sightings of common dolphin (Ddel) seen during the SCANS-III surveys (1994-2016)

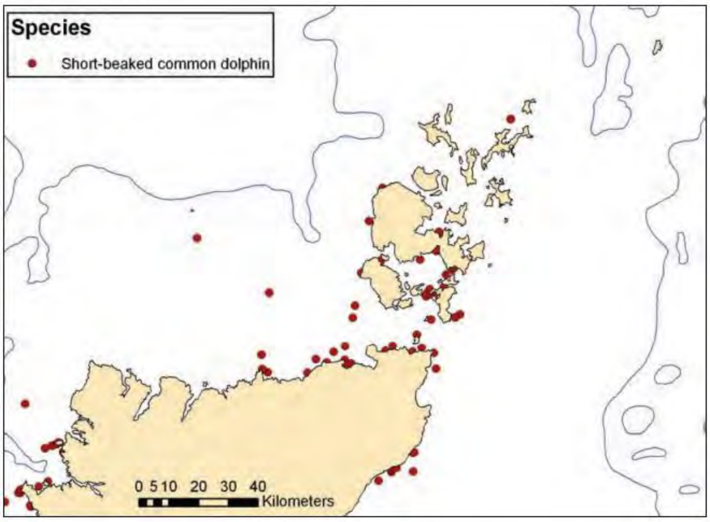

Figure 2-28: Distribution sightings of short-beaked common dolphin (1980-2010)

2.2.15 Bottlenose Dolphin

Bottlenose dolphin are not strongly associated with Orkney islands and have been rarely recorded in the area since 1980. Bottlenose dolphin are observed in the greatest numbers between July and October (with a secondary peak number of records occurring in some localities in March-April).

Bottlenose dolphin are considered selectively opportunistic and eat a variety of fish and squid species, including cod, saithe, whiting, haddock, salmon, sprat, sandeels, pout, flatfish (*Pleuronectiformes*), and cephalopods[43].

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[43] SWF, bottlenose dolphin fact sheet (2020), available at: https://www.seawatchfoundation.org.uk/wp-content/uploads/2020/07/Bottlenose-Dolphin.pdf

No sightings of bottlenose dolphin have been recorded within the development area. No records of bottlenose dolphin were returned from SWF or HWDC. However, OW state that bottlenose dolphin have been observed offshore of Orkney. Three records of bottlenose dolphin sightings within 10km radius of SDWQ have been submitted to OMMRI between 2013-2022. The nearest statutory designated site featuring marine mammals is the Moray Firth SAC, approximately 9113km from SDWQ, which is designated for supporting the only known resident bottlenose dolphin (*Tursiops truncatus*) population in the North Sea (estimated to be around 130 individuals). Dolphins are present all year round[44]. Figure 2-29 shows UK bottlenose dolphin sightings during the SCANS-III surveys [10]. Bottlenose dolphins are thought to be rarely occurring north of the Orkney isles as details in Figure 2-30.

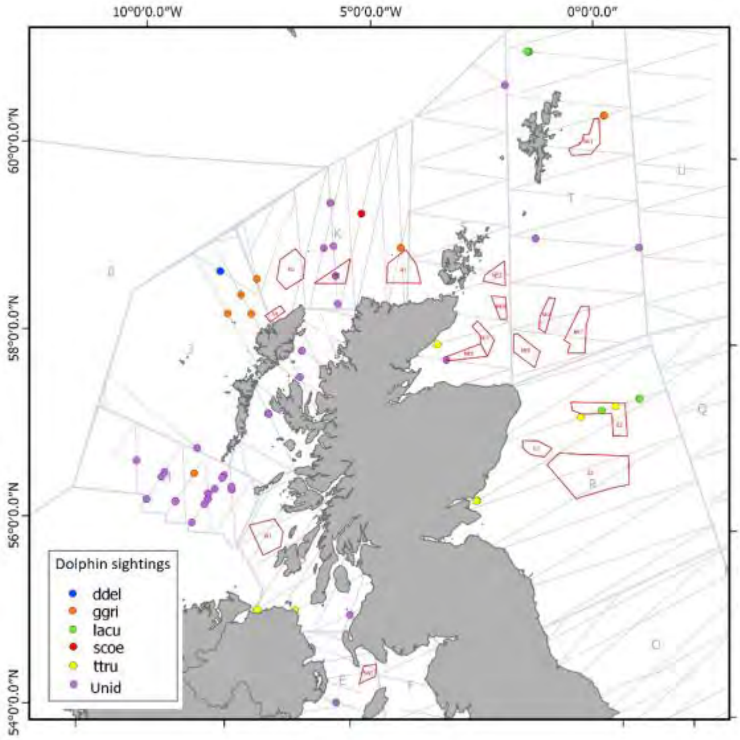

Figure 2-29: Sightings of bottlenose dolphin (ttru) seen during the SCANS-III surveys (1994-2016)

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[44] JNCC SAC Site Details available at: https://sac.jncc.gov.uk/site/UK0019808 last accessed 12/12/2022

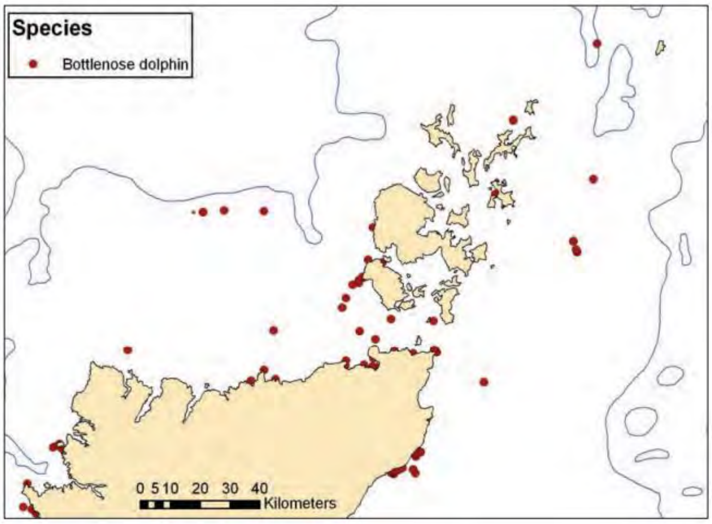

Figure 2-30: Distribution sightings of bottlenose dolphin (1980-2010)

2.2.16 Short-finned Pilot Whale

Short-finned and long-finned pilot whale species can be difficult to separate at sea. In general, short-finned pilot whale tend to be associated and reside in tropical and warm-temperate areas, whilst long-finned pilot whales occur in more cooler waters. Although the possibility exists that some of the pilot whales observed off Orkney (one record submitted to SWF in 2022) are short-finned, the conditions in these areas do not tend to suit the requirements of this species[45]. They feed mainly on squid, with octopus and fish (mackerel, hake, herring and cod) comprising some of their diet[46].

2.2.17 Other Cetaceans

Other rare cetacean species recorded around the shores of Orkney since 1980 include Sowerby's beaked whale (PMF), Northern bottlenose whale (PMF), false killer whale, blue whale, narwhal and Beluga. In general, the conditions off Orkney do not tend to suit the requirements of the majority of these species and no recent records of these species were returned from SWF, HWDC, OW or OMMRI.

2.3 Seals

Both harbour seal (*Phoca vitulina*) and grey seal (*Halichoerus grypus*) are PMFs and can be seen all around Scotland, predominantly on many of the offshore islands and along much of the west mainland coast.

Orkney is a stronghold for breeding grey seals and is part of the North Coast and Orkney Seal Management Unit (SMU). It is estimated that the Orkney colonies produced nearly a third of UK pups

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[45] No JNCC UK distribution map was available as all sightings were assumed to be of long-finned pilot whales, supported by all strandings in the study area having been of long-finned pilot whales

[46] WDC short-finned pilot whale species guide, available at: https://uk.whales.org/whales-dolphins/species-guide/short-finned-pilot-whale/

in 2019[47]. The overall trend is for an increased numbers in the UK population but there was a slight reduction in the Orkney population estimate between 2016 and 2019.

The latest estimate of the UK harbour seal population is 43,750 with the Orkney and North Coast SMU being home to c.4.5% of that[48]. Whilst the overall trend for harbour seals within the UK is increasing, there has been a dramatic change in distribution. Counts within the Orkney and North Coast SMU have gone from c.9000 in the late 1990's to less than 2000 by 2020. Within Scotland there is a general pattern of population increases in the west and losses along the east and north coasts.

The site and adjacent coastline is considered suitable (by report authors) for use as a haul out by harbour seals due to the relatively low level of disturbance associated with the area and lack of human/ commercial/ vehicular activity. However, the site is near Scapa Pier, where vessels regularly commute to, past the site and the site is not within a designated site for harbour or grey seal, as such is not considered that the habitat is suitable for use as a breeding or moulting haul out site.

Grey seals travel large distances, frequently over 100km, to forage and prefer offshore feeding areas as well as exposed coasts and islands to come ashore, with the outer fringes of Orkney being classed as suitable. Harbour seals routinely travel 40-50km from their haul-out sites to forage and prefer more sheltered waters. The waters surrounding the site offer habitat for various gadoids and flat fish which are grey seal prey species. From research undertaken by St Andrews Sea Mammal Research Unit on seal diets[49], in Orkney sandeels were the greatest prey resources, with gadoids (haddock, cod, whiting) being the second biggest contributor (harbour seal diet is yet to be studied as in depth).

There are many seal haul outs, an SSSI and an SAC designated for grey seals within 100km of the site, which is considered to be their typical foraging range. There are several designated haul outs for harbour seal within 50km of the site, which is considered to the typical foraging range. This means both harbour seals and grey seals may therefore use the coastal waters within and adjacent to the site for commuting between haul outs and/or foraging.

Records of 420 out of 461 tagged harbour seals within UK waters (2001-2018) show a primarily coastal distribution, with concentrations of tagged seals in Hebrides, the Moray Firth, Orkney and Shetland, as detailed in Figure 2-31. Estimated at sea usage for the area around the site is c.1 - <5 individuals per 5km^2 (Figure 2-32).

Records of 285 out of 355 tagged grey seals within UK waters (1988-2018) show a broad-scale distribution, with tagged grey seals utilising both coastal and offshore habitat, with Orkney being a key high-use area, as detailed in Figure 2-33. The estimated sea usage for grey seals within the site is less than other areas of the Orkney Isles though (10 - <50 vs >100 individuals per 5km^2 to the north, east and south) as detailed in Figure 2-34.

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[47] Scientific Advice on Matters Related to the Management of Seal Populations: 2021, Natural Environment Research Council Special Committee on Seals. Availabe at: http://www.smru.st-andrews.ac.uk/files/2022/08/SCOS-2021.pdf (Accessed 08/02/2023)

[48] Scientific Advice on Matters Related to the Management of Seal Populations: 2021, Natural Environment Research Council Special Committee on Seals. Availabe at: http://www.smru.st-andrews.ac.uk/files/2022/08/SCOS-2021.pdf (Accessed 08/02/2023)

[49] http://www.smru.st-andrews.ac.uk/documents/scotgov/CSD3-3_Grey_Seal_Diet_Composition_and_Prey_Consumption.pdf

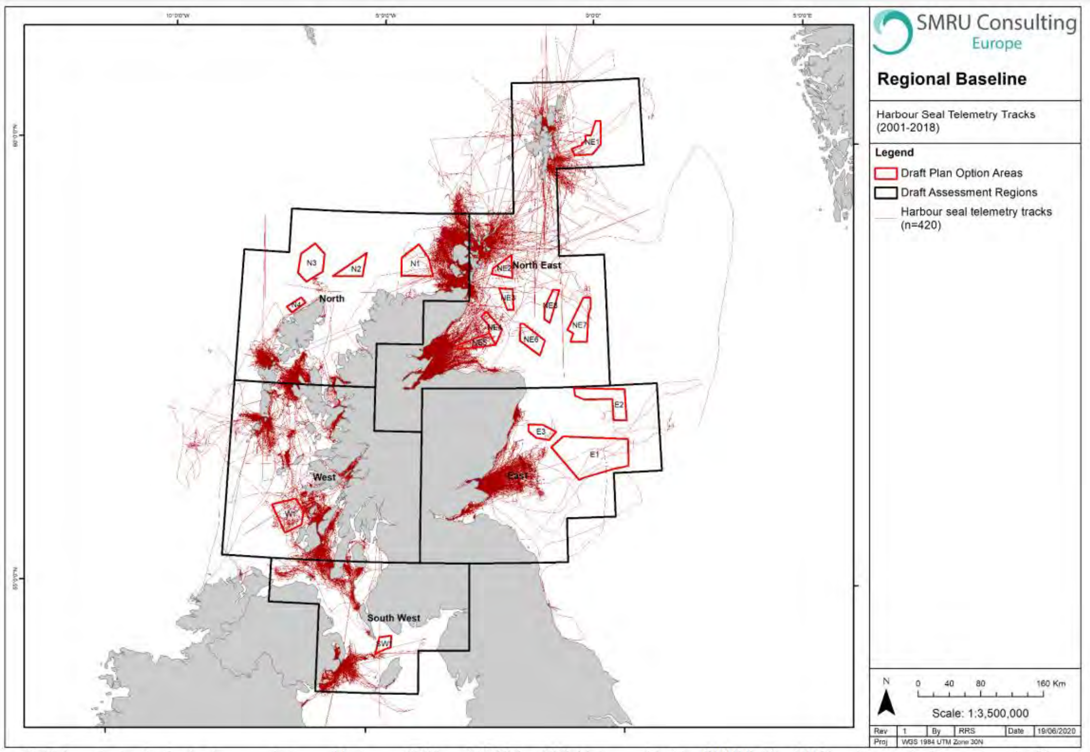

Figure 2-31: Telemetry tracked harbour seals (2001-2018)

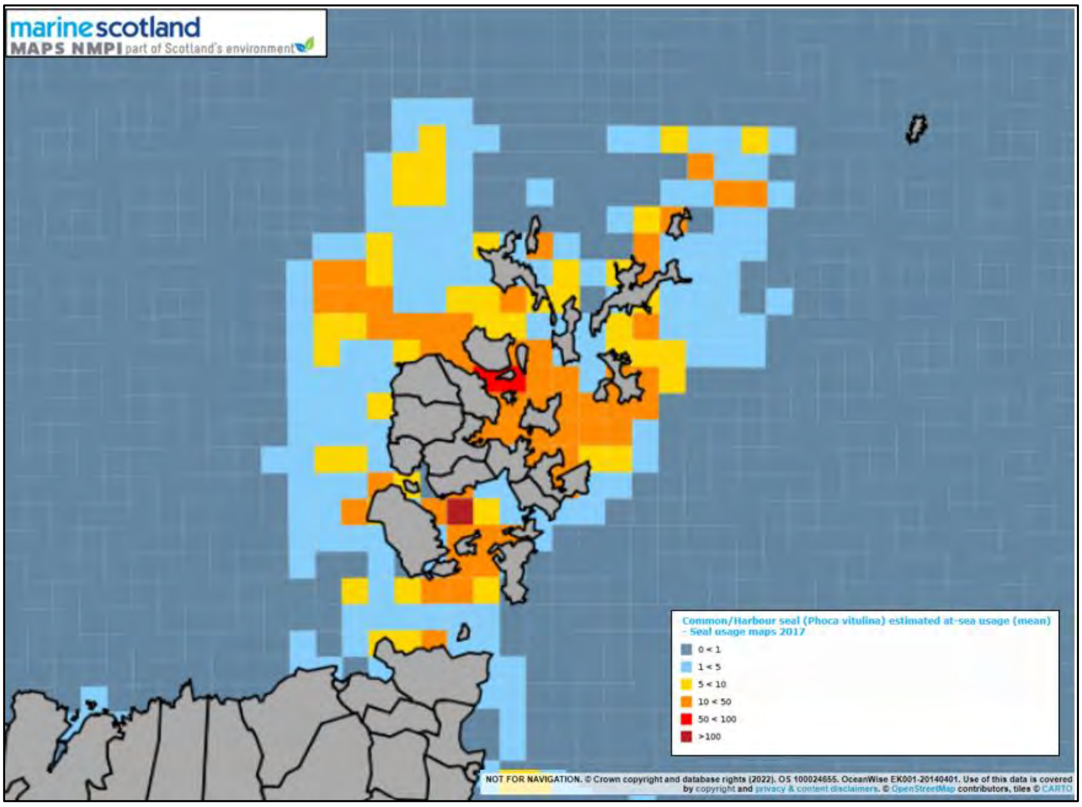

Figure 2-32: Map showing the estimated mean harbour seal density at sea. Image taken from the NMPi. Data from surveys conducted between 1991 and 2016, originated from the Sea Mammal Research Unit.

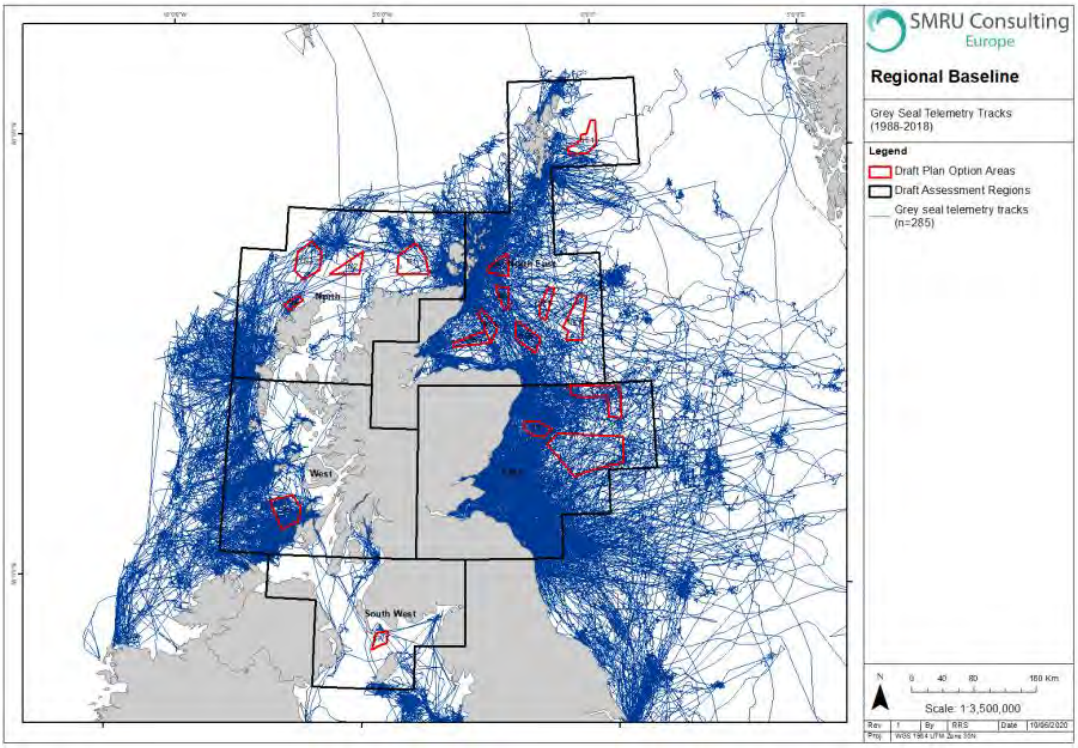

Figure 2-33: Telemetry tracked grey seals (1988-2018)

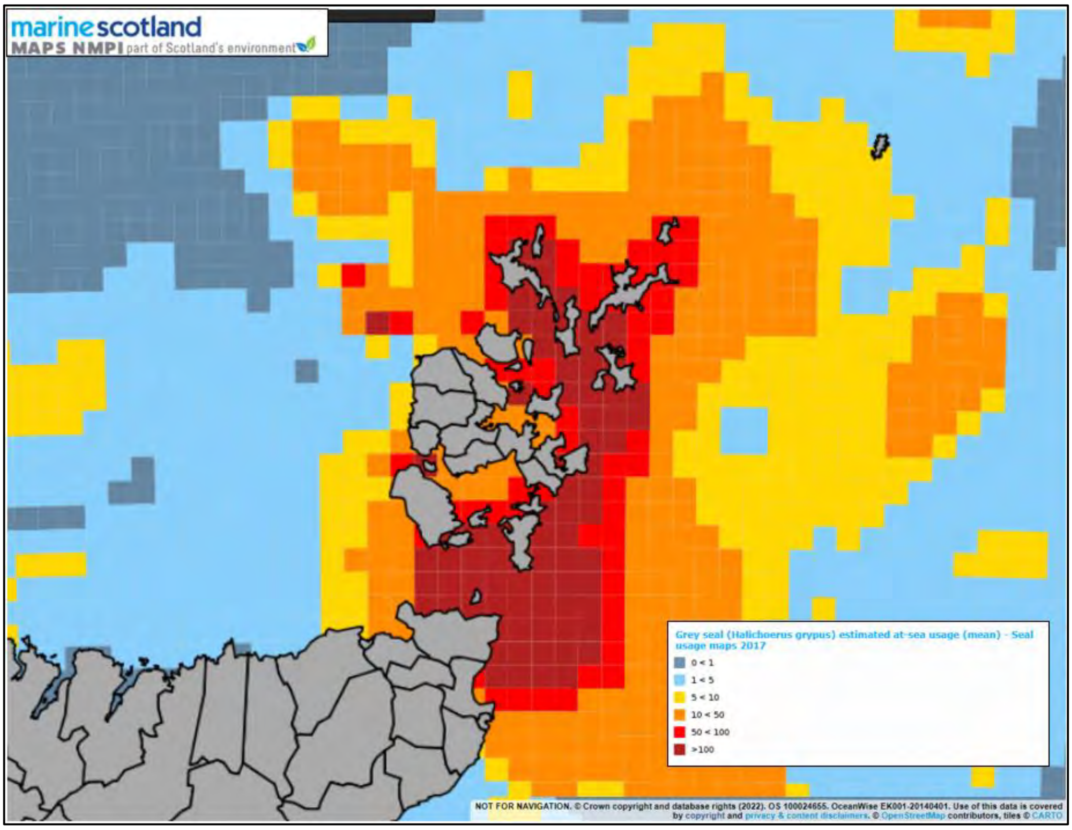

Figure 2-34: Map showing the estimated mean grey seal density at sea. Image taken from the National Marine Plan Interactive Map (NMPi). Data from surveys conducted between 1991 and 2016, originated from the Sea Mammal Research Unit.

Seal haul out data counts for harbour seal and grey seal also show the important association with Orkney, as detailed in Figure 2-35[12].

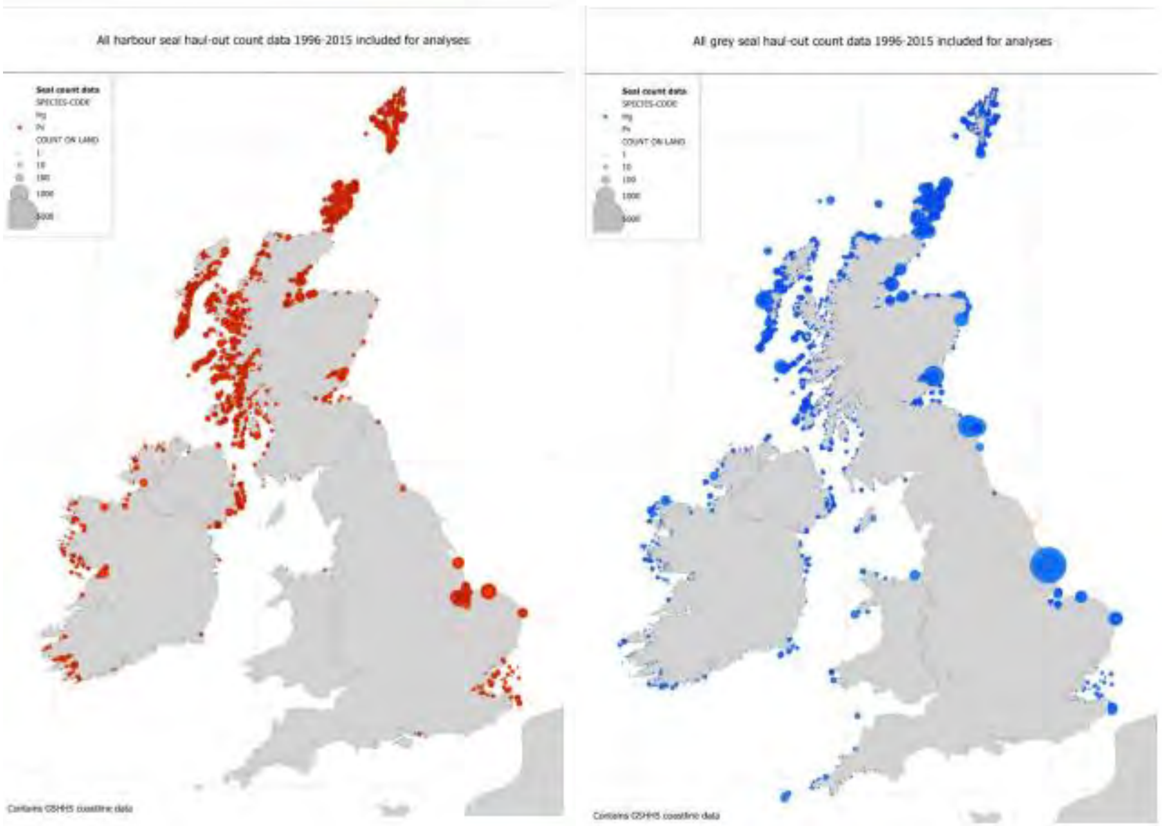

Figure 2-35: Haul out seal count data (1996-2015)

SMASS have recorded 23 harbour seal strandings within 8km of the site between 1992-2016 and 112 records of stranded grey seal between 1992-2021.

2.4 Fish

2.4.1 Basking Shark

Basking sharks *(Cetorhinus maximus)* are listed as endangered on the International Union for Conservation of Nature and Natural Resources (IUCN) Redlist[50]. They are a PMF and are afforded domestic protection under the Wildlife and Countryside Act. The nearest known basking shark hotspot[51] during the summer months, between May and October is along the coast of the Isle of Skye, approximately 243km south west of Orkney. No records of basking shark strandings have been reported by SMASS near Orkney. Basking shark sightings have been reported to HWDC since 2017, with three records nearest to the site being approximately 41km west in 2022, 52km south in 2022 and 90km south west in 2019. 17 records of basking shark sightings within 10km of SDWQ (Billia Croo and Black Craig, Stromness) have been submitted to OMMRI between 2013-2015, with two additional sightings in 2022 (Houton Bay, Orphir). Various records of basking shark have been reported over a

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[50] IUCN Redlist available at: http://www.iucnredlist.org/ last accessed 12/12/2022
[51] The Shark Trust basking shark sightings available at: https://www.sharktrust.org/basking-shark-project last accessed 12/12/2022

30 year study, via data collated from a range of sources by Evans *et al* (2011)[24] as detailed in Figure 2-36.

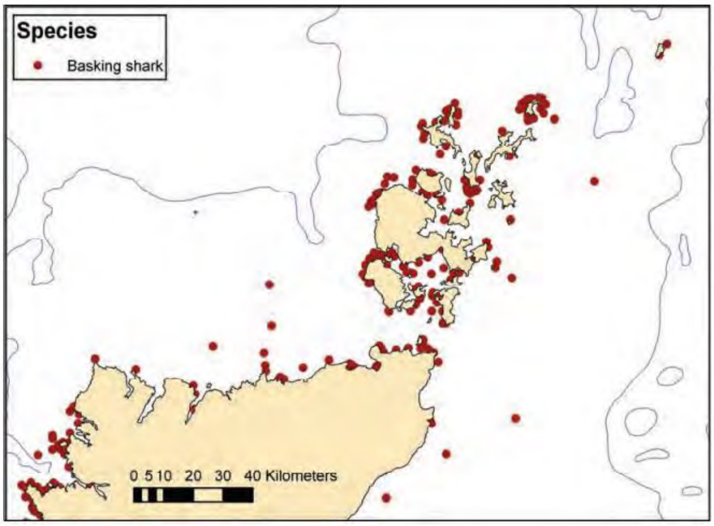

Figure 2-36: Distribution sightings of basking shark (1980-2010)

2.4.2 Diadromous Fish

A series of burns and watercourses are present throughout Orkney, which have potential to provide suitable habitat for a range of fish species for spawning, nursery grounds and residing. The Burn of Button is an open watercourse, flowing through agricultural land, through the north east of the SDWQ site boundary and joins with the Burn of Deepdale which also flows through agricultural and heathland, before flowing into the Bay of Deepdale. The Burn of Gangsta also flows south of the site, approximately 340m. This watercourse flows through agricultural ground and discharges into Scapa Flow.

Malcolm Thomson of the Orkney Trout Fishing Association completed survey work (approx.15 years ago) looking at streams around Orkney to identify which held populations of brown trout (*Salmo trutta*) and of those, which were also producing sea trout (*Salmo trutta*). Out of the freshwater systems surveyed, 36 contained brown trout, and evidence of sea trout was found in 23 of those. However, no trout were found in any of the burns close to the SDWQ development site, only eel (*Anguilla anguilla*) and threespine stickleback (*Gasterosteus aculeatus*) (pers comm). The Burn of Gangsta was not included in the survey. These watercourses are also not considered Atlantic salmon or sea trout rivers by Marine Scotland[52]. The nearest watercourse surveyed by Malcolm Thomson with trout present was the Graemeshall Burn, approximately 7km south east (mouth of watercourse following coast to SDWQ site boundary).

A recent site visit undertaken by EnviroCentre considered the Burn of Button, Burn of Deepdale and Burn of Gangsta to be unsuitable for Atlantic salmon or sea trout, specifically due to the constrained access between the watercourse mouth and sea (limited water levels, underground flow, impassable falls and exposed nature) (Photograph 1 - 3).

A number of trout burns are also present in the wider area, with Scapa Flow, being a known feeding area for sea trout.

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[52] Marine Scotland Salmon and Sea Trout – Scottish Salmon Rivers, available ta: https://marine.gov.scot/information/atlantic-salmon-distribution-scotland, last accessed 09/01/2023

The Atlantic salmon, sea trout and European eel are PMFs (marine part of life cycle).

Although river lamprey (*Lampetra fluviatilis*) and sea lamprey (*Petromyzon marinus*) are PMFs (marine part of life cycle), they are not considered to be of relevance to the site as lampreys were absent from all survey sites on Orkney during the National Lamprey Survey of Scotland, undertaken by NatureScot between 2003-2005[53].

Photograph 1: Burn of Deepdale, with underground flow between watercourse mouth and sea during low tide in February 2023.

Photograph 2: Impassable fall in Burn of Button, approximately 15m upstream of confluence with Burn of Deepdale. Further upstream the burn is canalised, lacking suitable bed substrate for salmonid spawning and relatively shallow, with signs of agricultural enrichment, during low tide in February 2023.

Photograph 3: Low water levels, lack of suitable bed substrate for salmonid spawning and exposed nature of Burn of Gangsta, with signs of agricultural enrichment, during low tide in February 2023.

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[53] NatureScot (2020). National Lamprey Survey of Scotland (2003-2005). Occurrence dataset https://doi.org/10.15468/gbeajh accessed via GBIF.org on 2023-01-23.

2.4.3 Flapper Skate

Flapper skate (*Dipturus intermedius*) are PMFs and considered to be Critically Endangered within the IUCNs red list. It is thought that their population has declined by over 80% within the past three generations with the main pressures relating to commercial fishing activities[54]. They take over 10 years to reach sexual maturity and have small numbers of young. Their egg cases also take a year to mature. Due to this life history, populations are slow to recover from individual losses. They are found over various types of seabed, with a preference for sandy and muddy areas and have been recorded occurring in Scapa Flow.

The Orkney Skate Trust (OST) have observed flapper skate laying egg cases on rough ground in close proximity to sediments, such as a boulder field skerry over sand, in Orkney[55]. In 2021 the OST counted > 21,000 spent flapper skate egg cases washed on Orkney shorelines, recorded over 200 sightings of flapper skate around Orkney and recorded the locations of inshore egg laying areas (establishing the habitats skate are using). A study undertaken by Phillips et al (2021)[56] presents OST data on egg case records, as shown in Figure 2-37, with the highest numbers being found to the north and west of the mainland. The study found that areas where egg cases were repeatedly found had similar habitat traits being >20 m depth, with boulders or exposed bedrock, in moderate current flow (0.3–2.8 knots) with low sedimentation.

The Shark Trust 'Great Egg Hunt' citizen science project[57] shows a similar distribution of records to those found by OST (Figure 2-38). OST have confirmed (by pers comm) that although there are no records for the proposed development site, they have not carried out targeted surveys in the area. They did report a historic record (date not provided) of a tagged adult near H.M.S Royal Oak which is c.2km to the north west.

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[54] Ellis, J.R., McCully-Philipps, S.R., Sims, D., Walls, R.H.L., Cheok, J., Derrick, D. & Dulvy, N.K. 2021. Dipturus intermedius. The IUCN Red List of Threatened Species 2021: e.T18903491A68783461. https://dx.doi.org/10.2305/IUCN.UK.2021-2.RLTS.T18903491A68783461.en. Accessed on 28 June 2023

[55] Orkney Skate Trust, available at: https://www.orkneyskatetrust.co.uk/flapper-skate/

[56] Phillips et al., (2021) Evidence of egg-laying grounds for critically endangered flapper skate (Dipturus intermedius) off Orkney, UK, Jounral of Fish Biology, Vol 99, Issue 4, pages 1492-1496, available at: https://doi.org/10.1111/jfb.14817

[57] The Shark Trust Great Egg Hunt Citizen Science Project, available at: https://www.sharktrust.org/Handlers/Download.ashx?IDMF=8b6b55ee-522b-4dbb-8d33-1fbd6082a635

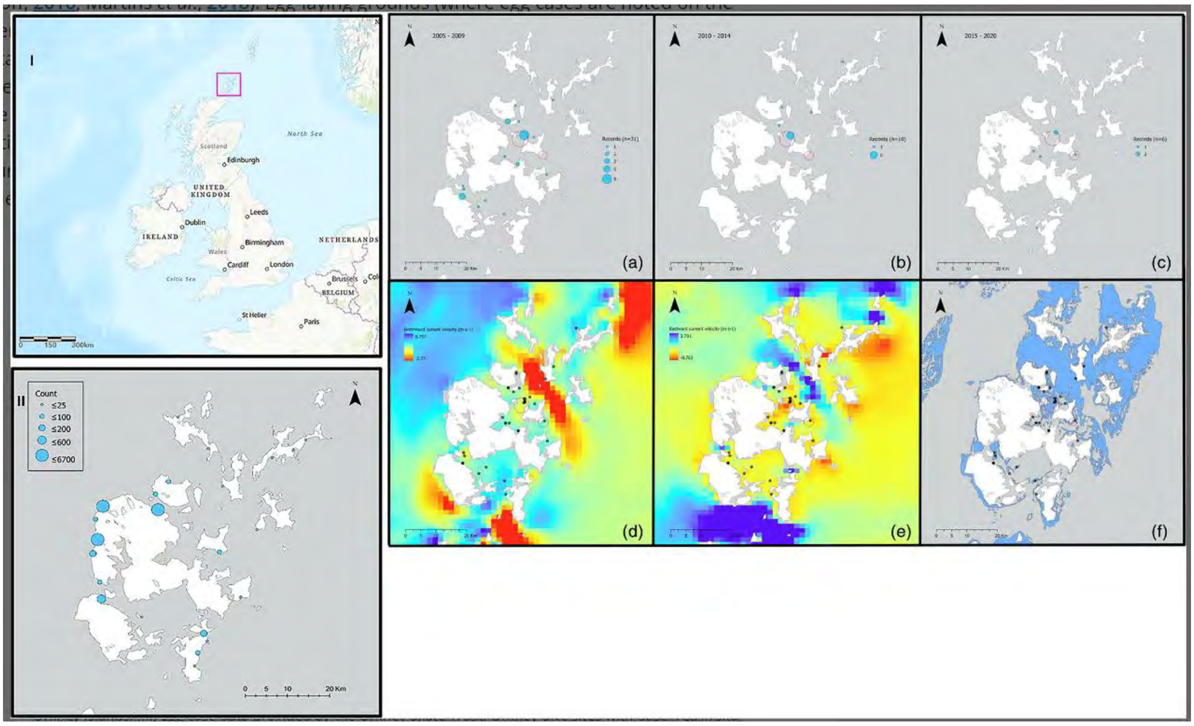

Figure 2-37: (I) Map of UK, with Orkney Islands highlighted in a pink box. (II) Map of flapper egg case records around the Orkney Islands. (III) Egg case data provided by the Orkney Skate Trust. Orkney dive sites with observed in situ flapper skate egg cases from 2005 to 2020; red open circles indicate sites of interest at the Foot of Shapinsay and Galt. (a–c) Maps showing in situ observations of egg cases, Orkney. Data points represent the number of records recorded at each location for the years (a) 2005–2009, (b) 2010–2014 and (c) 2015–2020. (d and e) In situ egg case observations overlaid on (d) northward and (e) current velocity data (m s–1) obtained from E.U. Copernicus Marine Service Information (CMEMS, 2020). (f) In situ egg case observations in relation to hard-rock substrata indicated in blue (EMODnet, 2021). Figure obtained from Philips *et al*

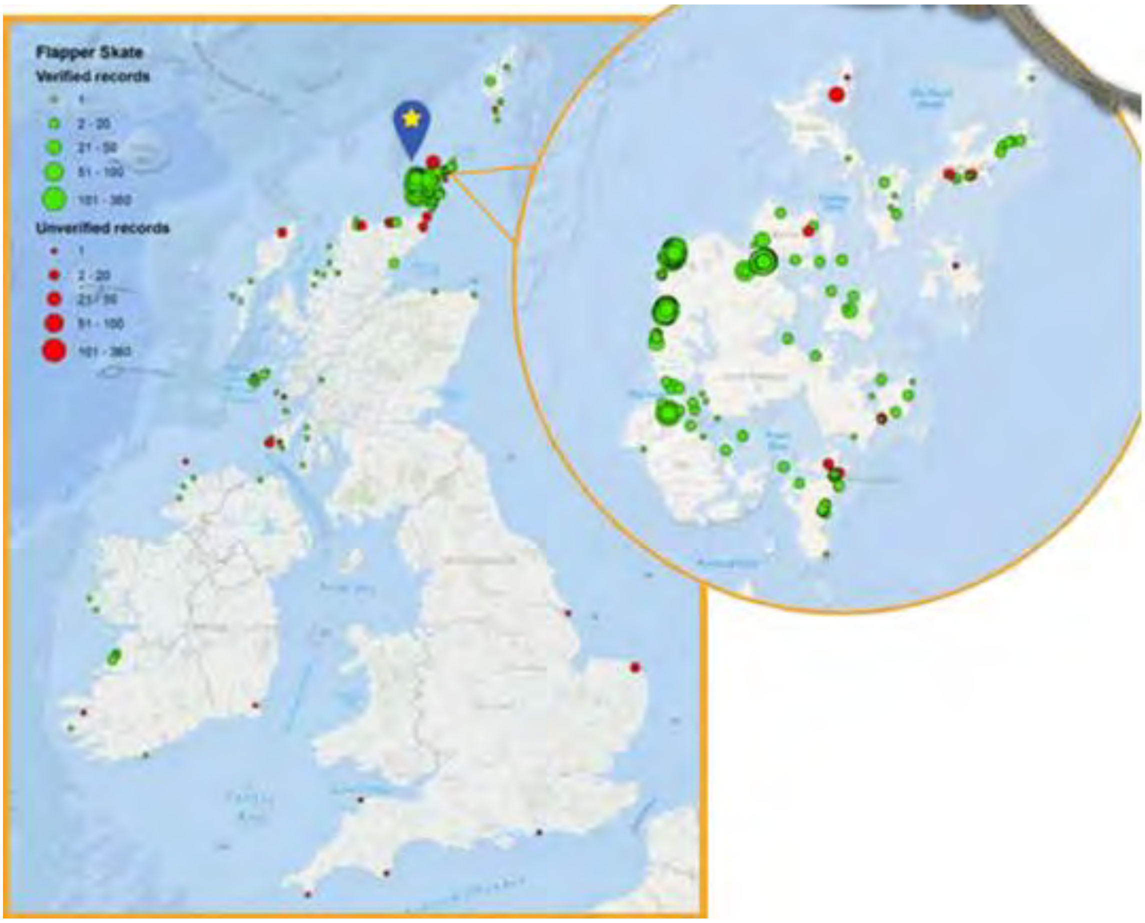

Figure 2-38: Flapper skate egg cases submitted to the Great Egg Hunt (The Shark Trust)

The intertidal and sub-tidal habitat surveys conducted in December 2022[58] found that the seabed habitats within the proposed development site comprised soft muddy sand sediments. There are some areas of hard substrate in the inshore sections of the survey area (within the consent boundary), however these were shallow (<20 m). The habitat therefore may be sub-optimal for egg laying.

Visual searches for flapper skate and egg cases (or any elasmobranch egg cases) were made via underwater video and intertidal transects but none found (Seastar, pers comm).

2.4.4 Other Marine Fish

A range of fish species have been caught by the Orkney Islands Sea Angling Association (OISAA) off the wider Orkney coast, some of which are PMFs (as indicated by *). Some species recorded by OISAA include:

- Mackerel*
- Cod*
- Whiting*
- Atlantic Horse-Mackerel*
- Pollack
- Haddock
- Ling (*Molva molva*)

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[58] O'Dell, J., Forster, S., Dewey, S., and MacMillan, A. (2023). Scapa Deep Water Quay Habitat Mapping Survey. A report to EnviroCentre by Seastar Survey Ltd. and Physalia Associates Ltd.

- Conger Eel (*Conger myriaster*)
- Plaice (*Pleuronectes platessa*)
- Lesser spotted dogfish (*Scyliorhinus caniculus*)
- Flounder (*Platichthys flesus*)
- Dab (*Limanda limanda*)
- Red Gurnard (*Chelidonichthys cuculus*)
- Turbot (*Scophthalmus maximus*)
- Thornback Ray (*Raja clavata*)
- Wolf Fish (*Anarhichas lupus*)
- Halibut (*Hippoglossus stenolepis*)
- Spur Dogfish (*Squalus acanthias*)
- Tope (*Galeorhinus galeus*)
- Ballan Wrasse (*Labrus bergylta*)
- Cuckoo Wrasse (*Labrus bimaculatus*)
- Porbeagle Shark (*Lamna nasus*)

Data available from a number of surveys undertaken in Scapa Flow by Seasearch volunteers collected via dives/snorkels/inter-tidal walks provides lists of species at defined locations. Fish species recorded at the nearest survey location to the site was Scapa Bay (2013) approximately 4km north[59], which recorded species including longspined bullhead (*Taurulus bubalis*), sand goby (*Pomatoschistus minutus*), two-spotted goby (*Pomatoschistus flavescens*) and common dab (*Limanda limanda*)

Species which have also been noted in Scapa Flow include cod and pollack[60], saithe, ling and cuckoo wrasse, with less abundant species including poor cod (*Trisopterus minutes*), goldsinny (*Ctenolabrus rupestris*), conger eel and mackerel[61]. Other species that may be seasonally present include juvenile and non-spawning adult monkfish (*Lophius piscatorius*) and gurnard (*Triglidae spp.*).

The following PMF fish species, have either been recorded in proximity to the site (I) or are marine mammal prey sources (II). Information (where possible) on, nursery and spawning ground areas [62] [63] [64] as well as distribution has been used to assess whether the species could be present within the SDWQ development site in Orkney. In addition, benthic habitat surveys undertaken on the site revealed underwater habitat types comprising predominantly of soft muddy and sandy mixed sediments with a significant shell and/or gravel fraction, with small pockets of bedrock, boulders and cobbles[65]. Therefore PMFs for which there is not habitat have been excluded. Those of relevance are detailed in Table 3-1.

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[59] Seasearch (2013). Seasearch Marine Surveys in Scotland. Occurrence dataset https://doi.org/10.15468/0hyjxi accessed on 30/01/2023.

[60] http://www.scapa-flow.co.uk/blog/11-This-year-Scapa-Flow-is-thriving-with-wildlife-above-and-below-the-water-line-MV-Invincible

[61] https://tethys.pnnl.gov/project-sites/emec-scapa-flow-scale-wave-test-site#:~:text=Fish%20species%20that%20are%20commonly,cuckoo%20wrasse%20(Labrus%20mixtus).

[62] MS NMPi data available at: https://marine.gov.scot/maps/nmpi?title=&items_per_page=25

[63] CEFAS Ellis, J.R., Milligan, S.P., Readdy, L., Taylor, N. and Brown, M.J. 2012. Spawning and nursery grounds of selected fish species in UK waters. Sci. Ser. Tech. Rep., Cefas Lowestoft, 147: 56pp.,

[64] NatureScot https://www.nature.scot/sites/default/files/Publication%202016%20-%20SNH%20Commissioned%20Report%20406%20-%20Descriptions%20of%20Scottish%20Priority%20Marine%20Features%20%28PMFs%29.pdf

[65] O'Dell, J., Forster, S., Dewey, S., and MacMillan, A. (2023). Scapa Deep Water Quay Habitat Mapping Survey. A report to EnviroCentre by Seastar Survey Ltd. and Physalia Associates Ltd. 67 pages.

Table 2-1: Fish PMFs in Relation to SDWQ Development Site

PMF	Spawning Grounds Cover the Site	Nursery Grounds Cover the Site	Distribution Covers the Site
Anglerfish (*Lophius piscatorius*)	Unlikely (insufficient data)	Yes (high density)	Yes
Atlantic halibut (II)	No	No	Yes
Atlantic herring (I) (II)	Yes	Yes (low density)	Yes
Atlantic mackerel (I) (II)	No	No	Yes
Atlantic salmon (II)	No	No	Yes
Blue whiting (I) (II)	No	Yes (low density)	Yes
Cod (I) (II)	No	No	Yes
Horse mackerel (I) (II)	No	No	No
Ling (I)	No	Yes (low density)	Yes
Saithe (II)	No	Yes (unknown density)	Yes
Sandeels (*Ammodytes marinus* & *Ammodytes tobianus*) (II)	Yes	Yes (low density)	Yes
Sand goby (I) (II)	Highly likely	Highly likely	Yes
Sandy ray (*Leucoraja circularis*) (II)	No	No	No
Spiny dogfish (*Squalus acanthias*)	No	Yes (low density)	Yes
Whiting (I) (II)	No	Yes (low density)	Yes

2.4.5 Aquaculture/Fisheries

A number of active commercial fisheries are present within 20km of the site, comprising of Atlantic Salmon, lumpsucker (*Cyclopteridae*) and wrasse (*Labridae*). The nearest commercial fisheries is Westerbister, present 500m south west of the SDWQ site and consists of Atlantic salmon, lumpsucker and wrasse.

3 MARINE MAMMALS AND FISH SPECIES LIKELY TO BE IMPACTED

From the proposed works associated with the development, the following potential impacts may occur:

- Noise and vibration generated during construction of pier and future operations, ship traffic and other port activities may temporarily or permanently impact marine mammals, seals and fish and any prey resources causing death, injury or disturbance.
- Potential impacts on water quality as a result of pollution events (fuel spills, sediment runoff etc.) during and post construction. This could result in death, injury or disturbance to individuals.
- Removal of benthic habitat for construction of pier.
- Any dredging will remove bottom biota and dumping of dredged material covers bottom habitat, both of which may reduce fish resources.
- Introduction or further spread of any non-native species during and post construction.
- Increased ship movement may result in collisions with cetaceans, seals or basking sharks.

Based on the above information, it has been assessed that the most frequently observed species, and therefore the species considered to be of most concern within the zone of influence of the proposed SDWQ development, are harbour porpoise, Risso's dolphin, killer whale, white-beaked dolphin, long-finned pilot whale, grey seal, harbour seal, basking sharks, commercial fisheries, and some fish PMFs. The other species aforementioned are less frequently observed in Orkney waters and therefore are less likely to be of concern within the zone of influence.

Table 3-1: Marine Mammals and Fish Species Likely to be Impacted by Proposed Development

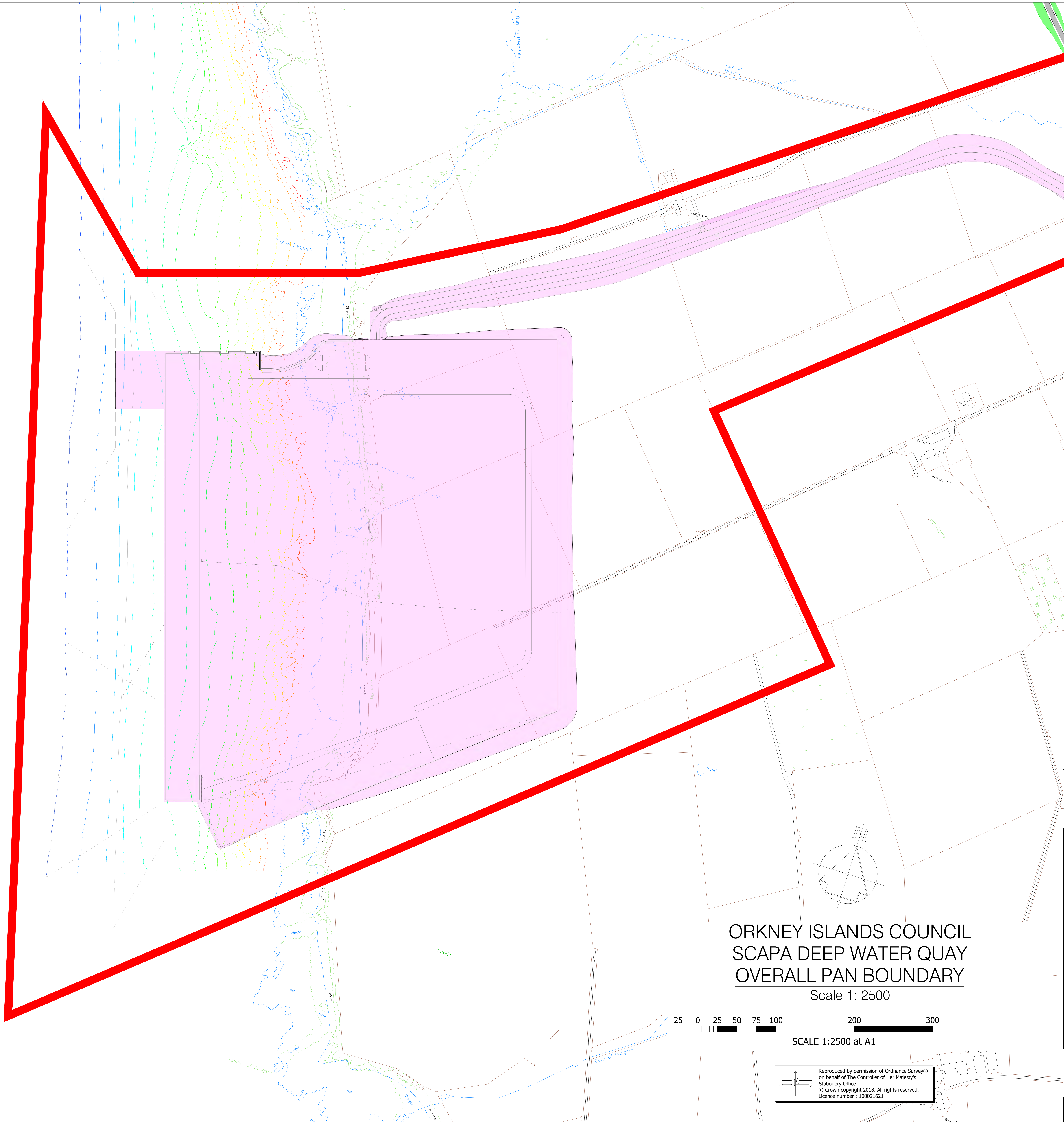
Species	Regularly Present near SDWQ	Potential to be Significantly Impacted
Harbour porpoise	Yes	Yes
Risso's dolphin	Yes	Yes
Killer whale	Yes	Yes
White beaked dolphin	Yes	Yes
Long-finned pilot whale	Yes	Yes
Minke whale	Yes	Yes
Short-beaked common dolphin	No	No
Striped dolphin	No	No
Atlantic white-sided dolphin	No	No
Bottlenose dolphin	No	No
Humpback whale	No	No
Sperm whale	No	No
Fin whale	No	No
Cuvier's beaked whale	No	No
Sei whale	No	No
Short-finned pilot whale	No	No
Sowerby's beaked whale	No	No
Northern bottlenose whale	No	No
False killer whale	No	No
Blue whale	No	No
Narwhal	No	No
Beluga	No	No

Harbour seal	Yes	Yes
Grey seal	Yes	Yes
Basking shark	Yes	Yes
Diadromous fish	Yes	No
Commercial fisheries	Yes	Yes
European Eel	Yes	No
PMF fish species with nursery and spawning grounds covering the site	Yes	Yes
Flapper Skate	Yes	Yes

APPENDICES

A PROPOSED SITE LOCATION AND LAYOUT

Chart Datum (Scapa Flow)	Ordnance Datum (Newlyn)	Quay Heights and Tide Data Scapa Deep Water Quay
+7.00m	+5.31m	Quay Edge Level
+3.60m	+1.91m	Mean High Water Spring Tides
+1.69m	0.00m	Ordnance Datum (Newlyn)
+0.70m	-0.99m	Mean Low Water Spring Tides
0.00m	-1.69m	Chart Datum (Scapa Flow)
-5.00m	-6.69m	
-10.00m	-11.69m	
-15.00m	-16.69m	
-20.00m	-21.69m	



ORKNEY ISLANDS COUNCIL
SCAPA DEEP WATER QUAY
OVERALL PAN BOUNDARY

Scale 1: 2500

25 0 25 50 75 100 200 300

SCALE 1:2500 at A1

P5	08.11.2022	Preliminary Issue P5	PRN	
P4	07.11.2022	Preliminary Issue P4	PRN	
P3	04.11.2022	Preliminary Issue P3	PRN	
P2	03.11.2022	Preliminary Issue P2	PRN	
P1	28.10.2022	Preliminary Issue P1	PRN	
REV	DATE	REVISION	DRN	CHK

ORKNEY ISLANDS COUNCIL
Harbour Authority

Scapa Deep Water Quay Proposal

Overall PAN Boundary

Arch Henderson
1919

Civil Engineers
Structural Engineers
Architects
CDM Co-ordinators
Geotechnical services
Environmental services

Stewart Building, Lerwick, Shetland. ZE1 0LL.
Tel : 01595 695512
www.arch-henderson.co.uk - email : lerwick@arch-henderson.co.uk

Aberdeen; Dundee; Glasgow; Lerwick; Inverness; Thurso; Stromness; Southampton; Falkland Islands

DRAWN : PRN	DATE : October 2022	CHECKED : SSJ	APPROVED : APS
SCALE : (A1) As Shown		DRAWING STATUS : Preliminary	
DRAWING No : 212089-S-CB-01		REV : P5	

TECHNICAL APPENDIX 5.3

SCAPA DEEP WATER QUAY

Ornithology:

Technical Report

Prepared by:

Andrew Upton
FIRTH ECOLOGY
Finstown, Orkney
01856 880176
firth.ecology@btinternet.com

Date: 02 March 2023

Contents

1. INTRODUCTION

This report presents details of the methods and findings of all field surveys undertaken to identify the ornithological interests at the proposed Scapa Deep Water Quay site.

Ornithological surveys took place between November 2020 and September 2022 covering the following periods:

- Year 1: November 2020 to September 2021 (2020/21 non-breeding season and 2021 breeding season);
- Year 2: October 2021 to September 2022 (2021/22 non-breeding season and 2022 breeding season).

All fieldwork was undertaken by Andrew Upton of Firth Ecology, Finstown, Orkney, who has carried out previous inshore bird survey work in Orkney for British Trust for Ornithology (2016/17) and under contract from NatureScot (2017/18).

1.1 Site description

The Scapa Deep Water Quay site is located on an undeveloped part of the eastern shore of Scapa Flow at Deepdale, Holm.

The shoreline at the site consists of a rocky intertidal area with stretches of shingle along the upper beach. It lies below steep vegetated sea-banks, with short sections of vertical rocky cliffs, all less than 15 m high. Behind the shore, variously improved and semi-improved fields slope gently up from a narrow fringe of rich maritime vegetation.

The whole of the marine part of the quay footprint lies within the ill-defined Bay of Deepdale, with the land on either side extending forward only a little. Close to the north of the proposal site the Burn of Deepdale arrives at the shoreline from the northeast; immediately beyond the mouth of the burn, higher and steeper cliffs rise gradually to the north, backed by moorland. To the south of the site, the sea-banks remain lower and backed by improved farmland.

1.2 Inshore and offshore marine activities during the survey period

Current inshore developments include a fish farm about 1 km south of the quay footprint and, beyond that, an area used (infrequently) by the European Marine Energy Centre (EMEC) about 2 km south of the quay – these locations are shown on the maps in **Appendix A**. There was more or less daily boat activity at the fish cages, the attendant workboats arriving from the south or southwest and very rarely straying north across the core survey area. The EMEC site was seen in use on only five watch days from mid-February to early May 2022, the attendant workboat and rib arriving and departing westwards to Stromness, except once when a survey vessel came north through the proposal site.

Throughout the survey period, up to three oil rigs were moored at locations about 2 km offshore, to the west and south of the proposal site. Each rig was present for weeks or months at a time, mostly over the winter; the closest position to the proposal is indicated on the Year 1 maps in **Appendix A**. When rigs were in place there could be regular boat traffic (e.g. on an approximately hourly basis) to and from Scapa Bay, typically traversing at 1.5 to 2 km offshore from the proposal site.

There were irregular and much more distant activities of tugs and pilot boats, to and from Scapa pier, to attend tankers out towards the centre of the Flow – these remained almost entirely at well beyond 2 km from the proposal site.

In Year 2, some boat-based survey work occurred at the same time as the bird surveys, with a small boat carrying out transects within 500 m of the shore, and parallel to it, on several days in November and December 2021. A small drilling platform was towed to within a few hundred metres of the shore on 14th January 2022 and towed away again on 2nd April 2022 as shown on the Year 2 maps in **Appendix A**. It was moved to various locations during its stay, including within the marine footprint of the quay. When operational, it was accompanied throughout by a small boat and a small tug; however, the platform was present but not in use for about a month in February 2022.

Other occasional use of the inshore waters was by one to two creel boats, once in November 2020, and again between July and September 2021. In the latter period, buoys were present each day within a couple of hundred metres of the shore, but the boats themselves were encountered on only two survey days.

1.3 Overview of vantage point survey methods

An introductory watch-day was carried out in late October 2020 to establish the range of birds present and to consider suitable survey methods. It was decided that the best Vantage Point (VP) position would be centred on the quay footprint and that it was of prime importance to use methods that gauged the numbers and usage of the inshore area around it by the Scapa Flow Special Protection Area (SPA) qualifying species.

The fieldwork covered the period from November 2020 through to September 2022. It was largely based on VP watches viewing offshore, during which various recording methods were used to capture different aspects of bird distribution and behaviour around the proposal site.

1.3.1 VP watches

The aim was to carry out four VP watch days every month, separated by at least three days, with two up to the 15th of each month and two from the 16th onwards. This was achieved in all months, apart from June 2021 (three watch days only), December 2021 (three watch days in first half and one in second) and May 2022 (one watch day in first half and three in second). **Table 1** shows the dates on which VP watches were undertaken in each month.

Watch days were targeted towards days that were largely dry and with light winds. However, the main factor affecting visibility was the sea-state, which meant that stronger winds from the east could be accommodated, when the shelter provided by the land meant that sea-states were lower than would otherwise have been expected. No counts were made in sea-states of more than 4.

Full details of the wind, sea and weather conditions for each count are given in the detailed count data in **Data Appendices A** to **D**.

Table 1. *Dates of fieldwork across the survey period.*

Month	Year	VP watch dates				Walkover survey	Other
October	2020				27		Introductory visit only
November	2020	06	12	17	27	17 Nov	
December	2020	03	15	18	27		
January	2021	03	08	20	26	03 Jan	
February	2021	03	11	20	27	20 Feb	
March	2021	03	08	21	25		
April	2021	01	13	09	27	27 Apr	1-hour watch across moorland
May	2021	03	09	17	23	17 May	1-hour watch across moorland
June	2021	05		23	29	26 June	1-hour watch across moorland
July	2021	08	13	27	31		
August	2021	05	09	19	24		
September	2021	04	12	18	29		
October	2021	06	12	19	24		
November	2021	01	04	25	30		
December	2021	04	07	12	17	04 Dec	
January	2022	09	14	24	30	30 Jan	
February	2022	02	07	19	25	25 Feb	
March	2022	04	07	16	29		
April	2022	02	10	20	25	23 Apr	2-hour watch across moorland
May	2022	07	20	24	30	21 May	2-hour watch across moorland
June	2022	03	09	20	27	10 June	2-hour watch across moorland
July	2022	05	11	23	28		
August	2022	01	14	23	27		
September	2022	09	12	23	29		

The methods used at the VP were developed and adapted as the work progressed and comprised the following elements:

- Counts of birds on the water within defined sectors out to 1 km from the centre of the quay footprint – November 2020 to September 2022;
- Counts of birds on the water within defined sectors out to 2 km from the centre of the quay footprint – for divers, November 2020 to September 2022 and for all other species, April 2022 to September 2022;

- Counts of Eider *Somateria mollissima* and Long-tailed Duck *Clangula hyemalis* at the fish cages, between one and two kilometres to the south – February 2021 to March 2022 (subsumed into the 2 km counts after this);
- Counts of all birds within 2 km from the centre of the quay footprint along the unsighted shorelines to north and south, using additional VPs – mid-March 2022 to September 2022;
- Counts from an upper VP situated behind the higher cliffs to the north to count all divers within visible distance – late January 2022 to September 2022;
- Observations of specific birds or groups of birds over periods of at least 40 minutes, mapping their location and noting their behaviour at approximately five-minute intervals – November 2020 to mid-January 2022 and at lower intensity through to September 2022;
- Ad hoc noting of flight paths for all divers, other selected waterfowl, Arctic Skua *Stercorarius parasiticus* and scarce raptors (Hen Harrier *Circus cyaneus*, Merlin *Falco columbarius*, Peregrine *Falco peregrinus* and Short-eared Owl *Asio flammeus*) as they were seen during any survey work– from all survey days;
- Timed flight logging of species offshore, including drawing flight paths for terns and noting their foraging locations – for at least six hours per month from late June 2021 to September 2022;
- Recording of bird/boat interactions where they were noted during other fieldwork, from January 2022 to September 2022.

Table 2 summarises the progression of the survey methods, with further detail under given in **section 2** below.

Table 2. *Approximate summary by month of VP methods across the survey period from November 2020 to September 2022. Darkest shading is when three counts were carried out per watch-day from the Main VP (otherwise two); lightest shading is for VPs with only one count per watch-day, and when swimming tracks were less prioritised. [E. = Eider; LN = Long-tailed Duck]*

Method	**N**	**D**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**
1km counts	▓	▓	▓	▓	▓	▓	▓	▓	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒
Divers >1km	▓	▓	▓	▓	▓	▓	▓	▓	▒	▒	▒	▒	▒	▒	▒	▒	▒						
2km counts																		▒	▒	▒	▒	▒	▒
E./LN at cages				▓	▓	▓	▓	▓	▒	▒	▒	▒	▒	▒	▒	▒	▒						
N & S VPs																	░	░	░	░	░	░	░
Upper VP																░	░	░	░	░	░	░	░
Swimming tracks	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	░	░	░	░	░	░	░	░
Flight logs									▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒
Boat interactions															░	░	░	░	░	░	░	░	░

1.3.2 Target species from VP watches

The main targets species from VP watches were the qualifying interests of the Scapa Flow SPA:

- Non-breeding:
  - Black-throated Diver *Gavia arctica*
  - Great Northern Diver *Gavia immer*
  - Slavonian Grebe *Podiceps auritus*
  - Eider
  - Long-tailed Duck
  - Red-breasted Merganser *Mergus serrator*
  - Shag *Gulosus aristotelis*

- Breeding:
  - Red-throated Diver *Gavia stellata*

Of the SPA species, all were regular at the site apart from Red-breasted Merganser, which occurred very infrequently in ones or twos close inshore or flying past.

All non-SPA species occurring offshore were covered by at least one of the survey methods, so that other locally important species could be identified. The additional species regularly occurring at the site include:

- Breeding or summering:
  - Eider (amber-listed), summering birds in addition to SPA wintering non-breeders.
  - Shag (red-listed), breeding birds in addition to SPA non-breeders.
  - Arctic Skua (red-listed)
  - Common Tern *Sterna hirundo* (Annex 1)
  - Arctic Tern *Sterna paradisaea* (Annex 1)

- Resident:
  - Black Guillemot *Cepphus grylle* (amber-listed)

The detailed results of the VP survey work below cover all of these species as well as other regularly occurring birds offshore, such as auks, gulls and other seabirds.

1.4 Overview of walkover survey methods

1.4.1 Walkover surveys

Onshore surveys for breeding and wintering birds were also carried out. These comprised walkovers, done three times across each summer (April to June) and three times across each winter (November to February). The breeding season walkovers also included watches across the moorland to the north of the proposal site for potential breeding raptors.

1.4.2 Shoreline counts

Partial counts of birds on the shoreline were made on each VP watch day, based on what was seen during the walk in from the north to the main VP and what was visible to the south from the VP, plus any wader movements noted during the day. Complete counts along the shore were made during the breeding and wintering walkover surveys and also when the additional north and south VPs were in use from March 2022 onwards.

2. VP SECTOR COUNTS – METHODS AND RESULTS

2.1 Main VP – 1 km sector counts, method

The main VP was selected at a point near the middle of the quay footprint, where the observer was seated in a folding chair.

It lies at HY 45281 04109, about 10 m AOD with a clear view across the eastern part of the Flow apart from narrow inshore areas to the north and south where the shoreline bends around short headlands (see Section **2.4** below) and close in to the rear of the fish cages.

The method adopted consisted of counts of birds on the water out to 1 km around the VP, with the sectors radiating from the VP towards recognisable landmarks. This reduced the error in estimating the positions of birds on the water, so that their distance away from the observer was the sole judgement required. The distances of shoreline features, together with the known location of the fish cages, the Royal Oak marker and the closest rig (in 2020/21) helped with distance estimation. A maximum distance for counting all species was initially set at 1 km, to avoid the undercounts likely beyond that.

The distance bands used were:

- 0 – 250 m
- 250 – 500 m
- 500 m – 1 km

The whole viewing arc was radially split into four approximately equal parts, giving 12 recording sectors, sectors 1 to 12. However, in the analyses, the four innermost sectors, which all lie within the offshore footprint of the quay, have been combined into one larger inner sector as shown on the heat maps in **Appendix A**.

Each part of the defined survey area was counted by scanning at least twice across it. Most birds could be seen relatively easily with binoculars out to some way beyond the 250 m mark, but a telescope was useful for the middle circle of sectors, 5 to 8, and essential for the outer sectors, 9 to 12.

Each count lasted as long as it took to achieve full coverage of the 1 km sector area, which depended particularly on the sea conditions and the numbers of birds present. Each bird or group of birds was allocated to the sector in which it was first seen. However, due to the length of time each count took, these were not strictly snapshot counts and birds moving into the outer sectors as the count progressed were also included.

During the introductory visit it was noted that the birds on the water could move around widely during a period of a few hours, implying that a single sector count on each day would not necessarily be a good reflection of their distribution. Therefore, from November 2020 to June 2021, three 1 km sector counts were made on each watch day in order to arrive at a better average distribution for each day. From July 2021 onwards the addition of a period of flight logging meant that only two 1 km sector counts were made on each watch day. This increases the notional error bars around the sector averages obtained, but otherwise produces the same metric as obtained in the earlier months – i.e. an average distribution of birds per visit – and is therefore comparable.

2.2 Diver and duck counts beyond 1 km, method

Due to their larger size and their conservation importance, all diver species seen beyond 1 km were noted from mid-November 2020 onwards and allocated to four additional notional sectors radiating out beyond the 1 km mark. Up to October 2021 this was restricted only to the divers *readily visible* beyond 1 km – these would all have been within 2 km, and some more distant birds at the outer 2 km edge may have been missed. Subsequently, each sector count specifically looked to record *all* divers visible beyond 1 km. During this later effort, the divers were not allocated to a specific distance band, so a small proportion may have been beyond 2 km; however, they have all been treated in the analysis as within the 1–2 km distance band from the VP.

From February 2021 any Eider and Long-tailed Duck visible at the fish cages were also added to the 1 km sector counts, these all lying within the southernmost notional sector.

2.3 Main VP – 2 km sector counts, method

The sector counts were extended out to 2 km for all species from 10th April 2022, thus incorporating the previous diver counts beyond 1 km and the Eider and Long-tailed Duck counts at the fish cages.

Four additional sectors were then formally in use – sectors 13 to 16, as shown on the relevant heat maps in **Appendix A**.

Essentially the same count method was used as before but doing full 2 km counts meant that each one took considerably longer. For divers the more distant birds were now allocated to the sectors 13 to 16 or noted as at greater than 2 km. For all of the smaller waterfowl species the confidence in the results from the new outer sectors is necessarily reduced.

The most distant divers could often not be identified with any certainty and were recorded as 'diver sp'. A minority of such diver sp were judged to be within 2 km and have been allocated to either Black-throated or Great Northern for the heat maps and in Table 3 below, so as not to underestimate their numbers. (However, the monthly bar-charts in Appendix C do not include unidentified birds). The allocation has been on the following basis:

- all birds thought to have been 'probable' Black-throated Divers have been treated as confirmed Black-throated: Year 1, two birds; Year 2, 11 birds;
- single divers and groups of up to six through to March have been treated as Black-throated: Year 1, seven birds; Year 2, 14 birds;
- larger groups (i.e. in double figures) have been treated as Great Northern: Year 2, one group of 16 birds;
- smaller groups in April and May have been treated as Great Northern (since there was just one record each year of a single Black-throated Diver in April within the 1 km sectors and none in May): Year 2, 14 birds.

Distant unidentified auks in the 1 – 2 km distance band have also been allocated as either Razorbills *Alca torda* or Guillemots *Uria aalge*, pro rata with the numbers of those two species during that count.

2.4 Counts from north and south VPs for unsighted shorelines, method

There were two sea areas which the 1 km and 2 km sector counts did not cover. These were the inshore areas to the north and south of the main VP where the waters closest to shore were out of view due to the curve of the shoreline behind short headlands. To the north of the VP this is a narrow sector in the 1–2 km distance band. To the south it is a wider stretch of water, including part of the 500m–1 km band as well as beyond 1 km.

In order to address this, two additional VPs were used to give more or less complete coverage to north and south out to 2 km from the main VP, back to whole length of the shoreline. One count was made at each of these VPs on all visits from 16th March 2022 onwards.

Since both of these VPs also viewed across a part of the main sector area, the counts from each were split into those birds that could have been seen from the main VP and those that were hidden from it. In compiling the count results for presentation, it is only the birds out of view from the main VP that have been used. The relevant heat maps in **Appendix A** indicate the additional visible areas of water as 'Inner N sector' and 'Inner S sector' and show the locations of the north and south VPs.

The count dates at these two VPs, from mid-March to September 2022, covered a full breeding season for Red-throated Diver. They incorporated the peak period for Long-tailed Duck (spring passage) and one of the two seasonal peaks for Great Northern Divers (again, spring passage). They also covered the late summer peaks in Eider and Black Guillemot numbers. The date range overall appears rather average for Shag numbers but missed the periods of occurrence of Black-throated Divers and Slavonian Grebes more or less completely.

The narrow sector to the north lies entirely below vertical cliffs and held few additional birds other than some of those breeding on the cliffs, principally Shags, Black Guillemots, Razorbills and Herring Gulls *Larus argentatus*. The southern inner sector generally held small numbers of all of the target species that were present in the spring and summer. It was perhaps most important for Eider, of which small flocks could be present, although often at more than 2 km from the main VP (in which case they were not included in the counts).

The target species' heat maps in **Appendix A**, indicate the relative importance of each of these inner sector areas for those species encountered. Where they contributed to the average or peak numbers within 1 – 2 km, the counts in the inner sectors are included in the 1 – 2 km figures in **Tables 3 and 4** below.

2.5 VP sector counts – results

This section gives a brief summary of the VP count results.

Daily charts of the numbers of each species counted within 1 km are given in **Appendix B** and monthly charts of the average and peak numbers within 1 km and 2 km are in **Appendix C**. It should be noted that these charts do not include unidentified divers or auks and cover only the sectors visible from the main VP (i.e. not including those visible from the additional north and south VPs later in the survey period).

The full details from *each VP count* are given in **Data Appendices A** to **D**, including:

- times and conditions;
- the numbers of each species in each sector out to 1 km;
- the number of birds at 1 – 2 km where counted (see Sections **2.2**, **2.3** and **2.4**); and
- the numbers of divers beyond 2 km, where counted.

All species on the water were included in the sector counts, excluding only Fulmars *Fulmarus glacialis* (which were present sitting off the cliffs to the north of the main VP for most of the year, primarily in sectors 9 and 13) and odd ones and twos of Common Gulls *Larus canus* (although larger groups and flocks were included). **Tables 3 and 4** summarise the seasonal occurrence of all of the more frequently recorded species, giving the proportion of days on which they were seen and the average numbers, or the range of numbers, within 1 km of the main VP (and within 2 km, where the data was collected).

A further 12 species were recorded on the water from the main VP on less than ten VP days throughout the two-year survey period (from a total of 91 days). These are:

- Wigeon *Mareca penelope*: five days, Nov-Mar, 2 – 11 birds
- Goldeneye *Bucephala clangula*: five days, Feb-Apr, 1 – 2 birds
- Mallard *Anas platyrhynchos*: three days, Mar-Apr, 1 – 4 birds
- Common Scoter *Melanitta nigra*: two days, Dec & May, 1 – 2 birds (plus 1 day at 1–2 km, 3 birds)
- Mute Swan *Cygnus olor*: two days, Apr-June, 2 birds
- Lesser Black-backed Gull *Larus fuscus*: two days, May-June, 2 birds
- Pink-footed Goose *Anser brachyrhynchus*: one day, Jan, 2 birds
- Teal *Anas crecca*: one day, July, 1 bird
- Manx Shearwater *Puffinus puffinus*: one day, June, 9 birds (at 1–2 km)
- Grey Phalarope *Phalaropus fulicarius*: one day, Jan, 1 bird

For the SPA interests and the more regular and locally important species, the count data in **Table 3**, the heat maps in **Appendix A** and the bar charts in **Appendices B and C** give an overview of their numbers and distributions within and between the survey seasons.

Table 3. *Summary of sector count results (species for which heat maps produced).*
SPA qualifying interests high-lighted;
[RH = Red-throated Diver; BV = Black-throated Diver; ND = Great Northern Diver; SZ = Slavonian Grebe; E. = Eider; LN = Long-tailed Duck; SA = Shag; TY = Black Guillemot; RA = Razorbill; GU = Guillemot; LK = Little Auk Alle alle];
Blue boxes include birds in inner N and S sectors in Year 2, April – Sept;
Divers, RA and GU at 1–2 km include the allocation of unidentified birds to species.

Species	Season	Survey year	Propn of days at < 1 km	Avge no. in season < 1 km	Peak no. < 1 km	Propn of days at 1–2km	Avge no. in season 1–2km	Peak no. 1–2km	Overall peak within 2 km
RH non-breeding	Oct-Mar	Year 1	5/20	0.12	2	0/20	0	0	2
		Year 2	4/24	0.12	2	1/24	0.021	1	2
RH breeding	Apr-Sept	Year 1	7/23	0.32	4	0/23	0	0	4
		Year 2	9/24	0.33	2	2/24	0.125	2	2
BV non-breeding	Oct-Apr	Year 1	15/24	1.26	7	3/22	0.24	5	7
		Year 2	10/28	0.77	10	7/28	0.91	11	11
ND non-breeding	Oct-May	Year 1	28/28	5.93	27	16/26	5.67	21	30
		Year 2	32/32	6.33	27	29/32	9.52	28	38
SZ non-breeding	Nov-Mar	Year 1	16/20	2.83	7				7
		Year 2	15/20	1.63	5				5
E. non-breeding	Oct-Mar	Year 1	18/20	7.98	39	0	0	0	39
		Year 2	24/24	7.35	34	4/24	0.33	6	40
E. summer	Apr-Sept	Year 1	11/23	8.44	93	13/23	5.74	35	93
		Year 2	18/24	8.21	59	22/24	22.37	69	91
LN non-breeding	Oct-May	Year 1	27/28	5.34	18	14/17	57.69	400	414
		Year 2	23/32	2.97	30	17/32	17.31	230	234
SA non-breeding	Oct-Feb	Year 1	16/16	9.10	38				38
		Year 2	20/20	11.15	72				72
SA breeding	Mar-Sept	Year 1	27/27	6.85	44				44
		Year 2	28/28	7.04	51	24/24	7.11	19	66
TY non-breeding	Oct-Mar	Year 1	20/20	8.87	28				28
		Year 2	24/24	8.88	27				27
TY breeding	Apr-Sept	Year 1	23/23	18.02	46				46
		Year 2	24/24	14.38	38	23/24	15.60	77	115
RA non-breeding	Sept-Mar	Year 1	17/20	0.95	5				5
		Year 2	10/28	0.62	13				13
RA breeding	Apr-June	Year 1	11/11	4.08	12				12
		Year 2	12/12	9.12	76	11/12	34.58	239	193
GU non-breeding	Sept-Mar	Year 1	11/20	0.35	3				3
		Year 2	21/28	1.73	11				11
GU breeding	Apr-July	Year 1	15/15	2.26	12				12
		Year 2	15/16	2.72	27	15/16	7.50	86	87
LK non-breeding	Nov-Feb	Year 1	14/16	1.94	11				11
		Year 2	7/16	0.47	4				4

The patterns of occurrence vary between species. The three diver species were all likely to swim and forage widely across the whole survey area and were not restricted close to shore – indeed it is clear from the swimming track maps in **Appendix E** that only single birds and very small groups of Black-throated and Great Northern Divers tended to found within 500 m of the shore.

Great Northern Divers showed a clear seasonal pattern that was evident in both survey years, with highest numbers during the passage periods (November and April/May). At these times there was an average of about 20 – 25 birds within 2 km of the main VP with peak counts of up to 40 in both years.

Black-throated Divers were less numerous and less consistently present in the survey area, with monthly averages ranging from zero to five birds within 2 km across both winters, and a peak of 11 birds in January 2022.

Red-throated Divers were absent between January and March in both years, otherwise present in low numbers averaging less than one bird per count within 2 km, with a peak count of four in May 2021. They were most consistently present from May to November. In 2022 many of the birds seen from other fieldwork were clearly local East Mainland breeders commuting between Scapa Flow (including the survey area) and inland nesting grounds (see Section **3.6** below).

Several species were highly concentrated within 500 m of the shoreline. Slavonian Grebes in particular were nearly all found close to shore and were relatively predictable in their movements. Each winter there appeared to be a core group of grebes (up to five in 2020/21 and up to three in 2021/22) which circulated around the Bay of Deepdale, rarely moving far from shore and often staying entirely within the 1 km sectors during watch days.

Eiders were present on nearly all watch days, with groups and small flocks moving around between the Bay of Deepdale and the vicinity of the fish cages to the south. They could be quite mobile on occasion, but also spent extended periods loafing within the bay. The highest numbers were in the late summer in both years when up to about 70 could be present, often in the vicinity of the fish cages. Apart from those at the fish cages, only a small proportion were found more than 500 m offshore.

Within the 1 km sectors Long-tailed Ducks were less frequent and less numerous than Eiders, with monthly averages of less than ten birds across both winters. The highest numbers were during spring passage, strongly concentrated to the south near the fish cages, but very variable between years. There were yearly peak counts of 414 in May 2021 and 232 in March 2022, which are much higher than their respective monthly averages, indicating the transience of these peak numbers.

As a locally resident species, Shags were present almost continuously within the 1 km sectors, usually as scattered foraging individuals, but averaging up to 15 birds per count. Most birds were concentrated within 500 m of the shore. Peak counts were often not much greater than the monthly averages, indicating steady numbers within the 1 km sectors. However, in some months the peak count was much higher (up to 72 birds in October 2021) when larger groups fed for short periods. The flight logging records (see Section **3.4** below) showed clearly that most of the Shags breeding or roosting to the north of the site flew well south beyond the survey area to feed. Groups of more than ten birds were very infrequent within the survey area, and when followed tended to move fast and split up quite quickly.

Black Guillemots showed a similarly stable pattern, since it too is a locally resident breeding species. The clear peak in August of each year may be due to the presence of all of the year's fledged young out on the water along with their parents. Most birds were concentrated within 500 m of the shore, but they became more frequent further out during the summer.

Razorbills and Guillemots were somewhat irregularly present in the survey area in most months, with small numbers (less than five birds on average) within 1 km. They were more consistently present and in higher numbers in the breeding seasons. In Year 2, the extension of the counts out to 2 km showed the occasional much larger numbers that could be more distant, with peak counts for both species on the first (early morning) count on 3rd June 2022. Guillemots did not appear to breed nearby and their numbers within 1 km were similar between 2021 and 2022. However, tens of pairs of Razorbills appeared to be breeding on the cliffs to the north of the site in 2022, when the May and June counts within 1 km were clearly higher than in 2021. The summer 2022 heat map for this species shows relatively high densities of birds in each of the sectors lying alongside the shore to the north. Because the north VP was not in use in 2021 it is not known how many breeding birds were present then.

Table 4 summarises the sector counts for the species deemed less important at the site, occurring either in very low numbers (especially close inshore), or at low frequency. Greylag Goose *Anser anser* is an exception, being both frequent and very numerous, but of low conservation importance in Orkney.

Table 4. *Summary of sector count results (species for which heat maps not produced).*
SPA qualifying interests high lighted;
[RM = Red-breasted Merganser; GJ = Greylag Goose; GX = Gannet Morus bassanus; CA = Cormorant Phalacrocorax carbo; NX = Great Skua Stercorarius skua; PU = Puffin Fratercula arctica; KI = Kittiwake Rissa tridactyla; CM = Common Gull; HG = Herring Gull; GB = Great Black-backed Gull Larus marinus];
Blue boxes include birds in inner N and S sectors in Year 2, April – Sept.

Species	Season	Survey year	Proportion of days seen < 1 km	Numbers when present	Proportion of days seen 1 – 2 km	Numbers when present	Peak no. within 2 km
RM non-breeding	Oct-Mar	Year 1	4/20	1			1
		Year 2	8/24	1 – 3			3
GJ non-breeding	Oct-Mar	Year 1	8/20	2 – 820			820
		Year 2	15/24	1 – 115			115
GJ breeding	Apr-Sept	Year 1	16/23	1 – 314			314
		Year 2	20/24	1 – 243	7/24	1 – 240	278
GX summer	June-Oct	Year 1	6/19	1 – 2			2
		Year 2	4/20	1 – 2	5/20	1 – 11	11

Species	Season	Survey year	Proportion of days seen < 1 km	Numbers when present	Proportion of days seen 1 – 2 km	Numbers when present	Peak no. within 2 km
CA non-breeding	All year	Year 1	10/47	1 – 6			6
		Year 2	8/48	1 – 7	0	0	7
NX summer	May-Aug	Year 1	5/19	2 – 3			3
		Year 2	4/20	1 – 3	4/20	1 – 2	3
PU non-breeding	All year	Year 1	3/47	1 – 2			2
		Year 2	7/48	1 – 3	3/24	2	3
KI non-breeding	Oct-Mar	Year 1	3/20	1 – 3			3
		Year 2	3/24	1 – 3			3
KI breeding	Apr-Sept	Year 1	1/23	7			7
		Year 2	2/24	5 – 13	12/24	1 – 70	83
CM non-breeding	Oct-Mar	Year 1	9/20	8 – 130			130
		Year 2	15/24	5 – 489			489
HG non-breeding	Oct-Mar	Year 1	19/20	1 – 14			14
		Year 2	23/24	2 – 45			45
HG breeding	Apr-Sept	Year 1	9/23	1 – 19			19
		Year 2	15/24	1 – 40	16/24	1 – 45	59
GB non-breeding	Oct-Mar	Year 1	10/20	1 – 3			3
		Year 2	12/24	1 – 2			2
GB breeding	Apr-Sept	Year 1	12/23	1 – 6			6
		Year 2	15/24	1 – 8	12/24	1 – 7	11

Red-breasted Merganser is the only SPA interest relegated to this table, due to its infrequency and very low numbers (only a few single birds in Year 1 and one-three in Year 2).

Common and Herring Gulls were the only other species with more than single figures present at times within the 1 km sectors; the largest numbers of these occurred when flocks that were feeding on the fields behind came down to the shore for short periods.

Of the various seabirds in this table, only Herring Gull (single figures of pairs) and Great Black-backed Gull (one pair) bred close to the site.

2.6 Upper VP counts 2022 – method and results

A new, upper VP was established on 24th January 2022, at HY 44944 04763, above the cliffs to the north of the main VP, lying at about 27 m AOD. Watches from this VP were commenced in an attempt to gain better coverage of the more distant divers, given its greater height above the water. It gave unrestricted views across Scapa Flow to the south, southwest, west and northwest, but there was still a lack of visibility close in to shore at the far south-southeast beyond Tongue of Gangsta and close in to the north-northwest below the Gaitnip cliffs.

From the last January visit in 2022, and onwards, this VP was used to count all divers within visible range (which was dependent on the sea-state and could be several kilometres in calm conditions) and to mark their locations on a map, with reference to the known positions of the fish cages, the Royal Oak marker and any moored rigs.

Table 5 gives the numbers of divers counted from the upper VP on each visit and compares them to the numbers from the preceding, or following, main VP count.

Table 5. *Upper VP diver counts 2022, compared to the preceding or following main VP count – all counts out to the maximum visible distance, therefore highly dependent on sea-state and other visibility factors. (BV = Black-throated Diver; ND = Great Northern Diver; UID = unidentified diver sp.)*

	Upper VP						Main VP					
Date	Time	Sea-sate	BV	ND	UID	Tot.	Time	Sea-sate	BV	ND	UID	Tot.
30 Jan	09:20-09:40	2	1	23	2	26	10:15-11:05	1-2 to 2	6	29	1	36
02 Feb	15:40-16:15	3		11	4	15	14:40-15:20	3		13	1	14
07 Feb	09:05-09:50	3-4	2	11	1	14	07:40-08:30	1-2 to 3	2	20		22
19 Feb	08:05-09:45	2-3		2	15	17	11:15-12:05	1-2	6	25	8	39
25 Feb	16:35-17:05	3-4 to 4	8	5	12	25	15:20-16:15	3 to 3-4	1	18	1	20
04 Mar	07:45-09:00	1-2		22	35	57	09:50-10:50	1-2 to 1	5	26	26	57
07 Mar	08:15-08:55	0-1		19	74	93	09:50-11:15	0-1		13	117	130
16 Mar	17:45-18:40	2		14	23	37	15:25-16:20	0-1		28	161	189
29 Mar	Late a.m.	2-3		5	1	6	12:20-13:00	2-3		5	2	7
02 Apr	11:00-13:00	1 to 1-2	1	42	87	130	13:25-14:35	2 to 2-3		50	35	85
10 Apr	07:50-08:50	1		37	121	158	11:15-12:25	1-2 to 2	1	42	58	101
20 Apr	17:55-18:45	3		7	8	15	16:00-16:50	2-3		13	2	15
25 Apr	09:50-10:55	2		17	17	34	12:45-13:50	1-2		35	14	49
07 May	11:45-13:20	2-3		12	4	16	08:45-10:15	2		48	19	67
20 May	11:05-12:10	3		8	2	10	13:20-14:25	3		11	2	13
24 May	12:45-13:45	2-3		14		14	10:20-11:25	2-3		10		10
30 May	11:10-12:05	2-3		14	1	15	13:05-14:10	1-2		11		11

One of the main variables accounting for the numbers seen appears to be the sea-state. In all cases (other than 30th May 2022) when there was a noticeable difference in sea-state, the watch at the lower sea-state counted more birds, irrespective of the VP location.

On 16th March 2022 from the main VP, about 125 unidentified divers were seen very distant to the south and southwest on a nearly calm sea; after picking up to sea-state 2, these birds became invisible from the upper VP.

Other differences, e.g. on 7th March and 7th May 2022 are more difficult to explain, with bird movements likely to be an important factor. On 7th May 2022, a broad, sparkling glare and heavy shimmer restricted distant viewing from the upper VP, but even so there was a halving in the number of closer birds (from 25 to 13 within 2 km) compared to the preceding main VP count.

Given that the two VPs generally produced similar numbers in similar conditions, the sole advantage of using the upper VP was in the (probably) better accuracy in mapping diver locations out to the west of the proposal site.

Maps of the diver locations from the upper VP, covering 30th January to 30th May 2022 are in **Appendix D**. These are all the divers that were found, excluding those certainly identified as Red-throated (very few) and the great majority will have been Great Northern. The maps show a rather even distribution out to well over 2 km from shore across most of the visible area, but with larger groups more likely out towards the centre and south of the Flow.

3. OTHER FIELDWORK FOR INSHORE SPECIES

3.1 Swimming tracks – method

For all of Year 1, and up to January 2022, there were two periods of dedicated swimming track recording during each watch day. These aimed to be a minimum of 40 minutes long and to follow two or more groups of birds, recording their locations on a map and noting their behaviours at approximately five-minute intervals. Black-throated and Great Northern Divers and Slavonian Grebe were particularly targeted.

From January 2022, swimming track recording concentrated on divers, particularly those out at 1 – 2 km offshore, and was carried out flexibly from any of the VPs (main, upper, north or south) as the opportunity presented itself, rather than in two dedicated sessions.

The majority of tracks lasted at least half-an-hour, with the location and behaviour of the bird(s) recorded at approximately five-minute intervals. Including the start position, a 40-minute track could record up to nine locations, although this was often reduced when a bird(s) could not be found during one or more intervals. For efficiency, two or more birds or bird groups were usually followed at the same time, but this did increase the incidence of birds going missing for some intervals, or resulted in shortened tracks if they were lost completely.

In the data, a 'bird-record' is equivalent to the individual five-minute interval record of location and behaviour for one bird. Thus for a single bird watched for 40 minutes (nine records, including the first and last) there are nine bird-records. If it was a group of five birds being followed for 40 minutes (and they were sighted on every five-minute interval) there would be 5 x 9 = 45 bird records.

When a bird(s) could not be found in some intervals, the missing periods have not been entered into the figures and the number of bird-records for the track is reduced accordingly.

3.2 Swimming tracks – results

The full details of all of the swimming tracks are tabulated in **Data Appendix E**. Each individual track is shown on the maps in **Data Appendix F**, with summaries of the bird locations, and of the tracks, on the maps in **Appendix E**.

Where the same birds were picked up in both episodes of swimming track recording during a visit, they are included as two separate tracks in the tables. The detailed maps in **Data Appendix F** show where this happened.

The swimming tracks recorded during the Year 1 non-breeding season covered a high proportion of the more important species present. Compared to the numbers within 1 km from the preceding sector counts (i.e. sector counts 1 and 2), the number of birds followed for at least 30 minutes was 83 % for Black-throated Diver, 76 % for Slavonian Grebe, 58 % for Eider and 31 % for Great Northern Diver.

Table 6. *Numbers and proportion of birds foraging from swimming track mapping in Year 1. The percentage foraging is obtained by the number of bird-records foraging compared to the total number of bird-records for each species (species codes given in Tables 3 and 4 above).*

Species	Year & span of months covered by tracks	No. tracks	No. birds	Average group size	Total track time (hours)	Total no. bird-records	% foraging
RH	Year 1: Dec 20-Sep 21	10	14	1.4	7.0	122	37 %
	Year 2: Nov 21-Sep 22	19	26	1.4	14.4	221	26 %
BV	Year 1: Nov 20-Apr 21	24	75	3.1	13.8	493	33 %
	Year 2: Sep 21-Apr 22	22	83	3.8	26.8	1,126	66 %
ND	Year 1: Nov 20-Jun 21	89	217	2.4	46.8	1,494	46 %
	Year 2: Oct 21-Apr 22	58	196	3.4	42.8	3,669	52 %
SZ	Year 1: Dec 20-Apr 21	42	103	2.5	23.5	786	64 %
	Year 2: Nov 20-Apr 22	16	29	1.8	9.4	187	79 %
E.	Year 1: Nov 20-Sep 21	48	195	4.1	34.2	3,864	17 %
	Year 2: Oct 21-Feb 22	22	86	3.9	13.7	1,362	28 %
LN	Year 1: Dec 20-May 21	28	144	5.1	14.75	760	55 %

SA	Year 1: Nov 20-Nov21	6	101	16.8	2.0	439	91 %

Table 6 above shows the numbers of tracks, and the numbers of birds involved, split between the two survey years. The change in emphasis from January 2022 resulted in a lower number of tracks for species other than divers in Year 2. It should be noted that the percentages of bird-records noted as foraging for each species and season are most likely understatements in all cases, since the reason for being unable to relocate birds on many occasions was likely due to their diving.

A distinction between Red-throated Divers and the other two diver species, appears evident in the percentage of foraging records from the swimming track recording. From **Table 6** above the figures are:

- wintering Black-throated Diver – 33 % and 66 % (Year 1 and Year 2 respectively)
- wintering Great Northern Diver – 46 % and 52 % (Year 1 and Year 2 respectively)
- breeding Red-throated Diver – 37 % and 26 % (Year 1 and Year 2 respectively)

This may indicate that the inshore survey area is utilised as a staging and loafing site for breeding Red-throated Divers as well as for foraging. The 2022 flight path maps for this species in **Appendix H** show that there was at least one pair breeding inland to the east and that on their outward flights they often alighted within the survey area as their first destination.

Shags had the highest foraging percentage from the swimming track records of any species (91 %), although the number of tracks was few. This is likely due to its non-waterproof plumage, meaning that the birds do not loaf on the water, but rather come ashore to rest.

Eiders could be quite mobile on occasion, but also spent extended periods loafing in the survey area, as indicated by the relatively low percentage of time spent foraging (averaging a little over 20 %, the lowest of any of the species sampled). Swimming tracks for this species have not been reproduced but were in close alignment with the heat maps in **Appendix A**, and all were within 500 m of the shore.

Relatively few swimming tracks of Long-tailed Duck were attempted, since most of the birds within manageable viewing range were in only small groups. Five out of the 28 groups followed (18 %) were terminated when all of the birds flew off, and on another four tracks (14 %) some of the birds flew off – this was in contrast to any of the other species followed, where voluntary flight was a rare occurrence.

3.3 Bird-boat interactions and general offshore disturbance

Vessel movements in the vicinity of the development were noted throughout each watch day from August 2021. Where swimming birds were seen to react, or appeared likely to react, to passing boats a note was made and the approximate positions and directions of travel of the boat and bird(s) were marked on maps.

Table 7 below lists the boats and interactions noted. All encounters apart from the first two Slavonian Grebes are shown on maps in **Appendix F**.

The main variables which elicited a response from birds were the relative direction of movement and the speed of the boat. Flight reactions were unusual, with none of the divers responding in this way (although Great Northern Divers have a period of wing-moult during the winter, during which they would be unable to fly). Two Slavonian Grebes and a flock of Eider did fly up as small boats approached them very closely, with multiple short flights, but only one of the grebes leaving the immediate area.

When most alarmed the three diver species dived, otherwise they swam slowly to one side or sat alertly until the boat had passed. The maximum impact observed was a temporary cessation of foraging (usually just a few minutes). Where birds had previously been loafing, the disturbance sometimes prompted them to start foraging.

Table 7. *Bird-boat interactions in the Deepdale survey area*

Date	Time	Boat type	Boat speed	Species & no.	Closest distance	Boat direction relative to birds	Bird reaction	Comment
30 Nov 21	10:30	Small launch	Slow	1 SZ	<100m	Not seen	Short flight	Same bird, flying up as a boat doing transects parallel to the shore got close; it stayed within the shoreline sectors; (no map)
	11:00				<50m	Nearly directly at it	Short flight	
	11:15				<50m	Nearly directly at it	Short flight	
18 Dec 21	10:23	Creel boat	Quite slow	1 SZ	Not noted, but close	Towards it	Long flight	Flying out of survey area to S for 1-2 mins, then lost to view
14 Jan 22	11:00	Small tug towing platform	Very slow	9 BV & 6 ND	150-200m	Perpendicular to swimming direction	Slow swim out of way as boat approached	Previously foraging, which recommenced once the boat passed
24 Jan 22	15:30	Small tug	Slow	3 ND	c.250m	Passing loafing birds at c.250m	Diving as boat passed, but not moving far	Loafing at first – continued foraging and swimming after boat had gone
07 Feb 22	10:00	Work boat	Quite slow	2 BV	c.400m	Perpendicular to swimming direction	Slow swim away	These birds joined up, then foraging when boat gone
				1 ND	c.600m	Parallel to swimming direction	No reaction	
	10:20	Launch	Quite fast	2 BV & 1 ND	c.750m	Parallel to swimming direction	Sat up alert, but not moving	Same birds as above; continued foraging, with only a short pause
	10:45	Launch	Quite fast	6 BV	c.750m	Parallel to swimming direction	Sitting up alertly and slow swim away	Same birds each time; otherwise foraging – brief pauses only
	11:10	Launch	Quite fast	6 BV	c.750m	Parallel to swimming direction	Sitting up alertly and slow swimming	
	12:20	Work boat	Quite slow	1 ND	c.500m	Passing at c.500m	Unmoved	-
04 Mar 22	08:35	Small tug	Slow	1 ND	250-300m	Probably parallel	Swimming alertly	Not moving far
	08:35	Small tug	Slow	3 SZ	250-300m	Probably parallel	Swimming alertly	Not moving far
	10:40	Work boat	Quite slow	2 ND	c.350m	Perpendicular to swimming direction	Slow swim away	Same birds, previously swimming and loafing; commenced foraging after dive
	10:45	Launch	Fast	2 ND	c.100m	Parallel to swimming direction	Diving as boat advanced; up separately behind it	
	10:50	Small tug	Slowly circling	3 SZ	c.250m	Staying quite close to platform	No reaction	Bird found already at c.250m from tug and platform, swimming and foraging

Date	Time	Boat type	Boat speed	Species & no.	Closest distance	Boat direction relative to birds	Bird reaction	Comment
04 Mar 22	11:40	Small tug	Slowly circling	5 BV	c.400m	Birds actively swimming past where the boat manoeuvred	At closest point several dived, apparently because 1 ND suddenly surfaced amongst them	No reaction to boat, but may have set their course northwards to have deliberately given it a wide berth
07 Mar 22	07:20	Launch	Quite fast	3 ND	350-400m	Passing loafing birds	Drifting slowly away	-
	07:36	Launch	Fast	1 ND	c.200m	Two boats passing by on either side of bird	Swimming slowly	At most a pause in foraging, since essentially unmoved
	07:37	Pilot	Accelerating		c.250m		Swimming slowly	
16 Mar 22	17:05	Launch	Pausing by platform, then accelerating	5 ND	c.400m	Fast, directly at them	Swimming slowly away (N) from it while boat was paused, then diving as it approached	7 birds resurfaced in a scattered group once the boat was well past (had been under for a few minutes) and swam away in the opposite direction from it (now S)
29 Mar 22	07:40	Small launch to platform	slow	1 ND	100-150m	Parallel to swimming direction	No reaction	Bird seen even closer to platform later, while it was manned
	08:45	Launch	Fast	6 ND	c.300m	Parallel to swimming direction	No reaction	Continued swimming and loafing
02 Apr 22	11:35	Pilot	Quite fast	3 ND	300-350m	Perpendicular to swimming direction	Swimming away	Joined two others further to E (at c.800m from boat track)
	12:40	Tug	Moderate	2 ND	150-200m	Parallel to swimming direction	1 diving, 1 stayed swimming	Both continued swimming after boat past
20 Apr 22	14:10	Pilot	Fast	2 ND	c.350m	Directly at them	Diving	Resurfaced separately – only one refound
	14:20	Pilot	Slowing	1 ND	c.250m	Obliquely towards it	Diving	One of above birds; diving again as boat slowed
	14:30	Pilot	Fast	1 ND	150-200m	Passing at 150-200m	Sitting alertly	Not diving, nor swimming as boat fast past it
09 Jun 22	14:40	Work boat	Quite slow	2 RH	250-300m	Parallel to swimming direction	Swimming alertly	Birds loafing, then swimming as boat passed (14:40-14:45); foraging from 14:50
23 Jul 22	15:35	Rib	Slow	20 E. female	<100m	Around loafing birds beside fish cages	Short flights away	Up from W side of cages to N end; up again as rib continued, back round to start
				30 E. male	<50m	Directly at loafing flock	Swim/flap across water for c.100m	Swimming back almost as soon a rib past

There was greater disturbance within 500 m of shore during the Year 2 winter than during Year 1, due to the activities of survey boats and a small test-drilling platform (see Section **1.2** above). Daily bar-charts for each of the more important species, with the dates of substantial inshore disturbance indicated by arrows, are shown in **Appendix B**. For most of the species there is no clear correlation between the disturbance dates and lower than normal numbers.

In four cases there were more disturbance days associated with clearly lower numbers than disturbance days where there appeared to be little or no effect. These are Great Northern Diver, Black-throated Diver, Eider and Slavonian Grebe. However, for the first three of these species, the monthly bar-charts in **Appendix C** (based on the average counts across each month) do not indicate overall reductions from Year 1 to Year 2 – indeed, for Great Northern Diver the numbers within 500 m were higher in Year 2 when most of the disturbance took place. Only for Slavonian Grebe do both the daily and monthly bar-charts indicate the possibility of a reduction in numbers correlated with disturbance.

Other than Slavonian Grebe, only Little Auk showed a clear reduction in numbers between years. However, the numbers of Little Auk in British waters are very variable from winter to winter, due to factors far removed from Orkney, and the daily bar-charts showed no correlation with disturbance.

3.4 Flight logging – method

Flight logging commenced from July 2021, when the wintering SPA species had reduced, and it became obvious that Arctic and Common Terns were using the survey area for foraging on a regular basis. It replaced the middle sector count in each watch-day, so that only two sector counts were made from then onwards. The method was straightforward, consisting of a record of all seabird species flying past the proposal site, by five-minute period, and noting them as flying north, south or 'other' in three distance bands:

- movements along the shore itself;
- movements from just offshore out to 500 m; and
- movements at 500m – 1 km.

This was carried out on three or four of the visits each month aiming for a total of at least six hours of observation per month and was continued through to September 2022 so as to have a record of the seabird movements on a year-round basis.

During this exercise, terns and Arctic Skuas were treated as target species with flight paths recorded and mapped. For terns, the locations of plunge-dives were noted, irrespective of whether they were successful or not, to give a more precise indication of their foraging areas.

Other species included for flight logging were: Fulmar, Gannet, Cormorant, Shag, all auks, Great Skua, all gulls and all ducks. An exception was Common Gull, for which records excluded ones or twos moving around in the survey area, although larger groups and passing birds during obvious directional movements were recorded.

3.5 Flight logging – results

Tables 8 and **9** below summarise the results of the most frequent and less frequent species recorded by flight logging. Bar charts illustrating the seasonal patterns for all of these species are in **Appendix G**. The full flight logging data is in **Data Appendix G**.

The time spent following target species was deducted from the flight logging, so that the birds per hour indicated in the tables and charts reflect the actual recording time.

Table 8. *Monthly birds per hour for the most frequent species from flight logging.*

Month	Shag		Fulmar		Herring Gull		Gt Black-back		Common Gull		Kittiwake	
	<500m	to 1km	<500m	to 1km	<500m	to 1km	<500m	to 1km	<500m	to 1km	<500 m	to 1km
July 21	77.82	4.41	31.06	1.76	4.41	0.18	2.65	0	0	0	6.00	0.53
Aug 21	153.09	6.45	30.27	1.45	3.73	0	8.27	0	8.27	0	4.00	0.09
Sep 21	123.06	16.00	22.94	3.29	9.53	0	3.76	0	5.18	0	5.06	4.47
Oct 21	42.90	6.25	0	0	32.38	0.33	3.45	0	22.85	0	0.49	0.49
Nov 21	13.83	0.33	5.33	1.33	27.00	0.17	10.33	0	29.17	0	0.17	0.33
Dec 21	9.17	1.50	24.50	16.00	52.50	2.00	2.00	0.50	71.83	0.50	0.00	0.17
Jan 22	4.17	1.00	41.50	5.50	21.33	0.00	8.67	0.17	125.83	1.67	5.50	2.33
Feb 22	5.50	0.50	57.83	0.67	10.83	0.00	8.83	0.17	265.00	0	0	0
Mar 22	12.50	3.00	15.67	3.33	13.83	0.83	4.67	0.33	42.33	0	0	0
Apr 22	25.50	3.50	20.17	2.50	12.17	0	3.17	0	4.33	0	0.50	0
May 22	49.53	3.71	36.65	1.09	22.91	0	5.89	0.44	0	0	5.24	0.87
June 22	54.76	2.70	33.97	0.17	18.25	0	6.08	0.17	12.00	0	7.44	0.85
July 22	76.55	2.69	56.07	2.90	24.41	0.21	4.97	0.41	8.28	0	5.38	1.03
Aug 22	86.03	3.72	41.24	1.18	7.94	0.17	7.94	0	0	0	1.35	0
Sep 22	63.00	5.17	9.00	1.67	8.50	0.17	2.67	0.50	0	0	0.00	0

Table 9. *Monthly birds per hour for the less frequent species from flight logging.*

Month	Gannet		Cormorant		Great Skua		Razorbill		Guillemot		Long-t Duck	
	<500m	to 1km	<500m	to 1km	<500m	to 1km	<500m	to 1km	<500m	to 1km	<500 m	to 1km
July 21	5.47	1.06	0.18	0	4.24	0.35	0	0	0	0	0	0
Aug 21	7.55	0.73	1.36	0	2.27	0.18	0	0	0	0	0	0
Sep 21	6.24	2.94	1.29	0	0.59	0.12	0.71	0.35	0.24	0	0	0
Oct 21	5.59	1.97	0.49	0	0	0	0.33	0	0.16	0	0.66	0
Nov 21	2.33	1.83	2.50	0.17	0	0	0.17	0	0	0.17	3.50	0.50
Dec 21	0.17	0.67	4.83	0.50	0	0	0.17	0	0	0	4.17	0.17
Jan 22	2.17	1.33	5.67	0	0	0	0	0	0.17	0	1.50	0
Feb 22	0.33	0	8.00	0.67	0	0	0	0	0	0	0.67	0.17
Mar 22	0	0	1.17	0.33	0	0	0	0.33	0	0	1.00	0
Apr 22	0	0.17	0.67	0.33	0	0	0	0	0	0	0.83	0
May 22	0	0.22	0	0	1.09	0	7.85	0.22	1.96	0	0	0.44
June 22	0.85	0.85	0.34	0	0.68	0.34	3.21	5.07	2.20	6.42	0	0
July 22	2.90	3.93	0.21	0	0.83	0	0	1.03	0	0	0	0
Aug 22	3.89	0.68	1.18	0	0.51	0	0	0	0	0	0	0
Sep 22	1.33	0.50	0.17	0	0.17	0	0	0	2.00	0.17	0	0

Several other species were recorded more or less regularly, but at low rates, across the period, with a total of 30 – 49 birds from the entire 94.5 hours of watching:

- Eider, Mallard, Black Guillemot, Black-headed Gull *Chroicocephalus ridibundus* and Lesser Black-backed Gull.

More irregular still were those species with three records of 1 – 2 birds each:

- Shelduck *Tadorna tadorna*, Wigeon, Red-breasted Merganser and Little Auk.

Finally there were just one or two records of 1 – 2 birds of the following:

- Black-throated Diver, Slavonian Grebe, Mute Swan, Puffin, Glaucous Gull La*rus hyperboreus* and Iceland Gull *Larus glaucoides*.

Shag was the most frequent species flying past the site, with peaks in late summer of both years covered. Otherwise Red-throated Diver (see Section **3.6** below) and Long-tailed Duck were the only SPA species recorded frequently in flight past the site.

On two mornings there was such an obvious movement of Shags south past the VP that a note was made of the numbers involved. These were:

- 18th Dec 2020 – 101 birds from 08:25 to 08:55 (then much quieter)
- 19th Oct 2021 – 487 birds from 07:35 to 09:00 (petering out)

These high figures indicate the size of the winter population roosting on the cliffs to the north. In the non-breeding season these movements may be essentially once a day for most birds, and this could be a factor in the lower flight logging rates then.

Flight rates are likely to be more frequent and uniform throughout the day in the breeding season as adults commute several times a day to their nests.

For all species, the birds flying at less than 500 m offshore were split between those coasting along the shoreline (or at the very edge of the water), and those over the water out to 500 m. There were distinct differences between species, with Fulmar and the various gulls having much higher percentages of movements along the shoreline itself as they glided on the updraft from the sea-banks. For the large gull species and Great Skua, around 60 % of their movements within 500 m were along the shore; the figure for Fulmar was 45 %, whereas for Shag it was less than 2 %.

Several points are evident from the bar-charts in **Appendix G**:

- For Gannet and Great Skua the numbers in summer 2022 were less than in 2021, presumably related to the high avian flu infection rates in these two species.
- Gannet and Kittiwake were (relatively) the most frequent species flying in the outer 500 m – 1 km recording band.
- The nil movement of Fulmars in October 2021 coincides with the brief post-breeding period when this species is absent from its nesting cliffs.

For Razorbill and Guillemot the highest rates of movement in June 2022 correlate with their peak numbers sitting out offshore at 1 – 2 km (see Section **2.5** above).

3.6 Ad hoc flight recording – seabirds

There were relatively very few flights by the wintering SPA species, so the recording of flight paths was primarily carried out in the summer for breeding Red-throated Diver, passing Arctic Skuas and foraging terns. Arctic Tern was the most frequent and numerous tern species, with Common Terns also regular, but only sporadic appearances of Sandwich Tern *Thalasseus sandvicensis*.

Red-throated Divers and Arctic Skuas were recorded in flight from any aspect of fieldwork, when the flight details and flight path would be noted down. Up until June 2021 the terns were also recorded in this way, but from July 2021 onwards they were only noted down during flight logging.

Table 10 below summarises the number of birds recorded for each of these species and the flight maps, with details of each flight path and overall summary maps are given in **Appendix H**, with the detailed maps in **Data Appendix H**.

Table 10. *Numbers of target species for flight mapping each month. [dash = no birds recorded]*

Month	Year	Red-throated Diver	Arctic Skua	Arctic Tern	Common Tern	Sandwich Tern
March	Year 1	3	-	-	-	-
April	Year 1	-	-	-	-	-
May	Year 1	1	-	11*	2*	1*
June	Year 1	-	-	26$^{\$}$	3	1

July	Year 1	6	1	48	16	2
August	Year 1	3	3	13	13	-
September	Year 1	-	1	-	-	-
April	Year 2	5	-	-	-	-
May	Year 2	7	-	25	5	-
June	Year 2	8	5	-	1	-
July	Year 2	19	1	24	2	-
August	Year 2	15	-	2	-	-

* *Year 1 terns in May were noted but not mapped*

[$] *On 7th May 2022, c.90 newly arrived Arctic Terns at the fish cages were not included in the flight logging*

From the table it can be seen that there were distinct differences between years, with Red-throated Divers much more in evidence in 2022 compared to 2021, but terns less so. However, these comparisons are affected by the different methods employed in each year; more time spent at the site on each watch day in 2022, covering the additional VPs, could partly explain the increased number of divers.

None of these species breeds close to the proposal site. Arctic Skuas were very infrequent and their known closest breeding areas are on East Mainland at ten or more kilometres distance, supporting only one or a few pairs at each location.

Red-throated Divers breed inland on moorland lochans and the flight paths clearly indicated that at least one pair bred to the east of the proposal site in 2022. There was little evidence that of this from the shorter fieldwork days in 2021.

The movements of terns away from the Bay of Deepdale in both years indicated differing colony locations for Arctic and Common Terns. Most Arctic Terns were seen to approach from the south along the shore and depart in that direction, including birds carrying fish. The closest likely breeding areas are on the Holms along the Churchill Barriers at about 5 km distant. Common Terns with fish were seen to depart northeast inland from Deepdale towards a known colony on a wreck in Inganess Bay, some 6 km distant.

4. FIELDWORK FOR ONSHORE BIRDS

4.1 Walkover surveys – method

Walkover surveys were made three times in each winter and three times in each summer. The first winter survey in 2020/21 covered only the fields immediately around the quay footprint. From the 2021 breeding season onwards the area was extended to include up to the main road alongside the proposed access route, and along the shore for about 500 m in both directions. The maps in **Appendices J** and **K** show the area covered in each season and the route followed on each visit.

The route was varied somewhat between visits, but always approached to within about 100 m of every point on the ground. The start point and overall direction was also varied.

As part of the summer walkovers time was taken to view across the moorland to the north to check for raptor activity – this was one hour per visit in 2021 and two hours per visit in 2022.

Table 11 below gives the dates, times and conditions for each of the walkover surveys.

Table 11. *Dates, times and conditions for the walkover surveys*

Season	Date	Times	Wind	Weather	Moorland watch time
Winter 2020/21	17 Nov	12:20-13:35	W 4	Cloud 4/8; dry	
	03 Jan	12:50-14:05	E 2	Cloud 6/8; dry	
	20 Feb	12:35-13:55	SSW 3-4	Cloud 7/8; dry	
Winter 2021/22	04 Dec	13:45-16:15	N 3	Cloud 8/8; dry	
	30 Jan	14:00-16:00	SSW 4	Cloud 8/8; light rain from 14:45	
	25 Feb	09:40-12:30	N 2 to SW 1-2	Cloud 1/8; dry	
Breeding 2021	27 Apr	11:35-16:00	ENE 3-4	Cloud 7/8; dry	13:45-14:45
	17 May	09:30-14:30	SE 2-3	Cloud 7/8; dry	09:55-10:55
	26 June	10:50-16:35	NW 2-3	Cloud 6/8; dry	14:25-15:25
Breeding 2022	23 Apr	11:30-15:00	NE 3	Cloud 8/8; dry	15:00-17:00
	21 May	12:00-17:40	W 3-4	Cloud 6/8; dry	10:00-12:00
	10 June	13:30-17:35	SW 4 to S 3	Cloud 4/8 to 6/8; 1 short shower	10:45-12:45

4.2 Winter walkover surveys – results

4.2.1 Walkover results at the proposal site

The key species in winter were those feeding in flocks in the fields and those along the shore. **Tables 12** and **13** below give the numbers of wildfowl, waders, gulls and selected flocking passerines for each winter, split between the bottom half of the site where the quay itself will lie (lower fields and shore) and the upper part of the site through with the access route will pass (upper fields). Maps are shown in **Appendix J**.

In addition to the counts from the walkover surveys, the peak count for each species made from other fieldwork (primarily from the walks in and out from the main VP) are given for both parts of the site. These exclude the moorland to the north and the shore stretching away south beyond the Bay of Deepdale and therefore relate closely to the area that will be most affected by the development.

Additional species recorded throughout the winters, from all fieldwork, include those of little or no conservation concern (such as very small numbers of Pheasant *Phasianus colchicus*, Rock Dove *Columba livia* and Hooded Crows *Corvus cornix*) and irregular records of wintering or resident passerines, again in small numbers (such as Wren *Troglodytes troglodytes* and thrushes). These are all widespread in Orkney and their occurrence at the proposal site is of no particular significance.

Table 12. *Winter walkover results 2020/21 (upper fields were covered partially in February and not in November or January); 'other peak' relates to records from all other fieldwork between October and March.*

Species	Lower fields & shore				Upper fields			
	17 Nov	03 Jan	20 Feb	other peak	17 Nov	03 Jan	20 Feb	other peak
Greylag Goose	80	-	-	100			150	520
Mallard	2	-	-	2			4	-
Oystercatcher	-	-	44	75				-
Ringed Plover	-	-	2	3			1	-
Turnstone	8	-	-	18				-
Redshank	4	5	3	13				-
Curlew	-	-	2	50				-
Snipe	-	-	2	6				-
Common Gull	-	45	-	45				110
Raven	-	-	-	-				4
Rook	5	-	-	-				7
Skylark	24	21	14	1				1
Starling	21	-	12	12				-
Rock Pipit	1	5	1	4				-
Twite	-	-	13	25				-

Table 13. *Winter walkover results 2021/22; 'other peak' relates to records from all other fieldwork between October and March.*

Species	Lower fields & shore				Upper fields			
	04 Dec	30 Jan	25 Feb	other peak	03 Dec	30 Jan	25 Feb	other peak
Greylag Goose	-	-	-	120	-	-	-	325
Mallard	-	-	2	4	-	-	-	-
Red-br Merg	-	3	-	-	-	-	-	-
Oystercatcher	5	27	84	65	-	-	-	15
Lapwing	-	-	-	75	-	-	-	40
Golden Plover	-	-	-	175				
Ringed Plover	-	-	-	15	-	-	-	-
Turnstone	5	-	-	20	-	-	-	-
Redshank	5	8	6	22	-	-	-	-
Curlew	125	8	1	260	-	-	-	25
Snipe	-	-	-	6	-	-	-	2
Common Gull	203	20	70	230	-	65	410	200
Raven	-	2	-	5	-	-	-	3
Rook	-	-	-	50	-	-	19	100
Jackdaw	-	-	-	100	-	-	-	80
Skylark	-	-	18	2	-	-	2	1
Starling	4	-	1	60	-	-	4	20
Rock Pipit	5	-	6	7	-	-	-	-
Twite	-	-	-	8	-	-	-	20

4.2.2 Additional non-breeding bird records

From late June 2021 it became apparent that the cliffs to the north, in the Holland Green area, were host to a Raven *Corvus corax* roost. On nearly all of the visits that extended towards the evening the birds could be seen gathering on the moorland above the cliffs, many of them flighting in across the fields from the southeast. The maximum numbers each year were 60 on 13th July 2021 and 90 on 24th January 2022.

Some species were present at the site as passage birds and were not fully captured by the winter walkover surveys but were noted primarily from the walks in and out from the main VP.

Those of note are:

- Golden Plover *Pluvialis apricaria* – up to 250 on the lower fields in April 2021 and up to 45 there in April 2022;
- Whimbrel *Numenius phaeopus* – up to 26 birds on the shore and lower fields in May 2022;
- Common Gull – over 100 birds present on the upper fields as late as April in both years, and up to 180 back there from July through to September 2022;
- Herring Gull – a flock of up to 90 birds, predominantly immatures, together with the Common Gulls in August and September 2022;
- Starling *Sturnus vulgaris* – post-breeding flocks of up to 200 in cut silage on the upper fields in July and August 2022.

4.3 Breeding walkover surveys – results

4.3.1 Walkover results at the proposal site

The key species in the breeding season are the farmland waders. There were few shorebirds nesting along the shoreline under the quay footprint, just one pair each of Rock Pipit *Anthus petrosus*, Pied Wagtail *Motacilla alba* and Ringed Plover *Charadrius hiaticula*. Despite the apparently suitable sea-banks, there was no indication of Fulmars nesting in either year, and this species was restricted to the cliffs north of the burn. Black Guillemots too were not seen coming ashore within the Bay of Deepdale and also appeared to be restricted as nesting birds to the northern cliffs.

Tables 14 and **15** below give the numbers of all species considered to be breeding on or adjacent to the proposal site for each year. The tables are split between the bottom half of the site, where the quay itself will lie (lower fields and shore), and the upper part of the site through with the access route will pass (upper fields). Maps are shown in **Appendix K**.

Other than Meadow Pipit *Anthus pratensis* (which was not included in the survey recording) there were no additional species noted as breeding from other fieldwork. However various species were present as passage birds in small numbers, and they are not included (such as Linnet *Linaria cannabina*, Greenfinch *Chloris chloris*, Goldfinch *Carduelis carduelis*, Reed Bunting *Emberiza schoeniclus* and Wheatear *Oenanthe oenanthe*).

Table 14. *Breeding bird results 2021 – lower and upper field areas (buildings = one to several pairs at farm buildings and old farmyard). Figures refer to the apparent number of pairs, apart from: Skylark – no. singing males.*

Species	Lower fields & shore			Upper fields		
	27 Apr	17 May	26 June	27 Apr	17 May	26 June
Mallard	2	-	-	-	-	-
Oystercatcher	16	17	13	9	12	10
Lapwing	2	4	1	3	4	-
Ringed Plover	1	2	1	1	-	-
Redshank	3	2	2	-	2	-
Curlew	2	2	2	-	-	-
Rock Dove	*buildings*	-	-	*buildings*	*buildings*	*buildings*
Skylark	6	7	6	3	7	1
Swallow	-	-	*buildings*	-	*buildings*	*buildings*
Starling	*buildings*	*buildings*	-	*buildings*	*buildings*	-
Wren	1	1	-	-	-	-
Pied Wagtail	-	1	1	1	-	-
Rock Pipit	2	-	-	-	-	-
Twite	1	1	1	-	-	-

Table 15. *Breeding bird results 2022 – lower and upper field areas (buildings = one to several pairs at farm buildings and old farmyard). Figures refer to the apparent number of pairs, apart from: Skylark – no. singing males.*

Species	Lower fields & shore			Upper fields		
	27 Apr	17 May	26 June	27 Apr	17 May	26 June
Oystercatcher	13	19	18	11	12	14
Lapwing	5	7	6	2	2	3
Ringed Plover	1	1	1	-	-	-
Redshank	2	4	4	1	2	3
Curlew	2	2	2	1	-	1
Rock Dove	-	-	*buildings*	*buildings*	*buildings*	*buildings*
Skylark	9	9	10	3	4	-
Swallow	-	*buildings*	-	-	*buildings*	*buildings*
Starling	*buildings*	*buildings*	*buildings*	*buildings*	*buildings*	*buildings*
Wren	1	-	-	-	-	-
Pied Wagtail	1	1	1	-	-	1
Rock Pipit	-	1	-	-	-	-

4.3.2 More distant shoreline and moorland bird results

Tables 16 and **17** list the breeding birds found along the cliffs to the north of the burn, the adjacent moorland to the north, and the shore (with its backing fields) to the south of the Bay of Deepdale – these areas are less likely to be affected by the development. Most birds seen on the moorland from the survey routes have been included, even where they were beyond the marked survey boundary – see maps in **Appendix K**.

In 2021 a Raven and a Red Grouse *Lagopus lagopus* were each seen once well to the north of the survey area boundary and are shown on the maps but not included in the tables. As noted in Section ***5.2.2*** above, subsequent observations indicated that the northern cliffs were a Raven roost site rather than a breeding site.

There were differences between the years, with no clear evidence of gulls breeding within the north part of the survey area in 2022, where there had been one each of Herring and Great Black-backed Gull in 2021. The maximum of three Great Skua territories in 2021 fell to just one record of one territory in 2022, likely due to the effects of avian flu on this species – all breeding attempts were unsuccessful.

Table 16. *Breeding bird results 2021 – shores to north and south and moorland area. (Figures refer to the apparent number of pairs, apart from: Shag – no. occupied nests; Black Guillemot – no. adults swimming close in to cliffs; Skylark – no. singing males).*

Species	Cliffs to north			Moorland to north			Shore to south		
	27/04	17/05	26/06	27/04	17/05	26/06	27/04	17/05	26/06
Pheasant	-	-	-	-	1	-	-	-	-
Fulmar	n/c	103	84	-	-	-	-	-	-
Shag	2	8	8	-	-	-	-	-	-
Oystercatcher	-	-	-	1	1	-	2	3	1
Lapwing	-	-	-	1	2	-	-	-	-
Redshank	-	-	-	2	1	-	1	-	-
Curlew	-	-	-	3	2	2	-	-	-
Snipe	-	-	-	-	-	1	-	-	-
Great Skua	-	-	-	2	3	1	-	-	-
Black Guillemot	-	12	-	-	-	-	-	-	-
Herring Gull	1	1	-	-	-	-	-	-	-
Gt Black-back	1	-	-	1	1	-	-	-	-
Rock Dove	several	several	several	-	-	-	-	-	-
Hooded Crow	-	-	-	-	-	-	1	1	1
Skylark	-	-	-	2	1	2	1	1	2
Wren	-	-	-	-	-	1	-	-	-
Rock Pipit	2	4	2	-	-	-	-	1	-
Twite	-	-	-	-	1	1	-	-	-

Counts from the northern VP in 2022 gave a view further north along the cliffs from Holland Green towards Haddiewell. Although much of the cliff face was out of view, the amount of activity indicated the following numbers of breeding birds there on 23rd April:

- Hundreds of pairs: Fulmar
- Tens of pairs: Shag, Black Guillemot, Razorbill, Rock Dove
- Single figures of pairs: Kittiwake, Herring Gull

A pair of crows (one a Hooded and one a hybrid) bred successfully on rocks along the shore to the south in 2021 but were not present in 2022.

Single pairs each of Stonechat *Saxicola rubicola* and Pied Wagtail to the north in 2022 had not been seen there in 2021.

Table 17. *Breeding bird results 2022 – shores to north and south and moorland area. (Figures refer to the apparent number of pairs, apart from: Shag – no. occupied nests; Black Guillemot – no. adults swimming close in to cliffs; Skylark – no. singing males).*

Species	Cliffs to north			Moorland to north			Shore to south		
	23/04	21/05	10/06	23/04	21/05	10/06	23/04	21/05	10/06
Mallard	-	-	-	1	6	-	-	-	-
Pheasant	-	-	-	-	-	-	-	-	-
Fulmar	n/c	112	119	-	-	-	-	-	-
Shag	n/c	9	13	-	-	-	-	-	-
Oystercatcher	-	-	-	-	1	1	1	3	1
Lapwing	-	-	-	1	1	-	-	-	-
Redshank	-	-	-	1	-	-	1	-	-
Curlew	-	-	-	3	4	2	-	-	-
Snipe	-	-	-	1	-	-	-	-	-
Great Skua	-	-	-	1	-	-	-	-	-
Black Guillemot	10	9	n/c	-	-	-	-	-	-
Rock Dove	several	several	several	-	-	-	-	-	-
Skylark	-	-	-	2	1	2	-	1	-
Wren	-	-	-	1	1	1	-	-	-
Stonechat	-	-	-	-	1	-	-	-	-
Pied Wagtail	1	1	-	-	-	-	-	-	1
Rock Pipit	-	1	3	-	-	-	1	-	-
Twite	-	-	-	-	-	1	-	-	-

4.3.3 Raptor flight recording and watches

The scarce raptor species – Hen Harrier, Peregrine, Merlin and Short-eared Owl – were recorded as flight paths whenever they were seen. The only specific raptor fieldwork related to watches across the moorland to the north, carried out during breeding walkover surveys. The extra time taken for the 2022 methods meant more likelihood of encountering these species, but even so, the rate of Hen Harrier and Peregrine records appeared to be distinctly higher in 2022 than 2021.

Table 18 indicates the numbers of each species seen in each survey season, with maps of all the flight paths and their accompanying notes shown in **Appendix L**.

Table 18. *Number of bird movements for the scarcer raptors from all fieldwork*

	Nov 20–Mar 21	Apr 21–Sep 21	Oct 21–Mar 22	Apr 22–Sep 22
Hen Harrier	4	6	4	17
Peregrine	4	2	4	22
Merlin	2	-	1	1
Short-eared Owl	-	2	-	4

The moorland watches and other fieldwork revealed significantly higher rates of activity for Hen Harrier and Peregrine in 2022 than in 2021. However neither species was considered to have bred within a kilometre of the proposed development area.

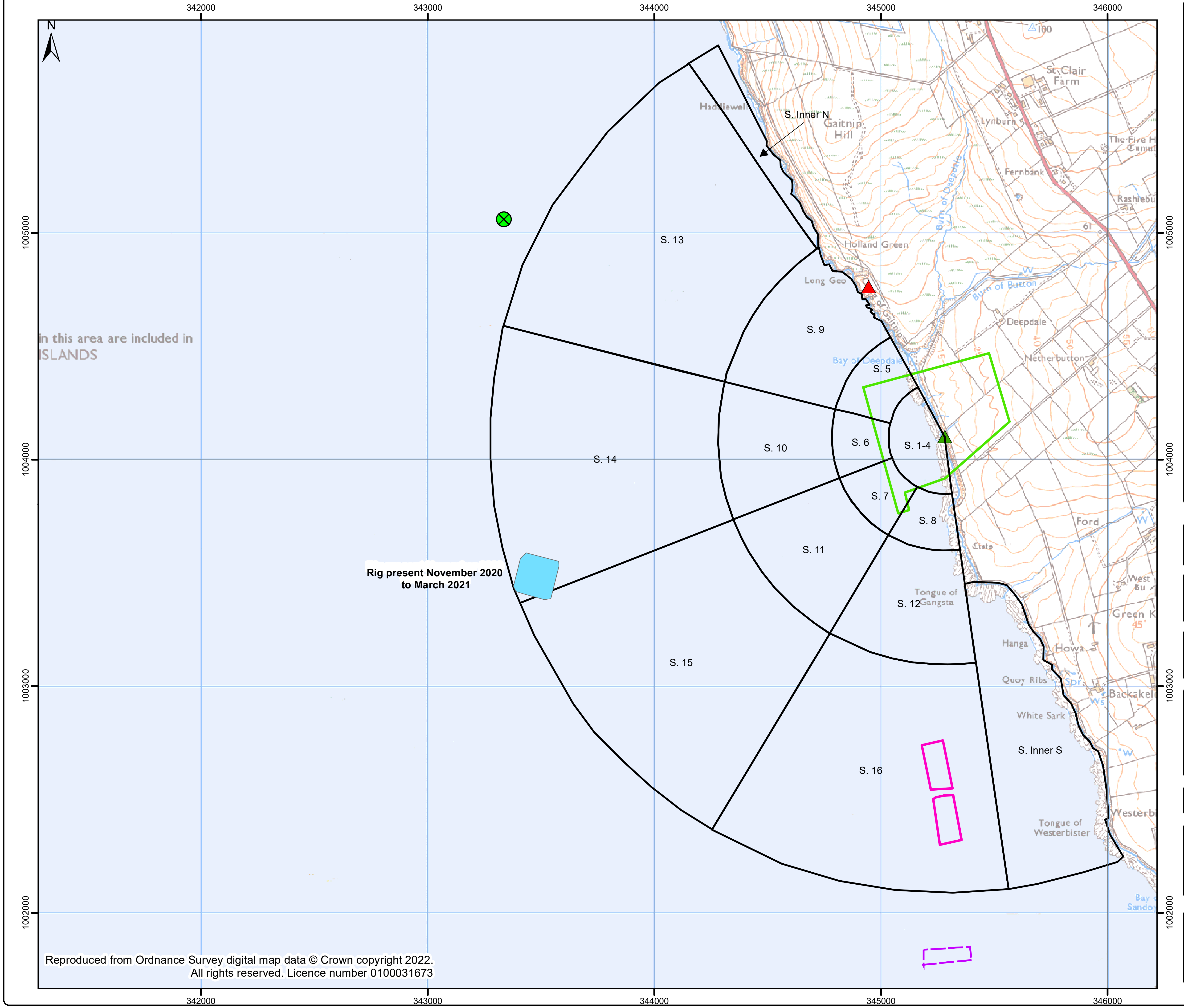
The Hen Harrier activity in 2022 included up to three individuals (an adult male, a one-year-old male and a female) present on the same day hunting over the moorland.

A Peregrine pair were present in 2022 at a traditional territory well to the north of the proposal site and fledged at least one youngster, which was seen occasionally later in the season from the main VP and walk-ins.

There were fewer sightings of Short-eared Owl, so the paucity of records gives little indication of whether breeding may have been attempted nearby. It is more difficult to establish breeding territories for this species, and it is possible that breeding took place somewhere on the moorland to the north in one or both survey years. An adult with a fledged juvenile in July 2022 was seen to approach the survey area from the east of the main road, and a further territory is likely there, where there are pockets of rough vegetation not far to the east.

APPENDIX A

Heat Maps for Selected Species



Legend

- ▢ Proposed Site Extent
- ▢ Survey Sectors
- ▲ Original Vantage Point (HY 45274 04102)
- ▲ Higher Elevation Vantage Point (HY 44943 04763)
- ⊗ Royal Oak Marker Buoy
- ■ Rig Location
- ▢ Emec Working Area
- ▢ Salmon Cages

Do not scale this map

Client

Orkney Islands Council Harbour Authority

Project

Orkney Scapa Deep Water Quay

Title

Scapa Platform and Rig Locations
Year 1 (Oct 2020-Sep 2021)

Status

Final

Drawing No.	Revision	Date
674795-GIS137	-	13 Oct 2022
Drawn	**Checked**	**Approved**
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Scale

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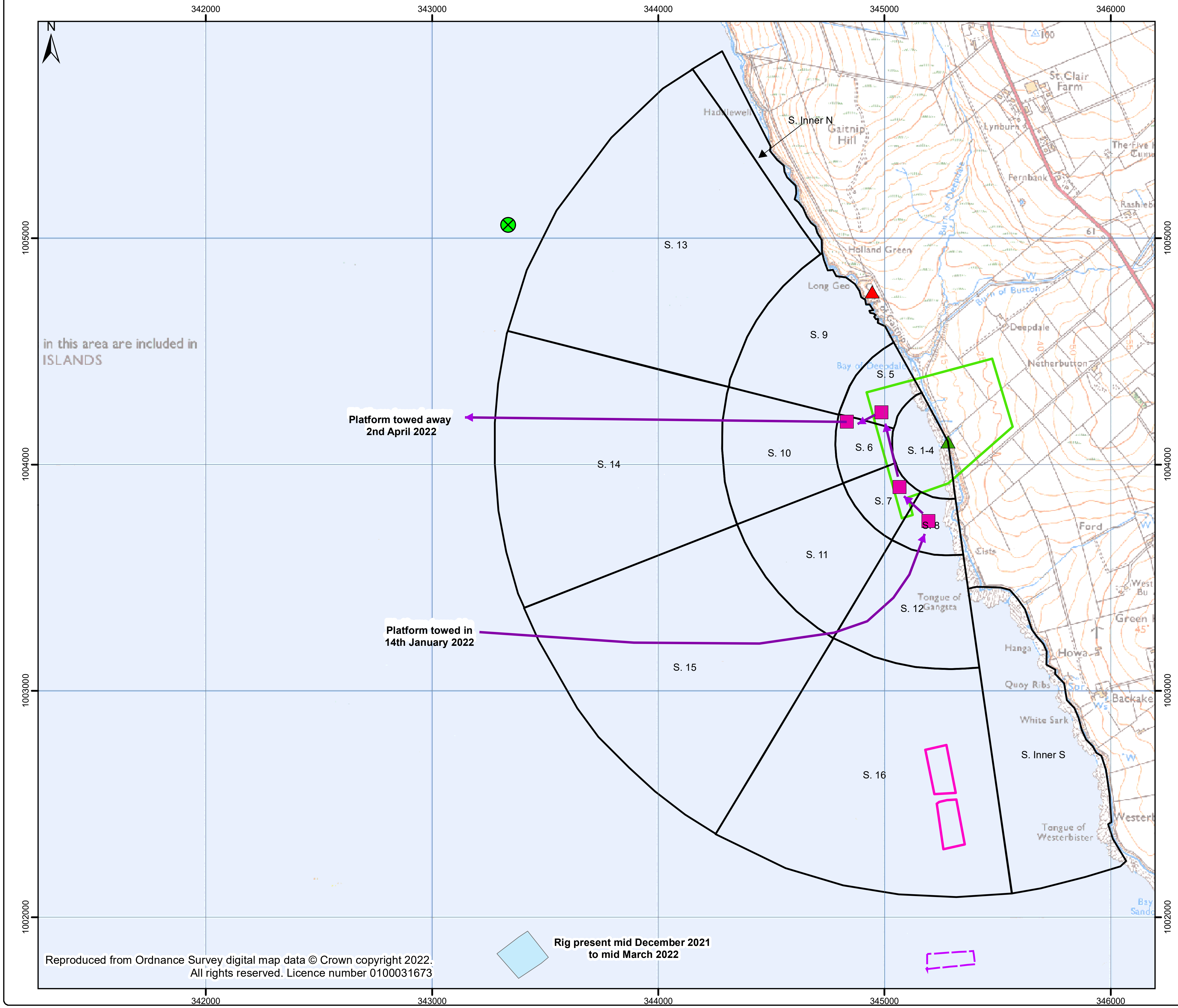

Legend

- ▢ Proposed Site Extent
- ▢ Survey Sectors
- ▲ Original Vantage Point (HY 45274 04102)
- ▲ Higher Elevation Vantage Point (HY 44943 04763)
- ■ Platform Location
- ⊗ Royal Oak Marker Buoy
- ▢ Rig Location
- ▢ Emec Working Area
- ▢ Salmon Cages
- ↗ Platform Movements

Do not scale this map

Client
Orkney Islands Council Harbour Authority

Project
Orkney Scapa Deep Water Quay

Title
Scapa Platform and Rig Locations
Year 2 (Nov 2021-Sep 2022)

Status
Final

Drawing No.	Revision	Date
674795-GIS138	-	13 Oct 2022
Drawn	**Checked**	**Approved**
JAS	EC	--

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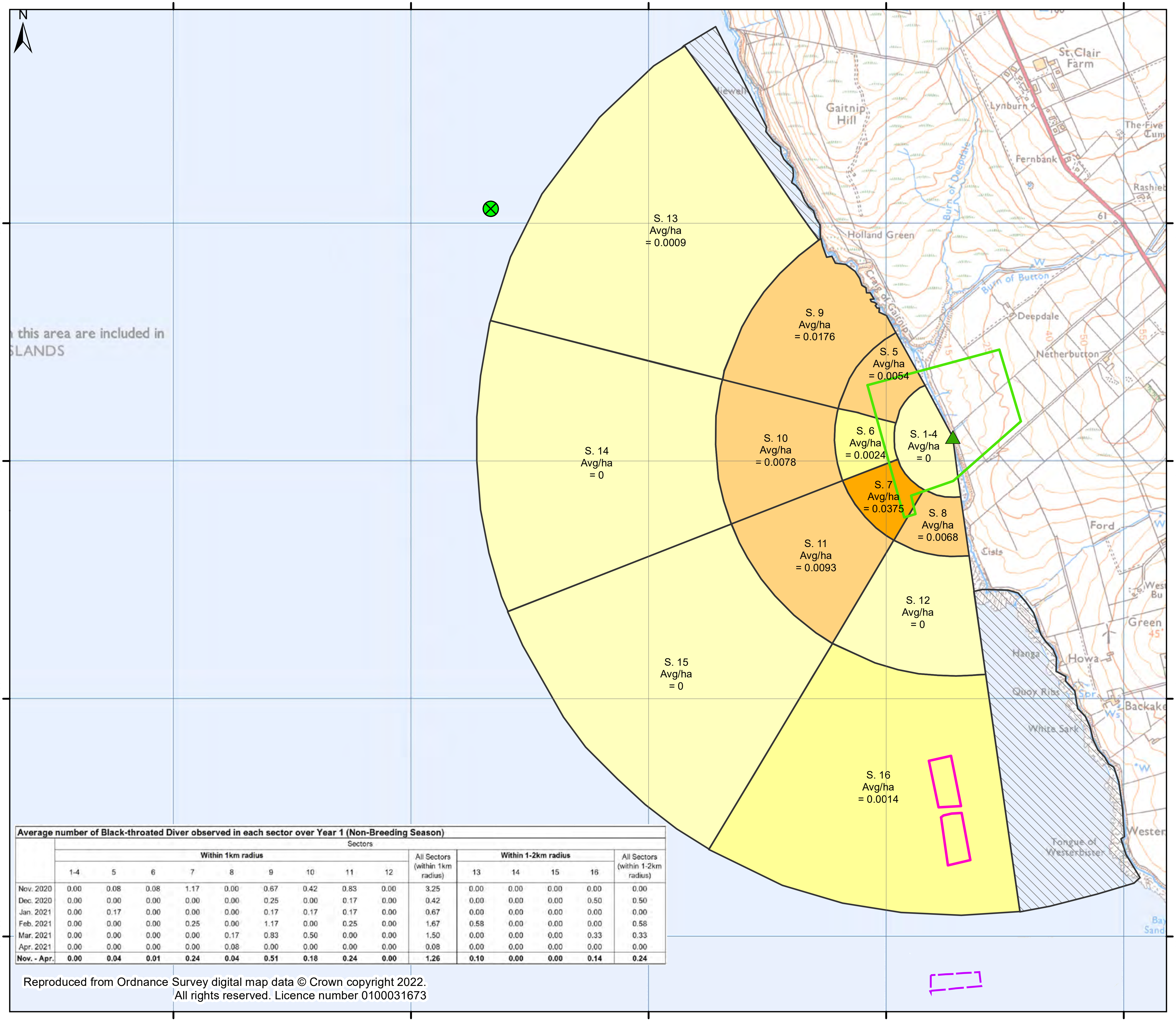

Average number of Black-throated Diver observed in each sector over Year 1 (Non-Breeding Season)

	Sectors														
	Within 1km radius									All Sectors (within 1km radius)	Within 1-2km radius				All Sectors (within 1-2km radius)
	1-4	5	6	7	8	9	10	11	12		13	14	15	16	
Nov. 2020	0.00	0.08	0.08	1.17	0.00	0.67	0.42	0.83	0.00	3.25	0.00	0.00	0.00	0.00	0.00
Dec. 2020	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.17	0.00	0.42	0.00	0.00	0.00	0.50	0.50
Jan. 2021	0.00	0.17	0.00	0.00	0.00	0.17	0.17	0.17	0.00	0.67	0.00	0.00	0.00	0.00	0.00
Feb. 2021	0.00	0.00	0.00	0.25	0.00	1.17	0.00	0.25	0.00	1.67	0.58	0.00	0.00	0.00	0.58
Mar. 2021	0.00	0.00	0.00	0.00	0.17	0.83	0.50	0.00	0.00	1.50	0.00	0.00	0.00	0.33	0.33
Apr. 2021	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00
Nov. - Apr.	**0.00**	**0.04**	**0.01**	**0.24**	**0.04**	**0.51**	**0.18**	**0.24**	**0.00**	**1.26**	**0.10**	**0.00**	**0.00**	**0.14**	**0.24**

Legend

- ▭ Proposed Site Extent
- ▭ Survey Sectors
- ▲ Original Vantage Point (HY 45274 04102)
- ⊗ Royal Oak Marker Buoy
- ▭ Emec Working Area
- ▭ Salmon Cages

Average Bird Count Density per ha

- ■ < 0.001
- ■ 0.001- 0.0025
- ■ 0.0025 - 0.005
- ■ 0.005 - 0.025
- ■ 0.025 - 0.05
- ■ 0.05 - 0.15
- ■ 0.15 - 0.3
- ■ 0.3 - 0.45
- ■ >0.45
- ▨ Sectors not surveyed during this period

Do not scale this map

Client
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Project
Orkney Scapa Deep Water Quay

Title
Black-throated Diver Observations
Year 1 Non-breeding (November 2020 to April 2021)

Status
Final

Drawing No.	Revision	Date
674795-GIS105	-	22 March 2023
Drawn	**Checked**	**Approved**
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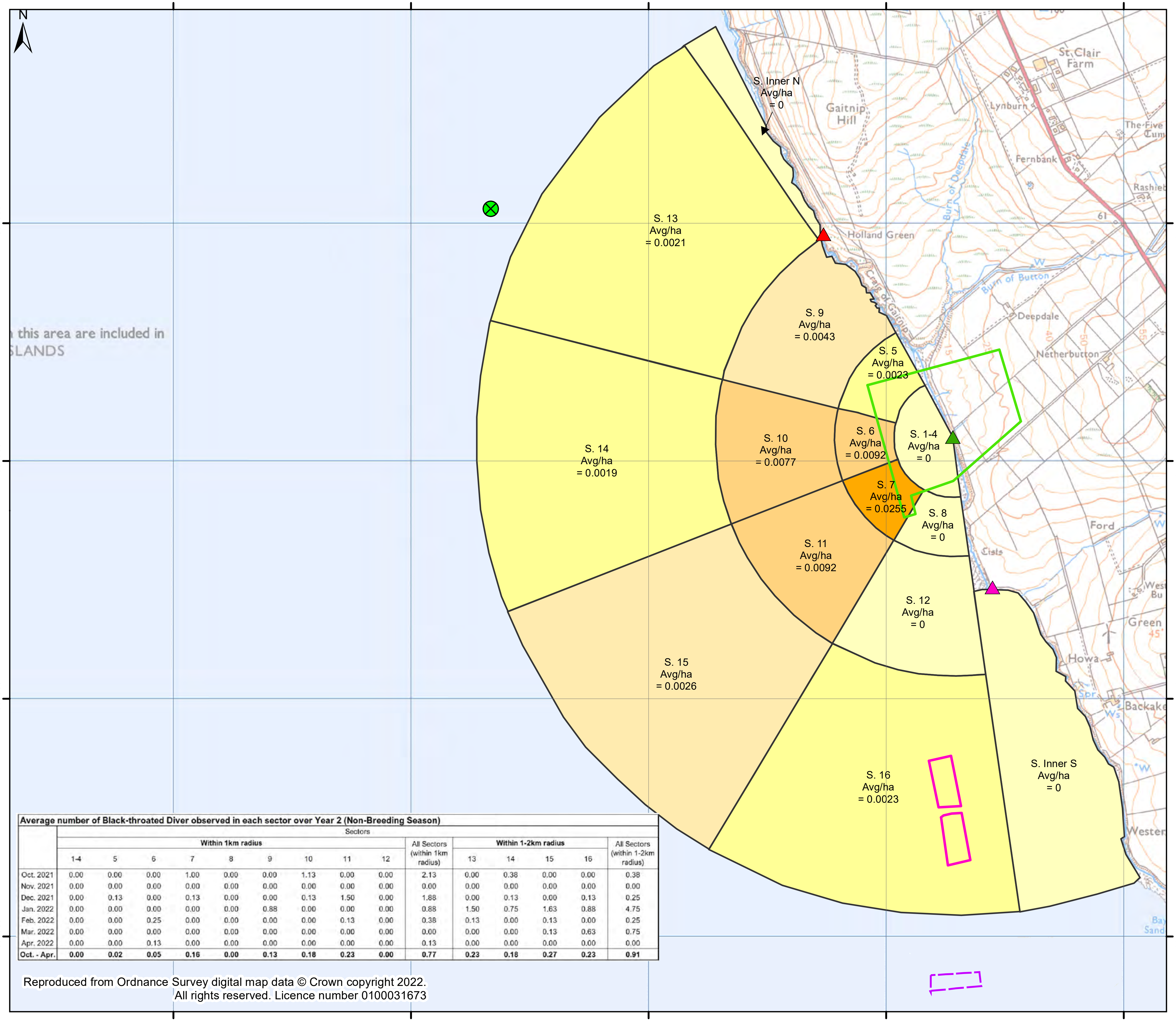

Average number of Black-throated Diver observed in each sector over Year 2 (Non-Breeding Season)

	Sectors														
	Within 1km radius									All Sectors (within 1km radius)	Within 1-2km radius				All Sectors (within 1-2km radius)
	1-4	5	6	7	8	9	10	11	12		13	14	15	16	
Oct. 2021	0.00	0.00	0.00	1.00	0.00	0.00	1.13	0.00	0.00	2.13	0.00	0.38	0.00	0.00	0.38
Nov. 2021	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dec. 2021	0.00	0.13	0.00	0.13	0.00	0.00	0.13	1.50	0.00	1.88	0.00	0.13	0.00	0.13	0.25
Jan. 2022	0.00	0.00	0.00	0.00	0.00	0.88	0.00	0.00	0.00	0.88	1.50	0.75	1.63	0.88	4.75
Feb. 2022	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.13	0.00	0.38	0.13	0.00	0.13	0.00	0.25
Mar. 2022	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.63	0.75
Apr. 2022	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00
Oct. - Apr.	**0.00**	**0.02**	**0.05**	**0.16**	**0.00**	**0.13**	**0.18**	**0.23**	**0.00**	**0.77**	**0.23**	**0.18**	**0.27**	**0.23**	**0.91**

Legend

▭	Proposed Site Extent
▭	Survey Sectors
▲	Original Vantage Point (HY 45274 04102)
▲	Northern Vantage Point (HY 45447 03468)
▲	Southern Vantage Point (HY 44736 04954)
⊗	Royal Oak Marker Buoy
▭	Emec Working Area
▭	Salmon Cages

Average Bird Count Density per ha

■	< 0.001
■	0.001 - 0.0025
■	0.0025 - 0.005
■	0.005 - 0.025
■	0.025 - 0.05
■	0.05 - 0.15
■	0.15 - 0.3
■	0.3 - 0.45
■	>0.45

Do not scale this map

Client
Orkney Islands Council Harbour Authority

Project
Orkney Scapa Deep Water Quay

Title
Black-throated Diver Observations
Year 2 Non-breeding (October 2021 to April 2022)

Status
Final

Drawing No.	Revision	Date
674795-GIS106	-	22 March 2023
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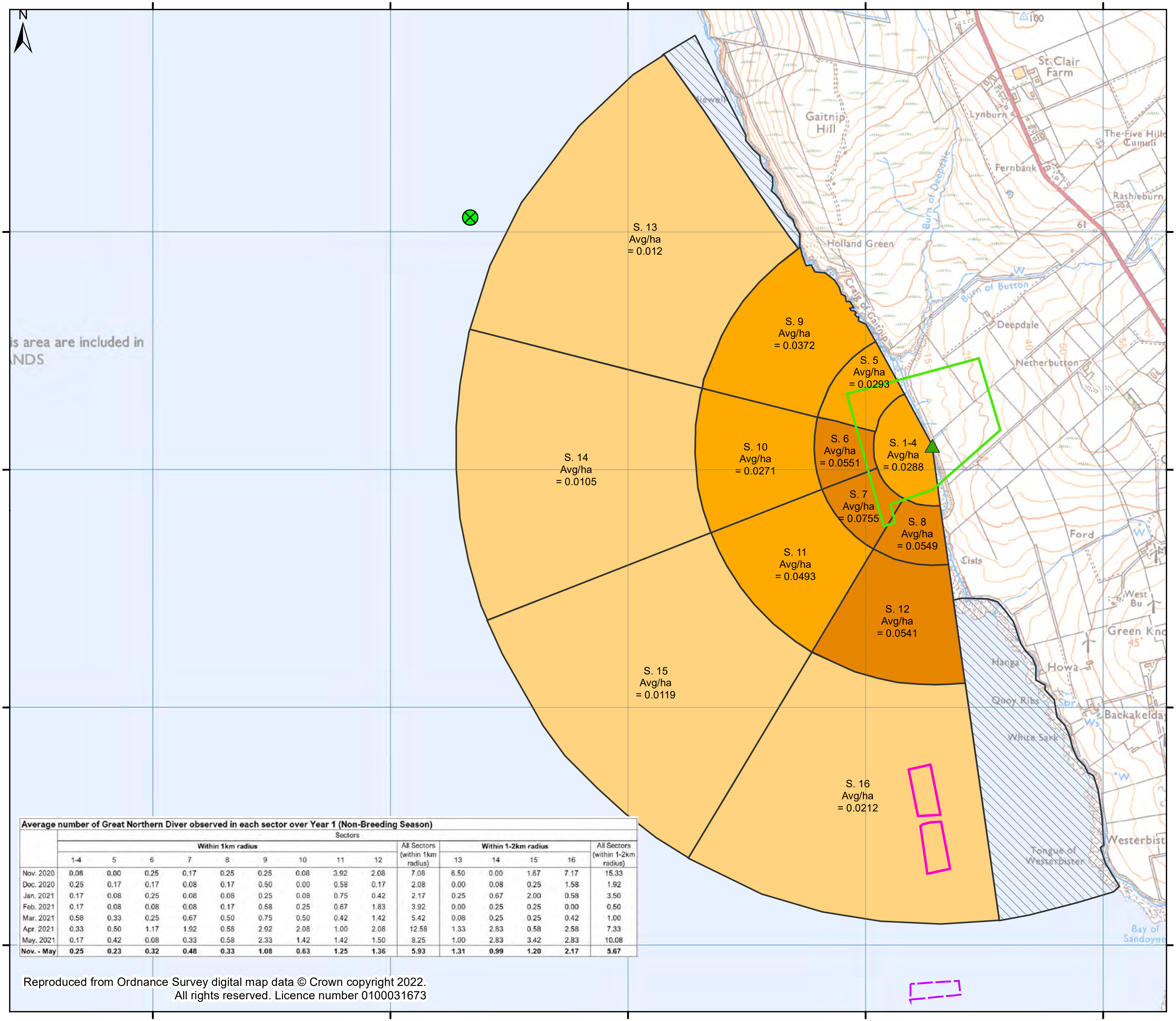

Average number of Great Northern Diver observed in each sector over Year 1 (Non-Breeding Season)

	Sectors													
	Within 1km radius								All Sectors (within 1km radius)	Within 1-2km radius				All Sectors (within 1-2km radius)
	1-4	5	6	7	8	9	10	11	12		13	14	15	16	
Nov. 2020	0.08	0.00	0.25	0.17	0.25	0.25	0.08	3.92	2.08	7.08	6.50	0.00	1.67	7.17	15.33
Dec. 2020	0.25	0.17	0.17	0.08	0.17	0.50	0.00	0.58	0.17	2.08	0.00	0.08	0.25	1.58	1.92
Jan. 2021	0.17	0.08	0.25	0.08	0.08	0.25	0.08	0.75	0.42	2.17	0.25	0.67	2.00	0.58	3.50
Feb. 2021	0.17	0.08	0.08	0.08	0.17	0.58	0.25	0.67	1.83	3.92	0.00	0.25	0.25	0.00	0.50
Mar. 2021	0.58	0.33	0.25	0.67	0.50	0.75	0.50	0.42	1.42	5.42	0.08	0.25	0.25	0.42	1.00
Apr. 2021	0.33	0.50	1.17	1.92	0.58	2.92	2.08	1.00	2.08	12.58	1.33	2.83	0.58	2.58	7.33
May. 2021	0.17	0.42	0.08	0.33	0.58	2.33	1.42	1.42	1.50	8.25	1.00	2.83	3.42	2.83	10.08
Nov. - May	**0.25**	**0.23**	**0.32**	**0.48**	**0.33**	**1.08**	**0.63**	**1.25**	**1.36**	**5.93**	**1.31**	**0.99**	**1.20**	**2.17**	**5.67**

Legend

▭	Proposed Site Extent
▭	Survey Sectors
▲	Original Vantage Point (HY 45274 04102)
⊗	Royal Oak Marker Buoy
⬚	Emec Working Area
▭	Salmon Cages

Average Bird Count Density per ha

■	<0.001
■	0.001 - 0.0025
■	0.002 - 0.005
■	0.005 - 0.025
■	0.025 - 0.05
■	0.05 - 0.15
■	0.15 - 0.3
■	0.3 - 0.45
■	>0.45
▨	Sectors not surveyed during this period

Do not scale this map

Client
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Project
Orkney Scapa Deep Water Quay

Title
Great Northern Diver Observations
Year 1 Non-breeding (Nov 2020 to May 2021)

Status
Final

Drawing No.	Revision	Date
674795-GIS119	-	23 March 2023
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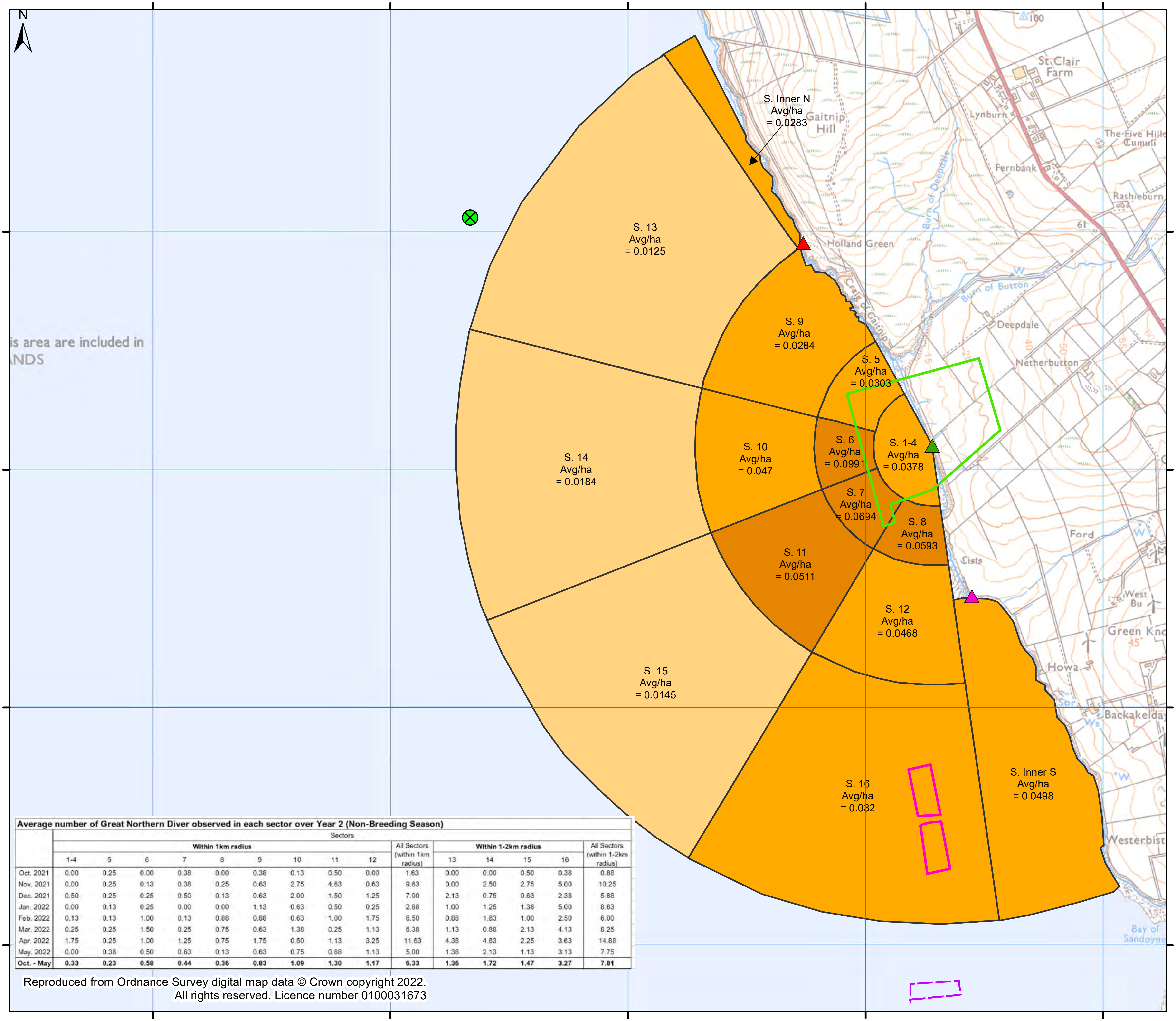

Average number of Great Northern Diver observed in each sector over Year 2 (Non-Breeding Season)

	Sectors														
	Within 1km radius									All Sectors (within 1km radius)	**Within 1-2km radius**				All Sectors (within 1-2km radius)
	1-4	5	6	7	8	9	10	11	12		13	14	15	16	
Oct. 2021	0.00	0.25	0.00	0.38	0.00	0.38	0.13	0.50	0.00	1.63	0.00	0.00	0.50	0.38	0.88
Nov. 2021	0.00	0.25	0.13	0.38	0.25	0.63	2.75	4.63	0.63	9.63	0.00	2.50	2.75	5.00	10.25
Dec. 2021	0.50	0.25	0.25	0.50	0.13	0.63	2.00	1.50	1.25	7.00	2.13	0.75	0.63	2.38	5.88
Jan. 2022	0.00	0.13	0.25	0.00	0.00	1.13	0.63	0.50	0.25	2.88	1.00	1.25	1.38	5.00	8.63
Feb. 2022	0.13	0.13	1.00	0.13	0.88	0.88	0.63	1.00	1.75	6.50	0.88	1.63	1.00	2.50	6.00
Mar. 2022	0.25	0.25	1.50	0.25	0.75	0.63	1.38	0.25	1.13	6.38	1.13	0.88	2.13	4.13	8.25
Apr. 2022	1.75	0.25	1.00	1.25	0.75	1.75	0.50	1.13	3.25	11.63	4.38	4.63	2.25	3.63	14.88
May. 2022	0.00	0.38	0.50	0.63	0.13	0.63	0.75	0.88	1.13	5.00	1.38	2.13	1.13	3.13	7.75
Oct. - May	**0.33**	**0.23**	**0.58**	**0.44**	**0.36**	**0.83**	**1.09**	**1.30**	**1.17**	**6.33**	**1.36**	**1.72**	**1.47**	**3.27**	**7.81**

Legend

🟩	Proposed Site Extent
☐	Survey Sectors
▲	Original Vantage Point (HY 45274 04102)
▲	Northern Vantage Point (HY 45447 03468)
▲	Southern Vantage Point (HY 44736 04954)
⊗	Royal Oak Marker Buoy
☐	Emec Working Area
☐	Salmon Cages

Average Bird Count Density per ha

■	< 0.001
■	0.001 - 0.0025
■	0.0025 - 0.005
■	0.005 - 0.025
■	0.025 - 0.05
■	0.05 - 0.15
■	0.15 - 0.3
■	0.3 - 0.45
■	>0.45

Do not scale this map

Client
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Project
Orkney Scapa Deep Water Quay

Title
Great Northern Diver Observations
Year 2 Non-breeding (Oct 2021 to May 2022)

Status
Final

Drawing No.	Revision	Date
674795-GIS120	-	23 March 2023
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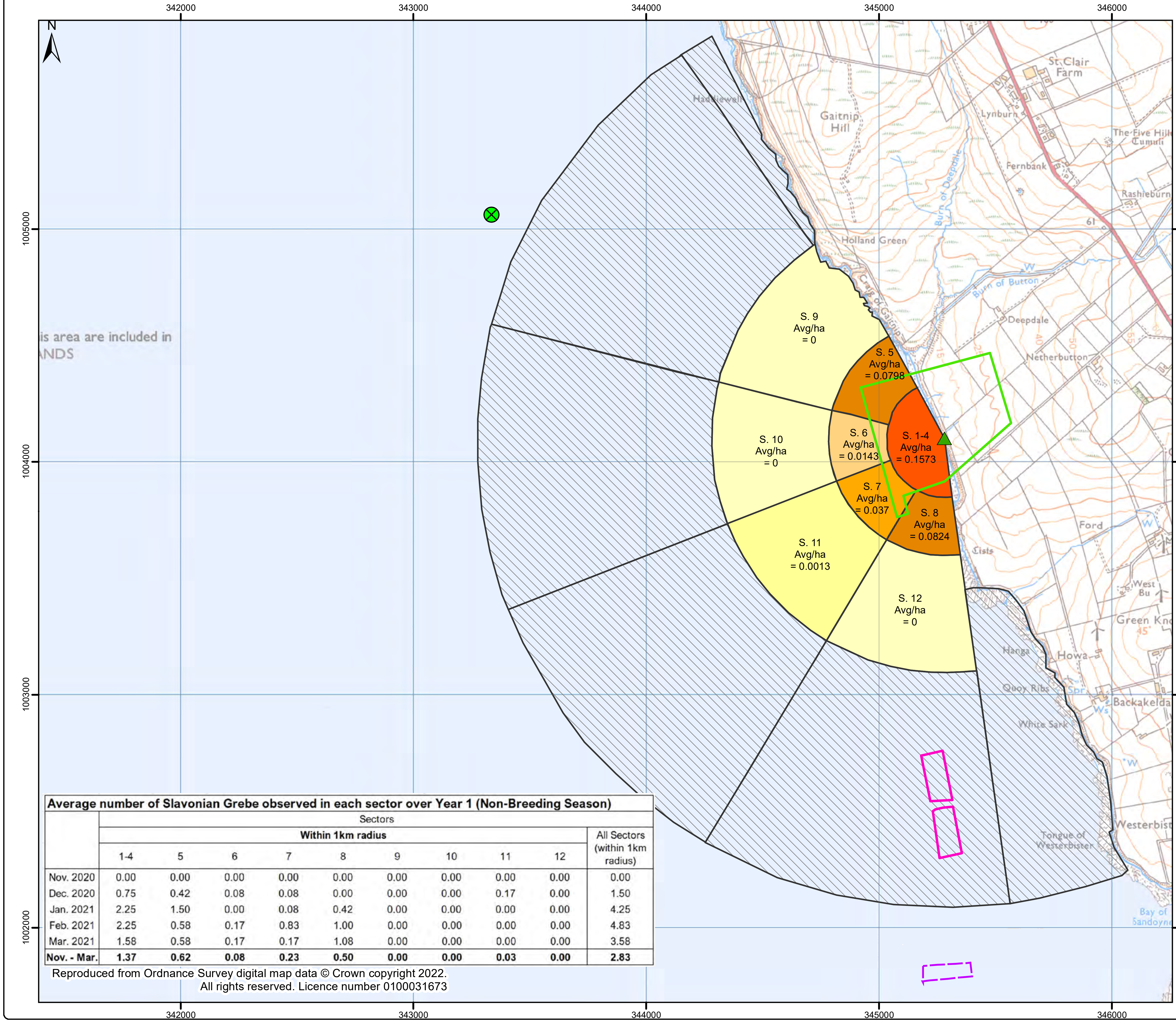

Average number of Slavonian Grebe observed in each sector over Year 1 (Non-Breeding Season)

	Sectors									
	Within 1km radius									All Sectors (within 1km radius)
	1-4	5	6	7	8	9	10	11	12	
Nov. 2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dec. 2020	0.75	0.42	0.08	0.08	0.00	0.00	0.00	0.17	0.00	1.50
Jan. 2021	2.25	1.50	0.00	0.08	0.42	0.00	0.00	0.00	0.00	4.25
Feb. 2021	2.25	0.58	0.17	0.83	1.00	0.00	0.00	0.00	0.00	4.83
Mar. 2021	1.58	0.58	0.17	0.17	1.08	0.00	0.00	0.00	0.00	3.58
Nov. - Mar.	**1.37**	**0.62**	**0.08**	**0.23**	**0.50**	**0.00**	**0.00**	**0.03**	**0.00**	**2.83**

Legend

- 🟩 Proposed Site Extent
- ☐ Survey Sectors
- ▲ Original Vantage Point (HY 45274 04102)
- ⊗ Royal Oak Marker Buoy
- ☐ Emec Working Area
- ☐ Salmon Cages

Average Bird Count Density per ha

- <0.001
- 0.001 - 0.0025
- 0.002 - 0.005
- 0.005 - 0.025
- 0.025 - 0.05
- 0.05 - 0.15
- 0.15 - 0.3
- 0.3 - 0.45
- \>0.45
- ▨ Sectors not surveyed during this period

Do not scale this map

Client
Orkney Islands Council Harbour Authority

Project
Orkney Scapa Deep Water Quay

Title
Slavonian Grebe Observations
Year 1 Non-breeding (Nov 2020 to March 2021)

Status
Final

Drawing No.	**Revision**	**Date**
674795-GIS127	-	23 March 2023
Drawn	**Checked**	**Approved**
JAS	MS	MS

Scale
1:15,500 @A3

0 75 150 300 450 Metres

Rev	Date	Amendment	Initials
-	-	-	-

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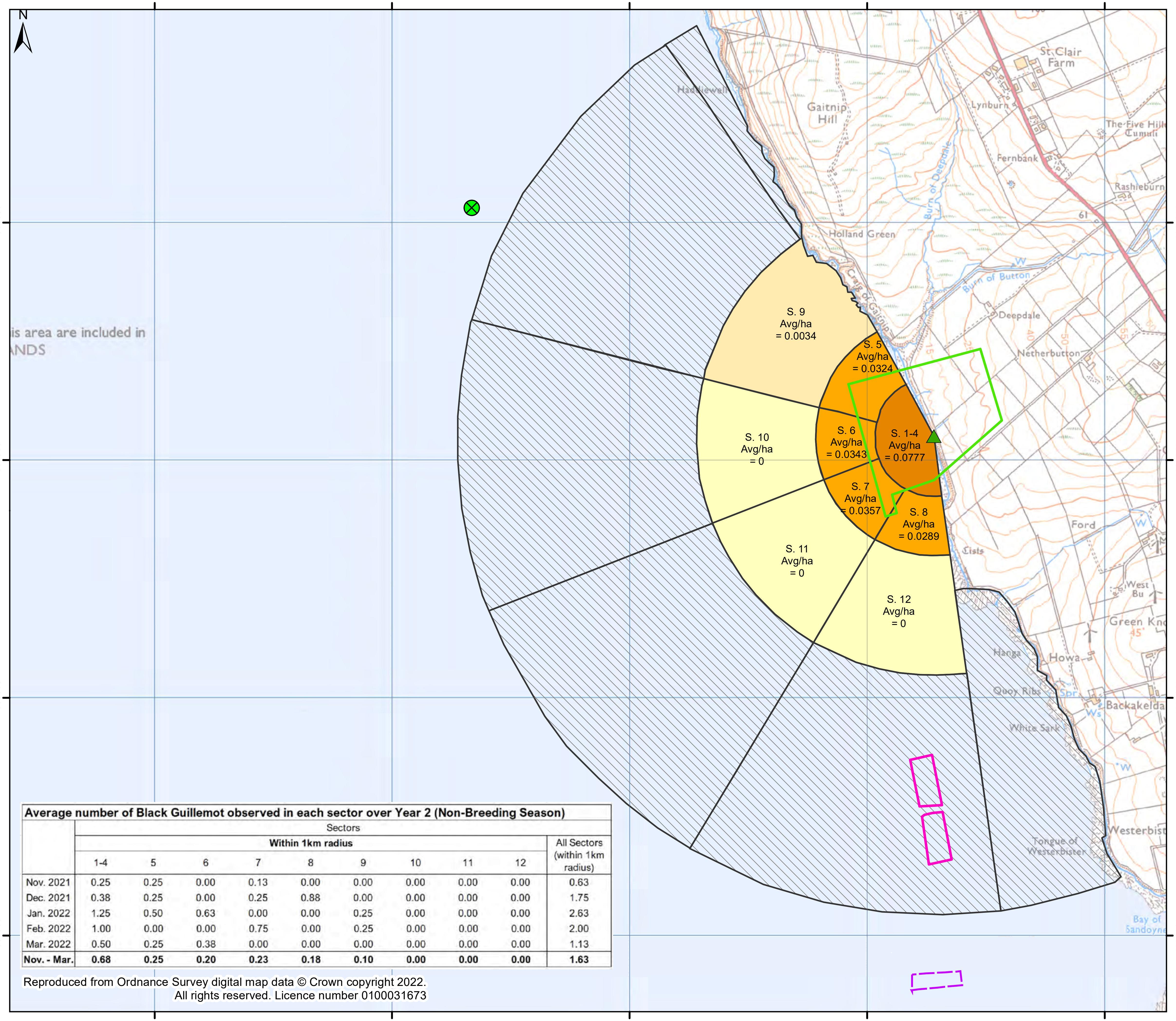

Average number of Black Guillemot observed in each sector over Year 2 (Non-Breeding Season)

	Sectors									
	Within 1km radius									All Sectors (within 1km radius)
	1-4	5	6	7	8	9	10	11	12	
Nov. 2021	0.25	0.25	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.63
Dec. 2021	0.38	0.25	0.00	0.25	0.88	0.00	0.00	0.00	0.00	1.75
Jan. 2022	1.25	0.50	0.63	0.00	0.00	0.25	0.00	0.00	0.00	2.63
Feb. 2022	1.00	0.00	0.00	0.75	0.00	0.25	0.00	0.00	0.00	2.00
Mar. 2022	0.50	0.25	0.38	0.00	0.00	0.00	0.00	0.00	0.00	1.13
Nov. - Mar.	**0.68**	**0.25**	**0.20**	**0.23**	**0.18**	**0.10**	**0.00**	**0.00**	**0.00**	**1.63**

Legend

- 🟩 Proposed Site Extent
- ☐ Survey Sectors
- ▲ Original Vantage Point (HY 45274 04102)
- ⊗ Royal Oak Marker Buoy
- ☐ Emec Working Area
- ☐ Salmon Cages

Average Bird Count Density per ha

- 🟨 <0.001
- 🟨 0.001 - 0.0025
- 🟨 0.002 - 0.005
- 🟧 0.005 - 0.025
- 🟧 0.025 - 0.05
- 🟧 0.05 - 0.15
- 🟥 0.15 - 0.3
- 🟥 0.3 - 0.45
- 🟥 >0.45
- ▨ Sectors not surveyed during this period

Do not scale this map

Client
Orkney Islands Council Harbour Authority

Project
Orkney Scapa Deep Water Quay

Title
Slavonian Grebe Observations
Year 2 Non-breeding (Nov 2021 to March 2022)

Status
Final

Drawing No.	**Revision**	**Date**
674795-GIS128	-	23 March 2023
Drawn	**Checked**	**Approved**
JAS	MS	MS

Scale
1:15,500 @A3
0 75 150 300 450 Metres

Rev	**Date**	**Amendment**	**Initials**
-	-	-	-

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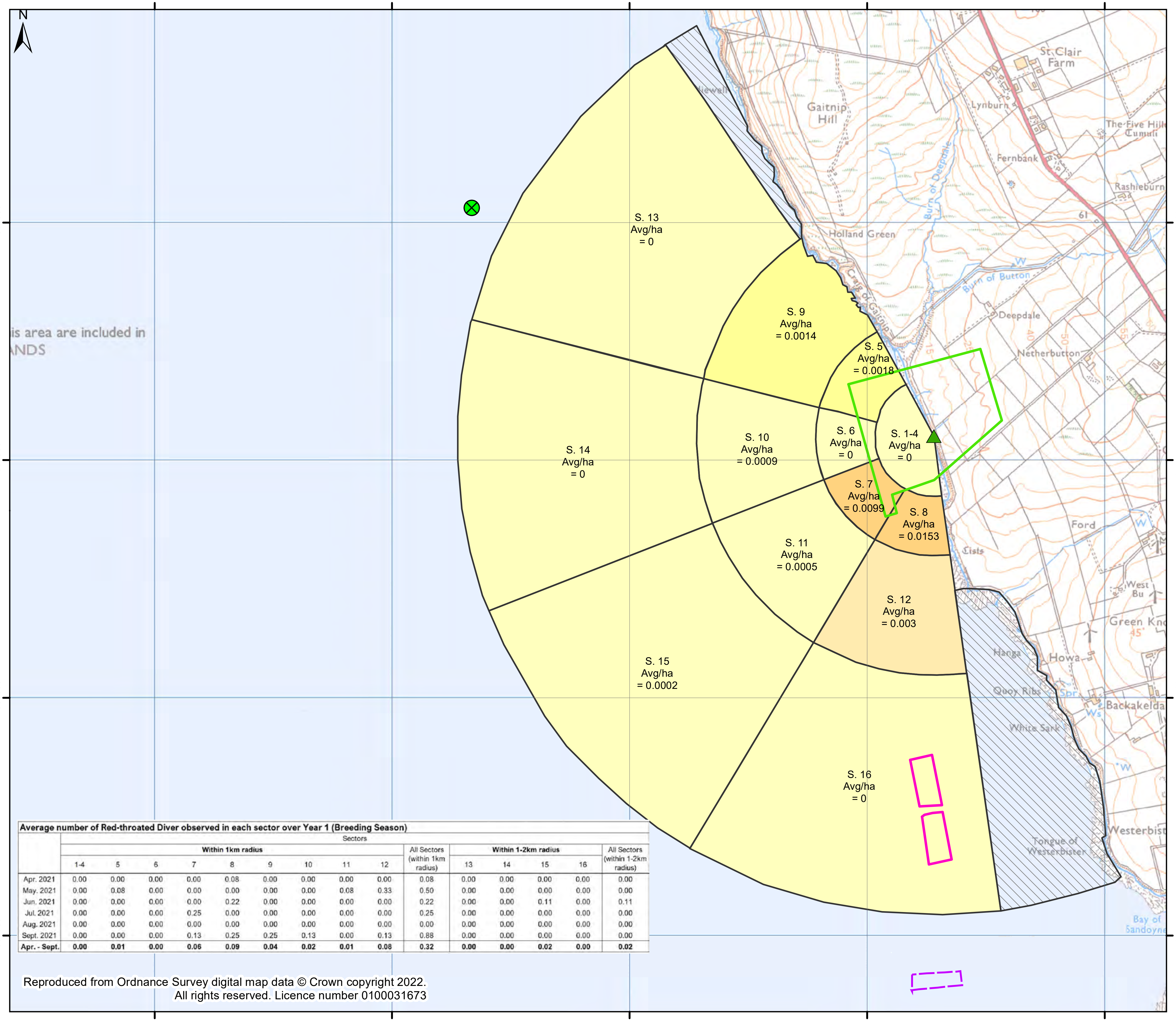

Average number of Red-throated Diver observed in each sector over Year 1 (Breeding Season)

	Sectors														
	Within 1km radius								All Sectors (within 1km radius)	Within 1-2km radius				All Sectors (within 1-2km radius)
	1-4	5	6	7	8	9	10	11	12		13	14	15	16	
Apr. 2021	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00
May. 2021	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.08	0.33	0.50	0.00	0.00	0.00	0.00	0.00
Jun. 2021	0.00	0.00	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.22	0.00	0.00	0.11	0.00	0.11
Jul. 2021	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00
Aug. 2021	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sept. 2021	0.00	0.00	0.00	0.13	0.25	0.25	0.13	0.00	0.13	0.88	0.00	0.00	0.00	0.00	0.00
Apr. - Sept.	**0.00**	**0.01**	**0.00**	**0.06**	**0.09**	**0.04**	**0.02**	**0.01**	**0.08**	**0.32**	**0.00**	**0.00**	**0.02**	**0.00**	**0.02**

Legend

- 🟩 Proposed Site Extent
- ☐ Survey Sectors
- ▲ Original Vantage Point (HY 45274 04102)
- ⊗ Royal Oak Marker Buoy
- ☐ Emec Working Area
- ☐ Salmon Cages

Average Bird Count Density per ha

- 🟨 <0.001
- 🟨 0.001 - 0.0025
- 🟧 0.002 - 0.005
- 🟧 0.005 - 0.025
- 🟧 0.025 - 0.05
- 🟧 0.05 - 0.15
- 🟥 0.15 - 0.3
- 🟥 0.3 - 0.45
- 🟥 >0.45
- ▨ Sectors not surveyed during this period

Do not scale this map

Client
Orkney Islands Council Harbour Authority

Project
Orkney Scapa Deep Water Quay

Title
Red-throated Diver Observations
Year 1 Breeding (April 2021 to Sep 2021)

Status
Final

Drawing No.	**Revision**	**Date**
674795-GIS125	-	23 March 2023
Drawn	**Checked**	**Approved**
JAS	MS	MS

Scale
1:15,500 @A3

Rev	Date	Amendment	Initials
-	-	-	-

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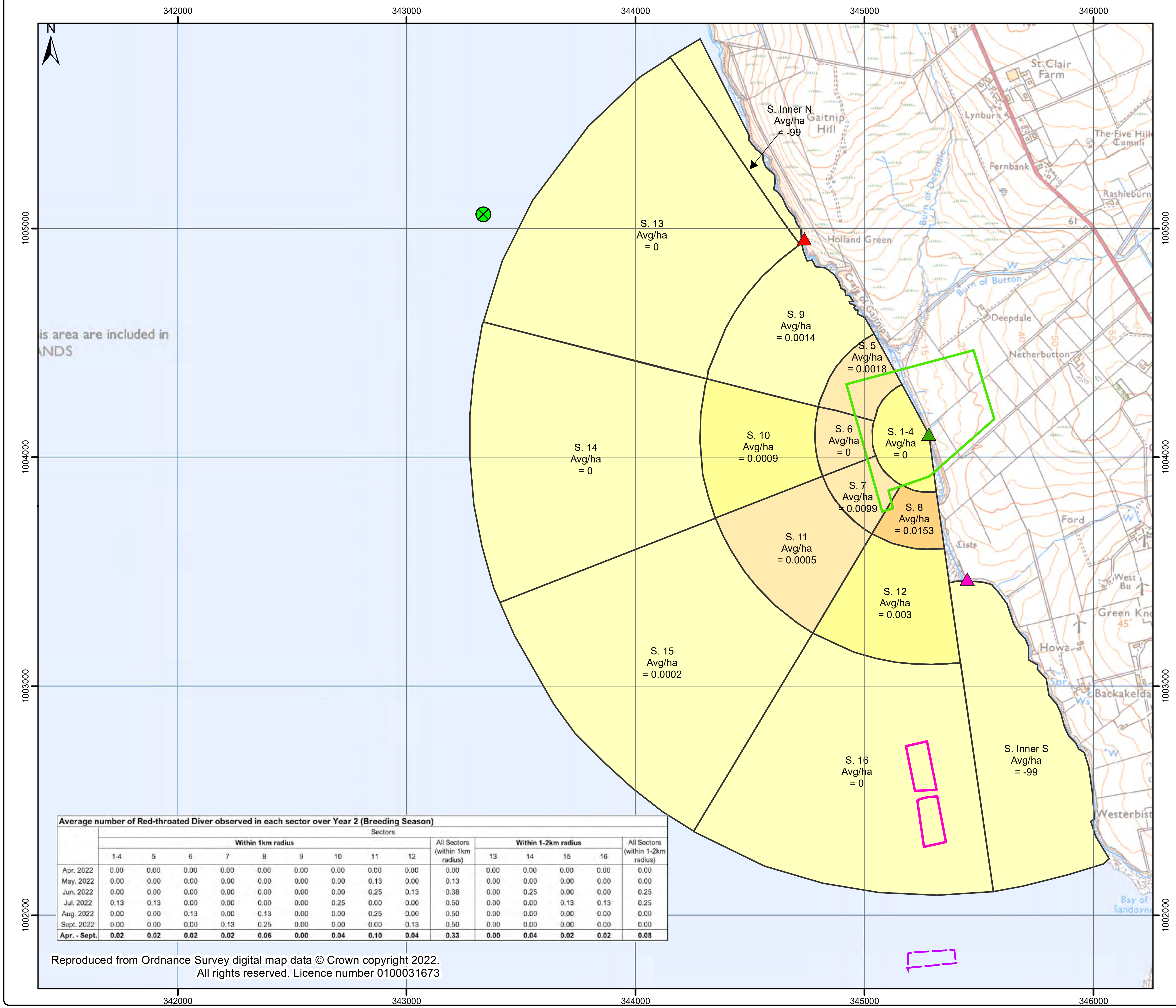

Average number of Red-throated Diver observed in each sector over Year 2 (Breeding Season)

	Sectors														
	Within 1km radius									All Sectors (within 1km radius)	**Within 1-2km radius**				All Sectors (within 1-2km radius)
	1-4	5	6	7	8	9	10	11	12		13	14	15	16	
Apr. 2022	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
May. 2022	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.13	0.00	0.00	0.00	0.00	0.00
Jun. 2022	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.13	0.38	0.00	0.25	0.00	0.00	0.25
Jul. 2022	0.13	0.13	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.50	0.00	0.00	0.13	0.13	0.25
Aug. 2022	0.00	0.00	0.13	0.00	0.13	0.00	0.00	0.25	0.00	0.50	0.00	0.00	0.00	0.00	0.00
Sept. 2022	0.00	0.00	0.00	0.13	0.25	0.00	0.00	0.00	0.13	0.50	0.00	0.00	0.00	0.00	0.00
Apr. - Sept.	**0.02**	**0.02**	**0.02**	**0.02**	**0.06**	**0.00**	**0.04**	**0.10**	**0.04**	**0.33**	**0.00**	**0.04**	**0.02**	**0.02**	**0.08**

Legend

▭	Proposed Site Extent
▭	Survey Sectors
▲	Original Vantage Point (HY 45274 04102)
▲	Northern Vantage Point (HY 45447 03468)
▲	Southern Vantage Point (HY 44736 04954)
⊗	Royal Oak Marker Buoy
▭	Emec Working Area
▭	Salmon Cages

Average Bird Count Density per ha

▭	< 0.001
▭	0.001 - 0.0025
▭	0.0025 - 0.005
▭	0.005 - 0.025
▭	0.025 - 0.05
▭	0.05 - 0.15
▭	0.15 - 0.3
▭	0.3 - 0.45
▭	>0.45

Do not scale this map

Client
Orkney Islands Council Harbour Authority

Project
Orkney Scapa Deep Water Quay

Title
Red-throated Diver Observations
Year 2 Breeding (April 2022 to Sep 2022)

Status
Final

Drawing No.	Revision	Date
674795-GIS126	-	23 March 2023
Drawn	**Checked**	**Approved**
JAS	MS	MS

Scale
1:15,500 @A3
0 75 150 300 450 Metres

Rev	Date	Amendment	Initials
-	-	-	-

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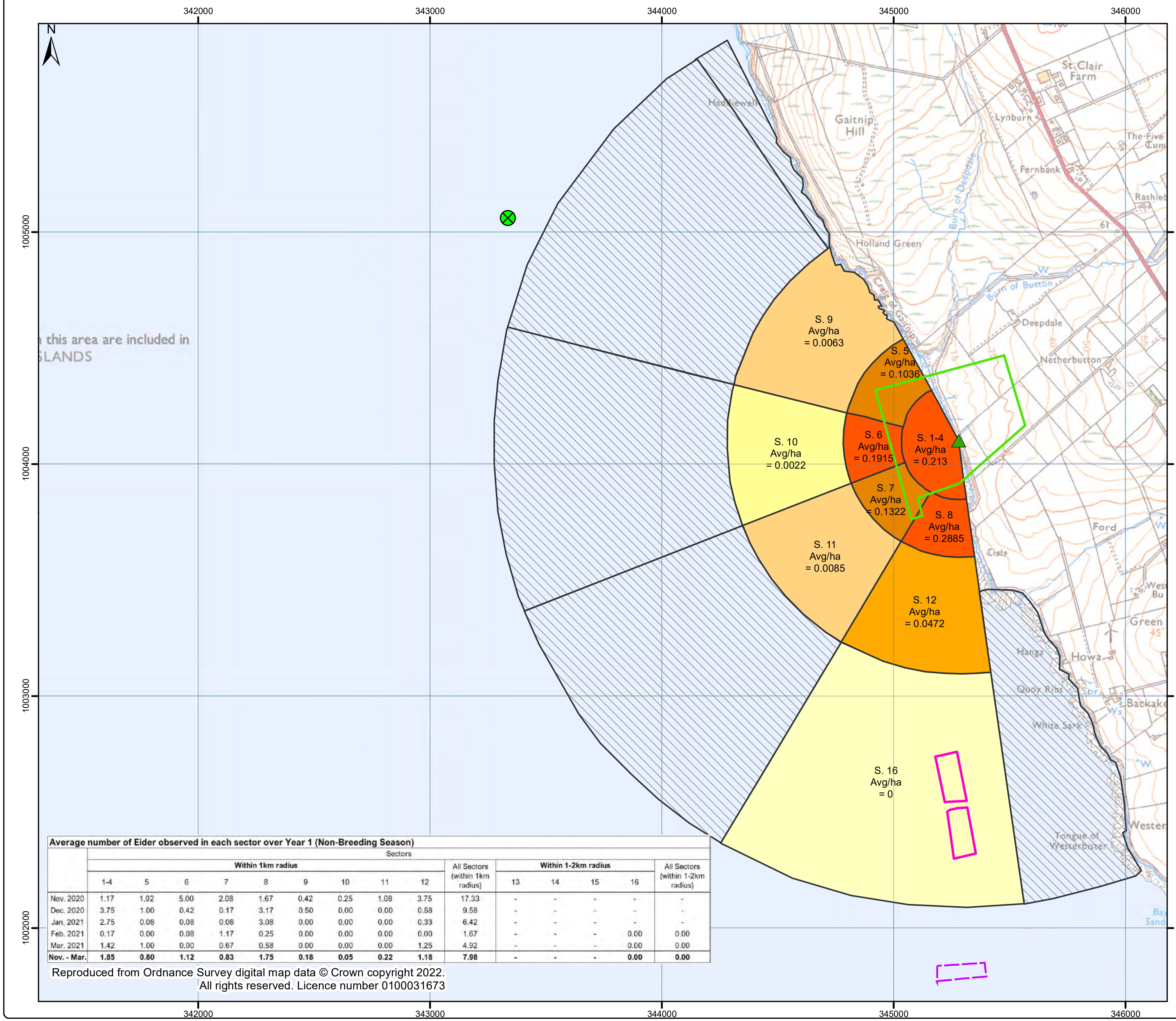

Average number of Eider observed in each sector over Year 1 (Non-Breeding Season)

	Sectors														
	Within 1km radius									All Sectors (within 1km radius)	Within 1-2km radius				All Sectors (within 1-2km radius)
	1-4	5	6	7	8	9	10	11	12		13	14	15	16	
Nov. 2020	1.17	1.92	5.00	2.08	1.67	0.42	0.25	1.08	3.75	17.33	-	-	-	-	-
Dec. 2020	3.75	1.00	0.42	0.17	3.17	0.50	0.00	0.00	0.58	9.58	-	-	-	-	-
Jan. 2021	2.75	0.08	0.08	0.08	3.08	0.00	0.00	0.00	0.33	6.42	-	-	-	-	-
Feb. 2021	0.17	0.00	0.08	1.17	0.25	0.00	0.00	0.00	0.00	1.67	-	-	-	0.00	0.00
Mar. 2021	1.42	1.00	0.00	0.67	0.58	0.00	0.00	0.00	1.25	4.92	-	-	-	0.00	0.00
Nov. - Mar.	**1.85**	**0.80**	**1.12**	**0.83**	**1.75**	**0.18**	**0.05**	**0.22**	**1.18**	**7.98**	**-**	**-**	**-**	**0.00**	**0.00**

Legend

- ▭ Proposed Site Extent
- ▭ Survey Sectors
- ▲ Original Vantage Point (HY 45274 04102)
- ⊗ Royal Oak Marker Buoy
- ▭ Emec Working Area
- ▭ Salmon Cages

Average Bird Count Density per ha

- ■ < 0.001
- ■ 0.001- 0.0025
- ■ 0.0025 - 0.005
- ■ 0.005 - 0.025
- ■ 0.025 - 0.05
- ■ 0.05 - 0.15
- ■ 0.15 - 0.3
- ■ 0.3 - 0.45
- ■ >0.45
- ▨ Sectors not surveyed during this period

Do not scale this map

Client
Orkney Islands Council Harbour Authority

Project
Orkney Scapa Deep Water Quay

Title
Eider Observations
Year 1 Non-breeding (Nov 2020 to March 2021)

Status
Final

Drawing No.	Revision	Date
674795-GIS107	-	22 March 2023
Drawn	**Checked**	**Approved**
JAS	MS	MS

Scale
1:15,500 @A3
0 75 150 300 450
Metres

Rev	Date	Amendment	Initials
-	-	-	-

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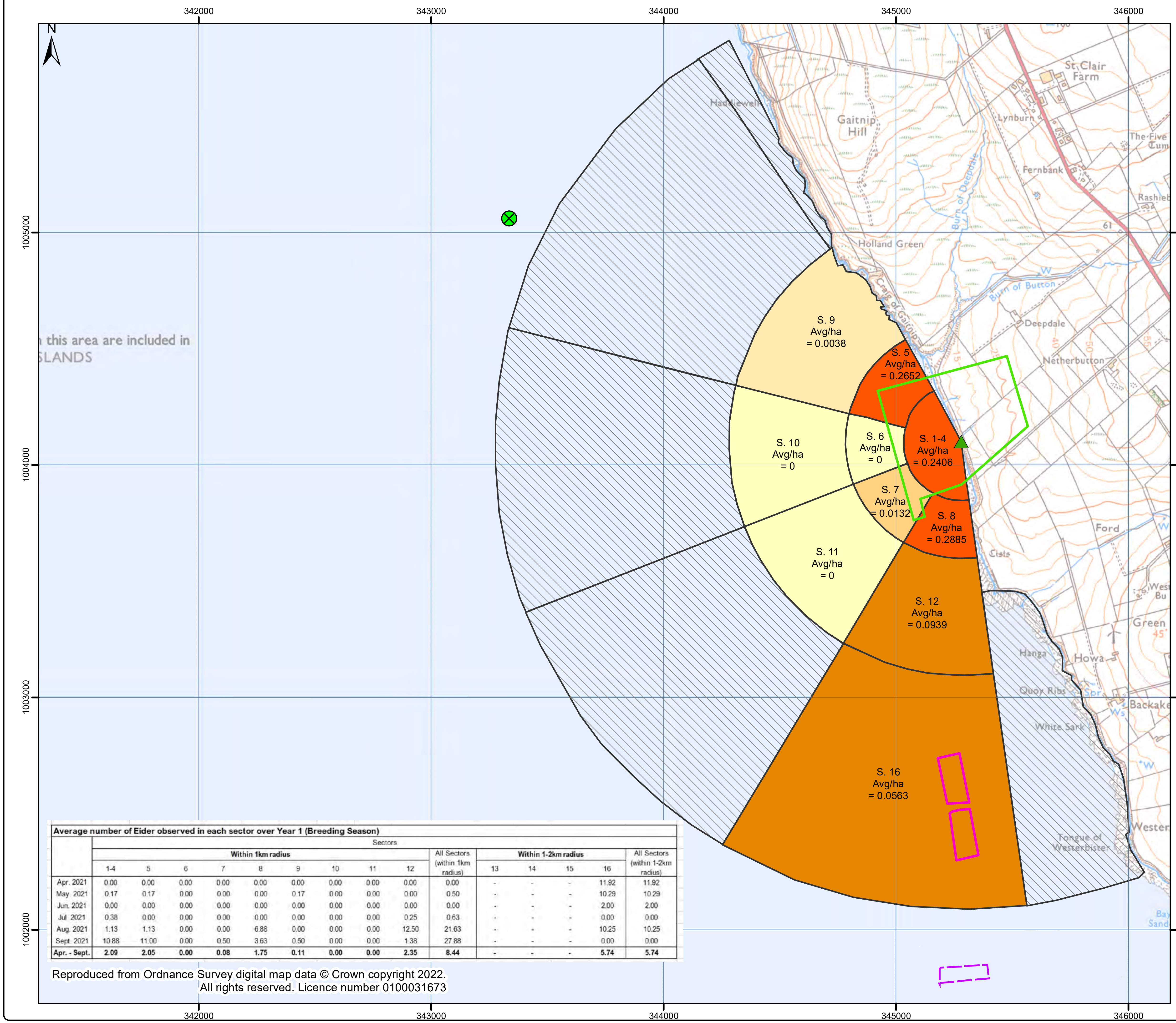

Average number of Eider observed in each sector over Year 1 (Breeding Season)

	Sectors														
	Within 1km radius									All Sectors (within 1km radius)	**Within 1-2km radius**				All Sectors (within 1-2km radius)
	1-4	5	6	7	8	9	10	11	12		13	14	15	16	
Apr. 2021	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-	11.92	11.92
May. 2021	0.17	0.17	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.50	-	-	-	10.29	10.29
Jun. 2021	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-	2.00	2.00
Jul 2021	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.63	-	-	-	0.00	0.00
Aug. 2021	1.13	1.13	0.00	0.00	6.88	0.00	0.00	0.00	12.50	21.63	-	-	-	10.25	10.25
Sept. 2021	10.88	11.00	0.00	0.50	3.63	0.50	0.00	0.00	1.38	27.88	-	-	-	0.00	0.00
Apr. - Sept.	**2.09**	**2.05**	**0.00**	**0.08**	**1.75**	**0.11**	**0.00**	**0.00**	**2.35**	**8.44**	**-**	**-**	**-**	**5.74**	**5.74**

Legend

🟩	Proposed Site Extent
▢	Survey Sectors
▲	Original Vantage Point (HY 45274 04102)
⊗	Royal Oak Marker Buoy
▢	Emec Working Area
▢	Salmon Cages

Average Bird Count Density per ha

■	< 0.001
■	0.001- 0.0025
■	0.0025 - 0.005
■	0.005 - 0.025
■	0.025 - 0.05
■	0.05 - 0.15
■	0.15 - 0.3
■	0.3 - 0.45
■	>0.45
▨	Sectors not surveyed during this period

Do not scale this map

Client
Orkney Islands Council Harbour Authority

Project
Orkney Scapa Deep Water Quay

Title
Eider Observations
Year 1 Breeding (April 2021 to Sep 2021)

Status
Final

Drawing No.	Revision	Date
674795-GIS108	-	22 March 2023
Drawn	**Checked**	**Approved**
JAS	MS	MS

