Dragados

Aberdeen Harbour Expansion Project

Supplementary Information for the Application for a European Protected Species Licence (2019 to 2020)

Variation – Charge Weight increase

AHEP EPS Charge weight increase

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1 Introduction

This document provides supplementary information to support a variation to the European Protected Species EPS Licence MS/EPS/06/2018/1 issued to Dragados on 15 October 2018. The variation is required to coincide with the Marine Construction and dredging Licence applications being undertaken for the Aberdeen Harbour Expansion Project (AHEP) within Nigg Bay, Aberdeen. The activities that have already been approved under the existing EPS Licence are described within this report for completeness; however, the request for an amendment/variation applies to Dragados intending to gradually increase the maximum blast charge weight beyond 20kg to (up to) 80kg and extending the licence end period from 27th February 2020 to the end December 2021.

Work relating to this EPS variation is planned to be undertaken over a period of 11 months starting no sooner than 15th March 2020 and finishing by 12th April 2021. The work is subject to conditions under two Marine Licences and two variations:

- Marine Licence 05964/16/0: Licence to carry out dredging and to deposit dredged spoil substances or objects within the Scottish marine Area. Issued 4 November 2016; and
- Marine Licence 05965/16/0: Licence to construct, alter or improve works and to deposit or use explosive substances or articles within the Scottish marine area. Issued 4 November 2016.
- Marine Licence 05964/18/0: Licence to carry out dredging and to deposit dredged spoil substances or objects within the Scottish marine Area. Issued 26 April 2018.
- Marine Licence 05964/19/0: Licence to carry out dredging and to deposit dredged spoil substances or objects within the Scottish marine Area. Issued 24 September 2019.

Following communications with Marine Scotland, Aberdeen Harbour Board and Dragados have been advised that a European Protected Species (EPS) License will be required prior to the commencement of any activities that could cause impacts on European Protected Species listed under Annex IV of the Habitats Directive and are species of European Community interest and in need of strict protection.

An Environmental Statement (ES) in support of AHEP was submitted to Marine Scotland on 4th November 2015 and further information was provided on 26th April 2016. AHEP received consent from the Scottish Government under the Harbours Act 1964 (as amended) on 19 December 2016.

Within the Environmental Statement and subsequent additional information an Environmental Impact Assessment (EIA) was undertaken that included the assessment of potential impacts on marine mammals from the construction and operation of the harbour (Fugro 2015, Aberdeen Harbour 2016a). The assessment identified the European Protected Species that could be impacted and the potential requirements for an EPS licence. A further Environmental Impact Assessment Report was undertaken (Fugro 2019). This report assessed the potential impact of charge weight increase and blasting duration change and should be read in conjunction with this EPS application.

There is a chance that the risk of injury or disturbance to EPS may not be sufficiently reduced by using construction alternatives and or mitigation measures and therefore a licence (EPS Licence) is required prior to the commencement of activities.

The licence assessment comprises three tests to ascertain:

- Whether the activity fits one of the purposes specified in the Regulations;
- Whether there are no satisfactory alternatives to the activity proposed (that would not incur the risk of an offence); and
- That the licensing of the activity will not be detrimental to the maintenance of the populations of the species concerned at a Favourable Conservation Status (FCS) in their natural range.

This document follows published guidance by Marine Scotland and Scottish Natural Heritage (SNH)

on the Application for a licence for European Protected Species (MS 2012a, SNH 2018) and 'The protection of Marine European Protected Species from injury and disturbance - Guidance for Scottish Inshore Waters' (MS 2014), that provide guidance for a licence application under Regulation 44 of the Habitats Regulations.

2 European Protected Species Legislation

The following section summarises the relevant legislation relating to European Protected Species.

All species of cetacean are listed on Annex IV of the Habitats Directive (92/43/EEC), the Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (The Habitats Directive), that requires they are offered strict protection from: all forms of deliberate capture, killing or disturbance, particularly during the period of breeding, rearing, hibernation or migration; and deterioration and destruction of breeding sites or resting places. There is also an obligation to establish a system to monitor incidental capture and killing of cetaceans.

The Habitats Directive has been transposed into domestic law via secondary legislation including:

- Conservation (Natural Habitats, &c.) Regulations 1994 (as amended);
- Conservation (Natural Habitats, &c.) Amendment (Scotland) Regulations 2012 in relation to the terrestrial environment and in territorial waters out to 12 nautical miles (nm). These are often referred to as the 'Habitats regulations';
- The Conservation of Offshore Marine Habitats and species Regulations 2017 apply to UK territorial waters outside 12 nm; and
- The Wildlife and Natural Environment (Scotland) Act (2011), WANE.

These pieces of legislation define two offences relating to European Protected Species (including marine mammals); deliberate injury and deliberate disturbance, as well as refining the circumstances in which disturbance may be particularly damaging to the animals concerned (as envisaged by Article 12 of the Directive). In addition, the amendments also provide for the offence of deliberate injury.

Under Regulations 39(1)(a) and (b) of the Habitats Regulations (as amended) for activities within Scottish inshore waters (12 nm) (MS 2014), it is an offence to:

(a) Deliberately or recklessly to capture, injure, or kill a wild animal of a European protected species;
(b) deliberately or recklessly:
  i. to harass a wild animal or group of wild animals of a European protected species;
  ii. to disturb such an animal while it is occupying a structure or place which it uses for shelter or protection;
  iii. to disturb such an animal while it is rearing or otherwise caring for its young;
  iv. to obstruct access to a breeding site or resting place of such an animal, or otherwise to deny the animal use of the breeding site or resting place;
  v. to disturb such an animal in a manner that is, or in circumstances which are, likely to significantly affect the local distribution or abundance of the species to which it belongs;
  vi. to disturb such an animal in a manner that is, or in circumstances which are, likely to impair its ability to survive, breed or reproduce, or rear or otherwise care for its young; or
  vii. to disturb such an animal while it is migrating or hibernating.

Regulation 39(2) provides that it is an offence to:

- Deliberately or recklessly disturb any dolphin, porpoise or whale (cetacean).

Furthermore, it is an offence of strict liability to damage or destroy a breeding site or resting place of such an animal (SNH 2014a).

All of the above offences apply to all stages of the animal's life to which they apply (SNH 2018).

2.1 Deliberate Injury Offence

The term "deliberate" has been interpreted as including indirect but foreseeable actions and the deliberate injury offence has been interpreted as occurring if a cetacean receives a sound exposure level, which may cause permanent threshold shift in hearing (JNCC 2010a).

2.2 Disturbance Offence

A disturbance offence may occur if the level of disturbance is likely to:

- Impair the ability to survive, to breed or reproduce, or to rear or nurture their young, or migrate;
- Affect significantly the local distribution or abundance.

The consideration of what constitutes disturbance should be undertaken on a species by species approach that takes into account the intensity, duration and frequency of repetition of disturbances and the specific characteristics of the species concerned and the situation. Consideration should be given to the rarity and favourable conservation status of the species in question and the impact of the disturbance on the local population of a species (MS 2014).

In JNCC guidance (JNCC 2010a) a disturbance offence is more likely to occur when there is a risk of:

- Animals incurring sustained or chronic disruption of behaviour scoring 5 or more in the Southall *et al.* (2007) 'behavioural response severity scale'; or
- Animals being displaced from the area, with redistribution significantly different from natural variation.
- The risk of a disturbance offence will exist if there is sustained noise in an area and/or chronic noise exposure, as a result of an activity (JNCC, 2010a).

In order to commit an offence under Regulation 39(2), the impact on the species must be certain or real. The activity concerned must have a "negative or adverse" impact on the conservation status of the species (MS 2014).

3 European Protected Species Licence

Under Regulation 44 of the Habitats Regulations and Regulation 49 of the Offshore Marine Regulations, certain activities that might be considered to cause an offence may be carried out under licence if it can be demonstrated that by doing so the licensing authority remains fully compliant with the requirements of the Habitats Regulations.

In order to achieve this, it must be demonstrated that:

- The activity is one of the licensable purposes listed in Regulation 44;
- There is no satisfactory alternative; and
- That the action authorised will not be detrimental to the maintenance of the population of the species concerned at a favourable conservation status in their natural range (MS 2012a, SNH 2014b).

European Protected Species licensing in Scottish waters of commercial activities such as seismic surveying or testing, or installing renewable energy devices in inshore waters, and imperative reasons of overriding public interest which might affect cetaceans is the responsibility Marine Scotland (SNH 2014a). Marine Scotland may seek advice from SNH and/or JNCC.

Licences can only be issued for specific purposes (SNH 2014b). Under Regulation 44(2) these are as follows:

- Science, research and education,

- Ringing, marking or examining rings or marks,
- Conserving wild birds, wild animals or wild plants or introducing them to particular areas,
- Collecting zoological or botanical collections,
- 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,
- Preventing the spread of disease,
- Preventing serious damage to livestock, foodstuffs for livestock, crops, fruit, growing timber, or any other form of property or to fisheries.

4 Licensing Process

Marine Scotland have issued guidance on the EPS licensing process for areas both within and outwith 12 nm (Figure 1) (MS 2012b, MS 2014).

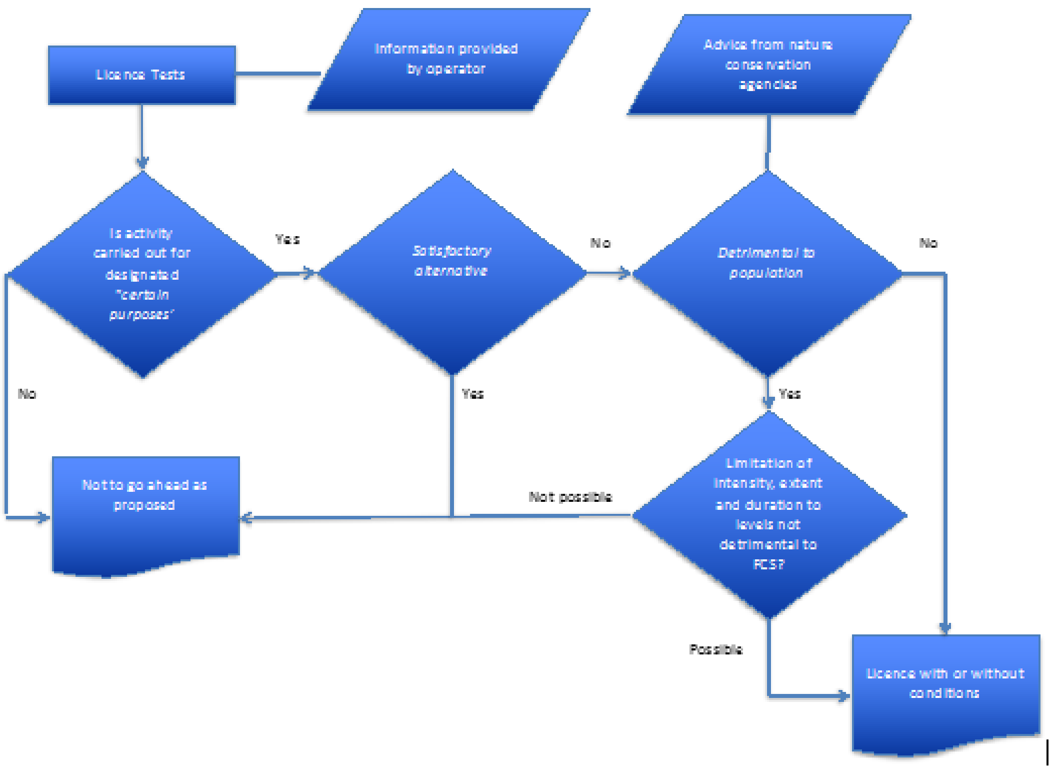

Figure 1: EPS Licensing Process (MS 2012b).

4.1 Applicant

The applicant for the European Protected Species License is Dragados UK Limited.

Dragados UK Limited recognise that as the licensee, it is responsible for ensuring compliance with the licence and its conditions.

4.2 Details of Previous Relevant Licences

The European Protected Species licence MS EPS 06/2018/1 was issued to Dragados UK on 15 October 2018, valid until 27 February 2020[1].

5 Other Developments

A review of potentially developments within the area has been undertaken to assess potential for cumulative impacts on marine mammals.

The existing Aberdeen Harbour carries out an annual maintenance dredging campaign typically in the Spring. This activity was considered as part of the baseline of activities occurring around the AHEP project in the AHEP EIA. Aberdeen Harbour Board (AHB) adhere to the marine mammal mitigation measures similar to that followed by AHEP including a 20 minute watch at the deposit site (CR110). Whilst maintenance dredging within the existing Aberdeen Harbour may coincide with activities at Nigg Bay, it is considered that if marine mammals are disturbed by the use of Acoustic Deterrent Devices (ADD's) during blasting they will not also encounter disturbance from AHB activities as it is assumed they will be disturbed away from the harbour area by other ongoing AHEP activities previously subject to an EPS licence.

Dragados have been in continued correspondence with Kincardine Offshore Wind Ltd (KOWL). The proposed activities at Kincardine Offshore wind farm do not include pile-driving or blasting. The loudest planned activities associated with the construction of the wind farm are trenching and rock dumping along the cable routes. The ES precited noise impacts could cause displacement behaviour by EPS out to 140 m from these activities. Construction is planned to start no sooner than 2020 and therefore there may be limited temporal and spatial overlap with Kincardine offshore wind farm and the Aberdeen Harbour expansion project. However, the very localised area across which disturbance is predicted to occur indicates that any potential cumulative impacts will be negligible.

It is not known if there will be any UXO clearance associated with the construction of the wind farm and if so, when this would be undertaken. Any future UXO clearance will be subject to a Marine Licence and its own assessment at the time the application is made.

Moray Offshore Renewables Ltd. are planning to develop two offshore windfarms clusters in the Moray Firth – Moray East Offshore Windfarm and Moray West Offshore Windfarm. The Moray Offshore West Project is currently at the consenting stage and construction is unlikely to commence prior to 2022, which is two years after the completion of AHEP.

Moray East was awarded consent for construction of up to 1,116 MW in 2016, with a Contract for Difference (CfD) for 950MW awarded in 2017. Construction is due to commence in 2019, with the installations of foundations from July 2019 to June 2020 (MOWL 2018a). Following the undertaking of an Appropriate Assessment a Marine Licence has been issued to undertake UXO clearance within the site between March 2019 and May 2019. The Appropriate Assessment concludes that there will be no in-combination impacts between the clearance of UXO and the AHEP (MS 2019). Furthermore, the UXO clearance is planned to be completed by 31 May 2019 and therefore there will be no temporal overlap in activities.

There is potential for a temporal overlap in activities during construction of Moray East Offshore Wind Farm. The spatial extent of impacts from the construction activities are not predicted to overlap, although could impact on the same EPS populations. Population modelling undertaken to support this application include the cumulative impacts from construction activities at Moray East Wind Farm and indicate that there will be no changes in the populations of any EPS and therefore no cumulative impacts that will affect the Conservation Status of any EPS (OSC 2019a).

[1] European Protected Species Licence MS EPS 27/2017/0 granted to Dragados UK Ltd from 04 September 2017 to 31 October 2017 can be viewed at http://www.gov.scot/Resource/0052/00527039.pdf. Accessed 17/01/2018.

Beatrice Offshore Windfarm Limited (BOWL) is a 588 MW wind farm project in the Moray Firth. BOWL has completed pile-driving operations and following the installation of the wind turbines the wind farm will be fully operational in 2019. Now the piling operations are completed, it is unlikely that any construction operations associated with BOWL have the potential for cumulative impacts on marine mammals alongside AHEP.

There are a number of consented wind farm developments within the Firth of Forth, namely Seagreen Alpha and Bravo, Inch Cape and Neart na Gaoithe. Of these three projects, Neart na Gaoithe is the only project to have received a Contract for Difference and consequently likely to proceed to the construction stage in the foreseeable future. According to the Indicative construction programme in the Neart na Gaoithe Environmental Impact Assessment Report (March 2018) submitted to Marine Scotland, offshore piling is scheduled to commence in Q4 2021. By this date all dredging and blasting will be likely have been completed at AHEP, meaning there is unlikely to be any cumulative impacts with activities at Neart na Gaoithe.

In conclusion, whilst there are a number of large infrastructure projects occurring in Scottish Waters from the Moray Firth to Firth of Forth, due to the exact timing of activities, the nature of the work being undertaken and the mitigation implemented by developers, cumulative impacts on marine mammals are not predicted.

6 Proposed Works

The following provides a summary of the project and information on the proposed works relevant for this EPS Licence application including the increase of blasting charge weight and blasting duration that is the subject of this variation. Further information on the project can be found in the Environmental Statement and associated additional information submitted in support of the application (Fugro 2015, Aberdeen Harbour 2016a) and the Construction Method Statement submitted to Marine Scotland and SNH as part of the Construction Environmental Management Document (CEMD) which was approved in May 2017. An updated version of the CEMD has been submitted in February 2019 incorporating mitigation measures for the proposed changes. Further information was produced to assess the impacts from the increase in blast charge weight and blasting duration in the Environmental Impact Assessment Report (EIAR, Fugro, February 2019) which supports this application.

The proposed Aberdeen Harbour Expansion lies within Nigg Bay, south of the existing Aberdeen Harbour. The project comprises the construction of two breakwaters (North and South), three quays (North, East and West) and associated infrastructure as detailed in Figure 2 below.

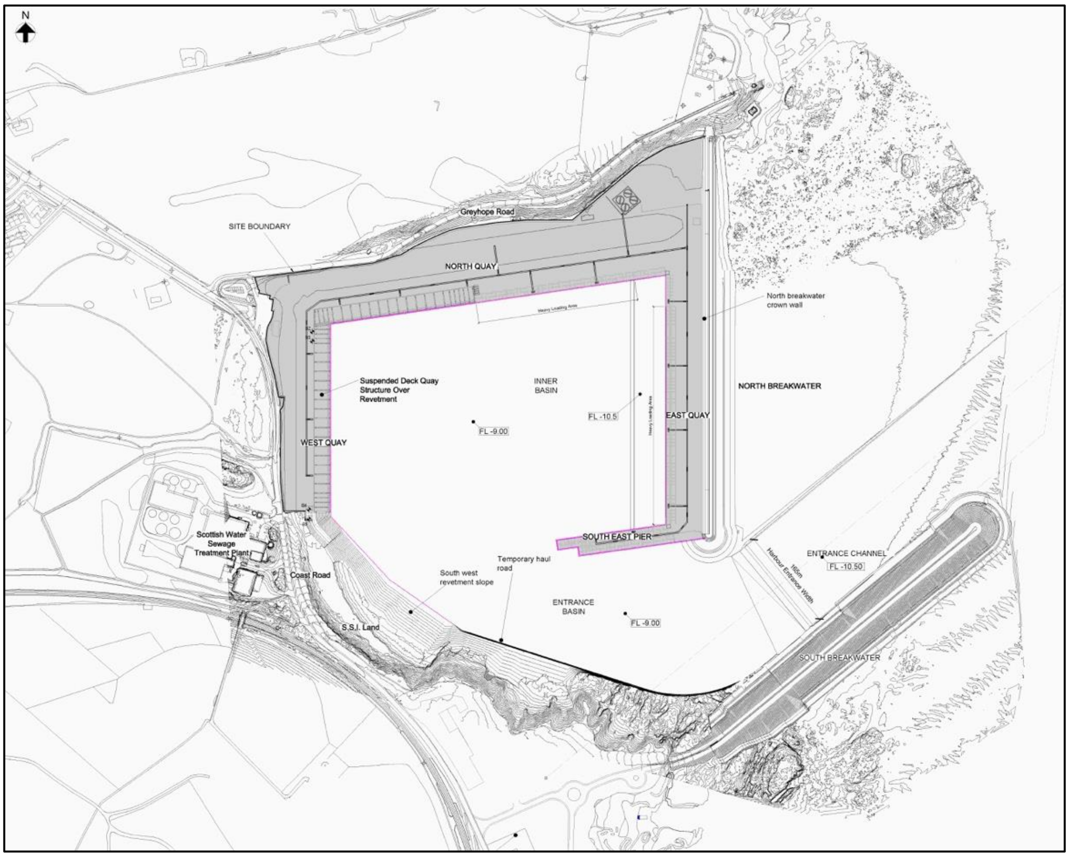

Figure 2: The proposed Aberdeen Harbour Expansion Project.

For the avoidance of doubt, there will be no impact piling in the marine environment (below Mean High Water Springs) associated with the construction of AHEP and as such, this type of operation is not considered further in this EPS application.

6.1 Drill and Blasting

Of the material dredged, an estimated 250,000m^3 will be rock, which will require preparation prior to it being dredged. This entails the use of drilling and blasting under the seabed in order to fracture and loosen the rock for it to be dredged.

Blasting will occur during daylight hours between the hours of 7am to 7pm Monday to Friday and 9am to 4pm on a Saturday. There will be no blasting on a Sunday. Blasting is anticipated to start in March 2020 and potentially continue up to April 2021, depending on the charge weight used.

Blasting will be undertaken from one or two pontoons which will be moved around Nigg Bay to allow for blasting and dredging to take place sequentially and as a continuous process (always within the constraints set within the Marine Licence, Harbour Revision Order and Construction Environmental Management Documents). Blasting will not occur over the whole of the bay but in distinct areas where rock is present (See Figure 3). The southern area of Nigg Bay will be targeted during better weather, when sea conditions are calmer, and the northern area, behind the northern breakwater in rougher weather. This will maximise the use of the pontoons and dredgers and minimise overall time on site.

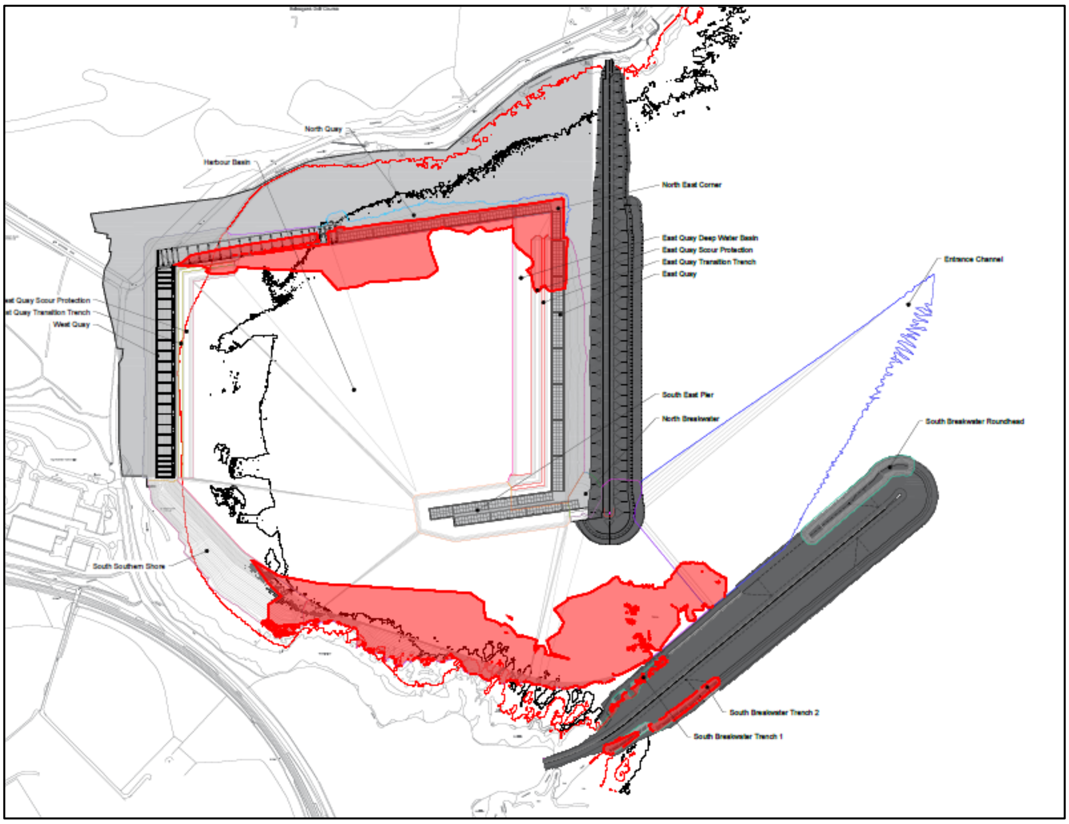

Figure 3: Areas of rock requiring blasting (shown in red).

The working principles for drilling and blasting are as follows:

- Holes will be drilled in the rock prior to charges being placed; and
- A typical field for blasting can be from 25 to 100 holes,

When the drill supervisor has decided that a field is complete, and all the environmental mitigation measures are in place, the field is blasted. Blasting is expected to take place once or a maximum of twice per day with some gaps to allow for dredging of the loosened material. The exact timing will depend on how much material the BHD is able to remove and the results of trial blasting.

