Beatrice Offshore Wind Farm

Piling Strategy Implementation Report

April 2018

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Title/ Location	Beatrice Offshore Wind Farm
Reference Number	LF000005
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Piling Strategy Implementation Report

Rev	Prepared By	Sign Off	Checked By	Sign Off	ECoW Review By	Sign-Off	Approved By	Sign Off	Date of Issue
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List of abbreviations and definitions

Term	Definition / Description
AC	Alternating Current.
ADD	Acoustic Deterrent Device.
Application	The Application letters and Environmental Statement (ES) submitted to the Scottish Ministers by BOWL on 23rd April 2012 and Supplementary Environmental Information Statement (SEIS) submitted to the Scottish Ministers by BOWL on 29 h May 2013.
Asset locations	A collective term to describe WTG and OTM locations
BOWL	Beatrice Offshore Windfarm Limited (Company Number SC350248) and having its registered office at Inveralmond House, 200 Dunkeld Road, Perth, PH1 3AQ.
Cefas	Centre for Environment, Fisheries and Aquaculture Science.
CLT	The BOWL Consent and Licensing Team.
Consents	S36 Consent and the OfTW Marine Licence.
Development	The Wind Farm and the OfTW.
DPR	Daily Progress Report.
DSFB	District Salmon Fisheries Board.
ECoW	Environmental Clerk of Works as required for approval under condition 30 of the S36 Consent and condition 3.2.2.12 of the OfTW Marine Licence.
EPS	European Protected Species.
ES	The Environmental Statement submitted to the Scottish Ministers by BOWL on 23rd April 2012 as part of the Application as defined above.
Foundation installation phase	The term used to describe the period over which the piled foundations, associated with the Development, were installed.
HLV	Heavy Lift Vessel.
Inter-array cables	The AC electrical cables that connect the Wind Turbine Generators (WTGs) to the Offshore Transformer Modules (OTMs).
JNCC	Joint Nature Conservation Committee.
Marine Licences	The written consents granted by the Scottish Ministers (referred to on the licence as the Licensing Authority) under the Marine (Scotland) Act 2010, Part 4. The Marine Licences were issued on 2 September 2014 and revised by the issue of a licence on 27 April 2016.
MHWS	Mean High Water Spring.
MFRAG-MM	Moray Firth Regional Advisory Group - Marine Mammal sub-group.
MMMP	Marine Mammal Monitoring Programme.

Term	Definition / Description
MMMT	Marine Mammal Mitigation Team.
MMO	Marine Mammal Observer.
MS	Marine Scotland.
MS-LOT	Marine Scotland Licensing Operations Team.
MSS	Marine Scotland Science.
NCR	Non-Compliance Report.
OfTW	The Offshore Transmission Works. The OfTW includes the transmissions cable required to connect the Wind Farm to the Onshore Transmission Works (OnTW). This covers the OTMs and the cable route from the OTMs to the MHWS at the landfall west of Portgordon on the Moray coast.
OSP	Offshore Substation Platform.
OTM	Offshore Transformer Module means an AC OSP which is a standalone modular unit that utilises the same substructure and foundation design as a wind turbine generator.
PAM	Passive Acoustic Monitoring.
PMP	Piling Mitigation Protocol - protocol to mitigate injurious effects on marine mammals developed as an alternative to the JNCC (2010) guidelines.
PEMP	Project Environmental Monitoring Plan as required for approval under condition 27 of the S36 Consent and condition 3.2.1.1 of the OfTW Marine Licence.
PIF	Pile Installation Frame.
Piling phase	The term used to describe the 103 days on which piling occurred during foundation installation.
PPMS	Phased Piling Mitigation Strategy – phased introduction of the PMP (see above) using standard JNCC mitigation protocol (JNCC, 2010) as the starting point.
PS	Piling Strategy as required for approval under condition 12 of the S36 Consent and condition 3.2.2.5 of the OfTW Marine Licence.
S36 Consent	Consent granted by the Scottish Ministers under Section 36 of The Electricity Act 1989 to construct and operate the Beatrice Offshore Wind Farm electricity generating station, dated 19th March 2014.
SAC	Special Area of Conservation.
SEIS	The Supplementary Environmental Information Statement submitted to the Scottish Ministers by the Company on 29th May 2013 as part of the Application as defined above.
SHL	Seaway Heavy Lifting.

Term	Definition / Description
SNH	Scottish Natural Heritage.
UoA	University of Aberdeen.
Wind Farm	The offshore development as assessed in the ES including WTGs, their foundations, and inter-array cabling, excluding the OfTW.
WP	Work Package.
WTG	Wind Turbine Generator.