Scale
1:15,500 @A3
0 75 150 300 450 Metres

Rev	Date	Amendment	Initials
-	-	-	-

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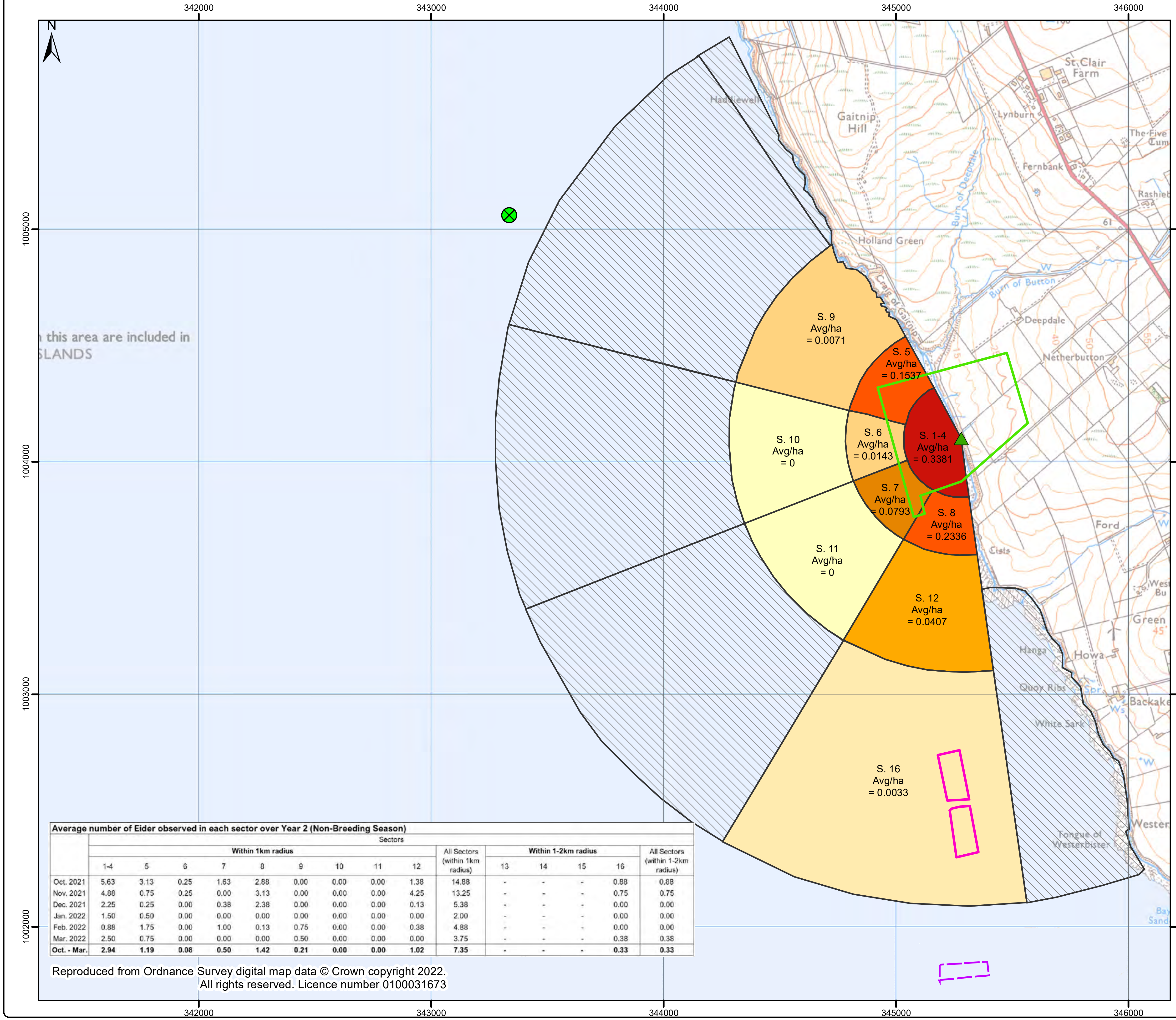

Average number of Eider observed in each sector over Year 2 (Non-Breeding Season)

	Sectors														
	Within 1km radius									All Sectors (within 1km radius)	Within 1-2km radius				All Sectors (within 1-2km radius)
	1-4	5	6	7	8	9	10	11	12		13	14	15	16	
Oct. 2021	5.63	3.13	0.25	1.63	2.88	0.00	0.00	0.00	1.38	14.88	-	-	-	0.88	0.88
Nov. 2021	4.88	0.75	0.25	0.00	3.13	0.00	0.00	0.00	4.25	13.25	-	-	-	0.75	0.75
Dec. 2021	2.25	0.25	0.00	0.38	2.38	0.00	0.00	0.00	0.13	5.38	-	-	-	0.00	0.00
Jan. 2022	1.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	-	-	-	0.00	0.00
Feb. 2022	0.88	1.75	0.00	1.00	0.13	0.75	0.00	0.00	0.38	4.88	-	-	-	0.00	0.00
Mar. 2022	2.50	0.75	0.00	0.00	0.00	0.50	0.00	0.00	0.00	3.75	-	-	-	0.38	0.38
Oct. - Mar.	**2.94**	**1.19**	**0.08**	**0.50**	**1.42**	**0.21**	**0.00**	**0.00**	**1.02**	**7.35**	**-**	**-**	**-**	**0.33**	**0.33**

Legend

- 🟩 Proposed Site Extent
- ☐ Survey Sectors
- ▲ Original Vantage Point (HY 45274 04102)
- ⊗ Royal Oak Marker Buoy
- ⬚ Emec Working Area
- ☐ Salmon Cages

Average Bird Count Density per ha

- ■ < 0.001
- ■ 0.001- 0.0025
- ■ 0.0025 - 0.005
- ■ 0.005 - 0.025
- ■ 0.025 - 0.05
- ■ 0.05 - 0.15
- ■ 0.15 - 0.3
- ■ 0.3 - 0.45
- ■ >0.45
- ▨ Sectors not surveyed during this period

Do not scale this map

Client
Orkney Islands Council Harbour Authority

Project
Orkney Scapa Deep Water Quay

Title
Eider Observations
Year 2 non- breeding (Oct 2021 to March 2022)

Status
Final

Drawing No.	**Revision**	**Date**
674795-GIS109	-	22 March 2023
Drawn	**Checked**	**Approved**
JAS	MS	MS

Scale
1:15,500 @A3

0 75 150 300 450 Metres

Rev	Date	Amendment	Initials
-	-	-	-

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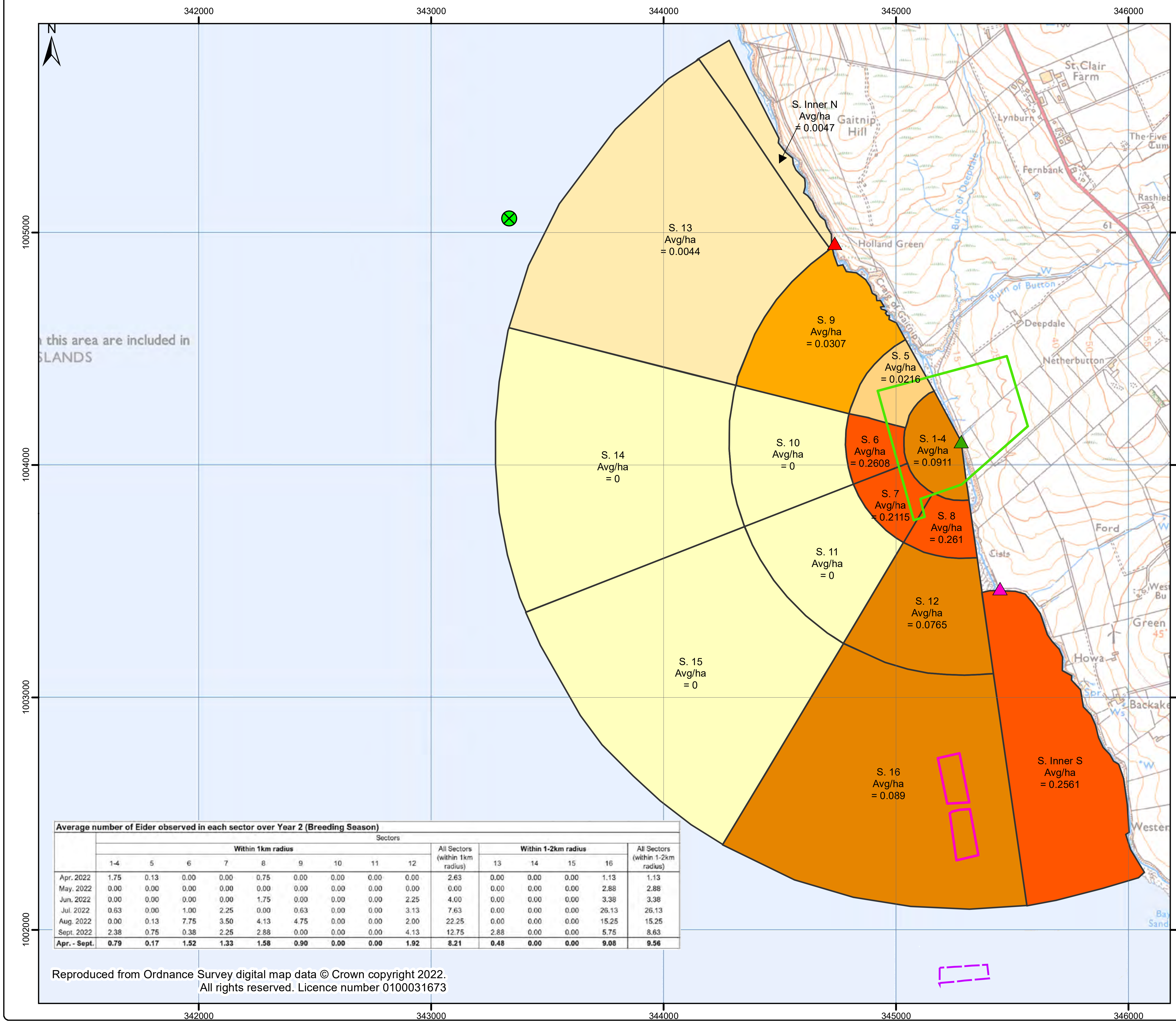

Average number of Eider observed in each sector over Year 2 (Breeding Season)

	Sectors														
	Within 1km radius									All Sectors (within 1km radius)	**Within 1-2km radius**				All Sectors (within 1-2km radius)
	1-4	5	6	7	8	9	10	11	12		13	14	15	16	
Apr. 2022	1.75	0.13	0.00	0.00	0.75	0.00	0.00	0.00	0.00	2.63	0.00	0.00	0.00	1.13	1.13
May. 2022	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.88	2.88
Jun. 2022	0.00	0.00	0.00	0.00	1.75	0.00	0.00	0.00	2.25	4.00	0.00	0.00	0.00	3.38	3.38
Jul. 2022	0.63	0.00	1.00	2.25	0.00	0.63	0.00	0.00	3.13	7.63	0.00	0.00	0.00	26.13	26.13
Aug. 2022	0.00	0.13	7.75	3.50	4.13	4.75	0.00	0.00	2.00	22.25	0.00	0.00	0.00	15.25	15.25
Sept. 2022	2.38	0.75	0.38	2.25	2.88	0.00	0.00	0.00	4.13	12.75	2.88	0.00	0.00	5.75	8.63
Apr. - Sept.	**0.79**	**0.17**	**1.52**	**1.33**	**1.58**	**0.90**	**0.00**	**0.00**	**1.92**	**8.21**	**0.48**	**0.00**	**0.00**	**9.08**	**9.56**

Legend

- ▭ Proposed Site Extent
- ▭ Survey Sectors
- ▲ Original Vantage Point (HY 45274 04102)
- ▲ Northern Vantage Point (HY 45447 03468)
- ▲ Southern Vantage Point (HY 44736 04954)
- ⊗ Royal Oak Marker Buoy
- ▭ Emec Working Area
- ▭ Salmon Cages

Average Bird Count Density per ha

- ■ < 0.001
- ■ 0.001 - 0.0025
- ■ 0.0025 - 0.005
- ■ 0.005 - 0.025
- ■ 0.025 - 0.05
- ■ 0.05 - 0.15
- ■ 0.15 - 0.3
- ■ 0.3 - 0.45
- ■ >0.45

Do not scale this map

Client
Orkney Islands Council Harbour Authority

Project
Orkney Scapa Deep Water Quay

Title
Eider Observations
Year 2 Breeding (April 2022 to Sep 2022)

Status
Final

Drawing No.	Revision	Date
674795-GIS110	-	22 March 2023
Drawn	**Checked**	**Approved**
JAS	MS	MS

Scale
1:15,500 @A3
0 75 150 300 450 Metres

Rev	Date	Amendment	Initials
-	-	-	-

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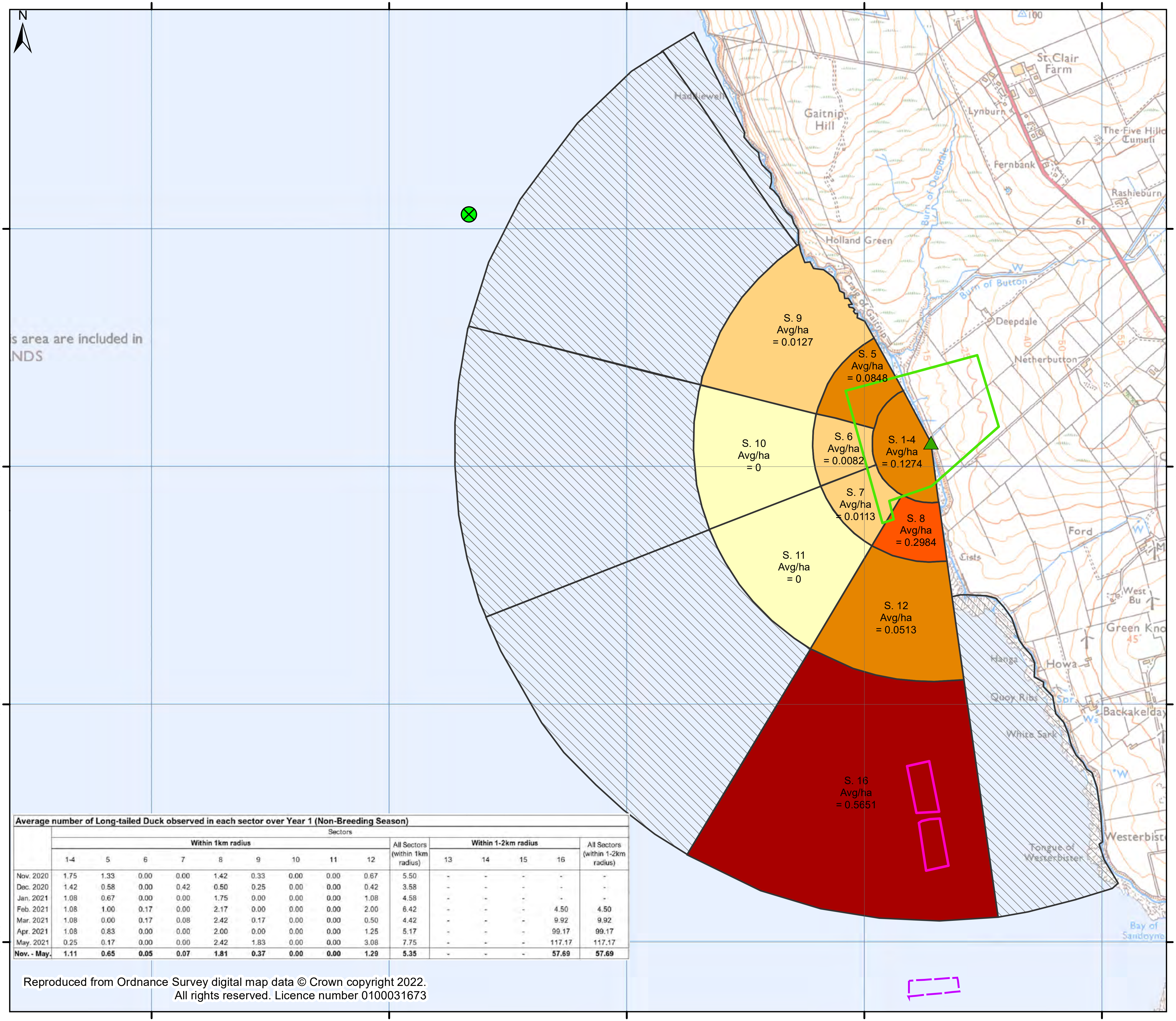

Average number of Long-tailed Duck observed in each sector over Year 1 (Non-Breeding Season)

	Sectors														
	Within 1km radius									All Sectors (within 1km radius)	Within 1-2km radius				All Sectors (within 1-2km radius)
	1-4	5	6	7	8	9	10	11	12		13	14	15	16	
Nov. 2020	1.75	1.33	0.00	0.00	1.42	0.33	0.00	0.00	0.67	5.50	-	-	-	-	-
Dec. 2020	1.42	0.58	0.00	0.42	0.50	0.25	0.00	0.00	0.42	3.58	-	-	-	-	-
Jan. 2021	1.08	0.67	0.00	0.00	1.75	0.00	0.00	0.00	1.08	4.58	-	-	-	-	-
Feb. 2021	1.08	1.00	0.17	0.00	2.17	0.00	0.00	0.00	2.00	6.42	-	-	-	4.50	4.50
Mar. 2021	1.08	0.00	0.17	0.08	2.42	0.17	0.00	0.00	0.50	4.42	-	-	-	9.92	9.92
Apr. 2021	1.08	0.83	0.00	0.00	2.00	0.00	0.00	0.00	1.25	5.17	-	-	-	99.17	99.17
May. 2021	0.25	0.17	0.00	0.00	2.42	1.83	0.00	0.00	3.08	7.75	-	-	-	117.17	117.17
Nov. - May.	**1.11**	**0.65**	**0.05**	**0.07**	**1.81**	**0.37**	**0.00**	**0.00**	**1.29**	**5.35**	-	-	-	**57.69**	**57.69**

Legend

▭	Proposed Site Extent
▭	Survey Sectors
▲	Original Vantage Point (HY 45274 04102)
⊗	Royal Oak Marker Buoy
▭	Emec Working Area
▭	Salmon Cages

Average Bird Count Density per ha

■	<0.001
■	0.001 - 0.0025
■	0.002 - 0.005
■	0.005 - 0.025
■	0.025 - 0.05
■	0.05 - 0.15
■	0.15 - 0.3
■	0.3 - 0.45
■	>0.45
▨	Sectors not surveyed during this period

Do not scale this map

Client
Orkney Islands Council Harbour Authority

Project
Orkney Scapa Deep Water Quay

Title
Long-tailed Duck Observations
Year 1 Non-breeding (Nov 2020 to May 2021)

Status
Final

Drawing No.	Revision	Date
674795-GIS117	-	23 March 2023
Drawn	**Checked**	**Approved**
JAS	MS	MS

Scale
1:15,500 @A3
0 75 150 300 450 Metres

Rev	Date	Amendment	Initials
-	-	-	-

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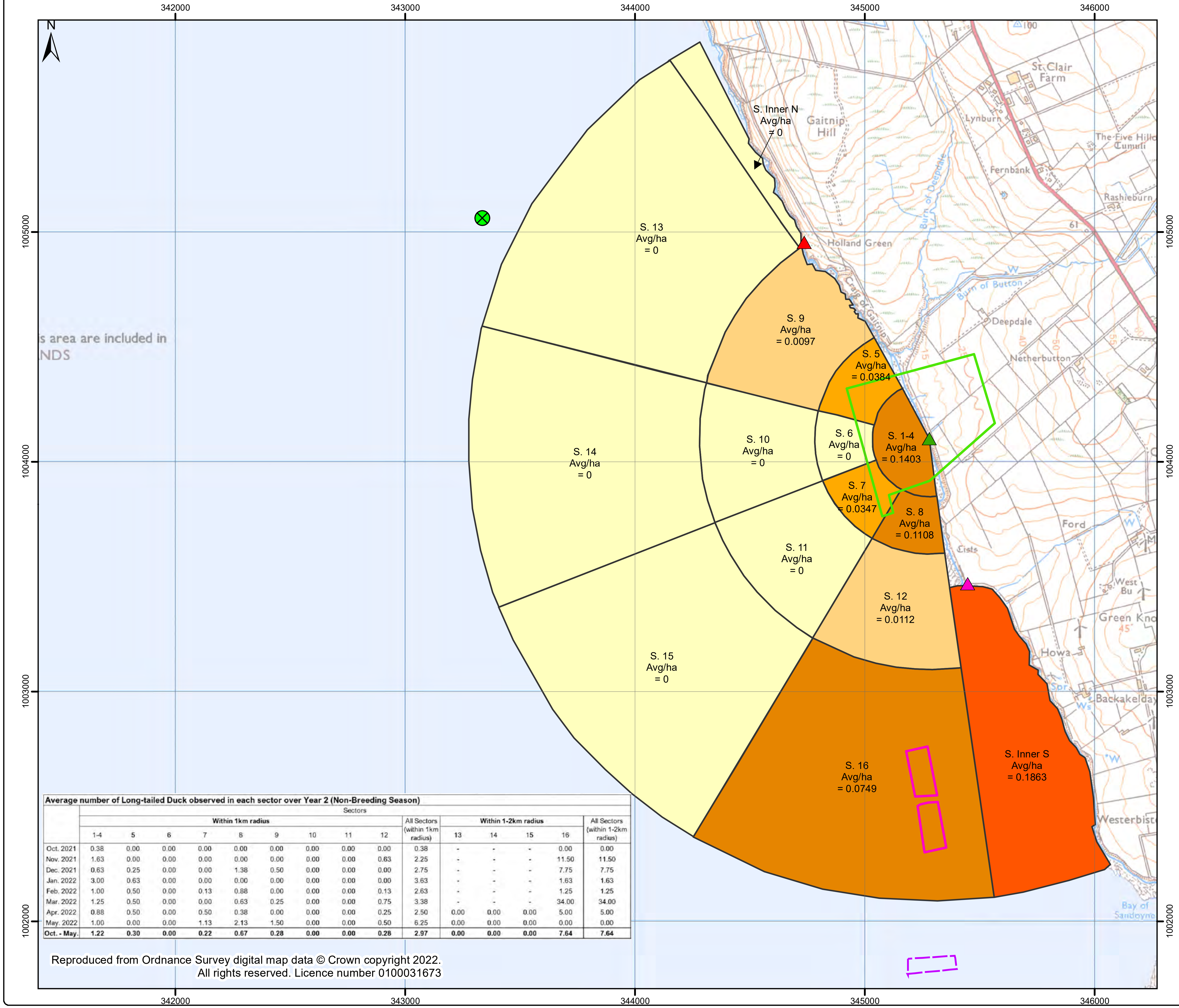

Average number of Long-tailed Duck observed in each sector over Year 2 (Non-Breeding Season)

	Sectors														
	Within 1km radius									All Sectors (within 1km radius)	Within 1-2km radius				All Sectors (within 1-2km radius)
	1-4	5	6	7	8	9	10	11	12		13	14	15	16	
Oct. 2021	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.38	-	-	-	0.00	0.00
Nov. 2021	1.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63	2.25	-	-	-	11.50	11.50
Dec. 2021	0.63	0.25	0.00	0.00	1.38	0.50	0.00	0.00	0.00	2.75	-	-	-	7.75	7.75
Jan. 2022	3.00	0.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.63	-	-	-	1.63	1.63
Feb. 2022	1.00	0.50	0.00	0.13	0.88	0.00	0.00	0.00	0.13	2.63	-	-	-	1.25	1.25
Mar. 2022	1.25	0.50	0.00	0.00	0.63	0.25	0.00	0.00	0.75	3.38	-	-	-	34.00	34.00
Apr. 2022	0.88	0.50	0.00	0.50	0.38	0.00	0.00	0.00	0.25	2.50	0.00	0.00	0.00	5.00	5.00
May. 2022	1.00	0.00	0.00	1.13	2.13	1.50	0.00	0.00	0.50	6.25	0.00	0.00	0.00	0.00	0.00
Oct. - May.	**1.22**	**0.30**	**0.00**	**0.22**	**0.67**	**0.28**	**0.00**	**0.00**	**0.28**	**2.97**	**0.00**	**0.00**	**0.00**	**7.64**	**7.64**

Legend

- ▭ Proposed Site Extent
- ▭ Survey Sectors
- ▲ Original Vantage Point (HY 45274 04102)
- ▲ Northern Vantage Point (HY 45447 03468)
- ▲ Southern Vantage Point (HY 44736 04954)
- ⊗ Royal Oak Marker Buoy
- ▭ Emec Working Area
- ▭ Salmon Cages

Average Bird Count Density per ha

- ■ < 0.001
- ■ 0.001 - 0.0025
- ■ 0.0025 - 0.005
- ■ 0.005 - 0.025
- ■ 0.025 - 0.05
- ■ 0.05 - 0.15
- ■ 0.15 - 0.3
- ■ 0.3 - 0.45
- ■ >0.45

Do not scale this map

Client
Orkney Islands Council Harbour Authority

Project
Orkney Scapa Deep Water Quay

Title
Long-tailed Duck Observations
Year 2 Non-breeding (Oct 2021 to May 2022)

Status
Final

Drawing No.	Revision	Date
674795-GIS118	-	23 March 2023
Drawn	**Checked**	**Approved**
JAS	MS	MS

Scale
1:15,500 @A3
0 75 150 300 450 Metres

Rev	Date	Amendment	Initials
-	-	-	-

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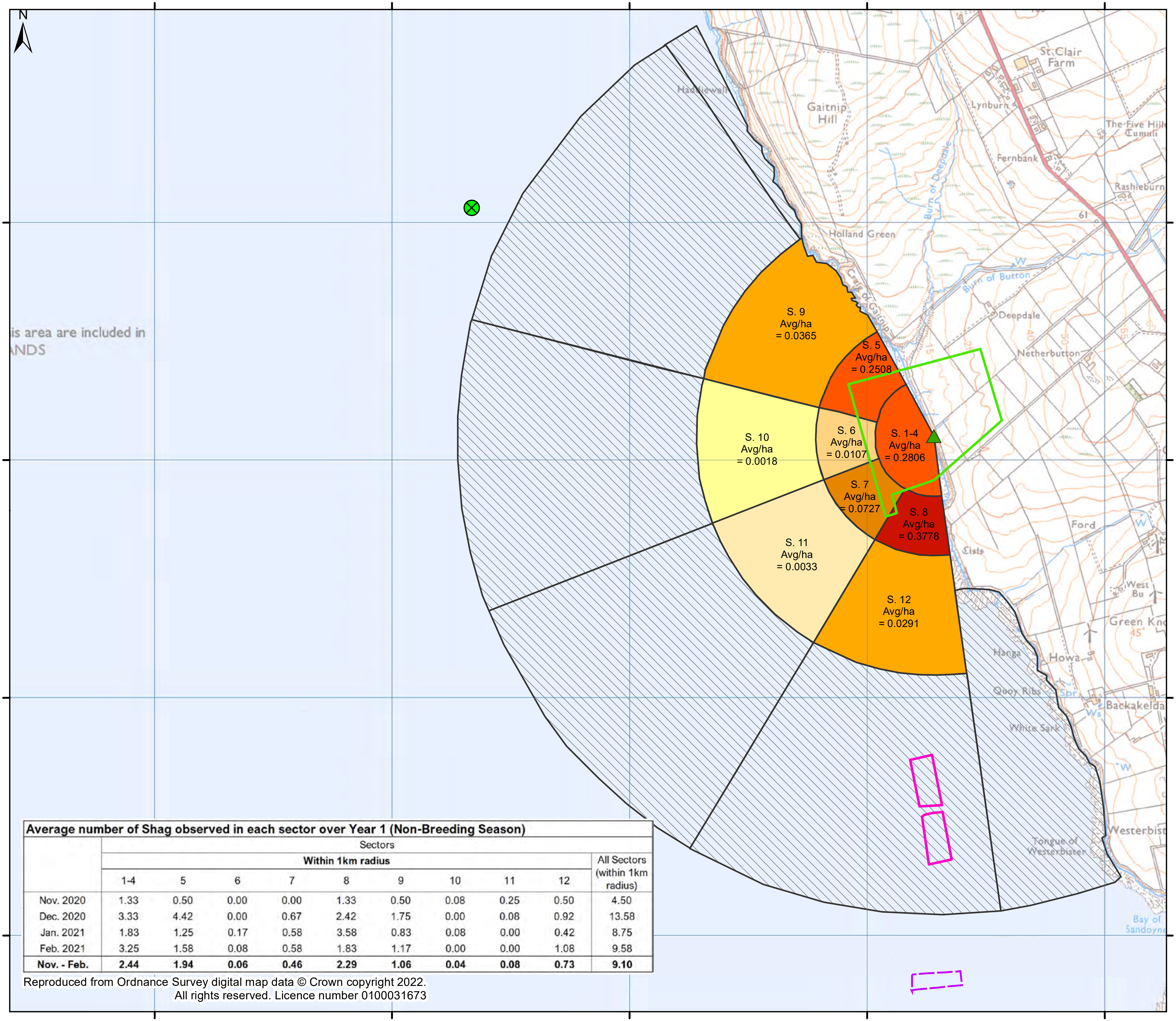

Average number of Shag observed in each sector over Year 1 (Non-Breeding Season)

	Sectors									
	Within 1km radius									All Sectors (within 1km radius)
	1-4	5	6	7	8	9	10	11	12	
Nov. 2020	1.33	0.50	0.00	0.00	1.33	0.50	0.08	0.25	0.50	4.50
Dec. 2020	3.33	4.42	0.00	0.67	2.42	1.75	0.00	0.08	0.92	13.58
Jan. 2021	1.83	1.25	0.17	0.58	3.58	0.83	0.08	0.00	0.42	8.75
Feb. 2021	3.25	1.58	0.08	0.58	1.83	1.17	0.00	0.00	1.08	9.58
Nov. - Feb.	**2.44**	**1.94**	**0.06**	**0.46**	**2.29**	**1.06**	**0.04**	**0.08**	**0.73**	**9.10**

Legend

- ▭ Proposed Site Extent
- ▭ Survey Sectors
- ▲ Original Vantage Point (HY 45274 04102)
- ⊗ Royal Oak Marker Buoy
- ▭ Emec Working Area
- ▭ Salmon Cages

Average Bird Count Density per ha

- ■ <0.001
- ■ 0.001 - 0.0025
- ■ 0.002 - 0.005
- ■ 0.005 - 0.025
- ■ 0.025 - 0.05
- ■ 0.05 - 0.15
- ■ 0.15 - 0.3
- ■ 0.3 - 0.45
- ■ >0.45
- ▨ Sectors not surveyed during this period

Do not scale this map

Client
Orkney Islands Council Harbour Authority

Project
Orkney Scapa Deep Water Quay

Title
Shag Observations
Year 1 Non-breeding (Nov 2020 to Feb 2021)

Status
Final

Drawing No.	Revision	Date
674795-GIS129	-	23 March 2023
Drawn	**Checked**	**Approved**
JAS	MS	MS

Scale
1:15,500 @A3
0 75 150 300 450 Metres

Rev	Date	Amendment	Initials
-	-	-	-

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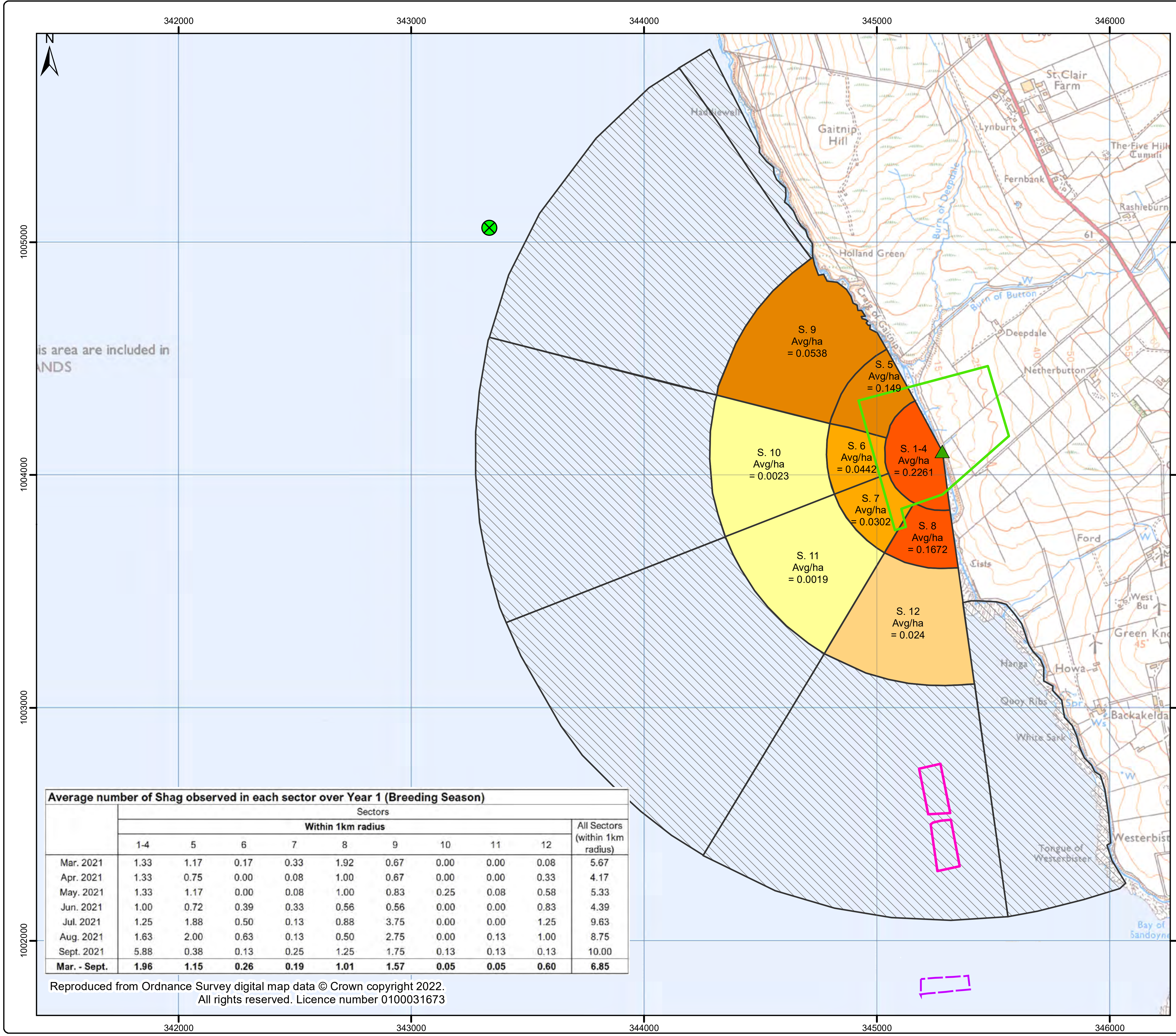

Average number of Shag observed in each sector over Year 1 (Breeding Season)

	Sectors									
	Within 1km radius									All Sectors (within 1km radius)
	1-4	5	6	7	8	9	10	11	12	
Mar. 2021	1.33	1.17	0.17	0.33	1.92	0.67	0.00	0.00	0.08	5.67
Apr. 2021	1.33	0.75	0.00	0.08	1.00	0.67	0.00	0.00	0.33	4.17
May. 2021	1.33	1.17	0.00	0.08	1.00	0.83	0.25	0.08	0.58	5.33
Jun. 2021	1.00	0.72	0.39	0.33	0.56	0.56	0.00	0.00	0.83	4.39
Jul. 2021	1.25	1.88	0.50	0.13	0.88	3.75	0.00	0.00	1.25	9.63
Aug. 2021	1.63	2.00	0.63	0.13	0.50	2.75	0.00	0.13	1.00	8.75
Sept. 2021	5.88	0.38	0.13	0.25	1.25	1.75	0.13	0.13	0.13	10.00
Mar. - Sept.	**1.96**	**1.15**	**0.26**	**0.19**	**1.01**	**1.57**	**0.05**	**0.05**	**0.60**	**6.85**

Legend

- Proposed Site Extent
- Survey Sectors
- ▲ Original Vantage Point (HY 45274 04102)
- ⊗ Royal Oak Marker Buoy
- Emec Working Area
- Salmon Cages

Average Bird Count Density per ha

- <0.001
- 0.001 - 0.0025
- 0.002 - 0.005
- 0.005 - 0.025
- 0.025 - 0.05
- 0.05 - 0.15
- 0.15 - 0.3
- 0.3 - 0.45
- >0.45
- ▨ Sectors not surveyed during this period

Do not scale this map

Client
Orkney Islands Council Harbour Authority

Project
Orkney Scapa Deep Water Quay

Title
Shag Observations
Year 1 Breeding (March 2021 to Sep 2021)

Status
Final

Drawing No.	Revision	Date
674795-GIS130	-	23 March 2023
Drawn	**Checked**	**Approved**
JAS	MS	MS

Scale
1:15,500 @A3
0 75 150 300 450 Metres

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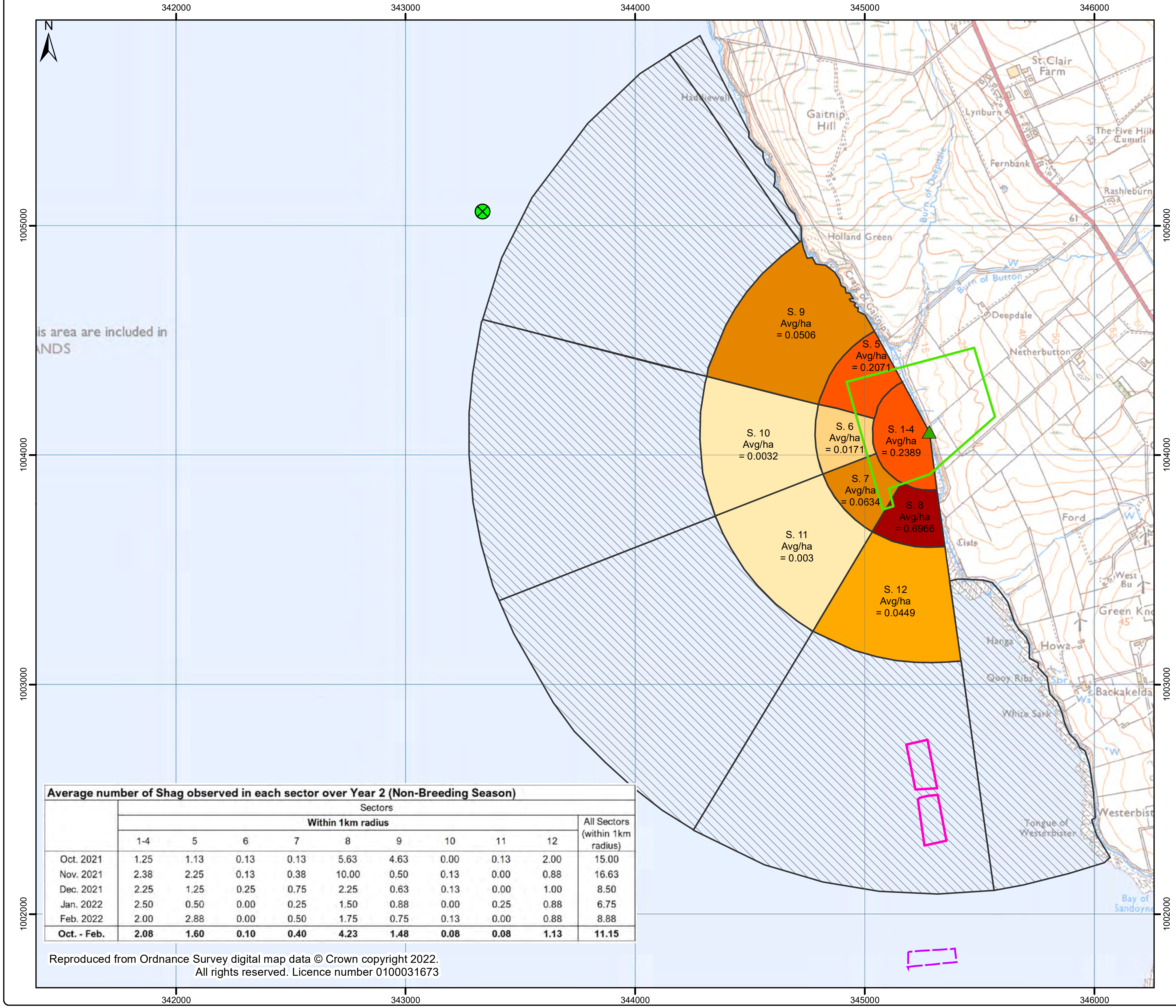

Average number of Shag observed in each sector over Year 2 (Non-Breeding Season)

	Sectors									
	Within 1km radius									All Sectors (within 1km radius)
	1-4	5	6	7	8	9	10	11	12	
Oct. 2021	1.25	1.13	0.13	0.13	5.63	4.63	0.00	0.13	2.00	15.00
Nov. 2021	2.38	2.25	0.13	0.38	10.00	0.50	0.13	0.00	0.88	16.63
Dec. 2021	2.25	1.25	0.25	0.75	2.25	0.63	0.13	0.00	1.00	8.50
Jan. 2022	2.50	0.50	0.00	0.25	1.50	0.88	0.00	0.25	0.88	6.75
Feb. 2022	2.00	2.88	0.00	0.50	1.75	0.75	0.13	0.00	0.88	8.88
Oct. - Feb.	**2.08**	**1.60**	**0.10**	**0.40**	**4.23**	**1.48**	**0.08**	**0.08**	**1.13**	**11.15**

Do not scale this map

Client
Orkney Islands Council Harbour Authority

Project
Orkney Scapa Deep Water Quay

Title
Shag Observations
Year 2 Non-breeding (Oct 2021 to Feb 2022)

Status
Final

Drawing No.	Revision	Date
674795-GIS131	-	23 March 2023
Drawn	**Checked**	**Approved**
JAS	MS	MS

Scale
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Rev	Date	Amendment	Initials
-	-	-	-

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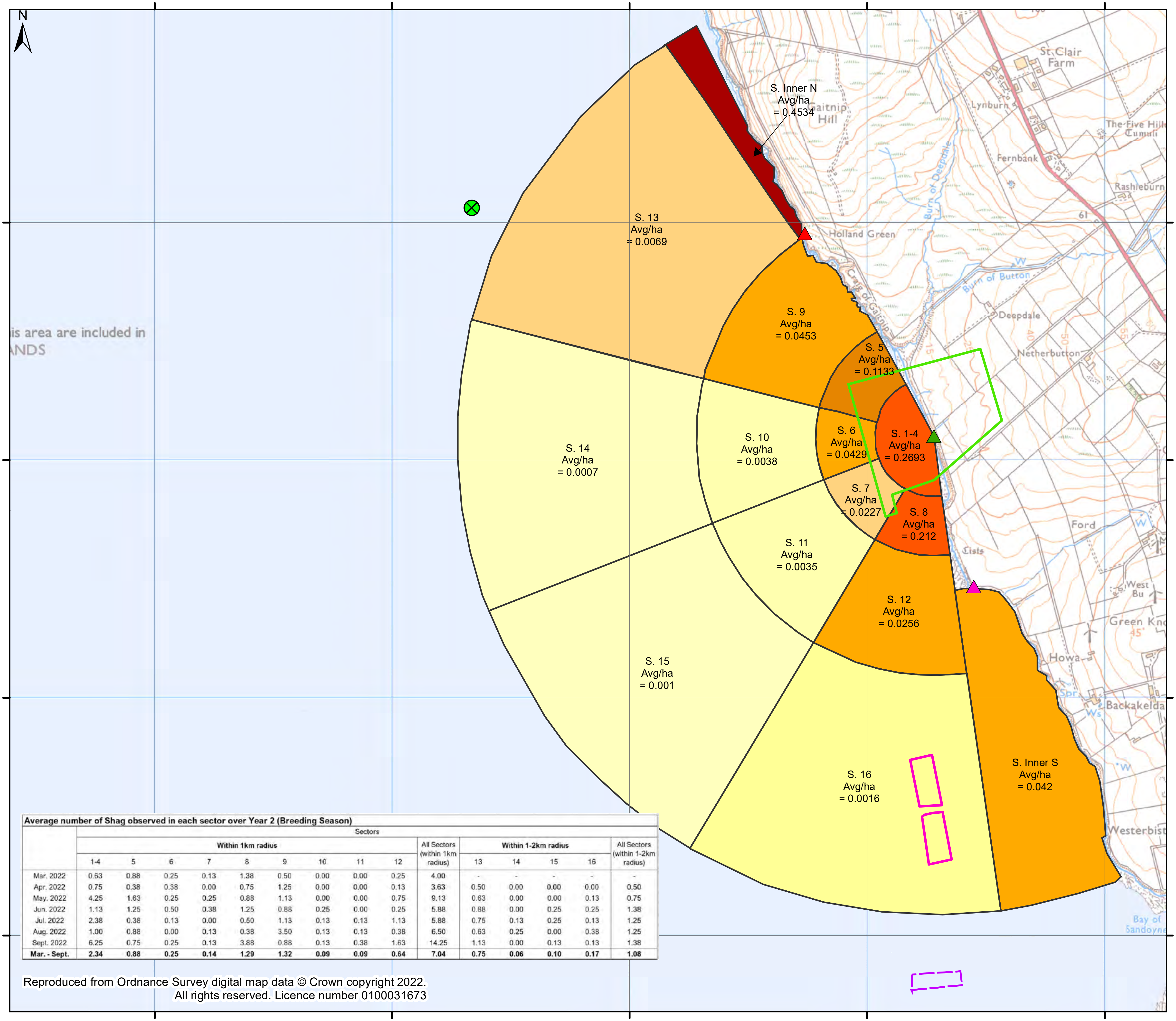

Average number of Shag observed in each sector over Year 2 (Breeding Season)

	Sectors													
	Within 1km radius								All Sectors (within 1km radius)	Within 1-2km radius				All Sectors (within 1-2km radius)
	1-4	5	6	7	8	9	10	11	12		13	14	15	16	
Mar. 2022	0.63	0.88	0.25	0.13	1.38	0.50	0.00	0.00	0.25	4.00	-	-	-	-	-
Apr. 2022	0.75	0.38	0.38	0.00	0.75	1.25	0.00	0.00	0.13	3.63	0.50	0.00	0.00	0.00	0.50
May. 2022	4.25	1.63	0.25	0.25	0.88	1.13	0.00	0.00	0.75	9.13	0.63	0.00	0.00	0.13	0.75
Jun. 2022	1.13	1.25	0.50	0.38	1.25	0.88	0.25	0.00	0.25	5.88	0.88	0.00	0.25	0.25	1.38
Jul. 2022	2.38	0.38	0.13	0.00	0.50	1.13	0.13	0.13	1.13	5.88	0.75	0.13	0.25	0.13	1.25
Aug. 2022	1.00	0.88	0.00	0.13	0.38	3.50	0.13	0.13	0.38	6.50	0.63	0.25	0.00	0.38	1.25
Sept. 2022	6.25	0.75	0.25	0.13	3.88	0.88	0.13	0.38	1.63	14.25	1.13	0.00	0.13	0.13	1.38
Mar. - Sept.	**2.34**	**0.88**	**0.25**	**0.14**	**1.29**	**1.32**	**0.09**	**0.09**	**0.64**	**7.04**	**0.75**	**0.06**	**0.10**	**0.17**	**1.08**

Legend

- ▭ Proposed Site Extent
- ▭ Survey Sectors
- ▲ Original Vantage Point (HY 45274 04102)
- ▲ Northern Vantage Point (HY 45447 03468)
- ▲ Southern Vantage Point (HY 44736 04954)
- ⊗ Royal Oak Marker Buoy
- ▭ Emec Working Area
- ▭ Salmon Cages

Average Bird Count Density per ha

- ■ < 0.001
- ■ 0.001 - 0.0025
- ■ 0.0025 - 0.005
- ■ 0.005 - 0.025
- ■ 0.025 - 0.05
- ■ 0.05 - 0.15
- ■ 0.15 - 0.3
- ■ 0.3 - 0.45
- ■ >0.45

Do not scale this map

Client
Orkney Islands Council Harbour Authority

Project
Orkney Scapa Deep Water Quay

Title
Shag Observations
Year 2 Breeding (March 2022 to Sep 2022)

Status
Final

Drawing No.	Revision	Date
674795-GIS132	-	23 March 2023
Drawn	**Checked**	**Approved**
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Scale
1:15,500 @A3
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Rev	Date	Amendment	Initials
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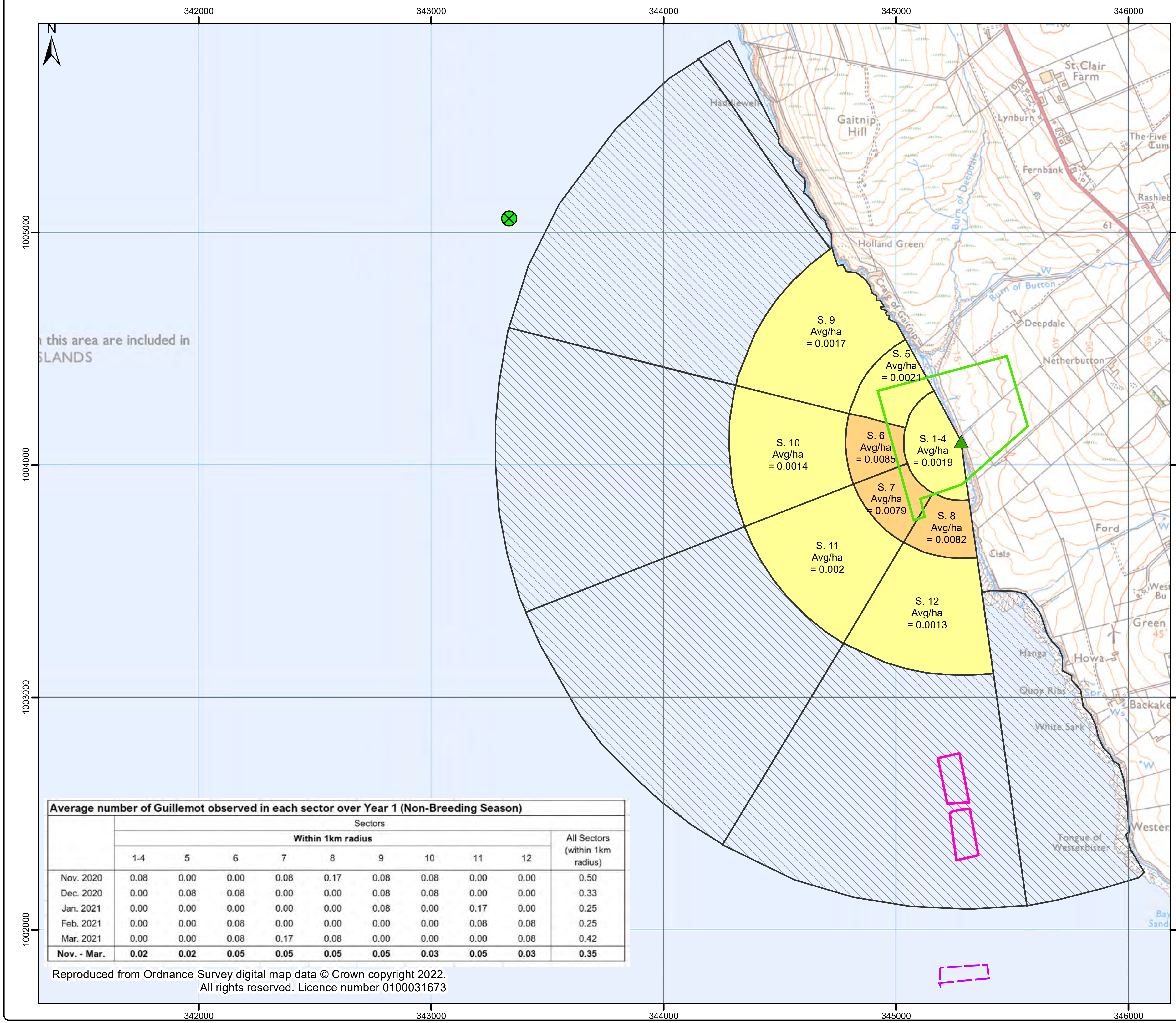

Average number of Guillemot observed in each sector over Year 1 (Non-Breeding Season)										
	Sectors									
	Within 1km radius									All Sectors (within 1km radius)
	1-4	5	6	7	8	9	10	11	12	
Nov. 2020	0.08	0.00	0.00	0.08	0.17	0.08	0.08	0.00	0.00	0.50
Dec. 2020	0.00	0.08	0.08	0.00	0.00	0.08	0.08	0.00	0.00	0.33
Jan. 2021	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.17	0.00	0.25
Feb. 2021	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.08	0.08	0.25
Mar. 2021	0.00	0.00	0.08	0.17	0.08	0.00	0.00	0.00	0.08	0.42
Nov. - Mar.	**0.02**	**0.02**	**0.05**	**0.05**	**0.05**	**0.05**	**0.03**	**0.05**	**0.03**	**0.35**

Legend

- ▢ Proposed Site Extent
- ▢ Survey Sectors
- ▲ Original Vantage Point (HY 45274 04102)
- ⊗ Royal Oak Marker Buoy
- ▢ Emec Working Area
- ▢ Salmon Cages

Average Bird Count Density per ha

- ▢ < 0.001
- ▢ 0.001- 0.0025
- ▢ 0.0025 - 0.005
- ▢ 0.005 - 0.025
- ▢ 0.025 - 0.05
- ▢ 0.05 - 0.15
- ▢ 0.15 - 0.3
- ▢ 0.3 - 0.45
- ▢ >0.45
- ▨ Sectors not surveyed during this period

Do not scale this map

Client
Orkney Islands Council Harbour Authority

Project
Orkney Scapa Deep Water Quay

Title
Gulliemot Observations
Year 1 Non-breeding (Nov 2020 to March 2021)

Status
Final

Drawing No.	Revision	Date
674795-GIS111	-	22 March 2023
Drawn	**Checked**	**Approved**
JAS	MS	MS

Scale
1:15,500 @A3

0 75 150 300 450 Metres

Rev	Date	Amendment	Initials
-	-	-	-

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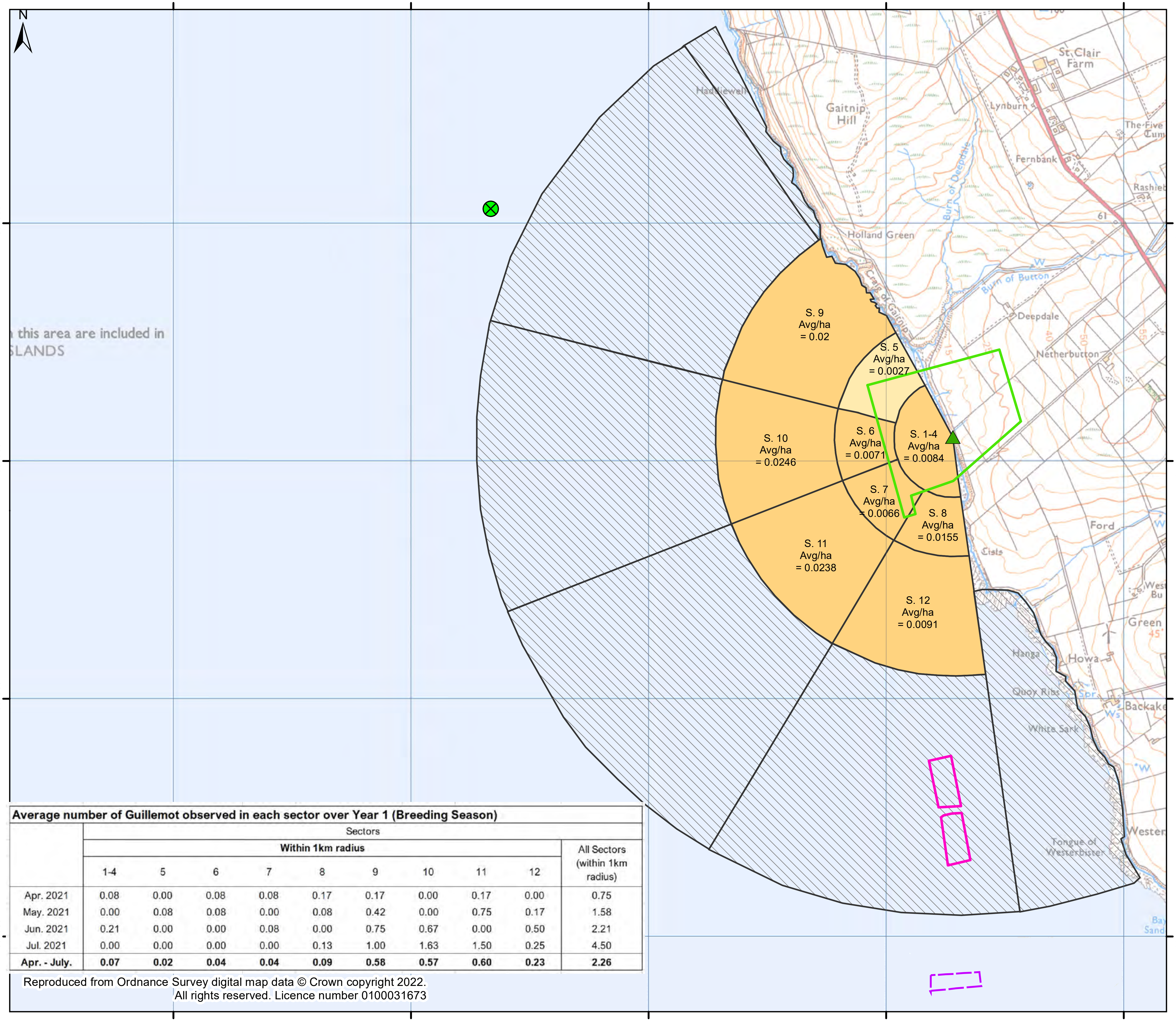

Average number of Guillemot observed in each sector over Year 1 (Breeding Season)

	Sectors									
	Within 1km radius									All Sectors (within 1km radius)
	1-4	5	6	7	8	9	10	11	12	
Apr. 2021	0.08	0.00	0.08	0.08	0.17	0.17	0.00	0.17	0.00	0.75
May. 2021	0.00	0.08	0.08	0.00	0.08	0.42	0.00	0.75	0.17	1.58
Jun. 2021	0.21	0.00	0.00	0.08	0.00	0.75	0.67	0.00	0.50	2.21
Jul. 2021	0.00	0.00	0.00	0.00	0.13	1.00	1.63	1.50	0.25	4.50
Apr. - July.	**0.07**	**0.02**	**0.04**	**0.04**	**0.09**	**0.58**	**0.57**	**0.60**	**0.23**	**2.26**

Legend

- 🟩 Proposed Site Extent
- ☐ Survey Sectors
- ▲ Original Vantage Point (HY 45274 04102)
- ⊗ Royal Oak Marker Buoy
- ☐ Emec Working Area
- ☐ Salmon Cages

Average Bird Count Density per ha

- ■ < 0.001
- ■ 0.001- 0.0025
- ■ 0.0025 - 0.005
- ■ 0.005 - 0.025
- ■ 0.025 - 0.05
- ■ 0.05 - 0.15
- ■ 0.15 - 0.3
- ■ 0.3 - 0.45
- ■ >0.45
- ▨ Sectors not surveyed during this period

Do not scale this map

Client
Orkney Islands Council Harbour Authority

Project
Orkney Scapa Deep Water Quay

Title
Gulliemot Observations
Year 1 Breeding (April 2021 to July 2021)

Status
Final

Drawing No.	Revision	Date
674795-GIS112	-	22 March 2023
Drawn	**Checked**	**Approved**
JAS	MS	MS

Scale
1:15,500 @A3
0 75 150 300 450 Metres

Rev	Date	Amendment	Initials
-	-	-	-

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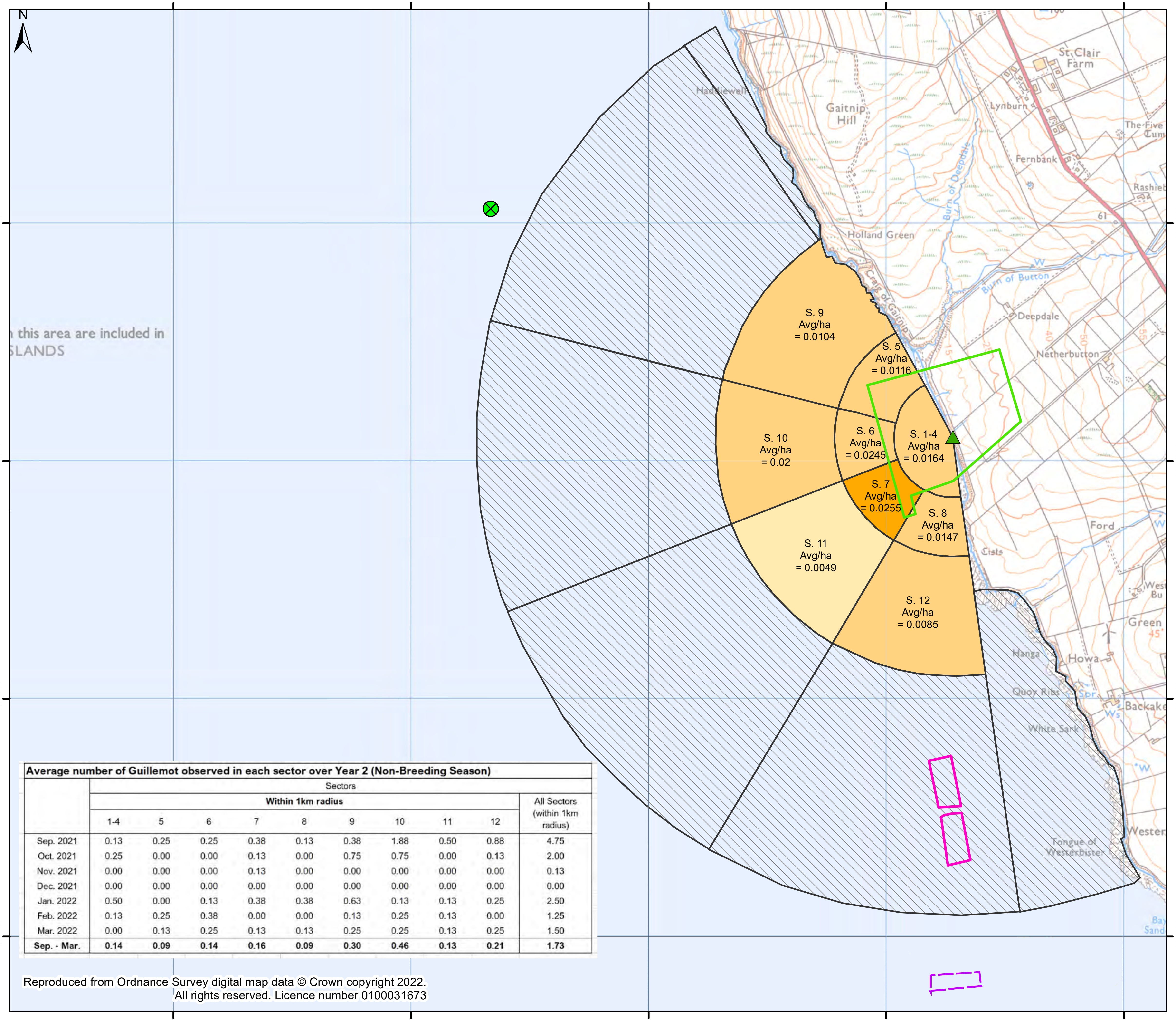

Average number of Guillemot observed in each sector over Year 2 (Non-Breeding Season)

	Sectors									
	Within 1km radius									All Sectors (within 1km radius)
	1-4	5	6	7	8	9	10	11	12	
Sep. 2021	0.13	0.25	0.25	0.38	0.13	0.38	1.88	0.50	0.88	4.75
Oct. 2021	0.25	0.00	0.00	0.13	0.00	0.75	0.75	0.00	0.13	2.00
Nov. 2021	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.13
Dec. 2021	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jan. 2022	0.50	0.00	0.13	0.38	0.38	0.63	0.13	0.13	0.25	2.50
Feb. 2022	0.13	0.25	0.38	0.00	0.00	0.13	0.25	0.13	0.00	1.25
Mar. 2022	0.00	0.13	0.25	0.13	0.13	0.25	0.25	0.13	0.25	1.50
Sep. - Mar.	**0.14**	**0.09**	**0.14**	**0.16**	**0.09**	**0.30**	**0.46**	**0.13**	**0.21**	**1.73**

Legend

- 🟩 Proposed Site Extent
- ☐ Survey Sectors
- ▲ Original Vantage Point (HY 45274 04102)
- ⊗ Royal Oak Marker Buoy
- ☐ Emec Working Area
- ☐ Salmon Cages

Average Bird Count Density per ha

- ■ < 0.001
- ■ 0.001- 0.0025
- ■ 0.0025 - 0.005
- ■ 0.005 - 0.025
- ■ 0.025 - 0.05
- ■ 0.05 - 0.15
- ■ 0.15 - 0.3
- ■ 0.3 - 0.45
- ■ >0.45
- ▨ Sectors not surveyed during this period

Do not scale this map

Client
Orkney Islands Council Harbour Authority

Project
Orkney Scapa Deep Water Quay

Title
Gulliemot Observations
Year 2 Non-breeding (Sep 2021 to March 2022)

Status
Final

Drawing No.	Revision	Date
674795-GIS113	-	22 March 2023
Drawn	**Checked**	**Approved**
JAS	MS	MS

Scale
1:15,500 @A3
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Rev	Date	Amendment	Initials
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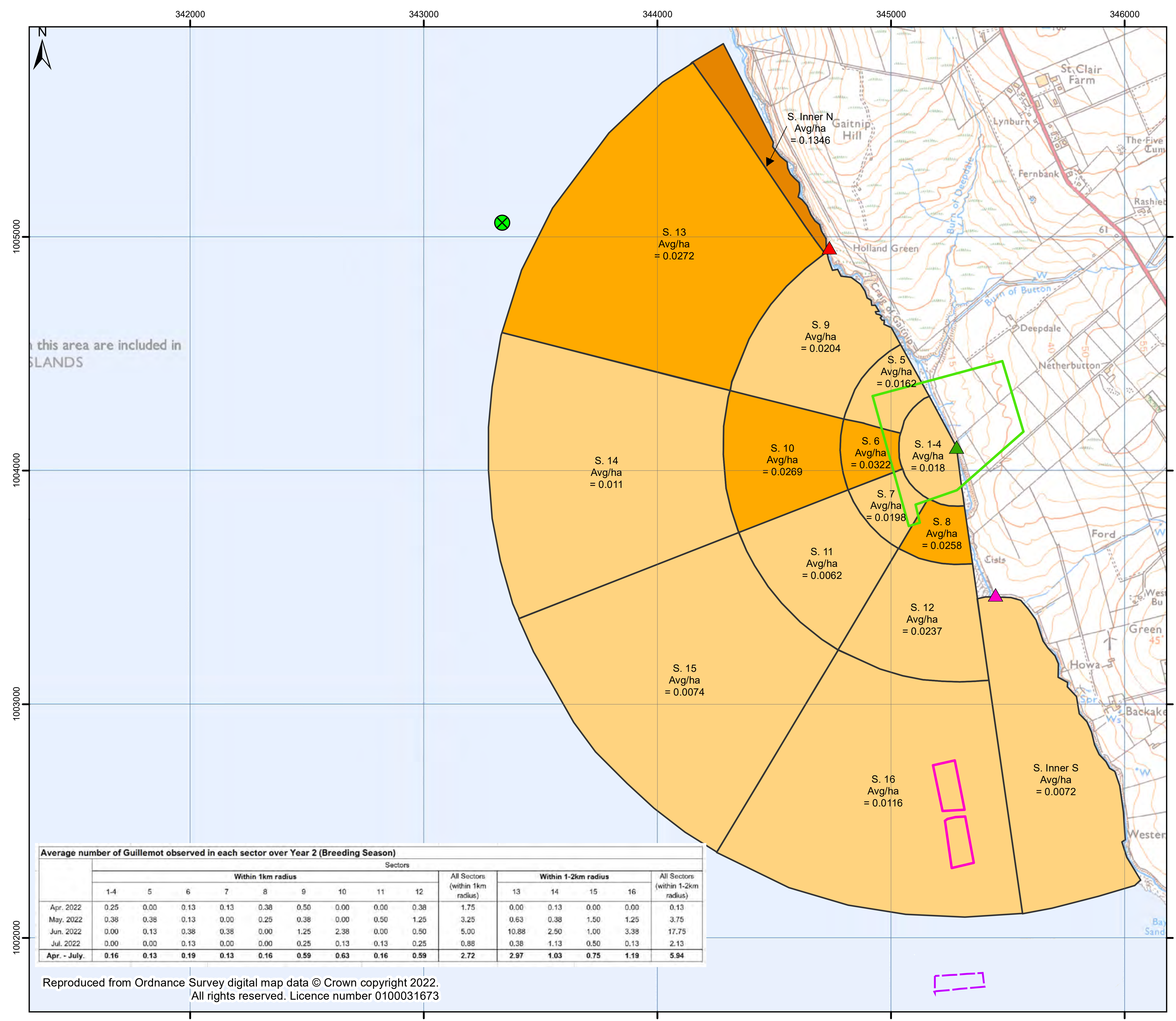

Average number of Guillemot observed in each sector over Year 2 (Breeding Season)

	Sectors														
	Within 1km radius									All Sectors (within 1km radius)	**Within 1-2km radius**				All Sectors (within 1-2km radius)
	1-4	5	6	7	8	9	10	11	12		13	14	15	16	
Apr. 2022	0.25	0.00	0.13	0.13	0.38	0.50	0.00	0.00	0.38	1.75	0.00	0.13	0.00	0.00	0.13
May. 2022	0.38	0.38	0.13	0.00	0.25	0.38	0.00	0.50	1.25	3.25	0.63	0.38	1.50	1.25	3.75
Jun. 2022	0.00	0.13	0.38	0.38	0.00	1.25	2.38	0.00	0.50	5.00	10.88	2.50	1.00	3.38	17.75
Jul. 2022	0.00	0.00	0.13	0.00	0.00	0.25	0.13	0.13	0.25	0.88	0.38	1.13	0.50	0.13	2.13
Apr. - July.	**0.16**	**0.13**	**0.19**	**0.13**	**0.16**	**0.59**	**0.63**	**0.16**	**0.59**	**2.72**	**2.97**	**1.03**	**0.75**	**1.19**	**5.94**

Legend

▭	Proposed Site Extent
▭	Survey Sectors
▲	Original Vantage Point (HY 45274 04102)
▲	Northern Vantage Point (HY 45447 03468)
▲	Southern Vantage Point (HY 44736 04954)
⊗	Royal Oak Marker Buoy
▭	Emec Working Area
▭	Salmon Cages

Average Bird Count Density per ha

■	< 0.001
■	0.001 - 0.0025
■	0.0025 - 0.005
■	0.005 - 0.025
■	0.025 - 0.05
■	0.05 - 0.15
■	0.15 - 0.3
■	0.3 - 0.45
■	>0.45

Do not scale this map

Client
Orkney Islands Council Harbour Authority

Project
Orkney Scapa Deep Water Quay

Title
Gulliemot Observations
Year 2 breeding (April 2022 to July 2022)

Status
Final

Drawing No.	Revision	Date
674795-GIS114	-	22 March 2023
Drawn	**Checked**	**Approved**
JAS	MS	MS

Scale
1:15,500 @A3
0 75 150 300 450 Metres

Rev	Date	Amendment	Initials
-	-	-	-

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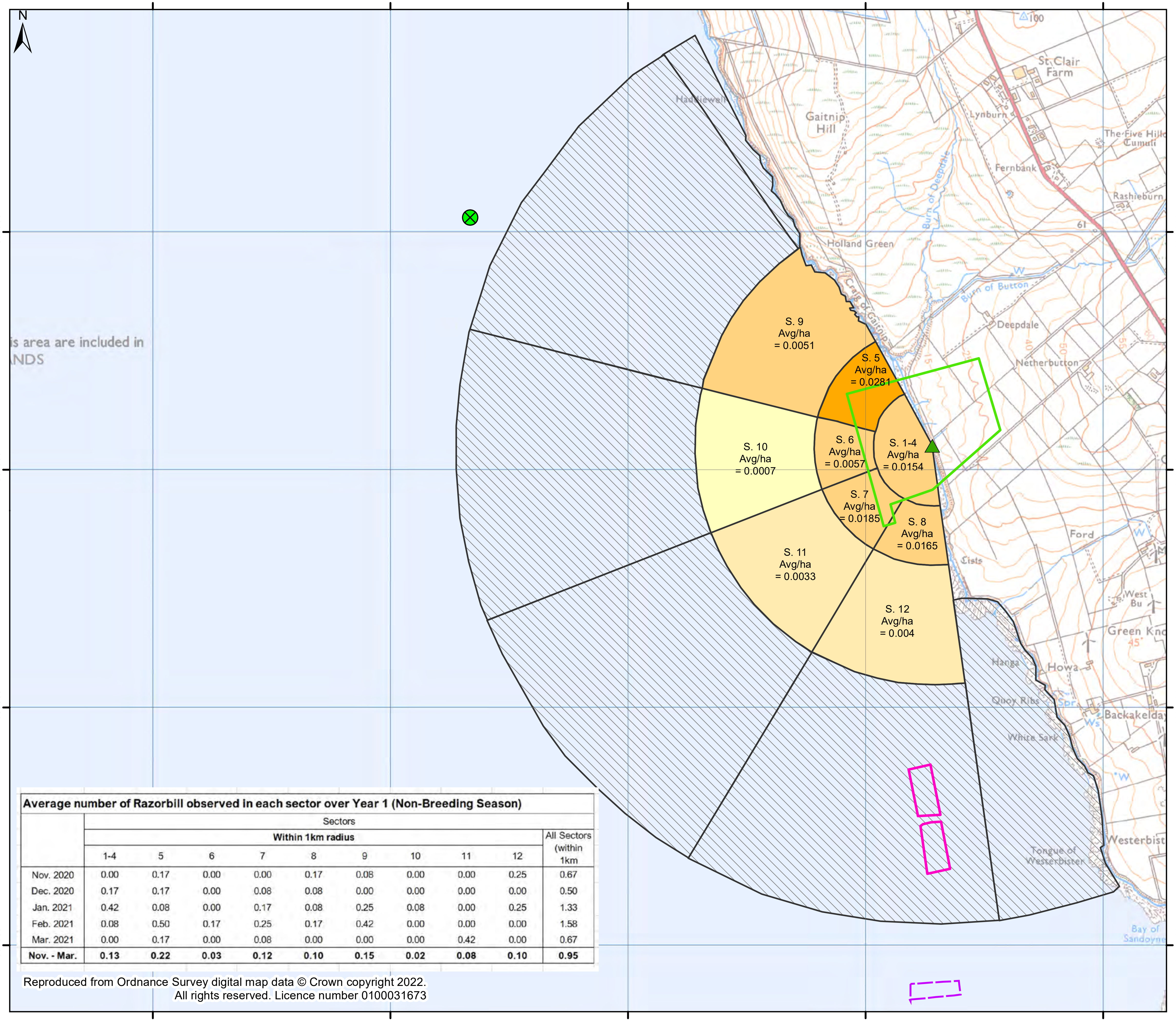

Average number of Razorbill observed in each sector over Year 1 (Non-Breeding Season)

	Sectors									
	Within 1km radius									All Sectors (within 1km
	1-4	5	6	7	8	9	10	11	12	
Nov. 2020	0.00	0.17	0.00	0.00	0.17	0.08	0.00	0.00	0.25	0.67
Dec. 2020	0.17	0.17	0.00	0.08	0.08	0.00	0.00	0.00	0.00	0.50
Jan. 2021	0.42	0.08	0.00	0.17	0.08	0.25	0.08	0.00	0.25	1.33
Feb. 2021	0.08	0.50	0.17	0.25	0.17	0.42	0.00	0.00	0.00	1.58
Mar. 2021	0.00	0.17	0.00	0.08	0.00	0.00	0.00	0.42	0.00	0.67
Nov. - Mar.	**0.13**	**0.22**	**0.03**	**0.12**	**0.10**	**0.15**	**0.02**	**0.08**	**0.10**	**0.95**

Legend

- 🟩 Proposed Site Extent
- ☐ Survey Sectors
- ▲ Original Vantage Point (HY 45274 04102)
- ⊗ Royal Oak Marker Buoy
- ☐ Emec Working Area
- ☐ Salmon Cages

Average Bird Count Density per ha

- ■ <0.001
- ■ 0.001 - 0.0025
- ■ 0.002 - 0.005
- ■ 0.005 - 0.025
- ■ 0.025 - 0.05
- ■ 0.05 - 0.15
- ■ 0.15 - 0.3
- ■ 0.3 - 0.45
- ■ >0.45
- ▨ Sectors not surveyed during this period

Do not scale this map

Client
Orkney Islands Council Harbour Authority

Project
Orkney Scapa Deep Water Quay

Title
Razorbill Observations
Year 1 Non-breeding (Nov 2020 to March 2021)

Status
Final

Drawing No.	Revision	Date
674795-GIS121	-	23 March 2023
Drawn	**Checked**	**Approved**
JAS	MS	MS

Scale
1:15,500 @A3
0 75 150 300 450 Metres

Rev	Date	Amendment	Initials
-	-	-	-

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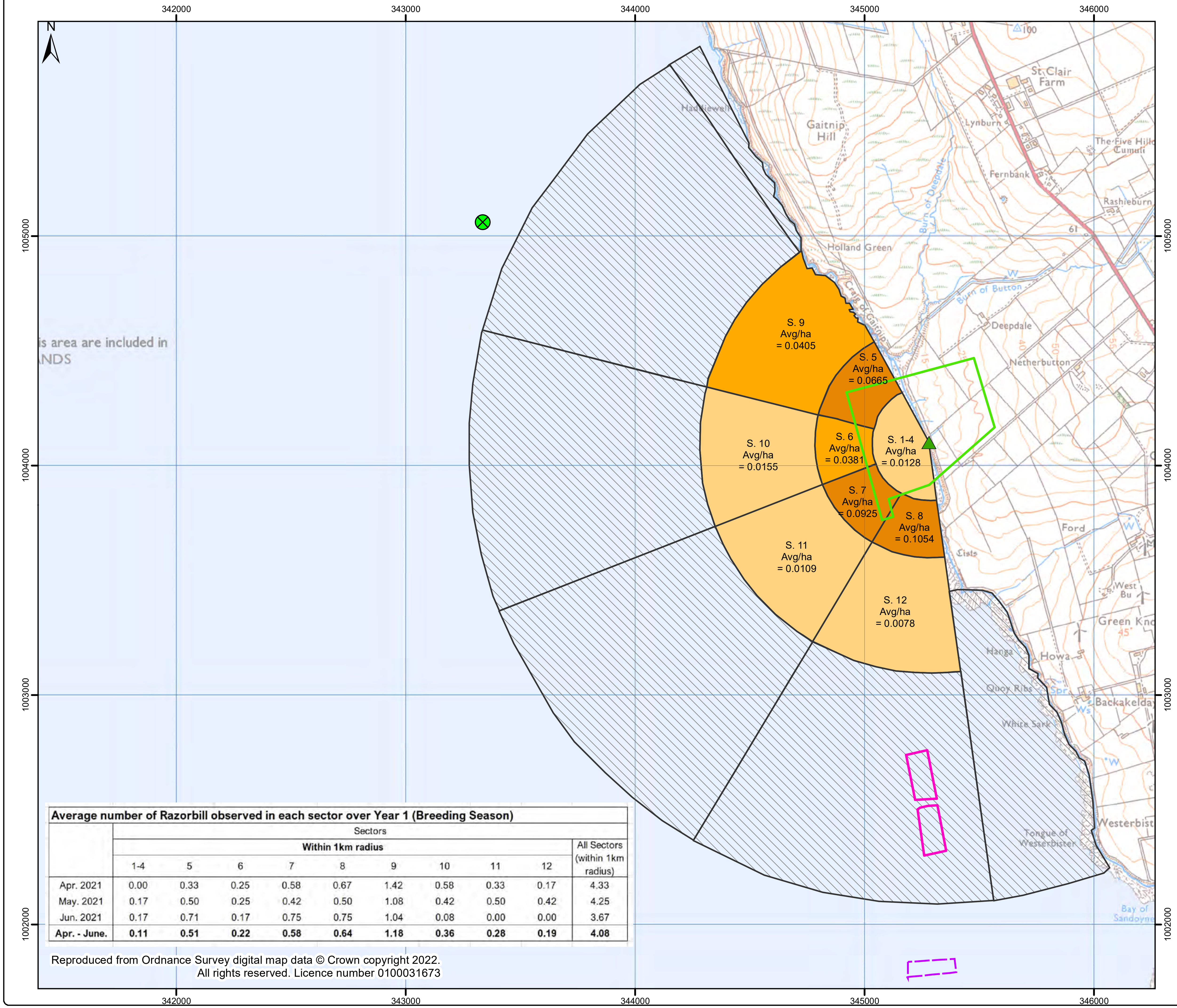

Average number of Razorbill observed in each sector over Year 1 (Breeding Season)

	Sectors									
	Within 1km radius									All Sectors (within 1km radius)
	1-4	5	6	7	8	9	10	11	12	
Apr. 2021	0.00	0.33	0.25	0.58	0.67	1.42	0.58	0.33	0.17	4.33
May. 2021	0.17	0.50	0.25	0.42	0.50	1.08	0.42	0.50	0.42	4.25
Jun. 2021	0.17	0.71	0.17	0.75	0.75	1.04	0.08	0.00	0.00	3.67
Apr. - June.	**0.11**	**0.51**	**0.22**	**0.58**	**0.64**	**1.18**	**0.36**	**0.28**	**0.19**	**4.08**

Legend

- 🟩 Proposed Site Extent
- ☐ Survey Sectors
- ▲ Original Vantage Point (HY 45274 04102)
- ⊗ Royal Oak Marker Buoy
- ☐ Emec Working Area
- ☐ Salmon Cages

Average Bird Count Density per ha

- ■ <0.001
- ■ 0.001 - 0.0025
- ■ 0.002 - 0.005
- ■ 0.005 - 0.025
- ■ 0.025 - 0.05
- ■ 0.05 - 0.15
- ■ 0.15 - 0.3
- ■ 0.3 - 0.45
- ■ >0.45
- ▨ Sectors not surveyed during this period

Do not scale this map

Client
Orkney Islands Council Harbour Authority

Project
Orkney Scapa Deep Water Quay

Title
Razorbill Observations
Year 1 Breeding (April 2021 to June 2021)

Status
Final

Drawing No.	Revision	Date
674795-GIS122	-	23 March 2023
Drawn	**Checked**	**Approved**
JAS	MS	MS

Scale
1:15,500 @A3
0 75 150 300 450 Metres

Rev	Date	Amendment	Initials
-	-	-	-

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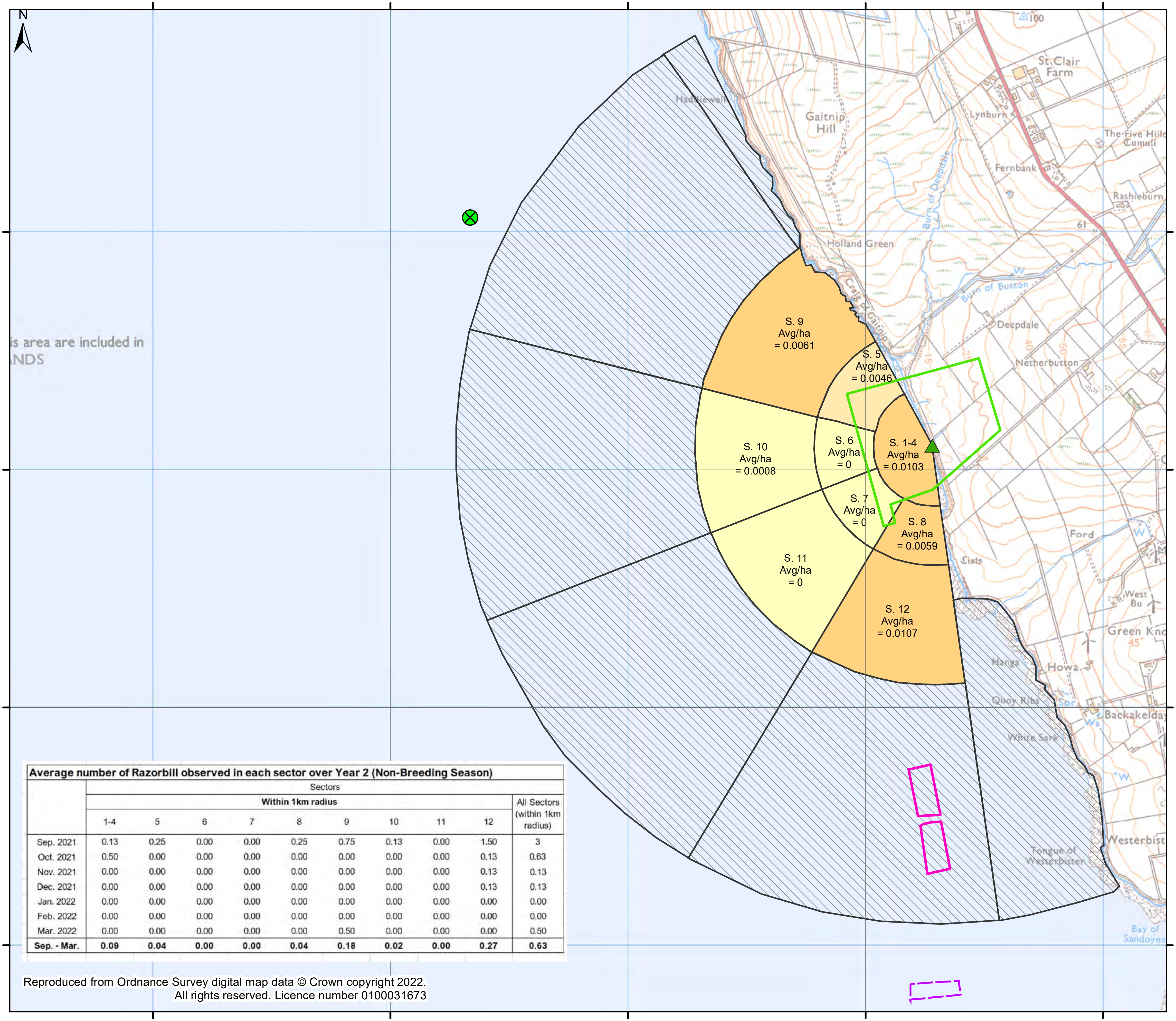

Average number of Razorbill observed in each sector over Year 2 (Non-Breeding Season)

	Sectors									
	Within 1km radius									All Sectors (within 1km radius)
	1-4	5	6	7	8	9	10	11	12	
Sep. 2021	0.13	0.25	0.00	0.00	0.25	0.75	0.13	0.00	1.50	3
Oct. 2021	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.63
Nov. 2021	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.13
Dec. 2021	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.13
Jan. 2022	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Feb. 2022	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mar. 2022	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.50
Sep. - Mar.	**0.09**	**0.04**	**0.00**	**0.00**	**0.04**	**0.18**	**0.02**	**0.00**	**0.27**	**0.63**

Legend

🟩	Proposed Site Extent
☐	Survey Sectors
▲	Original Vantage Point (HY 45274 04102)
⊗	Royal Oak Marker Buoy
☐	Emec Working Area
☐	Salmon Cages

Average Bird Count Density per ha

■	<0.001
■	0.001 - 0.0025
■	0.002 - 0.005
■	0.005 - 0.025
■	0.025 - 0.05
■	0.05 - 0.15
■	0.15 - 0.3
■	0.3 - 0.45
■	>0.45
▨	Sectors not surveyed during this period

Do not scale this map

Client
Orkney Islands Council Harbour Authority

Project
Orkney Scapa Deep Water Quay

Title
Razorbill Observations
Year 2 Non-breeding (Sep 2021 to March 2022)

Status
Final

Drawing No.	Revision	Date
674795-GIS123	-	23 March 2023
Drawn	**Checked**	**Approved**
JAS	MS	MS

Scale
1:15,500 @A3
0 75 150 300 450 Metres

Rev	Date	Amendment	Initials
-	-	-	-

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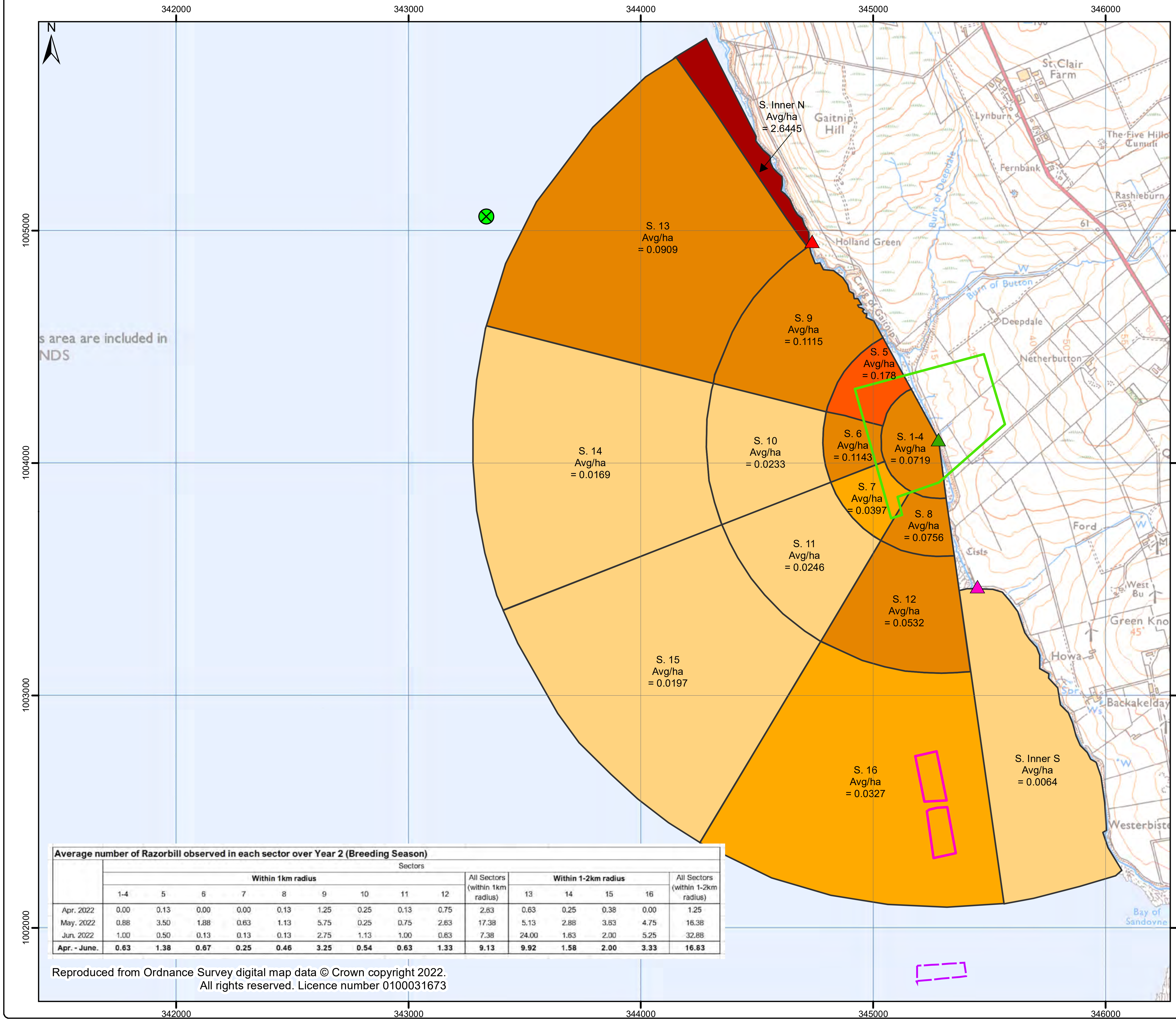

Average number of Razorbill observed in each sector over Year 2 (Breeding Season)

	Sectors														
	Within 1km radius									All Sectors (within 1km radius)	Within 1-2km radius				All Sectors (within 1-2km radius)
	1-4	5	6	7	8	9	10	11	12		13	14	15	16	
Apr. 2022	0.00	0.13	0.00	0.00	0.13	1.25	0.25	0.13	0.75	2.63	0.63	0.25	0.38	0.00	1.25
May. 2022	0.88	3.50	1.88	0.63	1.13	5.75	0.25	0.75	2.63	17.38	5.13	2.88	3.63	4.75	16.38
Jun. 2022	1.00	0.50	0.13	0.13	0.13	2.75	1.13	1.00	0.63	7.38	24.00	1.63	2.00	5.25	32.88
Apr. - June.	**0.63**	**1.38**	**0.67**	**0.25**	**0.46**	**3.25**	**0.54**	**0.63**	**1.33**	**9.13**	**9.92**	**1.58**	**2.00**	**3.33**	**16.83**

Legend

- ▢ Proposed Site Extent
- ▢ Survey Sectors
- ▲ Original Vantage Point (HY 45274 04102)
- ▲ Northern Vantage Point (HY 45447 03468)
- ▲ Southern Vantage Point (HY 44736 04954)
- ⊗ Royal Oak Marker Buoy
- ▢ Emec Working Area
- ▢ Salmon Cages

Average Bird Count Density per ha

- ■ < 0.001
- ■ 0.001 - 0.0025
- ■ 0.0025 - 0.005
- ■ 0.005 - 0.025
- ■ 0.025 - 0.05
- ■ 0.05 - 0.15
- ■ 0.15 - 0.3
- ■ 0.3 - 0.45
- ■ >0.45

Do not scale this map

Client
Orkney Islands Council Harbour Authority

Project
Orkney Scapa Deep Water Quay

Title
Razorbill Observations
Year 2 Breeding (April 2022 to June 2022)

Status
Final

Drawing No.	Revision	Date
674795-GIS124	-	23 March 2023
Drawn	**Checked**	**Approved**
JAS	MS	MS

Scale
1:15,500 @A3
0 75 150 300 450
Metres

Rev	Date	Amendment	Initials
-	-	-	-

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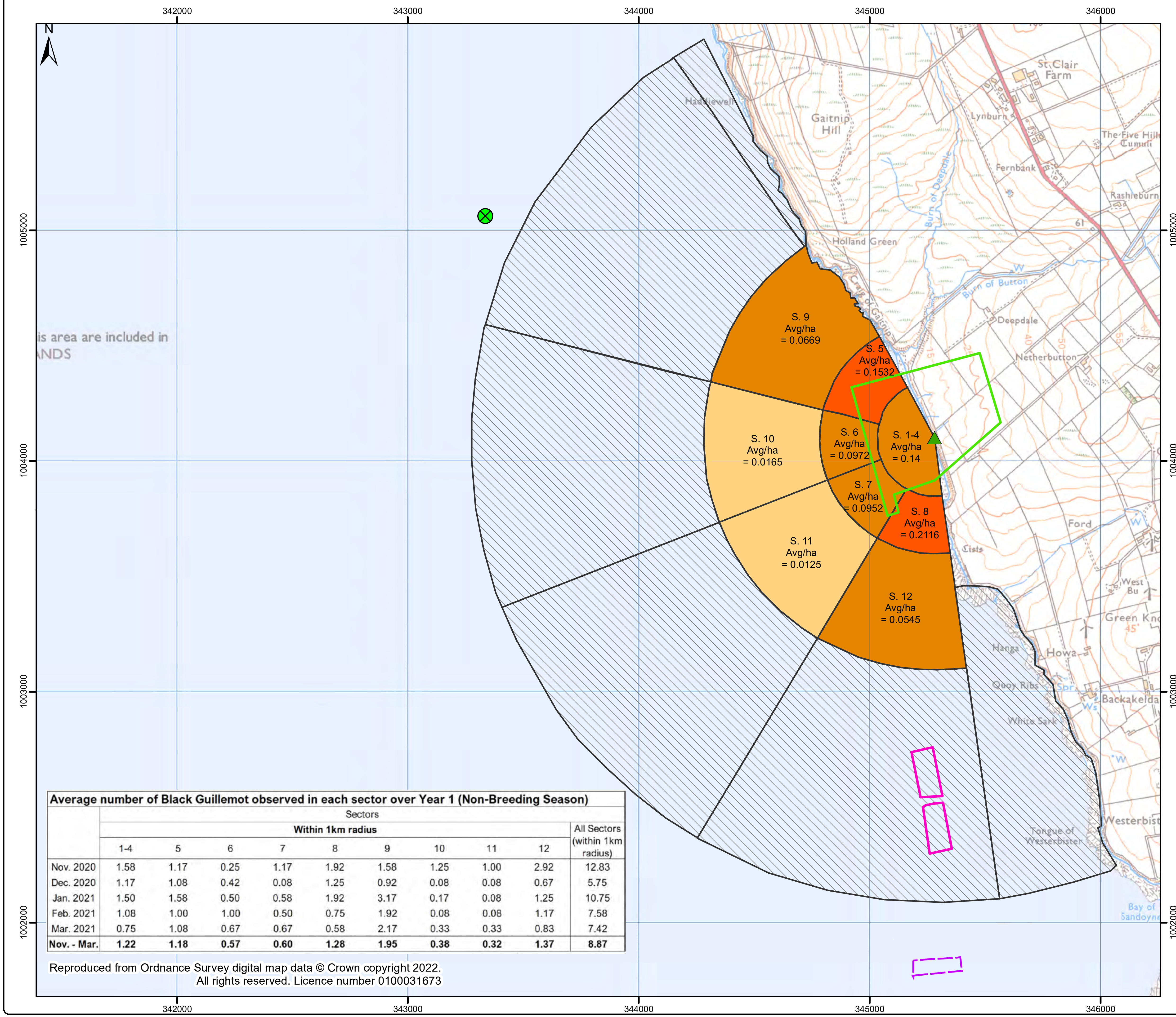

Average number of Black Guillemot observed in each sector over Year 1 (Non-Breeding Season)

	Sectors									
	Within 1km radius									All Sectors (within 1km radius)
	1-4	5	6	7	8	9	10	11	12	
Nov. 2020	1.58	1.17	0.25	1.17	1.92	1.58	1.25	1.00	2.92	12.83
Dec. 2020	1.17	1.08	0.42	0.08	1.25	0.92	0.08	0.08	0.67	5.75
Jan. 2021	1.50	1.58	0.50	0.58	1.92	3.17	0.17	0.08	1.25	10.75
Feb. 2021	1.08	1.00	1.00	0.50	0.75	1.92	0.08	0.08	1.17	7.58
Mar. 2021	0.75	1.08	0.67	0.67	0.58	2.17	0.33	0.33	0.83	7.42
Nov. - Mar.	**1.22**	**1.18**	**0.57**	**0.60**	**1.28**	**1.95**	**0.38**	**0.32**	**1.37**	**8.87**

Legend

- 🟩 Proposed Site Extent
- ☐ Survey Sectors
- ▲ Original Vantage Point (HY 45274 04102)
- ⊗ Royal Oak Marker Buoy
- ⬚ Emec Working Area
- ☐ Salmon Cages

Average Bird Count Density per ha

- <0.001
- 0.001 - 0.0025
- 0.002 - 0.005
- 0.005 - 0.025
- 0.025 - 0.05
- 0.05 - 0.15
- 0.15 - 0.3
- 0.3 - 0.45
- \>0.45
- ▨ Sectors not surveyed during this period

Do not scale this map

Client
Orkney Islands Council Harbour Authority

Project
Orkney Scapa Deep Water Quay

Title
Black Guilliemot Observations
Year 1 Non-breeding (Nov 2020 to March 2021)

Status
Final

Drawing No.	Revision	Date
674795-GIS133	-	23 March 2023
Drawn	**Checked**	**Approved**
JAS	MS	MS

Scale
1:15,500 @A3
0 75 150 300 450 Metres

Rev	Date	Amendment	Initials
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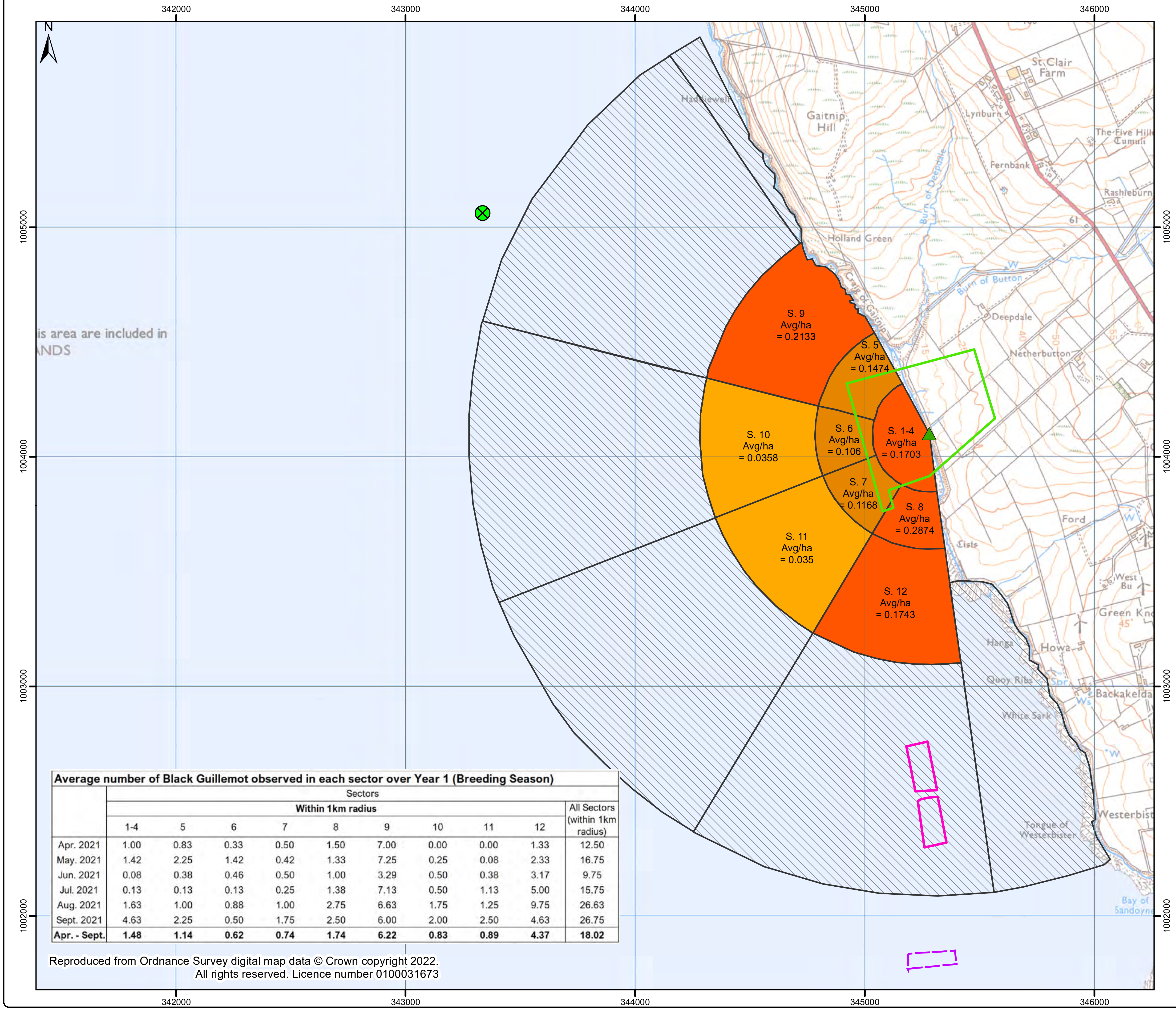

Average number of Black Guillemot observed in each sector over Year 1 (Breeding Season)

	Sectors									
	Within 1km radius									All Sectors (within 1km radius)
	1-4	5	6	7	8	9	10	11	12	
Apr. 2021	1.00	0.83	0.33	0.50	1.50	7.00	0.00	0.00	1.33	12.50
May. 2021	1.42	2.25	1.42	0.42	1.33	7.25	0.25	0.08	2.33	16.75
Jun. 2021	0.08	0.38	0.46	0.50	1.00	3.29	0.50	0.38	3.17	9.75
Jul. 2021	0.13	0.13	0.13	0.25	1.38	7.13	0.50	1.13	5.00	15.75
Aug. 2021	1.63	1.00	0.88	1.00	2.75	6.63	1.75	1.25	9.75	26.63
Sept. 2021	4.63	2.25	0.50	1.75	2.50	6.00	2.00	2.50	4.63	26.75
Apr. - Sept.	**1.48**	**1.14**	**0.62**	**0.74**	**1.74**	**6.22**	**0.83**	**0.89**	**4.37**	**18.02**

Legend

- 🟩 Proposed Site Extent
- ☐ Survey Sectors
- ▲ Original Vantage Point (HY 45274 04102)
- ⊗ Royal Oak Marker Buoy
- ☐ Emec Working Area
- ☐ Salmon Cages

Average Bird Count Density per ha

- ☐ <0.001
- ☐ 0.001 - 0.0025
- ☐ 0.002 - 0.005
- ☐ 0.005 - 0.025
- ☐ 0.025 - 0.05
- ☐ 0.05 - 0.15
- ☐ 0.15 - 0.3
- ☐ 0.3 - 0.45
- ☐ >0.45
- ▨ Sectors not surveyed during this period

Do not scale this map

Client
Orkney Islands Council Harbour Authority

Project
Orkney Scapa Deep Water Quay

Title
Black Guilliemot Observations
Year 1 Breeding (April 2021 to Sep 2021)

Status
Final

Drawing No.	**Revision**	**Date**
674795-GIS134	-	23 March 2023
Drawn	**Checked**	**Approved**
JAS	MS	MS

Scale
1:15,500 @A3
0 75 150 300 450 Metres

Rev	Date	Amendment	Initials
-	-	-	-

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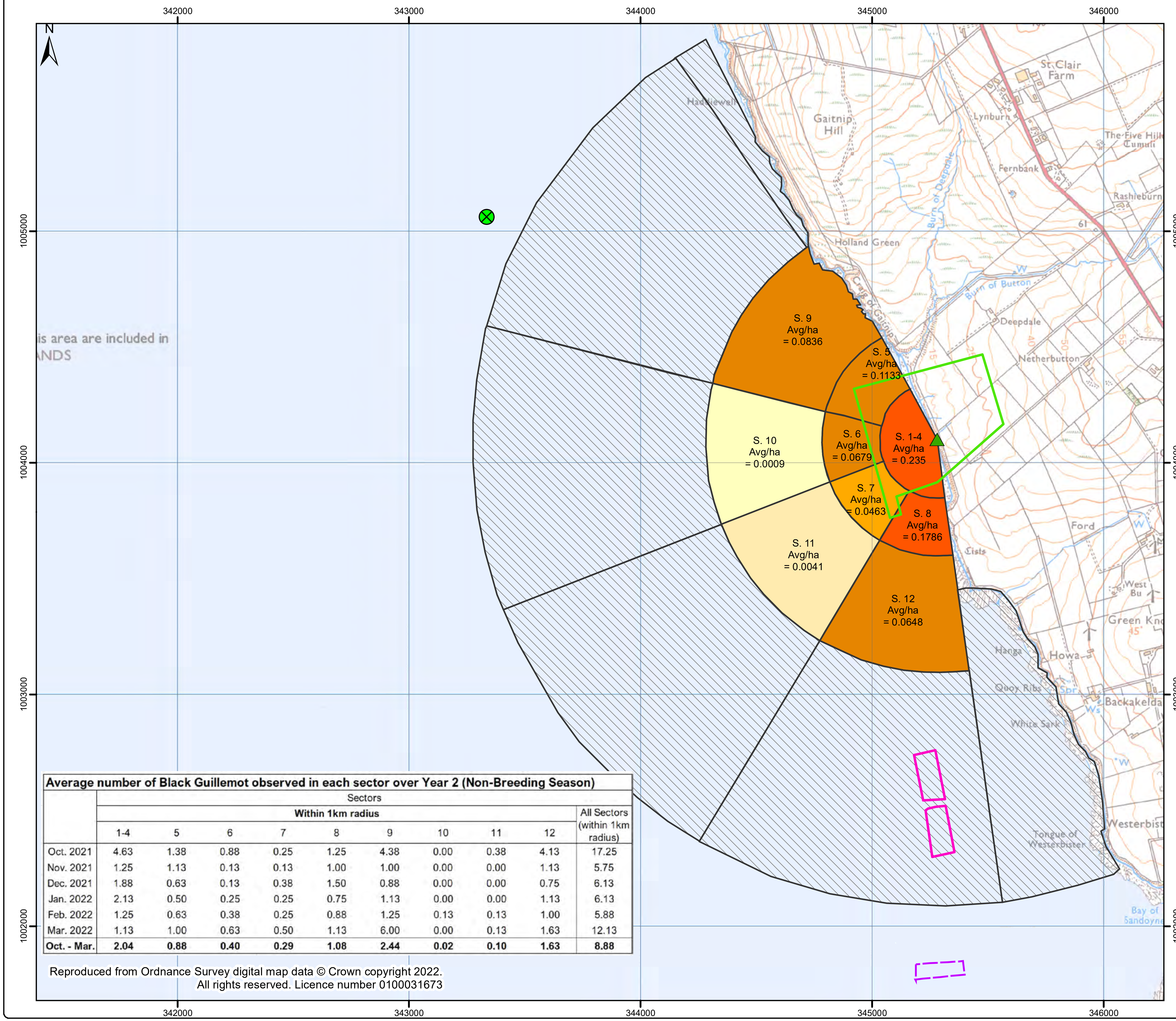

Average number of Black Guillemot observed in each sector over Year 2 (Non-Breeding Season)										
	Sectors									
	Within 1km radius									All Sectors (within 1km radius)
	1-4	5	6	7	8	9	10	11	12	
Oct. 2021	4.63	1.38	0.88	0.25	1.25	4.38	0.00	0.38	4.13	17.25
Nov. 2021	1.25	1.13	0.13	0.13	1.00	1.00	0.00	0.00	1.13	5.75
Dec. 2021	1.88	0.63	0.13	0.38	1.50	0.88	0.00	0.00	0.75	6.13
Jan. 2022	2.13	0.50	0.25	0.25	0.75	1.13	0.00	0.00	1.13	6.13
Feb. 2022	1.25	0.63	0.38	0.25	0.88	1.25	0.13	0.13	1.00	5.88
Mar. 2022	1.13	1.00	0.63	0.50	1.13	6.00	0.00	0.13	1.63	12.13
Oct. - Mar.	**2.04**	**0.88**	**0.40**	**0.29**	**1.08**	**2.44**	**0.02**	**0.10**	**1.63**	**8.88**

Legend

- 🟩 Proposed Site Extent
- ▢ Survey Sectors
- ▲ Original Vantage Point (HY 45274 04102)
- ⊗ Royal Oak Marker Buoy
- ▢ Emec Working Area
- ▢ Salmon Cages

Average Bird Count Density per ha

- ■ <0.001
- ■ 0.001 - 0.0025
- ■ 0.002 - 0.005
- ■ 0.005 - 0.025
- ■ 0.025 - 0.05
- ■ 0.05 - 0.15
- ■ 0.15 - 0.3
- ■ 0.3 - 0.45
- ■ >0.45
- ▨ Sectors not surveyed during this period

Do not scale this map

Client
Orkney Islands Council Harbour Authority

Project
Orkney Scapa Deep Water Quay

Title
Black Guilliemot Observations
Year 2 Non-breeding (Sep 2021 to March 2022)

Status
Final

Drawing No.	Revision	Date
674795-GIS135	-	23 March 2023
Drawn	**Checked**	**Approved**
JAS	MS	MS

Scale
1:15,500 @A3
0 75 150 300 450 Metres

Rev	Date	Amendment	Initials
-	-	-	-

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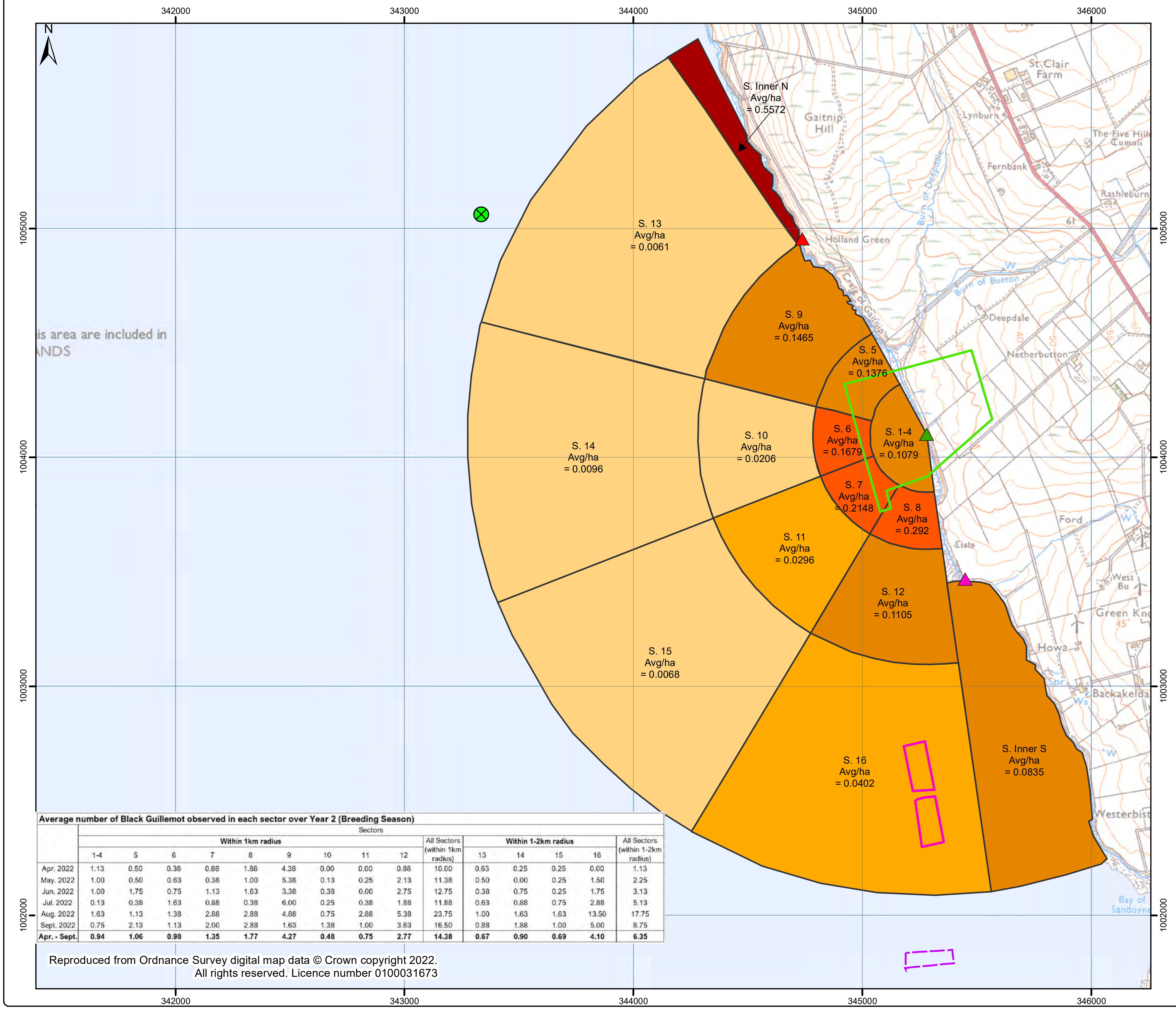


Average number of Black Guillemot observed in each sector over Year 2 (Breeding Season)

	Sectors														
	Within 1km radius									All Sectors (within 1km radius)	**Within 1-2km radius**				All Sectors (within 1-2km radius)
	1-4	5	6	7	8	9	10	11	12		13	14	15	16	
Apr. 2022	1.13	0.50	0.38	0.88	1.88	4.38	0.00	0.00	0.88	10.00	0.63	0.25	0.25	0.00	1.13
May. 2022	1.00	0.50	0.63	0.38	1.00	5.38	0.13	0.25	2.13	11.38	0.50	0.00	0.25	1.50	2.25
Jun. 2022	1.00	1.75	0.75	1.13	1.63	3.38	0.38	0.00	2.75	12.75	0.38	0.75	0.25	1.75	3.13
Jul. 2022	0.13	0.38	1.63	0.88	0.38	6.00	0.25	0.38	1.88	11.88	0.63	0.88	0.75	2.88	5.13
Aug. 2022	1.63	1.13	1.38	2.88	2.88	4.88	0.75	2.88	5.38	23.75	1.00	1.63	1.63	13.50	17.75
Sept. 2022	0.75	2.13	1.13	2.00	2.88	1.63	1.38	1.00	3.63	16.50	0.88	1.88	1.00	5.00	8.75
Apr. - Sept.	**0.94**	**1.06**	**0.98**	**1.35**	**1.77**	**4.27**	**0.48**	**0.75**	**2.77**	**14.38**	**0.67**	**0.90**	**0.69**	**4.10**	**6.35**

Legend

▢	Proposed Site Extent
▢	Survey Sectors
▲	Original Vantage Point (HY 45274 04102)
▲	Northern Vantage Point (HY 45447 03468)
▲	Southern Vantage Point (HY 44736 04954)
⊗	Royal Oak Marker Buoy
▢	Emec Working Area
▢	Salmon Cages

Average Bird Count Density per ha

■	< 0.001
■	0.001 - 0.0025
■	0.0025 - 0.005
■	0.005 - 0.025
■	0.025 - 0.05
■	0.05 - 0.15
■	0.15 - 0.3
■	0.3 - 0.45
■	>0.45

Do not scale this map

Client
Orkney Islands Council Harbour Authority

Project
Orkney Scapa Deep Water Quay

Title
Black Guillemot Observations
Year 2 Breeding (April 2022 to Sep 2022)

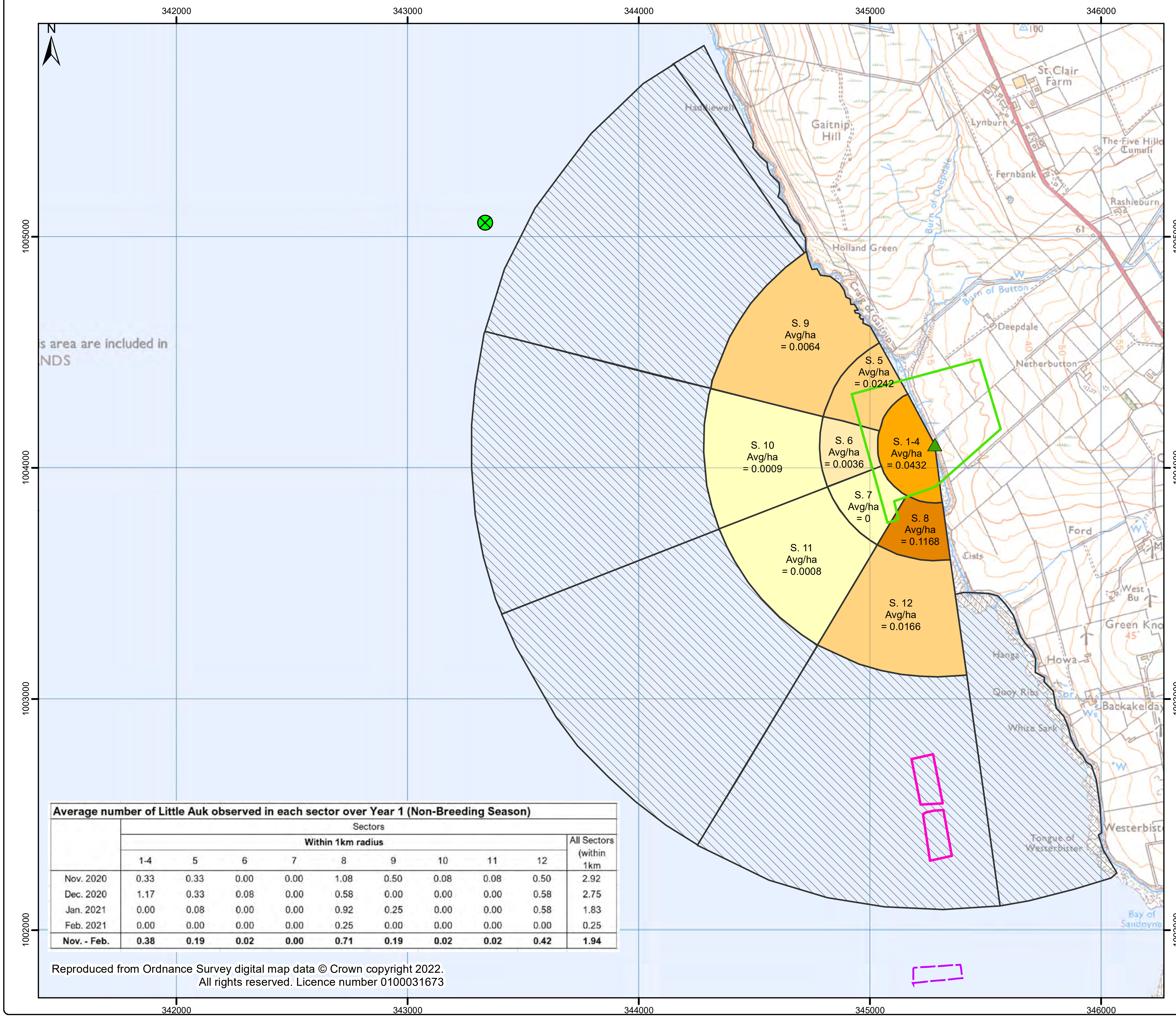
Status
Final

Drawing No.	Revision	Date
674795-GIS136	-	23 March 2023
Drawn	**Checked**	**Approved**
JAS	MS	MS

Scale
1:15,500 @A3
0 75 150 300 450 Metres

Rev	Date	Amendment	Initials
-	-	-	-

envirocentre
8 Eagle Street, Craighall Business Park, Glasgow, G4 9XA.
T: 0141 341 5040 E: info@envirocentre.co.uk
W: www.envirocentre.co.uk



Average number of Little Auk observed in each sector over Year 1 (Non-Breeding Season)										
	Sectors									
	Within 1km radius									All Sectors (within 1km
	1-4	5	6	7	8	9	10	11	12	
Nov. 2020	0.33	0.33	0.00	0.00	1.08	0.50	0.08	0.08	0.50	2.92
Dec. 2020	1.17	0.33	0.08	0.00	0.58	0.00	0.00	0.00	0.58	2.75
Jan. 2021	0.00	0.08	0.00	0.00	0.92	0.25	0.00	0.00	0.58	1.83
Feb. 2021	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.25
Nov. - Feb.	**0.38**	**0.19**	**0.02**	**0.00**	**0.71**	**0.19**	**0.02**	**0.02**	**0.42**	**1.94**

Legend

- 🟩 Proposed Site Extent
- ☐ Survey Sectors
- ▲ Original Vantage Point (HY 45274 04102)
- ⊗ Royal Oak Marker Buoy
- ▭ Emec Working Area
- ▭ Salmon Cages

Average Bird Count Density per ha

- 🟨 < 0.001
- 🟨 0.001- 0.0025
- 🟧 0.0025 - 0.005
- 🟧 0.005 - 0.025
- 🟧 0.025 - 0.05
- 🟧 0.05 - 0.15
- 🟥 0.15 - 0.3
- 🟥 0.3 - 0.45
- 🟥 >0.45
- ▨ Sectors not surveyed during this period

Do not scale this map

Client
Orkney Islands Council Harbour Authority

Project
Orkney Scapa Deep Water Quay

Title
Little Auk Observations
Year 1 Non-breeding (Nov 2020 to Feb 2021)

Status
Final

Drawing No.	Revision	Date
674795-GIS115	-	23 March 2023
Drawn	**Checked**	**Approved**
JAS	MS	MS

Scale
1:15,500 @A3
0 75 150 300 450 Metres

Rev	Date	Amendment	Initials
-	-	-	-

envirocentre

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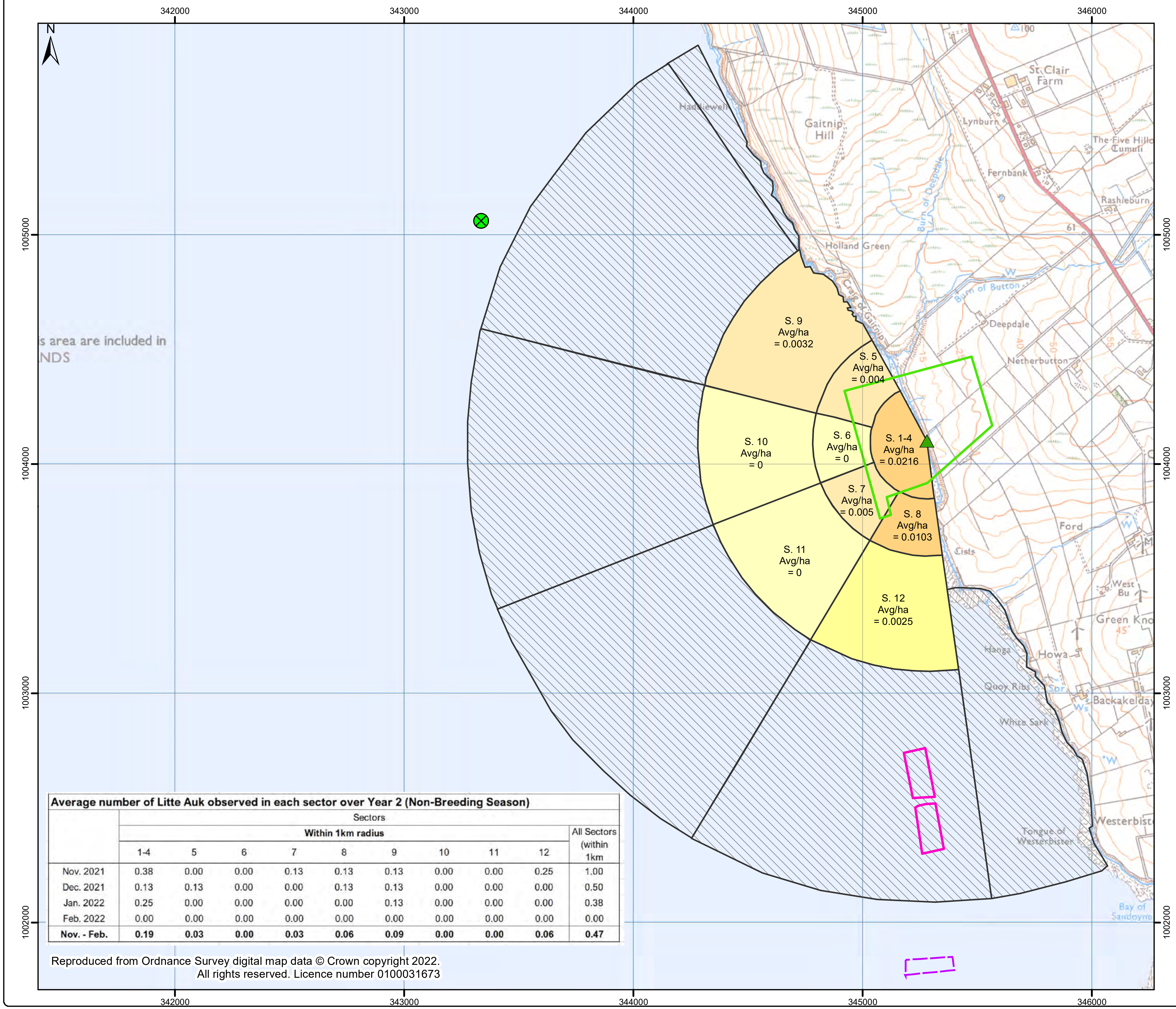

Average number of Litte Auk observed in each sector over Year 2 (Non-Breeding Season)

	Sectors									
	Within 1km radius									All Sectors (within 1km
	1-4	5	6	7	8	9	10	11	12	
Nov. 2021	0.38	0.00	0.00	0.13	0.13	0.13	0.00	0.00	0.25	1.00
Dec. 2021	0.13	0.13	0.00	0.00	0.13	0.13	0.00	0.00	0.00	0.50
Jan. 2022	0.25	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.38
Feb. 2022	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nov. - Feb.	**0.19**	**0.03**	**0.00**	**0.03**	**0.06**	**0.09**	**0.00**	**0.00**	**0.06**	**0.47**

Legend

- Proposed Site Extent
- Survey Sectors
- ▲ Original Vantage Point (HY 45274 04102)
- ⊗ Royal Oak Marker Buoy
- Emec Working Area
- Salmon Cages

Average Bird Count Density per ha

- < 0.001
- 0.001- 0.0025
- 0.0025 - 0.005
- 0.005 - 0.025
- 0.025 - 0.05
- 0.05 - 0.15
- 0.15 - 0.3
- 0.3 - 0.45
- >0.45
- ▨ Sectors not surveyed during this period

Do not scale this map

Client
Orkney Islands Council Harbour Authority

Project
Orkney Scapa Deep Water Quay

Title
Little Auk Observations
Year 2 Non-breeding (Nov 2021 to Feb 2022)

Status
Final

Drawing No.	Revision	Date
674795-GIS116	-	23 March 2023
Drawn	**Checked**	**Approved**
JAS	MS	MS

Scale
1:15,500 @A3
0 75 150 300 450 Metres

Rev	Date	Amendment	Initials
-	-	-	-

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APPENDIX B

Daily Bar Charts

Daily Total Count of Birds -Data is only shown for sectors 1 to 12 only

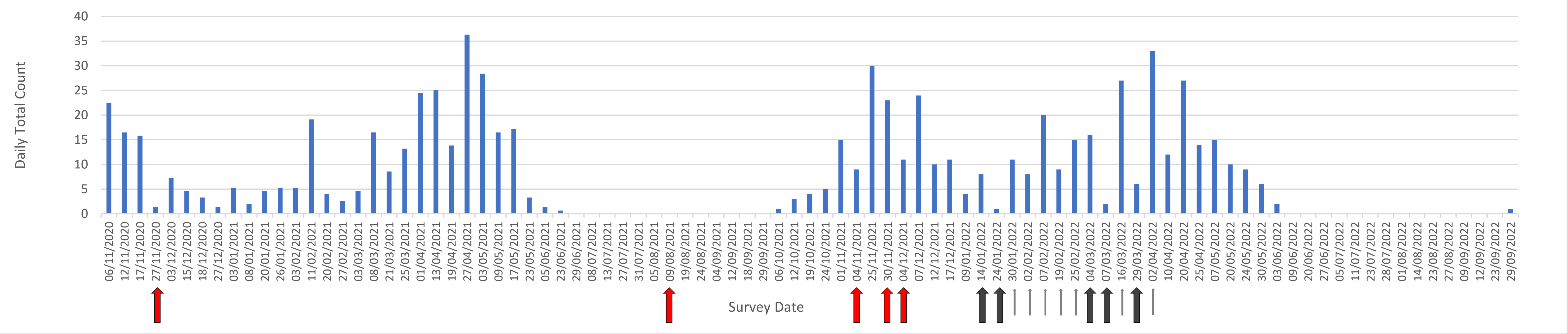


Figure 1: Great Northern Diver (red arrow = dates when small boats busy within 500 m of shore; black arrow = days when test platform operational with attendant boats; grey arrow = test platform present but not manned)

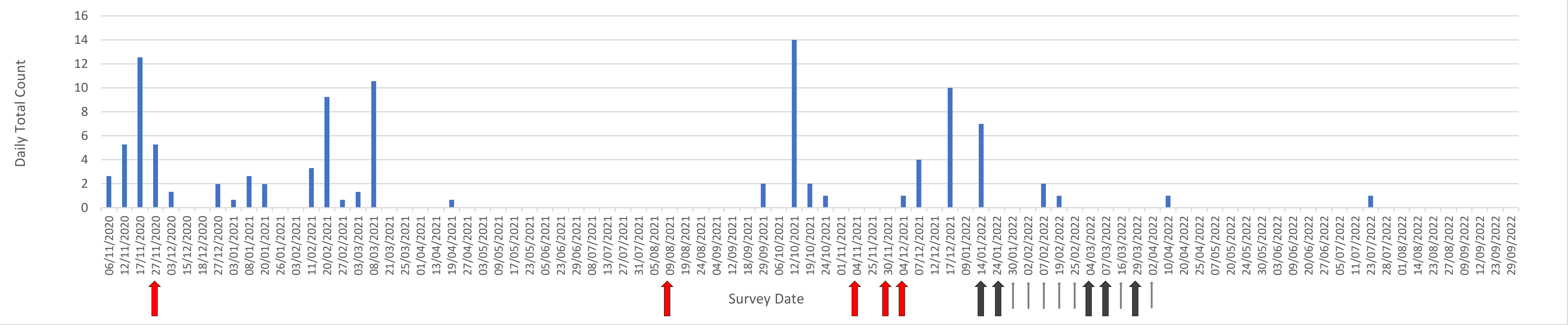


Figure 2: Black-throated Diver (red arrow = dates when small boats busy within 500 m of shore; black arrow = days when test platform operational with attendant boats; grey arrow = test platform present but not manned)

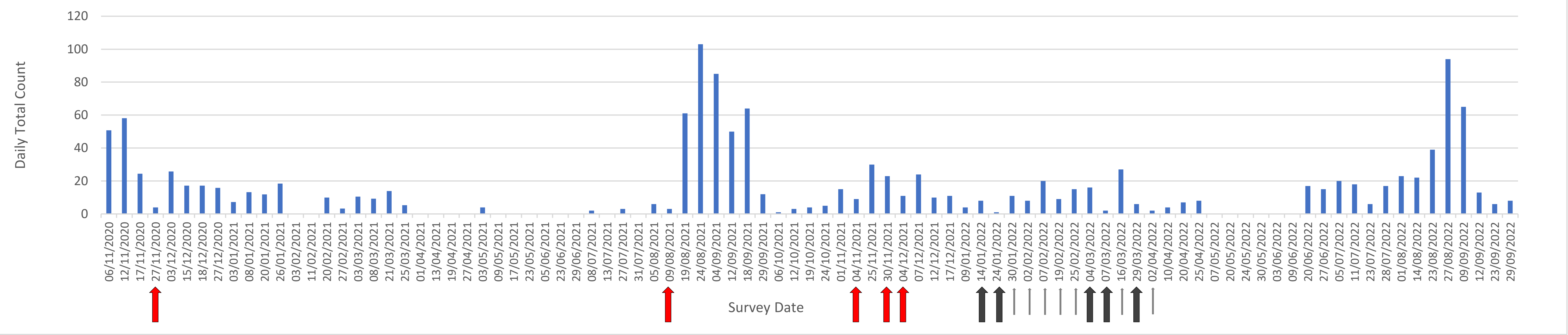


Figure 3: Eider (red arrow = dates when small boats busy within 500 m of shore; black arrow = days when test platform operational with attendant boats; grey arrow = test platform present but not manned)

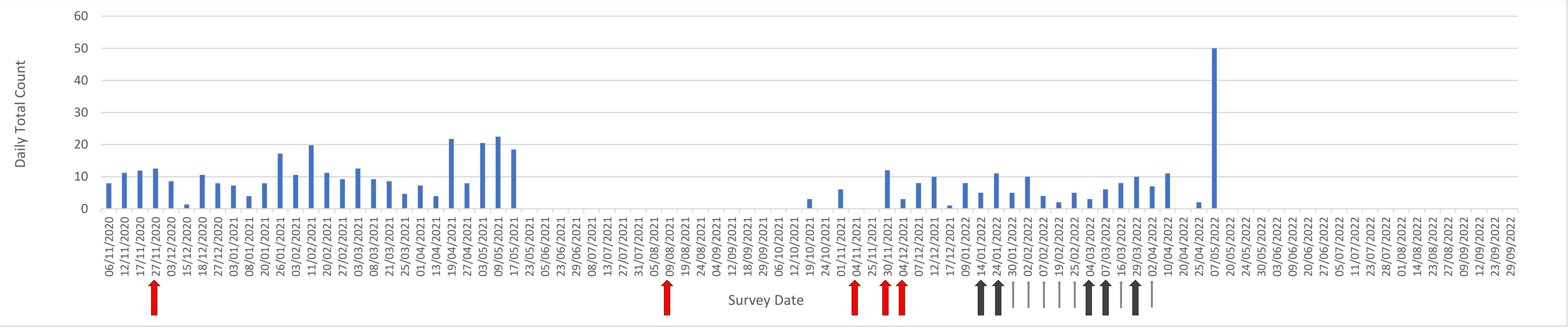


Figure 4: Long-Tailed Duck (red arrow = dates when small boats busy within 500 m of shore; black arrow = days when test platform operational with attendant boats; grey arrow = test platform present but not manned)

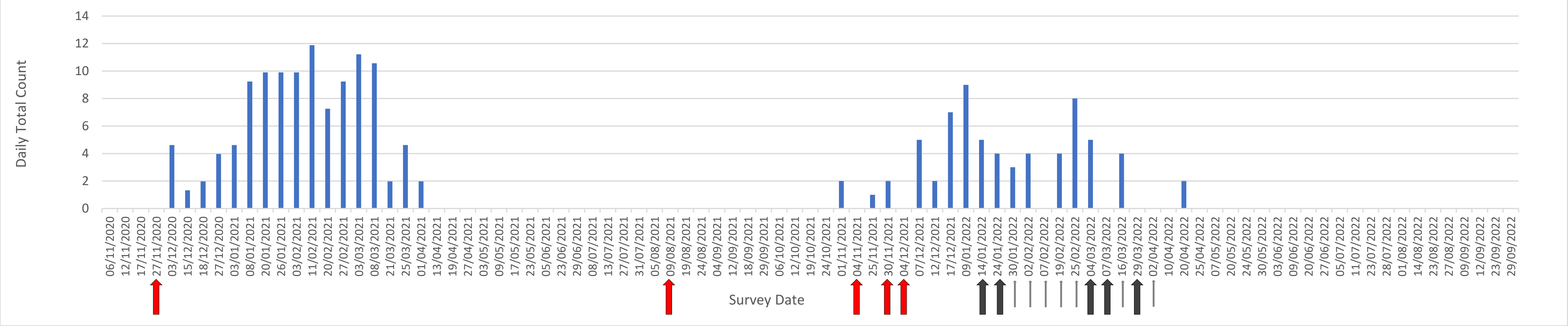


Figure 2: Slavonian Grebe (red arrow = dates when small boats busy within 500 m of shore; black arrow = days when test platform operational with attendant boats; grey arrow = test platform present but not manned)

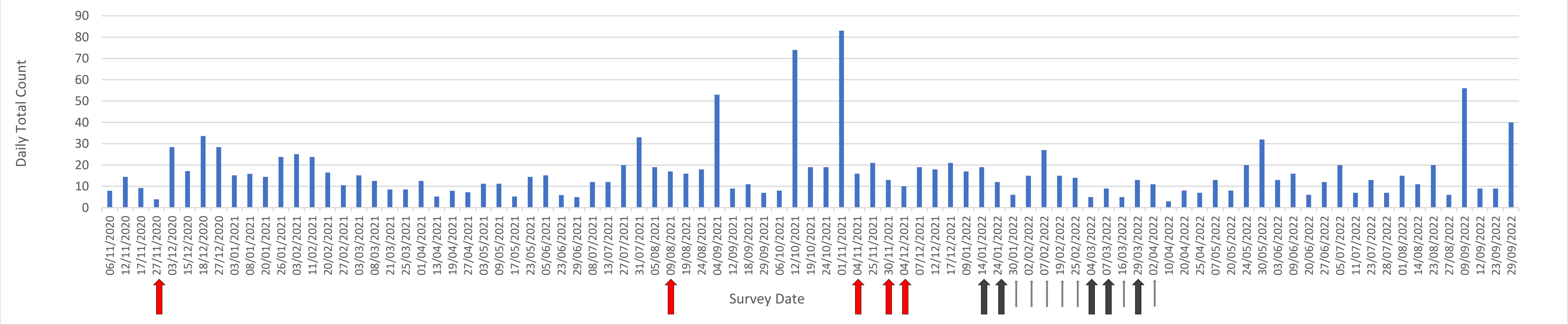


Figure 3: Shag (red arrow = dates when small boats busy within 500 m of shore; black arrow = days when test platform operational with attendant boats; grey arrow = test platform present but not manned)

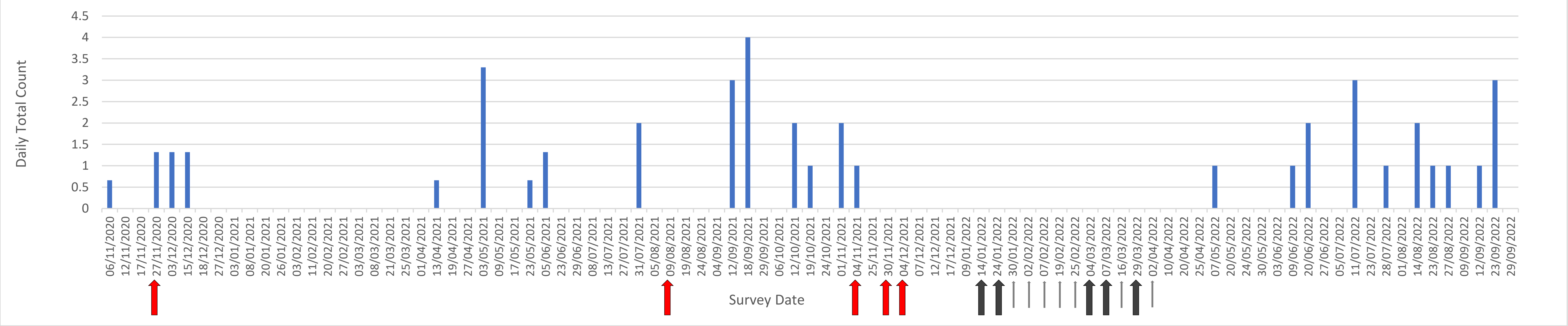


Figure 4: Red-throated Diver (red arrow = dates when small boats busy within 500 m of shore; black arrow = days when test platform operational with attendant boats; grey arrow = test platform present but not manned)

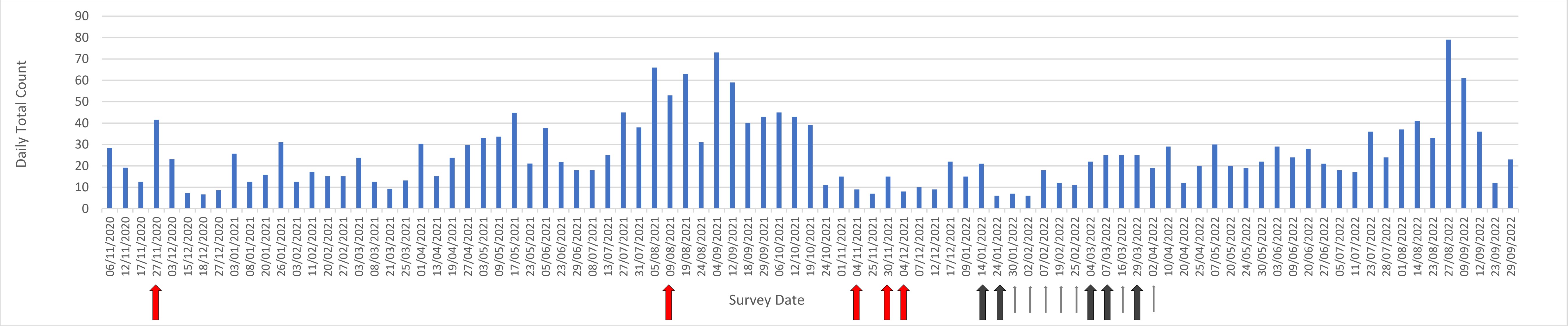


Figure 5: Black Guillemot (red arrow = dates when small boats busy within 500 m of shore; black arrow = days when test platform operational with attendant boats; grey arrow = test platform present but not manned)

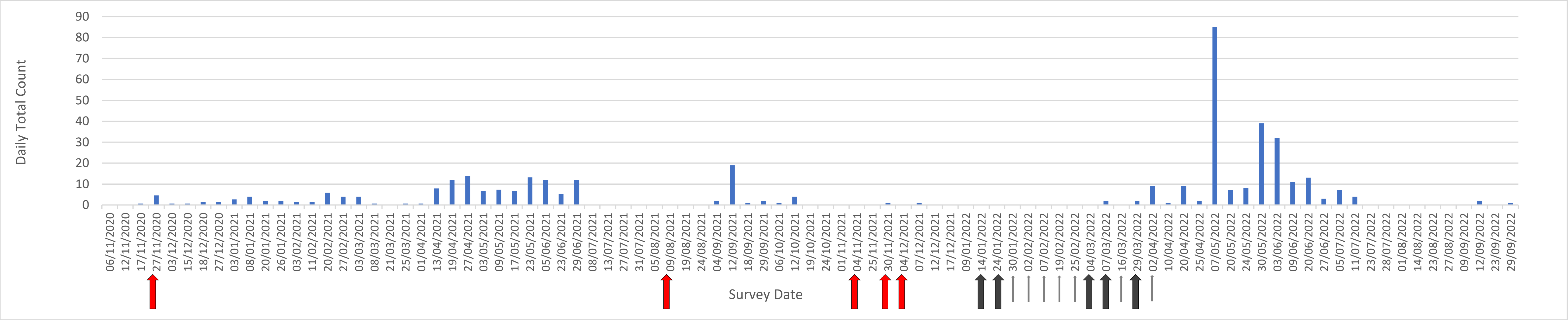


Figure 6: Razorbill (red arrow = dates when small boats busy within 500 m of shore; black arrow = days when test platform operational with attendant boats; grey arrow = test platform present but not manned)

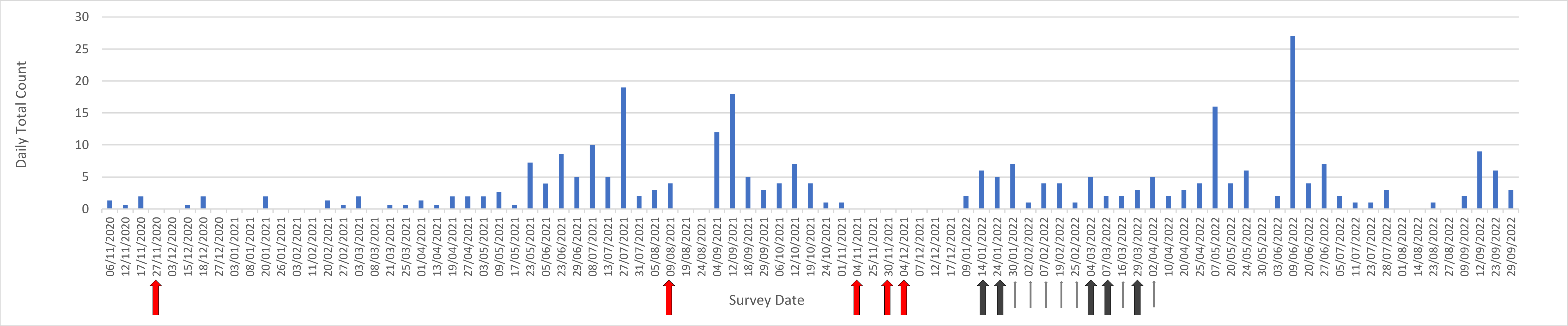


Figure 7: Guillemot (red arrow = dates when small boats busy within 500 m of shore; black arrow = days when test platform operational with attendant boats; grey arrow = test platform present but not manned)

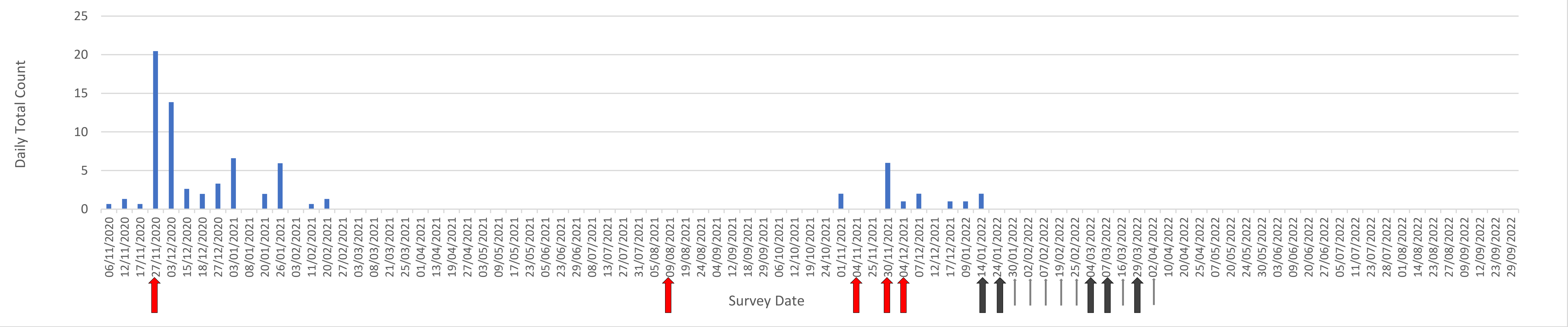
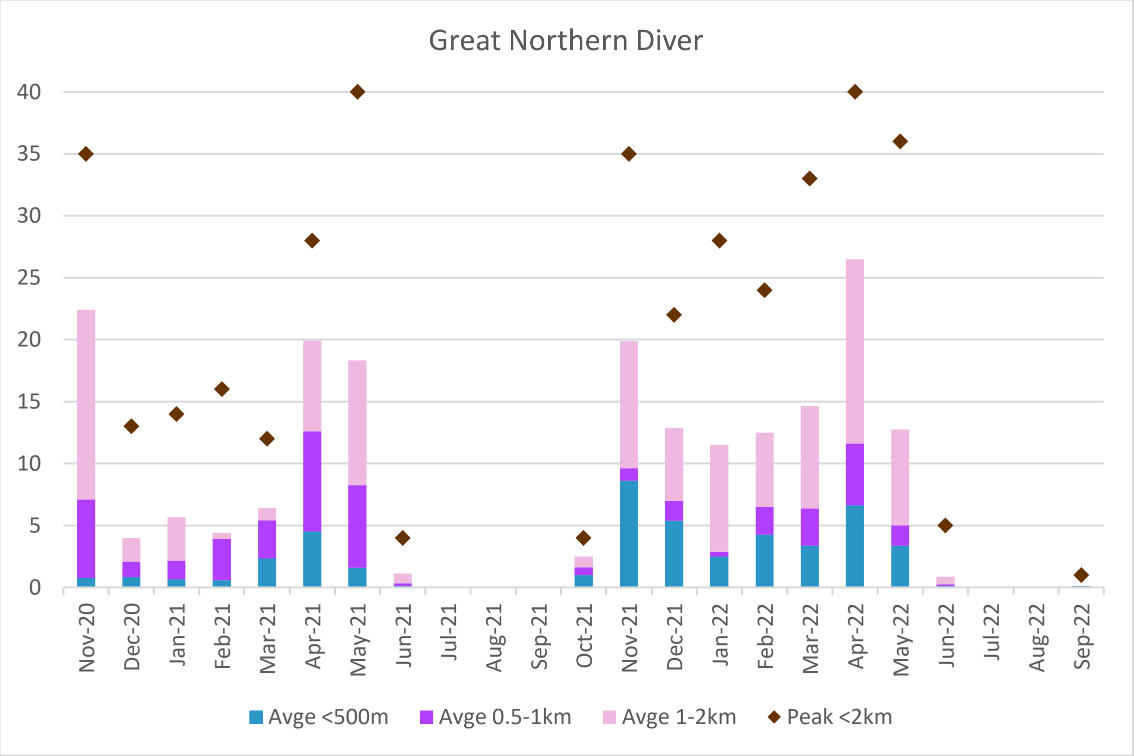


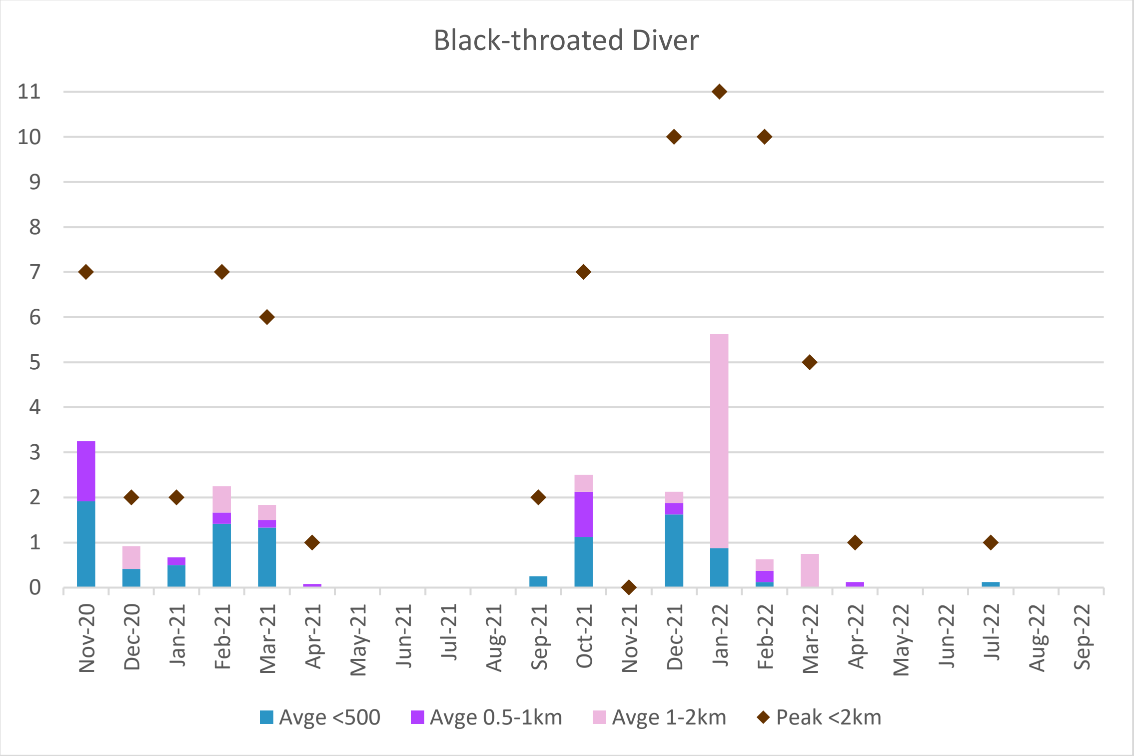
Figure 8: Little Auk (red arrow = dates when small boats busy within 500 m of shore; black arrow = days when test platform operational with attendant boats; grey arrow = test platform present but not manned)

APPENDIX C

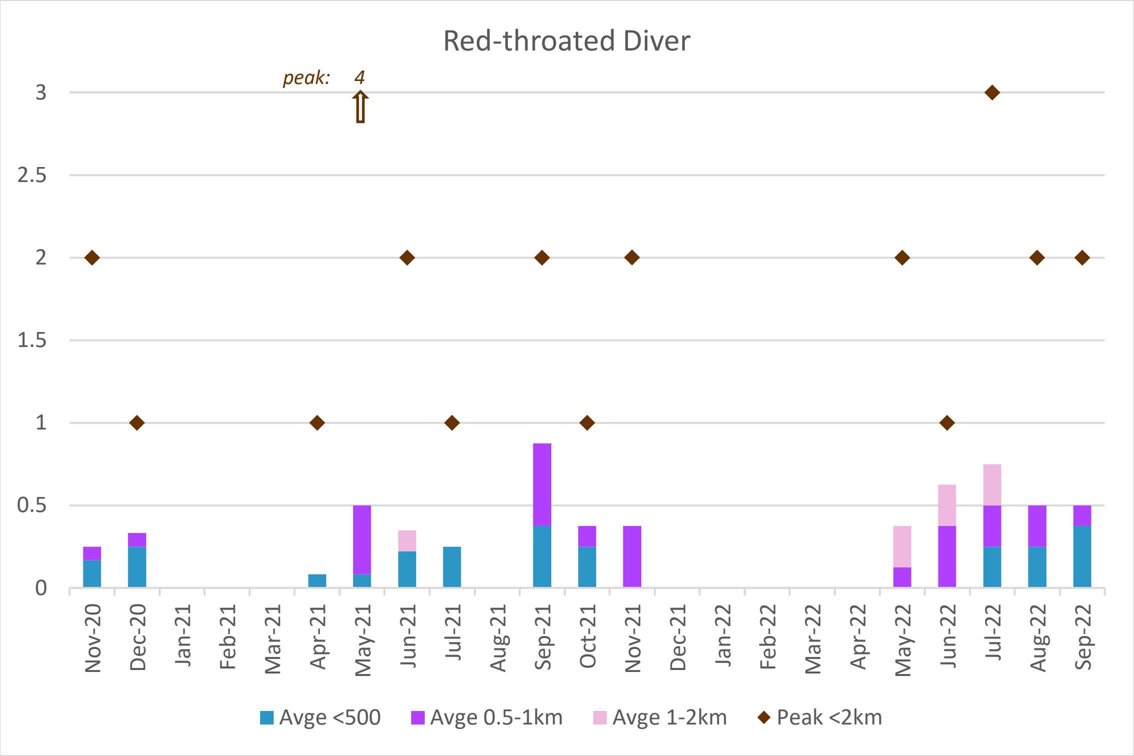
Monthly bar-charts:
average and peak counts

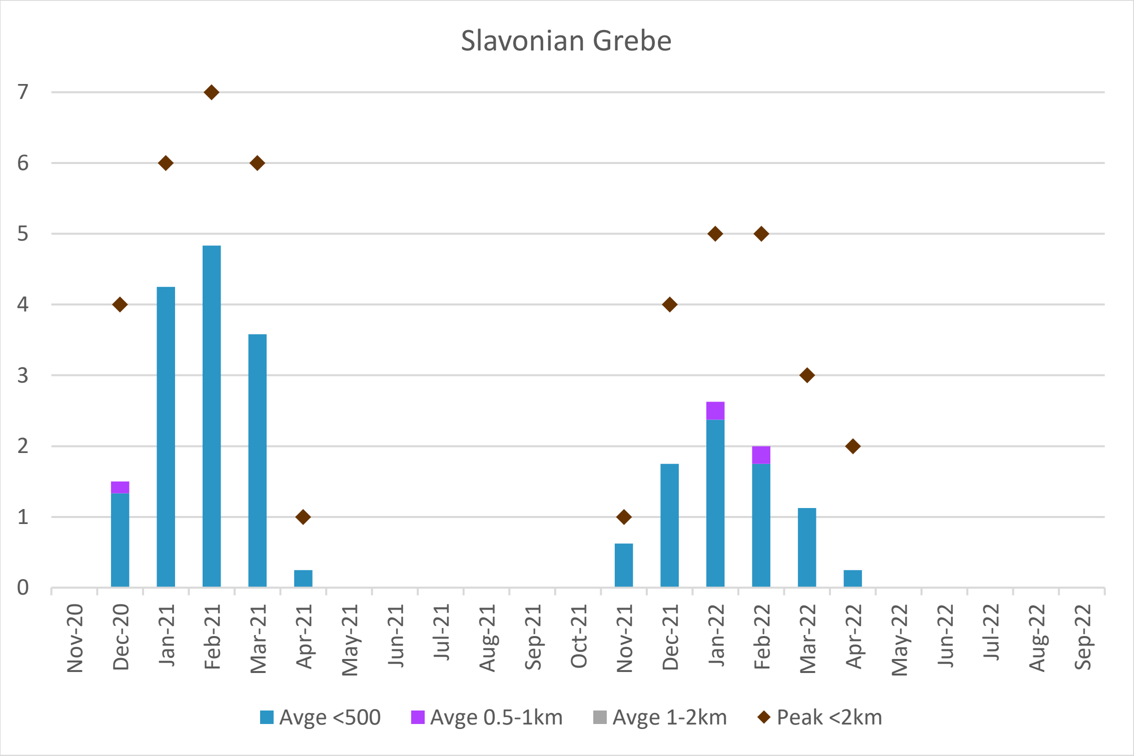
Average and peak counts by month and distance from the VP



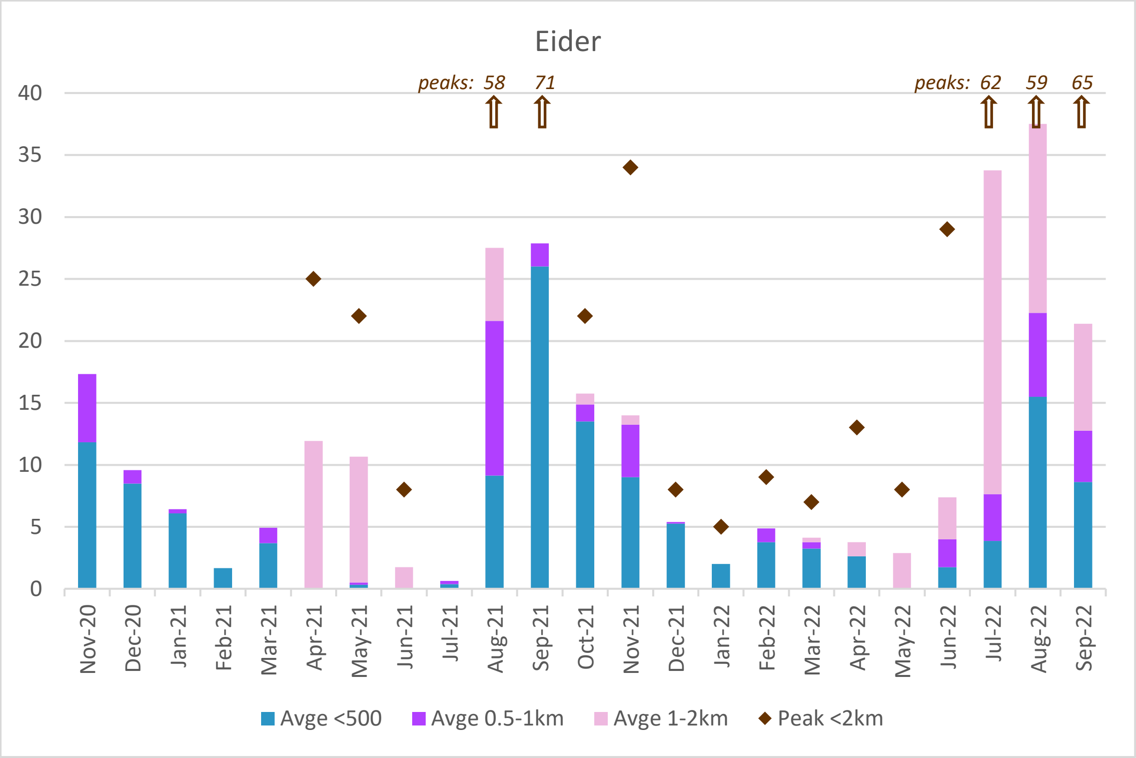


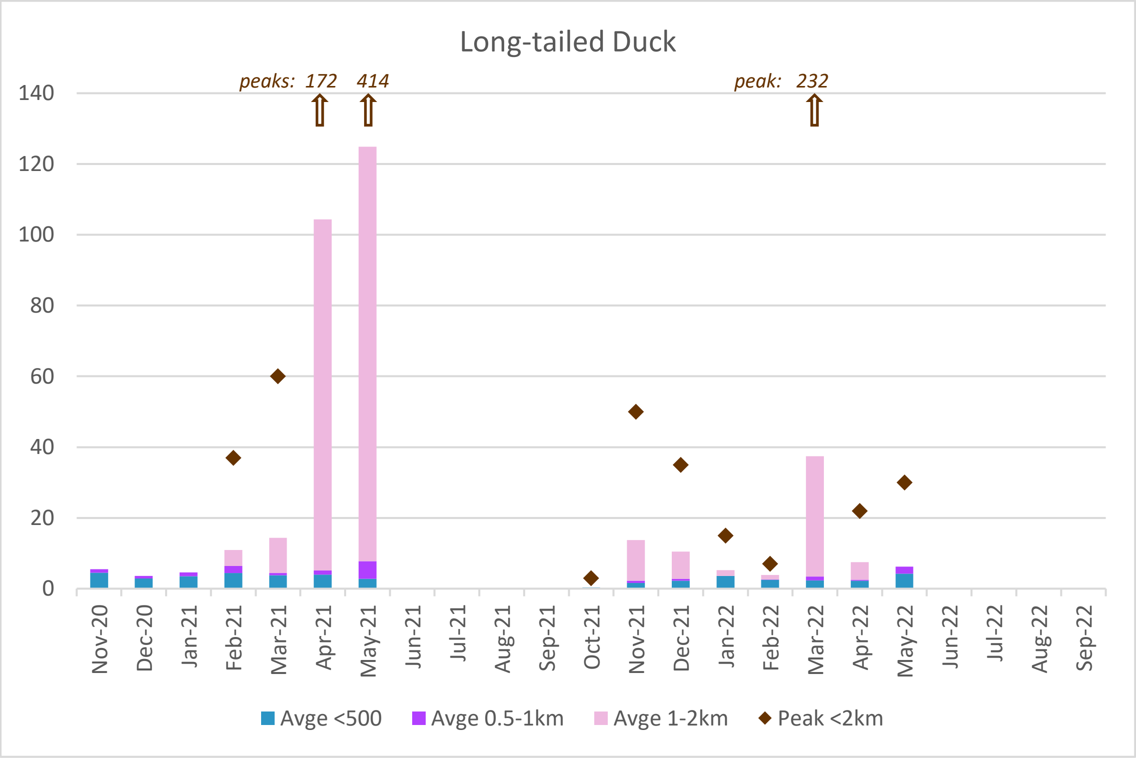
Average and peak counts by month and distance from the VP



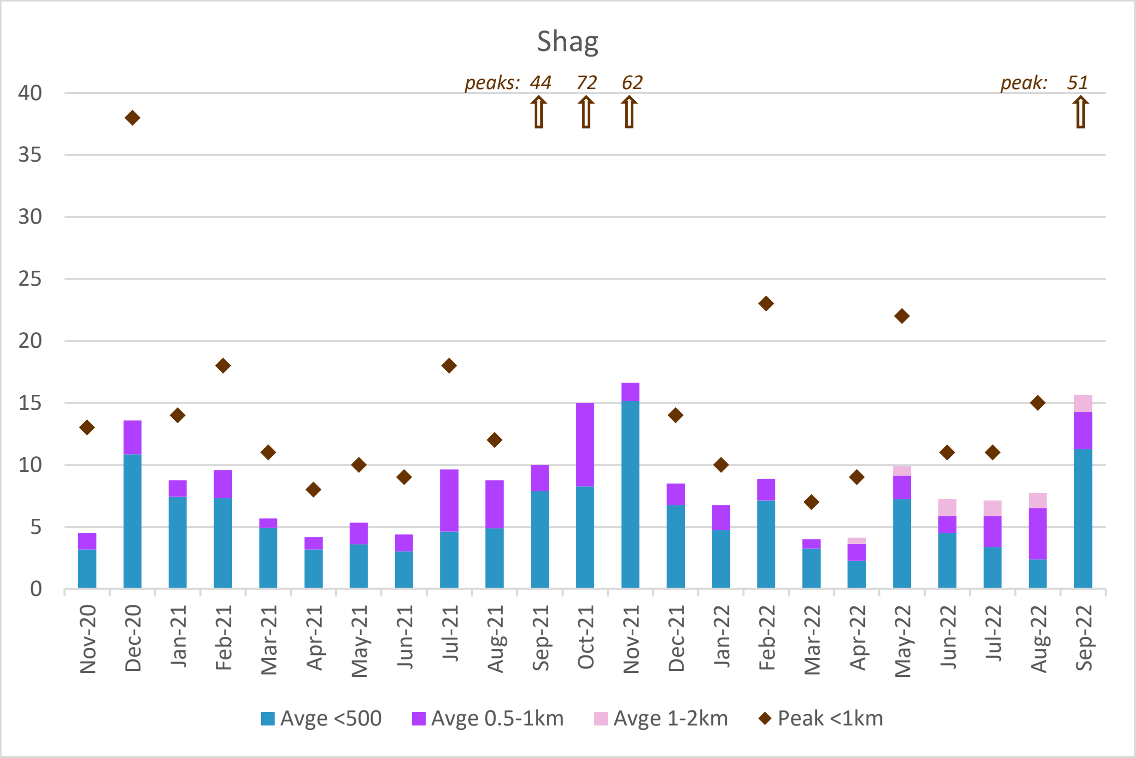


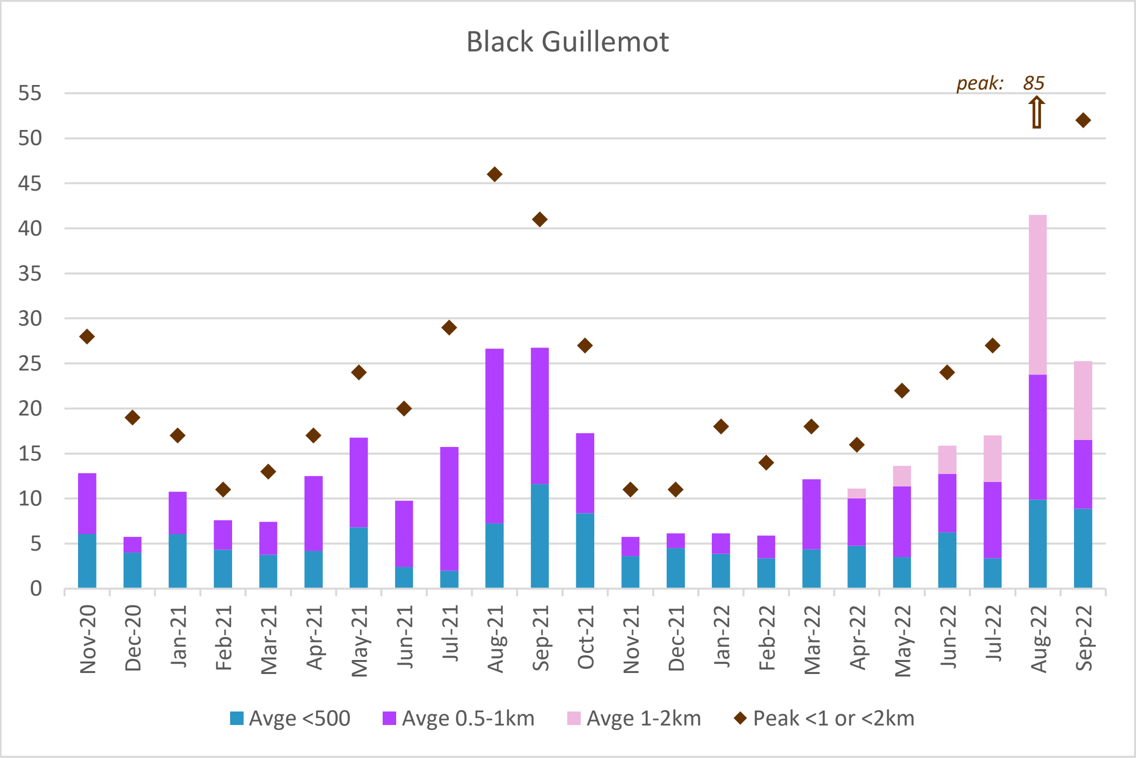
Average and peak counts by month and distance from the VP





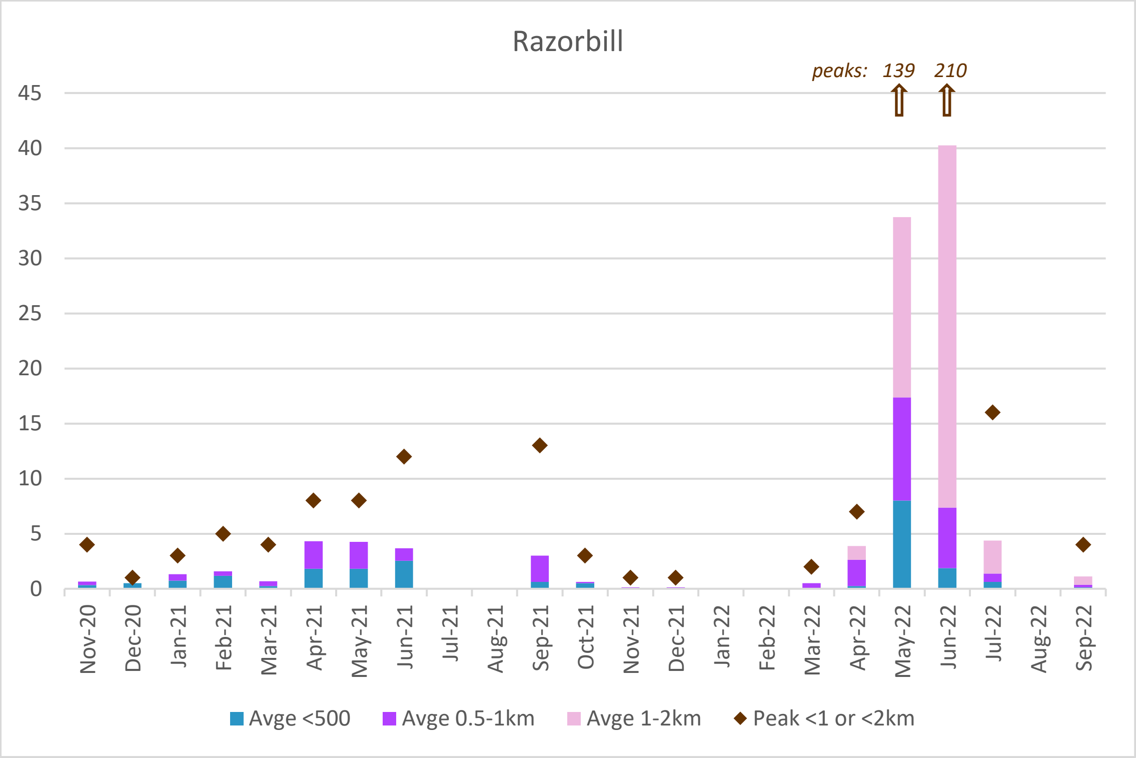
Average and peak counts by month and distance from the VP



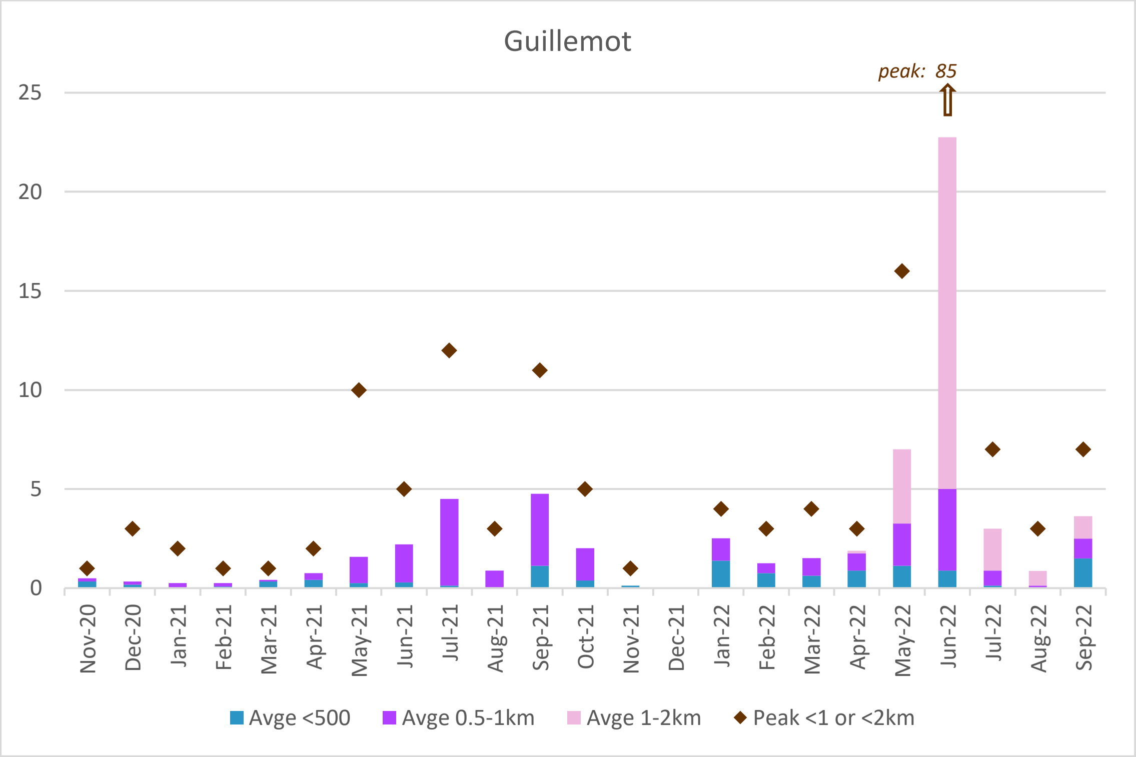


Peaks shown are out to 1 km for Nov 20–Mar 22 and to 2 km for Apr 22–Sep 22

Average and peak counts by month and distance from the VP

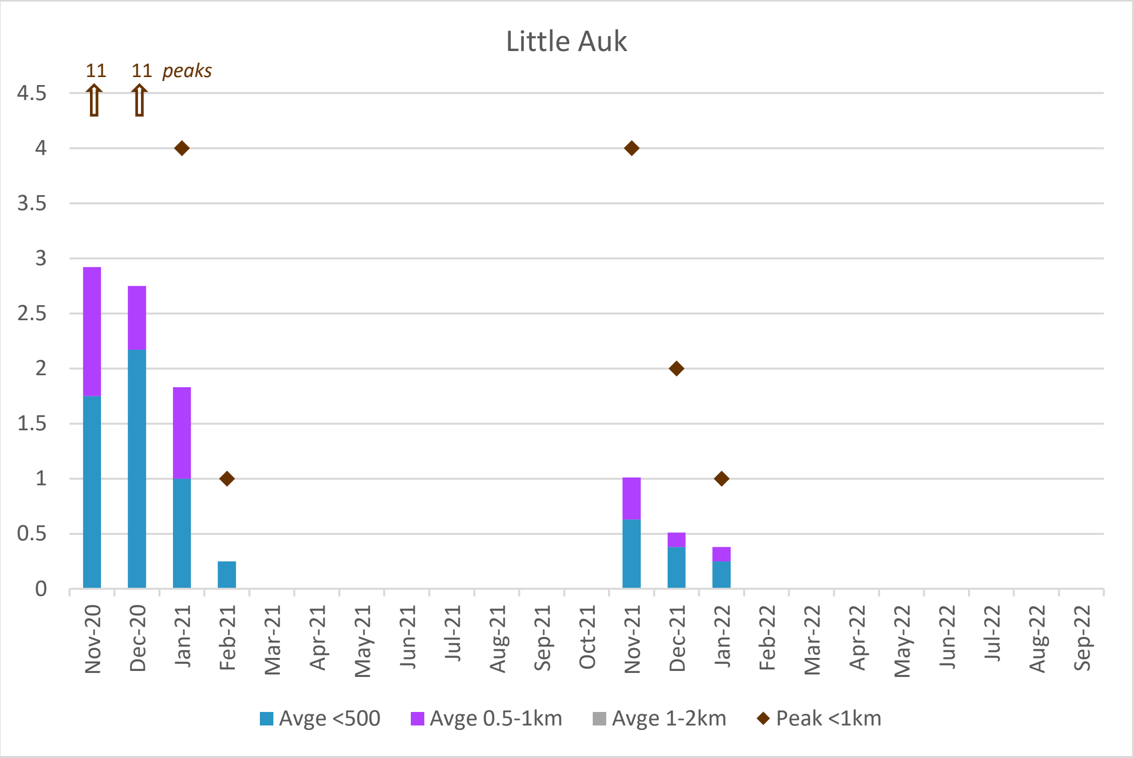


Peaks shown are out to 1 km for Nov 20–Mar 22 and to 2 km for Apr 22–Sep 22



Peaks shown are out to 1 km for Nov 20–Mar 22 and to 2 km for Apr 22–Sep 22

Average and peak counts by month and distance from the VP



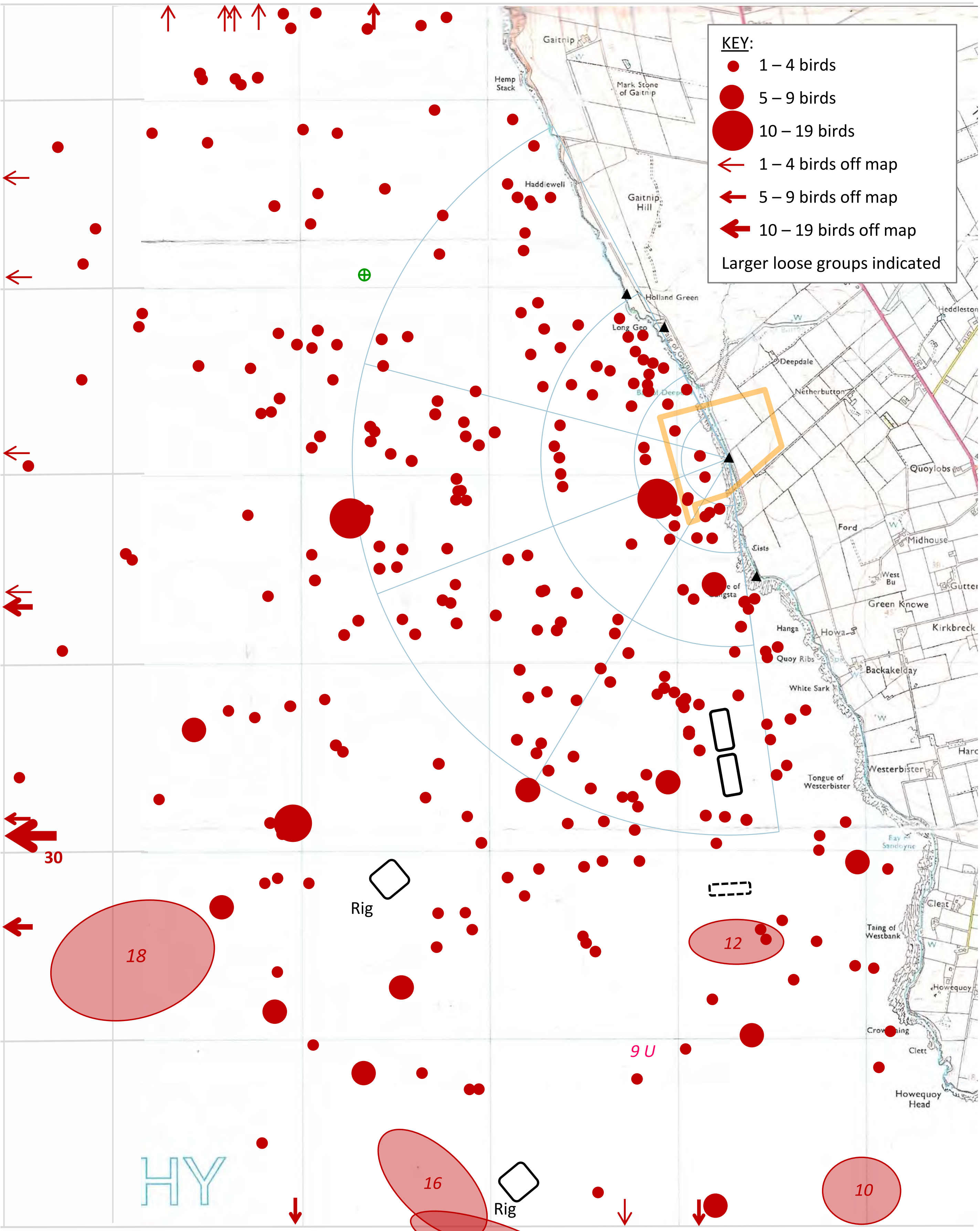
APPENDIX D

Diver locations from Upper VP

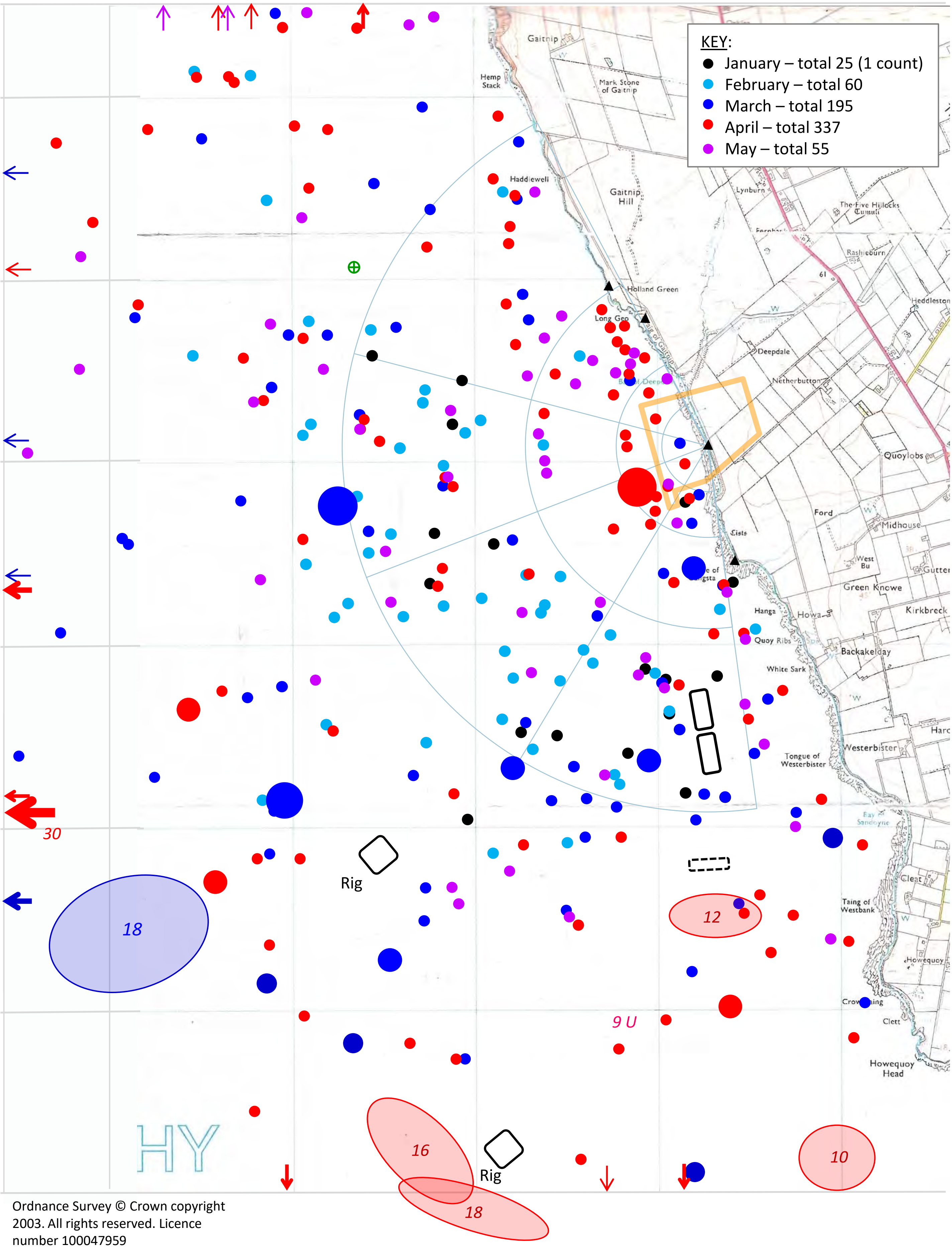
(30th January to 30th May 2022)

Upper VP – diver locations, Jan-May 2022

17 counts from 30th January to 30th May
Total 672 divers



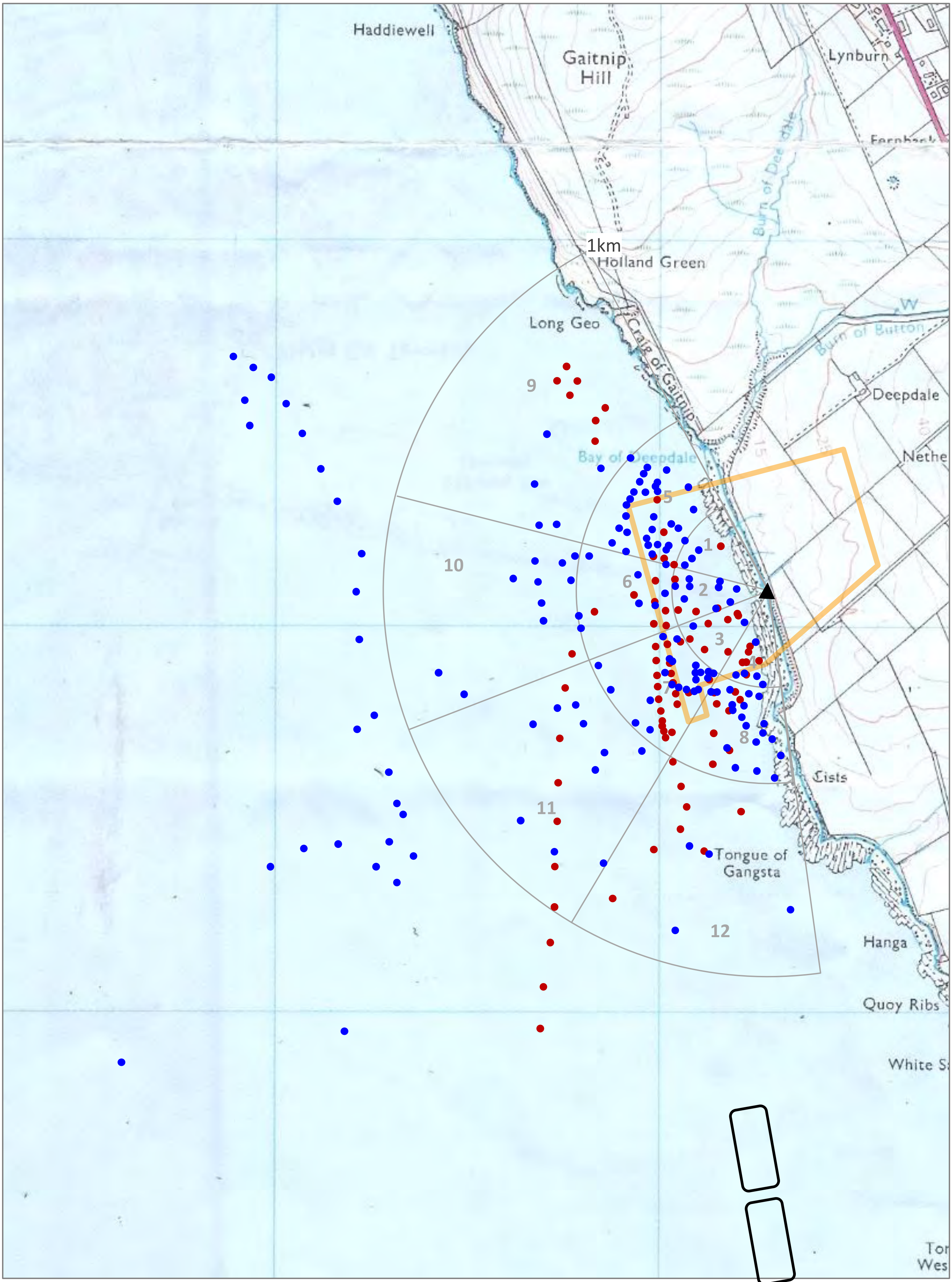
Upper VP – diver locations, Jan-May 2022



APPENDIX E i

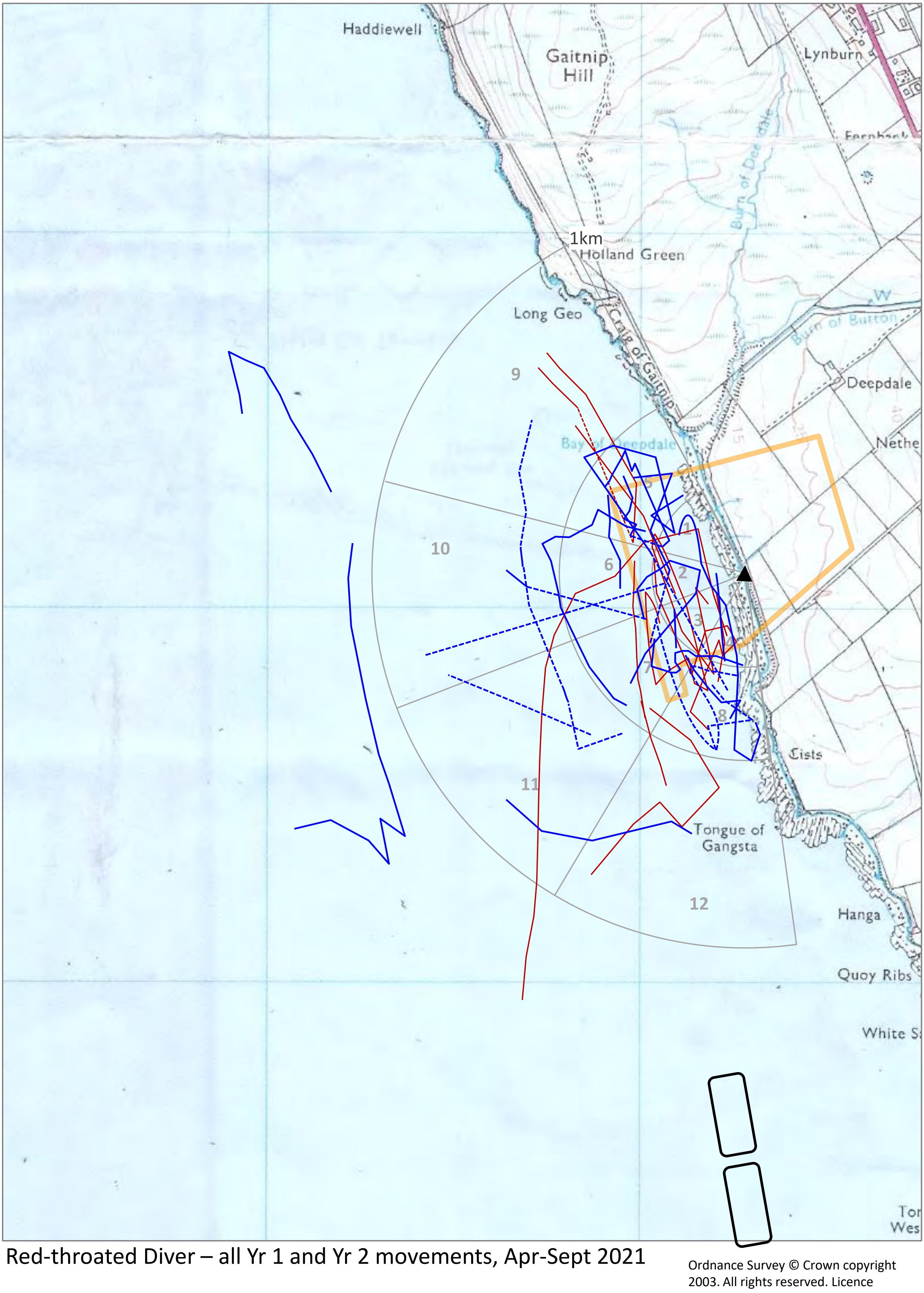
Red-throated Diver:

swimming track locations and movements



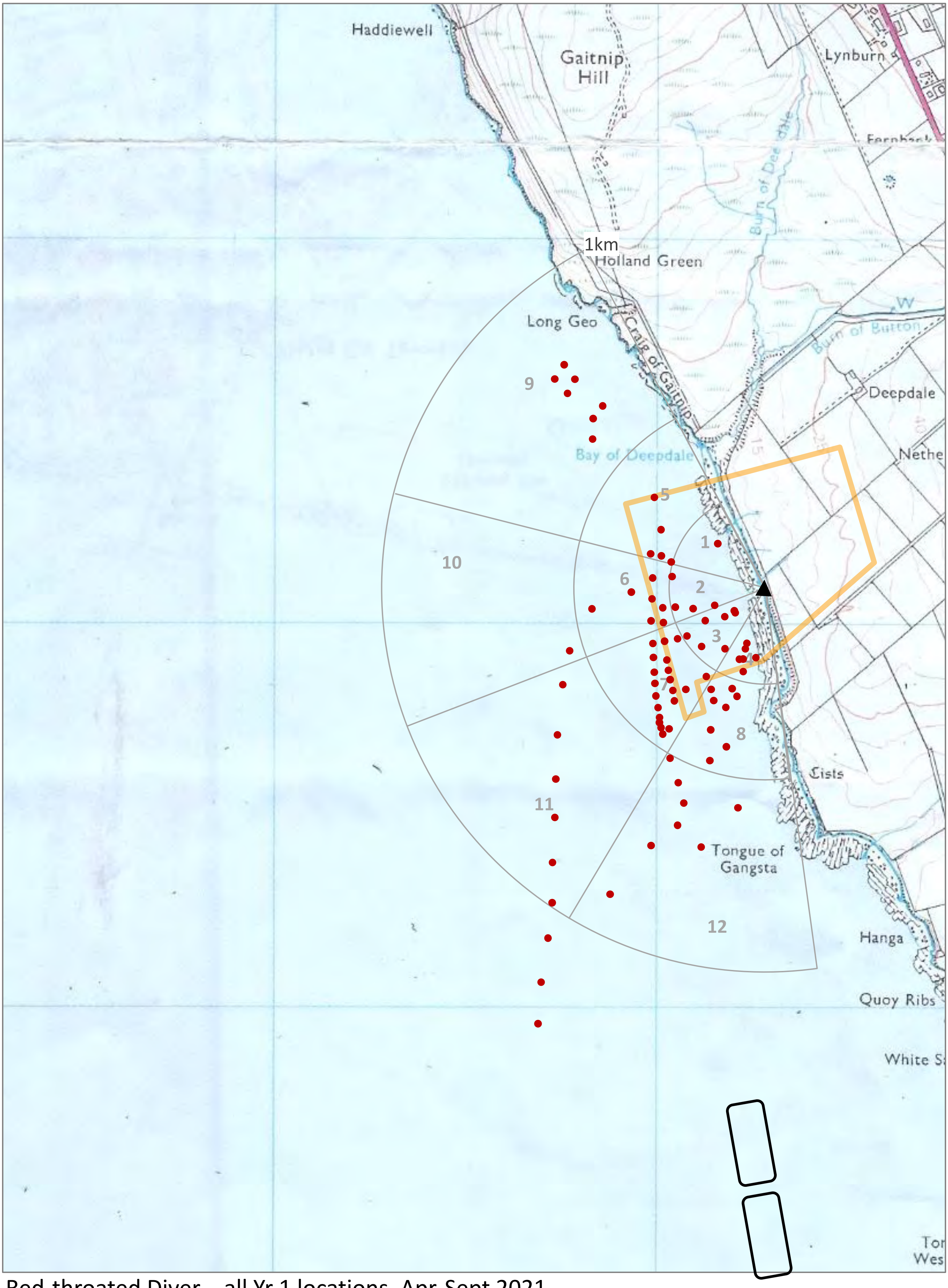
Red-throated Diver – all Yr 1 and Yr 2 locations, Apr-Sept 2021