The parameters for blasting are: Hole spacing;

- Hole diameter;
- Hole depth to design level;
- Over drill (sub drill);

- Charging the hole with explosives (kg/m3 rock);
- Delay between the rows and delays between the holes; and
- Number of holes in a row, and number of holes in a field.

Prior to the actual blast, agreed and approved safety and warning procedures are followed. For this project the agreed procedures could read as follows:

1. One hour prior to the blast the Blast master alerts the agreed parties of the coming blast;
2. Drill platform / dredger is moved to safe distance from the blast area;
3. Prior to the blast the Blast master informs the Marine Mammal Observer(s) and Passive Acoustic Monitoring (PAM) operator in order that they jointly make sure that environmental mitigation is adhered to and to ensure no marine mammals will be present prior to blasting. This includes a 30 minute watch period for marine mammals during which the MMO/PAM operator will notify Blast Master if any animals are spotted (See Marine Mammal Mitigation Plan within CEMD for details of the MMO and PAM procedures);
4. Noise mitigation measures (bubble curtains) are activated after instruction of the Blast master;
5. Blast master is visually checking the area of blasting, to make sure no ships come near;
6. Blast master has assured himself that no swimmers / divers are in the water of the bay;
7. If there is a vessel approaching (or other activity occurs in or near) the area of blasting, procedure is suspended, until the vessel has left the area;
8. Blast master will make final check with MMO/PAM operator that no marine mammals are present;
9. During the one minute before the blast the crew of the drill/blast platform will signal the load horn using the blasting signal (increasing intervals);
10. Blasting occurs;
11. Immediately after blasting, the crew of the drill/blast platform will signal the “no more danger” signal (one long signal);
12. Bubble curtain switched off, any fish kill etc. or unusual activity recorded;
13. Drill/Blast Platform is put back into position, the Nonell cords are gathered, drilling can be resumed;
14. Blasting/dredging areas where blasting took place, and original depths are not yet restored, shall be marked by yellow buoys;

For areas around the southern slopes of Nigg Bay, it will be possible to undertake blasting from land, although this area is still below mean high water springs and hence part of activities managed through the Marine Licence(s). A haul road would be constructed running along the southern shore and sea protection platforms which the land blasting would be performed from. A similar process to that described for marine blasting will be undertaken, with holes drilled through the platform into the rock layers below and then explosives set into these holes. The same mitigation is provided for land based blasting as with marine blasting, the exact same procedures from stages 1 to 11 above will then be followed and any blasting managed as per the Marine Licence restrictions of a maximum of two blasts across the whole of AHEP per day in daylight hours (with timing restrictions as per the HRO). Once blasting is completed the fractured rock will be used to either create the next stage of the rock platform and ultimately in construction of the harbour such as placement in the southern breakwater or elsewhere.

6.2 Charge weight increase

Presently, 115,000 m^3 of rock is still to be removed by blasting since the blasting programme was suspended following delays caused by adverse weather and technical issues. A charge weight greater than 20 kg will be required to complete the blasting programme. DUK intend to gradually increase charge weights from the initially assessed 20kg in the EIA. Increasing the charge weight will reduce the blasting duration required from an estimated 393 days in the event that charge weight no greater the 20 kg are used to 225 days in the event that 80 kg charge weights are used (Table 1).

Table 1: Anticipated programme of remaining blasting.

Charge Weight (kg)	Planned Start Date	Planned End date (no delays)	Total days needed to complete blasting	End date after delays (approx.) (worst case)
20	15/03/2020	22/11/2020	393	12/04/2021
40	15/03/2020	14/10/2020	333	11/02/2021
50	15/03/2020	25/09/2020	303	12/01/2021
60	15/03/2020	07/09/2020	274	14/12/2020
70	15/03/2020	23/08/2020	251	21/11/2020
75	15/03/2020	14/08/2020	238	08/11/2020
80	15/03/2020	06/08/2020	225	26/10/2020

The final charge weight to be used is 80kg but the upper size will be limited by the need to stay below the currently agreed threshold of 170 dB re 1 µPa rms (equivalent to 183 dB re 1µPa peak) at 400 m from the blast location or outside the bubble curtain, whichever is the greater distance

On the basis of measurements of double bubble curtain (DBC) effectiveness during 2018 blasting, it is estimated that the double bubble curtain attenuation at the time of the issue of the calibration report was 45 dB ±10dB. In addition, it was predicted with a high degree of certainty (97.7%) that the maximum permitted explosive charge weight could be increased to over 100 kg, without exceeding agreed thresholds regardless of double bubble curtain location assuming an attenuation performance of 45 dB.

Therefore, the proposal for incrementally increasing blast weights is divided in two phases;

Phase 1 starts with a charge weight of 20 kg, and then the charge weight is increased to 40 kg in 10 kg increments. During phase 1, six blasts will be undertaken for each charge weight before increasing to the next.

Phase 2 then starts and the charge weight increments are reduced to 5 kg. The number of repetitions with each charge weight remains six before increasing to the next charge weight. The maximum charge weight is 80kg.

The increments are summarized below:

- Phase 1 blasting regime: 20, 30,and 40 kg
- Phase 2 blasting regime: 45, 50, 55, 60, 65, 70, 75 and 80 kg.

After each detonation, if the peak level measured is below the noise threshold (183 dB Peak/170 dB RMS), then the charge weight will be increased to the next increment. All noise measurements will be reported on the same day of the blasting to MS-LOT.

Additional considerations:

A Precautionary Control Limit (PCL) has been defined by AHEP to minimise the chances of reaching the noise threshold. PCL is set as 178 dB Peak/167dB RMS (5dB below peak level threshold (183dB)) and 3dB below RMS threshold (170dB) respectively). The following actions will take place in respect of the PCL.

1 If any noise measurement reaches the PCL (but remains below the noise threshold), all remaining planned blasts for that charge weight will be undertaken. Two scenarios are then contemplated:

  1.1 If the noise measured for the remaining blasts with that same charge size are all below the PCL, the charge size will continue to be gradually incremented but reducing the size of the planned increments by half .i.e. 5 kg instead of 10 kg and so on).

  1.2 If the noise level measured for any of the remaining blasts for that same charge size is again over the PCL, the charge size will not be incremented further.

2 If any noise measurement reaches or exceeds the noise threshold (183 dB Peak/170 dB RMS), the charge size will be reduced by 5 kg. and the blasting plan will continue but all planned increments will be reduced by half (i.e. 2.5 kg instead of 5 kg). The following scenarios are then considered:

  2.1 If all following blasts are below the PCL, the charge weight will continue to be gradually incremented with reduced increments as described above.

  2.2 If any of the following blasts reaches the PCL, the charge weight will not be incremented further.

  2.3 If any of the following blasts reaches the threshold, the charge weight will be further reduced by 5 kg and will remain fixed for all remaining blasts.

Colour	Meaning
Green	Noise level measured below PCL
Amber	Noise level measured over PCL but below RMS/Peak threshold
Red	Noise level measured equal or higher than RMS/Peak threshold

Scenario 1 - No exceedances

Charge size (Kgs.)	20.0	30.0	40.0	45.0	50.0	55.0	60.0	65.0	70.0	75.0	80.0
Blast number	1	7	13	19	25	31	37	43	49	55	61
	2	8	14	20	26	32	38	44	50	56	62
	3	9	15	21	27	33	39	45	51	57	63
	4	10	16	22	28	34	40	46	52	58	64
	5	11	17	23	29	35	41	47	53	59	65
	6	12	18	24	30	36	42	48	54	60	66

Scenario 1.1 - One measurement over PCL

Charge size (Kgs.)	20.0	30.0	40.0	45.0	50.0	52.5	55.0	57.5	60.0	62.5	65.0	67.5	70.0	72.5	75.0	77.5	80.0
Blast number	1	7	13	19	25	31	37	43	49	55	61	67	73	79	85	91	97
	2	8	14	20	26	32	38	44	50	56	62	68	74	80	86	92	98
	3	9	15	21	27	33	39	45	51	57	63	69	75	81	87	93	99
	4	10	16	22	28	34	40	46	52	58	64	70	76	82	88	94	100
	5	11	17	23	29	35	41	47	53	59	65	71	77	83	89	95	101
	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102

Scenario 1.2. - Two measurements over PCL

Charge size (Kgs.)	20.0	30.0	40.0	45.0	50.0	55.0	55.0	55.0	55.0	55.0	55.0
Blast number	1	7	13	19	25	31	37	43	49	55	61
	2	8	14	20	26	32	38	44	50	56	62
	3	9	15	21	27	33	39	45	51	57	63
	4	10	16	22	28	34	40	46	52	58	64

Scenario 2.1 - One exceedance, then always below PCL

Charge size (Kgs.)	20.0	30.0	40.0	45.0	50.0	55	60.0	55	57.5	60.0	62.5	65	67.5	70.0	72.6	75.0	77.5	80.0
Blast number	1	7	13	19	25	31	37	43	49	55	61	67	73	79	85	91	97	103
	2	8	14	20	26	32	38	44	50	56	62	68	74	80	86	92	98	104
	3	9	15	21	27	33	39	45	51	57	63	69	75	81	87	93	99	105
	4	10	16	22	28	34	40	46	52	58	64	70	76	82	88	94	100	106
	5	11	17	23	29	35	41	47	53	59	65	71	77	83	89	95	101	107
	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108

Scenario 2.2 - One exceedance, one subsequent measurement over PCL

Charge size (Kgs.)	20.0	30.0	40.0	45.0	50.0	55	60.0	55	55	55	55
Blast number	1	7	13	19	25	31	37	43	49	55	61
	2	8	14	20	26	32	38	44	50	56	62
	3	9	15	21	27	33	39	45	51	57	63
	4	10	16	22	28	34	40	46	52	58	64
	5	11	17	23	29	35	41	47	53	59	65
	6	12	18	24	30	36	42	48	54	60	66

Scenario 2.3 - One threshold exceedance, one subsequent measurement over threshold

Charge size (Kgs.)	20.0	30.0	40.0	45.0	50.0	55	60.0	55	50	50	50
	1	7	13	19	25	31	37	43	49	55	61

Blast number										
2	8	14	20	26	32	38	44	50	56	62
3	9	15	21	27	33	39	45	51	57	63
4	10	16	22	28	34	40	46	52	58	64
5	11	17	23	29	35	41	47	53	59	65
6	12	18	24	30	36	42	48	54	60	66

6.2.1 Breaking rock by mechanical means

In periods where the blasting is not permitted and where volume of rock is too small to justify blasting, it is possible to loosen rock by mechanicals means. Proposed means are, but not limited to:

- Xcentric Ripper 120 – above and below water;
- Gravity fall rock breaker to be used from crane – above and below water;
- Hydraulic breaker to be used with excavator – above and below water;

The exact specifications of the requirement may change depending on success of the rock removal process.

During first use of mechanical means to loosen rock below water, noise monitoring will be carried out when in use at full power and a report will be issued to MS-LOT within 72 hours. UWN monitoring will be discontinued if noise levels are below noise benchmark following discussions with MS-LOT.

6.3 Dredging and Deposit

The seabed within the harbour will be dredged to a depth of 9 m below Chart Datum (CD) with areas beneath the breakwaters/quays dredged to a maximum of 15.24 m below CD. The dredged material will, if suitable, be used for the construction of the breakwaters or if not suitable deposited at a licensed deposit site. A maximum of 2,850,000 m^3 of material will be dredged during the course of construction with a least 660,000 m^3 reused. A maximum of 2,190,000 m^3 of capital dredge material will be deposited at the offshore deposit site.

Dredging will be undertaken using a combination of Cutter Suction Dredger (CSD), Trailing Suction Hopper Dredger (TSHD) and a Back Hoe Dredger (BHD) and a Drum Cutter. The CSD/TSHD will remove loose material such as sands and gravels followed by the BHD which will remove harder materials such as glacial tills. A CSD may also be used to remove the glacial tills. The BHD will also remove rock after fracturing by blasting. The Drum Cutter will create trenches close to the breakwaters, sculpt the southern shore slopes and, if required, remove rock peaks (see Section 6.3.1 for further details).

Dredging commenced in late March 2018 and will continue until End of 2021

The spread of dredging vessels is likely to consist of:

- 1 Trailer Suction Hopper Dredger,
- 1 Cutter Suction Dredger,
- Maximum of 6 Back Hoe Dredgers,
- Maximum of 17 Split Hopper Barges.
- Maximum of 4 Flat top barge
- Maximum of 4 Split hopper dredger,
- Various support vessels (tugboats, multi-cat type vessels)

Dredging will be undertaken throughout the Nigg Bay area and the timing and type and number of dredgers used is planned to facilitate other construction activities such as blasting and caisson, breakwater and quayside installation.

6.3.1 Drum cutter

It is necessary to create trenches close to the northern and southern breakwaters where material, such as concrete blocks, will be placed to create a barrier for the breakwater material to rest against. In the area to the south of bay it will also be necessary to create a slope of varying angles to minimise the reflection of water, and thus movements within the completed harbour. Where blasting cannot be used to achieve these trenches/slopes, a drum cutter will be used.

A drum cutter is an hydraulic cutting unit consisting of rotating rock cutting drums fitted with picks which are used to undertake rock grinding, trenching and scaling. Rockwheels are used as an attachment to a hydraulic excavator and are available in various sizes, to fit a range of machines, and to suit the specific application and ground conditions. The drum cutter has been described as a mini CSD.

At AHEP, a rock berm will be constructed in all areas, either consisting of the breakwaters, or in the southern slopes of the bay, a temporary rock berm. Once the platform has been established, an excavator with a drum cutter attached will be positioned at the top of the platform (See Figure 4).

Figure 4: Example of a drum cutter.

By sweeping slowly with the drum cutter over the bedrock, material will be grinded to the required design. The fractured particles will then be excavated using a BHD or long reach excavator and reused during construction.

Drum cutter operations will take place for approximately 2 weeks at the northern breakwater and 11 weeks at the southern breakwater and intermittently for approximately 10 weeks at the southern shore area. It may be necessary to use the drum cutter in other areas to remove peaks in rock formations instead of using blasting, which could over fracture rock.

6.4 Vessel Activity

From March 2018 until the end of construction there will be a variety of vessels used during construction. These will include dredgers, hopper barges, multi-cats including survey and safety vessels, tugs and vessels associated with the installation of caissons such as barges. These vessels will operate mainly from the existing harbour and follow all required safety and environmental codes.

6.5 Acoustic Deterrent Device

The use of an ADD is required to ensure no seals are present within the mitigation zone, of the blasting activities. It has previously been agreed that the use of an ADD is not required for the protection of EPS present within the area as other mitigation measures, e.g. the use of bubble curtains and PAM and MMO monitoring are in place to effectively reduce the risk. However, grey seals have been observed within Nigg Bay during the construction of the breakwaters and during dredging activities. They have been observed within 600 m of the planned blasting operations in the North Breakwater area and are located adjacent to the Southern Trench blasting areas and are preventing blasting works progressing. Consequently, additional mitigation is required. The use of an ADD 'seal scarer' has been advised by SNH as mitigation to reduce the risk of seals being present within the area during blasting operations.

The ADD will be used for all marine blasting works and any blasting from land that is below the MHWS if only seals are present.

The ADD being proposed to be used is developed by Lofitech and has previously been used as a deterrent device during the construction of the Beatrice Offshore Wind Farm. It will be used when seals are present for the duration of all blasting activities in the marine area.

The ADD will be located on a vessel which will be at anchor within Nigg Bay. The exact location of the ADD will vary depending on where blasting activities are being undertaken within Nigg Bay and the location of any seals. A separate vessel from that used by the PAM operators will be used for the deployment of the ADD. However, the operation of the ADD will be controlled by the Lead PAM operator.

If seals are present the following protocol will be followed and adhered too when using ADD.

- Prior to blasting the MMO/PAM will undertake a minimum 30 minute watch for all marine mammals out to 1 km to confirm there are no marine mammals present.
- If seals are observed within the mitigation zone after this 30 minute observation period and no other marine mammals are present the ADD seal scarer will be activated until seals are observed to swim away and beyond the mitigation zone.
- The mitigation zone for seals in the East, North Quay areas will be the bubble curtain as identified by the blue line in Figure 5 below. The Southern Trench & Southern Shore mitigation boundary will be following agreement with MS-LOT on approval of the Southern Breakwater & Shore Blasting Methodology Environmental Mitigation Rev02.
- The ADD will located on an anchored vessel at a distance of 100 m from any seal activity. Dependant on the water depth the ADD will be positioned mid –water. Vessels must not harass or approach the seals in an attempt to herd the seals out of the area.
- The audio frequency of the proposed ADD is 14 kHz.

- Initially a soft start procedure will be used with the ADD activated for short bursts, consisting of a few minutes, before ramping up to the full activation period detailed below.
- The ADD will be activated for a maximum 20 minute period and will only be attempted twice within any one blasting operation, if this is not effective then use of the ADD will be ceased for that blasting operation.
- Reports will be sent every 2 weeks to SNH and MS-LOT which will contain details of when the ADD’s were in operation, the efficiency of the ADD’s and the effect this had on the seals behaviour during and after use.
- Following confirmation by the MMO/PAM that no marine mammals are within 1 km of the blasting activities and no seals are within bubble curtain boundary, the bubble curtain will be switched on and blasting procedures (as described above from point four onwards) will commence.
- The MMO/PAM will continue observations during blasting and for at least 20 minutes post blasting.
- All observations will be recorded and reported.
- If the ADD appears to be ineffective or seals show habituation MS-LOT will be consulted immediately to discuss further mitigation measures.
- Note ADDS will only be used for Marine Blasting and any blasting from Land that is below MHWS and when seals are present in the blast mitigation zone.

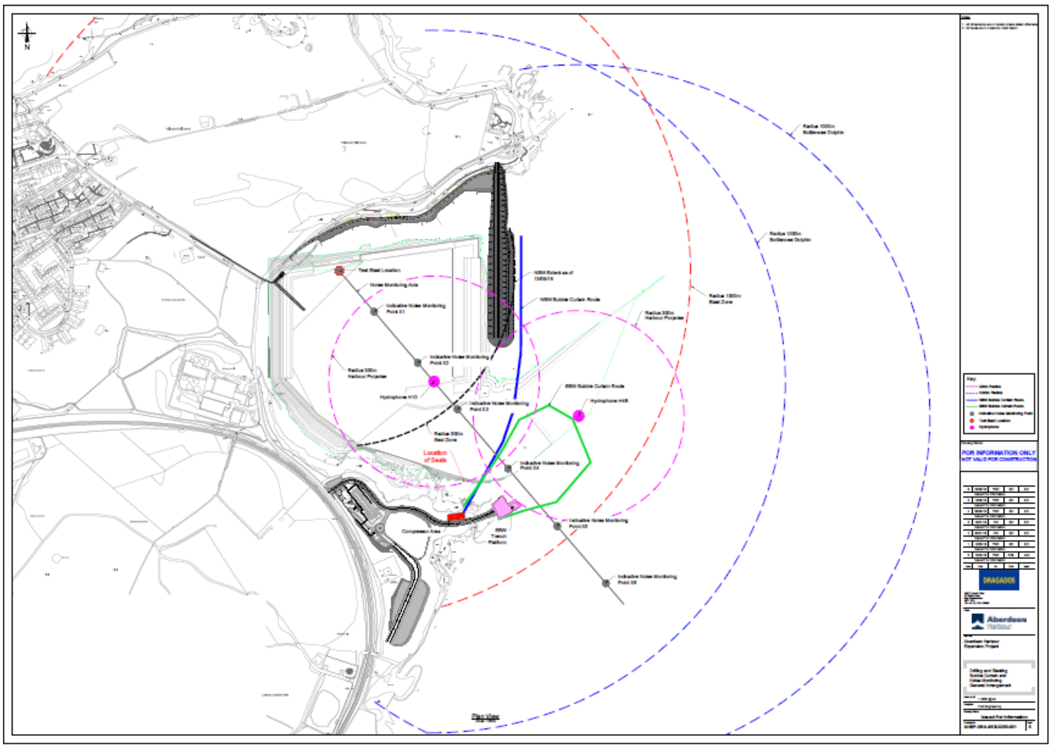

Figure 5: Drilling and blasting mitigation.

6.6 Programme of works – 2019

The planned programme of works for 2019/2021 is presented in Figure 6. Dredging is planned to continue throughout 2019 and 2020 with blasting planned to be undertaken from March 2020. However, the duration of blasting is variable depending on a number of factors including the weight of the charge .

AHEP - Main Construction Activities Schedule - 6 Month Look Ahead

ID	Task Name	Start	Finish
1	**AHEP - Streamline Summary Schedule - Construction 1st half of 2020**		
2	**Dredging & Blasting**	**29/01/19**	**12/02/21**
3	Soft Dredging - Seasons 2019 and 2020	20/05/19	14/12/20
4	Rock removal by marine mechanical means - Seasons 2019 and 2020	29/01/19	14/04/20
5	Marine D&B - 2019 season & onwards	15/04/20	05/02/21
6	Land D&B - 2020 Season & onwards	22/04/20	12/02/21
7	North Breakwater (inc. Crownwall) - Land Works - 2019 onwards	05/04/19	27/05/21
8	South Breakwater - Land & Marine Works - 2020 season	13/05/20	16/11/20
9	South East Pier - Marine works	11/09/19	27/02/21
10	East Quay & North Closed Quay - Marine Works	29/11/18	30/09/20
11	West Open Quay & North Open Quay construction	05/03/18	29/04/21

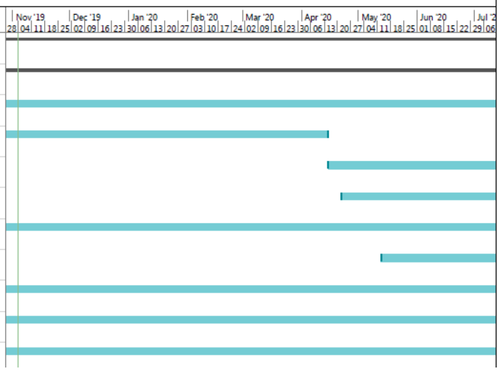

Figure 6: Programme of works during 2019/2020 showing period when blasting is planned to be undertaken.

7 European Protected Species Recorded in the Vicinity of AHEP

Marine mammal surveys were undertaken using visual observations from vantage points between June 2014 and May 2015 and passive acoustic monitoring using two C-PODs between August 2014 and August 2015 (Figure 7).

Further information on the survey methods used to collect data on marine mammals can be found within the Environmental Statement: Chapter 15 Marine Mammals and Appendix 15a Baseline Distribution of Marine Mammals Using Integrated Passive Acoustic and Visual Data for Nigg Bay (Clarkin and McMullan 2015, Fugro 2015).

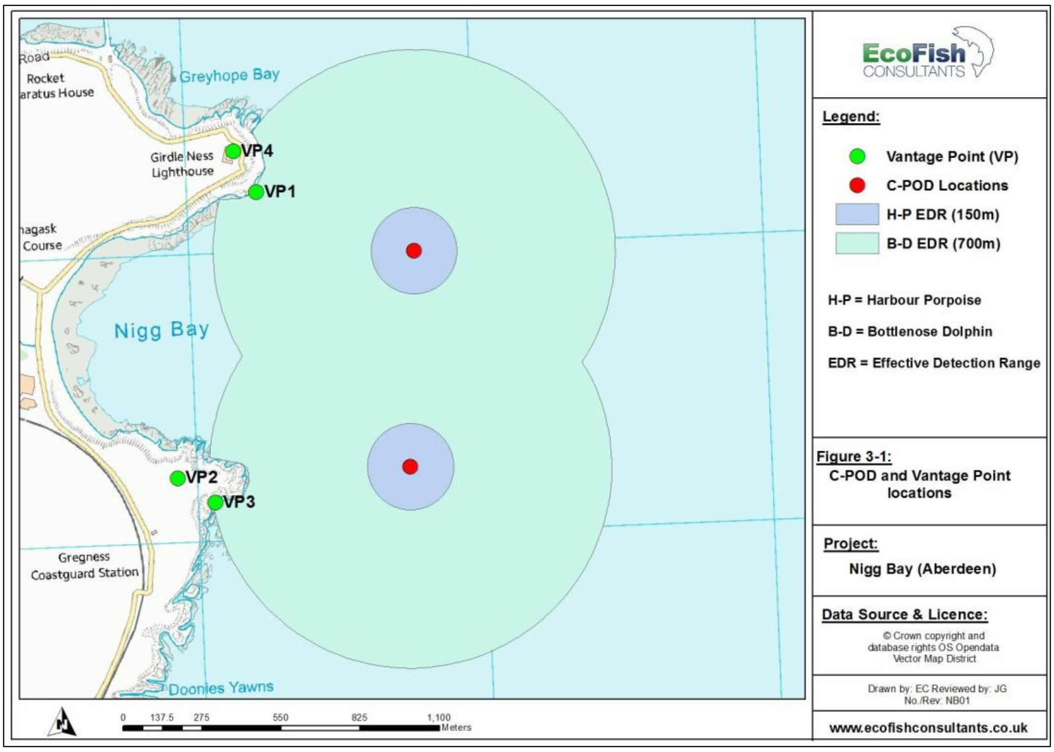

Figure 7: Vantage point and C-POD locations used to obtain baseline marine mammal data at Nigg Bay (Source: Clarkin and McMullan 2015).