1 Introduction

1.1 Background

The Beatrice Offshore Wind Farm development received consent under Section 36 of the Electricity Act 1989 from the Scottish Ministers on 19th March 2014 (the S36 Consent) and was issued two marine licences from the Scottish Ministers for the Wind Farm and for the Offshore Transmission Works (OfTW) respectively, on 2nd September 2014 (the Marine Licences), as revised by the issue of licences 04461/16/0 and 04462/16/0 on 27th April 2016 and as revised by the issue of licences 04461/18/0 and 04462/18/0 on 9h April 2018. The Wind Farm and the OfTW are collectively referred to as the 'Development' and the S36 Consent and the Marine Licences are collectively referred to as the 'Consents'.

A Piling Strategy (PS) consent plan (BOWL, 2017a; ref: LF000005-PLN-142) was produced to address the specific requirements of the relevant conditions attached to the Consents issued to Beatrice Offshore Windfarm Limited (BOWL). The most recent revision of the PS approved by Marine Scotland Licensing Operations Team (MS-LOT) is Revision 05 dated 1 March 2017 and unless otherwise stated this is the revision being referred to throughout this Report.

The aim of the PS was to present how underwater noise, arising from piling activity during construction and leading to potential effects on key marine mammals and fish (bottlenose dolphin *Tursiops truncatus*, harbour seal *Phoca vitulina*, Atlantic salmon *Salmo salar*, cod *Gadus morhua* and herring *Clupea harengus*), was to be mitigated. The PS included the following information:

- Full details of the proposed method and anticipated duration of piling at all asset locations;
- Details of soft-start procedures and anticipated maximum piling energy required at each pile asset location; and
- Details of mitigation and monitoring to be employed during piling.

As per the requirements under the Consents, the PS was developed in accordance with the Environmental Statement (ES) and Supplementary Environmental Information Statement (SEIS) and reflecting additional surveys that were carried out following the Application. .

The PS included a detailed Piling Mitigation Protocol (PMP) to meet the requirements of the Consents (see Appendix C of the PS). BOWL also developed a Phased Piling Mitigation Strategy (PPMS) at the request of MS-LOT (BOWL, 2016a). The PPMS provided a high-level comparison between the draft guidelines (JNCC, 2010a) using Marine Mammal Observers (MMOs) and Passive Acoustic Monitoring (PAM) as well as the use of an Acoustic Deterrent Device (ADD) to ensure marine mammals were clear of the identified 60 m injury zone prior to soft start piling.

1.2 Aim and objectives of the Piling Strategy Implementation Report

This Report has been written for MS-LOT and other key stakeholders as a means of illustrating how BOWL implemented the mitigation detailed in the PS (see Table 1.1 of the PS), including provision of details on the species observed in the field, maximum hammer energies and piling durations.

Specific objectives of this Report are:

- To report on implementation of the PMP (developed by Tessa McGarry at RPS and Prof. Paul Thompson and the University of Aberdeen (UoA)), including the soft start procedure.
- To present a summary of the parameters measured during piling activity and present a comparison between what was predicted in the PS and actual data collected during the piling phase, including:
    - Maximum and average hammer energies achieved per asset location;
    - Maximum and average duration of piling per asset location; and
    - Example piling profiles associated with maximum and average piling activity.
- To provide commentary of the species observed.

1.3 Additional licences and legal requirements

A European Protected Species (EPS) licence was issued to BOWL by MS-LOT on the 29th February 2016 (MS EPS 01/2016/00) to permit the disturbance of bottlenose dolphin, harbour porpoise *Phocoena phocoena*, northern minke whale *Balaenoptera acutorostrata*, common dolphin *Delphinus delphis*, white-beaked dolphin *Lagenorhynchus albirostris* and Risso's dolphin *Grampus griseus*, during the construction phase of the Development (which included the use of ADDs). The EPS licence required all piling operations and ADD operations to be carried out in accordance with the PS.

This Report demonstrates how relevant EPS licence requirements have been met.

1.4 Scope of the Piling Strategy Implementation Report

Section 13.5 of the PS states that a final piling report will be submitted to MS-LOT on completion of construction works. It states that the report will:

"…..be a compilation of the field records gathered by the ADD Operators. It will include a piling profile for each pile installed, and include details of soft-start procedures, maximum hammer energy used and the duration of impact piling at each pile location. This will enable comparison against this PS. It will also include records of ADD testing and deployment.'