Year 1 – dark red; Year 2 - blue

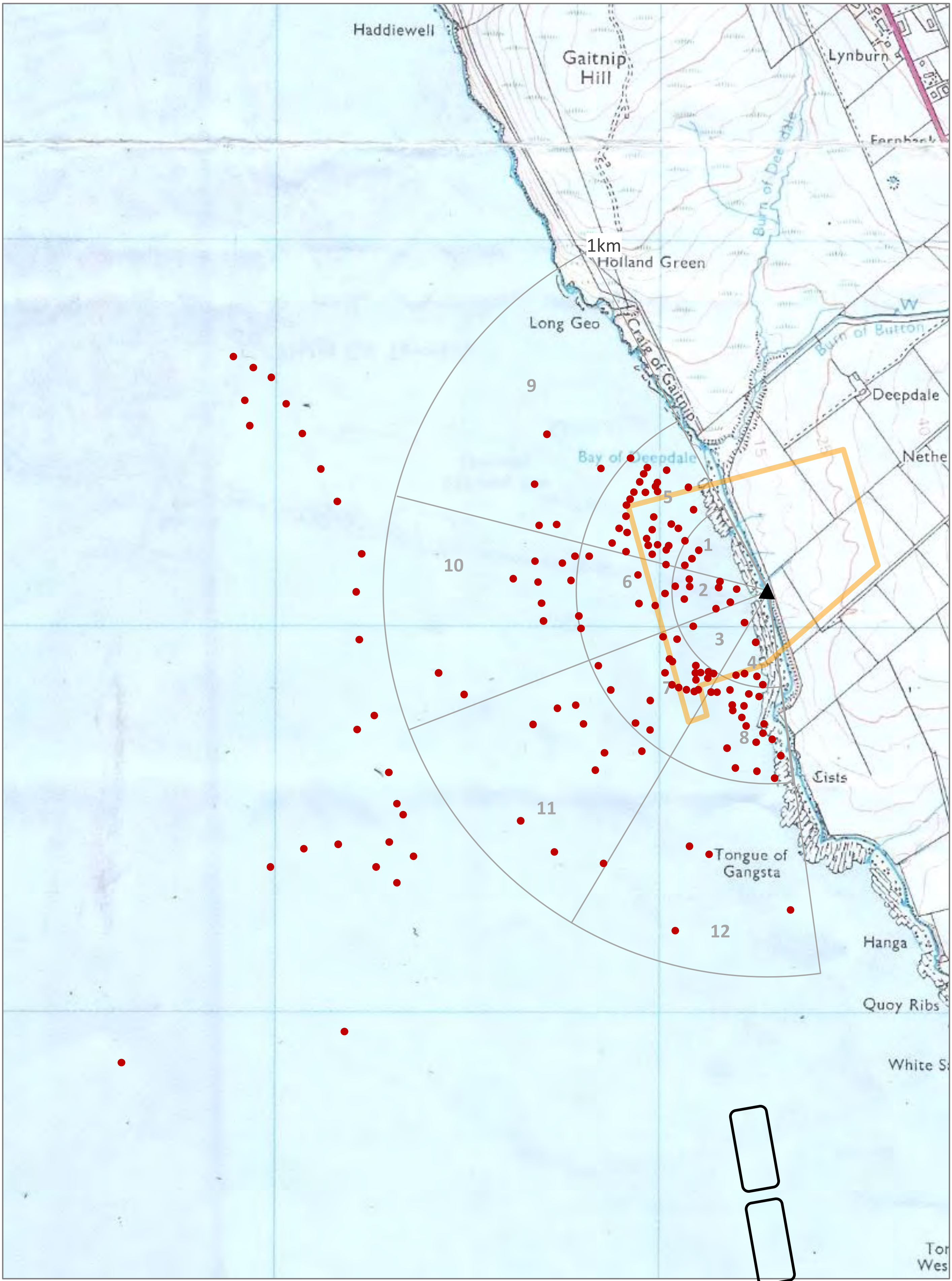


Red-throated Diver – all Yr 1 and Yr 2 movements, Apr-Sept 2021

Year 1 – dark red; Year 2 - blue



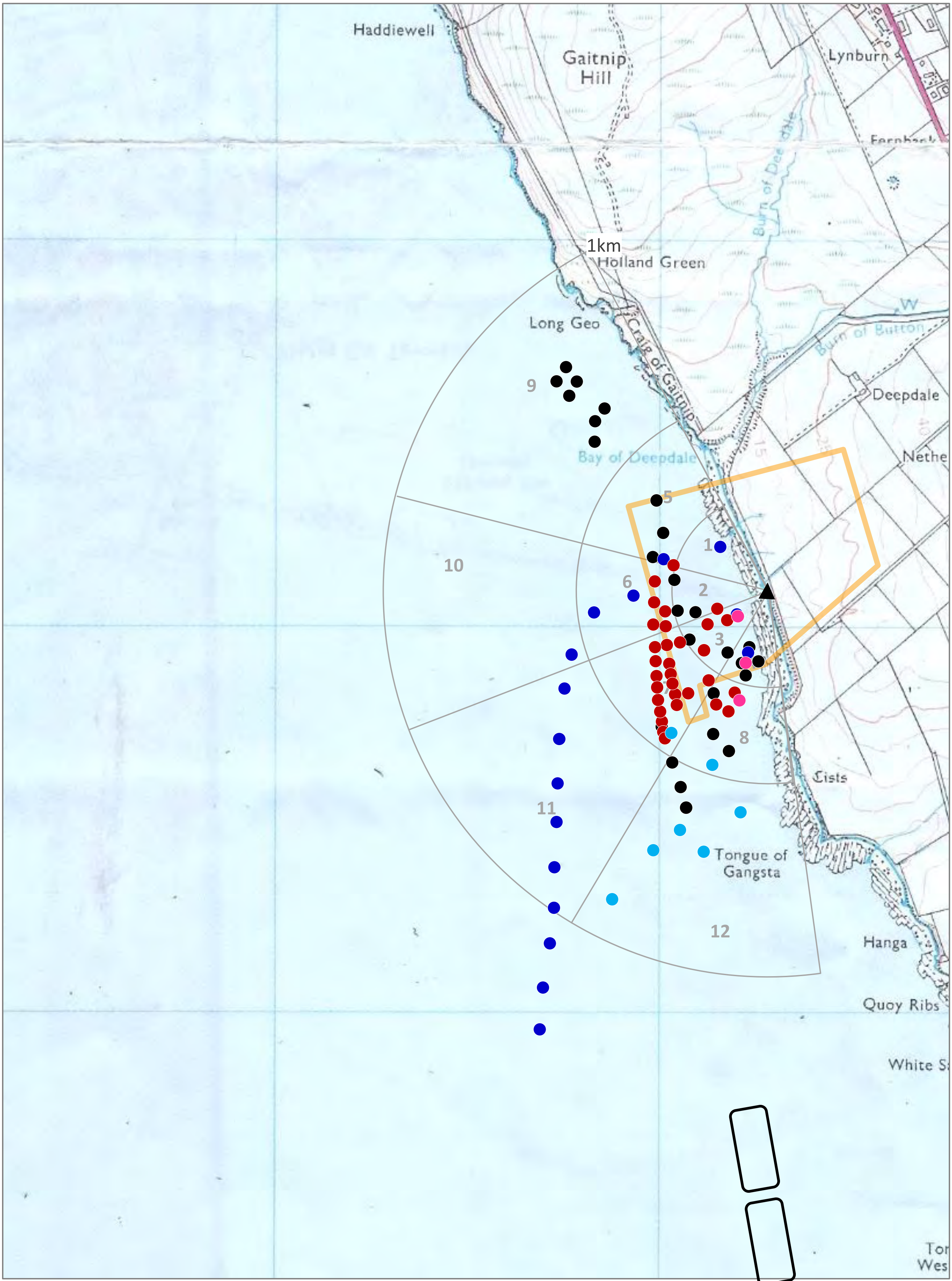
Red-throated Diver – all Yr 1 locations, Apr-Sept 2021



Red-throated Diver – all Yr 2 locations, Apr-Sept 2022

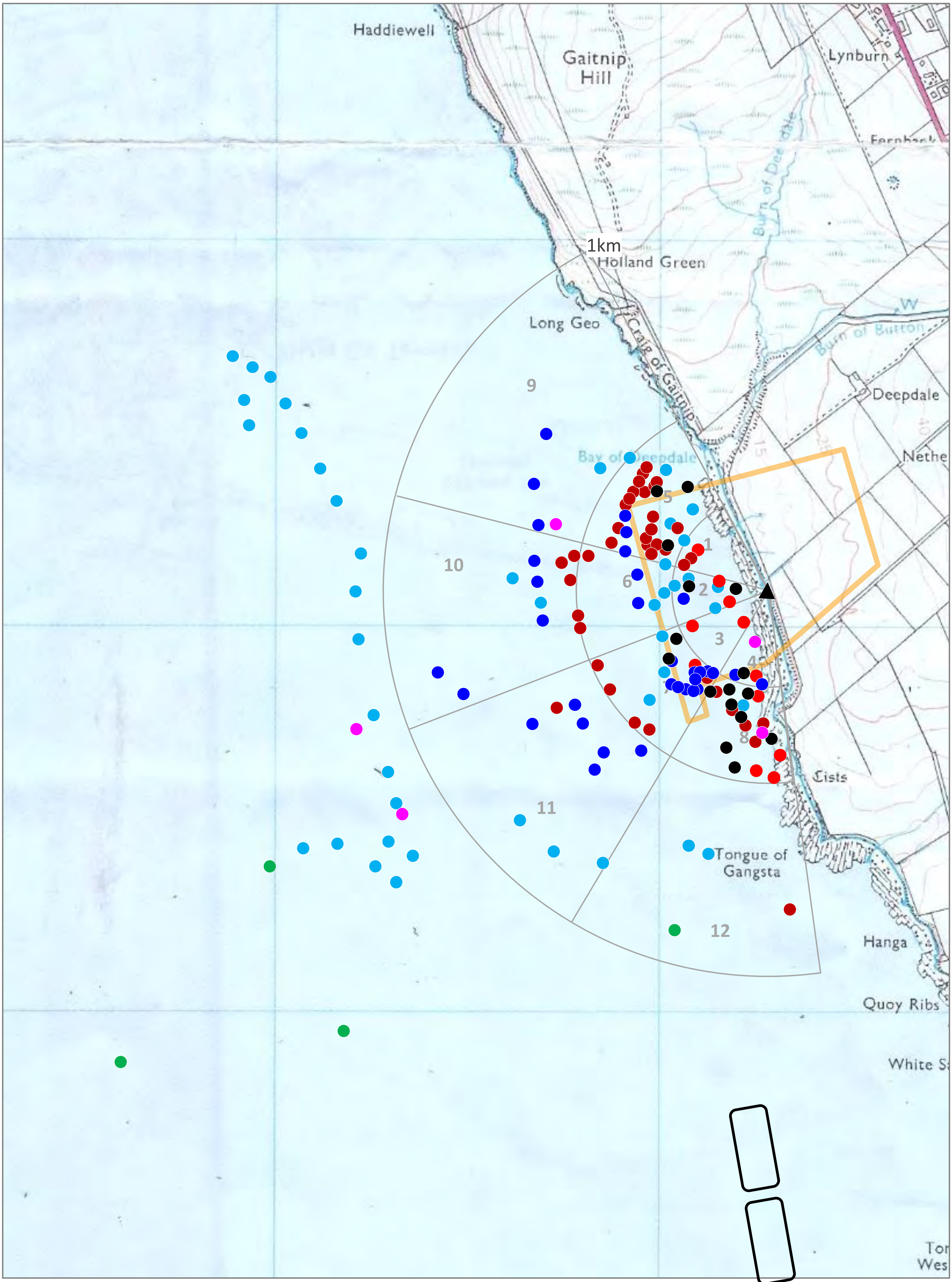
Red-throated Diver – all Yr 1 movements, Apr-Sept 2021

Red-throated Diver – all Yr 2 movements, Apr-Sept 2022



Red-throated Diver – all locations, Apr-Sept 2021

Apr – pink; June – light blue; July – dark red; August – blue; Sept – black

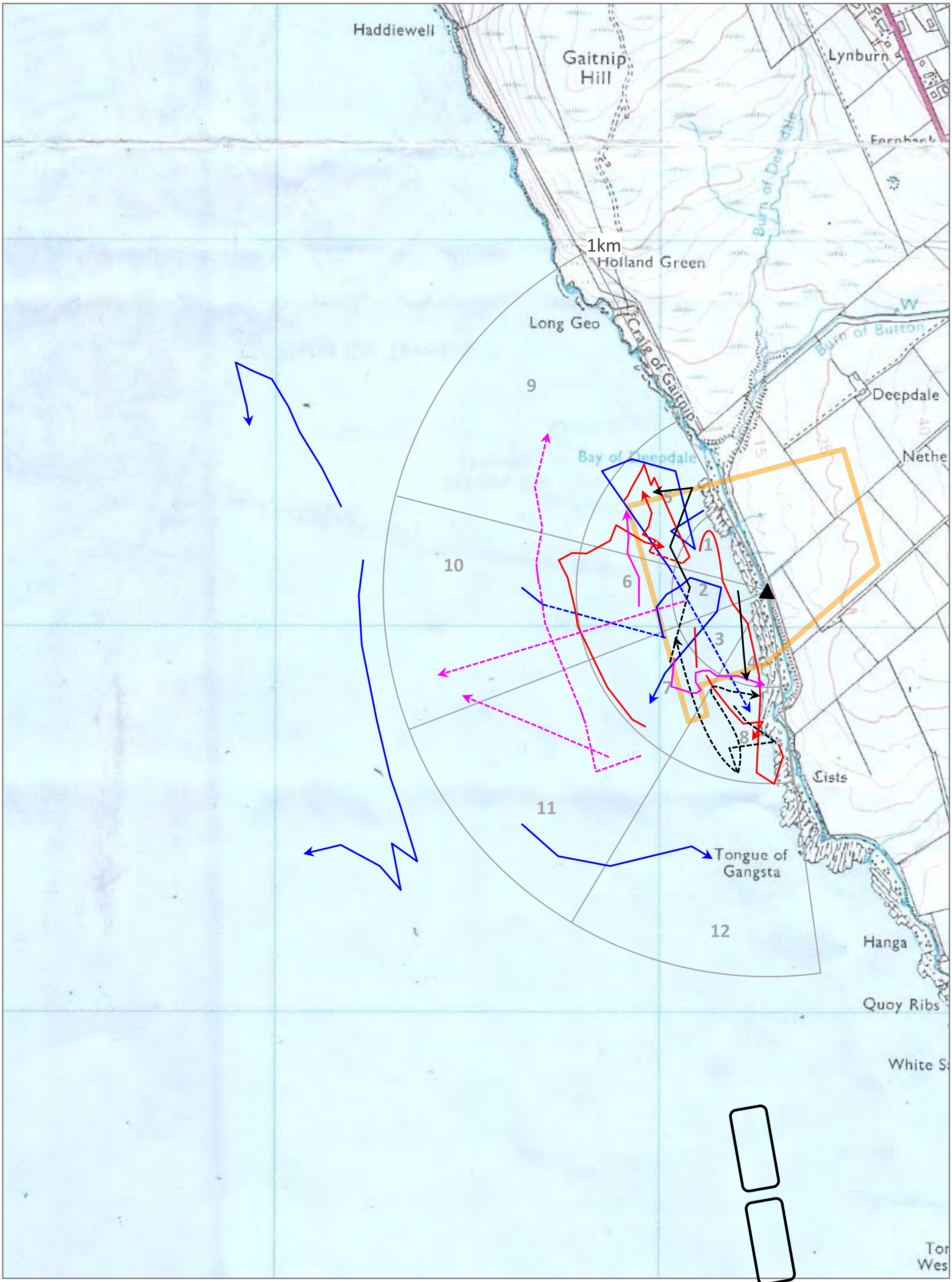


Red-throated Diver – all locations, Apr-Sept 2022

Apr – pink; May; green; June – light blue; July – dark red; August – blue; Sept – black

Red-throated Diver – all movements, Apr-Sept 2021

Apr – pink; June – light blue; July – dark red; August – blue; Sept – black



Red-throated Diver – all movements, Apr-Sept 2022

Apr – pink; May; green; June – light blue; July – dark red; August – blue; Sept – black

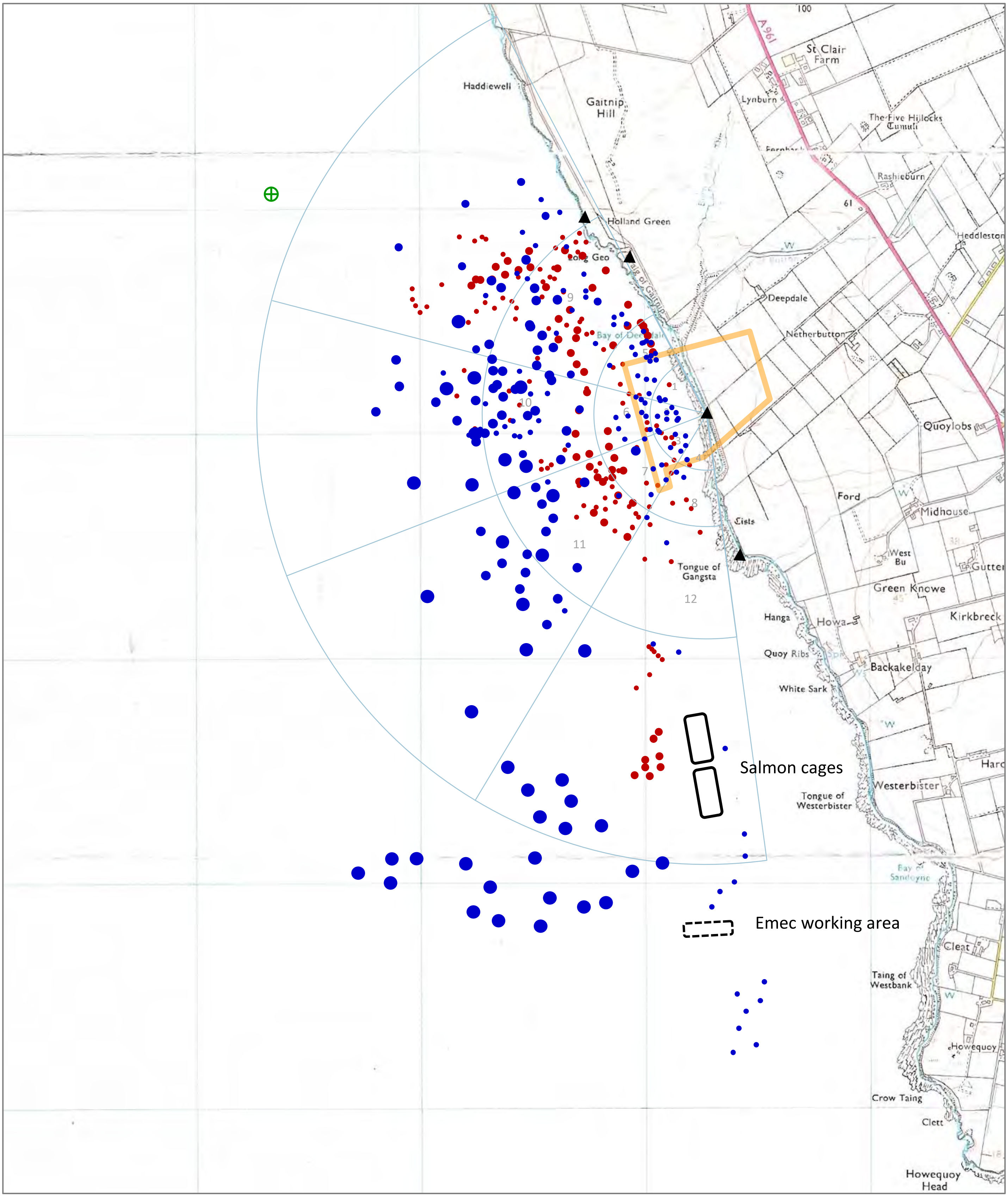
APPENDIX E ii

Black-throated Diver:

swimming track locations and movements

Black-throated Diver – all Year 1 and Year 2 locations, Oct – Apr 21/22

Year 1 – dark red; Year 2 - blue



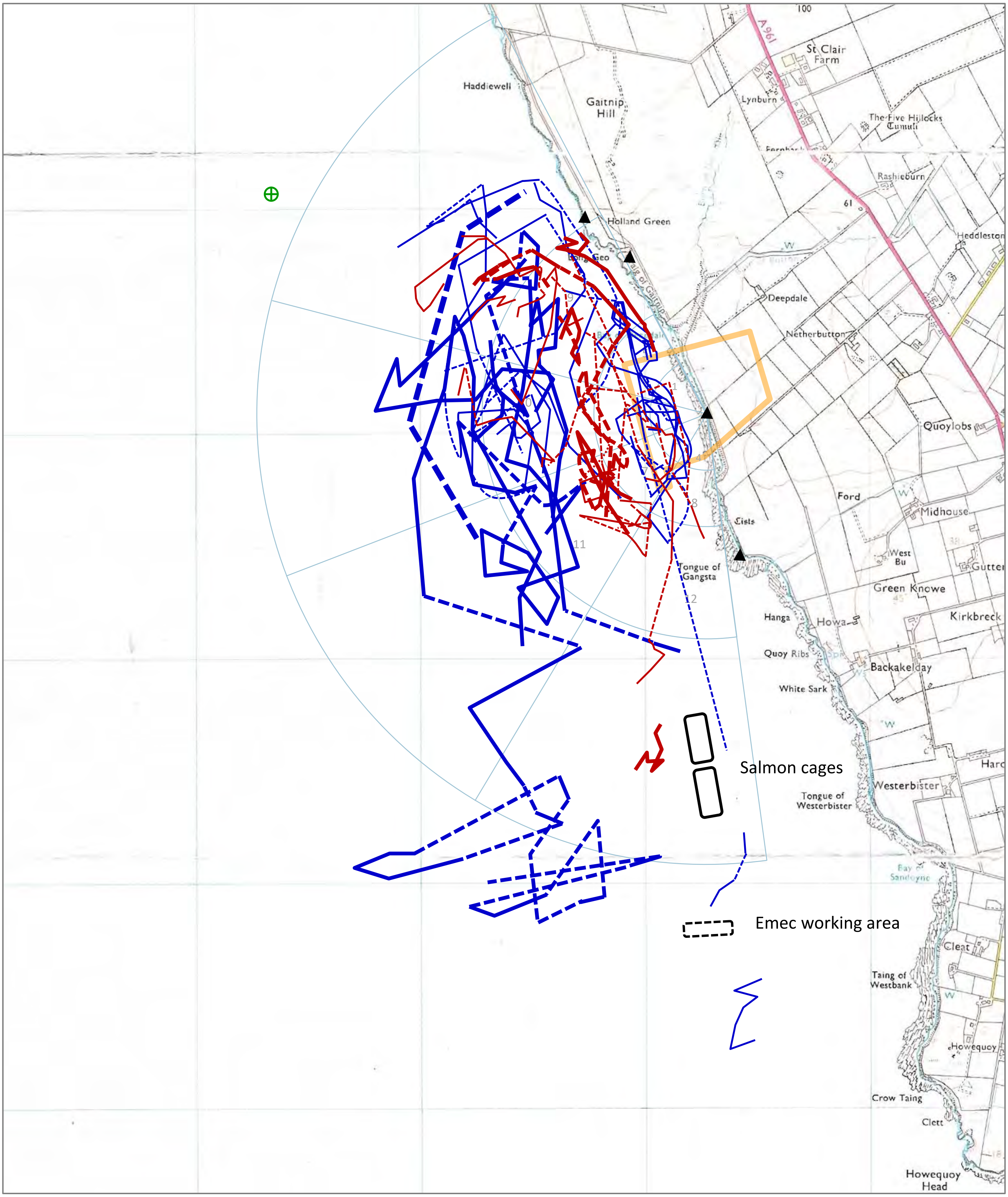
● 1 – 4 birds

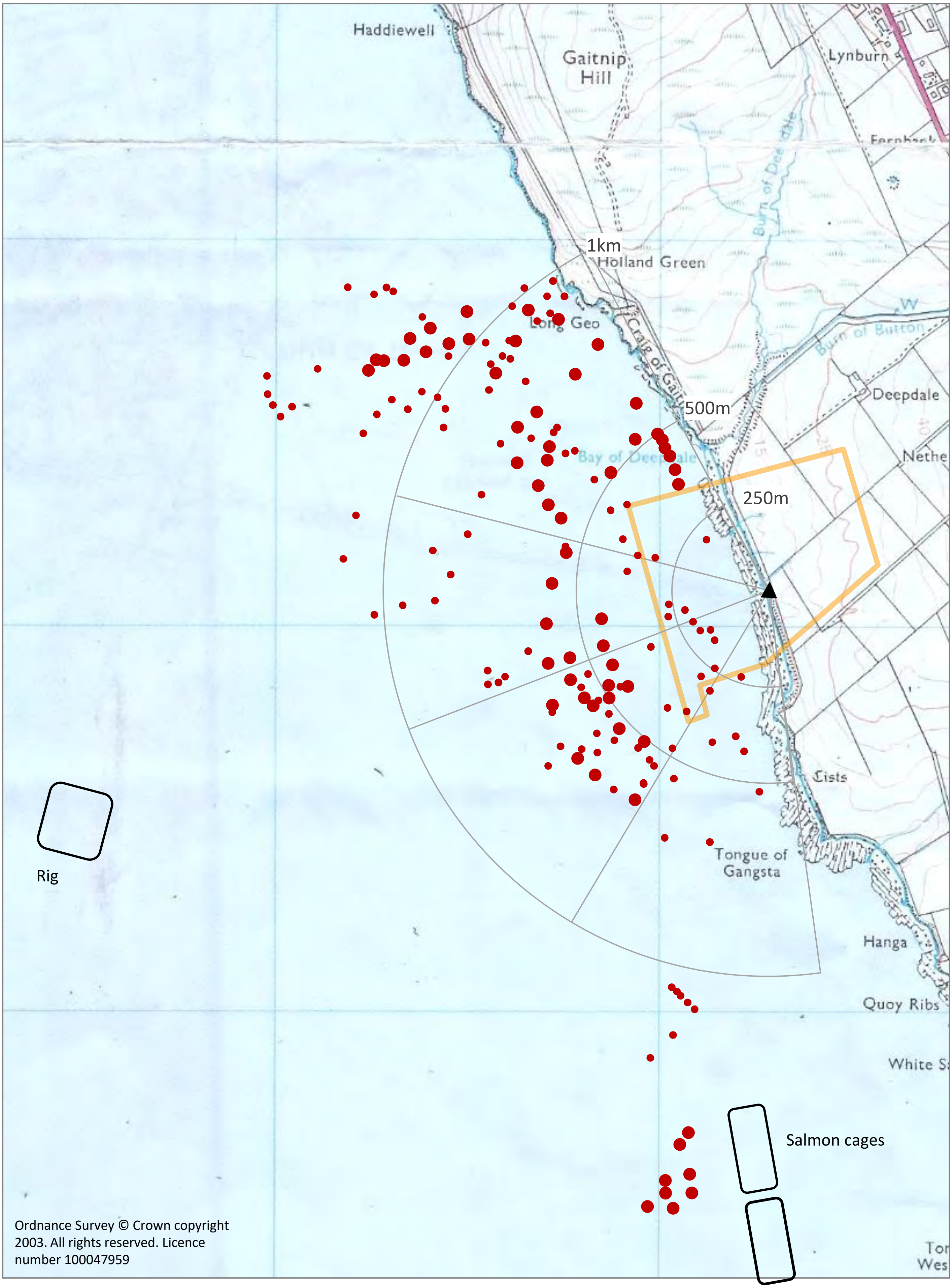
● 5 – 9 birds

● 10-19 birds

Black-throated Diver – all Year 1 and Year 2 movements, Oct – Apr 21/22

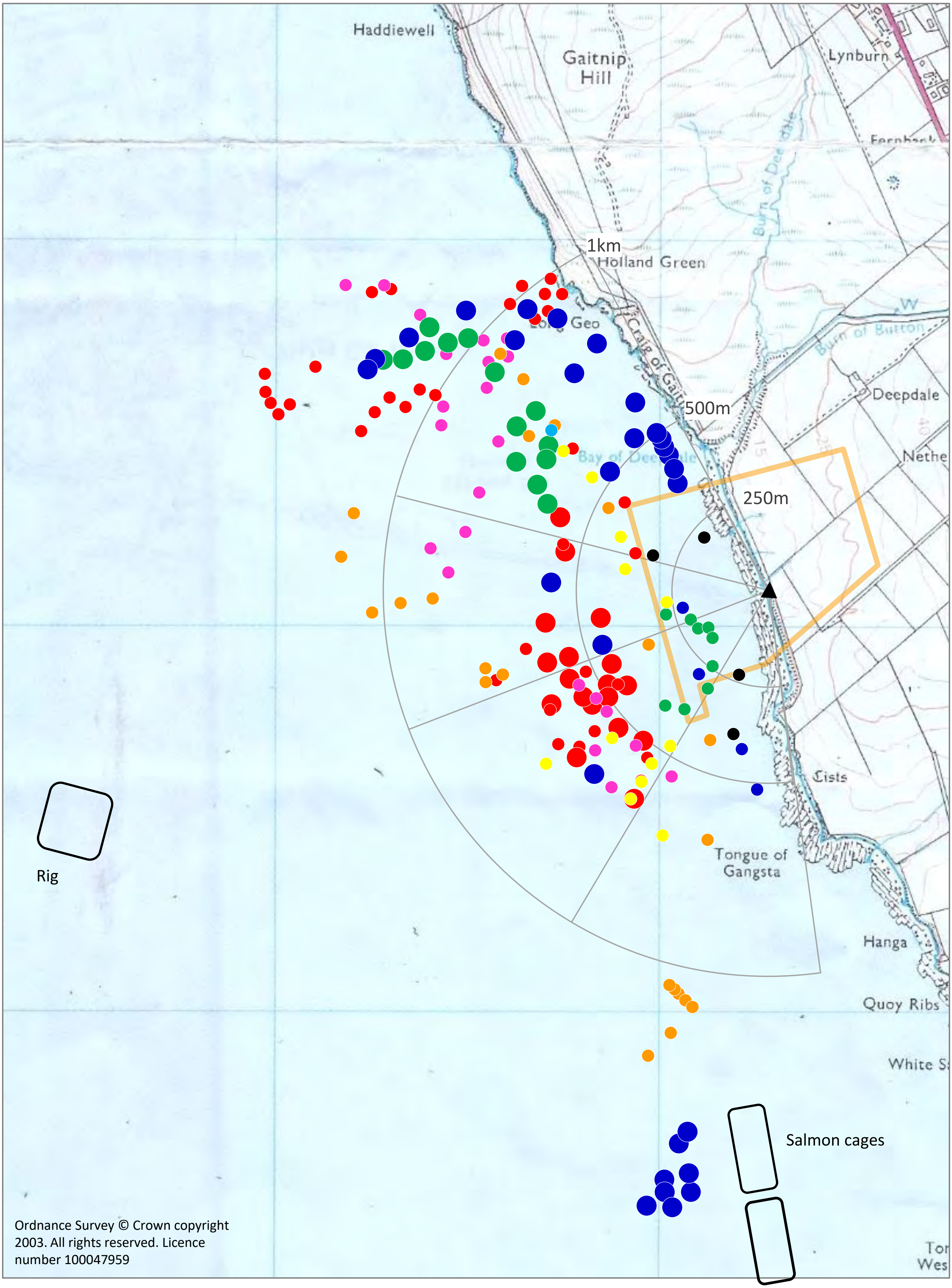
Year 1 – dark red; Year 2 - blue





Black-throated Diver – all Year 1 locations, Oct-Apr 2020/21

Black-throated Diver – all Year 1 movements, Oct-Apr 2020/21



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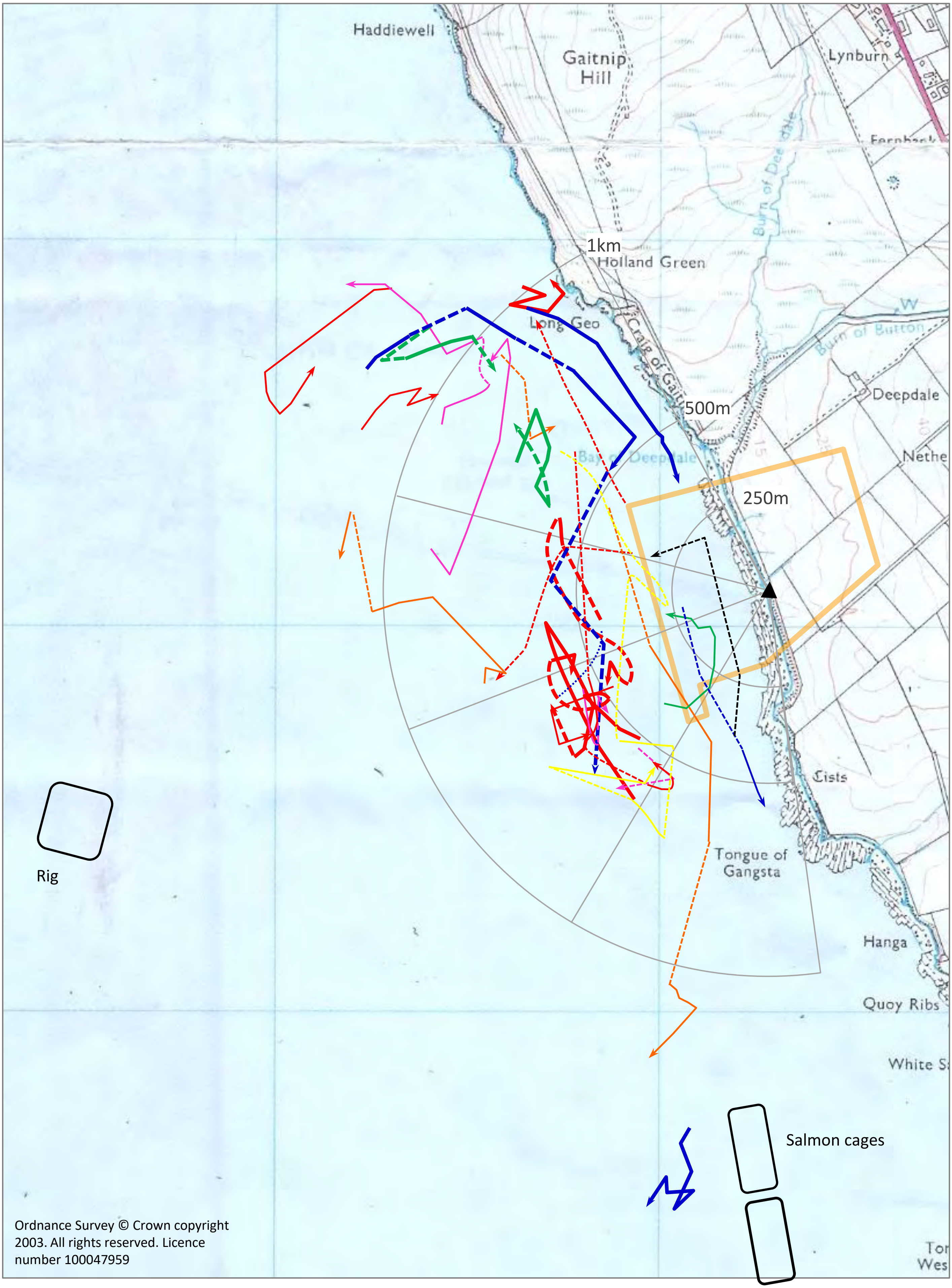
Black-throated Diver – all Year 1 locations, Oct-Apr 2020/21

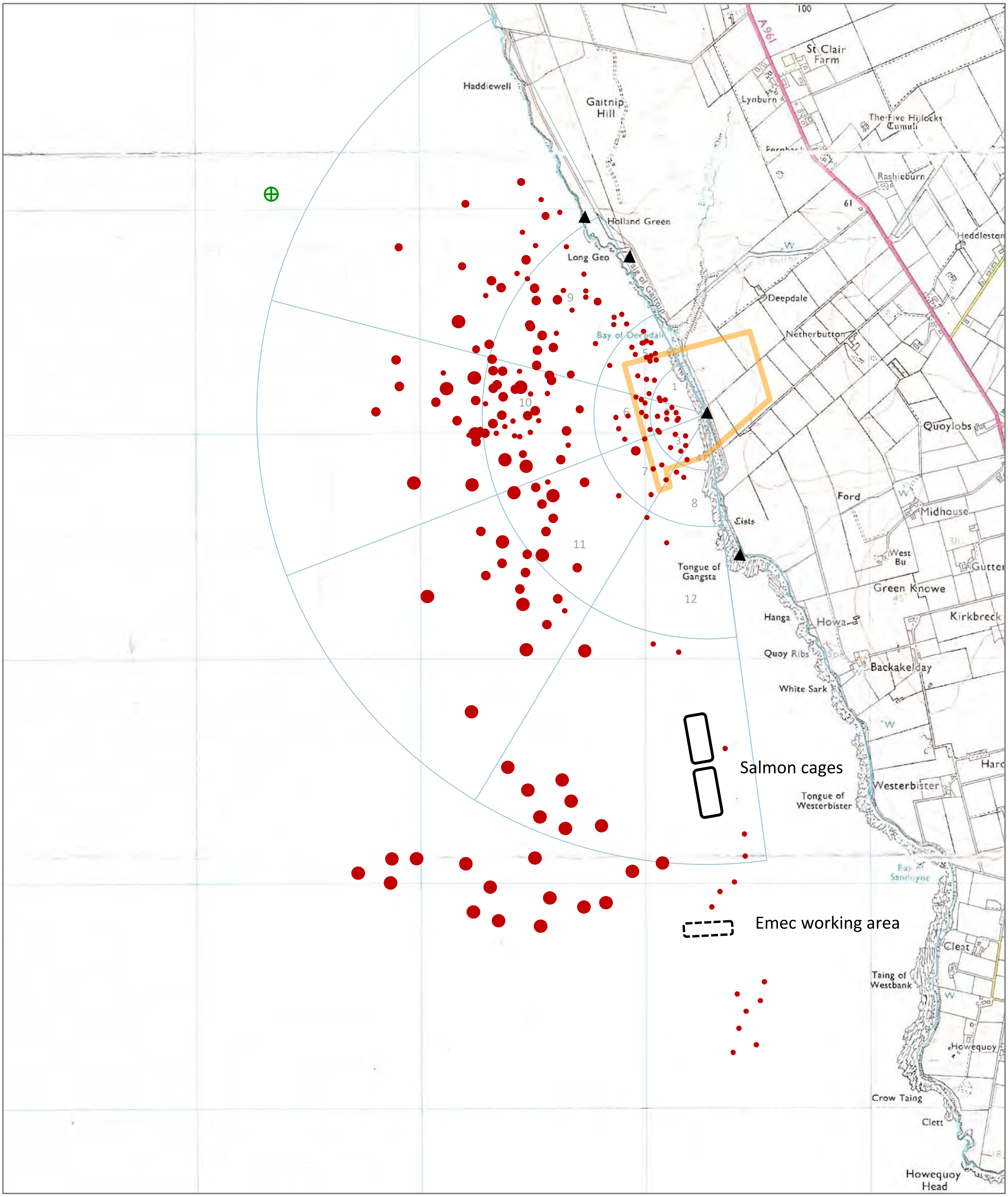
Oct – yellow; Nov: - red; Dec – pink; Jan – orange; Feb – green; Mar – blue; Apr – black



Black-throated Diver – all Year 1 movements, Oct-Apr 2020/21

Oct – yellow; Nov: - red; Dec – pink; Jan – orange; Feb – green; Mar – blue; Apr – black

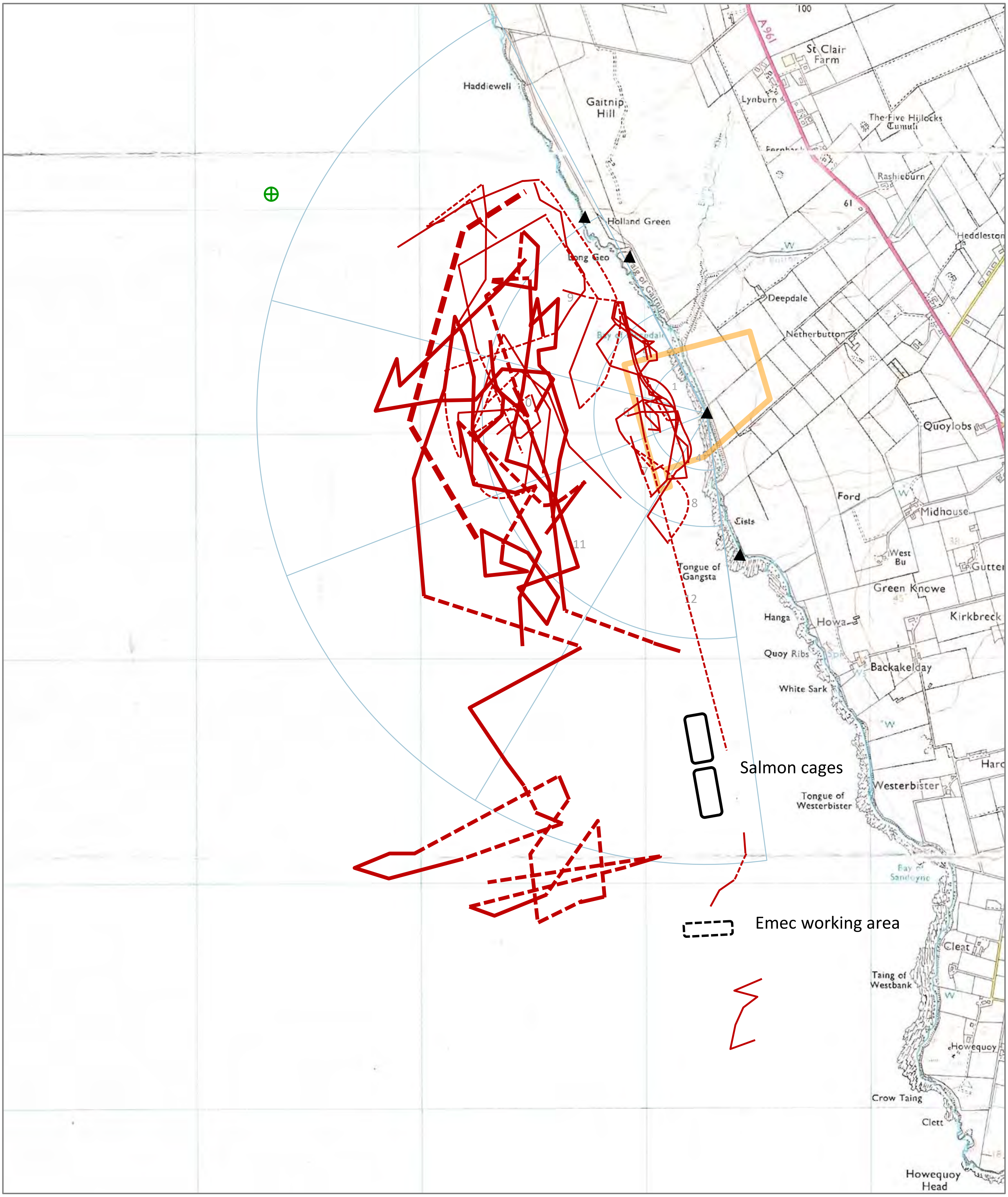
Black-throated Diver – all Year 2 locations, Oct – Apr 2021/22



Black-throated Diver – all Year 2 locations, Oct-Apr 2021/22

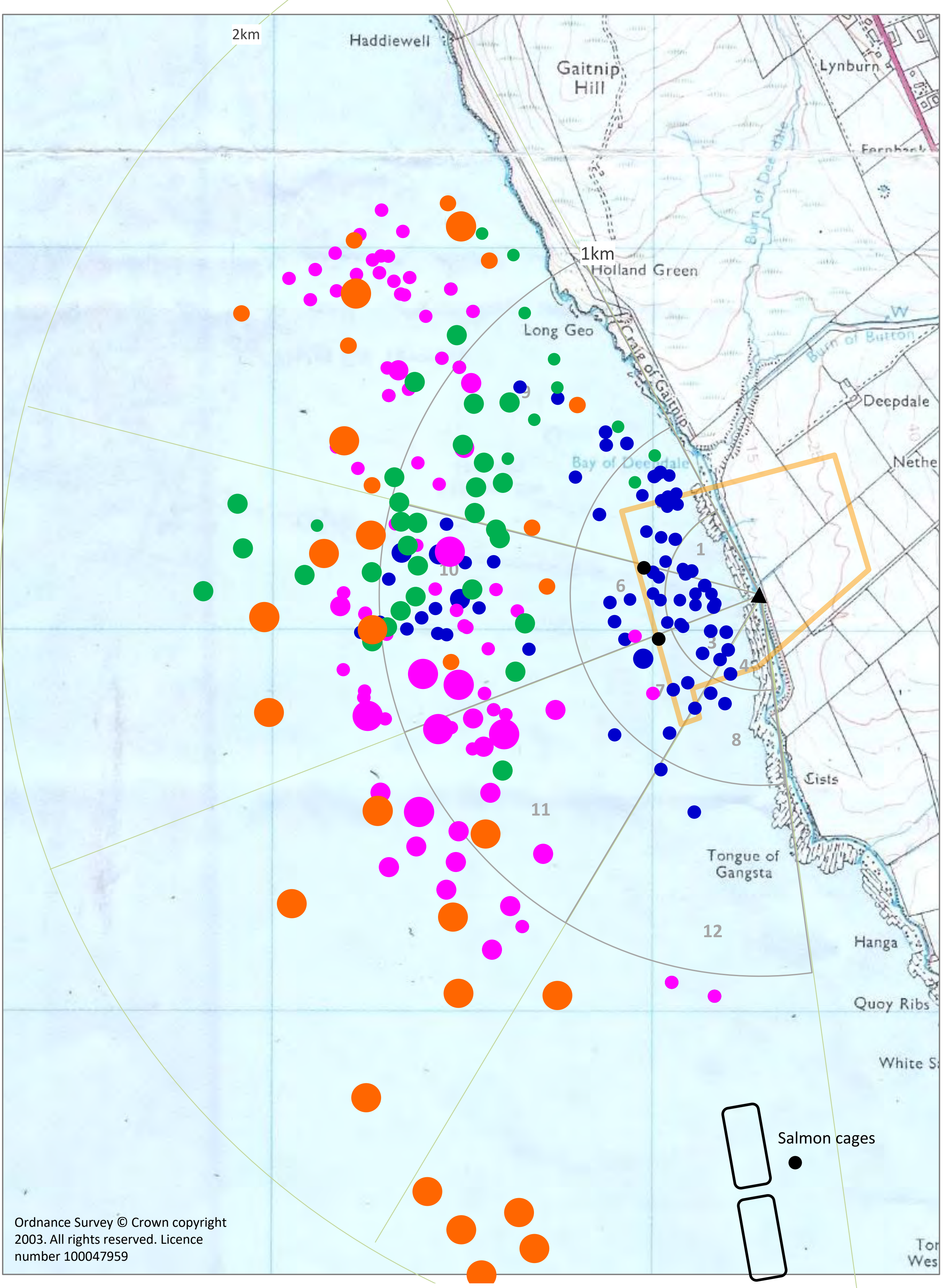
●	1 – 4 birds
●	5 – 9 birds
●	10-19 birds

Black-throated Diver – all Year 2 movements, Oct – Apr 2021/22



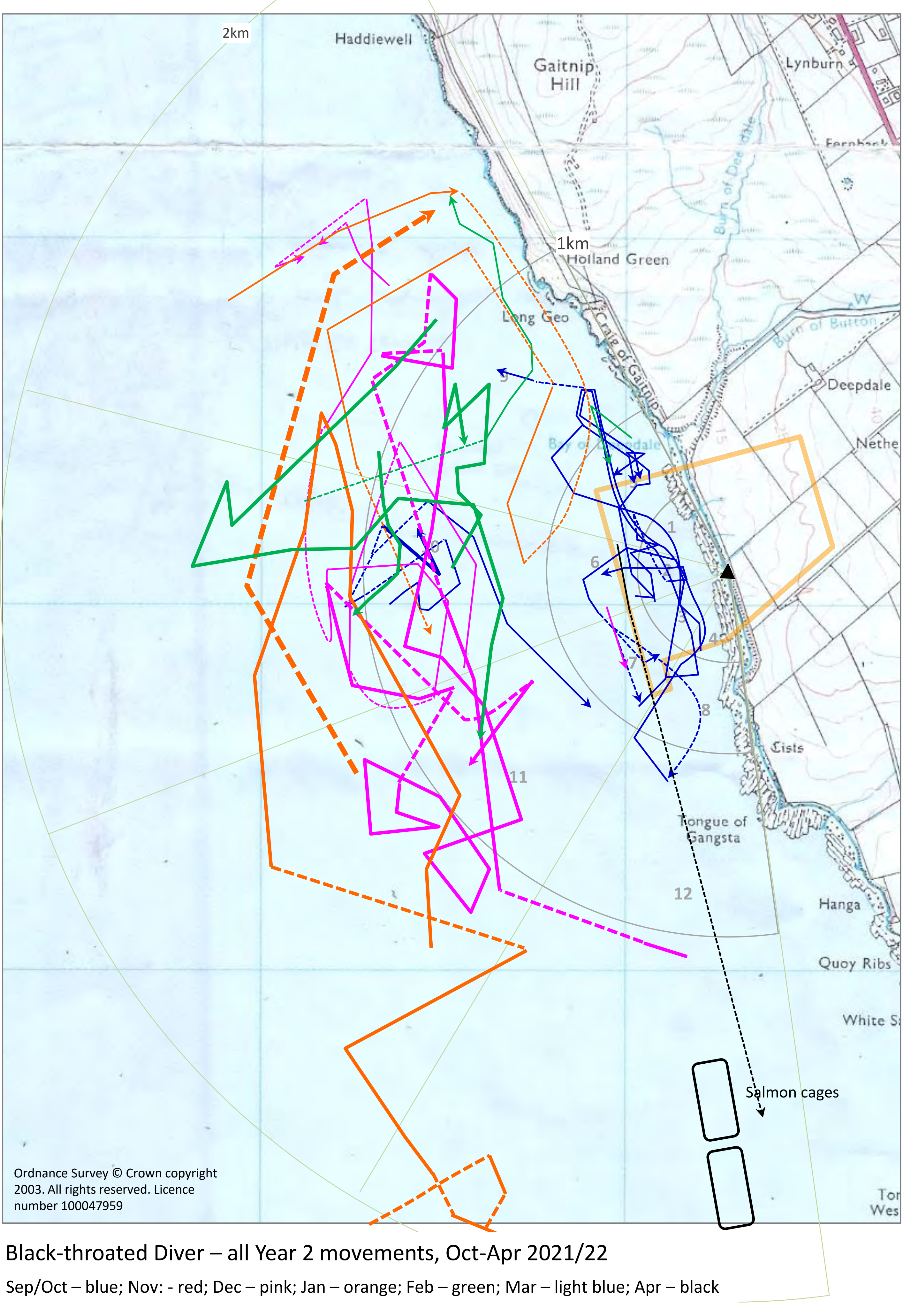
Black-throated Diver – all Year 2 movements, Oct-Apr 2021/22

→ 1 – 4 birds
→ 5 – 9 birds
→ 10-19 birds



Black-throated Diver – all Year 2 locations, Oct-Apr 2021/22

Sep/Oct – blue; Nov: - red; Dec – pink; Jan – orange; Feb – green; Mar – light blue; Apr – black



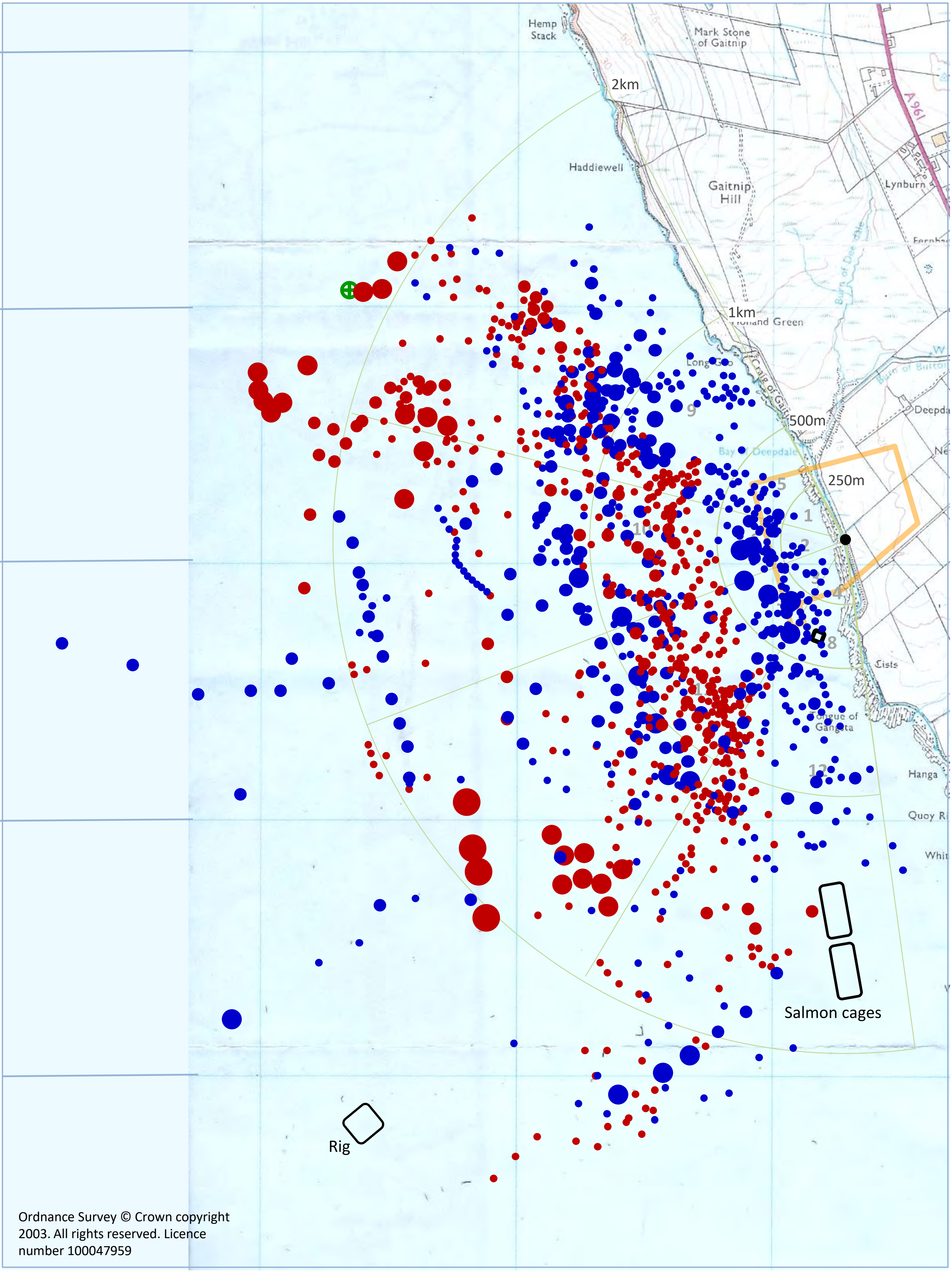
Black-throated Diver – all Year 2 movements, Oct-Apr 2021/22

Sep/Oct – blue; Nov: - red; Dec – pink; Jan – orange; Feb – green; Mar – light blue; Apr – black

APPENDIX E iii

Great Northern Diver:

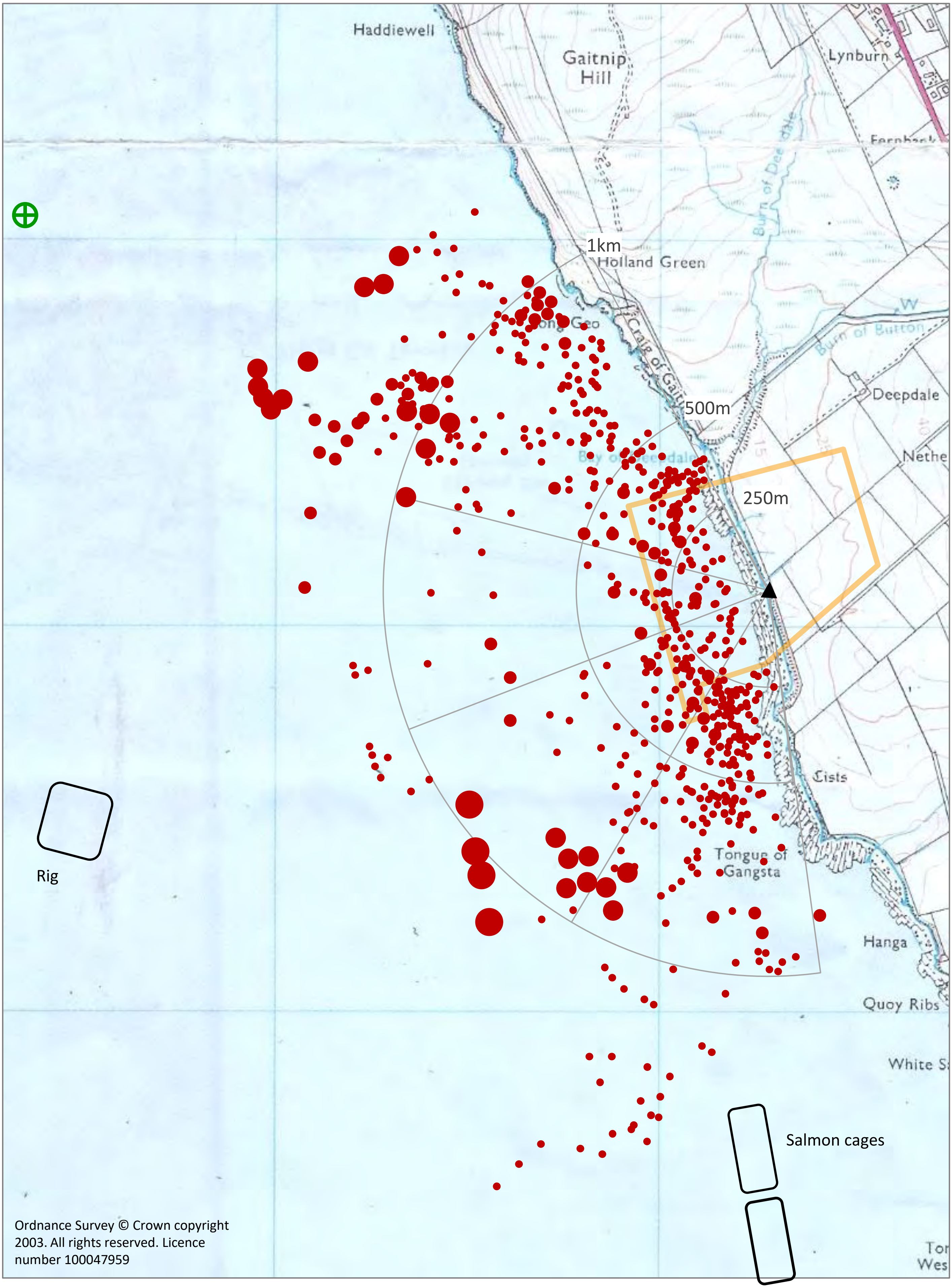
swimming track locations and
movements



Great Northern Diver – all year 1 and Year 2 locations

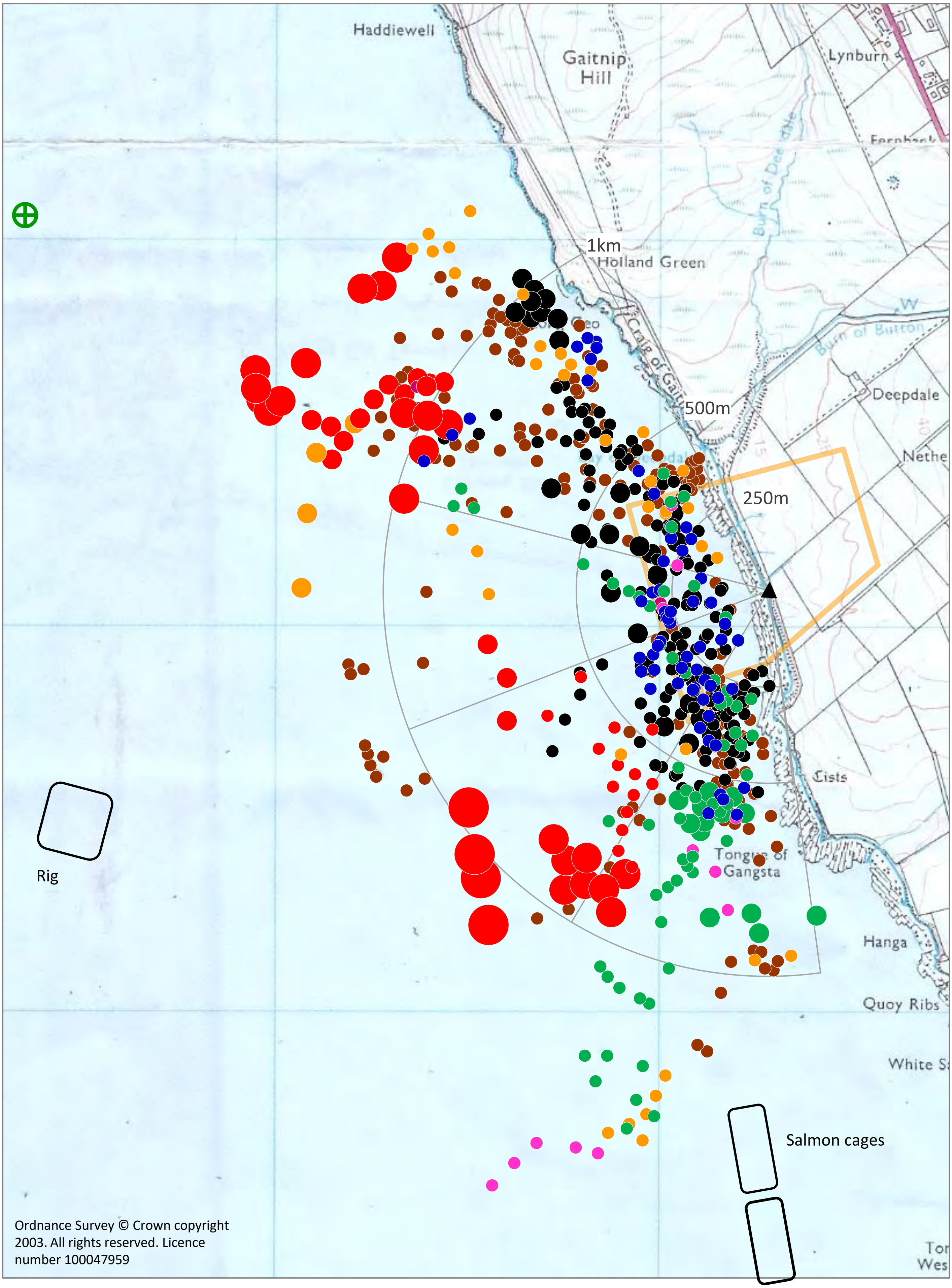
Year 1 – dark red; Year 2 - blue

- ● 1 – 4 birds
- ● 5 – 9 birds
- ● 10-19 birds



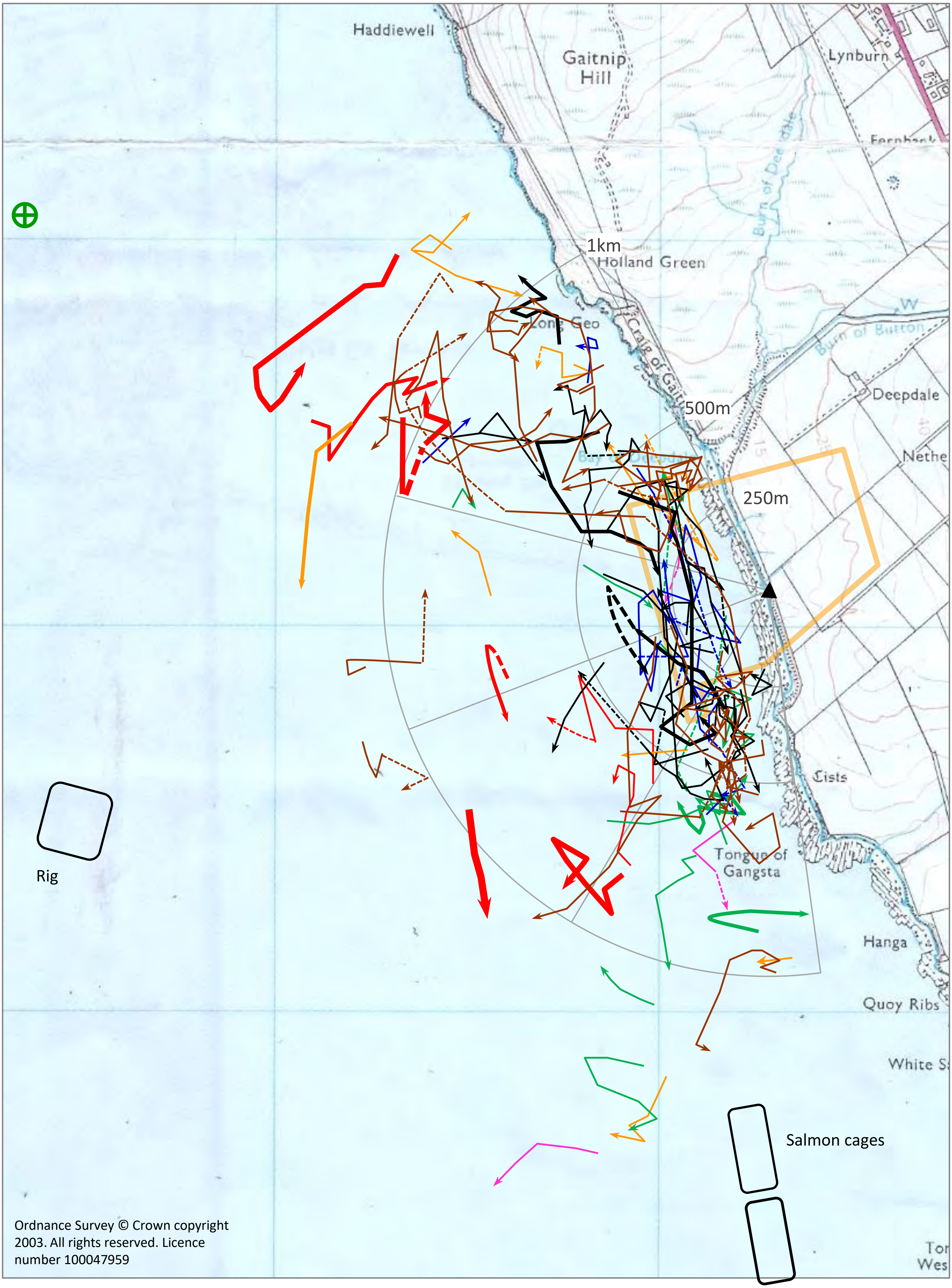
Great Northern Diver – all Year 1 locations – Nov-June 2020/21

Great Northern Diver – all Year 1 movements – Nov-June 2020/21



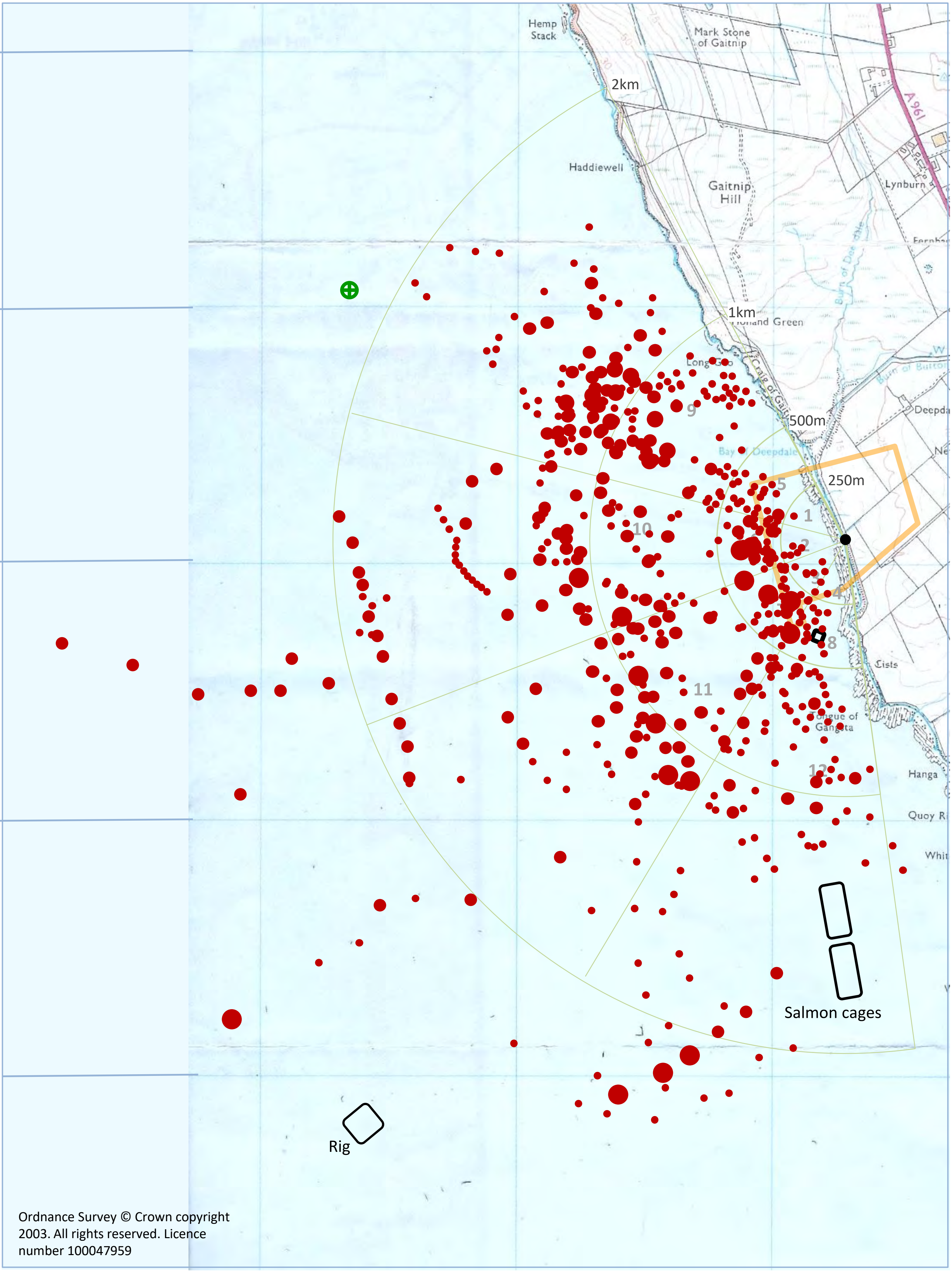
Great Northern Diver – all Year 1 locations – Nov-June 2020/21

Nov: - red; Dec – pink; Jan – orange; Feb – green;
Mar – blue; Apr – black; May/Jun – brown



Great Northern Diver – all Year 1 movements – Nov-June 2020/21

Nov: - red; Dec – pink; Jan – orange; Feb – green;
Mar – blue; Apr – black; May/Jun – brown



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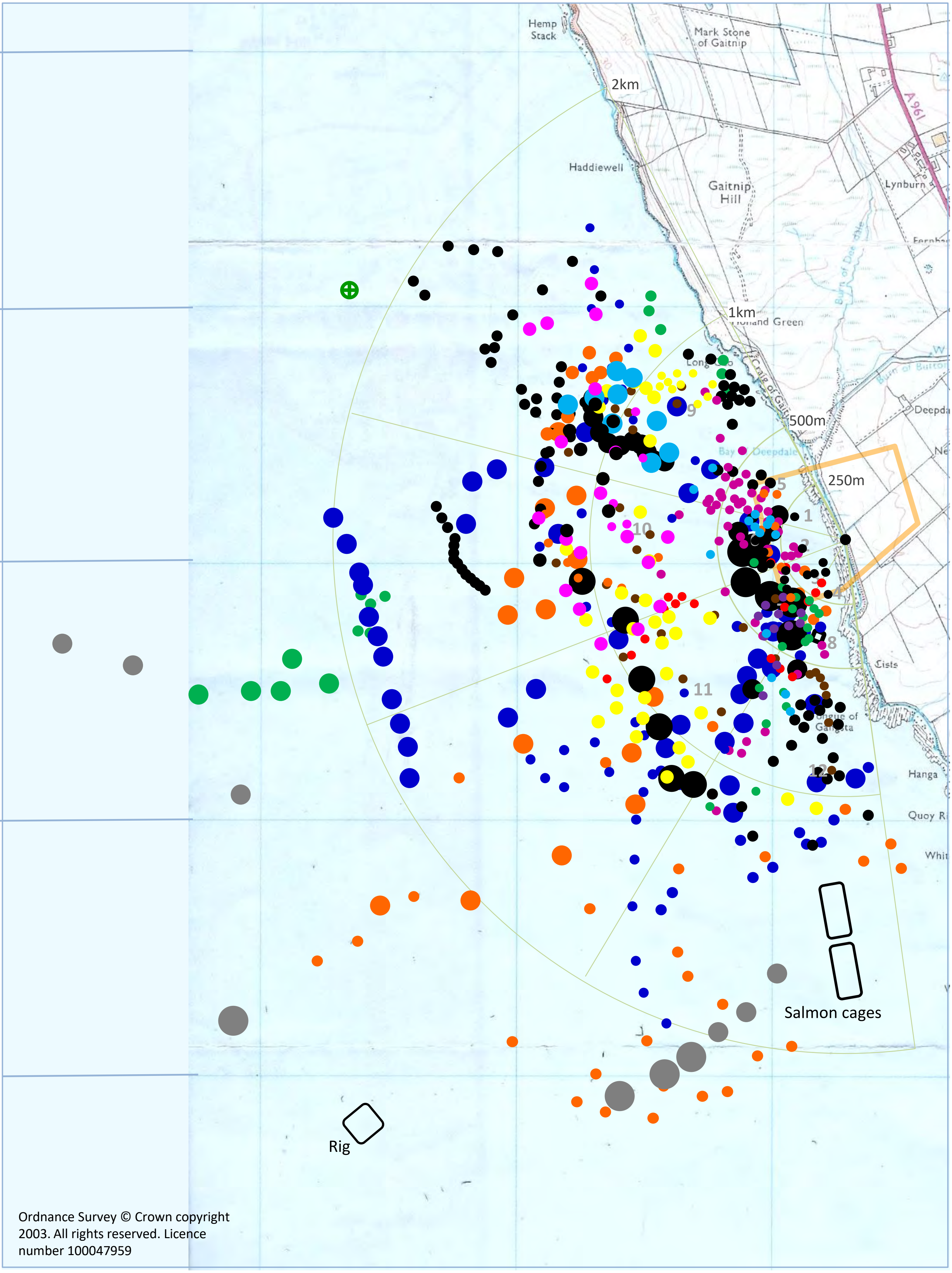
Great Northern Diver – all Year 2 locations, Oct-Apr 2021/22

Year 1 – dark red; Year 2 - blue

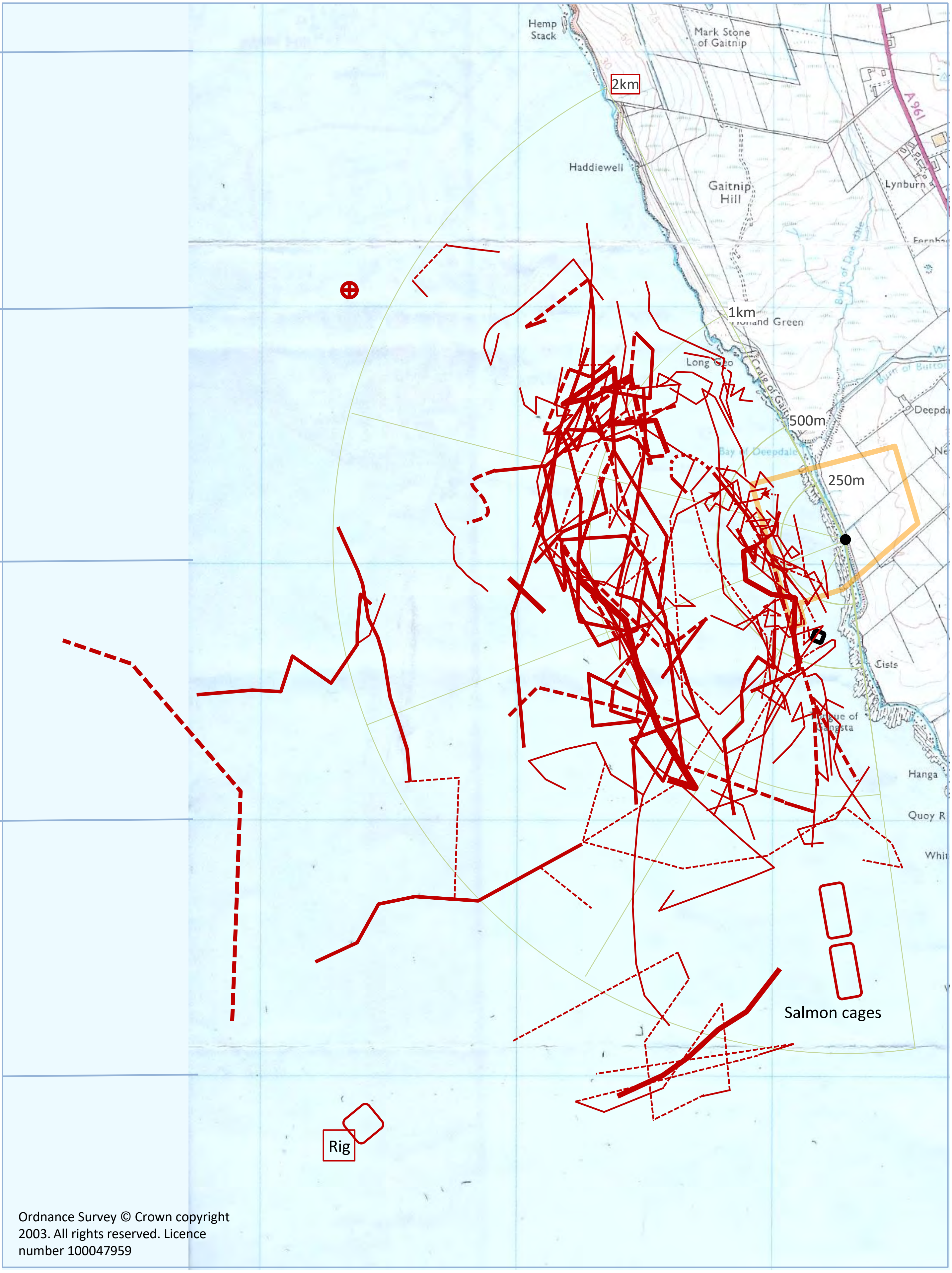
● 1 – 4 birds
● 5 – 9 birds
● 10-19 birds



Great Northern Diver – all Year 2 locations, Oct-Apr 2021/22

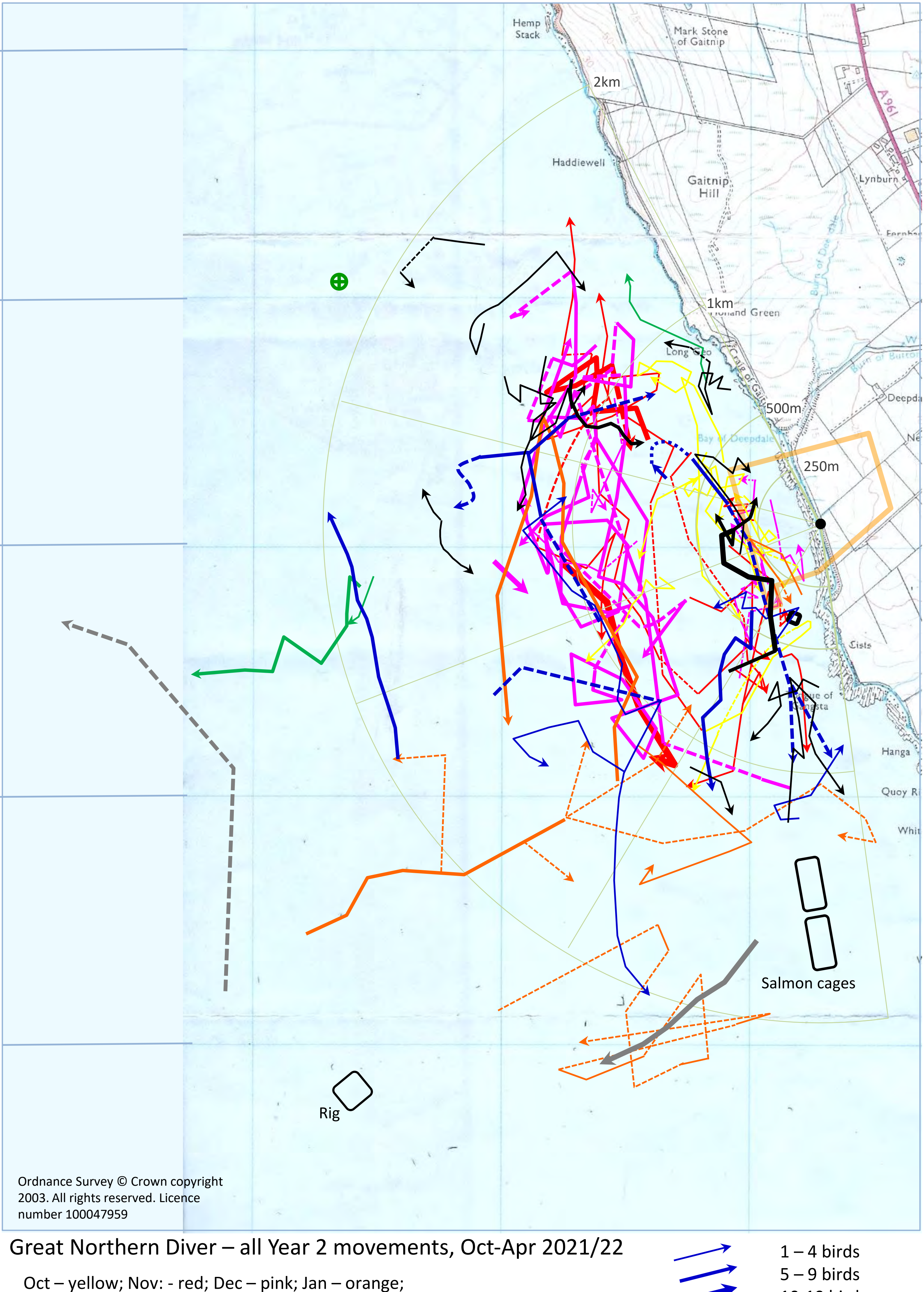
Oct – yellow; Nov: - red; Dec – pink; Jan – orange;
Feb – green; Mar – blue; Apr – black; diver sp. – grey

- ● 1 – 4 birds
- ● 5 – 9 birds
- ● 10-19 birds



Great Northern Diver – all Year 2 movements, Oct-Apr 2021/22

→ 1 – 4 birds
→ 5 – 9 birds
→ 10-19 birds
→ 20-29 birds



Great Northern Diver – all Year 2 movements, Oct-Apr 2021/22

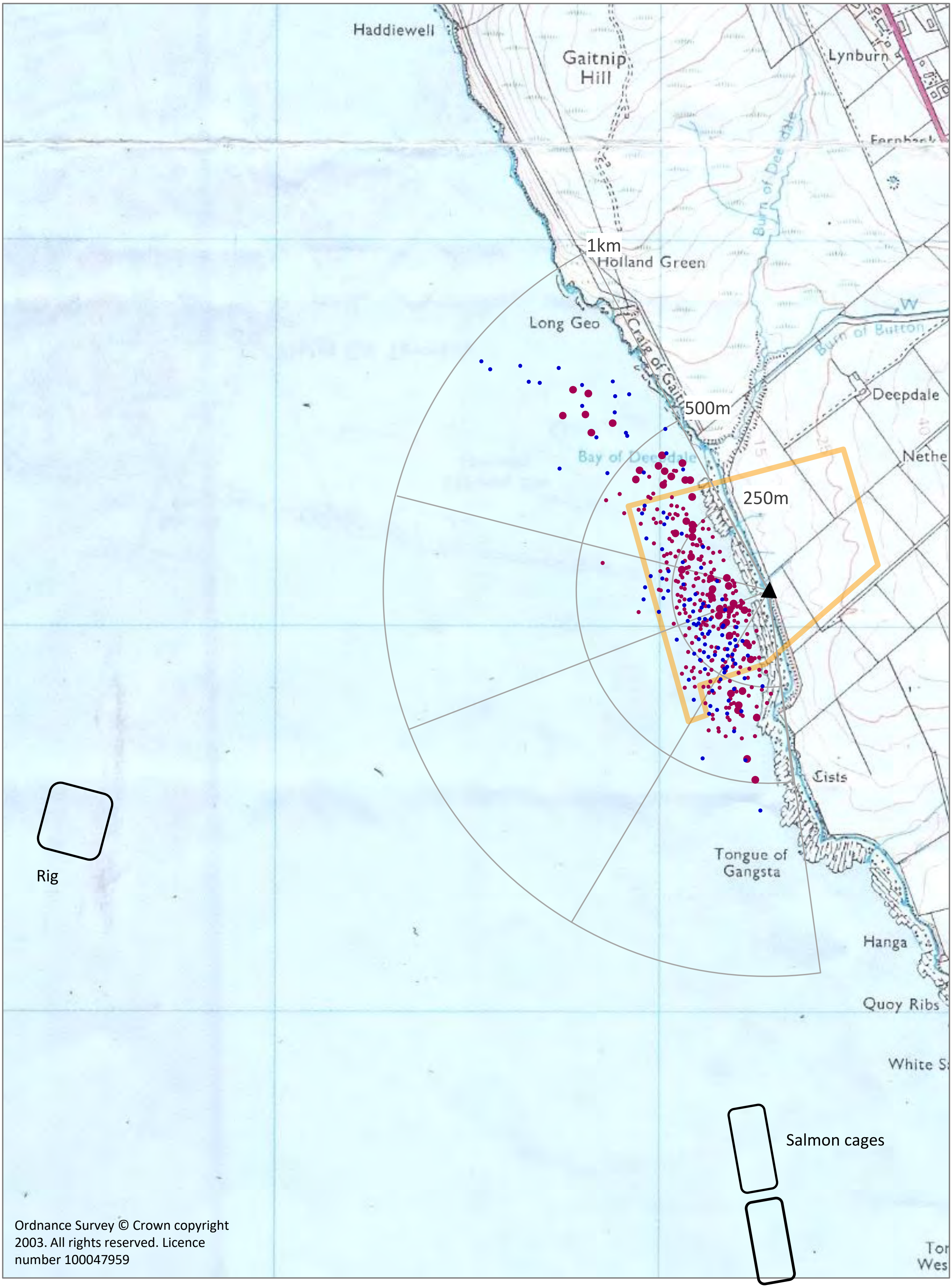
Oct – yellow; Nov: - red; Dec – pink; Jan – orange;
Feb – green; Mar – blue; Apr – black; diver sp. – grey

1 – 4 birds
5 – 9 birds
10-19 birds
20-29 birds

APPENDIX E iv

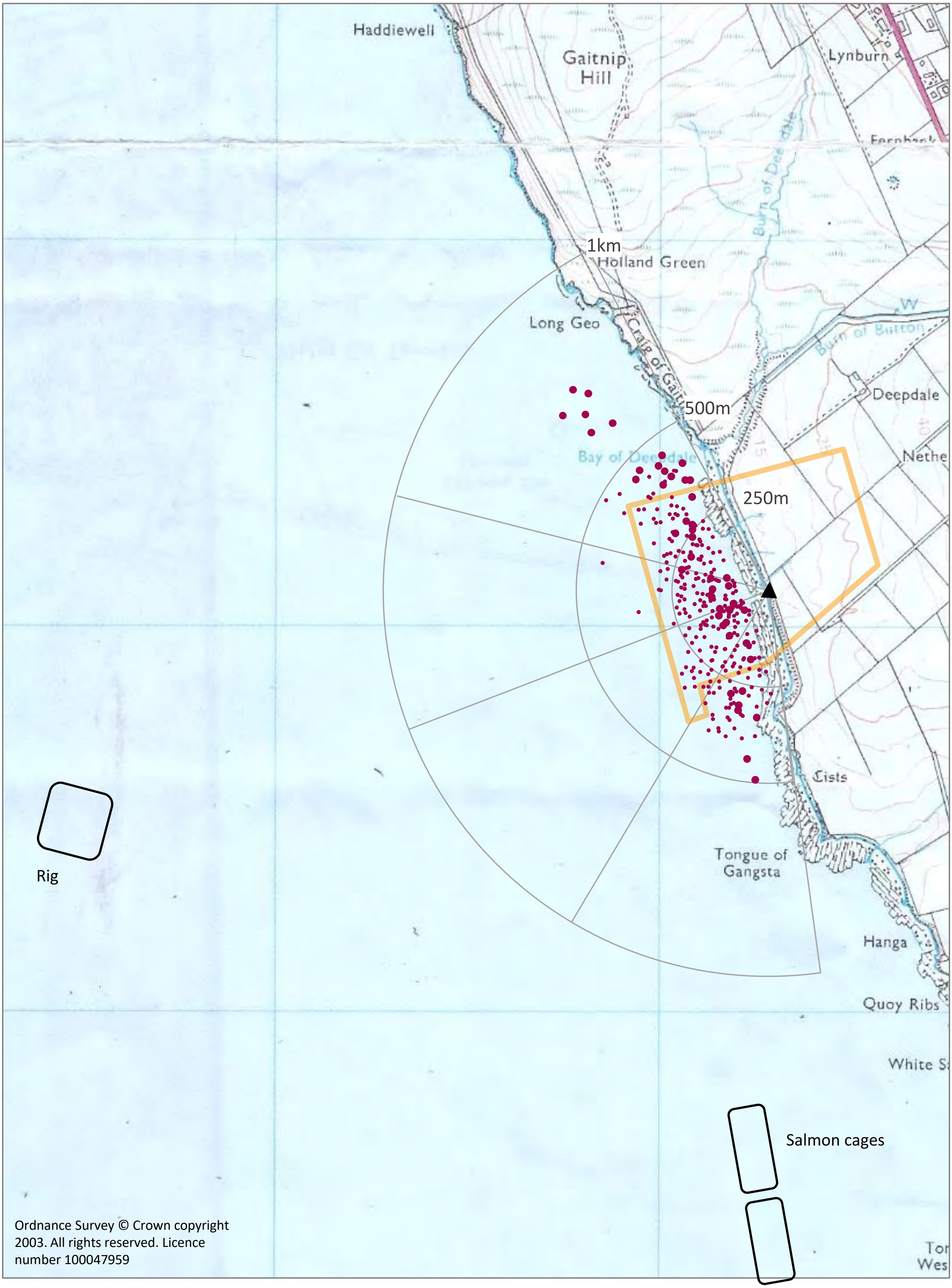
Slavonian Grebe:

swimming track locations and movements



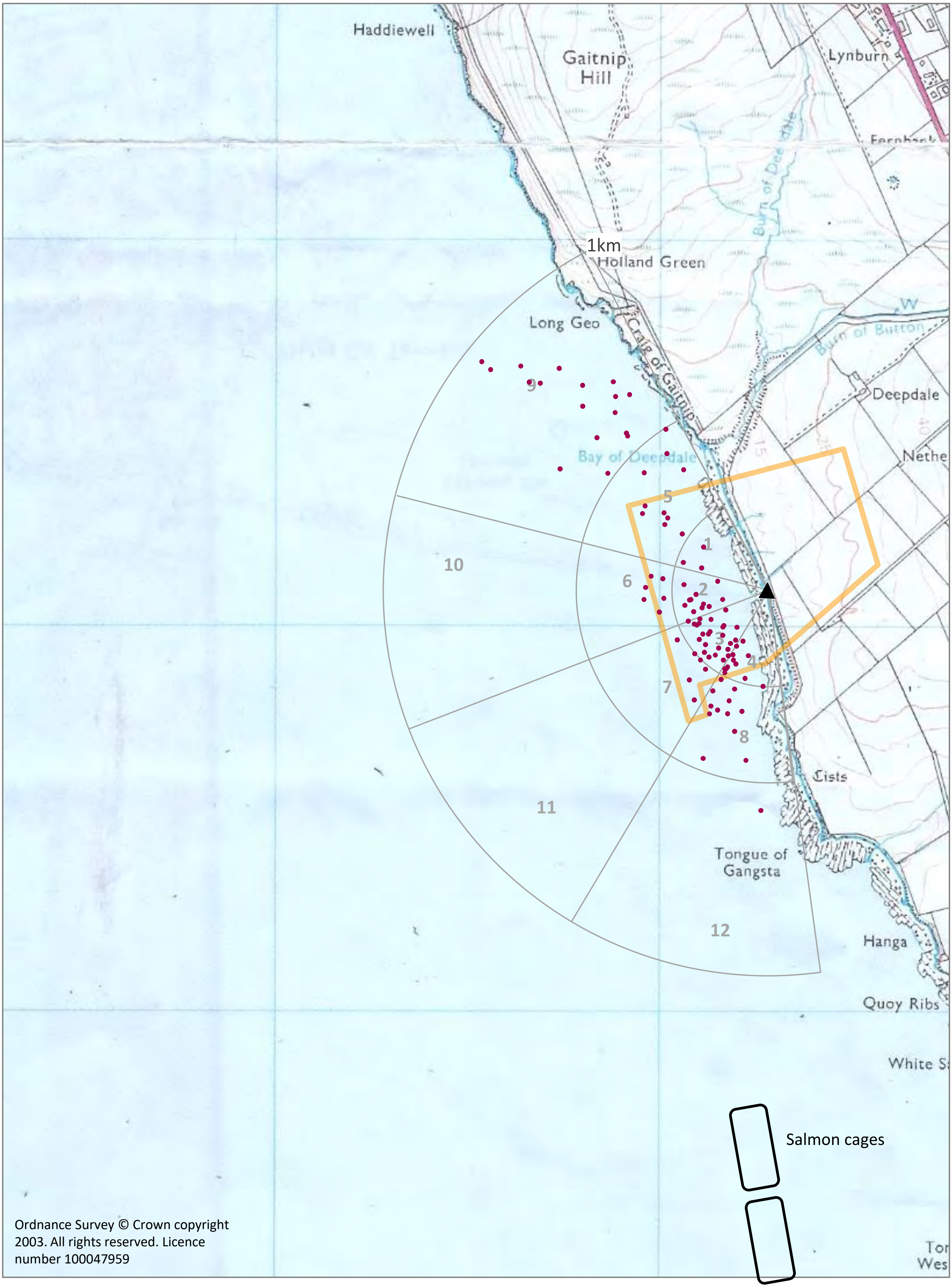
Slavonian Grebe – all Year 1 and Year 2 locations

• 1 – 4 birds
● 5 – 9 birds



Slavonian Grebe – all Year 1 locations, Dec-Apr 2020/21

Slavonian Grebe – all Year 1 movements, Dec-Apr 2020/21



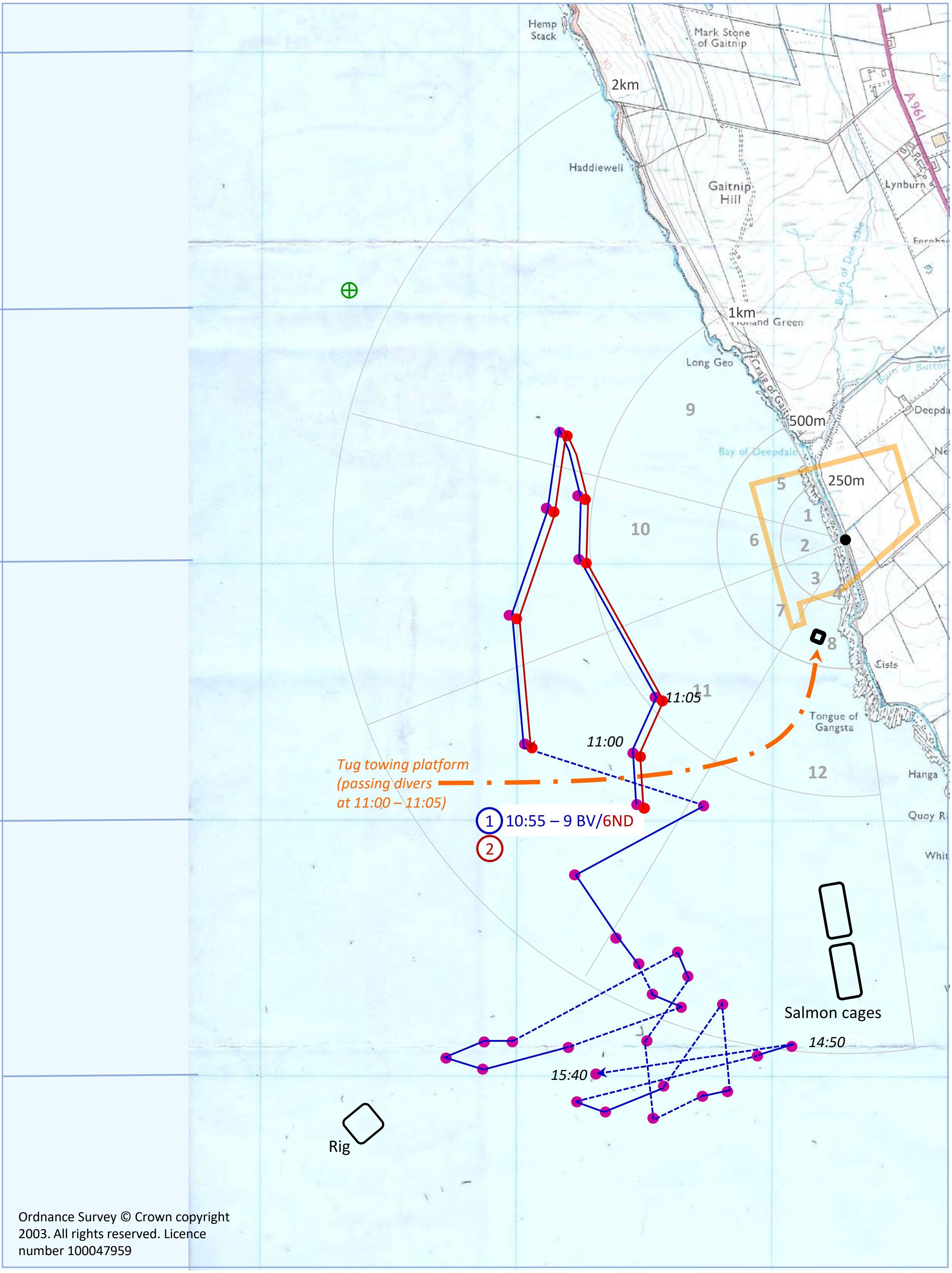
Slavonian Grebe – all Year 2 locations, Nov-Apr 2021/22

● 1 – 4 birds

Slavonian Grebe – all Year 2 movements, Nov-Apr 2021/22

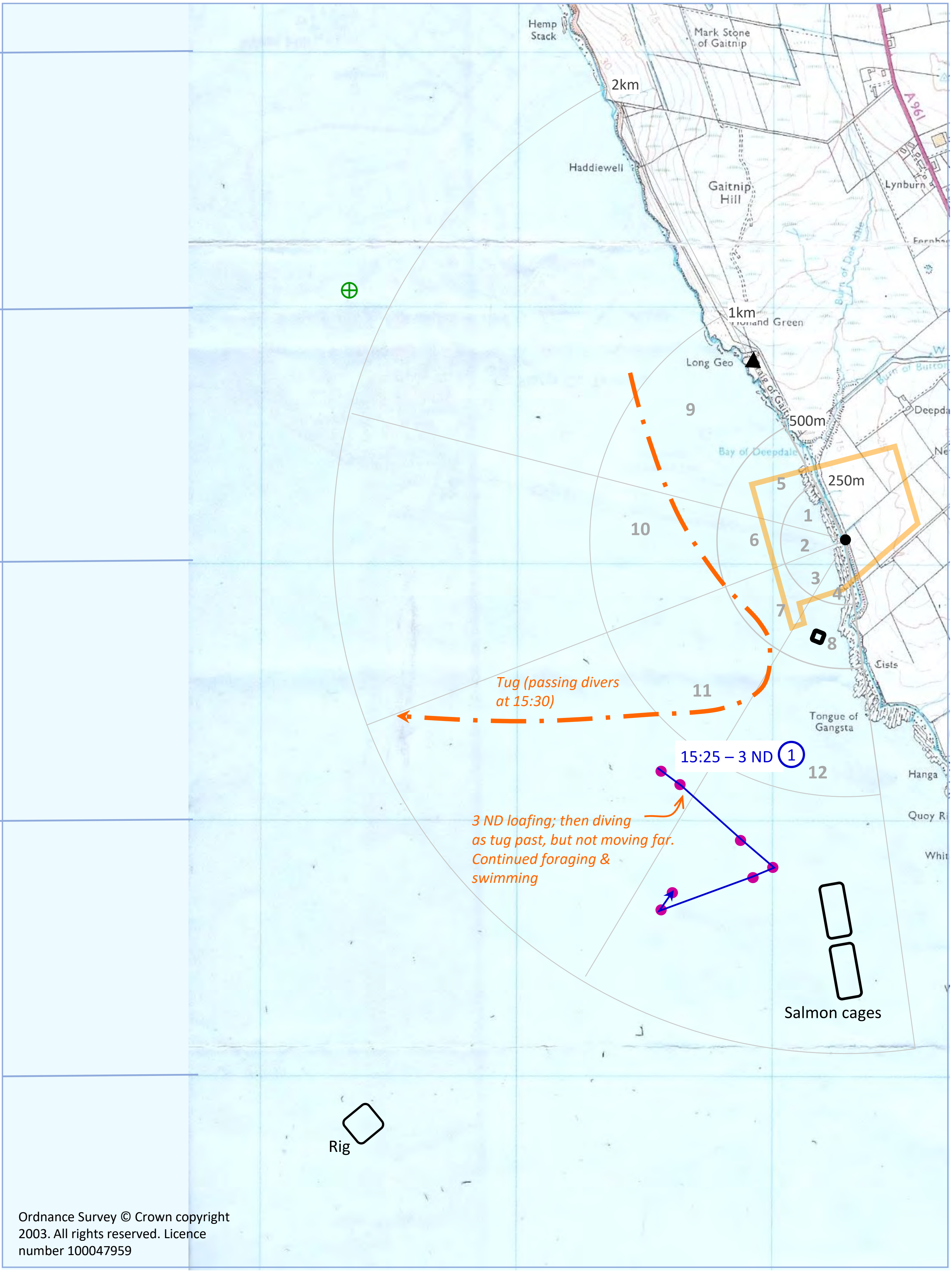
APPENDIX F

Boat interaction maps



14th Jan 2022 – Black-throated & Great Northern Diver/boat ineraction (@1)

Circles represent locations at approximate 5-minute intervals). Dotted lines indicate where birds were missed at an interval(s), i.e. two or more intervals between dots; dotted lines also shown from location at preceding count to first interval or after end of watch. Yellow dotted line indicates same birds from both watches. Compound line is birds flying.



24th Jan 2022 – Great Northern Diver/boat interaction (1)

Circles represent locations at approximate 5-minute intervals). Dotted lines indicate where birds were missed at an interval(s), i.e. two or more intervals between dots; dotted lines also shown from location at preceding count to first interval or after end of watch. Yellow dotted line indicates same birds from both watches. Compound line is birds flying.

Launch passing at 10:20 – 2BV & 1 ND sitting up but unmoved

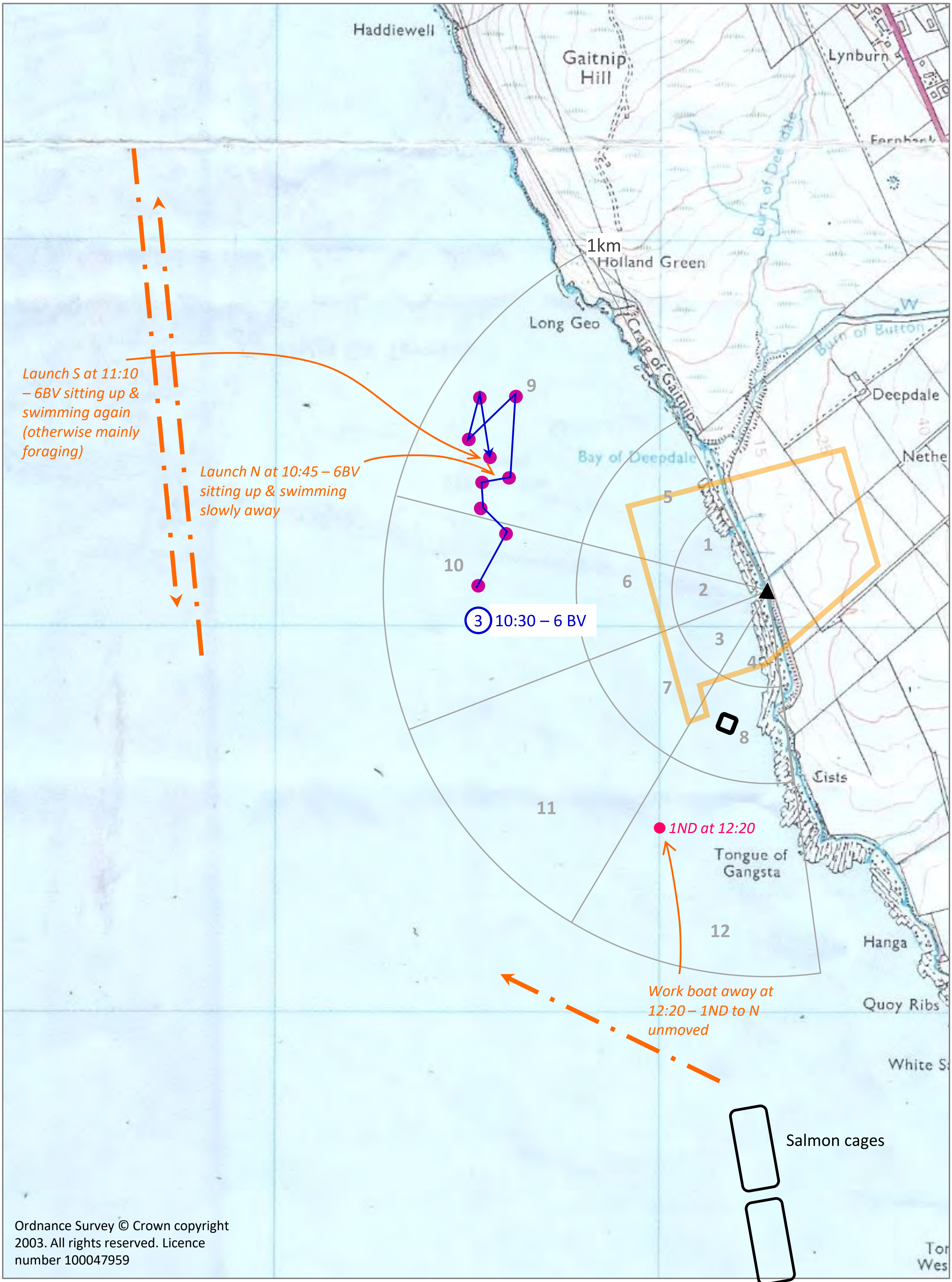
Work boat passing at 10:00 – 2BV swimming slowly away

10:00 – 1 ND ②

09:55 – 2 BV ①

7th Feb 2022 – Black-throated &Great Northern Diver/boat movements (@1)

Circles represent locations at approximate 5-minute intervals). Dotted lines indicate where birds were missed at an interval(s), i.e. two or more intervals between dots; dotted lines also shown from location at preceding count to first interval or after end of watch. Yellow dotted line indicates same birds from both watches. Compound line is birds flying.

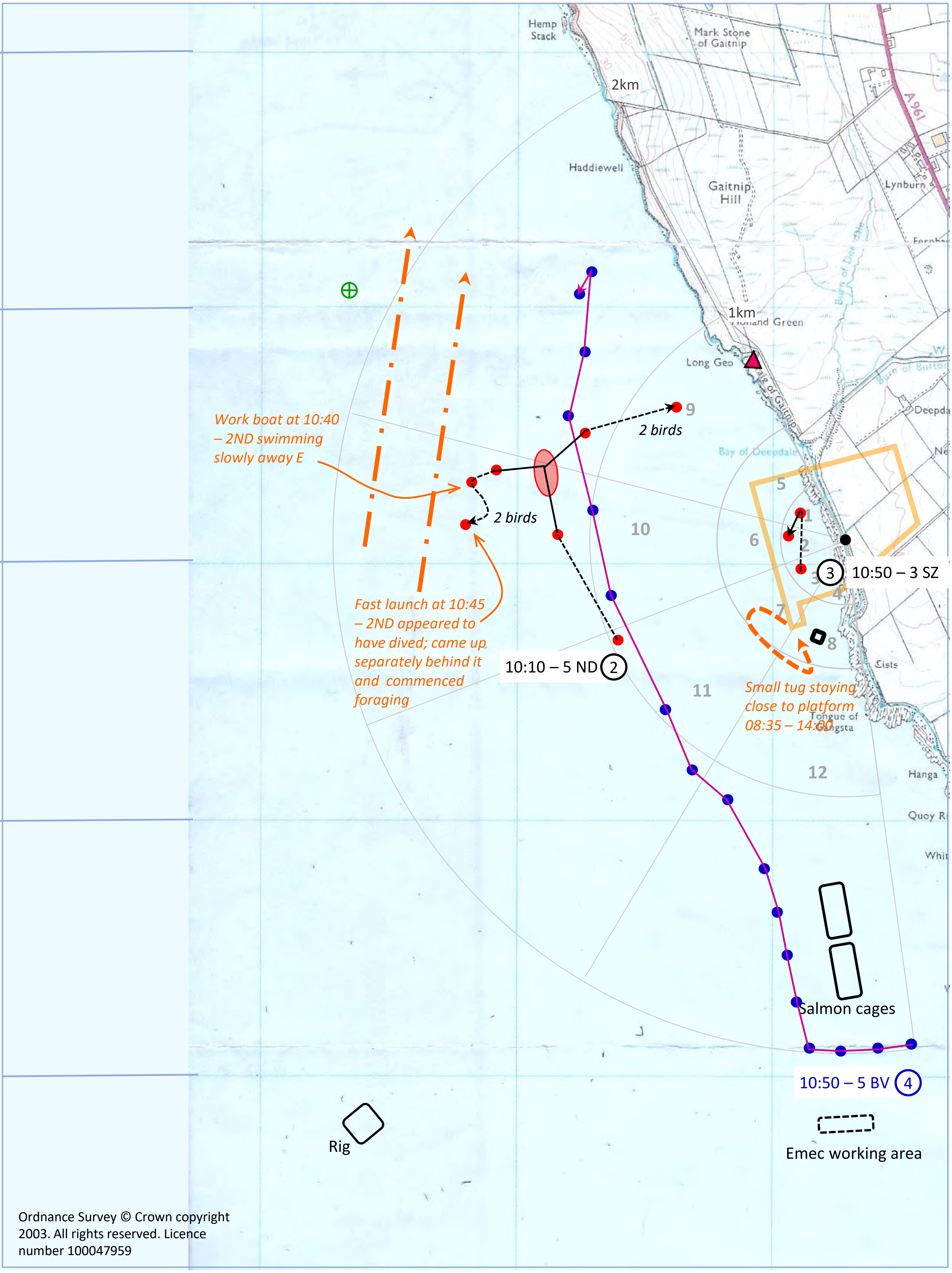


7th Feb 2022 – Black-throated & Great Northern Diver/boat interactions (2 and 1)
Circles represent locations at approximate 5-minute intervals). Dotted lines indicate where birds were missed at an interval(s), i.e. two or more intervals between dots; dotted lines also shown from location at preceding count to first interval or after end of watch. Yellow dotted line indicates same birds from both watches. Compound line is birds flying.

Small tug slowly in at 08:35 – 1ND & 3SZ swimming alertly but not moving far

4th March 22 – Great Northern Diver & Slavonian Grebe/boat interaction (@1)

Circles represent locations at approximate 5-minute intervals). Dotted lines indicate where birds were missed at an interval(s), i.e. two or more intervals between dots.



Work boat at 10:40 – 2ND swimming slowly away E

Fast launch at 10:45 – 2ND appeared to have dived; came up separately behind it and commenced foraging

10:10 – 5 ND ②

10:50 – 3 SZ ③

Small tug staying close to platform 08:35 – 14:00

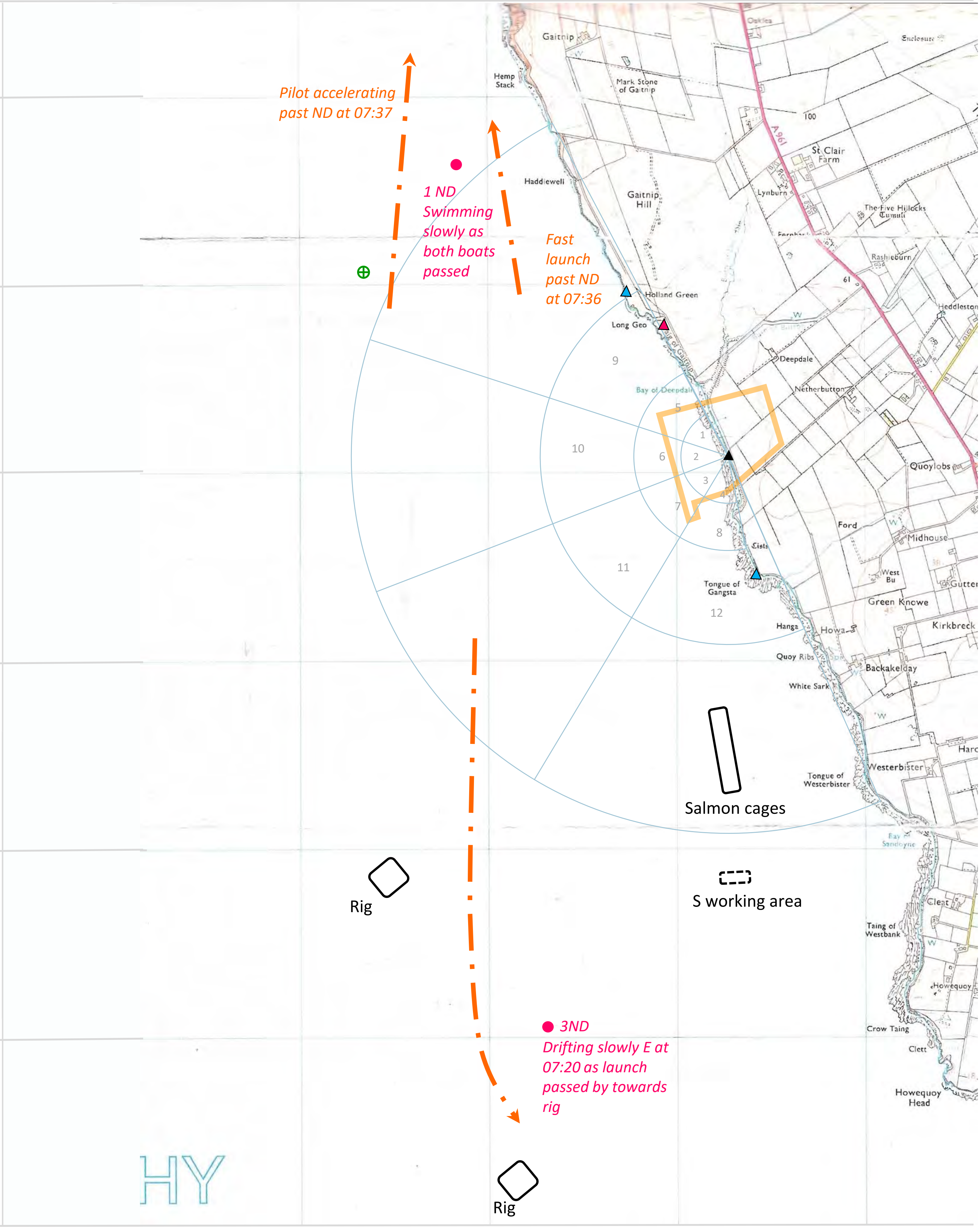
10:50 – 5 BV ④

4th March 22 – Great Northern & Black-throated Diver & Slavonian Grebe movements/ boat interactions (@1)

Circles represent locations at approximate 5-minute intervals). Dotted lines indicate where birds were missed at an interval(s), i.e. two or more intervals between dots.

Upper VP
7th March 2022

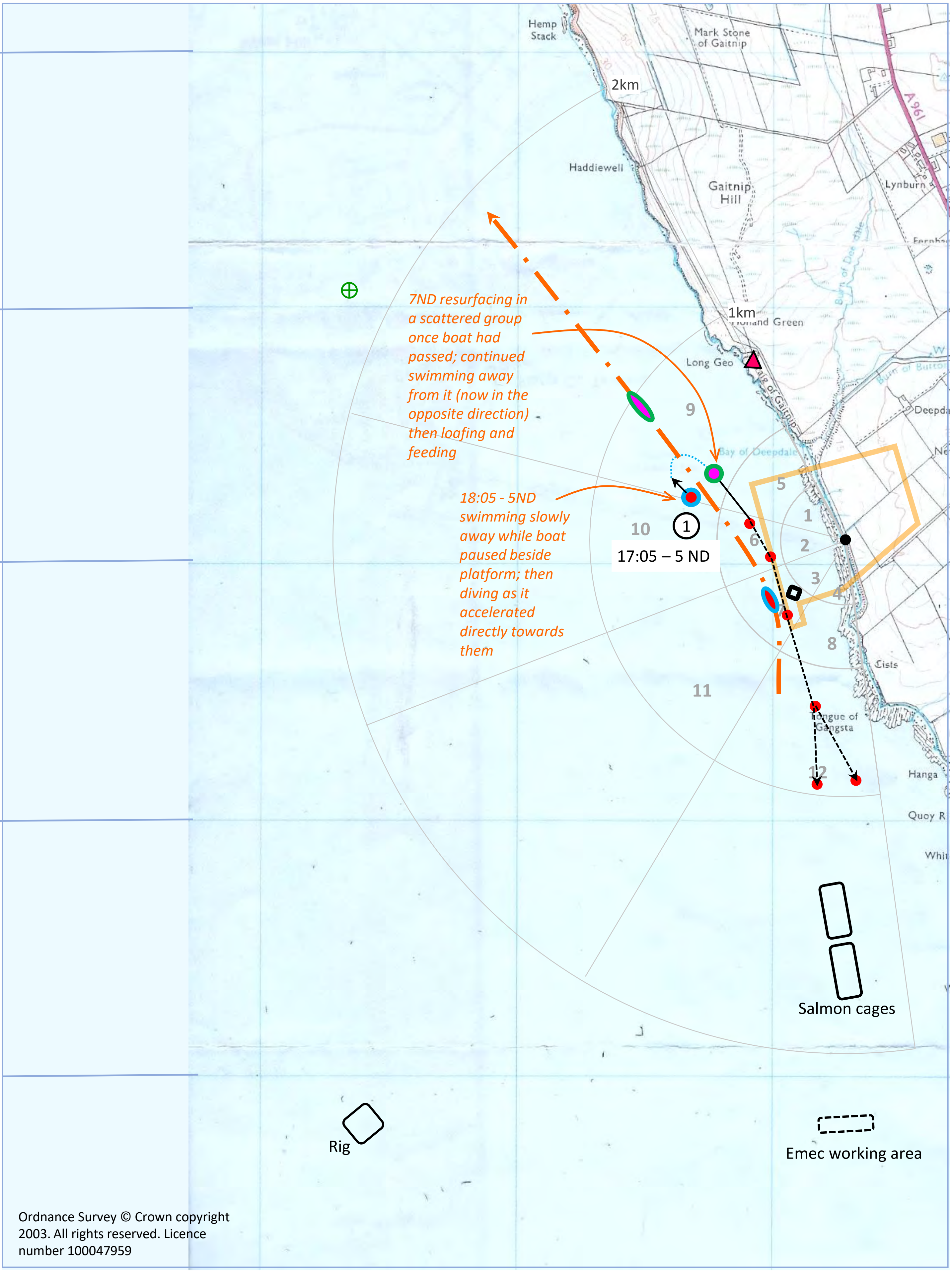
Great Northern Diver/boat interactions (3)


Pilot accelerating past ND at 07:37

1 ND Swimming slowly as both boats passed

Fast launch past ND at 07:36

3ND Drifting slowly E at 07:20 as launch passed by towards rig



7ND resurfacing in a scattered group once boat had passed; continued swimming away from it (now in the opposite direction) then loafing and feeding

18:05 - 5ND swimming slowly away while boat paused beside platform; then diving as it accelerated directly towards them

16th March 2022 – Great Northern Diver movement /boat interaction (1)

Circles represent locations at approximate 5-minute intervals). Dotted lines indicate where birds were missed at an interval(s), i.e. two or more intervals between dots.

07:40 – 1 ND no particular reaction while small boat arrived at platform; seen later even closer, while platform manned

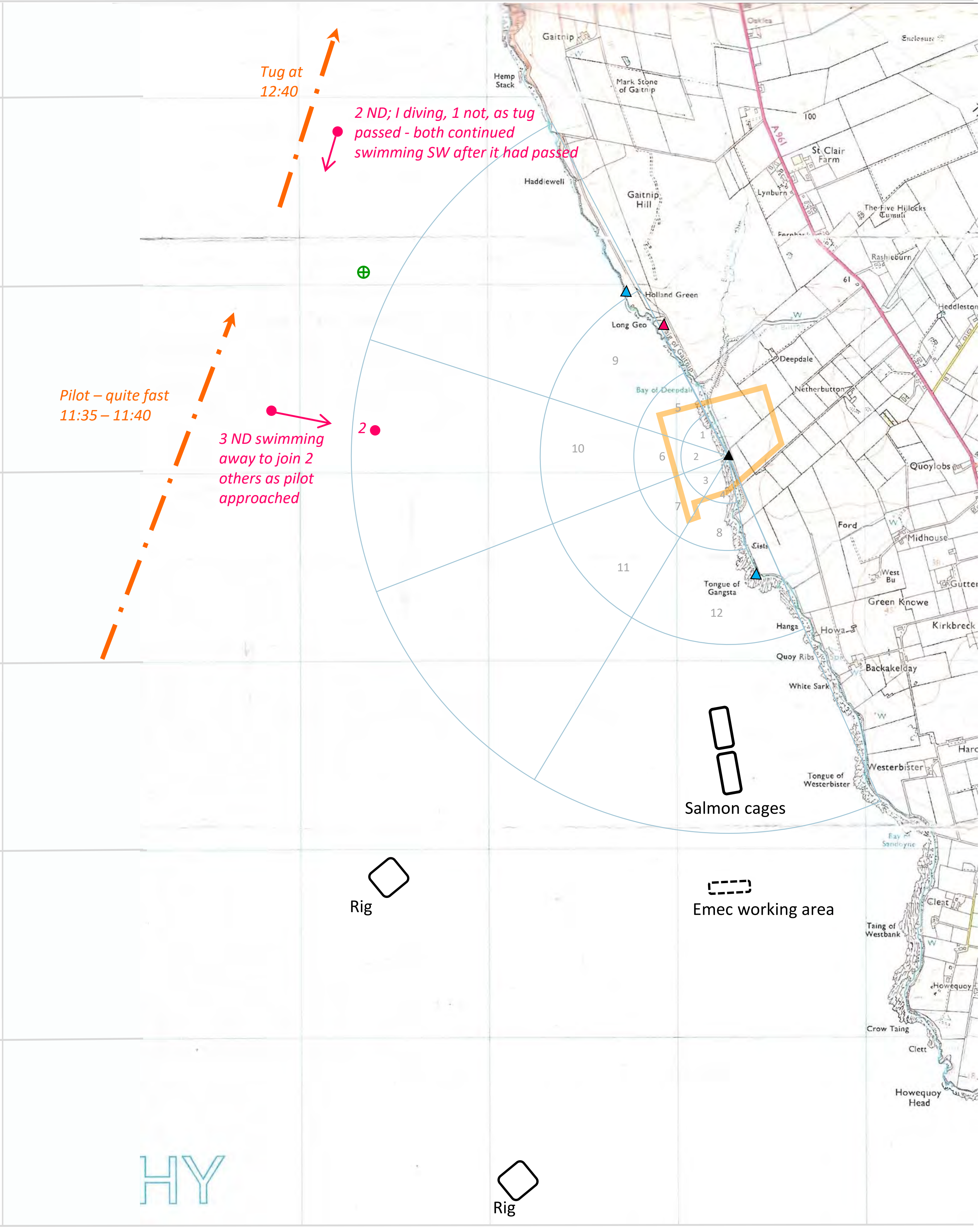
08:45 – 6 ND swimming unconcerned as fast launch passed

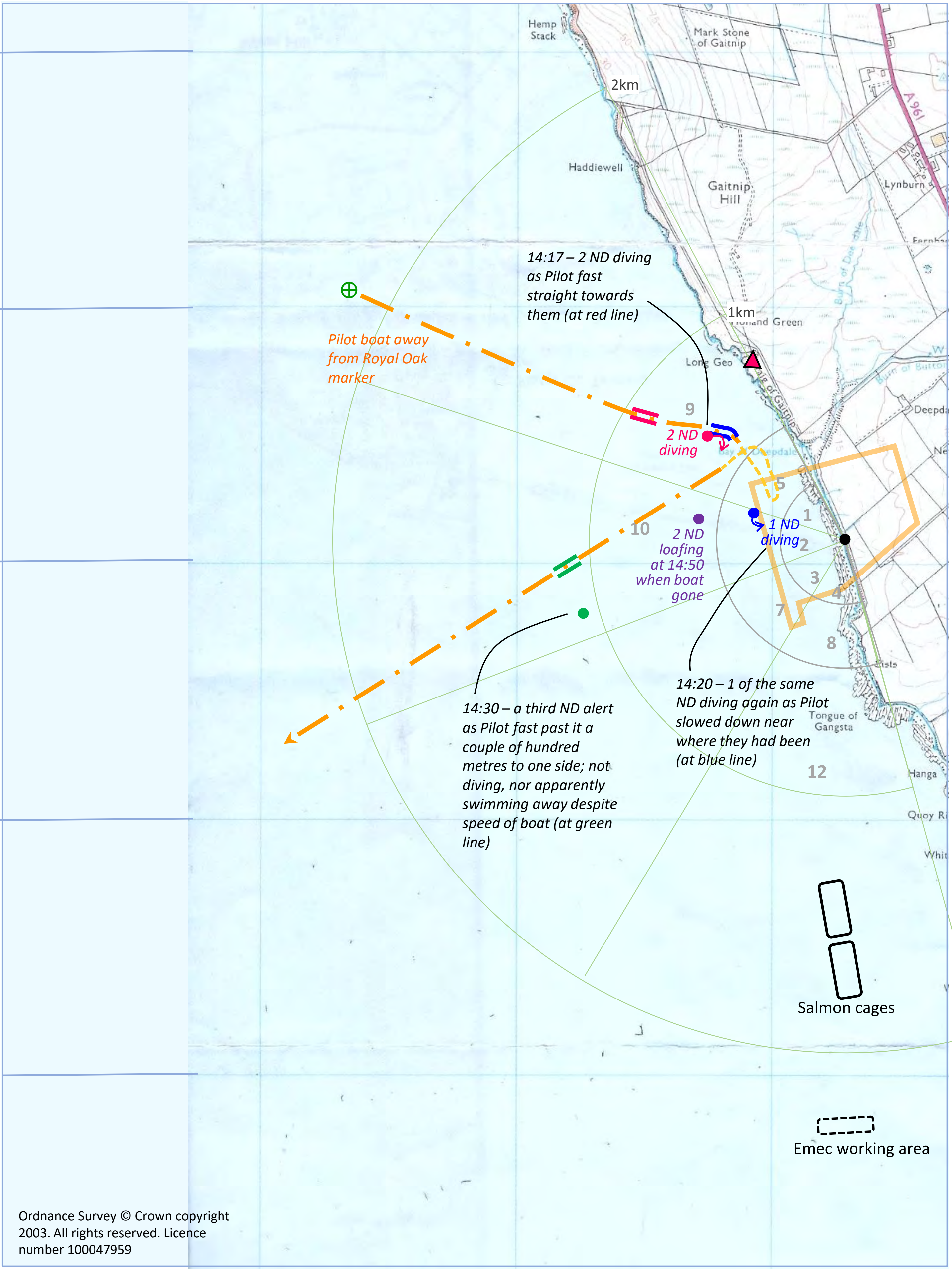
29th March 2022 – Great Northern Diver movements/boat interactions (2)

Circles represent locations at approximate 5-minute intervals). Dotted lines indicate where birds were missed at an interval(s), i.e. two or more intervals between dots.

Upper VP
2nd April 2022

Great Northern Diver/boat interactions (2)





14:17 – 2 ND diving as Pilot fast straight towards them (at red line)

Pilot boat away from Royal Oak marker

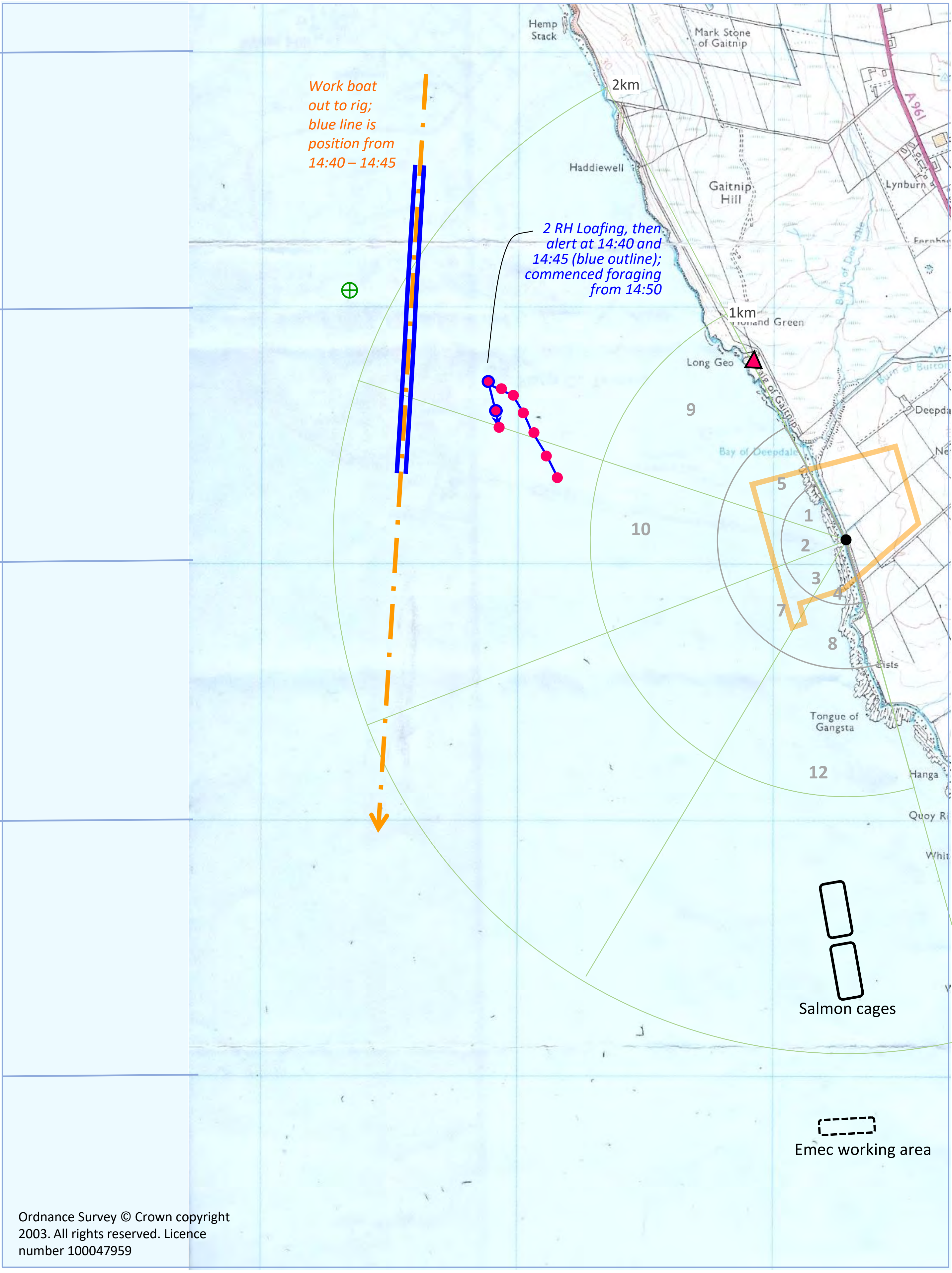
2 ND loafing at 14:50 when boat gone

14:30 – a third ND alert as Pilot fast past it a couple of hundred metres to one side; not diving, nor apparently swimming away despite speed of boat (at green line)

14:20 – 1 of the same ND diving again as Pilot slowed down near where they had been (at blue line)

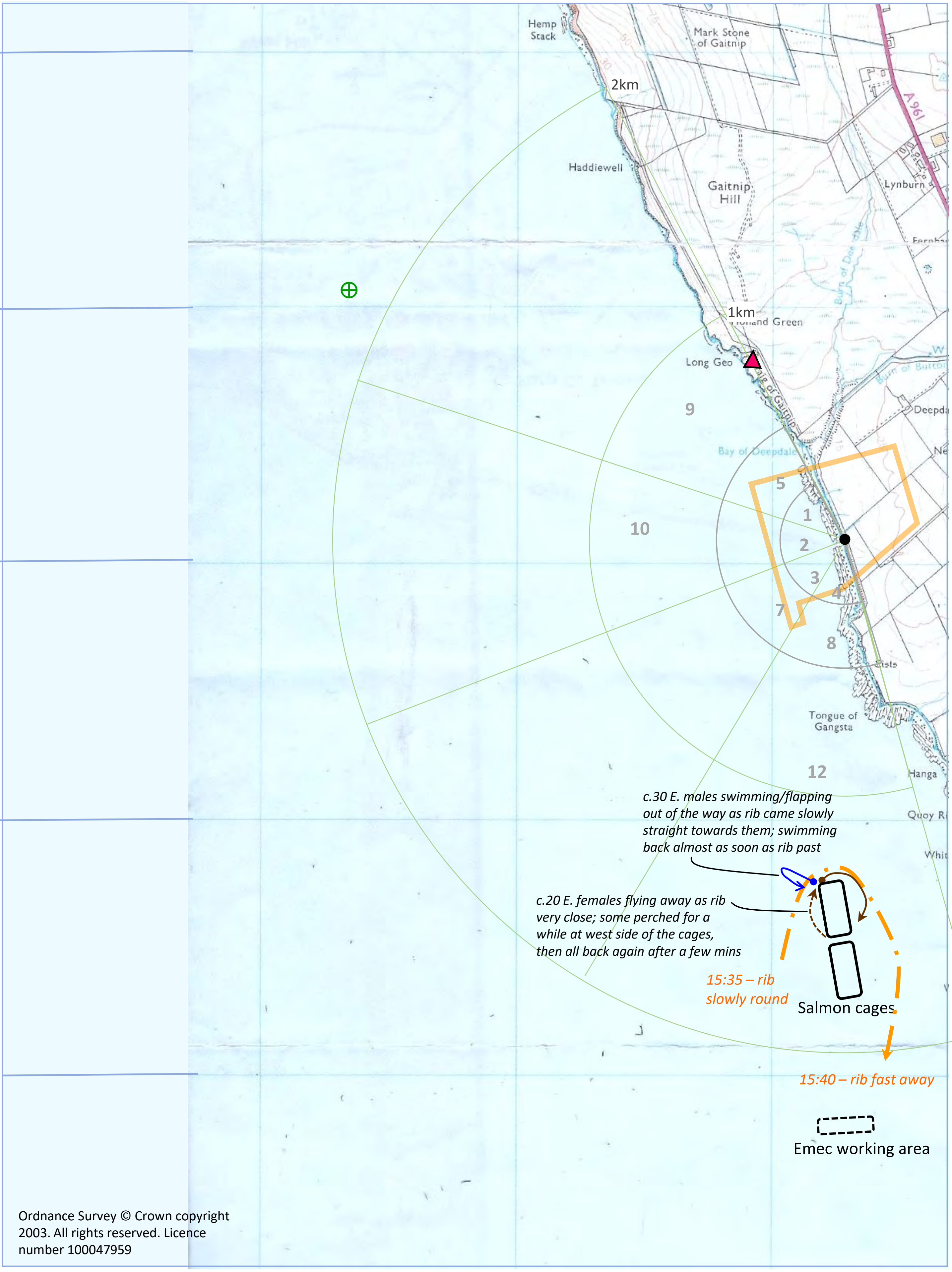
20th April 2022 – Great Northern Diver/boat interactions (3)

Orange track is Pilot boat – lighter orange & dotted where moving much more slowly. Two divers reacting on its initial approach and one of them diving again; two loafing nearby at 14:50 after boat had gone thought to be the same birds. A third diver alert only as boat passed to the side of it.



9th June 2022 – Red-throated Diver/boat interactions (1)

Orange track is Pilot boat – lighter orange & dotted where moving much more slowly. Two divers reacting on its initial approach and one of them diving again; two loafing nearby at 14:50 after boat had gone thought to be the same birds. A third diver alert only as boat passed to the side of it.



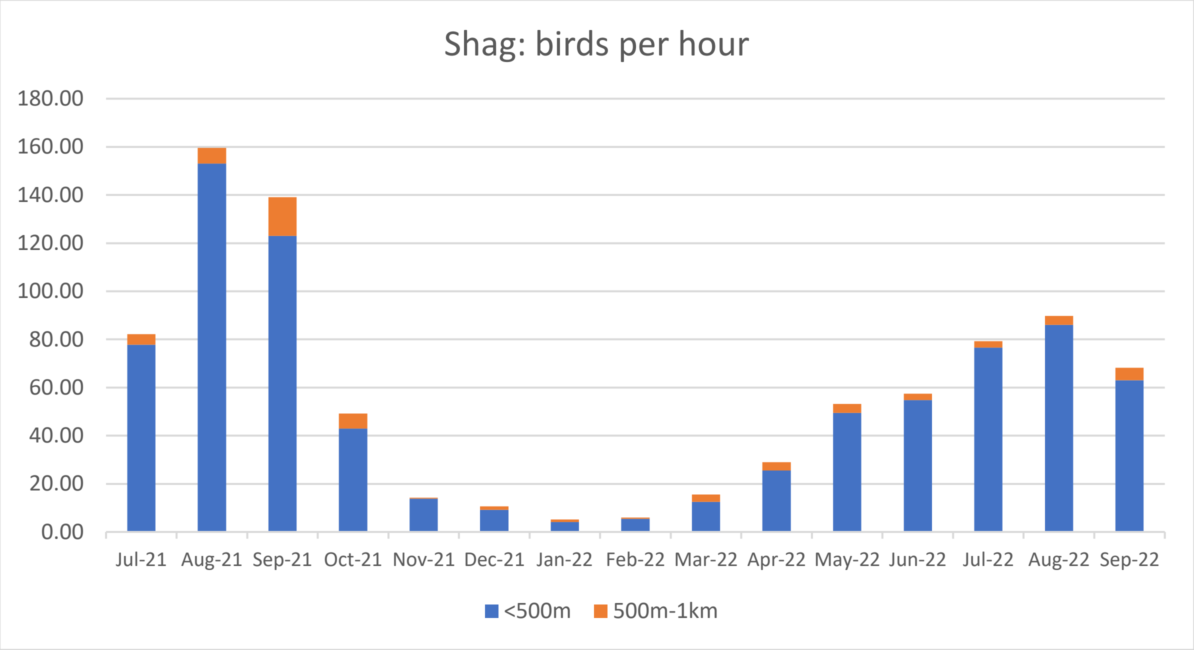
23rd July 2022 – Eider/boat interactions (2)

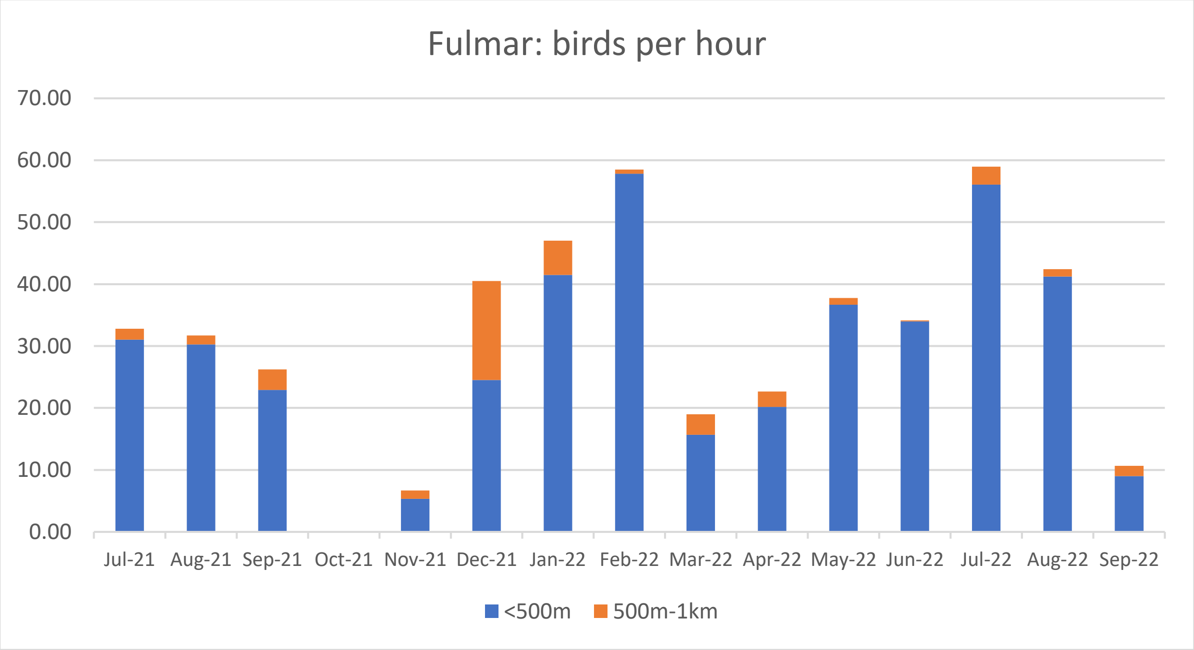
Orange track is Pilot boat – lighter orange & dotted where moving much more slowly. Two divers reacting on its initial approach and one of them diving again; two loafing nearby at 14:50 after boat had gone thought to be the same birds. A third diver alert only as boat passed to the side of it.

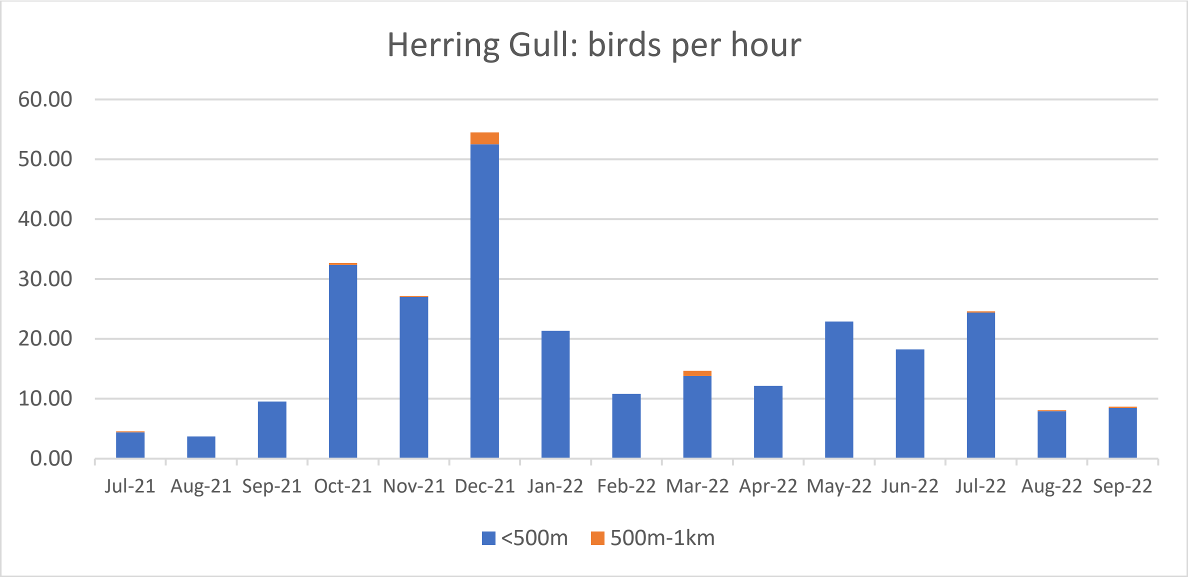
APPENDIX G

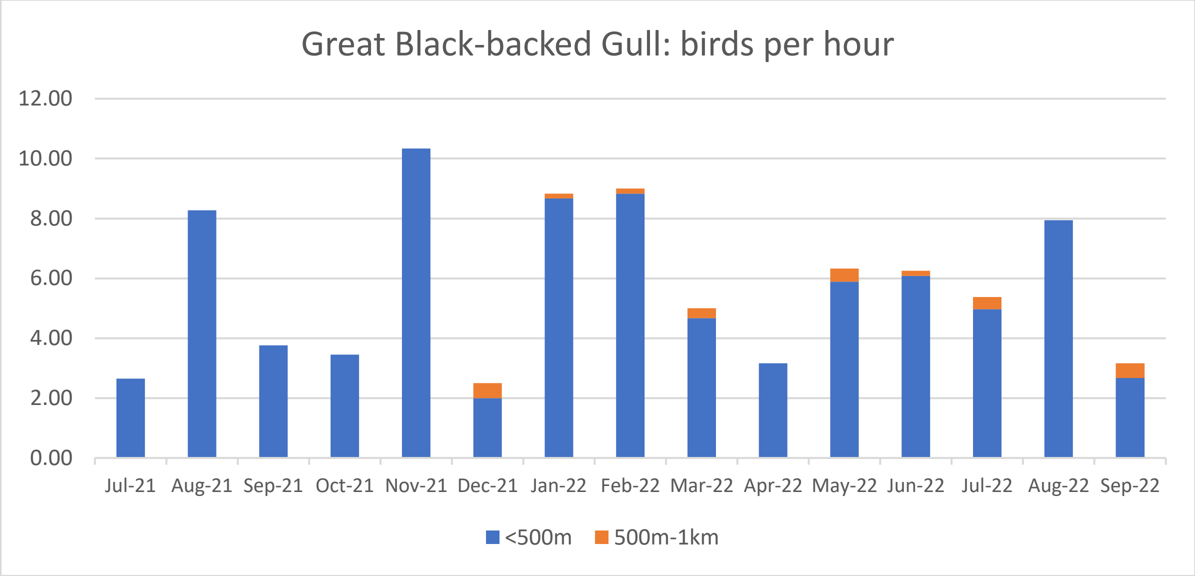
Flight logging bar-charts

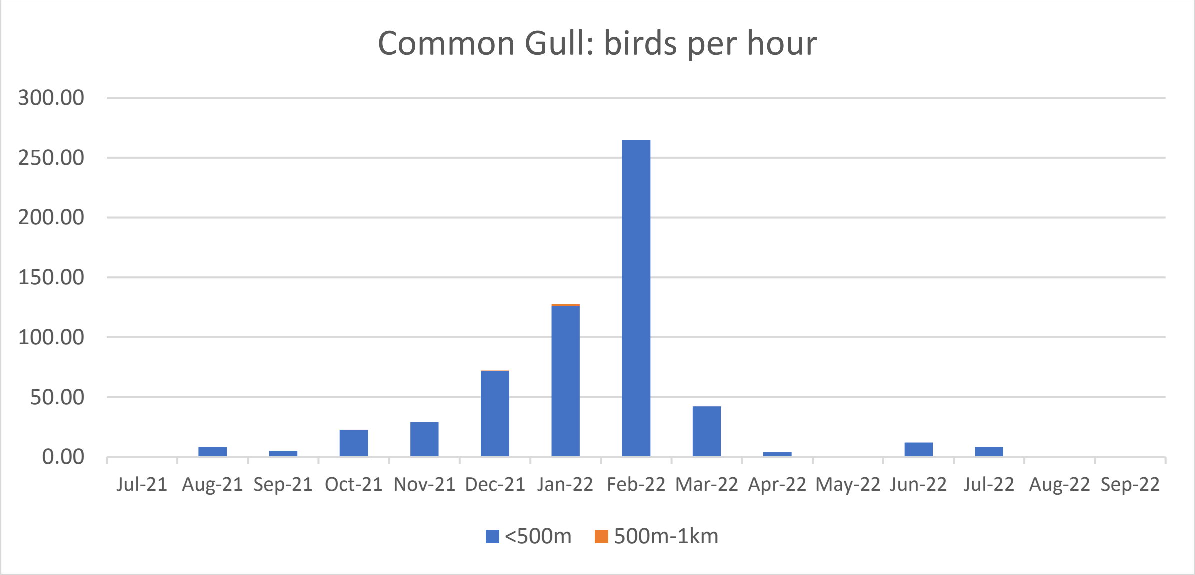
Bird movements per hour past the site: July 2021 to September 2022

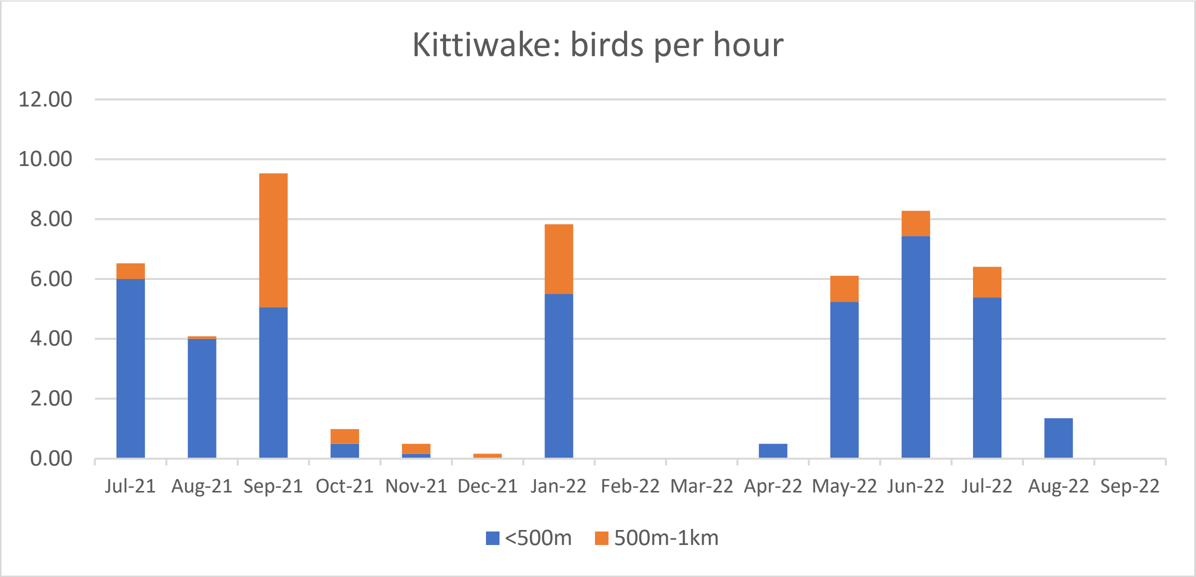


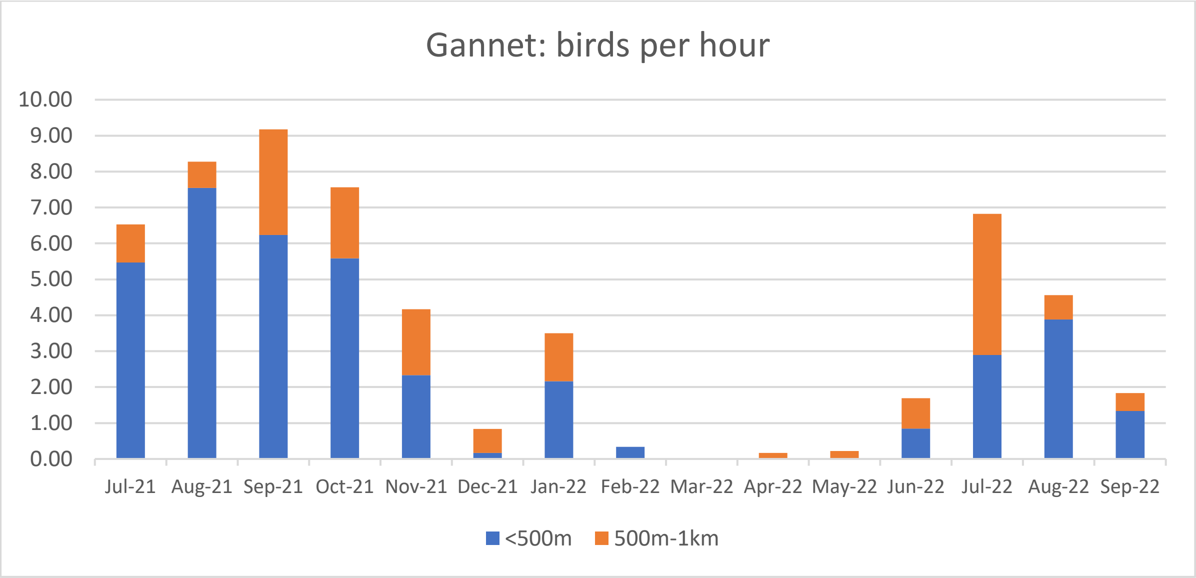


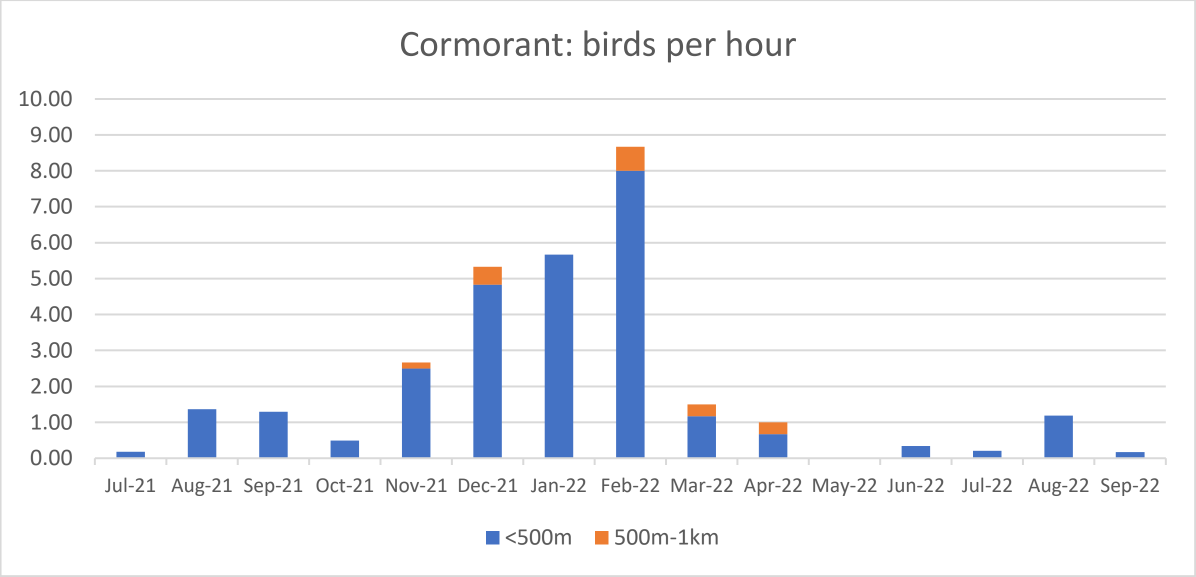

Herring Gull: birds per hour
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22
Mar-22
Apr-22
May-22
Jun-22
Jul-22
Aug-22
Sep-22
<500m
500m-1km

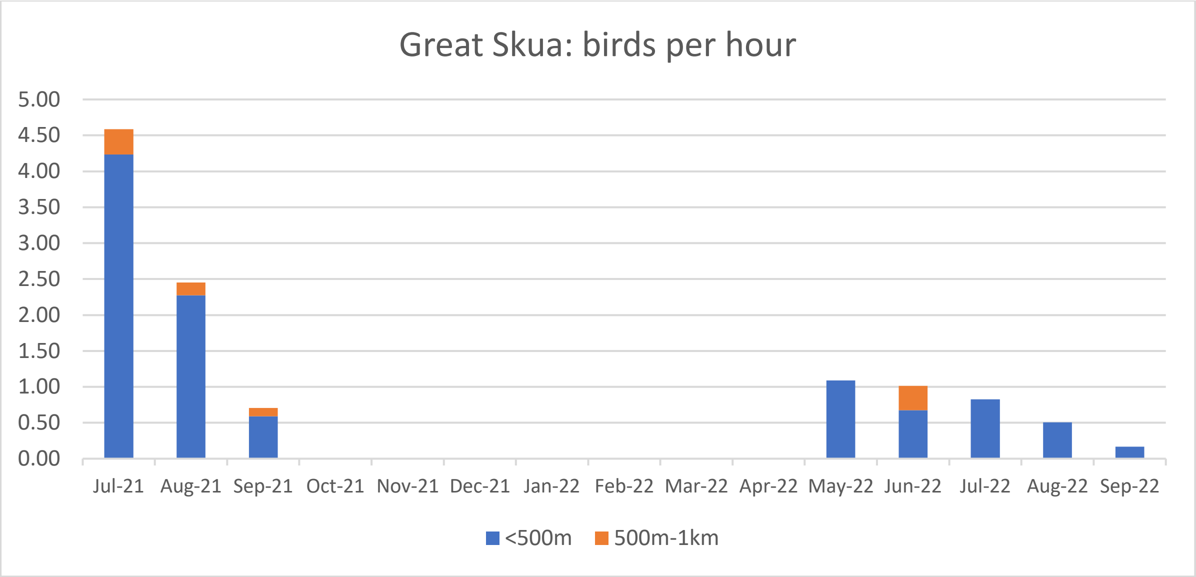

Great Black-backed Gull: birds per hour
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22
Mar-22
Apr-22
May-22
Jun-22
Jul-22
Aug-22
Sep-22
<500m
500m-1km

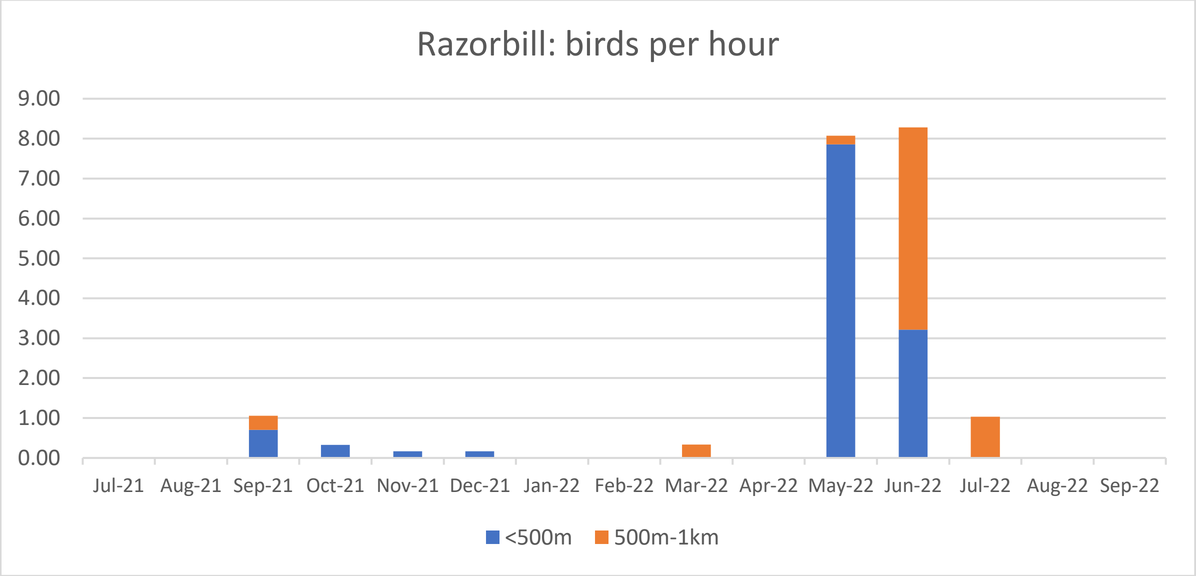

Common Gull: birds per hour
300.00
250.00
200.00
150.00
100.00
50.00
0.00
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22
Mar-22
Apr-22
May-22
Jun-22
Jul-22
Aug-22
Sep-22
<500m
500m-1km

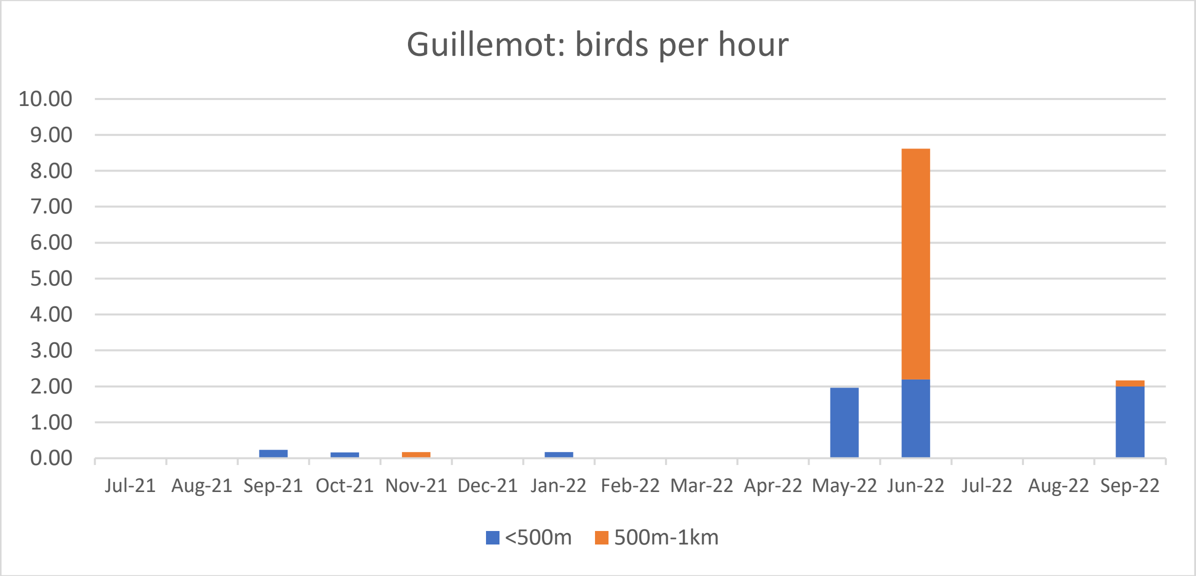

Kittiwake: birds per hour
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22
Mar-22
Apr-22
May-22
Jun-22
Jul-22
Aug-22
Sep-22
🟦 <500m
🟧 500m-1km

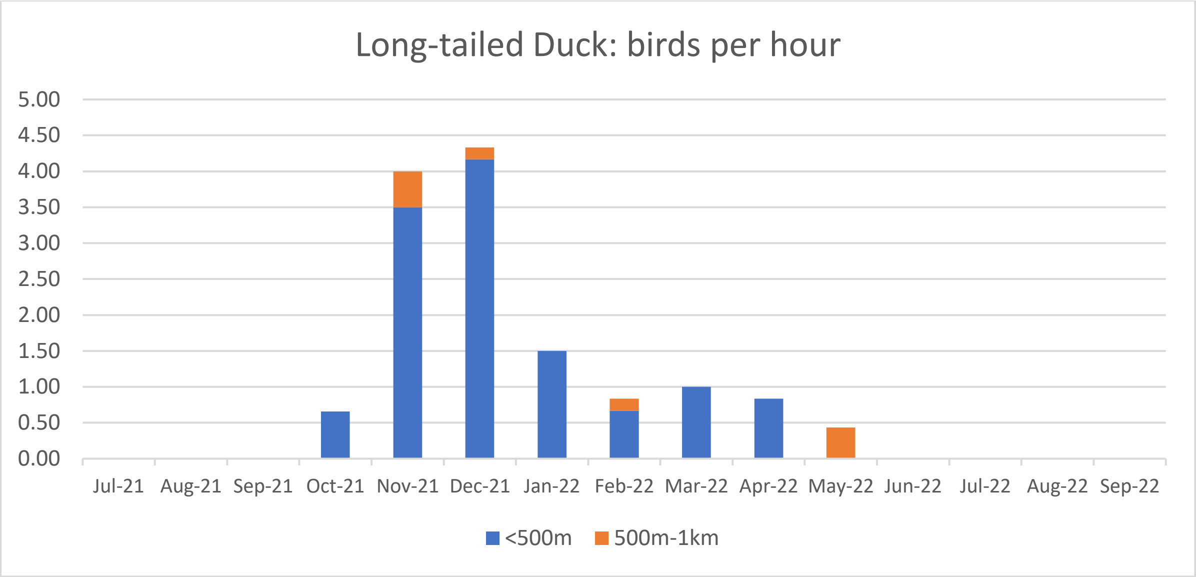

Gannet: birds per hour
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22
Mar-22
Apr-22
May-22
Jun-22
Jul-22
Aug-22
Sep-22
🟦 <500m
🟧 500m-1km


Cormorant: birds per hour
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22
Mar-22
Apr-22
May-22
Jun-22
Jul-22
Aug-22
Sep-22
🟦 <500m
🟧 500m-1km


Great Skua: birds per hour
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22
Mar-22
Apr-22
May-22
Jun-22
Jul-22
Aug-22
Sep-22
<500m
500m-1km


Razorbill: birds per hour
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22
Mar-22
Apr-22
May-22
Jun-22
Jul-22
Aug-22
Sep-22
<500m
500m-1km


Guillemot: birds per hour
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22
Mar-22
Apr-22
May-22
Jun-22
Jul-22
Aug-22
Sep-22
<500m
500m-1km


Long-tailed Duck: birds per hour
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21
Jan-22
Feb-22
Mar-22
Apr-22
May-22
Jun-22
Jul-22
Aug-22
Sep-22
<500m
500m-1km

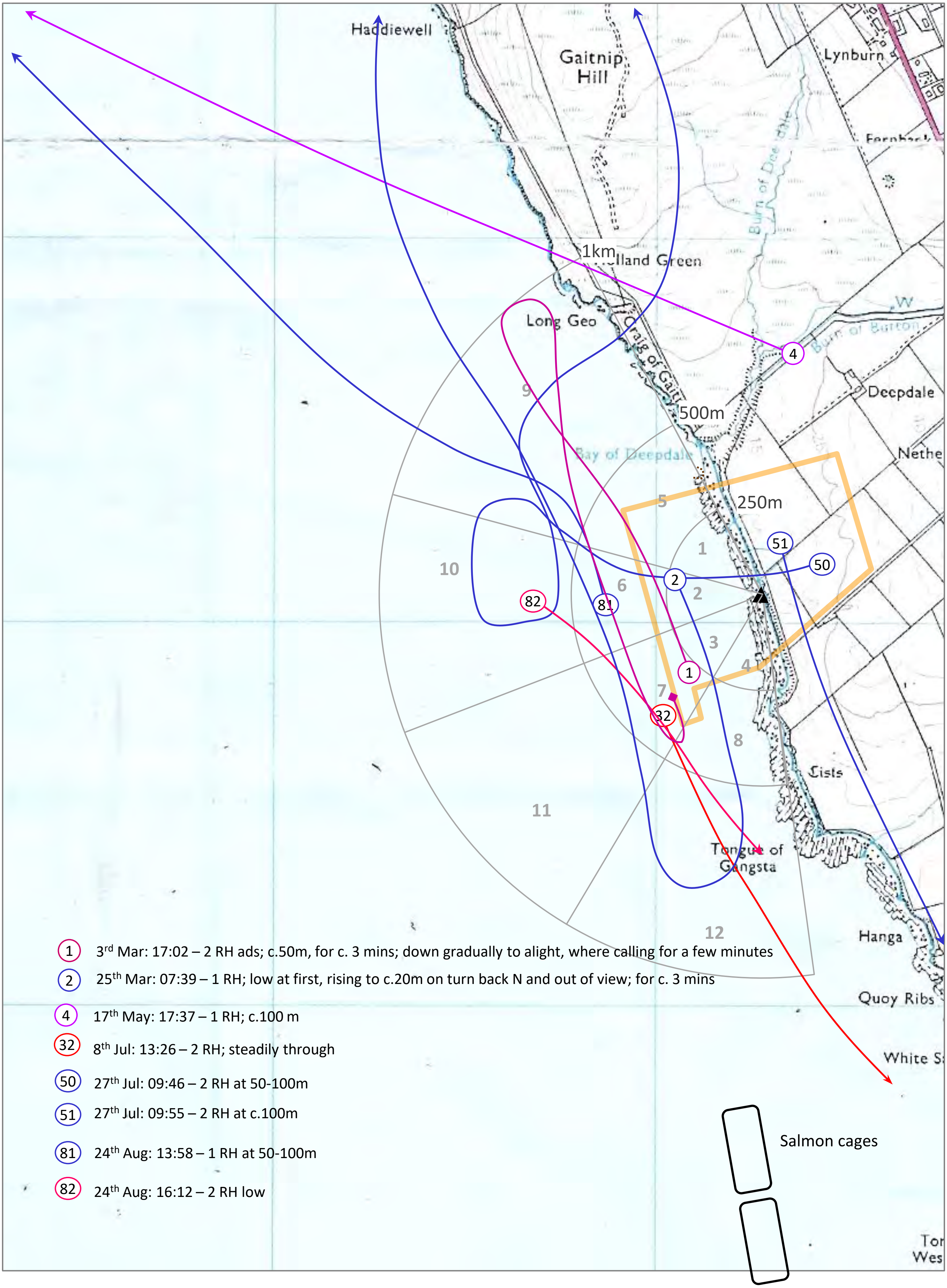
APPENDIX H i

Year 1 offshore flight maps:

Red-throated Diver, Arctic Skua, Arctic Tern and Common Tern

Red-throated Diver flights 2021

Thin line – one bird; thick line – two birds



① 3rd Mar: 17:02 – 2 RH ads; c.50m, for c. 3 mins; down gradually to alight, where calling for a few minutes

② 25th Mar: 07:39 – 1 RH; low at first, rising to c.20m on turn back N and out of view; for c. 3 mins

④ 17th May: 17:37 – 1 RH; c.100 m

㉜ 8th Jul: 13:26 – 2 RH; steadily through

㊿ 27th Jul: 09:46 – 2 RH at 50-100m

(51) 27th Jul: 09:55 – 2 RH at c.100m

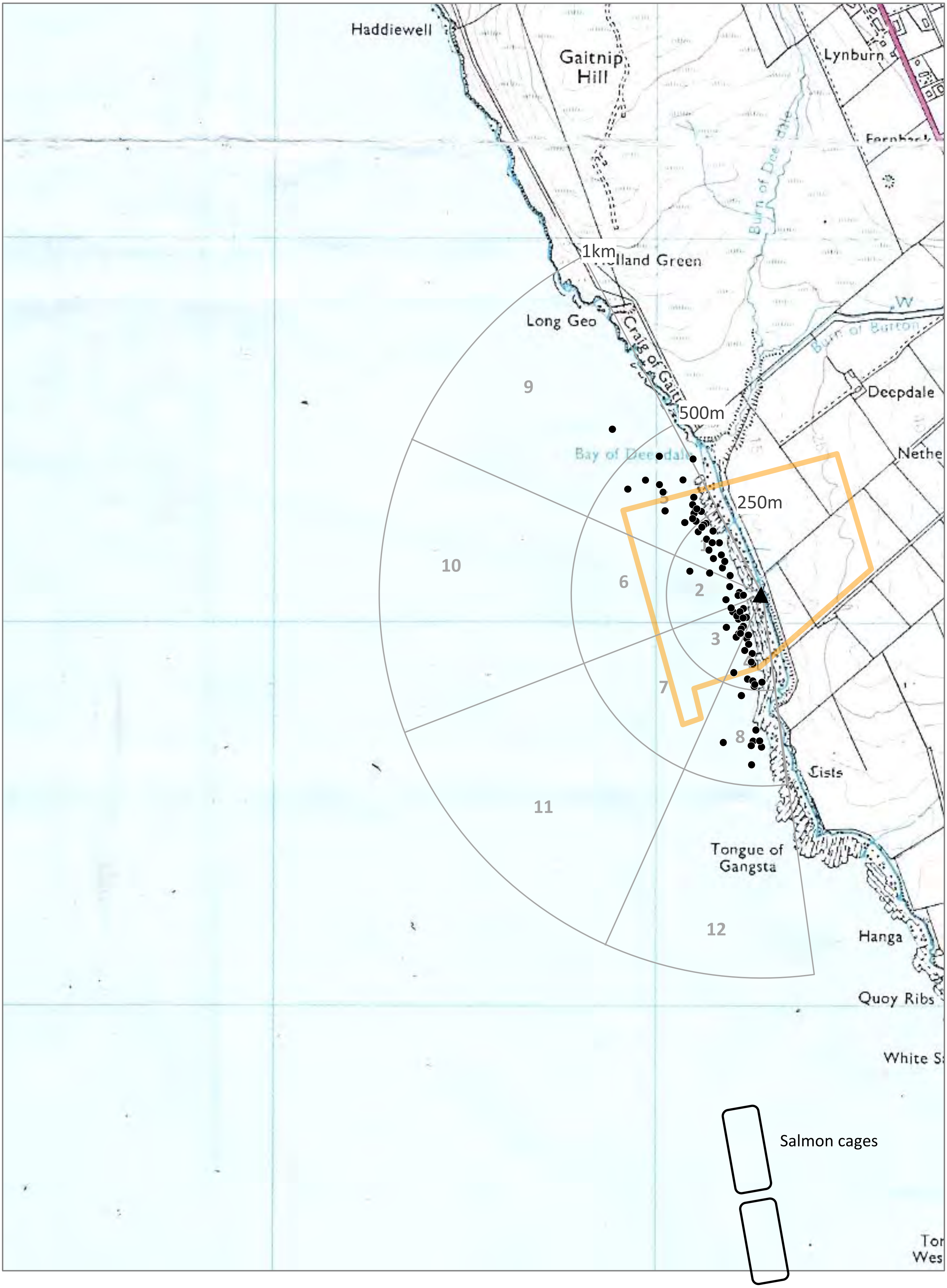
(81) 24th Aug: 13:58 – 1 RH at 50-100m

(82) 24th Aug: 16:12 – 2 RH low

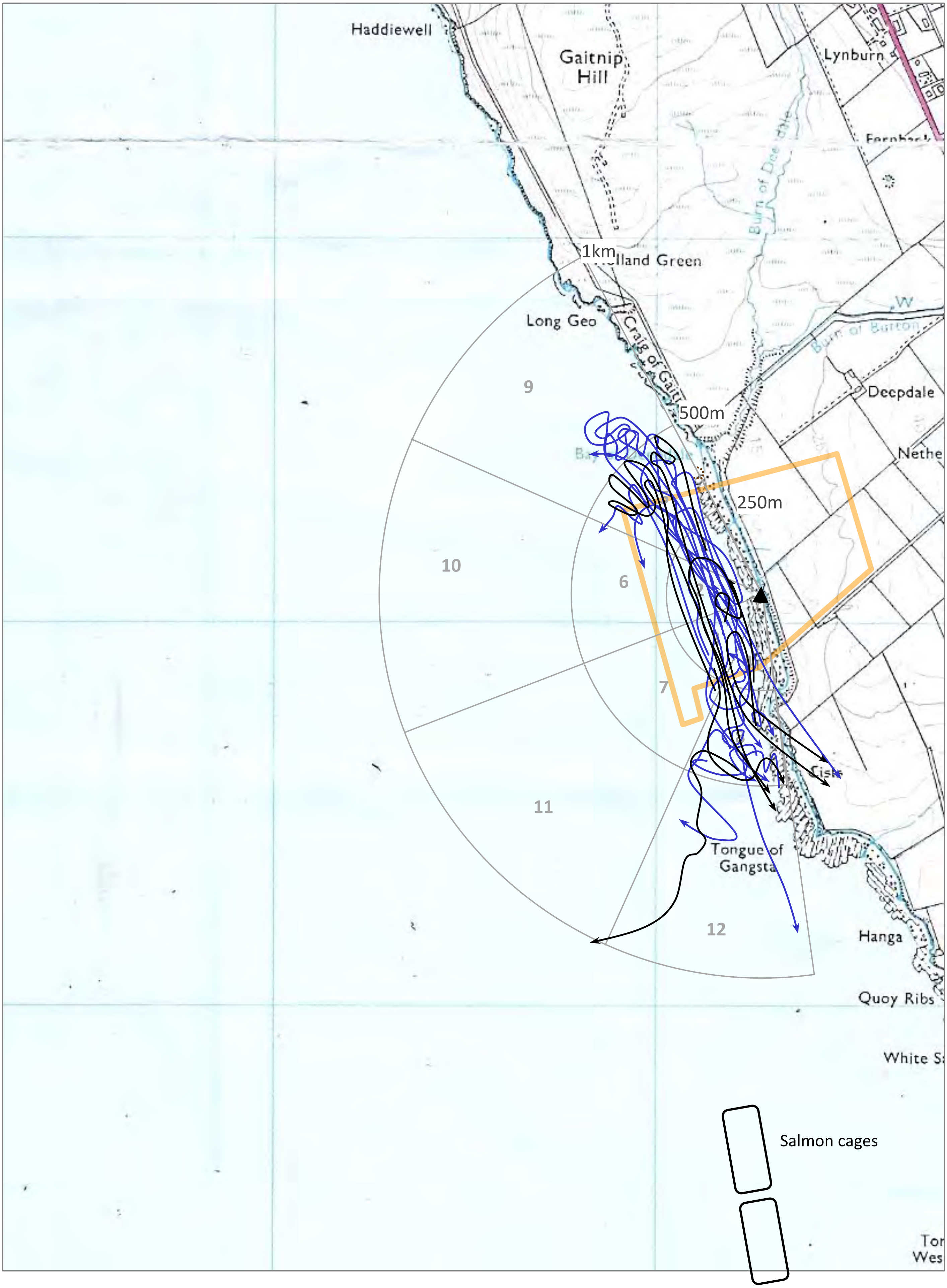
Red-throated Diver flights 2021

Arctic Skua flights 2021

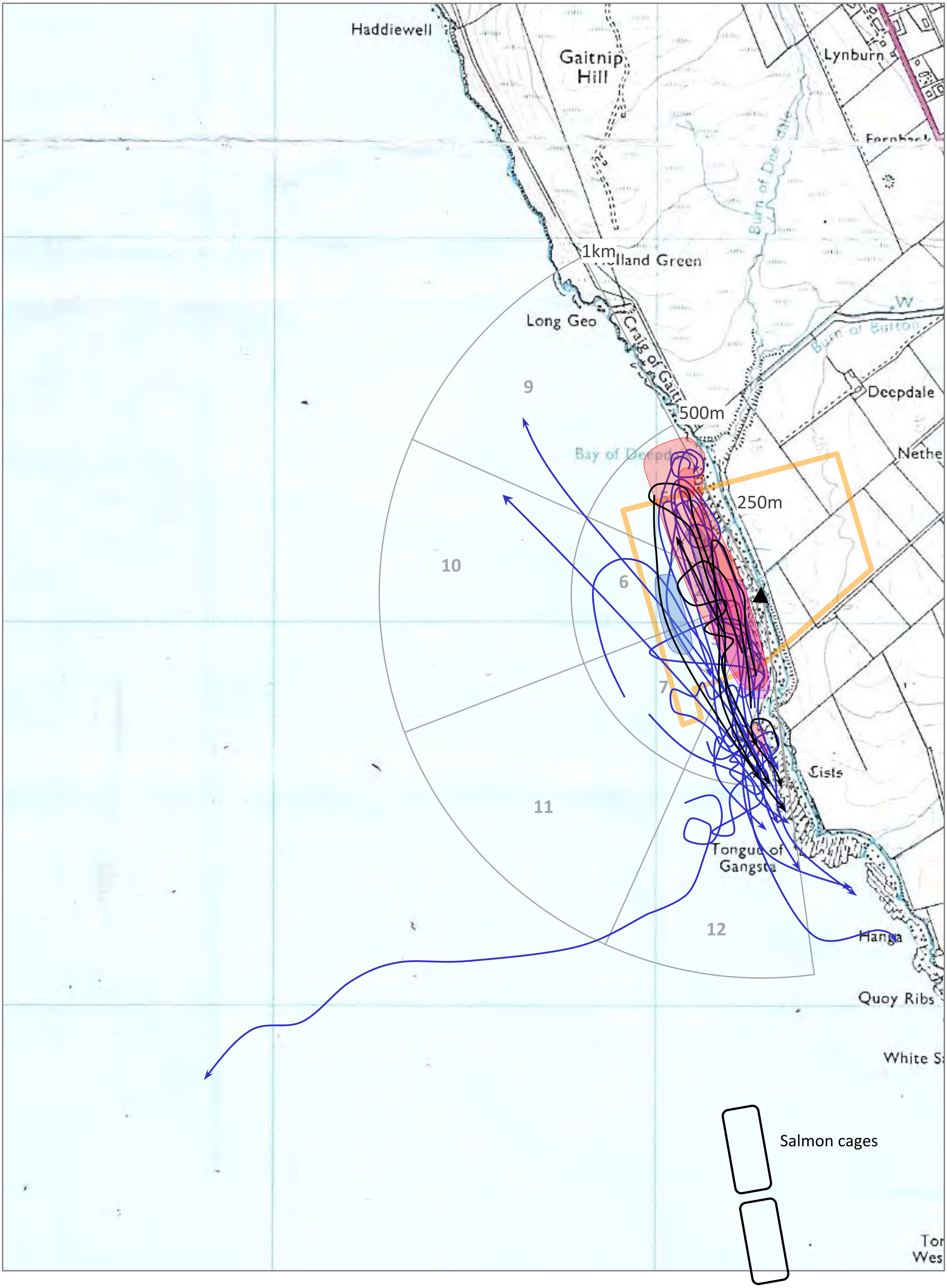
Arctic Skua flights 2021



Arctic Tern flight plunges – June-July 2021
circle is a plunge for fish (successful or not)

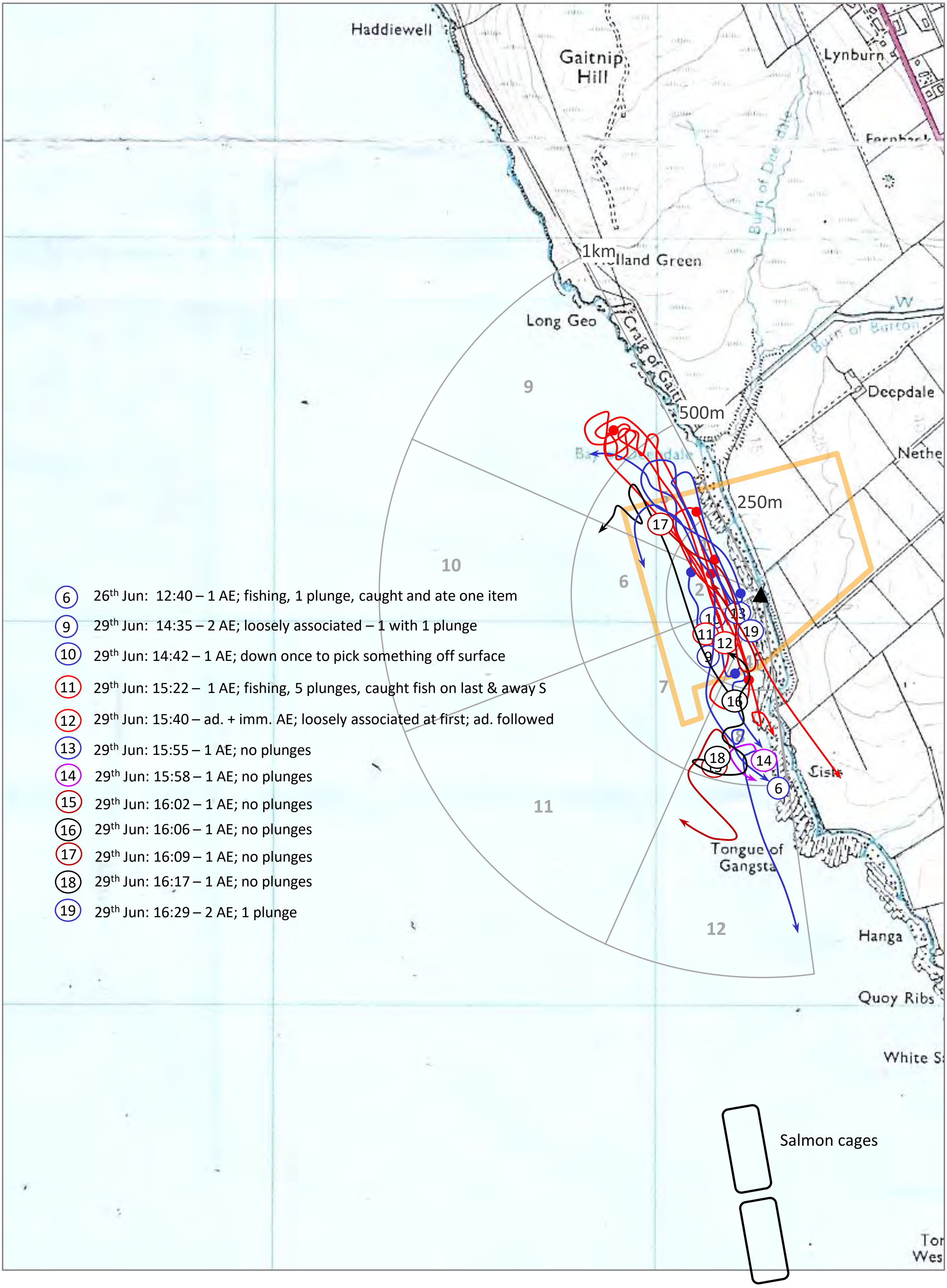


Arctic Tern flight paths – June 2021



Arctic Tern flight paths – July 2021

Arctic Tern flight paths – August 2021



⑥ 26th Jun: 12:40 – 1 AE; fishing, 1 plunge, caught and ate one item

⑨ 29th Jun: 14:35 – 2 AE; loosely associated – 1 with 1 plunge

⑩ 29th Jun: 14:42 – 1 AE; down once to pick something off surface

⑪ 29th Jun: 15:22 – 1 AE; fishing, 5 plunges, caught fish on last & away S

⑫ 29th Jun: 15:40 – ad. + imm. AE; loosely associated at first; ad. followed

⑬ 29th Jun: 15:55 – 1 AE; no plunges

⑭ 29th Jun: 15:58 – 1 AE; no plunges

⑮ 29th Jun: 16:02 – 1 AE; no plunges

⑯ 29th Jun: 16:06 – 1 AE; no plunges

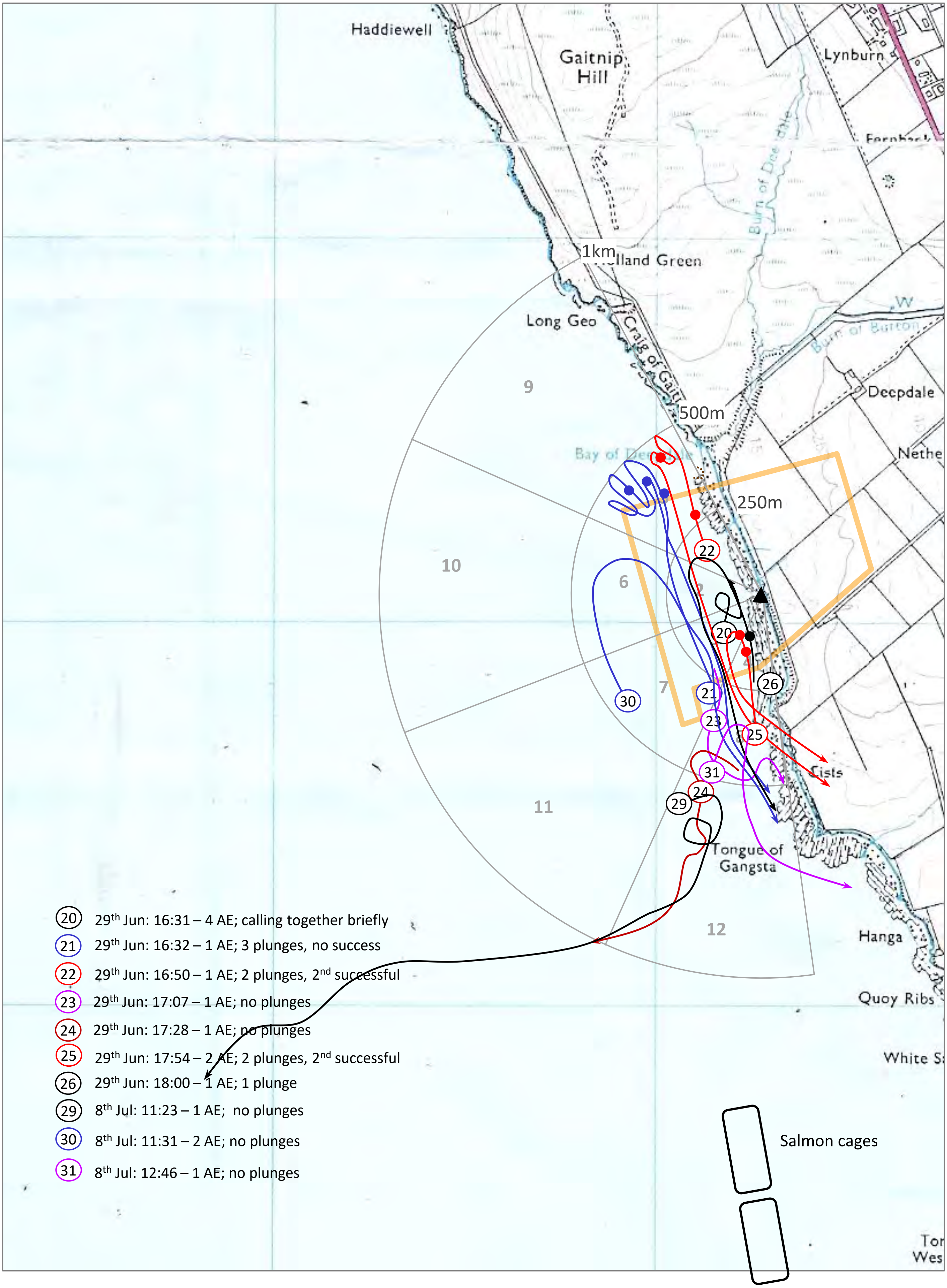
⑰ 29th Jun: 16:09 – 1 AE; no plunges

⑱ 29th Jun: 16:17 – 1 AE; no plunges

⑲ 29th Jun: 16:29 – 2 AE; 1 plunge

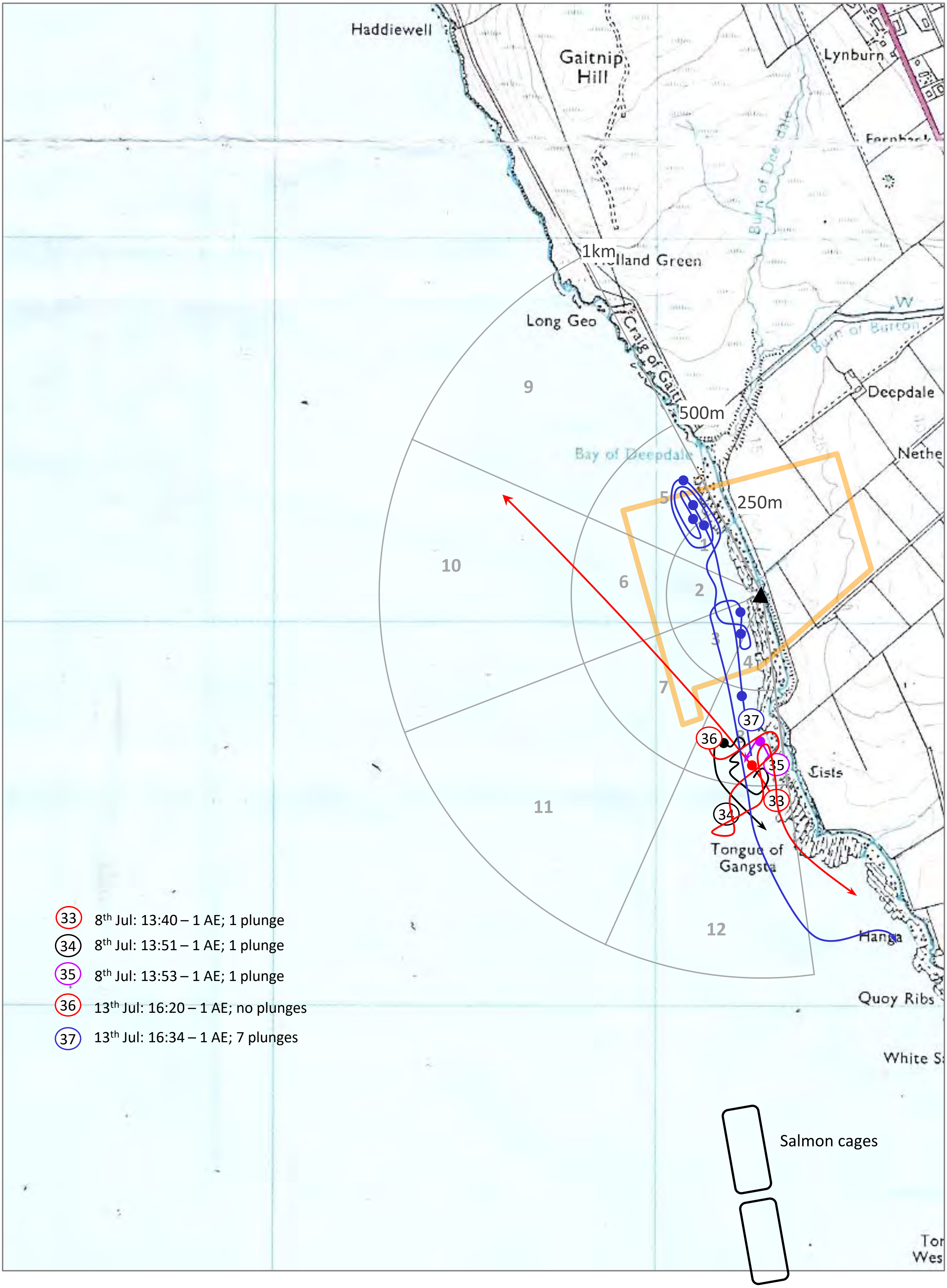
Arctic Tern flights 2021 – 1 of 7

circle is a plunge for fish (successful or not)



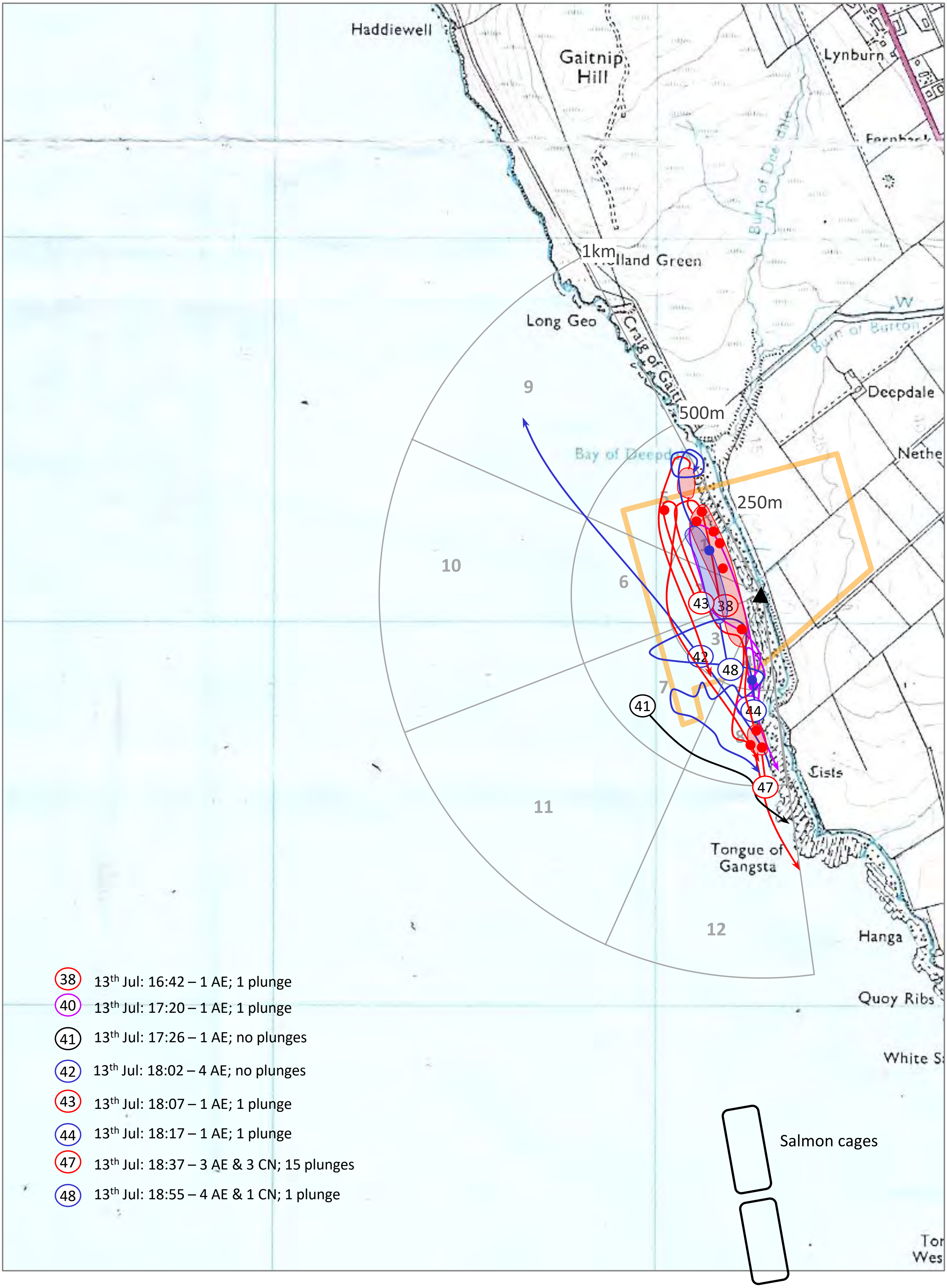
Arctic Tern flights 2021 – 2 of 7

circle is a plunge for fish (successful or not)