The European Protected Species recorded each month during vantage point surveys are presented in Table 2 and during pre-construction baseline C-POD surveys in Table 3.

Table 2: Number of EPS recorded each month during vantage point surveys undertaken between June 2014 and May 2015.

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Harbour porpoise	1	1	0	12	7	14	10	7	8	2	0	0	62
Bottlenose dolphin	13	17	33	31	23	52	0	0	18	11	0	7	205
White-beaked dolphin	0	0	0	0	0	0	3	0	0	0	0	0	3

Table 3: Proportion of hours harbour porpoise and dolphin Sp. were detected at two C-PODs located within Nigg Bay, Aberdeen 2014 and 2015.

Species	C-Pod location	% hours recorded				
		1	2	3	4	5
		Aug – Oct 2014	Nov – Feb 2015	Feb – Apr 2015	Apr – Jun 2015	Jun – Aug 2015
Harbour porpoise	North	50	59.43	65	12.7	46.1
	South	62.6	65.22	63.5	16.7	66
Dolphin Sp.	North	3.7	3.58	5.4	9.9	4.4
	South	2.38	4.79	7	13.3	4.8

The results from site specific vantage point and C-POD surveys recorded three European Protected Species:

- Harbour porpoise *(Phocoena phocoena)*;
- Bottlenose dolphin *(Tursiops truncatus)*; and
- White-beaked dolphin *(Lagenorhynchus albirostris)*.

However, both Risso's dolphin and minke whale are known to occasionally occur in the region (AOWFL 2012, Reid *et al.* 2003) and consequently are considered in this application.

Since April 2018 two C-PODs have been deployed in Nigg Bay (one to the north and one to the south) to continuously record cetacean presence around the AHEP during construction. The data (click trains) are periodically downloaded from the C-PODs and reported as detection positive hours (DPH) for dolphin and porpoise (please note species of dolphins were not differentiated during these C-POD deployments). Currently, four C-COD data downloads and four reports on cetacean presence have been provided as summarised in Table 4.

Table 4: Detection positive hours per day for porpoise and dolphins between April 2018 and May.

Deployment Period	No. Hours Deployed	Concurrent Blasting Activity	Median and Inter- Quartile Range Porpoise DPH	Median and Inter-Quartile Range Dolphin DPH
27/04/18 - 06/05/18	216	No blasting undertaken during deployment	3 (2-4) (north) 5 (3.25-6) (south)	3.5 (3-5) (north) 4.0 (3-4) (south)
03/08/18 – 06/09/18	810	20/08/18 (1951 BST) 24/08/18 (1303 BST) 06/09/18 (1901 BST)	10 (7-15 (north) 10 (7-14.5) (south)	1 (0-2.5 (north) 2 (0-3) (south)
06/09/18 - 27/10/18 06/06/18 – 12/10/18*	1,222	12/09/18 (1030 BST) 14/09/18 (1305 BST) 17/09/18 (1642 BST) 08/10/18 (1701 UTC) 13/10/10 (0942 UTC) 17/10/18 (1149 UTC) 25/10/18 (0813 UTC)	10 (7-14 (north) 5 (3-7) (south)	0 (0-1) (north) 0 (0-2) (south)
08/12/18 – 10/01/19	790	17/11/18 (1356 UTC) 24/11/18 (0950 UTC)	12 (9-15.75) (south)	1 (0-3) south)
10/01/19 – 31/01/19	499	No blasting undertaken during deployment	18.5 (16 – 21.75) (south)	2 (1–3) (south)
30/01/19 – 25/03/19	1,271	No blasting undertaken during deployment	16 (12.25 – 19) (south)	2 (1-3) (south)
25/03/19 – 07/05/19	1,028	No blasting undertaken during deployment	5.5 (2-16) (south)	2.6 (1-7) (south)

In addition to the C-POD deployments, marine mammal observations (MMO) and passive acoustic monitoring (PAM) were undertaken since 2018 as part of the ongoing licence condition monitoring and mitigation during construction blasting activities at the AHEP. MMO and PAM weekly observations collected during the ongoing works are summarised in Table 5 and shows that bottlenose dolphin have been consistently observed within the vicinity of the AHEP throughout the construction observation period.

Table 5: Summary of weekly observations of marine mammals during AHEP construction (August to October 2018) (Source: Fugro, 2019).

Week commencing	Activity	No. of bottlenose dolphin detections per week	No. of porpoise detections per week
14/08/18	Drilling	30	1
20/08/18	Blasting	10	Faint clicks
27/08/18	-	5	-
03/09/18	Blasting	10	Clicks
10/09/18	Blasting	7	-
17/09/18	Blasting	-	-
24/09/18	Blasting	-	-
26/09/18	Drill/Blasting	17	-
05/10/18	Drill/Blasting	-	1
15/10/18	Drill/Blasting	7	-

7.1 Harbour Porpoise

Harbour porpoise were recorded throughout the year during baseline surveys undertaken in 2014/2015, with peak numbers observed from vantage point surveys undertaken between April and September (Figure 8). However, the proportion of harbour porpoises detected using C-PODs were lowest between April and June with relatively high number of detections recorded throughout the rest of the year (Figure 9).

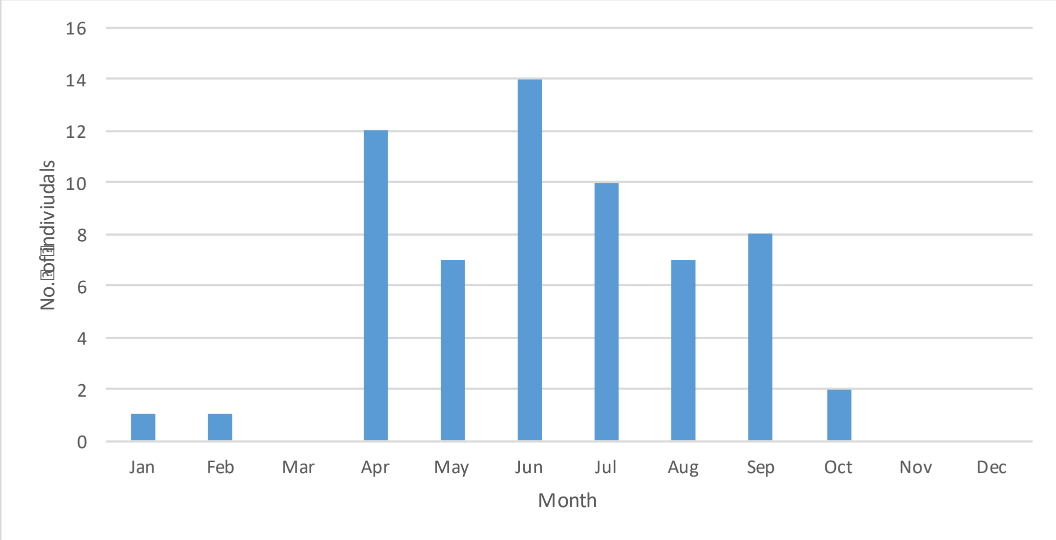

Figure 8: Number of harbour porpoise recorded from vantage point surveys at Nigg Bay during 2014/15.

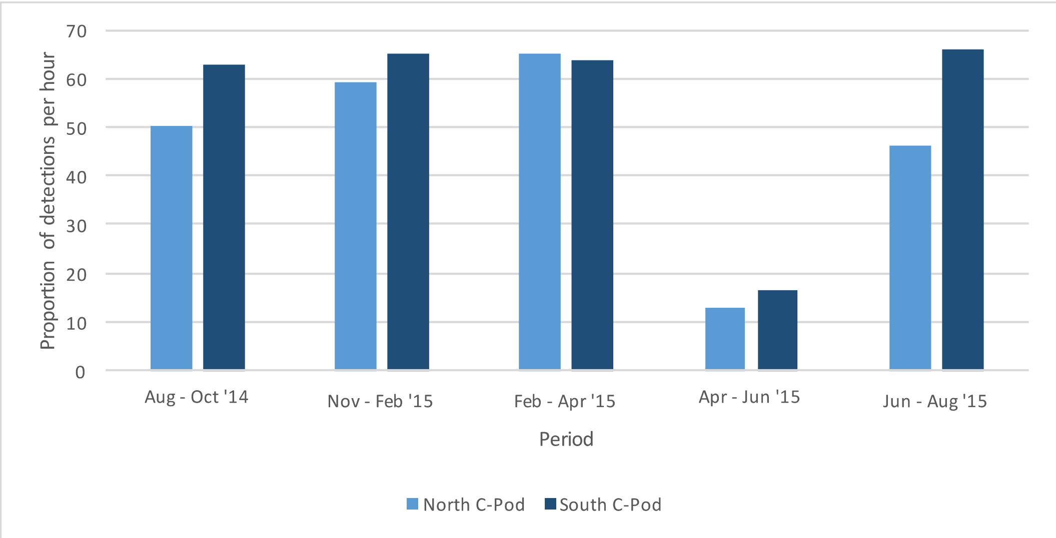

Figure 9: Proportion of harbour porpoise detected each hour from two C-PODs in Nigg Bay during 2014/15.

Harbour porpoise have a very broad distribution across the UKCS, although higher densities occur in areas of upwelling and strong tidal currents and in water depths of predominantly between 20 and 40 m (Clark 2005, Whaley 2004). Their distribution may also be strongly correlated with seabed type, with area of sandy gravel being preferred and this may be linked to prey availability (Clark 2005).

Evidence from surveys undertaken for Aberdeen Offshore Wind Farm indicate that harbour porpoises occur widely across Aberdeen Bay with higher numbers occurring to the north of Aberdeen Bay (Figure 10). Densities of harbour porpoise across Aberdeen Bay varied across the year, with a peak density of 0.92 ind/km2 occurring in January 2008, although typical densities throughout the majority of the year were considerably lower than this, particularly during surveys undertaken in 2010 and 2011 when densities were below 0.2 ind/km^2 (Figure 11 and Figure 12) (AOWFL 2012). SCANS III survey results indicate a regional harbour porpoise density of 0.59 ind/km^2 (Hammond *et al.* 2017).

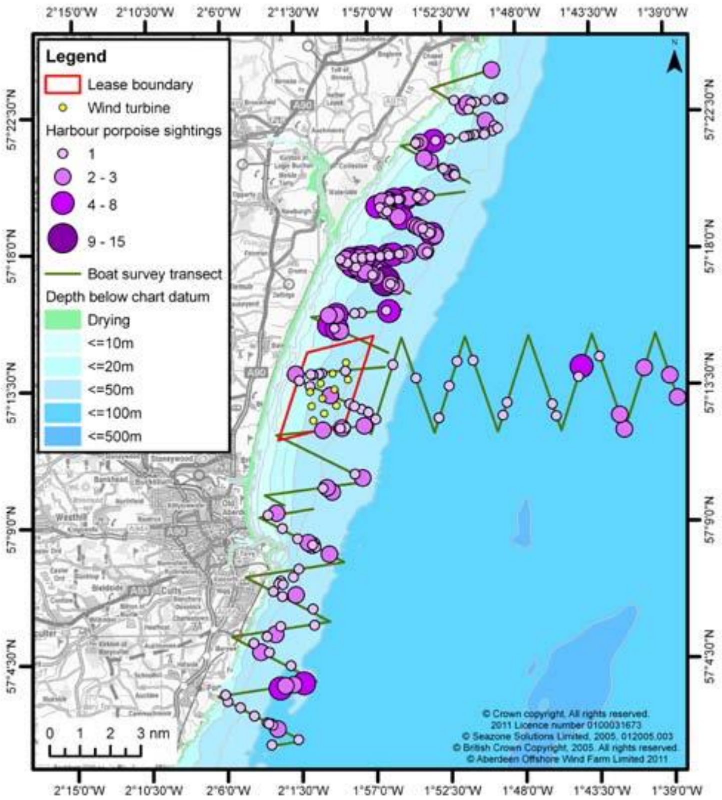

Figure 10: Distribution of harbour porpoise recorded during surveys undertaken in Aberdeen Bay 2010/2011 (Source: AOWFL 2012).

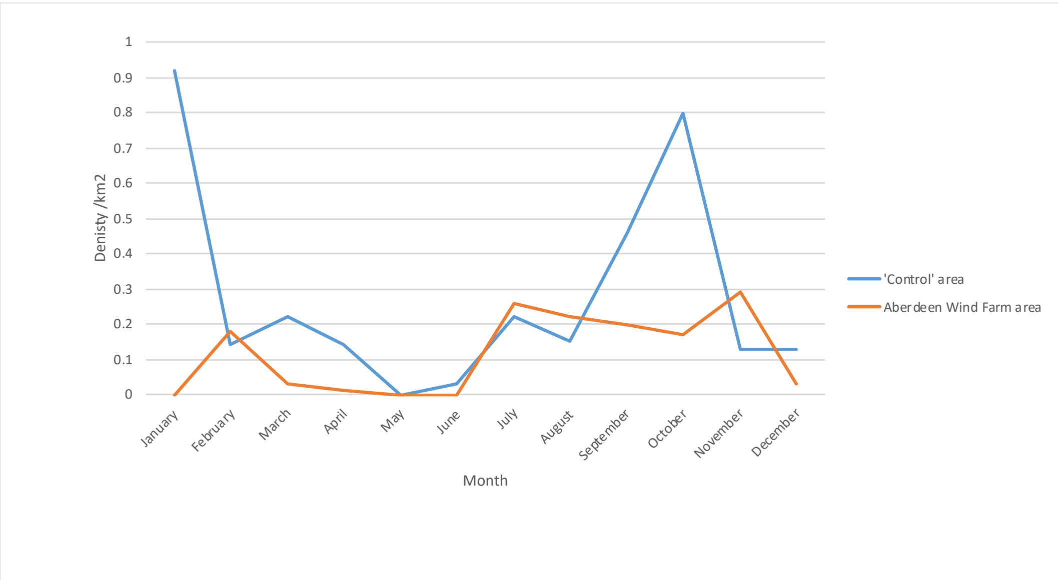

Figure 11: Monthly densities of Harbour porpoise in Aberdeen Bay during 2010-2011 (Source: AOWFL 2012).

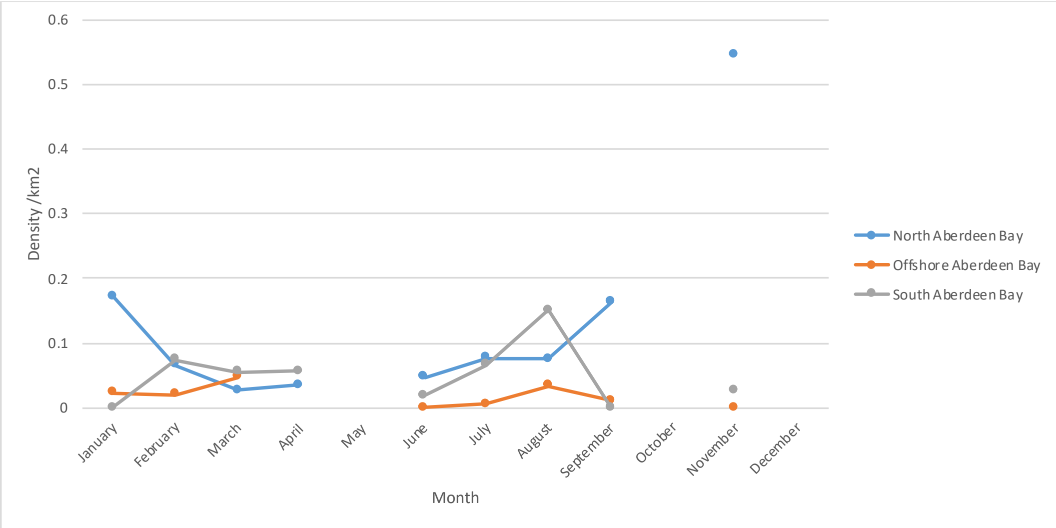

Figure 12: Monthly densities of harbour porpoise in Aberdeen Bay during 2010-2011 (Source: AOWFL 2012).

Figure 13 to Figure 19 present the number of detection positive hours for harbour porpoise during the first, second, third and fourth deployment of the C-PODS in the north and south of Nigg Bay during 2018-2019. The results indicate a relatively low level of harbour porpoise activity during April and beginning of May compared with the rest of the year. The pattern of occurrence reflects that observed during the surveys undertaken during 2014/15.

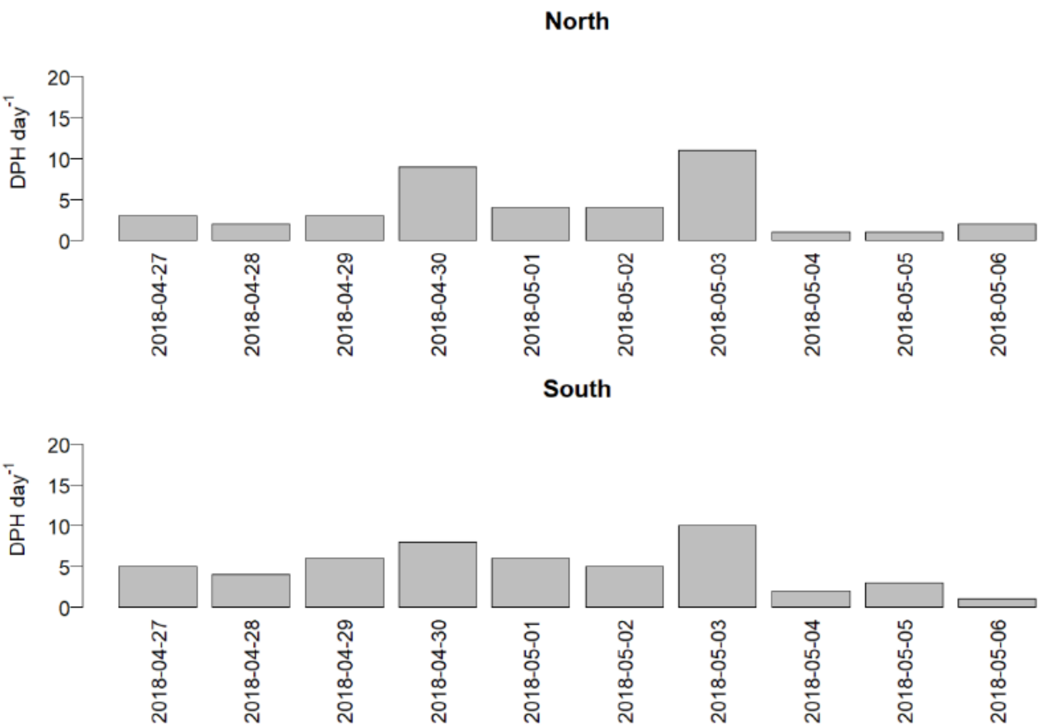

Figure 13: Detection positive hours per day for porpoise during deployment period 1 (27/04/18 – 06/05/18) (Source: OSC 2019b).

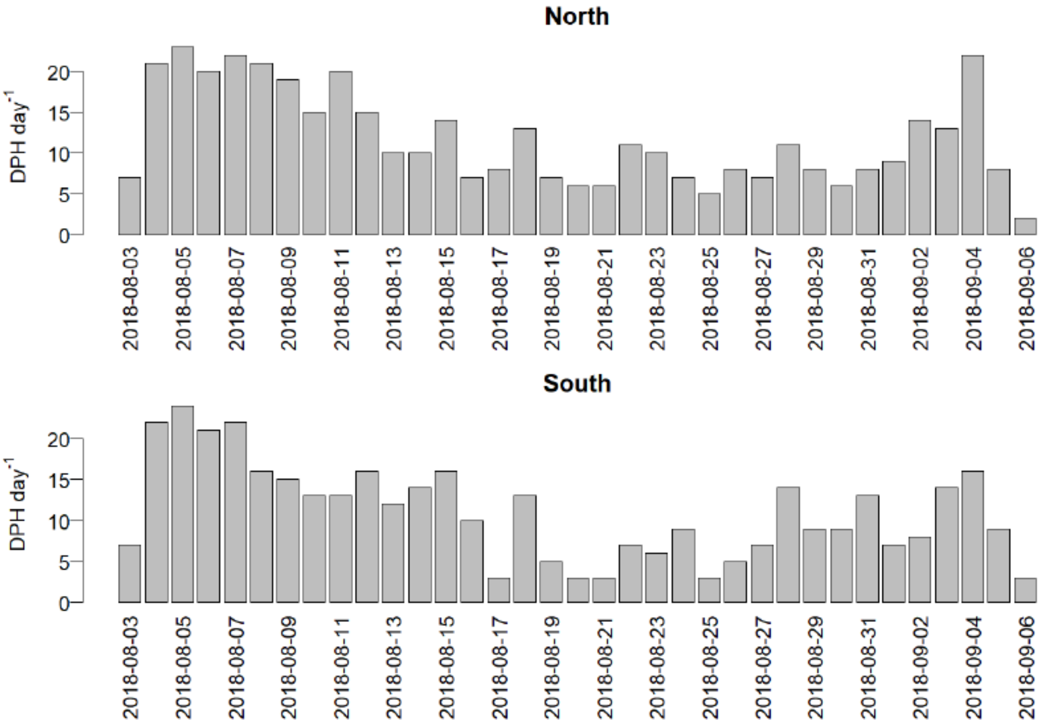

Figure 14: Detection positive hours per day for porpoise during deployment period 2 (03/08/2018 – 06/09/2018) (Source: OSC 2019c).

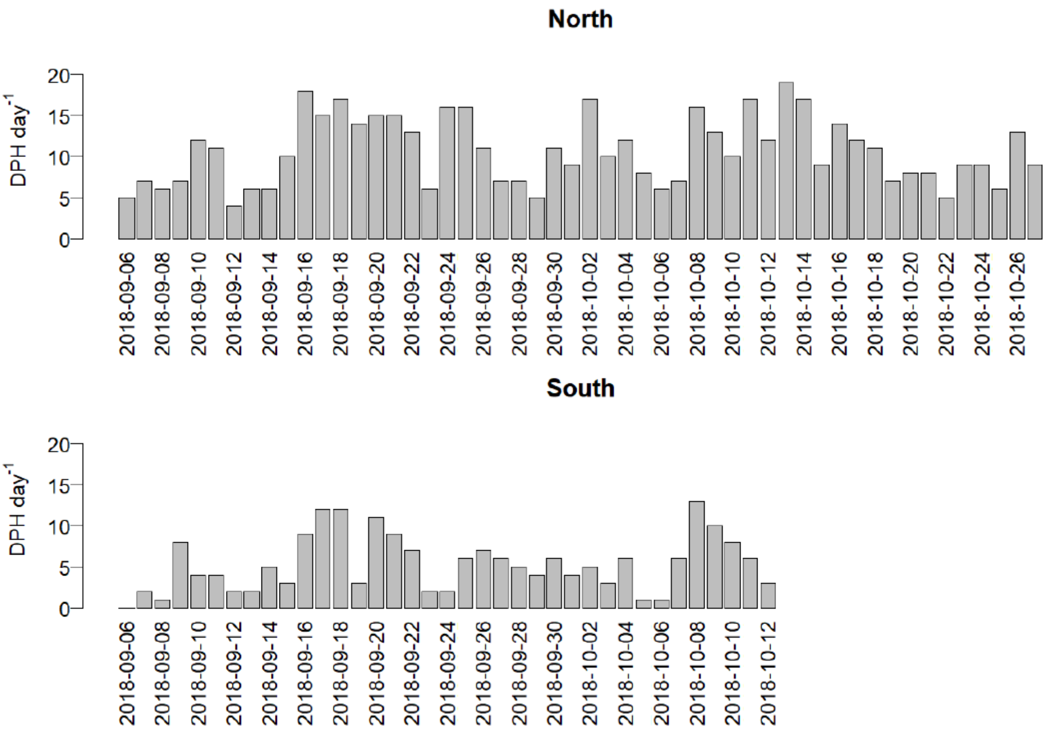

Figure 15: Detection positive hours per day for porpoise during deployment period 3 (06/09/18 – 12/10/18))(Source: OSC 2019d).