Arctic Tern flights 2021 – 3 of 7

circle is a plunge for fish (successful or not)



㊳ 13th Jul: 16:42 – 1 AE; 1 plunge

㊵ 13th Jul: 17:20 – 1 AE; 1 plunge

㊶ 13th Jul: 17:26 – 1 AE; no plunges

㊷ 13th Jul: 18:02 – 4 AE; no plunges

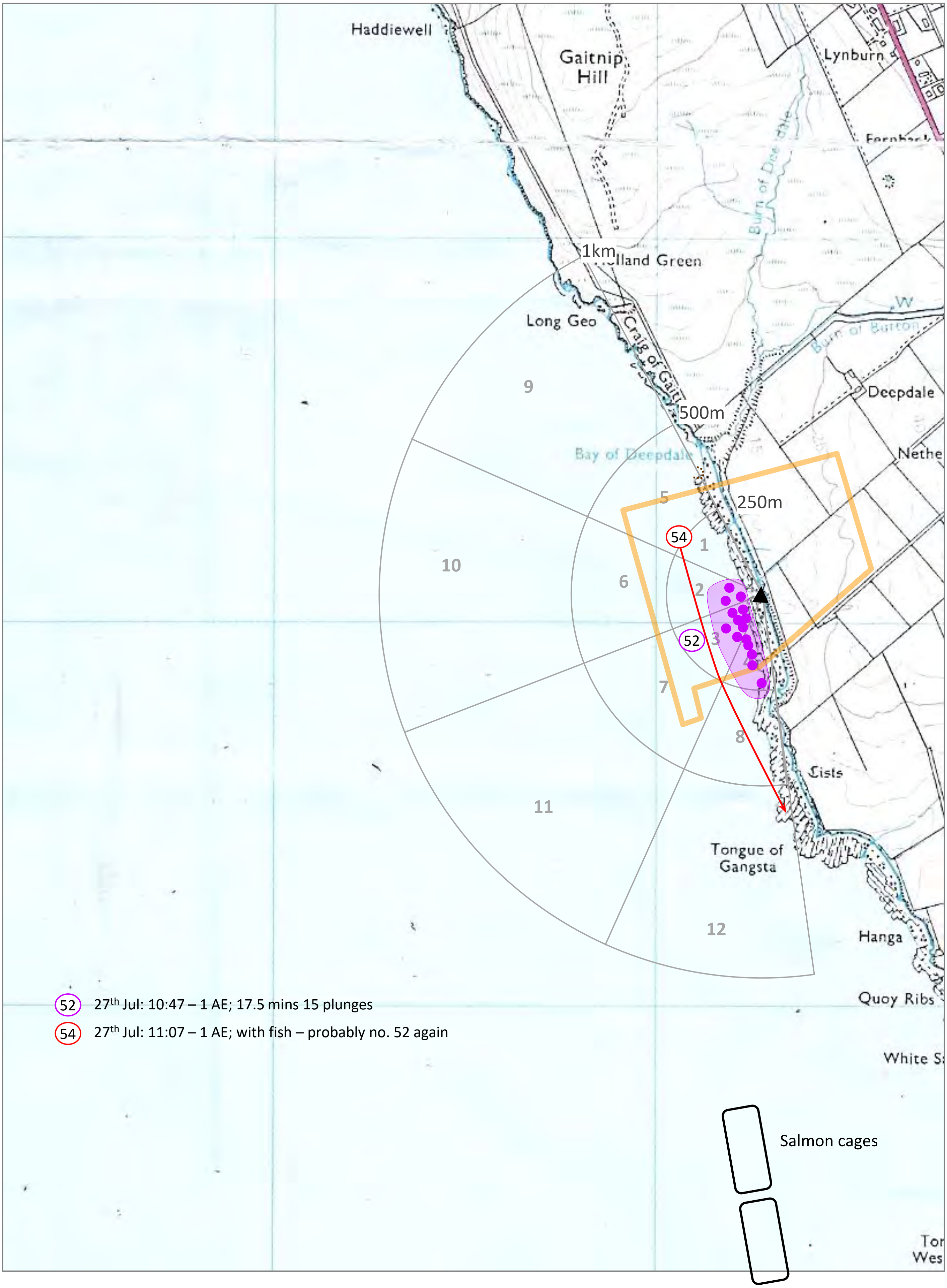
㊸ 13th Jul: 18:07 – 1 AE; 1 plunge

㊹ 13th Jul: 18:17 – 1 AE; 1 plunge

㊼ 13th Jul: 18:37 – 3 AE & 3 CN; 15 plunges

㊽ 13th Jul: 18:55 – 4 AE & 1 CN; 1 plunge

Arctic Tern flights 2021 – 4 of 7
circle is a plunge for fish (successful or not)

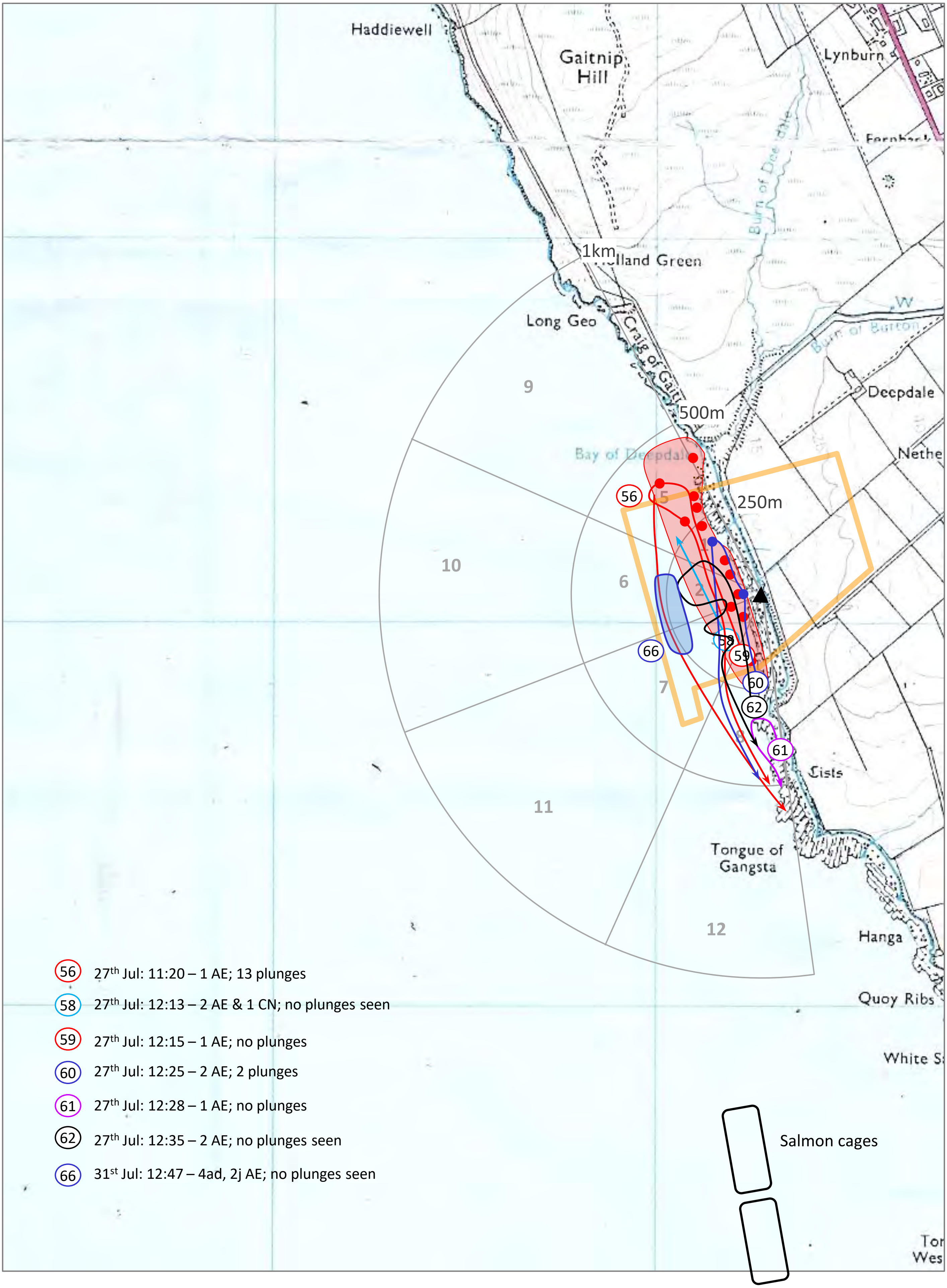


(52) 27th Jul: 10:47 – 1 AE; 17.5 mins 15 plunges

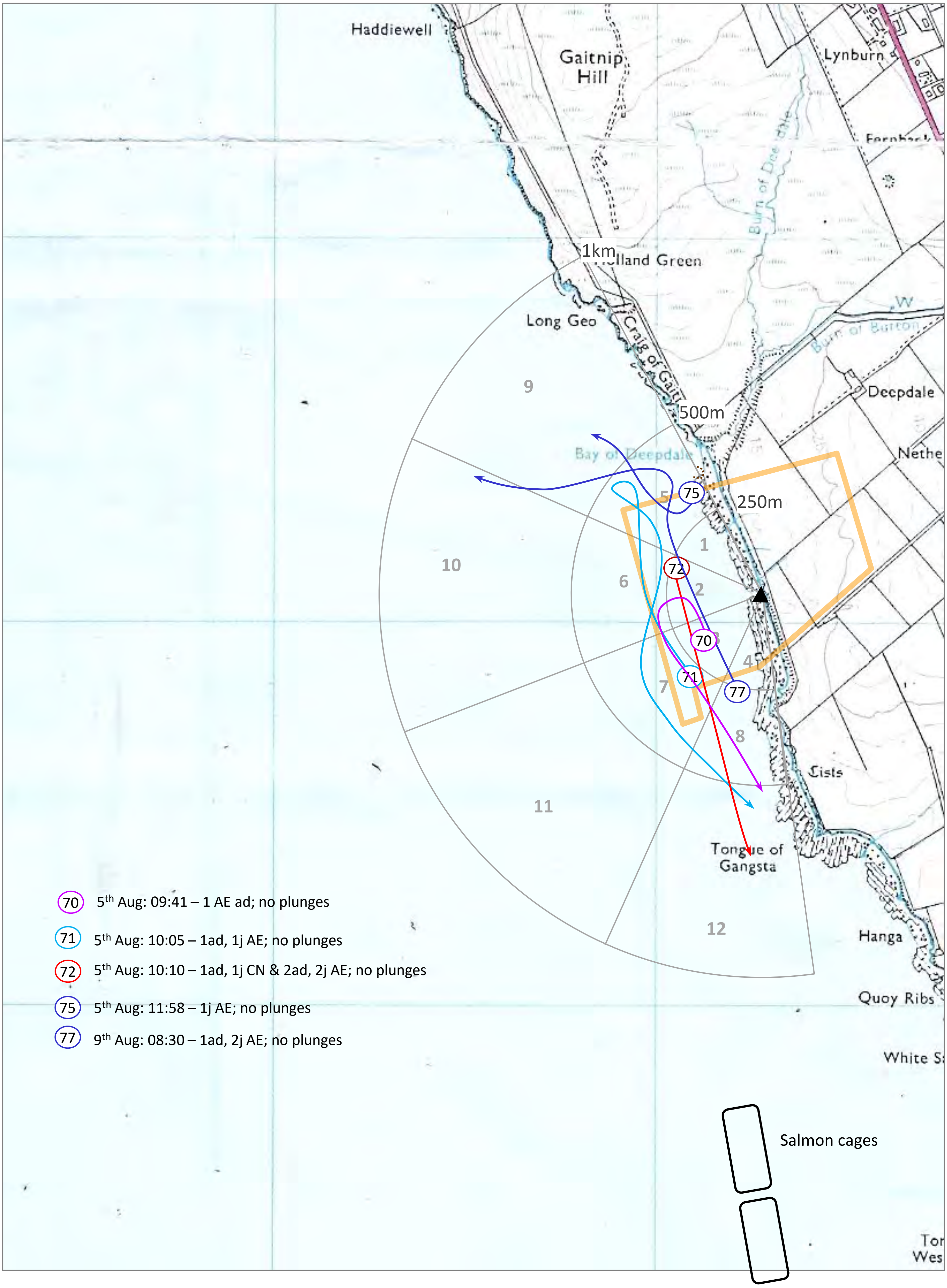
(54) 27th Jul: 11:07 – 1 AE; with fish – probably no. 52 again

Arctic Tern flights 2021 – 5 of 7

circle is a plunge for fish (successful or not)

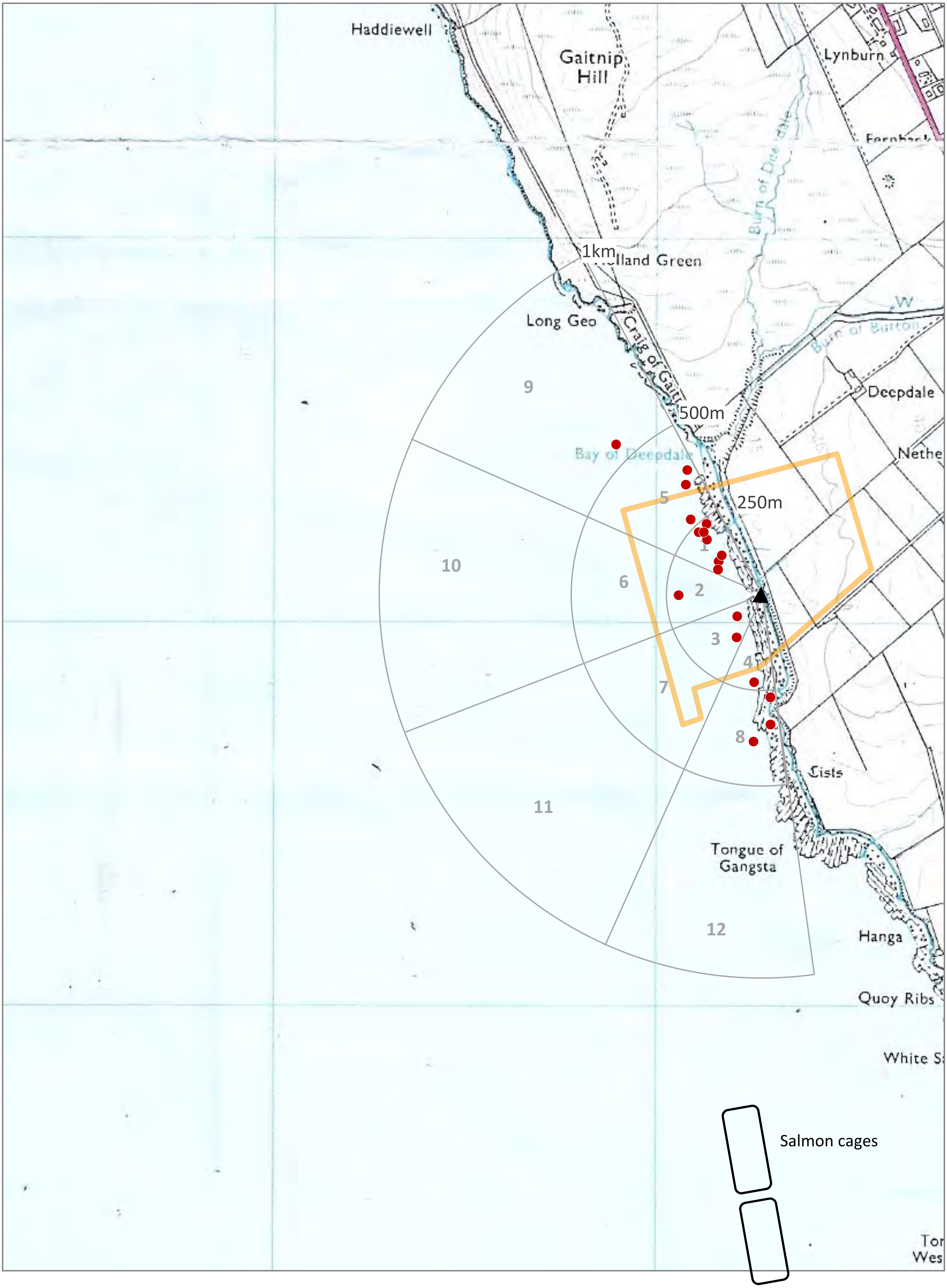


Arctic Tern flights 2021 – 6 of 7
circle is a plunge for fish (successful or not)

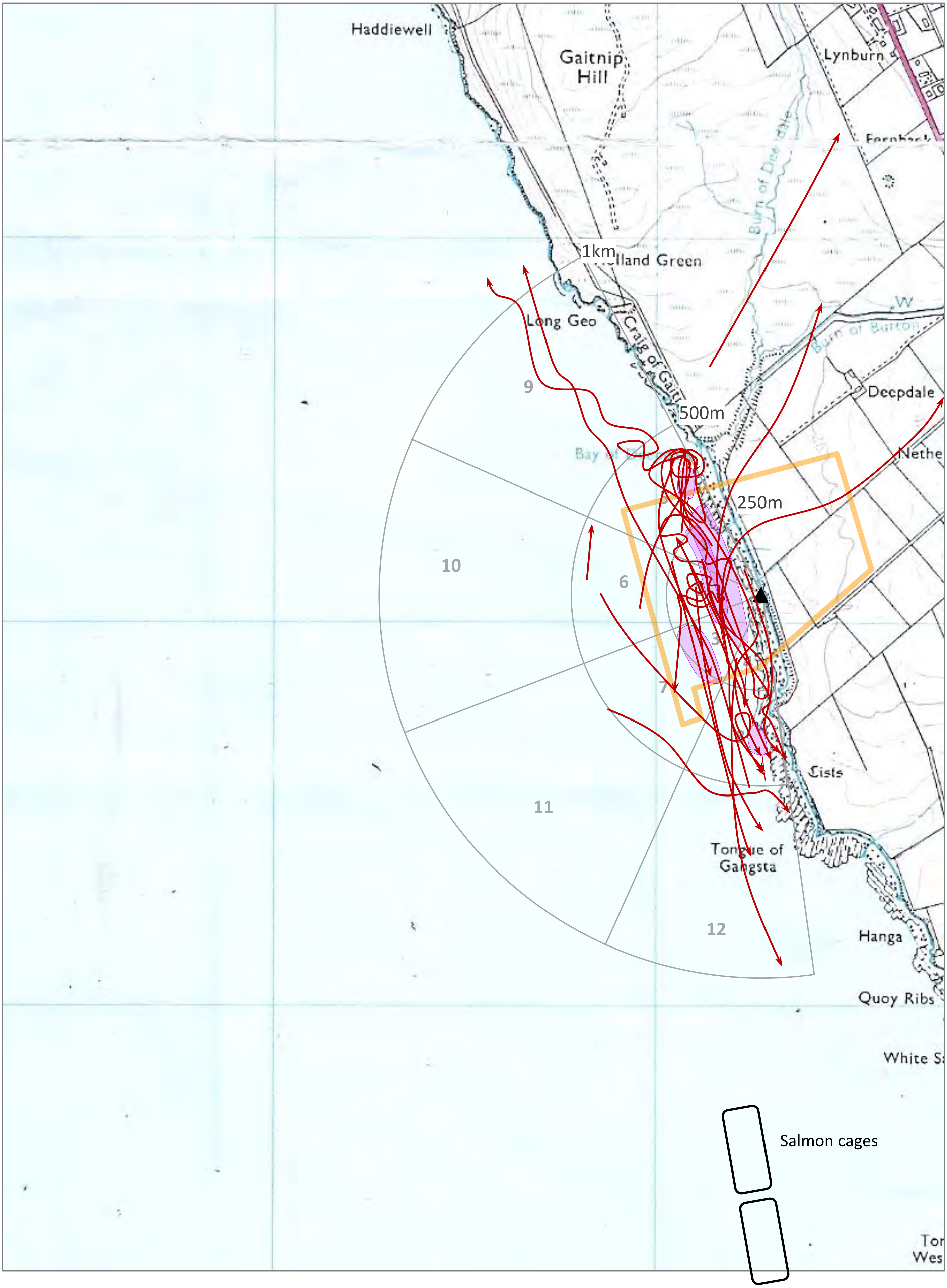


Arctic Tern flights 2021 – 7 of 7

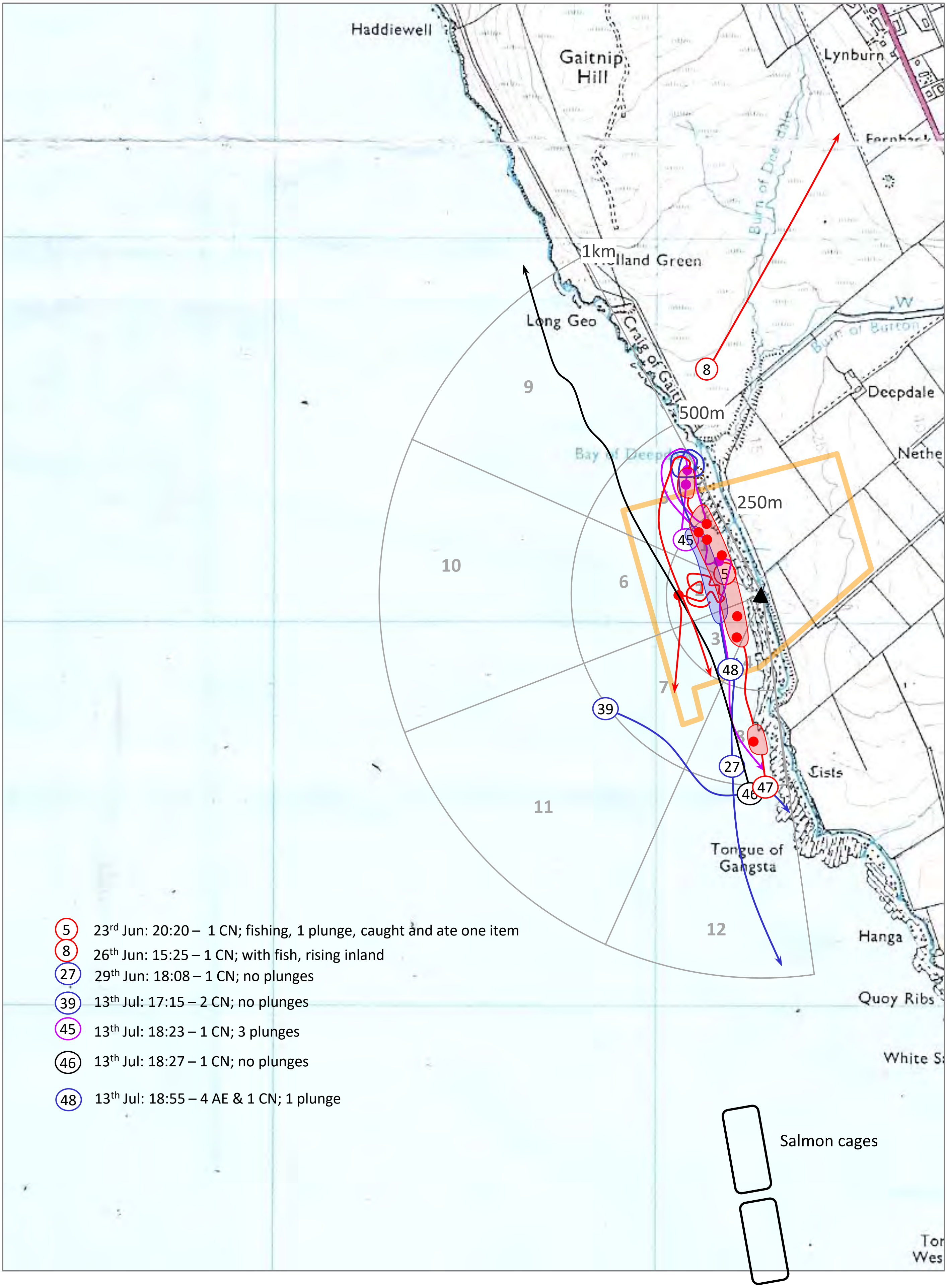
circle is a plunge for fish (successful or not)



Common Tern - all flight plunges 2021
circle is a plunge for fish (successful or not)

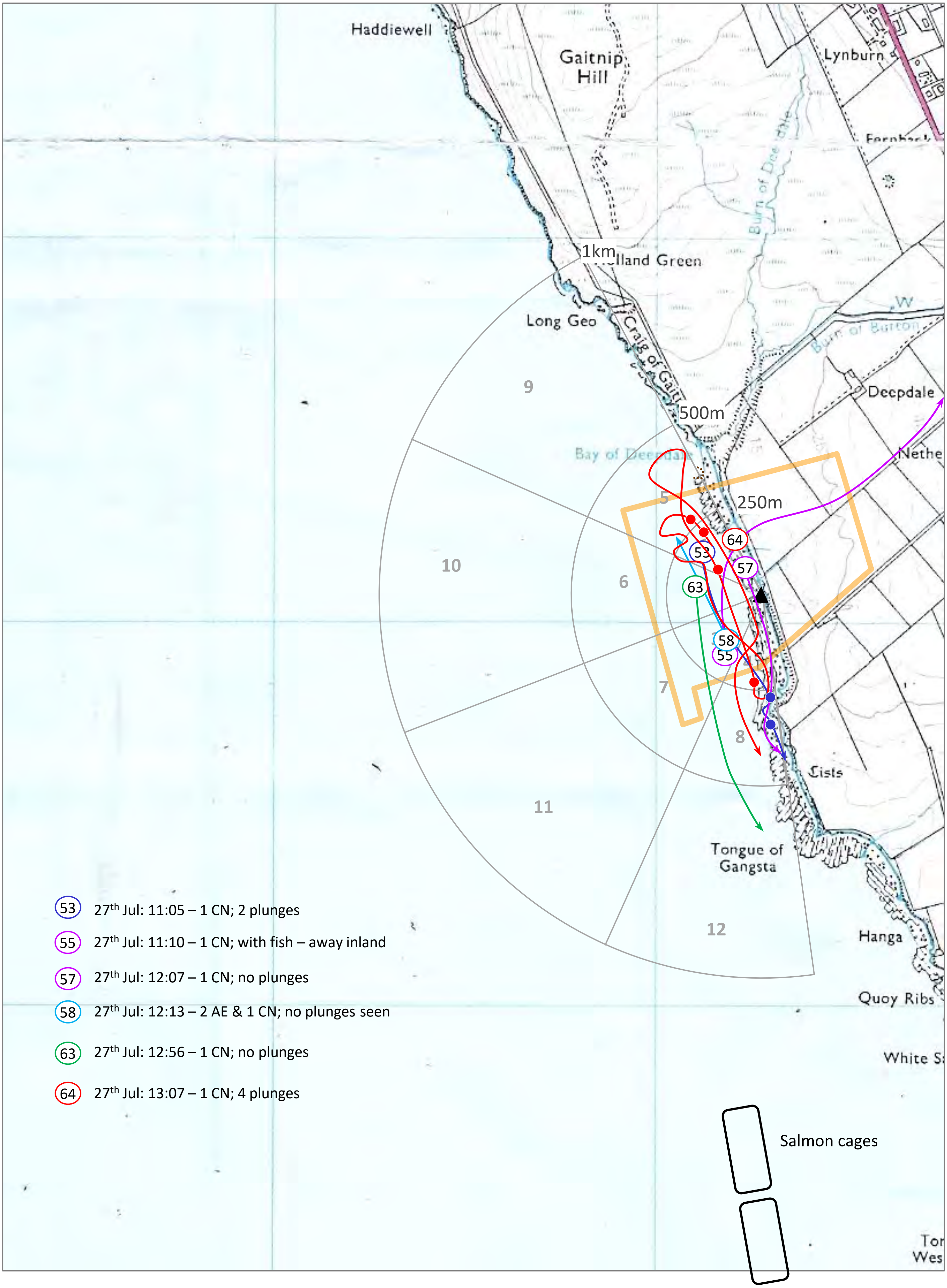


Common Tern – all flight paths 2021



Common Tern flights 2021 – 1 of 3

circle is a plunge for fish (successful or not)



(53) 27th Jul: 11:05 – 1 CN; 2 plunges

(55) 27th Jul: 11:10 – 1 CN; with fish – away inland

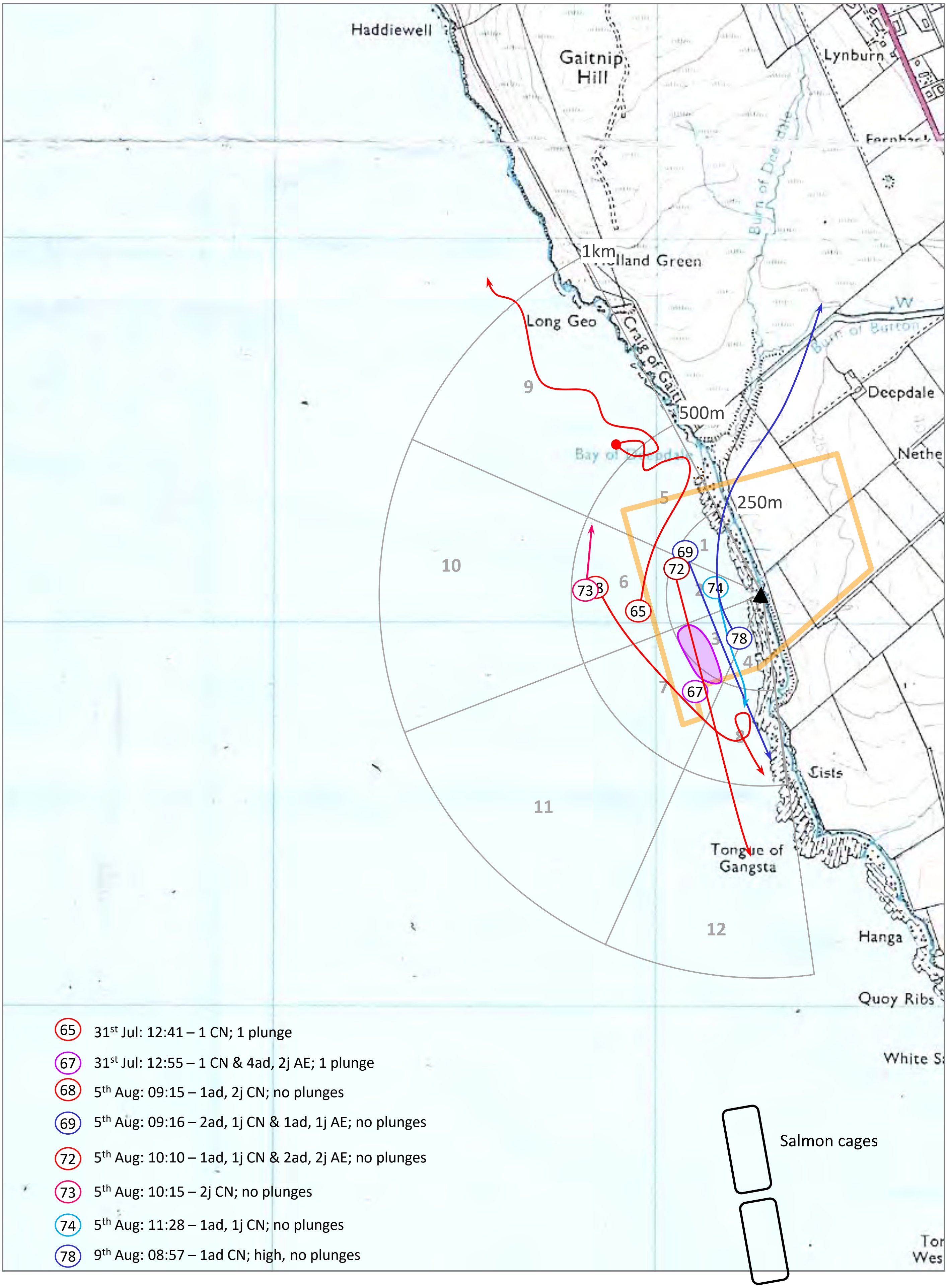
(57) 27th Jul: 12:07 – 1 CN; no plunges

(58) 27th Jul: 12:13 – 2 AE & 1 CN; no plunges seen

(63) 27th Jul: 12:56 – 1 CN; no plunges

(64) 27th Jul: 13:07 – 1 CN; 4 plunges

Common Tern flight paths 2021 – 2 of 3



65 31st Jul: 12:41 – 1 CN; 1 plunge
67 31st Jul: 12:55 – 1 CN & 4ad, 2j AE; 1 plunge
68 5th Aug: 09:15 – 1ad, 2j CN; no plunges
69 5th Aug: 09:16 – 2ad, 1j CN & 1ad, 1j AE; no plunges
72 5th Aug: 10:10 – 1ad, 1j CN & 2ad, 2j AE; no plunges
73 5th Aug: 10:15 – 2j CN; no plunges
74 5th Aug: 11:28 – 1ad, 1j CN; no plunges
78 9th Aug: 08:57 – 1ad CN; high, no plunges

Common Tern flights 2021 – 3 of 3
circle is a plunge for fish (successful or not)

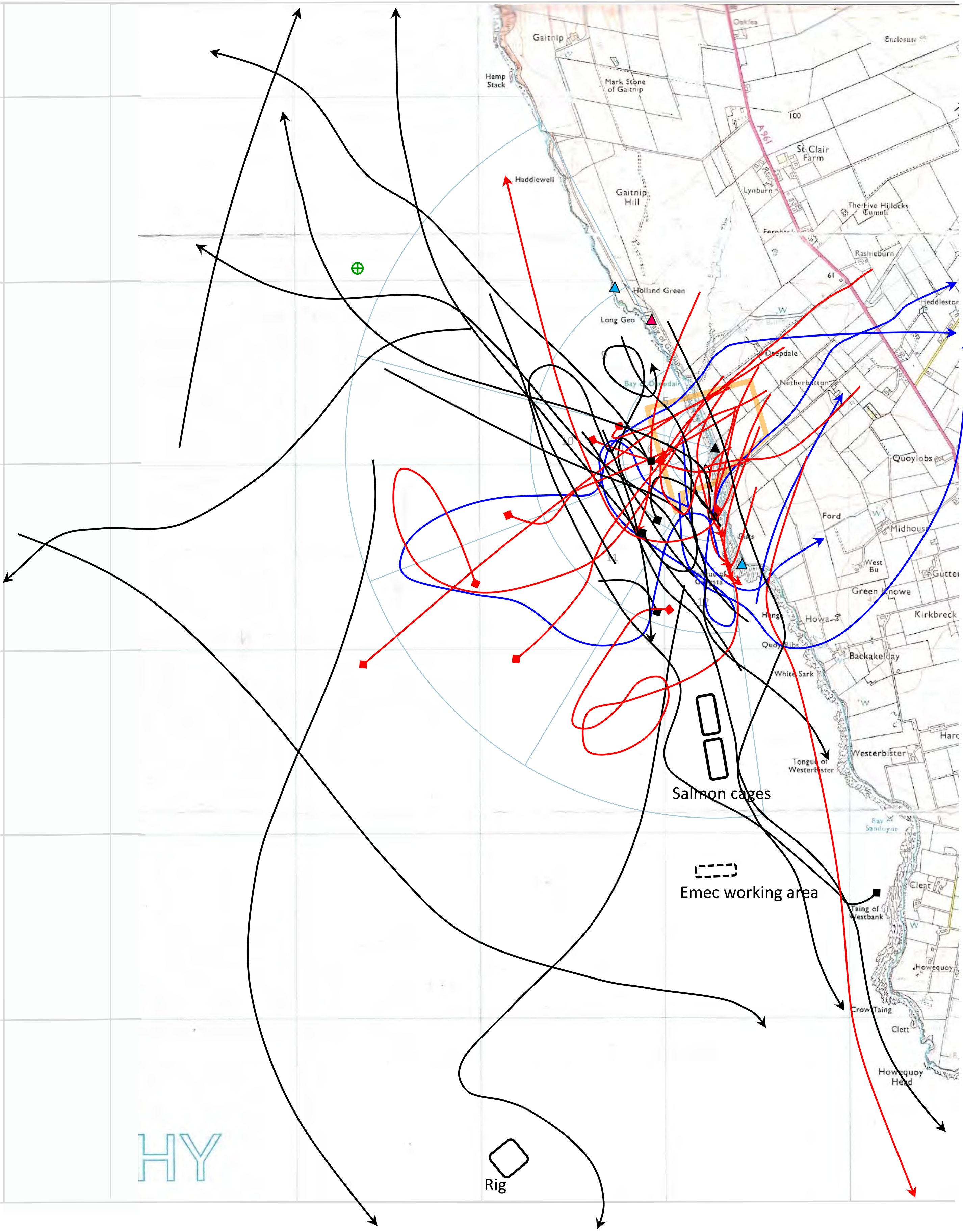
APPENDIX H ii

Year 2 offshore flight maps:

Red-throated Diver, Arctic Skua

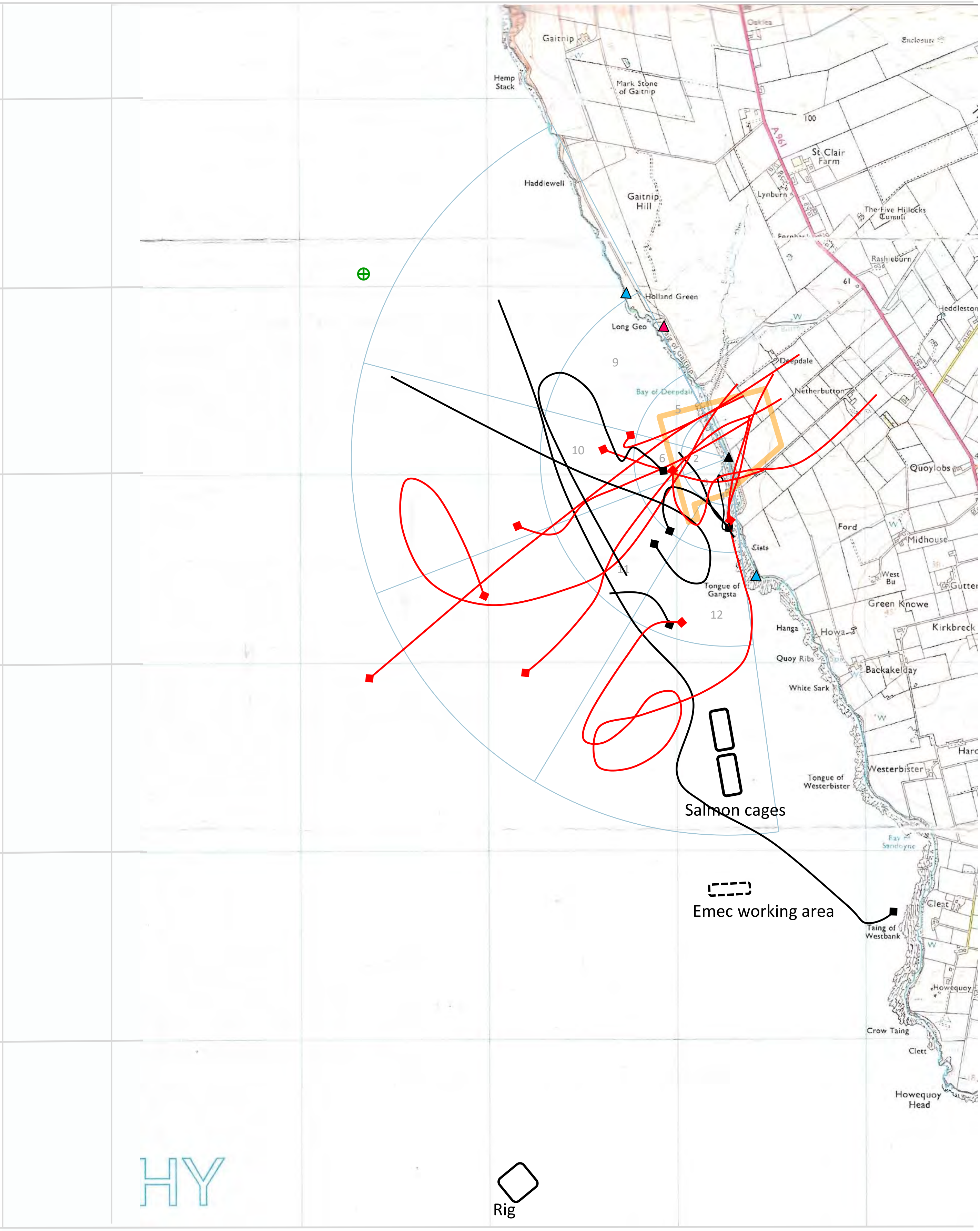
Red-throated Diver: All flights April to August 2022

Red: outgoing flights; blue: incoming flights; black: uncategorised (offshore)

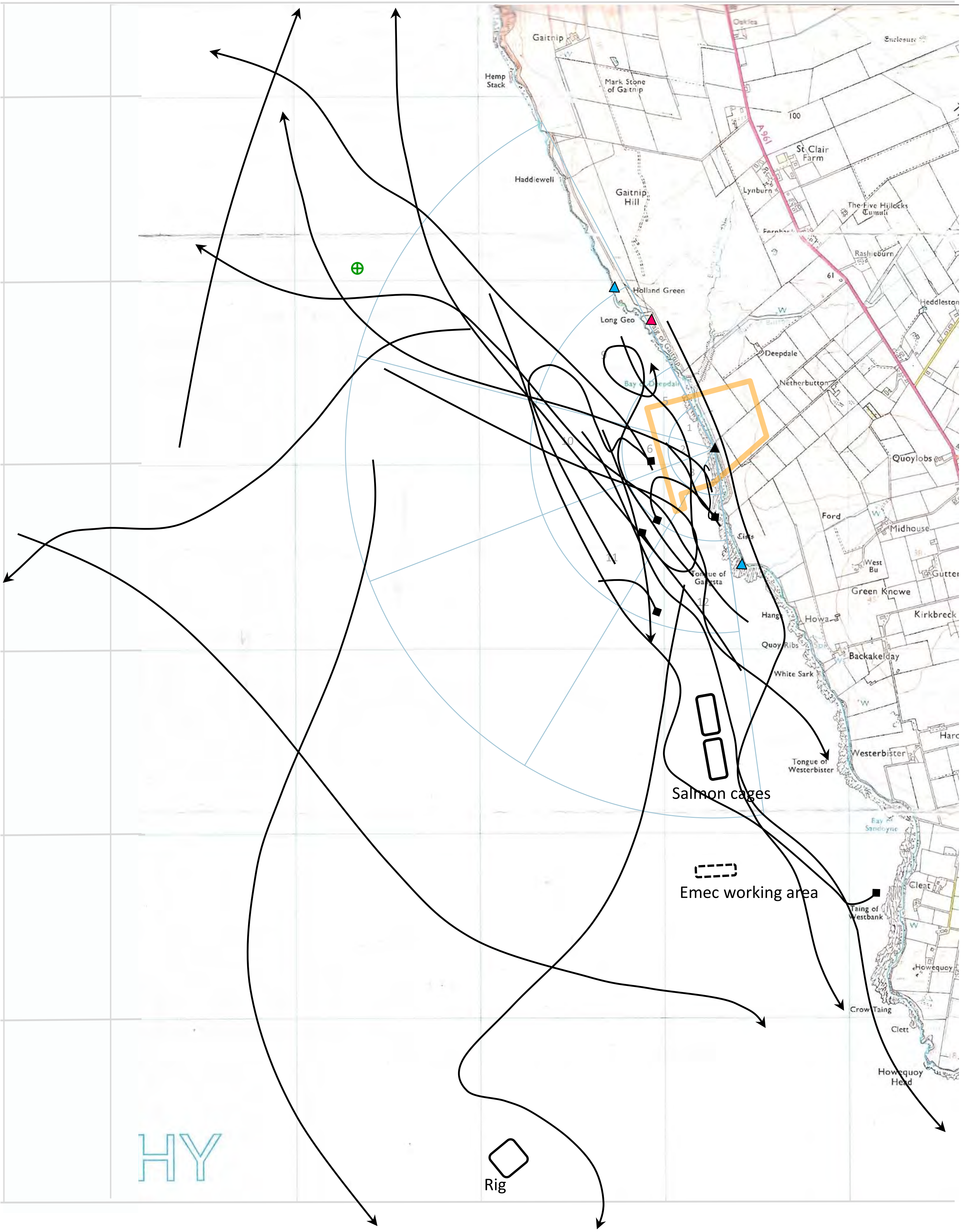


Red-throated Diver: Birds <u>alighting</u> April to August 2022

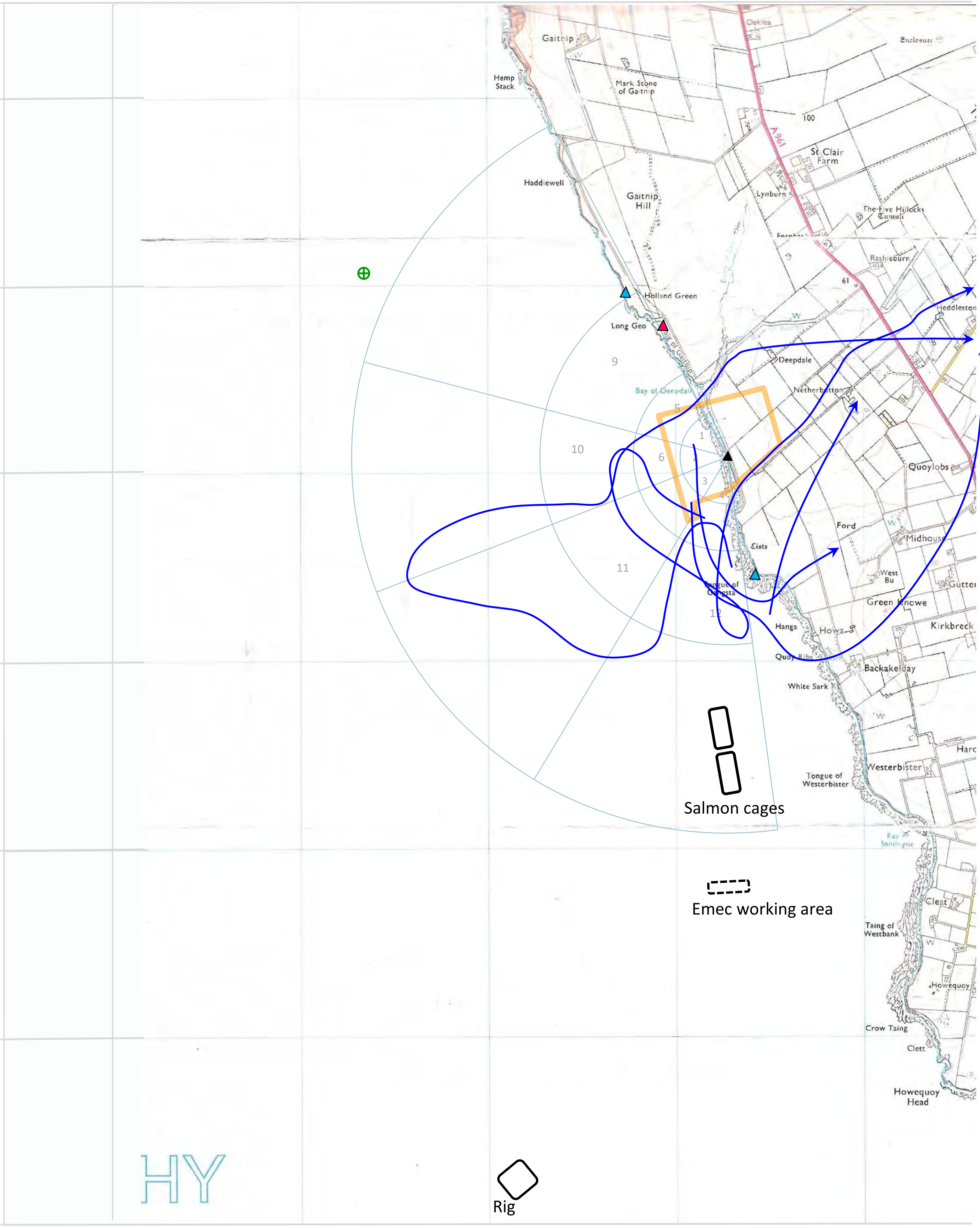
Red: outgoing flights from inland; black: flights arriving from offshore



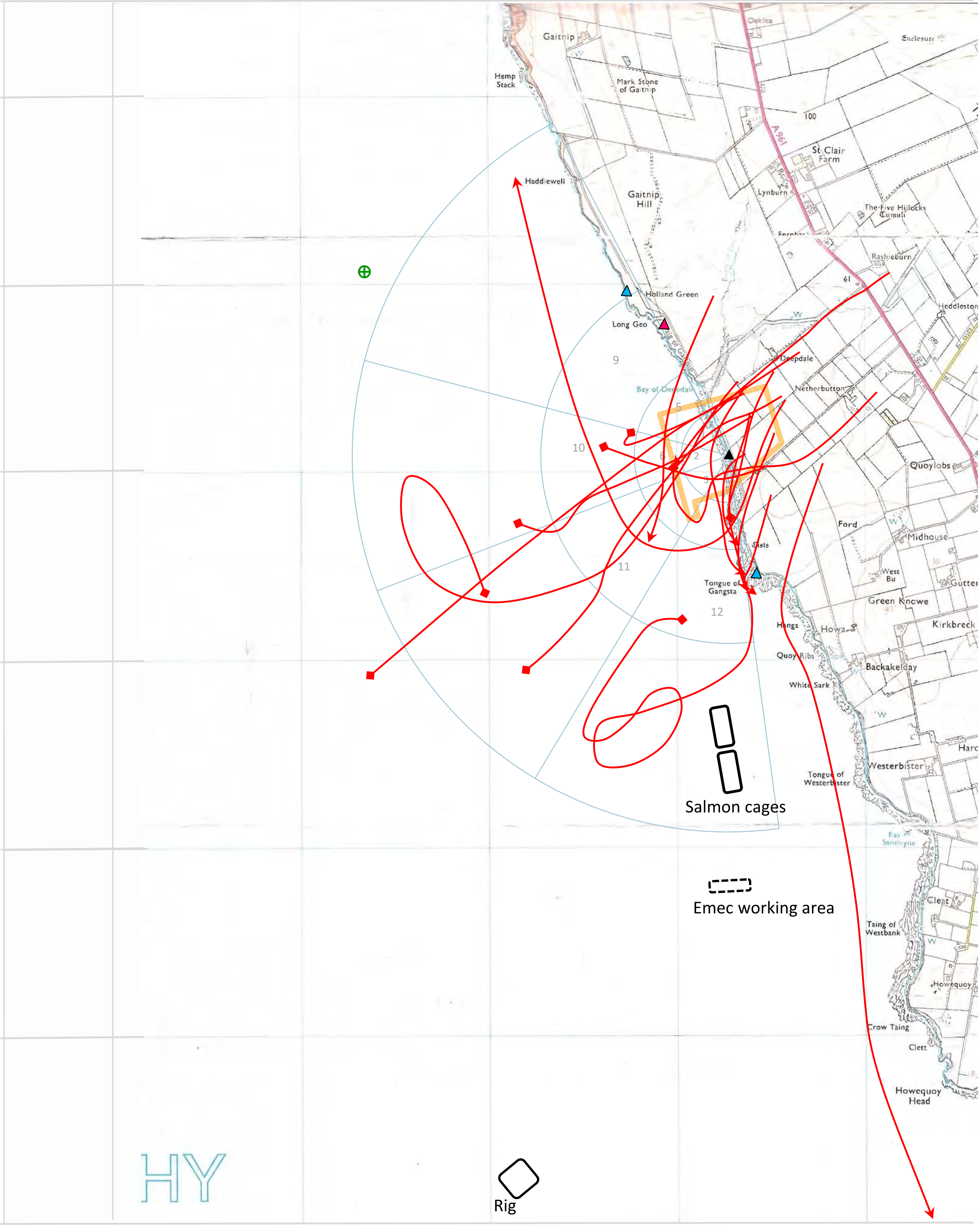
Red-throated Diver: All offshore flights April to August 2022



Red-throated Diver: All incoming flights April to August 2022



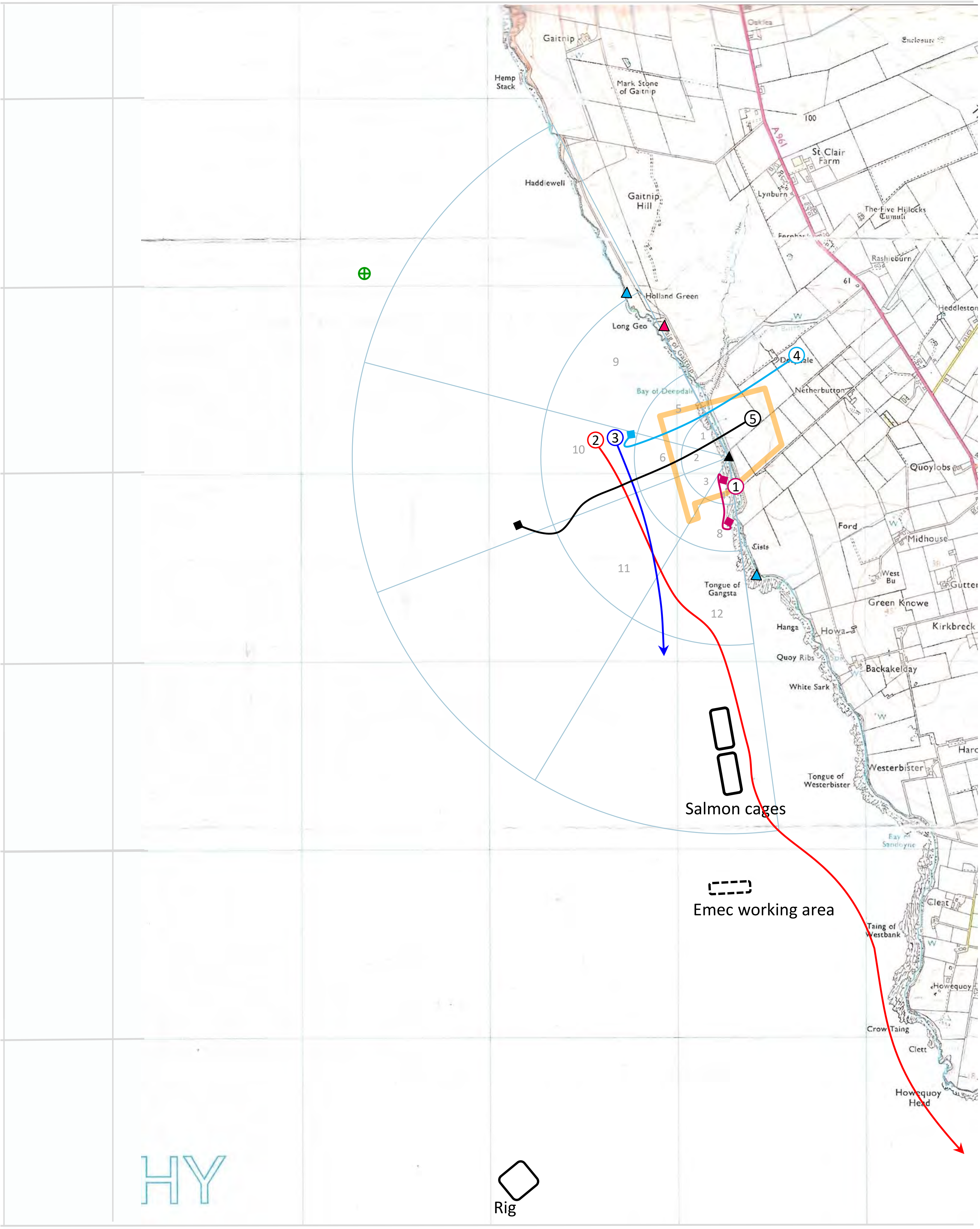
Red-throated Diver: All outgoing flights April to August 2022



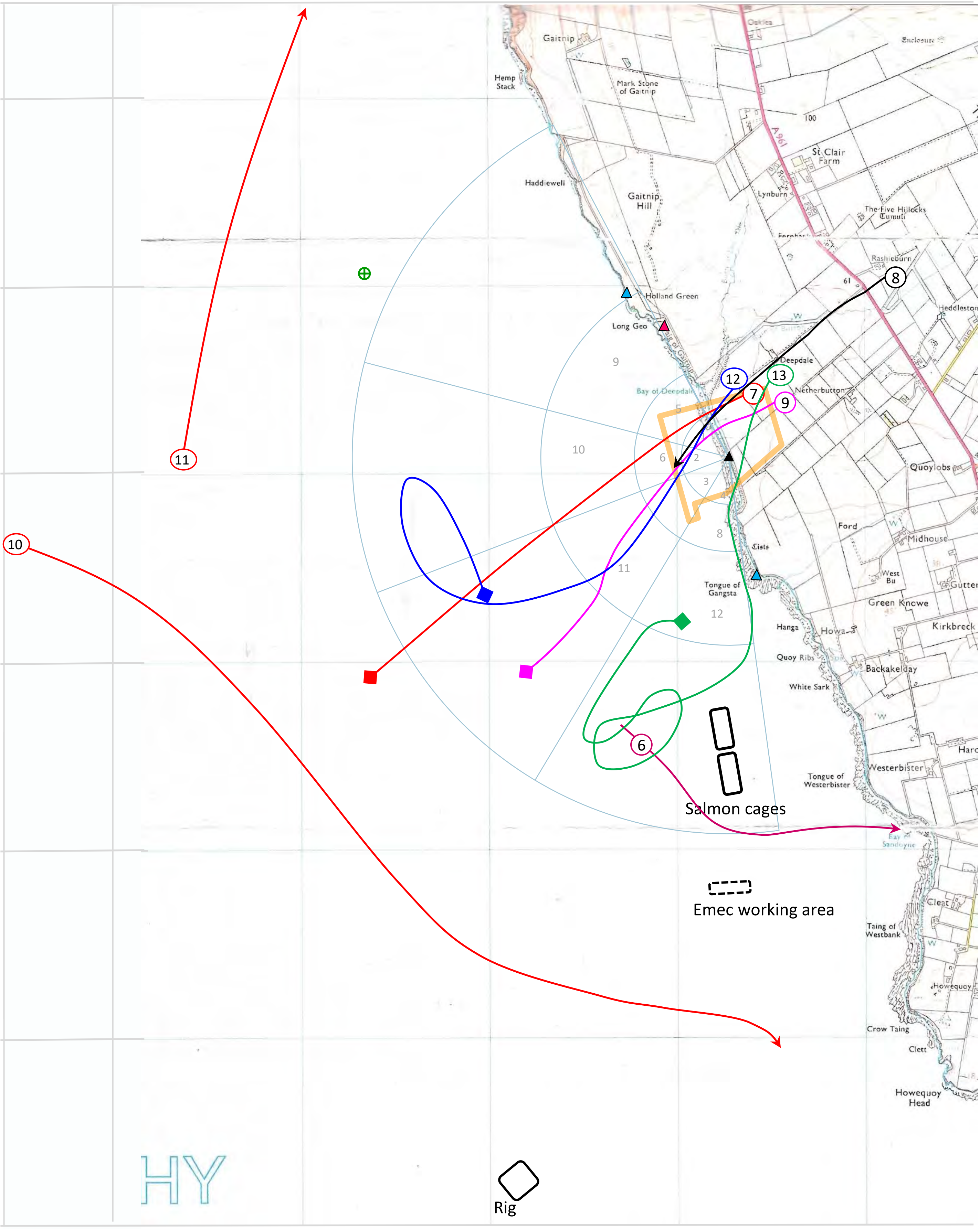
Red-throated Diver – all flights 2022

Date	Flight no.	Species	No. birds	Time start	Duration	Height	Observation point	Comment
02-Apr	1	RH	1	c.16:00	<1 min	<1 m	flight logging	in breeding plumage; up off water and low to alight again
20-Apr	2	RH	1	11:09	4	c.50m	walk-in	rising to 100m and in view well to south
20-Apr	3	RH	1	16:29	1	<2m	main VP	lost low against waves
23-Apr	4	RH	1	16:26	1	c.50m	MBS walkover	alighting within 1km
25-Apr	5	RH	1	16:43	1	50-100m	walk-out	alighting at 1-2km
20-May	6	ND	1	11:29	2	<20m	upper VP	
20-May	7	RH	1	17:13		c.50m	walk-out	steadily down to alight at more than 2km offshore
21-May	8	RH	1	17:38		c.50m	MBS walkover	gently down contours then lost low against waves
24-May	9	RH	1	08:34	1.5	c.50m	flight logging	alighting well beyond 1.5km and not visible in waves
24-May	10	RH	1	13:01	5	low	upper VP	rising to 50m then lower again - away SE
30-May	11	RH	1	17:13	3	<5m	main VP	north towards Scapa at 2.5 - 3km offshore
30-May	12	RH	1	17:45	2	c.100m	main VP	alighting at 1-2km
30-May	13	RH	1	17:55	2	c.100m	main VP	alighting within 1km
03-Jun	14	RH	1	09:06	3-4	20-50m	upper VP	heading out W into the Flow beyond the map
03-Jun	15	RH	1	12:35		<20m	flight logging	alighting at 1-2km and followed on the water for an hour
09-Jun	16	RH	1	11:09	1	low	walk across	lost low against waves
09-Jun	18	RH	1	12:05		c.20m	upper VP	lower towards fish cages, then lifting around them before alighting beyond at more than 2km
20-Jun	19	RH	2	12:03		water	main VP	up off water and rising to 50-100m past rig and continuing S beyond map
20-Jun	20	RH	1	16:25		<20m	flight logging	from inland - low over water and soon out of view round headland
20-Jun	21	RH	1	16:26		20-50m	flight logging	alighting within 1km and followed on the water to 17:25
05-Jul	22	RH	3	06:06		20-50	nr S VP	down to alight at 1-2km; 2 soon in flight again and over E skyline
05-Jul	23	RH	2	08:54	5	water	nr S VP	low away to NW and lost in distance
05-Jul	24	RH	2	09:02		<5m	nr S VP	staying low until out of view round N headland
05-Jul	25	RH	2	09:19		water	nr S VP	calling on water, then taking off and splitting up; one followed to 20-50m then lower into bay
05-Jul	26	RH	1	10:39		low	main VP	with fish, probably up off water; rising inland and out of view over E skyline
11-Jul	27	RH	1	16:20		20-50m	S VP	up contours inland
11-Jul	28	RH	2	18:01		20-50m	flight logging	alighting within 1km and followed on the water to 19:05
23-Jul	29	RH	1	16:21		20-50m	nr main VP	out low over water and soon lost to view round S headland
23-Jul	30	RH	1	17:40		c.20m	main VP	soon out of view beyond S headland
23-Jul	31	RH	1	18:33		20-50m	flight logging	away lower NW and lost in distance
23-Jul	32	RH	1	19:18		c.20m	flight logging	down to alight within 500m; followed on water to 20:15 when it headed back inland
23-Jul	33	RH	1	20:07		c.20m	main VP	straight in to alight within 500m, but soon dived and no refound
28-Jul	34	RH	1	13:05		water	main VP	had just caught a fish; taking off into wind and rising inland to disappear distantly beyond E skyline
01-Aug	35	RH	1	14:10		low	flight logging	shortly alighting; watched for 10 mins before lost
01-Aug	36	RH	1	17:27		20-50m	main VP	from inland - low over water and soon out of view round south headland
01-Aug	37	RH	2	19:47	2	c.50m	upper VP	from inland - swinging north and out of view beyond north headland
01-Aug	38	RH	1	19:54	2	<5m	upper VP	south close-in offshore and out of view against far south shoreline
14-Aug	39	RH	2	14:45		20-50m	S VP	from the south along the shore, alighting at c.1 km and followed on the water until 16:20
23-Aug	40	RH	1	16:25		20-50m	main VP	from the south offshore, alighting within 500m and followed on the water until 16:50
23-Aug	41	RH	1	17:58		c.50m	N VP	from the west offshore, alighting within 1km and followed sporadically on the water until 18:50
27-Aug	42	RH	1	07:16		c.50m	walk-in	from inland, alighting within 500m; possibly the same bird found later as no. 44
27-Aug	43	RH	2	08:01	4	50-100m	main VP	from inland and away south along the shore, still high well into the distance
27-Aug	44	RH	1	09:55		water	flight logging	possibly no. 42 again; had been followed on the water for an hour, then departing NW and lost in the distance, rising away
27-Aug	45	RH	1	09:59	2-3	50-100m	flight logging	probably the same bird as no. 44 coming back south along the shore and lost at c.100m in the distance
27-Aug	46	RH	1	14:18	8	low	N VP	low to water at c. 2km offshore - staying low until alighting well to the south of the map at the mouth of Water Sound

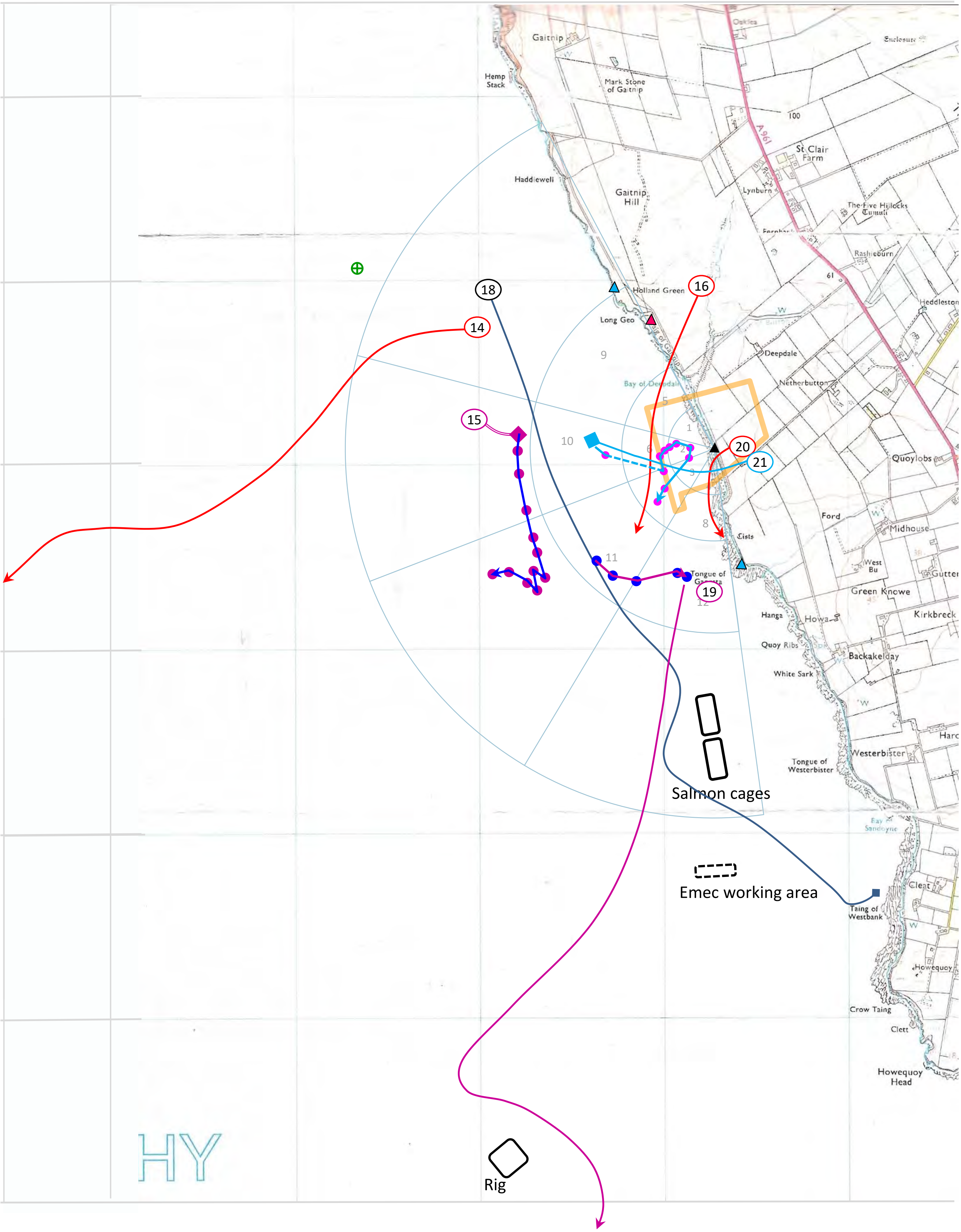
Red-throated Diver flights April/May 2022



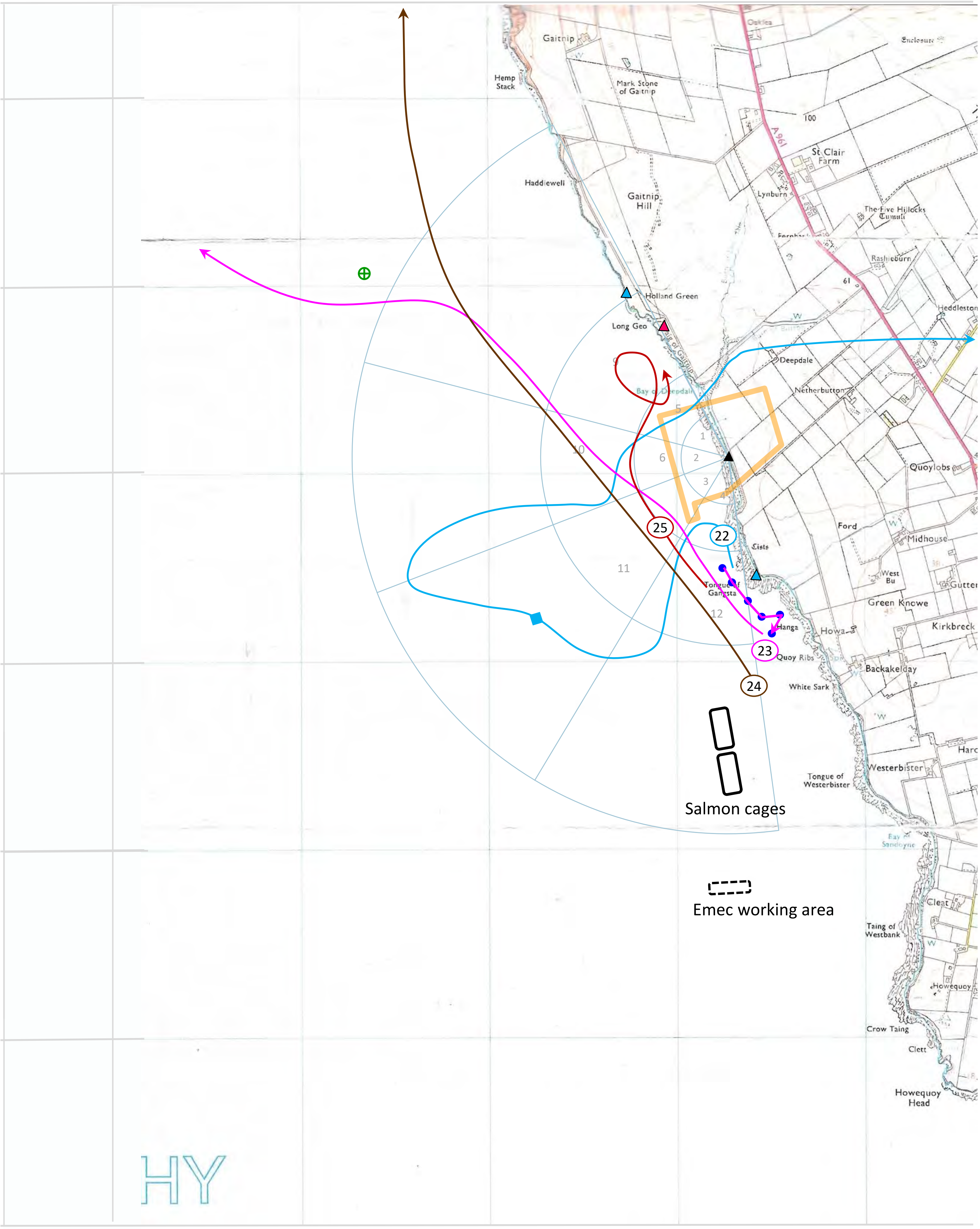
Red-throated Diver flights April/May 2022



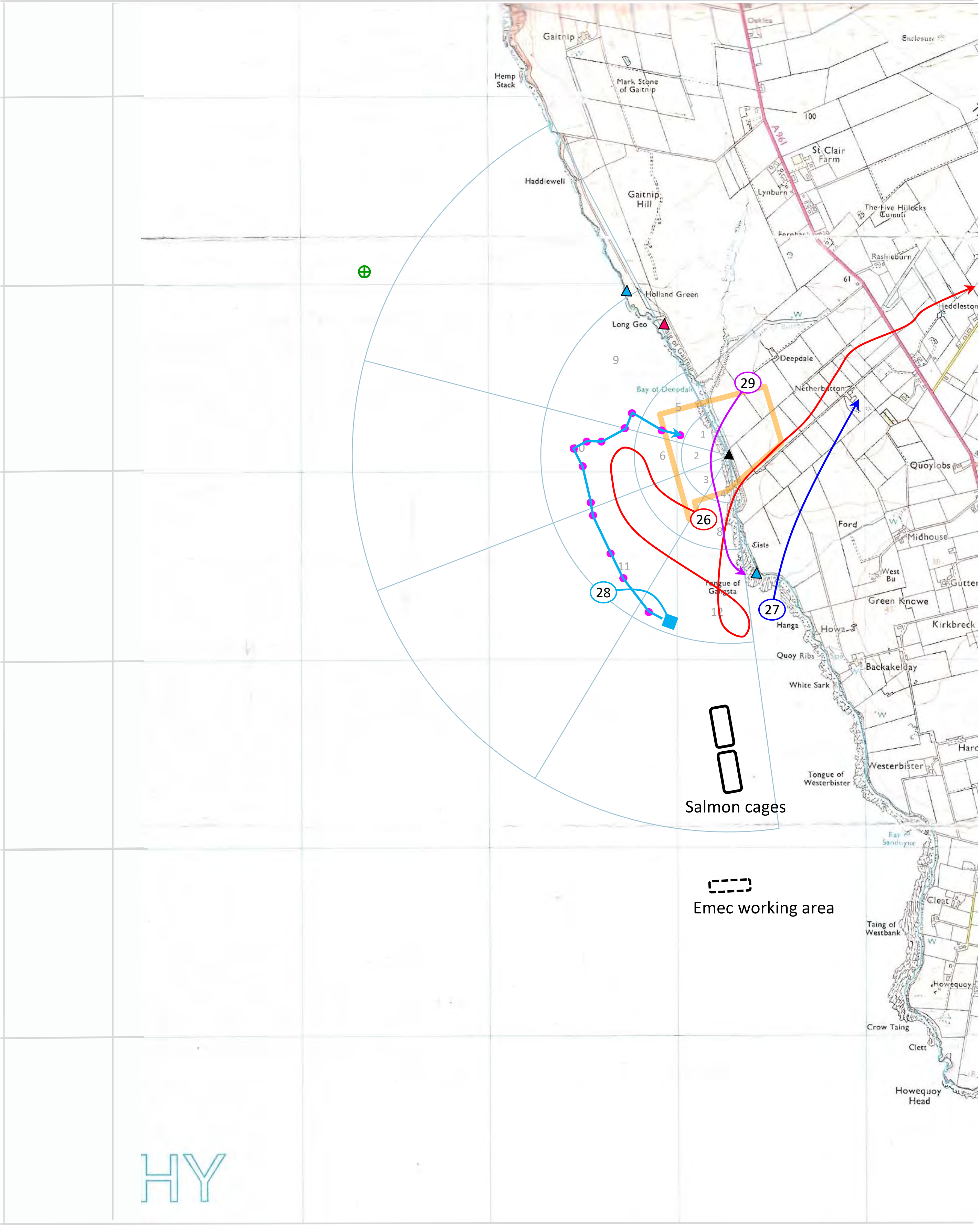
Red-throated Diver flights June 2022



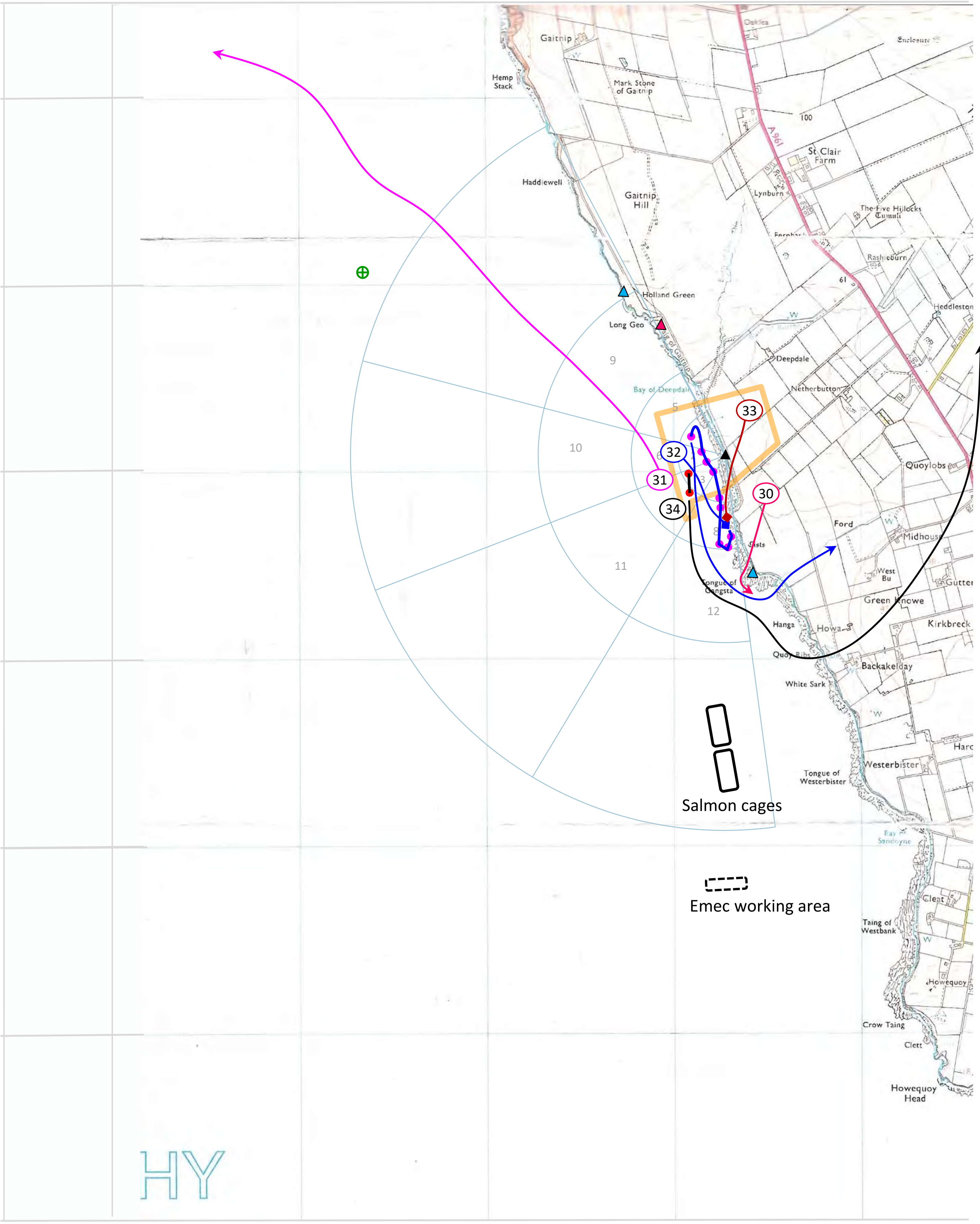
Red-throated Diver flights July (1 of 3) 2022



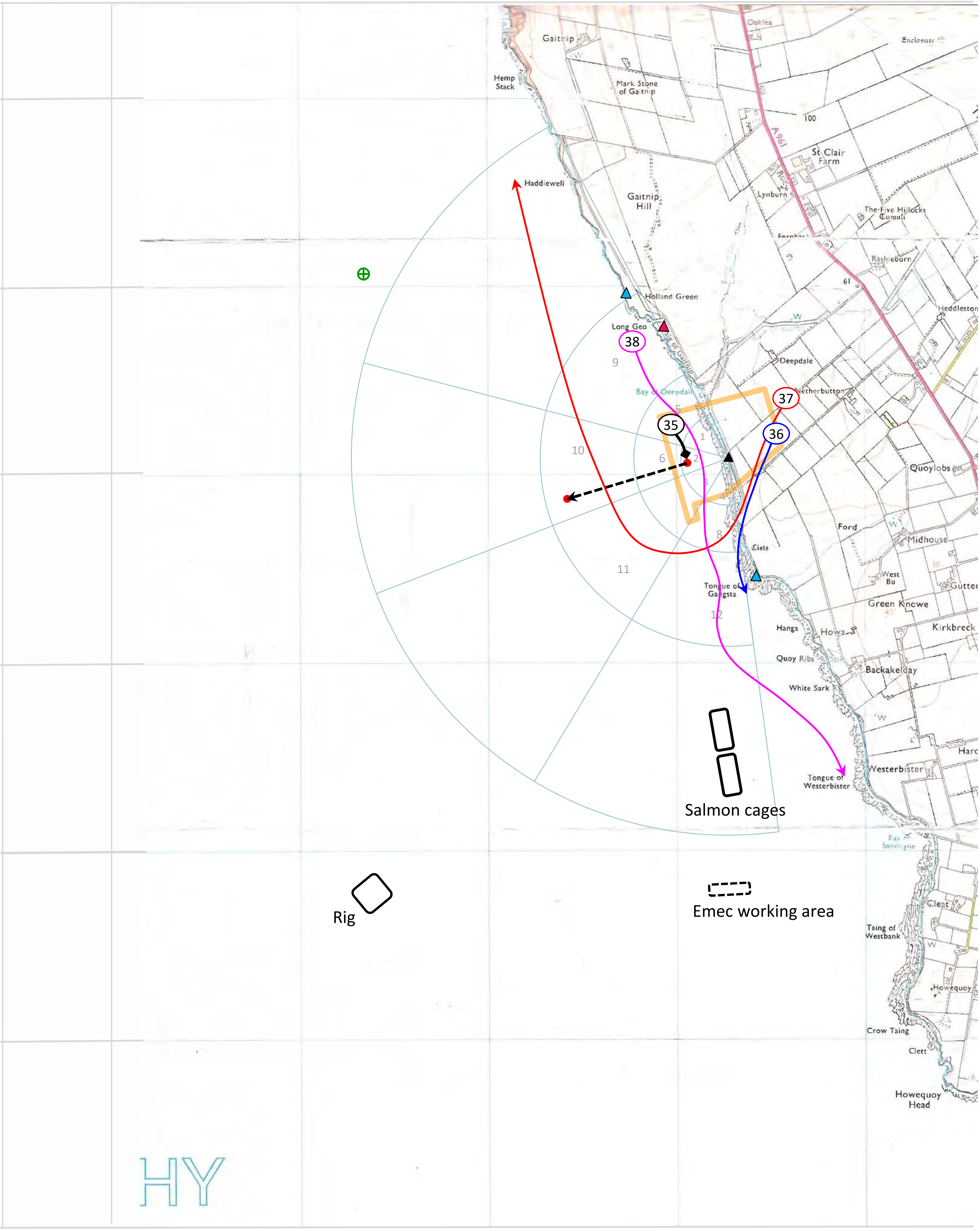
Red-throated Diver flights July (2 of 3) 2022



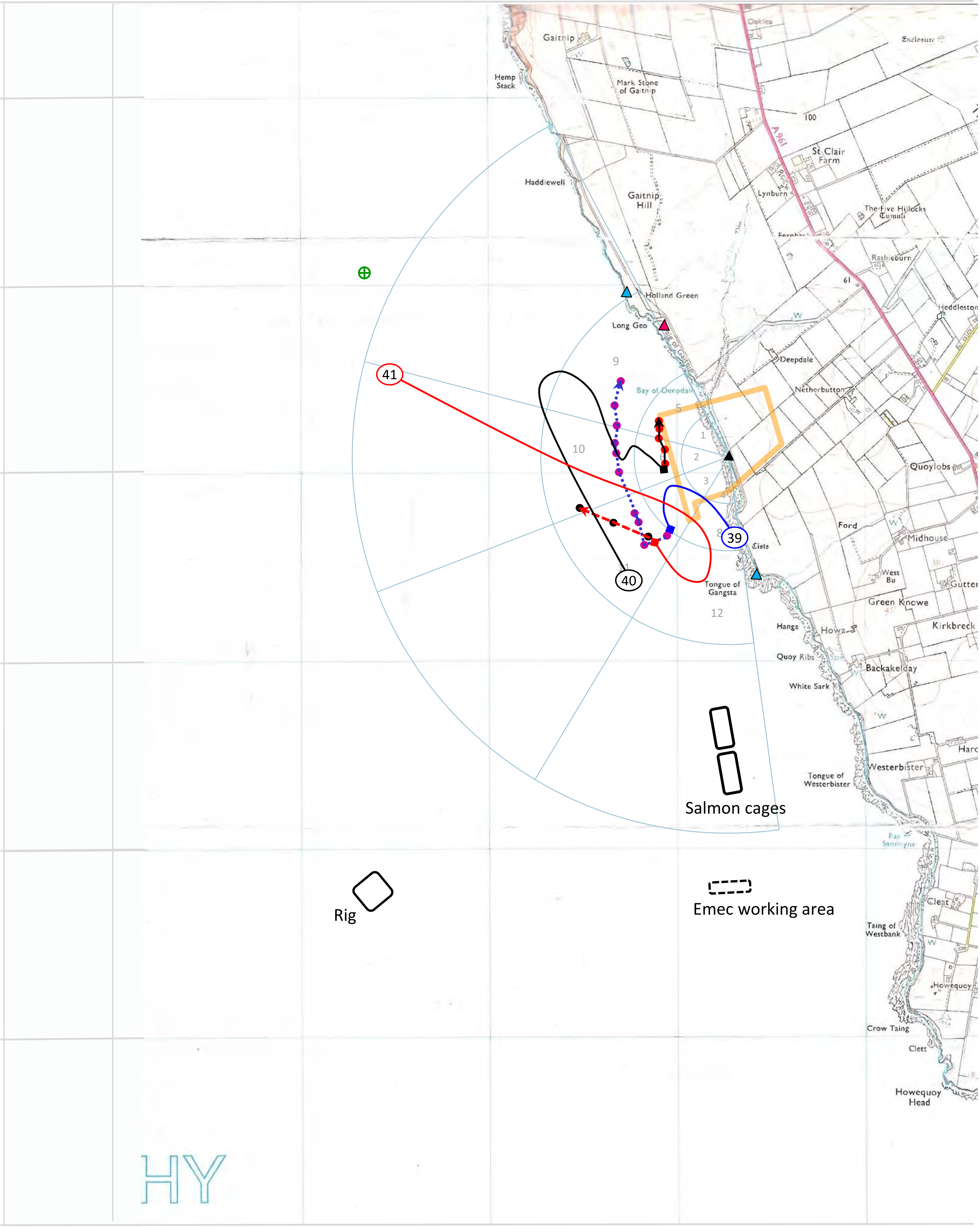
Red-throated Diver flights July (3 of 3) 2022



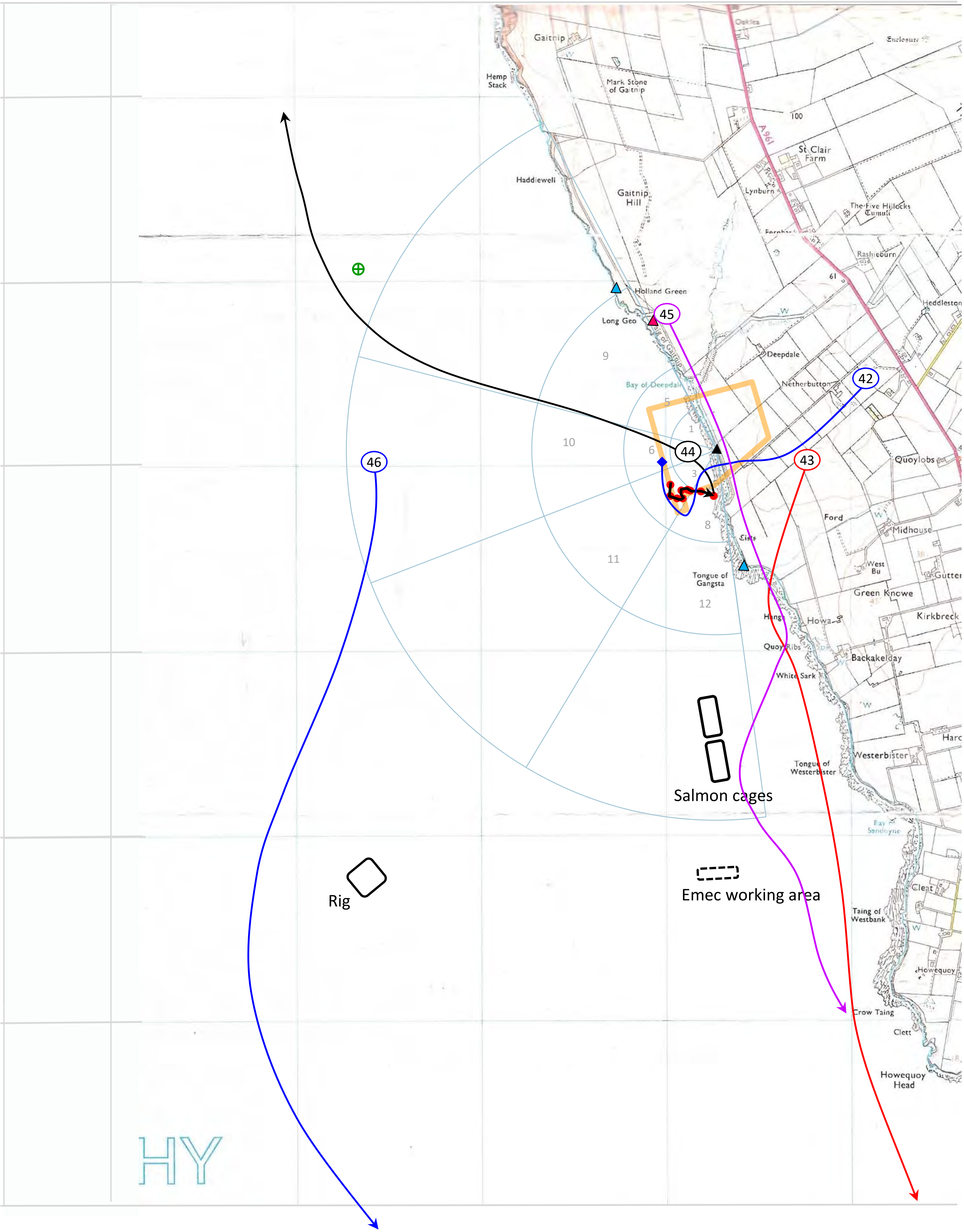
Red-throated Diver flights August (1 of 3) 2022



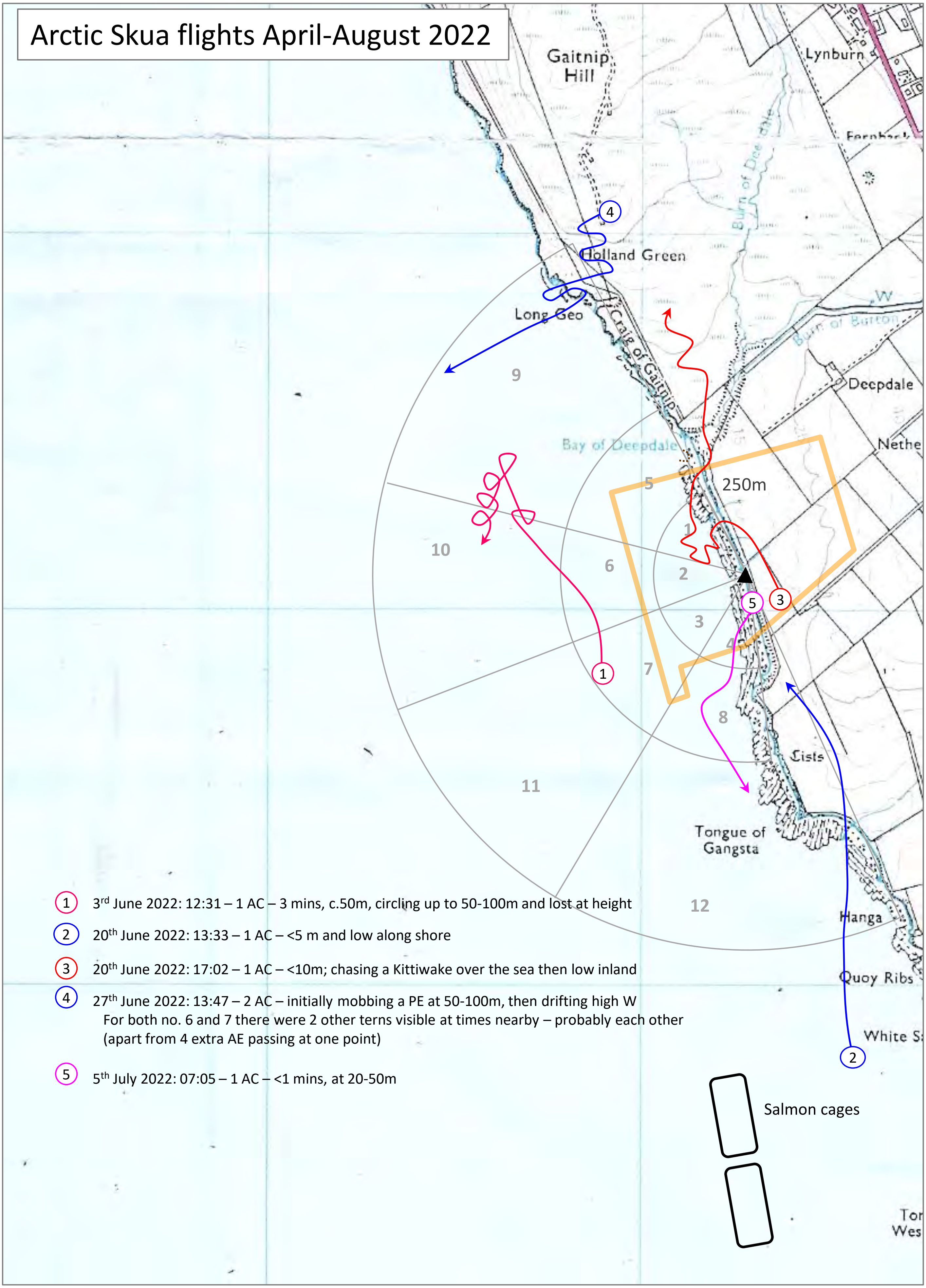
Red-throated Diver flights August (2 of 3) 2022



Red-throated Diver flights August (3 of 3) 2022



Arctic Skua flights April-August 2022



① 3rd June 2022: 12:31 – 1 AC – 3 mins, c.50m, circling up to 50-100m and lost at height

② 20th June 2022: 13:33 – 1 AC – <5 m and low along shore

③ 20th June 2022: 17:02 – 1 AC – <10m; chasing a Kittiwake over the sea then low inland

④ 27th June 2022: 13:47 – 2 AC – initially mobbing a PE at 50-100m, then drifting high W
For both no. 6 and 7 there were 2 other terns visible at times nearby – probably each other
(apart from 4 extra AE passing at one point)

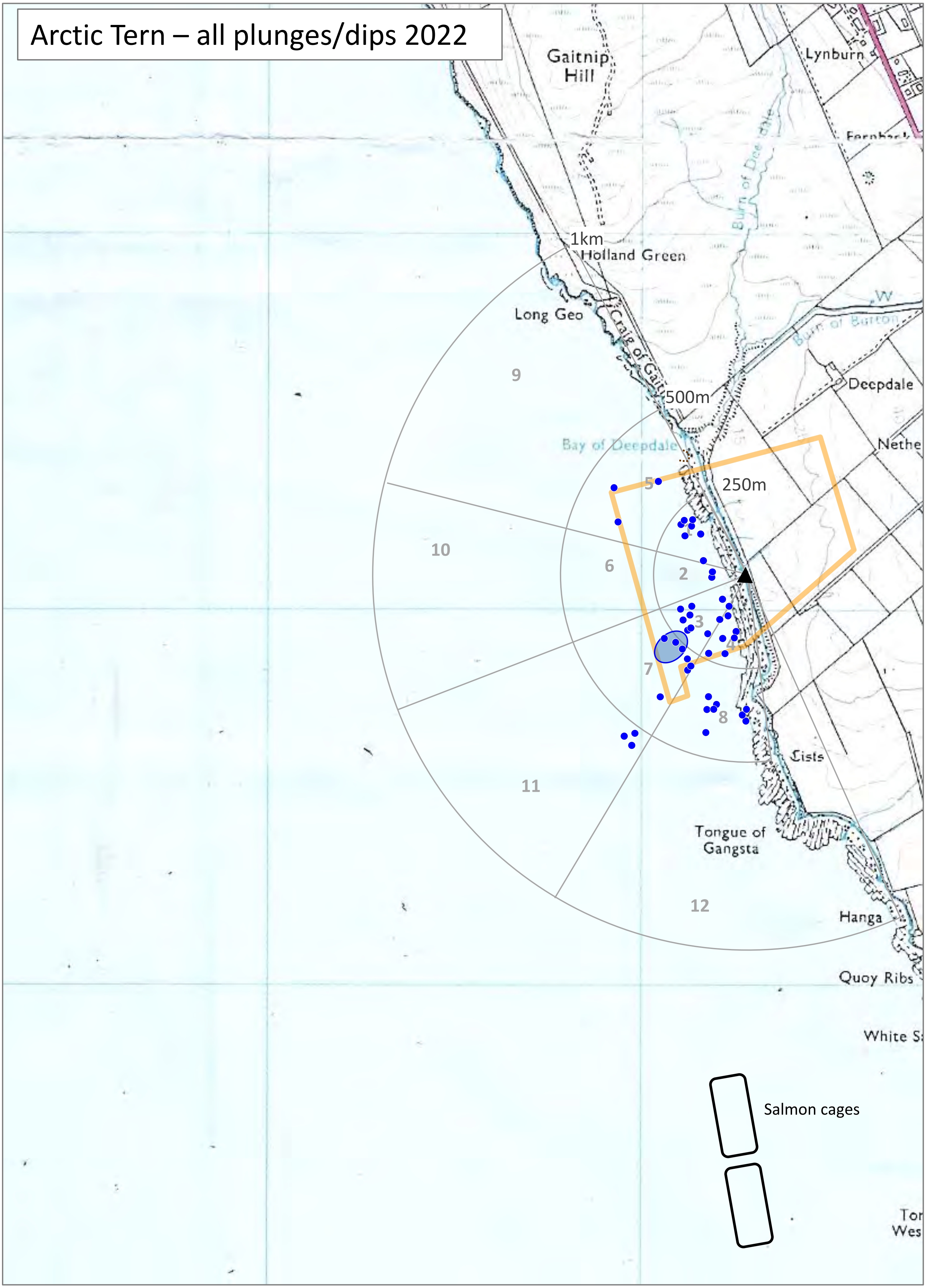
⑤ 5th July 2022: 07:05 – 1 AC – <1 mins, at 20-50m

APPENDIX H iii

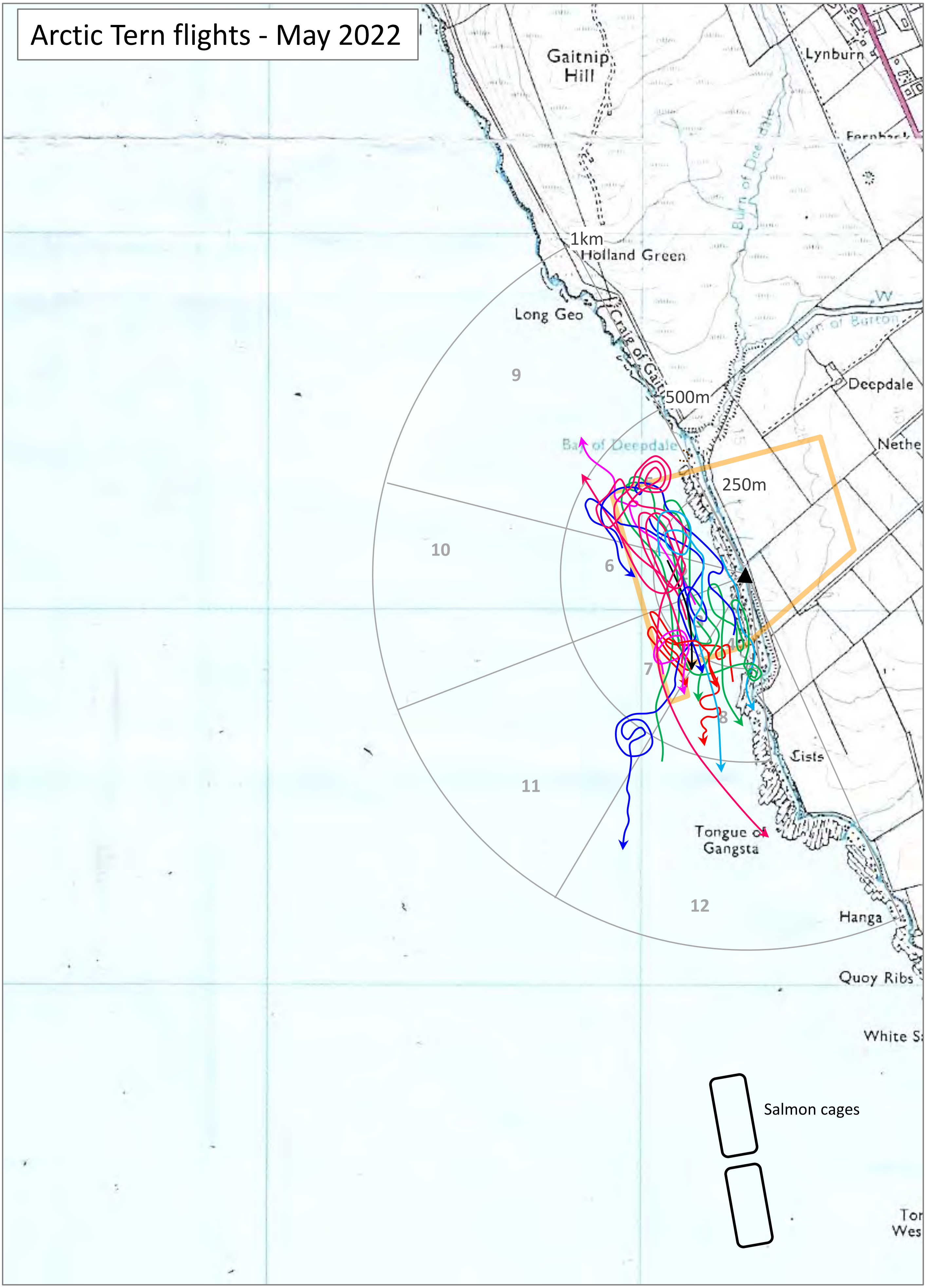
Year 2 offshore flight maps:

Arctic Skua, Arctic Tern and Common Tern

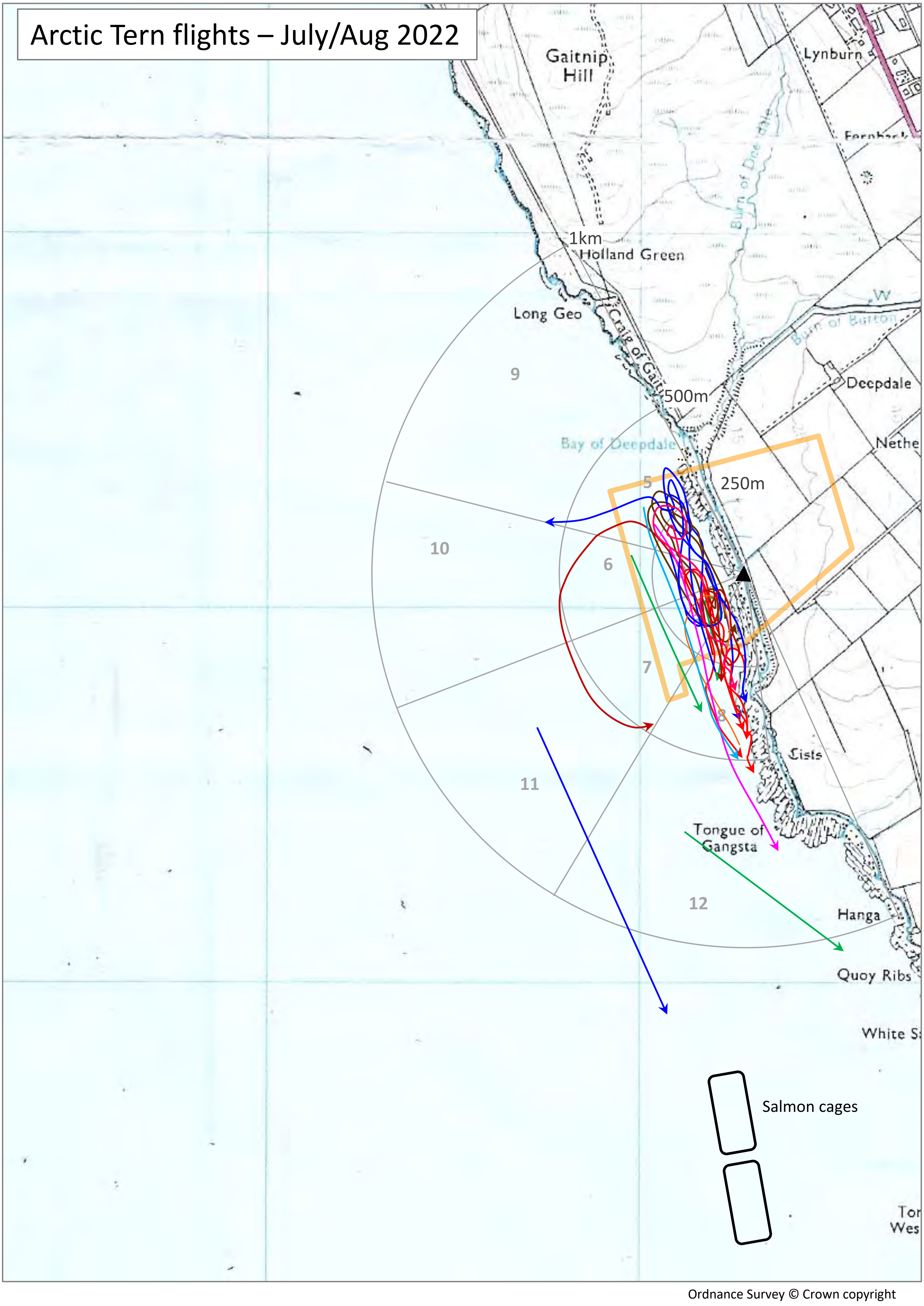
Arctic Tern – all plunges/dips 2022



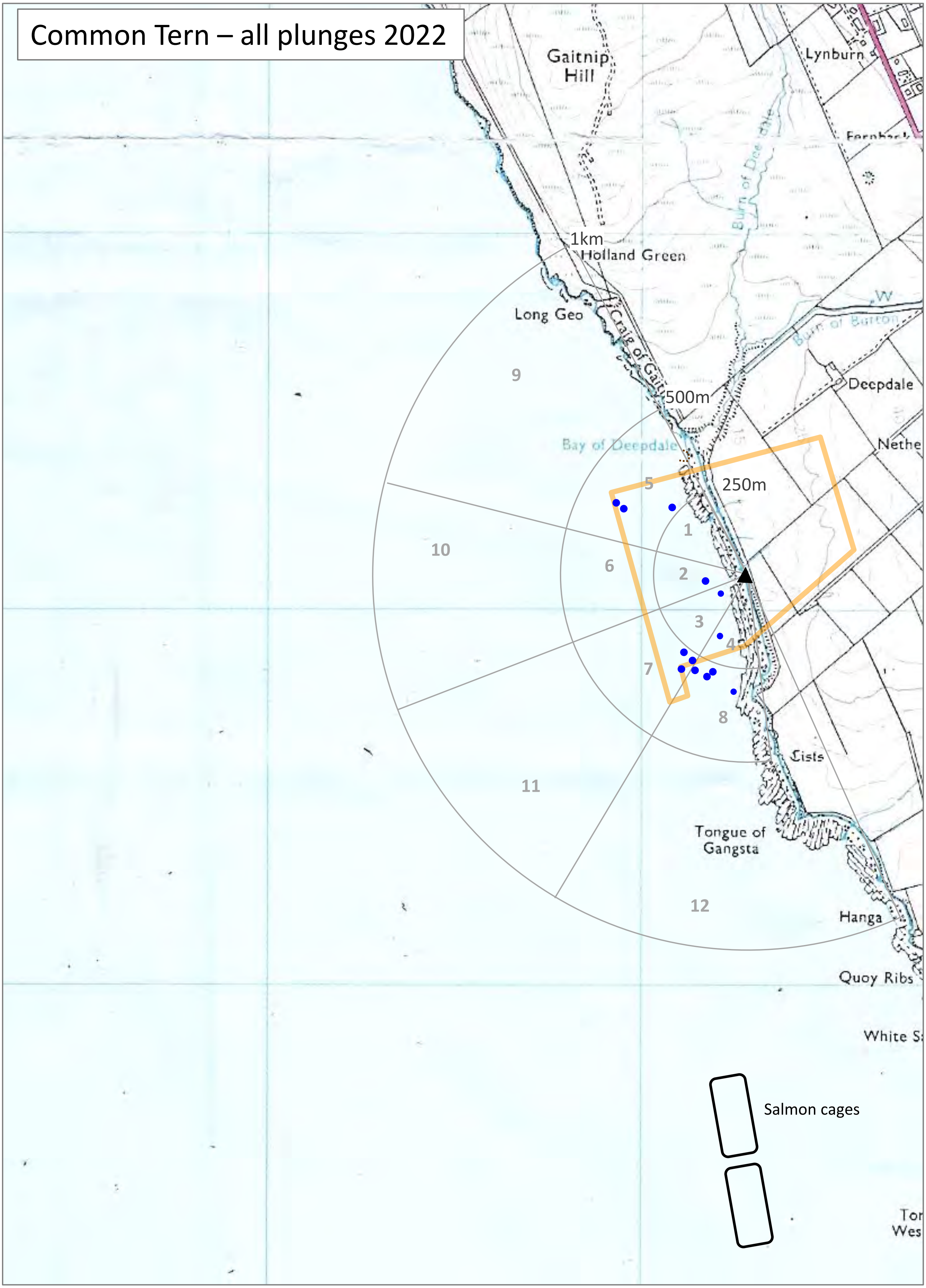
Arctic Tern flights - May 2022



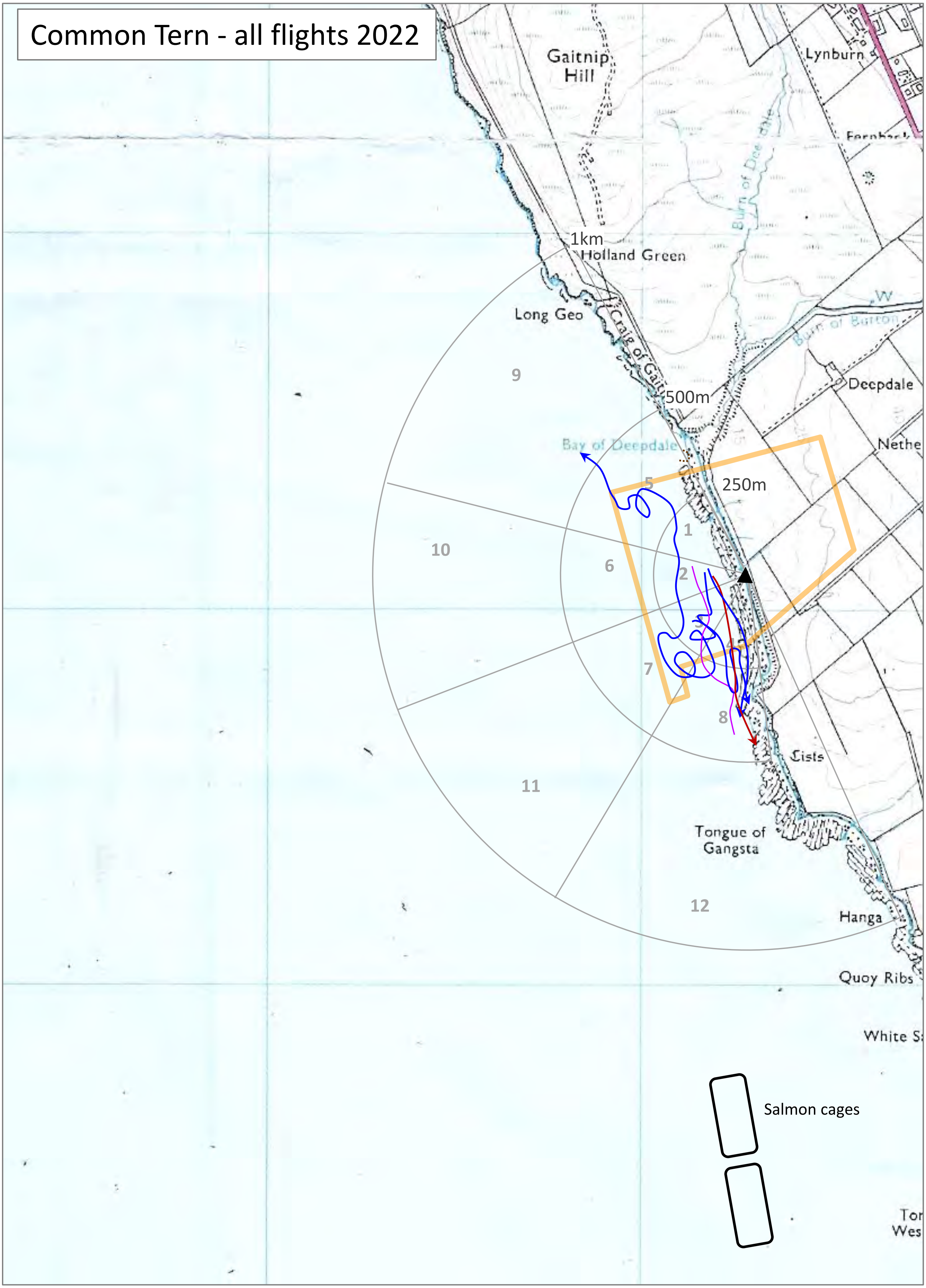
Arctic Tern flights – July/Aug 2022



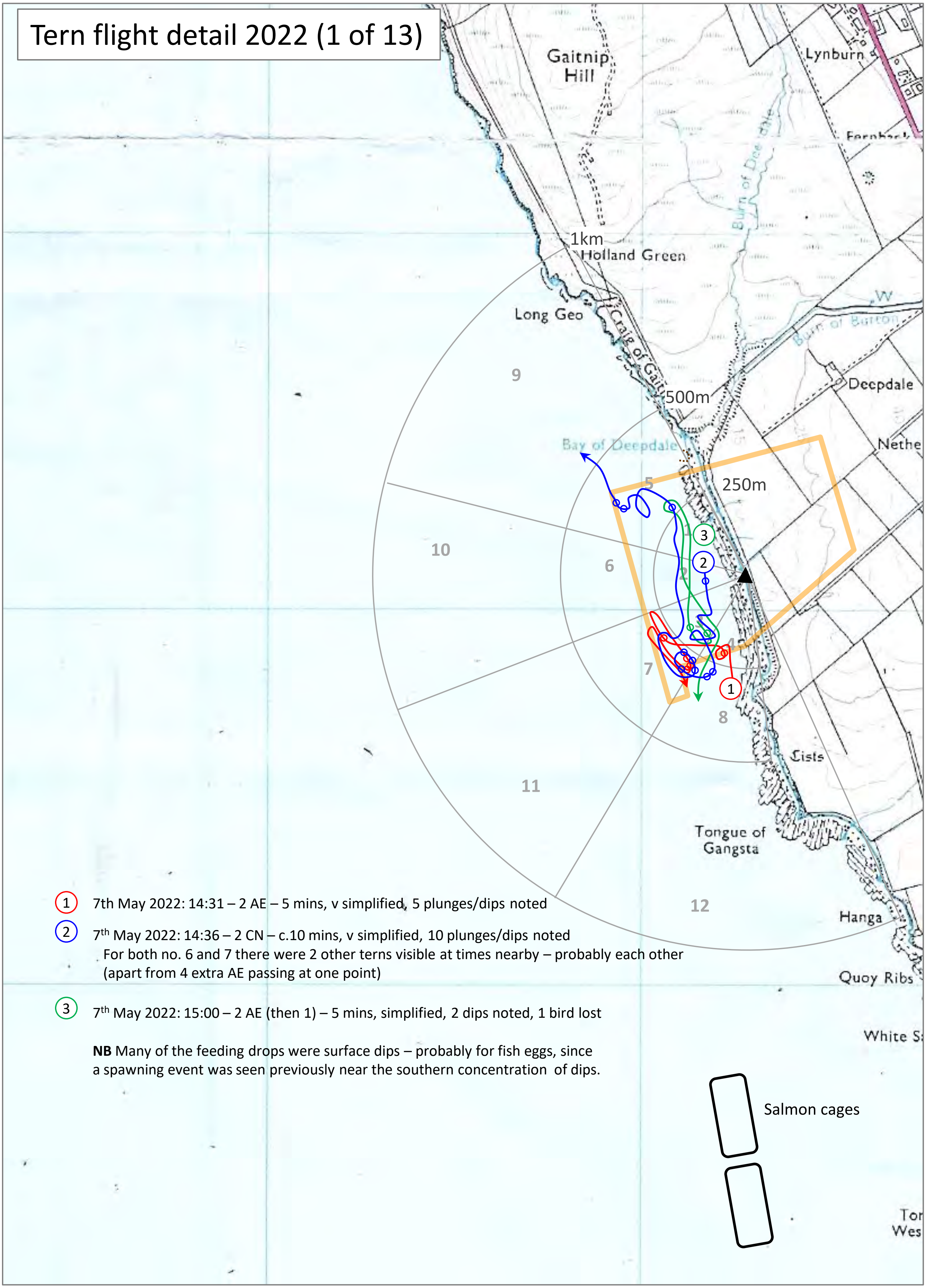
Common Tern – all plunges 2022



Common Tern - all flights 2022



Tern flight detail 2022 (1 of 13)



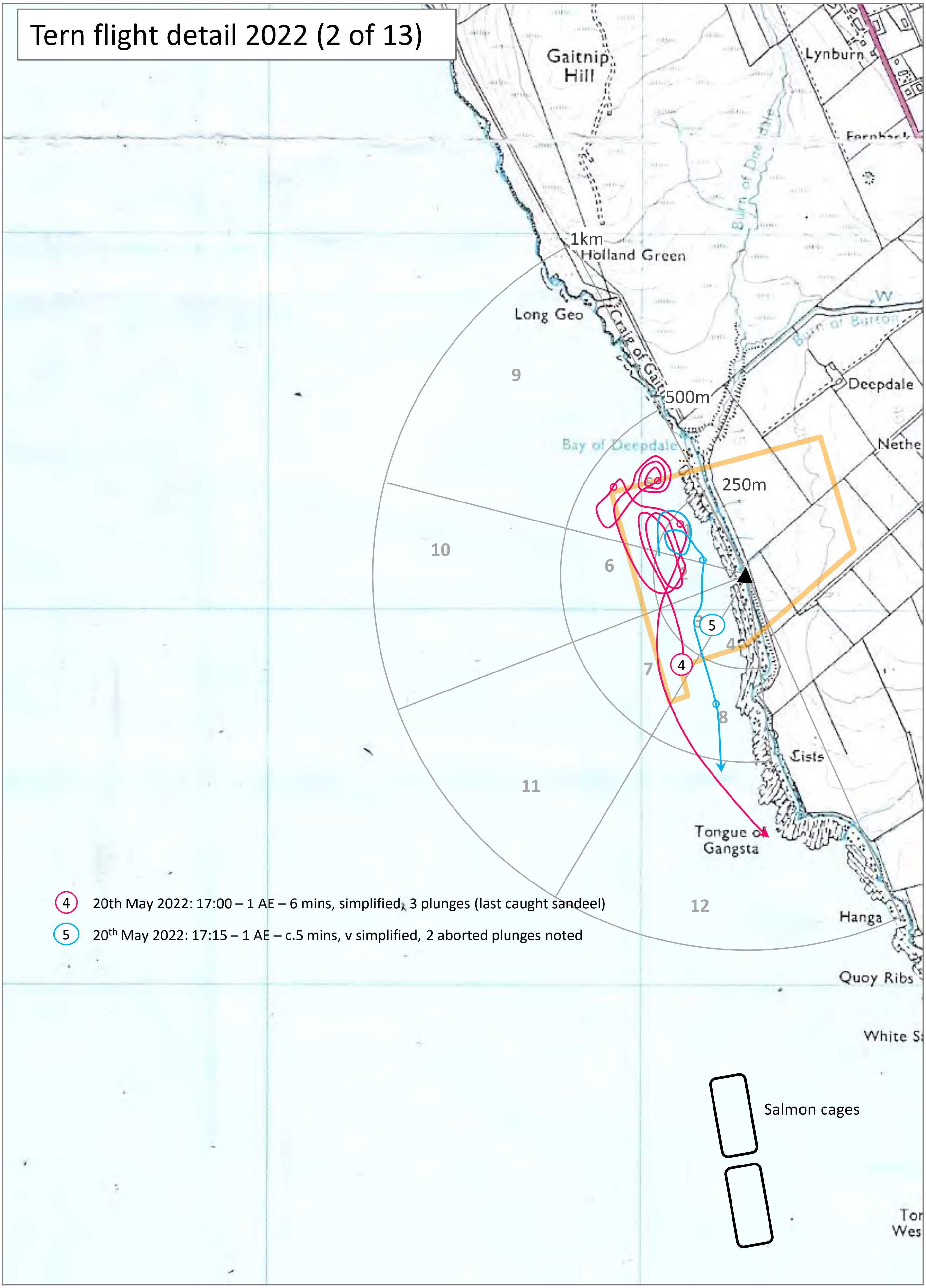
① 7th May 2022: 14:31 – 2 AE – 5 mins, v simplified, 5 plunges/dips noted

② 7th May 2022: 14:36 – 2 CN – c.10 mins, v simplified, 10 plunges/dips noted
For both no. 6 and 7 there were 2 other terns visible at times nearby – probably each other
(apart from 4 extra AE passing at one point)

③ 7th May 2022: 15:00 – 2 AE (then 1) – 5 mins, simplified, 2 dips noted, 1 bird lost

NB Many of the feeding drops were surface dips – probably for fish eggs, since a spawning event was seen previously near the southern concentration of dips.

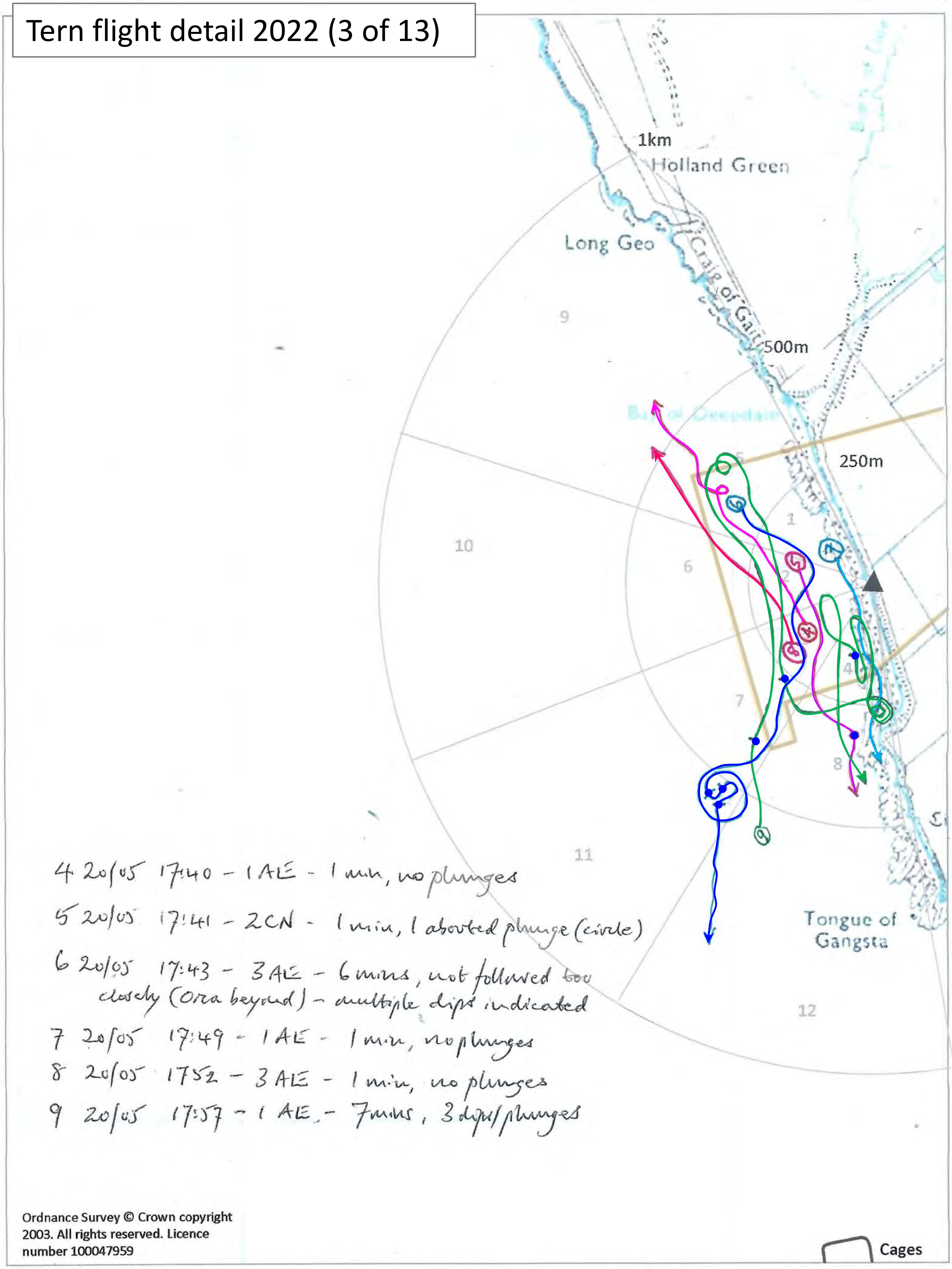
Tern flight detail 2022 (2 of 13)



④ 20th May 2022: 17:00 – 1 AE – 6 mins, simplified, 3 plunges (last caught sandeel)

⑤ 20th May 2022: 17:15 – 1 AE – c.5 mins, v simplified, 2 aborted plunges noted

Tern flight detail 2022 (3 of 13)



4 20/05 17:40 - 1 AE - 1 min, no plunges

5 20/05 17:41 - 2 CN - 1 min, 1 aborted plunge (circle)

6 20/05 17:43 - 3 AE - 6 mins, not followed ~~too~~ closely (Orca beyond) - multiple dips indicated

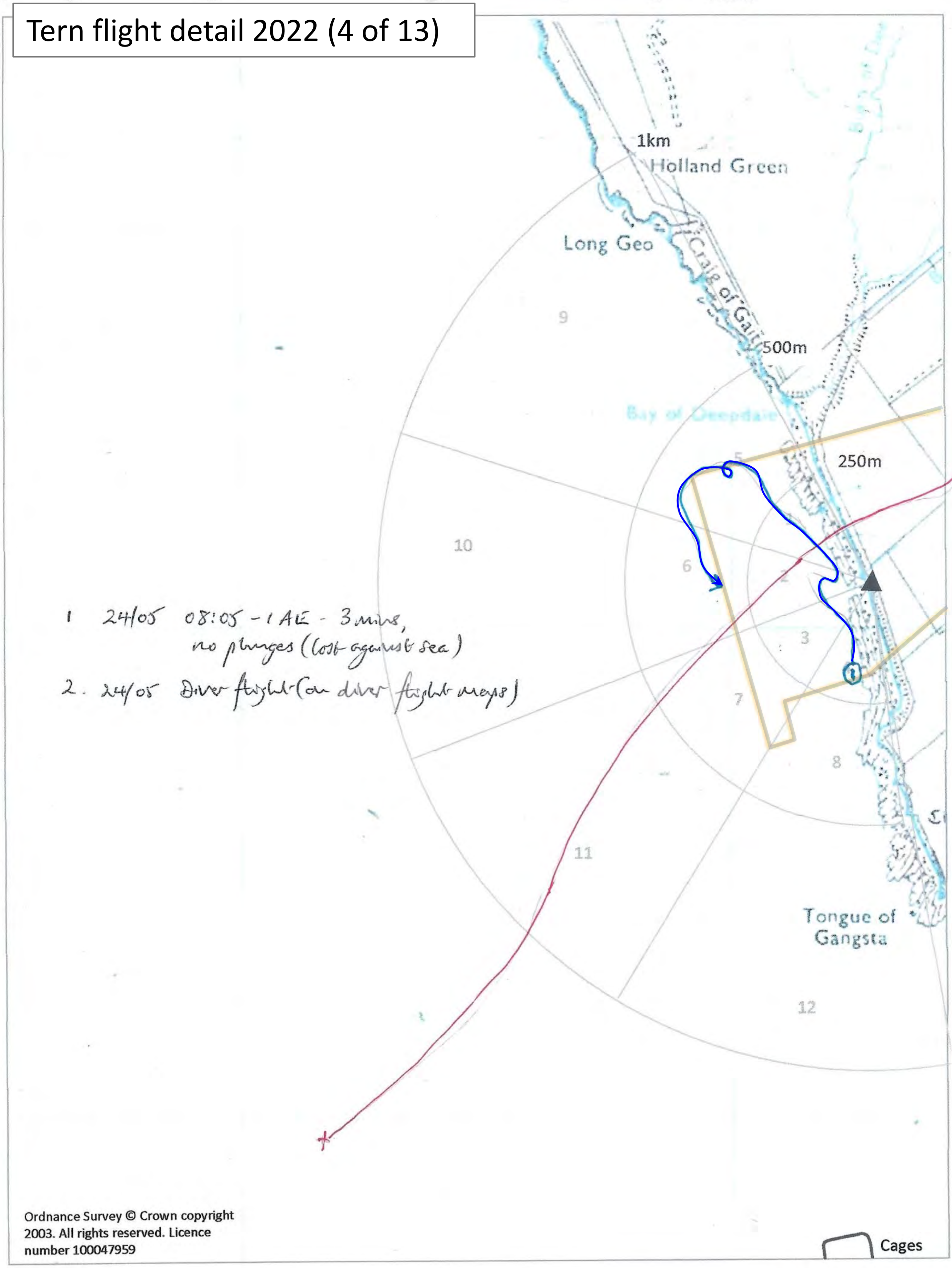
7 20/05 17:49 - 1 AE - 1 min, no plunges

8 20/05 1752 - 3 AE - 1 min, no plunges

9 20/05 17:57 - 1 AE - 7 mins, 3 dips/plunges

Tern Flights - 20th May 2022 (2 of 2)
(bar across line is point where tern plunged or dipped to surface)

Tern flight detail 2022 (4 of 13)

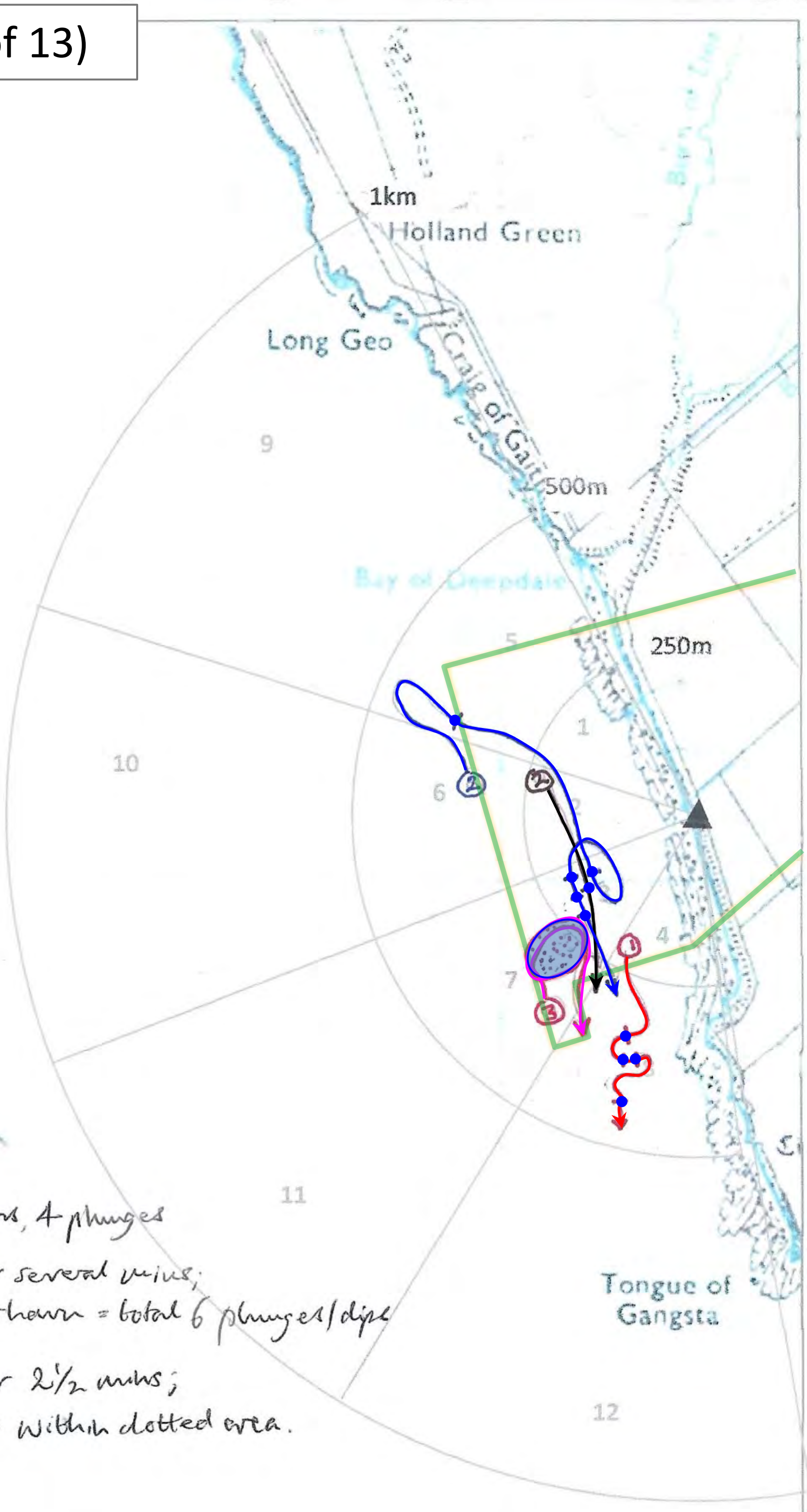


1 24/05 08:05 - 1 AE - 3 mins,
no plunges (lost against sea)

2. 24/05 Diver flight (on diver flight maps)

24/05/22

Tern flight detail 2022 (5 of 13)



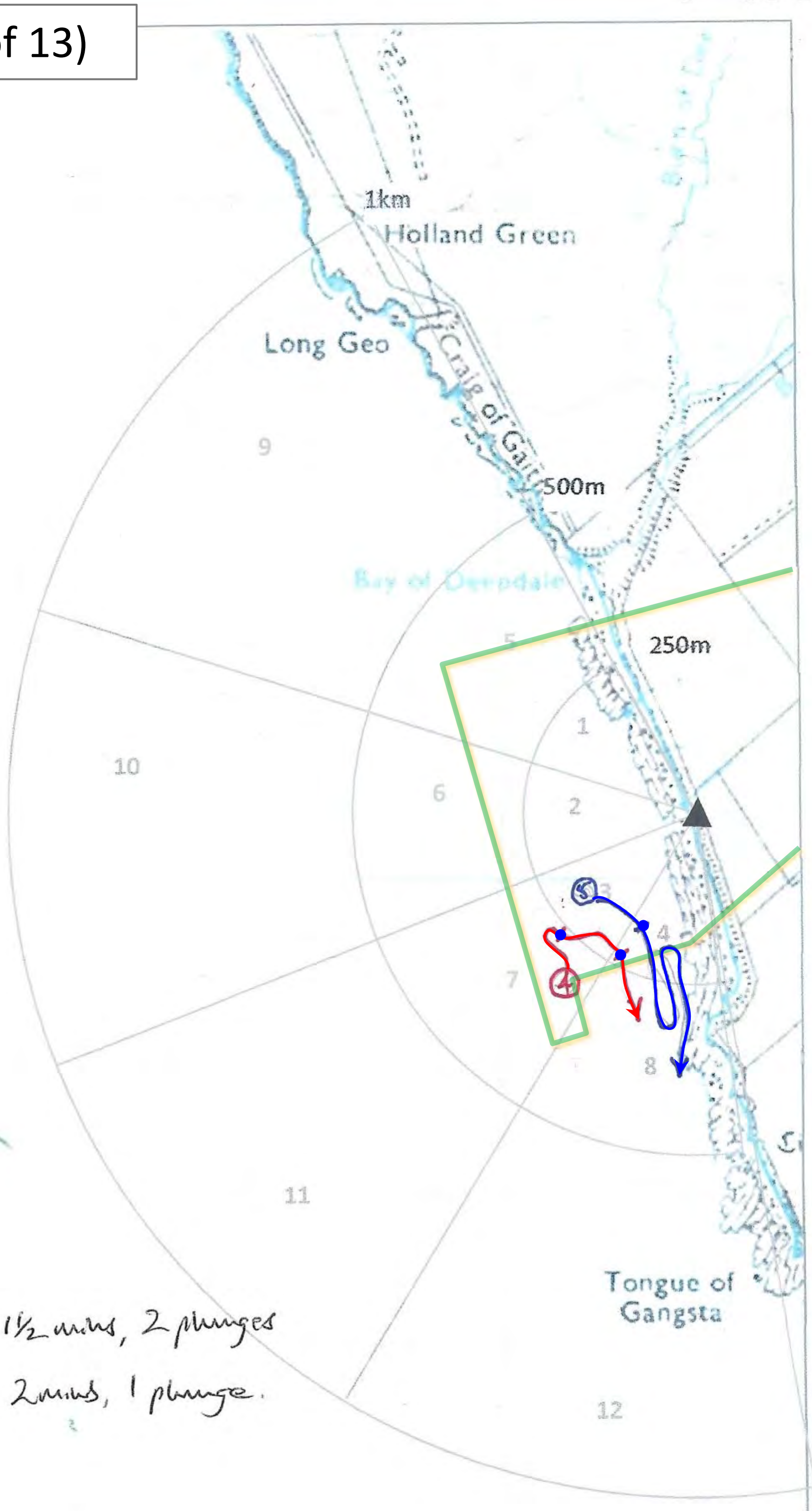
1 30/05 15:26 - 1 ALE - 1½ mins, 4 plunges

2 30/05 15:29 - up to 4 ALE for several mins;
two simplified lines shown = total 6 plunges/dips

3 30/05 16:12 - up to 3 ALE for 2½ mins;
total of 21 plunges within dotted area.

▭ Cages

Tern flight detail 2022 (6 of 13)

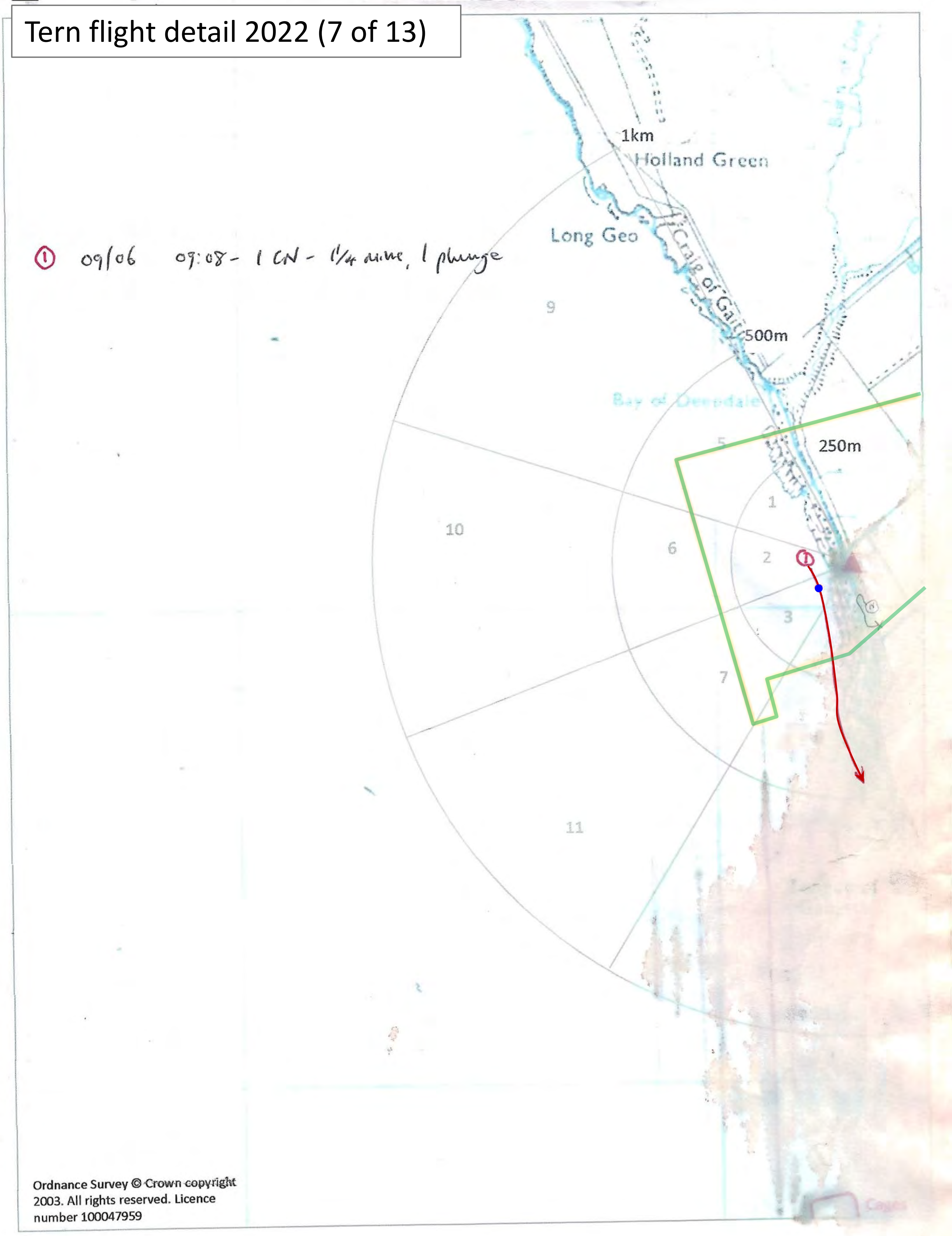


4. 30/05 16:29 - 1AE - 1½ mins, 2 plunges

5. 30/05 16:30 - 1CN - 2 mins, 1 plunge.

Cages

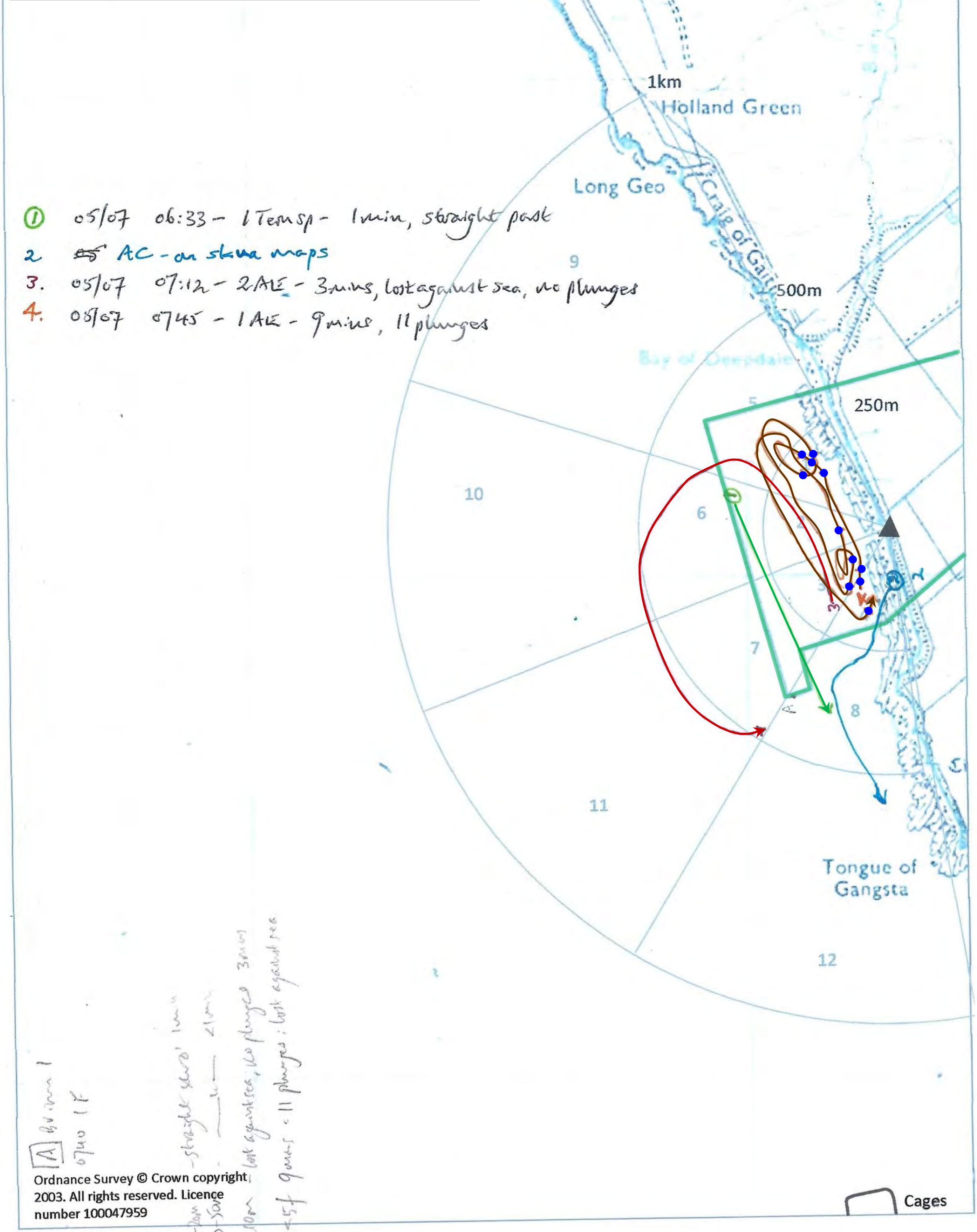
Tern flight detail 2022 (7 of 13)



① 09/06 09:08 - 1 CN - 1/4 mins, 1 plunge

09/06 2

Tern flight detail 2022 (8 of 13)



① 05/07 06:33 – 1 Tern sp – 1min, straight past
2 ~~05~~ AC – on skua maps
3. 05/07 07:12 – 2AE – 3mins, lost against sea, no plunges
4. 08/07 0745 – 1AE – 9mins, 11 plunges

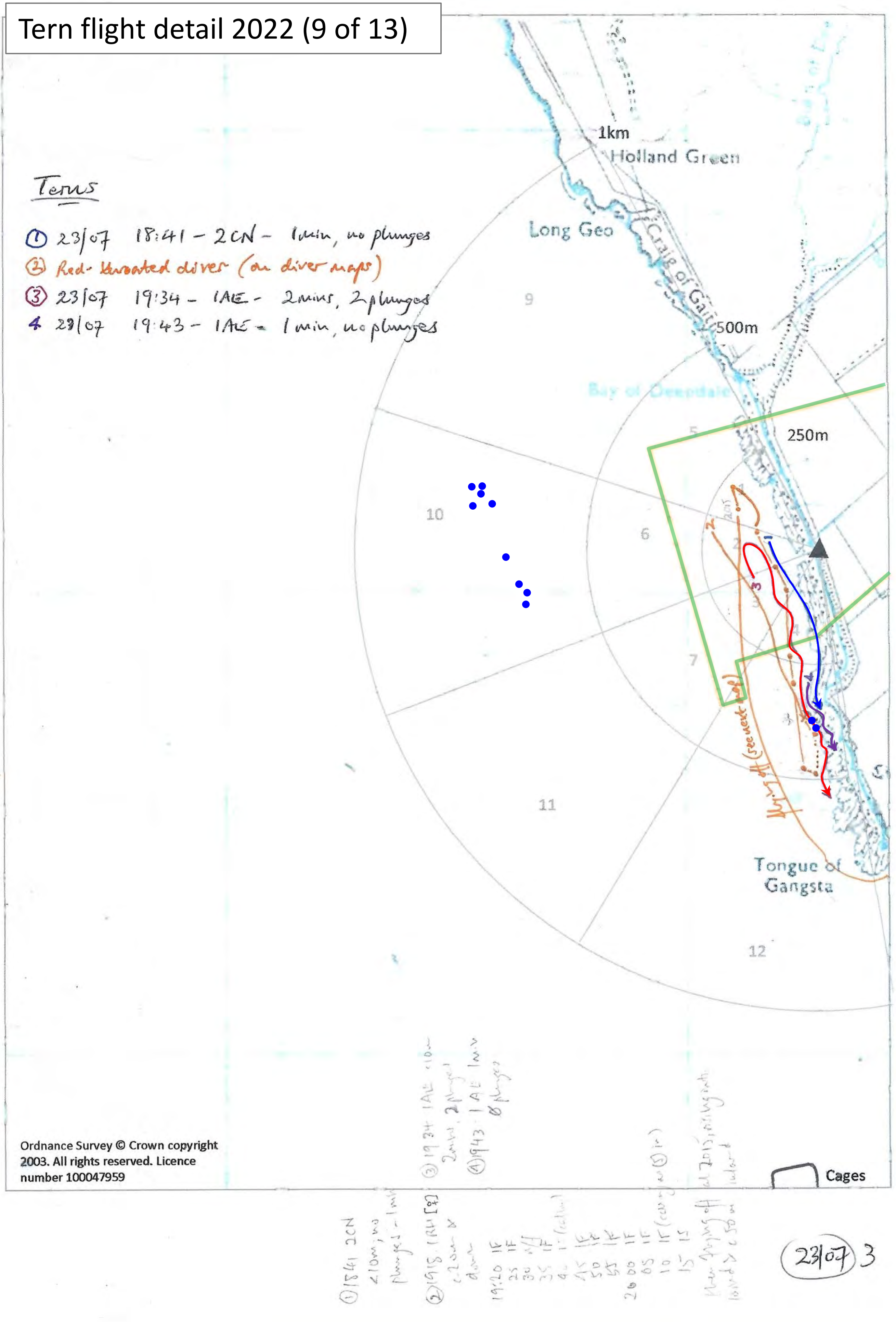
A 8v.inn 1
0740 1F

~~A BVinn~~ 7

① 06.33 Tsp 1 10-20m -straight past' 1min
② 0703 AC 1 20-50m —"— <1min
③ 07:12 AE 2 <50m lost against sea, no plunges 3min
④ 0745 AE 1 <5? 9mins : 11 plunges : lost against sea

(05/07) 4

Tern flight detail 2022 (9 of 13)

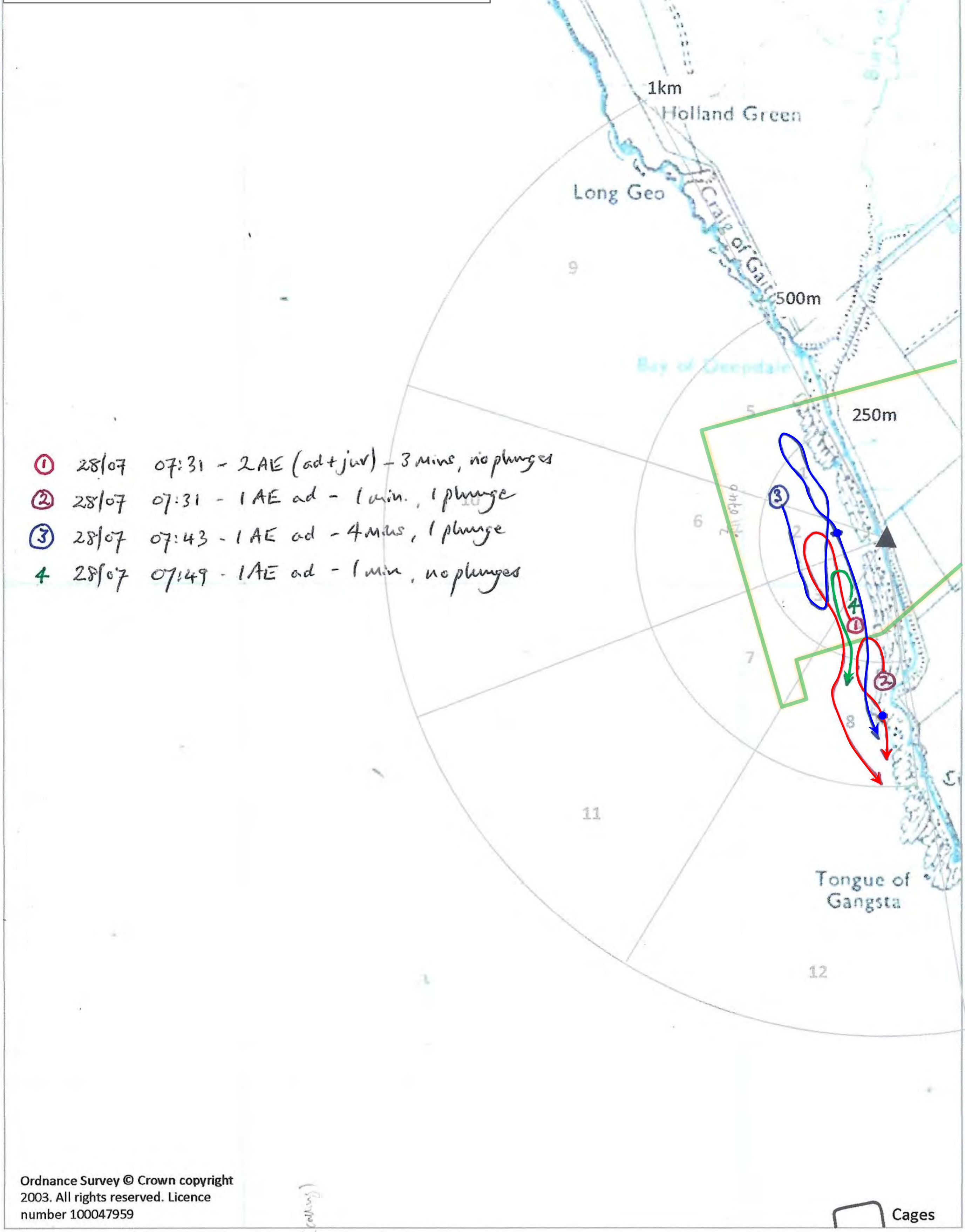


Terns

① 23/07 18:41 – 2CN – 1 min, no plunges
② Red-throated diver (on diver maps)
③ 23/07 19:34 – 1AE – 2 mins, 2 plunges
4 23/07 19:43 – 1AE – 1 min, no plunges

23/07 3

Tern flight detail 2022 (10 of 13)

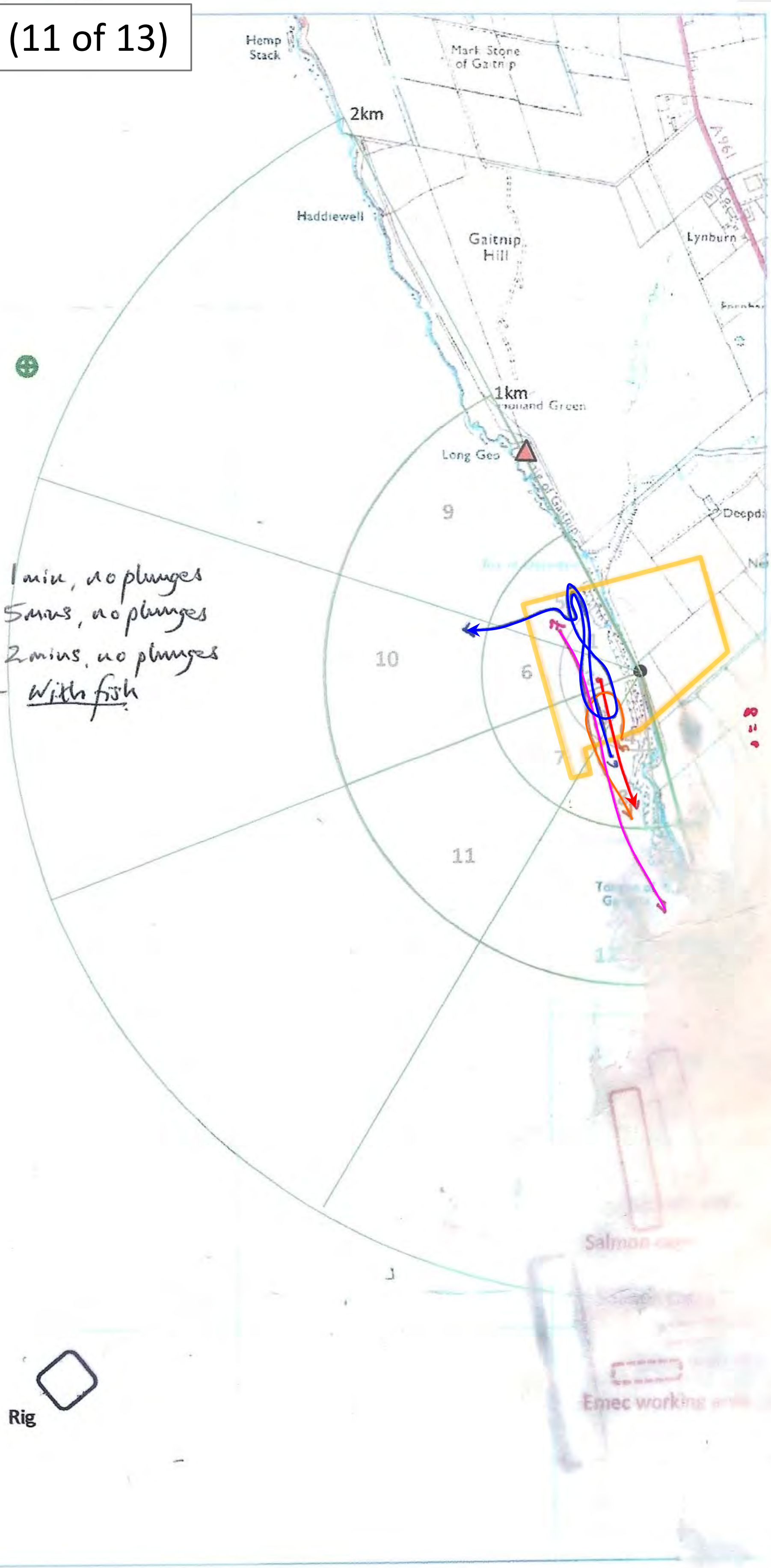


① 28/07 07:31 - 2AE (ad + juv) - 3 mins, no plunges
② 28/07 07:31 - 1AE ad - 1 min., 1 plunge
③ 28/07 07:43 - 1AE ad - 4 mins, 1 plunge
4 28/07 07:49 - 1AE ad - 1 min, no plunges

0740 2AE 2F (calling)
not found again

(28/07) 6

Tern flight detail 2022 (11 of 13)

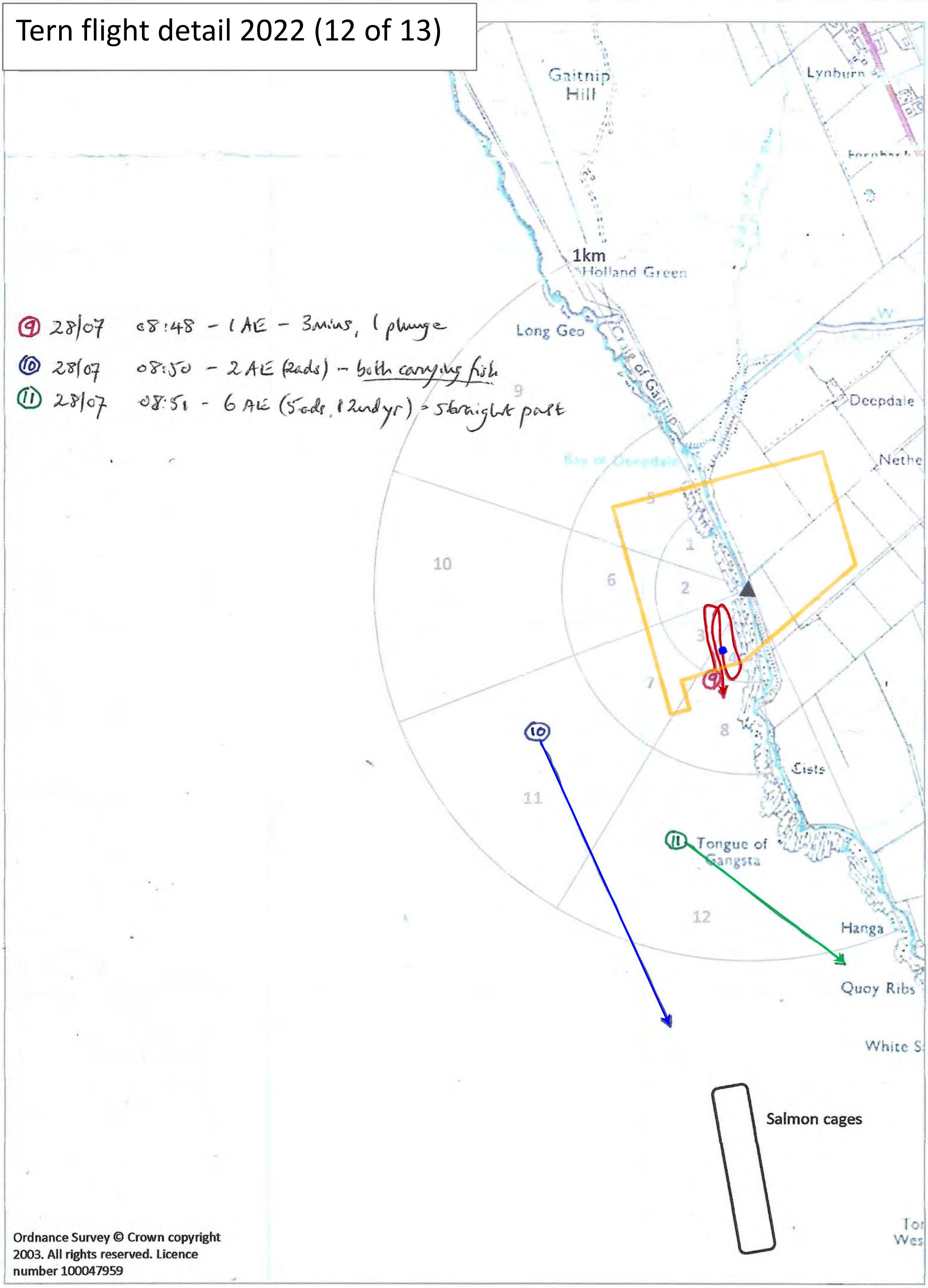


5. 28/07. 07:58 ~ 1 AE ad - 1 min, no plunges
6. 28/07 08:00 ~ 1 AE ad - 5 mins, no plunges
7 28/07 08:07 - 1 AE ad - 2 mins, no plunges
•8 28/07 08:09 ~ 1 AE ad - <u>With fish</u>

Date:

28/07 5 8

Tern flight detail 2022 (12 of 13)



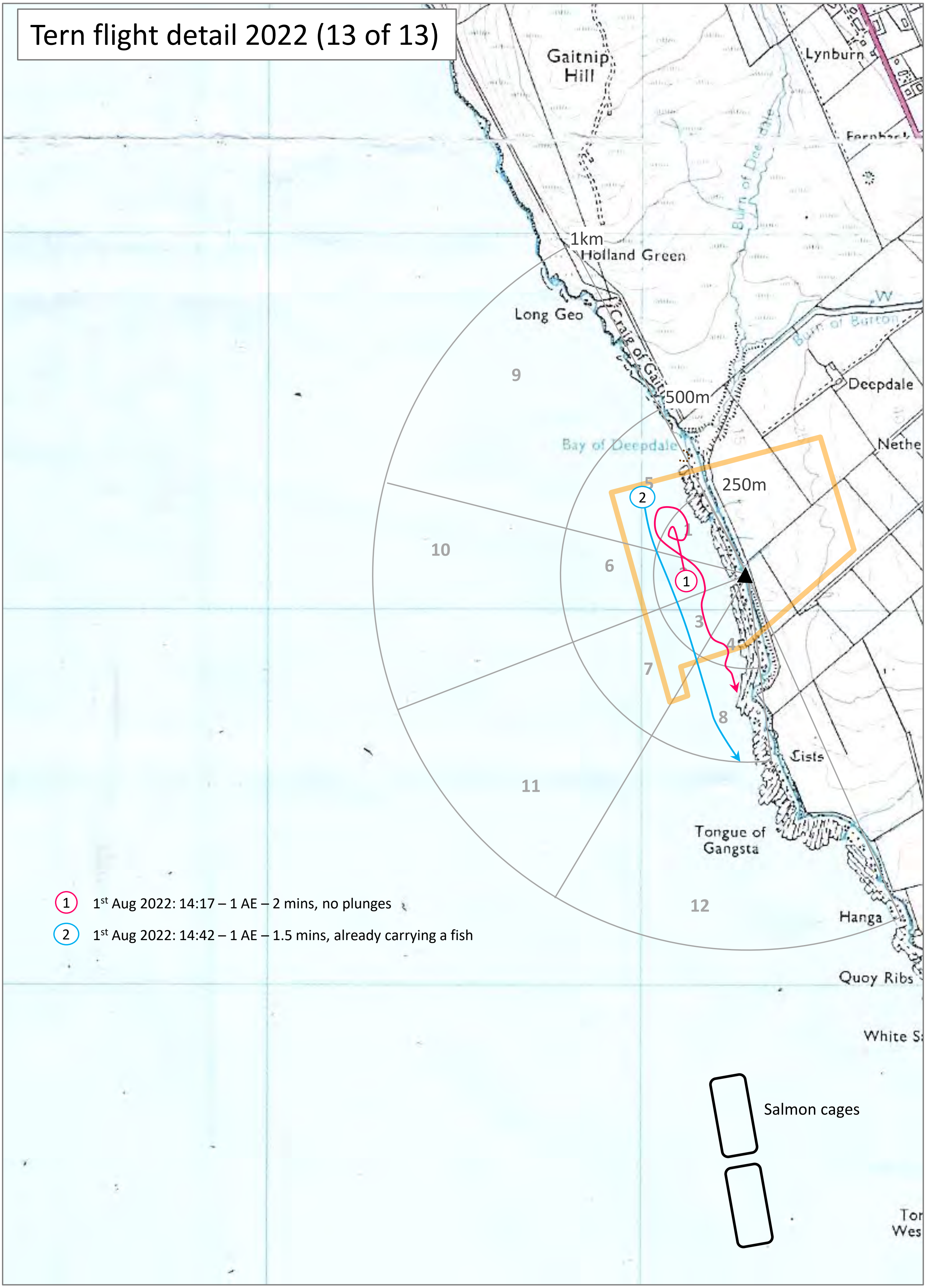
⑨ 28/07 08:48 - 1 AE - 3mins, 1 plunge

⑩ 28/07 08:50 - 2 AE (2ads) - both carrying fish

⑪ 28/07 08:51 - 6 AE (5ads, 1 2nd yr) - straight past

28/07 4/8

Tern flight detail 2022 (13 of 13)

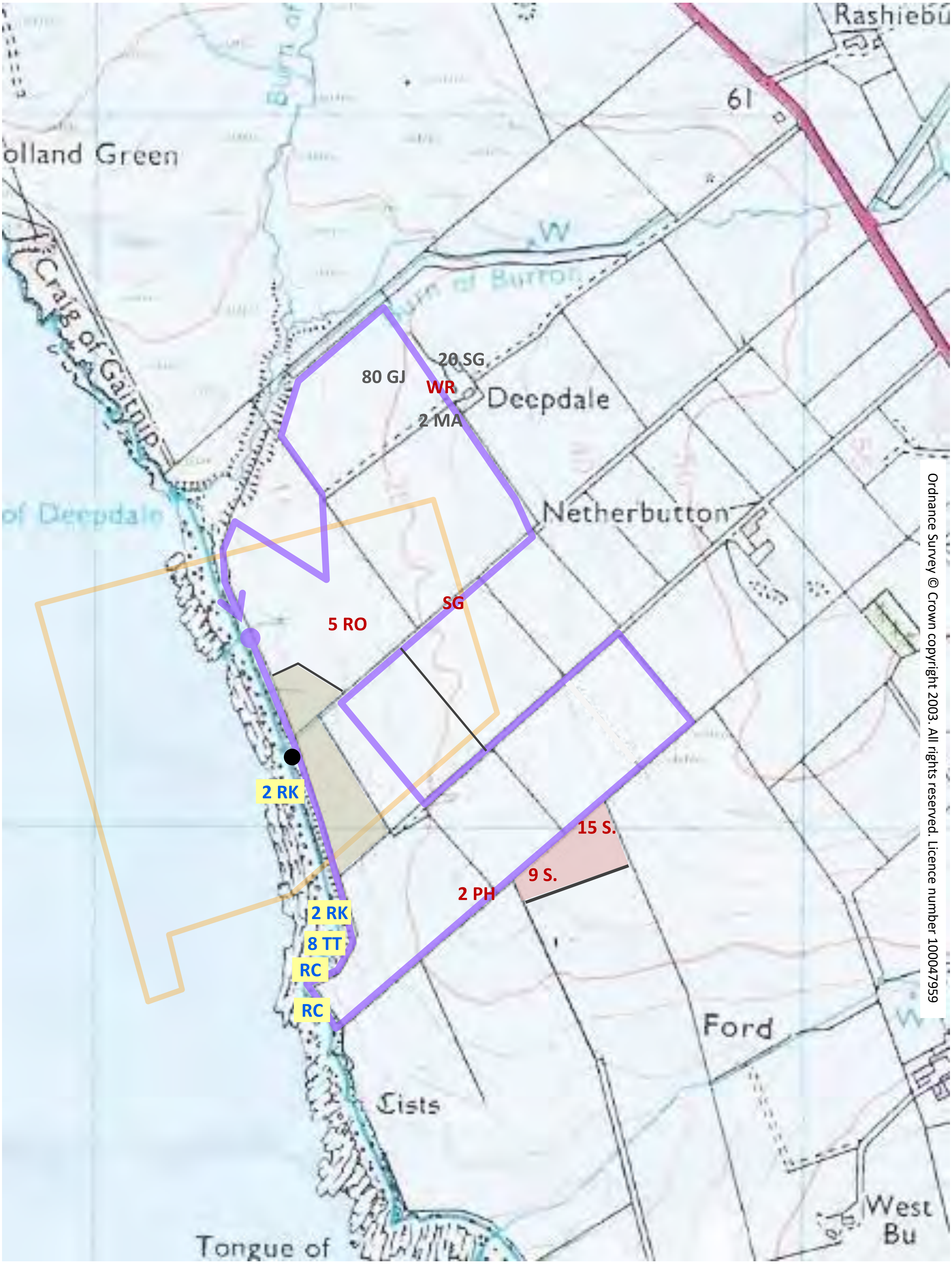


① 1st Aug 2022: 14:17 – 1 AE – 2 mins, no plunges

② 1st Aug 2022: 14:42 – 1 AE – 1.5 mins, already carrying a fish

APPENDIX J i

Winter walkover maps
2020/21



Deepdale walkover

17th Nov 2020 (12:20 – 13:35)

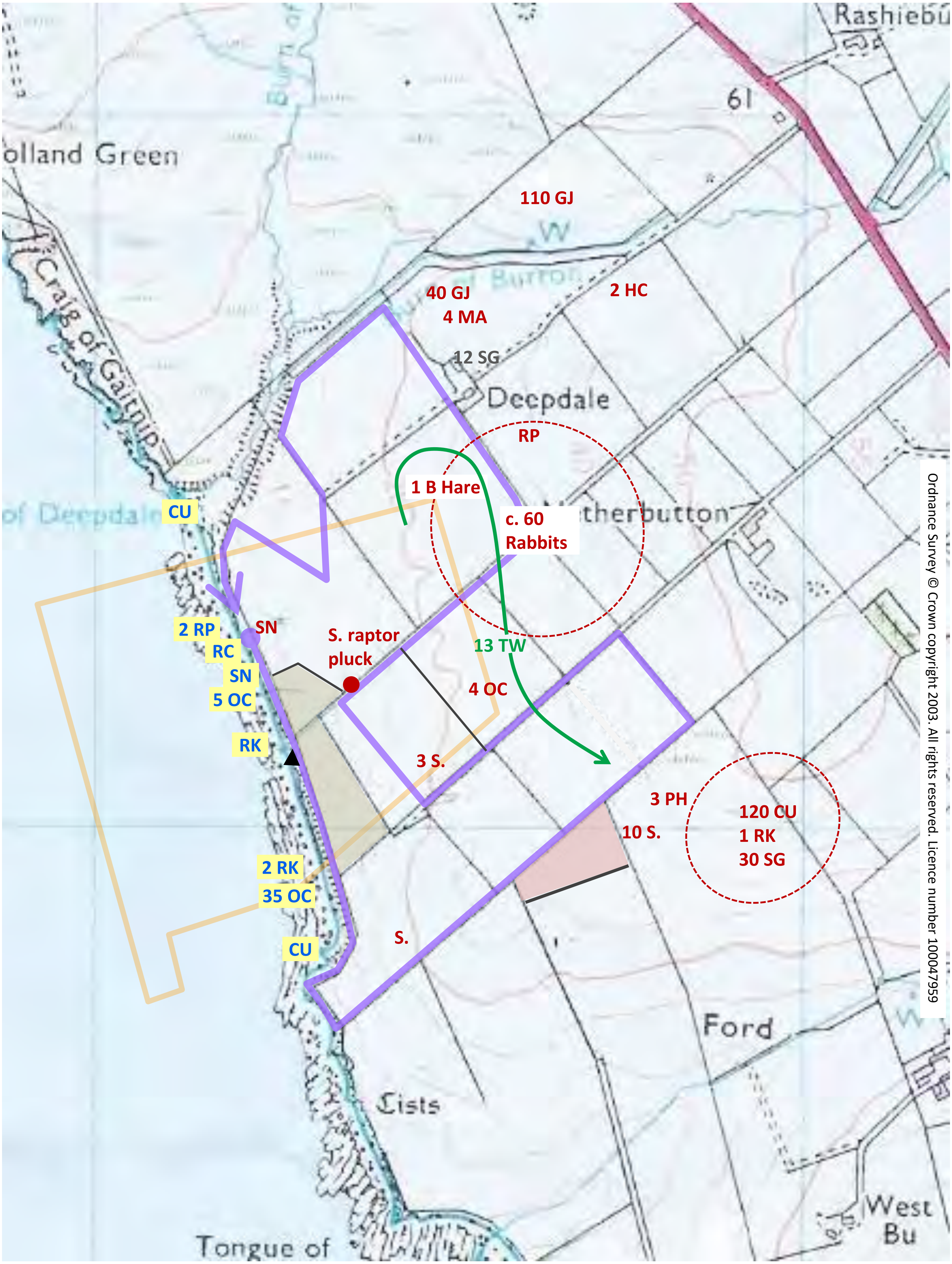
Wind: W4 Cloud: 4/8, dry

Purple line: route walked
Red text: birds on the ground behind the shore
Grey text: additional birds on ground from walk-in earlier
Blue text: birds along the shore
Beige tint: rough/marshy grass, Pink tint: stubble

Deepdale walkover

3rd Jan 2021 (12:50 – 14:05)
Wind: E2   Cloud: 6/8, dry

Purple line: route walked
Red text: birds on the ground behind the shore
Grey text: additional birds on ground from walk-in earlier
Blue text: birds along the shore
Beige tint: rough/marshy grass, Pink tint: stubbly



Deepdale walkover
20th Feb 2021 (12:35 – 13:55)
Wind: SSW3-4 Cloud: 7/8, dry

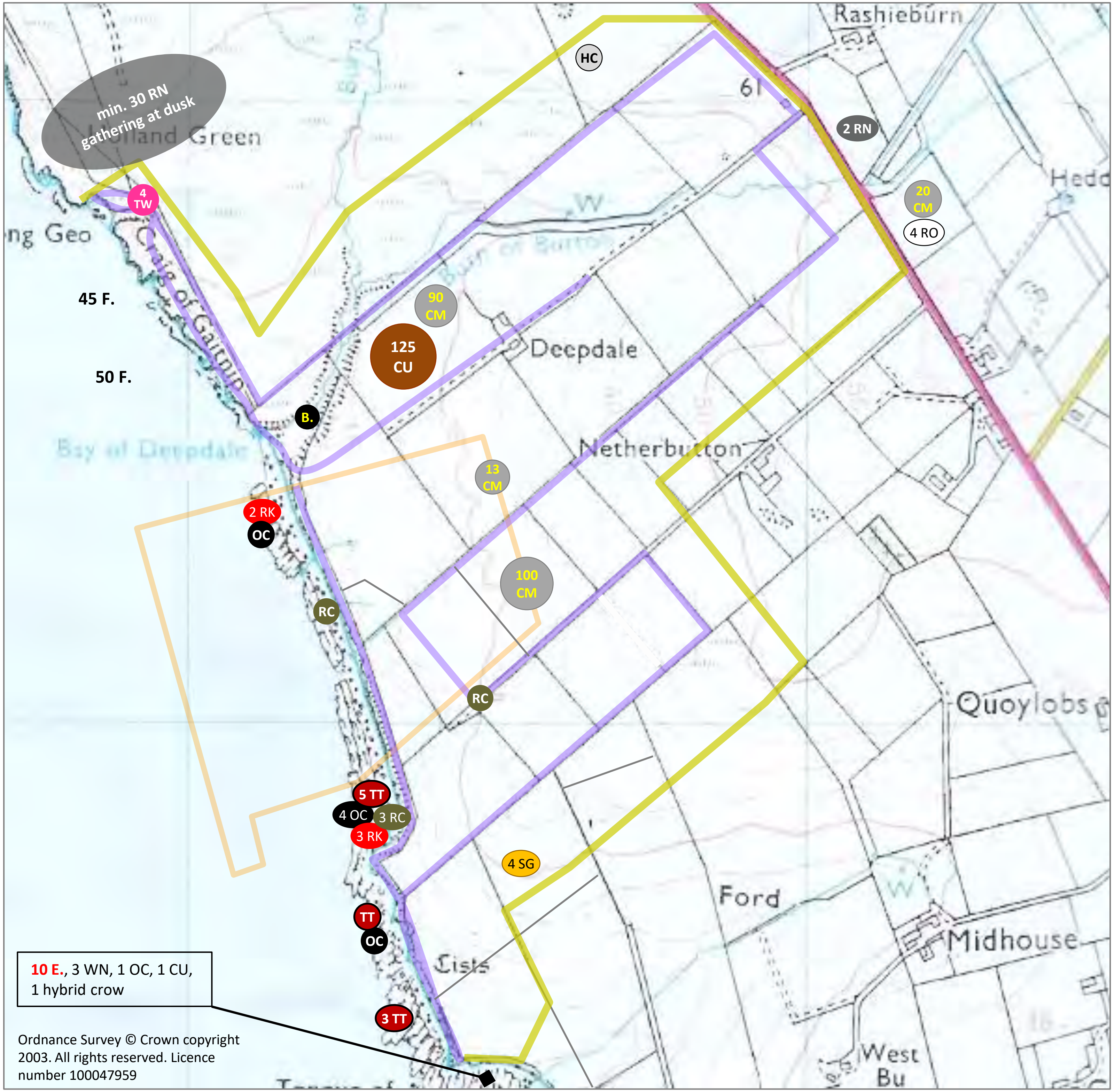
Purple line: route walked
Red text: birds on the ground behind the shore
Grey text: additional birds on ground from walk-in earlier
Green text & line: birds in flight
Blue text: birds along the shore

APPENDIX J ii

Winter walkover maps
2021/22

Deepdale winter walkover survey: 2021/22

Date: 4th December
Time: 13:45–16:15
Wind: N 3
Weather: 8/8 at >500m; dry



10 E., 3 WN, 1 OC, 1 CU, 1 hybrid crow

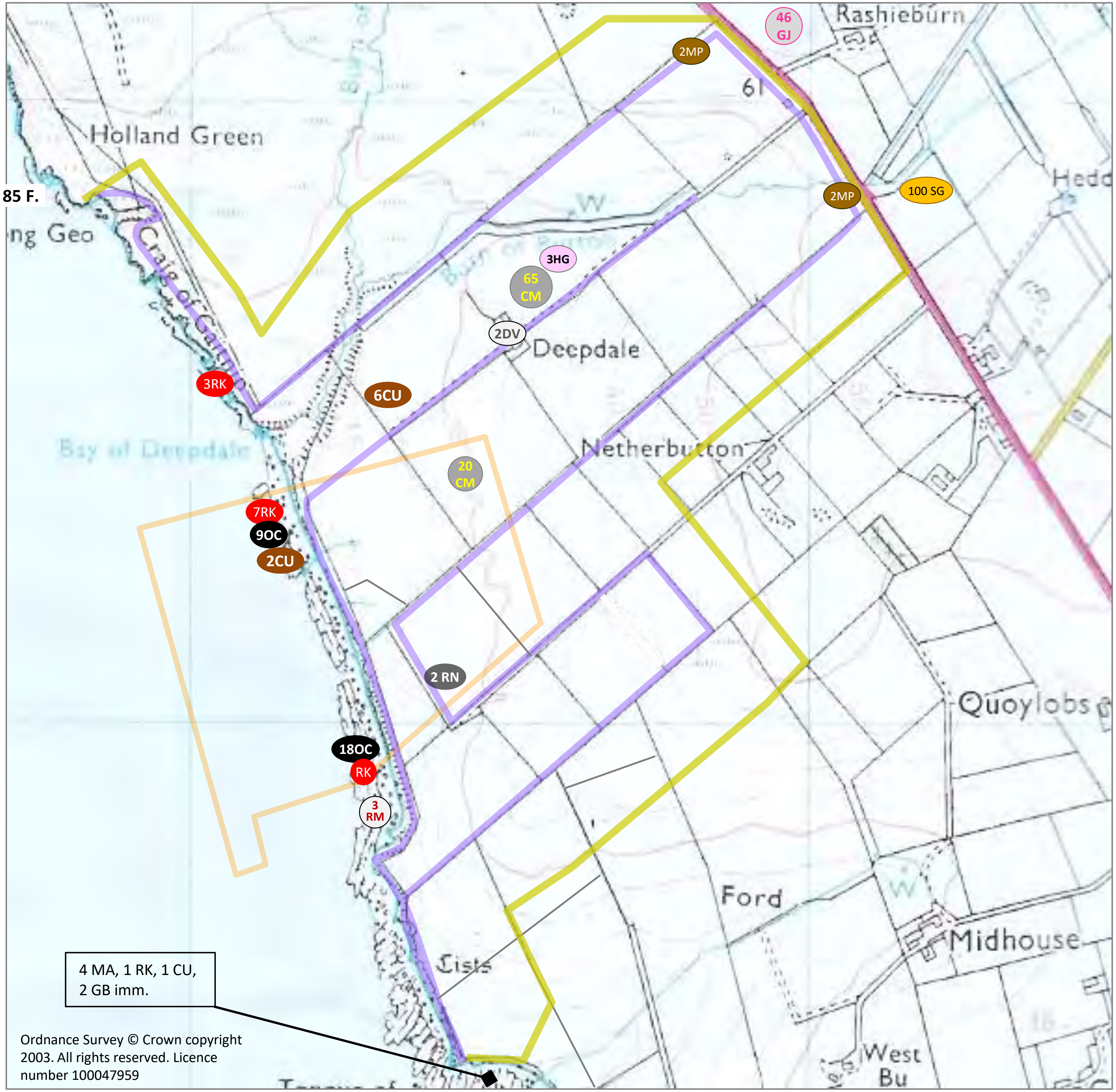
	December 2021 survey route
	Effective survey area
45 F.	Fulmars on the sea (95)
OC	Oystercatcher (6)
3 TT	Turnstone (9)
2 RK	Redshank (5)
125 CU	Curlew (125 feeding)
13 CM	Common Gull (223 feeding)
2 RN	Raven (min. 32)
HC	Hooded Crow (1)
4 RO	Rook (4)
4 SG	Starling (4)
B.	Blackbird (1)
RC	Rock Pipit (5)
4 TW	Twite (4 roosting on cliff)

Additionally:

- 18 Fulmar sites on cliffs to N (none S of burn)
- Several Shags on cliffs to N
- Birds in bay to S as shown in box on left

Deepdale winter walkover survey: 2021/22

Date: 30th January 2022
Time: 14:00 – 16:00
Wind: SSW 4
Weather: cloud 8/8; light rain from 14:45



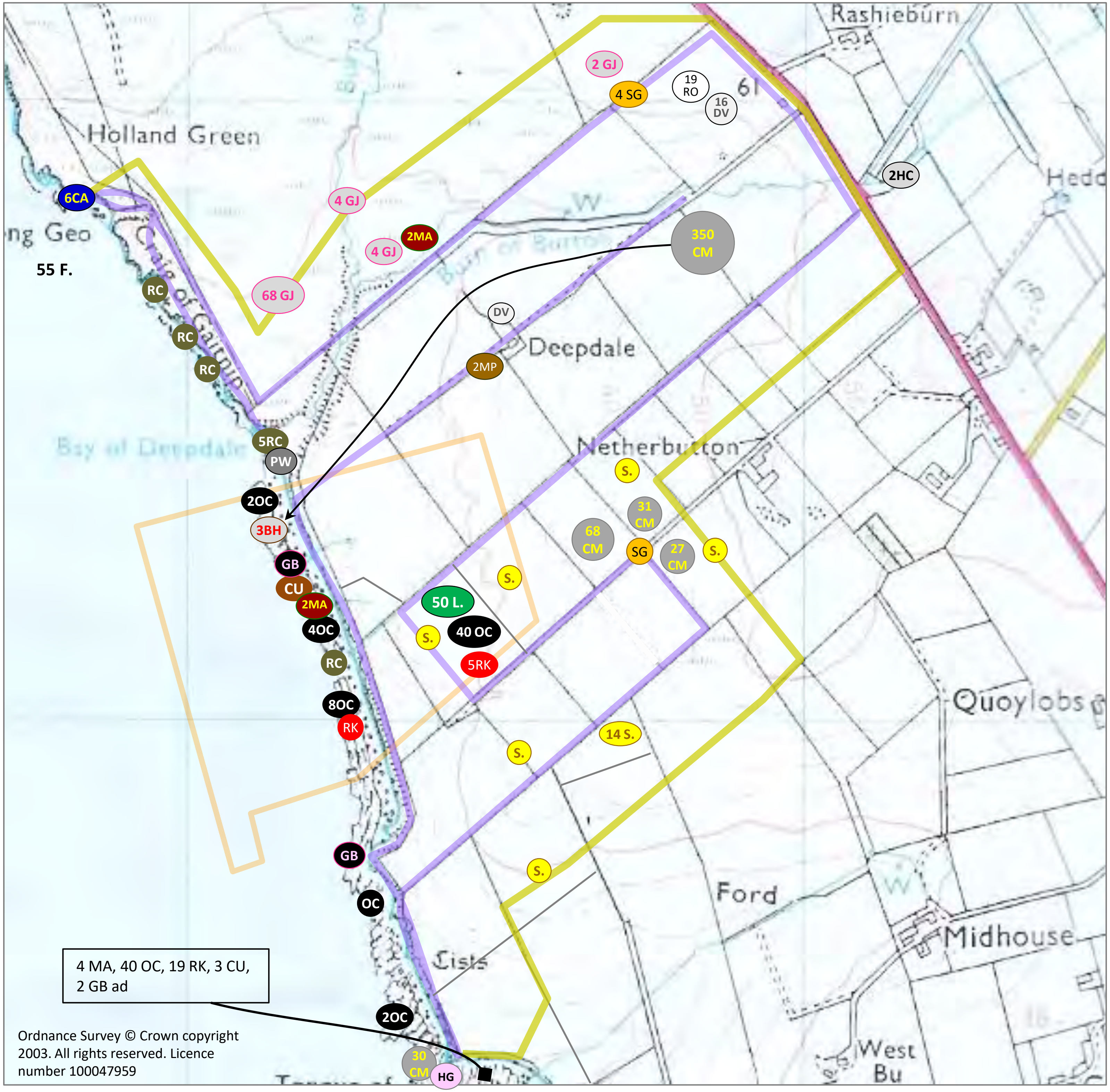
	January 2022 survey route
	Effective survey area
85 F.	Fulmars on the sea (85)
46 GJ	Greylag Goose (46 feeding)
3 RM	Red-breasted Merganser (3)
OC	Oystercatcher (27)
2RK	Redshank (11)
6CU	Curlew (8)
20 CM	Common Gull (85 feeding)
3HG	Herring Gull (3 feeding)
2DV	Rock Dove (2 + cliffs)
2 RN	Raven (2)
100 SG	Starling (100)
2MP	Meadow Pipit (4)

Additionally:

- c.40 Fulmar on/flying by cliffs to N of burn
- 1 Cormorant, 20 Rock Doves on cliffs to N
- Birds in bay to S as shown in box on left

Deepdale winter walkover survey: 2021/22

Date: 25th February 2022
Time: 09:40 – 12:30
Wind: N2 to SW1-2
Weather: cloud 1/8; dry



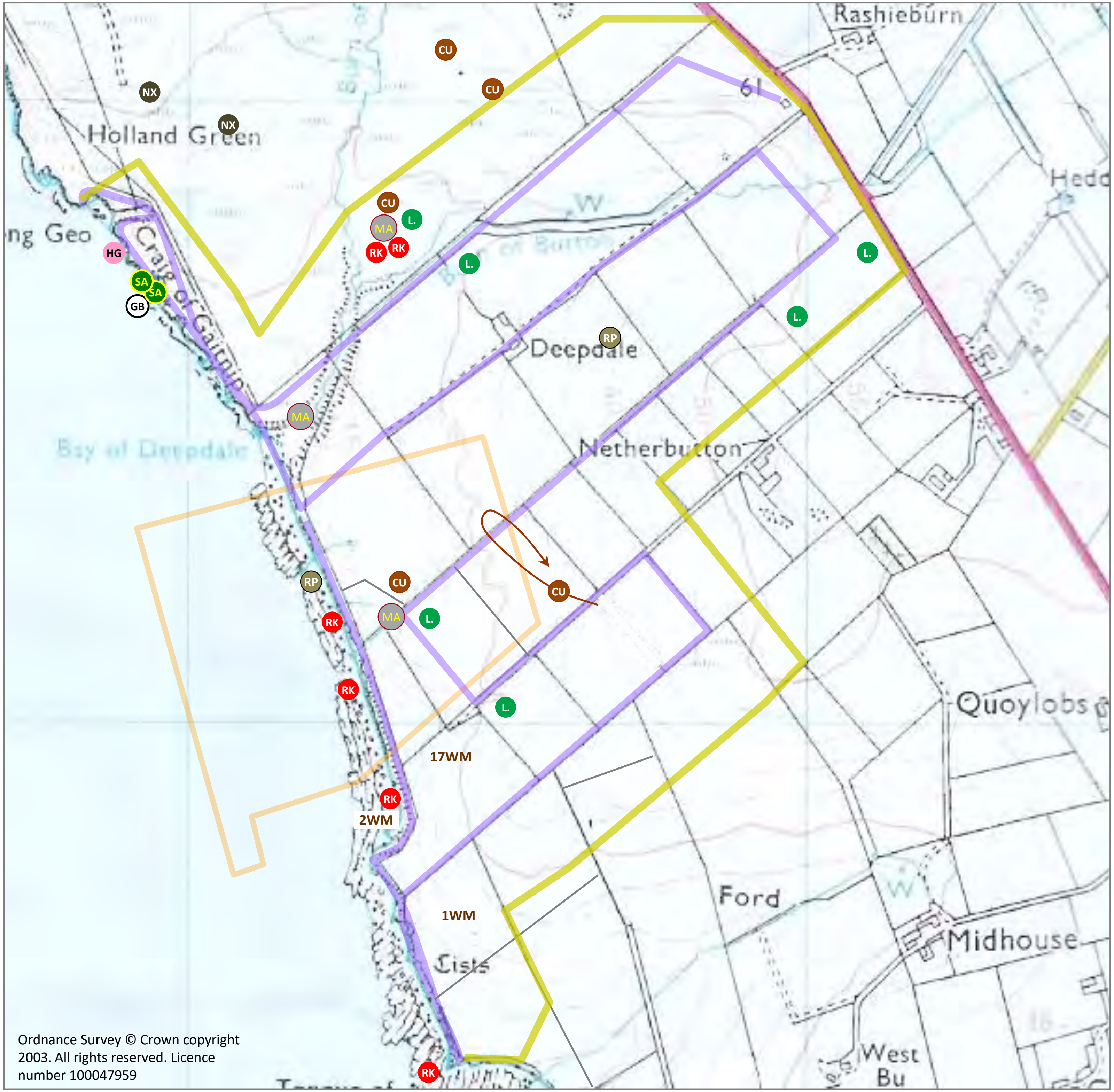
━	February 2022 survey route
━	Effective survey area
55 F.	Fulmars on the sea (55)
68 GJ	Greylag Goose (78 loafing)
2MA	Mallard (4)
6CA	Cormorant (6 on cliffs)
40 OC	Oystercatcher (57)
50 L.	Lapwing (50)
5RK	Redshank (6)
CU	Curlew (1 feeding)
3BH	Black-headed Gull (3)
27 CM	Common Gull (c.500)
HG	Herring Gull (1)
GB	Great Black-back (2)
16 DV	Rock Dove (17)
2HC	Hooded Crow (2)
19 RO	Rook (19)
S.	Skylark (6 singing, 14 feeding)
4 SG	Starling (5)
PW	Pied Wagtail (1)
2MP	Meadow Pipit (2)
RC	Rock Pipit (4 territories, 5 feeding)

Additionally:

- c.30 Fulmar on/flying by cliffs N of burn
- Birds in bay to S as shown in box on left

APPENDIX K i

Breeding walkover maps
2021



Deepdale breeding walkover survey: April 2021 – waders etc

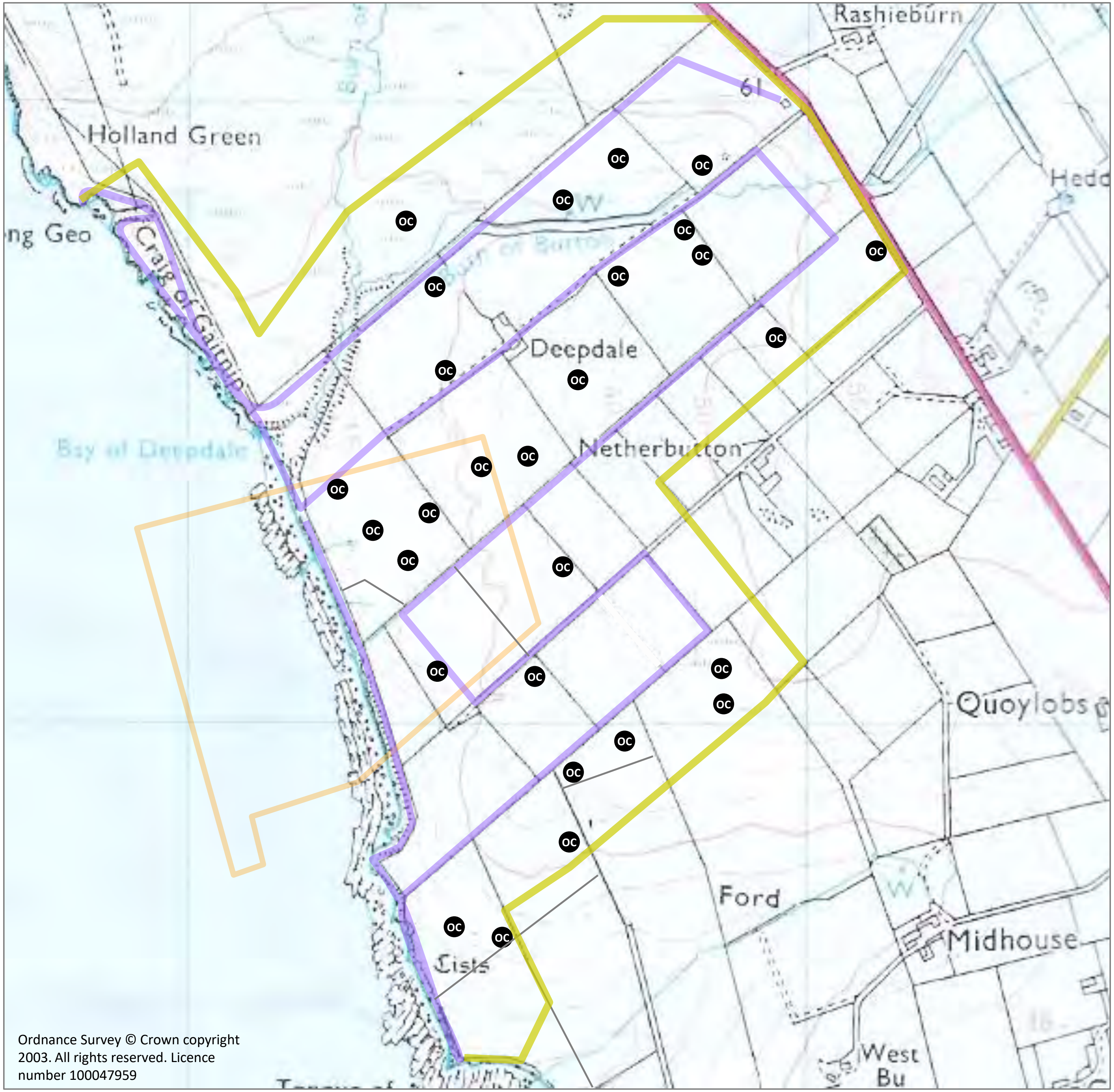
Date: 27th April
Time: 11:35–16:00
(incl Deepdale watch 13:45-14:45)
Wind: ENE 3-4
Weather: 7/8; dry and cool

April 2021 survey route
Effective survey area
MA Mallard single/pair (3)
SA Shag nest (2)
L. Lapwing pair (minimum of 6)
RP Ringed Plover pair/single (2)
RK Redshank pair (6)
CU Curlew displaying (5)
2WM Passage Whimbrels (20)
NX Great Skua AOT (2)
HG Herring Gull terr. (1)
GB Great Black-back pair (1)

Additionally:
c.40 Greylags, esp. at marshy area by burn
1 PG with Greylags
53 Fulmar sites on cliffs to N (none south of burn)
1 Cormorant on grassy cliff to N
Min. 10 adult Shags on cliffs (just 2 nests seen)
2 Tysties off cliffs

Deepdale breeding walkover survey: April 2021 – Oystercatcher

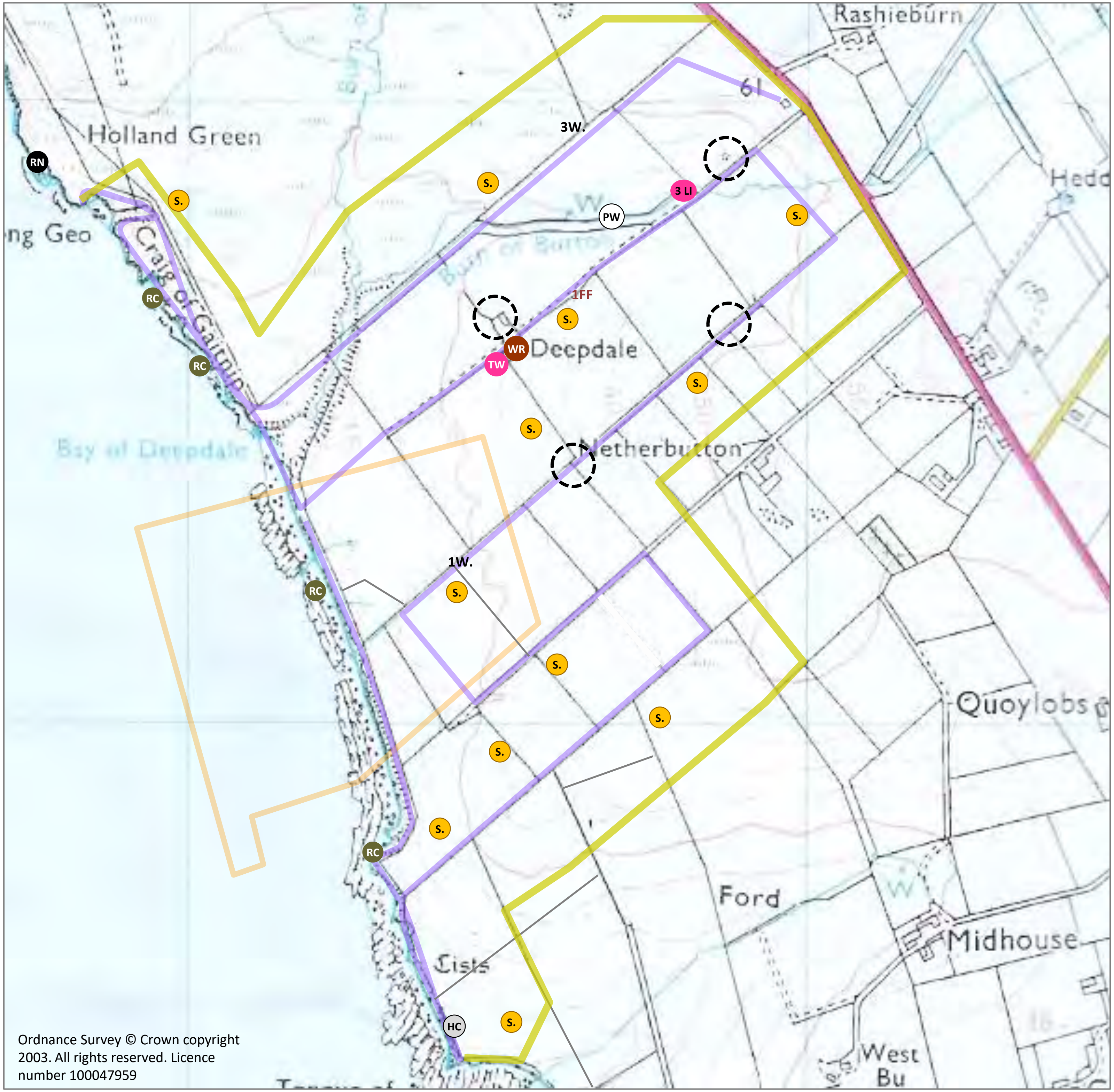
Date: 27th April
Time: 11:35–16:00
(incl Deepdale watch 13:45-14:45)
Wind: ENE 3-4
Weather: 7/8; dry and cool



— April 2021 survey route
— Effective survey area
OC Oystercatcher pair (28)

Deepdale breeding walkover survey: April 2021 - passerines

Date: 27th April
Time: 11:35–16:00
(incl Deepdale watch 13:45-14:45)
Wind: ENE 3-4
Weather: 7/8; dry and cool

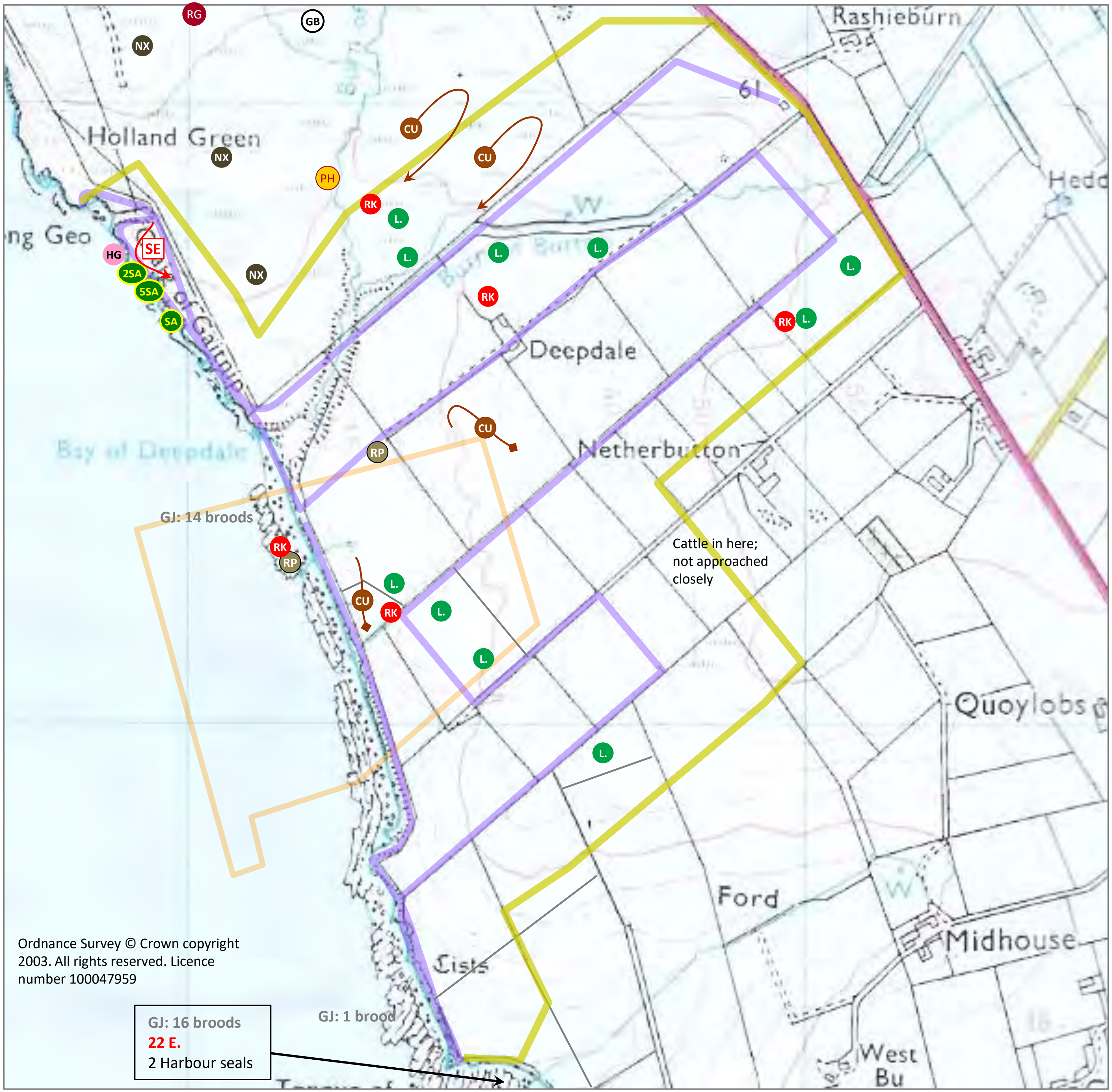


— April 2021 survey route
— Effective survey area
RN Raven on cliff (1)
HC Hoodie/hybrid crow pair (1)
S. Skylark singing (12)
WR Wren singing (1)
◌ Starling activity at buildings and rabbit holes
1FF Fieldfare (1)
3W. Wheatear (4)
PW Pied Wagtail (1)
RC Rock Pipit pair/single (4)
3 LI Linnets (3 together)
TW Twite (1)

Additionally:
Rock Doves at upper farm buildings by road
15 Meadow Pipit inds/pairs detected

Deepdale breeding walkover survey: May 2021 – waders etc

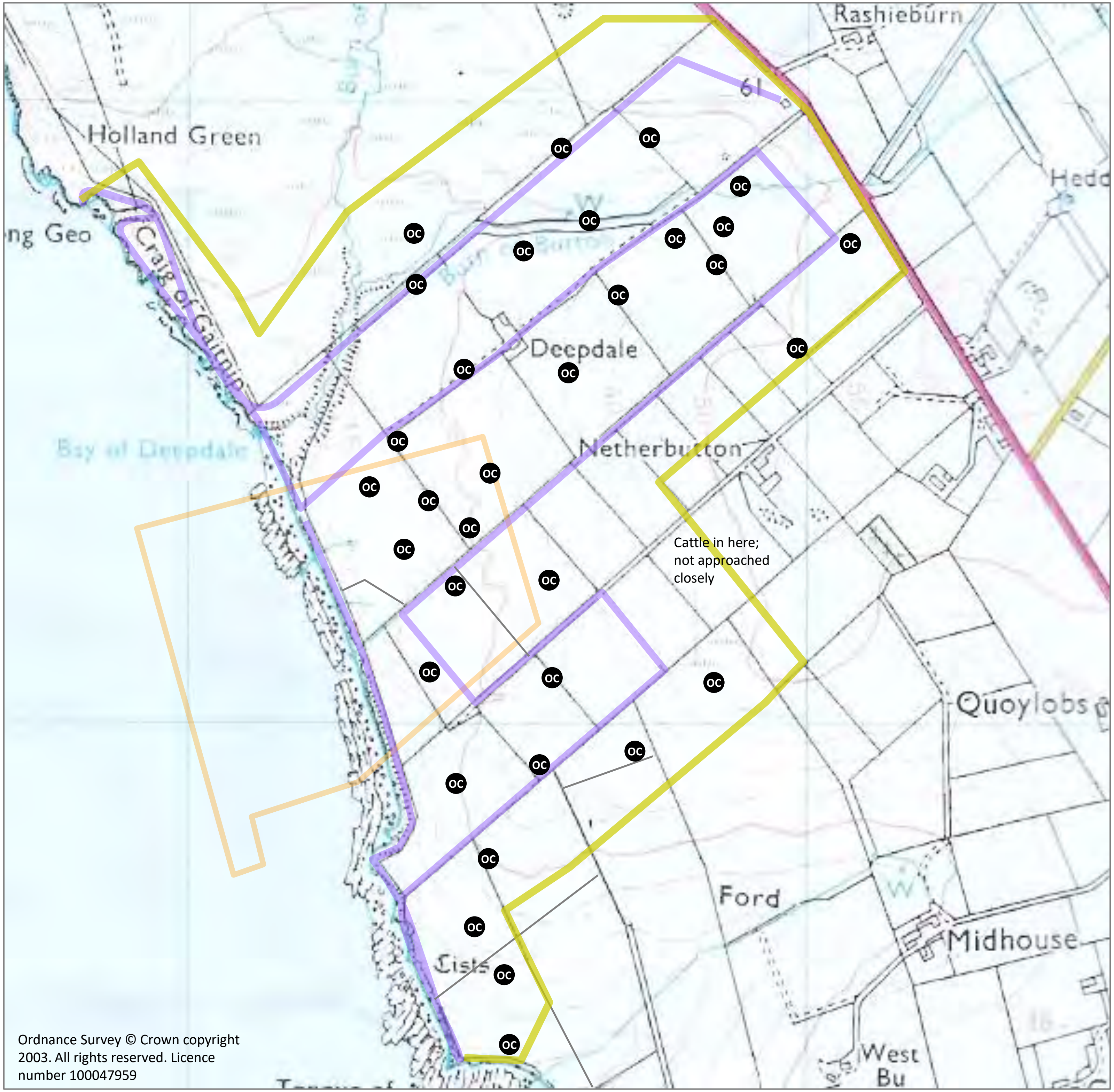
Date: 17th May
Time: 09:30–14:30
(incl Deepdale watch 09:55-10:55)
Wind: SE 2-3
Weather: 7/8; dry



	May 2021 survey route
	Effective survey area
RG	Red Grouse – male (1)
PH	Pheasant – male (1)
SA	Shag nest (8)
L.	Lapwing pair (10)
RP	Ringed Plover pair/single (2)
RK	Redshank pair/single (5)
CU	Curlew displaying (4)
NX	Great Skua AOT (3)
HG	Herring Gull ad. (1)
GB	Great Black-back AON (1)
SE	Short-eared Owl male hunting (1)

Additionally:

c.15 broods of Greylags along/off-shore, and a further 16 broods in bay just to S of survey area
c.30 additional GJ on moor and at marshy area by burn
22 Eider in bay just S of survey area
103 Fulmar sites on cliffs to N (none S of burn)
12 Tysties off cliffs
3 Razorbills off cliffs
3 ind/prs Rock Doves on cliffs
2 Harbour Seals hauled out on cobble beach of bay just to S of survey area



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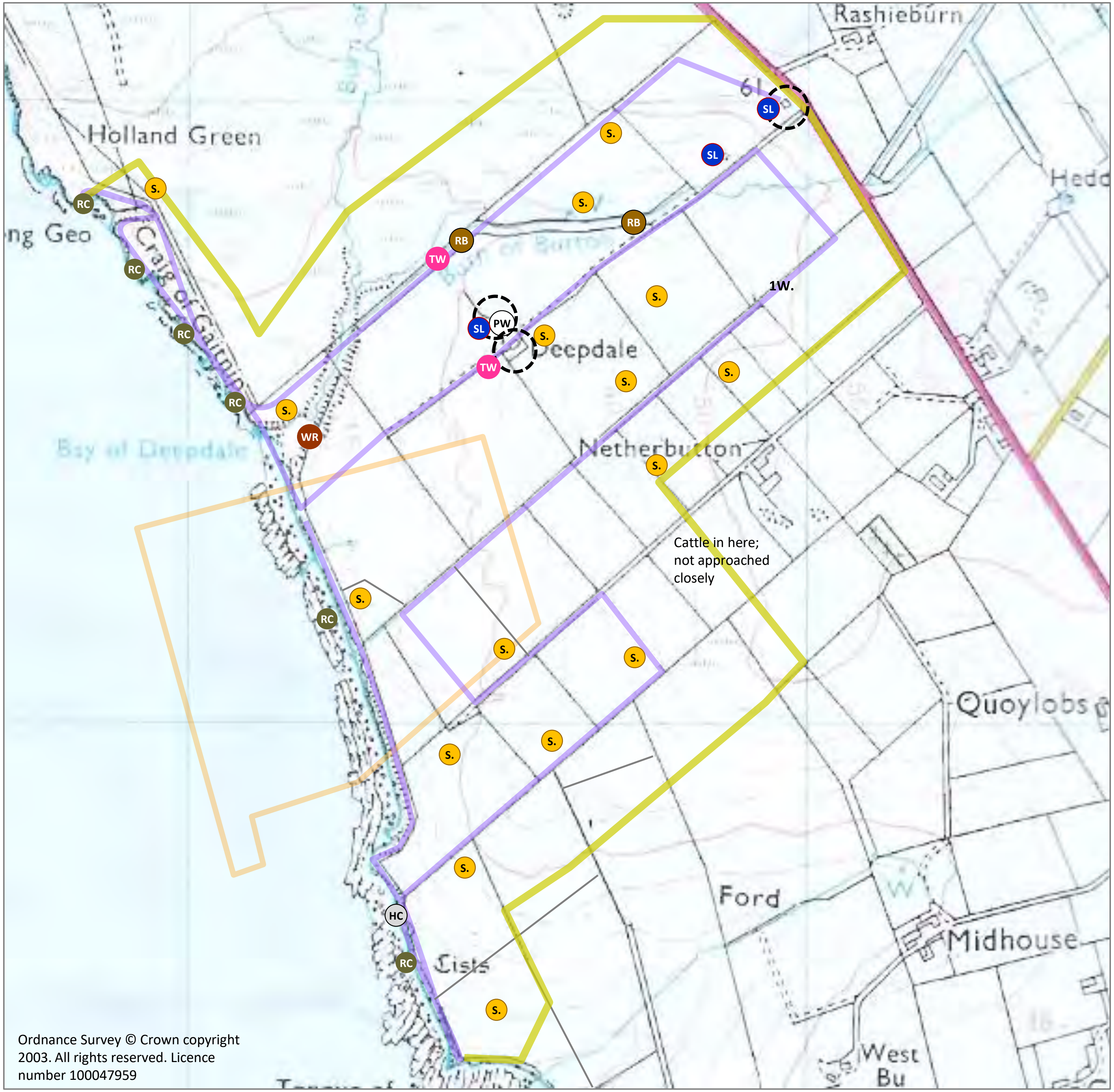
Deepdale breeding walkover survey: May 2021 – Oystercatcher

Date: 17th May
Time: 09:30–14:30
(incl Deepdale watch 09:55-10:55)
Wind: SE 2-3
Weather: 7/8; dry

▬	May 2021 survey route
▬	Effective survey area
OC	Oystercatcher pair (33)

Deepdale breeding walkover survey: May 2021 - passerines



Cattle in here; not approached closely

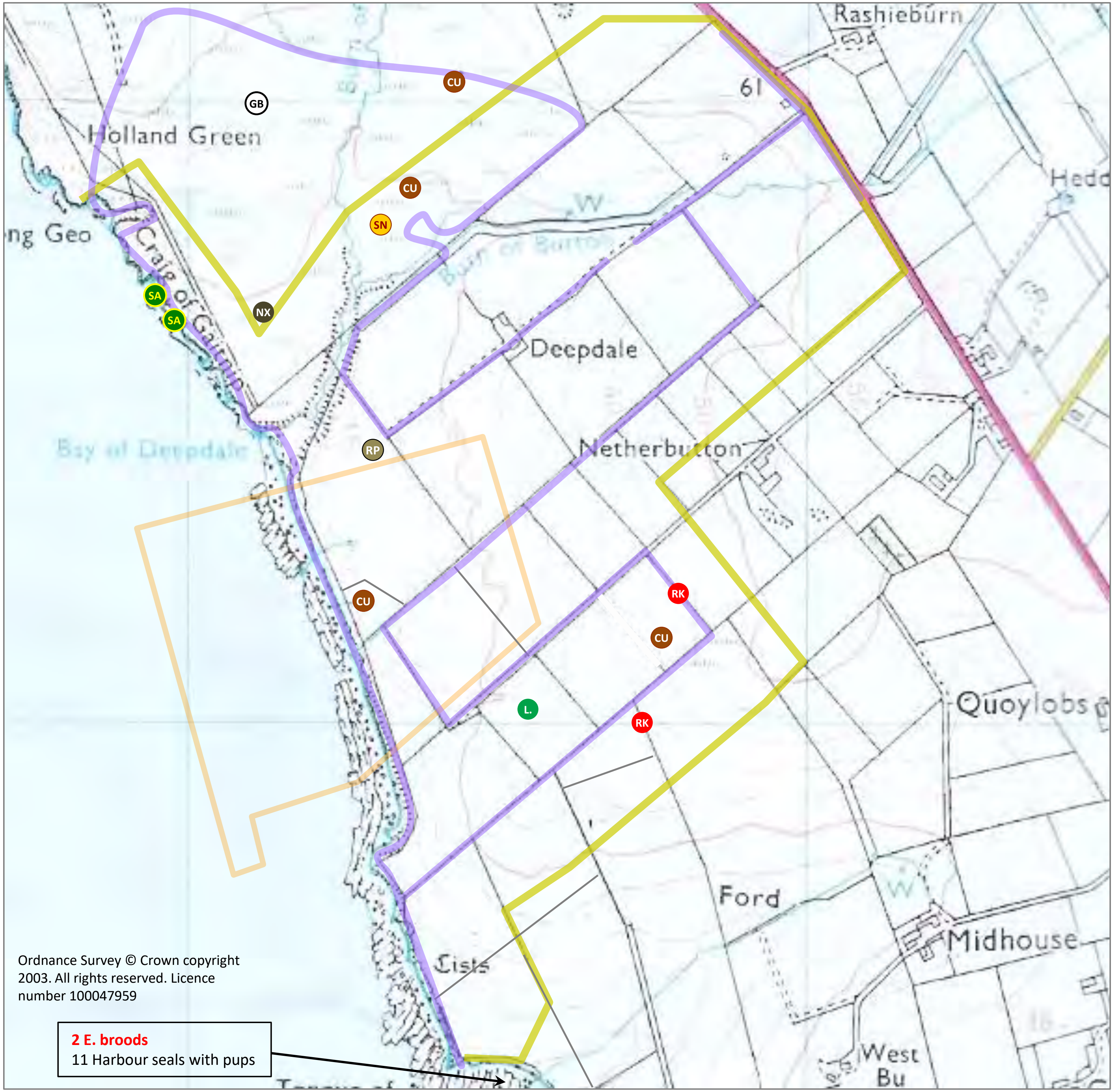
Date: 17th May
Time: 09:30–14:30
(incl Deepdale watch 09:55-10:55)
Wind: SE 2-3
Weather: 7/8; dry

May 2021 survey route
Effective survey area

HC Hoodie/hybrid crow nest b4 (1)
S. Skylark singing (16)
SL Swallow pairs near buildings (3)
WR Wren singing (1)
◌ Starling activity at buildings
1W. Wheatear (1)
PW Pied Wagtail (1)
RC Rock Pipit pair/single (6)

TW Twite pair/single (2)
RB Reed Bunting single (2)

Additionally:
6 Rock Doves and 2 House Sparrows at upper farm buildings by road;
8 Meadow Pipit inds/pairs detected



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2 E. broods
11 Harbour seals with pups

Deepdale breeding walkover survey: June 2021 – waders etc

Date: 26th June

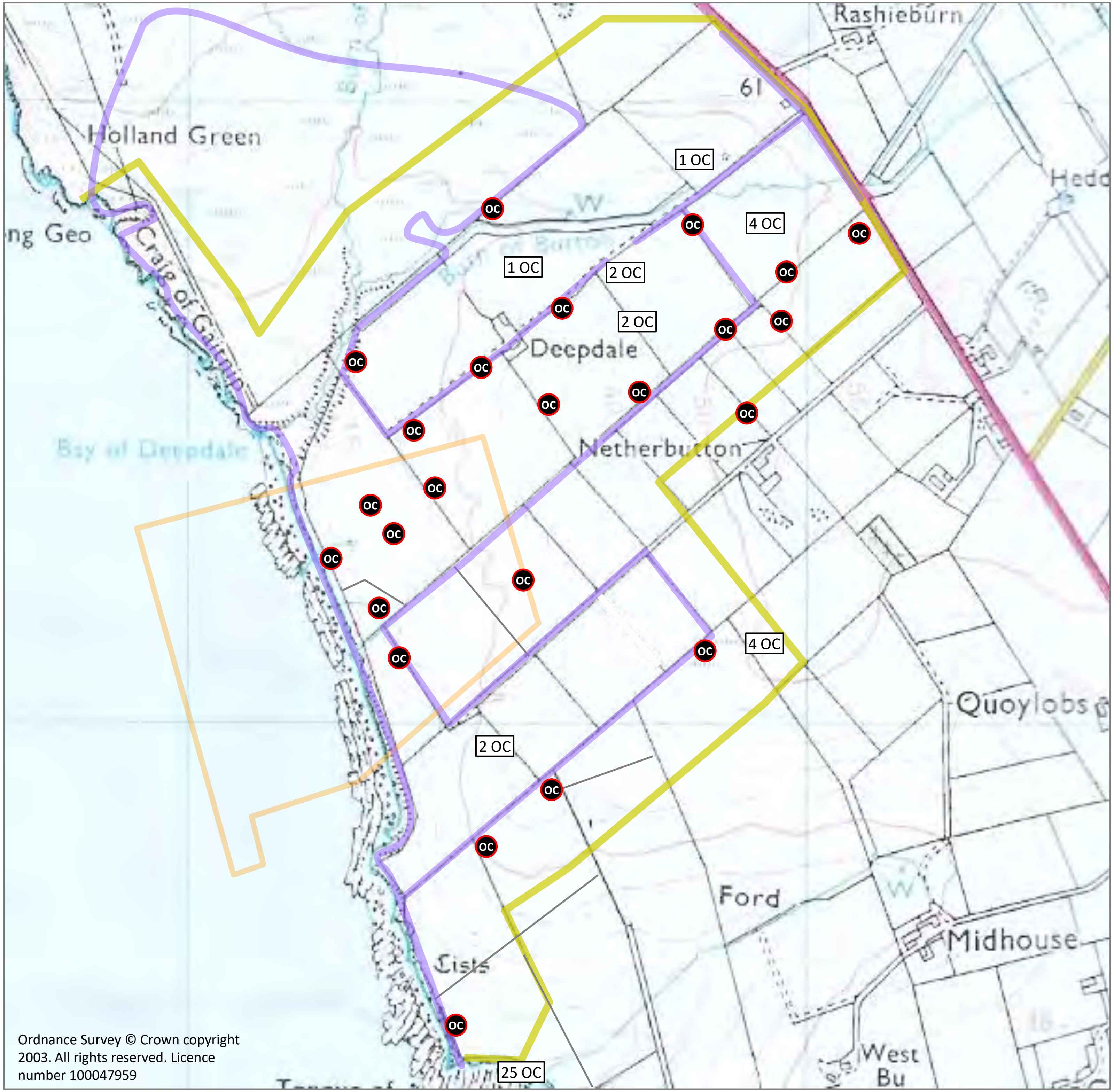
Time: 10:50 – 16:35
(incl 14:25 - 15:25 in Deepdale)

Wind: NW 2-3

Weather: 6/8 at >500m; dry

—	June 2021 survey route
—	Effective survey area
SA	Shag nest (6 + 2)
L.	Lapwing pair alarming (1)
RP	Ringed Plover pair alarming (1)
RK	Redshank pair/single alarming (2)
CU	Curlew displaying/alarming (4)
SN	Snipe alarmed (1)
NX	Great Skua AOT (1)
GB	Great Black-back alarming (1)

Additionally:
2 Eider broods in bay S of survey area
84 Fulmar sites on cliffs to N (none S of burn)
3 ind/prs Rock Doves on cliffs
11 Harbour Seals with pups in bay S of area



Deepdale breeding walkover survey: June 2021 – Oystercatcher

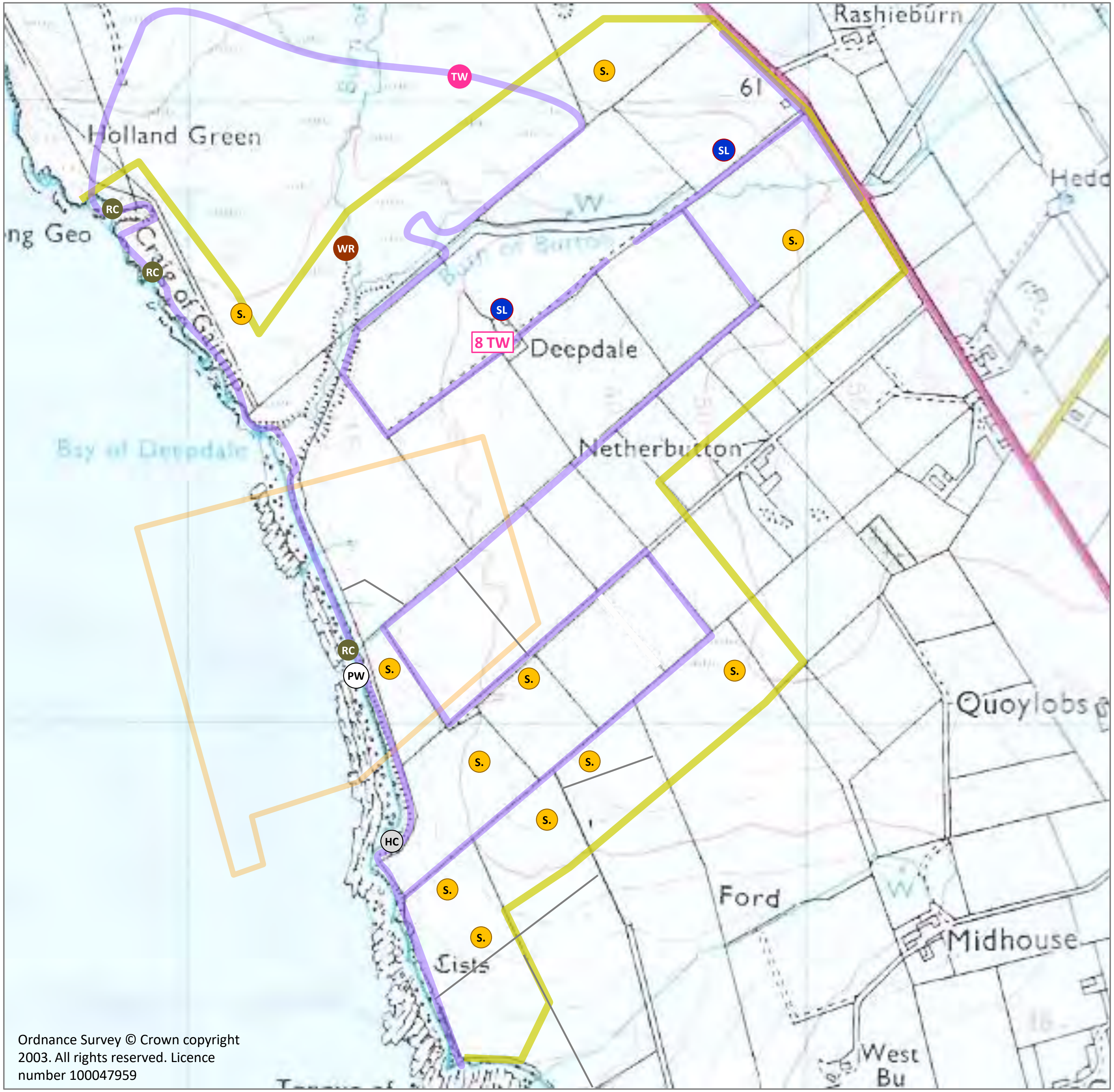
Date: 26th June

Time: 10:50 – 16:35
(incl 14:25 - 15:25 in Deepdale)

Wind: NW 2-3

Weather: 6/8 at >500m; dry

━	June 2021 survey route
━	Effective survey area
●	Oystercatcher pair alarming (24)
2 OC	Other Oystercatchers



Deepdale breeding walkover survey: June 2021 – passerines

Date: 26th June

Time: 10:50 – 16:35
(incl 14:25 - 15:25 in Deepdale)

Wind: NW 2-3

Weather: 6/8 at >500m; dry

June 2021 survey route

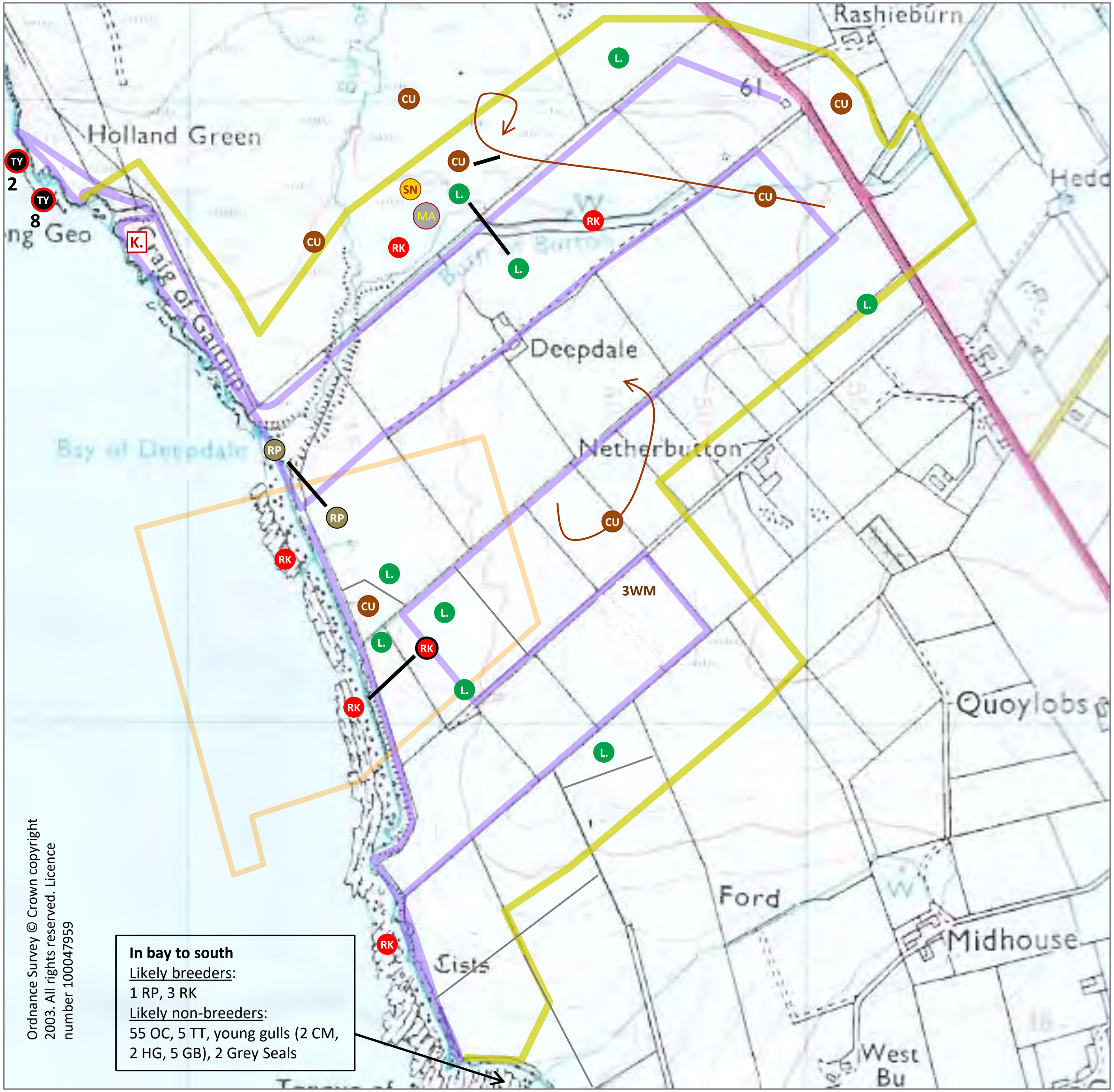
Effective survey area

HC	Hybrid crow & 1 juv. (1)
S.	Skylark singing (11)
SL	Swallow pairs near buildings (2)
WR	Wren singing (1)
PW	Pied Wagtail with food (1)
RC	Rock Pipit pair/single (3)
TW	Twite nest with 5 eggs (1)
8 TW	Twite group (? family) (1)

Additionally:
8 Rock Doves at upper farm buildings by road;
4 Ravens in upper fields
several Meadow Pipit inds/pairs detected

APPENDIX K ii

Breeding walkover maps
2022



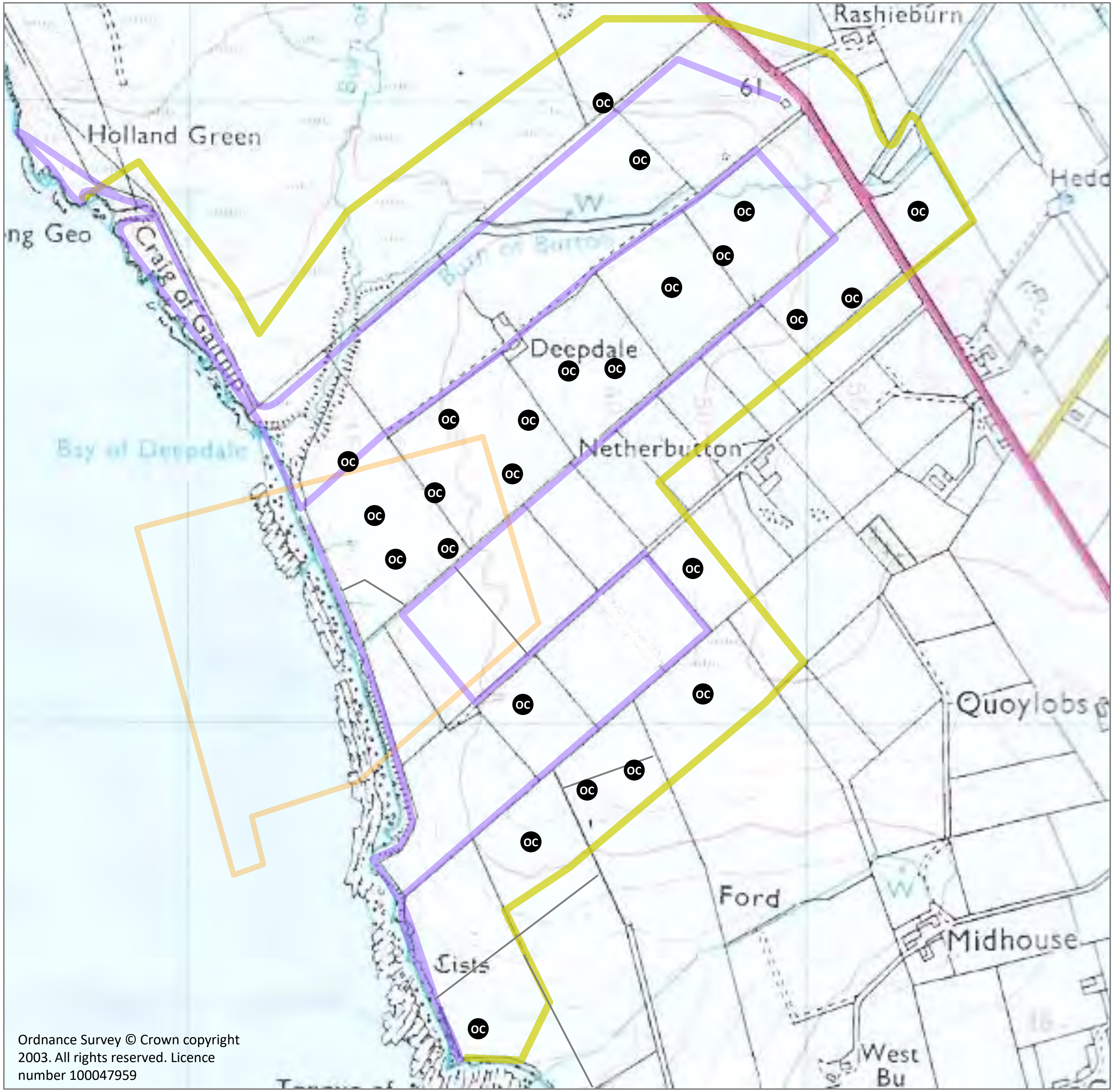
In bay to south
Likely breeders:
1 RP, 3 RK
Likely non-breeders:
55 OC, 5 TT, young gulls (2 CM, 2 HG, 5 GB), 2 Grey Seals

Deepdale breeding walkover survey: April 2022 – waders etc

Date: 23rd April
Time: 11:30–15:00
(Deepdale watch 15:00-17:00)
Wind: NE 3
Weather: 8/8 at 400m; dry

━	April 2022 survey route
━	Effective survey area
━	black line connects birds likely to be from the same pair
MA	Mallard male (1)
L.	Lapwing pair/single (min 8)
RP	Ringed Plover pair (1)
RK	Redshank pair/single (5) – nest site circled in black (4 eggs)
CU	Curlew displaying or pair (6)
3WM	Whimbrels on passage (3)
SN	Snipe displaying (1)
TY	Black Guillemot close in (10)
K.	Kestrel (1)

Additionally within survey area:
Groups of Greylags, e.g. at marshy area by burn;
Total 30 - 60 Fulmars on cliffs & sea to N of burn;
1 Sparrowhawk low up Burn of Deepdale;
1 Buzzard circling south across fields;
Additionally on cliffs to N of map:
100s of: Fulmar sites;
Tens of: Shag, Black Guillemot, Razorbill & Rock Dove sites;
Single figures of: Kittiwake and Herring Gull sites.



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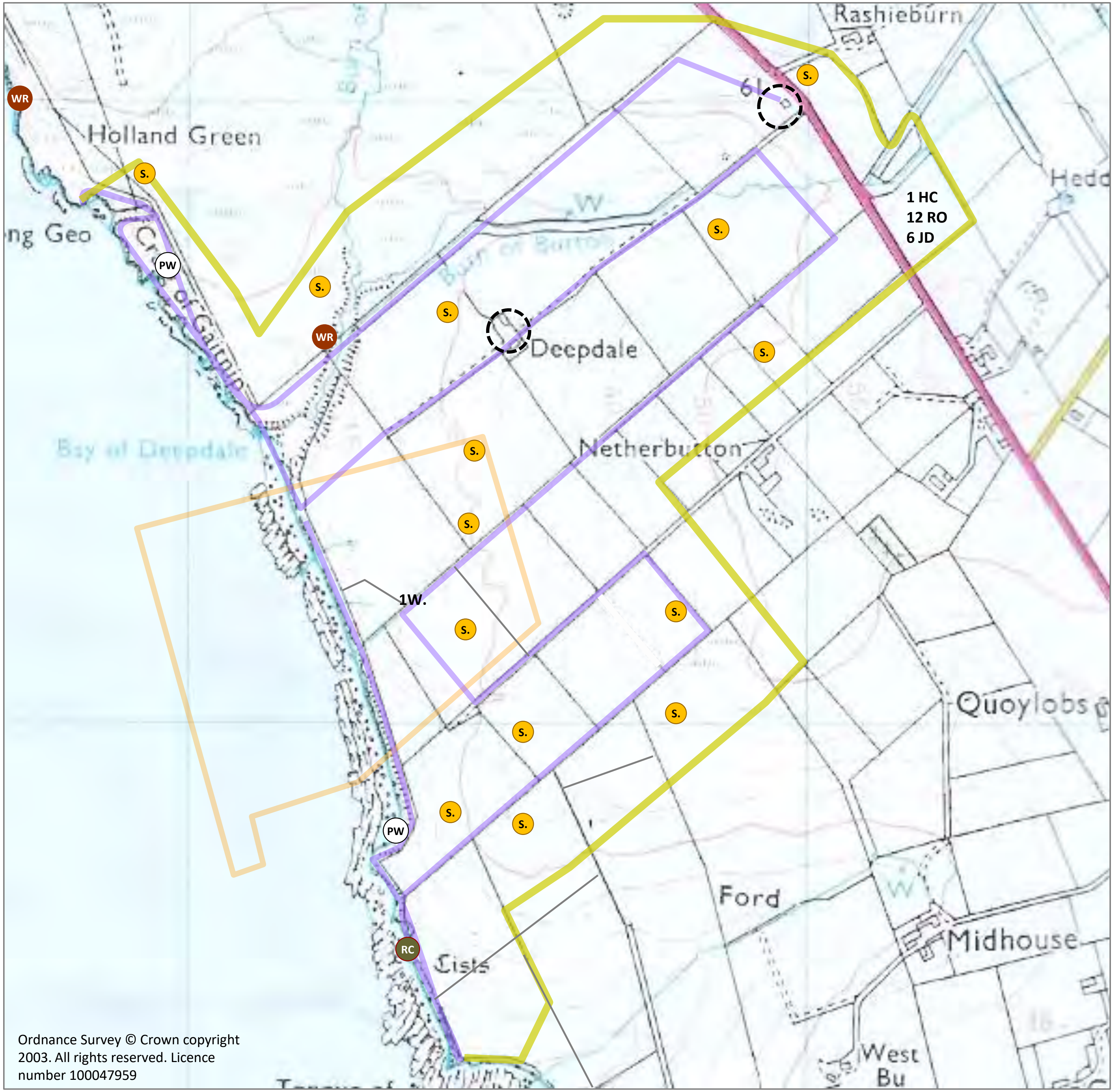
Deepdale breeding walkover survey: April 2022 – Oystercatcher

Date: 23rd April
Time: 11:30–15:00
(Deepdale watch 15:00-17:00)
Wind: NE 3
Weather: 8/8 at 400m; dry

▬	April 2022 survey route
▬	Effective survey area
● OC	Oystercatcher pair/single (25)

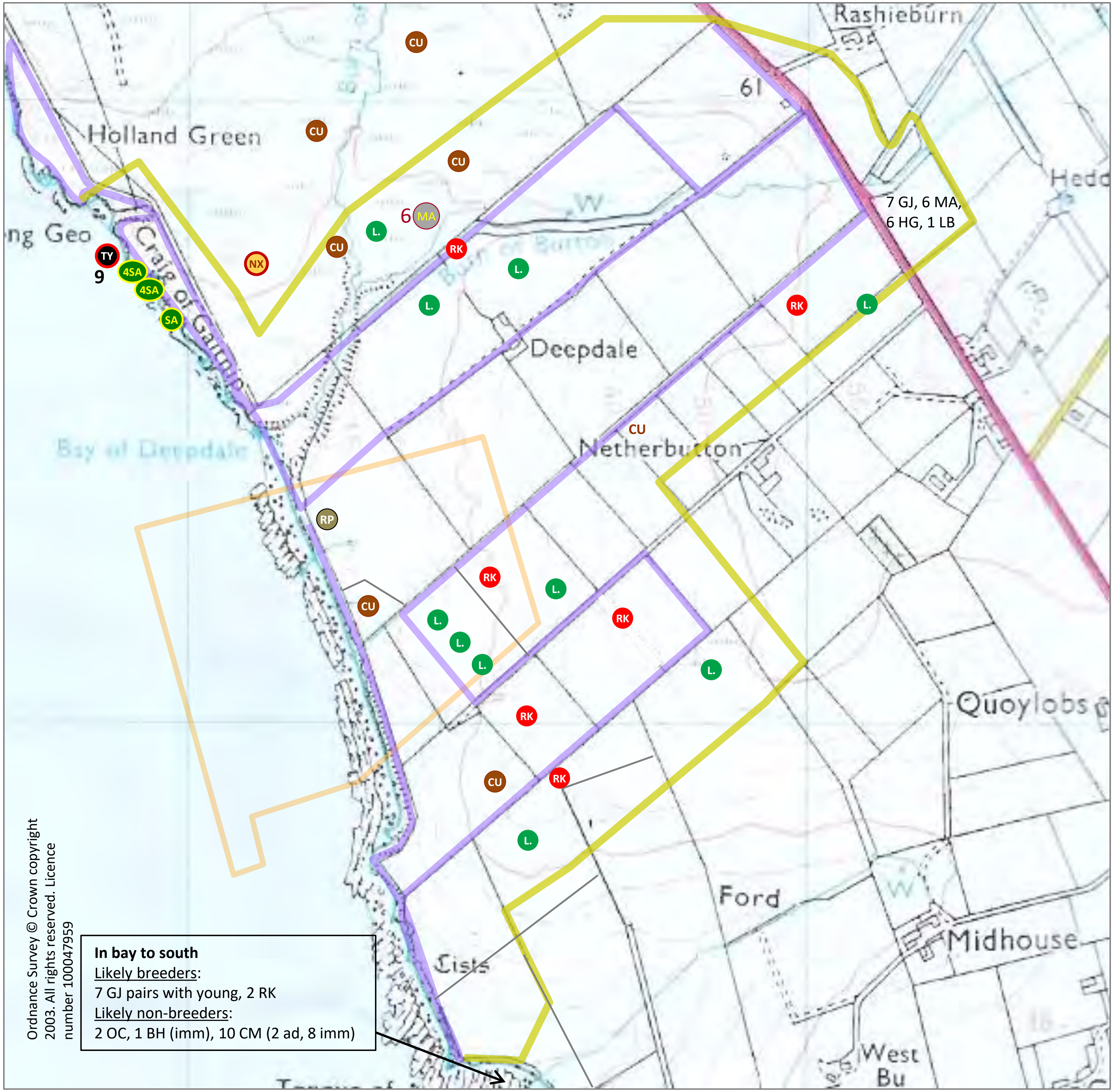


Deepdale breeding walkover survey: April 2022 - passerines

Date: 23rd April
Time: 11:30–15:00
(Deepdale watch 15:00-17:00)
Wind: NE 3
Weather: 8/8 at 400m; dry

— April 2022 survey route
— Effective survey area
S. Skylark singing (14)
WR Wren singing (2)
◌ Starling activity at buildings
1W. Wheatear (1)
PW Pied Wagtail (2)
RC Rock Pipit pair/single (1)

Additionally:
A Rock Dove at upper farm buildings by road;
Meadow Pipits frequent but not recorded.



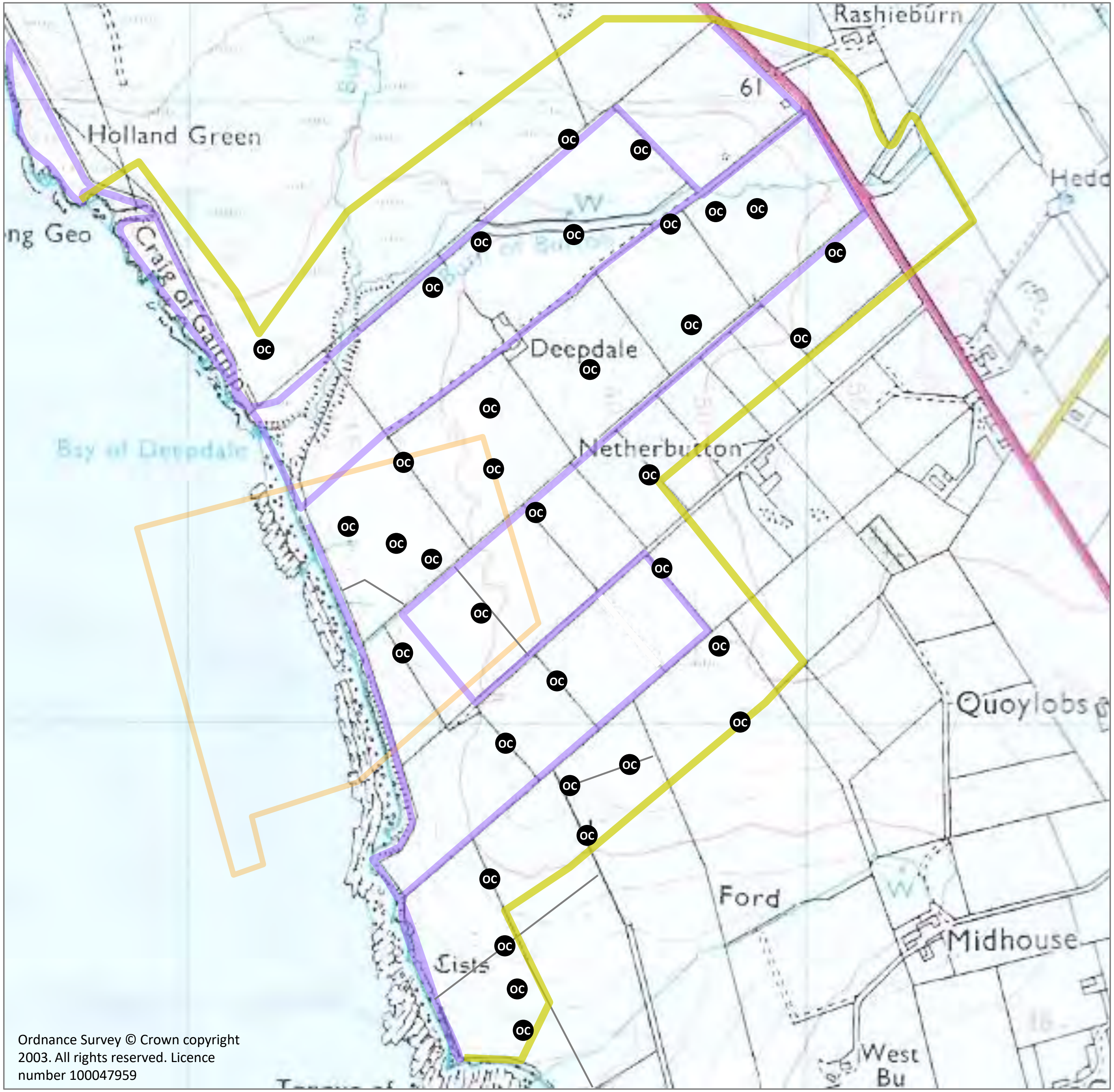
In bay to south
Likely breeders:
7 GJ pairs with young, 2 RK
Likely non-breeders:
2 OC, 1 BH (imm), 10 CM (2 ad, 8 imm)

Deepdale breeding walkover survey: May 2022 – waders etc

Date: 21st May
Time: 12:00–16:30 & 17:00–17:40
(Deepdale watch 10:00-12:00)
Wind: W 3-4
Weather: 6/8 >500m; dry

- ▬ May 2022 survey route
- ▬ Effective survey area
- 6 MA Mallard male (6)
- L. Lapwing pair/single (10)
- RP Ringed Plover pair (1)
- RK Redshank pair/single alarming or displaying (6)
- CU Curlew displaying or pair (6)
- CU Single Curlew (1)
- TY Black Guillemot close in (9)
- NX Great Skua territory (1)
- SA Shag nest (9)

Additionally within survey area:
Groups of Greylags, e.g. at marshy area by burn and (especially) along/off shore;
112 Fulmar sites on cliffs N of burn to Long Geo;
Birds feeding in ploughed field to east of road as listed.



Deepdale breeding walkover survey: May 2022 - Oystercatcher

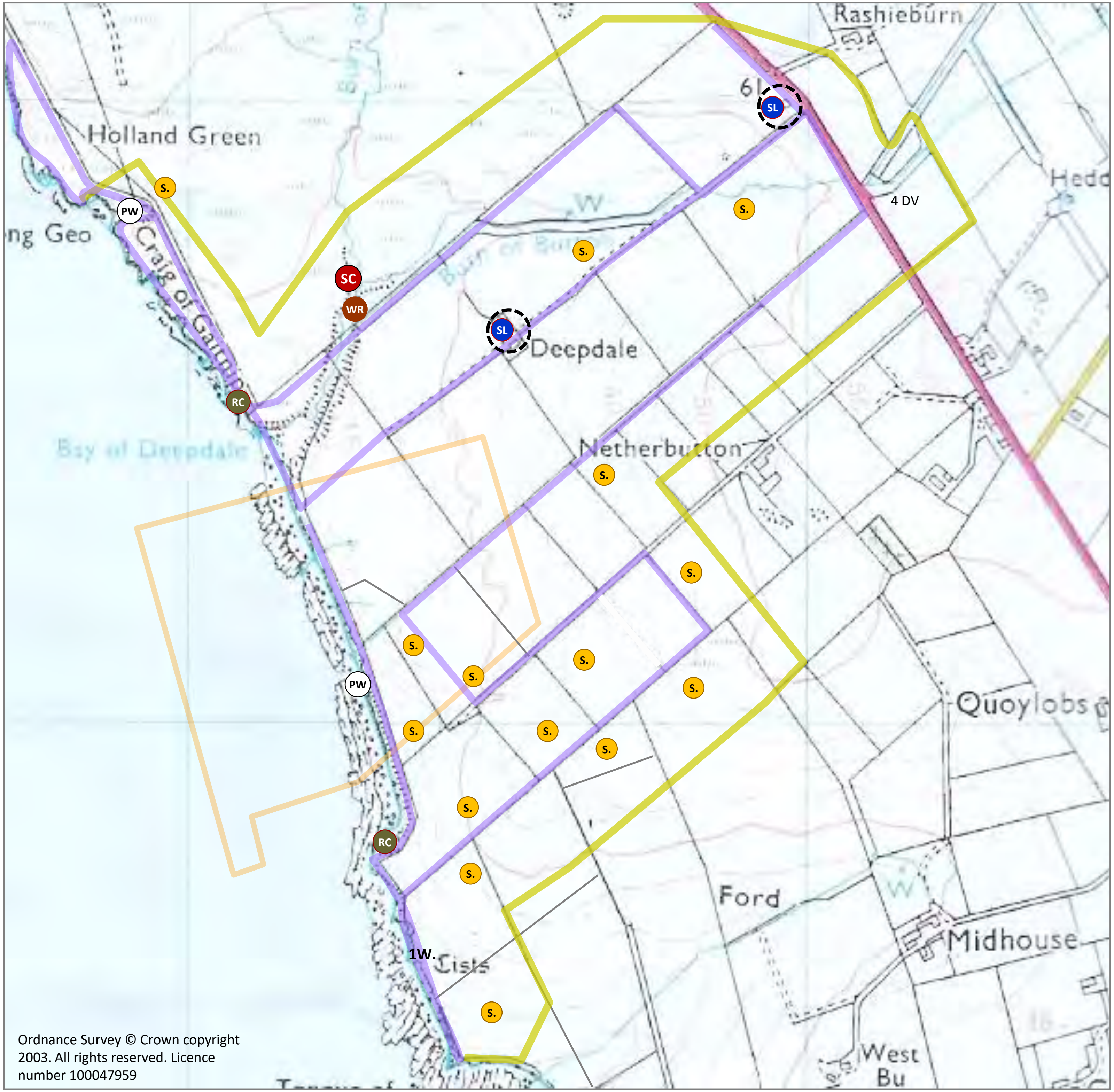
Date: 21st May
Time: 12:00–16:30 & 17:00–17:40
(Deepdale watch 10:00-12:00)
Wind: W 3-4
Weather: 6/8 >500m; dry

May 2022 survey route
Effective survey area
● Oystercatcher pair/single (35)

Additionally:

Deepdale breeding walkover survey: May 2022 – passerines etc

Date: 21st May
Time: 12:00–16:30 & 17:00–17:40
(Deepdale watch 10:00-12:00)
Wind: W 3-4
Weather: 6/8 >500m; dry

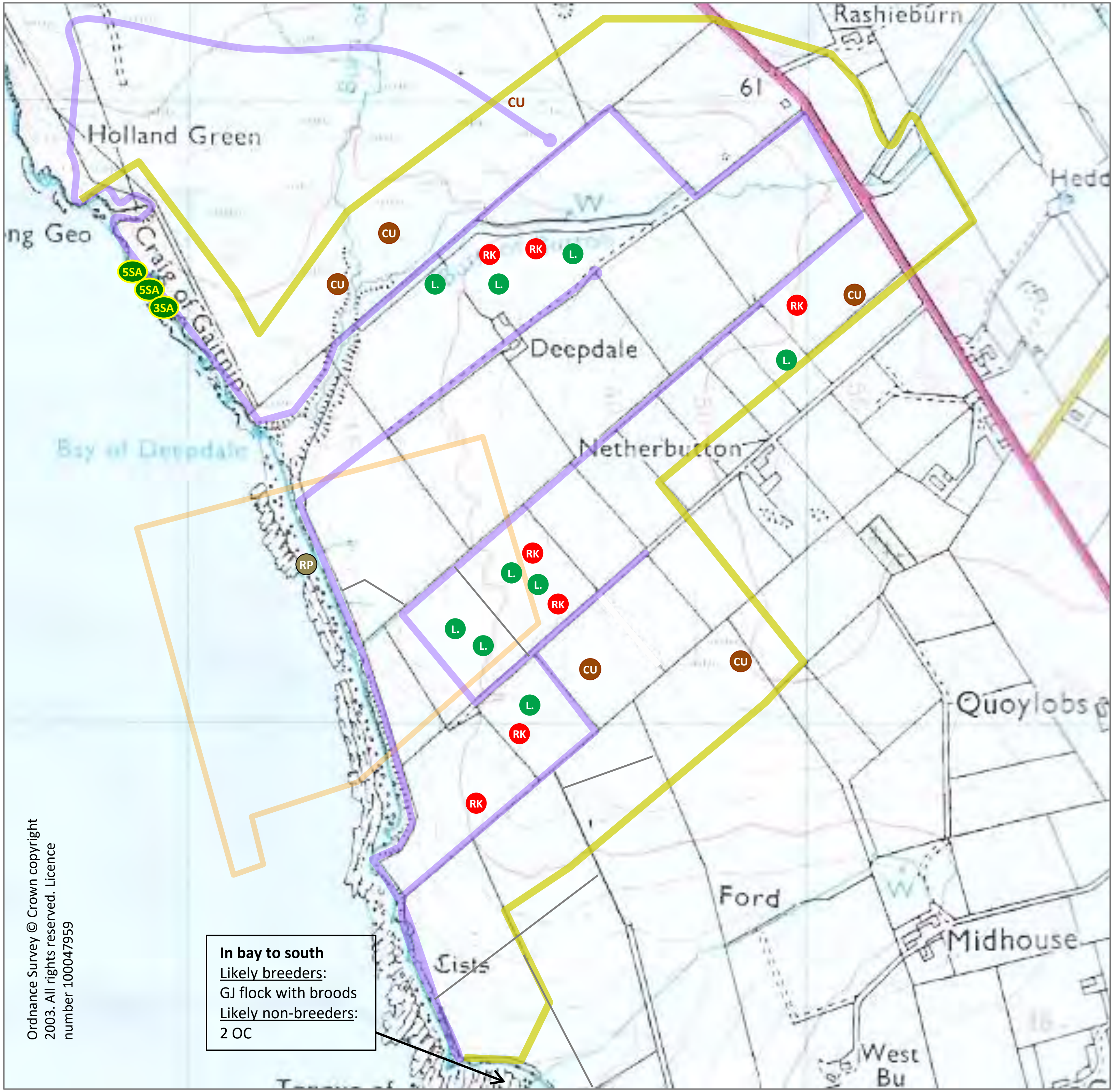


━	May 2022 survey route
━	Effective survey area
S.	Skylark singing (15)
WR	Wren singing (1)
◌	Starling & Rock Dove pairs
1W.	Wheatear (1)
PW	Pied Wagtail (2)
RC	Rock Pipit pair/single (2)
SC	Stonechat male (1)
SL	Swallow pair near buildings (2)

Additionally:
Group of 5 Hooded/Hybrid Crows along the shore within the development footprint;
One Jackdaw at the old Deepdale buildings.

Deepdale breeding walkover survey: June 2022 – waders etc

Date: 10th June
Time: 13:30–17:35
(Deepdale watch 10:45-12:45)
Wind: SW 4 to S 3
Weather: 4/8 to 6/8; edge of one shower

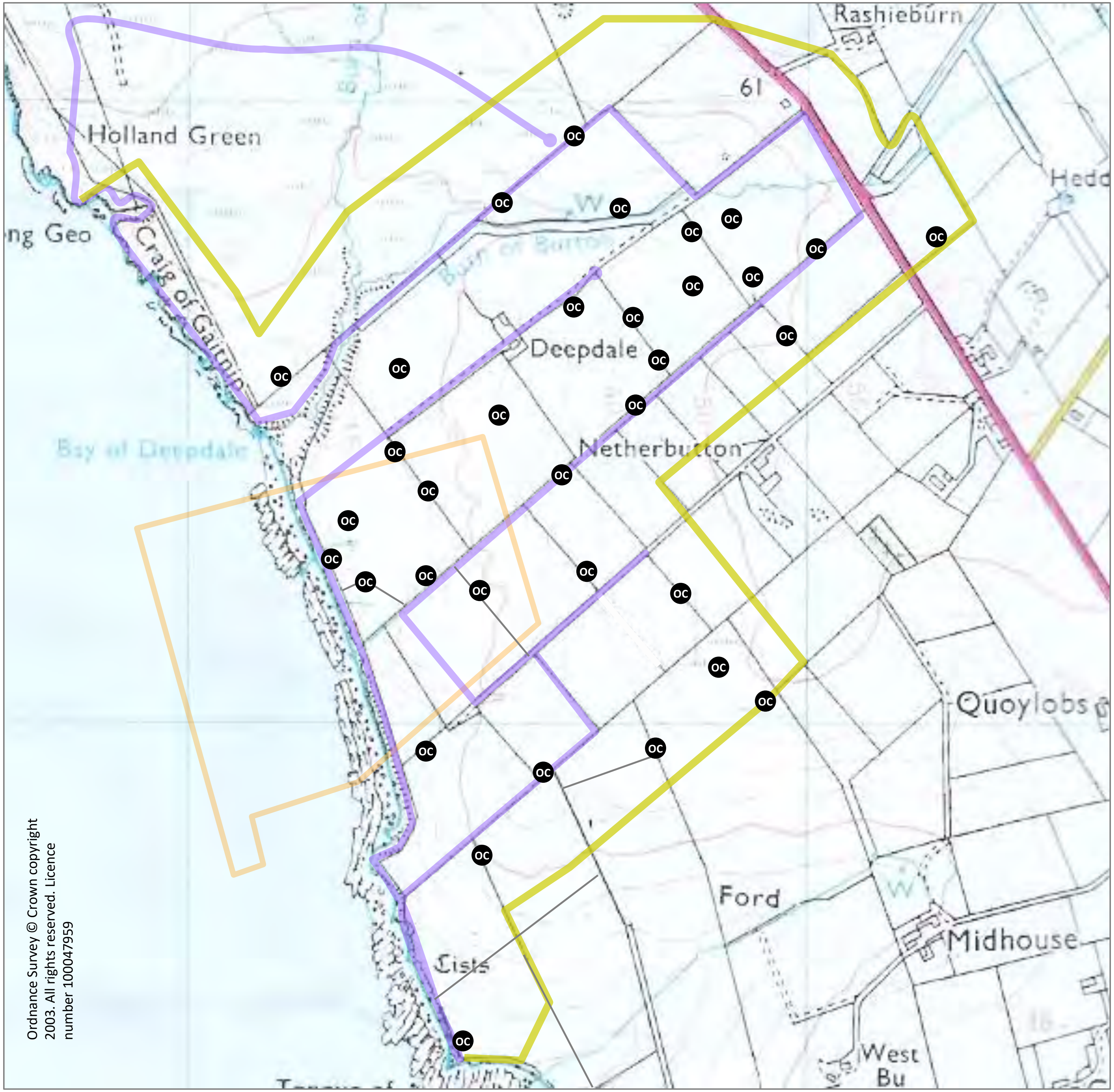


In bay to south
Likely breeders:
GJ flock with broods
Likely non-breeders:
2 OC

June 2022 survey route
Effective survey area

L. Lapwing pair (9)
RP Ringed Plover pair (1)
RK Redshank pair/single alarming (7)
CU Curlew alarming or mobbing (5)
CU Single Curlew (1)
5SA Shag nest (13)

Additionally within survey area:
A pair of Greylag Geese with three young at moorland edge;
119 Fulmar sites on cliffs N of burn to Long Geo.



Deepdale breeding walkover survey: June 2022 – Oystercatcher

Date: 10th June
Time: 13:30–17:35
(Deepdale watch 10:45-12:45)
Wind: SW 4 to S 3
Weather: 4/8 to 6/8; edge of one shower

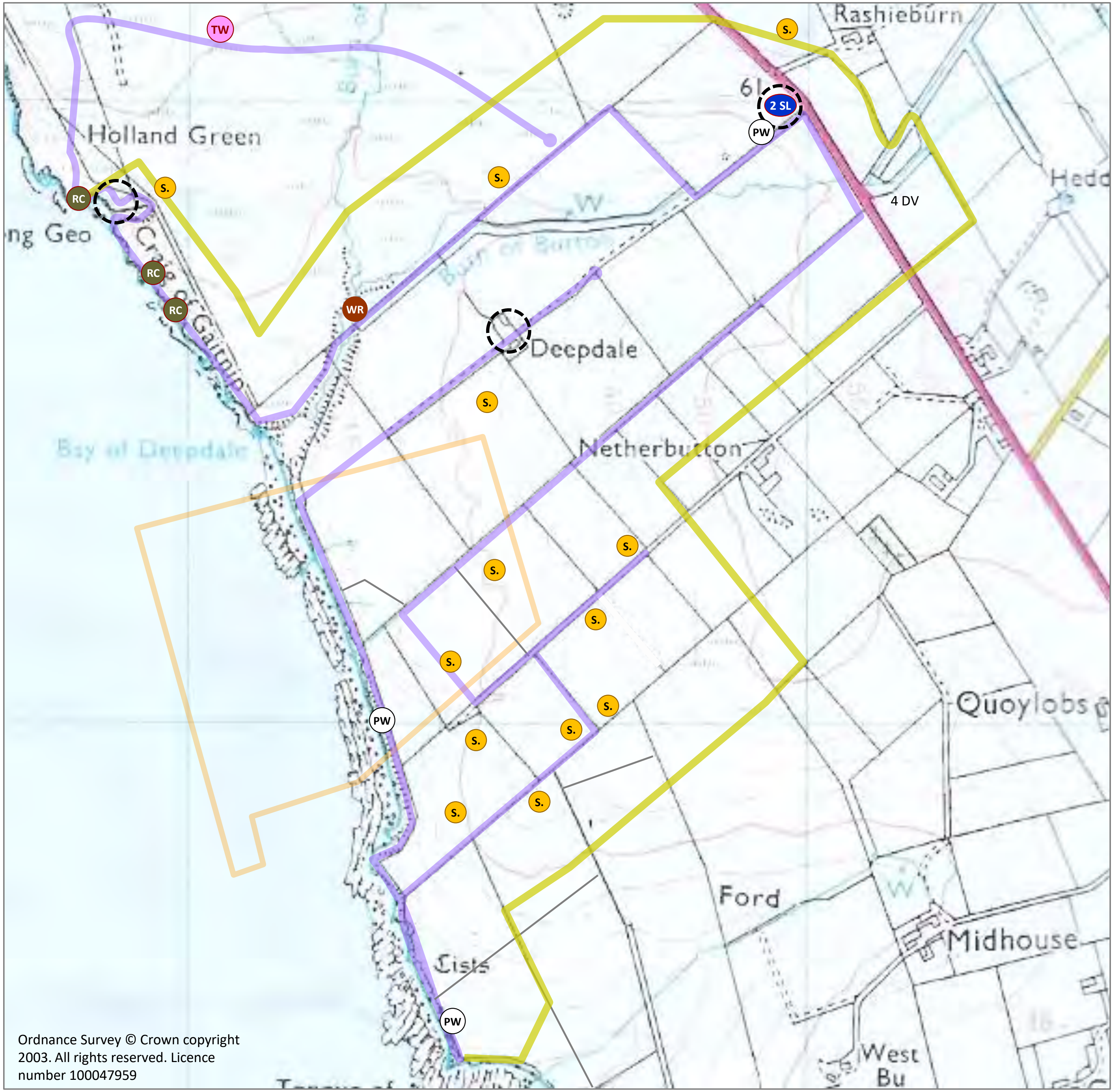
June 2022 survey route
Effective survey area

OC Oystercatcher pair/ single (34)

Several groups of 3 or more OC (perhaps failed breeders) joining in with mobbing - these not marked.

Deepdale breeding walkover survey: May 2022 – passerines etc

Date: 21st May
Time: 12:00–16:30 & 17:00–17:40
(Deepdale watch 10:00-12:00)
Wind: W 3-4
Weather: 6/8 >500m; dry



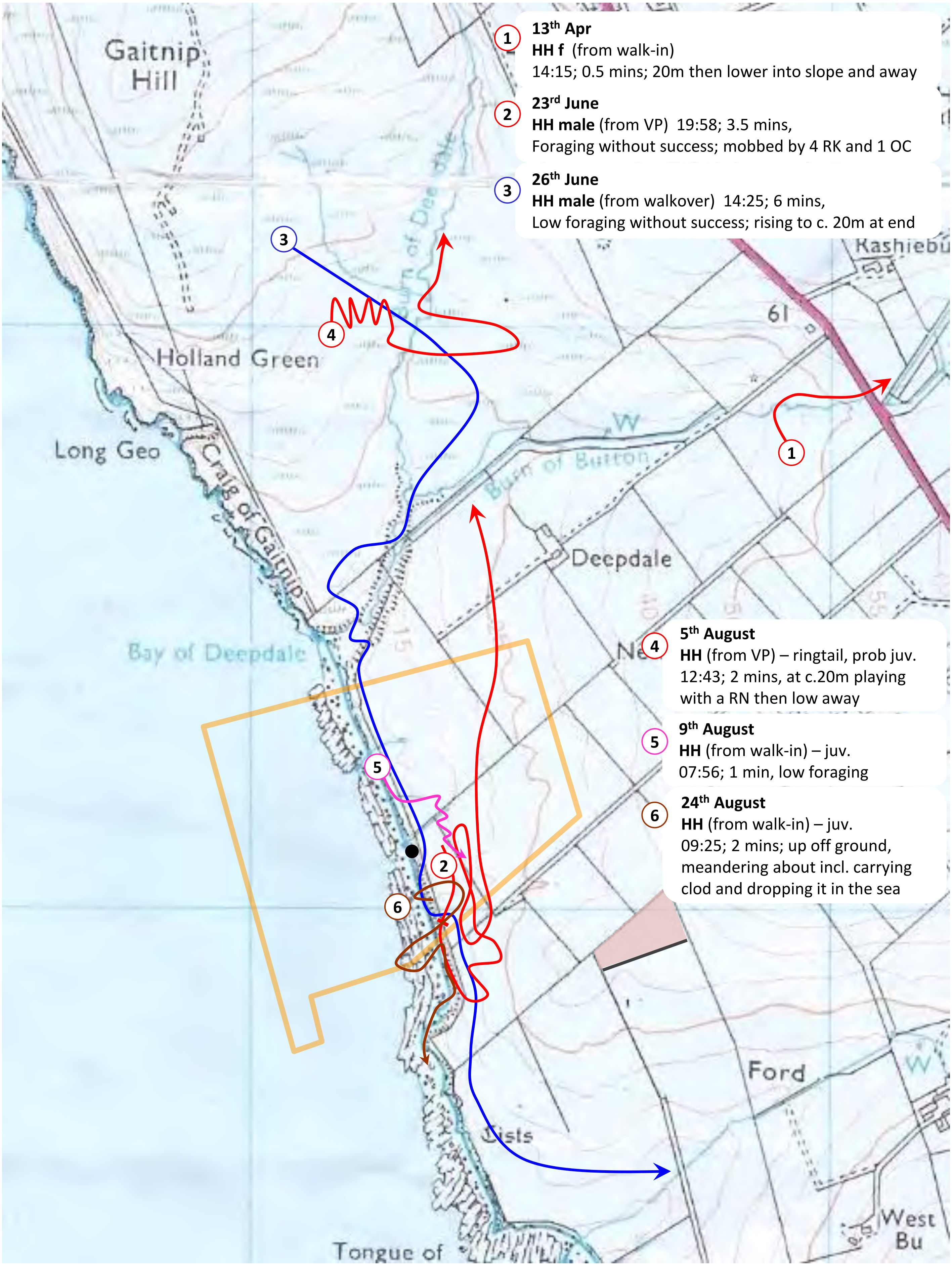
May 2022 survey route
Effective survey area
S. Skylark singing (12)
WR Wren singing (1)
◌ Starling & Rock Dove pairs

PW Pied Wagtail (3)
RC Rock Pipit pair/single (3)
TW Twite pair(1)
2 SL Swallow pairs near buildings (2)

Additionally:
Group of 14 Ravens feeding in upper fields

APPENDIX L

Raptor flight path maps



① **13th Apr**
HH f (from walk-in)
14:15; 0.5 mins; 20m then lower into slope and away

② **23rd June**
HH male (from VP) 19:58; 3.5 mins,
Foraging without success; mobbed by 4 RK and 1 OC

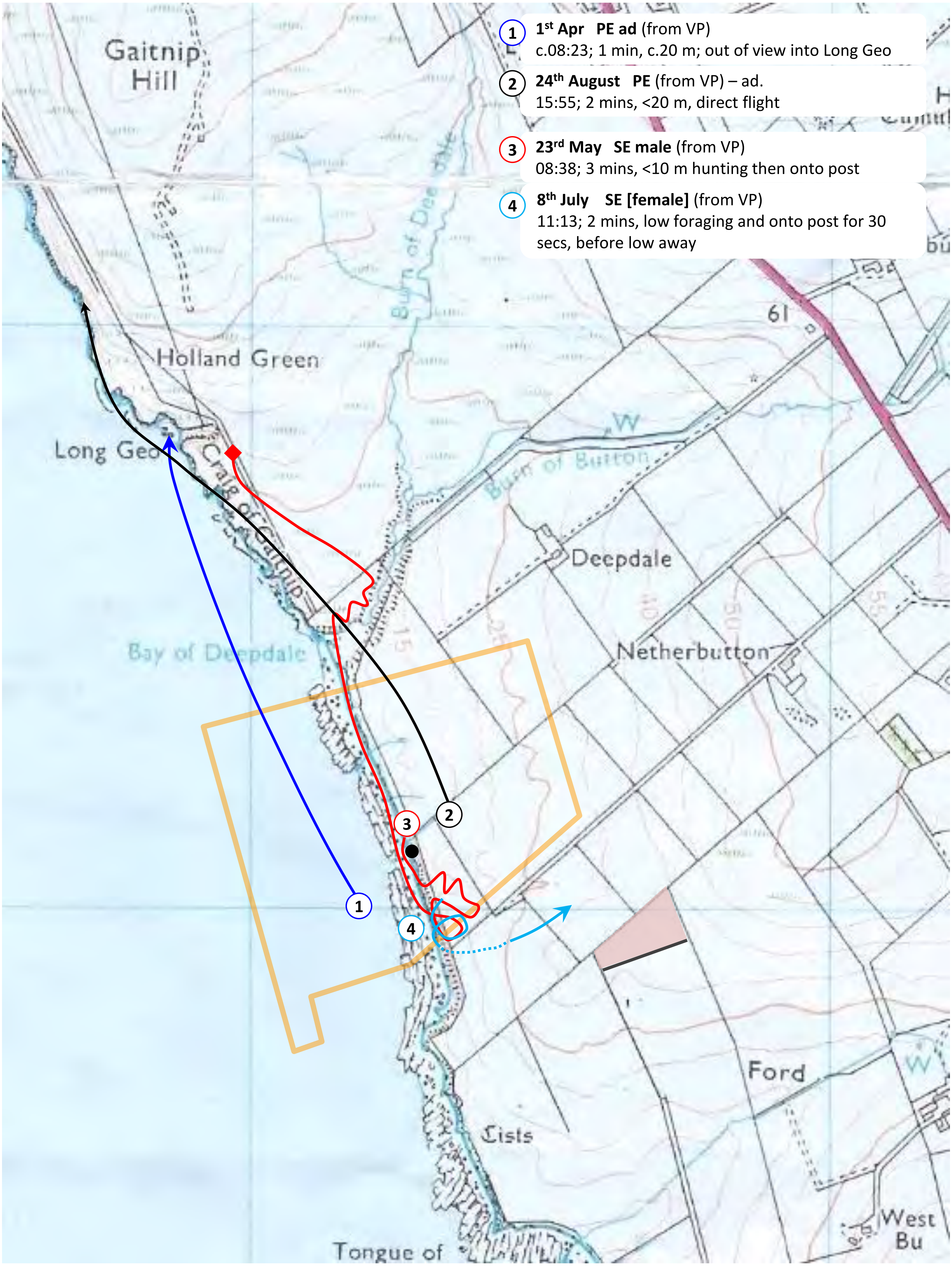
③ **26th June**
HH male (from walkover) 14:25; 6 mins,
Low foraging without success; rising to c. 20m at end

④ **5th August**
HH (from VP) – ringtail, prob juv.
12:43; 2 mins, at c.20m playing with a RN then low away

⑤ **9th August**
HH (from walk-in) – juv.
07:56; 1 min, low foraging

⑥ **24th August**
HH (from walk-in) – juv.
09:25; 2 mins; up off ground, meandering about incl. carrying clod and dropping it in the sea

Hen Harrier flights
Year 1 – summer 2021



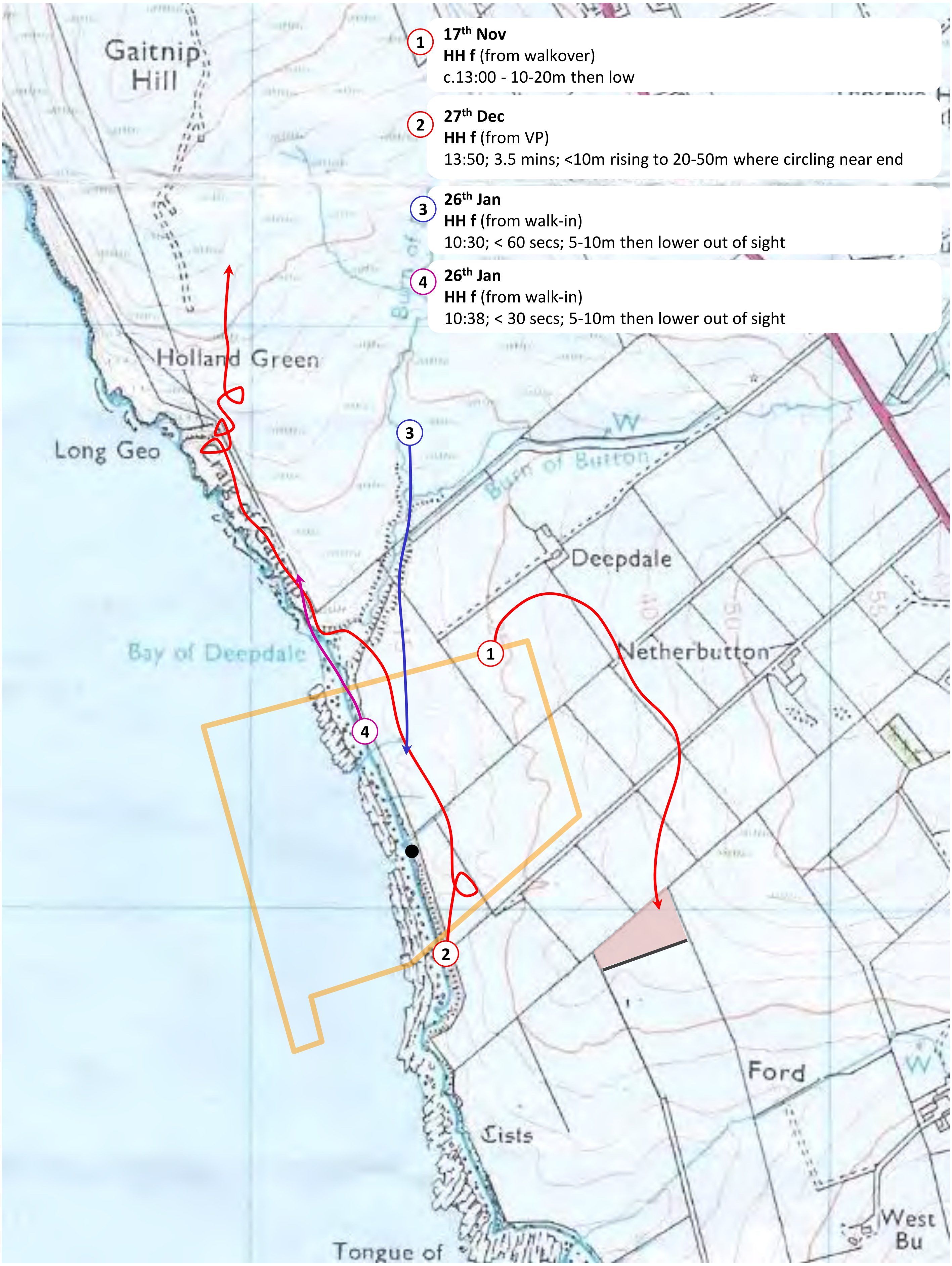
① **1st Apr PE ad** (from VP)
c.08:23; 1 min, c.20 m; out of view into Long Geo

② **24th August PE** (from VP) – ad.
15:55; 2 mins, <20 m, direct flight

③ **23rd May SE male** (from VP)
08:38; 3 mins, <10 m hunting then onto post

④ **8th July SE [female]** (from VP)
11:13; 2 mins, low foraging and onto post for 30 secs, before low away

Peregrine and Short-eared Owl flights
Year 1 – summer 2021



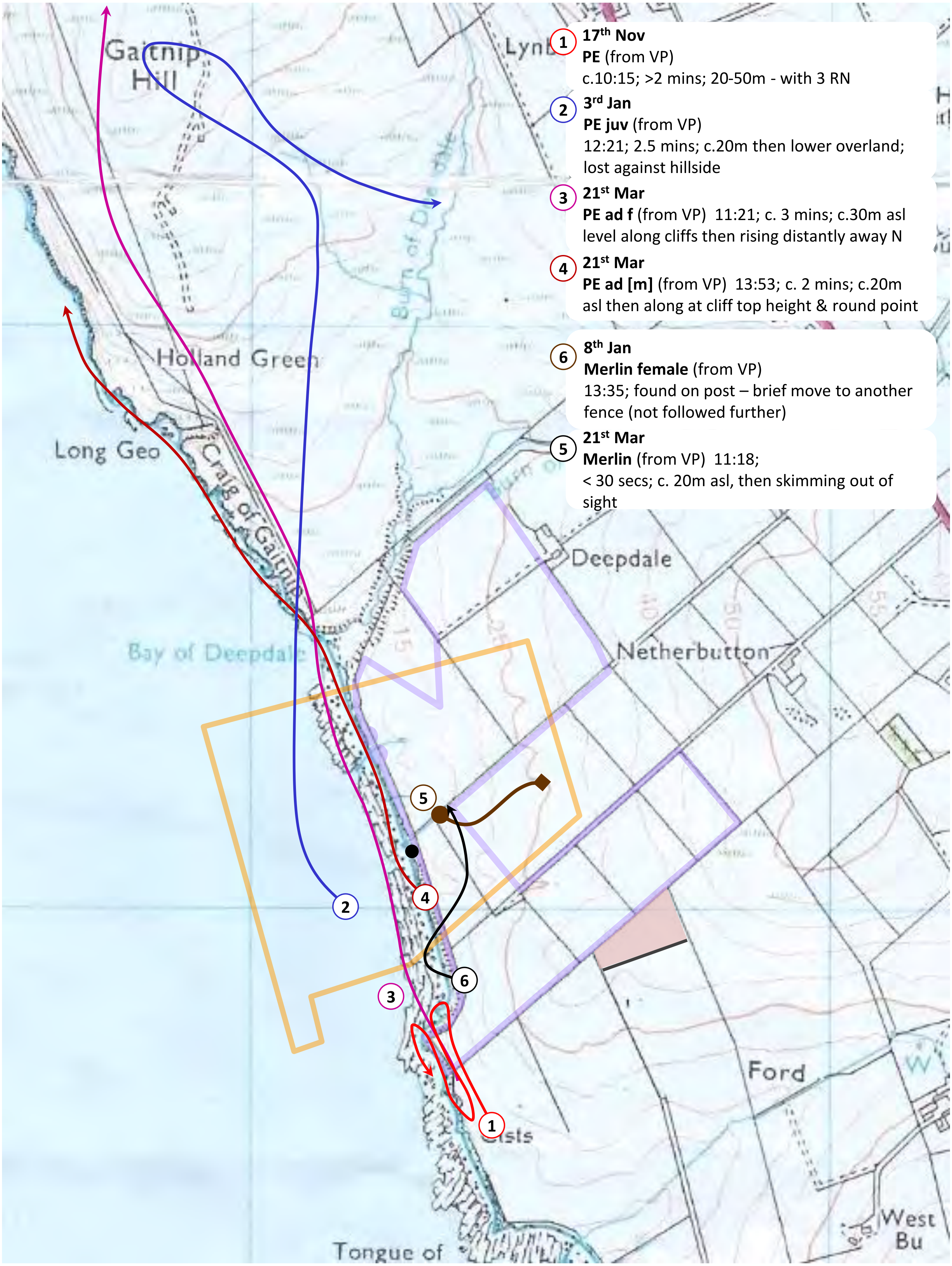
① **17th Nov**
HH f (from walkover)
c.13:00 - 10-20m then low

② **27th Dec**
HH f (from VP)
13:50; 3.5 mins; <10m rising to 20-50m where circling near end

③ **26th Jan**
HH f (from walk-in)
10:30; < 60 secs; 5-10m then lower out of sight

④ **26th Jan**
HH f (from walk-in)
10:38; < 30 secs; 5-10m then lower out of sight

Hen Harrier flights
Year 1 – winter 2020/21



① **17th Nov**
PE (from VP)
c.10:15; >2 mins; 20-50m - with 3 RN

② **3rd Jan**
PE juv (from VP)
12:21; 2.5 mins; c.20m then lower overland; lost against hillside

③ **21st Mar**
PE ad f (from VP) 11:21; c. 3 mins; c.30m asl level along cliffs then rising distantly away N

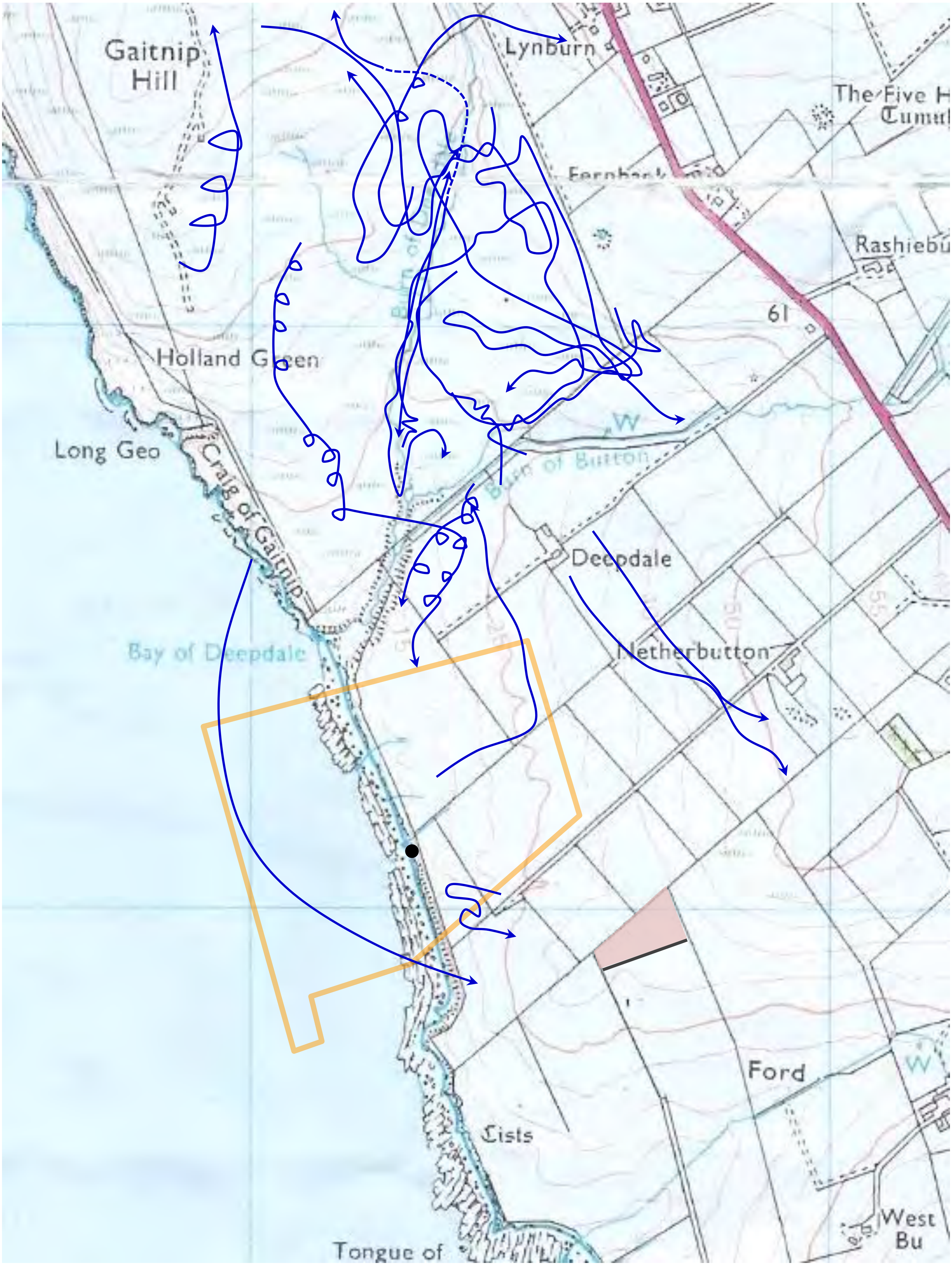
④ **21st Mar**
PE ad [m] (from VP) 13:53; c. 2 mins; c.20m asl then along at cliff top height & round point

⑥ **8th Jan**
Merlin female (from VP)
13:35; found on post – brief move to another fence (not followed further)

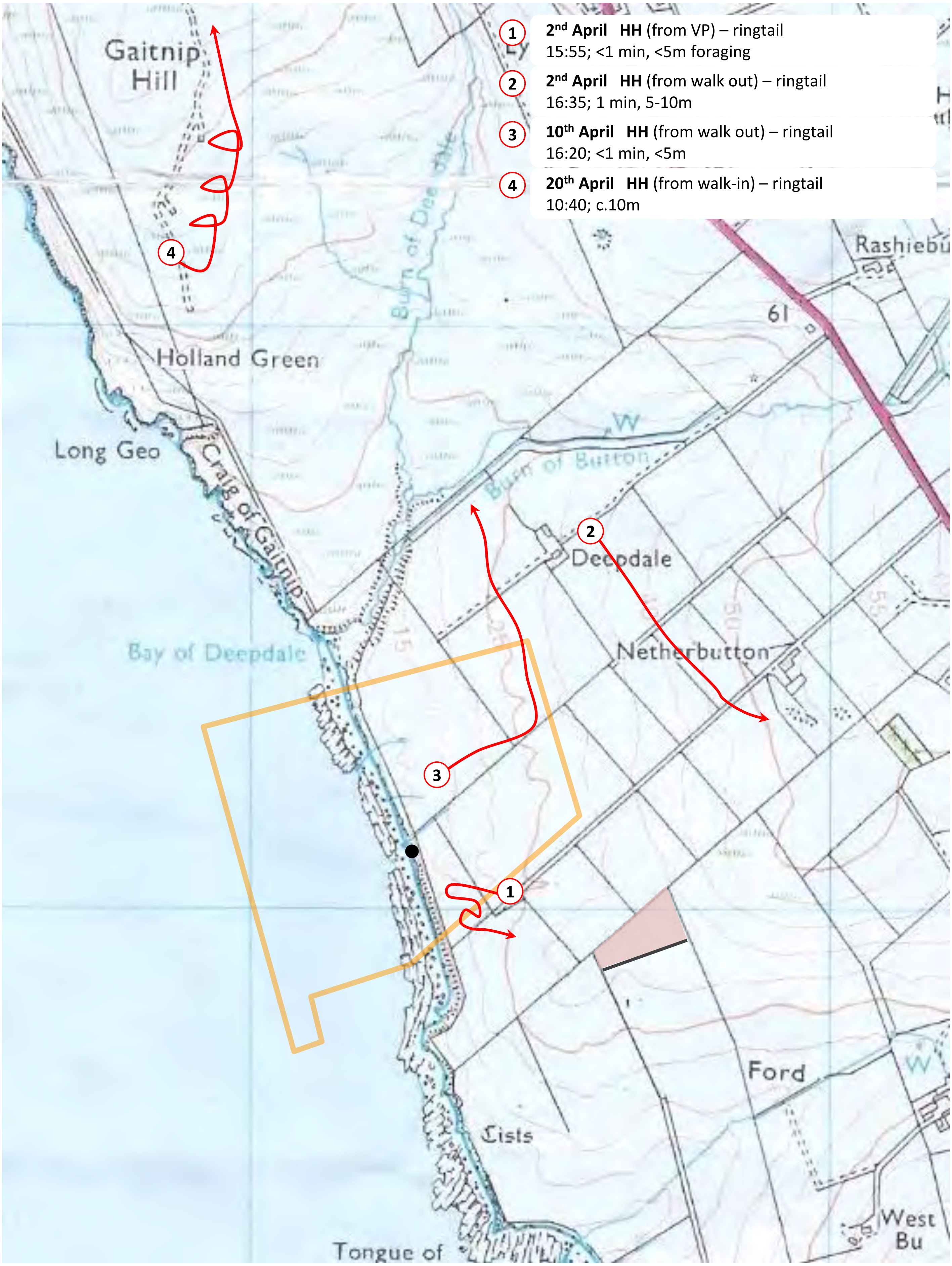
⑤ **21st Mar**
Merlin (from VP) 11:18;
< 30 secs; c. 20m asl, then skimming out of sight

Peregrine and Merlin flights
Year 1 – winter 2020/21

]



Hen Harrier – all flights
Year 2 – summer 2022



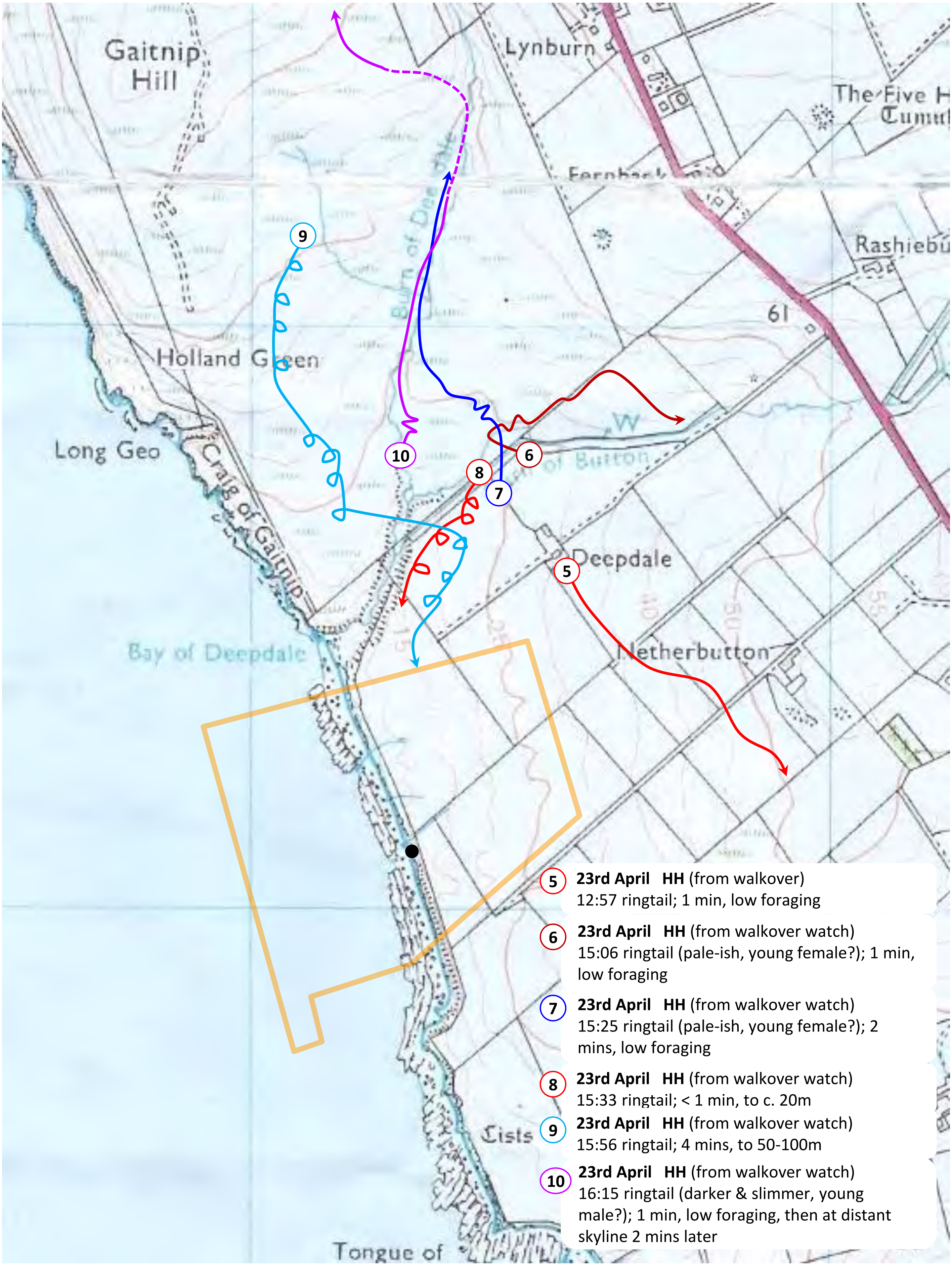
① **2nd April** **HH** (from VP) – ringtail
15:55; <1 min, <5m foraging

② **2nd April** **HH** (from walk out) – ringtail
16:35; 1 min, 5-10m

③ **10th April** **HH** (from walk out) – ringtail
16:20; <1 min, <5m

④ **20th April** **HH** (from walk-in) – ringtail
10:40; c.10m

Hen Harrier flights (1 of 3)
Year 2 – summer 2022



⑤ **23rd April HH** (from walkover)
12:57 ringtail; 1 min, low foraging

⑥ **23rd April HH** (from walkover watch)
15:06 ringtail (pale-ish, young female?); 1 min, low foraging

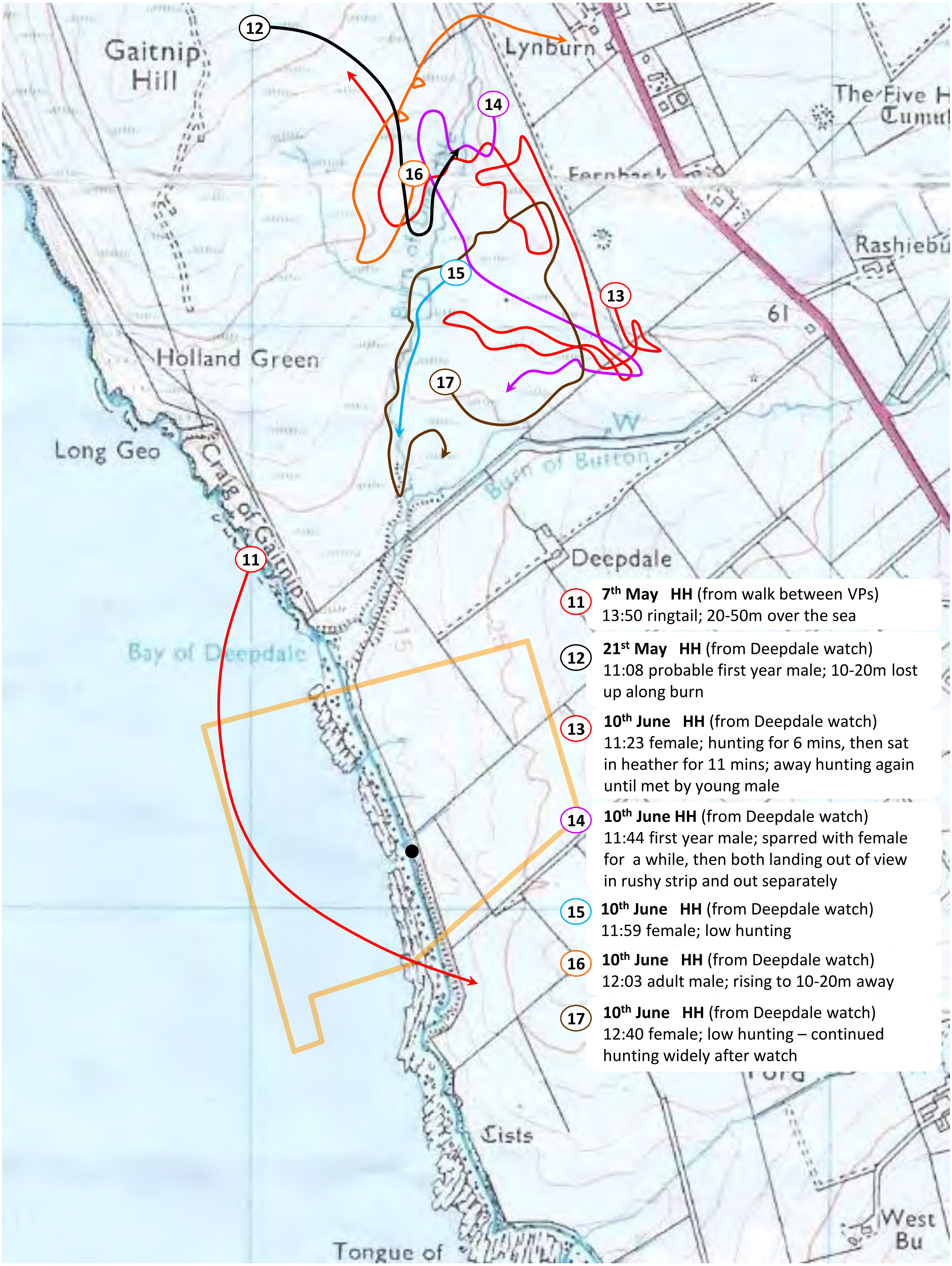
⑦ **23rd April HH** (from walkover watch)
15:25 ringtail (pale-ish, young female?); 2 mins, low foraging

⑧ **23rd April HH** (from walkover watch)
15:33 ringtail; < 1 min, to c. 20m

⑨ **23rd April HH** (from walkover watch)
15:56 ringtail; 4 mins, to 50-100m

⑩ **23rd April HH** (from walkover watch)
16:15 ringtail (darker & slimmer, young male?); 1 min, low foraging, then at distant skyline 2 mins later

Hen Harrier flights (2 of 3)
Year 2 – summer 2022



⑪ **7th May HH** (from walk between VPs)
13:50 ringtail; 20-50m over the sea

⑫ **21st May HH** (from Deepdale watch)
11:08 probable first year male; 10-20m lost up along burn

⑬ **10th June HH** (from Deepdale watch)
11:23 female; hunting for 6 mins, then sat in heather for 11 mins; away hunting again until met by young male

⑭ **10th June HH** (from Deepdale watch)
11:44 first year male; sparred with female for a while, then both landing out of view in rushy strip and out separately

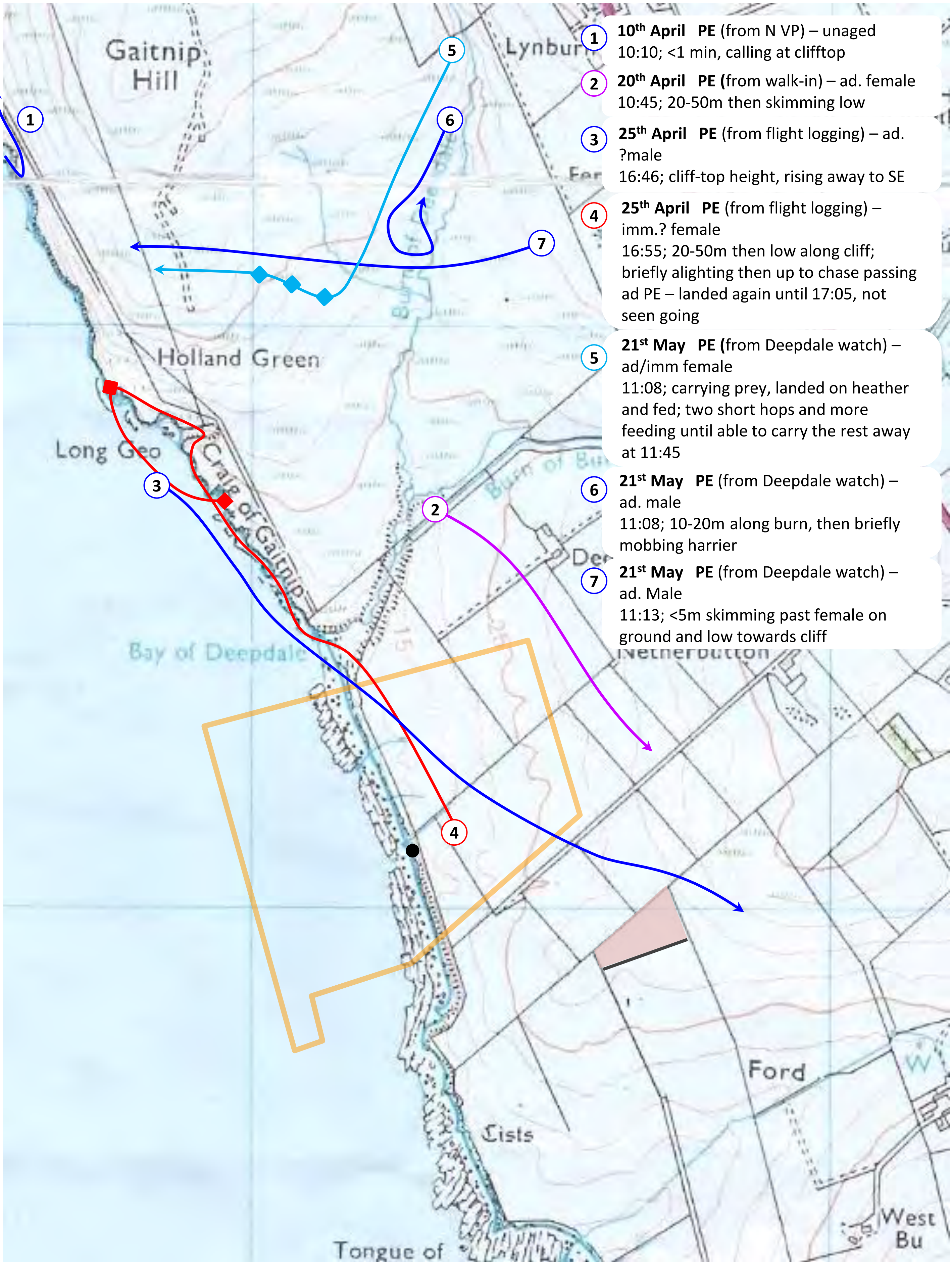
⑮ **10th June HH** (from Deepdale watch)
11:59 female; low hunting

⑯ **10th June HH** (from Deepdale watch)
12:03 adult male; rising to 10-20m away

⑰ **10th June HH** (from Deepdale watch)
12:40 female; low hunting – continued hunting widely after watch

Hen Harrier flights (3 of 3)
Year 2 – summer 2022

Peregrine – all flights
Year 2 – summer 2022



① **10th April PE** (from N VP) – unaged
10:10; <1 min, calling at clifftop

② **20th April PE (**from walk-in) – ad. female
10:45; 20-50m then skimming low

③ **25th April PE** (from flight logging) – ad. ?male
16:46; cliff-top height, rising away to SE

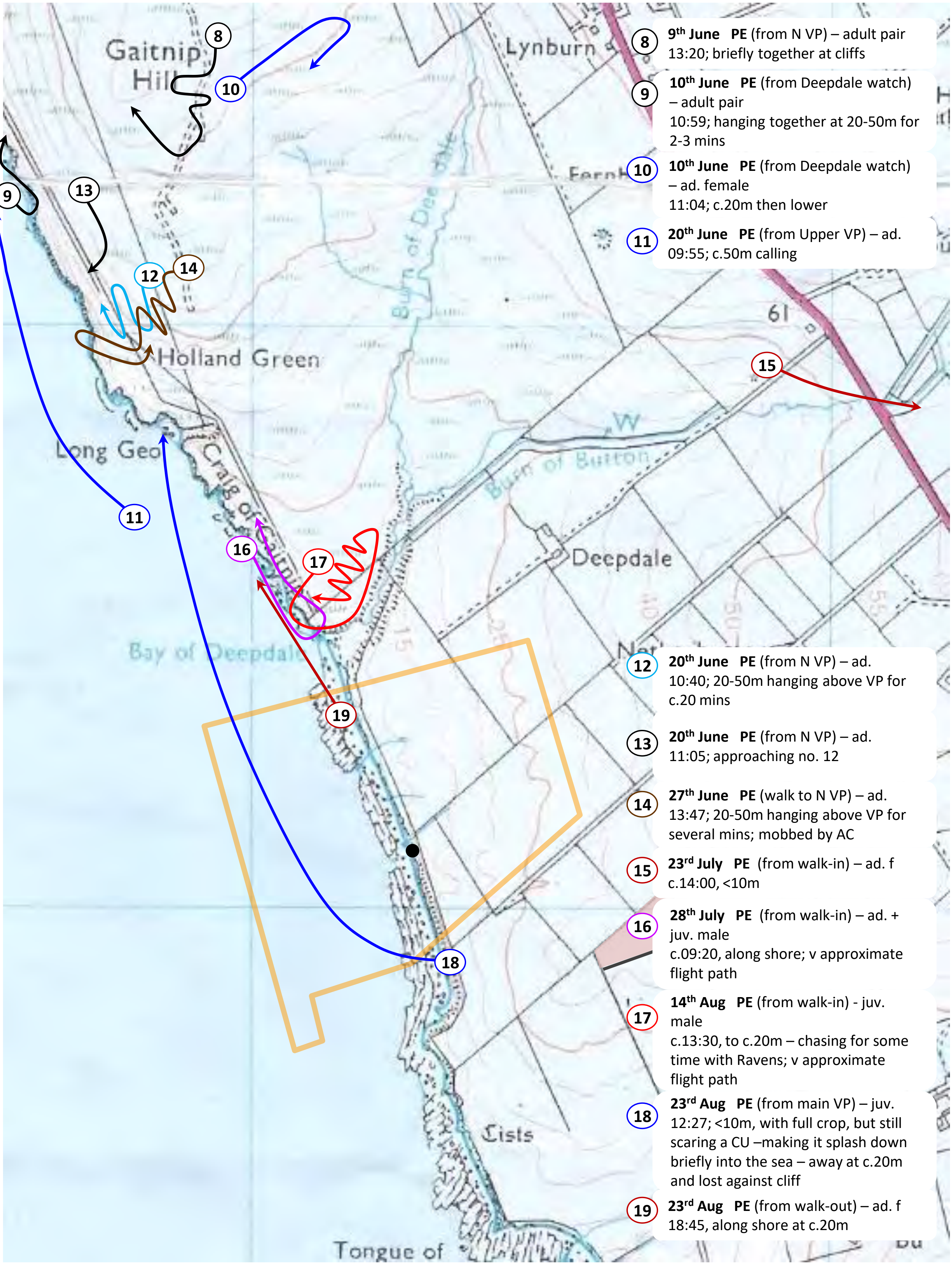
④ **25th April PE** (from flight logging) – imm.? female
16:55; 20-50m then low along cliff; briefly alighting then up to chase passing ad PE – landed again until 17:05, not seen going

⑤ **21st May PE (**from Deepdale watch) – ad/imm female
11:08; carrying prey, landed on heather and fed; two short hops and more feeding until able to carry the rest away at 11:45

⑥ **21st May PE** (from Deepdale watch) – ad. male
11:08; 10-20m along burn, then briefly mobbing harrier

⑦ **21st May PE** (from Deepdale watch) – ad. Male
11:13; <5m skimming past female on ground and low towards cliff

Peregrine flights (1 of 2)
Year 2 – summer 2022



⑧ **9th June** **PE** (from N VP) – adult pair
13:20; briefly together at cliffs

⑨ **10th June** **PE** (from Deepdale watch) – adult pair
10:59; hanging together at 20-50m for 2-3 mins

⑩ **10th June** **PE** (from Deepdale watch) – ad. female
11:04; c.20m then lower

⑪ **20th June** **PE** (from Upper VP) – ad.
09:55; c.50m calling

⑫ **20th June** **PE** (from N VP) – ad.
10:40; 20-50m hanging above VP for c.20 mins

⑬ **20th June** **PE** (from N VP) – ad.
11:05; approaching no. 12

⑭ **27th June** **PE** (walk to N VP) – ad.
13:47; 20-50m hanging above VP for several mins; mobbed by AC

⑮ **23rd July** **PE** (from walk-in) – ad. f
c.14:00, <10m

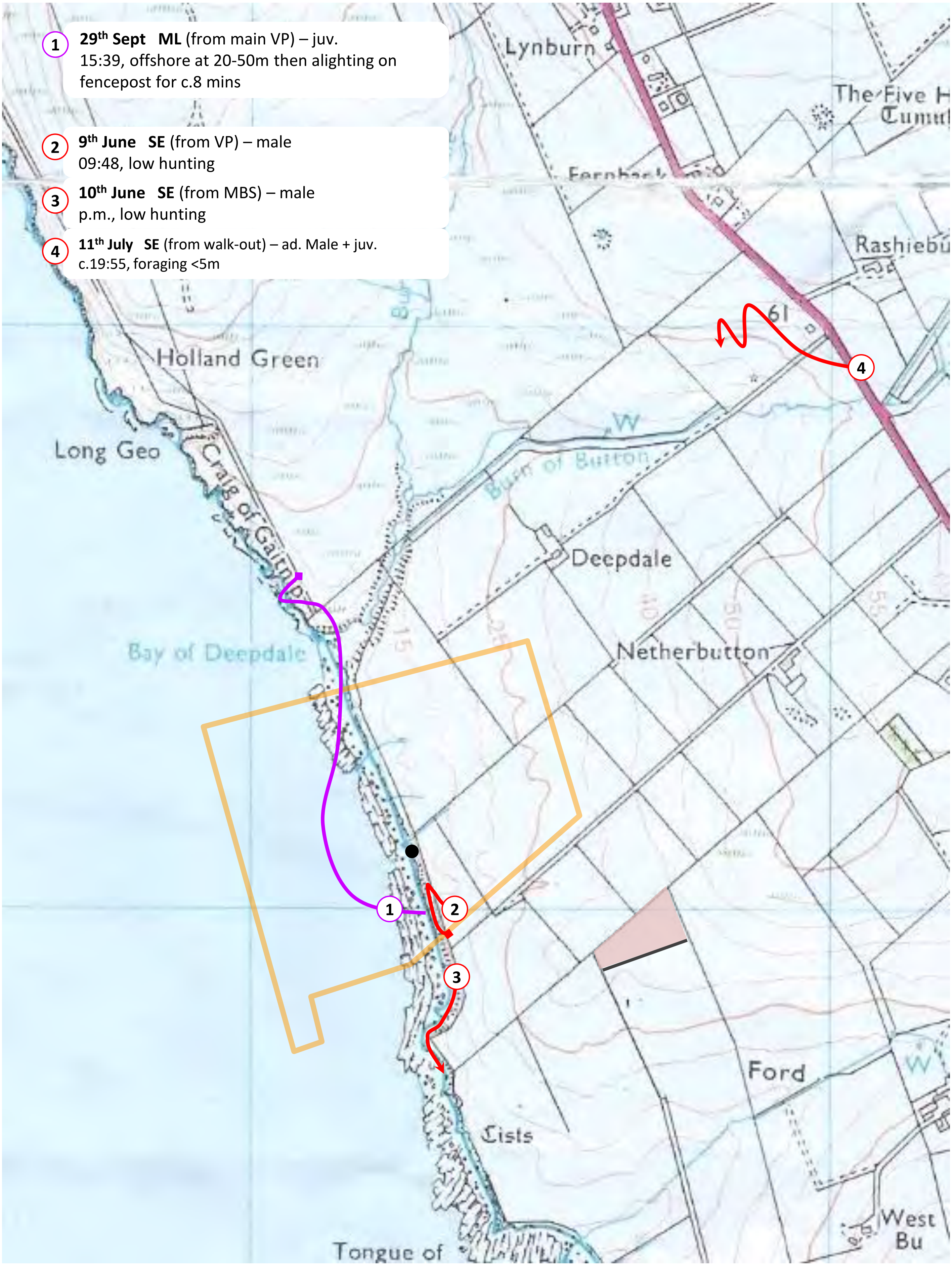
⑯ **28th July** **PE** (from walk-in) – ad. + juv. male
c.09:20, along shore; v approximate flight path

⑰ **14th Aug** **PE** (from walk-in) - juv. male
c.13:30, to c.20m – chasing for some time with Ravens; v approximate flight path

⑱ **23rd Aug** **PE** (from main VP) – juv.
12:27; <10m, with full crop, but still scaring a CU –making it splash down briefly into the sea – away at c.20m and lost against cliff

⑲ **23rd Aug** **PE** (from walk-out) – ad. f
18:45, along shore at c.20m

Peregrine flights (2 of 2)
Year 2 – summer 2022



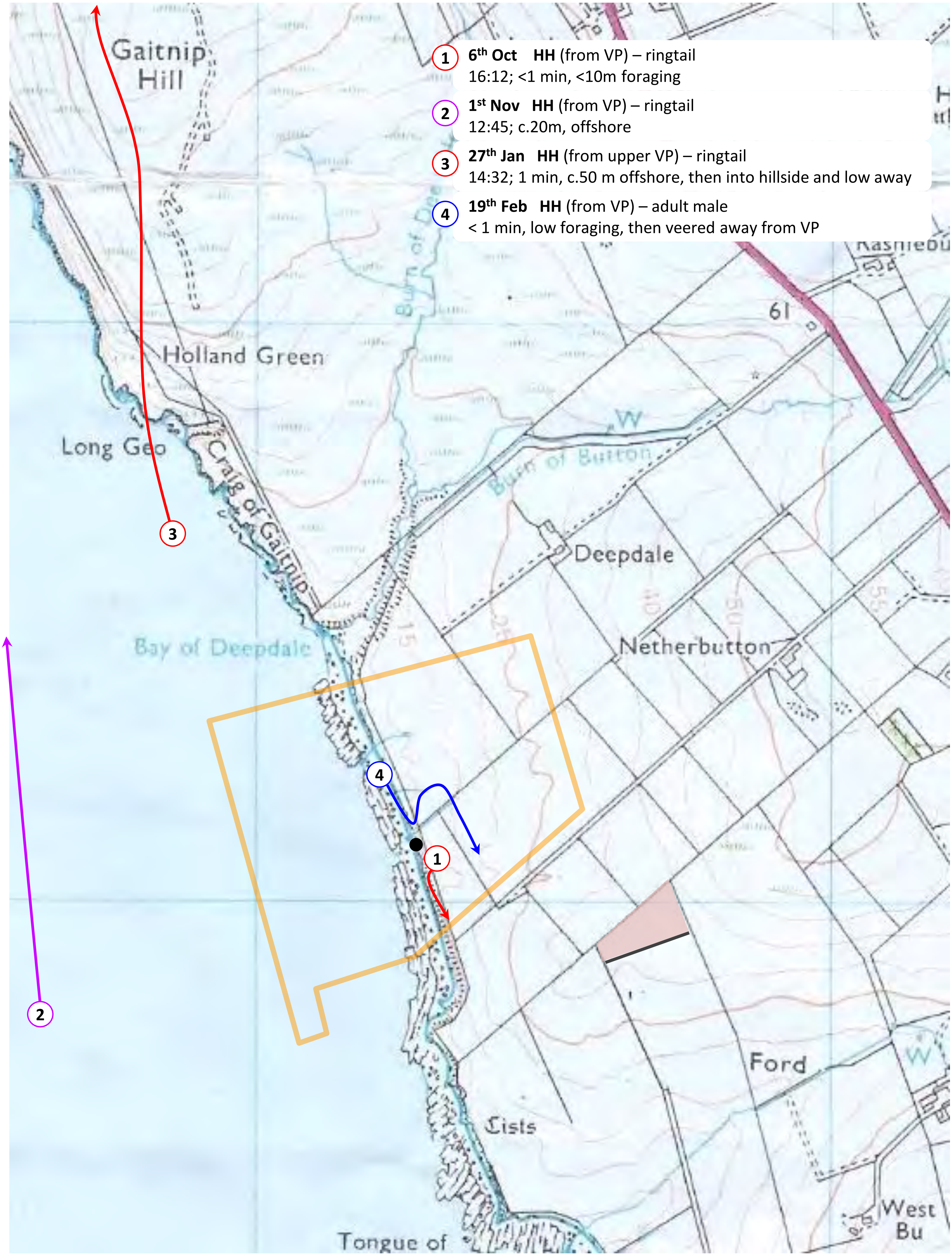
① **29th Sept ML** (from main VP) – juv.
15:39, offshore at 20-50m then alighting on fencepost for c.8 mins

② **9th June SE** (from VP) – male
09:48, low hunting

③ **10th June SE** (from MBS) – male
p.m., low hunting

④ **11th July SE** (from walk-out) – ad. Male + juv.
c.19:55, foraging <5m

Merlin and Short-eared Owl flights
Year 2 – summer 2022



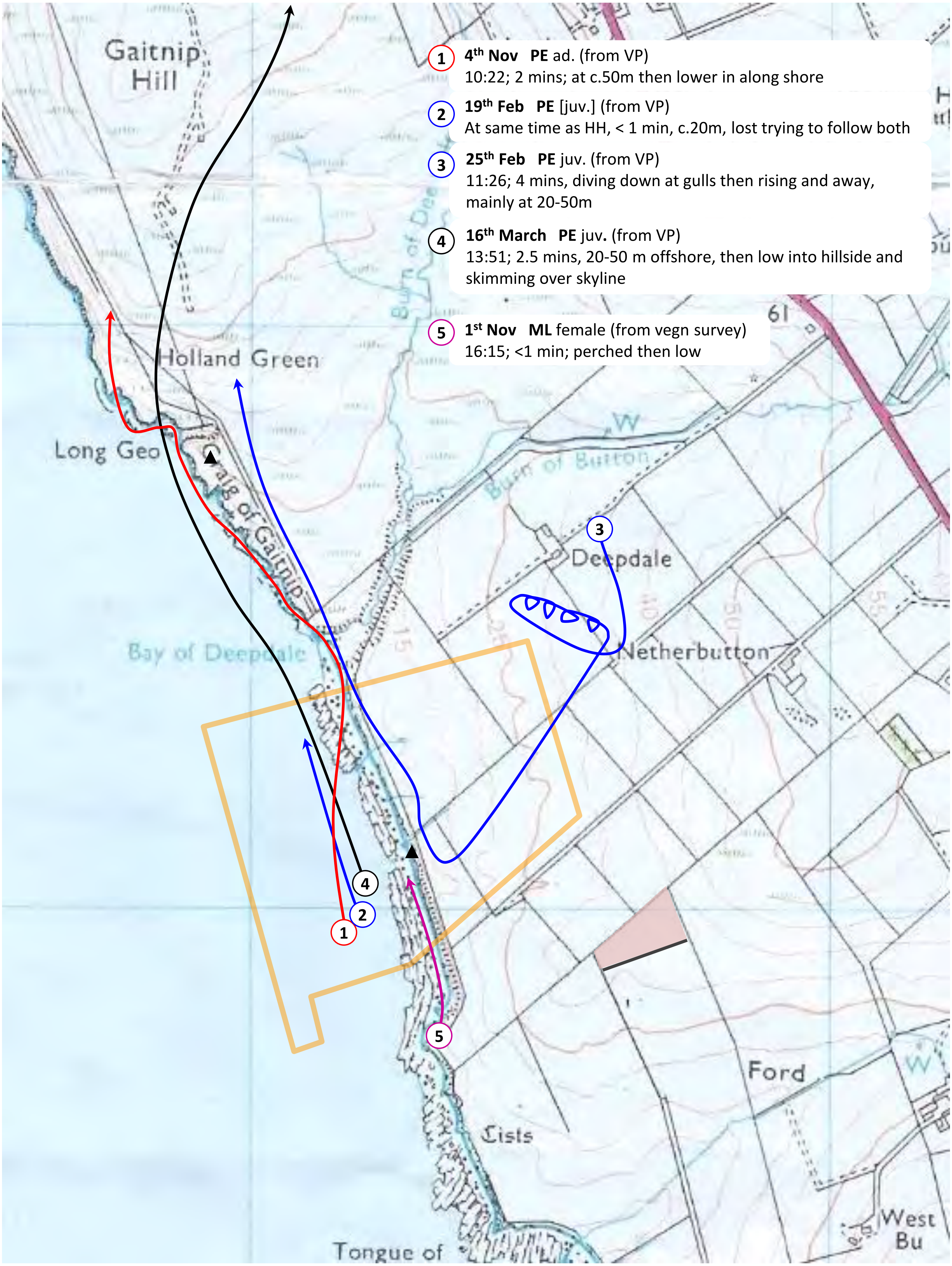
① **6th Oct HH** (from VP) – ringtail
16:12; <1 min, <10m foraging

② **1st Nov HH** (from VP) – ringtail
12:45; c.20m, offshore

③ **27th Jan HH** (from upper VP) – ringtail
14:32; 1 min, c.50 m offshore, then into hillside and low away

④ **19th Feb HH** (from VP) – adult male
< 1 min, low foraging, then veered away from VP

Hen Harrier flights
Year 2 – winter 2021/22



① **4th Nov** **PE** ad. (from VP)
10:22; 2 mins; at c.50m then lower in along shore

② **19th Feb** **PE** [juv.] (from VP)
At same time as HH, < 1 min, c.20m, lost trying to follow both

③ **25th Feb** **PE** juv. (from VP)
11:26; 4 mins, diving down at gulls then rising and away, mainly at 20-50m

④ **16th March** **PE** juv. (from VP)
13:51; 2.5 mins, 20-50 m offshore, then low into hillside and skimming over skyline

⑤ **1st Nov** **ML** female (from vegn survey)
16:15; <1 min; perched then low

Peregrine and Merlin flights
Year 2 – winter 2021/22

TECHNICAL APPENDIX 5.4

2022 Scapa Deep Water Quay Habitat Mapping Survey

Survey Report

17th August 2023

Physalia Associates Ltd.
Dr Simon Forster
Email: simon.forster@physalia.uk
Tel: +44(0)1435 883105

Seastar Survey Ltd.
Steven Dewey
Email: sdewey@seastarsurvey.co.uk
Tel: +44(0)23 8063 5000

This report to be cited as:
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CONTENTS

List of Figures

List of Tables

List of Appendices

1 INTRODUCTION

1.1 Background

In 2020, the Orkney Island Council Harbour Authority (OICHA) unveiled the Orkney Harbour Masterplan Phase I. The Masterplan proposed a £230 million investment in a range of harbour infrastructure enhancements to be completed over a 20-year period. Phase I of the Masterplan considers five locations on the Orkney mainland, namely:

- Scapa Deep Water Quay;
- Hatston Pier and Harbour;
- Scapa Pier;
- Kirkwall Pier and Harbour; and
- Stromness.

Phase II of the Masterplan will include the development and expansion of smaller harbours and piers across the wider Orkney Islands.

Seastar Survey Ltd. (hereafter Seastar) and Physalia Associates Ltd. (hereafter Physalia) were commissioned by Envirocentre to undertake a broadscale habitat assessment of the intertidal and subtidal habitats at and in the vicinity of the proposed Scapa Deep Water Quay expansion project. The data obtained will inform the Environmental Impact Assessment (EIA) that will be submitted with the project planning permission application by the Orkney Island Council Harbour Authority (OICHA). If planning permission is granted, a full baseline survey of the area will be conducted, which, when combined with a suitable monitoring scheme, will enable potential future changes to the local habitats and biological communities to be detected and quantified.

1.2 The existing site

The site selected for the proposed Scapa Deep Water Quay is in the area known as the Bay of Deepdale, located approximately 4.5 km south of the existing Scapa Pier and approximately 3.5 km northwest of the village of St Mary's. The shoreline at and in the vicinity of the proposed development comprises a mix of substrate types, including cobbles, boulders and bedrock leading to sand-dominated subtidal substrate. The upper shore is separated from the adjacent pasture fields by a rock cliff or a steep, rocky embankment, approximately 3 m in height.

Between 1974 and 1990, annual surveys of rocky shores in Orkney were conducted (e.g. Baxter, Jones and Simpson, 1985), which included a transect located in the vicinity of the current survey area ('Quoy Ribs'). However, as the associated data were not made available during the planning process, the transect was not incorporated into the current survey. Furthermore, as the associated data are not recent (predating the current survey by more than 30 years), their use in informing the current survey has been deemed to be limited.

1.3 Proposed development summary

The Scapa Deep Water Quay is to be developed as part of the Orkney Harbour Masterplan Phase I. As no existing dock facilities are currently available at the site, this would constitute a new development. It is proposed that the development be constructed in three phases and, upon completion, will comprise the following: an approximately 597 m long main quayside berth with a water depth of ~15 m below chart datum (CD), incorporating a 135 m quayside pocket with a water depth of ~20 m below CD; a tug and pilot boat berth approximately 180 m in length with a water depth of 6-9 m below CD; and 22.85 ha of laydown area directly behind the quay face.

The construction of the Scapa Deep Water Quay will necessitate the reclamation of 10.455 ha (Phase 1: 5.185 ha; Phase 2: 5.27 ha) of marine habitat (intertidal and subtidal) and the dredging of a total of 51,800 m^2 (Phase 1: 21,500 m^2; Phase 2: 16,500 m^2; Phase 3: 13,800 m^2) of marine benthic habitat. In addition, it is likely that maintenance dredging will be required to retain the required water depths during the operational phase of the proposed development.

Both land reclamation and capital dredging will result in the direct loss of both intertidal and subtidal habitats and the associated biotic communities. Maintenance dredging activities will also cause additional direct habitat loss and disturbance. Both maintenance dredging and construction activities also have the potential to cause indirect impacts on the environment due to dissemination of disturbed particulate substrate, including modification of habitat conditions and habitat smothering.

Details of the proposed Scapa Deep Water Quay and Harbour development and design drawings are presented in the project's EIA Scoping Report (see EnviroCentre, 2022).

1.4 Survey aims and objectives

Due to the timescales associated with the submission of the planning permission, there was a requirement to undertake both the intertidal and subtidal surveys in early winter 2022 on a single mobilisation. Winter is generally not considered an ideal time to conduct ecological surveys in the intertidal (and, to a lesser degree, the shallow subtidal), due both to logistical (see section 2.1.2) and ecological (see section 4.3) concerns. The decision was therefore taken ahead of the survey being conducted to reduce the scope of the intertidal surveys to only include rapid broadscale habitat identification and mapping (i.e. Phase I survey), rather than attempting to also collect quantitative and statistically robust species data, i.e. Phase II survey, which is best undertaken on a spring tide when algal growth is at maximum (generally in the summer months).

Despite the reduction in scope, the survey approach was considered to be appropriate for the project. Where there are little to no habitat data available for an area (as in this case) it is considered acceptable practice to conduct Phase I surveys prior to undertaking more focused characterisation and/or baseline surveys in order to gain a better understanding of the habitats and taxa present. The broadscale habitat data acquired during the Phase I surveys can then be used to inform and better plan subsequent quantitative data collection. In addition, the data collected as part of the Phase I surveys undertaken was considered to be of sufficient resolution to gain a good understanding of the habitats and dominant taxa present and therefore adequately inform assessments of the likely significant effects (LSE) of the proposed development, detailed in the EIA.

The overall aim of the survey was to conduct a broadscale habitat mapping survey, i.e. to identify and map the extent and distribution of the range of habitats and biotopes present at and in the vicinity of the proposed Scapa Deep Water Quay development. The objectives of the survey were to;

- conduct a Phase I survey of the intertidal habitats at a series of belt transects within the survey area;
- identify and map the extent and distribution of intertidal habitats at each transect;
- identify and map the extent and distribution of the littoral biotopes present;
- characterise the habitats observed by providing semi-quantitative data on species composition of representative intertidal habitats and biotopes;
- conduct a drop-down camera and benthic grab sampling survey of the subtidal benthic habitats within the survey area;
- identify and determine the extent and distribution of subtidal habitats within the survey area;
- identify and determine the extent and distribution of the sublittoral biotopes present;
- identify any protected species and/or communities including habitats of conservation or ecological importance such as Priority Marine Features (PMFs) and Annex I habitats;
- produce habitat data of sufficient resolution to enable an assessment of the LSE of the proposed development as part of the EIA.

2 METHODS

2.1 Intertidal survey

The aim of the Phase I intertidal survey was to determine the range, distribution and extent of the habitats present by assigning biotopes *in situ* on vertical (i.e. running from high to low shore) transects, in accordance with best practice guidance. The collection and analysis of the data was completed in accordance with Common Standards Monitoring guidance (JNCC, 2004) and procedural guidelines outlined in the Marine Monitoring Handbook (Davies *et al*., 2001) and the CCW Handbook for Marine Intertidal Phase I Survey and Mapping (Wyn, *et al*., 2006).

2.1.1 Transect locations

Prior to the survey, target locations for four intertidal ‘belt’ transects were selected. No aerial photography data for the survey area were available in which the intertidal zone was visible, and no previous habitat mapping data were available. Therefore, in order to achieve good geographical spread, and in an attempt to sample a range of habitat types, four transects were placed within the survey area. To the north of the proposed development area, the shore was deemed to be inaccessible due to the presence of steep cliffs (this was also confirmed in the field); three transects were therefore planned within the consent boundary with a fourth transect (SB_4) planned just to the south of the consent boundary. Start of line (SOL) and end of line (EOL) positions for each transect were input into a Garmin GPSMAP 276Cx portable chartplotter. These included a central transect line and two parallel ‘boundary’ lines, one 30 m either side of the central transect line.

Once in the field, the appropriateness of the planned transect sites was reassessed and, where necessary, locations were changed due to impediments to access. This included changes to the locations of both SB_3 and SB_4, which were both moved north along the shore due to the difficulties encountered when traversing southwards around the rocky outcrop/headland known as the Tongue of Gangsta.

The transect locations used for the Scapa intertidal survey are presented in Table 2.1 and illustrated in Figure 2.1.

Table 2.1: Start of line (SOL) and end of line (EOL) positions of the centre line of each of the four belt transects surveyed during the 2022 Scapa Deep Water Quay Phase I intertidal survey. Positions are WGS84 (DD MM.MMMM); negative longitudes are west.

Transect Name	Transect Number	SOL Position WGS84		EOL Position WGS84		Bearing to EOL
		Latitude	Longitude	Latitude	Longitude	
Scapa	**SB_1**	58 55.3519	-002 57.2125	58 55.3368	-002 57.2465	245
Scapa	**SB_2**	58 55.1976	-002 57.0979	58 55.1899	-002 57.1314	244
Scapa	**SB_3**	58 55.1124	002 57.0421	58 55.1122	-002 57.0885	270
Scapa	**SB_4**	58 55.0467	-002 57.0731	58 55.0361	-002 57.1011	250

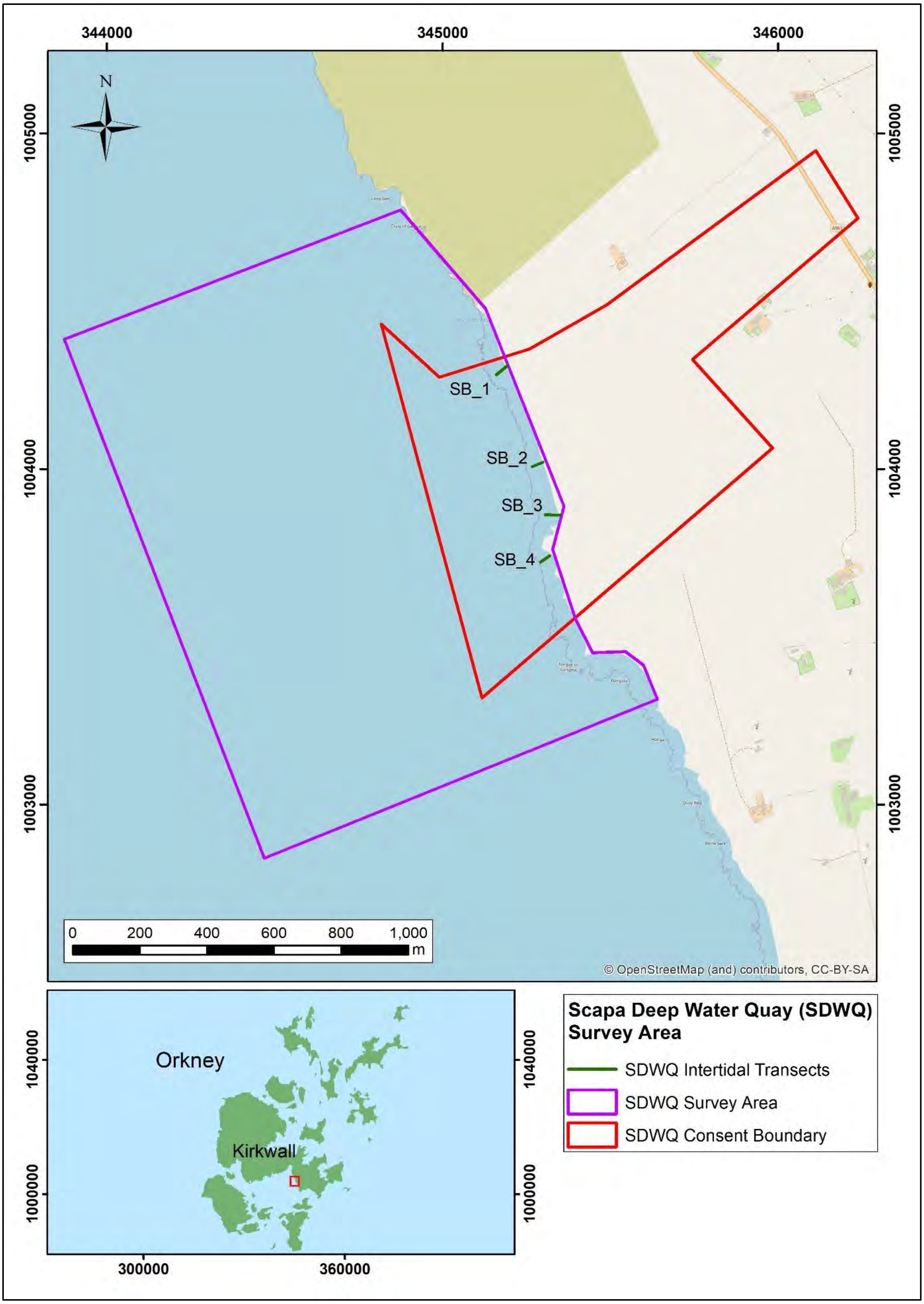


Figure 2.1: Locations of the four intertidal belt transects (centre lines only) surveyed during the 2022 Scapa Deep Water Quay Phase I intertidal survey.

2.1.2 Survey dates and tide times

Due to the requirement to undertake the survey in early winter 2022, it was not possible to undertake the survey at low tide on a spring tide as these coincided with hours of darkness. Instead, the best available low tides were utilised, maximising the tidal range (i.e. the amount of beach exposed) whilst ensuring work could be undertaken in daylight hours. The intertidal survey work at the Scapa Deep Water Quay site was completed on 3rd and 4th December 2022. Details of the tide times are provided in Table 2.2. The surveys were undertaken during the period two hours before and after low water.

Table 2.2: Tide times (UTC) and heights relative to Chart Datum during the Scapa Deep Water Quay Phase I intertidal survey.

Survey Day	High Water 1		Low Water		High Water 2	
	Time	Height (m)	Time	Height (m)	Time	Height (m)
Saturday 03/12/2022	06.02	2.82	11:57	1.48	17:59	3.03
Sunday 04/12/2022	06:57	0.91	12:49	1.33	18.58	3.09

2.1.3 Access

Access to the foreshore at Scapa was arranged by EnviroCentre. The foreshore was accessed from the A961 via a farm track leading to the mouth of the Burn of Deepdale at the northern end of the survey area. Permission was granted by the landowner to use the access route on the days of survey only.

2.1.4 Transect assessment

At each transect, all habitat types present within the 60 m wide ‘belt’ were recorded and assigned a biotope as per the latest iteration of the MNCR Marine Habitat Classification for Britain and Ireland (JNCC, 2022), incorporating information regarding species composition and abundance, shore height, exposure of the shore and substrate type. The vertical width (high-low shore) of each habitat was recorded and GPS positions were taken at the habitat boundaries along the central transect line using the GPSMAP portable chartplotter (which used both GPS and GLONASS sensors for improved positional accuracy). The distribution of biotopes 30 m either side of the central line was recorded using wireframe map annotations. In addition, the track function in the GPS was used to map each biotope boundary.

For each identified biotope, a detailed habitat description was recorded using modified MNCR field forms (see Appendix I), including information regarding shore position, substrate type and percentage cover, rock type, surface relief, texture and stability, modifiers such as scour, silt and macroalgal mats, and any anthropogenic influences present. In addition, for each identified habitat a list of the dominant/conspicuous biota present was produced with taxa enumerated using the semi-quantitative SACFOR[1] scale (see Appendix II). Any additional relevant metadata, including time, state of tide, weather etc., were also recorded.

---

[1] **S**uper-abundant, **A**bundant, **C**ommon, **F**requent, **O**ccasional, **R**are.

Photographs documenting the zonation patterns present were taken at three locations (high, mid and low shore) along the central transect line. Where images could not be taken in the low shore due to tidal timings (see section 2.1.2), 'low shore' images were taken as far down the shore as possible. At each location, the GPS position was recorded and photographs were taken up-shore, down-shore, and along-shore in both directions.

2.1.5 Additional observations

When transiting on foot to, from and between transects, any non-indigenous species (NIS), freshwater outflows, litter or other anthropogenic influences were documented. In each instance, the position was recorded from the GPS and a photograph was taken. Where anthropogenic influences were clearly impacting the surrounding environment, details of this were recorded. Where NIS were encountered, abundance was recorded using the semi-quantitative SACFOR scale.

2.1.6 Analysis

All field notes, including field sketches, were digitised post-survey and photographic records were reviewed by a senior marine ecologist to confirm the assigned biotopes and taxon identifications. Species lists were created for each Phase I habitat ensuring that all taxa were recorded in accordance with the World Register of Marine Species (WoRMS Editorial Board, 2023) and assigned an MCS alphanumeric bio-code according to Howson and Picton (1997), where applicable, to avoid problems in species nomenclature. Biotopes were assigned to each habitat according to the Marine Habitat Classification for Britain and Ireland (JNCC, 2022) following the guidance provided in Parry (2019).

2.1.7 GIS

Data obtained during the Phase I survey, included all GPS trackplots and relevant point data, were imported into ArcGIS. Utilising these data together with the wireframe map field sketches created during the Phase I surveys, polygons were created within the GIS in order to map the location of the different biotopes identified within each of the four belt transects.

2.2 Subtidal survey

The subtidal survey work comprised a drop-down camera survey for the acquisition of high-definition video and high-resolution still images and a grab sampling survey to acquire samples for macrobenthic invertebrate assessment and particle size analysis (PSA). The survey work was undertaken from *MV Uskmoor*, a local survey vessel suited to the work and equipped with a winch, A-frame, and crane. For the Scapa Deep Water Quay subtidal survey, the vessel was mobilised from Scrabster harbour.

The Scapa Deep Water Quay drop-down camera survey was undertaken on 7th December 2022, with grab sampling taking place on 8th December 2022.

2.2.1 Drop-down camera survey

The underwater imagery survey work was conducted in accordance with operational guidelines issued by the NMBAQC scheme for drop-down camera systems (Hitchin *et al*., 2015).

Prior to the survey, a total of 15 drop-down targets were selected for investigation, aiming to achieve good geographical spread at a range of depths. The plan was to run a 10-minute transect across each of the targets against the direction of the tide at the time of survey. However, in order to save time and reduce the number of deployments, multiple targets were surveyed on a single camera deployment resulting in deployments of approximately 20 – 30 minutes in duration.

The following equipment was used during the camera survey:

- Leica GX1230 RTK GPS;
- Hypack survey management software;
- SubC Rayfin camera system;
- SubC Aquorea LED Flash;
- Four CT4011 LED lights;
- NETMC digital video recorder with video overlay.

Survey navigation was achieved using a Leica GX1230 RTK GPS. The GPS antenna was mounted inboard and offsets between the antenna and vessel's A-frame measured and entered into Hypack prior to the survey.

The GPS was used in full RTK mode; within the GPS, satellite derived positions (WGS84 latitude and longitude) were updated in real-time with pseudo-range corrections from Leica Smartnet, via a GSM receiver. Used in full RTK mode, GPS positions were accurate to ± 0.03 m in three dimensions. During the survey, positional data were recorded using Hypack survey management software and converted to OSGB36 National Grid coordinates in real time using the OSTN15 model within Hypack. Navigation checks of the Leica GX1230 RTK GPS system were carried out against a known location at the start and end of the survey day.

Positioning of the camera frame was achieved by calculating a layback within the survey management software, and was based on the vessel's known position, vessel heading, vessel speed, water depth, height of the A-frame, and the amount of winch wire out.

A SubC Rayfin camera system was used which included a full colour HD video camera and a high-resolution stills camera with manual focus. The camera was mounted at an oblique angle on the camera frame (facing the direction of travel), with the external flash gun and LED video lights mounted on the frame so as to minimise backscatter, deliver bright and even illumination, and maximise image quality. The camera, flash, video lights, and lasers were connected to the surface using a 200 m multifunction soft umbilical, which allowed the LED lights, flash, and camera settings to be adjusted from the topside unit.

The HD video feed was viewed in real time and recorded to a hard drive using the digital video recorder with video overlay. The video overlay included date, time, sample number and height of camera above seabed. The still photographs were recorded sub-sea and uploaded at the end of the survey day. Before each deployment a new folder was created with a unique sample number and the video and stills data were saved to this folder using unique filenames.

The clocks associated with all equipment were synchronised with the GPS time at the start of each survey day, and all survey log entries were made with a record of the GPS time. The times (to the second) of the start and end of each deployment were recorded as were the times that each photograph was taken in order to enable the position of each video transect and photograph to be extracted from the navigation data following the survey.

Prior to camera deployment the skipper steered the vessel into the prevailing conditions (current and wind) and set up on a bearing toward the selected target. The camera was lowered to the seabed whilst the vessel moved toward the initial selected target. When the camera frame reached approximately 1 m above the seabed (as observed using the topside unit) the camera operator started logging navigation data and then started recording the HD video.

During each deployment the height of the camera system above the seabed was controlled by a winch operator on deck, who was in constant communication with the camera operator. The camera was flown just above the seabed to reduce impact on the environment and then landed to take still images at regular intervals (approximately every one minute). Vessel speeds over the ground were maintained at approximately 0.5 knots throughout each deployment.

At the end of each survey day, all survey navigation data, still photographs, and HD video recordings were backed-up onto an external hard drive, which was removed from the vessel.

2.2.2 Benthic grab sampling

Grab sampling locations were selected following completion of the drop-down camera survey and were based on an initial review of the video footage. A total of eight sampling locations were selected, spread geographically throughout the survey area and at a range of depths with the aim of sampling areas of different types of soft sediment.

At each sampling location the vessel set up on the proposed position and a 0.1 m^2 Day grab sampler was deployed over the side of the vessel. A ‘fix’ of GPS position and time was recorded in Hypack and manually logged in the logbook when the grab was determined to be on the seabed. The grab was recovered to deck and the sample inspected for quality.

Samples were to be rejected on the grounds of poor quality for the following reasons:

- Uneven surface indicative of striking the seabed at an angle;
- Washed out sample;
- Disturbed surface sediment;
- Contamination of the sediment (e.g. hagfish, paint chips, oil etc.);
- Sample touching the top of the grab;
- Sample <50 % of the grab’s capacity.

If the sample was not acceptable the vessel was repositioned on the sample location and the grab was redeployed. If after three attempts at a location a successful grab was not collected a new location was chosen close to the original station. If the sample was acceptable a brief description of the sediment was recorded (including appearance, texture, odour, etc.) and a labelled photograph taken.

A sub-sample for PSA was collected from each acceptable grab sample following the NMBAQC's Best Practice Guidance for PSA to support biological analysis (Mason, 2016). The PSA sub-sample was collected using a metal scoop to remove a 5 cm deep core from the grab sample, ensuring that at least 100 ml of sediment was collected. Any conspicuous biota was noted in the logbook and removed from the sub-sample before storing the sediment in labelled plastic bags.

Following sub-sampling for PSA the rest of the grab sample was processed for macrobenthic invertebrate analysis. The sediment in the grab was transferred to a dump tray and washed gently over a 0.5 mm field sieve. The sediment retained in the sieve was photographed before being transferred to a labelled plastic bucket and fixed using a 4 % buffered formaldehyde-seawater solution for subsequent laboratory analysis.

2.2.3 Laboratory methods

2.2.3.1 Particle size analysis

Particle size analysis (PSA) was carried out using wet and dry sieving at one phi intervals. Samples were visually assessed and all marine biota (>1 mm) that was alive at the time of sampling were removed. A brief sediment description was noted in the PSA log, together with details of any biota removed, and any other pertinent sediment characteristics (e.g. presence worm tubes, shell fragments).

The results were analysed to determine the proportions of gravel, sand, and mud within the samples and sediment names were assigned as per the modified Folk classification (1954).

2.2.3.2 Macrobenthic invertebrate analysis

In the laboratory, the macrobenthic invertebrate samples were washed through a 0.5 mm sieve in order to remove the fixative and any mud remaining in the sample. The sample retained on the sieve was then transferred to petri dishes and was sorted by experienced personnel using low magnification microscopes. The picked taxa were split by phyla and stored in glass vials in 80 % industrial methylated spirit (IMS) ready for identification.

Taxa were identified to the lowest practical taxonomic level with reference to WoRMS (WoRMS Editorial Board, 2023) for species nomenclature. Epifauna were identified and recorded when clearly attached to substrate.

Identified taxa were separated by major taxonomic group and preserved in 80 % IMS before being analysed for biomass by major taxonomic group. Taxa were removed from their sample vials and blotted dry to remove excess IMS before being weighed using a calibrated balance accurate to 5 decimal places. A reference collection, consisting of examples of each identified taxon, was also created.

2.2.4 Data analyses

2.2.4.1 Video analysis

The video analysis was conducted using software that enabled slow-motion, freeze frame and standard play analysis. During the first review, video footage was viewed at 2x - 4x normal speed in order to divide the footage into segments of different habitat types; any segments of video showing camera deployment and recovery were discounted from further review. Brief changes in habitat type, considered to be less than 5 m distance, were treated as incidental patches and not recorded as separate segments, however the presence of these habitats was recorded as part of the habitat description. The distance travelled by the camera was estimated based on the navigation data.

The start and end time and position of each segment was recorded, and each segment was then analysed in more detail. For each segment, all observations were recorded in a pro forma spreadsheet. Each video segment was assessed for quality, according to NMBAQC scheme guidelines (Turner *et al*., 2016). A description of the observed habitat and a broadscale habitat (BSH) type was assigned to each video segment, and the presence of any visible impacts or modifiers (e.g., trawl marks, litter, evidence of strong currents etc.) was also recorded.

A list of the encountered taxa was produced for each video segment, using species reference numbers as cited in the Marine Conservation Society Species Directory (Howson and Picton, 1997) with additional reference to the World Register of Marine Species (WoRMS Editorial Board, 2023) to avoid problems in species nomenclature. Taxa were identified to the lowest (i.e. most detailed) practical taxonomic level. Identification of taxa was only attempted where biota was considered to be large and conspicuous enough to be confidently and reliably identified. Where lifeforms could not be identified to a specific taxonomic group a brief description was used (e.g. mixed faunal turf). Sponge morphologies were divided into appropriate pre-defined categories after Berman *et al*. (2013). Where sponge species showed plasticity, separate records were made for each morphology type.

Assignment of biotopes

Following analysis of the video segments, the information recorded was reviewed and used to determine the most appropriate MNCR biotope according to JNCC (2022), following guidance outlined in Turner *et al*. (2016) and Parry (2019). Wherever possible biotopes were assigned at the biotope (level 5) or sub-biotope (level 6) level. However, where biological information was lacking (e.g., barren soft sediments with very little epifauna), biotopes were recorded at the biotope complex level (level 4). Where the seabed comprised a mosaic of more than one substrate type (e.g., <5 m alternating bands of exposed bedrock and coarse sediment) it was considered appropriate to assign more than one biotope to the same video segment. In these cases, the most dominant biotope was assigned as the ‘primary’ biotope and the other assigned as secondary.

Assignment of priority marine features

Following identification of biota and assignment of biotope(s) to each video segment, priority marine features (PMFs), as per Tyler-Walters *et al*. (2016), were assigned. If PMF components were found to be present within a video segment (i.e. if a relevant biotope had been assigned, or if a component species had been identified) the PMF was assigned. If two component biotopes had been assigned to one video segment (see above), two PMFs were assigned.

Where maerl was present, the NatureScot evolving definition was used as a guide to assignment of the PMF ‘maerl beds.’ A substrate consisting of a minimum of 20 % maerl that was clearly identifiable as either twiglets, medallions, or hedgehog stones (>1 cm in size) qualified as a maerl bed, irrespective of whether the rhodoliths were alive or dead. An exception to this is where the substrate underlying the fully formed maerl rhodoliths was comminuted maerl gravel; in this case a 5 % cover of maerl (dead or alive, fully formed rhodoliths > 1 cm) was sufficient to qualify a habitat as maerl bed. It should be noted, however, that areas conforming to this exception are considered to reflect degradation of previously healthy maerl bed habitat, as it can be assumed that fully formed maerl rhodoliths were once much more prolific to have created the maerl gravel substrate.

Assignment of Annex I habitats

The presence of any Annex I habitats and associated sub-features, including reef sub-features, was also recorded for each video segment. Reef features were determined using criteria outlined in Irving (2009), with a minimum of 10 % hard substrate (i.e. bedrock, boulders or cobbles) required for assignment of Annex I habitat. Due to difficulties inherent in estimating elevation from video footage, the assessment of ‘reefiness’ of stony reef habitats (Table 2.3) was primarily based on seabed composition, i.e. percentage coverage of hard substrate.

Table 2.3: The main characterising features of a stony reef, after Irving (2009).

Characteristic	Not a reef	Resemblance to being a stony reef		
		Low	Medium	High
Composition	< 10 %	10 - 40 %	40 - 95 %	> 95 %
Elevation	Flat seabed	< 64 mm	64 mm - 5 m	> 5 m
Extent	< 25 m^2	> 25 m^2		
Biota	Dominated by infaunal species			> 80 % of species epifauna

2.2.4.2 Still image analysis

The still image analysis was undertaken following analysis of the video. Each still image was assessed for quality, according to NMBAQC scheme guidelines (Turner *et al*., 2016), and a brief description of the habitat and characterising biota present in each image recorded. All observations were recorded in a pro forma spreadsheet. A BSH was recorded based on the substrate type present.

Epibiota were identified, with taxa recorded to the best practical taxonomic level. A list of the encountered taxa was produced for each image, using species reference numbers as cited in the Marine Conservation Society Species Directory (Howson and Picton, 1997) with additional reference to the World Register of Marine Species (WoRMS Editorial Board, 2023) to avoid problems in species nomenclature. For each image, all biota was identified and enumerated.

Taxon abundance data was recorded using the semi-quantitative SACFOR scale, with counts or percentage cover recorded where appropriate. The most appropriate MNCR biotope (JNCC, 2022) was assigned to each still image with reference to the parent video segment, following guidance outlined in Turner *et al*. (2016) and Parry (2019).

2.2.4.3 GIS

Data obtained during the drop-down camera and grab survey were imported into ArcGIS. These included all GPS video trackplots and relevant target (‘fix’) locations. These data were presented as annotated maps identifying the locations of the biotopes and benthic community types identified during the study.

3 RESULTS

3.1 Intertidal survey

Representative field photographs documenting the zonation at each of the transects are provided in Appendix III and the logs detailing the results of the Phase I survey are provided in Appendix IV. Full species lists for each habitat zone at each transect are provided in Appendix V, and a glossary of the biotopes assigned is provided in Appendix VI. Note that in the descriptive text below, the abundance (according to SACFOR), is provided in parentheses following the taxon name and refers to the abundance within the respective habitat zone.

3.1.1 Scapa Transect 1 (SB_1; Plates 1a – 1d)

Transect 1 was located approximately 160 m south of the mouth of the Burn of Deepdale (see Figure 2.1). The central transect line extended 27 m from the upper shore cliff to the low water mark on the day of the survey (low water was 1.33 m above CD).

The upper littoral zone was backed by a steeply sloping cliff of 7 – 8 m in height (see Appendix III). The upper half of the cliff face was colonised by a turf of coarse terrestrial grass species. The exposed rock of the cliff face at the northern edge of the transect was characterised by sporadic lichen growth, including *Orchrollechia parella*, *Caloplaca* sp. and *Ramalina siliquosa* (sea ivory). Adjacent to the centre line of the transect was a small freshwater seep that emanated from the pasture fields above the shore. The seep was characterised by the occurrence of an unidentified moss species and brown algal biofilm. Below the cliffs, five habitat zones were identified. The distribution of the biotopes identified at Transect 1 are shown in Figure 3.1.

SB_1 Zone 1. The upper foreshore adjacent to the cliff was composed of barren shingle (**LS.LCS.Sh.BarSh**; 'Barren littoral shingle') which extended approximately 8 m from the cliff base. Within the barren shingle zone were aggregations of overlying phytodetritus (**LS.LSa.St**; 'Strandline') primarily comprising detached kelp and fucoid fronds. No invertebrate taxa were recorded in this zone.

SB_1 Zone 2. The substrate in Zone 2 was more coarse than that present in Zone 1, with cobbles overlying the shingle. Beneath the cobbles, low densities of gammarid amphipods (occasional) were recorded. Sparse individuals of the small periwinkle *Melarhaphe neritoides* (rare) were also observed on the cobble surfaces. However, as no other taxa were recorded, this zone was also assigned the biotope **LS.LCS.Sh.BarSh**.

SB_1 Zone 3. Zone 3 consisted of a series of slightly raised bedrock 'fingers' which zig-zagged along the shore approximately parallel with the cliffs. As a result, this zone was somewhat variable in width, ranging from approximately 1 – 4 m. The rock was covered with dense *Fucus spiralis* (abundant) together with much lower densities of *Pelvetia canaliculata* (rare). Beneath the canopy, patches of red encrusting algae were present (rare to occasional) on the rock surface. Faunal taxa were also present amongst the *F. spiralis* and in rock cervices, including the periwinkles *Littorina littorea* (common), *L. saxatilis* (frequent) and *L. obtusata* (occasional), the common limpet *Patella vulgata* (common) and the beadlet anemone *Actinia equina* (frequent). Due to the dominance of *F. spiralis*, the biotope **LR.LLR.F.Fspi.FS** ('*Fucus spiralis* on full salinity sheltered upper eulittoral rock') was assigned to this zone.

SB_1 Zone 4. Zone 4 was characterised by dense *Fucus vesiculosus* (super-abundant) on uneven bedrock with *Osmundea pinnatifida* (super-abundant). In addition, low quantities of *Corallina officinalis* (rare) and *Fucus serratus* (rare) were present in crevices. Fauna present in this zone included *P. vulgata* (common), *L. obtusata* (common), *A. equina* (frequent), *L. littorea* (rare), the dogwhelk *Nucella lapillus* (occasional) and *Steromphala umbilicalis* (present). Despite the prevalence of *O. pinnatifida*, the very high abundance of *F. vesiculosus* meant that the biotope **LR.LLR.F.Fves.FS** (‘*Fucus vesiculosus* on full salinity moderately exposed to sheltered mid eulittoral rock’) was assigned to this habitat.

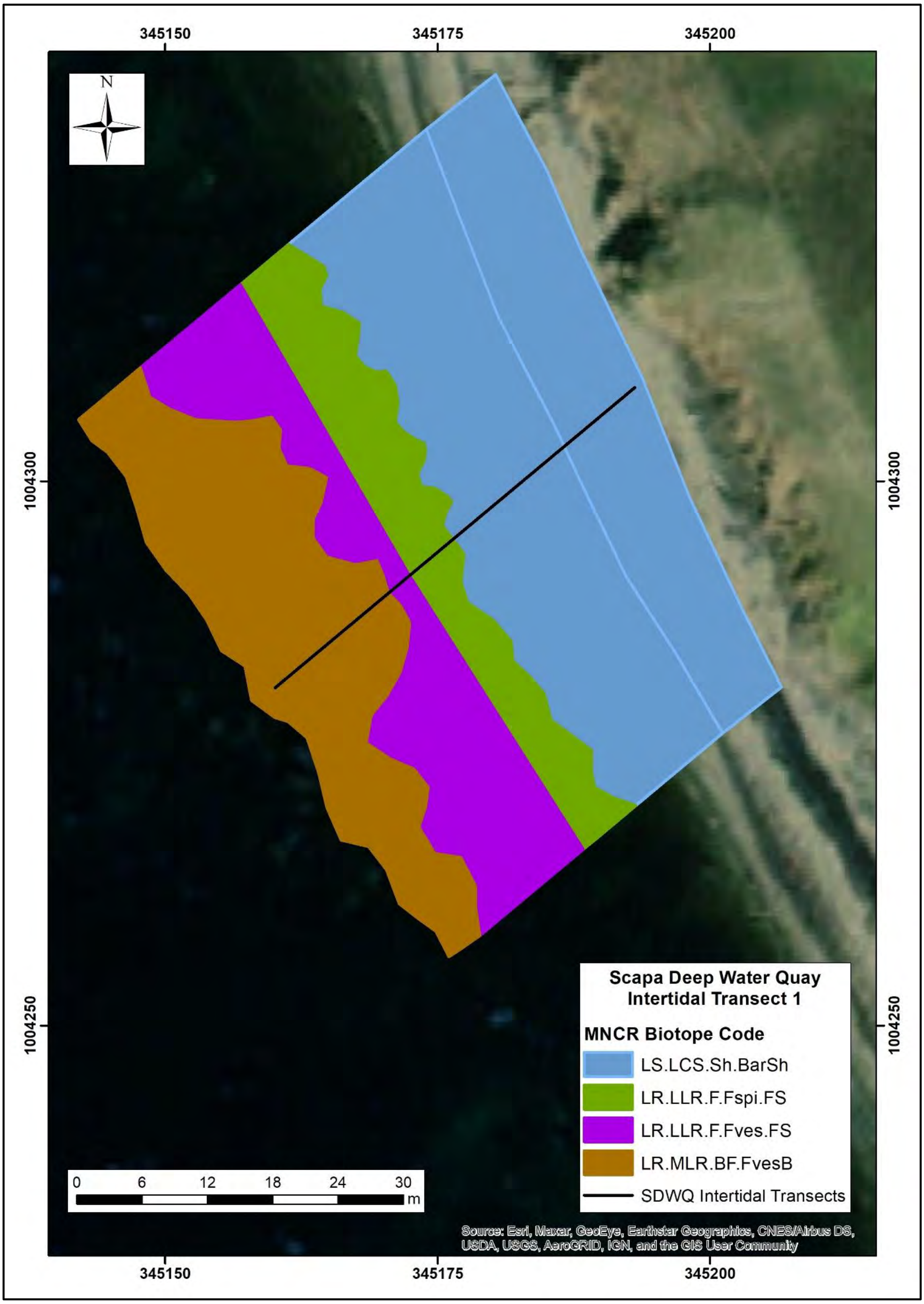
Zone 4 was variable in width, ranging from approximately 1 m in the centre of the transect to approximately 12 m at the north and south edges of the transect. This habitat also extended down the shore into Zone 5 where it occurred around the raised bedrock ridges.

SB_1 Zone 5. Zone 5 comprised a series of bedrock ridges and gullies on the lower shore. The ridges ran perpendicular to the coastline and rose to approximately 2 – 3 m above the gully bases. The zone was approximately 12 m wide at the centre of the transect and, at the time of survey, could be seen to extend for up to a further 10 m below the water line.

The biological communities present in this zone were variable, with vertical zonation apparent on the individual bedrock ridges and gullies. On the tops of the ridges, egg wrack, *Ascophyllum nodosum*, (rare) was dominant. Below this, and covering the majority of the rock, was the same biological community observed in zone 4, with dense *F. vesiculosus* (abundant) and *O. pinnatifida* (common) present together with *P. vulgata* (abundant) and the barnacle *Semibalanus balanoides* (frequent). Other faunal taxa recorded in this zone included *N. lapillus* (common), *L. obtusata* (common), *L. littorea* (rare), *S. umbilicalis* (rare) and *A. equina* (occasional). In the gullies, *F. serratus* (abundant) was the dominant taxa, with encrusting red algae (rare to occasional) present on the rock beneath.

The abundances of the taxa *F. vesiculosus, O. pinnatifida* and *S. balanoides* recorded are highly indicative of the biotope **LR.MLR.BF.FvesB** (‘*Fucus vesiculosus* and barnacle mosaics on moderately exposed mid eulittoral rock’). While this community was the dominant one within zone 5 and was therefore assigned to the observed habitat, the presence of *F. serratus* in gullies may suggest that this zone could be best described as a mosaic habitat together with **LR.LLR.F.Fserr.FS** (‘*Fucus serratus* on full salinity sheltered lower eulittoral rock’).

Below zone 5, below the water, kelp (*Laminaria* sp. indet.) was observed, likely indicating the presence of an infralittoral kelp biotope.



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Figure 3.1: Distribution of MNCR biotopes (JNCC, 2022) at Transect 1 (SB_1), surveyed as part of the 2022 Scapa Deep Water Quay Phase I intertidal survey.

3.1.2 Scapa Transect 2 (SB_2; Plates 2a – 2d)

Transect 2 was located approximately 470 m south of the Burn of Deepdale. The upper shore was backed by a steeply sloping cliff approximately 8 m in height. The top of the cliff supported a thin soil strata and coarse terrestrial grasses. Occasional clumps of grasses occurred in the crevices of the main rock face (see Appendix III). The rock surface supported the lichens *Hydropunctaria maura* (previously *Verrucaria maura*), *O. parella*, *Caloplaca* sp. and *R. siliquosa*. Freshwater was observed percolating from the soil at the top of the cliff causing an area of cliff rock at the centre of the transect to support a brown algal biofilm.

Below the cliff, six habitat zones were identified. The distribution of the biotopes identified at Transect 2 is shown in Figure 3.2.

SB_2 Zone 1. The upper shore directly under the cliff was characterised by barren shingle and cobbles with outcrops of bedrock. This habitat was variable in width and extended up to 4 m from the base of the cliff. The bedrock and more stable cobbles supported the black lichen *H. maura* (common), with *O. parella* (occasional) and *Caloplaca* sp. (occasional) occurring in lower abundances. The biotope **LR.FLR.Lic.Ver.Ver** (‘*Verrucaria maura* on very exposed to very sheltered upper littoral fringe rock’) was therefore assigned to this zone.

In addition to the lichens, a range of fauna was present in this zone. On the rock surface, *L. saxatilis* (occasional), *L. littorea* (rare) and *P. vulgata* (rare) were all observed, while underneath the less stable cobbles highly abundant talitrid amphipods (abundant) and the sea slater *Ligia oceanica* (frequent) were also recorded.

SB_2 Zone 2. The substrate in Zone 2 was similar to that present in Zone 1, and comprised a mixture of shingle, cobbles and exposed bedrock with occasional boulders. The rock was characterised by a 6 m wide band of dense *P. canaliculata* (super-abundant) and *F. spiralis* (abundant). The fauna was dominated by the winkles *L. saxatilis* (abundant) and *M. neritoides* (common), with *L. littorea* (occasional) and *P. vulgata* (rare) also present. Gammarid amphipods (occasional) were also recorded under cobbles and in patches of standing water.

Due to the high abundance of the characterising species *P. canaliculata*, the biotope **LR.LLR.F.Pel** (‘*Pelvetia canaliculata* on sheltered littoral fringe rock’) was assigned to this zone.

SB_2 Zone 3. Zone 3 was similar to Zone 2 in terms of substrate, however here the dominant seaweed was *F. spiralis* (abundant), with lower quantities of *P. canaliculata* (occasional) and *A. nodosum* (common) also present. Other algal taxa recorded in this zone included *Cladophora* sp. (occasional), red filamentous algae (rare), red calcareous encrusting algae (rare) and fucoid sporlings (rare). In the rock crevices and underneath the seaweeds fauna was relatively abundant and included *L. saxatilis* (abundant), *L. littorea* (common), *P. vulgata* (frequent), *A. equina* (frequent) and *N. lapillus* (rare), with gammarid shrimp (occasional) observed on the undersides of cobbles.

Due to the high abundance of the characterising species *F. spiralis*, and the relatively low abundance of both *P. canaliculata* and *A. nodosum*, the biotope **LR.LLR.F.Fspi.FS** was assigned to this zone.

SB_2 Zone 4. In the mid-shore, the substrate consisted of boulders and cobbles with gravel and sand infill. In the upper 7 m of this habitat the biological community was dominated by *F. vesiculosus* (common) with *A. nodosum* (occasional) also present, particularly in the upper parts of this zone. Faunal taxa recorded in this zone included *L. littorea* (common), *L. saxatilis* (frequent), *L. obtusata* (rare), *N. lapillus* (frequent) and *P. vulgata* (occasional), with gammarid amphipods (occasional) also observed under cobbles.

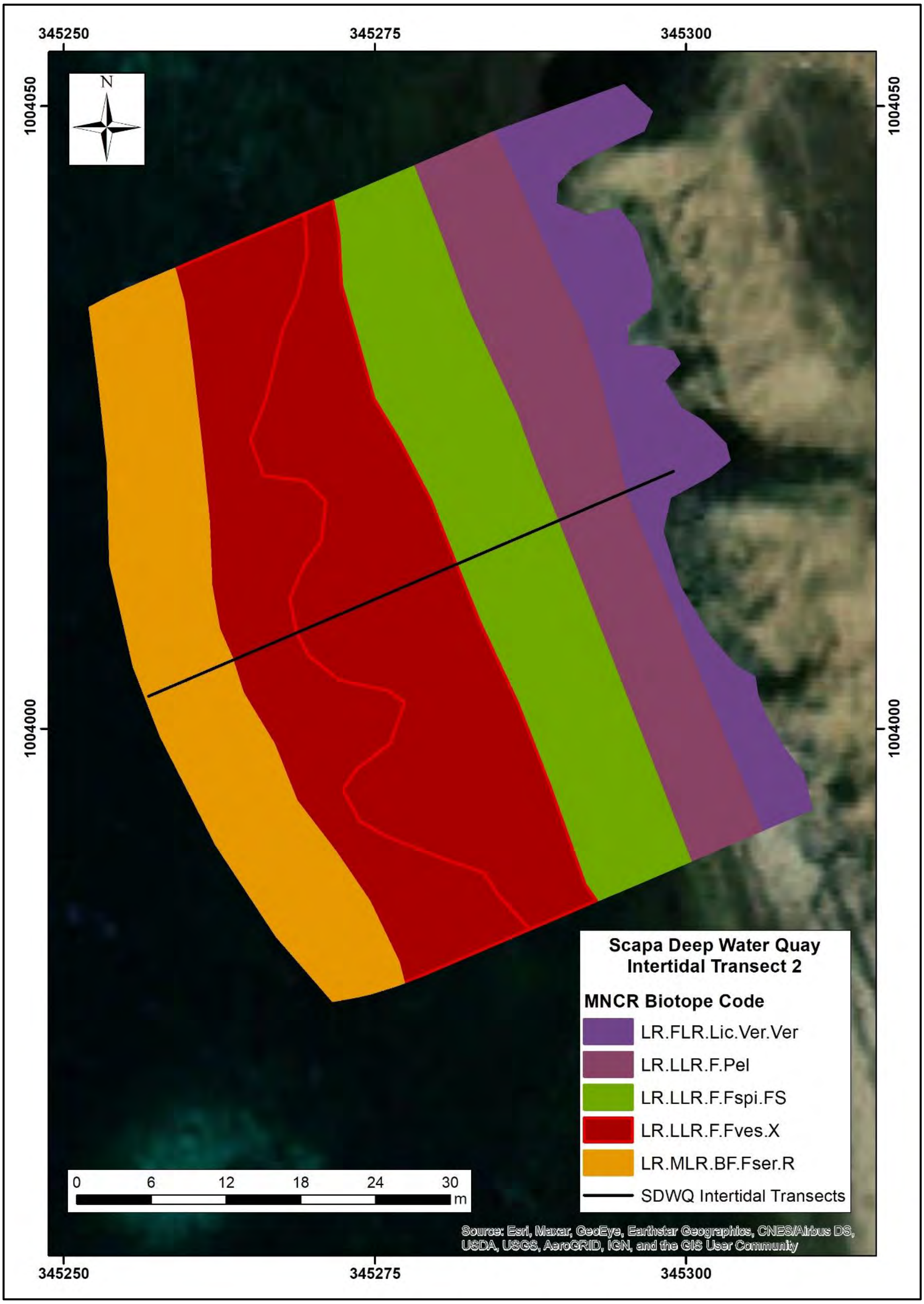
Due to the dominance of *F. vesiculosus*, the biotope **LR.LLR.F.Fves.X** ('*Fucus vesiculosus* on mid eulittoral mixed substrata') was assigned to this zone.

SB_2 Zone 5. Zone 5 was very similar to Zone 4, however much higher densities of the characterising seaweeds *F. vesiculosus* (super-abundant) and *A. nodosum* (abundant) were recorded. While the change in abundance of the characterising species necessitated classification of a separate habitat zone, the same biotope recorded for Zone 4 (**LR.LLR.F.Fves.X**) was also assigned here. In addition to *F. vesiculosus* and *A. nodosum*, *F. serratus* (occasional) and filamentous red seaweeds (occasional) were present as small patches. On the rock beneath the algal canopy, calcareous red algal crusts (frequent) were present together with relatively dense faunal taxa including *P. vulgata* (abundant), *L. littorea* (abundant), *N. lapillus* (common), *A. equina* (frequent), *S. umbilicalis* (rare), hermit crabs (occasional) and the shore crab *Carcinus maenas* (rare). Encrusting taxa including spirorbid worms (occasional), *S. balanoides* (rare) and *H. maura* (frequent) were also recorded in this zone.

SB_2 Zone 6. The parts of the low shore that were observable during the survey were primarily composed of bedrock protrusions with occasional cobbles and sand infill. The bedrock was uneven, forming ~0.3 m high ridges with gullies in between. The ridges were characterised by a mixture of *F. serratus* (abundant) and *F. vesiculosus* (common), while the lower rock surfaces, gullies and crevices were dominated by a mixture of *O. pinnatifida* (super-abundant) and *F. serratus*. Red seaweeds including *C. officinalis* (occasional) and *Chondrus crispus* (occasional) were also present in the gullies, with calcareous red algal crusts (frequent) also recorded. Fauna present in this zone included *P. vulgata* (common), *L. littorea* (common) and *N. lapillus* (frequent), *L. obtusata* (rare) and the topshells *S. umbilicalis* (rare) and *S. cineraria* (rare).

Due to the prevalence of *F. serratus* in this zone, together with the presence of various red seaweeds, the biotope **LR.MLR.BF.Fser.R** ('*Fucus serratus* and red seaweeds on moderately exposed lower eulittoral rock') was assigned to this zone.

As at Transect 1, kelp (*Laminaria* sp. indet.) was observed in the surf zone below low water, indicating the presence of an infralittoral kelp biotope in the shallow subtidal.



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Figure 3.2: Distribution of MNCR biotopes (JNCC, 2022) at Transect 2 (SB_2), surveyed as part of the 2022 Scapa Deep Water Quay Phase I intertidal survey.

3.1.3 Scapa Transect 3 (SB_3; Plates 3a – 3d)

Transect 2 was located approximately 650 m south of the Burn of Deepdale, immediately north of a rocky outcrop/headland known as the Tongue of Gangsta. The cliff that separated the upper intertidal zone from the adjacent field was not as sheer as at Transects 1 and 2 and was largely covered with terrestrial plants and grasses with only a few sections of exposed rock (see Appendix III). Below the cliff the shore was divided into six distinct habitat zones running parallel to the coastline. The distribution of biotopes at this transect is shown in Figure 3.3.

SB_3 Zone 1. Adjacent to the cliff was a 4 m band of gravel, pebbles and cobbles with some small patches (<0.25 m^2) of exposed bedrock. No taxa were recorded; the biotope **LS.LCS.Sh.BarSh** was therefore assigned to this zone.

SB_3 Zone 2. Below Zone 1 was a 9 m band of cobbles and boulders overlying gravel. The only macroalgae recorded was *P. canaliculata* (rare), however low numbers of *L. saxatilis* (occasional) were present on the more stable cobbles together with a thin and patchy green biofilm (common). Beneath the larger cobbles and boulders were high numbers of talitrid (abundant) and gammarid (frequent) amphipods.

Given the abundance of talitrids, the biotope **LS.LSa.St.Tal** ('Talitrids on the upper shore and strand-line') was assigned to this habitat. Whilst this zone did not possess the accumulations of decomposing seaweed detritus that are usually associated with this biotope, the occurrence of talitrids in large numbers indicated that such material does occur in this location, but may be transient and dependent on the sea conditions.

SB_3 Zone 3. The mid-shore substrate at Transect 3 was primarily composed of cobbles and small boulders with gravel and pebble infill and patches of exposed bedrock. The upper 5 m of this habitat was characterised by *F. spiralis* (abundant) and *A. nodosum* (occasional), with small dense patches of *P. canaliculata* (abundant) also present, particularly at the upper edge of the zone in the southern half of the transect. However, due to the patchy nature of the *P. canaliculata* present, these areas were not considered sufficient to justify the inclusion of a separate habitat zone or biotope allocation. Zone 3 was therefore classified as **LR.LLR.F.Fspi.X** ('*Fucus spiralis* on full salinity upper eulittoral mixed substrata').

A range of faunal taxa were recorded in this zone, including *M. neritoides* (abundant), *L. saxatilis* (common), *L. littorea* (rare), *P. vulgata* (occasional), *C. maenas* (occasional), *A. equina* (rare) and *S. balanoides* (rare). In addition, gammarid amphipods (frequent) were observed beneath cobbles. It was noted that faunal abundance and diversity in this zone was greater on the undersides of cobbles and boulders, particularly adjacent to standing water. The zone may therefore constitute an "underboulder-like" habitat.

SB_3 Zone 4. Below Zone 3 was a 7 m wide band dominated by *A. nodosum* (super-abundant) and *F. vesiculosus* (common). Beneath the macroalgae, fauna present included *P. vulgata* (abundant), *A. equina* (frequent) and the periwinkles *L. littorea* (common), *L. obtusata* (occasional), *L. saxatilis* (occasional) and *M. neritoides* (occasional). Beneath the cobbles and boulders gammarid amphipods (occasional) and *C. maenas* (occasional) were recorded in low numbers.

Due to the overall dominance of *A. nodosum*, the biotope **LR.LLR.F.Asc.X** ('*Ascophyllum nodosum* on full salinity mid eulittoral mixed substrata') was assigned to this zone.

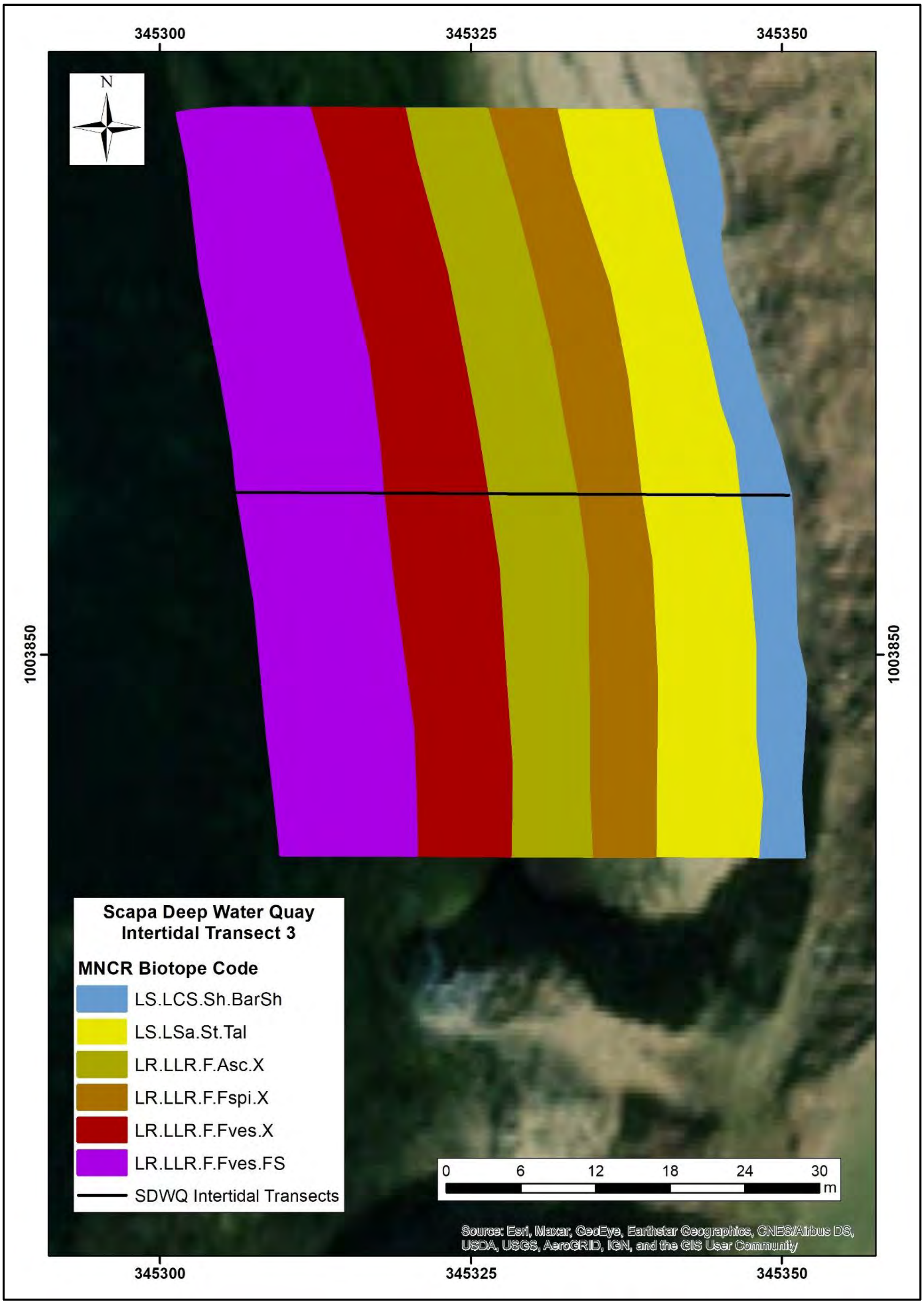
SB_3 Zone 5. Below Zone 4, and continuing on the same substrate type as the previous zone, was a 7 m wide band characterised by *F. vesiculosus* (abundant) with *O. pinnatifida* (frequent) occurring beneath the wrack canopy and between boulders. Other, less abundant algal taxa recorded in this zone included *Mastocarpus stellatus* (occasional), which occurred in standing water between the boulders.

Faunal taxa recorded in this zone were broadly similar to those occurring in previous zones and included *L. littorea* (abundant), *L. obtusata* (occasional), *L. saxatilis* (occasional), *P. vulgata* (common), *N. lapillus* (frequent), *A. equina* (occasional) and very low numbers of barnacles (present). Under the cobbles and boulders gammarid amphipods (common) and *C. maenas* (frequent) were also often observed.

Due to the presence of dense *F. vesiculosus* together with low quantities of red seaweeds, the biotope **LR.LLR.F.Fves.X** was assigned to this habitat.

SB_3 Zone 6. In contrast to the mid shore zones, the lower 10 m of exposed shore at Transect 3 was composed of bedrock and large boulders. However, the biological community present was similar to that observed in Zone 5, with *F. vesiculosus* (abundant) and *O. pinnatifida* (common) dominating the rock surface with low quantities of *F. serratus* (occasional) and *C. crispus* (rare) also present. Very high numbers of *L. littorea* (super-abundant) were present on the rock surface, together with *P. vulgata* (common), *N. lapillus* (frequent), *A. equina* (frequent).

While the community present was very similar to the preceding zone, due to the change in substrate type this zone was assigned the biotope **LR.LLR.F.Fves.FS**.



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Figure 3.3: Distribution of MNCR biotopes (JNCC, 2022) at Transect 3 (SB_3), surveyed as part of the 2022 Scapa Deep Water Quay Phase I intertidal survey.

3.1.4 Scapa Transect 4 (SB_4; Plates 4a – 4d)

Transect 4 was located on the Tongue of Gangsta, approximately 740 m south of the mouth of the Burn of Deepdale. The shore at this location was separated from the adjacent fields by a high (7 – 8 m), uneven, steep bedrock embankment (~45° slope) (see Appendix III). The upper levels of the embankment had a thin soil layer and terrestrial grass cover, while the lower rocks supported a range of lichens including *H. maura* (common), *O. parella* (occasional), *R. siliquosa* (frequent) and *Caloplaca* sp. (frequent). At the very base of the rocky embankment, a few fucoid sporelings were observed, however, as no mature specimens were recorded, it is unlikely that these represented a viable population. Below the embankment, four habitat zones were identified. The distribution of the biotopes identified at Transect 4 is shown in Figure 3.4.

SB_4 Zone 1. At the base of the bedrock embankment the shore comprised cobbles overlying gravel. This material infilled the crevices between the protrusions of rock strata (see Appendix III) and extended up to 4 m from the embankment base.

The lichen *H. maura* (occasional) was present as small patches while algae was restricted to small patches of *P. canaliculata* (rare). Despite the lack of algal growth, the cobbles supported a range of molluscan taxa including *L. saxatilis* (common), *L. littorea* (occasional), *M. neritoides* (frequent) and *P. vulgata* (rare). In addition, *C. maenas* (rare) was also observed in low numbers on the undersides of cobbles.

Due to the paucity of characterising taxa; this zone was recorded as the biotope **LS.LCS.Sh.BarSh**.

SB_4 Zone 2. Zone 2 consisted of a 7 m band of boulders and cobbles overlying bedrock, with pebble and gravel infill. A mixture of *F. spiralis* (common) and *F. vesiculosus* (common) was present throughout the zone. Other seaweed species present included small quantities of *P. canaliculata* (rare) and *Cladophora* sp. (rare).

Faunal taxa present in this zone included *P. vulgata* (common), *L. littorea* (frequent), *A. equina* (frequent), *N. lapillus* (occasional) and *S. balanoides* (rare). In addition, high numbers of gammarid shrimps (common) and a single *C. maenas* (rare) were observed underneath boulders.

No biotope was found to be a good fit for the communities observed. If *F. spiralis* or *F. vesiculosus* had been dominant, it is probable that either **LR.LLR.F.Fspi** or **LR.LLR.F.Fves** would have been assigned. However, due to the mix of fucoid species present, the biotope complex **LR.LLR.F** (‘Fucoids on sheltered marine shores’) was assigned to this zone.

SB_4 Zone 3. Below the somewhat mixed Zone 2 was a 6 m band of bedrock with overlying boulders dominated by *F. vesiculosus* (abundant) with *O. pinnatifida* (abundant) present in the areas between the boulders and in rock crevices. In addition, *C. officinalis* (frequent) and calcareous red algal crusts (frequent) were also conspicuous in this zone. Fauna recorded included *P. vulgata* (common), *N. lapillus* (common), *A. equina* (frequent) and low numbers of *Littorina* spp. (rare).

Due to dominance of *F. vesiculosus*, the biotope **LR.LLR.F.Fves.FS** was assigned to this zone.

SB_4 Zone 4. In the low shore, the beach was composed of exposed bedrock with occasional boulders. The rock was characterised by dense *F. serratus* (abundant) and red seaweeds including *O. pinnatifida* (common), *C. officinalis* (frequent) and *C. crispus* (occasional). The range of faunal taxa recorded was very similar to that observed in Zone 3, however most taxa were more abundant than previously. Taxa recorded included *P. vulgata* (abundant), *A. equina* (common), *N. lapillus* (common) and *L. littorea* (occasional).

Zone 4 extended 7 m to the low water mark on the day of survey, however the same habitat could be seen to extend a further ~10 m into the surf zone and would likely be exposed on a spring tide. The width of the Zone 4 was therefore recorded as 17 m.

Due to the prevalence of *F. serratus*, combined with the presence and abundance of a variety of red macroalgal taxa, the biotope **LR.MLR.BF.Fser.R** was assigned to this zone.

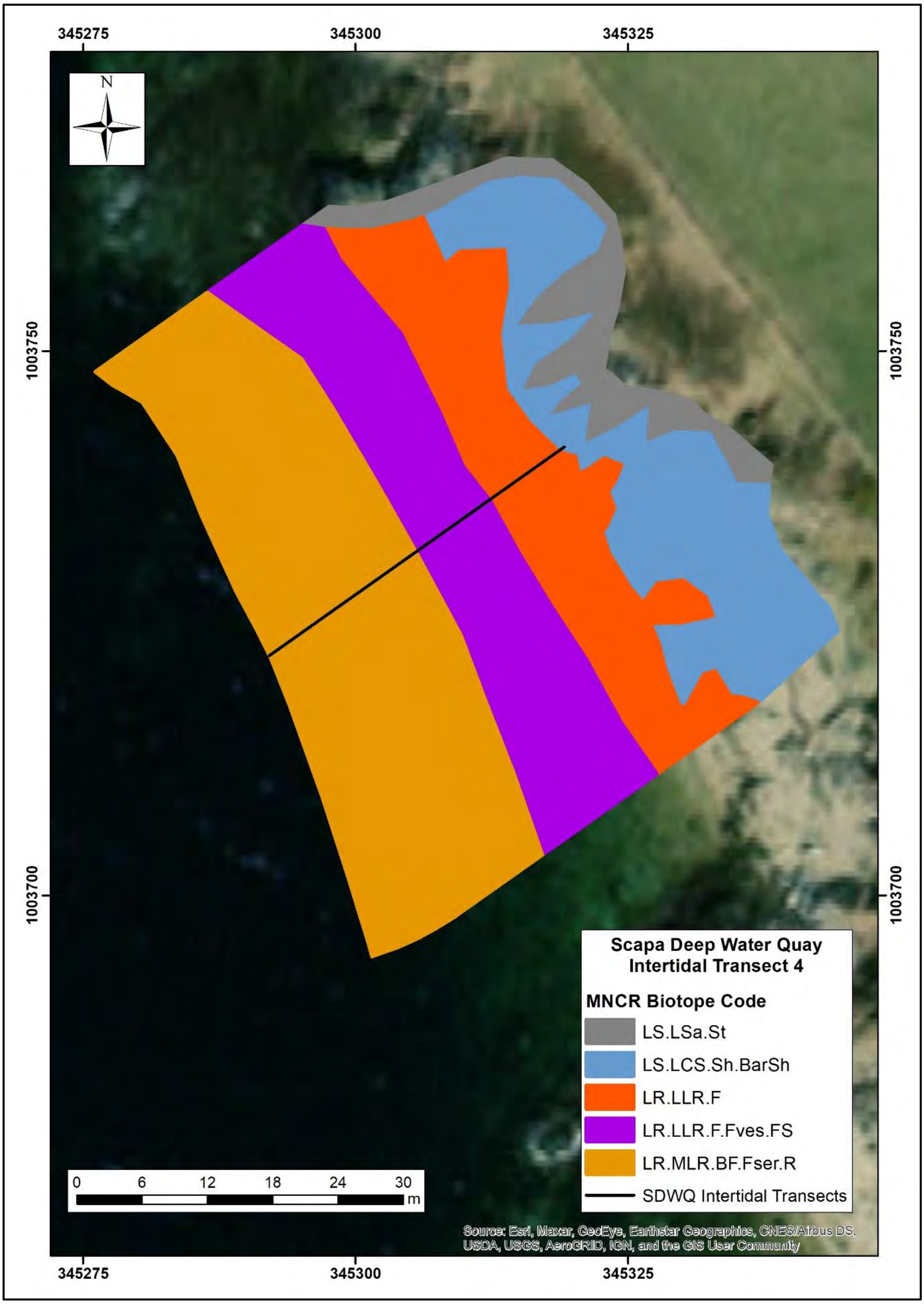


Figure 3.4: Distribution of MNCR biotopes (JNCC, 2022) at Transect 4 (SB_4), surveyed as part of the 2022 Scapa Deep Water Quay Phase I intertidal survey.