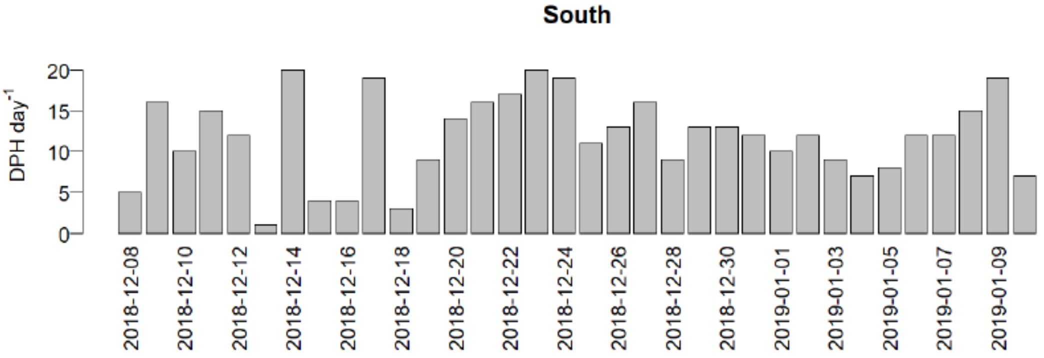

Figure 16: Detection positive hours per day for porpoise during deployment period 4 (8/12/18 – 09/01/19) (Source: OSC 2019e).[2]

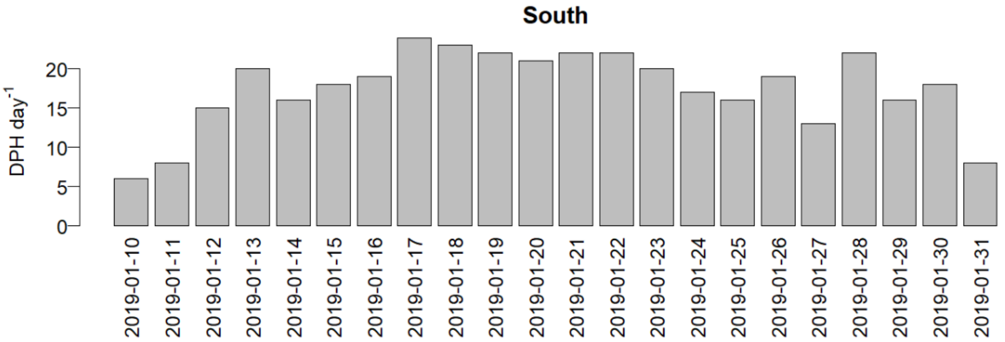

Figure 17: Detection positive hours per day for porpoise during deployment period 5 (10/01/19 – 31/01/19) (Source: OSC 2019f).

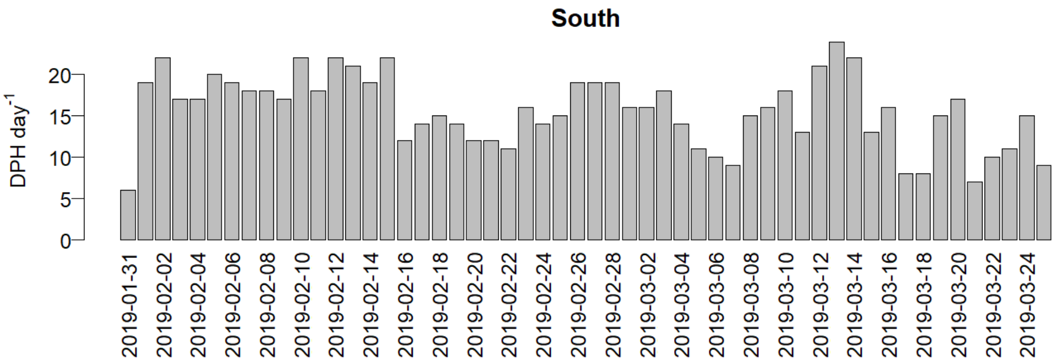

Figure 18: Detection positive hours per day for porpoise during deployment period 5 (31/01/19 – 25/03/19) (Source: OSC 2019g).

[2] Note data from the North CPoD were not retrieved during this deployment period.

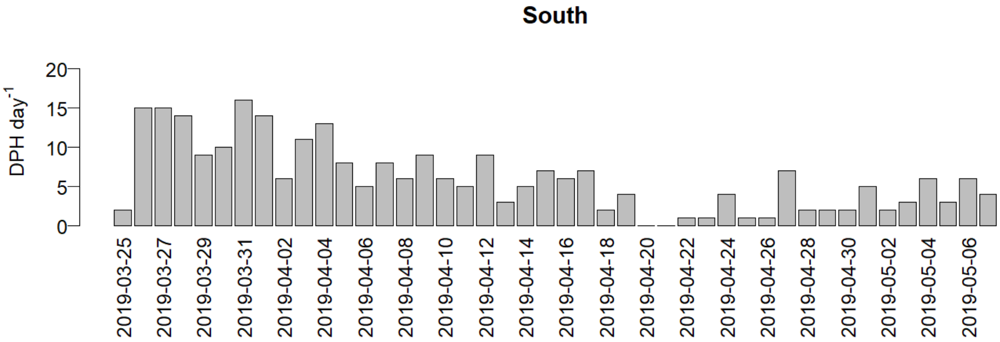

Figure 19: Detection positive hours per day for porpoise during deployment period 5 (25/03/19 – 07/05/19) (Source: OSC 2019h).

Harbour porpoise are opportunistic feeders, foraging close to the seabed or near the sea surface, preying on a wide range of fish species including, herring, cod, whiting and sandeels and their prey will vary during and between seasons (Santos and Pierce 2003). Studies undertaken in Denmark indicate that their local distribution may be correlated with prey availability (Sveegaard 2011).

Breeding is thought to occur primarily during the summer months between May and September, particularly in August, with calving 10 months later. Calves are nursed for eight to ten months but may remain with the mother until a new calf is born (Defra 2015, Lockyer 2003, Weir *et al.* 2007).

Porpoises are generally considered to be 'high frequency' specialists with a relatively poor ability to detect lower frequency sounds (Southall *et al.* 2007). Studies undertaken on captive harbour porpoises indicate that porpoises have a functional hearing range of between 250 Hz and 180 kHz with their best hearing between 16 to 140 kHz and their maximum sensitivity between 100 and 140 kHz. Their ability to detect sound below 16 kHz or above 140 kHz falls sharply (Kastelein *et al.* 2012, 2015, Southall *et al.* 2007).

Harbour porpoise are therefore most sensitive to sound sources between 16 to 140 kHz and, although audible, they are unlikely to be sensitive to sound either above or below those frequencies.

7.2 Bottlenose Dolphin

In Scotland, bottlenose dolphins occur widely along the east coast between the Moray Firth and the Firth of Forth (Figure 20). The main area for bottlenose dolphins in Scotland is the Moray Firth where there is a designated Special Area of Conservation (SAC) (the Moray Firth SAC), for which bottlenose dolphin is a qualifying species. The species is rarely recorded in offshore waters in the North Sea (e.g. Reid *et al.* 2003, Macleod & Sparling 2011) with nearly all sightings of bottlenose dolphin occurring within 2 km of the coast and largely within water depths of less than the 20 m (Brereton *et al.* 2010, Quick *et al.* 2014, Thompson and Brookes 2011).

Within Aberdeen Bay bottlenose dolphins occur primarily between the rivers Don and Dee (Figure 28). Bottlenose dolphin were recorded throughout the year during baseline surveys, with peak numbers recorded during July and August and lower numbers during the autumn and winter months. In contrast, more recent data obtained from vantage point surveys undertaken over a period of 12 months during 2014 and 2015 from Aberdeen Harbour reported highest numbers of bottlenose dolphins occurring between March and June, with no sightings during July and August. Similar results were obtained from the use of two C-PODS over the same period, with lowest number of detections between August and October (Clarkin and McMullan 2015).

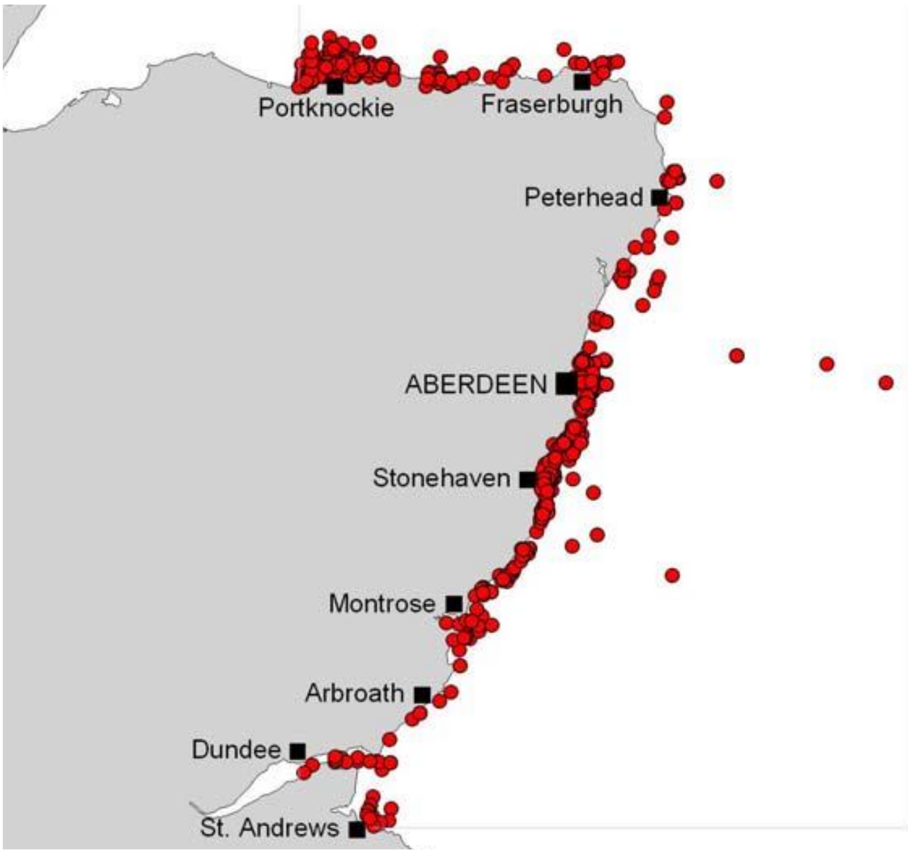

Figure 20: Distribution of bottlenose dolphin between the Moray Firth and Firth of Forth, North-east Scotland (Source: Anderwald and Evans 2010).

Data from C-PODS deployed since April 2018 indicate a relatively constant level of detection across the year. Overall there were relatively few detections each day particularly during September and October when on many days there were no detections (Figure 21 to Figure 27).

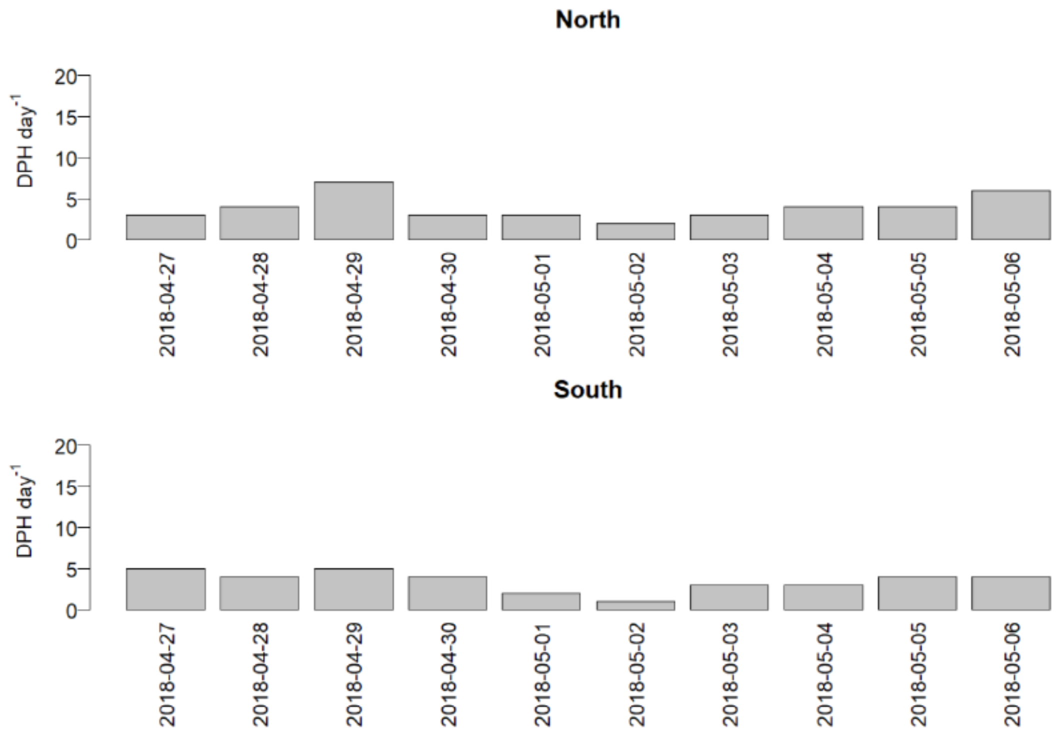

Figure 21: Detection positive hours per day for dolphin during deployment period 1 (27/04/18 – 06/05/18) (Source: OSC 2019b).

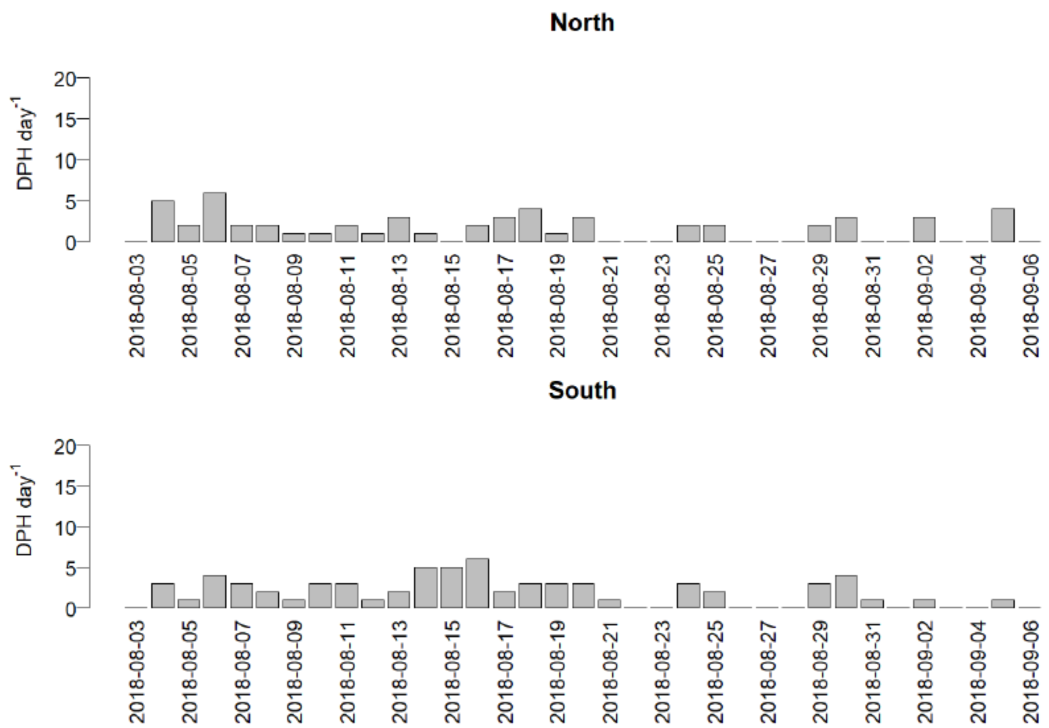

Figure 22: Detection positive hours per day for dolphin during deployment period 2 (03/08/18 – 06/09/18) (Source: OSC 2019c).

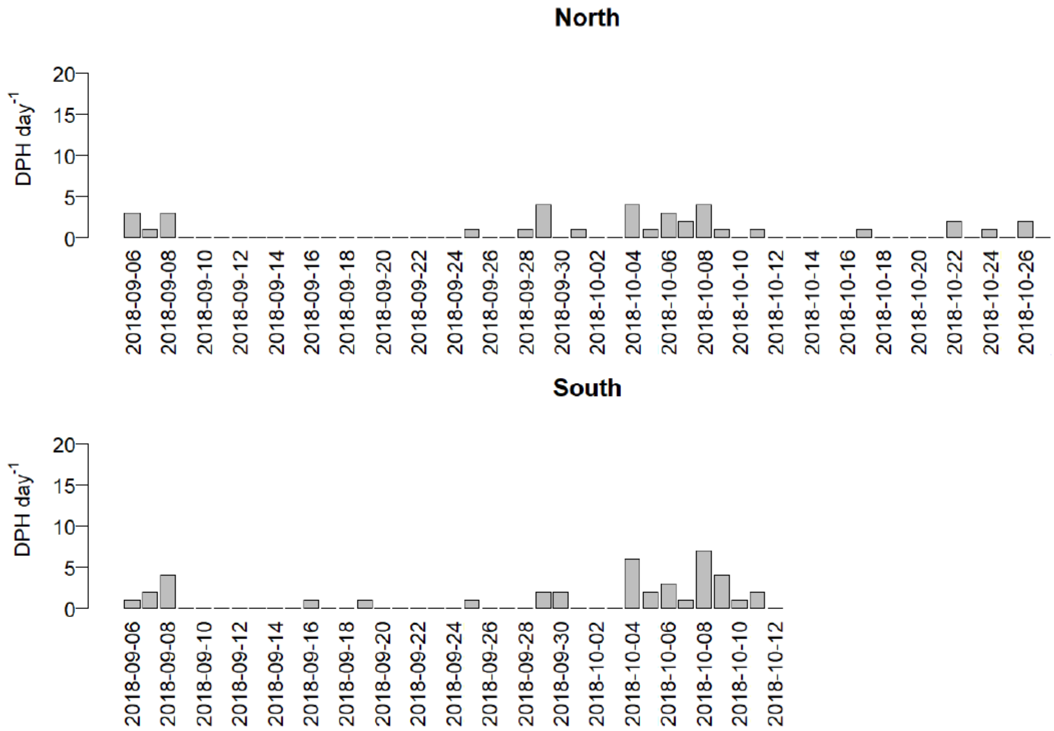

Figure 23: Detection positive hours per day for dolphin during deployment period 3 (06/09/18 – 12/10/18) (Source: OSC 2019d).

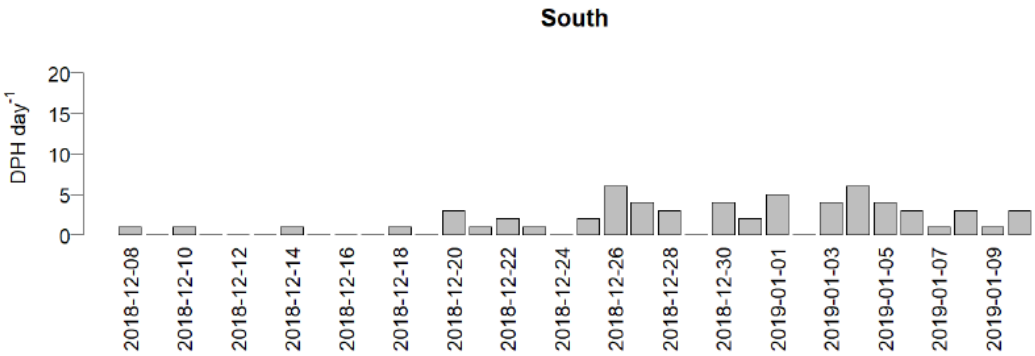

Figure 24: Detection positive hours per day for dolphin during deployment period 4 (08/12/18 – 09/01/19) (Source: OSC 2019e).[3]

[3] Note data from the North CPoD were not retrieved during this deployment period

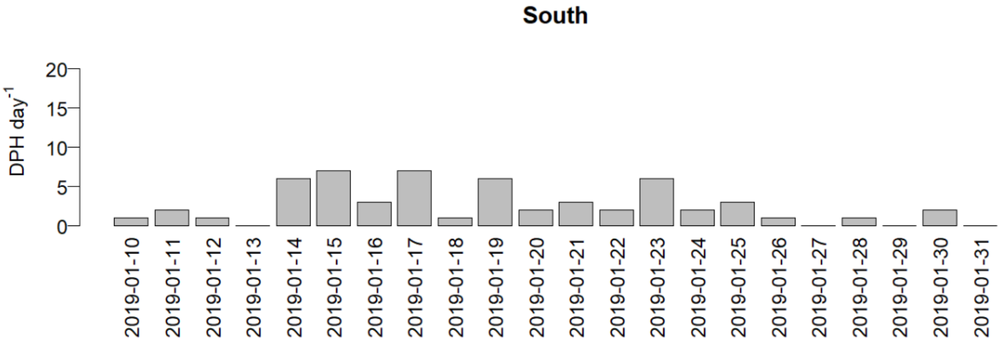

Figure 25: Detection positive hours per day for dolphin during deployment period 5 (10/01/19 – 31/01/19) (Source: OSC 2019f).

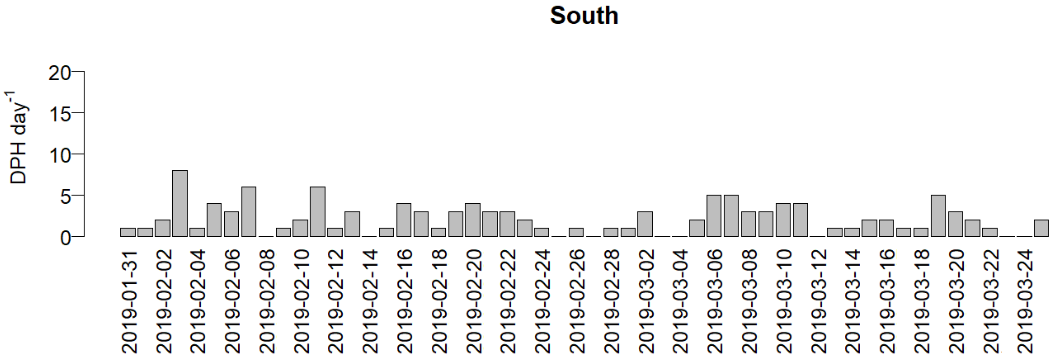

Figure 26: Detection positive hours per day for dolphin during deployment period 6 (31/01/19 – 25/03/19) (Source: OSC 2019g).

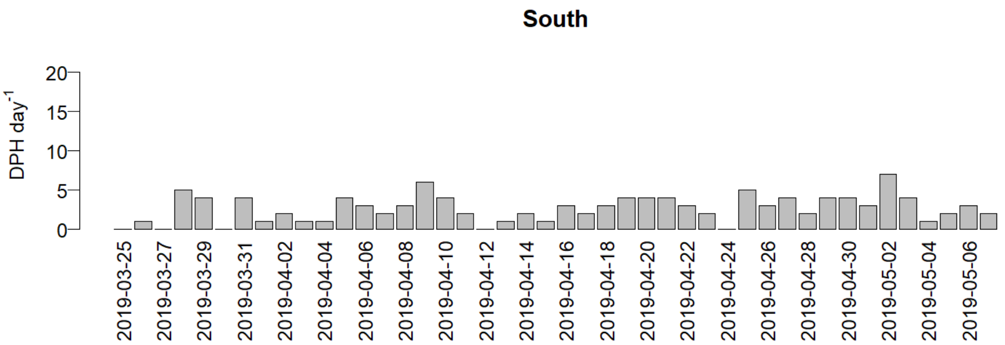

Figure 27: Detection positive hours per day for dolphin during deployment period 7 (25/03/19 – 07/05/19) (Source: OSC 2019h).

The estimated population of bottlenose dolphins in the Moray Firth and the east coast of Scotland was, in 2015, 189 (95% HPDI 155-216), with the Moray Firth SAC supporting the largest population (Cheyney *et al.* 2018). However, an estimated 25% of the total Scottish east coast population use the area between Stonehaven and Aberdeen and 61% between Aberdeen and the Firth of Forth (Thompson *et al.* 2011, Quick *et al.* 2014). Bottlenose dolphins associated with Moray Firth SAC are known to range widely with good evidence of a strong linkage between the individuals known to occur within the

SAC and elsewhere along the nearshore waters of the east coast of Scotland and North-east England (Quick and Cheney 2011, Quick *et al.* 2014).

There is no site specific density estimate for bottlenose dolphin in Aberdeen Bay. SCANS III survey results indicate a regional density of 0.03 ind/km^2 (Hammond *et al.* 2017). However, this covers a wide area of the North Sea, a significant proportion of which bottlenose dolphins do not occur. Consequently, for this assessment an alternative east coast of Scotland density of 0.07 ind/km^2 has been used. This takes into account the relatively higher densities occurring in nearshore coastal waters along the east coast of Scotland.

Immature bottlenose dolphins (juveniles/calves) have been observed off Aberdeenshire throughout the year, with an increase in the proportion of calves during the spring, between April and June (Canning 2007, Stockin *et al.* 2006, Weir and Stockin 2001). Very young calves have been recorded during spring and early summer (Weir and Stockin 2001).

The main prey items for bottlenose dolphins in the Moray Firth have been reported to be cod, saithe and whiting with some salmon, haddock and cephalopods (Santos *et al.* 2001).

Dolphins are opportunistic feeders and prey on a wide variety of fish species. Studies undertaken on fish behaviour indicate the potential for a localised and temporary change in their behaviour from relatively loud sound sources with normal behaviour returning once the activity has stopped (McCauley *et al* 2000, Pickett *et al.* 1994, Wardle *et al.* 2001). If disturbed, fish may move into deeper waters or may be potentially displaced but can return shortly after cause of the impact has ceased (McCauley *et al.* 2000, Peña *et al.* 2013, Slotte *et al.* 2004).

Although prey for dolphins may be displaced by the proposed activities, the extent of displacement, if any, will be relatively localised. Dolphins that may be present in the area of potential impact are not significantly restricted in their habitat usage, nor their prey and so will be able to adapt to any temporary changes in prey distribution or behaviour during the period impacts are predicted to occur.

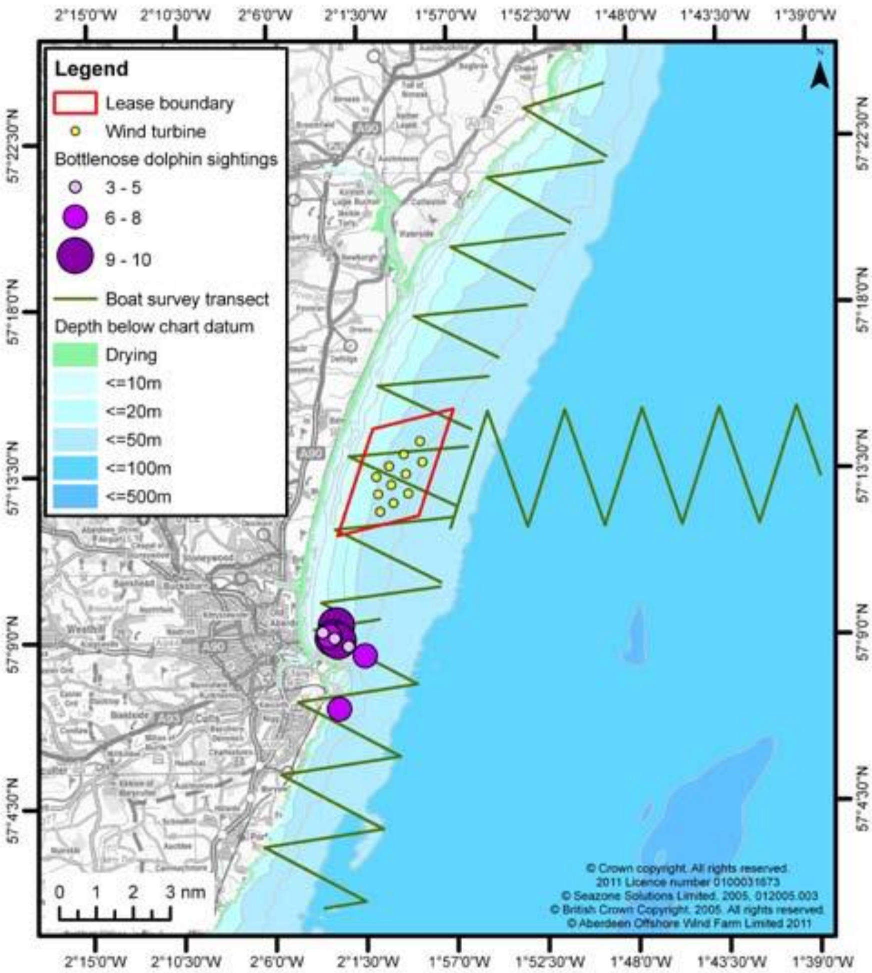

Figure 28: Distribution of bottlenose dolphins recorded during surveys in Aberdeen Bay 2010/2011 (Ref AOWFL 2012).

7.3 White-beaked dolphin

The white-beaked dolphin is a summer visitor to the coastal waters of North-east Scotland. During site specific vantage point surveys there was only one sighting of three individuals recorded in July (Clarkin and McMullan 2015). Surveys undertaken across Aberdeen Bay indicate that white-beaked dolphins occur further offshore with a total of 29 sightings consisting of 117 individuals during two years of boat-based surveys. The majority of sightings occurred in areas further offshore and the majority of all white-beaked dolphin sightings were in water depths of >20 m (Figure 29) (AOWFL 2012).

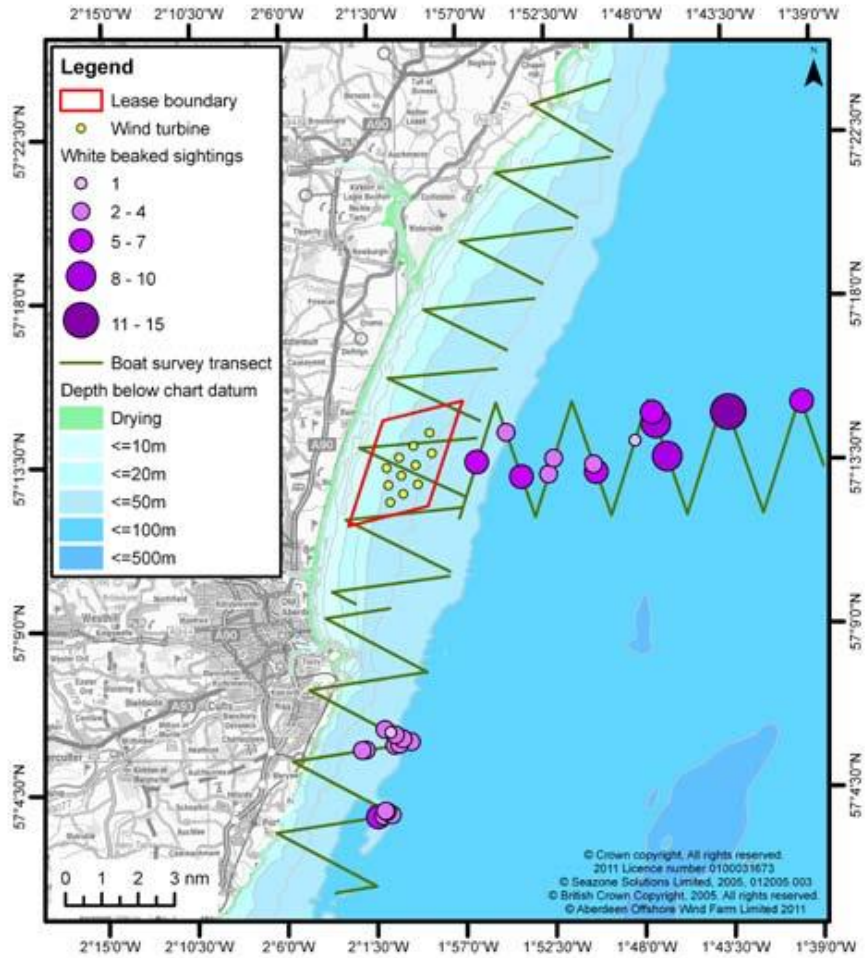

Figure 29: Distribution of white-beaked dolphins recorded during surveys undertaken in Aberdeen Bay 2010/2011 (Ref AOWFL 2012).

With few sightings of white-beaked dolphin in Aberdeen Bay there are no area site specific densities available. However, the wider regional SCANS III surveys estimated a density of 0.243 ind/km^2 (Hammond *et al.* 2017).

Relatively little is known about the ecology of white-beaked dolphins. Sightings of white-beaked dolphin off north-east coast of England indicate that white-beaked dolphins they are positively associated with sandy sediments, deeper, offshore waters and negatively associated with warm waters above 13-14^{o}C (Brereton *et al.* 2010).

Analysis of the sightings along the Aberdeenshire coast indicate that seabed depth and slope influence the distribution of white-beaked dolphins in this area and this is thought to be related to prey distribution. Sea temperature has been found to influence white-beaked dolphin group size, with smaller groups being recorded at higher temperatures, indicating white-beaked dolphins prefer cooler waters (Canning *et al.* 2008).

White-beaked dolphins breed mainly between July and August with gestation lasting approximately 11 months (Culik 2010). The higher number of calves observed during boat surveys off Aberdeenshire and in the stranding data during the summer, suggests the inshore movement of this species at this time of year may be related to calving (Canning *et al.* 2008).

White-beaked dolphins have a broad range of prey, feeding on mackerel, herring, cod, poor-cod, sandeels, whiting, haddock, and hake, as well as squid, octopus, and benthic crustaceans (Anderwald & Evans 2010).

7.4 Risso's Dolphin

In Scottish waters Risso's dolphins occur primarily on the west coast, particularly around the Hebrides (Reid *et al* 2003). They are a scarce visitor on the east coast of Scotland including north-east Scotland, although sightings in the region do occur with most records during April and September and October (Genesis 2012).

There are no regional population estimates or densities for Risso's dolphin in the area (Hammond *et al.* 2013, IAMMWG 2015).

No Risso's dolphins were recorded during site specific vantage point surveys and only two were recorded during two years of surveys undertaken in Aberdeen Bay (AOWFL 2012, Clarkin and McMullan 2015).

Although they occur widely offshore, their preferred habitats include steep shelf edges between 400 and 1,000 m, subsurface seamounts and escarpments (Lancaster *et al.* 2014).

Breeding occurs between April and July with calving in Scottish waters between July and December (Lancaster *et al.* 2014).

7.5 Minke Whale

Minke whales occur throughout the central and northern North Sea are widely distributed in the area off north-east Scotland, both in offshore and coastal areas (Reid *et al.* 2003, Robinson *et al.* 2007, 2008). Within Aberdeen Bay twelve minke whales were recorded across two years of surveys (AOWFL 2012). However, no minke whales were recorded during site specific vantage point surveys undertaken in 2014/15 (Fugro 2015).

SCANS III surveys in the region indicate a minke whale density of 0.039 ind/km^2 (Hammond *et al.* 2013).

Although minke whales have been recorded throughout the year, there is a strong seasonal variation in the number of sightings with of sightings occurring between May and August, with increasing numbers occurring within inshore waters during July and August (Robinson *et al.* 2007). There are few sightings of minke whale in the region between October and April (Anderwald and Evans 2010, Reid *et al.* 2003).

Minke whales feed on both invertebrates and a variety of fish species, particularly herring, sandeels, cod, haddock and saithe (Anderwald and Evans 2010).

Studies undertaken in the Moray Firth have identified strong correlations in the distribution of minke whales and water depth and sediment type, with minke whales occurring most frequently in water depths of between 20 m and 50 m and over areas with sandy gravel sediments. These habitats are known to be areas used by sandeels and it is thought that the distribution of minke whales during the summer months is associated with the distribution and availability of sandeels that make up between 62% and 87% of their diet by weight. Another strong influencing factor in their distribution is the seabed bathymetry with more frequent occurrence in areas of relatively steep slopes and, in the Moray Firth, north facing slopes were preferred (Robinson *et al.* 2009). The presence of relatively steep seabed is thought to provide up-wellings where increased concentrations of prey may occur.

8 Conservation Status and Designated Sites

Harbour porpoise and bottlenose dolphin are listed under Annex II of the Habitats Directive as species of Community Interest and for which sites identified as Special Areas of Conservation (SAC) are designated.

There are no SACs for which harbour porpoise is a qualifying species in Scottish waters. However, there is one candidate SAC off the west coast of Scotland (SNH 2019).

Bottlenose dolphin is a qualifying species for the Moray Firth SAC where their population is considered to be in Favourable Maintained condition (SNH 2016).

Bottlenose dolphins associated with Moray Firth SAC are known to forage widely with good evidence of a strong linkage between the individuals known to occur within the SAC and sites elsewhere along the near shore waters of the east coast of Scotland, including the waters surround the existing Aberdeen Harbour and the new harbour at Nigg Bay.

9 Potential Impacts / Effects

There is a substantial volume of literature describing the potential effects of sound on marine mammals with summaries in literature such as Thomsen *et al.* (2006), Southall *et al.* (2007) and OSPAR (2009).

There are recognised to be four main types of potential effect from noise in the marine environment:

- Fatal effects caused by significant levels of noise in close proximity to the receptor.
- Auditory injury, specifically hearing impairment, which might either be permanent or temporary. These can impact on the ability of the marine mammal to communicate, forage or avoid predators.
- Behavioural effects such as avoidance, potentially resulting in displacement from suitable feeding or breeding areas, changes in travelling routes.
- Secondary impacts caused by the direct effects of noise on potential prey causing an overall loss of available prey.

The range at which marine mammals may be able to detect sound arising from offshore activities depends on the hearing ability of the species and the frequency of the sound. Harbour porpoise are potentially more sensitive to relatively high frequency sounds than other marine mammal species and may also be more sensitive to sound than other marine mammal species (Defra 2015).

Other factors potentially affecting the potential impact sound may have on marine mammals includes ambient background noise, which can vary depending on water depth, seabed topography and sediment type. Natural conditions such as weather and sea state and other existing sources of human produced sound, e.g. shipping can reduce the auditory range.

The following sections provide a description of the potential impacts of noise in the marine environment on EPS species with reference to the proposed activities including dredging and vessel activity.

9.1 Fatal Effects

If source peak pressure levels are high enough there is the potential to cause a lethal effect on marine mammals. Studies suggest that potentially lethal effects can occur to marine mammals (seals and otters) when the peak pressure level is greater than 246 or 252 dB re. 1 μPa (Parvin, Nedwell & Harland 2007). Damage to soft organs and tissues can occur when the peak pressure level is greater than 220 dB re. 1 μPa.

9.2 Auditory Injury

Underwater sound has the potential to cause hearing damage in marine mammals, either permanently or temporarily. The potential for either of these conditions to occur is dependent on the hearing bandwidth of the animal, duty cycle and duration of the exposure (Southall *et al.* 2007, OSPAR 2009).

Physical injury is described as either a permanent loss of hearing range (permanent threshold shift (PTS)) or temporary loss of hearing range (temporary threshold shift (TTS)). Under US Marine Mammal Protection Act, Level A Harassment is described as any act that has the potential to injure a marine mammal and is akin to PTS and Level B Harassment is capable of causing disruption to behavioural patterns and covers broad range from TTS to behavioural responses (NOAA 2015). Although sound levels at which Level A and Level B harassment occurs are lower than those that are predicted to cause the onset of PTS or TTS.

Sound exposure levels considered capable of causing the onset of either PTS or TTS do not mean that such physical impacts will always occur. The probability of developing PTS or TTS will follow a dose response curve, with increasing risk of physical injury as exposure increases. Studies undertaken on bottlenose dolphin indicate that only between 18% and 19% of bottlenose dolphins exposed to sound exposure levels of 195 dB re 1 µPa2.s-1, actually resulted in the onset of TTS (Finneran *et al.* 2005).

Although PTS is a permanent physical injury impairing the marine mammal's ability to hear, TTS is not and impacts are relatively short-lived. Studies undertaken on harbour porpoise indicate that, depending on the exposure level and duration, hearing ability returns between 4 and 96 minutes after the sound causing the impact has ceased (Kastelein *et al.* 2012).

Following submission of the application for the AHEP, the National Oceanic and Atmospheric Administration (NOAA) produced an updated 'Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing' focussing on 'Thresholds for Onset of Permanent and Temporary Threshold Shifts'[4]; which has subsequently also been updated (NMFS 2018). For the purposes of this EPS Application, the information within the AHEP EIA has been used, based on the 2015 NOAA and Southall *et al* thresholds. Whilst there may be slight differences in TTS/PTS levels if the new NOAA guidance was used and all EIA assessments recalculated, the new guidance does not cover disturbance and as such, does not affect the maximum number of animals for which an EPS licence will be applied for.

AHEP will follow the mitigation measures described within the CEMD to ensure no animals will be subject to TTS/PTS.

9.3 Behavioural Change

Potential changes in behaviour may occur depending on the sound source levels and the species' and individuals' sensitivities. Behavioural changes can vary from changes in swimming direction, diving duration, avoidance of an area and reduced communication. The displacement of marine mammals could cause them to relocate to sub-optimal locations where there is lower prey availability or increased inter and intra-specific competition. If permanent or over a long period, this could cause lower fecundity or increased mortality.

Changes in behaviour arising from noise impacts may be easily detectable, e.g. a significant displacement from an area. Other effects caused by changes in behaviour, e.g. energetic stress, may be more difficult to detect and go unnoticed (OSPAR 2009).

Masking effects may also cause changes in the behaviour as the level of sound may impair the detection of echolocation clicks and other sounds that species use to communicate or detect prey thus causing them to alter their behaviour (David 2006).

There is potential for impacts on prey species to affect marine mammals, in particular possible impacts of noise on fish species. The potential effects on fish in the form of physical injury and displacement are predicted to be similar to those for marine mammals, although their sensitivity to sound will differ.

9.4 Activities resulting in potential impacts

9.4.1 Blasting

Explosive sources produce broadband frequencies with very high peak source levels and rapid rise times. The most damaging component from underwater explosions is caused by the high amplitude

[4] NOAA Technical Memorandum NMFS-OPR-55 July 2016.

underwater shock wave and the initial fast rise in pressure which has the potential to cause injury or death to marine mammals (Richardson *et al.* 1995, Lewis 1996, Ketten 2004).

The peak pressure shortly after an explosion is very high in comparison to other man-made sound sources. At distances close to the charge, a shockwave is formed, after which the wave propagates as a normal sound wave (Parvin *et al.* 2007). The higher frequencies reduce quickly in the water column and the area of impact from the shockwave is limited. Sound propagating out is largely below 1 kHz.

Shock waves can cause blast injuries due to the short signal rise time and the high peak pressure, which are transmitted through the body causing damage to tissues and gas filled cavities (Ascobans 2012). The pressure from a shock wave, and thus the potential for injury depends largely on the charge weight and specific detonation velocity. Radiation and attenuation of the pressure wave depends on depth of the charge within the bedrock, water depth, sediment, sea state, stratification of the water column, temperature, salinity and other variables.

The risk of physical injury occurring is affected by the distance at which the marine mammal is at the time of detonation, the water depth with increased risk in shallower water and seabed type and increased risk over hard rocky seabed. (Ascobans 2012). In shallow water, rapid pressure changes occur due to the surface reflected pulse occurring milliseconds after the direct pulse. This can cause gas bubbles to form within the soft tissues resulting in physical injury or death.

Studies of blast effects on cetaceans indicate that smaller species are at greatest risk for shock wave or blast injuries (Ketten 2004).

Results from noise modelling initially undertaken to support the application indicated that lethal effects to cetaceans could occur no further than 9 m from the detonation of a 20 kg charge placed 2.5 m within a drilled hole (Kongsberg 2015). The modelling also indicated that there would be no permanent injury to any European protected species within 16 m of a detonation. Based on the Level A auditory injury occurring at 180 dB re 1 μPa (rms) there was potential risk for auditory injury to occur within 410 m from the detonation source.

Disturbance to cetaceans from blasting was predicted to occur within 1,700 m from the sound source based on the Level B harassment thresholds of 160 dB re 1 μPa (rms) and 7,180 m at low level disturbance threshold of 140 dB re 1 μPa (rms).

Underwater noise monitoring, including noise from blasting, has been ongoing throughout the construction of the AHEP. These monitoring results were used to demonstrate compliance with existing licence conditions, validate the confined blast model used in the 2015 ES (Fugro 2015) and estimate the noise attenuation capabilities of the double bubble curtain. Table 6 and Table 7 present data from all blasting undertaken in 2018 both inside and outside the bubble curtain (Award Environmental Consultants Ltd, 201804-005-V0, 7th December 2018).

Table 6: Summary of peak and rms blast levels for each days blasting of 20 kg charges (except †10 kg, ††6 kg) recorded inside the bubble curtain.

Blast Date	Blast No.	Field	Charges detonated/primed	Dist. from blast site m	Blast level dB re 1 µPa			
					Peak modelle	Peak recorde	rms equivale	rms recorde
20 Aug 18	B1	1	42/45†	437	174.0	183.6	165.4	168.0
20 Aug 18	B2	2	90/90	442	178.5	215.9	169.7	199.9
24 Aug 18	B3	1	3/3†	457	173.4	160.0	157.8	135.8
24 Aug 18	B4	3	63/63	424	179.2	221.2	169.9	198.9
06 Sep 18	B5	4	65/65	285	184.8	207.4	171.2	188.1
06 Sep 18	B6	5	86/86	262	185.9	209.5	171.5	185.8
12 Sep 18	B7	6	92/132	232	187.6	211.3	172.0	185.6
12 Sep 18	B8	7	30/77	270	185.5	216.9	171.4	190.1
12 Sep 18	B7*	6	40/40	252	186.5	191.1	171.7	162.9
12 Sep 18	B8*	7	47/47	293	184.4	207.1	171.1	196.1
14 Sep 18	B9	8	59/99	326	182.9	214.5	170.7	191.8
14 Sep 18	B10	9	53/53	358	181.6	215.9	170.4	190.6
14 Sep 18	B10	9	53/53	358	181.6	199.9	170.4	177.1
14 Sep 18	B9*	8	40/40	336	182.5	183.1	170.6	152.5
14 Sep 18	B10*	8	40/40	336	182.5	204.9	170.6	185.3
17 Sep 18	B11	10	134/134	565	175.3	205.9	169.0	176.9
17 Sep 18	B12	11	47/47	589	174.7	207.6	168.8	175.5
08 Oct 18	B13	12	100/100	306	183.8	210.6	170.9	196.8
08 Oct 18	B14	13	48/48	463	178.0	213.8	169.5	198.9
08 Oct 18	B15	14	119/149	393	180.3	210.3	170.1	188.5

08 Oct 18	B15*	14	30/30	393	180.3	205.2	170.1	180.1
13 Oct 18	B16	15	84/84	446	178.5	209.3	169.6	180.3
17 Oct 18	B17	16	38/38	354	181.8	198.3	170.4	168.5
17 Oct 18	B18	17	49/49	371	181.1	226.5	170.2	197.9
25 Oct 18	B19	18	51/51	575	175.0	211.2	168.9	185.9
25 Oct 18	B20	20	12/69	613	174.1	204.7	168.7	181.7
25 Oct 18	B21	19	36/72	537	176.0	205.1	169.1	183.8
25 Oct 18	B21*	19	36/72	486	177.3	220.9	169.4	190.5
25 Oct 18	B20*	20	57/57	528	176.2	206.4	169.1	180.0
17 Nov 18	B22	21	121/121	257	186.2	231.3	171.5	208.3
17 Nov 18	B23	22	55/55	262	185.9	237.6	171.5	211.9
17 Nov 18	B24	23	70/70	245	186.9	234.8	171.7	208.8
17 Nov 18	B25	LSS1	3/3††	255	177.9	214.9	171.6	196.4
24 Nov 18	B26	24	217/217	459	178.1	186.2	169.6	158.5
24 Nov 18	B27	25	198/198	459	178.1	187.6	169.6	162.3

* Repeat blasting due to earlier non-detonations.

‡ Calculated equivalent dB re 1 μPa rms based on the threshold of 170 dB re 1 μPa rms at 400 m.

Table 7: Summary of peak and rms blast levels for each days blasting of 20 kg charges (except †10 kg, ††6 kg) recorded outside the bubble curtain.

Blast Date	Blast No.	Field	Charges detonated/primed	Dist. from blast site m	Blast level dB re 1 µPa			
					Peak modelled 0% att	Peak modelled 60% att	Peak recorded	rms recorded
24 Aug 18	B3	1	3/3†	806	165.5	157.5	‡	138.9‡
24 Aug 18	B4	3	63/63	769	171.0	163.0	168.5	153.7
14 Sep 18	B9	8	59/99	893	168.9	161.0	158.0	146.2
14 Sep 18	B10	9	53/53	922	168.4	160.5	154.4	137.6
14 Sep 18	B10	9	53/53	-	-	-	154.0	138.5
14 Sep 18	B9*	8	40/40	869	169.3	161.4	156.8	144.6
14 Sep 18	B10 *	8	40/40	899	168.8	160.9	*126*	*115.3*
17 Sep 18	B11	10	134/134	964	167.8	159.9	163.2	152.4
17 Sep 18	B12	11	47/47	990	167.5	159.6	156.4	146.1
08 Oct 18	B13	12	100/100	644	173.4	165.4	162.1	149.8
08 Oct 18	B14	13	48/48	846	169.6	161.6	162.1	152.3
08 Oct 18	B15	14	119/149	746	171.4	163.4	162.1	152.3
08 Oct 18	B15 *	14	30/30	746	171.4	163.4	161.8	146.1
13 Oct 18	B16	15	84/84	696	172.4	164.4	166.3	151.2
17 Oct 18	B17	16	38/38	919	168.5	160.5	163.0	151.6
17 Oct 18	B18	17	49/49	953	168.0	160.0	163.0	151.6
25 Oct 18	B19	18	51/51	1163	165.2	157.2	158.1	146.2
25 Oct 18	B20	20	12/69	1224	164.5	156.5	156.3	144.5
25 Oct 18	B21	19	36/72	1075	166.3	158.3	156.3	140.9
25 Oct 18	B21 *	19	36/72	1075	166.3	158.3	158.5	142.7
25 Oct 18	B20 *	20	57/57	1194	164.9	156.9	157.4	143.2
24 Nov 18	B26	24	217/217	860	169.4	161.4	166.0	151.9
24 Nov 18	B27	25	198/198	831	169.9	161.9	165.9	150.8

* Repeat blasting due to earlier non-detonations
‡ Not evident in acoustic record: estimated rms level only

The results from the monitoring undertaken indicate that the sound levels produced by blasting are greater than those predicted by the original noise modelling. However, the bubble curtains were effective at reducing propagated sound levels. Drawing on the underwater noise validation data collected to date, a technical underwater noise study was prepared to assess the noise levels and potential effects from a range of increases in charge weights (Fugro 2019). The results from the assessment indicate noise levels from the detonations increase from 242 dB re 1 μPa for a 20 kg charge weight to 255.4 dB re 1 μPa for a 100 kg charge weight (Table 8).