3.1.5 Additional observations

Between Transects 1 and 2, multiple small freshwater streams, apparently natural in origin, were observed flowing over the cliffs. These presumably comprised primarily surface run-off but may have had a groundwater component. The freshwater input did not appear to have a widespread effect on the intertidal communities. The only visible effect was an increase in the abundance and density of green epilithic algae, comprising *Ulva* spp. and filamentous algae, in the immediate vicinity of the stream path at the mid and upper foreshore. This conformed to the littoral rock feature **LR.FLR.Eph.Ulv** ('*Ulva* spp. on freshwater-influenced and/or unstable upper eulittoral rock').

3.2 Underwater imagery analysis

The 15 target sites selected for investigation were surveyed using a total of 8 camera deployments. A total of 192 still images were taken, with 176 of these deemed suitable for analysis. A summary of the logs for each camera deployment are provided in Appendix VII.

The survey area was found to be characterised primarily by soft sediment habitats, although areas of hard substrate, consisting variously of bedrock, boulders and cobbles, were also recorded. A total of seven different biotopes, biotope complexes and habitat complexes were identified. A summary of the habitats observed is given in Appendix VIII and the distribution of biotopes assigned to the video records is shown in Figure 3.5 (see Appendix VI for the biotope glossary).

The vast majority of the survey area was found to comprise sandy mixed sediments with a significant shell and/or gravel fraction. Where epibiota was sparse, the biotope complex **SS.SMx.IMx** ('Infralittoral mixed sediment') was assigned to imagery records. However, the mixed sediments were often overlain with loose-lying mats of red seaweed (likely *Phyllophora crispa*). The abundance of these mats was somewhat variable, ranging from very patchy (occasional to frequent) to very dense (abundant to super-abundant). Where the abundance of the seaweed was estimated at greater than 5 % (i.e. frequent or higher) the biotope **SS.SMp.KSwSS.Pcri** ('Loose-lying mats of *Phyllophora crispa* on infralittoral muddy sediment') was assigned. This biotope was found to be present on seven of the eight transects surveyed, being absent only from transect SBC5, located in the northern section of the consent boundary. On transect SBC2 the mats of red seaweed were present together with the kelp *Saccharina latissima*; this area was therefore assigned the biotope **SS.SMp.KSwSS.SlatR** ('*Saccharina latissima* and red seaweeds on infralittoral sediments'). Both of the SS.SMp.KSwSS biotopes identified are listed as components of the PMF 'kelp and seaweed communities on sublittoral sediment.' This PMF was therefore assigned to all associated imagery records.

Areas of hard substrate comprising a mixture of bedrock, boulders and cobbles were observed on a total of three transects (SBC1, SBC4 and SBC5), all located in the inshore of the survey area, within the consent boundary. Both rocky reef, present as 'stepped' bedrock, and stony reef, comprising cobbles and boulders overlying coarse sediment, were observed on all three transects. The observed hard substrate was generally heavily sediment-influenced, being present adjacent to coarse sands and gravels, and exhibited signs of scour. In addition, the hard substrate generally had the appearance of being heavily grazed, with the most conspicuous biota present being calcareous red algal crusts (corallinaceae) and the urchin *Echinus esculentus*. Where the biota was particularly sparse, the habitat complex **IR.LIR**

(‘Low energy infralittoral rock’) was assigned (often together with **SS.SCS.ICS**, ‘Infralittoral coarse sediment’). There were however some areas of hard substrate where sparse kelps were recorded. On transect SBC4 (S7), *S. latissima* was observed on an area of stepped bedrock, with the biotope **IR.LIR.K.Slat.Gz** (‘Grazed *Saccharina latissima* with *Echinus*, brittlestars and coralline crusts on sheltered infralittoral rock’) therefore assigned. On transect SBC5 (S3) an area of mixed kelps was observed and the biotope **IR.LIR.K.LhypSlat.Gz** (‘Grazed, mixed *Laminaria hyperborea* and *Saccharina latissima* on sheltered infralittoral rock’) was recorded. It should be noted, however, that this biotope was only tentatively assigned due to difficulties encountered in identifying the kelps present to species level. In both cases, due to the low abundance of the characterising taxa present, the communities observed likely represented an extremely impoverished version of the biotopes assigned.

Maerl was recorded on a total of four transects (SBC1, 2, 4 and 5), all in the inshore section of the survey area (i.e. inshore of the westward consent boundary). All observations were of so-called ‘hedgehog stones,’ maerl growing as a series of ‘spikes’ over hard substrate such as pebbles and cobbles. No free-living maerl or maerl gravel was observed. In all cases, the quantity of maerl present was very low, ranging from <1 % cover to a maximum of 2 % cover. The PMF ‘maerl beds’ was therefore not assigned to any video segment.

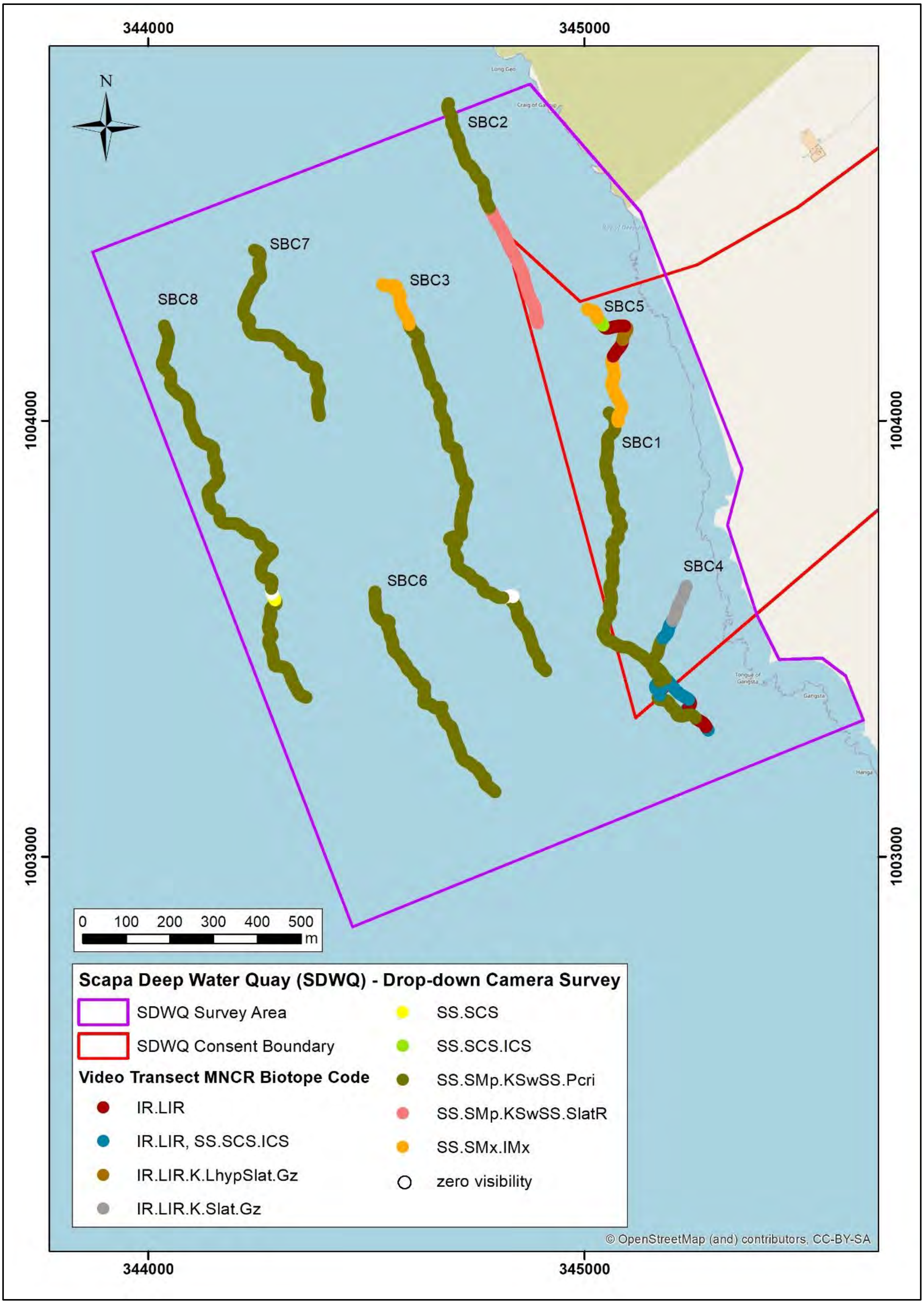


Figure 3.5: MNCR biotopes (JNCC, 2022) assigned to video segments following analysis of underwater imagery collected as part of the 2022 Scapa Deep Water Quay broadscale habitat mapping survey.

3.3 Benthic grab sample analyses

Eight grab samples were successfully collected from the survey area. The survey logs are provided in Appendix IX.

3.3.1 Sediment particle size analysis

A summary of the results of the PSA is given in Table 3.1. Full results are provided in Appendix X. The distribution of sediment types identified is shown in Figure 3.6.

Table 3.1: Summary of the particle size analysis results of grab samples collected as part of the 2022 Scapa Deep Water Quay broadscale habitat mapping survey.

Sample no.	Grab no.	Gravel	Sand	Mud	Classification	Abbreviation
568#09	SBG1	3.45	74.17	22.35	Slightly gravelly muddy sand	(g)mS
568#10	SBG2	9.08	71.23	19.71	Gravelly muddy sand	gmS
568#11	SBG3	6.42	72.03	21.50	Gravelly muddy sand	gmS
568#12	SBG4	0.33	86.78	12.89	Muddy sand	mS
568#13	SBG5	3.90	72.69	23.39	Slightly gravelly muddy sand	(g)mS
568#14	SBG6	19.43	57.94	22.68	Gravelly muddy sand	gmS
568#15	SBG7	9.94	71.50	18.51	Gravelly muddy sand	gmS
568#16	SBG8	9.36	74.79	15.90	Gravelly muddy sand	gmS

The soft sediments across the survey area was found to be fairly homogeneous, with seven of the eight samples found to be composed of mixed gravelly muddy sands. The final sample (SBG4), located in the approximate centre of the survey area, was less coarse, however, with a gravel fraction of < 1 %, and was therefore classified as muddy sand. Despite this, the fraction of mud present in the samples was fairly consistent throughout the survey area (13 – 23 %).

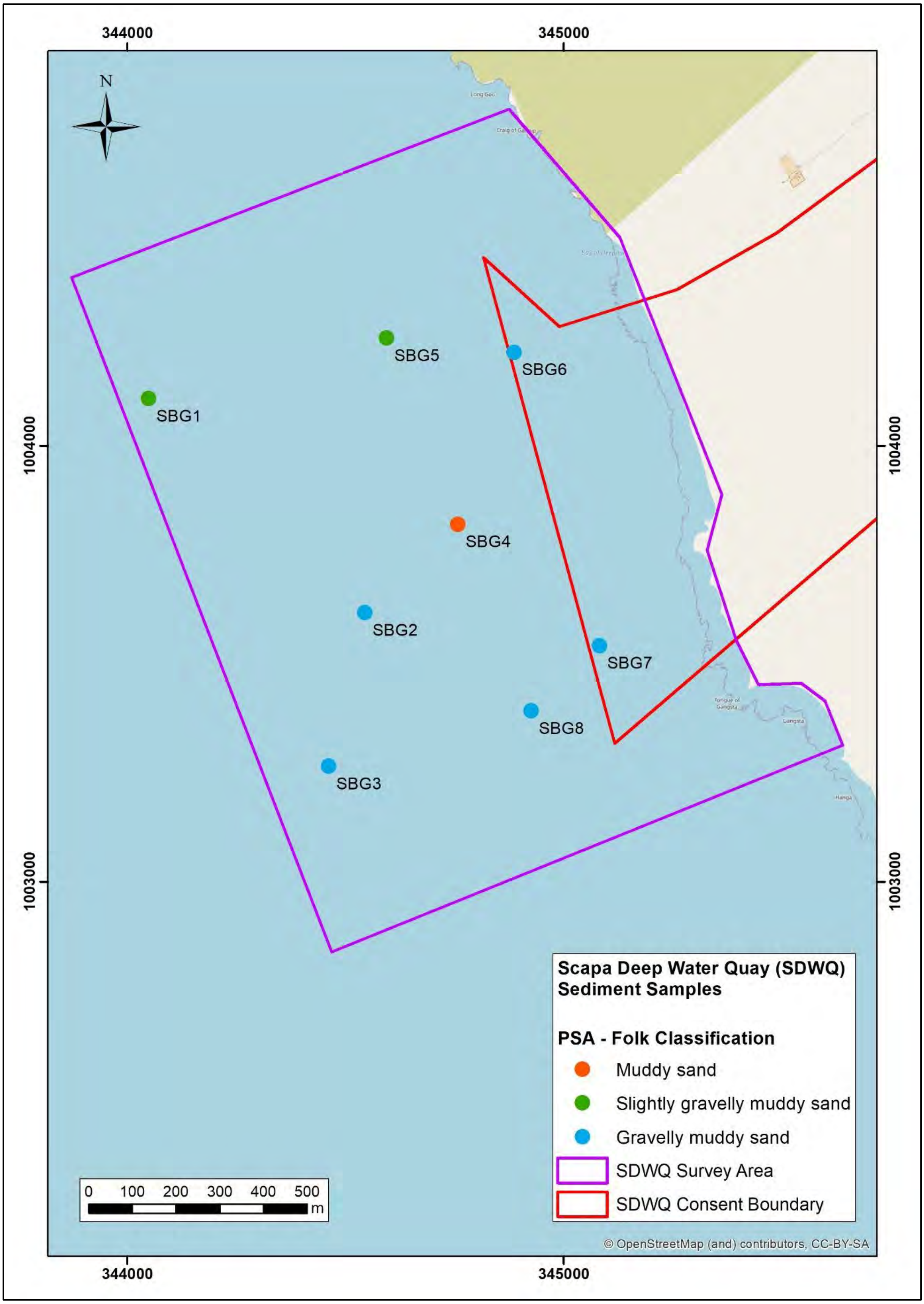


Figure 3.6: Sediment types assigned following particle size analysis of grab samples collected as part of the 2022 Scapa Deep Water Quay broadscale habitat mapping survey.

3.3.2 Macrobenthic invertebrate analysis

The macrofaunal analysis identified a total of 5172 individuals and 214 taxa (excluding unquantifiable meiofauna and epifauna). The full results of the macrobenthic invertebrate analysis are provided in Appendix XI. The total numbers of individuals (N) and taxa (S) for each sample are given in Table 3.2.

Table 3.2: Summary of the total numbers of individuals (N) and taxa (S) identified in grab samples collected as part of the 2022 Scapa Deep Water Quay broadscale habitat mapping survey.

Grab no.	Target no.	N	S
SBG1	SB_C15	396	101
SBG2	SB_C10	640	92
SBG3	SB_C13	505	84
SBG4	SB_C07	937	91
SBG5	SB_C08	766	104
SBG6	SB_C04	554	125
SBG7	SB_C02	550	124
SBG8	SB_C06	824	97

The total numbers of individuals at each station ranged from 396 to 937 individuals per sample. The total number of taxa (S) was however more consistent throughout the survey area, ranging from 84 to 125 per sample. Overall, the macrofauna was dominated by Annelida (60.2 %) followed by Crustacea (16.3%) and Mollusca (11.1 %) and Phoronida (7.7 %). The remaining 4.7 % of individuals comprised Nematoda (1.3 %), Nemertea (1.2 %), Cnidaria, Echinodermata, Foraminifera, Hemichordata, Platyhelminthes, Pycnogonida and Chaetognatha (all < 1 %). A summary of the most abundant taxa present in the samples is given in Table 3.3.

Table 3.3: Total abundance of the macrofaunal taxa identified in grab samples collected as part of the 2022 Scapa Deep Water Quay broadscale habitat mapping survey. Taxa shown comprise 70 % of total individuals identified.

Taxon	Qualifier	Abundance (total no. in all samples)
Lumbrineris	nr. cingulata	686
Phoronis	sp. indet.	396
Prionospio fallax		385
Thyasira flexuosa		349
Ampelisca	juvenile	234
Nephtys	juvenile	154
Tanaissus danica		130
Notomastus	sp. indet.	121
Ampelisca provincialis		112
Pseudopolydora paucibranchiata		107
Scoloplos armiger		93

Taxon	Qualifier	Abundance (total no. in all samples)
Mediomastus fragilis		80
Anobothrus gracilis		74
Turritellinella tricarinata		74
Dipolydora flava		71
Magelona alleni		70
Nematoda		69
Aurospio banyulensis		67
Myodocopida		66
Nemertea		64
Amphicteis gunneri		62
Verruca stroemia		61
Scalibregma celticum		60
Jasmineira caudata		57

Generally, the samples exhibited very similar macrofaunal assemblages, with only the relative abundance of the dominant species varying from sample to sample. The most abundant taxa present included a range of polychaetes, including *Prionospio fallax*, *Notomastus* sp. indet., *Pseudopolydora paucibranchiata*, *Scoloplos armiger* and *Mediomastus fragilis*. The errant polychaetes *Lumbrineris* sp. (nr. cingulata) and *Nephtys* spp. were also particularly abundant in all eight of the samples. The bivalve *Thyasira flexuosa*, the amphipod *Ampelisca* spp. and the horseshoe worm *Phoronis* sp. indet. were also among the most abundant taxa, also being present in all samples.

The dominant fauna present were generally characteristic of shallow mixed sediments. The best fit for the recorded assemblage was found to be the biotope **SS.SMx.CMx.KurThyMx** ('*Kurtiella bidentata* and *Thyasira* spp. in circalittoral muddy mixed sediment'). However, whilst *T. flexuosa* was present in high numbers, and other characterising taxa were also present throughout the survey area, the bivalve *Kurtiella bidentata* was only present in low numbers (n = 2 - 4) in 4 of the 8 samples. It is possible therefore that the recorded community is a variant of the described biotope.

While the PSA results indicated that the sediments at SBG4 were composed of muddy sands (and therefore not mixed sediment), the biotope **SS.SMx.CMx.KurThyMx** was also assigned to this sample due to high numbers of *T. flexuosa* (n = 128) and other taxa characteristic of this biotope (including *P. fallax*, *S. armiger*, *Ampelisca* spp. and *Lumbrineris* sp.) present.

4 SUMMARY

4.1 Intertidal survey

The habitats and associated biological communities recorded in the Scapa Deep Water Quay intertidal survey area were typical of low energy, sheltered, rocky and mixed substrate coastlines in the north of Scotland. The patterns of vertical zonation observed on the four representative transects were similar to those described for the Hatston Pier site (O'Dell *et al.*, 2023), and reflected the exposure tolerances of the seaweed and animal communities, ranging from the barren or lichen-dominated upper shore (supra-littoral zone) to the lower littoral fringe and infralittoral habitats.

Table 4.1 provides a summary of the biotopes recorded at each transect. None of the biotopes identified are considered of national or international importance or of special interest (see Annex I, Brazier *et al.* (2019)) and no PMF habitats or species (Tyler-Walters *et al.*, 2016) were observed.

Table 4.1: A summary of the biotopes identified at each transect surveyed as part of 2022 Scapa Deep Water Quay intertidal survey.

Biotope Code	SB_1	SB _2	SB _3	SB _4
LR.MLR.BF.FvesB	●			
LR.MLR.BF.Fser.R		●		●
LR.LLR.F				●
LR.LLR.F.Pel		●		
LR.LLR.F.Fspi.FS	●	●		
LR.LLR.F.Fspi.X			●	
LR.LLR.F.Fves.FS	●		●	●
LR.LLR.F.Fves.X		●	●	
LR.LLR.F.Asc.X			●	
LR.LLR.F.Fserr.FS	●			
LR.FLR.Lic.Ver.Ver		●		
LS.LCS.Sh.BarSh	●		●	●
LS.LSa.St		●		●
LS.LSa.St.Tal			●	

The dog whelk, *N. lapillus*, occurred at varying abundances on all four transects. This species was included on the OSPAR List of threatened and/or declining species and habitats in 2003 (OSPAR, 2009). The decline in the *N. lapillus* populations has been linked with contamination effects of tributyltin (TBT) compounds used in boat and ship antifouling paints. Even at low concentrations, these cause a condition known as imposex, where female *N. lapillus* develop male characteristics (the formation of a vas deferens and growth of a penis) and become sterile. Whilst recovery of *N. lapillus* populations has been demonstrated at some locations that were previously denuded of this species, *N. lapillus* still remains on the OSPAR list (OSPAR, 2018).

4.2 Subtidal survey

The results of the grab survey indicate that the soft-sediment infaunal communities in the survey area are fairly consistent, with only one biotope (**SS.SMx.CMx.KurThyMx**) assigned to all the grab samples. Similarly, the results of the underwater imagery analysis indicate that the epibiotic communities present are also fairly consistent within the survey area, with only seven biotopes (including habitat complexes and biotope complexes) assigned to the imagery records. A summary of the biotopes identified on each video transect is given in Table 4.2.

Table 4.2: A summary of the biotopes identified at each transect surveyed as part of 2022 Scapa Deep Water Quay subtidal drop-down camera survey.

Biotope code	SBC1	SBC2	SBC3	SBC4	SBC5	SBC6	SBC7	SBC8
IR.LIR	●			●	●			
IR.LIR.K.LhypSlat.Gz					●			
IR.LIR.K.Slat.Gz				●	○			
SS.SCS.ICS				○	●			●
SS.SMx.IMx			●		●	○	○	○
SS.SMp.KSwSS.SlatR*		●						
SS.SMp.KSwSS.Pcri*	●	●	●	●		●	●	●

● = Identified from video footage
○ = Identified from still images only (and therefore unlikely to represent an actual biotope)
* associated with PMF habitats

One PMF habitat was identified in the subtidal survey area. The PMF habitat ‘kelp and seaweed communities on sublittoral sediment’ was identified on a total of seven transects (all excepting SBC5), and was recorded within the proposed development consent boundary.

Maerl, whilst present in the survey area, was only observed as scattered/isolated ‘hedgehog stones’ in very low abundances (up to 2 % coverage in any given still image in which it occurred, and < 1% in any of the video records). The PMF ‘maerl beds’ was therefore not assigned to any of the imagery records.

While kelp communities were observed, these were typical of low-energy, highly sediment-influenced environments and were heavily grazed. The PMF ‘kelp beds’ has several biotope components (Tyler-Walters *et al.*, 2016), however these are all high- and moderate-energy biotopes not recorded in the present survey. The PMF ‘kelp beds’ was therefore not assigned to any of the imagery records.

4.3 Limitations

Due to the timings associated with the submission of the planning permission, there was a requirement to undertake the surveys in early winter 2022. In addition to the issues with the intertidal survey, caused due to spring low tide times coinciding with hours of darkness (see section 2.1.2), this is likely to have impacted the biological communities observed. This particularly pertains to the macroalgal-dominated habitats in the intertidal and the kelp communities observed in the shallow subtidal, as a significant amount of autumn/winter 'die-back' is likely to have occurred prior to the survey being conducted. It is possible that the communities and biotopes recorded would change significantly if the survey was conducted in the summer.

4.4 Report summary and recommendations

The survey detailed in this report achieved all of the stated objectives, and the data collected were deemed to be sufficient for the purpose of informing the EIA and enabling assessments of the LSE associated with the proposed development. Despite the reduction in scope (see section 1.4), the survey approach was deemed appropriate for the project, as the data acquired were of sufficient resolution to gain a good understanding of the range and distribution of habitats, biotopes and dominant taxa at and in the vicinity of the proposed development. Furthermore, the data acquired can be used to inform subsequent surveys, including baseline and monitoring surveys.

It is strongly recommended that a full baseline survey is carried out prior to commencement of the proposed development. The data collected should be of sufficient quality and resolution to be suitable in supporting future assessments of feature condition and of measuring the magnitude and direction of any potential change related to the proposed development. A marine monitoring plan (MMP) should be developed by personnel familiar with such surveys in conjunction with the regulators and with relevant local stakeholder groups and specialists, where available.

It is recommended that baseline surveys should include Phase II intertidal surveys to collect quantitative, statistically robust species data and to investigate those low-shore habitats which could not be covered by the present Phase I survey, thereby resolving any data gaps. It is strongly recommended that these surveys are conducted in late summer (ideally August) when macroalgal growth is at maximum and spring low tides can be utilised for intertidal survey.

The lack of available acoustic (bathymetry and sidescan sonar) data in the subtidal region of the survey area meant that predictive broadscale habitat maps could not be produced using the present data. While the subtidal sediments and infaunal communities identified within the survey area were relatively homogenous, it is recommended that bathymetry and sidescan sonar surveys be conducted as part of the baseline survey in conjunction with additional drop-down camera and grab sample surveys in order to enable the creation of high-resolution predictive habitat maps. Given the prevalence of shallow subtidal macroalgal communities in the survey area, it is recommended that drop-down camera work be carried out during the summer months when macroalgal diversity is likely to be highest. A grab sampling survey should be conducted to provide additional macrobenthic invertebrate data, although it is also recommended that grab samples are taken for analysis of sediment chemistry. Sampling for marine water quality parameters may also be required. Both the drop-down camera and grab surveys should have a greater level of replication than in the present survey in order to provide statistically robust data against which potential future changes can be measured.

All baseline surveys should be conducted with reference to the broadscale habitat identification surveys described in this report and should aim to build upon the data collected using readily comparable methodologies. Suitable intertidal and subtidal control sites should also be identified, and a suitable monitoring programme developed.

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6 APPENDICES

Appendix I: Modified MNCR field form used as part of the Phase I intertidal surveys conducted as part of the 2022 Scapa Deep Water Quay habitat mapping survey.

Intertidal Ecological Surveys - Phase I recording form (one per habitat per transect)

1) Site information

Date:				
Time/weather/state of tide/other data				
Transect no.:				
Habitat no.				
Shore position (circle appropriate):	**Strandline**	**High**	**Mid**	**Low**
Position (centre point of habitat):		**N**		**W**

2) Photo Taken (tick as appropriate):	Up-shore ☐	Down-shore ☐	Right ☐	Left ☐

3) Site Description (tick appropriate score):		**1**	**2**	**3**	**4**	**5**
Surface relief (even-rugged)						
Texture (smooth-pitted)						
Stability (stable-mobile)						
Scour (none-scoured)						
Silt (none-silted)						
Fissures > 10mm (none-many)						
Crevices < 10mm (none-many)						
Boulder/cobble/pebble shape (rounded-angular)						
Rockpools (none-all)						

4) Note if the following are present:	**Tick as appropriate**
Burrows / holes	
Tubes	
Algal mat	
Drainage channels / creeks / freshwater runoff	
Standing water	
Sediment veneer	
Sabellaria alveolata (detail below)	
Macroalgae (detail below)	
Anthropgenic feature (detail below)	
Other (please specify)	

Substrate Type	**% cover (approx.)**
Bedrock	
Boulders (S/L/XL)	
Cobbles	
Pebbles	
Gravel (stone/shell)	
Sand	
Mud	
Biogenic (specify below)	
Artificial (specify below)	
Peat	

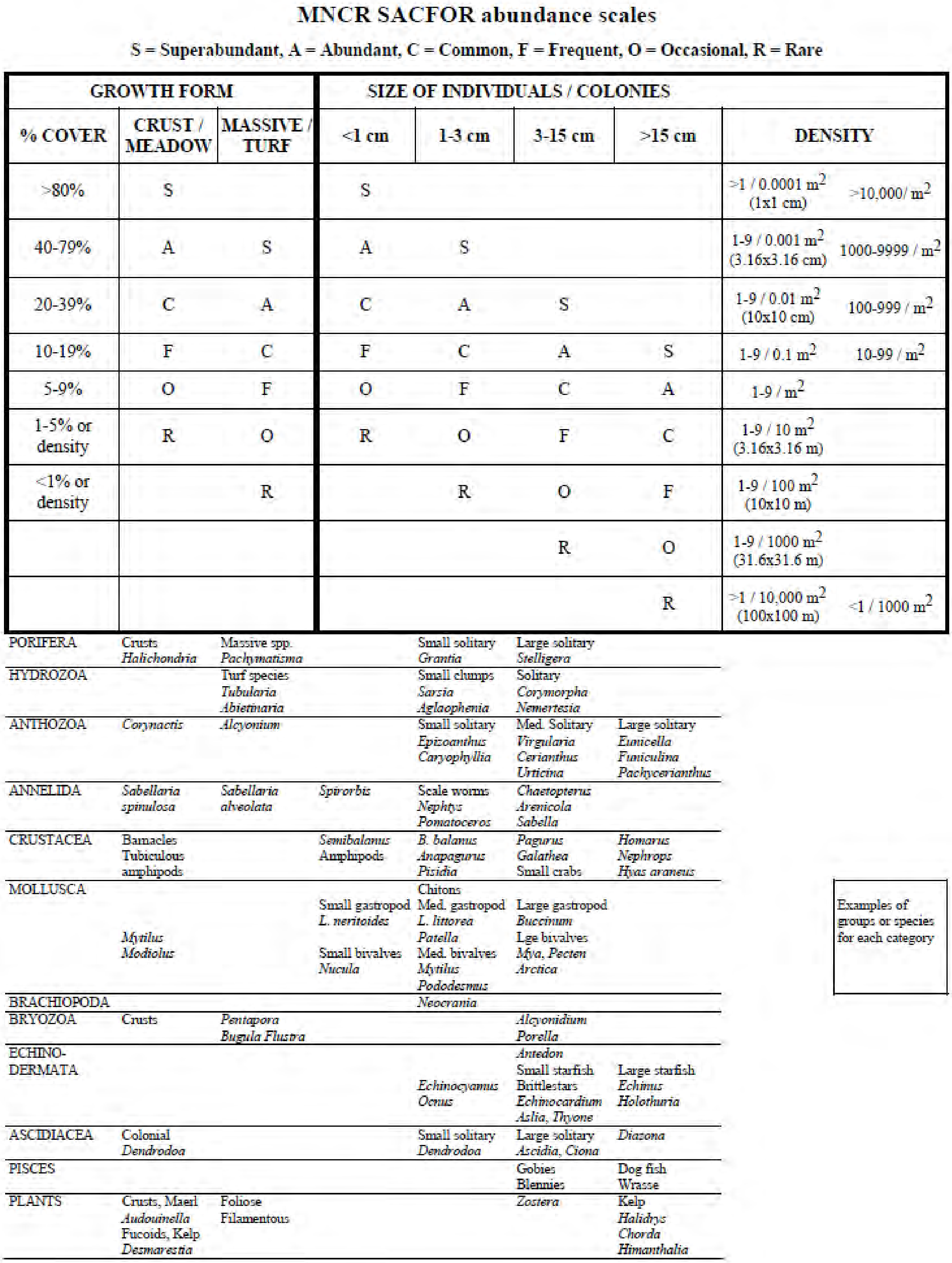
5) MNCR Biotope code / notes (e.g. variant)

6) Major taxa present (Please note species below with SACFOR abundance)

7) Additional notes (rock type, anthropogenic features etc.)

Appendix II: MNCR SACFOR abundance scale.

The MNCR cover/density scales adopted from 1990 onwards (see Hiscock, 1996) provide a unified system for recording the abundance of marine benthic taxa in intertidal and subtidal marine surveys. The scales are given below.



MNCR SACFOR abundance scales

S = Superabundant, A = Abundant, C = Common, F = Frequent, O = Occasional, R = Rare

GROWTH FORM			SIZE OF INDIVIDUALS / COLONIES					
% COVER	CRUST / MEADOW	MASSIVE / TURF	<1 cm	1-3 cm	3-15 cm	>15 cm	DENSITY	
>80%	S		S				>1 / 0.0001 m^2 (1x1 cm)	>10,000/ m^2
40-79%	A	S	A	S			1-9 / 0.001 m^2 (3.16x3.16 cm)	1000-9999 / m^2
20-39%	C	A	C	A	S		1-9 / 0.01 m^2 (10x10 cm)	100-999 / m^2
10-19%	F	C	F	C	A	S	1-9 / 0.1 m^2	10-99 / m^2
5-9%	O	F	O	F	C	A	1-9 / m^2	
1-5% or density	R	O	R	O	F	C	1-9 / 10 m^2 (3.16x3.16 m)	
<1% or density		R		R	O	F	1-9 / 100 m^2 (10x10 m)	
					R	O	1-9 / 1000 m^2 (31.6x31.6 m)	
						R	>1 / 10,000 m^2 (100x100 m)	<1 / 1000 m^2
PORIFERA	Crusts *Halichondria*	Massive spp. *Pachymatisma*		Small solitary *Grantia*	Large solitary *Stelligera*			
HYDROZOA		Turf species *Tubularia* *Abietinaria*		Small clumps *Sarsia* *Aglaophenia*	Solitary *Corymorpha* *Nemertesia*			
ANTHOZOA	*Corynactis*	*Alcyonium*		Small solitary *Epizoanthus* *Caryophyllia*	Med. Solitary *Virgularia* *Cerianthus* *Urticina*	Large solitary *Eunicella* *Funiculina* *Pachycerianthus*		
ANNELIDA	*Sabellaria spinulosa*	*Sabellaria alveolata*	*Spirorbis*	Scale worms *Nephtys* *Pomatoceros*	*Chaetopterus* *Arenicola* *Sabella*			
CRUSTACEA	Barnacles Tubiculous amphipods		*Semibalanus* Amphipods	*B. balanus* *Anapagurus* *Pisidia*	*Pagurus* *Galathea* Small crabs	*Homarus* *Nephrops* *Hyas araneus*		
MOLLUSCA	*Mytilus* *Modiolus*		Small gastropod *L. neritoides* Small bivalves *Nucula*	Chitons Med. gastropod *L. littorea* *Patella* Med. bivalves *Mytilus* *Pododesmus*	Large gastropod *Buccinum* Lge bivalves *Mya, Pecten* *Arctica*			
BRACHIOPODA				*Neocrania*				
BRYOZOA	Crusts	*Pentapora* *Bugula Flustra*			*Alcyonidium* *Porella*			
ECHINO-DERMATA				*Echinocyamus* *Ocnus*	*Antedon* Small starfish Brittlestars *Echinocardium* *Aslia, Thyone*	Large starfish *Echinus* *Holothuria*		
ASCIDIACEA	Colonial *Dendrodoa*			Small solitary *Dendrodoa*	Large solitary *Ascidia, Ciona*	*Diazona*		
PISCES					Gobies Blennies	Dog fish Wrasse		
PLANTS	Crusts, Maerl *Audouinella* Fucoids, Kelp *Desmarestia*	Foliose Filamentous			*Zostera*	Kelp *Halidrys* *Chorda* *Himanthalia*		

Examples of groups or species for each category

Appendix III: Transect and habitat photographs taken during the Phase I intertidal survey conducted as part of the 2022 Scapa Deep Water Quay habitat mapping survey.

Field photographs captured on the centre line at each intertidal belt transect in the upper shore. Photographs were taken up-shore, down-shore and along-shore in both directions and have been displayed in this order. Note that, due to the timing of the survey relative to the spring tide, the low shore was not always visible, however the label ‘low shore’ has been retained for simplicity.

Plate 1a. Scapa Deep Water Quay intertidal survey Transect 1 (SB_1), upper shore.

Plate 1b. Scapa Deep Water Quay intertidal survey Transect 1 (SB_1), mid and lower shore.

Plate 1c. Scapa Deep Water Quay intertidal survey Transect 1 (SB_1), view north from upper shore.

Plate 1d. Scapa Deep Water Quay intertidal survey Transect 1 (SB_1), view south from the upper shore.

Plate 2a. Scapa Deep Water Quay intertidal survey Transect 2 (SB_2), upper shore.

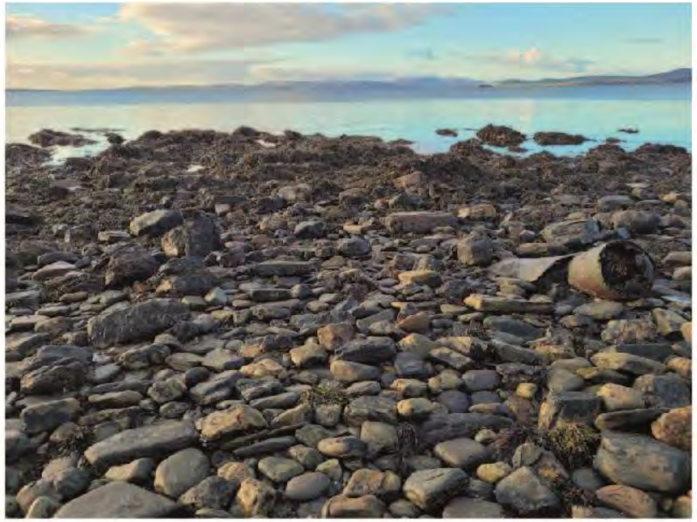


Plate 2b. Scapa Deep Water Quay intertidal survey Transect 2 (SB_2), mid and lower shore.

Plate 2c. Scapa Deep Water Quay intertidal survey Transect 2 (SB_2), view north from upper shore.

Plate 2d. Scapa Deep Water Quay intertidal survey Transect 2 (SB_2), view south from the upper shore.

Plate 3a. Scapa Deep Water Quay intertidal survey Transect 3 (SB_3), mid and upper shore.

Plate 3b. Scapa Deep Water Quay intertidal survey Transect 3 (SB_3), lower shore.

Plate 3c. Scapa Deep Water Quay intertidal survey Transect 3 (SB_3), view north from mid shore.

Plate 3d. Scapa Deep Water Quay intertidal survey Transect 3 (SB_3), view south from the upper shore.

Plate 4a. Scapa Deep Water Quay intertidal survey Transect 4 (SB_4), upper shore.

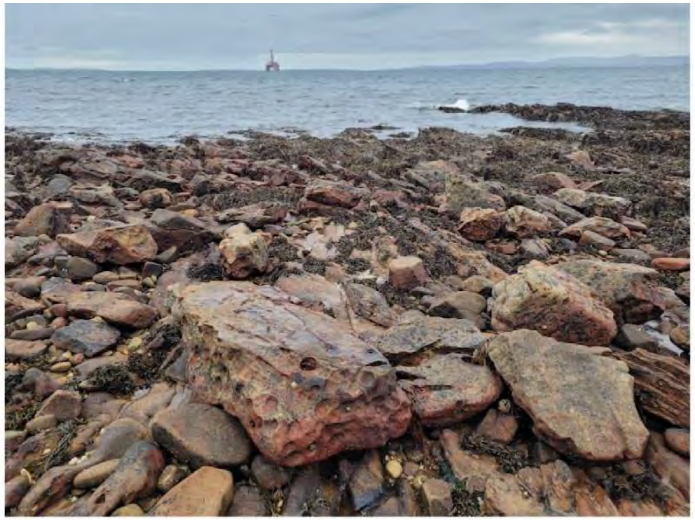


Plate 4b. Scapa Deep Water Quay intertidal survey Transect 4 (SB_4), mid and lower shore.

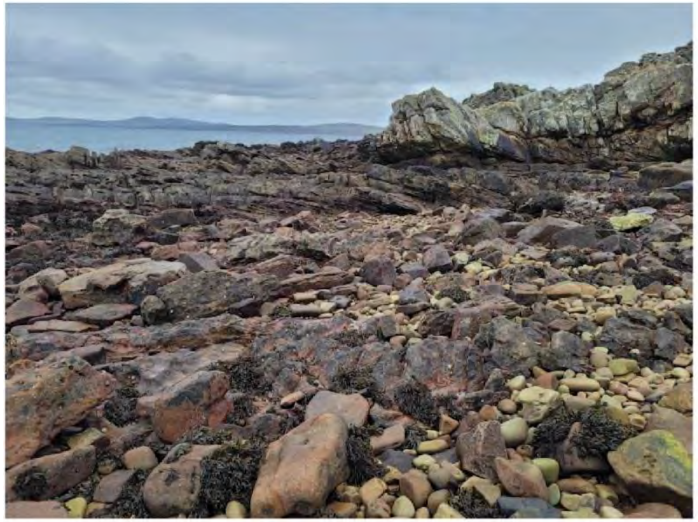


Plate 4c. Scapa Deep Water Quay intertidal survey Transect 4 (SB_4), view north from upper shore.

Plate 4d. Scapa Deep Water Quay intertidal survey Transect 4 (SB_4), view south from the upper shore.

Appendix IV: Phase I intertidal survey logs for work conducted as part of the 2022 Scapa Deep Water Quay habitat mapping survey.

All positions represent the lower boundary of the habitat as recorded on the central transect line and are given in WGS84 latitude and longitude (DD MM.MMMM; negative longitudes are west).

Transect No.	Habitat No.	Shore Position	Date	Time (BST)	Latitude	Longitude	Habitat width (m)	Habitat Description	MNCR Biotope Code
SB_1	1	High	04/12/2022	12:58	58 55.3523	-002 57.2114	8	Barren shingle.	LS.LCS.Sh.BarSh
SB_1	2	High	04/12/2022	13:01	58 55.3497	-002 57.2222	11	Barren shingle with sparse Gammaridae under cobbles.	LS.LCS.Sh.BarSh
SB_1	3	Mid	04/12/2022	13:08	58 55.3482	-002 57.2241	4	Dense *Fucus spiralis* on exposed bedrock.	LR.LLR.F.Fspi.FS
SB_1	4	Low	04/12/2022	13:16	[Not recorded - habitat width narrower than GPS error]		1	Dense *Fucus vesiculosus* on bedrock with *Osmundea pinnatifida*.	LR.LLR.F.Fves.FS
SB_1	5	Low	04/12/2022	13:22	58 55.3368	-002 57.2465	16	Mosaic of *Semibalanus balanoides* and *Fucus vesiculosus* on bedrock with *Fucus serratus* in gullies.	LR.MLR.BF.FvesB
SB_2	1	Strandline	04/12/2022	11:15	58 55.1976	-002 57.0979	0	Near-vertical cliff face with moss and lichens, freshwater input with associated brown algal biofilm.	LS.LSa.St
SB_2	2	High	04/12/2022	11:20	58 55.1962	-002 57.0995	4	Bedrock with *Verrucaria maura* with barren shingle.	LR.FLR.Lic.Ver.Ver
SB_2	3	High	04/12/2022	11:30	58 55.1968	-002 57.1047	6	*Pelvetia canaliculata* and *Fucus spiralis* on bedrock with cobbles and pebbles.	LR.LLR.F.Pel
SB_2	4	Mid	04/12/2022	11:45	58 55.1964	-002 57.1083	5	*Fucus spiralis* on bedrock with cobbles and pebbles.	LR.LLR.F.Fspi.FS

Transect No.	Habitat No.	Shore Position	Date	Time (BST)	Latitude	Longitude	Habitat width (m)	Habitat Description	MNCR Biotope Code
SB_2	5	Mid	04/12/2022	11:58	58 55.1953	-002 57.1134	7	*Fucus vesiculosus* and *Ascophyllum nodosum* on cobbles and boulders with coarse sediment infill.	LR.LLR.F.Fves.X
SB_2	6	Low	04/12/2022	12:12	58 55.1906	-002 57.1271	15	*Fucus vesiculosus* on cobbles and boulders.	LR.LLR.F.Fves.X
SB_2	7	Low	04/12/2022	12:25	58 55.1899	-002 57.1314	5	*Fucus serratus* and red seaweeds on bedrock with occasional cobbles and sand infill.	LR.MLR.BF.Fser.R
SB_3	1	Strandline	03/12/2022	12:45	58 55.1124	-002 57.0463	4	Barren shingle.	LS.LCS.Sh.BarSh
SB_3	2	High	03/12/2022	12:38	58 55.1123	-002 57.0546	9	Mixed coarse sediment with talitridae and gammaridae between/beneath larger cobbles and boulders.	LS.LSa.St.Tal
SB_3	3	Mid	03/12/2022	12:26	58 55.1123	-002 57.0599	5	*Fucus spiralis* on cobbles and small boulders with *Pelvetia canaliculata* and *Melarhaphe neritoides*.	LR.LLR.F.Fspi.X
SB_3	4	Mid	03/12/2022	12:11	58 55.1124	-002 57.0674	7	*Ascophyllum nodosum* on cobbles and small boulders with *Patella vulgata*.	LR.LLR.F.Asc.X
SB_3	5	Mid	03/12/2022	11:57	58 55.1122	-002 57.0761	7	*Fucus vesiculosus* on cobbles and boulders overlying bedrock .	LR.LLR.F.Fves.X
SB_3	6	Low	03/12/2022	11:42	58 55.1122	-002 57.0885	10	*Fucus vesiculosus* on bedrock and boulders with *Osmundea pinnatifida*.	LR.LLR.F.Fves.FS
SB_4	1	Strandline	03/12/2022	10:31	58 55.0468	-002 57.0711	0	Bedrock cliffs with lichen.	LS.LSa.St

Transect No.	Habitat No.	Shore Position	Date	Time (BST)	Latitude	Longitude	Habitat width (m)	Habitat Description	MNCR Biotope Code
SB_4	2	High	03/12/2022	10:39	58 55.0465	-002 57.0735	4	Bare cobbles overlying gravel with periwinkles.	LS.LCS.Sh.BarSh
SB_4	3	Mid	03/12/2022	10:50	58 55.0440	-002 57.0801	7	*Fucus vesiculosus* and *Fucus spiralis* on boulders and bedrock with *Patella vulgata* and *Littorina* spp..	LR.LLR.F
SB_4	4	Low	03/12/2022	10:58	58 55.0414	-002 57.0871	6	*Fucus vesiculosus* on bedrock and occasional boulders with *Osmundea pinnatifida* and *Nucella lapillus*.	LR.LLR.F.Fves.FS
SB_4	5	Low	03/12/2022	11:10	58 55.0361	-002 57.1011	17	*Fucus serratus* and red seaweeds on bedrock with occasional boulders.	LR.MLR.BF.Fser.R

Appendix V: Species lists for each habitat at each intertidal transect surveyed as part of the 2022 Scapa Deep Water Quay habitat mapping survey.

		Transect no.	SB_1	SB_1	SB_1	SB_1
		Habitat no.	1	2	3	4
		Shore position	High	High	Mid	Low
Taxon	**Qualifier**	**SACFOR class**				
Biofilm	brown	massive/turf				
Biofilm	green	massive/turf				
Plantago	sp.	crust/meadow	R			
Hydropunctaria maura		crust/meadow			O	R
Ochrolechia parella		crust/meadow	R		R	
Caloplaca	sp.	crust/meadow	R			
Ramalina siliquosa		crust/meadow	R			
Actinia equina		1 - 3 cm				F
Spirorbinae		crust/meadow				
Chthamalus	sp.	crust/meadow				
Semibalanus balanoides		crust/meadow			R	
Talitridae		<1 cm				
Gammaridae		<1 cm		O	O	
Ligia	sp.	<1 cm				
Paguridae		3 - 15 cm				
Carcinus	sp.	3 - 15 cm				
Carcinus maenas		3 - 15 cm			P	
Steromphala cineraria		1 - 3 cm				
Steromphala umbilicalis		1 - 3 cm				P
Patella vulgata		3 - 15 cm			C	C
Littorina littorea		1 - 3 cm			C	R
Littorina obtusata		1 - 3 cm			O	C
Littorina saxatilis		1 - 3 cm			F	
Melarhaphe neritoides		<1 cm		R		
Nucella lapillus		1 - 3 cm				O
Rhodophyta	dark red crusts	crust/meadow			O	R
Rhodophyta	rust red crusts	crust/meadow				
Rhodophyta	filamentous red	massive/turf				R
Corallinaceae		crust/meadow			R	O
Corallina officinalis		massive/turf				R
Chondrus crispus		massive/turf				
Mastocarpus stellatus		massive/turf				
Osmundea pinnatifida		massive/turf				S
Laminaria digitata		crust/meadow				
Fucales	sporelings	crust/meadow				
Halidrys siliquosa		crust/meadow				
Ascophyllum nodosum		crust/meadow				
Fucus spiralis		crust/meadow			A	
Fucus vesiculosus		crust/meadow				S
Pelvetia canaliculata		crust/meadow			R	
Fucus serratus		crust/meadow				R
Ulva	spp. indet	massive/turf				
Cladophora	sp.	massive/turf			R	

		Transect no.	SB_1	SB_2	SB_2	SB_2
		Habitat no.	5	1	2	3
		Shore position	Low	Strandline	High	High
Taxon	Qualifier	SACFOR class				
Biofilm	brown	massive/turf		R	R	
Biofilm	green	massive/turf				O
Plantago	sp.	crust/meadow		C		
Hydropunctaria maura		crust/meadow	R	C	C	C
Ochrolechia parella		crust/meadow		R	O	R
Caloplaca	sp.	crust/meadow		O	O	
Ramalina siliquosa		crust/meadow				
Actinia equina		1 - 3 cm	O			
Spirorbinae		crust/meadow	R			
Chthamalus	sp.	crust/meadow				
Semibalanus balanoides		crust/meadow	F			R
Talitridae		<1 cm			A	
Gammaridae		<1 cm				O
Ligia	sp.	<1 cm			F	
Paguridae		3 - 15 cm	R			
Carcinus	sp.	3 - 15 cm				
Carcinus maenas		3 - 15 cm				
Steromphala cineraria		1 - 3 cm				
Steromphala umbilicalis		1 - 3 cm	R			
Patella vulgata		3 - 15 cm	A		R	R
Littorina littorea		1 - 3 cm	R			O
Littorina obtusata		1 - 3 cm	C		R	
Littorina saxatilis		1 - 3 cm			O	A
Melarhaphe neritoides		<1 cm				C
Nucella lapillus		1 - 3 cm	C			
Rhodophyta	dark red crusts	crust/meadow	R			R
Rhodophyta	rust red crusts	crust/meadow				
Rhodophyta	filamentous red	massive/turf	R			
Corallinaceae		crust/meadow	O			
Corallina officinalis		massive/turf				
Chondrus crispus		massive/turf				
Mastocarpus stellatus		massive/turf				
Osmundea pinnatifida		massive/turf	C			
Laminaria digitata		crust/meadow				
Fucales	sporelings	crust/meadow				R
Halidrys siliquosa		crust/meadow	R			
Ascophyllum nodosum		crust/meadow	R			
Fucus spiralis		crust/meadow				A
Fucus vesiculosus		crust/meadow	A			
Pelvetia canaliculata		crust/meadow				S
Fucus serratus		crust/meadow	A			
Ulva	spp. indet	massive/turf			O	
Cladophora	sp.	massive/turf				

		Transect no.	SB_2	SB_2	SB_2	SB_2
		Habitat no.	4	5	6	7
		Shore position	Mid	Mid	Low	Low
Taxon	**Qualifier**	**SACFOR class**				
Biofilm	brown	massive/turf				
Biofilm	green	massive/turf				
Plantago	sp.	crust/meadow				
Hydropunctaria maura		crust/meadow	O	C	F	O
Ochrolechia parella		crust/meadow				
Caloplaca	sp.	crust/meadow				
Ramalina siliquosa		crust/meadow				
Actinia equina		1 - 3 cm	F	C	F	O
Spirorbinae		crust/meadow			O	R
Chthamalus	sp.	crust/meadow	R			
Semibalanus balanoides		crust/meadow	R	O	R	R
Talitridae		<1 cm				
Gammaridae		<1 cm	O	O		
Ligia	sp.	<1 cm				
Paguridae		3 - 15 cm			O	
Carcinus	sp.	3 - 15 cm				
Carcinus maenas		3 - 15 cm			R	
Steromphala cineraria		1 - 3 cm				R
Steromphala umbilicalis		1 - 3 cm			R	R
Patella vulgata		3 - 15 cm	F	O	A	C
Littorina littorea		1 - 3 cm	C	C	A	C
Littorina obtusata		1 - 3 cm		R		R
Littorina saxatilis		1 - 3 cm	A	F		
Melarhaphe neritoides		<1 cm				
Nucella lapillus		1 - 3 cm	R	F	C	F
Rhodophyta	dark red crusts	crust/meadow				
Rhodophyta	rust red crusts	crust/meadow				
Rhodophyta	filamentous red	massive/turf	R		O	
Corallinaceae		crust/meadow	R	O	F	F
Corallina officinalis		massive/turf				O
Chondrus crispus		massive/turf				O
Mastocarpus stellatus		massive/turf				
Osmundea pinnatifida		massive/turf			A	S
Laminaria digitata		crust/meadow				
Fucales	sporelings	crust/meadow	R			
Halidrys siliquosa		crust/meadow				
Ascophyllum nodosum		crust/meadow	C	O		
Fucus spiralis		crust/meadow	A			
Fucus vesiculosus		crust/meadow		C	S	C
Pelvetia canaliculata		crust/meadow	O			
Fucus serratus		crust/meadow			O	A
Ulva	spp. indet	massive/turf				
Cladophora	sp.	massive/turf	O			

		Transect no.	SB_3	SB_3	SB_3	SB_3
		Habitat no.	1	2	3	4
		Shore position	Strandline	High	Mid	Mid
Taxon	**Qualifier**	**SACFOR class**				
Biofilm	brown	massive/turf				
Biofilm	green	massive/turf		C	O	
Plantago	sp.	crust/meadow				
Hydropunctaria maura		crust/meadow			F	R
Ochrolechia parella		crust/meadow		O		
Caloplaca	sp.	crust/meadow				
Ramalina siliquosa		crust/meadow				
Actinia equina		1 - 3 cm			R	F
Spirorbinae		crust/meadow				
Chthamalus	sp.	crust/meadow			R	R
Semibalanus balanoides		crust/meadow			R	R
Talitridae		<1 cm		A		
Gammaridae		<1 cm			F	O
Ligia	sp.	<1 cm				
Paguridae		3 - 15 cm				R
Carcinus	sp.	3 - 15 cm				
Carcinus maenas		3 - 15 cm		O	O	O
Steromphala cineraria		1 - 3 cm				
Steromphala umbilicalis		1 - 3 cm				
Patella vulgata		3 - 15 cm			O	A
Littorina littorea		1 - 3 cm			R	C
Littorina obtusata		1 - 3 cm				O
Littorina saxatilis		1 - 3 cm		O	C	O
Melarhaphe neritoides		<1 cm			A	O
Nucella lapillus		1 - 3 cm				
Rhodophyta	dark red crusts	crust/meadow				
Rhodophyta	rust red crusts	crust/meadow			R	
Rhodophyta	filamentous red	massive/turf				
Corallinaceae		crust/meadow				R
Corallina officinalis		massive/turf				
Chondrus crispus		massive/turf				
Mastocarpus stellatus		massive/turf				
Osmundea pinnatifida		massive/turf				
Laminaria digitata		crust/meadow				
Fucales	sporelings	crust/meadow			R	R
Halidrys siliquosa		crust/meadow				
Ascophyllum nodosum		crust/meadow			O	S
Fucus spiralis		crust/meadow			A	O
Fucus vesiculosus		crust/meadow				C
Pelvetia canaliculata		crust/meadow		R	F	
Fucus serratus		crust/meadow				
Ulva	spp. indet	massive/turf				
Cladophora	sp.	massive/turf				O

		Transect no.	SB_3	SB_3	SB_4	SB_4
		Habitat no.	5	6	1	2
		Shore position	Mid	Low	Strandline	High
Taxon	**Qualifier**	**SACFOR class**				
Biofilm	brown	massive/turf				
Biofilm	green	massive/turf				
Plantago	sp.	crust/meadow				
Hydropunctaria maura		crust/meadow	R	R	C	O
Ochrolechia parella		crust/meadow				
Caloplaca	sp.	crust/meadow			F	
Ramalina siliquosa		crust/meadow			F	
Actinia equina		1 - 3 cm	O	F		
Spirorbinae		crust/meadow		R		
Chthamalus	sp.	crust/meadow	R			
Semibalanus balanoides		crust/meadow	R	R		
Talitridae		<1 cm				
Gammaridae		<1 cm	C	A		
Ligia	sp.	<1 cm				
Paguridae		3 - 15 cm		R		
Carcinus	sp.	3 - 15 cm	O			
Carcinus maenas		3 - 15 cm	F	F		R
Steromphala cineraria		1 - 3 cm		R		
Steromphala umbilicalis		1 - 3 cm				
Patella vulgata		3 - 15 cm	C	C		R
Littorina littorea		1 - 3 cm	A	S		O
Littorina obtusata		1 - 3 cm	O	O		
Littorina saxatilis		1 - 3 cm	O	R		C
Melarhaphe neritoides		<1 cm				F
Nucella lapillus		1 - 3 cm	F	F		
Rhodophyta	dark red crusts	crust/meadow				
Rhodophyta	rust red crusts	crust/meadow				
Rhodophyta	filamentous red	massive/turf				
Corallinaceae		crust/meadow	R	F		
Corallina officinalis		massive/turf				
Chondrus crispus		massive/turf		R		
Mastocarpus stellatus		massive/turf	O			
Osmundea pinnatifida		massive/turf	F	C		
Laminaria digitata		crust/meadow				
Fucales	sporelings	crust/meadow			R	
Halidrys siliquosa		crust/meadow				
Ascophyllum nodosum		crust/meadow	O			
Fucus spiralis		crust/meadow				R
Fucus vesiculosus		crust/meadow	A	A		
Pelvetia canaliculata		crust/meadow			R	
Fucus serratus		crust/meadow		O		
Ulva	spp. indet	massive/turf				
Cladophora	sp.	massive/turf	O			

		Transect no.	SB_4	SB_4	SB_4
		Habitat no.	3	4	5
		Shore position	Mid	Low	Low
Taxon	**Qualifier**	**SACFOR class**			
Biofilm	brown	massive/turf			
Biofilm	green	massive/turf			
Plantago	sp.	crust/meadow			
Hydropunctaria maura		crust/meadow		F	R
Ochrolechia parella		crust/meadow			
Caloplaca	sp.	crust/meadow			
Ramalina siliquosa		crust/meadow			
Actinia equina		1 - 3 cm	F	F	C
Spirorbinae		crust/meadow			R
Chthamalus	sp.	crust/meadow			
Semibalanus balanoides		crust/meadow	R	R	
Talitridae		<1 cm			
Gammaridae		<1 cm	C	F	
Ligia	sp.	<1 cm			
Paguridae		3 - 15 cm			
Carcinus	sp.	3 - 15 cm			
Carcinus maenas		3 - 15 cm	R		
Steromphala cineraria		1 - 3 cm			R
Steromphala umbilicalis		1 - 3 cm			
Patella vulgata		3 - 15 cm	C	C	A
Littorina littorea		1 - 3 cm	F	R	O
Littorina obtusata		1 - 3 cm		R	R
Littorina saxatilis		1 - 3 cm	R		
Melarhaphe neritoides		<1 cm			
Nucella lapillus		1 - 3 cm	O	C	C
Rhodophyta	dark red crusts	crust/meadow	R		
Rhodophyta	rust red crusts	crust/meadow			
Rhodophyta	filamentous red	massive/turf			R
Corallinaceae		crust/meadow	R	F	R
Corallina officinalis		massive/turf		F	F
Chondrus crispus		massive/turf			O
Mastocarpus stellatus		massive/turf			
Osmundea pinnatifida		massive/turf		A	C
Laminaria digitata		crust/meadow			R
Fucales	sporelings	crust/meadow			
Halidrys siliquosa		crust/meadow			
Ascophyllum nodosum		crust/meadow			
Fucus spiralis		crust/meadow	C		
Fucus vesiculosus		crust/meadow	C	A	O
Pelvetia canaliculata		crust/meadow	R		
Fucus serratus		crust/meadow			A
Ulva	spp. indet	massive/turf			
Cladophora	sp.	massive/turf	R	R	O

Appendix VI: Glossary of biotopes assigned to habitats and samples assessed as part of the 2022 Scapa Deep Water Quay habitat mapping survey.

Biotope code	Biotope name
LR.MLR.BF.FvesB	*Fucus vesiculosus* and barnacle mosaics on moderately exposed mid eulittoral rock
LR.MLR.BF.Fser.R	*Fucus serratus* and red seaweeds on moderately exposed lower eulittoral rock
LR.LLR.F	Fucoids on sheltered marine shores
LR.LLR.F.Pel	*Pelvetia canaliculata* on sheltered littoral fringe rock
LR.LLR.F.Fspi.FS	*Fucus spiralis* on full salinity sheltered upper eulittoral rock
LR.LLR.F.Fspi.X	*Fucus spiralis* on full salinity upper eulittoral mixed substrata
LR.LLR.F.Fves.FS	*Fucus vesiculosus* on full salinity moderately exposed to sheltered mid eulittoral rock
LR.LLR.F.Fves.X	*Fucus vesiculosus* on mid eulittoral mixed substrata
LR.LLR.F.Asc.X	*Ascophyllum nodosum* on full salinity mid eulittoral mixed substrata
LR.LLR.F.Fserr.FS	*Fucus serratus* on full salinity sheltered lower eulittoral rock
LR.FLR.Lic.Ver.Ver	*Verrucaria maura* on very exposed to very sheltered upper littoral fringe rock
LS.LCS.Sh.BarSh	Barren littoral shingle
LS.LSa.St	Strandline
LS.LSa.St.Tal	Talitrids on the upper shore and strand-line
IR.LIR	Low energy infralittoral rock
IR.LIR.K.LhypSlat.Gz	Grazed, mixed *Laminaria hyperborea* and *Saccharina latissima* on sheltered infralittoral rock
IR.LIR.K.Slat.Gz	Grazed *Saccharina latissima* with *Echinus*, brittlestars and coralline crusts on sheltered infralittoral rock
SS.SCS.ICS	Infralittoral coarse sediment
SS.SMx.IMx	Infralittoral mixed sediment
SS.SMx.CMx.KurThyMx	*Kurtiella bidentata* and *Thyasira* spp. in circalittoral muddy mixed sediment
SS.SMp.KSwSS.SlatR	*Saccharina latissima* and red seaweeds on infralittoral sediments
SS.SMp.KSwSS.Pcri	Loose-lying mats of *Phyllophora crispa* on infralittoral muddy sediment

Appendix VII: Underwater imagery logs for the drop-down camera survey conducted as part of the 2022 Scapa Deep Water Quay habitat mapping survey.

Positions are given in OSGB36 Easting and Northing (m).

Sample no.	Transect No.	Date	Start time (UTC)	Start of line position		End time (UTC)	End of line position		Video duration	No. stills
				Easting	Northing		Easting	Northing		
568#01	SBC1	7th Dec 2022	09:39:39	345226.74	1003322.33	10:12:34	345046.27	1004028.27	00:32:55	37
568#02	SBC2	7th Dec 2022	10:32:20	344893.67	1004223.21	10:52:55	344691.38	1004731.78	00:20:35	20
568#03	SBC3	7th Dec 2022	11:09:59	344919.43	1003399.63	11:58:20	344535.99	1004321.61	00:48:21	40
568#04	SBC4	7th Dec 2022	12:14:08	345282.55	1003292.35	12:32:01	345234.37	1003621.48	00:17:53	15
568#05	SBC5	7th Dec 2022	12:42:55	345078.48	1003987.73	12:55:07	345005.48	1004260.52	00:12:12	10
568#06	SBC6	7th Dec 2022	13:13:50	344799.42	1003133.61	13:41:05	344525.28	1003620.77	00:27:15	25
568#07	SBC7	7th Dec 2022	13:54:50	344389.09	1004002.48	14:12:04	344235.43	1004395.70	00:17:14	15
568#08	SBC8	7th Dec 2022	14:28:26	344362.91	1003365.17	15:01:56	344037.55	1004228.51	00:33:30	30

Appendix VIII: Summary of the results of the analysis of underwater imagery captured during the drop-down camera survey conducted as part of the 2022 Scapa Deep Water Quay habitat mapping survey.

NB. Video segments with zero visibility have not been included.

Transect no.	Section no.	Habitat description	MNCR biotope code(s) assigned	PMF(s) present	Annex I habitats present
SBC1	S1	Coralline crusts on cobbles and boulders overlying gravel.	IR.LIR SS.SCS.ICS		Reefs
SBC1	S2	Coralline crusts and *Echinus esculentus* on bedrock outcrop with vertical face.	IR.LIR		Reefs
SBC1	S3	Pebbles, cobbles and boulders overlying gravel.	IR.LIR SS.SCS.ICS		Reefs
SBC1	S4	Shelly mixed sediment with loose-lying mats of red seaweed.	SS.SMp.KSwSS.Pcri	Kelp and seaweed communities on sublittoral sediment	
SBC2	S1	*Saccharina latissima* and loose-lying mats of red seaweeds on shelly mixed sediment.	SS.SMp.KSwSS.SlatR SS.SMp.KSwSS.Pcri	Kelp and seaweed communities on sublittoral sediment	
SBC2	S2	Loose-lying mats of red seaweed on gravelly mixed sediment with sparse *Saccharina latissima*.	SS.SMp.KSwSS.Pcri	Kelp and seaweed communities on sublittoral sediment	
SBC3	S1	Loose-lying mats of red seaweed on mixed sediment.	SS.SMp.KSwSS.Pcri SS.SMx.IMx	Kelp and seaweed communities on sublittoral sediment	
SBC3	S3	Patchy loose-lying mats of red seaweed on sandy mixed sediment with simple burrows.	SS.SMp.KSwSS.Pcri SS.SMx.IMx	Kelp and seaweed communities on sublittoral sediment	
SBC3	S4	Sandy mixed sediment with sparse biota.	SS.SMx.IMx		
SBC4	S1	Coralline crusts on cobbles and boulders overlying gravel.	IR.LIR SS.SCS.ICS		Reefs
SBC4	S2	Coralline crusts on stepped bedrock with gravel infill.	IR.LIR		Reefs
SBC4	S3	Patchy loose-lying mats of red seaweed on shelly mixed sediment with small quantities of maerl.	SS.SMp.KSwSS.Pcri	Kelp and seaweed communities on sublittoral sediment	
SBC4	S4	Sparse biota on stepped bedrock with gravel infill.	IR.LIR SS.SCS.ICS SS.SMp.KSwSS.Pcri		Reefs
SBC4	S5	Patchy loose-lying mats of red seaweed on shelly mixed sediment with small quantities of maerl.	SS.SMp.KSwSS.Pcri	Kelp and seaweed communities on sublittoral sediment	

Transect no.	Section no.	Habitat description	MNCR biotope code(s) assigned	PMF(s) present	Annex I habitats present
SBC4	S6	Coralline crusts on pebbles, cobbles and boulders with sand and gravel infill.	IR.LIR SS.SCS.ICS		Reefs
SBC4	S7	Coralline crusts on stepped bedrock with sparse kelps.	IR.LIR.K.Slat.Gz		Reefs
SBC5	S1	Sparse red seaweeds on shelly mixed sediment.	SS.SMx.IMx		
SBC5	S2	Coralline crusts on pebbles, cobbles and boulders with *Echinus esculentus*.	IR.LIR SS.SCS.ICS		Reefs
SBC5	S3	Sparse kelps on stepped bedrock with coralline crusts.	IR.LIR.K.LhypSlat.Gz		Reefs
SBC5	S4	Patchy coralline crusts on bedrock, boulders and cobbles with gravel infill.	IR.LIR		Reefs
SBC5	S5	Sand and gravel with occasional bedrock outcrops.	SS.SCS.ICS		
SBC5	S6	Shelly mixed sediment with sparse red seaweeds.	SS.SMx.IMx		
SBC6	S1	Patchy loose-lying mats of red seaweed on gravelly mixed sediment with burrows.	SS.SMp.KSwSS.Pcri SS.SMx.IMx	Kelp and seaweed communities on sublittoral sediment	
SBC7	S1	Patchy loose-lying mats of red seaweed on sandy mixed sediment with burrows.	SS.SMp.KSwSS.Pcri SS.SMx.IMx	Kelp and seaweed communities on sublittoral sediment	
SBC8	S1	Loose-lying mats of red seaweed on gravelly mixed sediment with burrows.	SS.SMp.KSwSS.Pcri SS.SMx.IMx	Kelp and seaweed communities on sublittoral sediment	
SBC8	S2	Rock debris overlying mixed sediment.	SS.SCS		
SBC8	S4	Patchy loose-lying mats of red seaweed on gravelly mixed sediment with burrows.	SS.SMp.KSwSS.Pcri SS.SMx.IMx	Kelp and seaweed communities on sublittoral sediment	

Appendix IX: Benthic grab logs for samples collected as part of the 2022 Scapa Deep Water Quay habitat mapping survey.

Positions are given in OSGB36 Easting and Northing (m).

Sample no.	Grab no.	Date	Time (UTC)	Easting	Northing
568#09	SBG1	8th Dec 2022	10:00	344048.89	1004108.33
568#10	SBG2	8th Dec 2022	10:24	344544.43	1003617.64
568#11	SBG3	8th Dec 2022	10:44	344461.88	1003265.39
568#12	SBG4	8th Dec 2022	11:03	344757.72	1003819.71
568#13	SBG5	8th Dec 2022	11:25	344594.51	1004247.62
568#14	SBG6	8th Dec 2022	11:45	344886.79	1004214.84
568#15	SBG7	8th Dec 2022	12:07	345082.34	1003541.48
568#16	SBG8	8th Dec 2022	12:22	344926.76	1003396.67

Appendix X: Results of the particle size analysis of grab samples collected as part of the 2022 Scapa Deep Water Quay habitat mapping survey.

Percentage of sediment retained at each phi interval for each grab sample collected as part of the 2022 Scapa Deep Water Quay habitat mapping survey.

Sieve mesh size	SBG1	SBG2	SBG3	SBG4	SBG5	SBG6	SBG7	SBG8
16 mm	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8 mm	0.00	0.10	0.36	0.00	0.00	3.07	0.00	2.54
4 mm	0.88	2.75	1.89	0.07	1.09	7.67	1.82	1.07
2 mm	2.58	6.23	4.17	0.26	2.81	8.69	8.12	5.74
1 mm	4.59	9.36	4.92	1.03	4.21	7.98	10.42	10.88
500 µm	5.14	5.85	5.59	3.79	3.47	3.80	5.37	7.62
250 µm	11.14	12.88	10.77	19.31	14.00	4.07	7.83	10.98
125 µm	23.58	23.85	26.19	42.49	29.55	18.61	27.72	22.63
63 µm	29.73	19.27	24.59	20.16	21.47	23.46	20.19	22.65
< 63 µm	22.35	19.71	21.51	12.89	23.39	22.67	18.52	15.89

Appendix XI: Results of the macrobenthic invertebrate analysis of grab samples collected as part of the 2022 Scapa Deep Water Quay habitat mapping survey.

Taxon	Qualifier	SBG1	SBG2	SBG3	SBG4	SBG5	SBG6	SBG7	SBG8
Lagotia viridis		P	P	P		P	P		
Astrorhiza	indet.	1	1	1	2				1
Porifera		P	P	P	P		P	P	
Cliona	indet.	P		P			P	P	
Sycon ciliatum		1						3	
Campanulariidae				P					
Bougainvilliidae		P		P					
Actiniaria				1		1			
Cerianthus lloydii			2			2		1	3
Edwardsiidae		3	4	4	3	4	3	7	9
Nemertea		7	5	11	9	6	10	6	10
Nematoda		1	5	1	13	6	1	14	28
Platyhelminthes						1	2	1	
Sipuncula	bits							FRAG	
Sipuncula	juvenile							1	3
Golfingia (Golfingia) elongata			4	1		2			2
Golfingia (Golfingia) vulgaris vulgaris		1	1			1	1		
Phascolion (Phascolion) strombus strombus					2				
Thysanocardia procera		1	3	1	2	2	1	1	5
Chaetognatha								1	
Annelida	bits	FRAG	FRAG	FRAG	FRAG	FRAG	FRAG	FRAG	FRAG
Harmothoe	indet.	2	3	1	1	2	3	3	1
Harmothoe extenuata							4	1	
Harmothoe impar								1	
Malmgrenia	indet.		2			1			
Malmgrenia arenicolae			3		1	3	1		
Malmgrenia ljungmani							1	1	
Pholoe baltica			5	3	1	4	2		5
Pholoe inornata		2	4		1		7	10	4
Sigalionidae	juvenile						1		

Taxon	Qualifier	SBG1	SBG2	SBG3	SBG4	SBG5	SBG6	SBG7	SBG8
Sthenelais limicola		2			2	1			
Eteone longa	agg.			1	3		4	4	1
Pseudomystides limbata		1	2	1					1
Eumida	indet.		4	1	2	1	9	4	1
Eumida bahusiensis		1	3		2	3	2	2	1
Eumida sanguinea			4				3	3	
Hesiospina aurantiaca							2	1	
Nereimyra punctata							2		
Oxydromus flexuosus					1	3			
Oxydromus	indet.	1	6	4		2	21	11	9
Podarkeopsis capensis		1	5	1	4	4	4	2	3
Psamathe fusca			1				6	1	1
Syllidia armata		1	2			1	5	6	1
Autolytinae		1							
Eusyllis blomstrandi							1		
Odontosyllis gibba							4		
Syllides benedicti			1						1
Exogoninae	epitoke					1			
Parexogone hebes			5	2	22	6	2	10	5
Exogone naidina		1					2	2	
Sphaerosyllis taylori					1		1		
Scoloplos armiger		6	1	10	11	6	20	24	15
Sphaerodorum gracilis							1		
Glycera	juvenile	3	9	3	2	4	2		2
Glycera alba		1	2	1		5		1	3
Glycera lapidum	agg.						2	3	2
Goniadidae	juvenile	2	2	4	4				
Glycinde nordmanni						3	1	2	3
Goniada maculata		4			2	4	1		5
Eunereis longissima						2	1		

Taxon	Qualifier	SBG1	SBG2	SBG3	SBG4	SBG5	SBG6	SBG7	SBG8
Platynereis	indet.	6	1			1	5	13	
Nephtys	juvenile	20	30	29	11	13	14	14	23
Nephtys hombergii		1			5		1		
Nephtys kersivalensis		1	4	3			2	7	3
Magelona alleni		8	7	16	19	13		2	5
Magelona filiformis		1	3	1	1	5		2	1
Poecilochaetus serpens			1	1	3	5			
Protodorvillea kefersteini								1	
Ophryotrocha	indet.				7	3	1		
Notocirrus scoticus			1						
Lumbrineris	nr. cingulata	94	121	94	61	108	68	32	108
Paradoneis lyra					17	4	5	11	
Aurospio banyulensis		11	11	3	10	6	4	6	16
Spio decorata					2			1	1
Spio symphyta					6			1	6
Prionospio cirrifera		1				1		4	5
Prionospio fallax		11	3		311	39		2	19
Spiophanes bombyx			1		1				
Spiophanes kroyeri		1					1	2	
Dipolydora flava		6	16	9	9	10	1	13	7
Pseudopolydora paucibranchiata		7	8	8	12	18	10	15	29
Pseudopolydora pulchra						2		2	
Chaetozone setosa		1	2	2	9	11	1	1	
Chaetozone zetlandica		1	5	1					
Cirratulus	juvenile							1	
Cirratulus cirratus					1				
Tharyx killariensis			1	3	1	1		1	1
Ophelina acuminata				1			1		
Polyophthalmus pictus								2	
Diplocirrus glaucus		1	4	5	9	3		4	1

Taxon	Qualifier	SBG1	SBG2	SBG3	SBG4	SBG5	SBG6	SBG7	SBG8
Scalibregma celticum			16	6		3	9	5	21
Scalibregma inflatum			16	2		10	1	2	10
Notomastus	indet.	2	42	8	2	43	7	2	15
Mediomastus fragilis		3	6	8		32	6	10	15
Leiochone	indet.	6					1		
Praxillella affinis		2		1	1		6		
Euclymene oerstedii		6	4	11	4	5	5	1	7
Euclymene lombricoides				1					
Micromaldane ornithochaeta								1	
Galathowenia oculata				7					
Owenia	indet.	8	3	9	4	6	2		2
Amphictene auricoma		3		1		3	9	3	6
Ampharetidae	juvenile	2		2	3	3	1		1
Ampharete lindstroemi		4	1		2	2	3	4	4
Amphicteis gunneri		4	6	10	4	19		5	14
Anobothrus gracilis		10	3	5	6	12	12	6	20
Terebellidae	indet.	1	1		1		1		
Pista	juvenile			1			1	2	2
Pista mediterranea							2	1	
Amphitritides gracilis			1			2			
Polycirrini		4	4		6	4	1	3	2
Polycirrus plumosus						1			
Streblosoma intestinale				1		1			
Terebellides	indet.	2	1	1		2	1	2	2
Trichobranchus roseus		3	4	1	1	5		1	
Serpulidae	indet.						1	3	
Hydroides norvegica							1		
Spirobranchus lamarcki						1	4	16	
Sabellidae	indet.				1			2	
Euchone rubrocincta		1	1	6	3	2	7	11	4

Taxon	Qualifier	SBG1	SBG2	SBG3	SBG4	SBG5	SBG6	SBG7	SBG8
Jasmineira caudata		12	7	8	4	9	4	6	7
Anoplodactylus petiolatus						1			
Sessilia	juvenile	1							
Balanus balanus				1					
Verruca stroemia		36		23		1	1		
Copepoda					4	2	3	8	3
Myodocopida		2	18	1			25	18	2
Podocopida								1	
Phtisica marina		3	3		1	2	3	3	
Lysianassa plumosa							3	5	
Socarnes erythrophthalmus							1		
Acidostoma obesum			2		1				1
Apolochus neapolitanus									1
Gitana sarsi									1
Metaphoxus fultoni				1			5	13	4
Westwoodilla caecula				2		4			
Leucothoe lilljeborgi				1	2	1			
Ampelisca	juvenile	7	13	54	24	44	4	11	77
Ampelisca diadema					2				
Ampelisca provincialis		10	5	22	5	7	19	12	32
Aoridae	female	1					3	3	
Microdeutopus anomalus							1		
Othomaera othonis							1		
Cheirocratus	female	1	1			4	4	7	4
Cheirocratus intermedius								2	1
Gammaropsis maculata			1		1	1		1	
Photis longicaudata		3							12
Megamphopus cornutus					2				5
Corophiidae	sp. indet		1			1	6	5	1
Monocorophium sextonae							7	1	

Taxon	Qualifier	SBG1	SBG2	SBG3	SBG4	SBG5	SBG6	SBG7	SBG8
Leptocheirus pectinatus								1	
Dexamine spinosa							1	2	
Nototropis vedlomensis									1
Eurydice pulchra									1
Pseudoparatanais batei							4	3	1
Tanaissus danica		2	15	3	36	24	6	24	20
Iphinoe trispinosa						1			
Eudorella truncatula				9			2	7	3
Paguridae	juvenile	2	1	1		1			
Pagurus cuanensis						2			
Axiidea	juvenile								1
Galathea intermedia		2					12	1	
Caridea	indet.	2							
Eualus cranchii		2					1		
Processa nouveli holthuisi				1					
Crangonidae	indet.					1			
Philocheras bispinosus bispinosus									1
Liocarcinus	sp. juv							1	
Liocarcinus marmoreus	juvenile		1						
Hyas araneus		1							
Sepiola atlantica						1			
Chaetoderma nitidulum		3	2	1	1	1			
Polyplacophora	juvenile						3	3	1
Leptochiton asellus							2		
Leptochiton cancellatus							1	1	
Callochiton septemvalvis								2	
Cylichna cylindracea					1				
Laona quadrata					2		1		1
Testudinalia testudinalis							4	1	
Euspira nitida			1						

Taxon	Qualifier	SBG1	SBG2	SBG3	SBG4	SBG5	SBG6	SBG7	SBG8
Lacuna pallidula							1		
Turritellinella tricarinata		6	3	8	50	5			2
Brachystomia eulimoides					1				
Onoba semicostata			1						
Buccinum undatum	juvenile				1				
Nucula nucleus		1	5	5		2	2		2
Anomiidae	juvenile	1		1	1	4	21	1	
Mytilidae	juvenile	1					1		
Limaria loscombi								2	
Aequipecten opercularis						1	1		
Parvicardium pinnulatum								1	
Parvicardium scabrum					1	7	1	2	3
Thyasira flexuosa		4	13	28	128	42	36	40	58
Kurtiella bidentata			2		3	3			4
Abra alba						3			
Abra nitida		1		1	1	1			
Lucinoma borealis			1			3			
Lucinoma borealis	juvenile		1	2	1	1	1		1
Timoclea ovata									1
Chamelea striatula			1						
Chamelea striatula	juvenile				1	1			
Dosinia	juvenile				1				
Polititapes rhomboides	juvenile						1		
Mya arenaria								1	
Saxicavella jeffreysi								1	
Phaxas pellucidus					1				1
Phaxas pellucidus	juvenile					2			
Hiatella arctica									1
Thraciidae	juvenile					1			3
Thracia phaseolina								1	

Taxon	Qualifier	SBG1	SBG2	SBG3	SBG4	SBG5	SBG6	SBG7	SBG8
Phoronis	indet.	9	123	21	29	102	21	5	86
Hippothoa divaricata		P							
Hippothoa flagellum		P							
Aetea truncata		P					P	P	
Escharella immersa		P					P	P	
Escharoides coccinea		P					P		
Chorizopora brongniartii		P							
Fenestrulina malusii		P				P	P		
Microporella ciliata			P				P		
Bugulina fulva							P	P	
Disporella hispida		P	P						
Electra pilosa			P						
Crisia	indet.	P		P					
Crisidia cornuta								P	
Asterias rubens	juvenile	1						2	
Luidia sarsii	juvenile								1
Ophiuroidea		FRAG		FRAG	FRAG				
Ophiuroidea	juvenile				3				
Amphiura filiformis		2			1				
Amphipholis squamata		2					7	6	
Ophiothrix fragilis	juvenile				1				
Spatangoida	juvenile		2	2	3				1
Psammechinus miliaris	juvenile	1					5	2	
Cucumariidae	juvenile	1						FRAG	
Didemnidae				P					
Hemichordata							1		4
Chlorophyta					P				
Chlorophyta	Filamentous greens	P		P	P	P	P	P	P
Corallinaceae		P	P			P	P	P	
Corallina	indet.							P	

Taxon	Qualifier	SBG1	SBG2	SBG3	SBG4	SBG5	SBG6	SBG7	SBG8
Rhodophyta							P		
Rhodophyta	Encrusting red						P	P	P
Rhodophyta	Feathery reds							P	
Ochrophyta	Encrusting brown	P	P	P	P	P	P	P	P
Ochrophyta	Filamentous browns		P				P		
Ochrophyta	Foliaceous brown							P	

Plastics	P							
Plastic fibres	P		P			P		P
Paint chips		P				P		P
Ceramic bead			1					

TECHNICAL APPENDIX 5.5

SDWQ
Habitats Regulations Appraisal

May 2023

CONTROL SHEET

Client: Orkney Island Council Harbour Authority
Project Title: SDWQ
Report Title: Habitats Regulations Appraisal
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EnviroCentre Limited Office Locations:

Glasgow **Edinburgh** **Inverness** **Banchory**

Registered Office: Craighall Business Park 8 Eagle Street Glasgow G4 9XA
Tel 0141 341 5040 info@envirocentre.co.uk www.envirocentre.co.uk

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EXECUTIVE SUMMARY

Envirocentre Limited has been commissioned by Orkney Island Council Harbour Authority (OICHA) to undertake a Habitats Regulation Appraisal (HRA) to determine whether the proposed development of Scapa Deep Water Quay (SDWQ) will have any adverse impact on the integrity of any European designated sites.

The potential effects of the proposal on the designated features of the European designated site were considered as part of a Habitats Regulations Assessment. Likely Significant Effects (LSE) on Scapa Flow Special Protection Area (SPA), Orkney Mainland Moors SPA, Hoy SPA and Sanday Special Area of Conservation (SAC) could not be ruled out during the screening stage of the assessment; and so an Appropriate Assessment (AA) has been conducted to ascertain whether the proposed works will adversely affect the integrity of the site's qualifying features.

During the AA process it was possible to rule out adverse effects from impacts to the assessed designated sites. Mitigation to be enacted includes:

- Vessels to adhere to strict speed limits;
- Deployment of an Ornithologist and marine mammal observer to monitor for the presence of qualifying species of the Scapa Flow SPA, and cetaceans and pinnipeds (in particular harbour seal) in the vicinity of the Proposed Development during piling and blasting works;
- A soft-start approach to piling works to prevent disturbance;
- Production and adherence to detailed Marine Mammal Protection Plan (MMPP);
- Production and adherence to a detailed Pollution Prevention Plan; and
- A silt boom to contain fine sediments will be used whilst work activities are undertaken.

Contents

Tables

1 INTRODUCTION

1.1 Terms of Reference

Envirocentre Limited has been commissioned by Orkney Island Council Harbour Authority (OICHA) to undertake a Habitats Regulation Appraisal (HRA) to determine whether the proposed development of Scapa Deep Water Quay (SDWQ) will have any adverse impact on the integrity of any European designated sites.

1.2 Scope of Report

A HRA is required to assess whether the project, alone or in combination with other projects, will have an adverse impact on the integrity of the European designated site. It is the responsibility of the competent authority to conduct the HRA. This document aims to provide the information necessary for them to carry out Stage One of the assessment (Screening) by:

- Providing a description of the proposed works;
- Identifying those European designated sites which are connected to and/or could potentially be affected by the proposed works;
- Identifying how the proposed works may impact on the qualifying features of the designated site(s);
- Considering other projects which may have “in combination” effects on the European designated sites; and
- Recommending the designated sites which need to be taken forward for further assessment if impacts on their qualifying features cannot be ruled out.

1.3 Report Usage

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2 METHODOLOGY

2.1 The Habitats Regulations Appraisal Process

The HRA is a four-stage process. An important aspect of the process is that the outcome at each successive stage determines whether a further stage in the process is required. The stages are summarised in Table 2-1. It is stated within the EU guidelines that “where, without any detailed assessment at the screening stage, it can be assumed (because of the size or scale of the project or the characteristics of the national site network) that significant effects are likely, it will be sufficient to move directly to the appropriate assessment (Stage Two) rather than complete the screening assessments explained below.”

Table 2-1 Key Stages in the HRA Process

Stage 1	
Screening for Likely Significant Effect (LSE)	- Identify international sites in and around the project area. - Examine conservation objectives of the interest feature(s) (where available). - Review plan policies and proposals and consider potential effects on UK sites (magnitude, duration, location, extent). - Examine other plans and programmes that could contribute to ‘in combination’ effects.
	- If no effects likely – report no likely significant effect. - If effects are judged likely or uncertainty exists – the precautionary principle applies, proceed to Stage 2. - If following screening the project is reviewed and includes integral mitigation which will ensure no likely significant effects, then no further Appropriate Assessment needed.
Stage 2	
Appropriate Assessment (AA)	- Complete additional scoping work including the collation of further information on sites as necessary to evaluate impact in light of conservation objectives. - Agree scope and method of AA with the competent authority. - Consider how the project ‘in combination’ with other projects will interact when implemented (the Appropriate Assessment). - Consider how effects on integrity of the site could be avoided by changes to the project and the consideration of alternatives. - Develop mitigation measures (including timescale and mechanisms). - Report outcomes of AA including mitigation measures.
	- If the project will not adversely affect European site integrity proceed with plan. - If effects or uncertainty remain following the consideration of alternatives and development of mitigation proceed to Stage 3.
Stage 3	
Alternative Solutions	- Consider alternative solutions, delete from project or modify. - Consider if priority species/habitats affected - identify ‘imperative reasons of overriding public interest’ (IROPI), economic, social, environmental, human health, public safety (only applicable in highly exceptional circumstances).
Stage 4	
Imperative Reasons of Overriding Public Interest (IROPI)	- Stage 4 is the main derogation process of Article 6(4) which examines whether there are imperative reasons of overriding public interest (IROPI) for allowing a plan or project that will have adverse effects on the integrity of a UK site to proceed in cases where it has been established that no less damaging alternative solution exists. - The extra protection measures for Annex I priority habitats come into effect when making the IROPI case. Compensatory measures must be proposed and assessed. The Commission must be informed of the compensatory measures.

	Compensatory measures must be practical, implementable, likely to succeed, proportionate and enforceable, and they must be approved by the Minister.

2.2 Screening

Screening determines whether or not the project is likely to (or potentially could) have significant effects on the national site network. A list of all SACs, cSACs, SPAs and potential SPAs (pSPAs) that are within proximity to the site, or sites designated for mobile species which have the potential to be affected by the proposed development, was compiled and the qualifying interest features noted. Following this, the key environmental conditions (conservation objectives) needed to support site integrity were detailed for each site.

With reference to the NatureScot guidance[1]the screening stage determines whether Appropriate Assessment is required, by:

- Determining whether a project (or plan) is directly connected with or necessary to the conservation management of any European sites;
- Describing the details of the project (or plan) proposals and other projects that may cumulatively affect any European sites;
- Describing the characteristics of relevant European sites; and
- Appraising likely significant effects (LSE) of the proposed project on relevant European sites.

The guidance gives the following definition of LSE:

"The test of significance is where a plan or project could undermine the site's conservation objectives. The assessment of that risk (of 'significance') must be made in the light, amongst other things, of the characteristics and specific environmental conditions of the site concerned."

*"A likely effect is one that cannot be ruled out on the basis of objective information. The test is a 'likelihood' of effects rather than a 'certainty' of effects. Although some dictionary definitions define 'likely' as 'probable' or 'well might happen', in the Waddenzee case the European Court of Justice ruled that a project should be subject to Appropriate Assessment "**if it cannot be excluded, on the basis of objective information, that it will have a significant effect on the site, either individually or in combination with other plans and projects**". Therefore, 'likely', in this context, should not simply be interpreted as 'probable' or 'more likely than not', but rather whether a significant effect can objectively be ruled out."*

2.3 Screening Conclusion

The outcome of screening for appropriate assessment is to reach one of the following determinations:

a) A Stage Two AA of the proposed development is required if it cannot be excluded, on the basis of objective information, that the proposed development, individually or in combination with other plans or projects, will have a significant effect on a European site.
b) A Stage Two AA of the proposed development is not required if it can be excluded, on the basis of objective information, that the proposed development, individually or in combination with other plans or projects, will have a significant effect on a European site

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[1] NatureScot, formerly SNH guidance available at : https://www.nature.scot/sites/default/files/2019-07/Habitats%20Regulations%20Appraisal%20of%20Plans%20-%20plan-making%20bodies%20in%20Scotland%20-%20Jan%202015.pdf (Accesses 20/12/2022)

2.4 Appropriate Assessment

The Appropriate Assessment establishes whether or not a project's LSE identified during the screening stage will have an adverse effect on the integrity of the affected site with regard to its conservation objectives. Based on the guidance provided by NatureScot guidance the effects of the proposal on the designated sites' qualifying features will determined by:

- Gathering information required to assess impacts (from site documents, scientific literature, EU and UK guidance on impact assessment and impact assessments from similar projects);
- Predicting the type and nature of impacts e.g. direct or indirect, short or long term;
- Assessing whether there will be adverse effects on the integrity of the site as defined by the conservation objectives and the status of the site. The precautionary principle must be applied at this stage. If it cannot be demonstrated with supporting evidence that there will be no adverse effects then adverse effects will be assumed; and
- Ascertaining if it is possible to mitigate adverse effects.

2.1 In-Combination Effects

Under Regulation 43(1)(a) of the Habitats Regulations 1995 (as amended) it is necessary to consider whether a plan or project is likely to have a significant effect on a national site network site "either alone or in combination with other plans or projects."

These should include:

- Approved but as yet uncompleted plans or projects;
- Plans and projects for which an application has been made and which are currently under consideration but not yet approved by the competent authorities; and
- Permitted ongoing activities such as discharge consents, abstraction licences or consecutive/simultaneous maintenance activities.

3 DESCRIPTION OF THE PROPOSED DEVELOPMENT

3.1 Site Location

The proposed development is located on the southern shore of the Orkney mainland, approximately 8km south of Kirkwall. It is located on the coastline within Scapa Flow, approximately 4km south of the existing Scapa Pier and approx. 835m from a fish farm site to south.

3.2 Project Description

The main purpose of this facility would be to undertake multiple industrial activities that require both deep-water berthing and large laydown area. It is envisaged that the main activity will be the construction/assembly and maintenance of offshore wind turbines. This is also a potential location for the development of a storage and supply hub for future marine fuels. There will also be an access road from the A961 to the site.

It is proposed that the main quay berth depth at the site should be a minimum of minus 15m to CD with a further phased deep water site to between minus 20 and 24m CD to allow for potential future requirements.

In summary, the proposed development contains the following components during each Phase:

Phase 1

- Installation of an access road from the A961 to the site;
- Excavation of current landform along with reclamation of shore to form 12Ha of laydown area bounded by bunds on the north and eastern edges;
- Creation of 450m of berthing by formation of a quay 300m x ~46m wide with a 100m wide section on the northern edge providing water depth of up to -15m CD; and
- Dredging adjacent to the newly formed quay.

Phase 2

- Excavation of current landform along with reclamation of shore to form an additional 6Ha of laydown area to the south of Phase 1 laydown area. The bund on the eastern edge will be extended along the length of the new laydown area and partially along the southern edge;
- Extension of the Phase 1 quay area by 275m x ~46m to the south; and
- Dredging adjacent to the newly formed quay extension to provide -15m CD water depth.

Phase 3

- Dredging on the northern side of the newly formed quay extension to provide -20m CD water depth.

4 SCREENING FOR LIKELY SIGNIFICANT EFFECT

4.1 Likely Significant Effect

For significant effects to arise, there must be a risk enabled by having a 'source' (e.g. construction works at a proposed development site), a 'receptor' (e.g. a European site or its qualifying interests), and a pathway between the source and the receptor (e.g. mobile marine species travelling between the proposed development site and the designated site). The identification of a pathway does not automatically mean that significant effects will arise. The likelihood for significant effects will depend upon the characteristics of the source (e.g. duration of construction works), the characteristics of the pathway (e.g. what species and the number of individuals travelling between the two sites) and the characteristics of the receptor (e.g. the sensitivities of the European site and its qualifying interests).

NatureScot (2015) guidance states that sites with mobile species should be considered within the screening process where there is a significant ecological link between the designated site and the proposed development site. It also states that for developments which could increase recreational pressures on designated sites, all sites within reasonable travel distance of the development should be considered for screening. It is also necessary to consider sites which are part of the same coastal ecosystem, where the proposed development may affect coastal processes.

4.2 Relevant European Sites

The following sites have been scoped in for assessment due to them being within proximity to the site and/ or considered connected to the site via dispersal of designated mobile species:

- Scapa Flow SPA
- North Orkney SPA
- Orkney Mainland Moors SPA
- Hoy SPA
- Loch of Stenness SAC
- Sanday SAC

The sites are listed in Table 4-1, along with their screening assessment The location of the designated site in relation to the proposed development is shown in Appendix A.

4.2.1 In-Combination Effects

- Orkney Islands Council (OIC) identified the following projects which should be considered in-combination with the proposed development within the EIA scoping response[2]:Proposal to demolish household waste and recycling centre and former abattoir to create an integrated waste facility (Planning application 21/015/SCR).
- Erection of 6 wind turbines, a meteorological mast and substation with associated access tracks and infrastructure (Planning application 20/037/TPPMAJ)
- Extension of Kirkwall pier to provide additional quay infrastructure, reclaim land to create a mixed-use development are and reconfigure and the expand marina (20/240/SCR)

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[2] Planning reference 21/159/SCO

Table 4-1: List of European Designated Sites within proximity to the site along with their Qualifying Features and Screening Assessment for Likely Significant Effects

Site Name (distance and orientation from works)	**Conservation Objectives**	**Qualifying Features**	**Likely Significant Effect (LSE)**	**Screening Assessment**
Scapa Flow SPA (On site)	To ensure that the qualifying features of the Scapa Flow SPA are in favourable condition and make an appropriate contribution to achieving Favourable Conservation Status.	Great northern diver, non-breeding	Pathway for LSE identified. There is potential for the species to be subject to disturbance during the construction and operational phase of the proposed development via temporary noise from piling, dredging and vessel and onshore vehicle movements. This could result in displacement from the habitat and a reduction in overall foraging habitat.	Scoped in
		Long-tailed duck (*Clangula hyemalis*), non-breeding	Pathway for LSE identified. There is potential for the species to be subject to disturbance during the construction and operational phase of the proposed development via temporary noise from piling, dredging and vessel and onshore vehicle movements. This could result in displacement from the habitat and a reduction in overall foraging habitat	Scoped in
		Red-breasted merganser (*Mergus serrator*), non-breeding	Pathway for LSE identified. There is potential for the species to be subject to disturbance during the construction and operational phase of the proposed development via temporary noise from piling, dredging and vessel and onshore vehicle movements. This could result in displacement from the habitat and a reduction in overall foraging habitat	Scoped in
		Red-throated diver, breeding	Pathway for LSE identified. During the construction and operational phase of the proposed development foraging Red-throated Divers could be impacted temporarily by noise from piling, dredging and vessel and onshore vehicle movements. This could result in displacement from the habitat and a reduction in overall foraging habitat.	Scoped in

Site Name (distance and orientation from works)	**Conservation Objectives**	**Qualifying Features**	**Likely Significant Effect (LSE)**	**Screening Assessment**
		Shag (*Phalacrocorax aristotelis*), non-breeding	Pathway for LSE identified. There is potential for the species to be subject to disturbance during the construction and operational phase of the proposed development via temporary noise from piling, dredging and vessel and onshore vehicle movements. This could result in displacement from the habitat and a reduction in overall foraging habitat	Scoped in
		Slavonian grebe (*Podiceps auritus*), non-breeding	Pathway for LSE identified. There is potential for the species to be subject to disturbance during the construction and operational phase of the proposed development via temporary noise from piling, dredging and vessel and onshore vehicle movements. This could result in displacement from the habitat and a reduction in overall foraging habitat	Scoped in
		Great northern diver, non-breeding	Pathway for LSE identified. There is potential for the species to be subject to disturbance during the construction and operational phase of the proposed development via temporary noise from piling, dredging and vessel and onshore vehicle movements. This could result in displacement from the habitat and a reduction in overall foraging habitat	Scoped in
		Long-tailed duck (*Clangula hyemalis*), non-breeding	Pathway for LSE identified. There is potential for the species to be subject to disturbance during the construction and operational phase of the proposed development via temporary noise from piling, dredging and vessel and onshore vehicle movements. This could result in displacement from the habitat and a reduction in overall foraging habitat	Scoped in
North Orkney SPA (4 km north east)	To ensure that the qualifying features of the North Orkney SPA are in	Great northern diver (*Gavia immer*), non-breeding	As there is no works planned across land and given the hydrological distance from the site and North Orkney SPA, it is considered unlikely the species will be subject to direct impacts from development activities or indirectly via accidental pollution events. No LSE is predicted.	Scoped out

Site Name (distance and orientation from works)	**Conservation Objectives**	**Qualifying Features**	**Likely Significant Effect (LSE)**	**Screening Assessment**
	favourable condition and make an appropriate contribution to achieving Favourable Conservation Status.	Red-throated diver (*Gavia stellata*), breeding	As there is no works planned across land and given the hydrological distance from the site and North Orkney SPA, it is considered unlikely the species will be subject to direct impacts from development activities or indirectly via accidental pollution events. No LSE is predicted.	Scoped out
		Slavonian grebe (*Podiceps auritus*), non-breeding	As there is no works planned across land and given the hydrological distance from the site and North Orkney SPA, it is considered unlikely the species will be subject to direct impacts from development activities or indirectly via accidental pollution events. No LSE is predicted.	Scoped out
		Velvet scoter (*Melanitta fusca*), non-breeding	As there is no works planned across land and given the hydrological distance from the site and North Orkney SPA, it is considered unlikely the species will be subject to direct impacts from development activities or indirectly via accidental pollution events. No LSE is predicted.	Scoped out
Orkney Mainland Moors SPA (6km north west)	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.	Hen harrier (*Circus cyaneus*), breeding	Pathway for LSE identified. Pendlebury et al. (2011) state that the maximum foraging range from nests is 2km for females and males can travel up to 8.5km from a nest site. Hen harriers can utilise coastal areas to predate waders, therefore it is It possible that birds breeding within the SPA could utilise the water within the proposed harbour area for foraging. During the construction phase of the proposed development foraging Hen Harriers could be impacted temporarily by noise from piling, dredging and vessel and onshore vehicle movements. This could result in displacement from the habitat and a reduction in overall foraging habitat. However as Hen harriers favour heather moorland and stream habitat when nesting, and there are plenty of accessible coastal areas outside the working area available, it is unlikely that works associated with the Scapa site will have a significant effect on the foraging success of breeding Hen Harrier.	Scoped out

Site Name (distance and orientation from works)	**Conservation Objectives**	**Qualifying Features**	**Likely Significant Effect (LSE)**	**Screening Assessment**
		Hen harrier non-breeding	Pathway for LSE identified. It possible that birds within the SPA could utilise the water within the proposed harbour area for foraging. During the construction phase of the proposed development foraging Hen Harriers could be impacted temporarily by noise from piling, dredging and vessel and onshore vehicle movements. This could result in displacement from the habitat and a reduction in overall foraging habitat. However, as winter foraging Hen Harriers favour open rank habitats for foraging, and there are plenty of accessible coastal areas outside the working area available, it is unlikely that works associated with the pier will have a significant effect on the foraging success of foraging Hen Harrier in the locale.	Scoped out
		Red-throated diver, breeding	Pathway for LSE identified. Pendlebury et al. (2011) state that the maximum foraging range from nests during the breeding season is generally 8km for Red-throated Diver but can be up to 13.5km in the Western Isles. It is possible that birds breeding within the SPA could utilise the water within the proposed works area for foraging. During the construction phase of the proposed development foraging Red-throated Divers could be impacted temporarily by noise from piling, dredging and vessel and onshore vehicle movements. This could result in displacement from the habitat and a reduction in overall foraging habitat.	Scoped in
		Short-eared owl (*Asio flammeus),* breeding	No pathway identified. No potential impacts to breeding Short- eared owl or their habitat within the SPA are predicted due to the distance between the SPA and the proposed development and the species not being associated with coastal habitats. No LSE is predicted.	Scoped out

Site Name (distance and orientation from works)	**Conservation Objectives**	**Qualifying Features**	**Likely Significant Effect (LSE)**	**Screening Assessment**
Hoy SPA (16.5 km west)	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.	Arctic skua (*Stercorarius parasiticus*), breeding	Pathway for LSE identified. It possible that birds within the SPA could utilise the water within the proposed works area for foraging. During the construction phase of the proposed development foraging Arctic Skua could be impacted temporarily by noise from piling, dredging and vessel and onshore vehicle movements. This could result in displacement from the habitat and a reduction in overall foraging habitat.	Scoped in
		Fulmar (*Fulmarus glacialis*), breeding	Pathway for LSE identified. It possible that birds within the SPA could utilise the water within the proposed works area for foraging. During the construction phase of the proposed development foraging Fulmar could be impacted temporarily by noise from piling, dredging and vessel and onshore vehicle movements. This could result in displacement from the habitat and a reduction in overall foraging habitat.	Scoped in
		Great black-backed gull (*Larus marinus*), breeding	Pathway for LSE identified. It possible that birds within the SPA could utilise the water within the proposed works area for foraging. During the construction phase of the proposed development foraging Great Black-backed Gull could be impacted temporarily by noise from piling, dredging and vessel and onshore vehicle movements. This could result in displacement from the habitat and a reduction in overall foraging habitat.	Scoped in

Site Name (distance and orientation from works)	**Conservation Objectives**	**Qualifying Features**	**Likely Significant Effect (LSE)**	**Screening Assessment**
		Great skua (*Stercorarius skua*), breeding	Pathway for LSE identified. It possible that birds within the SPA could utilise the water within the proposed works area for foraging. During the construction phase of the proposed development foraging Great Skua could be impacted temporarily by noise from piling, dredging and vessel and onshore vehicle movements. This could result in displacement from the habitat and a reduction in overall foraging habitat.	Scoped in
		Guillemot (*Uria aalge*), breeding	Pathway for LSE identified. It possible that birds within the SPA could utilise the water within the proposed works area for foraging. During the construction phase of the proposed development foraging Guillemot could be impacted temporarily by noise from piling, dredging and vessel and onshore vehicle movements. This could result in displacement from the habitat and a reduction in overall foraging habitat.	Scoped in
		Kittiwake (*Rissa tridactyla*), breeding	Pathway for LSE identified. It possible that birds within the SPA could utilise the water within the proposed works area for foraging. During the construction phase of the proposed development foraging Kittiwake could be impacted temporarily by noise from piling, dredging and vessel and onshore vehicle movements. This could result in displacement from the habitat and a reduction in overall foraging habitat.	Scoped in
		Peregrine (*Falco peregrinus*), breeding	No Pathway for LSE identified. The core foraging range for Peregrine is 2km. The site is located 16.5km from the SPA. Therefore at the distance It is unlikely for birds from within the SPA utilise the site for foraging.	Scoped out

Site Name (distance and orientation from works)	**Conservation Objectives**	**Qualifying Features**	**Likely Significant Effect (LSE)**	**Screening Assessment**
		Puffin (*Fratercula arctica*), breeding	No Pathway for LSE identified. No Puffin were recorded during any of the surveys undertaken at the site. Therefore it is considered birds from the SPA are present within the site and environs.	Scoped out
		Red-throated diver (*Gavia stellata*), breeding	No Pathway for LSE identified. Pendlebury et al. (2011) state that the maximum foraging range from nests during the breeding season is generally 8km for Red-throated Diver but can be up to 13.5km in the Western Isles. The site is located 16.5km from the SPA. Therefore at the distance It is unlikely for birds from within the SPA utilise the site for foraging.	Scoped out
		Seabird assemblage, breeding	Pathway for LSE identified. It possible that bird assemblages within the SPA could utilise the water within the proposed works area for foraging. During the construction phase of the proposed development foraging Hen Harriers could be impacted temporarily by noise from piling, dredging and vessel and onshore vehicle movements. This could result in displacement from the habitat and a reduction in overall foraging habitat.	Scoped in
Loch of Stenness SPA (16km north west)	To maintain the condition of the SAC feature	Lagoons	No pathway for LSE identified At its nearest point the site is 16km north west of the proposed development. No alterations to coastal processes are predicted at these distances and no significant sediment transportation is likely	Scope out

Site Name (distance and orientation from works)	**Conservation Objectives**	**Qualifying Features**	**Likely Significant Effect (LSE)**	**Screening Assessment**
Sanday SAC (36km north east)	To avoid deterioration of the qualifying habitats 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 habitats are maintained in the long term:	Harbour seal (*Phoca vitulina*)	Pathway for LSE identified. There is potential for the species to be subject to disturbance as a result of noise, vibration, human presence and light pollution during construction activities. There is potential for the species to be indirectly impacted by accidental pollution incidents or increased sedimentation and turbidity during works impacting water quality and therefore food availability. Harbour seals could be subject to death or injury through underwater noise or collision with vessels during works.	Scoped in
		Intertidal mudflats and sandflats	No pathway for LSE identified At its nearest point the site is 16km north west of the proposed development. No alterations to coastal processes are predicted at these distances and no significant sediment transportation is likely	Scoped out
		Reefs	No pathway for LSE identified At its nearest point the site is 16km north west of the proposed development. No alterations to coastal processes are predicted at these distances and no significant sediment transportation is likely	Scoped out
		Subtidal sandbanks	No pathway for LSE identified At its nearest point the site is 16km north west of the proposed development. No alterations to coastal processes are predicted at these distances and no significant sediment transportation is likely	Scoped out

4.3 Screening Conclusion

The outcome of screening for appropriate assessment is to reach one of the following determinations:

a) A stage 2 AA of the proposed development is required if it is concluded, on the basis of objective information, that the proposed development, individually or in combination with other plans or projects, will have a significant effect on a European site.
b) A stage two AA of the proposed development is not required if it can be concluded, on the basis of objective information, that the proposed development, individually or in combination with other plans or projects, will not have a significant effect on a European site.

Following an examination, analysis and evaluation of the relevant information including, in particular, the nature of the proposed development and the likelihood of significant effects on scoped in designated sites

- Scapa Flow SPA;
- Orkney Mainland Moors SPA (Red-throated Diver)
- Hoy SPA (Arctic Skua, Great Skua, Fulmar, Great Black-backed Gull, Kittiwake and Guillemot); and
- Sanday SAC (Harbour Seal)

5 APPROPRIATE ASSESSMENT: SCAPA FLOW SPA

5.1 Site Description

The Scapa Flow SPA comprises a total area of 31819 ha located within Scapa Flow, an enclosed sea area, sheltered by Mainland Orkney to the north, Hoy, South Walls and Flotta to the west and south, and Burray and South Ronaldsay to the east. The Flow is linked to the Pentland Firth in the south through the Sound of Hoxa, and to the Atlantic Ocean in the west through Hoy Sound. The site also includes nearshore waters to the east of Orkney, extending from South Ronaldsay to Deerness, and including the sheltered shallow waters of Holm Sound, between Burray and East Mainland. It encompasses a range sheltered and diverse marine communities which provide a range of food resource for breeding, moulting and roosting sea birds.

The SPA supports the following species:

- The third largest population of wintering Great Northern Diver (c.20% of the GB population or 500 individuals).
- Wintering Black-throated Diver (c. 9.5% of the GB population or 57 individuals).
- Wintering Slavonian Grebe (c.12% of GB population or 135 birds)
- The second largest population of wintering European shag in Scotland (c.3% of GB population or 2927 individuals)
- Wintering Common Eider (3% of GB population or 1997 individuals)
- Wintering Red-breasted Merganser (6% of GB population or 539 individuals)
- Wintering Long-tailed Duck (13% of GB population or 1395 individuals)
- Red-throated Diver (c.6% of GB population or 76 pairs) breeding within fresh water lochans within 10km of the SPA.

All the designated site features are assessed as favourable.

5.2 Conservation Objectives

The conservation objectives for Scapa Flow SPA are as follows:

1. To ensure that the qualifying features of the Scapa Flow SPA are in favourable condition and make an appropriate contribution to achieving Favourable Conservation Status.

2. To ensure that the integrity of the Scapa Flow SPA is maintained in the context of environmental changes by meeting objectives 2a, 2b and 2c for each qualifying feature:

> 2a. The populations of qualifying features are viable components of the site.
>
> 2b. The distribution of the qualifying features is maintained throughout the site by avoiding significant disturbance of the species.
>
> 2c. The supporting habitats and processes relevant to qualifying features and their prey/food resources are maintained.

5.3 Great Northern Diver, non-breeding

5.3.1 Assessment of Potential Impacts on Conservation Objectives

5.3.1.1 Conservation Objective 2a: The populations of qualifying features are viable components of the site

During the vantage point surveys undertaken between 2020 and 2022, a peak count of 27 Great Northern Divers were recorded within 1km of the Proposed Development, with a peak of 38 birds within 2km. This correlates well with the inshore surveys undertake by HiDef for NatureScot, where a peak count of 28 birds were recorded in the same general area in January 2022. The peak of 38 birds represents ~7.5% of the Scapa Flow SPA population.

As can be seen in the density heat maps produced in Technical Appendix 5.3: Scapa Deep Water Quay Ornithology Technical Report, birds were recorded within the Proposed Development footprint area, although in small numbers (usually singles, with a peak count of four birds on 17th February 2022).

The Proposed Development will result in the loss of 32Ha of the Scapa Flow SPA. This equates to 0.1% of the total SPA area. The wider SPA site has the capacity to accommodate Great Northern Divers that utilise the current Proposed Development site boundary for foraging.

There is minimal risk of mortality through collision with marine vessels as a result of the Proposed Development. Other direct effects affecting water quality is dealt with in Conservation Objective 2c and indirect effects (ie disturbance resulting in reduced body condition and survival) are dealt with in Conservation Objective 2b.

With no predicted impacts in either conservation Objectives 2b and 2c, it is considered that the population of Great Northern Diver remain a viable component of the site.

5.3.1.2 Conservation Objective 2b: The distribution of the qualifying features is maintained throughout the site by avoiding significant disturbance of the species

During the vantage point surveys undertaken between 2020 and 2022, a peak count of 27 Great Northern Divers were recorded within 1km of the Proposed Development, with a peak of 38 birds within 2km. This correlates well with the inshore surveys undertake by HiDef for NatureScot, where a peak count of 28 birds were recorded in the same general area in January 2022. The peak of 38 birds represents ~7.5% of the Scapa Flow SPA population.

As can be seen in the density heat maps produced in Technical Appendix 5.3: Scapa Deep Water Quay Ornithology Technical Report, birds were recorded within the Proposed Development footprint area, although in small numbers (usually singles, with a peak count of four birds on 17th February 2022).

Disturbance may occur through piling activities during the construction phase. It is not currently known the exact method to be used for construction, however applying the precautionary principle, blasting may be required. Blasting could have the potential to cause disturbance to this species. Blasting would be staggered in time to avoid simultaneous blast waves. Mitigation, such as a soft start approach and an ECoW monitoring for the presence of this species prior to piling works (with works to be undertaken once birds are a sufficient distance away), would limit any potential disturbance impact. This localised and short-term impact would not result in significant Impacts to Great Northern Diver within the SPA.

During the ornithological surveys undertaken between 2020 and 2022, bird and boat interactions were recorded. For Great Northern Diver, there were 18 observations of interactions with boats. Of these, five resulted in no reaction, seven resulted in birds swimming away slowly and six were of birds diving. There were no instances of boat movements causing a flight response.

The majority of material (rock etc) required for the development will be transported via the road network. It is not currently known how many vessel movements will occur during construction works, but it is anticipated that there will not be a significant increase in marine vessel movements during construction.

The Navigational Risk Assessment carried out (Technical Appendix 2.2) documents the predicted operational traffic movements associated with the new quay. Operational vessel movements provided within the NRA can be summarised as follows:

- Delivery and installation vessel movements are noted as being 18 and 8 respectively for 2028;
- 2029 shows delivery vessel movements as 19 calls in total with 12 delivery vessel calls;
- Similarly for 2030 delivery and installation vessel calls are 18 and 9;
- For 2031 delivery calls decrease to 8 but installation vessel calls increase to 19.

Although Great Northern Divers are known to be highly sensitive to disturbance through vessel movements, this level of increased vessel movements (between 1 and 2 every month) is not likely to result in significant effects on Great Northern Diver.

None of these potential disturbance effects will result in barriers to movement, or reduce access to, preferred foraging and roosting habitats, resulting in a significant energy expenditure and possible reduction in body condition required for survival and subsequent migration.

Therefore, it is considered that distribution of Great Northern Diver will be maintained throughout the site.

5.3.1.3 Conservation Objective 2c: The supporting habitats and processes relevant to qualifying features and their prey/food resources are maintained

As described in NatureScot's Conservation and Management Advice Document for Scapa Flow SPA[3], supporting habitats refer to the characteristics of the seabed and water column relevant to their use by the qualifying features. It relates to wider oceanographic processes such as up-wellings, tidal Flows, hydrological movements which may be necessary for the habitat and could affect nutrient cycling and prey distribution.

In section 4.7.2.4 in Volume 1, hydrodynamic modelling has shown that during the construction and operational phases, low current speeds and corresponding low bed shear stresses observed remain, as under existing baseline conditions, indicative of a low energy environment and that any impacts are negligible. Therefore, post-construction, prey items for Great Northern Diver (fish species) will remain as existing.

During construction, dredging activities will occur. The dredge volume is estimated to be 174,000m^3, based on the bathymetry surveys and proposed berth design. As outlined in section **Error! Reference source not found.** in Volume 1 of the EIAR, the marine deposits within the dredge area comprise an approximate stratigraphic order comprising superficial marine deposits (loose to medium dense

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[3] NatureScot: Conservation and Management Advice Scapa Flow SPA, UK Site: 9020321, June 2022

gravelly silty sands with shell fragments and occasional cobbles) overlying glacial till. A Dredging Best Practicable Environmental Option Report (BPEO) has been produced for the proposed development which identifies the dredge budget to consist of approximately 17% gravel, 60% sand, and 23% silt and clay.

Dredge plume dispersal modelling has been undertaken, utilising a hydrodynamic model, as described in Technical Appendix 4.1, Volume 3 of this EIAR. The model results highlight that due to the relatively coarse nature of the dredge budget, and the weak tidal currents within the vicinity of the proposed dredge pockets, plumes generated as a result of the dredging works will be very localised and short term in duration. Due to the low current speeds, any sands and gravels lost to the water column during dredging will fall out of suspension immediately, within the dredge footprint. Clay and silt lost to the water column during dredging will remain in suspension for longer, being dispersed gradually over the tidal cycle, with the residual dominance of ebb tide currents resulting in net northwards plume dispersal. Total suspended solids concentrations are predicted to be low, highest within the dredge zone and immediate surrounds of the dredger, decreasing towards the plume limits.

Due to the small potential volume of any dredge budget disposed direct to the sea bed, it is considered that any impacts from this activity would be localised in extent, and of short duration. Therefore, it is considered the magnitude of impact of sediment discharge and dispersion from dredging works will be low within the dredge area and immediate vicinity, and negligible out with this area, thus the supporting habitats for Great Northern Diver will be maintained.

There is the risk of pollution events (oil spills etc) during both the construction and operational phases of the Proposed Development. Adherence to strict Pollution Prevention controls and the use of silt booms during land reclamation works will mitigate against pollution spills which could affect the qualifying interest of the SPA and their prey sources. Therefore, the supporting habitats for Great Northern Diver will be maintained.

In terms of surface water pollution, drainage will be designed to ensure that there are no untreated surface water discharges directly to surrounding coastal waters. Suitable prevention measures will be in place at all times to prevent the release of pollutants to the water environment, including adjacent coastal waters. Again, with this in place, the supporting habitats for Great Northern Diver will be maintained.

5.3.1.4 Conservation Objective 1: To ensure that the qualifying features of the Scapa Flow SPA are in favourable condition and make an appropriate contribution to achieving Favourable Conservation Status.

It is predicted that, with mitigation, there will be no significant impacts on Conservation Objectives 2a to 2c. Therefore, the favourable condition of Great Northern Diver in Scapa Flow SPA will be maintained.

5.4 Black-throated Diver, non-breeding

5.4.1 Assessment of Potential Impacts on Conservation Objectives

5.4.1.1 Conservation Objective 2a: The populations of qualifying features are viable components of the site

During the vantage point surveys undertaken between 2020 and 2022, a peak count of 10 Black-throated Divers were recorded within 1km of the Proposed Development, with a peak of 11 birds within 2km. This correlates well with the inshore surveys undertake by HiDef for NatureScot, where a peak count of 14 birds were recorded in the same general area in January 2022. The peak of 11 birds represents 28% of the Scapa Flow SPA population, with the peak of 14 birds during the HiDef surveys representing 36% of the SPA population.

As can be seen in the density heat maps produced in Technical Appendix 5.3: Scapa Deep Water Quay Ornithology Technical Report, birds were recorded within the Proposed Development footprint area, although in small numbers (singles). However, there were two instances of higher numbers with a peak count of seven birds on 12th October 2021 and six on 17th November 2022.

The Proposed Development will result in the loss of 32Ha of the Scapa Flow SPA. This equates to 0.1% of the total SPA area. The wider SPA site has the capacity to accommodate Black-throated Divers that utilise the current Proposed Development site boundary for foraging.

There is minimal risk of mortality through collision as a result of the Proposed Development. Other direct effects affecting water quality is dealt with in Conservation Objective 2c and indirect effects (ie disturbance resulting in reduced body condition and survival) are dealt with in Conservation Objective 2b.

With no predicted impacts in either conservation Objectives 2b and 2c, it is considered that the population of Black-throated Diver remains a viable component of the site.

5.4.1.2 Conservation Objective 2b: The distribution of the qualifying features is maintained throughout the site by avoiding significant disturbance of the species

During the vantage point surveys undertaken between 2020 and 2022, a peak count of 10 Black-throated Divers were recorded within 1km of the Proposed Development, with a peak of 11 birds within 2km. This correlates well with the inshore surveys undertake by HiDef for NatureScot, where a peak count of 14 birds were recorded in the same general area in January 2022. The peak of 11 birds represents 28% of the Scapa Flow SPA population, with the peak of 14 birds during the HiDef surveys representing 36% of the SPA population.

As can be seen in the density heat maps produced in Technical Appendix 5.3: Scapa Deep Water Quay Ornithology Technical Report, birds were recorded within the Proposed Development footprint area, although in small numbers (singles). However, there were two instances of higher numbers with a peak count of seven birds on 12th October 2021 and six on 17th November 2022.

Disturbance may occur through piling activities during the construction phase. It is not currently known the exact method to be used for construction, however applying the precautionary principle, blasting may be required. Blasting could have the potential to cause disturbance to this species. Blasting would be staggered in time to avoid simultaneous blast waves. Mitigation, such as a soft start approach and an ECoW monitoring for the presence of this species prior to piling works (with works to be undertaken once birds are a sufficient distance away), would limit any potential disturbance impact. This localised and short-term impact would not result in significant Impacts to Black-throated Diver within the SPA

During the ornithological surveys undertaken, bird and boat interactions were recorded. For Black-throated Diver, there were six observations of interactions with boats. Of these, four resulted in birds swimming away slowly and two were of birds diving. There were no instances of boat movements causing a flight response.

The majority of material (rock etc) required for the development will be transported via the road network. It is not currently known how many vessel movements will occur during construction works, but it is anticipated that there will not be a significant increase in marine vessel movements during construction.

The Navigational Risk Assessment carried out (Technical Appendix 2.2) documents the predicted operational traffic movements associated with the new quay. Operational vessel movements provided within the NRA can be summarised as follows:

- Delivery and installation vessel movements are noted as being 18 and 8 respectively for 2028;
- 2029 shows delivery vessel movements as 19 calls in total with 12 delivery vessel calls;
- Similarly for 2030 delivery and installation vessel calls are 18 and 9;
- For 2031 delivery calls decrease to 8 but installation vessel calls increase to 19.

Although Black-throated Divers are known to be highly sensitive to disturbance through vessel movements, this level of increased vessel movements (between 1 and 2 every month) is not likely to result in significant effects on Black-throated Diver.

None of these potential disturbance effects will result in barriers to movement, or reduce access to, preferred foraging and roosting habitats, resulting in a significant energy expenditure and possible reduction in body condition required for survival and subsequent migration.

Therefore, it is considered that distribution of Black-throated Diver will be maintained throughout the site.

5.4.1.3 Conservation Objective 2c: The supporting habitats and processes relevant to qualifying features and their prey/food resources are maintained

As described in NatureScot's Conservation and Management Advice Document for Scapa Flow SPA[4], supporting habitats refer to the characteristics of the seabed and water column relevant to their use by the qualifying features. It relates to wider oceanographic processes such as up-wellings, tidal Flows, hydrological movements which may be necessary for the habitat and could affect nutrient cycling and prey distribution.

In section 4.7.2.4 in Volume 1, hydrodynamic modelling has shown that during the construction and operational phases, low current speeds and corresponding low bed shear stresses observed remain, as under existing baseline conditions, indicative of a low energy environment and that any impacts are negligible. Therefore, post-construction, prey items for Black-throated Diver (small fish species) will remain as existing.

During construction, dredging activities will occur. The dredge volume is estimated to be 174,000m^3, based on the bathymetry surveys and proposed berth design. As outlined in section 4.7.2.4 in Volume 1 of the EIAR, the marine deposits within the dredge area comprise an approximate stratigraphic order comprising superficial marine deposits (loose to medium dense gravelly silty sands with shell fragments and occasional cobbles) overlying glacial till. A Dredging Best Practicable Environmental Option Report (BPEO) has been produced for the proposed development which identifies the dredge budget to consist of approximately 17% gravel, 60% sand, and 23% silt and clay.

Dredge plume dispersal modelling has been undertaken, utilising a hydrodynamic model, as described in Technical Appendix 4.1, Volume 3 of this EIAR. The model results highlight that due to the relatively coarse nature of the dredge budget, and the weak tidal currents within the vicinity of the proposed dredge pockets, plumes generated as a result of the dredging works will be very localised and short term in duration. Due to the low current speeds, any sands and gravels lost to the water column during dredging will fall out of suspension immediately, within the dredge footprint. Clay and silt lost to the water column during dredging will remain in suspension for longer, being dispersed gradually over the

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[4] NatureScot: Conservation and Management Advice Scapa Flow SPA, UK Site: 9020321, June 2022

tidal cycle, with the residual dominance of ebb tide currents resulting in net northwards plume dispersal. Total suspended solids concentrations are predicted to be low, highest within the dredge zone and immediate surrounds of the dredger, decreasing towards the plume limits.

Due to the small potential volume of any dredge budget disposed direct to the sea bed, it is considered that any impacts from this activity would be localised in extent, and of short duration. Therefore, it is considered the magnitude of impact of sediment discharge and dispersion from dredging works will be low within the dredge area and immediate vicinity, and negligible out with this area, the supporting habitats for Black-throated Diver will be maintained.

There is the risk of pollution events (oil spills etc) during both the construction and operational phases of the Proposed Development. Adherence to strict Pollution Prevention controls and the use of silt booms during land reclamation works will mitigate against pollution spills which could affect the qualifying interest of the SPA and their prey sources. Therefore, the supporting habitats for Black-throated Diver will be maintained.

In terms of surface water pollution, drainage will be designed to ensure that there are no untreated surface water discharges directly to surrounding coastal waters. Suitable prevention measures will be in place at all times to prevent the release of pollutants to the water environment, including adjacent coastal waters. Again, with this in place, the supporting habitats for Black-throated Diver will be maintained.

5.4.1.4 Conservation Objective 1: To ensure that the qualifying features of the Scapa Flow SPA are in favourable condition and make an appropriate contribution to achieving Favourable Conservation Status.

It is predicted that, with mitigation, there will be no significant impacts on Conservation Objectives 2a to 2c. Therefore, the favourable condition of Black-throated Diver in Scapa Flow SPA will be maintained.

5.5 Slavonian Grebe, non-breeding

5.5.1 Assessment of Potential Impacts on Conservation Objectives

5.5.1.1 Conservation Objective 2a: The populations of qualifying features are viable components of the site

During the vantage point surveys between 2020 and 2022, a peak count of 7 Slavonian Grebes were recorded within 1km of the Proposed Development, with a peak of 7 birds within 2km. This is slightly higher than the counts from the inshore surveys undertake by HiDef for NatureScot, where a peak count of 2 birds were recorded in the same general area in January and February 2022. The peak of 7 birds represents 5% of the Scapa Flow SPA population.

As can be seen in the density heat maps produced in Technical Appendix 5.3: Scapa Deep Water Quay Ornithology Technical Report, birds were recorded within the Proposed Development footprint area, although in small numbers (usually singles). However, there was a peak count of five birds on 26th January 2022

The Proposed Development will result in the loss of 32Ha of the Scapa Flow SPA. This equates to 0.1% of the total SPA area. Although the Proposed Development footprint provides suitable foraging habitat for Slavonian Grebes, the wider SPA site has the capacity to accommodate these birds.

There is minimal risk of mortality through collision with marine vessels as a result of the Proposed Development. Other direct effects affecting water quality is dealt with in Conservation Objective 2c and indirect effects (ie disturbance resulting in reduced body condition and survival) are dealt with in Conservation Objective 2b.

With no predicted impacts in either conservation Objectives 2b and 2c, it is considered that the population of Slavonian Grebe remains a viable component of the site.

5.5.1.2 Conservation Objective 2b: The distribution of the qualifying features is maintained throughout the site by avoiding significant disturbance of the species

During the vantage point surveys between 2020 and 2022, a peak count of 7 Slavonian Grebes were recorded within 1km of the Proposed Development, with a peak of 7 birds within 2km. This is slightly higher than the counts from the inshore surveys undertake by HiDef for NatureScot, where a peak count of 12 birds were recorded in the same general area in January and February 2022. The peak of 7 birds represents 5% of the Scapa Flow SPA population.

As can be seen in the density heat maps produced in Technical Appendix 5.3: Scapa Deep Water Quay Ornithology Technical Report, birds were recorded within the Proposed Development footprint area, although in small numbers (usually singles). However, there was a peak count of five birds on 26th January 2022

Disturbance may occur through piling activities during the construction phase. It is not currently known the exact method to be used for construction, however applying the precautionary principle, blasting may be required. Blasting could have the potential to cause disturbance to this species. Blasting would be staggered in time to avoid simultaneous blast waves. Mitigation, such as a soft start approach and an ECoW monitoring for the presence of this species prior to piling works (with works to be undertaken once birds are a sufficient distance away), would limit any potential disturbance impact. This localised and short-term impact would not result in significant Impacts to Slavonian Grebe within the SPA.

During the ornithological surveys undertaken between 2020 and 2022, bird and boat interactions were recorded. For Slavonian Grebe, there were six observations of interactions with boats. Of these, one resulted in no reaction, one resulted in birds swimming away slowly and four resulted in a flight response.

The majority of material (rock etc) required for the development will be transported via the road network. It is not currently known how many vessel movements will occur during construction works, but it is anticipated that there will not be a significant increase in marine vessel movements during construction.

The Navigational Risk Assessment carried out (Technical Appendix 2.2) documents the predicted operational traffic movements associated with the new quay. Operational vessel movements provided within the NRA can be summarised as follows:

- Delivery and installation vessel movements are noted as being 18 and 8 respectively for 2028;
- 2029 shows delivery vessel movements as 19 calls in total with 12 delivery vessel calls;
- Similarly for 2030 delivery and installation vessel calls are 18 and 9;
- For 2031 delivery calls decrease to 8 but installation vessel calls increase to 19.

Although Slavonian Grebe are known to be highly sensitive to disturbance through vessel movements, this level of increased vessel movements (between 1 and 2 every month) is not likely to result significant effects on Slavonian Grebe.

None of these potential disturbance effects will result in barriers to movement, or reduce access to, preferred foraging and roosting habitats, resulting in a significant energy expenditure and possible reduction in body condition required for survival and subsequent migration.

Therefore, it is considered that distribution of Slavonian Grebe will be maintained throughout the site.

5.5.1.3 Conservation Objective 2c: The supporting habitats and processes relevant to qualifying features and their prey/food resources are maintained

As described in NatureScot's Conservation and Management Advice Document for Scapa Flow SPA[2], supporting habitats refer to the characteristics of the seabed and water column relevant to their use by the qualifying features. It relates to wider oceanographic processes such as up-wellings, tidal Flows, hydrological movements which may be necessary for the habitat and could affect nutrient cycling and prey distribution.

In section 4.7.2.4 in Volume 1, hydrodynamic modelling has shown that during the construction and operational phases, low current speeds and corresponding low bed shear stresses observed remain, as under existing baseline conditions, indicative of a low energy environment and that any impacts are negligible. Therefore, post-construction, prey items for Slavonian Grebe (small fish species, crustaceans) will remain as existing.

During construction, dredging activities will occur. The dredge volume is estimated to be 174,000m^3, based on the bathymetry surveys and proposed berth design. As outlined in section **Error! Reference source not found.** in Volume 1 of the EIAR, the marine deposits within the dredge area comprise an approximate stratigraphic order comprising superficial marine deposits (loose to medium dense gravelly silty sands with shell fragments and occasional cobbles) overlying glacial till. A Dredging Best Practicable Environmental Option Report (BPEO) has been produced for the proposed development which identifies the dredge budget to consist of approximately 17% gravel, 60% sand, and 23% silt and clay.

Dredge plume dispersal modelling has been undertaken, utilising a hydrodynamic model, as described in Technical Appendix 4.1, Volume 3 of this EIAR. The model results highlight that due to the relatively coarse nature of the dredge budget, and the weak tidal currents within the vicinity of the proposed dredge pockets, plumes generated as a result of the dredging works will be very localised and short term in duration. Due to the low current speeds, any sands and gravels lost to the water column during dredging will fall out of suspension immediately, within the dredge footprint. Clay and silt lost to the water column during dredging will remain in suspension for longer, being dispersed gradually over the tidal cycle, with the residual dominance of ebb tide currents resulting in net northwards plume dispersal. Total suspended solids concentrations are predicted to be low, highest within the dredge zone and immediate surrounds of the dredger, decreasing towards the plume limits.

Due to the small potential volume of any dredge budget disposed direct to the sea bed, it is considered that any impacts from this activity would be localised in extent, and of short duration. Therefore, it is considered the magnitude of impact of sediment discharge and dispersion from dredging works will be low within the dredge area and immediate vicinity, and negligible out with this area, the supporting habitats for Slavonian Grebe will be maintained.

There is the risk of pollution events (oil spills etc) during both the construction and operational phases of the Proposed Development. Adherence to strict Pollution Prevention controls and the use of silt booms during land reclamation works will mitigate against pollution spills which could affect the qualifying interest of the SPA and their prey sources. Therefore, the supporting habitats for Slavonian Grebe will be maintained.

In terms of surface water pollution, drainage will be designed to ensure that there are no untreated surface water discharges directly to surrounding coastal waters. Suitable prevention measures will be in place at all times to prevent the release of pollutants to the water environment, including adjacent coastal waters. Again, with this in place, the supporting habitats for Slavonian Grebe will be maintained.

5.5.1.4 Conservation Objective 1: To ensure that the qualifying features of the Scapa Flow SPA are in favourable condition and make an appropriate contribution to achieving Favourable Conservation Status.

It is predicted that, with mitigation, there will be no significant impacts on Conservation Objectives 2a to 2c. Therefore, the favourable condition of Slavonian Grebe in Scapa Flow SPA will be maintained.

5.6 European Shag, non-breeding

5.6.1 Assessment of Potential Impacts on Conservation Objectives

5.6.1.1 Conservation Objective 2a: The populations of qualifying features are viable components of the site

During the vantage point surveys between 2020 and 2022, a peak count of 72 Shag were recorded within 1km of the Proposed Development, with a peak of 72 birds within 2km. This is higher than the counts from the inshore surveys undertake by HiDef for NatureScot, where a peak count of 24 birds were recorded in the same general area in January and February 2022. The peak of 72 birds represents 2.5% of the Scapa Flow SPA population.

As can be seen in the density heat maps produced in Technical Appendix 5.3: Scapa Deep Water Quay Ornithology Technical Report, birds were recorded within the Proposed Development footprint area, although in small numbers (usually between one and five). However, there was a peak count of 30 birds on 18th December 2022

The Proposed Development will result in the loss of 32Ha of the Scapa Flow SPA. This equates to 0.1% of the total SPA area. Although the Proposed Development footprint provides suitable foraging habitat for Shag, the wider SPA site has the capacity to accommodate these birds..

There is minimal risk of mortality through collision with marine vessels as a result of the Proposed Development. Other direct effects affecting water quality is dealt with in Conservation Objective 2c and indirect effects (ie disturbance resulting in reduced body condition and survival) are dealt with in Conservation Objective 2b.

With no predicted impacts in either conservation Objectives 2b and 2c, it is considered that the population of Shag remains a viable component of the site.

5.6.1.2 Conservation Objective 2b: The distribution of the qualifying features is maintained throughout the site by avoiding significant disturbance of the species

During the vantage point surveys between 2020 and 2022, a peak count of 72 Shag were recorded within 1km of the Proposed Development, with a peak of 72 birds within 2km. This is higher than the counts from the inshore surveys undertake by HiDef for NatureScot, where a peak count of 24 birds were recorded in the same general area in January and February 2022. The peak of 72 birds represents 2.5% of the Scapa Flow SPA population.

As can be seen in the density heat maps produced in Technical Appendix 5.3: Scapa Deep Water Quay Ornithology Technical Report, birds were recorded within the Proposed Development footprint area, although in small numbers (usually between one and five). However, there was a peak count of 30 birds on 18th December 2022.

Disturbance may occur through piling activities during the construction phase. It is not currently known the exact method to be used for construction, however applying the precautionary principle, blasting may be required. Blasting could have the potential to cause disturbance to this species. Blasting would be staggered in time to avoid simultaneous blast waves. Mitigation, such as a soft start approach and an ECoW monitoring for the presence of this species prior to piling works (with works to be undertaken once birds are a sufficient distance away), would limit any potential disturbance impact. This localised and short-term impact would not result in significant Impacts to Shag within the SPA.

The majority of material (rock etc) required for the development will be transported via the road network. It is not currently known how many vessel movements will occur during construction works, but it is anticipated that there will not be a significant increase in marine vessel movements during construction.

The Navigational Risk Assessment carried out (Technical Appendix 2.2) documents the predicted operational traffic movements associated with the new quay. Operational vessel movements provided within the NRA can be summarised as follows:

- Delivery and installation vessel movements are noted as being 18 and 8 respectively for 2028;
- 2029 shows delivery vessel movements as 19 calls in total with 12 delivery vessel calls;
- Similarly for 2030 delivery and installation vessel calls are 18 and 9;
- For 2031 delivery calls decrease to 8 but installation vessel calls increase to 19.

Although Shag are known to be vulnerable to disturbance through vessel movements, this level of increased vessel movements (between 1 and 2 every month) is not likely to result significant effects on Shag.

None of these potential disturbance effects will result in barriers to movement, or reduce access to, preferred foraging and roosting habitats, resulting in a significant energy expenditure and possible reduction in body condition required for survival and subsequent migration.

Therefore, it is considered that distribution of Shag will be maintained throughout the site.

5.6.1.3 Conservation Objective 2c: The supporting habitats and processes relevant to qualifying features and their prey/food resources are maintained

As described in NatureScot's Conservation and Management Advice Document for Scapa Flow SPA[2], supporting habitats refer to the characteristics of the seabed and water column relevant to their use by the qualifying features. It relates to wider oceanographic processes such as up-wellings, tidal Flows, hydrological movements which may be necessary for the habitat and could affect nutrient cycling and prey distribution.

In section 4.7.2.4 in Volume 1, hydrodynamic modelling has shown that during the construction and operational phases, low current speeds and corresponding low bed shear stresses observed remain, as under existing baseline conditions, indicative of a low energy environment and that any impacts are negligible. Therefore, post-construction, prey items for Shag (fish species, polychaetes, cephalopods etc) will remain as existing.

During construction, dredging activities will occur. The dredge volume is estimated to be 174,000m^3, based on the bathymetry surveys and proposed berth design. As outlined in section **Error! Reference source not found.** in Volume 1 of the EIAR, the marine deposits within the dredge area comprise an approximate stratigraphic order comprising superficial marine deposits (loose to medium dense gravelly silty sands with shell fragments and occasional cobbles) overlying glacial till. A Dredging Best Practicable Environmental Option Report (BPEO) has been produced for the proposed development which identifies the dredge budget to consist of approximately 17% gravel, 60% sand, and 23% silt and clay.

Dredge plume dispersal modelling has been undertaken, utilising a hydrodynamic model, as described in Technical Appendix 4.1, Volume 3 of this EIAR. The model results highlight that due to the relatively coarse nature of the dredge budget, and the weak tidal currents within the vicinity of the proposed dredge pockets, plumes generated as a result of the dredging works will be very localised and short term in duration. Due to the low current speeds, any sands and gravels lost to the water column during dredging will fall out of suspension immediately, within the dredge footprint. Clay and silt lost to the water column during dredging will remain in suspension for longer, being dispersed gradually over the tidal cycle, with the residual dominance of ebb tide currents resulting in net northwards plume dispersal. Total suspended solids concentrations are predicted to be low, highest within the dredge zone and immediate surrounds of the dredger, decreasing towards the plume limits.

Due to the small potential volume of any dredge budget disposed direct to the sea bed, it is considered that any impacts from this activity would be localised in extent, and of short duration. Therefore, it is considered the magnitude of impact of sediment discharge and dispersion from dredging works will be low within the dredge area and immediate vicinity, and negligible out with this area, thus maintaining the supporting habitats for Shag.

There is the risk of pollution events (oil spills etc) during both the construction and operational phases of the Proposed Development. Adherence to strict Pollution Prevention controls and the use of silt booms during land reclamation works will mitigate against pollution spills which could affect the qualifying interest of the SPA and their prey sources. Therefore, the supporting habitats for Shag will be maintained.

In terms of surface water pollution, drainage will be designed to ensure that there are no untreated surface water discharges directly to surrounding coastal waters. Suitable prevention measures will be in place at all times to prevent the release of pollutants to the water environment, including adjacent coastal waters. Again, with this in place, the supporting habitats for Shag will be maintained.

5.6.1.4 Conservation Objective 1: To ensure that the qualifying features of the Scapa Flow SPA are in favourable condition and make an appropriate contribution to achieving Favourable Conservation Status.

It is predicted that, with mitigation, there will be no significant impacts on Conservation Objectives 2a to 2c. Therefore, the favourable condition of Shag in Scapa Flow SPA will be maintained.

5.7 Eider, non-breeding

5.7.1 Assessment of Potential Impacts on Conservation Objectives

5.7.1.1 Conservation Objective 2a: The populations of qualifying features are viable components of the site

During the vantage point surveys between 2020 and 2022, a peak count of 39 Eider were recorded within 1km of the Proposed Development, with a peak of 40 birds within 2km. This is higher than the counts from the inshore surveys undertake by HiDef for NatureScot, where a peak count of 30 birds were recorded in the same general area in January 2022. The peak of 40 birds represents 2% of the Scapa Flow SPA population.

As can be seen in the density heat maps produced in Technical Appendix 5.3: Scapa Deep Water Quay Ornithology Technical Report, a large proportion of the birds were recorded within the Proposed Development footprint area, feeding and loafing close inshore.

The Proposed Development will result in the loss of 32Ha of the Scapa Flow SPA. This equates to 0.1% of the total SPA area. Although the Proposed Development footprint provides suitable foraging habitat for Eider, the wider SPA site has the capacity to accommodate these birds.

There is minimal risk of mortality through collision as a result of the Proposed Development. Other direct effects affecting water quality is dealt with in Conservation Objective 2c and indirect effects (ie disturbance resulting in reduced body condition and survival) are dealt with in Conservation Objective 2b.

With no predicted impacts in either conservation Objectives 2b and 2c, it is considered that the population of Slavonian Grebe remains a viable component of the site.

5.7.1.2 Conservation Objective 2b: The distribution of the qualifying features is maintained throughout the site by avoiding significant disturbance of the species

During the vantage point surveys between 2020 and 2022, a peak count of 39 Eider were recorded within 1km of the Proposed Development, with a peak of 40 birds within 2km. This is higher than the counts from the inshore surveys undertake by HiDef for NatureScot, where a peak count of 30 birds were recorded in the same general area in January 2022. The peak of 40 birds represents 2% of the Scapa Flow SPA population.

As can be seen in the density heat maps produced in Technical Appendix 5.3: Scapa Deep Water Quay Ornithology Technical Report, a large proportion of the birds were recorded within the Proposed Development footprint area, feeding and loafing close inshore.

Disturbance may occur through piling activities during the construction phase. It is not currently known the exact method to be used for construction, however applying the precautionary principle, blasting may be required. Blasting could have the potential to cause disturbance to this species. Blasting would be staggered in time to avoid simultaneous blast waves. Mitigation, such as a soft start approach and an ECoW monitoring for the presence of this species prior to piling works (with works to be undertaken once birds are a sufficient distance away), would limit any potential disturbance impact. This localised and short-term impact would not result in significant Impacts to Eider within the SPA.

The majority of material (rock etc) required for the development will be transported via the road network, thus. It is not currently known how many vessel movements will occur during construction works, but it is anticipated that there will not be a significant increase in marine vessel movements during construction.

During the ornithological surveys undertaken, bird and boat interactions were recorded. For Eider, there were two observations of interactions with boats. Of these, both resulted in a short flight reaction, before returning to their original position.

The Navigational Risk Assessment carried out (Technical Appendix 2.2) documents the predicted operational traffic movements associated with the new quay. Operational vessel movements provided within the NRA can be summarised as follows:

- Delivery and installation vessel movements are noted as being 18 and 8 respectively for 2028;
- 2029 shows delivery vessel movements as 19 calls in total with 12 delivery vessel calls;
- Similarly for 2030 delivery and installation vessel calls are 18 and 9;
- For 2031 delivery calls decrease to 8 but installation vessel calls increase to 19.

Although Eider are known to be vulnerable to disturbance through vessel movements, this level of increased vessel movements (between 1 and 2 every month) is not likely to result significant effects on Eider.

None of these potential disturbance effects will result in barriers to movement, or reduce access to, preferred foraging and roosting habitats, resulting in a significant energy expenditure and possible reduction in body condition required for survival and subsequent migration.

Therefore, it is considered that distribution of Eider will be maintained throughout the site.

5.7.1.3 Conservation Objective 2c: The supporting habitats and processes relevant to qualifying features and their prey/food resources are maintained

As described in NatureScot's Conservation and Management Advice Document for Scapa Flow SPA[2], supporting habitats refer to the characteristics of the seabed and water column relevant to their use by the qualifying features. It relates to wider oceanographic processes such as up-wellings, tidal Flows, hydrological movements which may be necessary for the habitat and could affect nutrient cycling and prey distribution.

In section 4.7.2.4 in Volume 1, hydrodynamic modelling has shown that during the construction and operational phases, low current speeds and corresponding low bed shear stresses observed remain, as under existing baseline conditions, indicative of a low energy environment and that any impacts are negligible. Therefore, post-construction, prey items for Eider (mussel etc) will remain as existing.

During construction, dredging activities will occur. The dredge volume is estimated to be 174,000m^3, based on the bathymetry surveys and proposed berth design. As outlined in section **Error! Reference source not found.** in Volume 1 of the EIAR, the marine deposits within the dredge area comprise an approximate stratigraphic order comprising superficial marine deposits (loose to medium dense gravelly silty sands with shell fragments and occasional cobbles) overlying glacial till. A Dredging Best Practicable Environmental Option Report (BPEO) has been produced for the proposed development which identifies the dredge budget to consist of approximately 17% gravel, 60% sand, and 23% silt and clay.

Dredge plume dispersal modelling has been undertaken, utilising a hydrodynamic model, as described in Technical Appendix 4.1, Volume 3 of this EIAR. The model results highlight that due to the relatively coarse nature of the dredge budget, and the weak tidal currents within the vicinity of the proposed dredge pockets, plumes generated as a result of the dredging works will be very localised and short term in duration. Due to the low current speeds, any sands and gravels lost to the water column during dredging will fall out of suspension immediately, within the dredge footprint. Clay and silt lost to the water column during dredging will remain in suspension for longer, being dispersed gradually over the tidal cycle, with the residual dominance of ebb tide currents resulting in net northwards plume dispersal. Total suspended solids concentrations are predicted to be low, highest within the dredge zone and immediate surrounds of the dredger, decreasing towards the plume limits.

Due to the small potential volume of any dredge budget disposed direct to the sea bed, it is considered that any impacts from this activity would be localised in extent, and of short duration. Therefore, it is considered the magnitude of impact of sediment discharge and dispersion from dredging works will be low within the dredge area and immediate vicinity, and negligible out with this area, thus maintaining the supporting habitats for Eider.

There is the risk of pollution events (oil spills etc) during both the construction and operational phases of the Proposed Development. Adherence to strict Pollution Prevention controls and the use of silt booms during land reclamation works will mitigate against pollution spills which could affect the qualifying interest of the SPA and their prey sources. Therefore, the supporting habitats for Eider will be maintained.

In terms of surface water pollution, drainage will be designed to ensure that there are no untreated surface water discharges directly to surrounding coastal waters. Suitable prevention measures will be in place at all times to prevent the release of pollutants to the water environment, including adjacent coastal waters. Again, with this in place, the supporting habitats for Eider will be maintained.

5.7.1.4 Conservation Objective 1: To ensure that the qualifying features of the Scapa Flow SPA are in favourable condition and make an appropriate contribution to achieving Favourable Conservation Status.

It is predicted that, with mitigation, there will be no significant impacts on Conservation Objectives 2a to 2c. Therefore, the favourable condition of Eider in Scapa Flow SPA will be maintained.

5.8 Red-breasted Merganser, non-breeding

5.8.1 Assessment of Potential Impacts on Conservation Objectives

5.8.1.1 Conservation Objective 2a: The populations of qualifying features are viable components of the site

During the vantage point surveys between 2020 and 2022, Red-breasted Merganser was very infrequently recorded, with a peak of three birds noted. This correlates well with the counts from the inshore surveys undertake by HiDef for NatureScot, where a peak count of 2 birds were recorded in the same general area. The peak of 3 birds represents 0.5% of the Scapa Flow SPA population.

The Proposed Development will result in the loss of 32Ha of the Scapa Flow SPA. This equates to 0.1% of the total SPA area. Although the Proposed Development footprint provides suitable foraging habitat for Rd-breasted Merganser, the wider SPA site has the capacity to accommodate these birds..

There is minimal risk of mortality through collision as a result of the Proposed Development. Other direct effects affecting water quality is dealt with in Conservation Objective 2c and indirect effects (ie disturbance resulting in reduced body condition and survival) are dealt with in Conservation Objective 2b.

With no predicted impacts in either conservation Objectives 2b and 2c, it is considered that the population of Red-breasted Merganser remains a viable component of the site.

5.8.1.2 Conservation Objective 2b: The distribution of the qualifying features is maintained throughout the site by avoiding significant disturbance of the species

During the vantage point surveys, Red-breasted Merganser was very infrequently recorded, with a peak of three birds noted. This correlates well with the counts from the inshore surveys undertake by HiDef for NatureScot, where a peak count of 2 birds were recorded in the same general area. The peak of 3 birds represents 0.5% of the Scapa Flow SPA population.

Disturbance may occur through piling activities during the construction phase. It is not currently known the exact method to be used for construction, however applying the precautionary principle, blasting may be required. Blasting could have the potential to cause disturbance to this species. Blasting would be staggered in time to avoid simultaneous blast waves. Mitigation, such as a soft start approach and an ECoW monitoring for the presence of this species prior to piling works (with works to be undertaken once birds are a sufficient distance away), would limit any potential disturbance impact. This localised and short-term impact would not result in significant Impacts to Red-breasted Merganser within the SPA.

The majority of material (rock etc) required for the development will be transported via the road network, thus. It is not currently known how many vessel movements will occur during construction works, but it is anticipated that there will not be a significant increase in marine vessel movements during construction.

The Navigational Risk Assessment carried out (Technical Appendix 2.2) documents the predicted operational traffic movements associated with the new quay. Operational vessel movements provided within the NRA can be summarised as follows:

- Delivery and installation vessel movements are noted as being 18 and 8 respectively for 2028;
- 2029 shows delivery vessel movements as 19 calls in total with 12 delivery vessel calls;
- Similarly for 2030 delivery and installation vessel calls are 18 and 9;
- For 2031 delivery calls decrease to 8 but installation vessel calls increase to 19.

Although Red-breasted Merganser are known to be vulnerable to disturbance through vessel movements, this level of increased vessel movements (between 1 and 2 every month) is not likely to result significant effects on Red-breasted Merganser.

None of these potential disturbance effects will result in barriers to movement, or reduce access to, preferred foraging and roosting habitats, resulting in a significant energy expenditure and possible reduction in body condition required for survival and subsequent migration.

Therefore, it is considered that distribution of Red-breasted Merganser will be maintained throughout the site.

5.8.1.3 Conservation Objective 2c: The supporting habitats and processes relevant to qualifying features and their prey/food resources are maintained

As described in NatureScot's Conservation and Management Advice Document for Scapa Flow SPA[2], supporting habitats refer to the characteristics of the seabed and water column relevant to their use by the qualifying features. It relates to wider oceanographic processes such as up-wellings, tidal Flows, hydrological movements which may be necessary for the habitat and could affect nutrient cycling and prey distribution.

In section 4.7.2.4 in Volume 1, hydrodynamic modelling has shown that during the construction and operational phases, low current speeds and corresponding low bed shear stresses observed remain, as under existing baseline conditions, indicative of a low energy environment and that any impacts are negligible. Therefore, post-construction, prey items for Red-breasted Merganser (small fish etc) will remain as existing.

During construction, dredging activities will occur. The dredge volume is estimated to be 174,000m^3, based on the bathymetry surveys and proposed berth design. As outlined in section **Error! Reference source not found.** in Volume 1 of the EIAR, the marine deposits within the dredge area comprise an approximate stratigraphic order comprising superficial marine deposits (loose to medium dense gravelly silty sands with shell fragments and occasional cobbles) overlying glacial till. A Dredging Best Practicable Environmental Option Report (BPEO) has been produced for the proposed development which identifies the dredge budget to consist of approximately 17% gravel, 60% sand, and 23% silt and clay.

Dredge plume dispersal modelling has been undertaken, utilising a hydrodynamic model, as described in Technical Appendix 4.1, Volume 3 of this EIAR. The model results highlight that due to the relatively coarse nature of the dredge budget, and the weak tidal currents within the vicinity of the proposed dredge pockets, plumes generated as a result of the dredging works will be very localised and short term in duration. Due to the low current speeds, any sands and gravels lost to the water column during dredging will fall out of suspension immediately, within the dredge footprint. Clay and silt lost to the water column during dredging will remain in suspension for longer, being dispersed gradually over the tidal cycle, with the residual dominance of ebb tide currents resulting in net northwards plume dispersal. Total suspended solids concentrations are predicted to be low, highest within the dredge zone and immediate surrounds of the dredger, decreasing towards the plume limits.

Due to the small potential volume of any dredge budget disposed direct to the sea bed, it is considered that any impacts from this activity would be localised in extent, and of short duration. Therefore, it is considered the magnitude of impact of sediment discharge and dispersion from dredging works will be low within the dredge area and immediate vicinity, and negligible out with this area, thus maintaining the supporting habitats for Red-breasted Merganser.

There is the risk of pollution events (oil spills etc) during both the construction and operational phases of the Proposed Development. Adherence to strict Pollution Prevention controls and the use of silt booms during land reclamation works will mitigate against pollution spills which could affect the qualifying interest of the SPA and their prey sources. Therefore, the supporting habitats for Red-breasted Merganser will be maintained.

In terms of surface water pollution, drainage will be designed to ensure that there are no untreated surface water discharges directly to surrounding coastal waters. Suitable prevention measures will be in place at all times to prevent the release of pollutants to the water environment, including adjacent coastal waters. Again, with this in place, the supporting habitats for Red-breasted Merganser will be maintained.

5.8.1.4 Conservation Objective 1: To ensure that the qualifying features of the Scapa Flow SPA are in favourable condition and make an appropriate contribution to achieving Favourable Conservation Status.

It is predicted that, with mitigation, there will be no significant impacts on Conservation Objectives 2a to 2c. Therefore, the favourable condition of Red-breasted Merganser in Scapa Flow SPA will be maintained.

5.9 Long-tailed Duck, non-breeding

5.9.1 Assessment of Potential Impacts on Conservation Objectives

5.9.1.1 Conservation Objective 2a: The populations of qualifying features are viable components of the site

During the vantage point surveys undertaken between 2020 and 2022, a peak count of 30 Long-tailed Duck were recorded within 1km of the Proposed Development. However, beyond 1km there was a peak of 414 birds. This is significantly higher than the counts from the inshore surveys undertake by HiDef for NatureScot, where a peak count of 93 birds were recorded in the same general area in December 2021. The peak of 414 birds represents 30% of the Scapa Flow SPA population.

As can be seen in the density heat maps produced in Technical Appendix 5.3: Scapa Deep Water Quay Ornithology Technical Report, small numbers of Long-tailed Duck were recorded within the Proposed Development footprint (mainly between 1 and 3 but with a peak of 10 birds). The vast majority of birds were recorded to the south, in the vicinity of the fish cages.

The Proposed Development will result in the loss of 32Ha of the Scapa Flow SPA. This equates to 0.1% of the total SPA area. Although the Proposed Development footprint provides suitable foraging habitat for Long-tailed Duck, the wider SPA site has the capacity to accommodate these birds..

There is minimal risk of mortality through collision as a result of the Proposed Development. Other direct effects affecting water quality is dealt with in Conservation Objective 2c and indirect effects (ie disturbance resulting in reduced body condition and survival) are dealt with in Conservation Objective 2b.

With no predicted impacts in either conservation Objectives 2b and 2c, it is considered that the population of Long-tailed Duck remains a viable component of the site.

5.9.1.2 Conservation Objective 2b: The distribution of the qualifying features is maintained throughout the site by avoiding significant disturbance of the species

During the vantage point surveys, a peak count of 30 Long-tailed Duck were recorded within 1km of the Proposed Development. However, beyond 1km there was a peak of 414 birds. This is significantly higher than the counts from the inshore surveys undertake by HiDef for NatureScot, where a peak count of 93 birds were recorded in the same general area in December 2021. The peak of 414 birds represents 30% of the Scapa Flow SPA population.

As can be seen in the density heat maps produced in Technical Appendix 5.3: Scapa Deep Water Quay Ornithology Technical Report, small numbers of Long-tailed Duck were recorded within the Proposed Development footprint (mainly between 1 and 3 but with a peak of 10 birds). The vast majority of birds were recorded to the south, in the vicinity of the fish cages.

Disturbance may occur through piling activities during the construction phase. It is not currently known the exact method to be used for construction, however applying the precautionary principle, blasting may be required. Blasting could have the potential to cause disturbance to this species. Blasting would be staggered in time to avoid simultaneous blast waves. Mitigation, such as a soft start approach and an ECoW monitoring for the presence of this species prior to piling works (with works to be undertaken once birds are a sufficient distance away), would limit any potential disturbance impact. This localised and short-term impact would not result in significant Impacts to Long-tailed Duck within the SPA..

The majority of material (rock etc) required for the development will be transported via the road network, thus. It is not currently known how many vessel movements will occur during construction works, but it is anticipated that there will not be a significant increase in marine vessel movements during construction.

The Navigational Risk Assessment carried out (Technical Appendix 2.2) documents the predicted operational traffic movements associated with the new quay. Operational vessel movements provided within the NRA can be summarised as follows:

- Delivery and installation vessel movements are noted as being 18 and 8 respectively for 2028;
- 2029 shows delivery vessel movements as 19 calls in total with 12 delivery vessel calls;
- Similarly for 2030 delivery and installation vessel calls are 18 and 9;
- For 2031 delivery calls decrease to 8 but installation vessel calls increase to 19.

Although Long-tailed Duck are known to be vulnerable to disturbance through vessel movements, this level of increased vessel movements (between 1 and 2 every month) is not likely to result significant effects on this species.

None of these potential disturbance effects will result in barriers to movement, or reduce access to, preferred foraging and roosting habitats, resulting in a significant energy expenditure and possible reduction in body condition required for survival and subsequent migration.

Therefore, it is considered that distribution of Long-tailed Duck will be maintained throughout the site.

5.9.1.3 Conservation Objective 2c: The supporting habitats and processes relevant to qualifying features and their prey/food resources are maintained

As described in NatureScot's Conservation and Management Advice Document for Scapa Flow SPA[2], supporting habitats refer to the characteristics of the seabed and water column relevant to their use by the qualifying features. It relates to wider oceanographic processes such as up-wellings, tidal Flows, hydrological movements which may be necessary for the habitat and could affect nutrient cycling and prey distribution.

In section 4.7.2.4 in Volume 1, hydrodynamic modelling has shown that during the construction and operational phases, low current speeds and corresponding low bed shear stresses observed remain, as under existing baseline conditions, indicative of a low energy environment and that any impacts are negligible. Therefore, post-construction, prey items for Long-tailed Duck will remain as existing.

During construction, dredging activities will occur. The dredge volume is estimated to be 174,000m^3, based on the bathymetry surveys and proposed berth design. As outlined in section 4.7.4.2 in Volume 1 of the EIAR, the marine deposits within the dredge area comprise an approximate stratigraphic order comprising superficial marine deposits (loose to medium dense gravelly silty sands with shell fragments and occasional cobbles) overlying glacial till. A Dredging Best Practicable Environmental Option Report (BPEO) has been produced for the proposed development which identifies the dredge budget to consist of approximately 17% gravel, 60% sand, and 23% silt and clay.

Dredge plume dispersal modelling has been undertaken, utilising a hydrodynamic model, as described in Technical Appendix 4.1, Volume 3 of this EIAR. The model results highlight that due to the relatively coarse nature of the dredge budget, and the weak tidal currents within the vicinity of the proposed dredge pockets, plumes generated as a result of the dredging works will be very localised and short term in duration. Due to the low current speeds, any sands and gravels lost to the water column during dredging will fall out of suspension immediately, within the dredge footprint. Clay and silt lost to the water column during dredging will remain in suspension for longer, being dispersed gradually over the tidal cycle, with the residual dominance of ebb tide currents resulting in net northwards plume dispersal. Total suspended solids concentrations are predicted to be low, highest within the dredge zone and immediate surrounds of the dredger, decreasing towards the plume limits.

Due to the small potential volume of any dredge budget disposed direct to the sea bed, it is considered that any impacts from this activity would be localised in extent, and of short duration. Therefore, it is considered the magnitude of impact of sediment discharge and dispersion from dredging works will be low within the dredge area and immediate vicinity, and negligible out with this area, thus maintaining the supporting habitats for Long-tailed Duck.

There is the risk of pollution events (oil spills etc) during both the construction and operational phases of the Proposed Development. Adherence to strict Pollution Prevention controls and the use of silt booms during land reclamation works will mitigate against pollution spills which could affect the qualifying interest of the SPA and their prey sources. Therefore, the supporting habitats for Long-tailed Duck will be maintained.

In terms of surface water pollution, drainage will be designed to ensure that there are no untreated surface water discharges directly to surrounding coastal waters. Suitable prevention measures will be in place at all times to prevent the release of pollutants to the water environment, including adjacent coastal waters. Again, with this in place, the supporting habitats for Long-tailed Duck will be maintained.

5.9.1.4 Conservation Objective 1: To ensure that the qualifying features of the Scapa Flow SPA are in favourable condition and make an appropriate contribution to achieving Favourable Conservation Status.

It is predicted that, with mitigation, there will be no significant impacts on Conservation Objectives 2a to 2c. Therefore, the favourable condition of Long-tailed Duck in Scapa Flow SPA will be maintained.

5.10 Red-throated Diver, breeding

5.10.1 Assessment of Potential Impacts on Conservation Objectives

5.10.1.1 Conservation Objective 2a: The populations of qualifying features are viable components of the site

During the vantage point surveys and flight surveys undertaken between 2020 and 2022, at least one breeding pair of Red-throated Divers utilised the site and environs for foraging.

The Proposed Development will result in the loss of 32Ha of the Scapa Flow SPA. This equates to 0.1% of the total SPA area. Although the Proposed Development footprint provides suitable foraging habitat for Red-throated Diver, the wider SPA site has the capacity to accommodate this pair.

There is minimal risk of mortality through collision as a result of the Proposed Development. Other direct effects affecting water quality is dealt with in Conservation Objective 2c and indirect effects (ie disturbance resulting in reduced body condition and survival) are dealt with in Conservation Objective 2b.

With no predicted impacts in either conservation Objectives 2b and 2c, it is considered that the population of Red-throated Diver remains a viable component of the site.

5.10.1.2 Conservation Objective 2b: The distribution of the qualifying features is maintained throughout the site by avoiding significant disturbance of the species

During the vantage point surveys and flight surveys, at least one breeding pair of Red-throated Divers utilised the site and environs for foraging.

Disturbance may occur through piling activities during the construction phase. It is not currently known the exact method to be used for construction, however applying the precautionary principle, blasting may be required. Blasting could have the potential to cause disturbance to this species. Blasting would be staggered in time to avoid simultaneous blast waves. Mitigation, such as a soft start approach and an ECoW monitoring for the presence of this species prior to piling works (with works to be undertaken once birds are a sufficient distance away), would limit any potential disturbance impact. This localised and short-term impact would not result in significant Impacts to Red-throated Diver within the SPA.

The majority of material (rock etc) required for the development will be transported via the road network, thus. It is not currently known how many vessel movements will occur during construction works, but it is anticipated that there will not be a significant increase in marine vessel movements during construction.

The Navigational Risk Assessment carried out (Technical Appendix 2.2) documents the predicted operational traffic movements associated with the new quay. Operational vessel movements provided within the NRA can be summarised as follows:

- Delivery and installation vessel movements are noted as being 18 and 8 respectively for 2028;
- 2029 shows delivery vessel movements as 19 calls in total with 12 delivery vessel calls;
- Similarly for 2030 delivery and installation vessel calls are 18 and 9;
- For 2031 delivery calls decrease to 8 but installation vessel calls increase to 19.

Although Red-throated Diver are known to be highly sensitive to disturbance through vessel movements, this level of increased vessel movements (between 1 and 2 every month) is not likely to result significant effects on this species.

None of these potential disturbance effects will result in barriers to movement, or reduce access to, preferred foraging habitats, resulting in a significant energy expenditure and possible reduction in body condition required for breeding success.

Therefore, it is considered that distribution of Red-throated Diver is maintained throughout the site.

5.10.1.3 Conservation Objective 2c: The supporting habitats and processes relevant to qualifying features and their prey/food resources are maintained

As described in NatureScot's Conservation and Management Advice Document for Scapa Flow SPA[2], supporting habitats refer to the characteristics of the seabed and water column relevant to their use by the qualifying features. It relates to wider oceanographic processes such as up-wellings, tidal Flows, hydrological movements which may be necessary for the habitat and could affect nutrient cycling and prey distribution.

In section 4.7.2.4 in Volume 1, hydrodynamic modelling has shown that during the construction and operational phases, low current speeds and corresponding low bed shear stresses observed remain, as under existing baseline conditions, indicative of a low energy environment and that any impacts are negligible. Therefore, post-construction, prey items for Red-throated Diver will remain as existing.

During construction, dredging activities will occur. The dredge volume is estimated to be 174,000m^3, based on the bathymetry surveys and proposed berth design. As outlined in section **Error! Reference source not found.**2 in Volume 1 of the EIAR, the marine deposits within the dredge area comprise an approximate stratigraphic order comprising superficial marine deposits (loose to medium dense gravelly silty sands with shell fragments and occasional cobbles) overlying glacial till. A Dredging Best Practicable Environmental Option Report (BPEO) has been produced for the proposed development which identifies the dredge budget to consist of approximately 17% gravel, 60% sand, and 23% silt and clay.

Dredge plume dispersal modelling has been undertaken, utilising a hydrodynamic model, as described in Technical Appendix 4.1, Volume 3 of this EIAR. The model results highlight that due to the relatively coarse nature of the dredge budget, and the weak tidal currents within the vicinity of the proposed dredge pockets, plumes generated as a result of the dredging works will be very localised and short term in duration. Due to the low current speeds, any sands and gravels lost to the water column during dredging will fall out of suspension immediately, within the dredge footprint. Clay and silt lost to the water column during dredging will remain in suspension for longer, being dispersed gradually over the tidal cycle, with the residual dominance of ebb tide currents resulting in net northwards plume dispersal. Total suspended solids concentrations are predicted to be low, highest within the dredge zone and immediate surrounds of the dredger, decreasing towards the plume limits.

Due to the small potential volume of any dredge budget disposed direct to the sea bed, it is considered that any impacts from this activity would be localised in extent, and of short duration. Therefore, it is considered the magnitude of impact of sediment discharge and dispersion from dredging works will be low within the dredge area and immediate vicinity, and negligible out with this area, thus maintaining the supporting habitats for Red-throated Diver.

There is the risk of pollution events (oil spills etc) during both the construction and operational phases of the Proposed Development. Adherence to strict Pollution Prevention controls and the use of silt booms during land reclamation works will mitigate against pollution spills which could affect the qualifying interest of the SPA and their prey sources. Therefore, the supporting habitats for Red-throated Diver will be maintained.

In terms of surface water pollution, drainage will be designed to ensure that there are no untreated surface water discharges directly to surrounding coastal waters. Suitable prevention measures will be in place at all times to prevent the release of pollutants to the water environment, including adjacent coastal waters. Again, with this in place, the supporting habitats for Red-throated Diver will be maintained.

5.10.1.4 Conservation Objective 1: To ensure that the qualifying features of the Scapa Flow SPA are in favourable condition and make an appropriate contribution to achieving Favourable Conservation Status.

It is predicted that, with mitigation, there will be no significant impacts on Conservation Objectives 2a to 2c. Therefore, the favourable condition of Red-throated Diver in Scapa Flow SPA will be maintained.

6 APPROPRIATE ASSESSMENT: ORKNEY MAINLAND MOORS SPA

Orkney Mainland Moors SPA comprises four areas of moorland on Mainland; at its closest point, it lies within 6km from the Proposed Development site. The predominant habitats include extensive areas of blanket bog, heaths and mires, with these upland areas supporting 5.9% of the UK's breeding and 2% of the UK's overwintering Hen Harrier population, 2% of the UK's breeding Short-eared Owl population. In both cases one of very few sites to support such dense and significant numbers. The area also supports 2% of the UK's breeding Red-throated Diver population. This site's boundaries also correspond to Keelylang Hill and Swartaback Burn Site of Special Scientific Interest (SSSI) which is designated for breeding Hen Harrier.

Red-throated Diver is the only qualifying species of this SPA that could potentially be impacted by the works at Scapa. Breeding Red-throated Diver will use the Scapa Flow as a feeding resource during the breeding season, bringing food back to their nesting lochan.

6.1 Red-throated Diver, breeding

6.1.1 Assessment of Potential Impacts on Conservation Objectives

6.1.1.1 Conservation Objective 2a: The populations of qualifying features are viable components of the site

During the vantage point surveys and flight surveys, at least one breeding pair of Red-throated Divers utilised the site and environs for foraging.

The Proposed Development will result in the loss of 32Ha of the Scapa Flow SPA. This equates to 0.1% of the total SPA area. Although the Proposed Development footprint provides suitable foraging habitat for Red-throated Diver, the wider SPA site has the capacity to accommodate this pair.

There is minimal risk of mortality through collision as a result of the Proposed Development. Other direct effects affecting water quality is dealt with in Conservation Objective 2c and indirect effects (ie disturbance resulting in reduced body condition and survival) are dealt with in Conservation Objective 2b.

With no predicted impacts in either conservation Objectives 2b and 2c, it is considered that the population of Red-throated Diver remains a viable component of the site.

6.1.1.2 Conservation Objective 2b: The distribution of the qualifying features is maintained throughout the site by avoiding significant disturbance of the species

During the vantage point surveys and flight surveys, at least one breeding pair of Red-throated Divers utilised the site and environs for foraging.

Disturbance may occur through piling activities during the construction phase. It is not currently known the exact method to be used for construction, however applying the precautionary principle, blasting may be required. Blasting could have the potential to cause disturbance to this species. Blasting would be staggered in time to avoid simultaneous blast waves. Mitigation, such as a soft start approach and an ECoW monitoring for the presence of this species prior to piling works (with works to be undertaken once birds are a sufficient distance away), would limit any potential disturbance impact. This localised and short-term impact would not result in significant Impacts to Red-throated Diver within the SPA..

The majority of material (rock etc) required for the development will be transported via the road network, thus. It is not currently known how many vessel movements will occur during construction works, but it is anticipated that there will not be a significant increase in marine vessel movements during construction.

The Navigational Risk Assessment carried out (Technical Appendix 2.2) documents the predicted operational traffic movements associated with the new quay. Operational vessel movements provided within the NRA can be summarised as follows:

- Delivery and installation vessel movements are noted as being 18 and 8 respectively for 2028;
- 2029 shows delivery vessel movements as 19 calls in total with 12 delivery vessel calls;
- Similarly for 2030 delivery and installation vessel calls are 18 and 9;
- For 2031 delivery calls decrease to 8 but installation vessel calls increase to 19.

Although Red-throated Diver are known to be highly sensitive to disturbance through vessel movements, this level of increased vessel movements (between 1 and 2 every month) is not likely to result significant effects on this species.

None of these potential disturbance effects will result in barriers to movement, or reduce access to, preferred foraging habitats, resulting in a significant energy expenditure and possible reduction in body condition required for breeding success.

Therefore, it is considered that distribution of Red-throated Diver is maintained throughout the site.

6.1.1.3 Conservation Objective 2c: The supporting habitats and processes relevant to qualifying features and their prey/food resources are maintained

As described in NatureScot's Conservation and Management Advice Document for Scapa Flow SPA[2], supporting habitats refer to the characteristics of the seabed and water column relevant to their use by the qualifying features. It relates to wider oceanographic processes such as up-wellings, tidal Flows, hydrological movements which may be necessary for the habitat and could affect nutrient cycling and prey distribution.

In section 4.7.2.4 in Volume 1, hydrodynamic modelling has shown that during the construction and operational phases, low current speeds and corresponding low bed shear stresses observed remain, as under existing baseline conditions, indicative of a low energy environment and that any impacts are negligible. Therefore, post-construction, prey items for Red-throated Diver will remain as existing.

During construction, dredging activities will occur. The dredge volume is estimated to be 174,000m^3, based on the bathymetry surveys and proposed berth design. As outlined in section **Error! Reference source not found.** in Volume 1 of the EIAR, the marine deposits within the dredge area comprise an approximate stratigraphic order comprising superficial marine deposits (loose to medium dense gravelly silty sands with shell fragments and occasional cobbles) overlying glacial till. A Dredging Best Practicable Environmental Option Report (BPEO) has been produced for the proposed development which identifies the dredge budget to consist of approximately 17% gravel, 60% sand, and 23% silt and clay.

Dredge plume dispersal modelling has been undertaken, utilising a hydrodynamic model, as described in Technical Appendix 4.1, Volume 3 of this EIAR. The model results highlight that due to the relatively coarse nature of the dredge budget, and the weak tidal currents within the vicinity of the proposed dredge pockets, plumes generated as a result of the dredging works will be very localised and short term in duration. Due to the low current speeds, any sands and gravels lost to the water column during dredging will fall out of suspension immediately, within the dredge footprint. Clay and silt lost to the water column during dredging will remain in suspension for longer, being dispersed gradually over the tidal cycle, with the residual dominance of ebb tide currents resulting in net northwards plume dispersal. Total suspended solids concentrations are predicted to be low, highest within the dredge zone and immediate surrounds of the dredger, decreasing towards the plume limits.

Due to the small potential volume of any dredge budget disposed direct to the sea bed, it is considered that any impacts from this activity would be localised in extent, and of short duration. Therefore, it is considered the magnitude of impact of sediment discharge and dispersion from dredging works will be low within the dredge area and immediate vicinity, and negligible out with this area, thus maintaining the supporting habitats for Red-throated Diver.

There is the risk of pollution events (oil spills etc) during both the construction and operational phases of the Proposed Development. Adherence to strict Pollution Prevention controls and the use of silt booms during land reclamation works will mitigate against pollution spills which could affect the qualifying interest of the SPA and their prey sources. Therefore, the supporting habitats for Red-throated Diver will be maintained.

In terms of surface water pollution, drainage will be designed to ensure that there are no untreated surface water discharges directly to surrounding coastal waters. Suitable prevention measures will be in place at all times to prevent the release of pollutants to the water environment, including adjacent coastal waters. Again, with this in place, the supporting habitats for Red-throated Diver will be maintained.

6.1.1.4 Conservation Objective 1: To ensure that the qualifying features of the Scapa Flow SPA are in favourable condition and make an appropriate contribution to achieving Favourable Conservation Status.

It is predicted that, with mitigation, there will be no significant impacts on Conservation Objectives 2a to 2c. Therefore, the favourable condition of Red-throated Diver in Scapa Flow SPA will be maintained.

7 APPROPRIATE ASSESSMENT: HOY SPA

The island of Hoy lies to the south of the Orkney mainland and makes up much of the western shoreline of Scapa Flow. The Hoy SPA covers the northern and western two-thirds of the island, which is formed of Old Red Sandstone and contains Orkney's highest hills. Most of the island is moorland, drained by numerous streams, and it supports a diverse mixture of mire, heath and alpine vegetation, as well as Britain's most northerly native woodland. On the west coast, Old Red Sandstone cliffs reach 339m in height and include several notable stacks and crags. These cliffs provide important breeding sites for a number of seabird species such as Puffin, Guillemot, Kittiwake, Great Black-backed Gull and Fulmar. Inland moorland areas also support large numbers of breeding birds, in particular Great Skua and Arctic Skua. Red-throated Diver nest on the numerous small lochans found on the moorland. Peregrine are also known to breed in Hoy. The divers and seabirds feed in the rich waters around Hoy, outside the SPA.

7.1 Conservation Objectives

The conservation objectives for Hoy SPA are as follows:

- 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 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

7.1.1 Assessment of Potential Impacts on Conservation Objectives

All of the species scoped into this assessment have been recorded within and adjacent to the Proposed Development site. They are as follows:

- Arctic Skua – Small numbers were recorded flying past very infrequently during the summer months, with a peak of five birds in June 2022. The closest known breeding areas are on East Mainland, ~10km distance, supporting only one or a few pairs at each location.
- Great Skua – Small numbers, with a peak of 4 birds/hr flying past in July 2021. Numbers in 2022 were significantly lower, probably due to the prevalence of avian flu which has decimated the local, and national, populations.
- Great Black-backed Gull – a peak of 11 birds were recorded during the summer, and up to 7 birds and hour recorded flying past at its peak. One pair nesting close to the Proposed Development site. It is unlikely that birds recorded were part of the Hoy SPA complex.
- Fulmar – Sizable numbers were recorded flying past during the summer months, with a peak of 56/hr in July 2022. It is considered that the vast majority, if not all, birds recorded were from the breeding colony to the north of the Proposed Development site.
- Kittiwake – Small numbers were recorded flying past during the summer months, with a peak of 7/hr I June 2022. A peak count of 83 birds on the water within 2km was also recorded. It is considered that the vast majority, if not all, birds recorded were from the breeding colony to the north of the Proposed Development site.

- Guillemot – Small numbers were recorded, with a peak of 27 birds within 1km of the Proposed Development and 87 within 2km. Small numbers were also recorded flying past the Proposed Development site, with a peak of 6/hr in June 2022. It is considered that the vast majority, if not all, birds recorded were from the breeding colony to the north of the Proposed Development site.

Although unlikely given that the qualifying species of Hoy SPA are also present close to the Proposed Development, it is possible that some of the birds recorded above are part of the Hoy SPA complex.

Of the Conservation Objectives above, the only relevant one with regards to the Proposed Development is *"no significant disturbance to the species".*

As described in detail for Scapa Flow SPA features, there would be only a small increase in vessel movements both during construction and operation of the Proposed Development

The majority of material (rock etc) required for the development will be transported via the road network, thus. It is not currently known how many vessel movements will occur during construction works, but it is anticipated that there will not be a significant increase in marine vessel movements during construction.

The Navigational Risk Assessment carried out (Technical Appendix 2.2) documents the predicted operational traffic movements associated with the new quay.
Operational vessel movements provided within the NRA can be summarised as follows:

- Delivery and installation vessel movements are noted as being 18 and 8 respectively for 2028;
- 2029 shows delivery vessel movements as 19 calls in total with 12 delivery vessel calls;
- Similarly for 2030 delivery and installation vessel calls are 18 and 9;
- For 2031 delivery calls decrease to 8 but installation vessel calls increase to 19.

None of the species assessed for the Hoy SPA are highly sensitive to vessel movements, therefore disturbance to these species is considered to be minimal.

Disturbance may occur through piling activities during the construction phase. It is not currently known the exact method to be used for construction, however applying the precautionary principle, blasting may be required. Blasting could have the potential to cause disturbance to this species. Blasting would be staggered in time to avoid simultaneous blast waves. Mitigation, such as a soft start approach and an ECoW monitoring for the presence of this species prior to piling works (with works to be undertaken once birds are a sufficient distance away), would limit any potential disturbance impact. This localised and short-term impact will not result in significant impacts to Hoy SPA qualifying species.

8 APPROPRIATE ASSESSMENT: SANDAY SAC

Sanday is a large, low-lying island situated in the north-east of the Orkney archipelago. The island has a complex coastline characterised by extensive sandy beaches, sheltered inlets and exposed rocky headlands. The coastal waters of Sanday hold the largest colony of common seals at any relatively discrete site in Scotland. Around 1,450 adults haul out on the intertidal reefs to pup, moult and rest. This represents around 17% of the Orkney, 5% of the UK and 2% of the EU populations of the species. During the 1998 breeding survey over 550 pups were observed at the site, accounting for 34% of new born pups in Orkney. Large breeding colonies are important in maintaining overall population size and are significant as sources of emigration to smaller or newly established groups. The current status of harbour seals at Sanday is unfavourable declining, with a significant decline in numbers since the designation. Numbers are now assessed to be approximately 100 at this site, which is reflected across the whole of Orkney, where populations have declined by ~90%.

The SAC is located 36km north east from Scapa.

8.1 Assessment of Potential Impacts on Conservation Objectives

The conservation objectives are to avoid deterioration of the habitats of qualifying species (common seal) 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 the qualifying interest.

To ensure for the qualifying species that the following are maintained in the long term:

- Population of the species as a viable component of the site;
- Distribution of the species within site;
- Distribution and extent of habitats supporting the species;
- Structure, function and supporting processes of habitats supporting the species; and
- No significant disturbance of the species
-

The distance of the breeding colony (36km) is at a distance whereby the Proposed Development works would not have an impact.

Tagging studies have shown that harbour seals from Sanday do not travel into Scapa Flow to forage[5] However, taking the precautionary principle, individual seals which form part of the SAC population could potentially feed and forage within Scapa Flow. They could be at risk of temporary disturbance from underwater noise associated with the blasting. The noise is not predicted to cause long term negative effects on the SAC qualifying interest due to its short duration and adherence to a detailed Marine Mammal Mitigation Plan (MMMP).

Given the mitigation which will be employed and the short-term nature of the works producing underwater noise, the number of individuals affected will be negligible and any disturbance which may occur will not fall under the JNCC (2008) definition of significant disturbance. Therefore, it is considered that the MMMP will be sufficient to prevent short term negative effects.

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[5] McConnell, B., Smout, S. & Wu, M.(2017). Modelling Harbour Seal Movements. Scottish Marine and Freshwater Science Vol 8 No 20. pp. 33. DOI: 10.7489/1998-

9 IN COMBINATION EFFECTS AND CONCLUSION

9.1 In Combination Effects

It is a requirement of Appropriate Assessment that the cumulative or in-combination effects of the proposed development together with other plans or projects are assessed. Cumulative impacts can be defined as a project/plan/programme likely to have a significant effect thereon, either individually or in combination with other plans or projects.

In isolation, with mitigation, the Proposed Development will not have a significant impact on the integrity of the designated sites assessed. Therefore, it is considered highly unlikely that the Proposed Development would contribute cumulatively to adverse effects on the integrity of these designated sites.

10 MITIGATION

The following mitigation will be employed to avoid and minimise any impacts occurring both during the construction and operational phases of the proposed development:

- Vessels to adhere to strict speed limits;
- Deployment of an Ornithologist and marine mammal observer to monitor for the presence of qualifying species of the Scapa Flow SPA, and cetaceans and pinnipeds (in particular harbour seal) in the vicinity of the Proposed Development during piling and blasting works;
- A soft-start approach to piling works to prevent disturbance;
- Production and adherence to detailed Marine Mammal Protection Plan (MMPP);
- Production and adherence to a detailed Pollution Prevention Plan; and
- A silt boom to contain fine sediments will be used whilst work activities are undertaken.

TECHNICAL APPENDIX 5.6

IRWIN CARR
CONSULTING

Scapa Deep Water Quay, UW Noise Modelling

Kirkwall, Orkney

RP001 2022248 (Scapa DWQ, UW Modelling)

20 July 2023

PROJECT: SCAPA DEEP WATER QUAY, UW NOISE MODELLING

PREPARED FOR: ENVIROCENTRE

8 EAGLE STREET,

CRAIGHALL BUSINESS PARK,

GLASGOW, G4 9XA

SCOTLAND

ATTENTION: EMMA CORMACK

REPORT NO.: RP001 2022248 (Scapa DWQ, UW Modelling)

Document Control

Status:	Rev:	Comments	Date:	Author:	Reviewer:
Draft	1.0		20 July 2023	Rasmus Sloth Pedersen	Shane Carr
				Rasmus Sloth Pedersen	Shane Carr

EXECUTIVE SUMMARY

BRIEF DESCRIPTION OF WORK

In relation to the construction of a deep-water port in Scapa Flow, both dredging, drilling and piling is planned. The noise from these activities can adversely affect local fauna either through direct injury of sensory systems or indirect harm from noise pollution drowning out communication and foraging sounds. Noise modelling has been carried out in respect to the various noise sources and local animals to estimate impact from noise and what mitigation can/needs to be employed to keep impacts below levels of significant harm to the local wildlife.

Source sources (dredging, piling and blasting) are modelled from a combination of empirical models (based on recorded data) and numerical models (calculated source levels from inputs).

CONCLUSION & RESULTS SUMMARY

Dredging

The noise from dredging, while presenting a significant Permanent Threshold Shift (PTS (hearing injury) risk to ranges >500 m for the Very High Frequency (VHF) group (e.g., porpoise), this is only for animals staying close to the activity for extended periods (> 1 hour) and assumes continuous dredging with the dredger level as given by the 90th percentile. For the best estimate (model mean) the PTS risk range is 450 m after 8 hours exposure. There is no acute risk of noise related injury related to the dredging, and animals have time to swim away. Further the area ensonified does not “block” access through a channel or strait.

Vibro piling

Prolonged exposure to vibro piling at close range (<100 m) carries some auditory risk for the animals assessed, specifically groups LF, VHF and P- (baleen whales, porpoises and salmon/trout), where the peak pressures in the noise have risk ranges up to 300 m for the VHF group. We therefore suggest surveillance takes place prior to piling to minimise the risk of impact on porpoises. While this is a significant risk for animals close to the activity, we stress that we have used a very conservative approach to estimating the source levels, and the realised emission will likely be significantly lower.

Further, animals will tend to move around, or away from noise, which will limit exposure. In Figure 16, p. 22 and Figure 18, p. 23 we show an example of the effect of using moving receivers (animats, modelled animals) to estimate what might be the effect of movement.

Table of Contents

Abbreviations and Definitions:

PTS	Permanent Threshold Shift
VHF	Very High Frequency
SOFAR	Sound Fixing And Ranging
SSP	Sound Speed Profile
SPL	Sound Pressure Level
Hearing group	Refers to the Southall 2019 hearing groups (Southall, et al., 2019).
“,” and “.”	Comma “,” is used as thousands separator, while dot “.” Is used as decimal separator.
TL, PL	Transmission Loss, Propagation Loss. Used interchangeably in this document.
Psu	Practical salinity unit, equivalent to parts per thousand as g/kg, mass of salts per mass of water.
Noise	Sound that causes, or is assumed to cause, annoyance or disadvantage. No automatic significance of impact is associated with this term.
Solver	Mathematical algorithm for calculating sound transmission losses in water.
[]	Square brackets are used throughout to denote units, e.g.: “Pressure [Pa]” means pressure in Pascals.
Degrees	Either angular degrees (0-360) or degrees Celsius
3rd octave, decidecade	Refers to the subdivision of octaves (doublings of frequency) and decades (10x frequency). Using the appropriate base frequency, the two are identical for practical purposes.
Worst case	Used as “reasonable worst case”. E.g. use of MHWS instead of historical maximum for max water level. Or 90th percentile as representative of worst-case.
Mean case	The expected case, both median and mean values will inform this.
Signature, Impulse	When in relation to a sound, this refers to the time-pressure signal associated with that sound, normally as a time-series of pressures relative to ambient pressure, in pascals.
Vibro	Vibration pile driving
MSL	Mean Sea Level
β, Log multiplier	Symbol used to denote the factor multiplied by the base ten Log in equations like: “$TL = \beta \times Log_{10}(range)$”
SL, Source level	Apparent monopoint source level as viewed from the acoustic far field

1 INTRODUCTION

In relation to the construction of a deep-water port in Scapa Flow, both dredging, drilling and piling is planned. The noise from these activities can adversely affect local fauna either through direct injury of sensory systems or indirect harm from noise pollution drowning out communication and foraging sounds. Noise modelling has been carried out in respect to the various noise sources and local animals to estimate impact from noise and what mitigation can/needs to be employed to keep impacts below levels of significant harm to the local wildlife.

Source sources (dredging, piling and blasting) are modelled from a combination of empirical models (based on recorded data) and numerical models (calculated source levels from inputs).

1.1 Underwater Acoustics Basics

Underwater acoustics modelling is the application of physical models to characterise the behaviour of sound in environments under the surface of the sea and in the top layers of the seabed. As some familiarity with in-air acoustics is assumed the focus here is on key differences between in-air acoustics and underwater acoustics, making waterborne propagation more efficient than airborne propagation.

This chapter only gives reader a quick overview, please see APPENDIX B – Underwater Acoustics Basics APPENDIX *for more detail.*

1.1.1 SOUND SPEED

Water is much harder to compress than air, and a soundspeed of 1500 m/s is often used as a standard soundspeed in water[1] much as 340 m/s is in air.

The soundspeed changes with depth, “sound speed profile”, this is quite important in sound propagation, as refraction (changes in propagation angle) will occur when sound moves between layers of water with varying sound speed. These effects can lead to profoundly inhomogeneous sound fields and SOFAR (Sound Fixing And Ranging) channels.

The same relationships are valid in the sediment, though sediments commonly have soundspeeds higher than water. Soundspeeds from 1700 m/s (fine sand/silt) to 2500 m/s (gravel) are common for non-solid sediments, with solid sediments (rocks) having much higher soundspeeds 2800 m/s (Calcarenite) to 6000 m/s (some granite).

1.1.2 SPREADING LOSS

Most of the propagation loss (loss in dB from source to receiver, “PL”) that occurs initially is governed by “spreading loss”. It is the simple “thinning out” of acoustic energy as it spreads away from the source, usually in all directions – spherically. This means a reduction in received level of 6 dB per doubling of distance

At longer ranges the medium is no longer unbounded. We reach ranges where the sound has interacted with the surface (near perfect acoustic reflector) or the seabed (lossy acoustic reflector). Here we expect spreading loss to be ~3 dB per doubling of distance.

1.1.3 ABSORPTION

Besides the “thinning out” of the sound energy as described above, the sound is also dissipated into heat by the way the pressure changes interact with water, molecules and particles in its path. This absorption is salinity dependant. Frequencies under 1 kHz experiences almost no absorption, while high frequencies, over 10 kHz, can be attenuated by over 10 dB / km.

Small bubbles, wind or wave induced, will further attenuate especially the high frequencies.

1.1.4 SEDIMENT

Depending on the incident angle of the sound, the frequency and the acoustic properties of the sediment, sound can either mostly penetrate the sediment or mostly be reflected by it.

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[1] Varies from 1450 m/s at 0° to 1550 m/s at 30° at salinity of 35 psu.

In shallow areas with soft sediment (acoustically similar to water), it is typical to find that close to the source, at high incidence angles and at low frequencies (<250 Hz) the sound will penetrate into the sediment and dissipate there, leading to very high transmission losses for these frequencies.

1.1.5 SOUND LEVEL UNITS

All references to sound pressure levels (SPL), peak pressure levels (L_p) and sound exposure levels (L_e) refer to a logarithmic ratio between a reported/measured pressure or exposure and a reference pressure or exposure. As an example, a level of 220 L_p (decibel zero-to-peak) is equal to a peak pressure of 100000 Pascals (Pa) over ambient pressure, while 120 L_p is equal to 1 Pa over ambient pressure.

To avoid dealing with these large numbers as pascals (as a linear scale), they are converted to a decibel ratio (Table 1 for definitions). Besides compressing large numbers to a smaller scale this also corresponds better to how animals are thought to perceive sound, namely as relative steps. This means that an increase from 1 to 2 Pa *sounds like* the same increase as from 100 to 200 Pa, even though the first step was only 1 Pa, while the second was 100 Pa. This is better reflected in a logarithmic scale based on ratios, where both steps are equal, here 3 dB.

However, while dBs are practical, they can be hard to compare between studies, due to vague definitions, and so we have adopted the standards set by ISO 18405-2017 (Table 1 below).

For ease of reference please see following overview for unit definition.

Table 1: Definitions.

Unit	Definition	Comments
SPL (dB_{RMS}) ISO 18405- 2017: 3.2.1.1	$SPL = 10 \cdot Log_{10}\left(\frac{\frac{1}{t_2 - t_1} \cdot \int_{t_1}^{t_2} p(t)^2 dt}{1 \cdot 10^{-12} Pa}\right)$	Functionally equivalent to deprecated $20 \cdot Log_{10}\left(\frac{RMS}{1 \cdot 10^{-6} Pa}\right)$
L_p ($dB_{z\text{-}p}$) ISO 18405- 2017: 3.2.2.1	$L_p = 20 \cdot Log_{10}\left(\frac{Pa_{max}}{1 \cdot 10^{-6} Pa}\right)$	This assumes that Pa_{max} is equal or greater than $\sqrt{{Pa_{min}}^2}$
$L_{p\text{-}p}$ ($dB_{p\text{-}p}$)	$L_{p-p} = 20 \cdot Log_{10}\left(\frac{Pa_{max} - Pa_{min}}{1 \cdot 10^{-6} Pa}\right)$	Often[2] equivalent to $L_P + 6.02\ dB$
L_E (dB_{SEL}) ISO 18405- 2017: 3.2.1.5	$L_E = 10 \cdot Log_{10}\left(\frac{\int_{t_1}^{t_2} p(t)^2 dt}{1 \cdot 10^{-12} Pa}\right)$	For continuous sound this is equivalent to $SPL + 10 \cdot Log_{10}(t_2 - t_1)$ “t” is seconds

Unless otherwise stated SPL has an averaging period of 1 second, and L_E for the duration of the specified event, sometimes indicated as $L_{E\text{-“time”}}$ or $L_{E\text{-single blow}}$.

If the averaging period for SPL is equal to the total even duration then SPL is equal to “Leq” the “equivalent constant level”.

When source levels are presented, the same units are used, and it is implicit that all source levels are given as if recorded 1 m from an omnidirectional mono-point source, unless otherwise specified.

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[2] If maximum pulse rarefaction is below ambient pressure and compression and rarefaction phases are of equal size.

2 SITE AND LOCAL ENVIRONMENT

The site is located in Orkney, Scotland:

- Scapa DWQ at Lat: 58.920345, Lon: -2.965084. Mean water depths 5-30 m.

The site is sheltered from oceanic swell, with little current and with no major outflows from rivers, meaning that the conditions important for sound propagation are quite stable. The sediment is generally a soft upper layer of mud/silt and gravel overlaid a layer of weathered sedimentary rock, before a stronger layer of sedimentary rock (silt-/mud-/sand-/lime-stone).

Figure 1. General location of Scapa DWQ development (in red circle) on Main Island of the Orkney Islands. Hatston site (just north west of Kirkwall, shown for completeness).

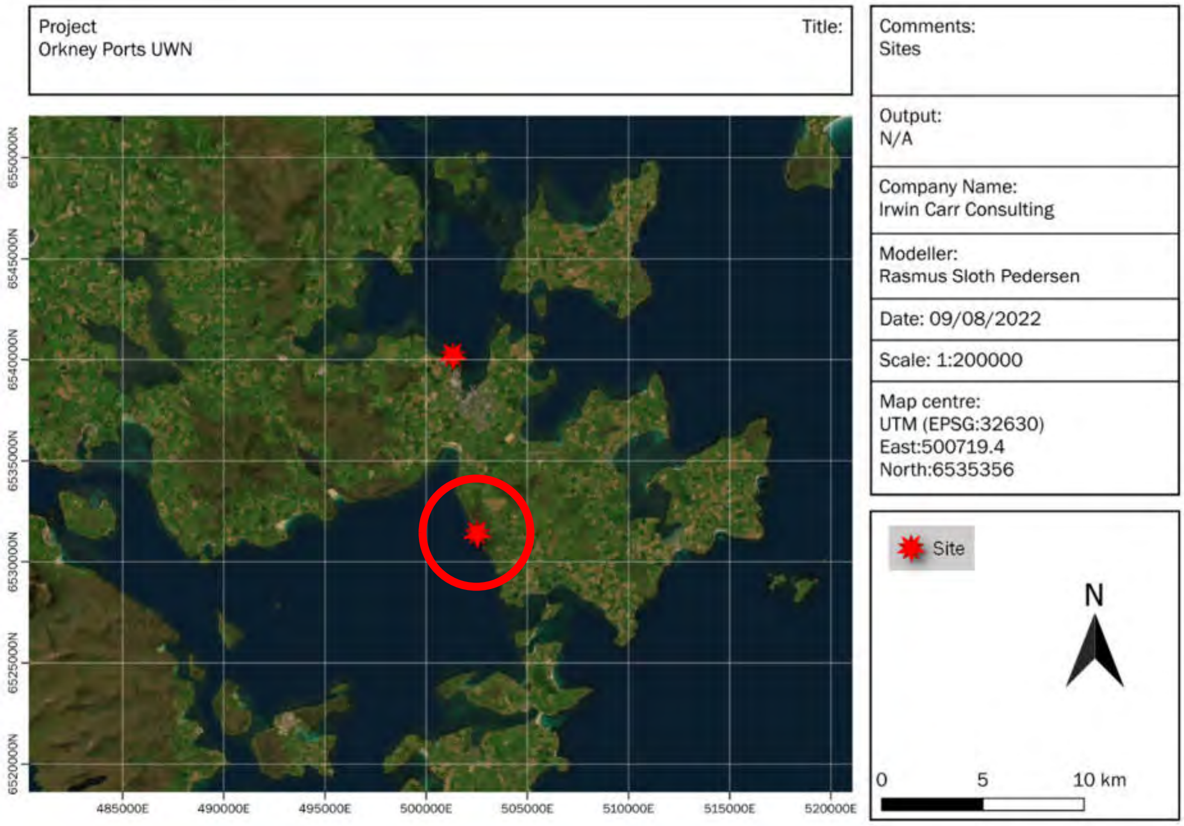
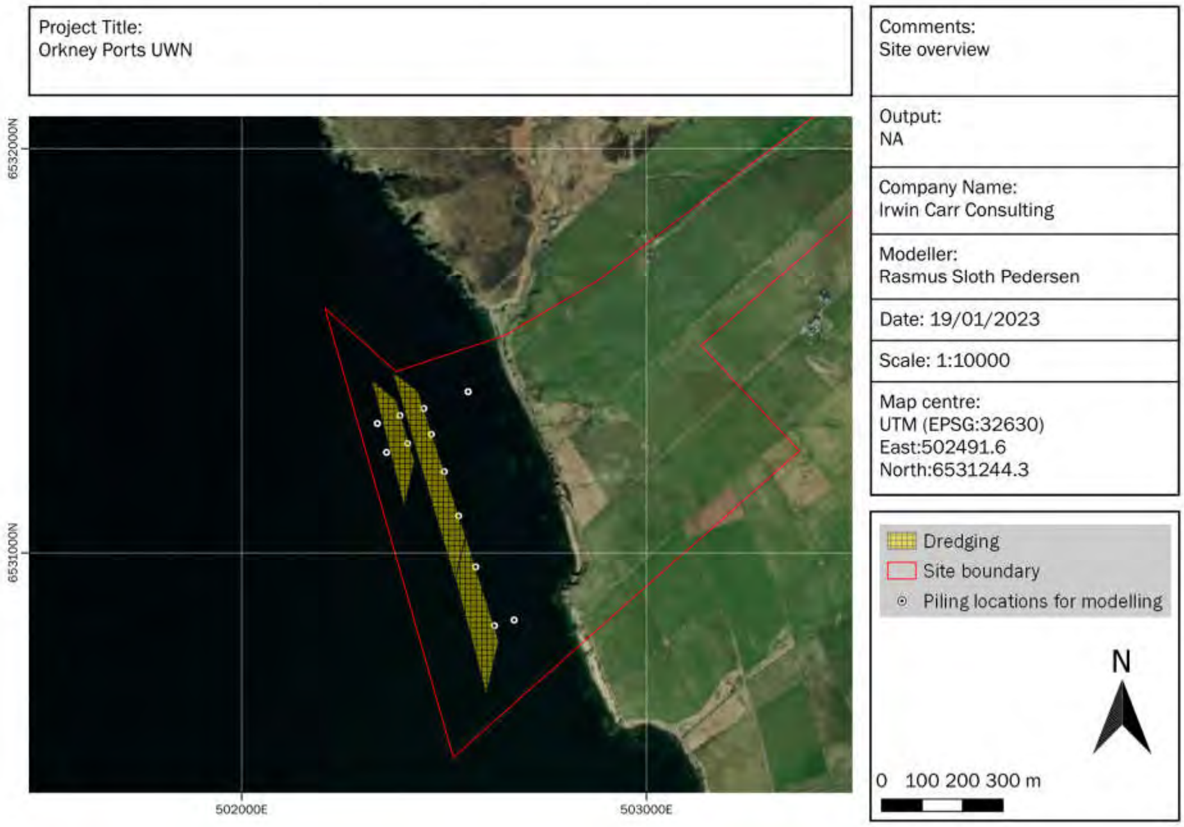


Figure 2. Overview of piling locations for modelling and approximate areas to be dredged.



2.1 Depth, Bathymetry

Depth data for the sites were collected from 3 sources:

- The proponent, detailed data near the site, 4 m resolution.
- EMODNet (European Marine Observation and Data Network, 2019), long range data, ~90 m resolution.
- Nautical charts such as http://fishing-app.gpsnauticalcharts.com, medium range data, variable resolution.

These were corrected to MSL and combined (using a mosaic method) to give the best possible total cover of the area.

For the "worst case" scenario the MHWS (Mean High Water Spring) level is used (deeper water decreases sound transmission loss).

2.2 Water properties

The water properties are important for the sound propagation. Generally the two sites have no major outflows of fresh water so salinity is expected to be near 35 psu (confirmed by (Marine Scotland, 2022)).

2.2.1 TEMPERATURE

The temperature was measured with the inbuilt thermometer of the Soundtrap hydrophone (used for on-site measurements).

Average water temperature at Scapa site during monitoring: 8.9 °C

The water columns are assumed to be well-mixed, given lack of nearby freshwater outflows, windy location, evaporation and generally shallow depths (<30 m).

2.2.2 SOUNDSPEED PROFILE

Given the water properties presented above, we assume the water soundspeed to be constant at all depths, with no significant deviations from the expected values.

The sound speed calculation is based on a widely used model for sound speed in water (Leroy, Robinson, & Goldsmith, 2008), with input of temperature, depth and salinity.

Sound speed in the water is calculated as 1486 m/s

2.3 Sediment properties

Given the project is a construction project there are sediment cores available for sediment characterisation provided by “Causeway Geotech”. These give good coverage in the areas close to the Scapa DWQ. For general sediment outside the development area, we have used data from British geological survey (British Geological Survey, 2022).

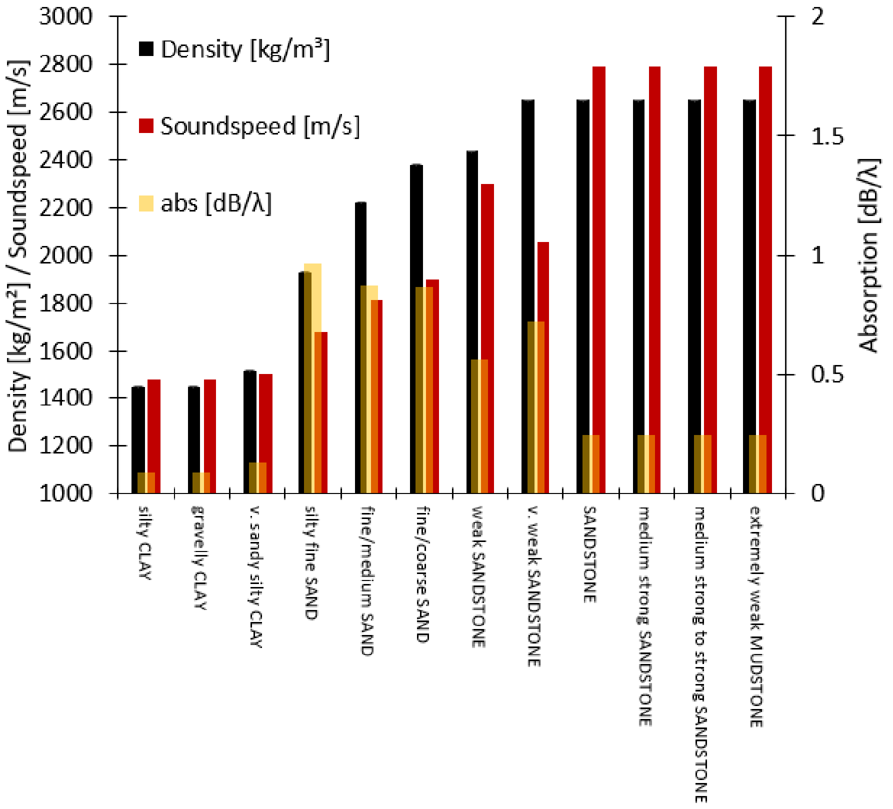
Where samples were taken we mapped the descriptions in the sediment core reports in relation to their Udden-Wentworth or Folk sediment description where these matched the nomenclature well. For other sediment types, e.g. sandstone/mudstone/limestone we have used given values for nominal “sandstone” (Jensen, Kuperman, Porter, & Schmidt, 2011; Boyce, 1981). The cores also contain classifications such as “weak sandstone” this was interpreted as loose, sandy sandstone, and we characterised this with density and soundspeed between that of sandstone and sand. This interpolation was based on an assumption that the scale “very weak-, weak-, medium weak-, sandstone” corresponds to linear interpolation between sand and sandstone (see Table 2 below). We have not changed the properties for categories indicating harder than usual sediments, such as “medium strong”, “very strong“.

Table 2. Example of interpolation scheme for Sand-sandstone.

Material	Interpolation value	Density [kg/m^3]
Sand	0	1931
Very weak sandstone	0.25	2111
Weak sandstone	0.5	2291
Medium weak sandstone	0.75	2470
Sandstone	1	2650

Where we had no direct properties (density, sound speed, absorption) for the sediment we have used a modelling approach to estimate them, following (Ainslie, 2010).

Figure 3. Sediment types. Note that absorption is read on the right vertical axis.



2.4 Background/Ambient Noise

Baseline noise monitoring was carried out on 29-30 November 2022. On both days the weather was very calm (< sea state 1) with no detectable current. The Scapa site was unexpectedly noisy with ~130 dB SPL for all measurements (unaffected by range to our vessel). There were multiple other vessels in the bay, but all far away (> 1km). The most likely source was the small oil platform stationed a few km to the south. This could have some active machinery causing the noise, indicated by the tonal components (seen as horizontal bands in spectrogram in Figure 4).

Note that ambient noise here excludes noise from nearby vessel passes, it is meant as the ambient noise with no identifiable noise sources.

Table 3. Typical background noise levels.

Site	SPL [dB]
Scapa	129.9
Hatston	107.2

Figure 4. Spectrogram of ambient noise at Scapa.

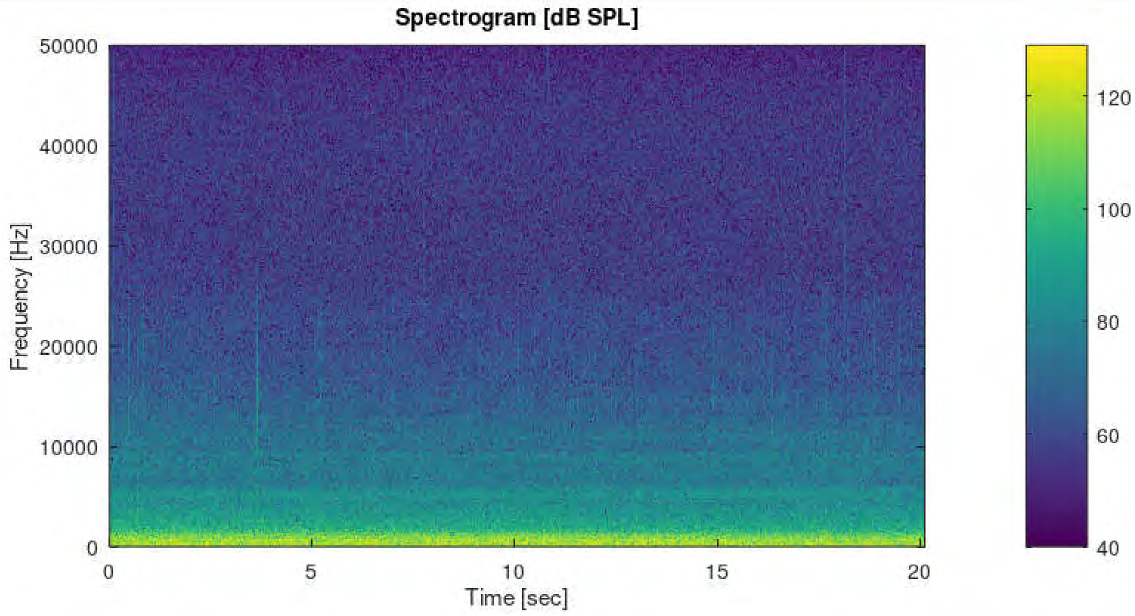


Figure 5. Spectrogram of ambient noise at Hatston.

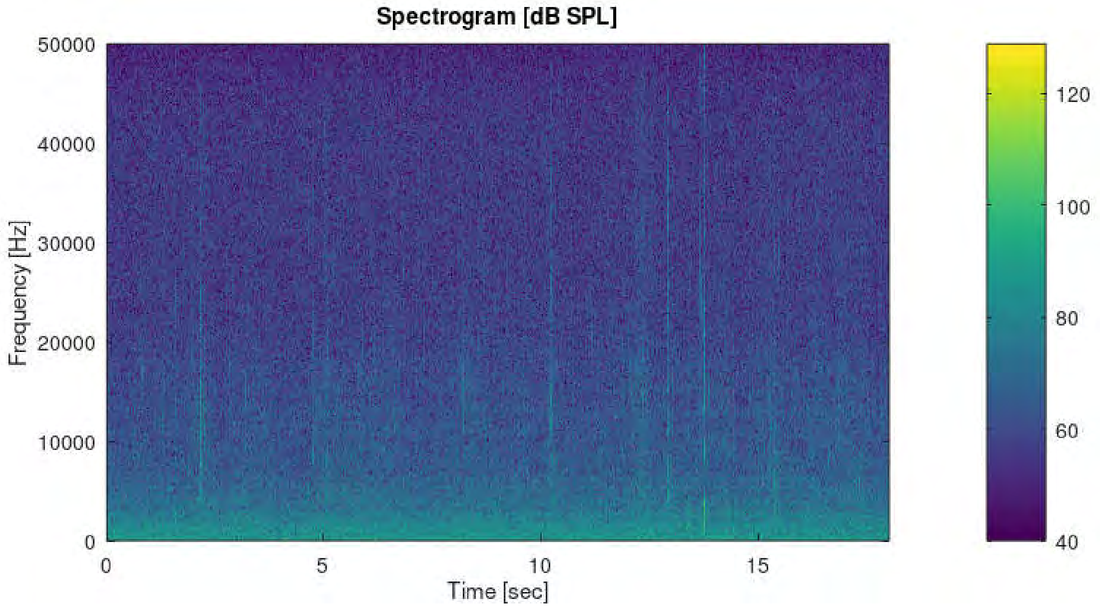
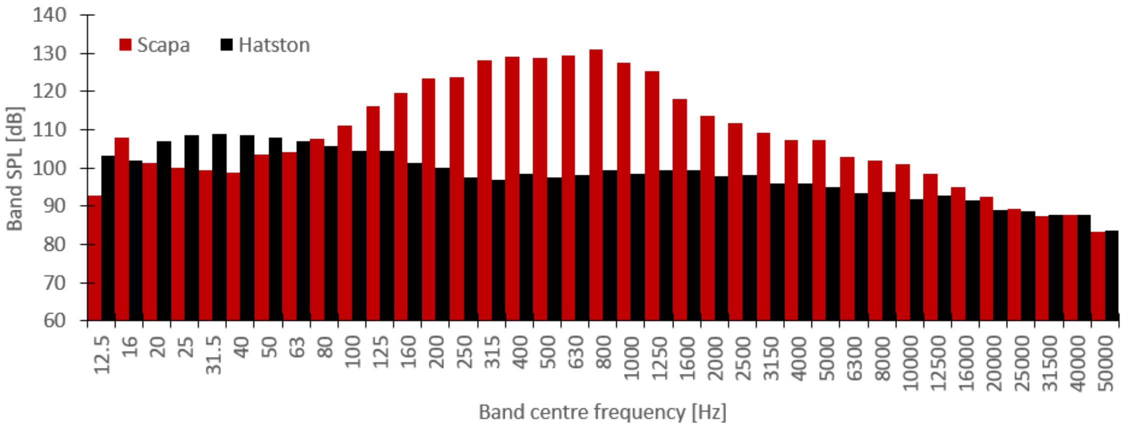


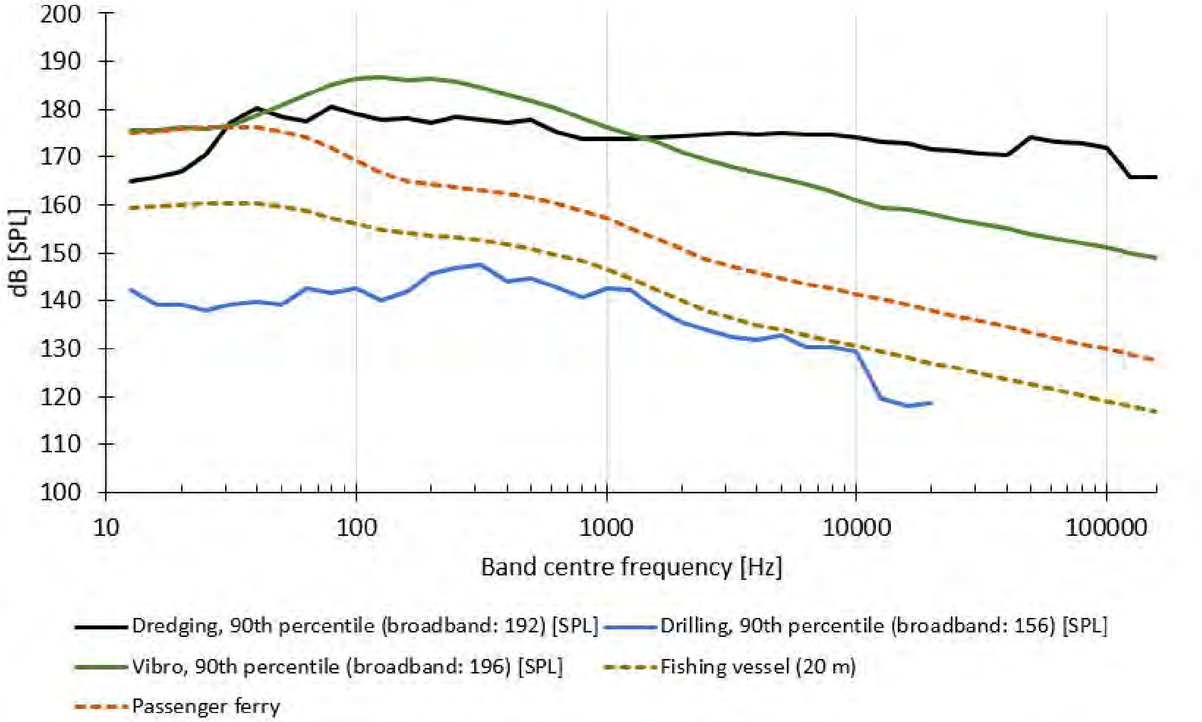
Figure 6. Typical band levels of ambient noise at Scapa and Hatston.



3 SOUND SOURCE MODELLING

We have considered three noise sources for this assessment, but have screened out the drilling as it is not loud enough to meaningfully assess in an environment with many vessels and general human activity (compare with vessel noise in Figure 7, below).

Figure 7. The three sound sources considered in this report. A fishing boat and a small ferry has been added for context.

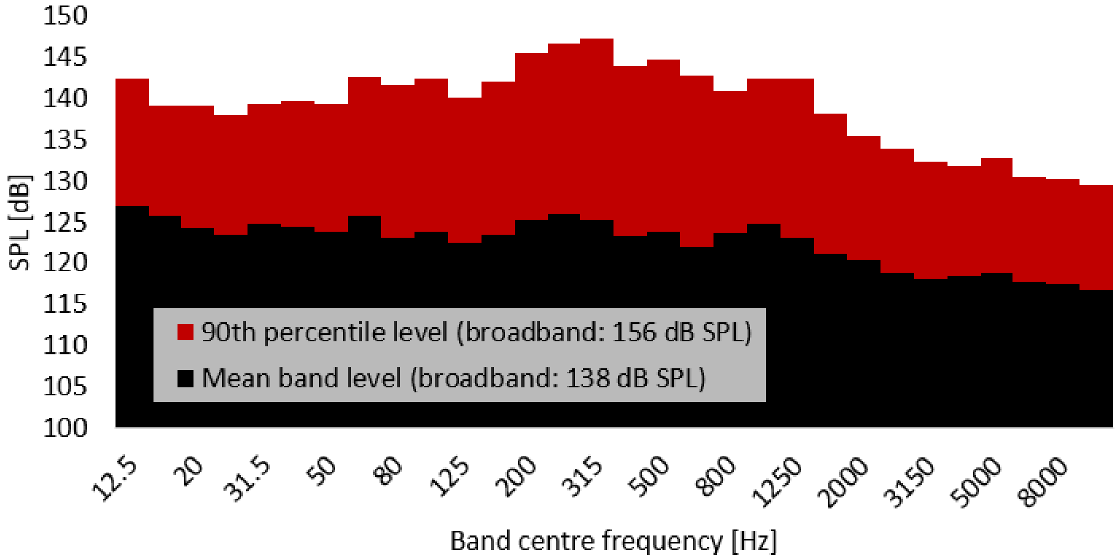


3.1 Drilling

As some hard sediment is expected round piles might be placed in pre-drilled holes, based on the range of noise levels presented in Figure 8, the drilling noise is assumed to be insignificant to the marine life.

The measured levels presented are a summary of 13 different recorded drilling episodes shows noise levels to vary considerably between sites and equipment, and there is no clear connection between drill size, power or sediment type to the emitted noise level. However, given the modest broadband level of even the 90th percentile level (156 dB SPL) this noise source can be ignored.

Figure 8. Example of drilling noise band levels. Data from various drills, diameter 0.1-1.2 m and various rock types.



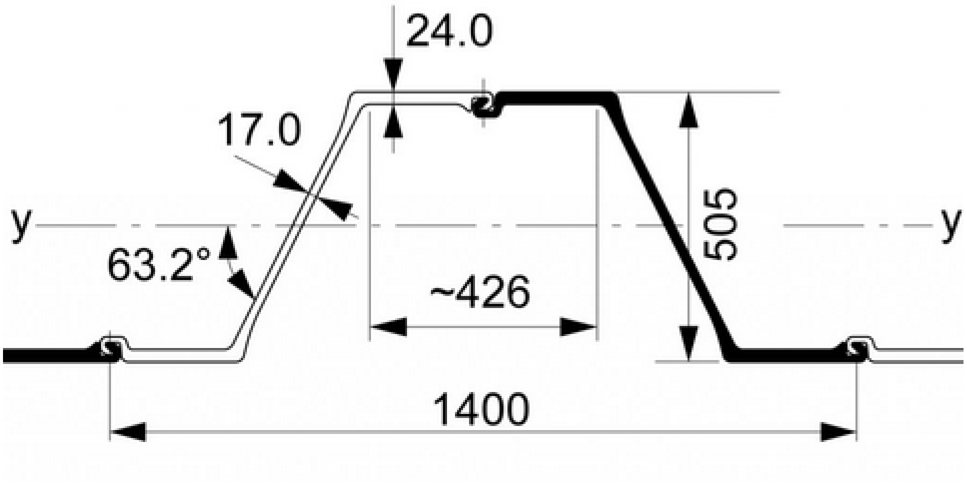
3.2 Vibration Piling Model

Two types of piles are expected to be used:

1. Tubular piles, expected to have a diameter of 2.1 m
2. Sheet piles (Arcelor Mittal AZ52-700[3]).

Both will be vibrated into the sediment or into holes left by the drilling campaign.

Figure 9. Schematic of the sheet piles.



The diameter of the tubular pile (210 cm) is used a basis for an empirical model based on 50 recorded levels as from CalTrans (CalTrans, 2015).

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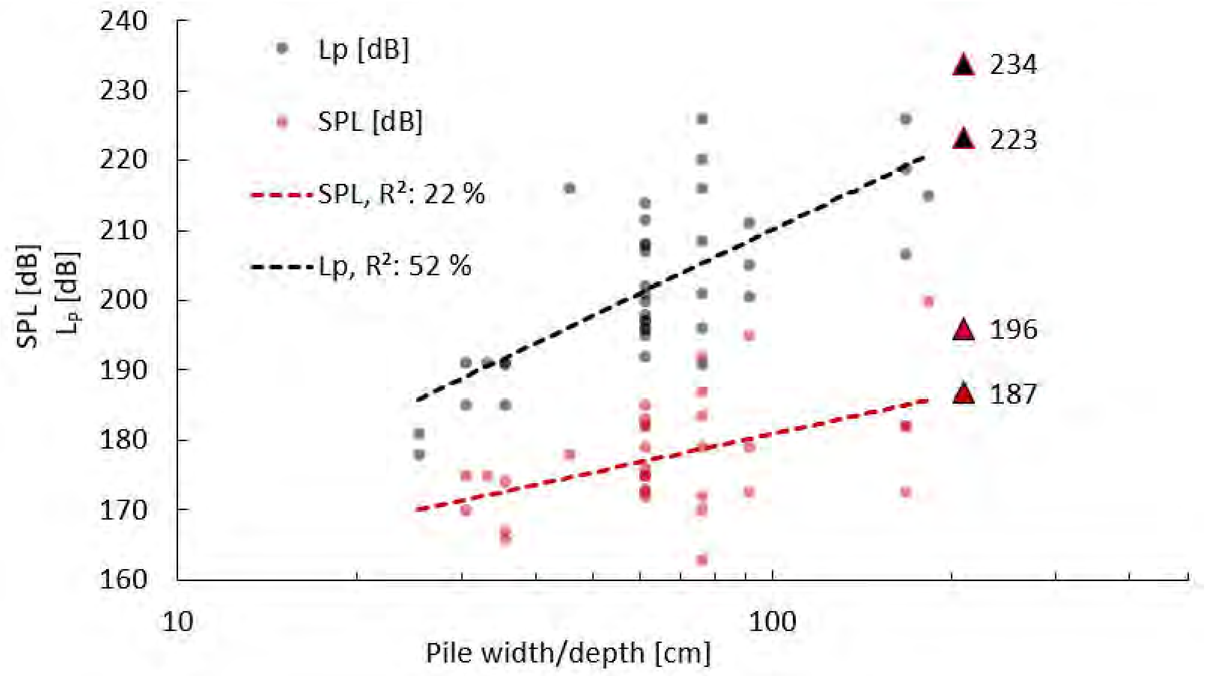
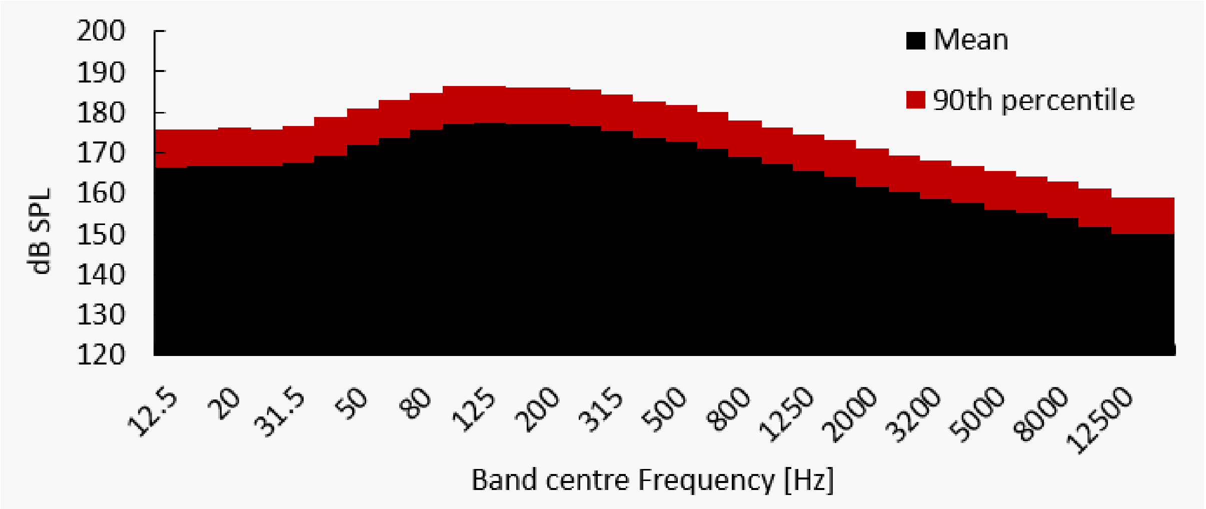
[3] https://sheetpiling.arcelormittal.com/products/az-52-700/

Figure 10. Basis of vibro piling broad band source level as a function of pile size (210 cm diameter).



Given the low confidence we have in this approach (low R² values) we use the 90th percentile level as the broadband source level. L_P is estimated to be 234 dB and SPL 196 dB. The frequency content is assumed to be identical to that of the impact piling.

Figure 11. Band levels for vibro-piling.



3.3 Dredging

Dredging is done to chart Datum -15 metres, meaning this will likely be done with a cutter suction dredger (Max reach 15 m) and possible assistance from a backhoe dredger. For the cutter suction dredger a cutter power of 540 kW is assumed, equivalent to the Boskalis “Seine”[4] cutter suction dredger. For cumulative modelling it’s assumed that the dredging is potentially active 24 hours per day. The Backhoe dredging is quieter and has been ignored in favour of using the louder method for the assessment.

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[4] https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwibnqWF-sH8AhUQg1wKHfYmBVoQFnoECB8QAQ&url=https%3A%2F%2Fboskalis.com%2Fmedia%2Fqbjnfdlv%2Fseine_cutter_suction_dredger.pdf&usg=AOvVaw1bBD75xRPcFc3H0TUXTFkD

Figure 12. Approximate extent of dredging campaign (yellow hatched area).

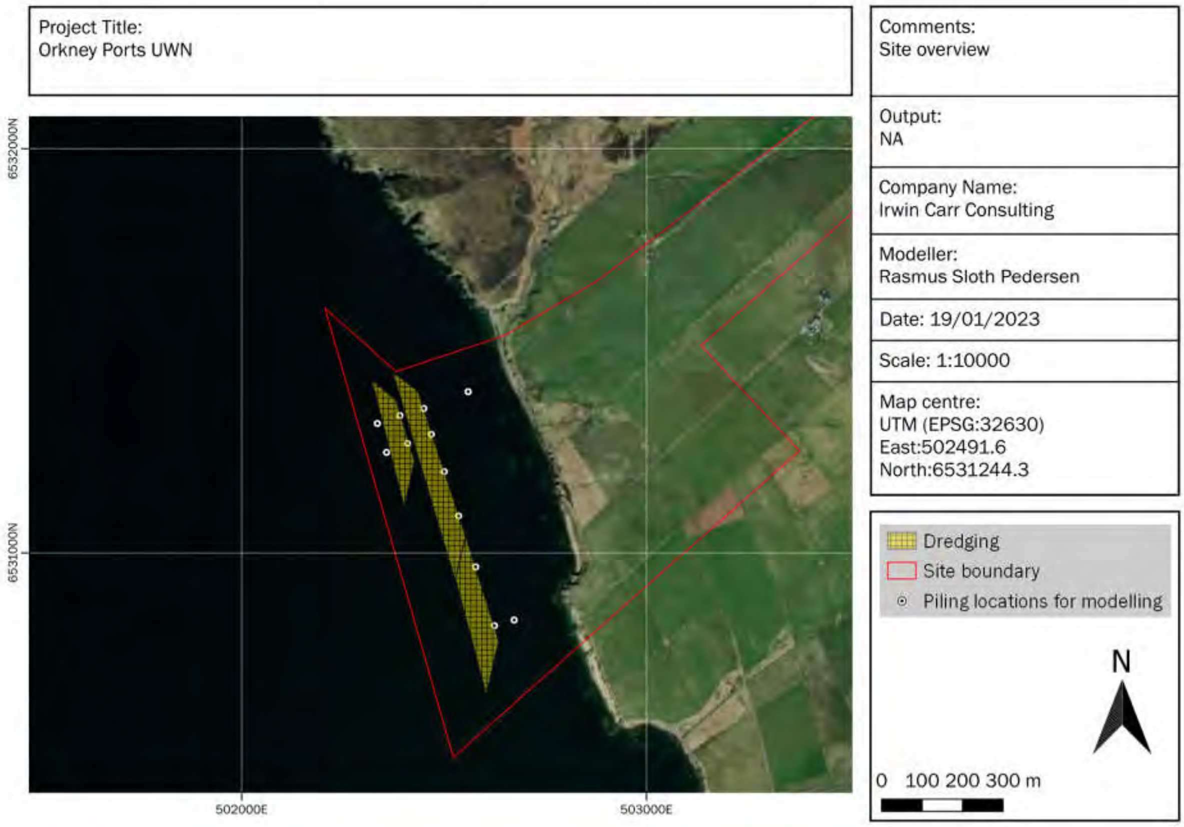
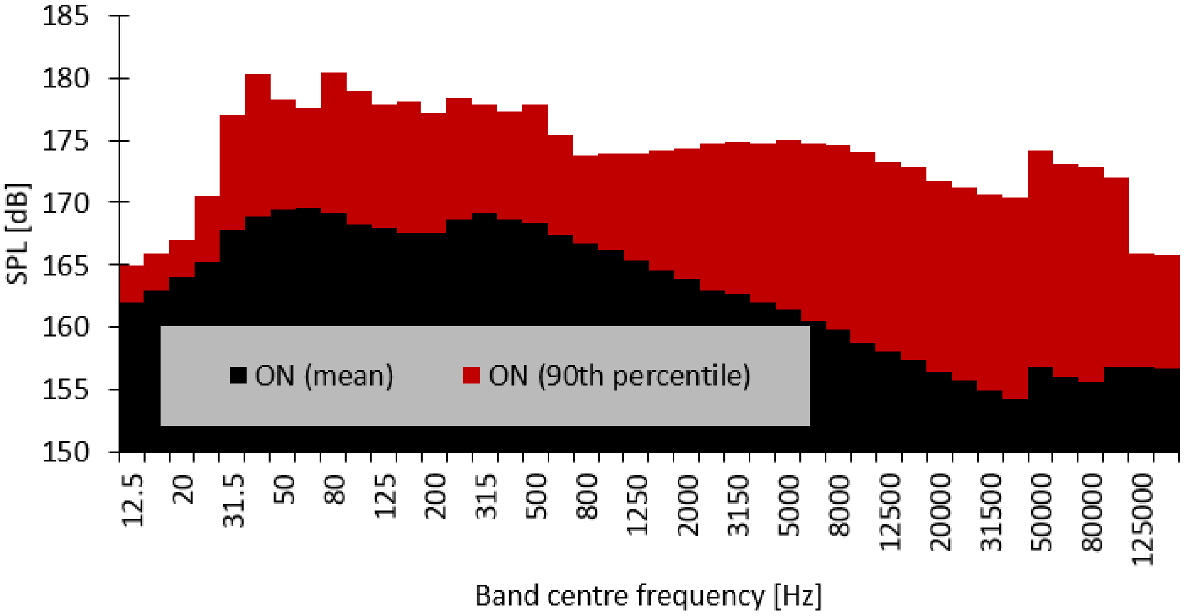


Figure 13. Band levels as modelled for a 540 kW cutter suction dredger with coarse sediment. "ON" refers to active dredging.



4 TRANSMISSION LOSS MODELLING

Transmission loss modelling is done using dBSea underwater noise modelling software.

This software is partially developed by us and can model frequencies from 10 Hz to 168 kHz, normally as 3rd octave bands, but any logarithmic band-spacing can be used. All solvers are range dependent (meaning all conditions can change with range not just depth).

Further details of this modelling software package can be found in APPENDIX A - dBSea.

The sound sources from section 3, Sound Source Modelling, p. 13, was used sources for the model, both as band levels when modelling energy transmission losses (L_E, SPL) and as timeseries/impulse for modelling peak pressure (L_P).

Previous to this assessment measurements of the actual transmission loss for the two sites were measured along two transects for each site. The modelling has been calibrated to match the measurements of these recordings (details in APPENDIX D – MODEL CALIBRATION).

The measurements show a broadband transmission loss consistent with ~12 × Log_{10}(range) at Scapa. However, these are frequency specific, and these losses are not consistent across all frequencies. We have matched the frequency-wise transmission losses to the extend that they are less than 20 × Log_{10}(range) as we find it unlikely that a transmission loss, even for higher frequencies, of > 20 × Log_{10}(range) is sufficiently representative for the site as a whole.

5 ASSESSMENT CRITERIA

5.1 Reporting units

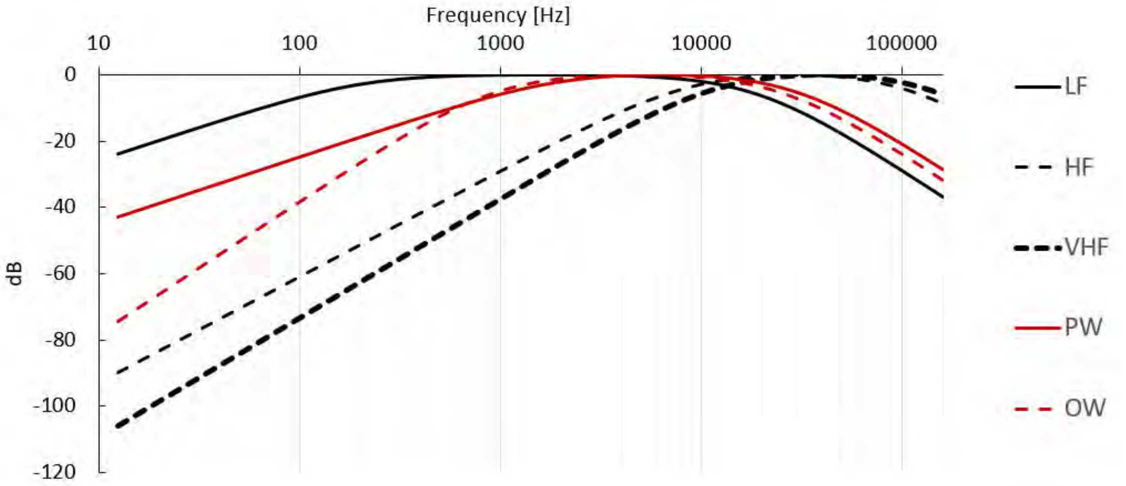
See 1.1.5, p. 7 for definitions.

5.2 Weighting of Noise Levels

When not reporting L_p or $L_{p\text{-}p}$ levels, the noise levels are often weighted according to a generalised hearing sensitivity profile for up to ten different hearing groups. This is done to better reflect the actual impact on the species in question, much like dB(C) level unit for humans.

See Table 4, for full group names and limits.

Figure 14. Weightings for various hearing groups. For L_E levels, the weightings are applied to the noise level to give the weighted noise level (similar to dB(A) or dB(C)-weighted noise for humans).



5.2.1 MARINE MAMMAL WEIGHTINGS

For the marine/aquatic mammals present we will adhere to the thresholds described in “Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing” (National Marine Fisheries Service, 2018), which determines impact from an assessment of area wherein the noise will induce either

"Temporary Threshold Shift" (TTS) or "Permanent Threshold Shift" (PTS)[5] as judged by the weighted SEL level (L_{E-24}) over a typical 24-hour period or by L_P levels, for the different hearing groups.

Please note that the Southall 2019 thresholds and weightings are identical to the NMFS 2018 criteria, only the nomenclature has changed (Southall, et al., 2019; National Marine Fisheries Service, 2018).

Thresholds for behavioural disruption are set by NOAA fisheries[6]. These are 120 dB RMS[7] for continuous noise and 160 dB SPL[8] for impulsive noise.

The hearing groups from the Southall 2019 and the NMFS 2018 guidance were specified by collating available information on marine mammal hearing and generalising their hearing sensitivity into representative groups. This grouping represents a significant research effort and are reviewed by the leading experts (academic, industrial and conservation) on the topic. Because of the large amount of work this represents and the widespread acceptance of the method, the thresholds and the methodology associated, have become de-facto standards for assessing noise impact on marine mammals and represents best available knowledge and practise.

Along with weighting curves, similar in function to the human dB(C) curves, a set of thresholds for hearing impact and injury is associated with the framework and allows for conversion of threshold exceedance into ranges with risk of impact. E.g. we might see that the PW group (true seals) has a risk of PTS at ranges shorter than 50 meters, and a risk of TTS at ranges shorter than 200 meters.

All marine mammal species are covered by the hearing groups and a full list of species in the different groups can be found in the "Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects" (Southall, et al., 2019), but in general the groups cover the following species:

Table 4. Summary of Southall 2019 thresholds and groups with species examples. For full species list see source (National Marine Fisheries Service, 2018; Southall, et al., 2019)

Hearing group	Species examples	Non-impulsive TTS/PTS threshold [$L_{E\text{-}24\ hours}$]	Impulsive TTS/PTS threshold [$L_{E\text{-}24\ hours}$]	Impulsive TTS/PTS threshold [L_p]
PW	Harbour seal, Grey seal	181/201	170/185	212/218
OW	Otters	199/219	188/203	226/232
LF	Minke whale, Humpback whale	179/199	168/183	213/219
HF	Sperm whale, Common dolphin, Bottlenose dolphin, Killer whale, Risso's dolphin, Pilot whales	178/198	170/185	224/230
VHF	Porpoise	153/173	140/155	196/202

It's important to note that the assessment is thus based on the received level of receptors with the above-described auditory sensitivity and not based on the sensitivity of the individual species.

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[5] TTS/PTS. A temporary/permanent change in hearing sensitivity caused by acoustic stimuli.

[6] Available from: https://archive.fisheries.noaa.gov/wcr/protected_species/marine_mammals/threshold_guidance.html

[7] Here taken as meaning "SPL"

[8] Assumed to be SPL of 90 % of energy in one impulse or SPL of total duration (L_{EQ}).

5.3 Fishes etc.

Impacts of noise on fishes is less well established than for marine mammals, but a review from 2014 (Popper, et al., 2014) provides guidelines on exposure limits for fish and turtles. The report does not directly use the PTS nomenclature (as above for mammals) as many fish have the capacity to repair structural damage to their ear, and even structural damage then cannot be said to be "permanent".

We use "PTS" here to cover the categories "Mortality and potential mortal injury" and "Recoverable injury".

Note that we use the impulsive limits from piling for all impulsive sources as the information for explosions is rather less well documented (and limits are significantly higher).

TTS is directly used in the report, and we use it in the same way here.

As there are no TTS/PTS limits for non-impulsive noise, we apply the limits for cumulative impulsive noise.

Table 5. Overview of Impact piling thresholds from (Popper, et al., 2014) (Table 7.3). We use these for all impulsive noise, even though explosions have separate thresholds (Table 7.2 in report)).

Hearing group	Species examples	Impulsive TTS/PTS threshold [$L_{E\text{-}24\ hours}$]	Impulsive TTS/PTS threshold [L_p]
P* (Fish with no swim bladder)	Sharks, Rays	186/216	TTS not specified/213
P- (Fish with swim-bladder, but not involved in hearing)	Salmon, Trout, Cod, Herring	186/203	TTS not specified/207
P+ (swim-bladder used in hearing)	Carp, Catfish	186/203	TTS not specified/207

5.4 Threshold Interpretation

5.4.1 THRESHOLD TYPES

The three threshold types refer to different ways that sound can affect the hearing of an animal and are ***important to keep in mind*** when evaluating the results of this report:

5.4.1.1 Non-impulsive, $L_{E\text{-}24\ hours}$

The threshold, over which an effect (TTS/PTS) occurs, taking into account ***continuous***[9] sound received by the animal over a typical 24-hour period as sound exposure, L_E.

When presented as a zone on a map, this refers to the area, within which, an animal would suffer the effect, if it stayed there for 24 hours (or the full duration of the activity or as otherwise specified). We thus identify areas given by this limit as areas of TTS-**risk** or PTS-**risk** respectively, i.e., an animal within the area has a risk of suffering from either TTS or PTS within the zone. Alternatively this can be thought of as the total sound-dose limit over 24 hours.

Weightings are applied for non-impulsive L_E (for mammals only[10]).

5.4.1.2 Impulsive, $L_{E\text{-}24\ hours}$

The threshold, over which an effect (TTS/PTS) occurs, taking into account ***impulsive*** sound received by the animal over a typical 24-hour period as sound exposure, L_E.

---

[9] Please see (National Marine Fisheries Service, 2018) for definitions of "non-impulsive" and "impulsive". For quick reference, if a sound is shorter than 1 second and is clearly intermittent in nature, it is impulsive – otherwise, it's continuous.

[10] When assessing for fish groups levels are not weighted.

When presented as a zone on a map, this refers to the area, within which, an animal would suffer the effect, if it stayed there for 24 hours (or the full duration of the activity or as otherwise specified). We thus identify areas given by this limit as areas of TTS-risk or PTS-risk respectively, i.e., an animal within the area has a risk of suffering from either TTS or PTS within this zone.
Alternatively this can be thought of as the total sound-dose limit over 24 hours.

5.4.1.2.1 Impulsive $L_{E\ \text{single impulse}}$ / $L_{E\ \#\ \text{impulses}}$

It is sometimes useful to assess the impact of a single/a number of impulse(s). When we do this, we will refer to it as "LE single impulse / LE # impulses".
Like for the Lp, when single-impulse LE is presented as an impact zone, this refers to the area, within which, an animal would suffer the effect acutely/instantly.

Weightings are applied for Impulsive L_E (for mammals only).

5.4.1.3 Impulsive, L_p

The threshold over which an effect (TTS/PTS) occurs, taking into account ***impulsive*** sound received by the animal at any instant as maximal peak pressure.
When presented as a zone on a map, this refers to the area, within which, an animal would suffer the effect acutely/instantly and from just one exposure.
Weightings are ***not*** applied for Impulsive L_P.

5.4.2 MASKING

Levels that are not over threshold can still cause significant impact, if that noise makes foraging, navigation or communication harder due to masking or where biologically relevant sounds are "drowned out" by the anthropogenic noise. Continuous noise is more likely than impulsive noise to cause this form of impact.

5.4.3 DISPERSAL

Many animals can recognise sounds and might be dispersed from an area at noise levels well below TTS limits. Quantifying a level of dispersal from desk-spaced studies is very challenging and not done here.

6 CONCLUSION & RESULTS SUMMARY

Dredging

The noise from dredging, while presenting a significant PTS risk to ranges >500 m for the VHF group, this is only for animals staying close to the activity for extended periods (> 1 hour) and assumes continuous dredging with the dredger level as given by the 90th percentile. For the best estimate (model mean) the PTS risk range is 450 m after 8 hours exposure. There is no acute risk of noise related injury related to the dredging, and animals have time to swim away. Further the area ensonified does not “block” access through a channel or strait.

There is no issue identified for species outside the VHF range.

Vibro piling

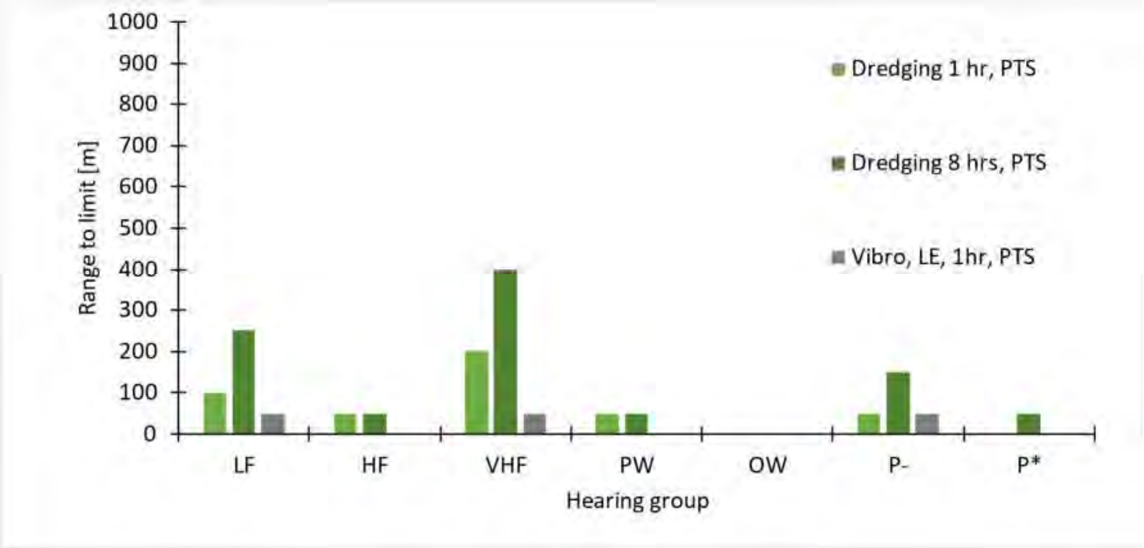
Prolonged exposure to vibro piling at close range (<100 m) carries some auditory risk for the animals assessed, specifically groups LF, VHF and P- (baleen whales, porpoises and salmon/trout), where the peak pressures in the noise have risk ranges up to 300 m for the VHF group. We therefore suggest surveillance takes place prior to piling to minimise the risk of impact on porpoises. While this is a significant risk for animals close to the activity, we stress that we have used a very conservative approach to estimating the source levels, and the realised emission will likely be significantly lower.

Further, animals will tend to move around, or away from noise, which will limit exposure. In Figure 16 and Figure 18 we show an example of the effect of using moving receivers (animats, modelled animals) to estimate what might be the effect of movement.

Table 6. Overview of maximal ranges to limits [m]. In bold where PTS is over 500m. Number in brackets are from best estimate of source level.

Activity	Dredging				Vibro piling			
Dose	1 hr L_E		8 hrs L_E		1 hr L_E		Peak pressure L_P	
Hearing group	TTS	PTS	TTS	PTS	TTS	PTS	TTS	PTS
LF	1500	65	8000	400	5000	200	<50	<50
HF	350	<50	1050	100	50	<50	<50	<50
VHF	4050	**500**	8700 (3700)	**1350** (450)	1150	75	550	300
PW	450	<50	1650	75	600	<50	100	<50
OW	<50	<50	100	<50	<50	<50	<50	<50
P-	725	<50	3900	225	2500	175	<50	125
P*	725	<50	3900	<50	2500	<50	<50	<50

Figure 15. Overview of PTS risk ranges, note that both LF and VHF groups have PTS range > 500 m long duration dredging and vibro piling.



7 RESULTS

The noise maps for each activity and hearing group are presented in APPENDIX E – Results.

7.1 Dredging

While exposure to 12 hours of dredging has significant PTS risk ranges (> 450 m) for 2 hearing groups: LF (baleen whales) and VHF (porpoises), but only after prolonged exposure (> 1 hour). The relatively low (compared to limits) source level of the dredging means that there is not acute risk from noise and animals have time to swim away.

Using a model approach to have moving receivers (animats, see Figure 18, p. 23) we can estimate the impact on moving animals. The animats in the model move 0.5-4 m/s depending on the received level and evade levels >120 dB.

Figure 16. Summary of total exposure (L_E) of 225 animats of the VHF group in the soundfield of the dredging. 44 exceeded TTS limit (20 %), none exceeded the PTS limit.

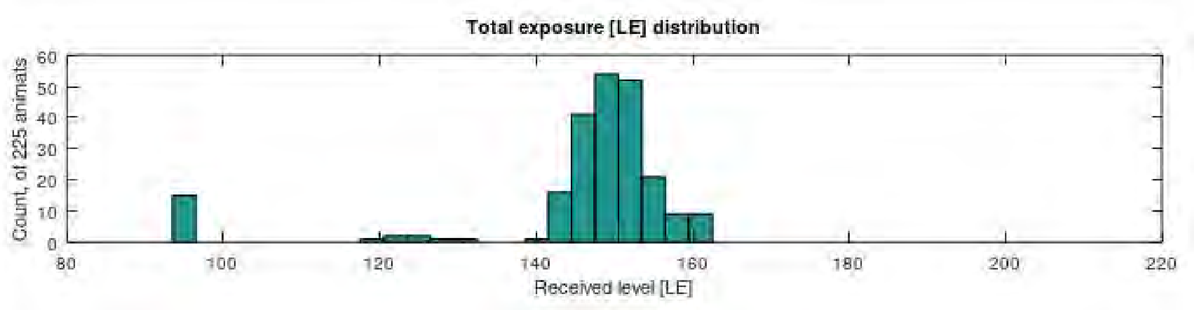


Figure 17. TTS and PTS risk ranges for all groups.

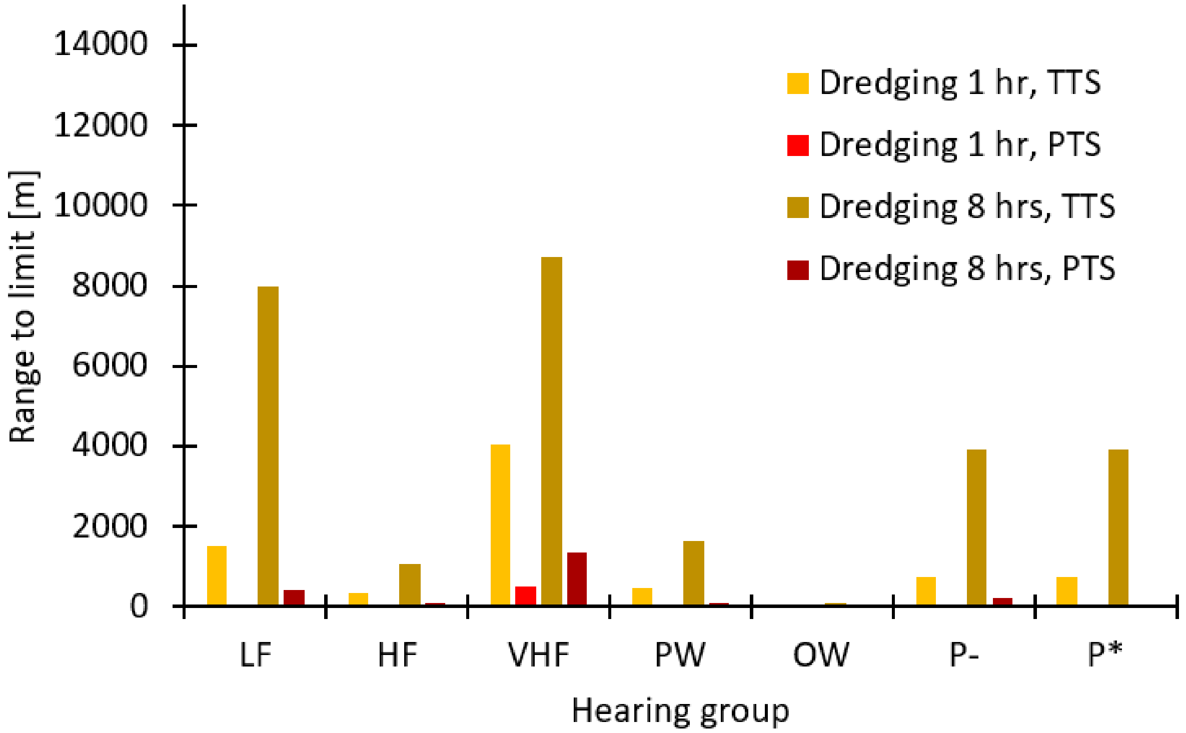
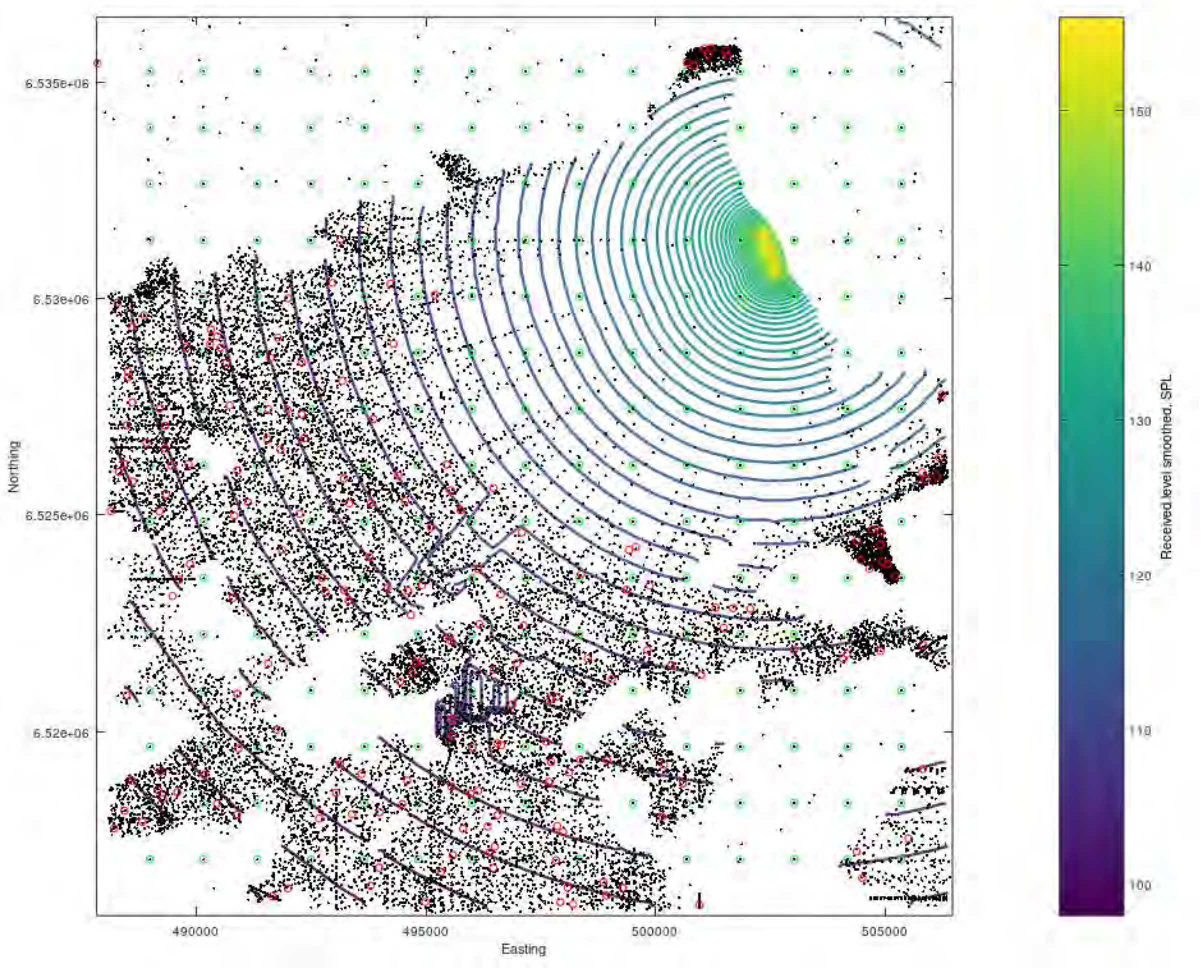


Figure 18. 225 “animats” in the dredger soundfield for 8 hours. Green spots are starting points, and red spots end points. Area covers Scapa Flow.a



7.2 Vibro piling

Longer exposures (> 1 hour) lead to significant PTS risk zones of ~200 m for LF and P- groups, but the proposed duration of vibro piling on this site is less than 1-hour per day.

The peak pressures in the vibro piling have a PTS risk zone max range of 300 m for the VHF group (porpoises). While the risk for the LF and P- groups is only for prolonged exposure, the risk to the VHF group is acute, i.e. the animal has no chance to swim away to avoid the risk.

Figure 19. TTS and PTS risk ranges for all groups.

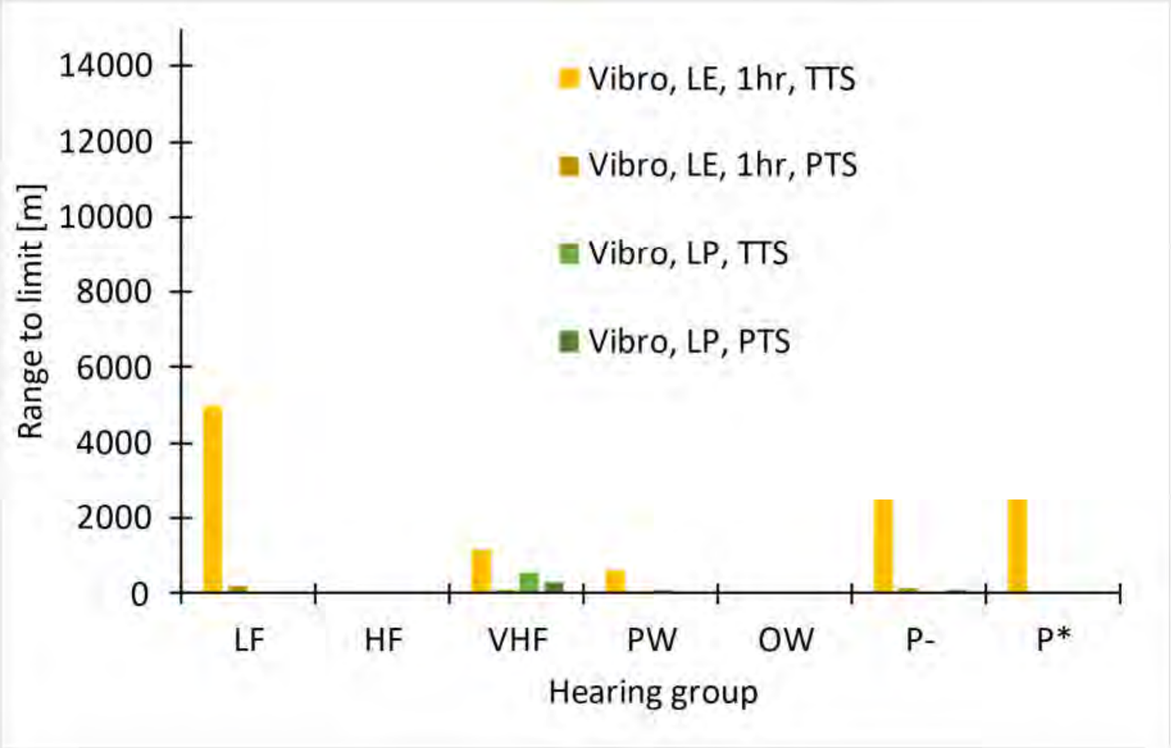
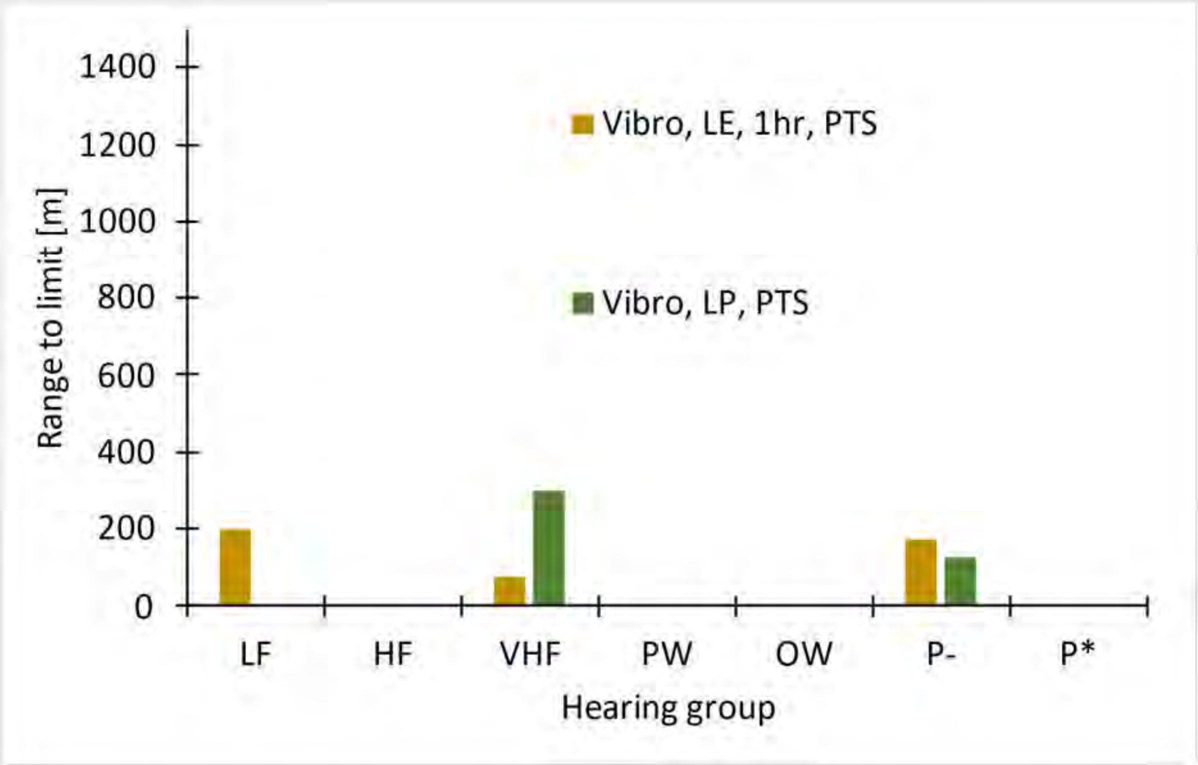


Figure 20. PTS risk ranges for all hearing groups.



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APPENDIX A - DBSEA

A summary of dBSea's models in standard scenarios can be found in the document (online):
http://www.dbsea.co.uk/media/30782/dBSea-Benchmark-Testing.pdf
(also see Figure 23, p. 28 for one example).

All solvers in dBSea are based on Jensen et al. 2011 (Jensen, Kuperman, Porter, & Schmidt, 2011)

dBSea has four primary models of calculation:

- Range dependent Parabolic Equation model - dBSeaPE
  dBSeaPE uses a split-step, wide angle parabolic equation method. It uses either Greene's approximation or several Padé terms (as set by user) to get very wide propagation with low phase error.

  dBSeaPE is best suited to deeper scenarios (>50 m) or where sediment interaction is not dominant relative to sound speed profile. The model is very efficient for low frequencies and only suffers a small efficiency penalty for higher frequencies.

  dBSeaPE will generally be used for deeper/long range scenarios in the frequency interval 10-1000 Hz.
- Range dependent Normal Modes model - dBSeaModes
  dBSeaModes is especially suited to shallower and sediment dependent scenarios and will typically be used where water is shallower than 50 m and depth changes are a large proportion of the total depth, or where sediment effects are thought to play a significant role. dBSeaModes incurs a significant efficiency-penalty at high frequencies and will normally be used in the frequency range 10-1000 Hz.
- Ray tracing
  dBSea uses a Gaussian raytracing method, dBSeaRay, to calculate transmission losses for higher frequencies (scenario dependent, but normally from 500 Hz). dBSeaRay compares favourably with the opensource BELLHOP model, in that it is accurate to lower frequencies and agrees well with PE and NM models.
- Full waveform propagation
  dBSeaRay also supports full waveform propagation in the frequency range 10 Hz to 168 kHz (limited by the waveform sample rate). Used in this way dBSeaRay takes into account all scenario range dependence (as models above) as well as the arrival time, phase information and transmission loss of all significant paths to any number of receivers in the scenario (the results grid).

General notes:

- dBSea is an "Nx2D" solver, meaning it models transmission losses in "N" number of vertical radial slices from the source (Figure 22, p. 27). There is no backwards propagation towards the source, and no sideways reflection/refraction (We're testing dBSea with full 3D solvers currently).

- dBSea models the sediment propagation only for compressional waves, not for shear waves. This generally means that the transmission loss will be slightly underestimated as no energy is transferred into shear waves, and also means that dBSeaRay does not propagate into the sediment, but relies on a complex reflection coefficient (calculated from the sediment layers) to calculate the reflection/refraction properties of the sediment. Given that dBSeaRay is generally only used for higher frequencies, this has very little practical effect, as higher frequencies will only interact weakly with deeper layers of the sediment.

- The individual sources in a scenario are modelled radially (radial coordinates) from the source at several depths. In post-processing levels are transferred to a cartesian "results grid". This results grid stores levels from all sources so that the cumulative level at any point in the scenario can be investigated immediately.

- Levels can be, and are often post-processed to apply a conservative margin and smooth results (Figure 21, p. 27). Radial smoothing (triangular kernel of variable width) is carried out to mitigate modelling artefacts arising from low environment sampling density or chance occurrences. Levels are often made to decrease monotonically from the source to make general trends more visible and decrease the risk of misinterpreting impact ranges.

- When refereeing to a level at a certain range, this usually refers to the greatest level at any depth at that range (unless specifically mentioned otherwise).

Figure 21. Post-processing to eliminate artefacts and ease interpretation. Level are radially smoothed by default, and are made to be monotonically decreasing with increasing range from the source.

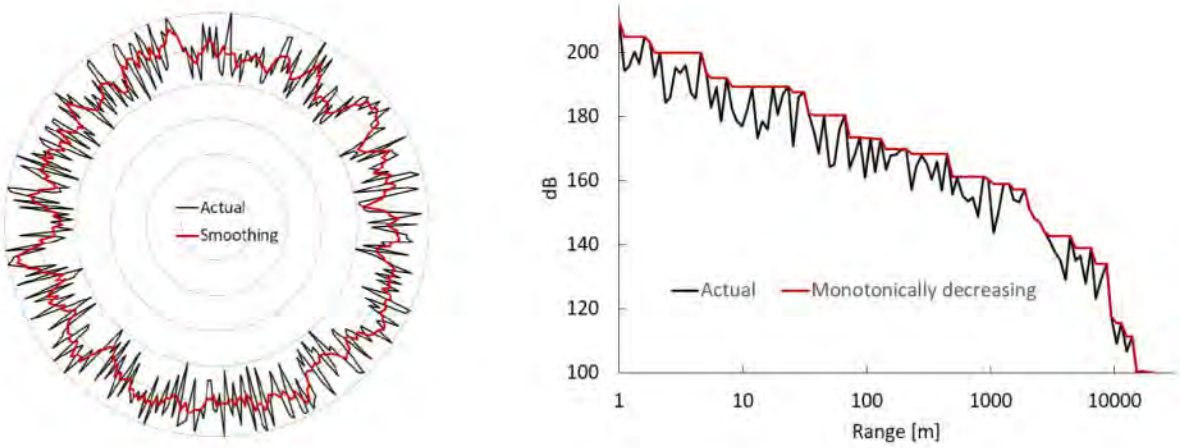


Figure 22. Low resolution schematic of the dBSea modelling space. Source transmission loss is modelled radially from the sources at a number of depths. Results are extracted from a "square" 3D grid that hold cumulative levels from all sources in the scenario.

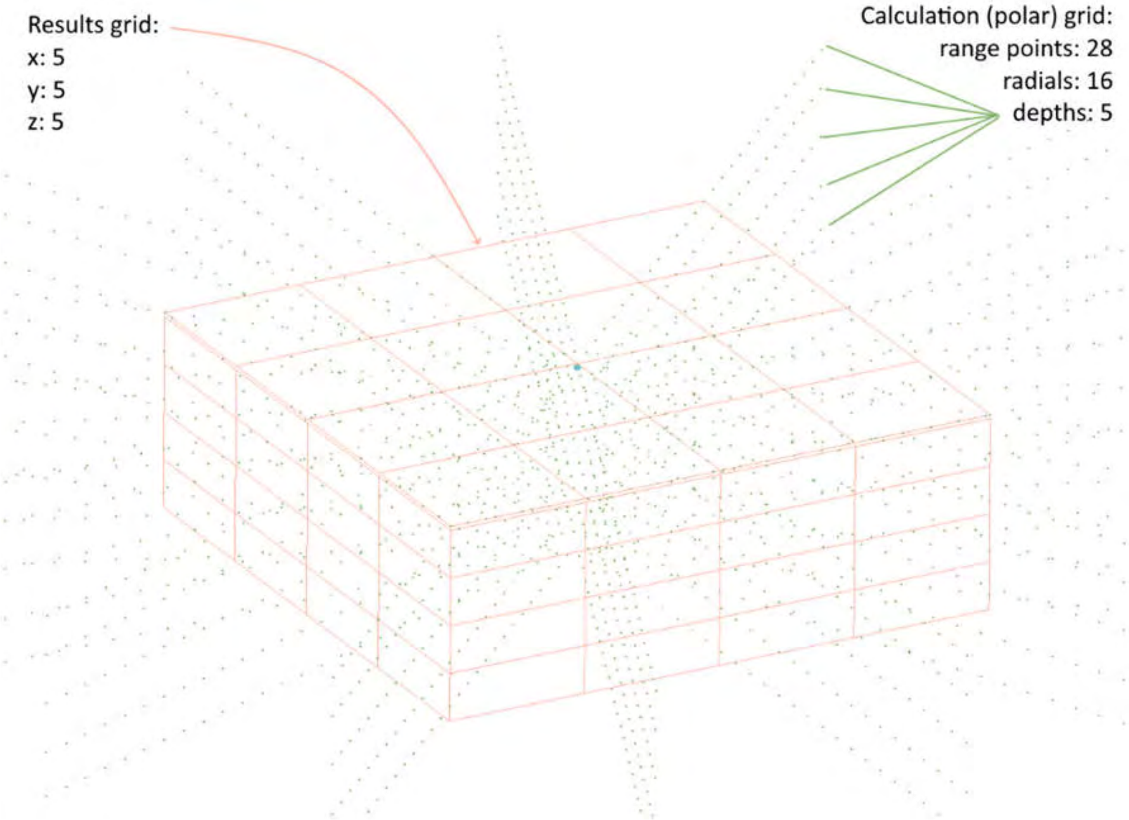
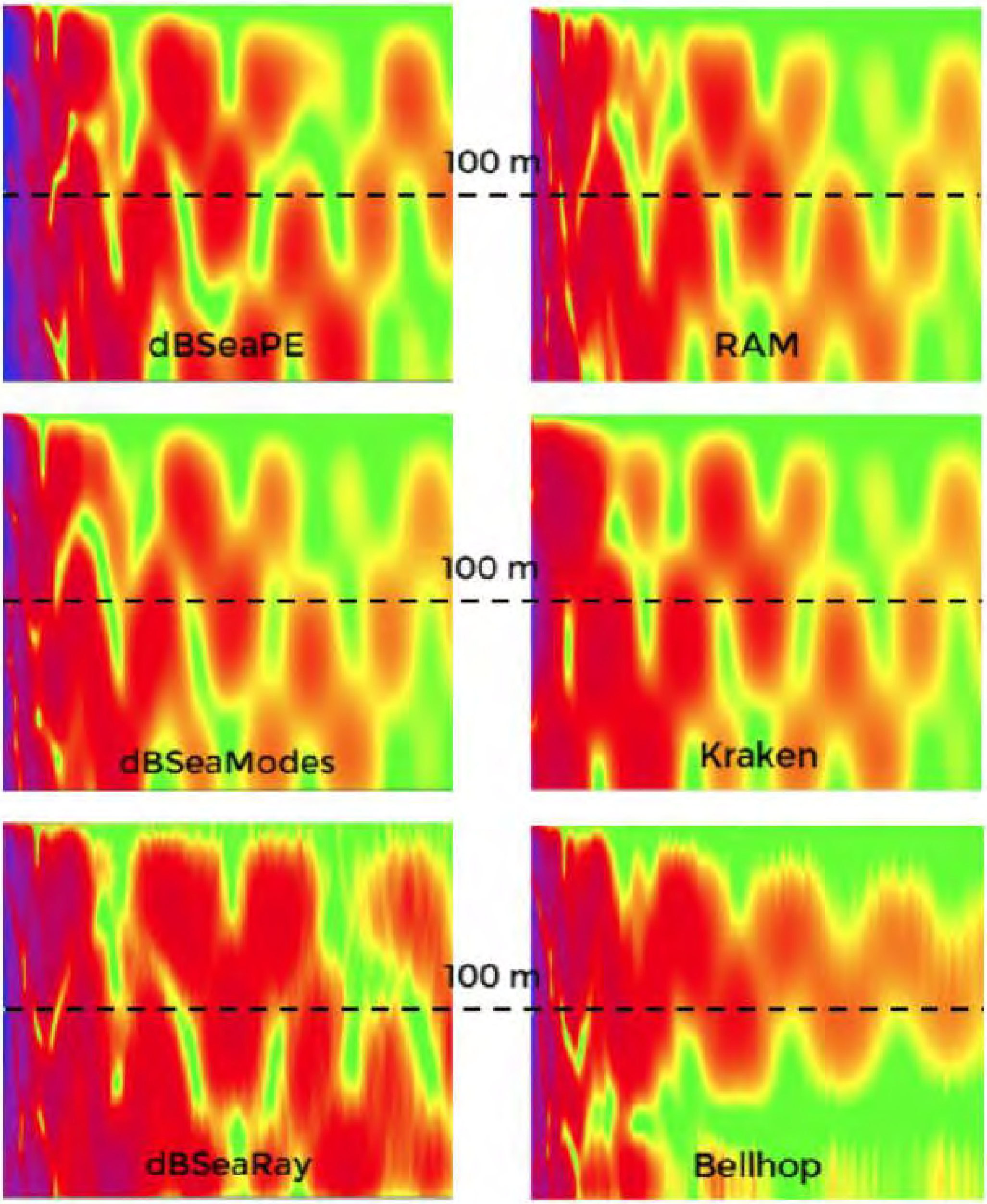


Figure 23. the “Pekeris” standard problem, a low frequency problem. Note that due to sediment effects, neither dBSeaRay nor Bellhop should be relied upon for low frequency problems, and are only include for completeness.



APPENDIX B – UNDERWATER ACOUSTICS BASICS

Sound Speed

Water is much harder to compress than air, and a soundspeed of 1500 m/s is often used as a standard soundspeed in water[11] much as 340 m/s is in air. Soundspeed is given by the following equation:

$$c = \frac{Z}{\rho}$$

$$Soundspeed\ [m/s] = \frac{Acoustic\ impedance\ \left[\frac{kg}{m^2 \cdot s}\right]}{Specific\ density\ [kg/m^3]}$$

Because changes to pressure, salinity and temperature occur with changes in depth, the specific density and acoustic impedance of water changes with depth, and thus the soundspeed changes as well.

The soundspeed profile is quite important in sound propagation, as refraction (changes in propagation angle) will occur when sound moves between layers of water with varying sound speed. This change is quantified in "Snell's Law" and results in sound being "bent" towards the depth of minimal soundspeed. These effects can lead to profoundly inhomogeneous sound fields and SOFAR channels.

The same relationships are valid in the sediment, though sediments commonly have soundspeeds higher than water. Soundspeeds from 1700 m/s (fine sand/silt) to 2500 m/s (gravel) are common for non-solid sediments, with solid sediments (rocks) having much higher soundspeeds 2800 m/s (Calcarenite) to 6000 m/s (some granite).

Spreading loss

Most of the propagation loss (loss in dB from source to receiver, "PL") that occurs initially is governed by "spreading loss". It is the simple "thinning out" of acoustic energy as it spreads away from the source, usually in all directions – spherically.

For a sound source in an unbound medium the initial PL will be dominated by spherical PL:

$$Received\ level = Source\ level_{at\ reference\ range} - 20 \cdot \log_{10}\left(\frac{range}{reference\ range}\right)$$

This means a reduction in received level of 6 dB per doubling of distance and explains the rapid reduction in received levels often seen close to the source, e.g.: with a reference range of 1 m, at 16 meters range, there has been 4 doublings of distance, and thus 24 dB loss (4×6 dB).

At longer ranges the medium is no longer unbounded. We reach ranges where the sound has interacted with the surface (near perfect acoustic reflector) or the seabed (lossy acoustic reflector). Also, at greater ranges a doubling of distance is no longer trivial as the PL from spherical spreading loss from 500 m to 1000 m is also just 6 dB.

Sound Channels and Wave guides

In bounded mediums where the sound energy is confined to cylindrical spreading, the PL (ignoring absorption) is often well-characterised by:

$$Received\ level = Source\ level_{at\ reference\ range} - 10 \cdot \log_{10}\left(\frac{range}{reference\ range}\right)$$

This means a reduction of received level of 3 dB per doubling of distance. Depending on the sediment this kind of "waveguide" can sustain efficient transmission of sound over long ranges, provided the sediment is acoustically hard and there is low absorption (such as is the case for low frequencies or in low salinity).

In absence of a bounding from the surface or the seabed, a soundspeed profile with a clear low-speed region, surrounded by higher soundspeeds can act a sound channel, by focusing the sound towards a single depth (with lower soundspeed), limiting the PL from spherical to cylindrical (a SOFAR channel is formed).

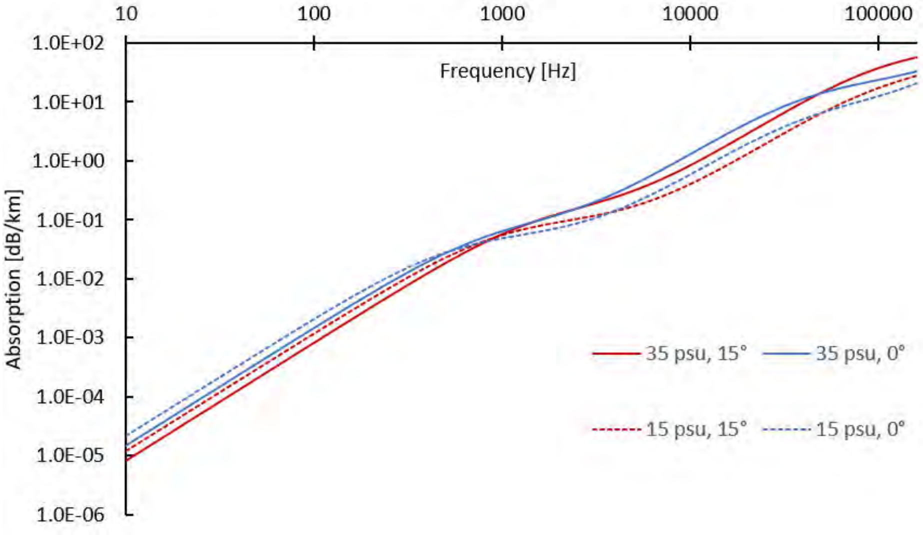
---

[11] Varies from 1450 m/s at 0° to 1550 m/s at 30° at salinity of 35 psu.

Absorption

Besides the “thinning out” of the sound energy as described above, the sound is also dissipated into heat by the way the pressure changes interact with water, molecules and particles in its path. This absorption is mostly governed by the concentration of boric acid and magnesium sulphate and is very dependent on the frequency, with lower frequencies, <1 kHz, experiencing almost no absorption, while high frequencies, > 10 kHz, can be attenuated by over 10 dB / km.

Figure 24. Absorption comparison at salinities of 35 psu & 15 psu and temperatures of 0° and 15°. Both scales are logarithmic. Note how increased salinity increases high-frequency absorption (solid v dashed lines), while a decrease in temperature increases absorption at lower frequencies (red v blue lines).



Small bubbles, wind or wave induced, will further attenuate especially the high frequencies, but as modelling is often done to estimate a worst-reasonable case, or for weather sensitive activities, fair weather with little wind and waves are assumed, thus ignoring this attenuation effect.

Sediment

Depending on the incident angle of the sound, the frequency and the acoustic properties of the sediment, sound can either mostly penetrate the sediment or mostly be reflected by it.

In shallow areas with soft sediment (acoustically similar to water), it is typical to find that close to the source, at high incidence angles and at low frequencies (<250 Hz) the sound will penetrate into the sediment and dissipate there, leading to very high transmission losses for these frequencies. This effect coupled with the high absorption at high frequencies often leads to the soundscape being dominated by frequencies from a few hundred hertz to a few thousand hertz. In deeper water, or with an upward refracting soundspeed profile, low frequencies will tend to dominate the soundscape away from sound sources, as there is no efficient mechanism for attenuating them.

A “cut-off[12]” frequency, below which, there will be high sediment-associated attenuation can be approximated by:

$$f_{cut-off} = \frac{c_{water}}{4 \cdot D \cdot \sqrt{1 - \left(\frac{c_{water}}{c_{sediment}}\right)^2}}$$

With “C_{water}” and “$C_{sediment}$” being the soundspeed in the water and the sediment respectively, and “D” the local depth (Jensen, Kuperman, Porter, & Schmidt, 2011).

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[12] The cut-off is not an immediate loss of energy in frequencies under this frequency, but rather something like a high pass, 1st-order, Butterworth filter (Audoly, 2020).

In water with lower salinity and less absorption, the soundscape will tend to have a relatively higher content of high frequencies as these are absorbed much less efficiently when the salinity is lower.

Sound transmission Across Interfaces

Sound waves are reflected and refracted (Snell's law) as they travel through interfaces. Also, depending on acoustic impedance and interface angles only a proportion of the incident acoustic energy is transmitted through that interface (the rest is reflected).

In the following: W: Watt; Pa: Pascal; s: second; m: metre; N: Newton; J: Joule; θ: angle; v: soundspeed; Z: acoustic impedance; p: pressure from ambient;

Snell's law:

$$\frac{\sin\theta_{in}}{\sin\theta_{out}} = \frac{v_{in}}{v_{out}}$$

- rearranged to give transmission angle from incidence angle and soundspeeds:

$$\sin^{-1}\left(\frac{\sin\theta_{in}}{\frac{v_{in}}{v_{out}}}\right) = \theta_{out}$$

Transmission fraction of sound pressure for plane waves (part of the Fresnel equations):

$$\frac{p_{out}}{p_{in}} = \frac{2 \cdot Z_{out} \cdot \cos\theta_{in}}{Z_{out} \cdot \cos\theta_{in} + Z_{in} \cdot \cos\theta_{out}}$$

Reflection fraction of sound pressure for plane waves (part of the Fresnel equations):

$$\frac{p_{out}}{p_{in}} = \frac{Z_{out} \cdot \cos\theta_{in} - Z_{in} \cdot \cos\theta_{out}}{Z_{out} \cdot \cos\theta_{in} + Z_{in} \cdot \cos\theta_{out}}$$

It follows from these relations that for transmission from an acoustically relatively slow medium like water to an acoustically faster medium here exists an incident angle above which there is total reflection, and thus no transmission of acoustic energy through the interface (real interfaces are rugged and lumpy, and perfect reflection is not realistic).

For the water/sediment interface presented here (sediment is sand with a soundspeed of 2000 m/s) this occurs at 0.84 radians (~48.5 degrees) from normal incidence.

The fraction of pressure transmission from water (soundspeed 1500 m/s) to sediment (2000 m/s) is around 146 % at normal incidence and drops as the incidence angle increases away from normal, much faster for water-to-sediment than for sediment-to-water.

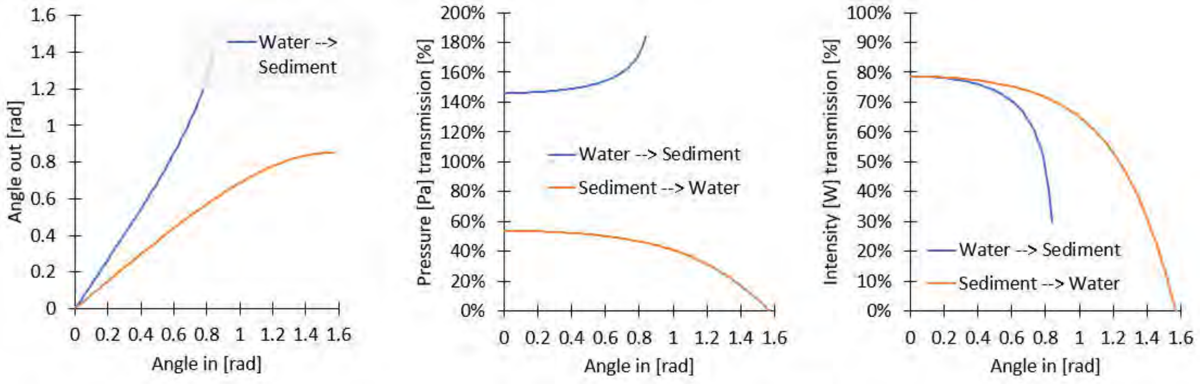
While it may seem counter-intuitive that pressure can increase after transmission over an interface, remember that the energy in the sound is a function of pressure *and* acoustic impedance:

$$I = \frac{p^2}{Z}$$

$$With\ units{:}\ [W] = \frac{[Pa]^2}{\left[\frac{Pa \cdot s}{m^3}\right]} = \frac{\frac{N^2}{m^4}}{\frac{\frac{N}{m^2} \cdot s}{m^3}} = \frac{N^2 \cdot m^3}{m^4 \cdot \frac{N}{m^2} \cdot s} = \frac{N}{m \cdot m^{-2} \cdot s} = \frac{J \cdot m}{m^{-1} \cdot s} = \frac{J}{s} = W$$

Thus, if the transmitted intensity fraction is 80 % then the reflected intensity is 20 %; there is energy conservation.

Figure 25. Transmission angles [radians] and fractions as function of incident angle between water and sediment (sand). Note that total reflection from water to sediment occurs around incident angle of 0.84 [rad] (48.5 degrees), meaning there is no transmission of sound at greater incidence angles.



Simplified Propagation Loss Model

Taking all the above into account we can construct a simplified model, that will give a good indication of the expected propagation loss (PL) in scenarios of constant depth:

$$PL = \left\{\begin{matrix} r < D \ : & -20\cdot\log_{10}\left(\frac{r}{r_0}\right) \\ r > D \ : & -20\cdot\log_{10}\left(\frac{D}{r_0}\right) - 10\cdot\log_{10}\left(\frac{D}{r_0}\right) \end{matrix}\right\} - \alpha(f)\cdot r - l(f)\cdot r$$

Where:

- “r” is horizontal range from source.
- “D” depth at source.
- “r_0” the reference range of the source (often 1 m).
- “f” the frequency,
- “l” the frequency specific leakage loss to the sediment.
- “α” the frequency specific absorption.

Sound Level Units

All references to sound pressure levels, peak pressure levels and sound exposure levels refer to a logarithmic ratio between a reported/measured pressure or exposure and a reference pressure or exposure. As an example, a level of 220 L_p (decibel zero-to-peak) is equal to a peak pressure of 100000 Pascals (Pa) over ambient pressure, while 120 L_p is equal to 1 Pa over ambient pressure.

To avoid dealing with these large numbers as pascals (as a linear scale), they are converted to a decibel ratio (Table 1 for definitions). Besides compressing large numbers to a smaller scale this also corresponds better to how animals are thought to perceive sound, namely as relative steps. This means that an increase from 1 to 2 Pa *sounds like* the same increase as from 100 to 200 Pa, even though the first step was only 1 Pa, while the second was 100 Pa. This is better reflected in a logarithmic scale based on ratios, where both steps are equal, here 3 dB.

However, while dBs are practical, they can be hard to compare between studies, due to vague definitions, and so we have adopted the standards set by ISO 18405-2017 (Table 1 below).

For ease of reference please see following overview for unit definition.

Table 7: Definitions.

Unit	Definition	Comments
SPL (dB$_{RMS}$) ISO 18405- 2017: 3.2.1.1	$SPL = 10 \cdot Log_{10}\left(\dfrac{\frac{1}{t_2 - t_1} \cdot \int_{t_1}^{t_2} p(t)^2 dt}{1 \cdot 10^{-12} Pa}\right)$	Functionally equivalent to deprecated $20 \cdot Log_{10}\left(\frac{RMS}{1 \cdot 10^{-6} Pa}\right)$
L$_p$ (dB$_{z\text{-}p}$) ISO 18405- 2017: 3.2.2.1	$L_p = 20 \cdot Log_{10}\left(\dfrac{Pa_{max}}{1 \cdot 10^{-6} Pa}\right)$	This assumes that Pa_{max} is equal or greater than $\sqrt{Pa_{min}{}^2}$
L$_{p\text{-}p}$ (dB$_{p\text{-}p}$)	$L_{p-p} = 20 \cdot Log_{10}\left(\dfrac{Pa_{max} - Pa_{min}}{1 \cdot 10^{-6} Pa}\right)$	Often[13] equivalent to $L_P + 6.02\ dB$
L$_E$ (dB$_{SEL}$) ISO 18405- 2017: 3.2.1.5	$L_E = 10 \cdot Log_{10}\left(\dfrac{\int_{t_1}^{t_2} p(t)^2 dt}{1 \cdot 10^{-12} Pa}\right)$	For continuous sound this is equivalent to $SPL + 10 \cdot Log_{10}(t_2 - t_1)$ "t" is seconds

Unless otherwise stated SPL has an averaging period of 1 second, and L$_E$ for the duration of the specified event, sometimes indicated as L$_{E\text{-"time"}}$ or L$_{E\text{-single blow}}$.

If the averaging period for SPL is equal to the total even duration, then SPL is equal to "Leq" the "equivalent constant level".

When source levels are presented, the same units are used, and it is implicit that all source levels are given as if recorded 1 m from an omnidirectional mono-point source, unless otherwise specified.

---

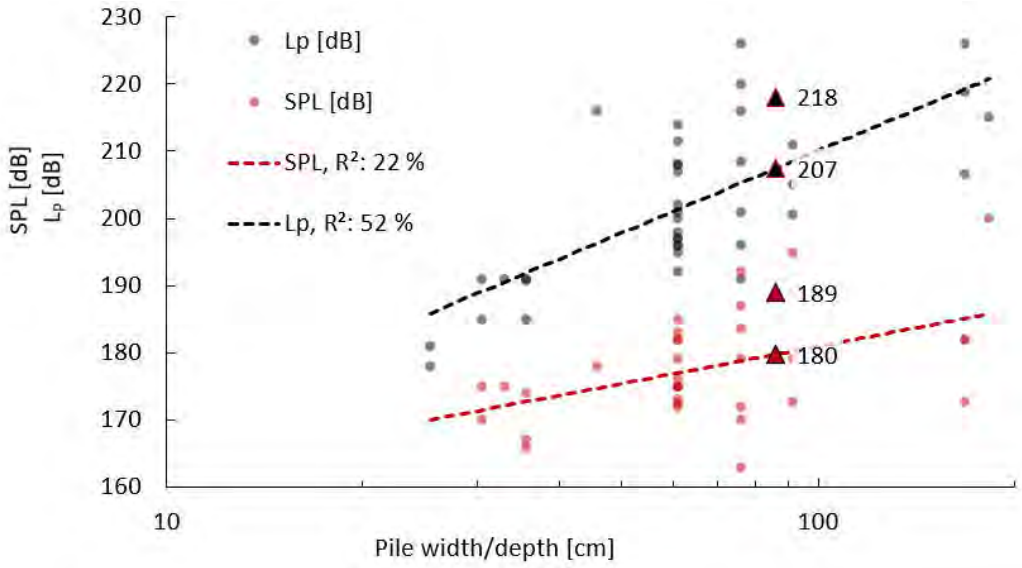
[13] If maximum pulse rarefaction is below ambient pressure and compression and rarefaction phases are of equal size.

APPENDIX C – SOURCE MODELS

Vibration piling model

We only have a few recordings (50) from vibration piling and have no dedicated source model for this type of piling. Instead, we rely on published recorded levels as from CalTrans (CalTrans, 2015).

Figure 26. Basis of vibro piling broad band source level as a function of pile size.



Given the low confidence we have in this approach (low R^2 values) we use the 90th percentile level as the broadband source level. L_P is estimated to be 218 dB and SPL 189 dB. The frequency content is assumed to be identical to that of the impact piling.

Table 8. Sources decidecade band levels.

Band centre frequency [Hz]	Dredging, Mean (broadband: 182) [SPL]	Dredging, 90th percentile (broadband: 192) [SPL]	Drilling, Mean (broadband: 138) [SPL]	Drilling, 90th percentile (broadband: 156) [SPL]	Vibro, Mean (broadband: 187) [SPL]	Vibro, 90th percentile (broadband: 196) [SPL]
12.5	162	165	127	142	166	176
16	163	166	126	139	167	176
20	164	167	124	139	167	176
25	165	170	123	138	167	176
31.5	168	177	125	139	168	177
40	169	180	124	140	169	179
50	169	178	124	139	172	181
63	170	178	126	143	174	183
80	169	180	123	142	176	185
100	168	179	124	142	177	186
125	168	178	123	140	178	187
160	168	178	123	142	177	186
200	168	177	125	146	177	186
250	169	178	126	147	177	186
315	169	178	125	147	175	184
400	169	177	123	144	174	183
500	168	178	124	145	173	182
630	167	175	122	143	171	180

800	167	174	124	141	169	178
1000	166	174	125	142	167	176
1250	165	174	123	142	165	175
1600	165	174	121	138	164	173
2000	164	174	120	135	162	171
2500	163	175	119	134	160	169
3150	163	175	118	132	159	168
4000	162	175	118	132	158	167
5000	162	175	119	133	156	165
6300	161	175	118	130	155	164
8000	160	175	117	130	154	163
10000	159	174	117	129	152	161
12500	158	173	110	120	150	159
16000	157	173	109	118	150	159
20000	156	172	109	119	149	158
25000	156	171			148	157
31500	155	171			147	156
40000	154	170			146	155
50000	157	174			145	154
63000	156	173			144	153
80000	156	173			143	152
100000	157	172			142	151
125000	157	166			141	150
160000	157	166			140	149

APPENDIX D – MODEL CALIBRATION

Recorded Transmission losses

Scapa

Broadband transmission losses for exposure levels (L_E) show good consistency between measurements and a transmission loss consistent with -14.7 × Log_{10}(range), suggesting a sediment with some ability to reflect sound back into the water column and form a waveguide.

Transmission loss for peak pressure levels (L_P) were near spherical spreading loss which is consistent with a poorly reflecting bottom resulting in little overlap in arrival times for the source impulse.

There was a clear pattern in the transmission losses versus frequency, with higher frequencies experiencing much higher losses, likely due to interaction with a rough sediment resulting in a lot of scattering.

Note that for the bands 50 – 1250 Hz the ambient noise at Scapa was above the source level, while we have tried to compensate for this, those values are still subject to considerable uncertainty (Figure 28*).*

Figure 27. Broadband transmission losses at Scapa. L_P losses follow a near spherical loss pattern while L_E shows a tendency to follow a waveguide with some absorption losses. Thick lines are best fit of logarithmic loss, while thin lines are for loss accounting for the depth at the source. Error bars are expected 95 % of measurements.

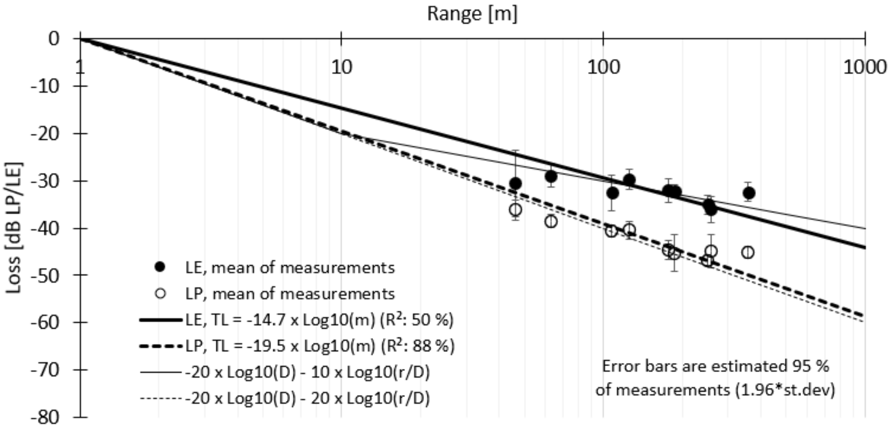
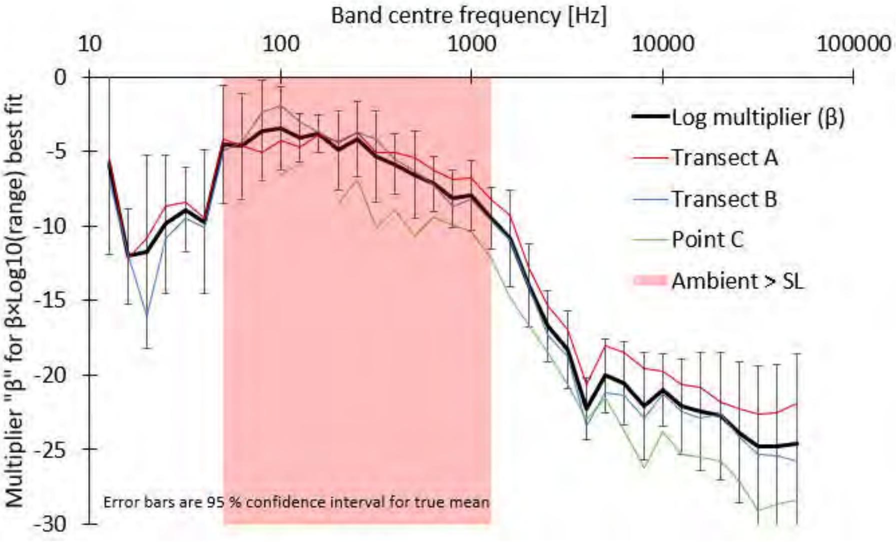


Figure 28. Transmission losses per band shown as the best fit multiplier "β" for a simple logarithmic transmission loss. Error bars are 95 % confidence interval for the true mean. While Transects A & B have some difference, this was not significant at a 10 % level in a t-test. Bands 50 – 1250 Hz have been corrected for contributing ambient noise as ambient noise was near or above recorded levels (red band).



APPENDIX E – RESULTS

Maps are presented with impact for different hearing groups as summarised here

Note that some maps have areas marked as “model artefacts”, these are areas where the levels are assumed to not be realistic, but rather an example of a digitisation problem with the bathymetry.

Group	Description	Example species
LF	Low frequency, baleen whales	Mike whale, Fin whale, Blue whale
HF	High frequency, most dolphins	Common dolphin, Risso’s dolphin, beaked whales, Bottlenose dolphin, Sperm whale, Killer whale
VHF	Very high frequency, few dolphins and porpoises	Harbour porpoise, Hourglass dolphin
PW	Phocid water, True seals	Harbour seal, Grey seal
OW	Otariid + other water, Fur seals, walruses and aquatic mammals	Walrus, Otter, Polar bear
P-	Fish with swim bladder, not coupled to inner ear	Salmon, Trout, Cod, Herring
P*	Fish with no swim bladder	Sharks and rays

Dredging L_E

Maps are provided for 90th percentile source levels for 1 hours and 8 hours.

Figure 29. Dredging, L_E, 1hr, LF group

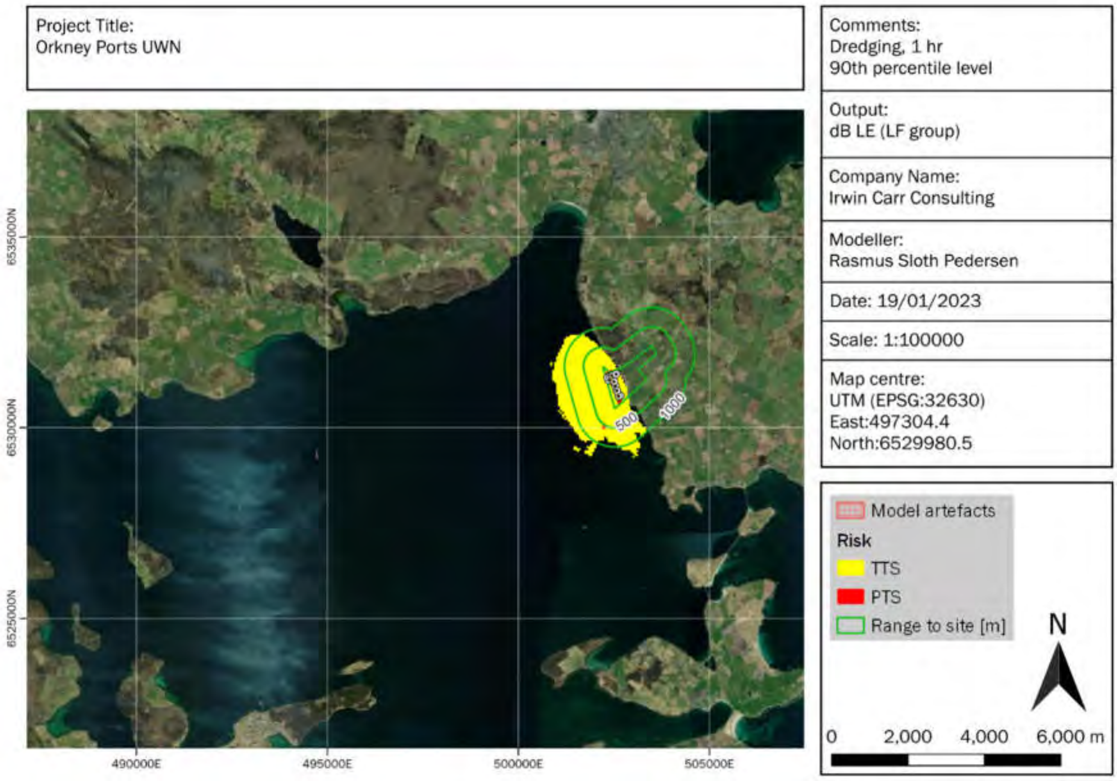


Figure 30. Dredging, L_E, 8hrs, LF group

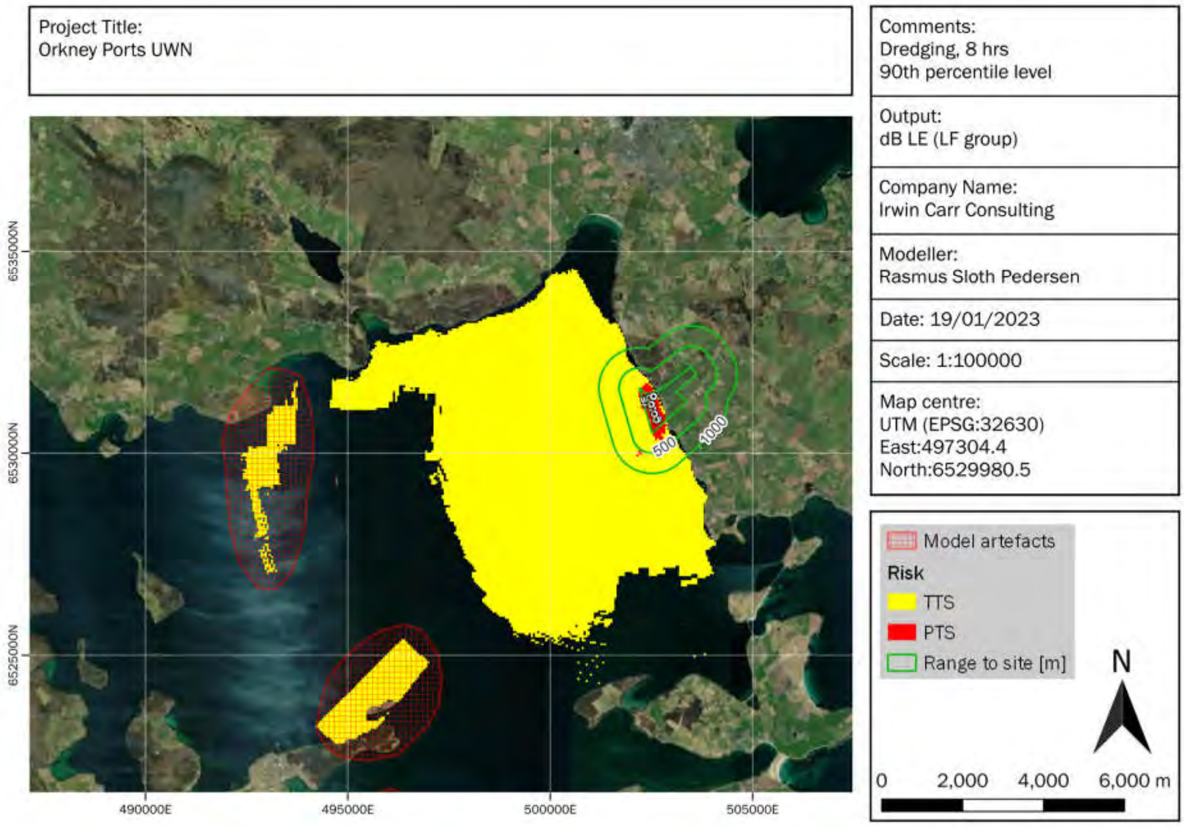
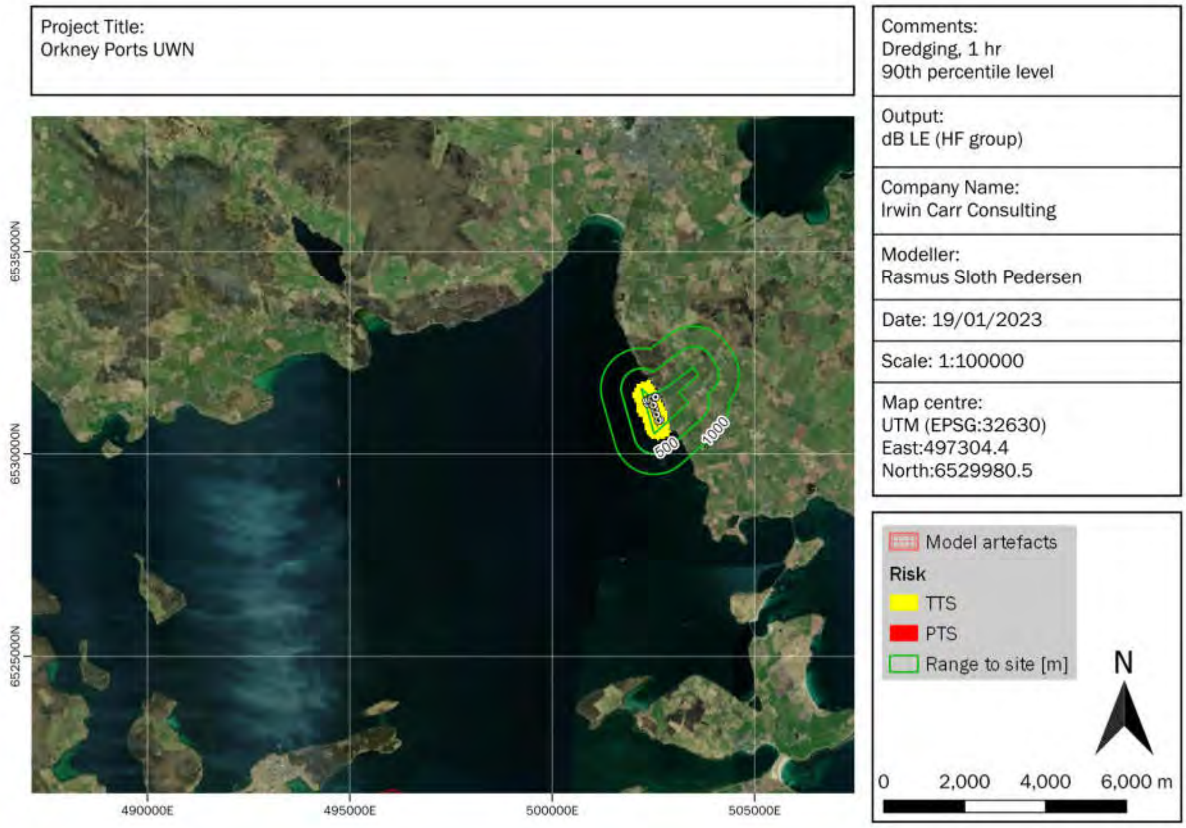


Figure 31. Dredging, L_E, 1hr, HF group



Project Title:
Orkney Ports UWN

Comments:
Dredging, 1 hr
90th percentile level

Output:
dB LE (HF group)

Company Name:
Irwin Carr Consulting

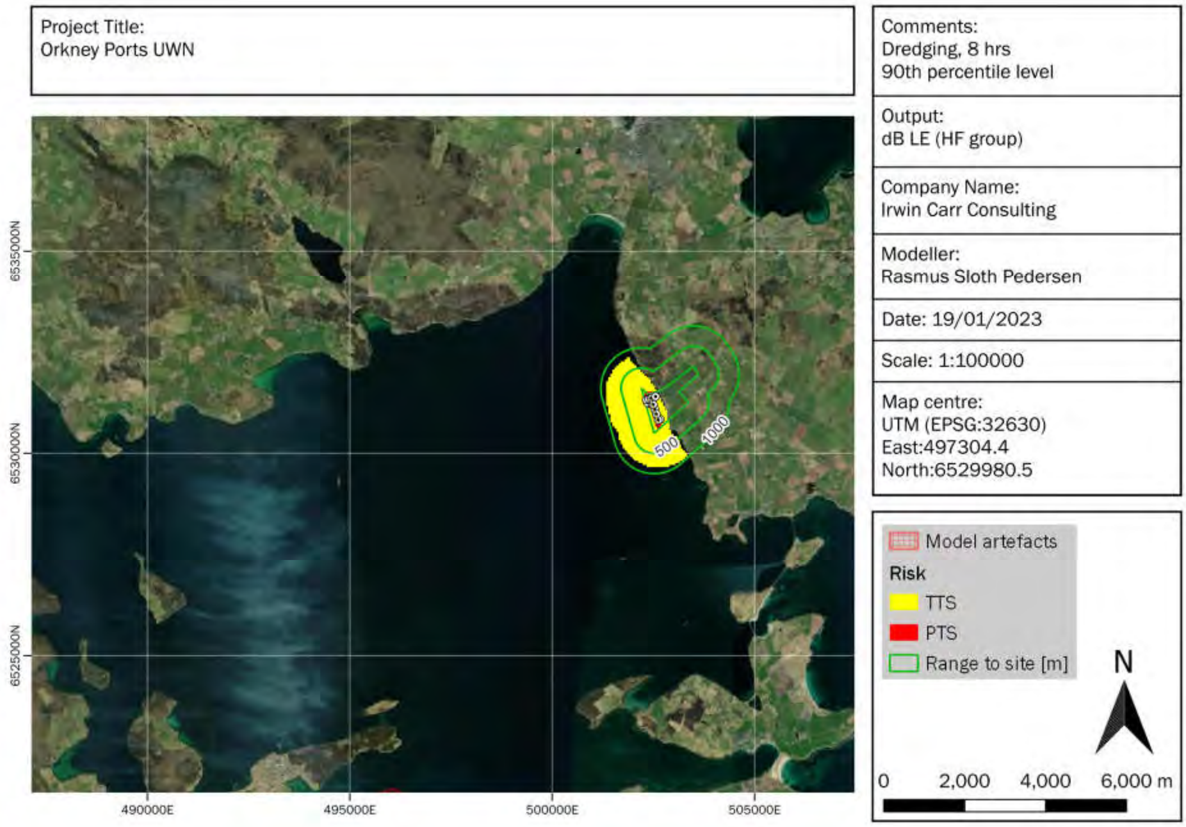
Modeller:
Rasmus Sloth Pedersen

Date: 19/01/2023

Scale: 1:100000

Map centre:
UTM (EPSG:32630)
East:497304.4
North:6529980.5

Figure 32. Dredging, L_E, 8hrs, HF group



Project Title:
Orkney Ports UWN

Comments:
Dredging, 8 hrs
90th percentile level

Output:
dB LE (HF group)

Company Name:
Irwin Carr Consulting

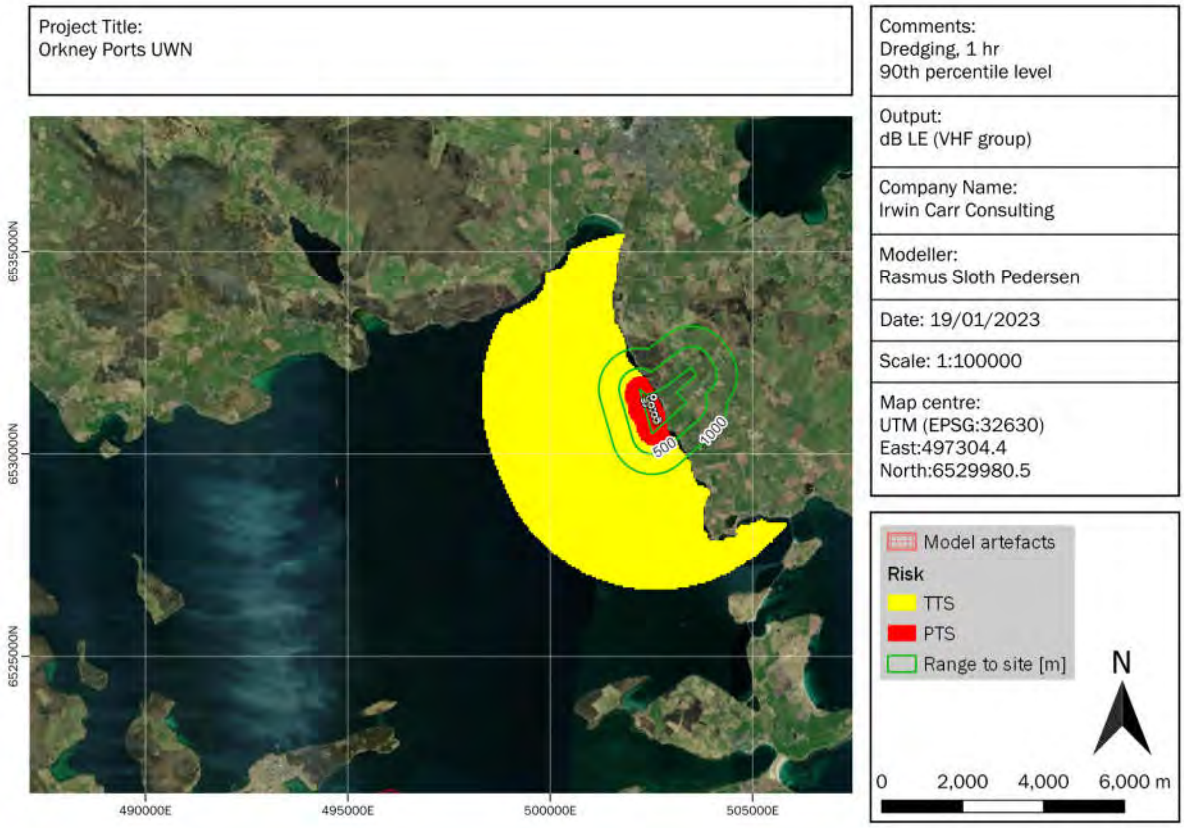
Modeller:
Rasmus Sloth Pedersen

Date: 19/01/2023

Scale: 1:100000

Map centre:
UTM (EPSG:32630)
East:497304.4
North:6529980.5

Figure 33. Dredging, LE, 1hr, VHF group


Project Title:
Orkney Ports UWN

Comments:
Dredging, 1 hr
90th percentile level

Output:
dB LE (VHF group)

Company Name:
Irwin Carr Consulting

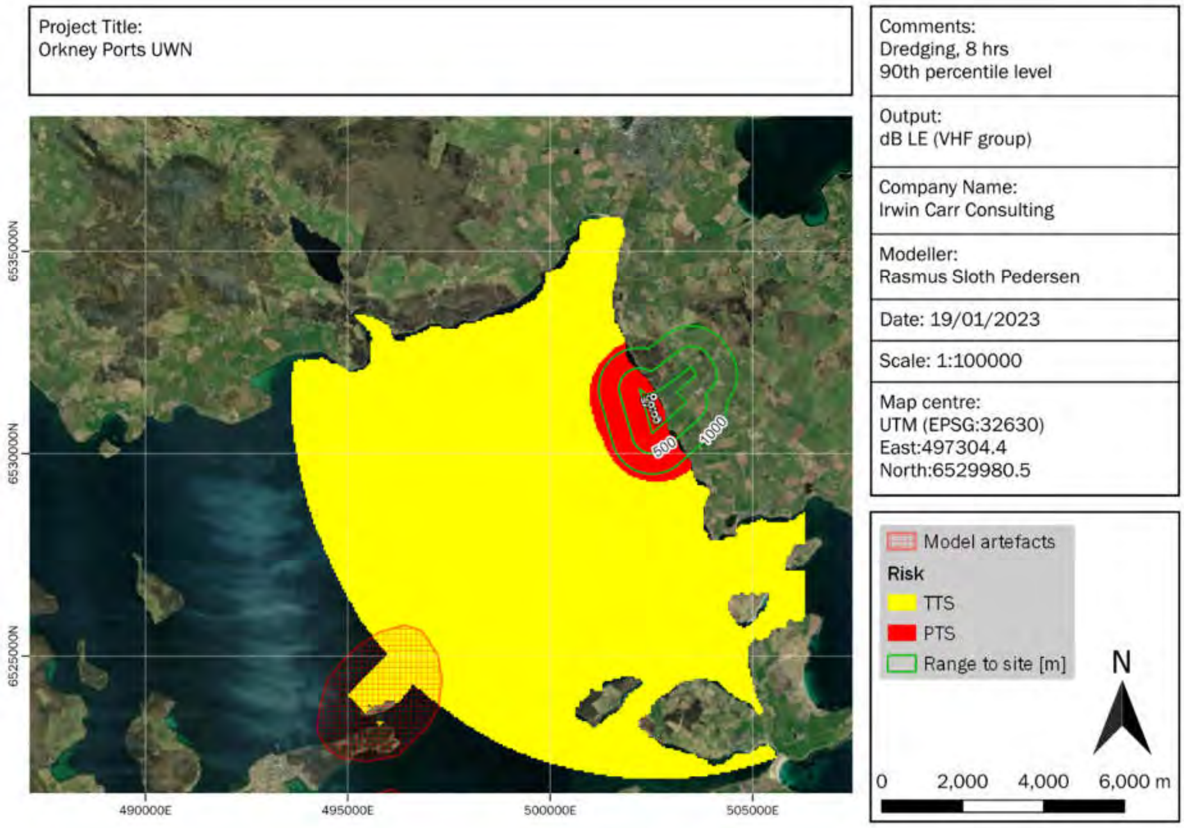
Modeller:
Rasmus Sloth Pedersen

Date: 19/01/2023

Scale: 1:100000

Map centre:
UTM (EPSG:32630)
East:497304.4
North:6529980.5

Figure 34. Dredging, LE, 8hrs, VHF group


Project Title:
Orkney Ports UWN

Comments:
Dredging, 8 hrs
90th percentile level

Output:
dB LE (VHF group)

Company Name:
Irwin Carr Consulting

Modeller:
Rasmus Sloth Pedersen

Date: 19/01/2023

Scale: 1:100000

Map centre:
UTM (EPSG:32630)
East:497304.4
North:6529980.5

Figure 35. Dredging, L_E, 8hrs, VHF group with average source level

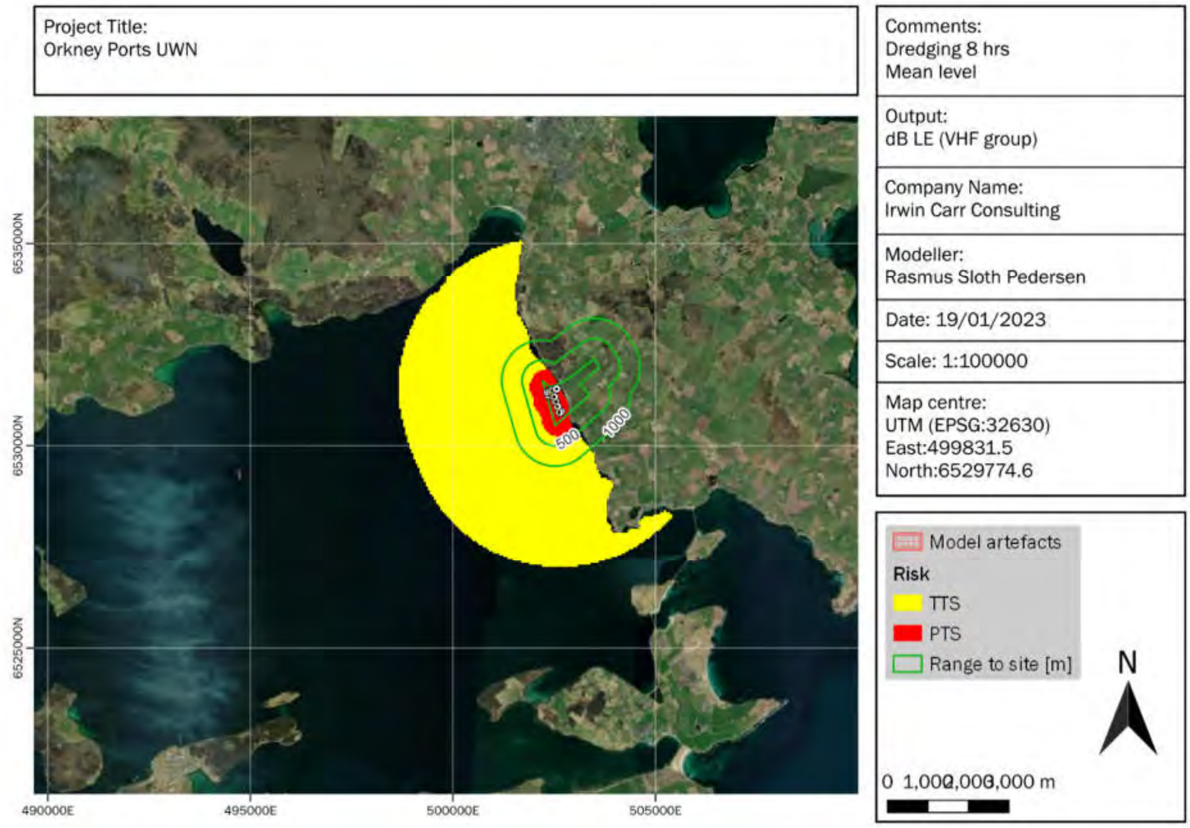


Figure 36. Dredging, L_E, 1hr, PW group

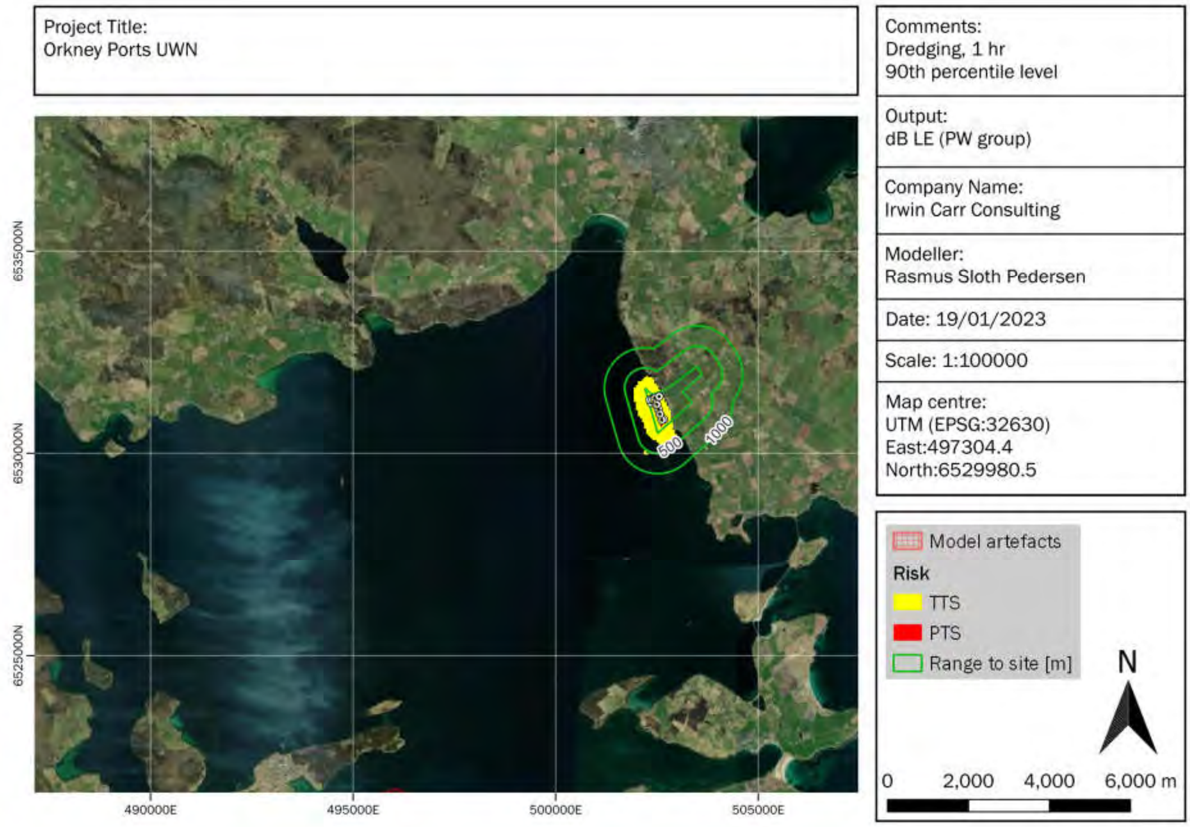
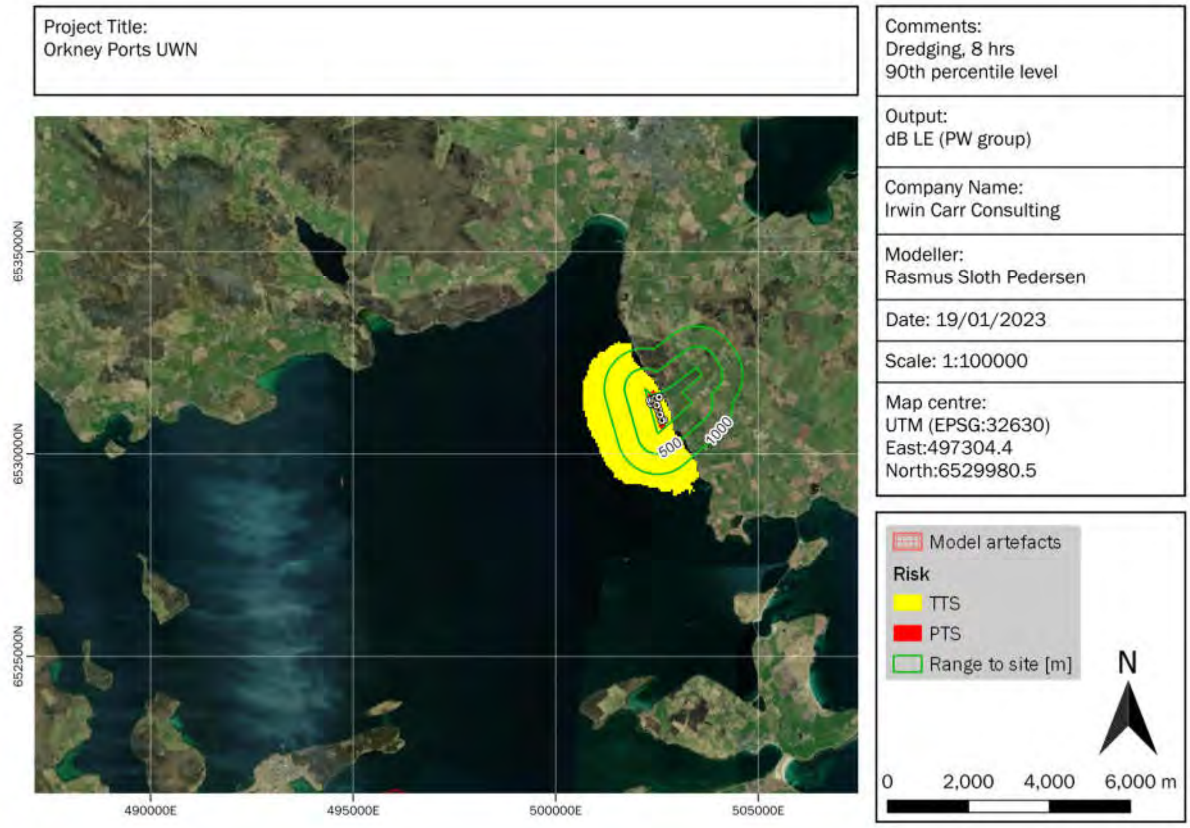


Figure 37. Dredging, L_E, 8hrs, PW group



Project Title:
Orkney Ports UWN

Comments:
Dredging, 8 hrs
90th percentile level

Output:
dB LE (PW group)

Company Name:
Irwin Carr Consulting

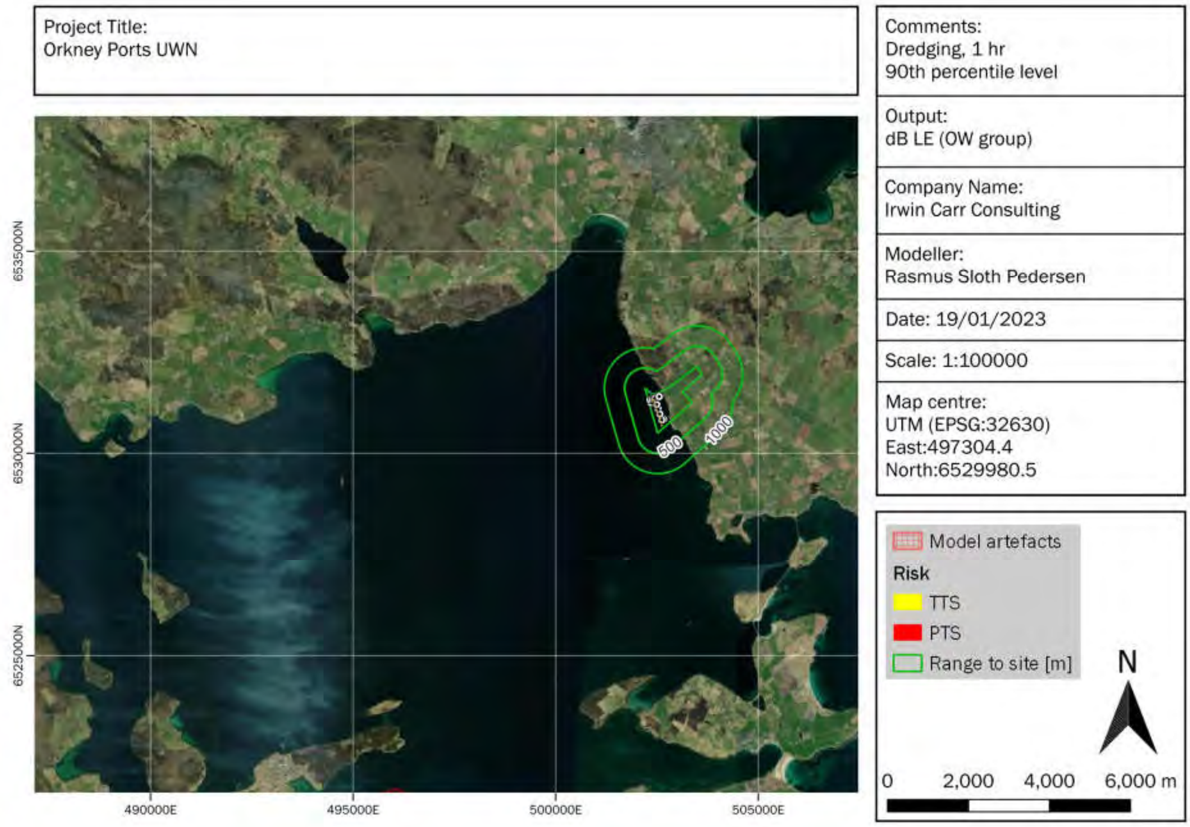
Modeller:
Rasmus Sloth Pedersen

Date: 19/01/2023

Scale: 1:100000

Map centre:
UTM (EPSG:32630)
East:497304.4
North:6529980.5

Figure 38. Dredging, L_E, 1hr, OW group



Project Title:
Orkney Ports UWN

Comments:
Dredging, 1 hr
90th percentile level

Output:
dB LE (OW group)

Company Name:
Irwin Carr Consulting

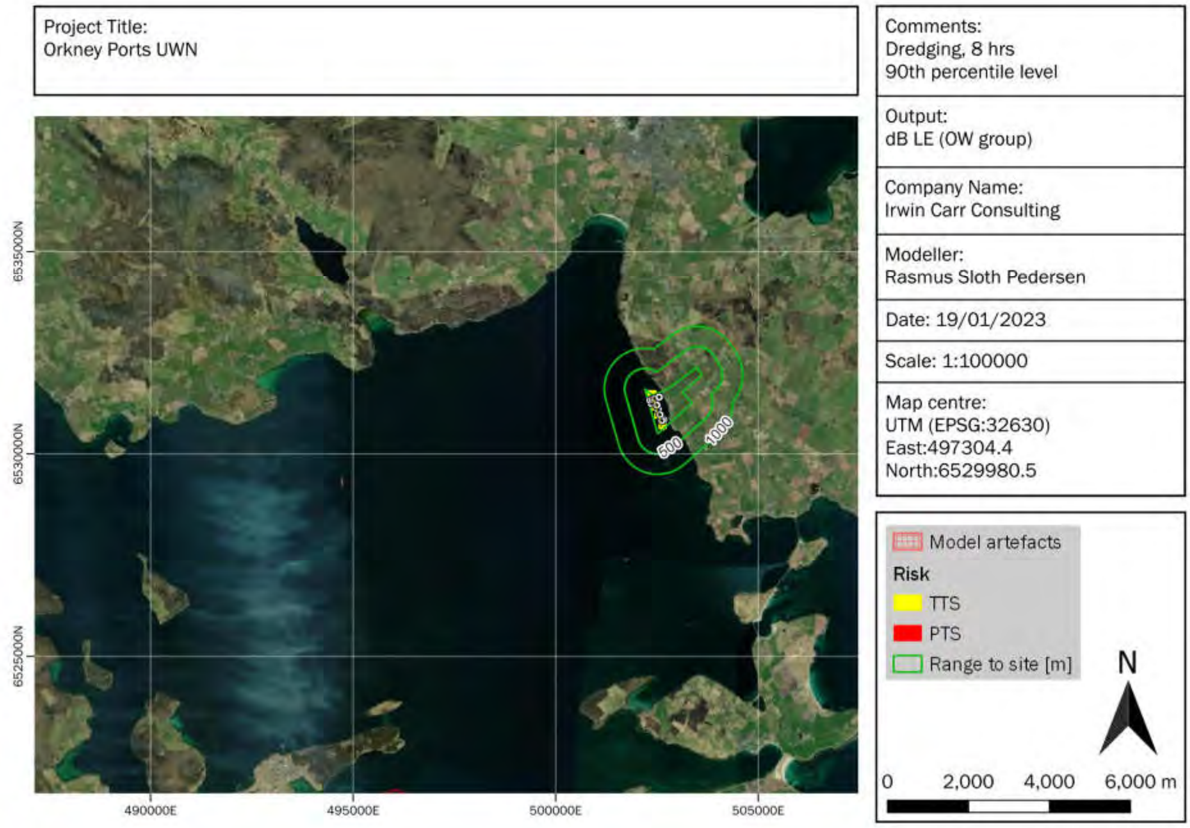
Modeller:
Rasmus Sloth Pedersen

Date: 19/01/2023

Scale: 1:100000

Map centre:
UTM (EPSG:32630)
East:497304.4
North:6529980.5

Figure 39. Dredging, L_E, 8hrs, OW group



Project Title:
Orkney Ports UWN

Comments:
Dredging, 8 hrs
90th percentile level

Output:
dB LE (OW group)

Company Name:
Irwin Carr Consulting

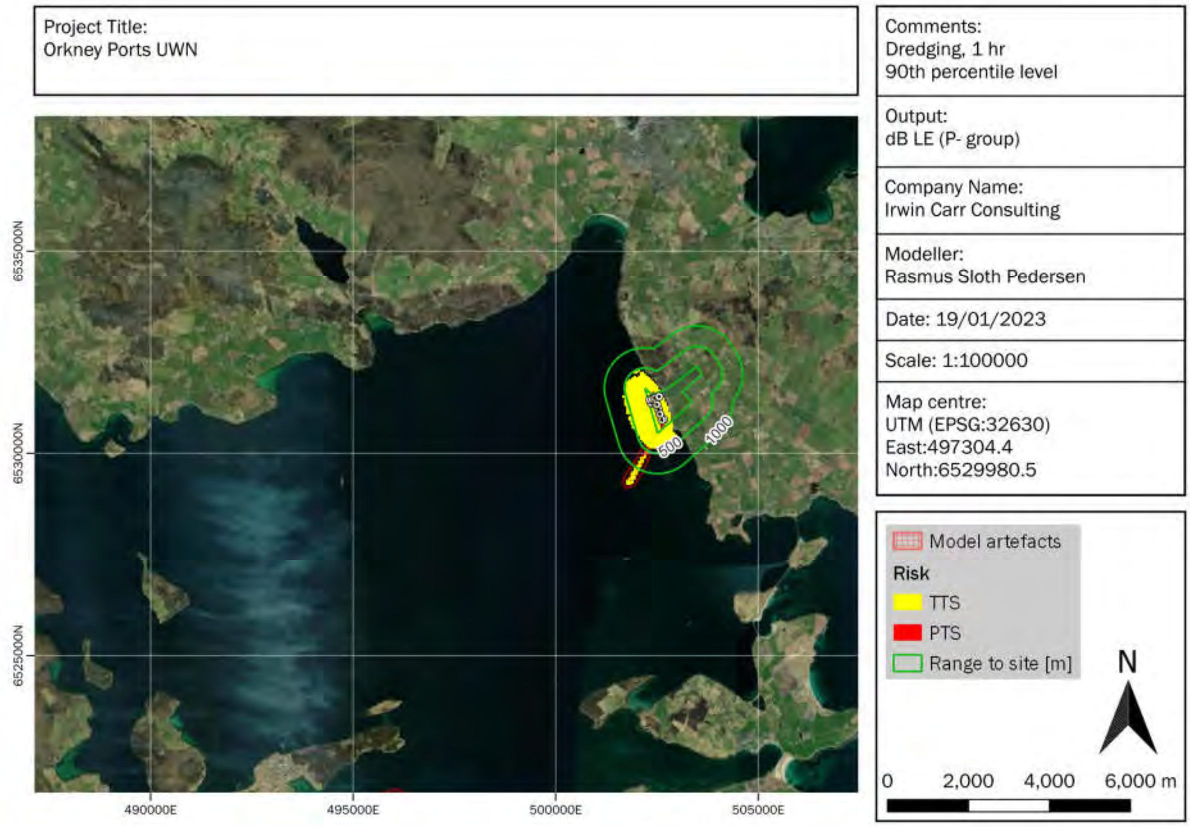
Modeller:
Rasmus Sloth Pedersen

Date: 19/01/2023

Scale: 1:100000

Map centre:
UTM (EPSG:32630)
East:497304.4
North:6529980.5

Figure 40. Dredging, L_E, 1hr, P- group



Project Title:
Orkney Ports UWN

Comments:
Dredging, 1 hr
90th percentile level

Output:
dB LE (P- group)

Company Name:
Irwin Carr Consulting

Modeller:
Rasmus Sloth Pedersen

Date: 19/01/2023

Scale: 1:100000

Map centre:
UTM (EPSG:32630)
East:497304.4
North:6529980.5

Figure 41. Dredging, L_E, 8hrs, P- group

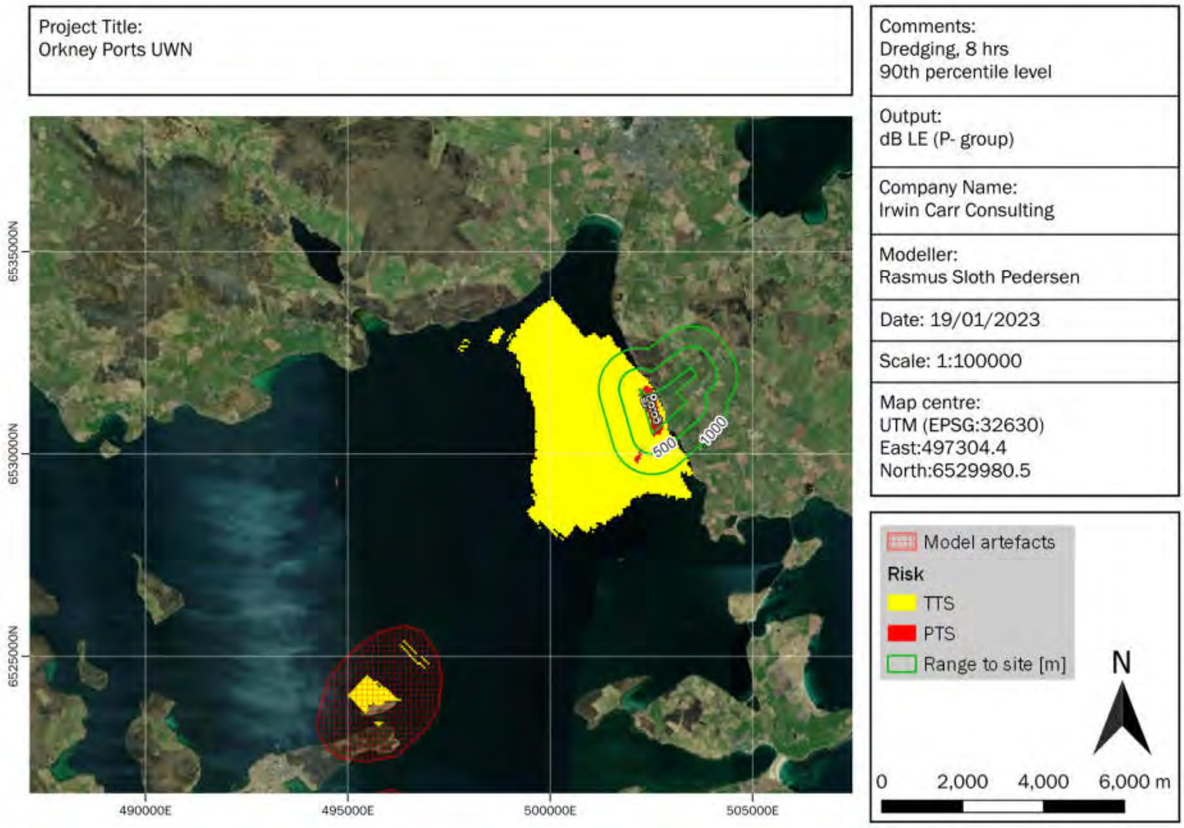


Figure 42. Dredging, L_E, 1hr, P* group

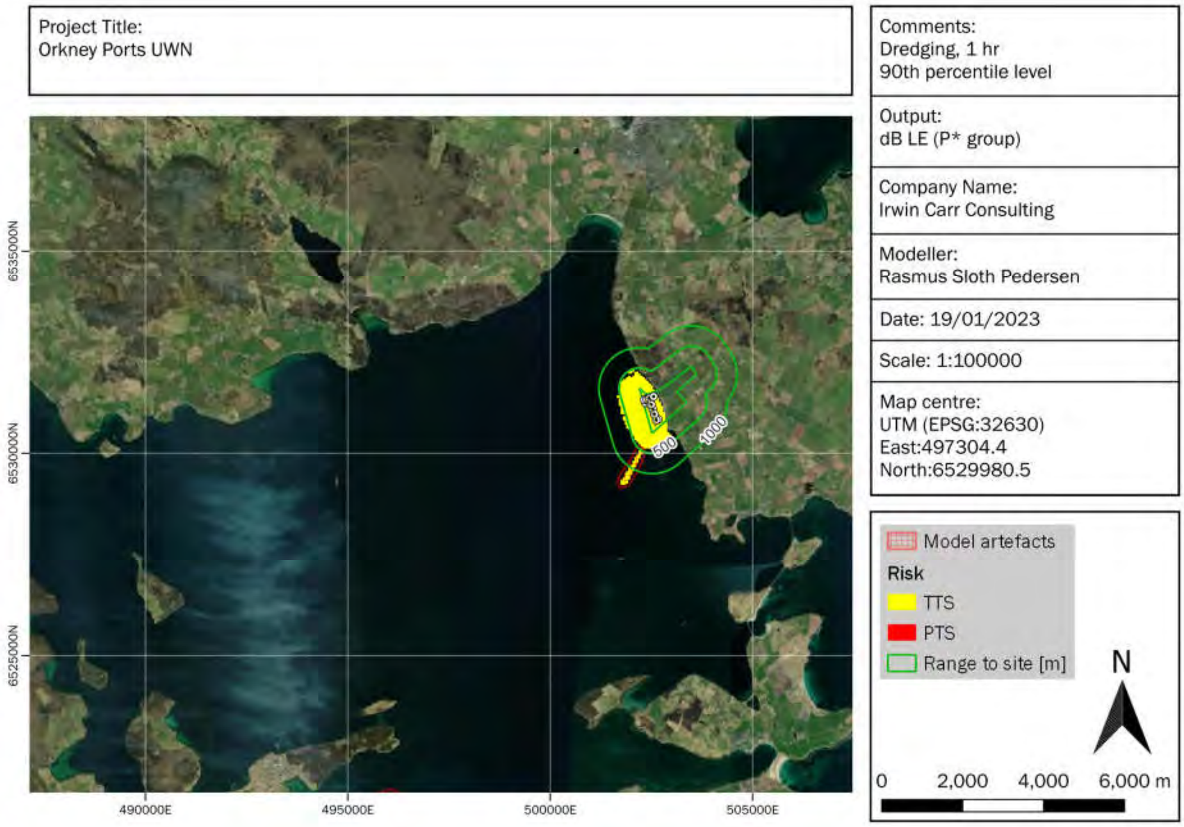
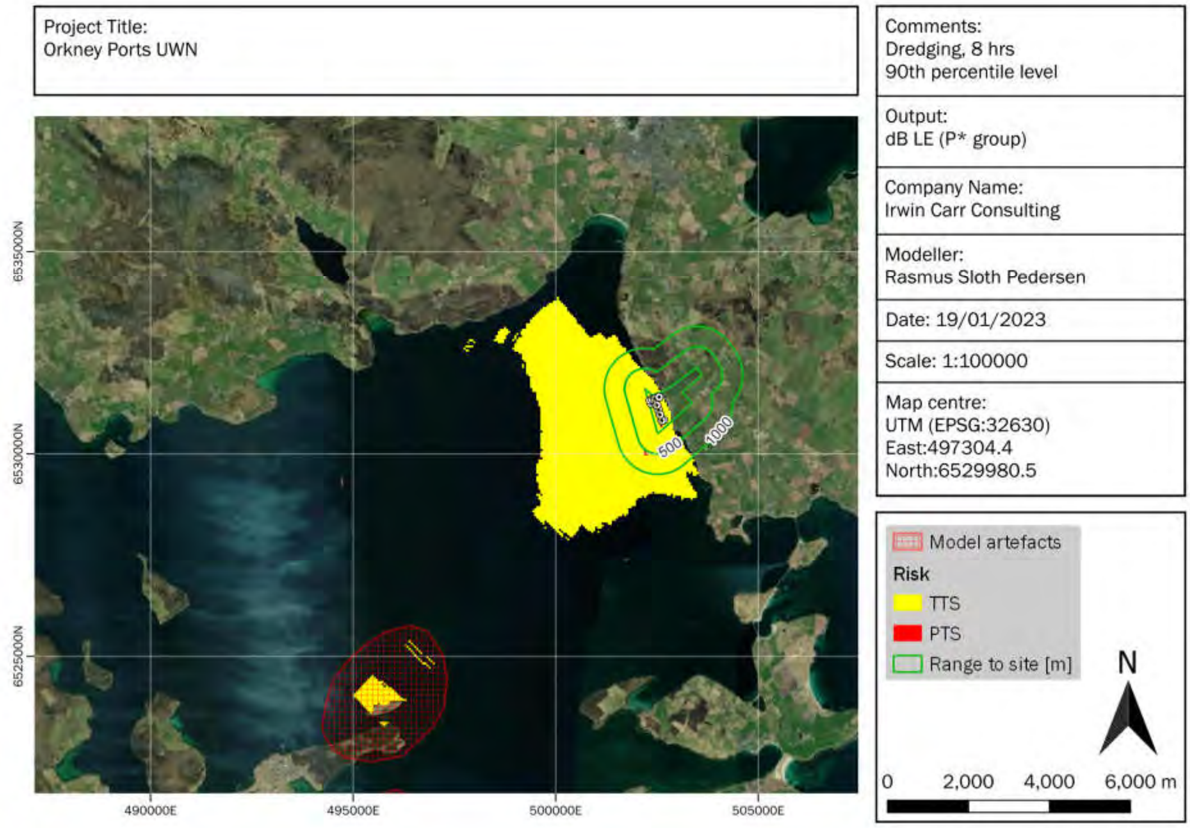


Figure 43. Dredging, L_E, 8hrs, P* group



Project Title:
Orkney Ports UWN

Comments:
Dredging, 8 hrs
90th percentile level

Output:
dB LE (P* group)

Company Name:
Irwin Carr Consulting

Modeller:
Rasmus Sloth Pedersen

Date: 19/01/2023

Scale: 1:100000

Map centre:
UTM (EPSG:32630)
East:497304.4
North:6529980.5

▨ Model artefacts

Risk

🟨 TTS

🟥 PTS

🟩 Range to site [m]

Vibro Piling L_E

Figure 44. Vibro piling, L_E, 1 hour, LF group

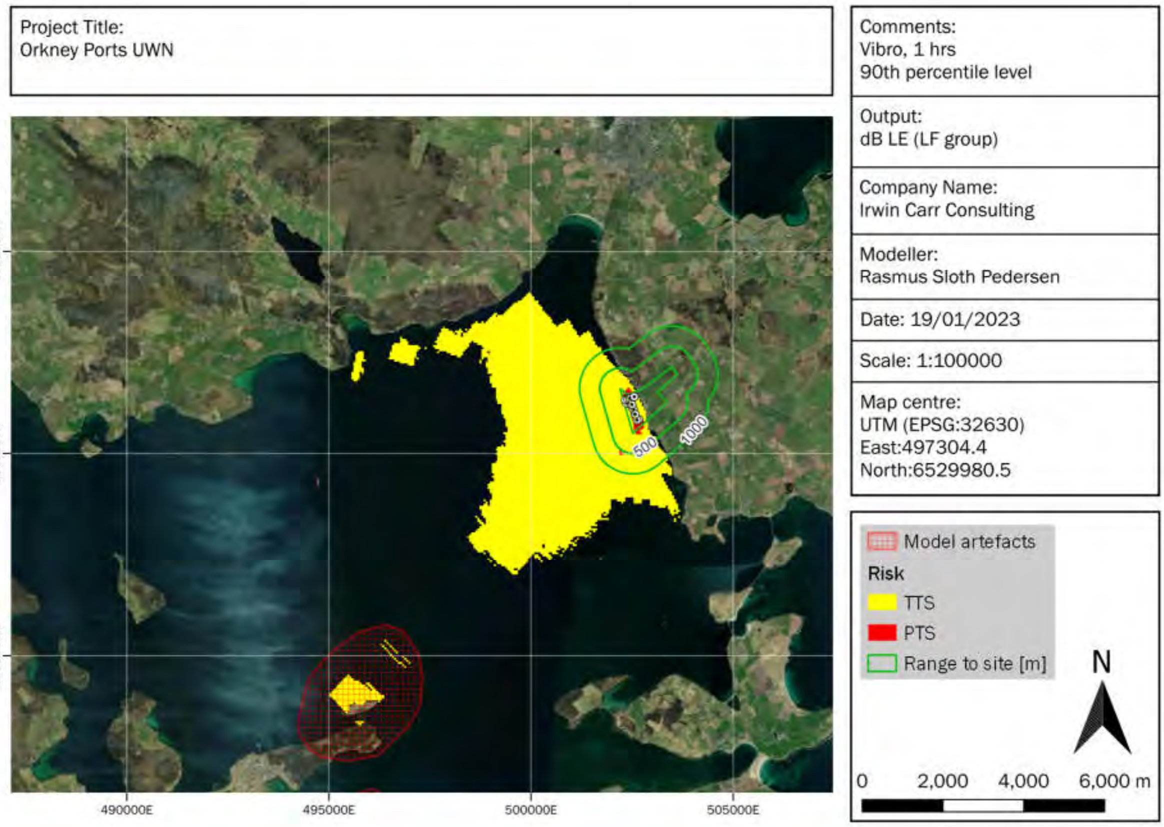


Figure 45. Vibro piling, L_E, 1 hour, HF group

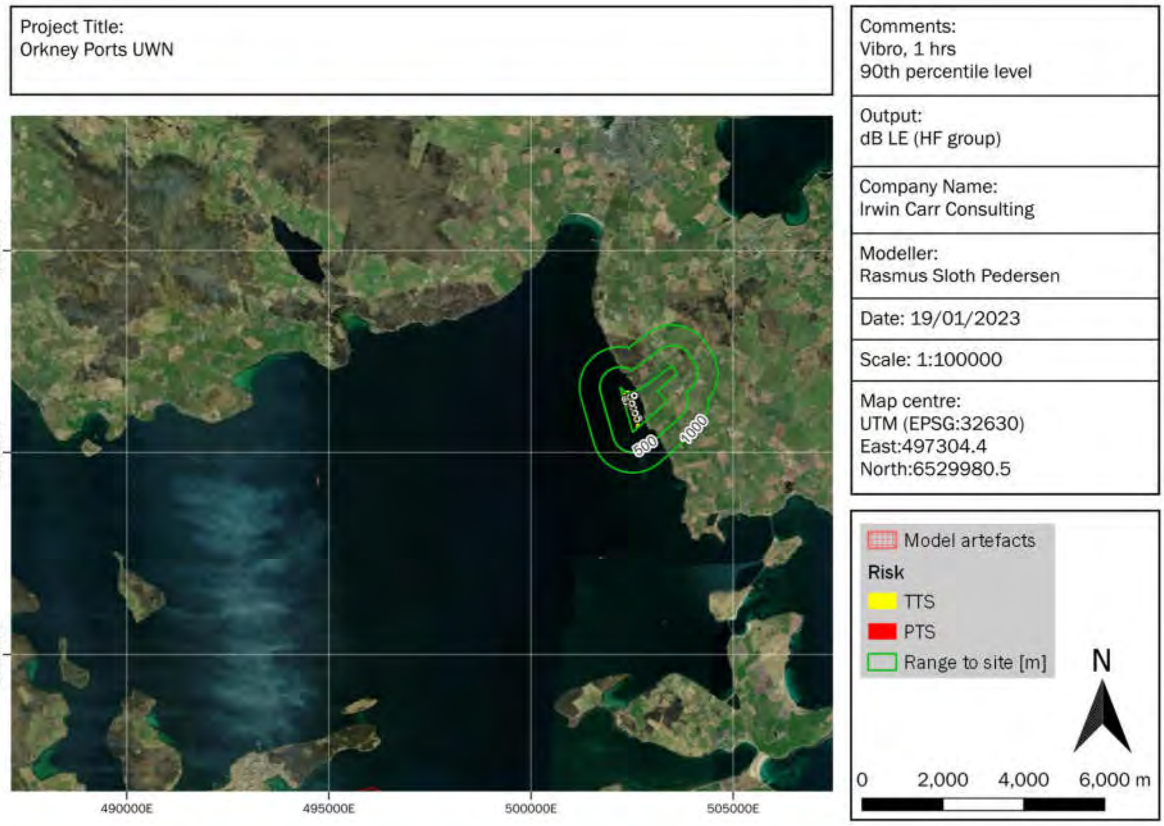


Figure 46. Vibro piling, L_E, 1 hour, VHF group

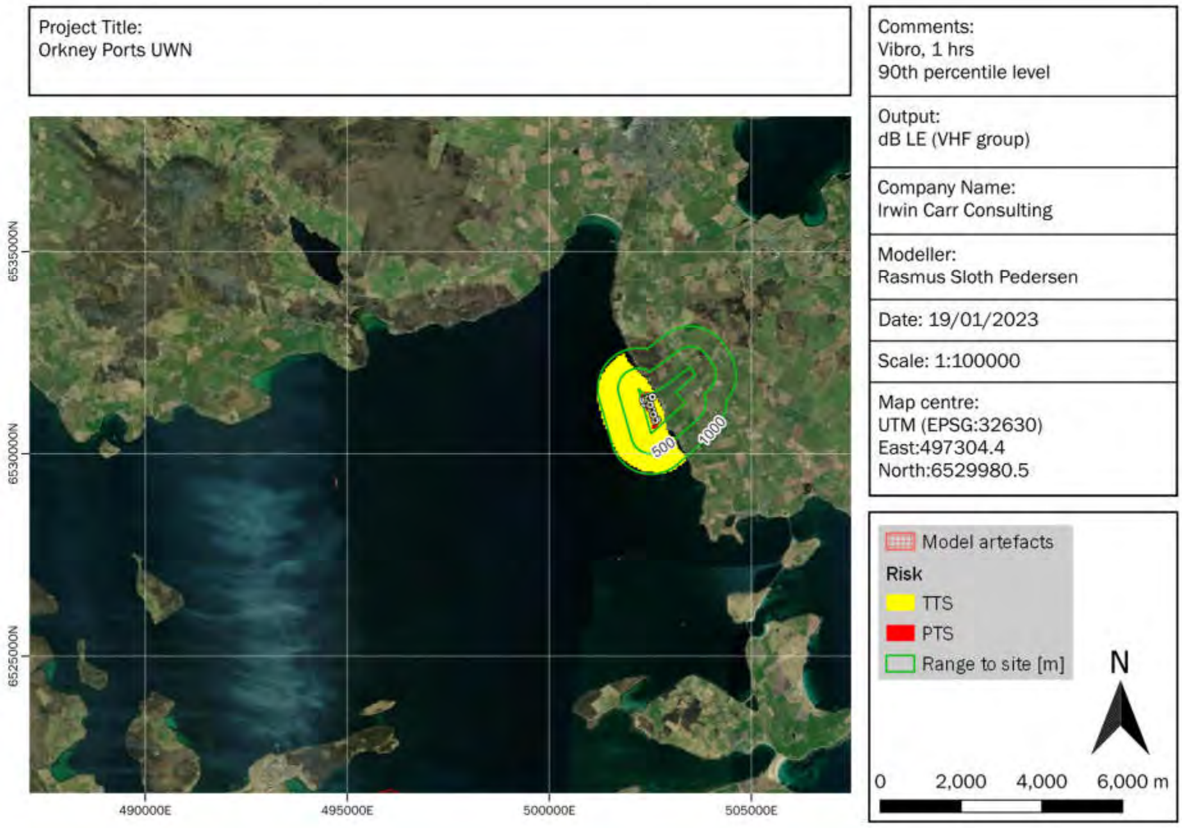


Figure 47. Vibro piling, L_E, 1 hour, PW group

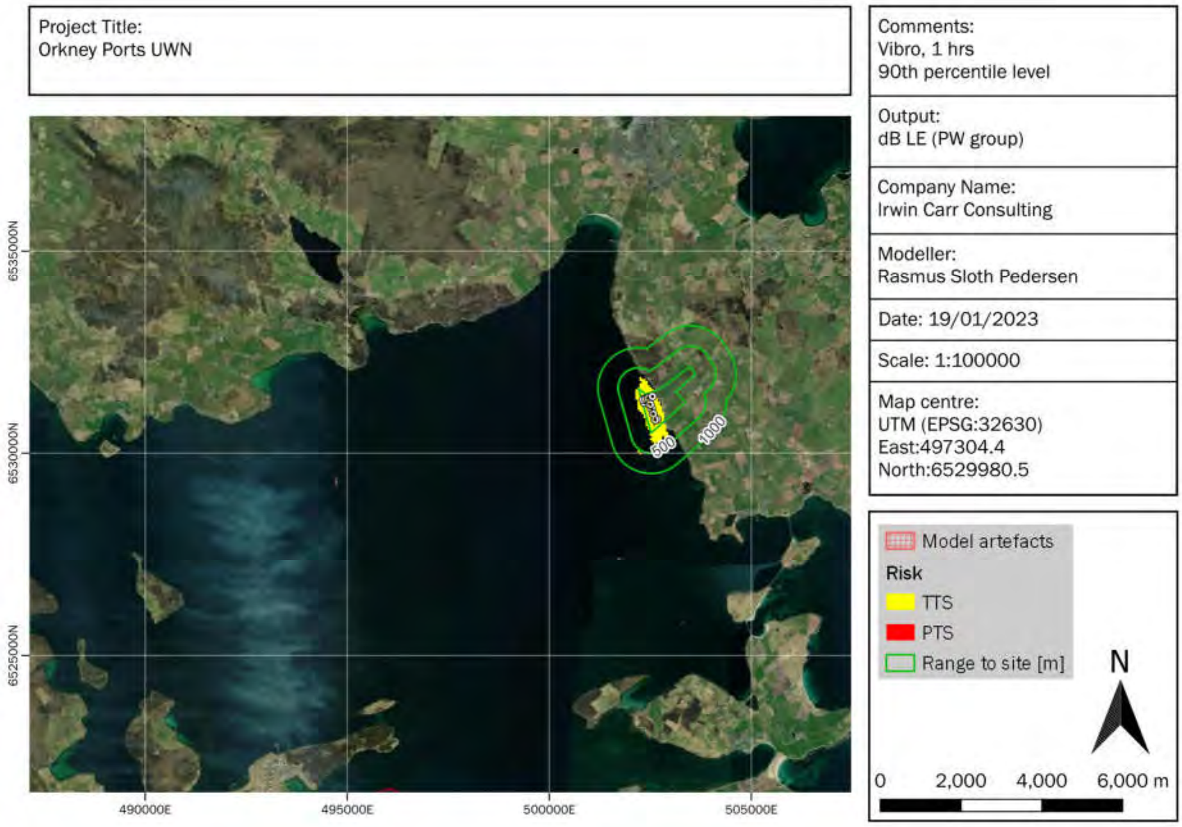
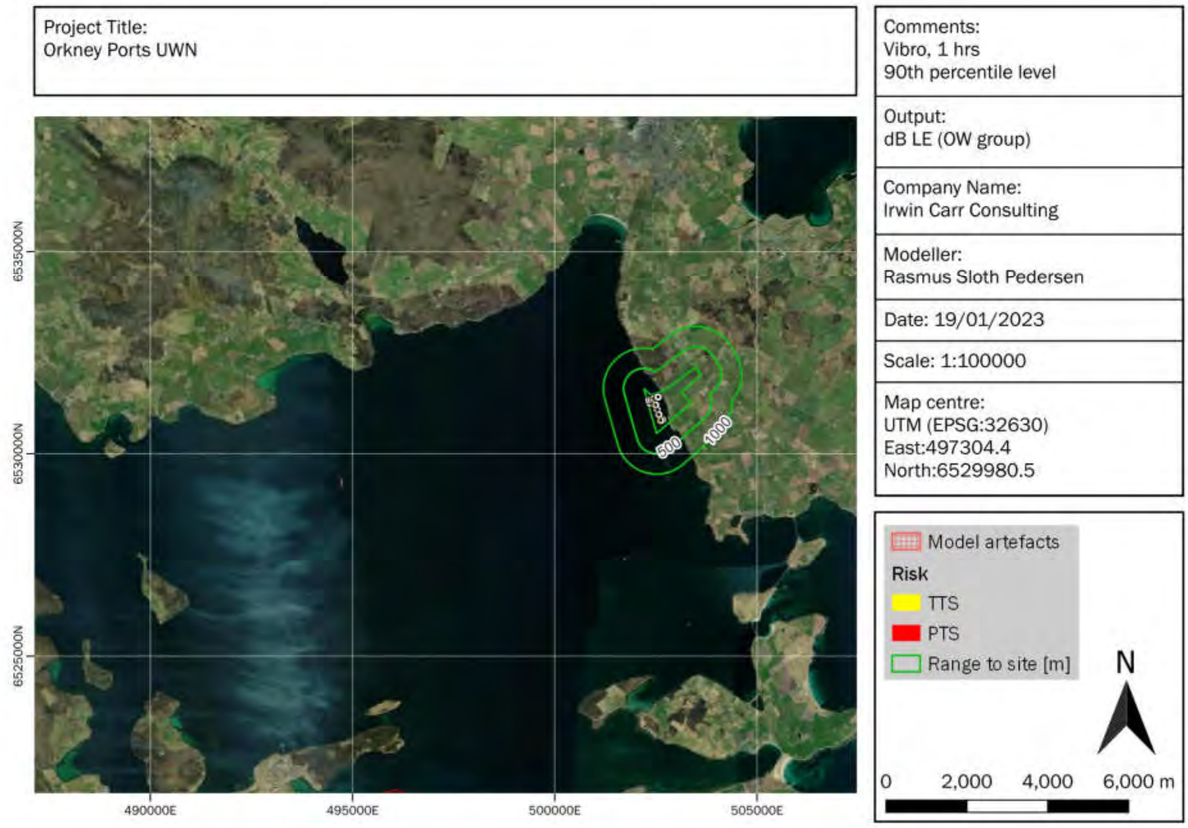


Figure 48. Vibro piling, L_E, 1 hour, OW group



Project Title:
Orkney Ports UWN

Comments:
Vibro, 1 hrs
90th percentile level

Output:
dB LE (OW group)

Company Name:
Irwin Carr Consulting

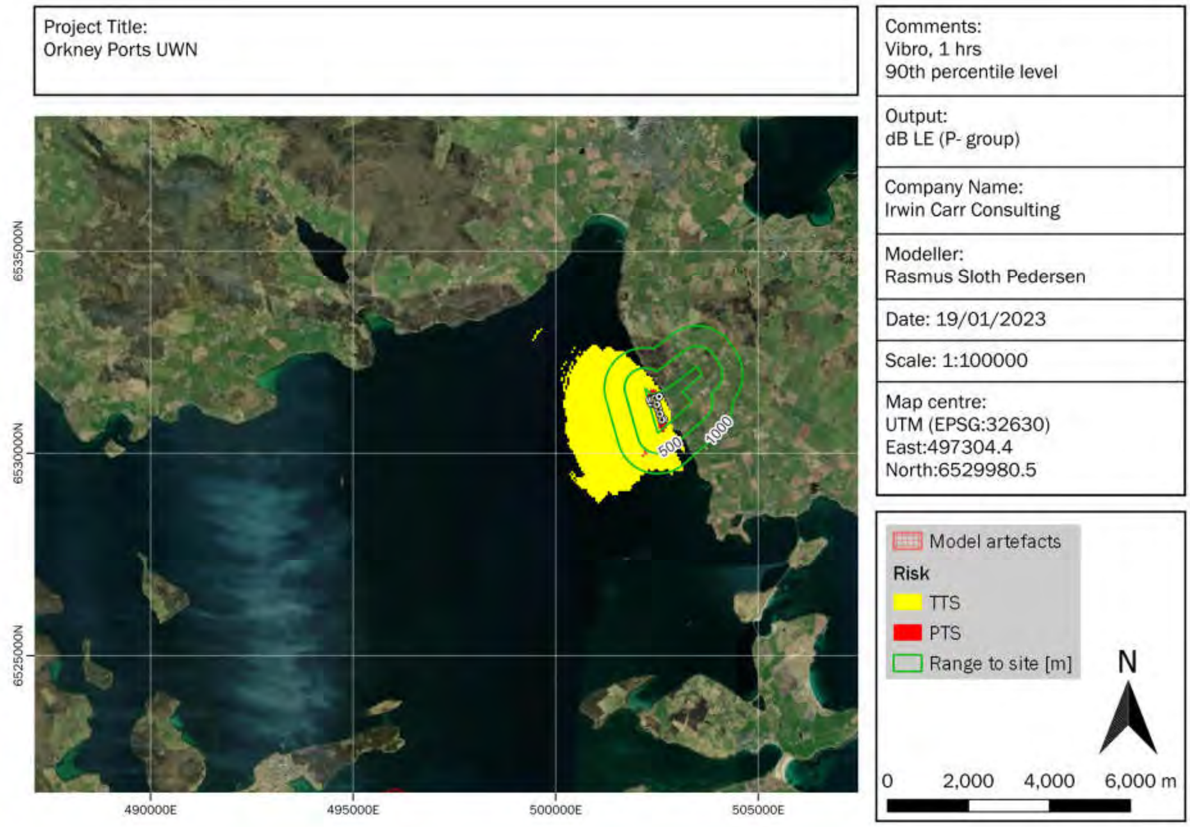
Modeller:
Rasmus Sloth Pedersen

Date: 19/01/2023

Scale: 1:100000

Map centre:
UTM (EPSG:32630)
East:497304.4
North:6529980.5

Figure 49. Vibro piling, L_E, 1 hour, P- group



Project Title:
Orkney Ports UWN

Comments:
Vibro, 1 hrs
90th percentile level

Output:
dB LE (P- group)

Company Name:
Irwin Carr Consulting

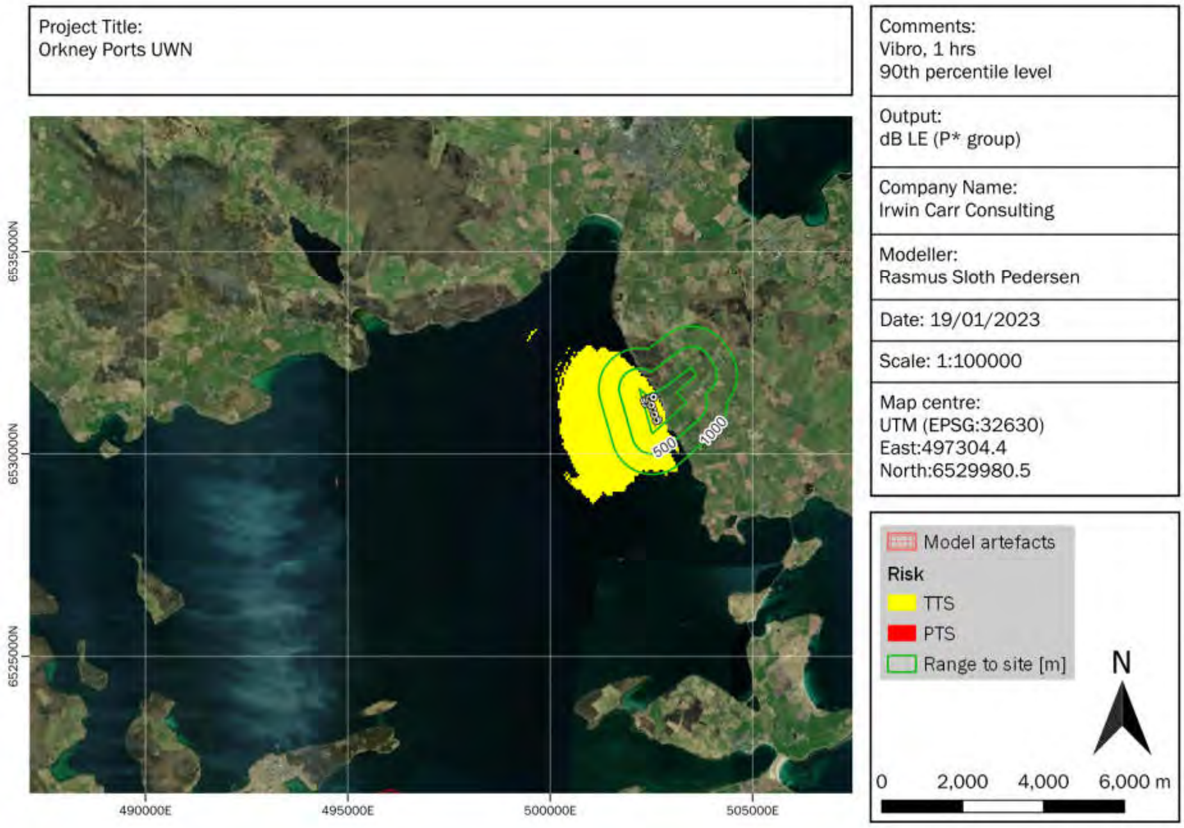
Modeller:
Rasmus Sloth Pedersen

Date: 19/01/2023

Scale: 1:100000

Map centre:
UTM (EPSG:32630)
East:497304.4
North:6529980.5

Figure 50. Vibro piling, L_E, 1 hour, P* group



Project Title:
Orkney Ports UWN

Comments:
Vibro, 1 hrs
90th percentile level

Output:
dB LE (P* group)

Company Name:
Irwin Carr Consulting

Modeller:
Rasmus Sloth Pedersen

Date: 19/01/2023

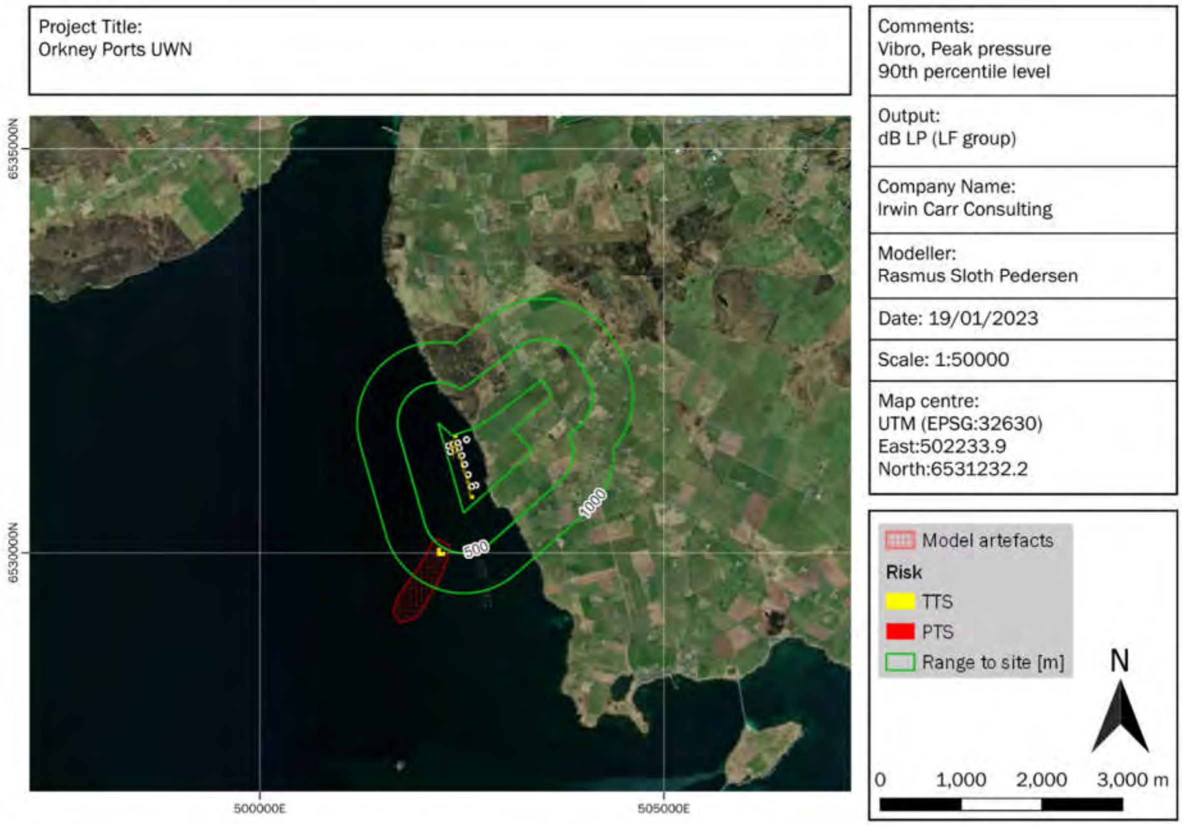
Scale: 1:100000

Map centre:
UTM (EPSG:32630)
East:497304.4
North:6529980.5

▨ Model artefacts
Risk
🟨 TTS
🟥 PTS
🟩 Range to site [m]

Vibro piling L_P

Figure 51. Vibro piling, L_P, LF group



Project Title:
Orkney Ports UWN

Comments:
Vibro, Peak pressure
90th percentile level

Output:
dB LP (LF group)

Company Name:
Irwin Carr Consulting

Modeller:
Rasmus Sloth Pedersen

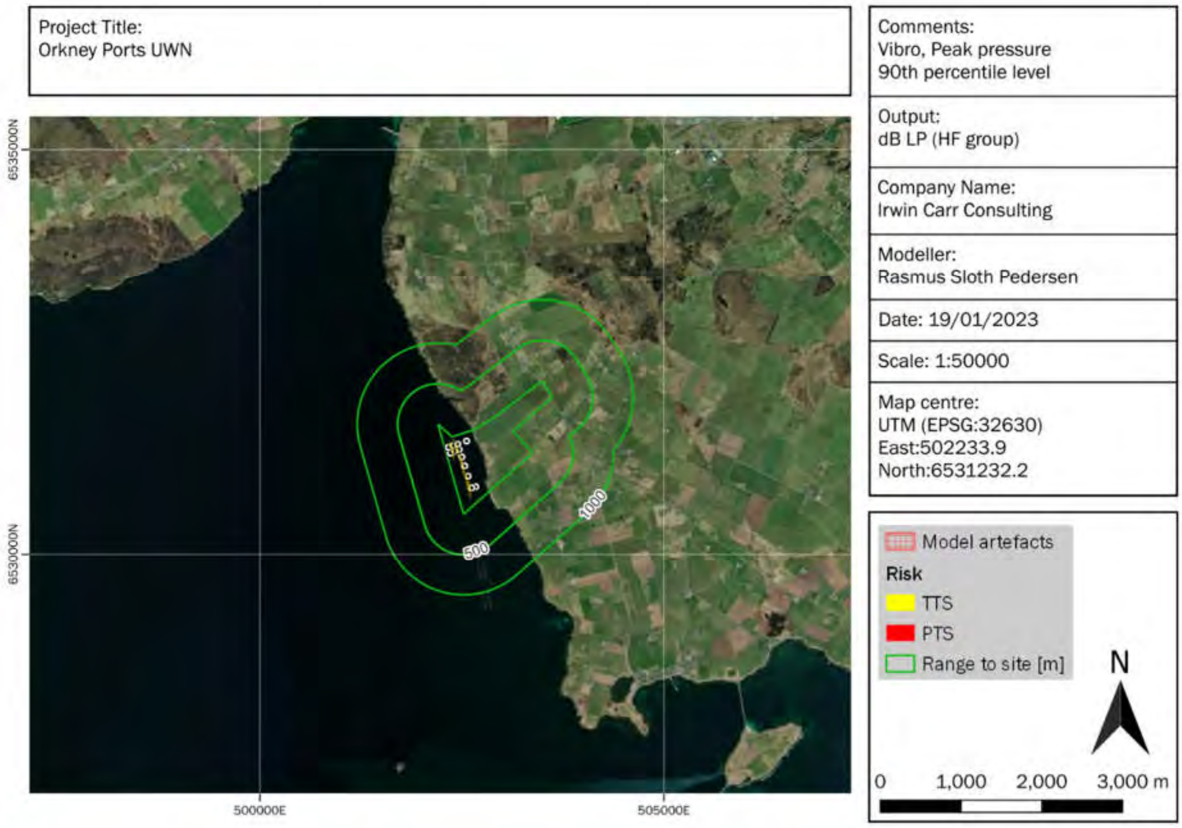
Date: 19/01/2023

Scale: 1:50000

Map centre:
UTM (EPSG:32630)
East:502233.9
North:6531232.2

▨ Model artefacts
Risk
🟨 TTS
🟥 PTS
🟩 Range to site [m]

Figure 52. Vibro piling, LP, HF group



Project Title:
Orkney Ports UWN

Comments:
Vibro, Peak pressure
90th percentile level

Output:
dB LP (HF group)

Company Name:
Irwin Carr Consulting

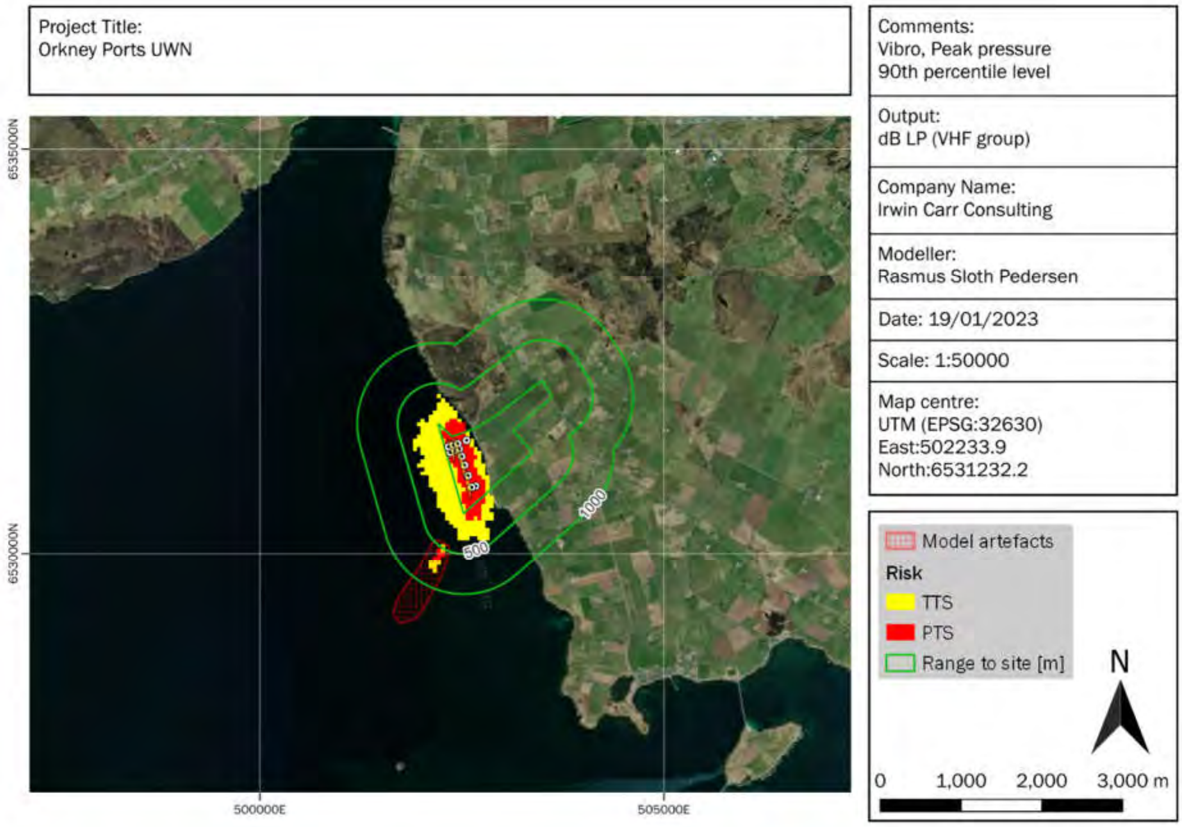
Modeller:
Rasmus Sloth Pedersen

Date: 19/01/2023

Scale: 1:50000

Map centre:
UTM (EPSG:32630)
East:502233.9
North:6531232.2

Figure 53. Vibro piling, LP, VHF group



Project Title:
Orkney Ports UWN

Comments:
Vibro, Peak pressure
90th percentile level

Output:
dB LP (VHF group)

Company Name:
Irwin Carr Consulting

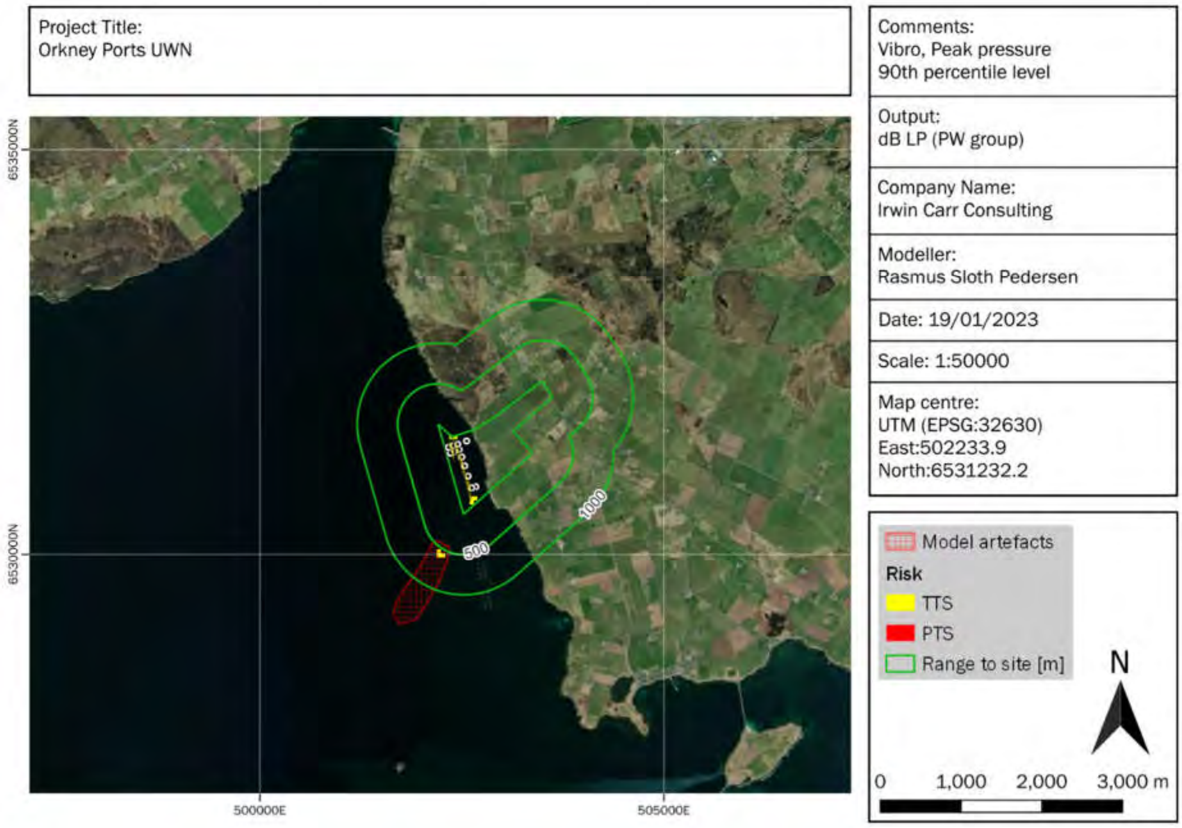
Modeller:
Rasmus Sloth Pedersen

Date: 19/01/2023

Scale: 1:50000

Map centre:
UTM (EPSG:32630)
East:502233.9
North:6531232.2

Figure 54. Vibro piling, Lp, PW group



Project Title:
Orkney Ports UWN

Comments:
Vibro, Peak pressure
90th percentile level

Output:
dB LP (PW group)

Company Name:
Irwin Carr Consulting

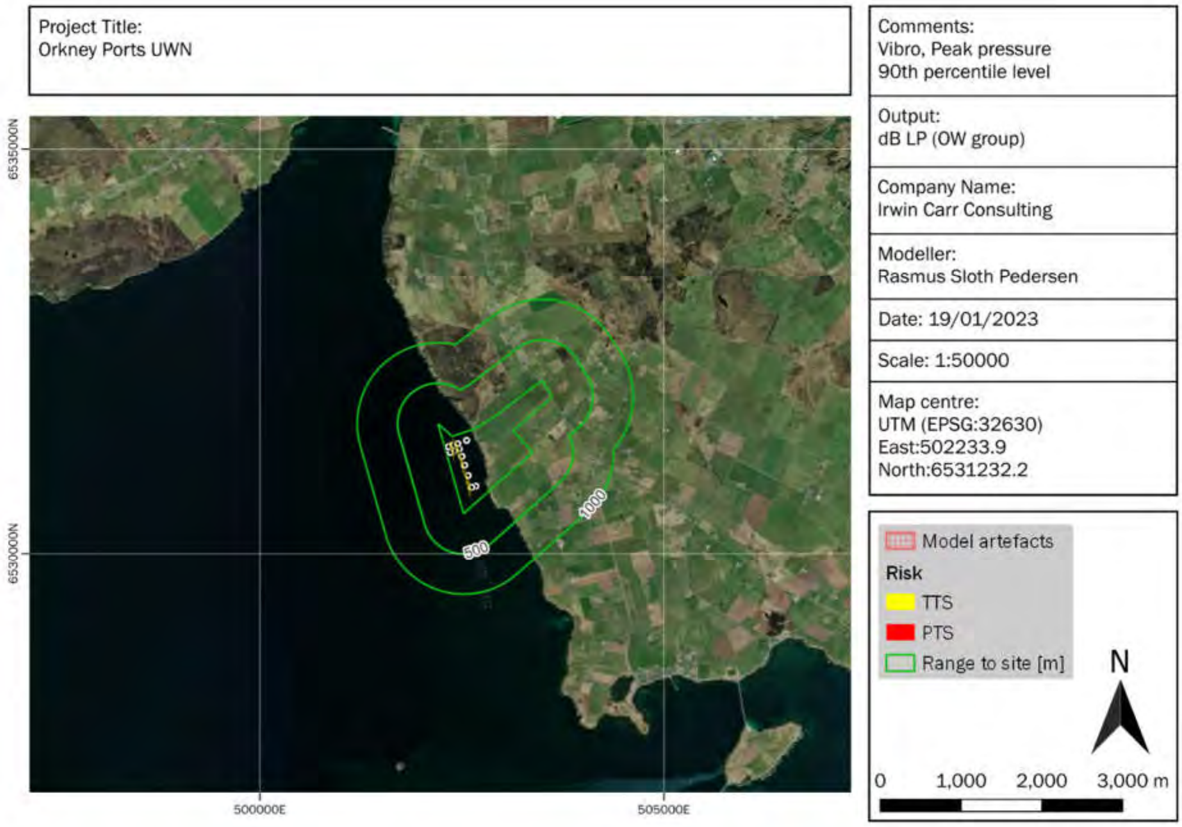
Modeller:
Rasmus Sloth Pedersen

Date: 19/01/2023

Scale: 1:50000

Map centre:
UTM (EPSG:32630)
East:502233.9
North:6531232.2

Figure 55. Vibro piling, Lp, OW group



Project Title:
Orkney Ports UWN

Comments:
Vibro, Peak pressure
90th percentile level

Output:
dB LP (OW group)

Company Name:
Irwin Carr Consulting

Modeller:
Rasmus Sloth Pedersen

Date: 19/01/2023

Scale: 1:50000

Map centre:
UTM (EPSG:32630)
East:502233.9
North:6531232.2

Figure 56. Vibro piling, L_P, P- group

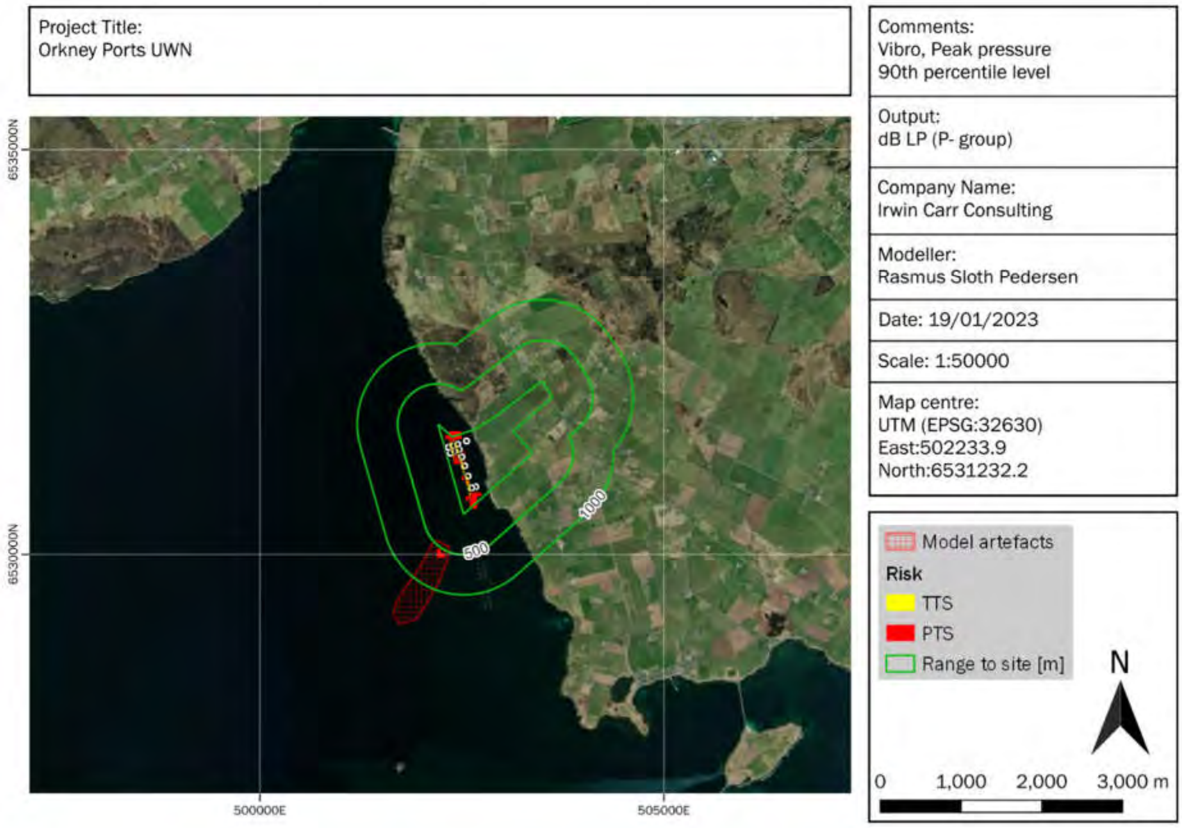
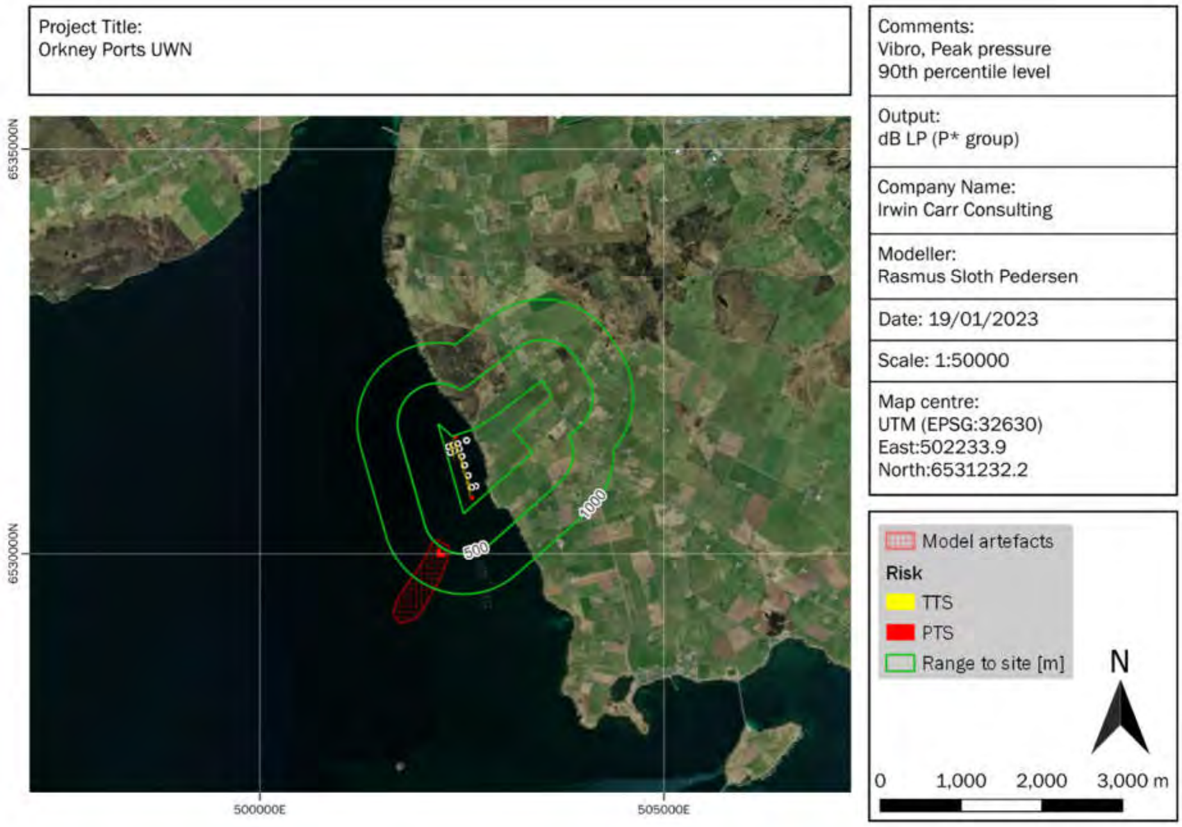


Figure 57. Vibro piling, L_P, P* group



TECHNICAL APPENDIX 5.7

Scapa Deep Water Quay
Marine Mammal Protection Plan

June 2023

CONTROL SHEET

Client:	Orkney Island Council Harbour Authority
Project Title:	Scapa Deep Water Quay
Report Title:	Marine Mammal Protection Plan
Document number:	13507
Project number:	674795

Issue Record

Issue	Status	Author	Reviewer	Approver	Issue Date
1	Draft For Comment	JEP	MM	MM	26/05/2023
2	Final	JEP	MM	MM	28/06/2023

EnviroCentre Limited Office Locations:

Glasgow **Edinburgh** **Inverness** **Banchory**

Registered Office: Craighall Business Park 8 Eagle Street Glasgow G4 9XA
Tel 0141 341 5040 info@envirocentre.co.uk www.envirocentre.co.uk

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VAT no. GB 348 6770 57.