Table 8: Summary of predicted noise levels using a range of charge weights.

Charge weight (kg)	20	30	40	50	60	70	80	90	100
Source level (dB re 1 μPa)	244.2	247.0	249.0	250.6	251.8	252.9	253.8	254.7	255.4

Applying these source levels to the established propagation characteristics, the revised noise modelling indicated that peak blast levels could be in excess of 200 dB re 1 μPa at a distance of 10 km.

In practice this condition is not met as a double bubble curtain is deployed at the mouth of the Nigg Bay which has the effect of absorbing a significant level of noise. From on-site measurements of noise from either side of the bubble curtain at the AHEP, which itself was located between 650 m and 700 m from the blast site, it can be seen that the bubble curtain has a mean attenuation of 38 ± 16 dB (Award Environmental 2018). The potential minimum attenuation is thus 22 dB although attenuation could be as high as 54 dB (Fugro 2019). The differences in the predicted ranges at which the onset of PTS is predicted to arise with and without a double bubble curtain are presented in Figure 30. The results indicate that with the use of a double bubble curtain the onset of PTS will not occur beyond 100 m of the bubble curtain for any European Protected Species.

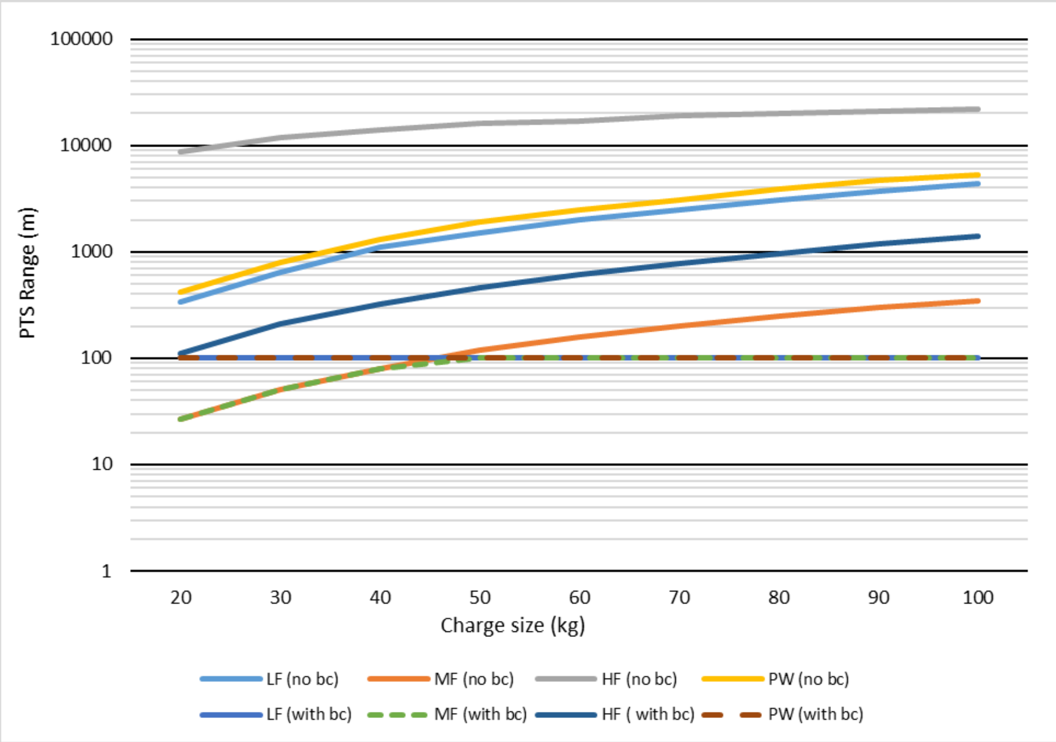

Figure 30: Predicted ranges for the onset of PTS for functional hearing group.

LF = Low frequency cetacean. MF = Mid-frequency cetacean. HF = High frequency cetacean. PW = Pinniped in water.

9.4.2 Drilling

The explosives to be used for rock blasting will be placed down holes drilled into the bedrock. Drilling noise will occur during this activity.

Sound associated with drilling operations will propagate from rotating equipment such as generators, pumps and the drill string. In general, sound from drilling has been found to be predominantly low frequency (<1kHz) with relatively low source levels. Source levels were found to be less than 195 dB (rms) re 1µPa-m for a drill ship (Nedwell and Edwards 2004). A study by Greene (1987) found that the sound generated by drilling activities from a semi-submersible did not exceed local ambient levels beyond 1 km, although weak tones were detectable up to 18 km away. Studies have shown that during drilling, other underwater sound levels increase when compared to periods of non-drilling, which has been related to the use of additional machinery and power demands (McCauley 1998). Drilling sounds, although of a relatively low level, will be continuously generated throughout the drilling activity.

Noise modelling undertaken to inform the EIA estimated that sound source levels of 136.3 dB(peak) re 1µPa @ 1 m would occur from the proposed drilling activities (Kongsberg 2015). Noise modelling based on the use of a drilling jack-up and three support vessels indicated that noise levels from drilling vessels would not cause levels of sound capable of causing injury or PTS to marine mammals or fish. At lower thresholds auditory injury (180 dB re 1µPa @ 1 m (rms)) impacts are predicted to occur within 25 m of the drilling activities. Vessel noise associated with the drilling activities will fall below levels at which disturbance could occur (120 dB re 1µPa @ 1m (rms)) within 37 km of activities in winter and 46 km in summer (Fugro 2015, Kongsberg 2015).

Cumulative impacts capable of causing the onset of PTS could arise within 20 m of the drilling activities and effects capable of causing the onset of TTS within 210 m (Fugro 2015). For harbour porpoise TTS or aversive behaviour are estimated to occur at distances greater than 10 km, based on a threshold of 164.3 dB re 1µPa @ 1m (rms) (Fugro 2015).

Drilling in the marine environment will occur over a period of twenty one months from May 2018 onwards.

Measurement of drilling noise conducted on the 11-13th of September 2018 and measured at five holes drilled in Nigg Bay reported estimated peak source levels of between 181.2 and 202.9 dB re 1 □Pa and concluded that at a range of 100 metres from the drilling the mean level of sound is likely to be well below 160 dB re 1µPa with occasional transients reaching 175 dB re 1µPa (Chickerell BioAcoustics 2018).

9.4.3 Dredging/Drum Cutter

For the purposes of the EPS application, it has been assumed that the drum cutter will have source levels akin to those from a Cutter Suction Dredging (CSD) and other dredgers, although the scale of the activity is smaller.

During the 2017 dredging operations noise measurements were undertaken by Award Environmental Consultants Ltd (Award Environmental 2017). The conclusion of the report state that 'Dredging activity in Nigg Bay involved a spread of three vessels, one being the dredger *Costa Verde*, another being a pilot boat and the third being the survey vessel *Marilyn M*. Source levels for the vessel spread lay in the range 173 dB re 1 □Pa to 197 dB re 1 □Pa with a mean around 185 dB re 1 □Pa. It is considered that the relatively wide range of source noise levels could be due to variation in seabed material types encountered during dredging from day to day. It was also assumed that the dominant noise source in the given vessel spread was *Costa Verde* itself as the other two vessels were very much smaller by comparison.'

In terms of source levels, the source levels used within the AHEP EIA are in line with the results of the noise monitoring undertaken in September 2017 with the TSHD assumed to have a source sound pressure level of 180.4 dB re 1µPa at 1m and the backhoe dredger 187.2 dB re 1µPa (Fugro 2015).

Results from the noise modelling undertaken for the AHEP EIA indicate that the sound capable of causing either the onset of PTS or TTS could occur within 1 m of the dredging activities (Table 9) (Fugro 2015). Auditory injury, based on the Level A threshold of 180 dB re 1 µPa (rms) is predicted to occur no greater than 82 m from the dredging activity.

Displacement to harbour porpoise is predicted to occur up to 390 m from the dredging activities. However, wider disturbance to all cetaceans could occur out to 59 km, based on the level B harassment level of 120 dB re 1 µPa (rms) (Table 9).

Table 9: Summary of acoustic impacts on European protected species from dredging activities (Source: Fugro 2015)

Dredging Effect	Thresholds	Range of Effect (m) (Worst Case Scenario)		
		Harbour porpoise	Dolphins	Minke whale
Lethality	240 dB re 1 µPa pk	<1	<1	<1
PTS	224 dB re 1 µPa pk	<1	<1	<1
TTS	218 dB re 1 µPa pk	-	<1	<1
TTS – Porpoise	199.7 dB re 1 µPa pk	<1	-	-
Level A injury	180 dB re 1 µPa (rms)	82	82	82
Aversive behaviour – porpoise	174 dB re 1 µPa pk-pk.	390	-	-
Level B harassment	120 dB re 1 µPa (rms)	59,000	59,000	59,000
Cumulative PTS	215 dB re 1 µPa pk	20	20	20
Cumulative TTS	195 dB re 1 µPa pk	-	350	350
Cumulative TTS – porpoise	164.3 dB re 1 µPa pk	>10,000	-	-
Cumulative Aversive behaviour – porpoise	145 dB re 1 µPa2 s .	>10,000	-	-

9.4.4 Vessel Activity

Construction vessels will be present in and adjacent to Nigg Bay throughout the construction of the AHEP, over a period of two years. Vessels will be required for dredging, blasting and breakwater construction. Aside from construction vessels, there will also be other vessels present including tugs, crew boats and survey vessels.

Vessel noise is continuous and varies depending on the type of vessel being used. The primary sources of sound from vessels are propellers, propulsion and other machinery (Ross 1976, Wales and Heitmeyer 2002). Source levels typically increase with increasing vessel size, with smaller vessels (< 50 m) having source levels 160-175 dB re 1µPa, medium size vessels (50-100 m) 165-180 dB re 1µPa and larger vessels (> 100 m) 180-190 dB re 1µPa (summarised by Richardson *et al.* 1995). Sound levels depend on the operating status of the vessel with vessels equipped with dynamic positioning systems exhibiting increased sound levels in the spectrum from 3 Hz to 30 Hz (Nedwell and Edwards 2004, OSPAR 2009). Most of the acoustic energy from vessels is below 1 kHz, typically within the 50-300 Hz range (Genesis 2012). Consequently, vessel noise has historically been thought to have a greater potential to impact marine mammals with relatively low frequency sensitivities e.g. seals and baleen whales rather than high frequency specialists, e.g. porpoise (Okeanos 2008). However, recent studies indicate that high frequency sound from vessels can have behavioural impacts on harbour porpoise (Dyndo *et al.* 2015).

Noise modelling undertaken for the disposal of seabed material was based on three different vessels: one survey vessel and two tug boats with broadband SPL ranging from between 184.0 and 200.8 dB re

1µPa @ 1m. It was assumed that all three vessels may be operating in the area simultaneously (Kongsberg 2015). Noise arising from the actual disposal of seabed material has a negligible impact with levels falling to below background levels within 35 m of the disposal activities. Consequently, the vessel noise modelling undertaken for the disposal of seabed material is representative of general vessel noise that may occur during construction.

Results from the noise modelling undertaken indicate that the sound capable of causing either the onset of PTS or TTS could occur within 1 m of construction vessel activities (Table 10) (Fugro 2015). Auditory injury, based on the Level A threshold of 180 dB re 1 µPa (rms) is predicted to occur no greater than 239 m from vessel activities.

Displacement to harbour porpoise is predicted to occur up to 462 m from the cumulative construction vessel activities. Wider disturbance to all cetaceans could, occur out to 62 km, based on the precautionary level B harassment level of 120 dB re 1 µPa (rms) (Table 10). However, this is very low threshold, at which the sound level may be below that of the current ambient conditions which, based on existing evidence, are estimated to be between 120 and 130 dB re 1 µPa (rms) (Kongsberg 2015).

Table 10: Summary of acoustic impacts on European protected species from dredging activities (Source: Fugro 2015)

Vessel Activity	Thresholds	Range of Effect (m) (Worst Case Scenario)		
		Harbour porpoise	Dolphins	Minke whale
Lethality	240 dB re 1 µPa pk	<1	<1	<1
PTS	224 dB re 1 µPa pk	<1	<1	<1
TTS	218 dB re 1 µPa pk	-	<1	<1
TTS - Porpoise	199.7 dB re 1 µPa pk	1.8	-	-
Level A injury	180 dB re 1 µPa (rms)	234	234	234
Aversive behaviour – porpoise	174 dB re 1 µPa pk-pk.	462	-	-
Level B harassment	120 dB re 1 µPa (rms)	62,000	62,000	62,000

9.4.5 Acoustic Deterrent Device

The Lofitech seal scarer ADD operates at a frequency of between 13.5 and 15 kHz with a signal duration of 0.5 seconds repeated randomly between <1 and 40 seconds. The sound source level is reported to be between 189 and 193 dB re 1m Pa @ 1 m (Coram *et al.* 2014).

Two studies have been undertaken on the effectiveness of using the Lofitech ADD to displace harbour porpoise (Brandt *et al.* 2012 and 2013). Although the studies showed slightly differing results with one recording a harbour porpoise as close 798 m of an active ADD and the other showing that all harbour porpoise avoided the area within 1.9 km and for half the time between 2.1 and 2.4 km. They both reported a strong avoidance behaviour by harbour porpoise to the ADDs with an effective range of between 1.3 km and 1.9 km. The effects of avoidance lasted approximately six hours. The minimum deterrence distance for harbour porpoise for the Lofitech ADD is reported to be 350 m and the maximum 7.5 km (Hermannsen *et al.* 2015).

It is recognised that the effects of ADD on harbour porpoise may be site specific but the results from these studies indicate that an ADD may effectively mitigate against the risk of harbour porpoise occurring in the area of risk of PTS at the onset of during pile driving.

The effectiveness of ADDs in causing avoidance behaviour in dolphins and minke whales are less well understood. However, the use of ADD on these species is predicted to have a similar deterrent effect.

Studies undertaken on harbour seals using three commercial Acoustic Deterrent Devices indicate that when operating the Lofitech ADD all harbour seals respond to ADDs when within approximately 1 km of the device, beyond which there is a steady decline. At distances of approximately 4 km about 20% of harbour seals responded (Gordon *et al* 2015). The study also showed that the response by seals to ADDs varied with those in nearshore waters swimming closer to shore before moving along the shoreline. Seals travelling further offshore detoured around the noise, occasionally occurring within a few hundred metres of the ADD. There was no significant increase in the swimming speeds of harbour seals with seals returning to the area shortly after the ADD was stopped. Studies undertaken on grey seals have also shown that the use of ADDs can be effective in reducing seal numbers in an area and found no evidence of habituation to the noise (Reported in Coram *et al.* 2014). However, an earlier study by Jacobs and Terhune (2002) undertaken at harbour seal haul out sites reported no apparent behavioural changes when an ADD was on. Consequently, although the use of ADD may be effective it may also have a limited effect on seals present within an area.

10 Imperative Reasons for Overriding Public Interest (IROPI)

The Scottish Government can only issues licenses under Regulation 44(2) of the Regulations (as amended) for specific purposes. These purposes include:

- 44(2)(e) 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; (MS 2012a).

There is guidance from the EU (EU 2010), Scottish Government (Scottish Executive 2000, MS 2014) and SNH (SNH 2011) as to what may be considered when identifying Imperative Reasons of Overriding Public Interests (IROPI).

It is clear from the guidance that only public interests, irrespective of whether they are promoted either by public or private bodies, can be balanced against the conservation aims of the Directive. Such public interests may include human health, public safety, beneficial consequences of primary importance for the environment, and other interests of a social (e.g. employment) or economic nature.

The public interest must be overriding and not every kind of public interest of a social or economic nature is sufficient. Public interest can only be overriding if it is a long-term interest; short term economic interests or other interests which would only yield short-term benefits are not sufficient. Overriding interests, as long-term, fundamental social interests, may be properly identified beforehand by published policies, and land-use and other plans (EU 2010).

Aberdeen Harbour is viewed as Scotland's gateway for trade, linking with more than 40 countries as well as other UK sites. With increasing demands the lack of space for new berths and lack of suitable back-up areas is restricting the future potential for growth of the port.

The Aberdeen Harbour Expansion Project demonstrates a direct benefit on a national and international scale. It is a long-term development that will contribute to ensuring the economic security of Aberdeen and the wider region. It is not a development for short-term economic interests.

The benefits arising from the development are recognised in Scotland's third National Planning Framework (Scottish Government 2014), in which Aberdeen Harbour Expansion is recognised as one of fourteen National Developments; and the National Renewables Infrastructure Plan where the role of the harbour in supporting the establishment of a strong renewable energy industry in Scotland is recognised (Scottish Enterprise 2010).

The international importance of the Aberdeen Harbour Expansion Project is recognised by the financial support provided by the EU Trans-European Transport Networks (TEN-T). TEN-T supports major transport projects that have either national or international importance. The support recognises the importance of Aberdeen Harbour in removing a bottleneck on the TEN-T network and creating better links with other EU ports. It will enhance and expand Aberdeen Harbour's role as a key trade hub in northern Europe by delivering around 1,500 m of new deep water quay that will be well connected to TEN-T road and rail links.

The development of Aberdeen Harbour Expansion Project complies with both international and national policies and plans and is therefore of Imperative Overriding Public Interest.

AHEP has received a Harbour Revision Order (HRO) and Marine Licence(s) from the Scottish Government following debate and approval in the Scottish Parliament in 2016.

10.1 Satisfactory Alternatives

10.1.1 Alternative Designs

Alternatives design options to the expansion of Aberdeen Harbour at Nigg Bay were considered in the Environmental Statement (Fugro 2015) these included:

1. The potential for expansion of the harbour within its current site were limited, with no opportunities for new berths. This would allow for very limited increase in capacity and reduce opportunities to encourage new customers into using the port. Due to these limitations this option was not considered viable.

2. The potential expansion of the harbour to the north of its current location, along the North Beach. This would increase the number of berths available but significant challenges would occur in developing a beach widely used for recreational purposes. Of all the possible options considered, the expansion of the harbour along the North Beach would require the greatest amount of dredging and construction. Due to these limitations, particularly the potential visual and physical impacts on an area used for recreational purposes, this option was not considered viable.

3. The option to develop Nigg Bay allows for the required increase in the number of berths and associated infrastructure whilst requiring the least amount of construction. For these reasons this option had significant advantages over alternative options and therefore has been taken forward.

Option 3 was the selected option - none of the design options considered presented any advantage in terms of impacts to marine mammals, as marine mammals can be present in all the locations considered, and disturbance to marine mammals would occur at all sites.

10.1.2 Alternative Construction Methodologies

A broad range of construction method variations were considered for the project. The selected options presented the optimal combination of environmental consideration for the sensitive surrounding area and an effective construction schedule.

The need to minimise the production of underwater noise has been a primary focus for the harbour design, and as a result the decision was taken by Dragados to remove all marine impact piling operations included within the ES design envelope.

10.1.2.1 Do Nothing

In terms of a 'do nothing' alternative for construction activities that may require an EPS licence, it is not possible to construct the project without the proposed construction works going ahead. AHB have been awarded the necessary consents to construct and operate the AHEP project including the Harbour Revision Order (HRO), Marine Licence(s) and the Planning Permissions in Principle for land based works have been discharged through a series of Matters Specified in Condition applications. These applications contained details of the proposed construction works and methods to minimise impacts to marine mammals and other receptors have been described within the Construction Environmental Management Documents which were approved in May 2017.

Alternative designs and construction methods which have been considered are described in further detail below.

10.1.2.2 Alternatives for Dredging Operations

The following dredging methodologies have been considered for project construction:

- Trailing Suction Hopper Dredging (TSHD)

  TSHD is a common method used for dredging large volumes of small loose materials in a short period of time. For AHEP it will be used to dredge the top sands and loose material. It may be possible to remove the top layer of loose material using a BHD however this is not understood to have a smaller noise footprint that TSHD and would extend the construction period so has therefore been discounted.

- Cutter Suction Dredging (CSD)

  CSD is used to dredge large volumes of partially consolidated material or weathered rock in a short period of time. For AHEP it will be used to dredge glacial till once the TSHD has removed the loose material above. The glacial till is a type of weathered rock, located at shallow depth and could also be extracted using a combination of TSHD and backhoe dredging (BHD). This alternative option may be used depending on vessel availability.

- Backhoe Dredging (BHD)

  BHD will be used for dredging partially consolidated materials during the development of the quay foundations and, after blasting operations, to remove fractured rock material. It is not possible to use the TSHD or CSD for this type of fractured material do to the size and type of material (TSHD is used for unconsolidated finer material and CSD for partially consolidated material). The backhoe dredger was selected as it is the best option for the type of materials arising from the blasting activity and is deemed to be the most efficient methodology for removing fractured rock at a shallow depth when compared to other dredging options. Collecting the rock with a backhoe dredger also allows for the rock to be reused in the harbour construction.

- Alternative to Drum Cutter

  A drum cutter has been selected to sculpt areas of the harbour including trenches close to the breakwater and areas to the south of the bay. The use of blasting has been investigated in these areas however, it is unlikely that blasting will achieve the correct profile required and may result in over fracturing of material. A drum cutter can also be used in more adverse weather conditions than blasting.

All the above techniques may be used to ensure an efficient dredging programme can be completed at AHEP.

10.1.2.3 Alternatives to Drilling

Drilling is required as part of the blasting operations to create holes to place the explosive charges in. There is no alternative to drilling these holes as the explosive must be placed at depth in order to fracture the rock.

10.1.2.4 Alternatives to Blasting Operations

Blasting is required to remove rock and allow the target dredged depth to be attained. The shot-holes that are required for the blasting operations are drilled from a platform. Blasting will be used for the fracturing and extraction of rock material. Dragados investigated hammering or picking of the rock as an alternative method however the duration of the operation would significantly increase as picking or hammering would be less efficient. Picking or hammering would also need to take place from land or a barge and is only possible in shallow water.

The role of blasting is to fracture rock to then enable the backhoe dredger to extract the rock material. There is no alternative available to the use of explosives for this type of operation.

The blasting will be delivered in the form of micro loads that will significantly reduce the impact the blasting will have in terms of noise and particulate movement. All explosives are placed down holes drilled into the rock itself. Operations will also be limited to a maximum of two blasts per day to minimise the impact to the surrounding environment. As part of the CEMD, trial blasting will be undertaken and the amount of explosives charge can be varied to ensure that, with the double bubble curtain in place, the noise produced is managed to minimise underwater noise transmission. Unless agreed by MS-LOT, the explosive charges used will not exceed 80kg.

10.1.2.5 Vessel Activity

For the duration of construction, a variety of vessels will be operating within the project site primarily performing dredging and material transportation operations. The type and size of the vessels will dependant on the volume of materials being moved and the type of dredging/installation taking place.

Alternatives to using vessels to undertake activities is to do as much of the work as possible from land. Whilst some dredging activities could be undertaken from land using a hammering or picking and a land based back hoe dredger, this would take considerably longer and has been discounted as unfeasible given the conditions and depth of material to be removed.

Vessels will be used to deliver and install the caissons. It would not be feasible to deliver these via land transport given the size and scale of the caissons.

10.1.2.6 Acoustic Deterrent Device

Although not an EPS, the use of an ADD has been used during 2018 in order to deter grey seals from within Nigg Bay during period when detonations were planned to be undertaken. Mitigation methods were enacted in which pre-blasting watches were carried out by Marine Mammal Observers (MMOs) and Passive Acoustic Monitoring Operators(PAMOs) for 30 minutes for all marine mammals to a distance of 1km from the blast location. If seals were observed within 500m during the observation period and no other marine mammal were within 1km, a Lofitech ADD was activated at a target frequency of 19-20kHz. The ADD was deployed from an anchored vessel 100m from the seals using a soft start procedure(activated for short bursts) before being activated at full power for 20 minutes if seals were present. During this entire period, the behaviour of seals were monitored by MMOs. If seals remained in the area after use of the ADD, blasting did not go ahead. This procedure was undertaken and the seals did not vacate during the ADD activation, causing significant delays to the project. It was therefore concluded that this method of seal deterrent produced no evident effect.