1 MARINE MAMMAL MITIGATION PLAN

The marine mammal mitigation will comprise a standard MMO protocol as per JNCC guidance which will be implemented during vibration and dredging operations in optimal sea states and during times of optimal visibility, and avoidance of works commencing during low hours of visibility and when sea state exceeds 2. This may be supplemented by use of Passive Acoustic Monitoring devices (PAMs).

1.1 Marine Mammal Observations

The Marine Mammal Observation Protocol (MMOP) will be implemented so that the vibration piling and dredging works do not cause injury or unnecessary disturbance to marine mammals. This section has been designed with reference to current JNCC guidance 'Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise' (August 2010) [1] [2].

1.1.1 Marine Mammal Observer

A suitably qualified Marine Mammal Observer (MMO), competent in the identification of marine mammals at sea, will be present during the vibratory piling and dredging. The MMO will undertake observation for marine mammals within the mitigation zone before and during vibratory piling and dredging and will be dedicated to that one task for the duration of any watch. The MMO will advise the contractors and crews on the implementation of the procedures set out in the agreed protocol, to ensure compliance with those procedures.

The JNCC guidance provides the following definitions of an MMO:

MMO: Individual responsible for conducting visual watches for marine mammals. It may be requested that observers are trained, dedicated and/or experienced.

Trained MMO: Has been on a JNCC recognised course.

Dedicated MMO: Trained observer whose role on board a vessel is to conduct visual watches for marine mammals.

Experienced MMO: Trained observer with three years of field experience observing for marine mammals, and practical experience of implementing the JNCC guidelines.

The MMO will be land based and will be trained. The identity and credentials of the MMO will be agreed with Marine Scotland.

1.1.2 MMO Equipment

The MMO will be equipped with binoculars (10X42 or similar) and/or a spotting scope (20-60 zoom or equivalent), a copy of the agreed protocol and the Marine Mammal Recording Form (MMRF), which is a Microsoft Excel spreadsheet containing embedded worksheets named Cover Page, Operations, Effort and Sightings. A Microsoft Word document named Deck forms is also available, and the MMO may prefer to use this when observing before transferring the details to the Excel spreadsheets.

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

[2] It should be noted that these protocols do not document measures to mitigate disturbance effects but have been developed to reduce to negligible levels of risk of injury or death to marine mammals in close proximity to piling operations.

Although these forms were developed for seismic surveys, they can be used for piling and dredging operations, although many columns will not be applicable. The ability to determine the range of marine mammals is a key skill for MMOs, therefore a hand-held rangefinder will be used to verify the range.

All MMO forms, including a guide to completing the forms; and instructions on how to make a rangefinder are available on the JNCC website: http://jncc.defra.gov.uk/marine/seismic_survey.

1.1.3 Passive Acoustic Monitoring (PAM)

Following appointment of contractor / Ecological Clerk of Works (ECoW), logistical information will be available/ updated to provide more detail regarding the use of PAMs.

In addition to MMOs, PAMs should be provided throughout the operation to supplement visual checks.

PAM are software systems that utilises hydrophones to detect the vocalisations of marine mammals. This will help aid in the detection of species which are less easily detected at the surface via MMOs or during unfavourable conditions.

Visual observation is an ineffective mitigation measure during periods of darkness or poor visibility (such as fog), or during periods when the sea state is not conducive to visual mitigation, as marine mammals in the vicinity of dredging/ vibration piling will not be detected. JNCC views PAM as the only available mitigation technique that can be used under these conditions, and that it can also be used to enhance the detection of certain marine mammal species[3].

Specialist PAM operatives are needed to set up and deploy the equipment and interpret the detected sounds. The PAM hydrophones should be situated as close as possible to the site of piling/ dredging, and sacrificial hydrophones may therefore be required.

Hydrophones deployed from standby vessels can be used for acoustic monitoring, but a disadvantage of these systems (in regard to dredging) is that they will move away from the site of dredging when the vessel moves and may then be too far away to detect any marine mammal vocalisations within the mitigation zone. Remotely operated static PAM systems, which can be left at the initial dredging site, may be an option, but they may not always be commercially available, or best suited for operations in shallow coastal environments.

PAM can provide a useful supplement to visual observations undertaken by MMOs. However, in many cases it is not as accurate as visual observation for determining range, and this will mean that the mitigation zone will reflect the range accuracy of the system. Some PAM systems do not have a reliable range determination facility or can only calculate the range for some species. In such cases, the detection of a confirmed cetacean vocalisation should still be used to initiate postponement of the piling/ dredging soft-start if the PAM operator is able to make a judgement about the range of the marine mammal (dependent on species) from the works, because of experience gained in differentiating between distant and close vocalisations. In the absence of PAM systems capable of range determination, this expert judgement will constitute the basis for deciding whether an area is free from marine mammals prior to the dredging/ piling soft-start.

PAM operators will submit a method statement and details of the equipment to be used to MS-LOT for approval before the equipment is deployed.

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[3] JNCC Guidelines for minimising the risk of injury to marine mammals from using explosives (2010), available at: https://data.jncc.gov.uk/data/24cc180d-4030-49dd-8977-a04ebe0d7aca/JNCC-Guidelines-Explosives-Guidelines-201008-Web.pdf

1.1.4 Communication

The contractor will be responsible for the communication channels between those providing the mitigation service and the crews working on the piling and dredging. A formal chain of communication from the MMO to the contractor, who will start/stop piling, will be established. In order to confirm the chain of communication and command the MMO will attend any relevant pre-mobilisation meetings.

1.1.5 Mitigation Zone

Following appointment of contractor / Ecological Clerk of Works (ECoW), logistical information will be available/ updated to provide more detailed mitigation zones for the MMO. This may change throughout the construction period due to ground levels changing and depending on the area of works which need to be viewed.

The JNCC guidance defines the mitigation zone as a pre-agreed radius around the piling or dredging site prior to any activity. This is the area where a MMO keeps watch for marine mammals (and delays the start of activity should any marine mammals be detected). The extent of this zone represents the area in which a marine mammal could be exposed to sound that could cause injury and will be determined by factors such as the length of vibratory piling, the water depth, the nature of the activities (for example whether drilling will also take place) and the effect of the substrate on noise transmission. From underwater noise modelling, minimum recommended mitigation zone of 500 metres from the piling or dredging location should be sufficient to avoid injury. The MMO should be located on the most appropriate viewing platform to ensure effective coverage of the mitigation zone (land or vessel based).

1.2 Vibration Piling and Dredging Protocol

Following appointment of contractor / Ecological Clerk of Works (ECoW), logistical information will be available/ updated to provide more detail regarding vibration piling and dredging protocols.

The standard JNCC protocol as outlined below shall be followed prior to works commencing or in the event piling / dredging activities stop for a period of 30 minutes or more:

1. Piling and dredging will not commence during poor visibility (such as fog) or during periods when the sea state is not conducive to visual searches (above sea state 4 is considered not conducive[4]) as there is a greater risk of failing to detect the presence of marine mammals. Harbour porpoise have small dorsal fins, therefore the MMO shall take additional precautions if the sea state exceeds 2 (eg PAMs). An elevated platform for the MMO to monitor from would be beneficial when the sea state is 2 or above, the piling and dredging works could also be scheduled on a day where the sea is expected to be calm.

2. The MMO(s) should be situated in location that provides the best viewing platform and is likely to be closest to the piling and dredging activities. For example, an elevation area of the coast or a vessels bridge that allows 360 degree cover (depending upon the size of the mitigation zone more than one MMO viewing platform (and therefore more than one vessel) may be required to ensure that the entire mitigation zone can be observed).

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[4] Detection of marine mammals, particularly porpoises, decreases as sea state increases. According to the JNCC guidance ideally sea states of 2 or less are required for optimal visual detection.

3. The mitigation zone will be monitored visually by the MMO for an agreed period prior to the commencement of piling/ dredging. This will be a minimum of 30 minutes.

4. At least 30 minutes before any type of works, a visual watch and, if required, acoustic monitoring, known as the ‘pre-works search’, should be carried out in the mitigation zone. The pre-works search should continue until the MMO advises that the mitigation zone is clear of marine mammals, and the piling/dredging works can start.

5. The MMO will scan the waters using binoculars or a spotting scope and by making visual observations. Sightings of marine mammals will be appropriately recorded in terms of date, time, position, weather conditions, sea state, species, number, adult/juvenile, behavior, range etc. on the JNCC standard forms. Communication between the MMO and the contractor and the start/end times of the activities will also be recorded on the forms.

6. Vibratory piling or dredging should not be undertaken within 20 minutes of a marine mammal being detected within the mitigation zone.

7. If a marine mammal is observed, or acoustically detected, within the mitigation zone, it should be monitored and tracked until it moves out of range. The MMO should notify the relevant chain of command of the detection and advise that the operation should be delayed. If the marine mammal is not detected again within 20 minutes, it can be assumed that it has left the area and the works may commence.

8. If an animal has been detected acoustically, the PAM operative should use a range indication and their judgement to determine whether the marine mammal is within the mitigation zone.

9. If an MMO or PAM operative is uncertain whether marine mammals are present within the mitigation zone, they should advise that the activity should be delayed as a precaution until they are certain that no animals are present.

10. A soft-start will be employed, with the gradual ramping up of vibratory piling. The soft-start duration will be a period of not less than 20 minutes. This will allow for any marine mammals to move away from the noise source.

11. If a marine mammal enters the mitigation zone during the soft-start then, whenever possible, the works will cease until the marine mammal exits the mitigation zone and there is no further detection for 20 minutes.

1.3 Reporting

As per the JNCC guidance, reports detailing the vibration piling and dredging activity and marine mammal mitigation (the MMO reports) will be sent to Marine Scotland at the conclusion of vibratory piling/ dredging activity. Reports will include:

- Completed MMRFs;
- Date and location of the piling/ dredging activities;
- A record of all occasions when piling/ dredging occurred, including details of the duration of the pre-piling/pre-dredging search and soft-start procedures, and any occasions when piling/ dredging activity was delayed or stopped due to presence of marine mammals;
- Details of watches made for marine mammals, including details of any sightings, and details of the piling/ dredging activity during the watches;
- Details of any problems encountered during the piling/ dredging activities including instances of non-compliance with the agreed piling/ dredging protocols; and

- Any recommendations for amendment of the protocols.

1.4 Vessel Movement Mitigation Protocol

The Harbour Authority implement speed restrictions on vessels within Orkney waters, mitigation protocols should be implemented to avoid disturbance to and/or collision with marine mammals including:

- A strict speed limit for both onshore and marine traffic will be implemented to reduce risk of collision with marine mammals (4 knots within the water).
- Implementation of a vessel management plan including agreed routes and speed limits.
- Safe vessel operation to minimise risk of collision with marine mammals to be promoted to users. Training courses such as those provided by the WiSe scheme[5] could be offered at regular intervals.

Additionally (where possible) leaflets can be created to provide additional advice to quay users to avoid disturbance to and/or collision with marine mammals which should include, but is not limited to the following:

- Keep a safe distance from marine mammals. Never get closer than 100m (200m if another boat is present), but if within 100m, switch the engine to neutral;
- Never drive head on to, or move between, scatter or separate marine mammals. If unsure of their movements, simply stop and put the engine into neutral;
- Spend no longer than 15 minutes near the animals;
- Special care must be taken with mothers and young;
- Maintain a steady direction and a slow ‘no wake’ speed; and
- Avoid sudden changes in speed.

Wildlife code of conduct methods have been created by NatureScot and are available on their website.

1.5 Additional Good Practice Recommendations

If any dead marine mammals are anecdotally observed during construction or operation, it should be reported to the Scottish Marine Animal Stranding Scheme (SMASS) (www.strandings.org) and live marine mammal strandings will be reported to British Divers Marine Live Rescue (www.bdmlr.org.uk).

The MMO should keep a record of all marine mammal sightings, whether in the mitigation zone or not, to be issued to NatureScot. An understanding of the location of species is essential to appropriately assess the impacts of a proposed development and plan and target effective mitigation, therefore this data could be used to inform future projects. Biodiversity data are extremely important as, aside from use in planning and decision making, they are key to delivering state of environment reporting, education, modelling trends in species and habitat distribution, and research and policy making.

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[5] Information available at: https://www.wisescheme.org/ (accessed 02/06/2023)

2 MARINE MAMMAL LICENSING

European Protected Species (EPS) are animals and plants (species listed in Annex IV of the Habitats Directive) that are afforded protection under The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended) and the Conservation of Offshore Marine Habitats and Species Regulations 2017. All cetacean species (whales, dolphins and porpoise) are European Protected Species. If any activity is likely to cause disturbance or injury to a European Protected Species a licence is required to undertake the activity legally.

The licensing of Marine European Protected Species in Scotland is shared between several regulators depending on the purpose and location of the activity in question. For activities taking place within 12 nautical miles of the coast (the Scottish Territorial Sea), EPS are protected under the 1994 Regulations. For commercial activities, including geophysical or seismic surveys (including those related to oil and gas), port and harbour developments and the installation of renewable energy devices Marine Scotland (on behalf of the Scottish Ministers) is the licensing authority under the 1994 Regulations: Regulation 39 (1) (a). For activities relating to scientific research or conservation, Scottish Natural Heritage is the licensing authority.

A licence may be granted to undertake such activities if certain strict criteria are met:

- There is a licensable purpose.
- There are no satisfactory alternatives.
- The actions authorised will not be detrimental to the maintenance of the population of the species concerned at favourable conservation status[6] in their natural range.

The flowchart in Figure 2-1 below shows the decision-making process for licensing, taken from the Marine Scotland guidance[7].

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[6] The ultimate objective of the Habitats Directive is to ensure that the species covered reach what is called a ‘Favourable Conservation Status’ and that their long-term survival is deemed secure across their entire natural range within Europe. Article 1(i) of the Habitats Directive defines Favourable Conservation Status (FCS) of a species as follows:
“Conservation status of a species means the sum of the influences acting on the species concerned that may affect the long-term distribution and abundance of its populations within its natural range.
The conservation status will be taken as ‘favourable’ when:
- population dynamics data on the species concerned indicates that it is maintaining itself on a long-term basis as a viable component of its natural habitats; and
- the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future; and
- there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis.”

[7] Guidance for Scottish Inshore Waters: The Protection of Marine European Protected Species from injury and disturbance. Marine Scotland 2014.

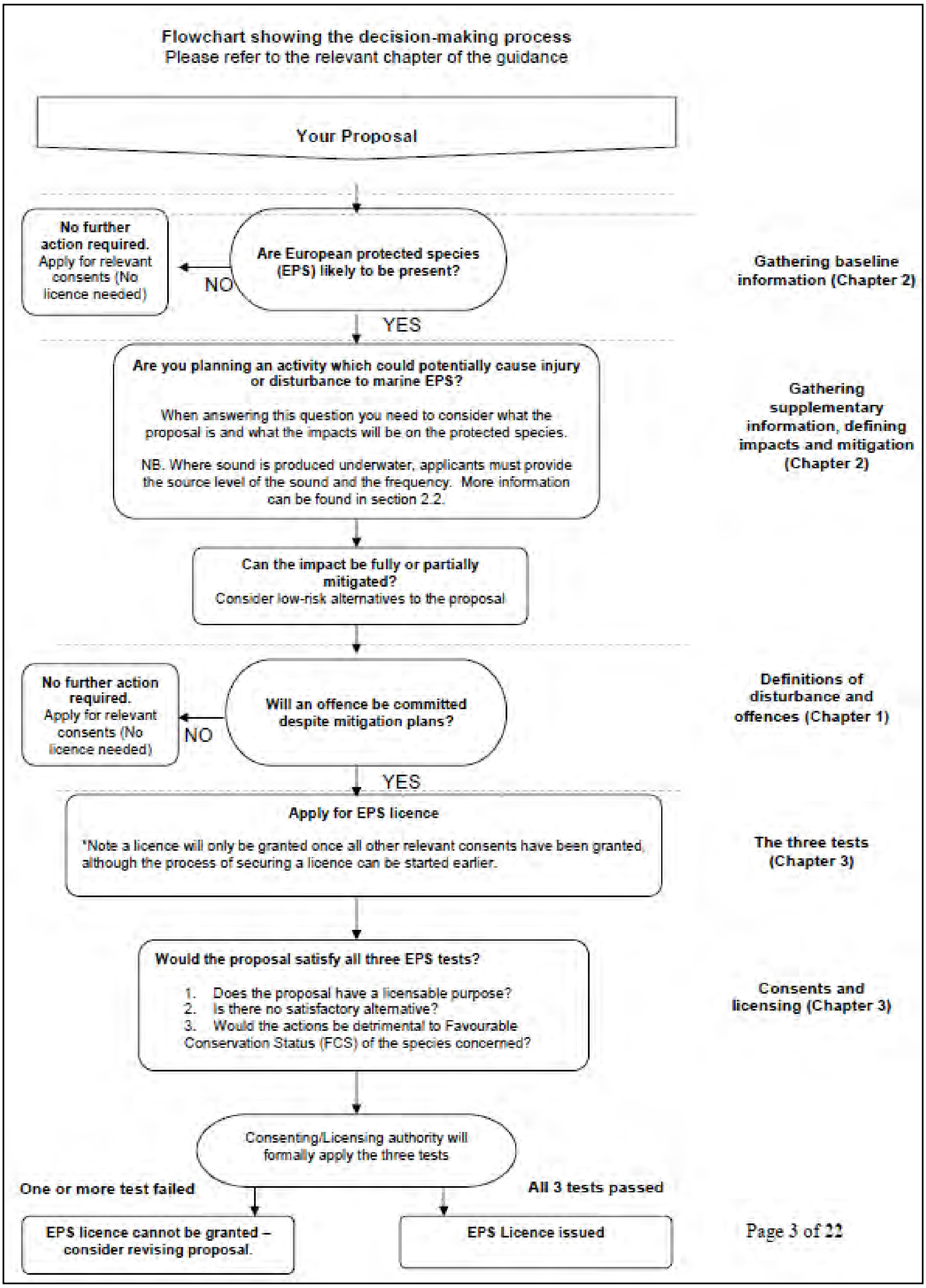

Figure 2-1: EPS Licencing Procedure

Vibration piling and dredging have the potential to produce underwater noise at levels which could cause injury and disturbance to cetaceans. If the mitigation in section 1 is employed effectively, it is predicted that there will be no risk of injury, however, the mitigation measures cannot fully protect against disturbance from vibration piling and dredging noise. The risk of disturbance is greater than that of injury, with TTS (disturbance) occurring over a much wider area than PTS (injury). **Therefore an EPS licence will be required for potential disturbance from vibration piling and dredging.**

APPENDICES

A PROPOSED SITE LOCATION AND LAYOUT

B DESIGNATED SITES

TECHNICAL APPENDIX 5.8

Scapa Deep Water Quay
Otter Survey

May 2023

CONTROL SHEET

Client:	Orkney Islands Harbour Authority
Project Title:	Scapa Deep Water Quay
Report Title:	Otter Survey
Document number:	13392
Project number:	674795

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Issue	Status	Author	Reviewer	Approver	Issue Date
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EnviroCentre Limited Office Locations:

Glasgow **Edinburgh** **Inverness** **Banchory**

Registered Office: Craighall Business Park 8 Eagle Street Glasgow G4 9XA
Tel 0141 341 5040 info@envirocentre.co.uk www.envirocentre.co.uk

EnviroCentre Limited is registered in Scotland under no. SC161777.

VAT no. GB 348 6770 57.

EXECUTIVE SUMMARY

EnviroCentre Limited was commissioned by Orkney Islands Harbour Authority to undertake a targeted otter survey associated with the Scapa Deep Water Quay (SDWQ) development in Orkney. The aim of the survey was to identify ecological constraints pertaining to otter which would require consideration pre, during and post development of the site.

[Redacted]

Camera traps installed (at an appropriate distance) near features A and C for two weeks (14th February - 1st/ 2nd March 2023), returned no footage of otter with high levels of rabbit activity at feature C. [Redacted]

[Redacted]

It is considered that a greater monitoring effort (monthly during a range of seasons) would likely capture otter use of these features more representatively. [Redacted]

[Redacted]

Although no resting sites have been confirmed at present, repeated camera trapping has potential to cause disturbance to otter in the locale and so a survey licence may be required. Depending on the outcome of the further survey works in spring, a licence for disturbance for further camera trapping in winter may be required. In addition, a development licence for destruction of otter resting places (A, B and C) may be required following survey outcomes.

The likely impacts to otter as a result of the proposed development include:

[Redacted]

- The development works could also impact resting, commuting and foraging otter via enhanced noise, lighting and human and vessel activity both during and post development.
- Death or injury to otter due to increased machinery, vehicle movement during and after proposed works.

Detailed mitigation will be defined following further survey works, with current mitigation including:

- Contractors should be made aware of the possibility of encountering otter at the site and in the locale prior to works commencing.
- A pre-works check of the site for otter should be completed prior to any further site works, by a suitably qualified ecologist.
- In the event that otter are discovered on site, all works in that area must stop and an ecologist contacted for advice.
- Works should be undertaken during daylight hours to avoid disturbance to crepuscular species (otter) in the locale.

Compensation measures should be implemented:

- Compensatory planting of scrub to ensure continued sheltering opportunities for otter as well as providing cover/screening for otter, from the development.

[Redacted]

Contents

Appendices

Tables

1 INTRODUCTION

1.1 Terms of Reference

EnviroCentre Limited was commissioned by Orkney Islands Harbour Authority to undertake a targeted otter survey associated with the Scapa Deep Water Quay (SDWQ) development in Orkney.

The site development plan is detailed in Appendix A.

1.2 Scope of Report

The aim of the survey was to identify ecological constraints pertaining to otter which would require consideration pre, during and post development of the site. The main objectives were as follows:

- Undertake a review of existing data pertaining to otter associated with the site;
- Search for and identify any evidence or field signs of otter in the survey area;
- Identify and assess any suitable habitat or features for otter in the survey area;
- Identify any potential impacts to otter;
- Make recommendations regarding any further survey and licensing for otter;
- Camera trapping of features with suitability for otter; and
- Outline appropriate mitigation and compensation actions.

1.3 Site Location and Description

The proposed site for SDWQ is located on the Orkney mainland coast and is situated circa 4km south from Scapa Pier and circa 8km south of Kirkwall. It is located on the coastline within Scapa Flow.

It is currently untouched coastline comprising a gravelly and in places exposed rock bordered on the landside by a rock face circa 3m in height. Improved grassland fields grazed by livestock (sheep and cows) dominate the landscape, with areas of coastal grassland, marshy grassland, heath, scrub and and semi-improved grassland also being present along the cliff top and near the A961 which binds the site to the east.

Three burns are associated with the site. The Burn of Button is an open watercourse, flowing through agricultural land, through the north east of the SDWQ site boundary and joins with the Burn of Deepdale which also flows through agricultural and heathland, before flowing into the Bay of Deepdale. The Burn of Gangsta also flows south of the site, approximately 340m. This watercourse flows through agricultural ground and discharges into Scapa Flow.

1.4 Legislation

Otter are a European Protected Species (EPS) listed in the EC Directive (92/43) The Conservation of Natural Habitats and of Wild Flora and Fauna (the “Habitats Directive”), which is transposed into Scottish law through the Conservation (Natural Habitats &c.) Regulations 1994 (the “Habitat Regulations”) as amended. Under this legislation it is an offence to deliberately or recklessly:

- Capture, injure or kill such an animal;
- Harass an animal or group of animals;

- Disturb an animal while it is occupying a structure or place used for shelter or protection;
- Disturb an animal while it is rearing or otherwise caring for its young;
- Obstruct access to a breeding site or resting place, or otherwise deny an animal use of a breeding site or resting place;
- Disturb an animal in a manner or in circumstances likely to significantly affect the local distribution or abundance of the species;
- Disturb an animal in a manner or in circumstances likely to impair its ability to survive, breed or reproduce, or rear or otherwise care for its young;
- Disturb an animal while it is migrating or hibernating; and
- Possess, control, transport, sell or exchange specimens of any animal listed on Annex IV of the Habitats Directive. This applies to living or dead specimens and to their derivatives.

It is an offence of strict liability to damage or destroy a breeding site or resting place of such an animal. These sites and places are protected even when the animal isn't present. For example, if an otter isn't present in a holt the feature is still protected by law.

A licence may be issued to permit the otherwise unlawful activities listed above if these three tests are satisfied:

- There must be a licensable purpose which includes 'preserving public health or public safety or other imperative reasons of overriding public interest including those of a social or economic nature and beneficial consequences of primary importance for the environment;'
- There is 'no satisfactory alternative'; and
- The derogation (i.e. any permission/licence granted) is 'not detrimental to the maintenance of the populations of the species concerned at a favourable conservation status in their natural range'.

1.5 Report Usage

The information and recommendations contained within this report have been prepared in the specific context stated above and should not be utilised in any other context without prior written permission from EnviroCentre Limited.

If this report is to be submitted for regulatory approval more than 12 months following the report date, it is recommended that it is referred to EnviroCentre Limited for review to ensure that any relevant changes in data, best practice, guidance or legislation in the intervening period are integrated into an updated version of the report.

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EnviroCentre Limited accepts no liability for use of the report for purposes other than those for which it was originally provided, or where EnviroCentre Limited has confirmed it is appropriate for the new context.

2 METHODS

2.1 Review of Previous Surveys

A review of existing survey data collected on 21st and 23rd July 2021 by Anne Bignall for the SDWQ site was undertaken[1].

2.2 Field Survey

The otter survey was conducted on the 14th February 2023 by EnviroCentre Ecologists Mhairi MacKintosh, who is a Full member of the Chartered Institute of Ecology and Environmental Management (FCIEEM), and Jennifer Paterson who is an Associate CIEEM member (ACIEEM). The survey included the minor burns north and south of the site and the coast, plus adjacent vegetated habitats where accessible. The survey was undertaken during low tide.

The weather conditions during the survey were dry, sunny and a light breeze and an air temperature of 8°C.

The otter survey followed best practice guidelines[2], and aimed to identify suitable otter habitat and field signs, including:

- Spraints (otter faeces/droppings used as territorial signposts. Often located in prominent positions and can be placed on deliberate piles of soil or sand). Three categories are used for describing otter spraint: Dried fragmented (Df); Dried intact (Di); and Not fully dry (Nd);
- Footprints;
- Feeding remains (can often be a useful indication of otter presence);
- Paths/slides (otter can often leave a distinctive path from and into the watercourse);
- Holts (underground shelter) are generally found:
    - Within trees roots at the edge of the bank of a river;
    - Within hollowed out trees;
    - In naturally formed holes in the river banks that can be easily extended;
    - Or preferably in ready-made holes created by other large mammals such as badger setts, rabbit burrows or outlet pipes; and
- Couches/lay-ups (couches or lay-ups are places for lying up above ground are usually located near a watercourse, between rocks or boulders, under dense vegetation).

In order to assess their importance, the status of otter resting sites was assigned from Low to High according to Table 2-1[3].

Table 2-1: Status of Otter Resting Sites

Resting Site Status	Definition
Low	Feature with limited evidence of otter activity – low number of spraints, not all age classes present. Insufficient seclusion to be a breeding site or key resting site, unlikely to have links to the key otter requirements. Most likely to provide a temporary 'stop off' for otters when moving through their territory. Loss/disturbance of such a feature is unlikely to be significant in terms of the individual or population.

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[1] Bignall, A. (2021). Deepdale_otter survey_2021_FINAL

[2] Chanin, P. (2003). *Monitoring the Otter Lutra Lutra. Conserving Natura 2000 Rivers, Monitoring Series (No. 10).* Peterborough: EN, CCW, EA, SEPA, SNH & SNIFFER.

[3] Bassett, S., & Wynn, J. (2010). *Otters in Scotland: How Vulnerable Are They to Disturbance?* CIEEM In Practice, (70), 19–22.

Resting Site Status	Definition
Moderate	Feature containing sprainting with a range of age classes, but not in significant quantities. Availability may be limited by season, tides or flow. Unlikely to be suitable as a breeding/natal site but will be a key resting site and may be linked to other important features within the territory. The impact arising from a loss or disturbance of such a feature will be determined by the availability of more suitable or well used sites within the otter's territory.
High	Feature has a high level of otter activity, including an abundance of sprainting of all age classes, large spraint mounds, well used grooming hollows, paths and slides. Affords a high degree of cover and is linked to key features such as fresh water and abundance of prey. May be suitable as a breeding area (spraints may be absent from natal holts). The site is usually available at all times of year and at high and low tide/flow. The loss/ disturbance of such as feature will often be considered significant in terms of the individual or population.

2.3 Camera Trap Monitoring

Camera traps were installed at two features which were identified as having moderate potential to be utilised as resting sites. The camera traps were deployed for two weeks, being installed on 14th February 2023 and collected on 1st and 2nd March 2023. Cameras were positioned so that they were not blocking access to, or would result in disturbance to, any otter who might utilise the features.

2.4 Disclaimer

Faunal species are transient and can move between favoured habitats regularly throughout and between years. This survey provides a snapshot of field signs present in the survey area in February 2023.

3 RESULTS AND ASSESMENT

3.1 Previous Survey Results

Previous survey identified the following in regards to otter on and adjacent to the site:

- A series of trails indicative of otter were present along the coasts, burns and within vegetation.
- Spraint on rocks, paths, rolling areas, a dyke and on the edge of watercourse banks.
- Features which could be used as lay-ups or rest sites for otter including; sea caves 200m north of the site, vegetated bank tops of Burn of Deepdale, Deepdale croft, rabbit burrows in drainage ditches and throughout the site.
- A cavity on the bank of the Burn of Button with no diagnostic evidence of otter.
- A sprainted trail leading to a gorse bush with high levels of rabbit activity (assessed as potential rest site and area for predating on rabbits).
- Foraging evidence via fish bones.
- Rolling/ grooming areas.

3.2 Field Survey Results

Please read in conjunction with Appendix B: Otter Survey Results Plan and Appendix C: Photographs.

[Redacted]

Scapa flow and the surrounding cliff and shore habitats provide foraging and commuting opportunities for otter in the locale. The Burn of Button, Burn of Deepdale and Burn of Gangsta all provide opportunities for commuting otter and some opportunities for resting via dense vegetation along Burn of Deepdale, rabbit burrows along Burn of Button and some vegetated areas along Burn of Gangsta.

The derelict Deepdale Croft, located within the site may also provide resting opportunities for otter due to the secluded and sheltered nature of the croft. However, no evidence of otter was identified at Deepdale Croft during the survey.

[Redacted]

[Redacted]

[Redacted]

3.3 Camera Trap Monitoring

[Redacted]

4 POTENTIAL IMPACTS AND LICENSING POTENTIAL IMPACTS

4.1 Potential Impacts

The likely impacts to otter as a result of the proposed development without mitigation include:

- Three potential rest sites are within the footprint of the SDWQ development and therefore would be removed to facilitate the development.
- The development works could also impact resting, commuting and foraging otter using nearby burns and coastline habitats via enhanced noise, lighting and human and vessel activity both during and post development.
- Death or injury to otter due to increased machinery, vehicle movement during and after proposed works.
- Pollution to the Burn of Button, Burn of Deepdale, Burn of Gangsta and Scapa Flow via increased silt loads and oil/fuel spills as a result of works and vessel movement, which may negatively impact the health of the otter directly and indirectly via pollution or disturbance to foraging resource (fish) within the locale.

4.2 Further Survey and Licensing

In order to confirm use of the potential rest features additional survey via camera trapping are recommended. A recent study identified that the optimal approach for otter camera trap surveys was found to be a minimum of 38 days in winter followed by 38 days in spring, resulting in a high (95%) chance of detecting rest site use[4]. Therefore, further camera trap monitoring should be undertaken during both seasons (spring and winter), for approximately 38 days each.

Although no resting sites have been confirmed at present, repeated camera trapping has potential to cause disturbance to otter which may be present and so a survey licence may be required.

Depending on the outcome of the further survey works in spring, a licence for disturbance for further camera trapping in winter may be required.

In addition, a development licence for destruction of an otter resting place may be required following survey outcomes.

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[4] Melanie A. Findlay, Robert A. Briers, Roger P. Ingledew, Patrick J. C. White (2022). An evidence-based approach to identifying resting sites of Eurasian otter Lutra lutra from camera-trap and field-sign data. Wildlife Biology, Vol 2023 Issue 1, https://doi.org/10.1002/wlb3.01036

5 MITIGATION AND COMPENSATION

More detailed mitigation will be defined following the results of further survey works.

5.1 Mitigation

- Contractors should be made aware of the possibility of encountering otter at the site and in the locale prior to works commencing.
- A pre-works check of the site for otter should be completed prior to any further site works, by a suitably qualified ecologist.
- In the event that otter are discovered on site, all works in that area must stop and an ecologist contacted for advice.
- Temporary lighting used during works, and any replacement lighting, should not illuminate surrounding buildings, Burn of Button, Burn of Deepdale, Burn of Gangsta and Scapa Flow which are likely utilised by otter for commuting and foraging routes.
- Works should be undertaken during daylight hours to avoid disturbance to crepuscular species (otter) in the locale.
- Vehicular access into and out of the site must be made slowly and cognisant of the possibility of striking an otter with a vehicle. A maximum speed limit of 15mph is suggested.
- Any trenches or pits made during construction must be covered when unattended or a shallow angled plank inserted to allow animals to escape, should they become trapped inside them.
- Measures should be in place to preserve water quality and prevent pollution of the river following SEPA Guidelines for Pollution Prevention (GPPs).

5.2 Compensation

[Redacted]

- Compensatory planting of scrub, such as gorse, along boundaries within the site and outside the site to ensure continued sheltering opportunities for otter as well as providing cover/screening for otter, from the development.

[Redacted]

APPENDICES

A PROPOSED DEVELOPMENT

Chart Datum (Scapa Flow)	Ordnance Datum (Newlyn)	Quay Heights and Tide Data Scapa Deep Water Quay
+7.00m	+5.31m	Quay Edge Level
+3.60m	+1.91m	Mean High Water Spring Tides
+1.69m	0.00m	Ordnance Datum (Newlyn)
+0.70m	-0.99m	Mean Low Water Spring Tides
0.00m	-1.69m	Chart Datum (Scapa Flow)
-5.00m	-6.69m	
-10.00m	-11.69m	
-15.00m	-16.69m	
-20.00m	-21.69m	

ORKNEY ISLANDS COUNCIL
SCAPA DEEP WATER QUAY
OVERALL PAN BOUNDARY

Scale 1: 2500

SCALE 1:2500 at A1

REV	DATE	REVISION	DRN	CHK
P5	08.11.2022	Preliminary Issue P5	PRN	
P4	07.11.2022	Preliminary Issue P4	PRN	
P3	04.11.2022	Preliminary Issue P3	PRN	
P2	03.11.2022	Preliminary Issue P2	PRN	
P1	28.10.2022	Preliminary Issue P1	PRN	

ORKNEY ISLANDS COUNCIL
Harbour Authority

Scapa Deep Water Quay Proposal

Overall PAN Boundary

Arch Henderson 1919
Civil Engineers
Structural Engineers
Architects
CDM Co-ordinators
Geotechnical services
Environmental services
Stewart Building, Lerwick, Shetland. ZE1 0LL.
Tel : 01595 695512
www.arch-henderson.co.uk - email : lerwick@arch-henderson.co.uk
Aberdeen; Dundee; Glasgow; Lerwick; Inverness; Thurso; Stromness; Southampton; Falkland Islands

DRAWN : PRN	DATE : October 2022	CHECKED : SSJ	APPROVED : APS
SCALE : (A1) As Shown		DRAWING STATUS : Preliminary	
DRAWING No : 212089-S-CB-01		REV : P5	

B OTTER SURVEY REULTS PLAN

[Redacted]

[Redacted]

SCAPA DEEP WATER QUAY EIAR

VOLUME 3

TECHNICAL APPENDIX 6

Technical Appendix 6.1	**Overview of Identified Onshore Environment Assets**

TECHNICAL APPENDIX 6.1

Appendix 6-1: Overview of Identified Onshore Historic Environment Assets

ORCA No.	Canmore ID	Site Name	Site Type	Period	Importance	Description
1	-	Deepdale	Farmstead	Post-Medieval?	Low	A farmstead is marked on the Ordnance Survey First Edition (1882), it survives as a multi-phase, enclosed complex of unroofed/ partly roofed traditional stone buildings arranged around central farmyard with additional buildings to the SE.
2	-	-	Mound	Uncertain	Uncertain	Sub-oval earthen mound (16m x 16m x 0.5m) with central depression, possible sheepfold but could also potentially be prehistoric
3	-	-	Dyke, sheep pens	Post-Medieval	Negligible	Remnants of a traditional drystane dyke with two adjoining small sub-rectangular, turf covered banks (3m x 2m x 0.5m)
4	-	-	Military installation	20th century	Medium	Turf-covered concrete chamber (8m x 8m x 2m), possible observation post
5	2342	The Five Hillocks, Rashieburn	Barrows/ Burnt Mound	Bronze Age	Medium	A group of eight earthen mounds of varying size with a slight bank of earth surrounding them, their appearance is partly consistent with a barrow cemetery but at least one is a burnt mound.
6	2375	Burn Of Gangsta	Burnt Mound	Bronze Age	Medium	A conspicuous mound in a boggy area, reportedly composed of black and and burnt stones
7	2385	Backakelday	Cists	Bronze Age	Uncertain	Two stone cists containing human remains and stone artefacts. Unclear if any remains survive
8	81727	Raf Netherbutton, Chain Home Radar Station	Anti Aircraft Defences, Military Camp, Radar Station	20th century	Medium	The most northerly of a chain of radar stations developed ahead of WWII, part of the defences of Scapa Flow. Consists of a Transmitter block, four base masts and at least two further concrete structures.
9	179645	Netherbutton	Farmstead	Post-Medieval	Medium	Later 19th century typical Orkney steading, largely complete and relatively unaltered. C listed building (LB46383).
10	314832	RAF Netherbutton	Military Housing	20th century	Medium	Warden’s house built for staff at Netherbutton Radio Station
11	269282	St Clair Farm	Military Camp	20th century	Medium	A group of eight huts visible on WWII RAF vertical air photographs but no longer extant
12	269283	Burn Of Button	Engine House	20th century	Medium	A brick and concrete building which was the main generator house for RAF Netherbutton Radar Station,
13	316861	Holm, Orkney, Rashieburn House And Steading	Farmstead	Post-Medieval	Uncertain	A farmstead with well is marked on the Ordnance Survey First Edition
14			Quarry	Post- Medieval	Negligible	A quarry is marked on the Ordnance Survey First Edition
15		Roadside	Farmstead	Post- Medieval	Uncertain	A farmstead is marked on the Ordnance Survey First Edition
16			Gravel pit	Post- Medieval	Negligible	A gravel pit is marked on the Ordnance Survey First Edition
17			Gravel pit	Post- Medieval	Negligible	A gravel pit is marked on the Ordnance Survey First Edition
18			Quarry	Post- Medieval	Negligible	A quarry is marked on the Ordnance Survey First Edition

19			Quarry	Post- Medieval	Negligible	A quarry is marked on the Ordnance Survey First Edition
20			Sheepright	Post- Medieval	Negligible	A sheepright is marked on the Ordnance Survey First Edition
21			Well	Post- Medieval	Negligible	A well is marked on the Ordnance Survey First Edition
22		Mid House	Farmstead	Post- Medieval	Uncertain	A farmstead is marked on the Ordnance Survey First Edition
23	269584	Backakelday, Royal Navy Degaussing Range Station	Naval	WW2	Medium	Site of Royal Navy degaussing range station. Accommodation for personnel was at West Bu farmsteading
24	182634	West Bu	Farmstead	Post-medieval	Uncertain	Farmstead
25	104559	Turnpike, Midhouse Battery	anti-aircraft battery	WW2	Low	Remains of the command and control block for Midhouse heavy anti-aircraft battery. Crew accommodation camp, gun emplacements, light anti-aircraft position and most of associated buildings no longer extant.
26	182635	Gutterpool	Farmstead	Post-Medieval	Uncertain	Courtyard farmstead.
27	269491	Turnpike, Midhouse Battery	Radar site	WW2	Low	Platform for mobile radar unit. Still present
28	292436	Turnpike, Midhouse Battery	Barrage Balloon	WW2	Negligible	Barrage balloon site, no longer extant.
29	296577	Turnpike, Midhouse Battery	Searchlight	WW2	Negligible	Location of searchlight emplacement, no longer extant.
30	179642,256355, 256356, 256357	Howa	Farmstead	19th-century	Medium	C-Listed farmstead (LB46381), including components of farmhouse, dwelling, byre, barn and kiln.

SCAPA DEEP WATER QUAY EIAR

VOLUME 3

TECHNICAL APPENDIX 9

Technical Appendix 9.1 Noise Impact Assessment

TECHNICAL APPENDIX 9.1

Scapa Deep Water Quay
Technical Appendix 9.1, Noise Impact Assessment

Note: The above image is indicative and provided for information purposes only

July 2023

CONTROL SHEET

Client: Orkney Island Council Harbour Authority
Project Title: Scapa Deep Water Quay
Report Title: Technical Appendix 9.1, Noise Impact Assessment
Document number: 13180
Project number: 674795

Issue Record

Issue	Status	Author	Reviewer	Approver	Issue Date
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EnviroCentre Limited Office Locations:

Glasgow **Edinburgh** **Inverness** **Banchory**

Registered Office: Craighall Business Park 8 Eagle Street Glasgow G4 9XA
Tel 0141 341 5040 info@envirocentre.co.uk www.envirocentre.co.uk

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VAT no. GB 348 6770 57.

EXECUTIVE SUMMARY

A construction and operational noise assessment has been carried out for the proposed Scapa Deep Water Quay (SDWQ)

Construction Noise

Worst case combined construction stages based on the proposed construction schedule have been modelled using CadnaA software. Details of construction activities have been provided by Arch Henderson.

The greatest weekday and weekend predicted noise levels are associated with construction Phases 1 & 2, in which activities including excavation, land reclamation and piling will be carried out.

There is the potential that dredging may be carried out over a 24 hour period, therefore evening and night-time noise levels have been predicted for this scenario.

The outcome of the assessment is that Neutral impacts are predicted during the day and night-time periods during all construction phases including dredging. There are no significant adverse impacts in EIA terms.

Operational Noise

The operational noise assessment considers the increase in potentially significant noise generating activities post development completion.

During the day and night-time periods noise levels are predicted to increase by up to 2.5dB at surrounding residential receptors as a result of the operational activities at SDWQ. The maximum significance of the changes in noise levels is Neutral / Slight, which is not significant in EIA terms.

Contents

Appendices

Tables

1 INTRODUCTION

1.1 Terms of Reference

EnviroCentre Ltd has been appointed by Orkney Island Council Harbour Authority (OICHA) to undertake a Noise Impact Assessment (NIA) of the proposed Scapa Deep Water Quay (SDWQ)(Refer to Drawing No 674795-GIS143, Appendix A).

This report presents the results of the noise assessment for the proposed development. The noise assessment considers the airborne construction and operational noise impacts at existing sensitive receptors surrounding the site. The effects of construction noise on marine life is considered as part of the Underwater Noise Assessment presented in Chapter 5, Biodiversity and Technical Appendix 5.6, Volume 3 of the EIAR.

1.2 Site Description

The SDWQ will be situated circa 4km south from Scapa Pier – before Holm and close to Deepdale. It is currently untouched coastline comprising a gravelly beach and in places exposed rock bordered on the landside by a rock face circa 3m in height. The land above the rock face comprises rough grazing which slopes upwards to the east and the A961. The Burn of Deepdale is to the north with a rocky promontory forming a natural barrier to the south.

There are a number of existing noise sensitive receptors in the surrounding area with full or partial line of sight to the development site. Gaitnip Farm is located circa 2km to the north, and there are several private residences along the A961 to the north of the Burn of Button circa 1.0 - 1.3km from the development site. The Netherbutton cottages are the closest receptors, located circa 500m east of the development site and comprising one private residence and one holiday let. There are additional private residences located to the south east at West Bu at circa 700m from the development site.

1.3 Proposed Development

The main purpose of this facility would be to undertake multiple industrial activities that require both deep-water berthing and large laydown area. It is envisaged that the main activity will be the construction / assembly and maintenance of offshore wind turbines.

This proposal comprises approx. 597m long main quayside berth with general -15m CD water depth, incorporating a 135m quayside pocket with -20m CD water depth. Further north tug (3No.) and pilot boat (2No.) berth approx. 180m long with depths between -6 and -9m CD. Laydown area directly behind quay face approx. 22.85 Hectares. The proposal will also include an access road leading from the A961 to the laydown area.

1.4 Potential Impacts

Noise from the proposed development has the potential to impact surrounding existing residential receptors during the construction and operational phases.

1.4.1 Construction Phase

Significant noise generating construction activities associated with the construction of the quayside and laydown area, including piling and dredging have the potential to impact existing residents in the surrounding area.

Noise generating activities during the construction phase are understood to include;

- Construction of new access road;
- Excavation of current landform and reclamation of shore to form laydown area;
- Formation of bunds around eastern, and parts of the north and southern perimeters of proposed laydown area using reclaimed materials;
- Dredging of area around proposed quay;
- Piling of structure for quay wall;
- Infilling of material to form reclaimed land;
- Delivery and tipping of materials, predominantly by sea; and
- HGV and plant movements in and around the site

1.4.2 Operational Phase

During the operational phase, new proposed noise generating activities have the potential to increase the day and night-time existing baseline noise levels at surrounding noise sensitive receptors.

Noise generating activities which could be carried out during the operational phase include:

- Deep-water ship berthing and mooring;
- Ship loading / unloading activities including operation of cranes;
- Movement of materials between ships and laydown area;
- Construction / assembly and maintenance of offshore wind turbines;
- Plant and HGV movements within quay and laydown area; and
- Loading / unloading of HGVs.

1.5 Report Usage

The information and recommendations contained within this report have been prepared in the specific context stated above and should not be utilised in any other context without prior written permission from EnviroCentre Limited.

If this report is to be submitted for regulatory approval more than 12 months following the report date, it is recommended that it is referred to EnviroCentre Limited for review to ensure that any relevant changes in data, best practice, guidance or legislation in the intervening period are integrated into an updated version of the report.

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2 NOISE POLICY AND GUIDANCE

This section outlines policy and guidance relevant to this NIA.

2.1 National Planning Framework 4

The purpose of the National Planning Framework 4[1] is to set out national planning policies which reflect Scottish Ministers priorities for the operation of the planning system and the development and use of land.

Noise is highlighted as a key aspect of a development which should be considered. Methods of attenuating noise levels are encouraged.

2.2 PAN 1/2011 Planning and Noise

Advice on the role of the planning system in helping to prevent and limit the adverse effects of noise is provided in Planning Advice Note (PAN) 1/2011 – Planning and Noise[2]. PAN 1/2011 promotes the principles of good acoustic design and a sensitive approach to the location of both noise sensitive and noise generating developments. PAN 1/2011 promotes the avoidance of significant adverse noise impacts from new development while supporting sustainable economic growth. The input of environmental health officers and professional acousticians from an early stage is recommended to avoid unreasonable effects on quality of life. PAN 1/2011 promotes the application of reasonable criteria to assess noise impact but does not suggest specific target levels, allowing for consideration of contextual and non-acoustic factors.

The associated *Technical Advice Note (TAN) 'Assessment of Noise'*[3] provides guidance on NIA methods. The recommended assessment method includes an initial identification of noise sensitive receptors and their sensitivity, a quantitative assessment, a qualitative assessment, a determination on the level of significance and recommendations for the decision process.

2.3 Assessment of Noise: Technical Advice Note

Assessment of Noise: Technical Advice Note[4] (TAN) is supplementary guidance to PAN 1/2011 published by the Scottish Government. TAN recommends a five stage process to the assessment of noise, as detailed below

Stage 1: Initial Process

The development is categorised according to whether it has the potential to generate noise *i.e.* a Noise Generating Development (NGD) or be affected by the existing noise *i.e.* a Noise Sensitive Development (NSD). All Noise Sensitive Receptors (NSRs) that have the potential to be impacted by the proposed development are identified and prioritised according to their level of sensitivity. Residential NSRs are noted to be of high sensitivity.

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[1] The Scottish Government (2023), *National Planning Framework 4.*
[2] The Scottish Government (2011), *PAN 1/2011 Planning and Noise*.
[3] The Scottish Government (2011), *TAN 1/2011 Technical Advice Note*.
[4] The Scottish Government (2011), *Assessment of Noise: Technical Advice Note.*

Stage 2: Quantitative Assessment

The quantitative assessment method depends on the type of development proposed *i.e.* Noise Sensitive Development (NSD) or Noise Generating Development (NGD). Typically the assessment will compare absolute levels (predicted or measured) with an agreed target. The magnitude of the impact is then defined by assessing the amount the predicted noise level exceeds the agreed assessment target criteria for either day or night time periods. The agreed target and magnitude of impact scales used in this assessment are presented in Section 3.

Stage 3: Qualitative Assessment

The qualitative assessment allows the magnitude of the impact established in Stage 2 to be adjusted accordingly to account for additional factors not addressed in the quantitative assessment.

Stage 4: Level of Significance

The level of significance of the noise impact at the NSR is obtained through the relationship of the receptor's sensitivity to noise and the magnitude of the noise impact. The prescribed level of significance is used to determine whether or not noise is a key decision making issue for the NSR in question.

Stage 5: The Decision Process.

Stages 2 to 4 are repeated for all identified NSRs and a Summary Table of Significance is completed which provides an overview of the level of significance of the noise impact on all NSRs. The recommendation from the environmental health officer to the planning officer should be informed by the distribution of levels of significance.

2.4 World Health Organization Guidelines for Community Noise

In *Guidelines for Community Noise*[5], 55 dB $L_{Aeq,16h}$ is indicated as a criterion threshold below which few people are seriously annoyed for an outdoor living area, during daytime and evening hours. A lower guideline value of 50 dB $L_{Aeq,16h}$ is provided as a criterion below which few people are annoyed. In addition, the guidance identifies that negative sleep impacts are avoided at 30 dB $L_{Aeq,8h}$ for continuous noise sources. It is stated that "for a good sleep, it is believed that indoor sound pressure levels should not exceed approximately 45 dB L_{Amax} more than 10 – 15 times per night".

It should be noted that these limits are typically understood to relate to the onset of adverse impact. This is clarified in TAN: *"The WHO guideline levels have been set at the threshold of detectable effects in the population. There is no evidence that anything other than a small minority of the population exposed at the WHO guideline noise levels finds them to be particularly onerous in the context of their daily lives."*

2.5 BS5228-1:2009+A1:2014; Code of Practice for Noise and Vibration Control on Construction and Open Sites.

Methods for calculating noise and vibration produced by construction and open sites are provided in BS5228-1:2009+A1:2014[6]. Annexes C and D of Part 1 provide generic source data for different types

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[5] World Health Organization (1999), *Guidelines for Community Noise*.

[6] British Standards Institution (2014), *BS 5228-1:2009+A1:2014 – Code of Practice for Noise and Vibration Control on Construction and Open Sites – Part 1: Noise.*

of noise source, as well as methods for calculating noise from stationary and mobile plant. Specific advice on noise from sources such as piling is provided.

2.6 BS 4142:2014+A1:2019, Methods for rating and assessing industrial and commercial sound

BS 4142:2014+A1:2019[7] provides methods for rating and assessing sound of an industrial and/or commercial nature, which includes:

a) Sound from industrial and manufacturing processes;
b) Sound from fixed installations which comprise mechanical and electrical plant and equipment;
c) Sound from loading and unloading of goods and materials at industrial and/or commercial premises; and
d) Sound from mobile plant and vehicles that is an intrinsic part of the overall sound emanating from premises or processes, such as that from forklift trucks, or that from train or ship movements in or around an industrial and/or commercial site.

The methods described use outdoor sound levels to assess the likely effects of sound on people who might be inside or outside a dwelling or premises used for residential purposes upon which sound is incident.

The measured specific sound source is corrected for acoustic features (if present) of intermittency, impulsivity and tonality to give the rated noise level. The assessment considers the impact of the specific sound by subtracting the measured background sound level from the rating level, and considering the following;

a) Typically, the greater this difference, the greater the magnitude of impact.
b) A difference of around +10dB or more is likely to be an indication of a significant adverse impact, depending on the context.
c) A difference of around +5dB(A) is likely to be an indication of an adverse impact, depending on the context.
d) The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact, or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context.

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[7] British Standards Institution (2019), *BS 4142:2014+A1:2019 – Methods for Rating and Assessing Industrial and Commercial Sound*.

3 CONSULTATION, METHODOLOGY AND TARGET CRITERIA

3.1 Consultation

A summary of the relevant responses to the Scoping Report submitted by EnviroCentre, and further email consultation with Orkney Island Council's (OIC) Environmental Health Department, is shown in Table 3-1.

Table 3-1: Summary of Consultation Responses

Organisation	Consultation Response	How and where addressed
Orkney Island Council (OIC)	With appropriate mitigation, including the provision of a Framework CEMP/ Dust Mitigation Strategy defined within the EIA, it should be possible to scope noise out during the construction phase of the proposed development for the reasons set out in the Scoping Report.	Assessment of construction and operational airborne noise have been included in the EIA report in order to address the responses from both OIC and Marine Scotland. Both assessments assume worst case scenarios.
	Operational noise should be scoped into the EIA	
Marine Scotland	The Scottish Ministers advise that airborne noise is scoped in for both construction and operation phases and a construction noise impact assessment must be included in the EIA Report. If construction methodologies have not been confirmed then the worst case scenario must be assessed.	

3.2 Methodology

The noise assessment was undertaken to establish the impact of construction and operational activities on noise sensitive receptors surrounding the Site. The assessment involved the following stages;

- Consultation with OIC Environmental Health Department to agree assessment methodology and noise criteria;
- Measurement of existing baseline noise environment at a sample of 2 areas representative of the most exposed noise sensitive receptors surrounding the proposed development; the monitoring locations are shown in Drawing No. 674795-GIS143 Appendix A;
- Review of construction activities, locations and noise data;
- Calculation and assessment of construction noise at the most exposed sensitive receptors, following guidance provided in BS5228-1:2009+A1:2-014; Code of Practice for Noise and Vibration on Construction and Open Sites. 3D computer noise modelling using CadnaA software has been used in the calculation of construction noise at sensitive receptors.
- Review of existing and proposed operational activities, locations and noise data;

- Prediction of operational noise using CadnaA software at location of most exposed sensitive receptors; and
- PAN 1/2011 assessment of operational noise, using principles defined in BS4142:2014.

3.3 Construction Noise Assessment Methodology and Target Criteria

3.3.1 BS5228-1:2009+A1: 2014 – Methodology (ABC Method)

The assessment of construction noise is carried out in accordance with guidance provided in BS 5228-1:2009+A1:2014[6] 'Code of Practice for Noise and Vibration Control on Construction and Open Sites – Part 1 Noise'. The standard describes methods for evaluating the potential significant effects of construction noise, one of which is the 'ABC' method which is based on exceedance of fixed noise limits. The ABC method, as detailed within Annex E.3.2 has been used within this noise assessment, as it considers the pre-existing industrial noise climate at the receptors.

The ABC method considers that a potential significant effect occurs when the total noise level at a dwelling, including construction activity, exceeds the appropriate category values shown in Table 3-2. The table is used as follows;

- The ambient noise is determined and rounded to the nearest 5dB;
- The rounded ambient noise level is then compared with the total noise level, including construction. A significant effect at a noise sensitive receptor is considered to occur when the total noise, including construction activity exceeds the appropriate category values, shown in Table 3-2.
- The ABC method of BS5228-1:2009+A1:2014 does not provide specific guidance on determining the magnitude and significance of noise impacts above the threshold values shown in Table 3-2. In order to determine the level of significance, guidance provided in the Technical Advice Note (TAN) 1/2011 has been used. The significance criteria adopted within this noise assessment are shown in Table 3-3.

Table 3-2: Threshold of Significant Effect at Dwellings

<table>
<tr><th rowspan="2">Period</th><th colspan="3">Threshold Value, in decibels (dB)</th></tr>
<tr><th>Category A</th><th>Category B</th><th>Category C</th></tr>
<tr><td>Night-time (23:00 to 07:00)</td><td>45</td><td>50</td><td>55</td></tr>
<tr><td>Evenings weekday (19:00-23:00), Saturdays (13:00-23:00) and Sundays (07:00-23:00)</td><td>55</td><td>60</td><td>65</td></tr>
<tr><td>Daytime weekday (07:00-19:00) and Saturdays (07:00-13:00)</td><td>65</td><td>70</td><td>75</td></tr>
<tr><td colspan="4">Note 1: A significant effect has been deemed to occur if the total L_{Aeq} noise level, including construction, exceeds the threshold level for the Category appropriate to the ambient noise level.
Note 2: If the ambient noise level exceeds the Category C threshold values given in the table (i.e. the ambient noise level is higher than the above values), then a potential significant effect is indicated if the total L_{Aeq}, T noise level for the period increases by more than 3 dB due to site noise.
Note 3: Applied to residential receptors only.</td></tr>
<tr><td colspan="4">Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are less than these values.
Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as category A values.
Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are higher than category A values.</td></tr>
</table>

Table 3-3: Significance Criteria for the Assessment of Construction Noise

Significance	Level Above Threshold Value dB(A)	Definition
Neutral	< 0	No effect, not significant, noise need not be considered as a determining factor in the decision making process.
Slight adverse	≤ 0 to < 3	These effects may be raised but are unlikely to be of importance in the decision making process.
Moderate adverse	≤ 3 to < 5	These effects, if adverse, while important, are not likely to be key decision making issues.
Large adverse	≤ 5.0 to < 10	The effects are likely to be important considerations but where mitigation may be effectively employed such that resultant adverse effects are likely to have a moderate or slight significance.
Very large adverse	≥ 10	These effects represent key factors in the decision making process. They are generally, but not exclusively, associated with impacts where mitigation is not practical or would be ineffective.

3.4 Operational Noise Assessment Target Criteria

Proposed activities from the operations within the site are assessed following guidance provided in PAN 1/2011 (as the associated document TAN 1/2011 ‘Technical Assessment of Noise’), using principles defined in BS4142:2014.

The noise criteria to be applied to operational industrial noise is summarised in Table 3-4. The table is used as follows;

- Calculate the difference between the rated operational noise level ($L_{Ar,T}$) and the background noise ($L_{A90,T}$) at each noise sensitive receptor, following principles defined in BS4142:2014. This difference in levels is used to define the Sensitivity of Receptor, as shown in Table 3-4.
- Calculate the total noise at each noise sensitive receptor, including operational activity ($L_{Aeq,T}$). The difference between the total noise including operational activity, and that before development at each sensitive receptor is used to define the Magnitude of Impact, as shown in Table 3-4.
- The Significance of Impact is then defined, as shown in Table 3-4.

Table 3-4: Significance of Effects; Operational Industrial Noise

Magnitude of Impact (After – Before) L_{AeqT} dB	Sensitivity of Receptor based on likelihood of complaint X = (Rating ($L_{Ar,Tr}$) – Background ($L_{A90,T}$)) dB		
	Low ($x < 5$)	**Medium ($5 \leq x < 10$)**	**High ($x \geq 10$)**
Major (≥ 5)	Slight / Moderate	Moderate / Large	Large / Very Large
Moderate (3 to 4.9)	Slight	Moderate	Moderate / Large
Minor (1 to 2.9)	Neutral / Slight	Slight	Slight / Moderate
Negligible (0.1 to 0.9)	Neutral / Slight	Neutral / Slight	Slight
No Change (0)	Neutral	Neutral	Neutral

4 BASELINE MONITORING

4.1 Introduction

A background noise survey was carried out in the area surrounding the proposed development site during day and night-time periods between 28th and 30th November 2022. The purpose of the survey was to establish day and night-time background noise levels at areas representative of the most exposed properties surrounding the development site. The noise monitoring locations and methodology were agreed with OIC Environmental Health Department through consultation.

Measurements were conducted using a Norsonic Nor140 (serial number 1403301) and a Norsonic Nor 118 (serial number 11831675), both calibrated using a Nor-1251 calibrator (serial number 312226), and a Norsonic Nor 145 (serial number 14529959) which was calibrated using a Nor-1255 calibrator (serial number 125526127) before and after measurements, with a maximum drift of 0.2 dB noted. Calibration certificates are available on request. Measurements were conducted 1.3 m above ground using a fast time weighting.

4.2 Noise Monitoring Locations

The noise monitoring locations are described in Table 4-1, and shown in Drawing No. 674795-GIS143, Appendix A.

Table 4-1: Noise Monitoring Locations

NML ID	Grid Reference	Location
01	345915 1004426	At the end of the farm track connected to the A961 which leads to Netherbutton Cottages with unobstructed views of Scapa Flow and the Bay of Deepdale.
02	345782 1005233	On the grass at Fernbank, adjacent to the A961. Chosen to be representative of the closest properties to the development located along the A961.

4.3 Meteorological Conditions and Observations

The weather conditions and observations noted during the monitoring period of 28/11/22 – 30/11/22 are summarised in Table 4-2 and Table 4-3.

Table 4-2: Baseline Noise Monitoring Weather Conditions

Date	Monitoring Period	Meteorological Conditions
28/11/22	Daytime – Afternoon	Mostly clear skies, 1 – 2 oktas. Generally negligible wind with some breezes from the west up to 2 or 3 m/s. Temperature 3 – 4°C.
28/11 to 29/11/22	Night-time	Clear skies, 0 – 1 oktas. Negligible wind. Temperature 1 – 2°C.
29/11/22	Daytime – Afternoon	Mostly clear skies, 1 – 2 oktas. Some light breezes from the south. Temperature 1 – 2°C.
29/11 to 30/11/22	Night-time	Clear skies, 0 – 1 oktas. Negligible wind. Temperature 0 – 2°C.

Table 4-3: Baseline Monitoring Observations

NML ID	Date	Period	Start Time	Observations
1	28/11/2022	Day	17:58	Background sound is a mix of offshore noise from barges and tankers visible in Scapa Flow as well as distant traffic, mostly from the south towards St. Mary's. Occasional passing traffic directly to the north east along the A961 is also clearly audible when present. Offshore noise includes some low frequency rumble and faint tonal components. Some bird calls and aircraft approaching Kirkwall Airport were also heard.
	29/11/2022		14:21	
	29/11/2022	Night	01:25	Background sound was predominantly from offshore noise in Scapa Flow during night time hours. As with daytime a mix of low frequency rumble and tonal components were heard. Road traffic noise from individual passing cars on A961 was clearly audible but there was no background traffic noise continuum as heard during the day.
	29/11/2022		23:45	
2	28/11/2022	Day	17:58	Road traffic passing on the A961 was dominant when present. During breaks in passing traffic, the noise environment was noted to be similar to that observed at Position 1 (Netherbutton). Some low frequency rumble and faint tonal components were heard from vessels in Scapa Flow. The contributions of distant traffic to the south were less prominent than at Position 1, causing shipping noise to stand out more. Some bird calls and aircraft approaching Kirkwall Airport were also heard.
	29/11/2022		14:21	
	29/11/2022	Night	00:41	As at Position 1 (Netherbutton), background sound is predominantly from offshore noise in Scapa Flow and made up of a mix of low frequency rumble and tonal components. Road traffic noise from individual passing cars on A961 was again dominant but very few cars were observed during night time hours. There was no background traffic noise continuum as heard during the day.
	29/11/2022		23:02	

4.4 Background Noise Data

A summary of the day and night-time results can be found in Table 4-4 and

Table 4-5.

Table 4-4: Daytime Background Sound Measured Results

NML ID	Date	Start time	Duration, T (hrs:mins)	$L_{Aeq,T}$ (dB)	$L_{A90,T}$ (dB)
1	28/11/2022	16:37	01:00	36.0	30.6
	29/11/2022	14:21	01:00	35.7	30.6
2	28/11/2022	17:58	01:00	59.8	35.1
	29/11/2022	17:01	01:00	62.6	36.1

Table 4-5: Night-time Background Sound Measured Results

NML ID	Date	Start time	Duration, T (hrs:mins)	$L_{Aeq,T}$ (dB)	$L_{A90,T}$ (dB)
1	29/11/2022	01:25	00:30	33.9	31.5
	29/11/2022	23:45	00:30	31.8	28.5
2	29/11/2022	00:41	00:30	48.3	28.9
	29/11/2022	23:02	00:30	49.9	31.9

5 CONSTRUCTION NOISE MODELLING AND ASSESSMENT

5.1 Noise Sensitive Receptors

A sample of four residential noise sensitive receptors have been identified following consultation with the EHO at OIC. They have been chosen as being representative of those most exposed to noise from construction and operational activities at the proposed development. These are described in Table 5-1, and shown in Drawing No. 674795-GIS144 Appendix A.

Table 5-1: Noise Sensitive Receptor Locations; Construction and Operational Noise

NSR ID	Location	Grid Reference
NSR 1	Gaitnip House and farm	344681 1006281
NSR 2	Midway, A961	345690 1005423
NSR 3	Netherbutton Cottages	345924 1004408
NSR 4	West Bu	346078 1003418

The background noise measured at Location 1 in Table 4-1 is considered representative of NSRs 1, 3 and 4. The background noise measured at Location 2 in Table 4-1 is considered representative of NSR 2. The noise measurement locations are shown in Drawing No.674795-GIS143, Appendix A.

Receptors have been modelled at 1.5m height at one-story properties, and 4m height at two-storeys.

5.2 Construction Noise Model Input Parameters

5.2.1 Construction Schedule

Details of the proposed construction schedule at the Site have been supplied by Arch Henderson. A summary of the proposed construction schedule is shown in Table 5-2.

Table 5-2: SDWQ, Proposed Construction Schedule

Phase	Description
Phase 1	Access road installed to main cut and fill site with graded hard core surface together with laying of all ducts and services to the site within road verge
	Excavation of current landform along with reclamation of shore to form laydown area bounded by overburden bunds on the north and eastern edges
	Creation of berthing by formation of a quay constructed of steel tubular piles with interlocking sheet piles with a further inner tied sheet pile anchor wall
	Dredging adjacent to the newly formed quay to provide -15m CD water depth
Phase 2	Excavation of current landform along with reclamation of shore to form an additional laydown area to the south of Phase 1 laydown area. The bund on the eastern edge will be extended along the length of the new laydown area and partially along the southern edge
	Extension of the Phase 1 quay area to the south

Phase	Description
	Dredging adjacent to the newly formed Phase 2 quay to provide -15 CD water depth
Phase 3	Dredging on the northern side of the newly formed quay extension to provide -20m CD water depth

The exemplar design is now well established for SDWQ and the anticipated timetable for works is expected to be:

- Main Works – Commencing September 2024 assuming planning and marine licences can be obtained.
- Phase 1 is anticipated to be completed by 2027; and
- Phase 2 is anticipated to commence September 2027 and completed in 2028.

Phase 3 dredging works are an aspiration to be completed at some point in the future.

5.2.2 Laydown Site

The primary intention behind the construction of the deep water quay site is to maximise and balance all excavated inert stone from the existing land to fill and form the reclaimed land and quay works, with all waste material not suitable for this purpose deposited and managed into material bunds on perimeter of the phased development site.

During Phase 1 material from excavation associated with access road construction will be temporarily stockpiled until the laydown areas are created.

For Phases 1 and 2, excavation would then progress using heavy tracked plant to excavate and rip material. For harder strata on land the excavation may require pre-treatment through drilling 100mm dia. holes and controlled delayed explosives (approximately 25kg per hole). Recovered material would be screened and suitable inert stone and glacial till (all free of organic and clay material) will be stockpiled. The stockpiled suitable material from these operations will then become the main inert material fill source for future reclamation and quay works. The unsuitable material would be used to form the northern and eastern perimeter bunds.

Other than the mobilisation of heavy vehicles and plant, the site is to be self-contained for Phases 1 and 2. Arch Henderson have indicated that as many 8 dump trucks, 10 excavators and 8 tracked drilling rigs may be required to service this. These have been assumed to be operational during each of the first two phases as required. Use of excavators and drilling equipment over 24 hours, including at weekends, has been confirmed.

5.2.3 Reclamation and Quay Works

The reclamation works would commence by forming the north perimeter reclamation bund leading from the access road to the rear of the quay works. Placement of secondary and primary rock armour will follow thereafter. Once this reclamation perimeter bund and armour slope is formed then this shall provide the main land route to access the quay works construction site.

Rock armour at the north of Phase 1 and the south of Phase 2 is to be predominantly imported by sea on barges, though some secondary rock armour may be won on site. For each phase, rock armour is expected to be placed by excavators mounted on barges which may be moored or tethered to tugboats. For a worst case scenario, each phase has assumed one vessel with two mounted excavators, two tug boats and additional dump truck movements and tipping on the shore.

The main quay berth face is proposed to be constructed of steel tubular piles with interlocking sheet piles forming a combi wall solution with a further inner tied sheet pile anchor wall. This combi quay wall will support a pre cast concrete cope and deck directly behind followed by a general hard core surfaced laydown reclamation area.

The tubular steel piles will be installed at specified locations using vibro hammering technique, which typically generates less noise than impact hammering techniques. Drilling will be undertaken using Bauer BG41 Drill rigs or similar, either from temporary piling platforms from the reclamation bund or a jack up barge with silt booms placed to seaward side. The sheet piles are also expected to be vibro hammered, with contingency for impact piling if vibro piling is ineffective. Tie rods are then installed and secured between front face and rear sheet pile wall and pre cast and in-situ concrete cope placed by crane.

As the quay works advance south the reclamation fill would advance behind. The concrete deck immediately behind the quay face will be placed with remaining reclamation and laydown area capped and compacted with graded hard core surface.

5.2.4 Terrestrial Rock Blasting

During creation of the laydown area, where hard rock strata is encountered pre-treatment involving drilling and controlled explosions will be necessary. The scope of BS5228-1:2009+A1:2014 does not cover the assessment of noise from rock blasting, however in relation to surface coal and mineral extraction sites, it states that good blasting practices will reduce the inherent and associated impulsive noise. Part 2 of the standard provides good practice guidelines in relation to controlling vibration emissions from surface coal and mineral extraction sites. The good practice guidance includes the following;

- Restriction of blasting as far as practicable to regular daytime periods, not on Sundays and away from public holidays;
- Good community relations; where relevant, informing nearby noise/vibration sensitive receptors ahead of periods of blasting;
- The choice of appropriate drilling rigs; and
- Designing blasts to maximize efficiency and reduce the transmission of noise/vibration.

Terrestrial rock blasting is therefore not included in this noise assessment.

5.2.5 Dredging

The assessment has assumed that a short dredging campaign will be carried out during each of the 2 construction phases as a worst case scenario to create the deepwater berths at the quayside. However, in reality there will only be one dredge campaign at the end of Phase 1. The assessment has assumed the dredging campaign will be carried out over a 24 hour period.

It has been assumed the dredging will be carried out using cutter suction to remove soft dredge and backhoe for ripping harder material. The dredge spoil will be removed into a split hopper barge for deposit within the reclamation behind the quay wall. Any unsuitable material would be transported to an offshore licensed dredge disposal site. Backhoe dredging generates higher airborne noise levels than the cutter suction method, therefore this NIA assumes use of the backhoe method as a worst-case scenario. Where cutter suction methods are employed the levels shall be less than those presented in this report.

5.2.6 Modelled Scenarios

The scenarios have been set up to model the worst-case combination of construction activities for the construction phases. The construction of the access road in Phase 1 has been considered as a separate modelling scenario as this work is required prior to mobilisation of plant for Phases 1 and 2, in addition to the proximity of the activities to NSRs 2 and 3.

As can be seen in Table 5-2, Phases 1 & 2 entail similar construction activities and there is anticipated to be overlap between these. In order to account for the worst case cumulative impact of concurrent activities, individual noise modelling scenarios have been set up for each of these phases assuming all proposed activities occurring simultaneously.

A summary of the combined construction activities and relevant assessment periods for each of the modelled scenarios is shown in Table 5-3. A full breakdown of the individual items of plant and activities for each set of construction activities and scenarios are shown in Appendix C. It should be noted that while the modelling has predicted all operations within a Phase/scenario to be concurrent, this is a conservative assumption, and some activities will in fact be contiguous.

Table 5-3: Modelled Scenarios; Construction Noise

Modelled Scenario	Modelled Combination of Construction Stages (Worst Case)	Relevant Assessment Periods
Access Road Construction	Excavation and drilling	Day, Evening, Night, Weekend
	HGV movement of material and tipping	
	Rolling/compaction	
Phase 1	Excavation and drilling, HGV movement of material and tipping	Day, Evening, Night, Weekend
	Rock armour revetment	
	Drainage, infill and compaction	
	Pile sea bed pre-treatment	
	Install sheet pile wall	
	Tie rod / anchor walls	
	Surfacing	
	Dredging	
Phase 2	Excavation and drilling, HGV movement of material and tipping	Day, Evening, Night, Weekend
	Rock armour revetment	
	Drainage, infill and compaction	
	Pile sea bed pre-treatment	
	Install sheet pile wall	
	Tie rod / anchor walls	
	Surfacing	
	Dredging	
Phase 3	Dredging	Day, Evening, Night, Weekend

5.2.7 Evening and Night-time Construction Noise

With reference to the assessment periods included in Table 5-3 only in the case of excavation and drilling of the existing landform, and dredging offshore are works scheduled to be carried out over a 24-hour period. All other activities are expected to have finished by 19:00 hours on a daily basis Monday to Saturday and by 14:00 hours on Sundays.

5.2.8 Weekend Construction Noise

The proposed construction schedule includes working during daytime hours during the week days and the weekends. The implication of this is that works associated with higher noise levels are likely to be continued during weekend hours (Saturday 07:00 – 19:00 and Sunday 08:00 – 14:00), which are subject to more stringent noise limits than during the weekdays (refer to Table 3-2).

5.2.9 Construction Noise Model Data

3D computer noise modelling of the various stages of construction activity at the site has been carried out using CadnaA software. Details on worst case construction activities, operating times, and associated items of noise generating plant for each stage of construction used within the noise models have been supplied by Arch Henderson.

Calculations were carried out using noise data and guidance provided in BS5228-1:2009+A1:2014, to derive predicted noise levels at noise sensitive receptors. Where data was not available within BS5228 it has been sourced from the Environmental Protection Department of Hong Kong's Technical Memorandum on Noise from Construction Work[8]. Noise data for backhoe dredging and impact wrenches was taken from published online sources[9],[10].

Full details of the items of modelled construction plant, noise data (including data source), operating times, durations and source heights for each of the considered scenarios is shown in Appendix C.

5.2.10 Construction Noise Model Assumptions

A number of assumptions have been established during the CadnaA modelling exercise, as detailed below:

- The ground model uses Lidar 1m resolution terrain height data for the existing site and the surrounding area;
- For completed sections of the laydown area and quayside the ground height has been set to 7m Above Chart Datum (ACD) per site sections provided by Arch Henderson;
- The heights of buildings have been estimated from photographs;
- Predicted noise levels are calculated in the free-field environment;
- Ground absorption has been set to 1 for areas of soft ground. Areas of hard ground and water have been set to 0 for reflective surfaces;
- Weekend daytime noise levels generated by construction activities have been assumed to be the same as those generated during weekday hours representing a worst case scenario;
- The noise model assumes locations of plant based on descriptions of construction activities provided by Arch Henderson;
- Worst case scenario combinations of construction activities likely to occur in any one day during the considered assessment periods have been assumed;

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[8] Environmental Protection Department of Hong Kong; *Technical Memorandum on Noise from Construction Work other than Percussive Piling,* 1989.

[9] Waterman. *Aberdeen Harbour Expansion Project, Environmental Statement, Volume 3, Appendix 20C.* Nov 2015.

[10] Markesino et al, *Study of Noise Transmission from an Electric Impact Wrench*, Noise-Con 2004, Baltimore

- Spud-leg barges on which piling equipment is intended to be located have been assumed to have a height of 1m above sea level. The height of equipment located on the barges (eg piling rigs) has been assumed as relative to the height of the barge.
- The following sources have been modelled as line sources within CadnaA;
    - Heavy goods vehicles (HGVs) and dump trucks;
    - Moving construction plant;
- All remaining sources (not outlined above) have been modelled within CadnaA as point sources.

5.2.11 ABC Category Thresholds

The appropriate ABC category thresholds above which there is considered to be a noise impact from construction noise have been calculated following guidance provided in BS5228-1:2009+A1:2014 (refer to Section 2.5). Details of the calculations are shown in Appendix B.

5.3 Construction Noise Model Results and Assessment

The noise model results for each modelled scenario of construction activity, along with the BS5228 assessment at each of the considered noise sensitive receptors are summarised in Table 5-4 to Table 5-7.

Table 5-4: Noise Model Results and BS5228 Assessment; Noise Sensitive Receptor No. 1

NSR 01	Weekday Daytime			Weekend Daytime			Evening			Night-time		
Scenario	Threshold Level dB(A)	Predicted Level dB(A)	Significance	Threshold Level dB(A)	Predicted Level dB(A)	Significance	Threshold Level dB(A)	Predicted Level dB(A)	Significance	Threshold Level dB(A)	Predicted Level dB(A)	Significance
ARC	65	36	Neutral	55	35	Neutral	55	35	Neutral	45	33	Neutral
1	65	36	Neutral	55	35	Neutral	55	34	Neutral	45	32	Neutral
2	65	36	Neutral	55	34	Neutral	55	34	Neutral	45	32	Neutral
3	65	36	Neutral	55	34	Neutral	55	34	Neutral	45	32	Neutral

Table 5-5: Noise Model Results and BS5228 Assessment; Noise Sensitive Receptor No. 2

NSR 02	Weekday Daytime			Weekend Daytime			Evening			Night-time		
Scenario	Threshold Level dB(A)	Predicted Level dB(A)	Significance	Threshold Level dB(A)	Predicted Level dB(A)	Significance	Threshold Level dB(A)	Predicted Level dB(A)	Significance	Threshold Level dB(A)	Predicted Level dB(A)	Significance
ARC	65	60	Neutral	60	57	Neutral	60	57	Neutral	55	49	Neutral
1	65	60	Neutral	60	57	Neutral	60	57	Neutral	55	49	Neutral
2	65	60	Neutral	60	57	Neutral	60	57	Neutral	55	49	Neutral
3	65	60	Neutral	60	57	Neutral	60	57	Neutral	55	48	Neutral

Table 5-6: Noise Model Results and BS5228 Assessment; Noise Sensitive Receptor No. 3

NSR 03	Weekday Daytime			Weekend Daytime			Evening			Night-time		
Scenario	Threshold Level dB(A)	Predicted Level dB(A)	Significance	Threshold Level dB(A)	Predicted Level dB(A)	Significance	Threshold Level dB(A)	Predicted Level dB(A)	Significance	Threshold Level dB(A)	Predicted Level dB(A)	Significance
ARC	65	36	Neutral	55	40	Neutral	55	38	Neutral	45	38	Neutral
1	65	44	Neutral	55	44	Neutral	55	42	Neutral	45	42	Neutral
2	65	42	Neutral	55	41	Neutral	55	39	Neutral	45	38	Neutral
3	65	40	Neutral	55	40	Neutral	55	39	Neutral	45	38	Neutral

Table 5-7: Noise Model Results and BS5228 Assessment; Noise Sensitive Receptor No. 4

NSR 04	Weekday Daytime			Weekend Daytime			Evening			Night-time		
Scenario	Threshold Level dB(A)	Predicted Level dB(A)	Significance	Threshold Level dB(A)	Predicted Level dB(A)	Significance	Threshold Level dB(A)	Predicted Level dB(A)	Significance	Threshold Level dB(A)	Predicted Level dB(A)	Significance
ARC	65	36	Neutral	55	36	Neutral	55	35	Neutral	45	34	Neutral
1	65	41	Neutral	55	40	Neutral	55	39	Neutral	45	38	Neutral
2	65	43	Neutral	55	43	Neutral	55	41	Neutral	45	40	Neutral
3	65	40	Neutral	55	40	Neutral	55	39	Neutral	45	39	Neutral

The greatest weekday and weekend noise levels are predicted during Phases 1 & 2 of construction. Evening and night-time levels relate to land drilling, and dredging activities only.

The outcome of the BS5228 assessment is that Neutral impacts are predicted at the surrounding residential receptors as a result of all construction phases during the day and night-time periods. There are no adverse effects predicted in EIA terms.

6 OPERATIONAL NOISE MODEL INPUT PARAMETERS

6.1 Proposed Operational Activities

During the operational stage, there is the potential for noise from ships berthing, loading / unloading activities, assembly of turbines and transfer of materials to / from to the laydown area to impact upon existing residents. In summary, the potentially significant noise generating operational activities as a result of the proposed quay and laydown area are anticipated to comprise of;

- Deep-water ship berthing (including on-board generators) and mooring;
- Movement, laydown, and storage of renewables components such as those for off shore wind farms. This is typically carried out using Self Propelled Modular Transporters (SMPTs);
- Movement of OIC tug and pilot boat vessels;
- Construction / assembly and maintenance of offshore wind turbines;
- Plant and HGV movements within quay and laydown area; and
- Loading / unloading of HGVs.

To account for the new berthing areas, two ship generators running over a 24 hour period have been modelled. As a worst case assumption a boat lift has been modelled as operating during both the day and night-time hours. This also applies to tug/pilot boat movements.

It is understood that it is proposed to use the laydown area predominantly for the assembly and storage of wind turbine components. These structures shall be loaded / unloaded directly from the ship using pairs of SPMTs. It is assumed that two pairs of SPMTs shall be driven onto the ship to load / unload each component, with approximately one movement within a daytime period.

For lifting operations, a 55T tracked mobile crane and a 400T wheeled telescopic crane has been modelled at each of the berths with additional heavy lifting provision from a 750T crane to service the laydown area.

Two additional 16 ton Fork Lift Trucks are likely to be present on the quay to service the vessels and move materials. Circa two additional HGV movements in and out of the quay and laydown area are likely to occur per 24 hour period. The noise model has assumed a worst case two movements per hour during the day and night-time period.

6.2 Operational Noise Model Input Parameters

6.2.1 Operational Noise Data

3D computer noise modelling of operational activity at the proposed development has been carried out using CadnaA software.

Calculations were carried out using plant manufacturer’s noise data, and published data in BS5228:2009+A1:2014, to derive predicted noise levels at noise sensitive receptors. Full details of the items of modelled operational plant, noise data (including data source), operating times, durations and source heights for the modelled operations are shown in Appendix D.

6.2.2 Operational Noise Model Assumptions

A number of assumptions have been established during the CadnaA modelling exercise, as detailed below.

- The ground model uses Lidar 1m resolution terrain height data for the surrounding area.
- The laydown area and quayside ground height has been set to 7m Above Chart Datum (ACD) per site sections provided by Arch Henderson;
- The heights of buildings have been estimated from photographs;
- Predicted noise levels are calculated in the free-field environment;
- Ground absorption has been set to 1 for areas of soft ground. Areas of hard ground and water have been set to 0.1 for reflective surfaces;
- Vehicle movements and mobile plant have been modelled as line sources within CadnaA;
- The ship generators and boat lift have been modelled as point sources.

6.3 BS4142:2014 Acoustic Feature Correction

CadnaA software has been used to model the specific sound level from operational activities at the location of the most exposed sensitive receptors. To calculate the rated sound level, the assessment considers the character of the sound being assessed at the receptor location. If present, corrections for impulsivity, intermittency and/or tonality are added to the specific sound level to calculate the rated sound level.

A sound source may exhibit acoustic characteristics at source, however, the prominence of these features may be masked at the location of the noise sensitive receptors by the residual (background) sound at these locations. The amount by which the residual sound masks these features varies as the residual sound changes in level and possible character. Similarly, the sources acoustic character may also vary with time.

In the case of ships loading / unloading, the movement of cargo and wind turbine components has the potential to create sound which is impulsive in nature. The modelled specific sound from these activities is predicted to be below, or close to the measured background noise at the most exposed sensitive receptors, which is an indication that the sound is predicted to be mostly inaudible. Despite this, due to the high transient peak levels that the movement of cargo and wind turbine components may create it is considered likely that some sound from these activities may be perceptible at the most exposed sensitive receptors. For this reason, a correction of 3dB(A), for impulsivity that is just perceptible, has been applied to the specific noise levels at NSR 1 (Gaitnip House and farm) and NSR 2 (Midway, A961) which are located over 1km from the laydown area. A correction of 6dB(A), for impulsivity that is clearly perceptible, has been applied to the specific noise levels at NSR 3 (Netherbutton Cottages) and NSR 4 (West Bu) as these receptors are located at distances of circa 500m and 700m from the laydown area with direct line of sight to the development.

The background noise measured at Location 1 in Table 4-1 is considered representative of NSR1 (Gaitnip House and farm), NSR3 (Netherbutton Cottages) and NSR4 (West Bu). The background noise measured at Location 2 in Table 4-1 is considered representative o fNSR2 (Midway, A961). The lowest measured background levels during daytime and night time have been used for assessment. The background noise monitoring locations and NSR locations are shown in Drawing Nos. 675795-GIS143 and GIS144 respectively.

6.4 Operational Noise Model Results and Assessment

The noise model results and TAN 2011 assessments for the day and night-time periods for operational activities are shown in Table 6-1 and Table 6-2.

Table 6-1: Noise Model Results and TAN 1/2011 Assessment; Daytime

Noise Sensitive Receptor ID	1	2	3	4
Modelled Specific Level $L_{S, (1\ hour)}$ dB	0.0	26.9	31.6	28.5
Acoustic Feature Correction dB(A)	3	3	6	6
Rated Noise $L_{Ar, (1\ hour)}$ dB	3.0	29.9	37.6	34.5
Background Noise $L_{A90, (1\ hour)}$ dB	30.6	35.1	30.6	30.6
Rated - Background Noise dB(A)	-27.6	-5.2	7.0	3.9
Sensitivity of Receptor	Low	Low	Medium	Low
Existing Level $L_{Aeq, (1\ hour)}$ dB	35.7	59.8	35.7	35.7
Specific Level + Existing Level $L_{Aeq, (1\ hour)}$ dB	35.7	59.8	37.1	36.5
Change in level	0.0	0.0	1.4	0.8
Magnitude of Impact (After – Before)	No Change	No Change	Minor	Negligible
Significance of Effects	Neutral	Neutral	Slight	Neutral / Slight

Table 6-2: Noise Model Results and TAN 1/2011 Assessment; Night-time

Noise Sensitive Receptor ID	1	2	3	4
Modelled Specific Level $L_{S, (1\ hour)}$ dB	0	24.1	27.4	25.2
Acoustic Feature Correction dB(A)	3	3	6	6
Rated Noise $L_{Ar, (1\ hour)}$ dB	3	27.1	33.4	31.2
Background Noise $L_{A90, (1\ hour)}$ dB	28.5	28.9	28.5	28.5
Rated - Background Noise dB(A)	-25.5	-1.8	4.9	2.7
Sensitivity of Receptor	Low	Low	Low	Low
Existing Level $L_{Aeq, (1\ hour)}$ dB	28.5	28.9	28.5	28.5

Noise Sensitive Receptor ID	**1**	**2**	**3**	**4**
Specific Level + Existing Level $L_{Aeq, (1\ hour)}$ dB	28.5	30.1	31.0	30.2
Change in level	0.0	1.2	2.5	1.7
Magnitude of Impact (After – Before)	No Change	Minor	Minor	Minor
Significance of Effects	Neutral	Neutral / Slight	Neutral / Slight	Neutral / Slight

The results show that the daytime noise from proposed operations is predicted to result in an increase in noise levels at sensitive receptors of between 0.8dB(A) at NSR 4 to 1.4dB(A) at NSR 3. No increase in noise levels is predicted at NSR 1 or NSR 2. The significance of the increases in noise levels is Neutral / Slight at NSR 4 and Slight at NSR 3.

At night the noise from proposed operations is predicted to result in an increase in noise levels at sensitive receptors NSR 2, 3 and 4 between 1.2dB(A) and 2.5dB(A). The significance of the increases in noise levels are Neutral / Slight. The noise levels are predicted to be unchanged at NSR 1.

In terms of human perception of sound, an increase of 3dB(A) is considered to be barely perceptible, therefore the maximum predicted increase of 2.5 dB(A) at night is considered likely to be mostly imperceptible.

There are no significant adverse impacts in EIA terms during the day or night time periods.

7 CONCLUSIONS

A construction and operational noise assessment has been carried out for the proposed Scapa Deep Water Quay.

7.1 Construction Noise

Worst case combined construction stages based on the proposed construction schedule have been modelled using CadnaA software. Details of construction activities have been provided by Arch Henderson.

The greatest weekday and weekend predicted noise levels are associated with construction Phases 1 & 2, in which activities including excavation, land reclamation and piling will be carried out.

There is the potential that dredging may be carried out over a 24 hour period, therefore evening and night-time noise levels have been predicted for this scenario.

The outcome of the assessment is that Neutral impacts are predicted during the day and night-time periods during all construction phases including dredging. There are no significant adverse impacts in EIA terms.

7.2 Operational Noise

The operational noise assessment considers the increase in potentially significant noise generating activities post development completion.

During the day and night-time periods noise levels are predicted to increase by up to 2.5dB at surrounding residential receptors as a result of the operational activities at SDWQ. The maximum significance of the changes in noise levels is Neutral / Slight, which is not significant in EIA terms.

NOISE DEFINITIONS

The following definitions relating to noise are used in this report:-

Ambient Sound Level: As defined in BS4142:2014; equivalent continuous A-weighted sound pressure level of the totally encompassing sound in a given situation at a given time, at the assessment location. The ambient sound level includes the contribution from the residual sound level and the specific sound level. Measured with $L_{Aeq,T}$.

Background Sound Level: The background sound level represents baseline conditions, filtering out intermittent noises, and can be thought of as a baseline over which a continuous noise would be heard. Defined in BS 4142 as the A-weighted sound pressure level that is exceeded by the residual sound at the assessment location for 90% of any given time interval, T, $L_{A90,T}$.

Free-field: Sound can propagate from a source to a receiver through a direct path as well as reflected paths. The free-field represents a scenario where there are no contributions from reflections. In environmental assessments this largely refers to the scenario where the contribution from reflections is negligible.

Façade Effect: When sound is reflected back towards its source, off a surface, such a wall, the reflected and incident sound waves sum. One metre from the façade of a building this typically results in an increase in level, compared to that of the free-field, by approximately 3 dB, referred to as the façade effect.

$L_{Aeq,T}$: Equivalent continuous A-weighted sound pressure level. This is the single number that represents the average sound energy over a given time period, T. It is the sound level of a notionally steady sound that has the same energy as a sound that fluctuates over the specified measurement period.

$L_{A10,T}$: The noise level exceeded for 10% of the measurement period, T.

$L_{A10,18h}$: The average noise level exceeded for 10% of the time in each of the eighteen one hour periods between 06:00 to 24:00 hours. This takes into account the fluctuation in traffic volumes over time to provide a single figure for assessment purposes and is typically used in road traffic assessments.

$L_{A90,T}$: The noise level exceeded for 90% of the measurement period.

L_{Amax}: The maximum A-weighted sound pressure level over the specified period.

Octave: A range of frequencies whose upper frequency limit is twice that of its lower frequency limit.

Octave Band: Sound pressure level is often measured in octave bands, the centre frequencies of the bands are defined by ISO – 31.5Hz, 63Hz, 125Hz, 250Hz, 500Hz, 1kHz, 2kHz, 4kHz, 8kHz, 16kHz to divide the audio spectrum into 10 equal parts. The sound pressure level of sound that has been passed through an octave band pass filter is termed the octave band sound pressure level. Additionally, sound is often represented by one-third octave bands, which divides each octave band into three.

Rating Level: The specific sound level with the addition of any character correction penalties.

Residual Sound Level: The continuous A-weighted sound pressure level at a given location in the absence of the specific sound level. This, unlike the background sound level, includes the contribution from fluctuating sounds.

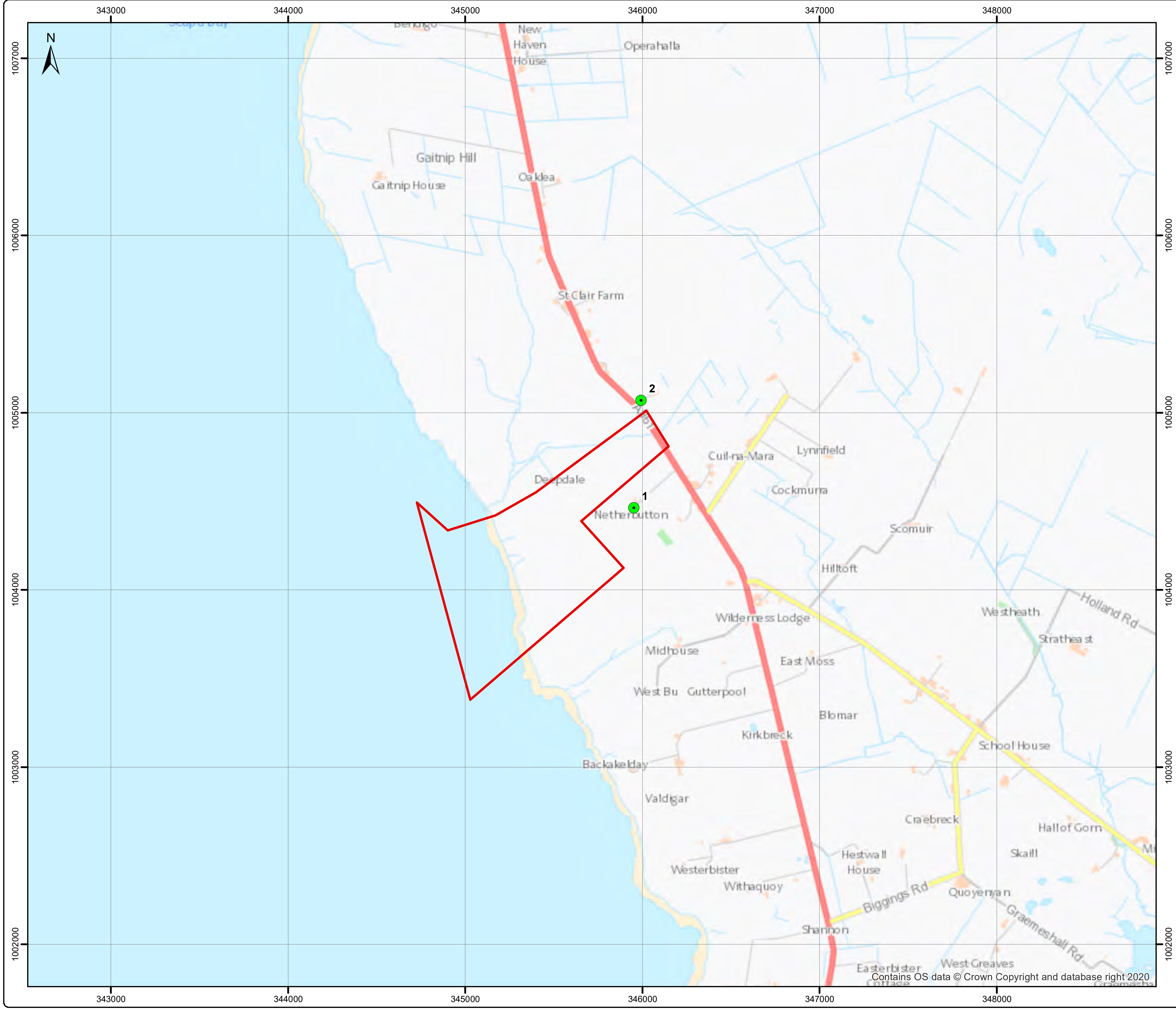
Specific Sound Level: The continuous A-weighted sound pressure level at a given location of the isolated industrial noise source.

Character Penalty: A penalty applied to a specific sound source to account for inherent character of a source as perceived at the position of the noise sensitive receptor. For example a tonal penalty can be derived subjectively (2 dB for a tone which is just perceptible at the receptor, 4 dB where it is clearly perceptible, and 6 dB where it is highly perceptible). The tonal penalty can be derived objectively through two procedures. The first is to assess the one-third octave band spectrum, where if certain criteria are met a 6 dB penalty is applicable. If a tone is not identified using the one-third octave band spectrum the penalty should be derived using the reference method, a more in depth narrow-band method based on a psychoacoustic model for tonal audibility.

Weighting: Human hearing is most sensitive to frequencies between about 500Hz and 6kHz and less sensitive to frequencies above and below these. In order to measure noise levels representative of human hearing a filter is applied termed a Frequency Weighting which is a prescribed frequency filter provided in a sound level meter. An A-weighted sound pressure level in decibels (denoted as dB(A)) is designed to reflect the sharpness of the human ear, which does not respond equally to all frequencies

APPENDICES

A DRAWINGS



Legend

- 🟥 Scapa Deep Water Quay Boundary
- ● Noise Monitoring Locations

Do not scale this map

Client
Orkney Island Council Harbour Authority

Project
Scapa Deep Water Quay

Title
Noise Monitoring Locations

Status
Final

Drawing No.	Revision	Date
674795-GIS143	-	27 April 2023
Drawn	**Checked**	**Approved**
AH	EC	EC

Scale
1:20,000 @A3

0 100 200 400 600 Metres

Rev	Date	Amendment	Initials
-	-	-	-

envirocentre

Craighall Business Park, Eagle Street, Glasgow, G4 9XA
T: 0141 341 5040 E: info@envirocentre.co.uk W: www.envirocentre.co.uk

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Legend

🟥 Scapa Deep Water Quay Boundary

● Noise Sensitive Receptors

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Client
Orkney Island Council Harbour Authority

Project
Scapa Deep Water Quay

Title
Noise Sensitive Receptors

Status
Final

Drawing No.	Revision	Date
674795-GIS144	-	27 April 2023
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envirocentre
Craighall Business Park, Eagle Street, Glasgow, G4 9XA
T: 0141 341 5040 E: info@envirocentre.co.uk W: www.envirocentre.co.uk

B ABC CATEGORY THRESHOLDS

The appropriate ABC category thresholds for each of the noise sensitive receptors has been calculated following guidance provided in Annex E of the standard (refer to Section 3.3.1 for assessment criteria).

Calculations for each of the noise sensitive receptors, based on measured day and night-time ambient noise levels in the absence of construction noise is shown in Table B-1 and Table B-2. Evening and Weekend ambient noise levels have been assumed to be Category A to ensure a conservative assessment.

Table B-1: ABC Category Thresholds, NSR 1, NSR 3 & NSR 4

NSR 01	Measured Daytime dB(A)	Measured Night-time dB(A)	Weekend dB(A)	Evening dB(A)
Ambient Levels	35.7	31.8	34.2	34.2
Ambient Levels Rounded	35	30	35	35
BS5228 ABC Category	**A**	**A**	**A**	**A**
Threshold Value	65	45	55	55

Table B-2: ABC Category Thresholds, NSR 2

NSR 02	Measured Daytime dB(A)	Measured Night-time dB(A)	Weekend dB(A)	Evening dB(A)
Ambient Levels	59.8	48.3	57.1	57.1
Ambient Levels Rounded	60	50	55	55
BS5228 ABC Category	**A**	**C**	**B**	**B**
Threshold Value	65	55	60	60

C CONSTRUCTION NOISE MODEL DATA

Construction Activities	Modelling Scenarios	Individual Plant / Activities	No. of Units	Lp at 10m dB(A)	Data Source	Source Height (m)	Operating Times	% On-time of Operating Hours	Operating Periods			
									D	W	E	N
Access Road Construction	ARC	Dump truck movements	2 p/h	90	BS5228 C.9 ref 21	0.5	07:00 – 19:00	80	X	X		
		Dump truck tipping fill	2 p/h	80	BS5228 C.1 ref 11	0.5		25	X	X		
		16T Twin Drum Rollers	2	73	BS 5228 C.2 ref 38	0.5		80	X	X		
		Tracked Hydraulic Drilling Rig	4	86	BS5228 C.6 ref 35	1	24 Hours	80	X	X	X	X
		40T Excavators	4	79	BS 5228 C.2 ref 14	1		80	X	X	X	X
HGV Deliveries	Phase 1 Phase 2	HGV delivery full	2 p/h	80	BS5228 C.6 Ref 21	0.5	07:00 – 19:00	7 p/h	X	X		
		HGV delivery empty	2 p/h	83	BS5228 C.6 Ref 22	0.5		7 p/h	X	X		
		Dump truck tipping fill	2 p/h	80	BS5228 C.1 Ref 11	0.5		7 p/h	X	X		
Drainage, Infill and Compaction	Phase 1 Phase 2	D6 Dozers - 18T	8	81	BS 5228 C.2 ref 12	1	07:00 – 19:00	80	X	X		
		Dump truck movements	8	90	BS5228 C.9 ref 21	0.5		80	X	X		
		Dump truck tipping fill	8	80	BS5228 C.1 ref 11	0.5		25	X	X		
		Tracked Hydraulic Drilling Rig	4	86	BS5228 C.6 Ref35	1	24 Hours	80	X	X	X	X
		40T Excavators	10	79	BS 5228 C.2 ref 14	1		80	X	X	X	X
		16T Twin Drum Rollers	2	73	BS 5228 C.2 ref 38	0.5	07:00 – 19:00	80	X	X		
		26T High Energy Impact Compaction Roller	1	80	BS5228 C.5 ref 19	0.5		80	X	X		
		9T Rapid Impact Compaction (compactor rammer)	1	91	BS5228 D.3 ref 121	0.5		80	X	X		
		Diesel water pump	1	91	BS5228 D.11 ref 1	0.5		80	X	X		
Surfacing	Phase 1 Phase 2	Asphalt spreader	1	82	BS5228 D.8 Ref 22	0.5	07:00 – 19:00	80	X	X		
		Batching Plant	1	78	BS5228 D.6 Ref 10	1		100	X	X		
		Truck mixer	1	81	BS5228 D.5 Ref 15	1		80	X	X		
		Lorry mounted Concrete pump	1	81	BS5228 D.5 Ref 16	1		80	X	X		
Rock Armour Revetment	Phase 1 Phase 2	40T Excavators on import vessel	2	79	BS 5228 C.2 ref 14	1	07:00 – 19:00	80	X	X		
		Jack up barge	1	76	CNP 061	1		100	X	X		
		Tug boat/Mooring vessels	2	82	CNP 221	1		80	X	X		
		Dump truck movements	1	90	BS5228 C.9 ref 21	0.5		80	X	X		
		Dump truck tipping	1	80	BS5228 C1 Ref. 11	1		25	X	X		
Install Sheet Pile Wall	Phase 1 Phase 2	100t crawler crane	2	67	BS5228 C.3 Ref 28	1	07:00 – 19:00	80	X	X		
		Large capacity vibrating hammer	3	88	BS5228 D.4 Ref 43	0.5		80	X	X		
		Vibrating hammer generator	3	74	BS5228 C.4 Ref 84	0.5		80	X	X		
Tie Rod, Anchor Walls	Phase 1 Phase 2	Impact wrenches	3	70	Markesino et al. Study of noise transmission from impact wrench.	1	07:00 – 19:00	80	X	X		

Construction Activities	**Modelling Scenarios**	**Individual Plant / Activities**	**No. of Units**	**Lp at 10m dB(A)**	**Data Source**	**Source Height (m)**	**Operating Times**	**% On-time of Operating Hours**	**Operating Periods**			
									D	**W**	**E**	**N**
		Hammer	3	79	BS5228 D.7 Ref 80	0.5		20	X	X		
Rotary Percussive Drilling (Sea bed Prep for Piling)	Phase 1 Phase 2 Phase 3	Small boat to transfer personnel between the barge and shore	1	82	CNP 221	1	07:00 – 19:00	5	X	X		
		Hopper barge	1	76	CNP 061	1		100	X	X		
		Tracked mobile drilling rig (23t / 110mm dia)	1	87	BS5228 C.9 Ref 3	0.5		80	X	X		
Dredging	Phase 1 Phase 2 Phase 3	Backhoe dredge	1	88	Aberdeen Harbour Expansion Project, Vol 3, Appendix 20C. Waterman, Nov 2015.	1	24 hours	100	X	X	X	X
		Vessel engine	1	72	Internoise 2010, Noise From Moored Ships, Rob Witte	0.1		100	X	X	X	X
		Hopper barge	1	76	CNP 061	1		100	X	X	X	X

D OPERATIONAL NOISE MODEL DATA

Description of Operations	Individual Plant / Activities	No. of Units	Lw	Data Source	Source Height (m)	Operating Periods	% On-time of Operating Hours	Mins per 16 Hour Daytime	Mins per 8 Hour Night-time	Assumptions
Proposed Scapa Deep Water Quay Operations	750t Liebher LR1750 Crane	1	111	EnviroCentre database	1.5	24 hours	50	480	240	Placed in laydown area to facilitate largest components and lifting operations
	400t Wheeled Mobile Telescopic Crane	2	106	BS5228, Table C4, Ref 38	2		50	480	240	Assume one per berth for loading/unloading ships
	Mobile crane	2	98	BS5228, Table C3, Ref 29	2		50	480	240	Assume one per berth for loading/unloading ships, in support of larger cranes and SPMTs
	OICHA Pilot boats/transfer vessels	2	100	Internoise 2010, Noise From Moored Ships, Rob Witte	1		25	240	120	Assume two pilot boats or transfer vessels may be required in a given day or night time period at north end of quay.
	Boat Lift (tracked crane)	1	99	BS5228 C4 Ref. 50	10		5	48	24	Assume may operate both day and night-time as worst case scenario.
	SPMT	2 pairs	111	EnviroCentre database	0.5		80	960	0	4 x SPMTs per renewables component typically move to yard and then back once in a 10 hour period, going at 2km/h. They go onto the ship to unload the components, then are jacked down in the yard. As worst case assume 1 movement per hour max and 2km/h.
	16 ton Fork Lift Trucks	2	107	EnviroCentre database	0.5		80	768	384	Assume 10 movements per hour during the day and night-time. 15km/h.
	HGV delivery or pick up	2 per hour max	108	BS5228, Table C6, Ref 21	0.5		2 per hour max	N/A	N/A	Assume 2 movements per hour during the day and night-time. 20km/h.
	Ship generator noise	2	100	EnviroCentre database	6		100	960	480	2 additional generators over existing operations.

SCAPA DEEP WATER QUAY EIAR

VOLUME 3

TECHNICAL APPENDIX 10

Technical Appendix 10.1	**Construction Dust Risk Assessment**
Technical Appendix 10.2	**Assessment of Instrument Flight Procedures**

TECHNICAL APPENDIX 10.1

Scapa Deep Water Quay

Technical Appendix 10.1 Construction Dust Risk Assessment

Change list

Ver	Date	Description of the change	Reviewed	Approved by
1.0	05/05/23	Draft	CR	DP
1.1	09/05/23	Response to Comments	CR	DP

Sweco UK Limited	2888385
Project Name	N/A
Project Number	N/A
Client	N/A
Date	
Document reference	

Table of contents

1 Introduction

The proposed Scapa Deep Water Quay (SDWQ) (referred to as the Proposed Development within this report) is located on the coast 6km south of Kirkwall. The Proposed Development comprises of the construction of a new harbour facility, an 18 hectares laydown area and an access road which will run from the A961 to the site. The facility will be used for industrial activities that require deep water berthing, and large laydown areas to support the activities.

A detailed review of the Proposed Development has been undertaken by Envirocentre to support the EIA Scoping Report and the potential change in air quality as a result of it. This considered the baseline air quality, the construction phase emissions and the operational phase emissions.

This Technical Appendix focuses on the assessment of dust during the construction phase. The findings of this assessment will inform the mitigation measures that are recommended to be implemented within a Construction Environmental Management Plan (CEMP) or Dust Mitigation Strategy (DMS).

2 Construction Dust Risk Assessment

Major construction sites can give rise to increasing long-term and short-term PM_{10} concentrations at off-site locations and may also cause dust nuisance unless appropriate mitigation measures are implemented. The impacts of dust therefore need to be addressed.

The assessment of dust during construction has been carried out using a qualitative risk-based appraisal with reference to the Site's location in relation to sensitive locations, the planned process and site characteristics, as described in follows *IAQM (2014) Guidance on the assessment of dust from demolition and construction guidance*[1].

2.1 Potential Sources

The key potential construction air quality emission sources are:

- Excavation/demolition activities;
- Earthworks;
- Construction vehicle movement: vehicles moving on and around the site emitting exhaust particulate and re-suspending loose material on the road;
- Material transfer: spillage from transferring material around the site, wind picking up dust from material stockpiles, particulate lifted from open container vehicles by the wind generated from the vehicle movement; and
- Passing vehicles: Material tracked out on the wheels of site traffic and re-suspended by passing traffic.

The construction dust assessment comprises a qualitative risk-based appraisal of potential sources of dust and the impacts at the sensitive locations close to the site. If required, a suite of recommended mitigation measures can be used to minimise the impact of dust during the construction phase of the development. This risk assessment is based on the IAQM guidance.

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[1] The Institute of Air Quality Management (IAQM), Guidance on the assessment of dust from demolition and construction, February 2014

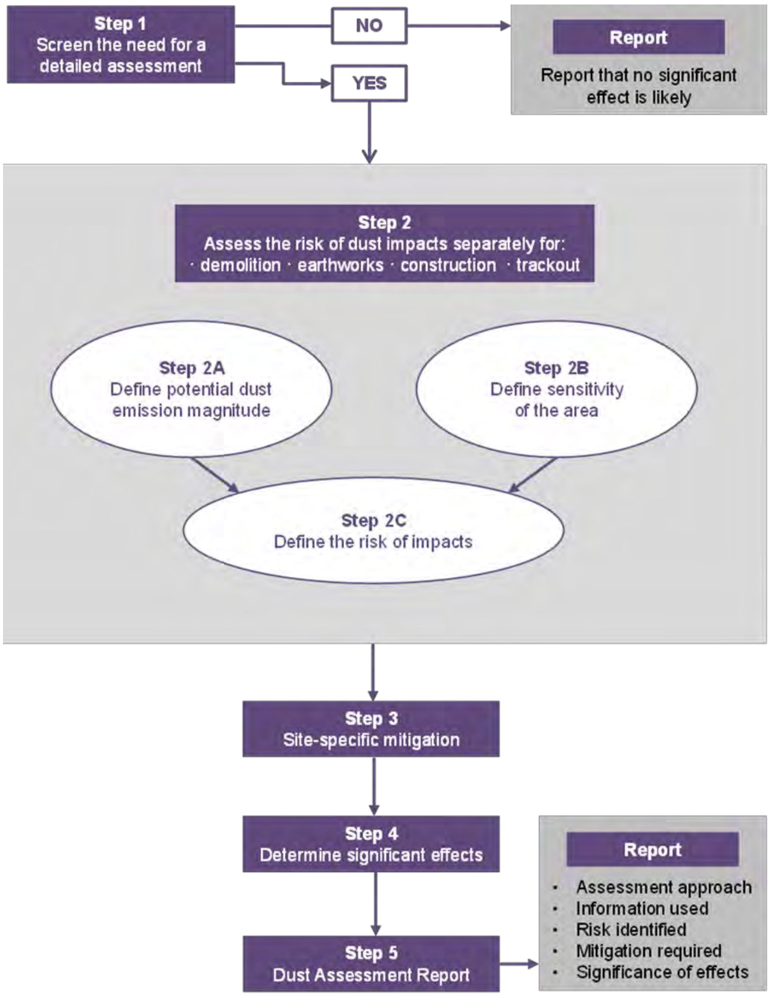
2.2 Environmental Risk

The methodology in the guidance provides an assessment on three separate dust effects, which are:

- Annoyance due to dust soiling;
- Harm to ecological receptors; and
- The risk of health effects due to a significant increase in exposure to PM_{10}.

The methodology for the assessment of the construction impacts is based on a five-step approach laid out in Figure 1**.**

Figure 1 Construction dust risk assessment method



2.2.1 Step 1 – Screen the need for a detailed assessment

Based on the IAQM guidance, the need for an assessment is based on simple distance-based criteria as follows:

"An assessment will normally be required where there are:

- *human receptors within 350 m of the site boundary and / or within 50 m of the access route(s) used by construction vehicles on the public highway, up to 500 m from the site entrance(s); and / or*
- *ecological receptors within 50 m of the site boundary and / or within 50 m of the access route(s) used by construction vehicles on the public highway, up to 500 m from the site entrance(s). "*

The construction phase dust risk assessment study area, defined with reference to the above IAQM guidance, has conservatively assumed that construction activities could occur anywhere within and up to the red line boundary for the Proposed Development site (see Figure 2).

The study area includes eight (8) human receptors within 350 m of the Proposed Development site boundary with the potential to be impacted by dust generated from earthworks and construction activities. The nearest receptors are Nether Button Cottage (residential dwelling) located approximately 100 m to the east of the site boundary and a residential dwelling located 100 m to the north of the site boundary where it encompasses the site access junction with the A691. With respect to trackout activities, there are six (6) residential dwellings within 20 m of the access route (A691) likely to be used by construction vehicles, up to 500 m from the site entrance.

Whilst Scapa Flow SPA adjacent to the Proposed Development, the appointed ecology consultant for the project has confirmed that the Scapa Flow SPA being a waterbody designated for non-breeding birds is not considered particularly sensitive to dust deposition. Given the construction dust control measures proposed, the SPA is unlikely to be significantly impacted upon by the Proposed Development with regards to construction dust emissions.

The locations of nearby receptors are presented in Figure 2.

Given that the above IAQM criteria has been met, the assessment was progressed to allow for identification of site-specific mitigation measures.

2.3 Potential Effects

In order to assess the risk of dust impacts this section considers Step 2A to 2C as outlined in **Figure 1**. These steps are followed for each of the four phases associated with the Construction Phase as described within the IAQM guidance, i.e., Demolition, Earthworks, Construction and Trackout.

2.3.1 Step 2A: Dust emissions magnitude

Demolition

The following are descriptors for the different dust emission classes for demolition.

- **Large**: Total building volume >50,000 m^3, potentially dusty construction material (e.g. concrete), on-site crushing and screening, demolition activities >20 m above ground level;
- **Medium**: Total building volume 20,000 m^3 – 50,000 m^3, potentially dusty construction material, demolition activities 10-20 m above ground level; and
- **Small**: Total building volume <20,000 m^3, construction material with low potential for dust release (e.g. metal cladding or timber), demolition activities <10m above ground, demolition during wetter months.

There are no existing structures on site, and therefore there are no demolition activities required. On this basis, the demolition activities have been screened out from further assessment.

Earthworks

The following are descriptors for the different dust emission classes for earthworks.

- **Large**: Total site area >10,000 m^2, potentially dusty soil type (e.g. clay, which will be prone to suspension when dry due to small particle size), >10 heavy earth moving vehicles active at any one time, formation of bunds >8m in height, total material moved >100,000 tonnes;
- **Medium**: Total site area 2,500 m^2 – 10,000 m^2, moderately dusty soil type (e.g. silt), 5-10 heavy earth moving vehicles active at any one time, formation of bunds 4 m - 8 m in height, total material moved 20,000 tonnes – 100,000 tonnes; and
- **Small**: Total site area <2,500 m^2, soil type with large grain size (e.g. sand), <5 heavy earth moving vehicles active at any one time, formation of bunds <4 m in height, total material moved <10,000 tonnes, earthworks during wetter months.

The construction phase and associated earthworks will be completed in three phases, with each phase focusing on a specific portion of the site and expected to take 10-14 months to complete.

The site area for each of the individual phases exceeds the 10,000m^2 area, meaning the dust emissions magnitude for earthworks has been classified as **Large**.

Construction

The following are descriptors for the different dust emission classes for construction.

- **Large**: Total building volume >100,000m^3, piling, on site concrete batching; sandblasting;
- **Medium**: Total building volume 25,000m^3 – 100,000 m^3, potentially dusty construction material (e.g. concrete), piling, on site concrete batching; and
- **Small**: Total building volume <25,000m^3, construction material with low potential for dust release (e.g. metal cladding or timber).

A review of all construction activities has been considered for potential dust emissions. It has been confirmed that there will be no concrete batching, however there will be piling.

Although it is likely that the total building volume will be between 25,000m^3 - 100,000m^3, a dust emission class of **Large** has been conservatively assigned given that piling activities will also be undertaken.

Trackout

Trackout is used to describe construction traffic accessing the Proposed Development and is the transport of dust and dirt from the site onto the public road network, where it may be deposited and re-suspended by other vehicles using the road network.

Only receptors within 50 m of the route(s) used by vehicles on the public highway up to 500 m from the site entrance(s) are considered to be at risk.

The following are descriptors for the different dust emission classes for Trackout.

- **Large**: >50 HDV (Heavy Duty Vehicle) (>3.5t) outward movements in any one day, potentially dusty surface material (e.g. high clay content), unpaved road length >100 m;
- **Medium**: 10-50 HDV (>3.5t) outward movements in any one day, moderately dusty surface material (e.g. high clay content), unpaved road length 50m – 100 m; and

- **Small/ Medium**: <10 HDV (>3.5t) outward movements in any one day, surface material with low potential for dust release, unpaved road length <50 m.

For the preliminary assessment it has been assumed that 10 HGVs will be access the site each day across the construction phase, as well as an estimated 45 LDVs for construction site staff. A paved road is proposed as part of the development, and it is likely this will be prioritised for ease of access to the site.

On this basis, the assessment for trackout is based on a dust emission magnitude of ***Medium.***

A summary of the dust emissions magnitude assessed under Step 2A is provided in Table 1.

Table 1: Dust emission magnitude

Activity	Dust emission magnitude
Demolition	N/A
Earthworks	Large
Construction	Large
Trackout	Medium

2.3.2 Step 2B Define the sensitivity of the area

The sensitivity of the area takes account of a number of factors:

- The specific sensitivities of receptors in the area;
- The proximity and number of those receptors;
- The local background PM_{10} concentrations; and
- Site-specific factors.

Human Receptors

For this assessment of sensitivities of people to dust soiling effects and health effects of PM_{10} the nearest receptors are residential properties that can reasonably expect an enjoyment of a high level of amenity and may be exposed for eight hours or more in a day.

Table 2 and Error! Reference source not found. set out the criteria to define the sensitivity of the area to dust soiling effects on people and property and the selection criteria for the sensitivity of the area to human health impacts, respectively.

Figure 2 presents the location of nearby sensitive receptors and distance buffers from the Proposed Development.

Figure 2 Identified sensitive receptors within defined distance buffers from the Proposed Development site boundary

Table 2 Sensitivity of the Dust Soiling Effects on People and Property

Receptor sensitivity	Number of receptors	Distance from the source (m)			
		<20	<50	<100	<350
High	>100	High	High	Medium	Low
	10 – 100	High	Medium	Low	Low
	1 – 10	Medium	Low	Low	Low
Medium	>1	Medium	Low	Low	Low
Low	>1	Low	Low	Low	Low

Table 3 Sensitivity of the Area to Human Health

Receptor sensitivity	Annual mean PM$_{10}$ conc.	Number of receptors	Distance from the source (m)				
			<20	<50	<100	<200	<350
High	>18 µg/m^3	>100	High	High	High	Medium	Low
		10 – 100	High	High	Medium	Low	Low
		1 – 10	High	Medium	Low	Low	Low
	16-18 µg/m^3	>100	High	High	Medium	Low	Low

Receptor sensitivity	Annual mean PM_{10} conc.	Number of receptors	Distance from the source (m)				
			<20	<50	<100	<200	<350
		10 – 100	High	Medium	Low	Low	Low
		1 – 10	High	Medium	Low	Low	Low
	14-16 µg/m^3	>100	High	Medium	Low	Low	Low
		10 – 100	High	Medium	Low	Low	Low
		1 – 10	Medium	Low	Low	Low	Low
	<14 µg/m^3	>100	Medium	Low	Low	Low	Low
		10 – 100	Low	Low	Low	Low	Low
		1 – 10	Low	Low	Low	Low	Low
Medium	N/A	>10	High	Medium	Low	Low	Low
		1 – 10	Medium	Low	Low	Low	Low
Low	N/A	>1	Low	Low	Low	Low	Low

There are eight (8) human receptors with 350 m of the site boundary with the potential to be impacted by dust generated from earthworks and construction activities. The nearest receptors are Nether Button Cottage (residential dwelling) located approximately 100 m to the east of the site boundary and a residential dwelling located within 100 m to the north where the site boundary crosses the A691. With respect to trackout, there are six (6) residential dwellings within 20 m of the access route likely to be used by construction vehicles. Therefore, the study area is classified as having **low sensitivity** with respect to dust soiling from earthworks and construction activities, and **medium sensitivity** with respect to dust soiling from trackout.

Defra provide estimated background concentrations[2] of key pollutants across the UK at a 1km resolution. The 1km grid-square the site is within (345500, 1004500) has an annual mean background PM_{10} of 4.7ug/m^3 for the current year (2023).

Therefore, taking account the nearby human receptors and their proximity to the Proposed Development and the low background PM_{10} concentrations, the site is classified as **low sensitivity** for human health with respect to potential impacts associated with changes in PM_{10} concentrations from construction related activities.

The sensitivity of the area to dust soiling and human health impacts for each activity is summarised in Table 4.

Table 4 Sensitivity of Area

Potential Impact	Sensitivity of the Surrounding area			
	Demolition	Earthworks	Construction	Trackout
Dust soiling	N/A	Low	Low	Medium
Human health	N/A	Low	Low	Low

2.3.3 *Step 2C: Define the Risk of Impacts*

The outcomes of the above (Steps 2A and 2B) have been combined to determine the risk of impacts with no mitigation applied, as summarised in Table 5. There is a **low risk of dust soiling and human health impacts**. These risk classifications have been used to determine the appropriate level of mitigation to be applied.

---

[2] https://www.scottishairquality.scot/data/mapping/data

Table 5 Summary of Risk of Dust Impacts

Potential Impact	Risk			
	Demolition	Earthworks	Construction	Trackout
Dust soiling	N/A	Low Risk	Low Risk	Low Risk
Human health	N/A	Low Risk	Low Risk	Low Risk

2.3.4 Step 3: Site Specific Mitigation

The qualitative dust risk assessment has been used to inform the appropriate construction dust mitigation measures required to prevent significant effects, all of which will feed into the draft CEMP or similar.

A comprehensive list of mitigation measures is provided below, based on Section 8.2 of the IAQM guidance. The measures are commensurate to the nature and location of the Proposed Development and the identified **low risk** of dust impacts.

Communications

- Display the name and contact details of person(s) accountable for air quality and dust issues on the site boundary. This may be the environment manager/engineer or the site manager.
- Display the head or regional office contact information.
- Develop and implement a Dust Management Plan (DMP), which may include measures to control other emissions, approved by the Local Authority. The DMP should include, as a minimum, the measures outlined in this section.

Site Management

- Record any exceptional incidents that cause dust and/or air emissions, either on- or offsite, and the action taken to resolve the situation in the log book.
- Record all dust and air quality complaints, identify cause(s), take appropriate measures to reduce emissions in a timely manner, and record the measures taken.
- Make the complaints log available to the local authority when asked.

Monitoring

- Carry out regular site inspections to monitor compliance with the DMP, record inspection results, and make an inspection log available to the local authority when asked.
- Increase the frequency of site inspections by the person accountable for air quality and dust issues on site when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions.

Site Maintenance

- Plan site layout so that machinery and dust causing activities are located away from receptors, as far as is possible.
- Erect solid screens or barriers around dusty activities or the site boundary that are at least as high as any stockpiles on site.
- Avoid site runoff of water or mud.

Operations and Waste Management

- Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction, e.g. suitable local exhaust ventilation systems.
- Ensure an adequate water supply on the site for effective dust/particulate matter suppression/mitigation, using non-potable water where possible and appropriate.
- Use enclosed chutes and conveyors and covered skips.
- Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate.

Vehicle operation and Sustainable Travel

- Ensure all vehicles switch off engines when stationary - no idling vehicles.
- Avoid the use of diesel or petrol powered generators and use mains electricity or battery powered equipment where practicable.

With the implementation of the above measures via a CEMP or similar, the residual effect of construction phase dust emissions on local air quality will be negligible and **not significant**.

3 Summary

A construction dust risk assessment has been completed which has identified the site as a **Low Risk** before mitigation is applied.

Provided that all mitigation measures outlined in this document are put in place and managed through a CEMP or similar, this should prevent any significant air quality effects arising from the construction phase of the Proposed Development.

TECHNICAL APPENDIX 10.2

Scapa Deep Water Quay – HIAL Kirkwall

Assessment of Instrument Flight Procedures

Date: 18th May 2023
Author: Liam Clarke (APD)
Revision: Issue 1.1
Osprey Ref: 71852-001

Cale House, Station Road Wincanton, Somerset BA9 9FE0
1420 520200 / enquiries@ospreycsl.co.uk
Registered in England and Wales under No: 06034579

Document Details

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Issue	Amendment	Date
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Version 1.1	OLS Results	18th May 2023

Approval Level	Authority	Name
Author	Osprey CSL	Liam Clarke (APD)
Technical Reviewer	Osprey CSL	Chris Latus (IAPD)
Release Reviewer	Osprey CSL	Mark Wakeman

Executive Summary

Osprey CSL has been commissioned by Orkney Island Council to examine the potential impact the proposed development named Scapa Deep Water Quay may have on the published Instrument Flight Procedures (IFPs) at Kirkwall Airport.

Impact on the IFPs

- The proposed development will require mitigation to ensure no impact on the RNP 27 Procedure.
- The Development would impact on the Visual Circling.
- The proposed development would impact the published MSA's.
- In this report the protection areas for the NDB and VOR Missed Approaches were drawn with the standard PANS OPS splays of 10.3° for the NDB and 7.8° for the VOR. This assumes aircraft are using track guidance from the navigational aids specified for the approach. If this isn't the case, then a 15° splay would be used for instances where no reference to a navigation aid is available. This would bring some obstacles into the protection area and should be investigated with the Airport at a suitable time and appropriate mitigation determined such as specifying a radial from the navigational aids on the chart if required.

Obstacle Limitation Surfaces (OLS)

The OLS were checked and there are penetrations to the Conical Surface and Outer Horizontal Surface. This report examines the impact on the published IFPs however a summary of the OLS penetrations is provided:

Note: The OLS was constructed assuming a Code 4 Precision Approach (CATI) Runway.

Surface	ID	Elevation	Penetration in metres
Conical	Quay 1	331	265.2
Conical	Quay 3	331	247.4
Conical	Quay 2	331	239.4
Conical	Quay 4	331	221.7
Outer Horizontal	Anchorage 4	306	144.1
Outer Horizontal	Anchorage 5	306	144.1
Outer Horizontal	Anchorage 10	306	144.1
Outer Horizontal	STS 3	306	144.1
Outer Horizontal	STS 4	306	144.1
Outer Horizontal	Anchorage 6	306	144.1
Outer Horizontal	Anchorage 5	306	144.1
Outer Horizontal	Anchorage 11	306	144.1

Table of Contents

Table of Figures

1 Introduction

1.1 Background

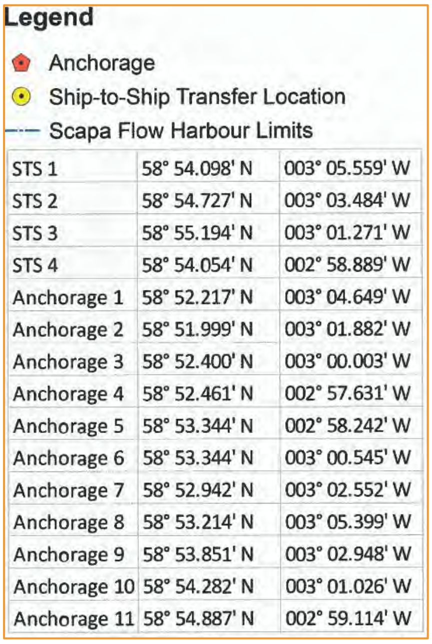
Osprey CSL has been commissioned by Orkney Island Council to examine the potential impact the proposed development named Scapa Deep Water Quay may have on the published Instrument Flight Procedures (IFPs) at Kirkwall Airport.

1.2 Scope of the Assessment

This report assesses the proposed development in relation to Instrument Flight Procedures (IFPs) as published in the State AIP and has been completed without the use of an Aerodrome survey. Relevant NavAid and Runway data was taken from the NATS eAIS package AIRAC 02/2023 effective 23 FEB 2023.

1.3 Data Provided by Client

Several site drawings were supplied by Arch Henderson LLP along with e-mails giving specific data on the anchorages, ship to ship transfer locations (STS) and quay location. The positions of the anchorages and STS are shown in Figure 1 below:



Legend

⬟ Anchorage
⊙ Ship-to-Ship Transfer Location
—·— Scapa Flow Harbour Limits

STS 1	58° 54.098' N	003° 05.559' W
STS 2	58° 54.727' N	003° 03.484' W
STS 3	58° 55.194' N	003° 01.271' W
STS 4	58° 54.054' N	002° 58.889' W
Anchorage 1	58° 52.217' N	003° 04.649' W
Anchorage 2	58° 51.999' N	003° 01.882' W
Anchorage 3	58° 52.400' N	003° 00.003' W
Anchorage 4	58° 52.461' N	002° 57.631' W
Anchorage 5	58° 53.344' N	002° 58.242' W
Anchorage 6	58° 53.344' N	003° 00.545' W
Anchorage 7	58° 52.942' N	003° 02.552' W
Anchorage 8	58° 53.214' N	003° 05.399' W
Anchorage 9	58° 53.851' N	003° 02.948' W
Anchorage 10	58° 54.282' N	003° 01.026' W
Anchorage 11	58° 54.887' N	002° 59.114' W

Figure 1 – Location Details provided by Arch Henderson LLP © Metoc Ltd 2015

Additionally, the site of the proposed quay is shown in Figure 2 below:

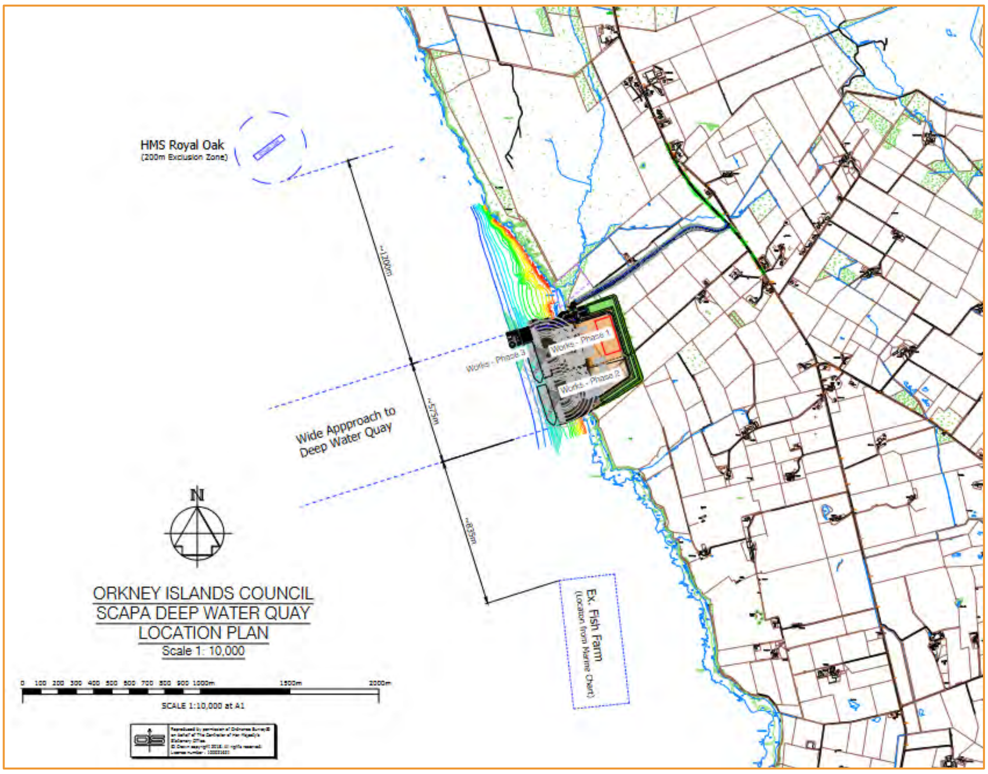
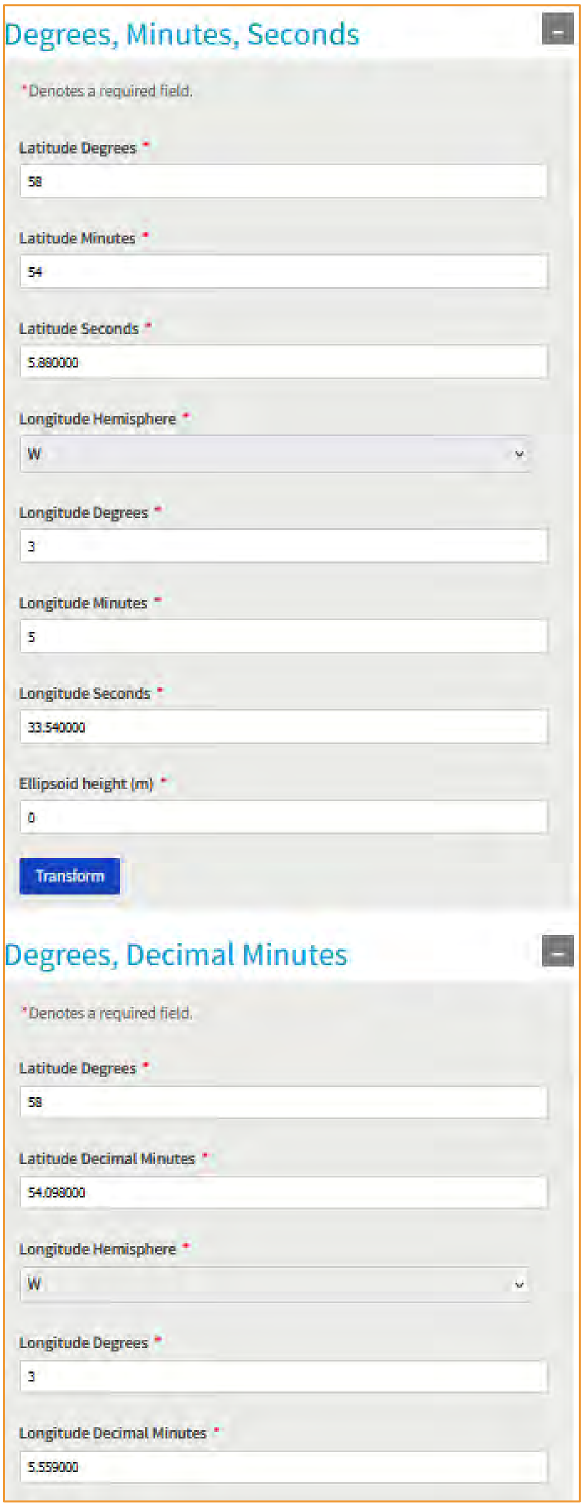


Figure 2 - Location of Proposed Quay
© Orkney Islands Council Harbour Authority background mapping © Ordnance Survey.

1.4 Assumptions and Transformations made to data

The above data was converted from ETRS 89 Degrees Decimal Min to ETRS89 Degrees Minutes Seconds using the Ordnance Survey converter to be used in AutoCAD and with PDToolkit software.

An example for STS 1 is shown in Figure 3 below:



Degrees, Minutes, Seconds

*Denotes a required field.

Latitude Degrees *: 58

Latitude Minutes *: 54

Latitude Seconds *: 5.880000

Longitude Hemisphere *: W

Longitude Degrees *: 3

Longitude Minutes *: 5

Longitude Seconds *: 33.540000

Ellipsoid height (m) *: 0

Degrees, Decimal Minutes

*Denotes a required field.

Latitude Degrees *: 58

Latitude Decimal Minutes *: 54.098000

Longitude Hemisphere *: W

Longitude Degrees *: 3

Longitude Decimal Minutes *: 5.559000

Figure 3 – Data Conversion from DD MM coordinates to ETRS89 DD MM SS Lat/Long © Ordnance Survey https://www.ordnancesurvey.co.uk/gps/transformation/

In order to assess the turbines against the IFPs, an elevation value Above Mean Sea Level (AMSL) needs to be established. To derive the elevation at the positions of the turbines, the Highest Astronomical Tide (HAT) for the given coordinates needs to be derived. Using data from the National Tidal and Sea Level Facility (NOC & University of Liverpool) a conservative value of 6m was selected.

The elevation (AMSL) of the turbines was notified by e-mail from Arch Henderson LLP on 03/11/22 as being 300m. It should be noted that this figure may be subject to change as the proposal develops, for example if the blades are fitted on-site and not at Scapa then the elevation will be lower for the period of time the turbines are in the vicinity of Kirkwall Airport.

The elevation of the turbines when added to the HAT gives an obstacle elevation of 306m or 1004ft.

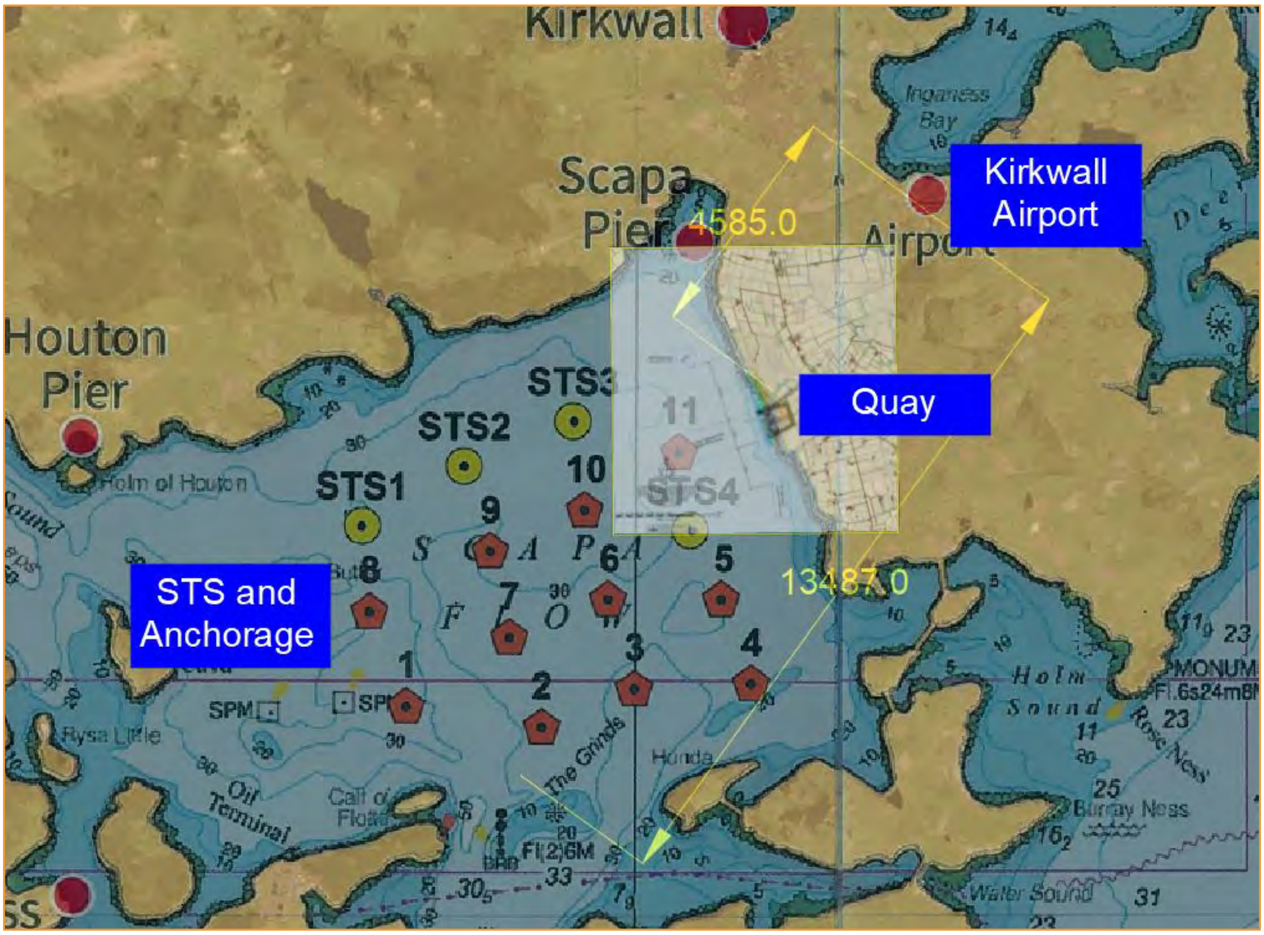


Figure 4 – Site Orientation

The obstacle positions were entered into Autodesk AutoCAD:

Figure 5 – STS and Turbine Location (Image © Google Earth Pro)

1.5 Final Obstacle and Orientation

The obstacle that is to be used for assessment, after all the required conversions, is as follows:

The Anchorages and STS were added to the AutoCAD Model, with a lateral tolerance (radius) of 200m and an elevation of 306m.

4 points were plotted at each corner of the proposed quay. Highest ground elevation was determined to be 31m. The elevation of the corners was set to a conservate 331m which would be the max turbine tip on the highest point of the site.

Figure 6 - Quay Location and 4 Points (Image © Google Earth Pro)

2 IFP Safeguarding

2.1 General

The IFPs assessed are as follows:

AIRAC 02/2023 effective 23 FEB 2023

- AD 2.EGPA-8-1 ILS DME VOR RWY09 (12 Aug 2021);
- AD 2.EGPA-8-2 LOC DME VOR RWY09 (12 Aug 2021);
- AD 2.EGPA-8-3 VOR DME RWY09 (12 Aug 2021);
- AD 2.EGPA-8-4 RNP RWY09 (02 Dec 2021);
- AD 2.EGPA-8-5 NDB(L) DME RWY09 (04 Nov 2021);
- AD 2.EGPA-8-6 DIRECT ARRIVALS RWY09 (12 Aug 2021);
- AD 2.EGPA-8-7 ILS DME VOR RWY27 (12 Aug 2021);
- AD 2.EGPA-8-8 LOC DME VOR RWY27 (12 Aug 2021);
- AD 2.EGPA-8-9 VOR DME RWY27 (12 Aug 2021);
- AD 2.EGPA-8-10 VOR RWY27 (12 Aug 2021);
- AD 2.EGPA-8-11 RNP RWY27 (02 Dec 2021);
- AD 2.EGPA-8-12 NDB(L) DME RWY27 (12 Aug 2021);
- AD 2.EGPA-8-13 NDB(L) RWY27 (12 Aug 2021);
- AD 2.EGPA-8-14 DIRECT ARRIVALS RWY27 (12 Aug 2021).

Additionally, the following were checked:

- Visual Circling
- Holding
- Visual Segment Surface
- Minimum Sector Altitudes

2.2 Assessment

2.2.1 ILS/DME/VOR RWY 09 CAT I AD2.EGPA-8-1 (12 August 2021)

The development site which includes all STS, anchorage points and the quay are outside of the protection are for the ILS OAS and Basic Surfaces:

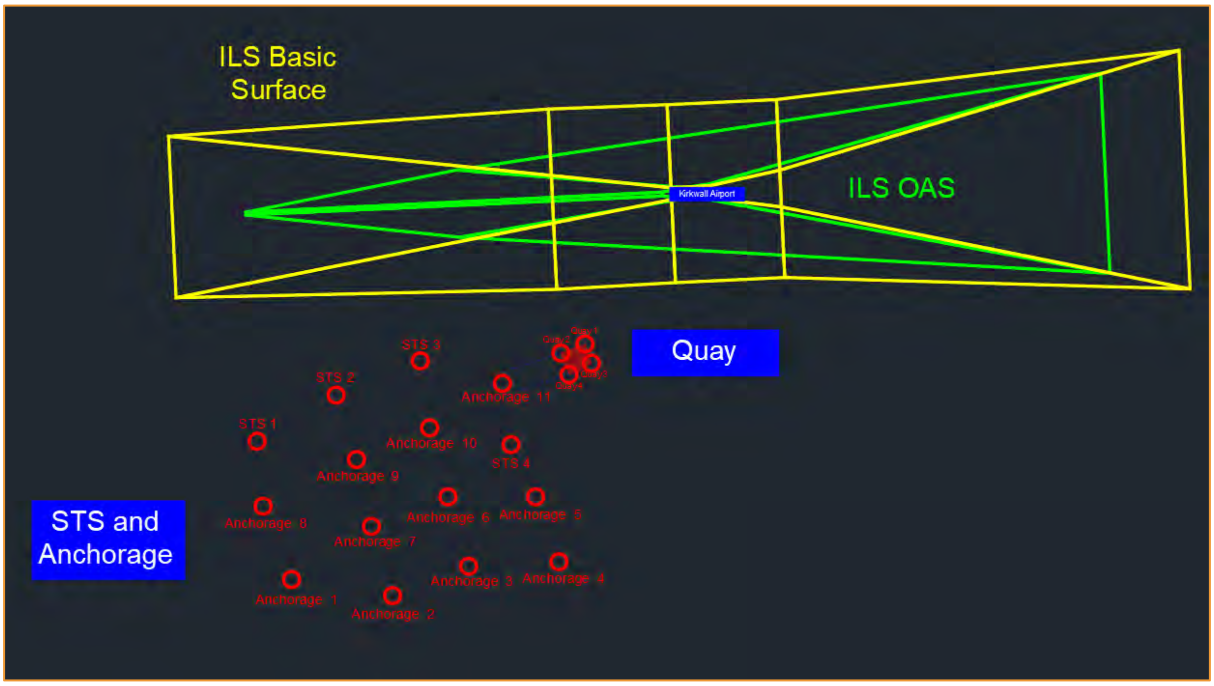


Figure 7 - Location of the Site in Relation to ILS OAS and Basic Surface

Due to the site being outside of the ILS Basic Surface we can determine that there will be no impact to the published minima for the Final Approach Segment. It is also clear that there will be impact to the Missed Approach as the published instruction is:

> *"Climb straight ahead. At **1500** or, **I-ORK** DME 3 (**KWL** DME 3.2) whichever is later, climbing turn left to return to **VOR KWL** at **2600** or as directed."*

Aircraft are protected by the ILS Basic Surface until they make a turn, in this case left away from the site. The obstacle with the highest elevation on the site is the quay at 331m. The minimum altitude an aircraft can turn is 1500ft AMSL which is 457.2m, applying a 50m MOC means any obstacle below 407.2m would not impact the procedure. In the Missed Approach instruction aircraft are instructed to be over **VOR KWL** at **2600** and so would not be impacted by the development even if they then flew over the quay or anchorages.

Next, we need to determine any potential impact on the reversals which aircraft use to position on the Final Approach.

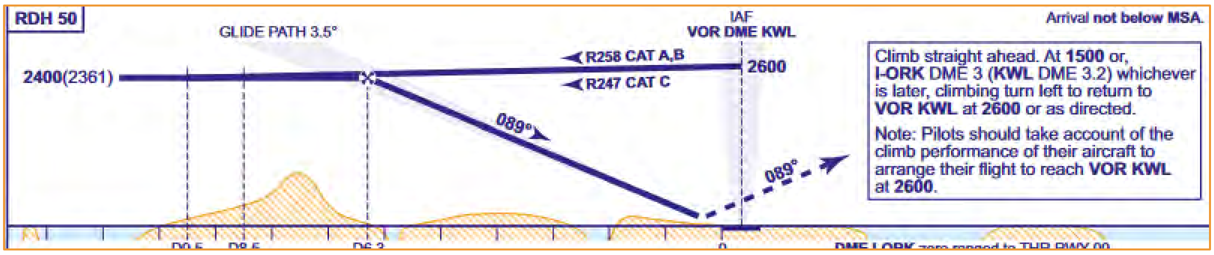


Figure 8 - ILS DME VOR Rwy 09 Profile

As can be seen in Fig 8 aircraft join the procedure at the Initial Approach Fix (IAF) **VOR DME KWL** before completing a reversal (Base Turn) to line up for the Final Approach. Aircraft cannot be below 2600ft at the IAF and 2400ft at the Final approach Fix (FAF). As already determined the maximum MOCA for the site, using a 300m MOC is 2071ft. The development would have no impact for the published minima in the Initial and Base Turn segments.

The Hold is covered later in the report.

There is a published alternative procedure and instructions for entry to the Base Turn after holding. Once again the reversal is not below 2600ft descending to 2400ft at the FAF.

The proposed development would have no impact on the ILS/DME/VOR RWY 09 CAT I Procedure.

2.2.2 LOC/DME/VOR RWY 09 AD2.EGPA-8-2 (12 August 2021)

For the LOC DME procedure the protection area for the Final Approach Segment is the same as Section 2.2.1.

The reversals, profile and additional instructions are common to those in Section 2.2.1.

The proposed development would have no impact on the LOC/DME/VOR RWY 09 Procedure.

2.2.3 VOR/DME RWY 09 AD2.EGPA-8-3 (12 August 2021)

The development site which includes all STS, anchorage points and the quay are outside of the protection area for the VOR/DME Final Approach Segment:

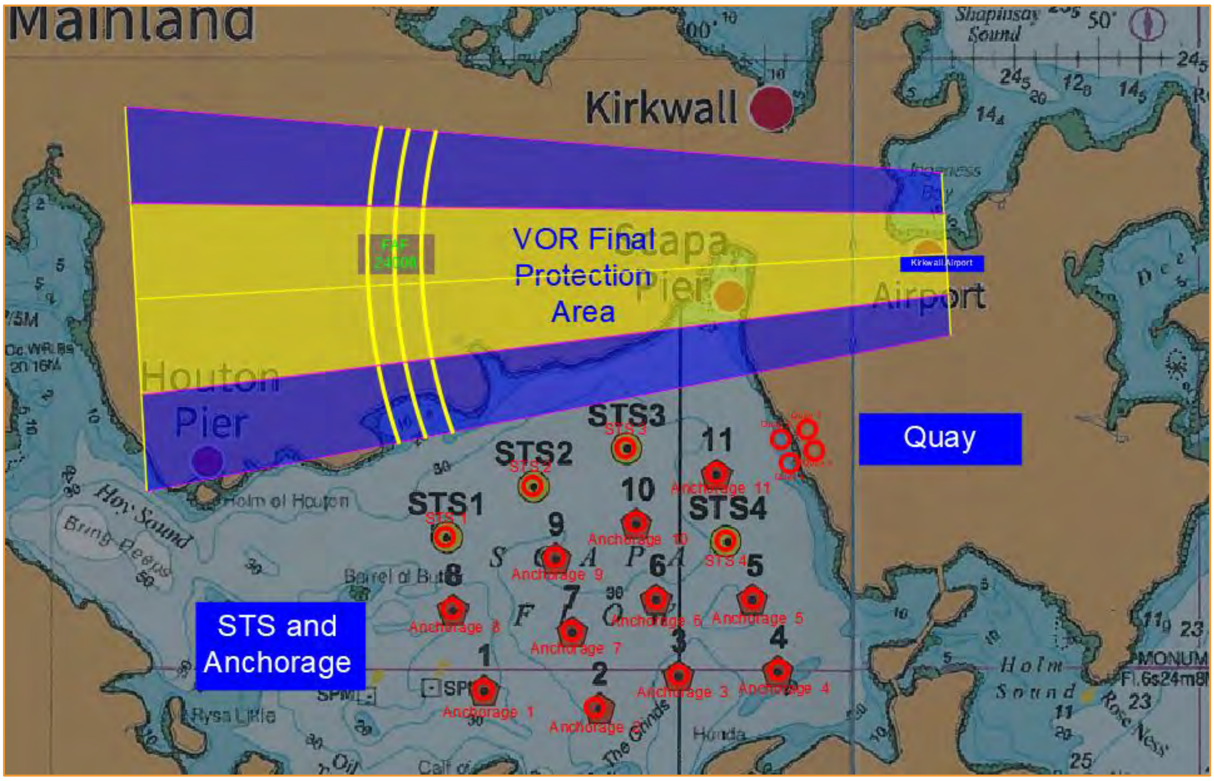


Figure 9 - VOR Final Protection Splay Runway 09

The Missed Approach is similar to that described in Section 2.2.1 albeit using the **KWL** DME to limit the turn point. In common with the ILS procedure the Procedure terminates at **VOR KWL** at 2600 and so once again there will be no impact on this procedure.

The reversals, profile and additional instructions are common to those in Section 2.2.1.

The proposed development would have no impact on the VOR DME RWY 09 Procedure.

2.2.4 RNP RWY 09 AD2.EGPA-8-4 (02 December 2021)

The development site which includes all STS, anchorage points and the quay are outside of the protection are for the RNP Approach to Rwy 09:

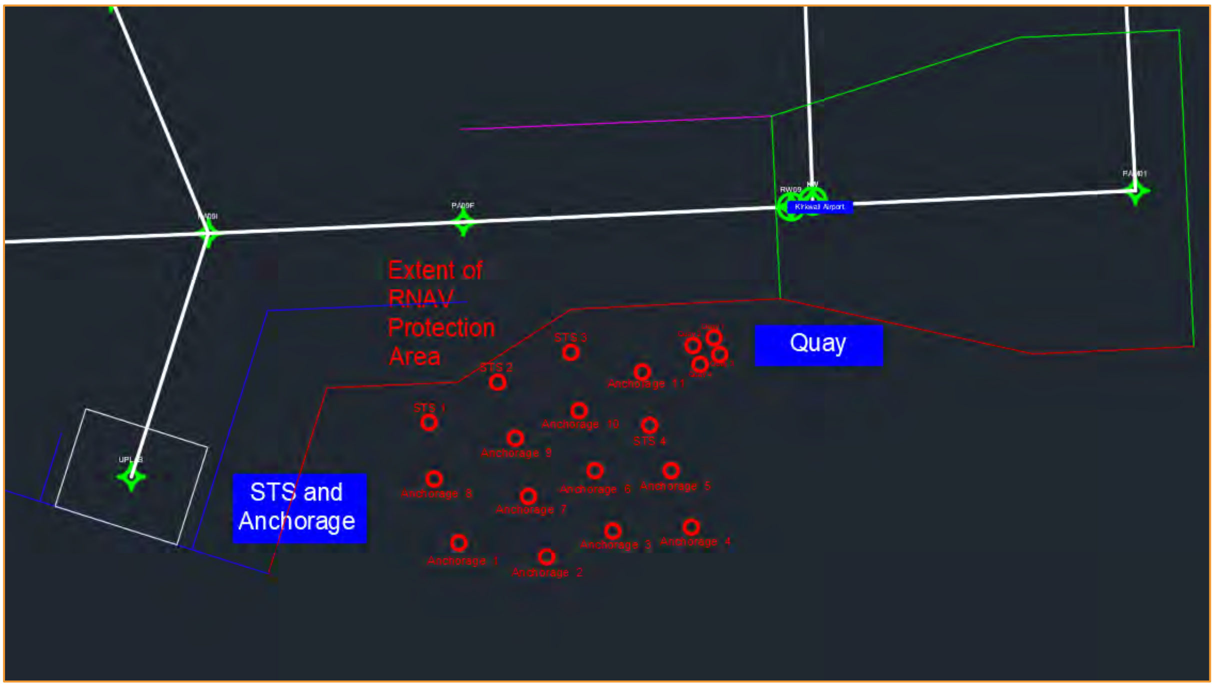


Figure 10 - Extent of RNP 09 Protection Area

The proposed development is outside of the protection areas associated with the RNP 09 Procedure which has a Missed Approach similar to the Conventional Approaches that turns left away from the development before terminating at KWL at 2600ft. In this case aircraft are directed to enter the hold which is examined separately.

The lowest Terminal Arrival Altitude associated with this procedure over the proposed site is not below 2100ft again as already demonstrated this altitude is not impacted with a MOC applied of 300m to the highest obstacle resulting in a MOCA of 2071ft.

The proposed development would have no impact on the RNP 09 Procedure.

2.2.5 NDB (L) DME RWY 09 AD2.EGPA-8-5 (04 November 2021)

The development site which includes all STS, anchorage points and the quay are outside of the protection area for the NDB (L)/DME Final Approach Segment:

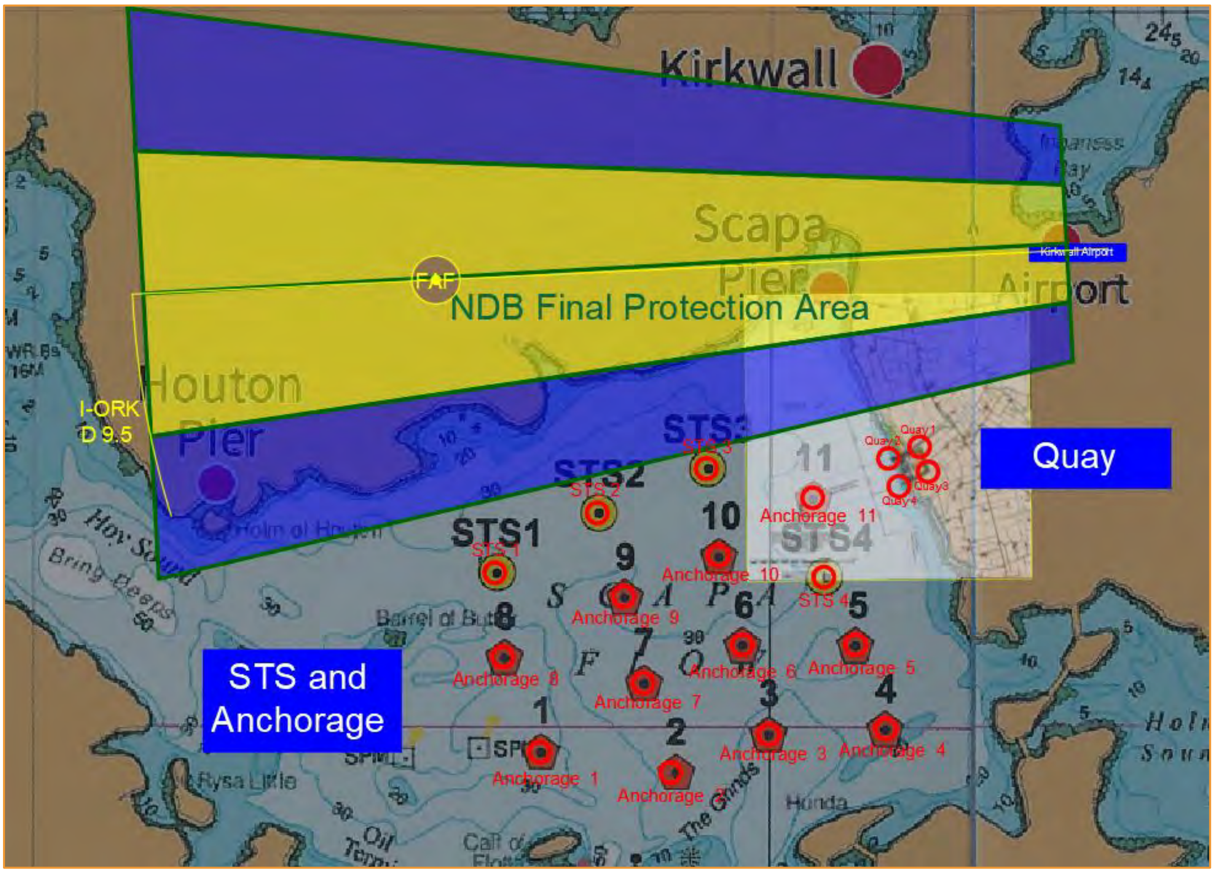


Figure 11 - NDB Final Protection Splay Runway 09

The Missed Approach is similar to that described in Section 2.2.1. In common with the ILS procedure the Procedure terminates at VOR KWL at 2600 and so once again there will be no impact on this procedure.

The reversals, profile and additional instructions are common to those in Section 2.2.1.

The proposed development would have no impact on the NDB(L) DME RWY 09 Procedure.

2.2.6 KIRKWALL DIRECT ARRIVALS RWY 09 AD2.EGPA-8-6 (12 August 2021)

The direct arrival procedure to Runway 09 descends to a termination fix not below 2400ft.

As already determined the maximum MOCA for the site, using a 300m MOC is 2071ft. The development would have no impact for the published direct arrivals.

The proposed development would have no impact on the DIRECT ARRIVALS RWY 09 Procedure.

2.2.7 ILS/DME/VOR RWY 27 CAT I AD2.EGPA-8-7 (12 August 2021)

The development site which includes all STS, anchorage points and the quay are outside of the protection are for the ILS OAS and Basic Surfaces:

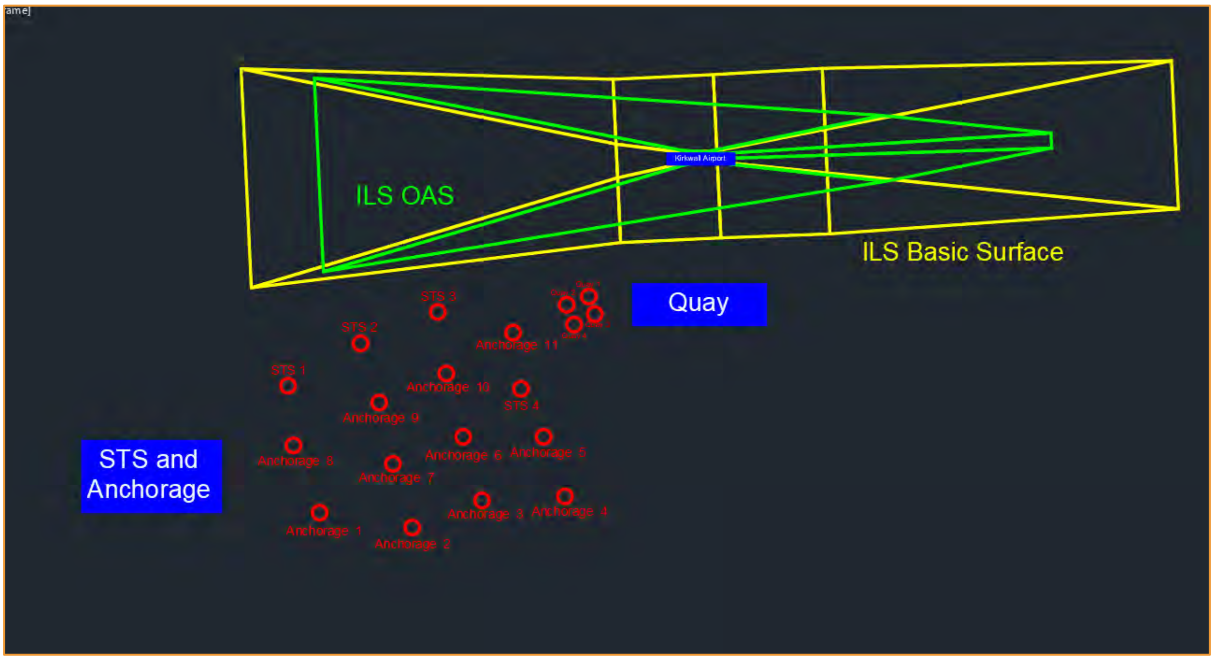


Figure 12 - Location of the Site in Relation to ILS OAS and Basic Surface

Due to the site being outside of the ILS Basic Surface we can determine that there will be no impact to the published minima for the Final Approach Segment. The Missed Approach instruction for this procedure is:

> *"Climb straight ahead. At **2000** or, **I-KIR** DME 3 (**KWL** DME 3.5) whichever is later, climbing turn left to return to **VOR KWL** at **2600** or as directed."*

Aircraft are protected by the ILS Basic Surface until they make a turn, in this case left ***towards*** the site. Previously in this report we have used a 300m MOC to determine MOCA we now need to use a more refined calculation. The Maximum MOC for the Missed Approach is 50m. Once this MOC is added to the highest obstacle in the development at 331m we get a MOCA value of 381m which is 1250ft. This is below the 2000ft which aircraft must achieve before they change direction towards the site and therefore there will be no impact on the Missed approach for this procedure.

Next, we need to determine any potential impact on the reversals which aircraft use to position on the Final Approach.

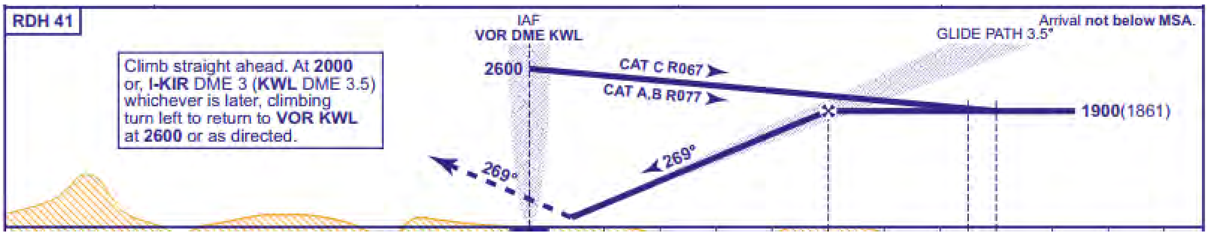


Figure 13 - ILS DME VOR Rwy 27 Profile

As can be seen in Fig 13 aircraft join the procedure at the Initial Approach Fix (IAF) **VOR DME KWL** before completing a reversal (Base Turn) to line up for the Final Approach. Aircraft cannot be below 2600ft at the IAF and 1900ft at the Final approach Fix (FAF).

We have already established that the 2600ft minima at the IAF is obstacle safe. For this procedure aircraft then head away from the site to complete the reversal and are protected by the ILS OAS once on Runway Heading and flying toward the development.

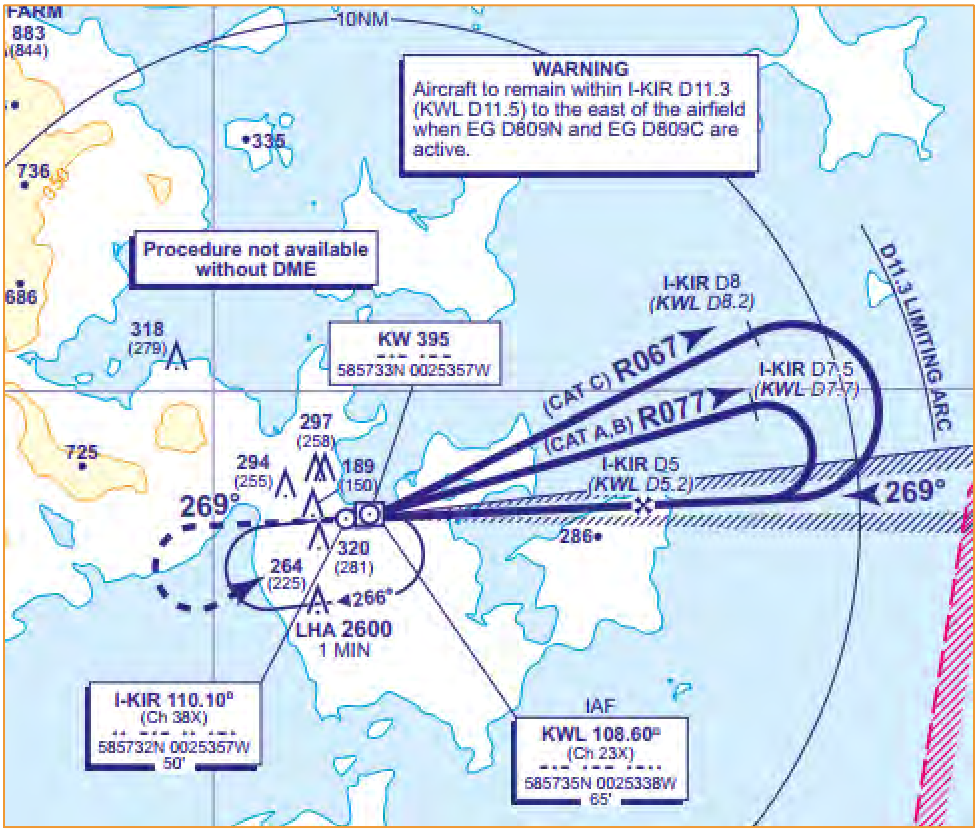


Figure 14 - ILS Runway 27 Reversals

The Hold is covered later in the report.

The proposed development would have no impact on the ILS/DME/VOR RWY 27 CAT I Procedure.

2.2.8 LOC/DME/VOR RWY 27 AD2.EGPA-8-8 (12 August 2021)

For the LOC DME procedure the protection area for the Final Approach Segment is the same as Section 2.2.7.

The Missed Approach instruction is the same with a climb to 2000ft before turning toward the development and the same MOCA is applicable.

The reversals, profile and additional instructions are common to those in Section 2.2.7.

The proposed development would have no impact on the LOC/DME/VOR RWY 27 Procedure.

2.2.9 VOR/DME RWY 27 AD2.EGPA-8-9 (12 August 2021)

The development site which includes all STS, anchorage points and the quay are outside of the protection area for the VOR/DME Final Approach Segment which approaches the Runway from the East. The site is also outside of the straight ahead element of the Missed Approach:

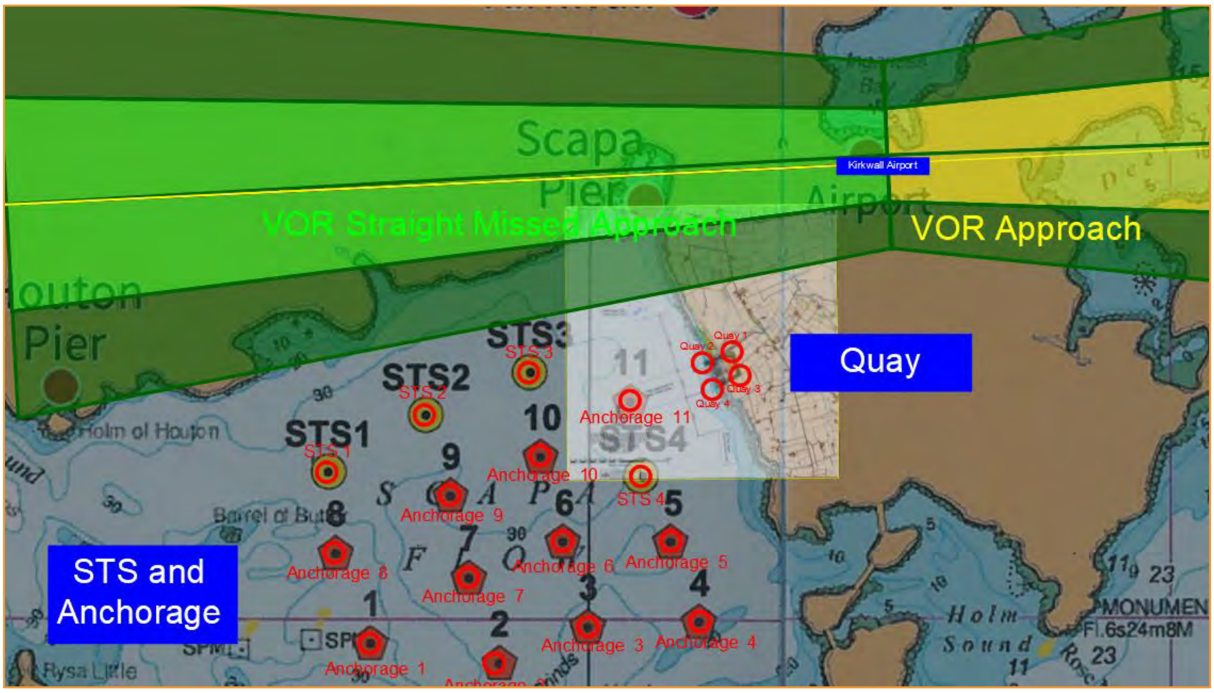


Figure 15 - VOR Approach and Missed Approach (Straight) Rwy 27

The Missed Approach instruction is once again to climb straight ahead, and no turn is permitted below 2000ft. The same MOCA value as described in Section 2.2.7 is applicable and so whilst the point at which aircraft may turn to towards and fly over the site cannot be precisely determined there would be no impact on the procedure.

The proposed development would have no impact on the VOR DME RWY 27 Procedure.

2.2.10 VOR RWY 27 AD2.EGPA-8-10 (12 August 2021)

The development site which includes all STS, anchorage points and the quay are outside of the protection area for the VOR Final Approach Segment which approaches the Runway from the East. The site is also outside of the straight ahead element of the Missed Approach (See Fig 15)

The Missed Approach instruction is once again to climb straight ahead, and no turn is permitted below 2000ft. The same MOCA value as described in Section 2.2.7 is applicable and so whilst the point at which aircraft may turn to towards and fly over the site cannot be precisely determined there would be no impact on the procedure.

The proposed development would have no impact on the VOR RWY 27 Procedure.

2.2.11 RNP RWY 27 AD2.EGPA-8-11 (02 December 2021)

The development site which includes all STS, anchorage points and the quay are outside of the protection are for the RNP Approach to Rwy 27, however, elements of the site are inside the Missed Approach protection areas:

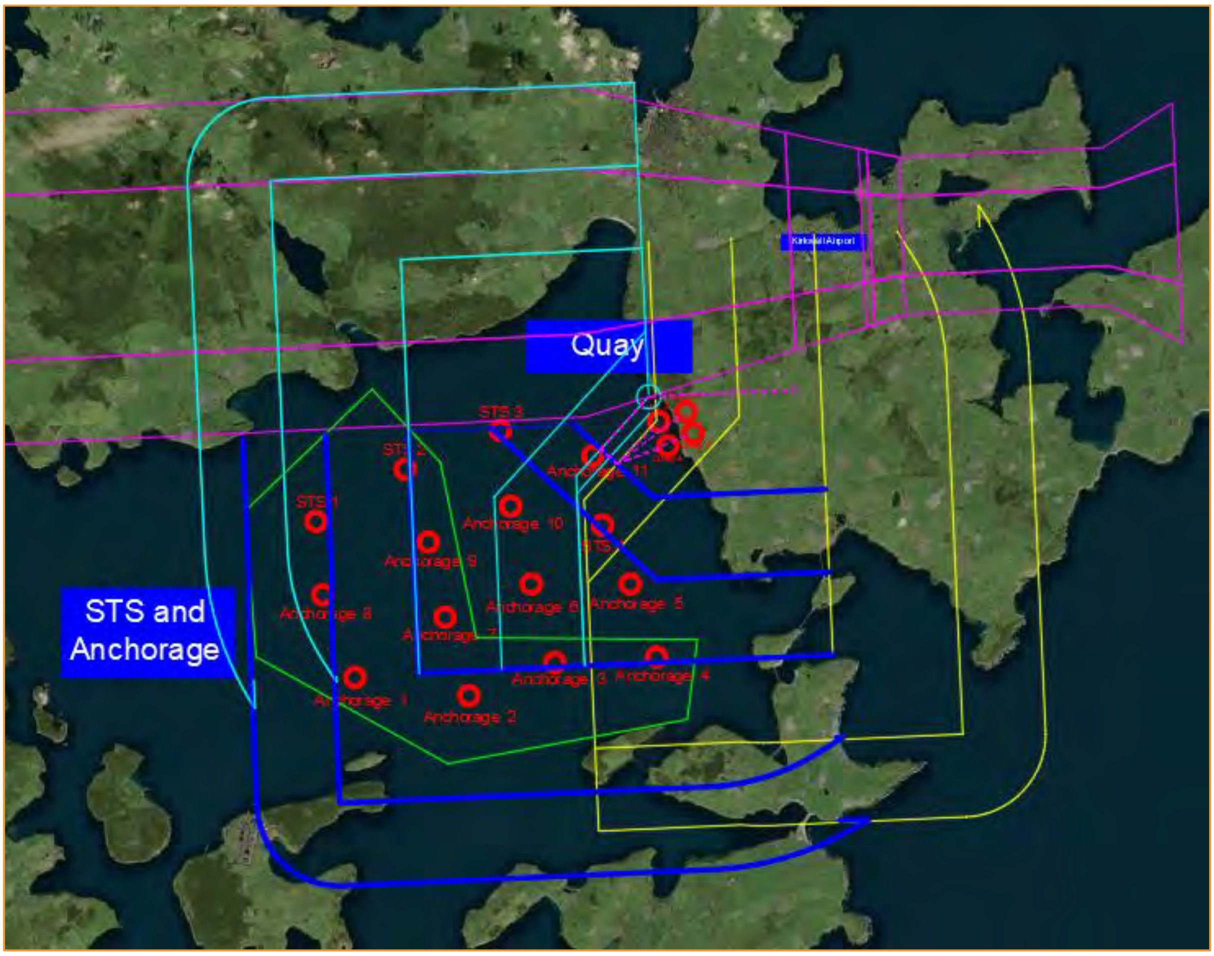


Figure 16 - Extent of RNP 27 Protection Area

First, we have to consider the lowest altitude an aircraft could be following the approach. Minima for this approach is 470ft which is 143.25m:

OCA (OCH)	LNAV	470(431)

Figure 17 - RNP 27 Minima

Aircraft that execute the Missed Approach will remain level from the Missed Approach Point (MAPt) to a point known as Start of Climb (SOC). From the SOC aircraft will climb at a minimum of 2.5% until reaching and altitude of 2600ft.

A calculation was made to determine the shortest distance an aircraft could fly before commencing each of the three turns that are specified to hold back over the Airport.

This results in a highly unlikely scenario as shown below where an aircraft flies to the most conservative turning points and then (in the instance shown in Fig 18) heads straight toward the quay. Whilst implausible this is a methodology stated in ICAO design criteria and was therefore employed here.

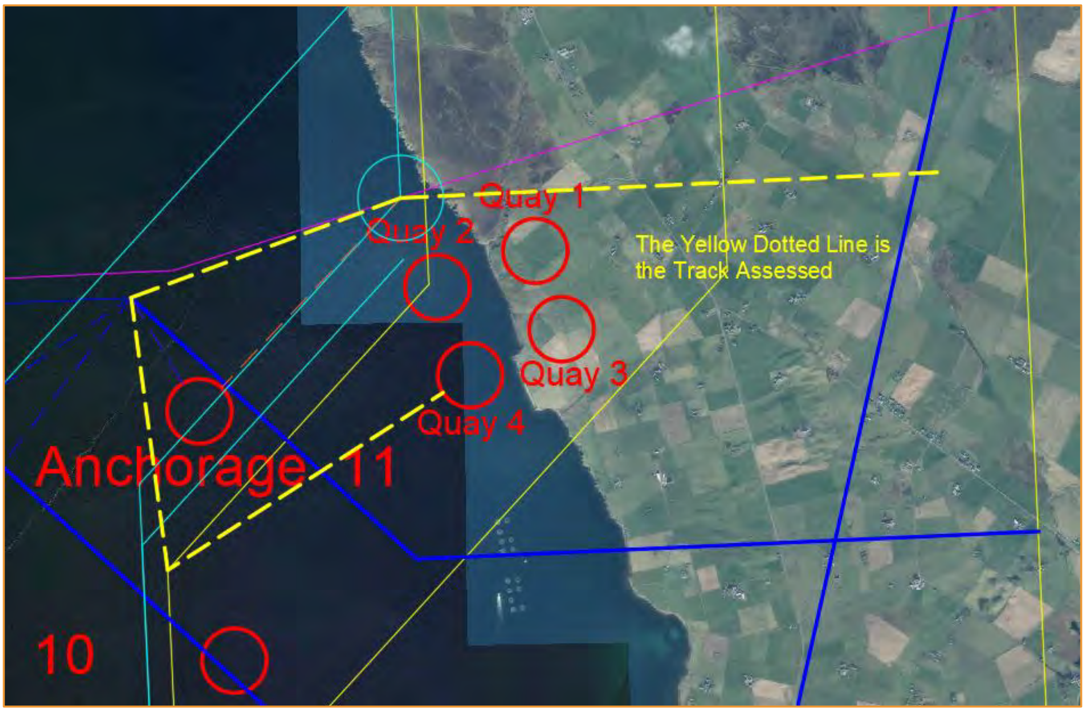


Figure 18 – Assessed Track

Calculated Results:

ID	Elevation	Distance from KKs	Elevation Req (m)	Height Gain 2.5%	A/C Elevation Obs (m)	Penetration (m)	MACG Required (%)	Max permitted Elevation (m)
Anchorage 11	306	1616.52	356.00	40.41	266.85	89.15	4.303	216.85
STS 4	306	2846.60	356.00	71.17	297.61	58.39	3.446	247.61
STS 3	306	3200.94	356.00	80.02	306.46	49.54	3.259	256.46
Anchorage 10	306	3733.59	356.00	93.34	319.78	36.22	3.013	269.78
Anchorage 5	306	4004.43	356.00	100.11	326.55	29.45	2.902	276.55
Quay 4	331	5513.94	381.00	137.85	364.29	16.71	2.689	314.29
Anchorage 6	306	4737.68	356.00	118.44	344.88	11.12	2.638	294.88
Quay 2	331	5705.09	381.00	142.63	369.07	11.93	2.632	319.07
Quay 3	331	6145.81	381.00	153.65	380.09	0.91	2.510	330.09
Quay 1	331	6301.37	381.00	157.53	383.97	-2.97	2.469	333.97
STS 2	306	5476.72	356.00	136.92	363.36	-7.36	2.416	313.36
Anchorage 4	306	5625.71	356.00	140.64	367.08	-11.08	2.376	317.08
Anchorage 9	306	5699.53	356.00	142.49	368.93	-12.93	2.357	318.93
Anchorage 3	306	6097.25	356.00	152.43	378.87	-22.87	2.257	328.87
Anchorage 7	306	6508.21	356.00	162.71	389.15	-33.15	2.163	339.15
Anchorage 2	306	7595.85	356.00	189.90	416.34	-60.34	1.948	366.34
STS 1	306	7738.56	356.00	193.46	419.90	-63.90	1.923	369.90
Anchorage 8	306	8321.31	356.00	208.03	434.47	-78.47	1.826	384.47
Anchorage 1	306	8881.02	356.00	222.03	448.47	-92.47	1.743	398.47

Table 1 LNAV K-K K-K K-K Turn Calculations

Should the development require higher elevations than those recorded here mitigation is available.

The Terminal Arrival Altitude (TAA) around the development is 2600ft and therefore will not be impacted.

The hold is considered separately.

The proposed development will require mitigation to ensure no impact on the RNP 27 Procedure.

2.2.12 NDB (L) DME RWY 27 AD2.EGPA-8-12 (12 August 2021)

The development site which includes all STS, anchorage points and the quay are outside of the protection area for the NDB (L) DME Final Approach Segment which approaches the Runway from the East. The site is also outside of the straight ahead element of the Missed Approach:

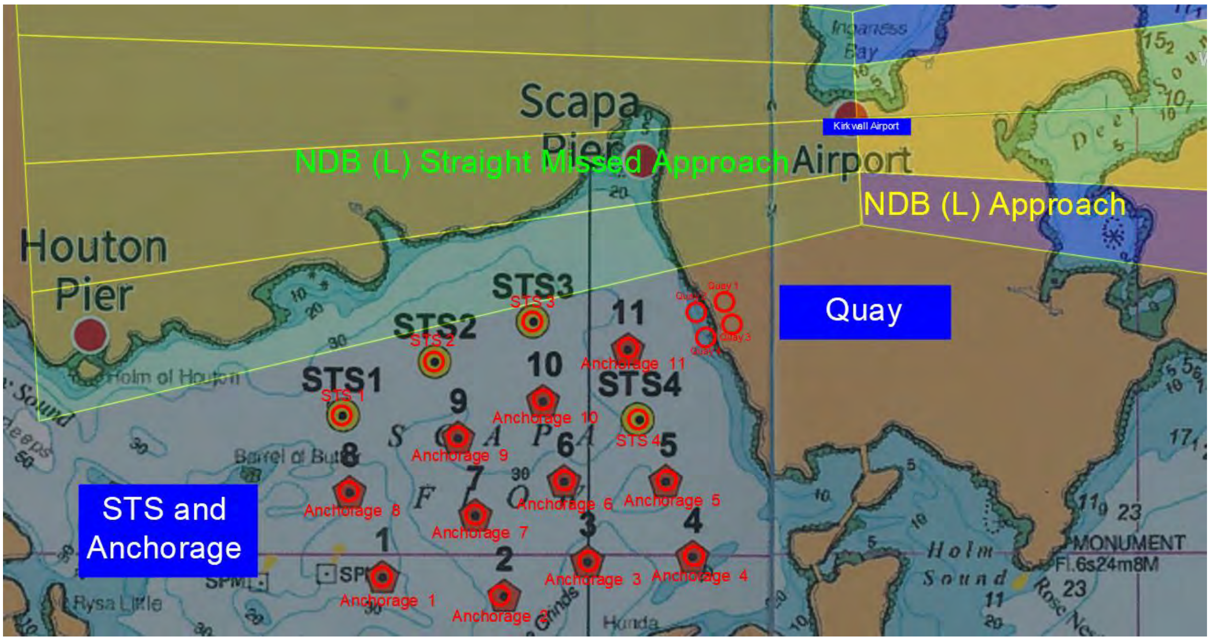


Figure 19 - NDB Approach and Missed Approach (Straight) Rwy 27

The Missed Approach instruction is once again to climb straight ahead, and no turn is permitted below 2000ft. The same MOCA value as described in Section 2.2.7 is applicable and so whilst the point at which aircraft may turn to towards and fly over the site cannot be precisely determined there would be no impact on the procedure.

The proposed development would have no impact on the NDB (L) DME RWY 27 Procedure.

2.2.13 NDB (L) RWY 27 AD2.EGPA-8-13 (12 August 2021)

The development site which includes all STS, anchorage points and the quay are outside of the protection area for the NDB (L) DME Final Approach Segment which approaches the Runway from the East. (See Fig 17)

The Missed Approach instruction is once again to climb straight ahead, and no turn is permitted below 2000ft. The same MOCA value as described in Section 2.2.7 is applicable and so whilst the point at which aircraft may turn to towards and fly over the site cannot be precisely determined there would be no impact on the procedure.

The proposed development would have no impact on the NDB (L) RWY 27 Procedure.

2.2.14 KIRKWALL DIRECT ARRIVALS RWY 27 AD2.EGPA-8-14 (12 August 2021)

The direct arrival procedure to Runway 27 descends to a termination fix not below 1900ft. Elements of the proposed development are inside of the protection area for the Direct Arrival:

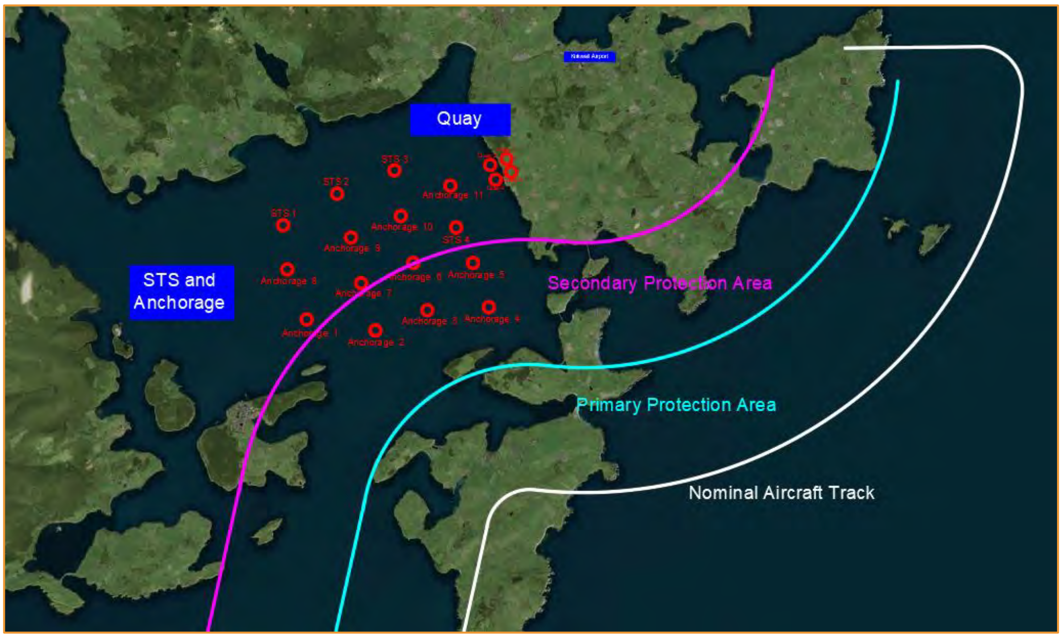


Figure 20 – Rwy 27 Direct Arrival Protection Area

The Anchorages are in the Secondary Protection Area and a MOC of 180m was applied, This results in a MOCA of 486m (rounded up to 1600ft). Aircraft are not below 2600ft at the lead-in fix to fly the DME Arc for the arrival. Aircraft will then descend along the arc to be not below 1900 at I-KIR D5.

The proposed development would have no impact on the DIRECT ARRIVALS RWY 27 Procedure.

2.2.15 Visual Circling

Elements of the proposed development are inside the CAT B and CAT C Circling protection areas:

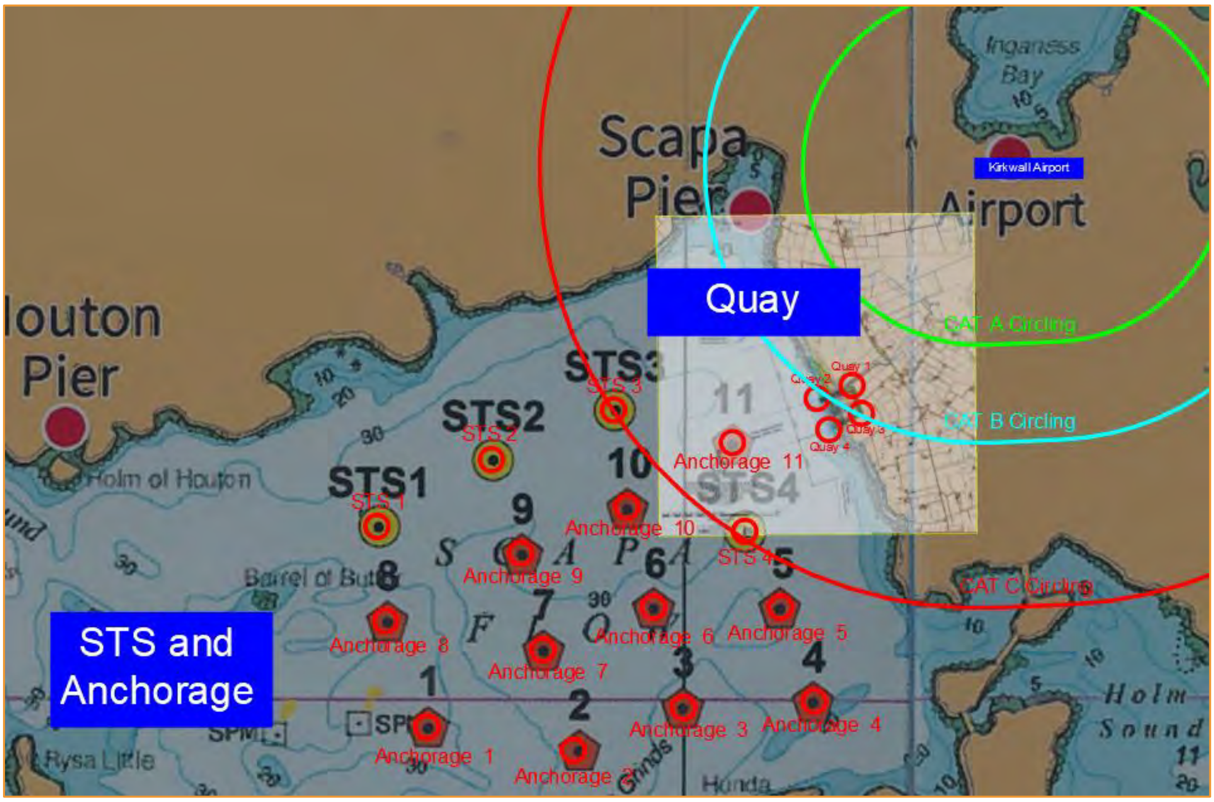
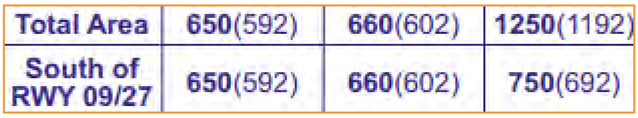


Figure 21 – Visual Circling

Published Circling Minima are:



Total Area	**650**(592)	**660**(602)	**1250**(1192)
South of RWY 09/27	**650**(592)	**660**(602)	**750**(692)

Figure 22 - Circling Minima

In order for obstacles not to impact the CAT B Circling Minima the maximum elevation is 660ft – 90m (295ft) MOC = 365ft (111m).

In order for obstacles not to impact the CAT C Circling Minima the maximum elevation is 750ft – 120m (394ft) MOC = 356ft (108m).

Alternatively, the Circling Minima would require an increase. For a 306m anchorage this would result in Circling Minima of:

CAT B **1300ft**.

CAT C **1400ft**.

The Quay with an elevation of 331m would require minima of:

CAT B **1400ft**.

CAT C **1500ft**.

The Development would impact on the Visual Circling.

2.2.16 Holding

The Lowest Holding Altitude (LHA) across all Approach Procedures is uniform at 2600ft (792m). Applying a 300m MOC results in a maximum obstacle elevation of 492m. No element of the development has such a planned altitude.

The Development would not impact any Hold.

2.2.17 Visual Segment Surface (VSS)

The proposed turbine is outside of the VSS for both Runways.

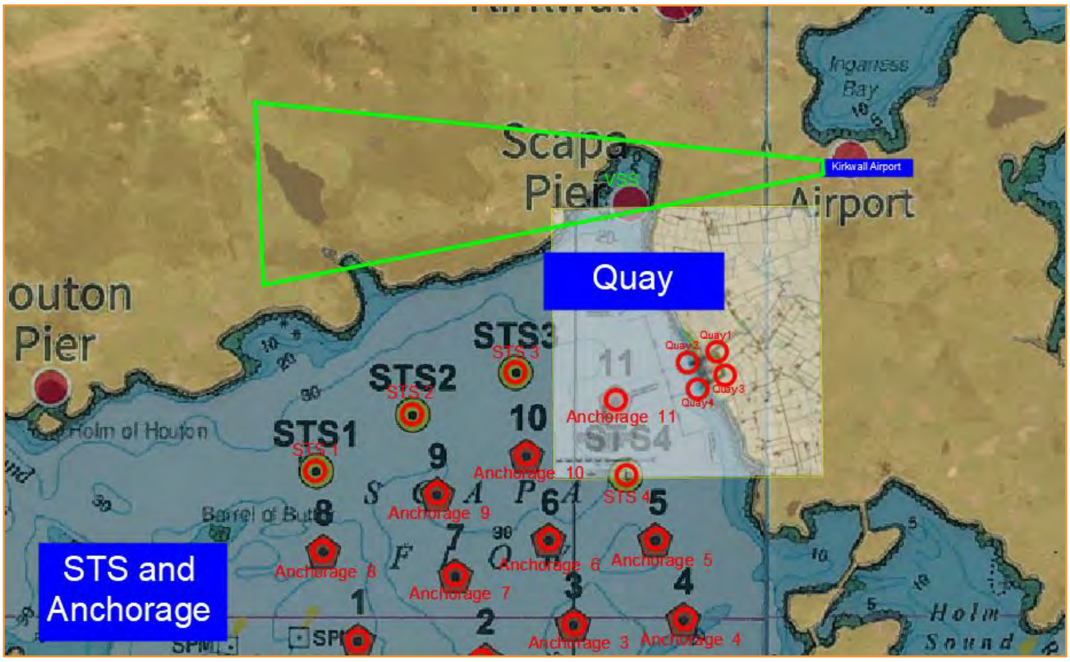


Figure 23 - VSS Areas

2.2.18 Minimum Sector Altitudes

The proposed development lies within the MSA 25NM VOR KWL South West, South East (Buffer) and North West (Buffer) Quadrants:

Figure 24 – MSA VOR KWL

With a MOC of 300m, using a max obstacle elevation of 331m the proposed development would require the MSA Quadrant to be **2100ft**:

The MSA for the South West and North West are sufficient as published. The Minima for the South East Quadrant would need to be raised to **2100ft**

The proposed development would impact the published MSA's.

3 Conclusions

Impact on the IFPs

- The proposed development will require mitigation to ensure no impact on the RNP 27 Procedure.
- The Development would impact on the Visual Circling.
- The proposed development would impact the published MSA's.
- In this report the protection areas for the NDB and VOR Missed Approaches were drawn with the standard PANS OPS splays of 10.3° for the NDB and 7.8° for the VOR. This assumes aircraft are using track guidance from the navigational aids specified for the approach. If this isn't the case, then a 15° splay would be used for instances where no reference to a navigation aid is available. This would bring some obstacles into the protection area and should be investigated with the Airport at a suitable time and appropriate mitigation determined such as specifying a radial from the navigational aids on the chart if required.