11 Favourable Conservation Status

Regulation 44(3)(b) states that a licence cannot be issued unless Scottish Government is satisfied that the action proposed "will not be detrimental to the maintenance of the population of the species concerned at a favourable conservation status in their natural range" (MS 2014).

This section considers whether the proposed activities that require licensing will be detrimental to the maintenance of the population of the species concerned at a favourable conservation status in their natural range. The information provided is based on the assessments undertaken in the Environmental Statement and this should be referred to for the full assessment and further detailed information, which is not presented here (Fugro 2015).

Mitigation measures are considered in Section 12 and it should be noted that the extensive mitigation plans (as described in the CEMD) are designed to ensure the risk of injury, temporary threshold shift (TTS) and permanent threshold shift (PTS) as well as disturbance are minimised. For the purposes of this FCS assessment the mitigation measures are not considered when analysing the number of individuals potentially disturbed by the proposed activities.

Under Article 1 of the Habitats Directive, the 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 the territory referred to in Article 2.

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;
- 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.

Five European Protected Species have been identified, based on the results from site specific surveys and relevant literature, as being potentially impacted by proposed activities that could affect their Conservation Status. The five species are:

- Harbour porpoise (*Phocoena phocoena*);
- Bottlenose dolphin (*Tursiops truncatus*);
- White-beaked dolphin (*Lagenorhynchus albirostris*);
- Risso's dolphin (*Grampus griseus*); and
- Minke whale (*Balaenoptera acutorostrata*).

The FCS of the cetaceans recorded during site specific vantage point surveys undertaken in support of the application and the regional and management unit populations are presented in Table 11.

Table 11: Favourable Conservation Status (FCS) and populations of marine mammals recorded during surveys in Aberdeen Bay

Species	FCS Assessment	Management Unit	Management Unit Population
Harbour porpoise	Favourable	Greater North Sea	333,808

Species	FCS Assessment	Management Unit	Management Unit Population
Phocoena phocoena			
Bottlenose dolphin *Tursiops truncatus*	Favourable (recovered)	East Coast Scotland	189 (95% HPDI 155-216)
White-beaked dolphin *Lagenorhynchus albirostris*	Favourable	Celtic and Greater North Sea	15,895 (107 – 27,743)
Risso's dolphin *Grampus griseus*	Unknown	-	Not available
Minke Whale *Balaenoptera acutorostrata*	Favourable	Celtic and Greater North Sea	11,820

12 Impacts on EPS

The following Section assesses the potential impacts the planned activities including the possible increase in explosive charge weight may have on European Protected Species.

Harbour porpoise (*Phocoena phocoena*)

The European Atlantic shelf harbour porpoise population is estimated to be 375,358 (95% CI 256,304 - 549,713) individuals, of which 227,298 (95% CI 176,360 - 292,948) occur in the North Sea Management Unit (**Error! Reference source not found.**) (Hammond *et al.* 2017, IAMMWG 2015, NCC 2017). The harbour porpoise population is recorded as being in favourable condition.

A total of 62 harbour porpoise were recorded during 12 months of vantage point baseline surveys with most sightings occurring during June and July (Table 2). However, data from C-PODs indicate that harbour porpoise occur more frequently between June and April with detections occurring in over 62% of the hours during this period. Lowest numbers were recorded between April and June when porpoises were detected during 16.7% of hours (Section 7.1). The apparent discrepancy between the visual sighting and acoustic detections may be due to the lower visual detectability of harbour porpoises during relatively poorer weather conditions out10with the summer months.

12.1.1 Predicted Impacts on Harbour porpoise

Blasting

Revised noise modelling has been undertaken since the original application was made. The results from the modelling and the associated assessment are presented in Fugro (2019).

Results from the noise modelling indicate that there is potential for the onset of PTS to occur in harbour porpoise within 8.8 km and 22 km depending on the charge weight and there being no mitigation in place. With the use of a double bubble curtain the range at which impacts are predicted to arise are reduced to within 1,000 m for all charge weights up to 80 kg (Table 12).

Disturbance likely to cause a behavioural response (140 dB re 1 µPa rms) is predicted to arise out to 130 km without any mitigation. As double bubble curtains will be being used this estimated range of disturbance is reduced to between 55 km and 75 km depending on the weight of the explosive charge (Table 13).

Table 12: Estimated range in metres at which onset of PTS could arise in harbour porpoise from detonation of explosive in Nigg Bay with and without mitigation.

Harbour porpoise	Charge weight (kg)						
	20	**30**	**40**	**50**	**60**	**70**	**80**
PTS (202 dB re 1 µPa peak)							
No bubble curtain	8,800	12,000	14,000	16,000	17,000	19,000	20,000
Double bubble curtain 100 m away	110	210	320	460	610	780	970
Double bubble curtain 650 m away	660	660	660	660	660	780	970

Table 13: Estimated range in metres at which disturbance could arise in harbour porpoise from detonation of explosive in Nigg Bay with and without mitigation.

Harbour porpoise	Charge weight (kg)						
	20	**30**	**40**	**50**	**60**	**70**	**80**
Disturbance (140 dB re 1 µPa rms)							
No bubble curtain	110,000	110,000	120,000	120,000	120,000	130,000	130,000
Double bubble curtain 100 m away	55,000	61,000	65,000	68,000	71,000	73,000	75,000
Double bubble curtain 650 m away	55,000	61,000	65,000	68,000	71,000	73,000	75,000

The estimated number of harbour porpoise at risk of PTS for a range of explosive charge weights (20 kg, 50 kg and 100 kg) are presented in Table 14. The results indicate that with mitigation in place there is very low risk of any harbour porpoise being impacted in the event that a 20 kg or 50 kg explosive charge is used. This increases to two individuals in the event a 100 kg charge is used (Fugro 2019).

Table 14: Estimated number of harbour porpoise at risk of the onset of PTS from a range of explosive charge weights and with and without a bubble curtain (Source: Fugro 2019).

Harbour porpoise	Charge weight					
	20 kg		**50 kg**		**100 kg**	
	No. of ind.	**% of pop.**	**No. of ind.**	**% of pop.**	**No. of ind.**	**% of pop.**
No bubble curtain	88.6	0.025	271.8	0.078	502.2	0.145
Double bubble curtain 100 m away	0.022	<0.001	0.293	<0.001	1.977	<0.001

In the event that disturbance from blasting occurs out to between 55 km and 75 km depending on the weight of the charge and including mitigation, it is estimated that up to 5,526 harbour porpoise may be impacted with levels of noise capable of causing disturbance based on SCANS III densities of 0.59 ind/km^2 (Table 15). An alternative approach is to assume that disturbance occurs no further than 26 km from the site of detonation. This follows an agreed limit for all UXO clearance irrespective of the weight of the charge, which could be up to 700 kg, and its position on the seabed surface (MS 2019, MOWL 2018). On this basis the number of harbour porpoise predicted to be disturbed would be 664 individuals.

Due to the nature of the sound arising from the detonation of explosives, i.e. a number of single discrete events undertaken over an extended period of time with each blast lasting for a very short duration, harbour porpoise are not predicted to be significantly displaced from an area. Should they occur, any changes in behaviour are predicted to be very short-lived. This is supported by initial results from blasting undertaken in 2018 which does not show any significant reduction in the number of harbour porpoise detections from either of the C-PODS immediately following blasting (Figure 30 and Figure 31).

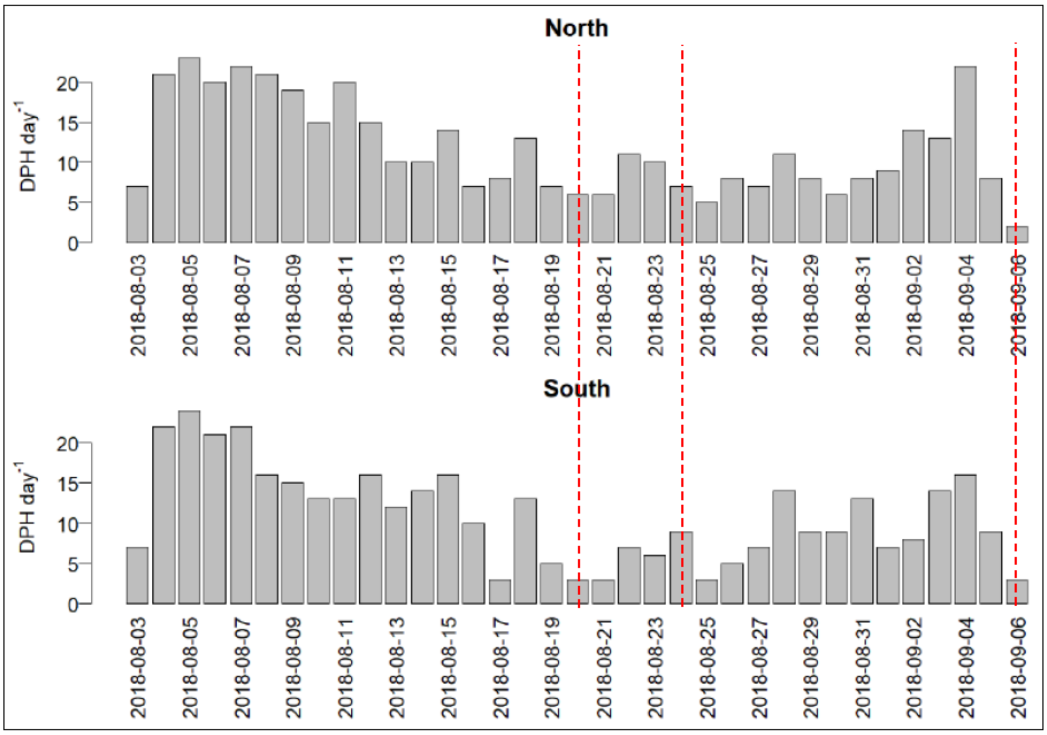

Figure 31: Detection positive hours per day for harbour porpoise during deployment period 2 and two occasions where blasting was undertaken (Source: Fugro 2019).

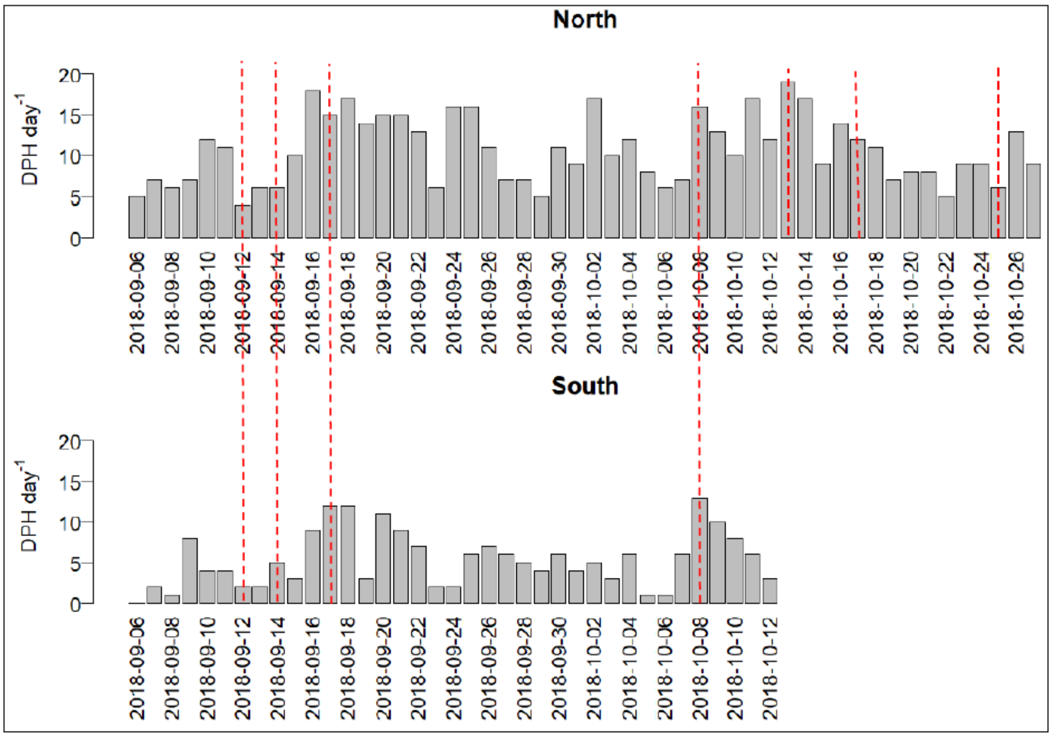

Figure 32: Detection positive hours per day for harbour porpoise during deployment period 3 and the seven occasions where blasting was undertaken (Source: Fugro 2019).

Table 15: Estimated number of harbour porpoise potentially disturbed from blasting activities.

Species	Regional Management Unit population	Density (ind/km^2)	Extent of potential disturbance (km)	Area of impact for disturbance (km^2)	Potential number impacted	Proportion of management unit (%)
Harbour porpoise	333,808	0.59	55	5,036	2,971	0.9
			75	9,365	5,526	1.6

There are few studies on disturbance or displacement impacts of blasting on marine mammals. However, studies based on other impulsive sound sources, e.g. seismic and piling activities indicate that displacement effects are temporary with porpoises returning to the area from which they had been displaced between 16 hours and 46 hours following cessation of activities (e.g. Brandt *et al.* 2016). Consequently, it is predicted in the event that displacement of harbour porpoise does occur that harbour porpoise will return to the area relatively quickly once blasting activities cease.

Population modelling undertaken indicates that an increase in charge weight up to 100 kg will not cause any changes in the harbour population (OSC 2019a).

Table 16: Unimpacted and impacted harbour porpoise population size (mean and 95% confidence interval) using a 100 kg charge (Source: OSC 2019a).

Year	Unimpacted population	Impacted population
2	346,528 (318,247 – 369,214)	346,528 (318,247 – 369,214)
7	347,456 (296,302 – 400,225)	347,452 (296,298 – 400,224)
13	347,833 (277,798 – 419,811)	347,829 (277,799 – 419,802)
19	348,383 (266,472 – 444,410)	348,379 (266,472 – 444,405)
25	349,021 (253,538 – 459,087)	349,017 (253,540 – 459,071)

Vessel Activity

The results from the C-PODs do not show any reduction in the number of harbour porpoise detected since the project started and vessel activity associated with the project increased (Figure 13 to Figure 16).

The main frequencies produced by vessels are below the main hearing frequencies for harbour porpoise. However, vessel noise is audible to harbour porpoise and has the potential to cause behavioural impacts, with localised displacement, a reduction in vocalisation and masking effects (Nowacek *et al.* 2007, Pirotta et al. 2015). Studies on harbour porpoise indicate that they may react to vessel noise at levels between 113 to 133 dB re 1 µPa and that sound at these levels may occur beyond 1 km from the vessel (Dyndo *et al.* 2015, Hermannsen *et al.* 2014). Thomsen *et al.* (2006) calculated that harbour porpoise may be able to detect vessel noise out to 20 km, although behavioural responses to vessels are predicted to be restricted to considerably closer than this, with studies estimating behavioural responses out to 1 km from the vessel (Thomsen *et al.* 2006).

The existing Aberdeen Harbour has over 8,000 vessel arrivals each year and 81 vessels pass within 12 nm of Nigg bay each day during the summer and 70 each day during the winter (Fugro 2015). Consequently, within the area of potential effect, there is already a relatively high level of ongoing shipping activity significantly in excess of the likely cumulative vessel noise arising during construction.

Although there is potential for relatively localised behavioural response arising from vessel noise which is predicted to occur throughout the construction period and could cause an increase in energetic costs to individual harbour porpoise, the increase in the number of vessels in the area during construction is relatively minor compared to the current baseline levels.

Dredging/Drum Cutter Activity

The results from the C-PODs do not show any reduction in the number of harbour porpoise detected since the project started and the commencement of dredging in 2018 (Figure 13 to Figure 16).

The results from the modelling undertaken at the time of the EIA application indicated that there was a very low risk of any harbour porpoise receiving levels of sound capable of causing the onset of PTS from any dredging activity, with less than one individual predicted to be affected.

Based on results from noise modelling dredging activities could potentially cause disturbance within 59 km of the dredging activities. However, aversive behaviour will be limited to within 390 m. Cumulatively there is potential for aversive behaviour to occur to at least 10 km from the sound source.

In the event that disturbance from dredging occurs out to 10 km, it is predicted that up to 122 harbour porpoise may be impacted with levels of noise capable of causing disturbance based on SCANS III densities of 0.59 ind/km^2 (Table 17).

Studies on the impacts on harbour porpoise from dredging sand extraction indicate that harbour porpoise are temporarily displaced when dredging occurs within 600 m. However, harbour porpoise returned to the area within three hours of cessation of dredging (Diederichs *et al.* 2010). Although potential areas of impact are site specific this study indicates that any displacement or disturbance caused by dredging activities will be temporary and potentially relatively localised.

Table 17: Estimated number of harbour porpoise impacted from dredging activities.

Species	Regional Management Unit population	Density (ind/km^2)	Extent of potential disturbance (km)	Area of impact for disturbance (km^2)	Potential number impacted	Proportion of management unit (%)
Harbour porpoise	333,808	0.59	10	206	122	0.04

Drilling

Results from noise monitoring undertaken during drilling operations within Nigg Bay indicate that at ranges of 100 m the mean level of sound is likely to be below 160 dB re 1µPa with occasional transients reaching 175 dB re 1µPa (Chickerell BioAcoustics 2018). Consequently, drilling noise is below that at which the onset of PTS is predicted to occur but may be capable of causing localised disturbance.

Data obtained from the C-PODs has overlapped period when drilling has been undertaken and the noise measurements were taken on 12th and 13th September 2018 (See Figure 15). The results from the C-POD data indicate that there was no significant disturbance to harbour porpoise from the drilling activities with the number of detections per hour remaining similar to those before and after the drilling was undertaken.

Acoustic Deterrent Device

The use of an ADD have shown a range over which displacement of harbour porpoise can occur. The maximum reported distance at which displacement or disturbance has been observed is 7,500 m. However, the extent of impact could be greater than this (Brandt *et al* 2012, Coram *et al* 2015). The studies undertaken have also found that harbour porpoise return to the area relatively quickly following cessation of ADD activities. In one study there were no differences in the number of harbour porpoise detected within 12 hrs of the cessation of ADD activities compared with pre ADD porpoise activity (Brandt *et al* 2012).

Due to the mitigation measures in place, there is very low risk of any harbour porpoises occurring within Nigg Bay and therefore at risk of disturbance from ADD. However, individuals offshore beyond the 1 km mitigation zone may be affected, the impacts of which will be a temporary displacement of harbour porpoise from the area.

Conclusion

Although, the impacts on harbour porpoises from displacement are unknown, displaced harbour porpoise will relocate elsewhere. Studies have indicated an increase in the number of porpoise occurring in areas beyond the area of disturbance (Brandt *et al*. 2016, Pirotta *et al*. 2014). Harbour porpoise occur widely across the North Sea and are therefore not constrained by specific habitat preferences. They are known to forage widely and prey on a wide selection of fish species (Sveegaard 2011) and are therefore adaptable and capable of relocating to other areas.

Although prey for harbour porpoise may be displaced by the proposed construction activities the extent of displacement, if any, will be relatively localised. Harbour porpoise are not restricted in their habitat usage nor their prey and so will be able to adapt to any temporary changes in prey distribution or behaviour during the relatively short period impacts are predicted to occur.

Evidence from the C-POD study undertaken during 2018 indicates that there has been little, if any, displacement of harbour porpoise from Nigg Bay during the construction activities to date.

Noise modelling undertaken to support the increase in charge weight indicates that, with agreed mitigation measures in place, harbour porpoise are not at risk of PTS at charge weights up to 80 kg. There is potential for disturbance to occur out to 75 km in the event that 80 kg detonations are used. Blasting will be an intermittent activity with dredging undertaken over the days following blasting activity. Consequently, there will be limited potential for displacement to arise and evidence from the C-PODs indicates that there is no significant, if any, displacement arising from the current activities.

Population modelling undertaken indicates that the proposed activities, including an increase in the charge weight will not cause any changes in the harbour porpoise population.

12.1.2 Harbour Porpoise Favourable Conservation Status

Based on the predicted scale and duration of possible impacts on harbour porpoise during the construction period, it is concluded that the proposed increase in charge weight and current activities will not be detrimental to the maintenance of the harbour porpoise population at a favourable conservation status within their natural range.

12.2 Dolphins (Bottlenose dolphin *Tursiops truncates*, White-beaked dolphin *Lagenorhynchus albirostris*, Risso's dolphin *Grampus griseus*)

The following section considers the potential impacts on dolphins recorded during site specific surveys, namely bottlenose dolphin (*Tursiops truncatus*), White-beaked dolphin (*Lagenorhynchus albirostris*) and Risso's dolphin (*Grampus griseus*). Based on the available evidence dolphin species have similar hearing abilities and sensitivities to noise. Consequently, the likely effects from noise on dolphins is predicted to be similar across all three species that may occur in the area.

Blasting

Revised noise modelling has been undertaken since the original application was made. The results from the modelling and the associated assessment are presented in Fugro (2019).

Results from the noise modelling indicate that there is potential for the onset of PTS to occur in dolphins within 27 m and 250 m depending on the charge weight and there being no mitigation in place. With the use of a double bubble curtain the range at which impacts are predicted to arise are predicted to remain the same (Table 18).

Disturbance likely to cause a behavioural response (170 dB re 1 µPa rms) is predicted to arise out to 58 km without any mitigation. As double bubble curtains will be being used this estimated range of disturbance is reduced to between 8 km and 19 km depending on the weight of the explosive charge (Table 19).

Table 18: Estimated range in metres at which onset of PTS could arise in bottlenose dolphin from detonation of explosive in Nigg Bay with and without mitigation.

Bottlenose dolphin	Charge weight (kg)						
	20	**30**	**40**	**50**	**60**	**70**	**80**
PTS (230 dB re 1 µPa peak)							
No bubble curtain	27	51	80	120	160	200	250
Double bubble curtain 100 m away	27	51	80	100	100	100	100
Double bubble curtain 650 m away	27	51	80	120	160	200	250

Table 19: Estimated range in metres at which disturbance could arise in bottlenose dolphin from detonation of explosive in Nigg Bay with and without mitigation.

Bottlenose dolphin	Charge weight (kg)						
	20	**30**	**40**	**50**	**60**	**70**	**80**
Disturbance (170 dB re 1 µPa rms)							
No bubble curtain	39,000	46,000	49,000	52,000	54,000	56,000	58,000
Double bubble curtain 100 m away	8,000	11,000	13,000	15,000	16,000	18,000	19,000
Double bubble curtain 650 m away	8,000	11,000	13,000	15,000	16,000	18,000	19,000

The estimated number of bottlenose dolphin at risk of PTS for a range of explosive charge weights (20 kg, 50 kg and 100 kg) are presented in Table 23. The results indicate that with mitigation in place there is very low risk of any bottlenose dolphin being impacted in the event that any explosive charge up to 100 kg is used (Fugro 2019).

Table 20: Estimated number of bottlenose dolphin at risk of the onset of PTS from a range of explosive charge weights and with and without a bubble curtain (Source: Fugro 2019).

Bottlenose dolphin	Charge weight					
	20 kg		50 kg		100 kg	
	No. of ind.	% of pop.	No. of ind.	% of pop.	No. of ind.	% of pop.
No bubble curtain	0.00001	0.00003	0.0014	0.00068	0.0115	0.00577
Double bubble curtain 100 m away	0.00001	0.00003	0.0009	0.00047	0.0009	0.00047

In the event that disturbance from blasting occurs out to between 8 km and 19 km depending on the weight of the charge and including mitigation, it is estimated that up to 48 bottlenose dolphin may be impacted with levels of noise capable of causing disturbance based on east coast of Scotland density of 0.07 ind/km^2 (Table 21).

Table 21: Estimated number of bottlenose dolphin potentially disturbed from blasting activities.

Species	Regional Management Unit population	Density (ind/km^2)	Extent of potential disturbance (km)	Area of impact for disturbance (km^2)	Potential number impacted	Proportion of management unit (%)
Bottlenose dolphin	189	0.07	8.0	138	10	5.3
			19	680	48	25

Population modelling undertaken to support this application indicates that the use of explosive charges up to 100 kg will not impact on the bottlenose dolphin population either in the short-term or over a period of 25 years, when it predicted that the differences in the impacted and unimpacted populations is one individual Table 22 (OSC 2019a).

Table 22: Unimpacted and impacted bottlenose dolphin population size (mean and 95% confidence interval) using a 100 kg charge (Source: OSC 2019a).

Year	Unimpacted population	Impacted population
2	204 (188 - 218)	204 (188 - 218)
7	233 (188 – 270)	233 (188 – 270)
13	265 (192 - 326)	265 (192 - 326)
19	297 (206 - 398)	297 (206 - 398)
25	334 (222 - 468)	335 (222 - 468)

There are few studies on the disturbance or displacement impacts of blasting on marine mammals. However, studies based on other impulsive sound sources, e.g. seismic and piling activities indicate that displacement effects are temporary and dolphins will return to the area once blasting activities cease.

Data from the C-PODs within Nigg Bay have indicated relatively little impact on the number of bottlenose dolphin detections per hour before during and after blasting activities (Figure 33 and Figure 34). However, the number of detections per hour were overall very low and therefore it is difficult to confirm whether or not a level of displacement did occur after blasting activities.

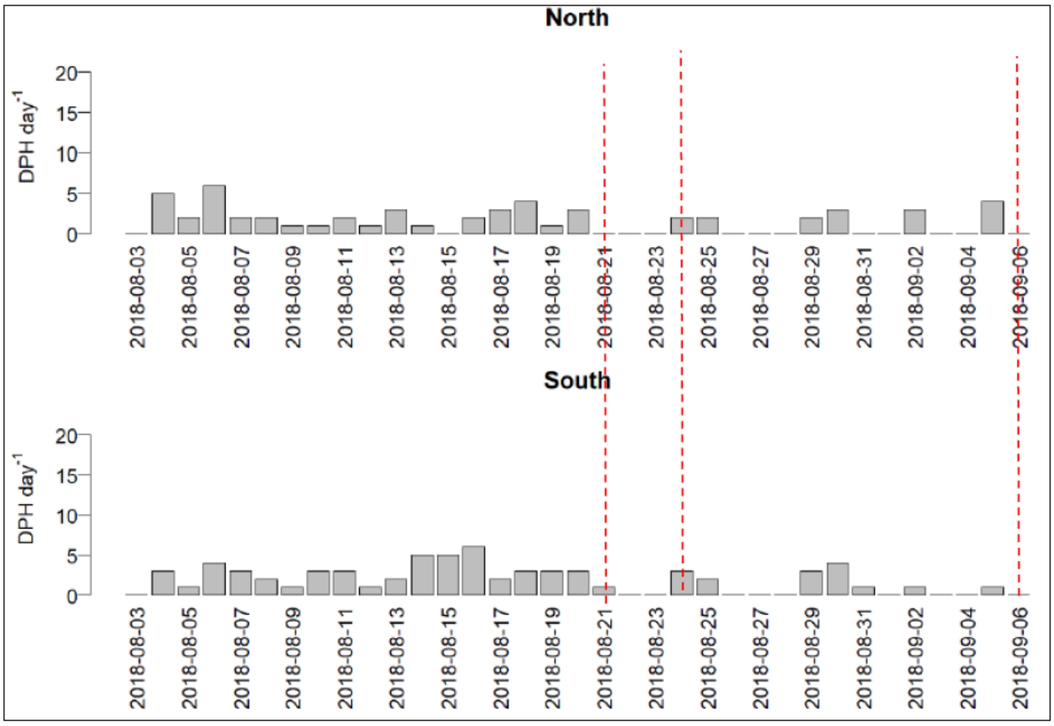

Figure 33: Detection positive hours per day for dolphin during period 2 and the two occasions when blasting was undertaken.

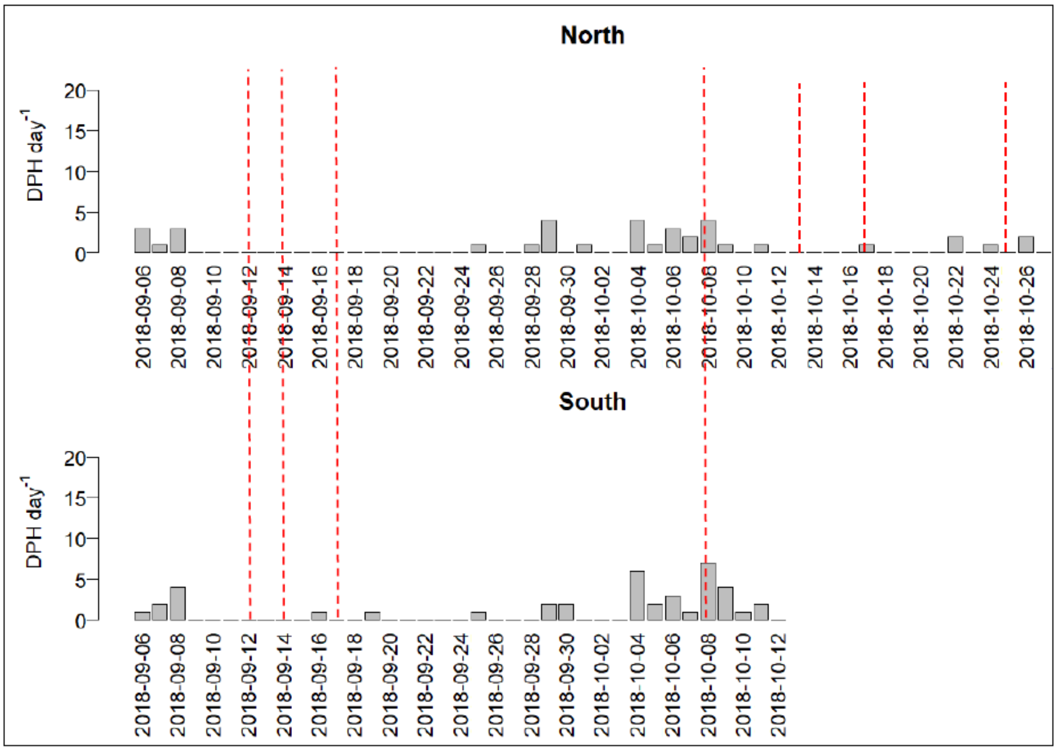

Figure 34: Detection positive hours per day for dolphin during period 3 and the seven occasions blasting was undertaken.

Vessel activity

The results from the C-PODs deployed during construction indicate there is no significant changes in the number of bottlenose dolphins in Nigg Bay since the start of activities (Figure 21 to Figure 24).

Studies undertaken on bottlenose dolphins have indicated that changes in vocalisation may occur up to 9 km from a vessel (Shaw 2012) and therefore disturbance is predicted to occur within 10 km from a vessel. Based on this disturbance radius it is estimated that up to 14 bottlenose dolphins could be impacted by disturbance from vessel activity within Nigg Bay, this is equivalent to 7.4% of regional bottlenose dolphin population.

It is predicted that up to 50 white-beaked dolphins may be impacted with levels of noise capable of causing disturbance based on SCANS III densities of 0.243 ind/km^2 (Table 20); this is equivalent to 0.31% of the management unit population.

Table 23: Estimated number of white-beaked and bottlenose dolphins impacted from vessel activity.

Species	Regional Management Unit population	Density (ind/km^2)	Extent of potential disturbance (km)	Area of impact for disturbance (km^2)	Potential number impacted	Proportion of management unit (%)
Bottlenose dolphin	189	0.07	10	206	14	7.4
White-beaked dolphin	15,895	0.243	10	206	50	0.31

There are no published densities for Risso's dolphin in order to estimate the potential number of individuals affected by vessel noise.

As previously discussed, the level of shipping activity within the area is relatively high with over 8,000 vessels a year entering and leaving the existing Aberdeen Harbour. Consequently, bottlenose dolphins are accustomed to a high level of vessel presence and associated noise. Other species of dolphin that are less frequent, and more transient, e.g. white-beaked dolphin and Risso's dolphin, may not be so accustomed to vessels and may be more sensitive to vessel noise than bottlenose dolphins. Evidence from site specific surveys indicate that the waters adjacent to the harbour are regularly used by bottlenose dolphins and are a preferred area within Aberdeen Bay (see Table 2 and Figure 28).

Studies undertaken on bottlenose dolphin using Aberdeen Harbour indicated that although not all dolphins are displaced by vessel activities, there is a reduction in the number of dolphins present with increasing vessel traffic (Pirotta *et al.* 2013). Therefore, there is potential for some displacement to occur with increased vessel activity during the construction period. However, as suggested by the results from the P-DOD data not all dolphins are predicted to be displaced and the relatively small increase in the number of vessels present, relative to the numbers currently and historically entering and exiting the harbour, is not predicted to significantly increase the level of baseline noise already occurring.

Both white-beaked and Risso's dolphins are uncommon or scarce in the area and although occasional individuals may be displaced by the presence of the construction vessels this is not going to have a population level effect.

Dredging/Drum Cutter activity

The results from the C-PODs do not show any reduction in the number of dolphins detected since the project started and the commencement of dredging in 2018 (Figure 21 to Figure 24).

The results from the modelling undertaken at the time of the EIA application indicated that there was a very low risk of any dolphins receiving levels of sound capable of causing the onset of PTS from any dredging activity, with less than one individual predicted to be affected (Table 9).

Based on results from noise modelling dredging activities could potentially cause disturbance within 59 km of the dredging activities. However, aversive behaviour will be limited to within 390 m. Cumulatively there is potential for aversive behaviour to occur to at least 10 km from the sound source.

In the event that disturbance from dredging occurs out to 10 km, it is predicted that up to 14 bottlenose dolphins and 50 white-beaked dolphins impacted from dredging activities (Table 24).

Table 24: Estimated number of dolphins impacted by noise from dredging activities.

Species	Regional Management Unit population	Density (ind/km^2)	Extent of potential disturbance (km)	Area of impact for disturbance (km^2)	Potential number impacted	Proportion of management unit (%)
Bottlenose dolphin	189	0.07	10	206	14	7.4
White-beaked dolphin	15,895	0.243	10	206	50	0.31

There are no suitable densities available for Risso's dolphin in order to estimate the potential number of individuals affected by vessel noise. However, Risso's dolphins are very scarce in North-east Scotland and are unlikely to be present during construction activities.

Studies on the impacts on bottlenose dolphin from dredging activities in Aberdeen showed that bottlenose dolphins were temporarily displaced for up to five weeks following periods of intense dredging activities (Pirotta *et al.* 2013). However, the results from the CPoDs operating during dredging activities indicate that there has been relatively little displacement effect

Modelling the predicted behavioural changes caused by increased boat traffic and dredging activities at three coastal developments in East Scotland, including the Aberdeen harbour expansion, has suggested that these construction activities will not have an adverse effect on the population size of bottlenose dolphins (Pirotta *et al.* 2015).

Drilling

Results from noise monitoring undertaken during drilling operations within Nigg Bay indicate that at ranges of 100 m the mean level of sound is likely to be below 160 dB re 1µPa with occasional transients reaching 175 dB re 1µPa (Chickerell BioAcoustics 2018). Consequently, drilling noise is below that at which PTS or is predicted to occur but may be capable of causing localised disturbance.

Data obtained from the C-PODs has overlapped period when drilling has been undertaken and the noise measurements were taken on 12th and 13th September 2018 (See Figure 23). However, there were no dolphins recorded immediately before, during or after this period and therefore it is not possible to determine whether drilling noise caused any displacement effects. However, the level of noise recorded from the drilling activities is relatively low and no significant disturbance is predicted to occur.

Acoustic Deterrent Device

There is limited information on the impacts ADD may have on dolphins. Studies undertaken on white-sided dolphin indicate that the use of seal scarers may reduce the number of dolphins present in the area (Morton 2000, Coram *et al.* 2015). The extent over which the use of an ADD may cause displacement or disturbance on dolphins are unknown but are predicted to be similar to those for other marine mammals.

There is very low risk of any dolphin occurring within Nigg Bay and therefore at risk of disturbance from ADD. However, individuals offshore beyond the 1 km mitigation zone may be affected, the impacts of which will be a temporary displacement of bottlenose dolphin from the area.

Conclusions

There is a high degree of certainty that bottlenose dolphin and potentially other species of dolphin will be displaced or disturbed by the construction activities, including the use of an ADD. However, the impacts will be temporary and only last during period construction is being undertaken. Dolphins will return to the area once the construction has been completed. Population modelling undertaken indicates that the detonation of charge weights up to 100 kg will not cause any change in the future population of bottlenose dolphins.

12.2.1 Bottlenose Dolphin Favourable Conservation Status

The European bottlenose dolphin population is estimated to be 16,485 individuals; CV = 0.422 (Hammond *et al*. 2013), with a regional and management unit population of 189 (95% HPDI 155-216) individuals (Cheyney *et al.* 2018). The population is reported to be in favourable (recovered) status (Cheyney *et al.* 2018).

A total of 205 bottlenose dolphins were recorded during vantage point surveys and was the most frequently recorded European Protected Species. Most sightings occurred between March and June (Table 1) and this is reflected in the acoustic detections of dolphins from C-PODs (Table 2).

The core distribution of the regional bottlenose dolphins ranges from between the Moray Firth and the Firth of Forth and they occur throughout their range (Figure 20). Their natural range is not restricted to specific areas or habitats and therefore, individuals that are displaced during the construction period will be able to temporarily relocate. Once the activities causing displacement has been completed bottlenose dolphins will return to the area.

The relatively localised extent of any potential impacts and their duration will not be detrimental to the maintenance of the bottlenose dolphin population at a favourable conservation status within their natural range.

12.2.2 White-beaked Dolphin Favourable Conservation Status

A total of three white-beaked dolphins were recorded during site specific surveys.

White-beaked dolphins occur widely across the North Sea and any individuals that may be displaced will be able to relocate elsewhere within areas beyond the zone of effect into areas already currently utilised by white-beaked dolphins and therefore areas where suitable habitat already exists.

The relatively localised area and temporary nature of any potential effects will not be detrimental to the maintenance of the white-beaked dolphin population at a favourable conservation status within their natural range.

12.2.3 Risso's Dolphin Favourable Conservation Status

No Risso's dolphins were recorded during site specific surveys. However, surveys within Aberdeen Bay have shown that this species may be present during the construction period (AOWFL 2012).

There is a low probability that any Risso's dolphins will be affected by the proposed construction activities. In the unlikely event that some are present they will be able to relocate to other suitable habitat and any impacts will be temporary. Consequently, it is concluded that the proposed development will not be detrimental to the maintenance of the Risso's dolphin population within their natural range.

12.3 Minke Whale (Balaenoptera acutorostrata)

Minke whales were not recorded during site specific baseline surveys but two were recorded in September 2018, a day after the use of explosives (Fugro 2019). Twelve minke whales were recorded during two years of baseline surveys undertaken at the proposed Aberdeen offshore wind farm, located in Aberdeen Bay and they are known to regularly occur along the east coast of Scotland (AOWFL 2012, Reid *et al.* 2013). Consequently, it is predicted that minke whales could be present within the area sound levels capable of causing disturbance are predicted to occur.

Revised noise modelling for detonation of explosives has been undertaken since the original application was made. The results from the modelling and the associated assessment are presented in Fugro (2019).

Results from the noise modelling indicate that there is potential for the onset of PTS to occur in minke whales within 300 m and 3,100 m depending on the charge weight and there being no mitigation in place. With the use of a double bubble curtain at 100 m away from the blast the modelling indicates that the onset of PTS will not extend beyond 100 m irrespective of the charge weight (Table 25).

Disturbance likely to cause a behavioural response (170 dB re 1 µPa rms) is predicted to arise out to 58 km without any mitigation. As double bubble curtains will be being used this estimated range of disturbance is reduced to between 8 km and 19 km depending on the weight of the explosive charge (Table 26).

Table 25: Estimated range in metres at which onset of PTS could arise in bottlenose dolphin from detonation of explosive in Nigg Bay with and without mitigation.

Minke whale	**Charge weight (kg)**						
	20	**30**	**40**	**50**	**60**	**70**	**80**
PTS (219 dB re 1 µPa peak)							
No bubble curtain	340	640	1,100	1,500	2,000	2,500	3,100
Double bubble curtain 100 m away	100	100	100	100	100	100	100
Double bubble curtain 650 m away	340	640	660	660	660	660	660

Table 26: Estimated range in metres at which disturbance could arise in bottlenose dolphin from detonation of explosive in Nigg Bay with and without mitigation.

Minke whale	**Charge weight (kg)**						
	20	**30**	**40**	**50**	**60**	**70**	**80**
Disturbance (170 dB re 1 µPa rms)							
No bubble curtain	39,000	45,000	49,000	52,000	54,000	56,000	58,000
Double bubble curtain 100 m away	8,000	11,000	13,000	15,000	16,000	18,000	19,000
Double bubble curtain 650 m away	8,000	11,000	13,000	15,000	16,000	18,000	19,000

The estimated number of minke whale at risk of PTS for a range of explosive charge weights (20 kg, 50 kg and 100 kg) are presented in Table 27. The results indicate that with mitigation in place there is very low risk of any minke whale being impacted in the event that any explosive charge up to 100 kg is used (Fugro 2019).

Table 27: Estimated number of minke whale at risk of the onset of PTS from a range of explosive charge weights and with and without a bubble curtain (Source: Fugro 2019).

Minke whale	Charge weight					
	20 kg		50 kg		100 kg	
	No. of ind.	% of pop.	No. of ind.	% of pop.	No. of ind.	% of pop.
No bubble curtain	0.0014	0.0001	0.1521	0.001	1.4481	0.0098
Double bubble curtain 100 m away	0.0001	0.0000 3	0.0009	0.0004 7	0.0009	0.0004 7

In the event that disturbance from blasting occurs out to between 8 km and 19 km depending on the weight of the charge and including mitigation, it is estimated that up to 48 bottlenose dolphin may be impacted with levels of noise capable of causing disturbance based on east coast of Scotland density of 0.07 ind/km^2 (Table 21).

Table 28: Estimated number of bottlenose dolphin potentially disturbed from blasting activities.

Species	Regional Management Unit population	Density (ind./km^2)	Extent of potential disturbance (km)	Area of impact for disturbance (km^2)	Potential number impacted	Proportion of management unit (%)
Minke whale	11,820	0.039	8.0	138	6	0.05
			19	680	27	0.22

Population modelling undertaken to support this application indicates that the use of explosive charges up to 100 kg will not impact on the minke whale population either in the short-term or over a period of 25 years, when it predicted that the differences in the impacted and unimpacted populations is one individual Table 22 (OSC 2019a).

Table 29: Unimpacted and impacted bottlenose dolphin population size (mean and 95% confidence interval) using a 100 kg charge (Source: OSC 2019a).

Year	Unimpacted population	Impacted population
2	14,778 (13,145 – 16,058)	14,778 (13,145 – 16,058)
7	14,771 (12,404 – 17,808)	14,771 (12,404 – 17,808)
13	14,698 (11,590 – 18,750)	14,698 (11,590 – 18,750)
19	14,719 (10,942 – 19,288)	14,720 (10,942 – 19,284)
25	14,670 (10,499 – 19,759)	14,670 (10,499 – 19,759)

There are few studies on the disturbance or displacement impacts of blasting on marine mammals. However, detection rates of minke whales during seismic surveys are significantly lower when the airguns are on than when they're off and studies undertaken using Acoustic Deterrent Devices indicated that minke whale will avoid impulsive noise by increasing swimming speed and moving away from the sound source (McGarry *et al*. 2017, Stone *et al*. 2017). Consequently, evidence from other impulsive sound sources, e.g. seismic and Acoustic Deterrent Devices indicate that displacement effects could arise although the impacts are predicted to be temporary and minke whales will return to the area once blasting activities cease.

A range of potential impacts may arise from vessel noise, in particular masking effects, reduced vocalisation or avoidance behaviour (OSPAR, 2009). Studies of minke whales in the Pacific Ocean have indicated potential avoidance behaviour and/or reduced vocalisation in response to vessels (Noris 2010) and in Ireland the number of Minke whales present within Broadhaven Bay decreased with increased vessel presence (Anderwald *et al.* 2013). However, none of the results suggest high levels of displacement in response to high vessel numbers but indicate slight degrees of avoidance behaviour (Anderwald *et al.* 2013).

Displacement and or disturbance to minke whales may arise from other construction activities, e.g. dredging and drilling. Based on disturbance from dredging activities occurring out to no more than 10 km, an estimated eight minke whales could be disturbed. Drilling noise capable of causing disturbance has previously been assessed and is limited to within 210 m from the sound source. Therefore no minke whales are predicted to impacted by drilling noise Although these activities may cause an impact, the number of minke whales within the area are, based on survey data, predicted to be relatively small. Displaced whales will be able to relocate to other suitable sites and are not predicted to be adversely affected by any displacement that may occur.

The use of an ADD within Nigg Bay could cause disturbance to minke whale if present within the area. Minke whales will be able to detect ADD and studies in Iceland have shown that they will swim away from an operating ADD although the range of disturbance is unknown (McGarry *et al*. 2017).

11.3.1 Minke Whale Favourable Conservation Status

Based on the low numbers of minke whales predicted to be affected by the proposed construction activities, including an increase in charge weights and the temporary nature of any disturbance impacts, it is concluded that the proposed development will not be detrimental to the maintenance of the minke whale population within their natural range.

13 Mitigation

A range of mitigation measures have been identified and agreed with Marine Scotland and Scottish Natural Heritage and Non-Government Organisations (NGOs) such As Whale and Dolphin Conservation (WDC) and Royal Society for the Protection of Birds (RSPB) for the entire AHEP construction activities and are detailed within the Construction Environmental Management Document (CEMD) approved in May 2017. The plans most relevant to this EPS are the Marine Mammal Mitigation Plan (Chapter 11) and the Dredging and Dredge Spoil Disposal Management Plan (Chapter 7). The detail within these plans is not repeated in full here (as agreed with MSLOT) but key points summarised below.

Specific mitigation includes:

- Blasting Operations

Blasting operations will be undertaken in accordance with the commitments made in the CEMD including the use of Marine Mammals Observers and Passive Acoustic Monitoring to ensure the area surrounding blasting operations is clear of marine mammals prior to operations commencing.

A double bubble curtain has and will continue to be deployed during blasting operations to reduce the transmission of noise and minimise disturbance to marine mammals. The details of the double bubble curtain are provided in the CEMD. Details of the current mitigation in place are presented in Section 6.1.

To support the proposed increase the charge weight to be used the CEMD chapter 11, Marine Mammal Mitigation Plan has been updated. This document provides the full details relating to additional mitigation being proposed in order to ensure that there is a minimal risk to EPS from the increase in blasting. Additional mitigation measures will be in place:

On the day of the blast, MS-LOT and Scottish Natural Heritage (SNH) will be notified. If the calibrated noise recorded at a certain charge increment is below the benchmark(170 dB re 1µPa rms or 183 dB re 1µPa peak outside the bubble curtain, or at 400 m if the bubble curtain is positioned less than 400 m from the blast location), the charge will be increased to the next increment. The size of increments is to be reduced if the calibrated noise level suggests that a full increment is likely to increase noise above the benchmark. If adverse effects on marine mammals are observed by the MMO'S, MS-LOT will be notified immediately.

- Dredging

Prior to start-up of dredging operations at AHEP, all crew members and bridge staff with be aware that, if marine mammals are spotted in the vicinity of proposed operations start-up of operations should be delayed. Where a dedicated MMO is onboard a vessel (be this CSD, BHD or TSHD) they will undertake a watch and report observations to bridge staff. If a marine mammals is spotted, this will be communicated to the spread of vessels in the AHEP construction area so that all vessels are aware of the presence of marine mammals and can take appropriate action (as defined in the CEMD).

Should marine mammals be observed, the operator will delay the start of operation until such a time that marine mammals are no longer in the area. The assistance of MMO's onshore to track marine mammals will be sought where appropriate.

- During Dredge Deposit Operations

Whilst deposit operations are taking place, the vessels (either the TSHD, CSD or Split Hopper Barges (SHB), which are required for backhoe dredging, will adhere to the following conditions in relation to marine mammals.

- Marine Mammal Observers will be used to ensure that at sea deposit operations do not start while marine mammals are within the 500m mitigation zone. A MMO will be present on the deposit vessel, or situated on an alternative vessel at the deposit site.
- A 20 minute watch must be kept prior to deposit operations commencing.
- A continuous watch must be kept during operations and if marine mammals are observed within 500m then, where technically possible, deposit operations must be ceased until the area has been clear of marine mammals for at least 20 minutes.

- Drum Cutter

Prior to the start of drum cutter operations, an MMO will carry out a watch for at least 20 minutes to ensure an area 500m from the drum cutter operations are free from marine mammals. Should marine mammals be identified in this area, operations will not commence until marine mammals have left the area.

- Vessels

All vessels will follow the Aberdeen Harbour Dolphin Code and toolbox talks and other training will be provided to ensure all vessel masters are aware of the requirements. Further details are provided in the CEMD Vessel Management Plan (Plan 17).

- Acoustic Deterrent Device

The ADD will be operated from a anchored vessel for a maximum period of 20 minutes switched on, followed by 20 minutes switched off, if seals are still present it will be reactivated for a further 20 minute period. This pattern will be followed until seals have left the mitigation zone. Details of the process for the use of ADD are presented in Section 6.5.

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