This Report has been set out to allow for straightforward comparison with the PS. The scope of this Report is provided in the following table and should be cross referenced to the relevant section in the PS (Table 1-1).

Table 1-1 Scope of the Piling Strategy Implementation Report

Section in this Report	Section title in this Report	Cross reference to relevant section in Piling Strategy
Section 2	Clarifications and amendments to mitigation during implementation of the Piling Strategy	Section 5: Updates and amendments to this Piling Strategy
Section 3	Foundation installation	Section 6: Wind farm construction overview
Section 4	Implementation of piling mitigation protocol and associated reporting	Section 10: Mitigation Section 13: Reporting and auditing
Section 5	Key outputs and results	Section 7: Anticipated maximum piling energies and durations Section 9: Reduction in design envelope in comparison to the ES/SEIS
Section 6	Observations and monitoring during foundation installation	Section 8: Environmental sensitivities Section 11: Monitoring
Section 7	Conclusions	n/a

BOWL implemented the PPMS between the 12th August 2017 and 25th August 2017. Reporting associated with the PPMS was concluded in October 2017 (BOWL, 2017b) and MS-LOT confirmed that all obligations associated with the PPMS had been discharged on 7th December 2017 (Marine Scotland, 2017)). As a result, no specific reporting on the implementation of the PPMS has been included in this Report.

It should be noted, however, that piling data recorded during the period 12th August 2017 to 25th August 2017 has been included in the scope of this report for completeness (i.e. so that the full piling dataset is analysed and presented in terms of hammer energy and piling duration).

2 Clarifications and amendments to mitigation during implementation of the Piling Strategy

During implementation of the mitigation, as detailed in the PS, there was one clarification and one approved update, both of which were discussed with MS-LOT and are set out in Table 2-1 below.

Table 2-1 Clarifications and amendments to mitigation during implementation of the Piling Strategy

Subject	Date raised	Ref to PS	Clarification/ Approved update	Consultation
Soft-start piling rate	10 April 2017	Figure 10.1 and Appendix C	Clarification Piling rates specified in the soft-start procedure are pre-fixed by an approximation sign therefore piling rate can vary minimally i.e. 1 blow every 2 seconds not workable however circa 1 blow every 1.5 seconds workable.	BOWL notified MS-LOT both verbally and via email (19 April 2017). Email states: "*BOWL noted that the frequency of hammer blows during piling soft start is approx. 1 blow per 1 – 1.5 seconds. All parties agreed on the call that the frequency of hammer blows is compliant with the PS (which states '~1 blow per 2 seconds'). No further action is required.*"
ADD activation periods	20 April 2017	Section 3, Figure 10.1 and Appendix C	Approved update Flexibility to allow for up to an additional two minutes, only where necessary, where PMP specifies 15 minutes.	BOWL notified MS-LOT both verbally (03 May 2017) and via email. MS-LOT email response states that: "*MS-LOT have discussed the issue regarding ADDs running for longer than 15 minutes. We note that the ADD have, on occasion, run for 16-17 minutes in total. We also note that the full ADD timings are included in the compliance reports, which is helpful.* *We have taken advice from MSS and whilst ADDs should not run routinely for extended periods of time, we are satisfied that you are not in breach of any licence conditions should the ADDs run for a couple of extra minutes on occasion. Please continue to include this information within your compliance reports.*"

3 Foundation installation

3.1 Overview

A total of 86 asset locations were piled pertaining to two OTMs and 84 WTGs. Piling occurred on 103 days (the 'piling phase') of the 256 day foundation installation phase (see Section 3.3). The total number of hours of actual piling during this period, when totalled, equates to circa 430 hours/18 days.

3.2 Piling method

A staged approach was undertaken to install the foundations as illustrated in Figure 6.4 of the PS. The only deviation to this process during foundation installation was that Stage 5 (relief pile drilling) was not required and therefore is omitted from this Report.

A summary of the approximate duration of each stage of the foundation installation process is provided in Table 3-1 alongside the actual duration experienced for each stage.

Table 3-1Summary of the duration of each stage of the foundation installation process (durations are per asset location).

Event	Approximate duration as presented in the PS	Actual[1] duration (averaged over 86 asset locations)
Vessel set up	5.5 hours	3 hours
Pile Installation Frame (PIF) positioning	4 hours	2 hours
Pile installation (placement in PIF and seabed stabbing)	7 hours	6 hours (including barge mooring operations and pile installation into PIF)
Piling (including the time required to implement the mitigation set out in the PMP described in Section 10.2 of the PS and piling to desired penetration depth) (excludes any time required for relief drilling or micro-siting)	Hammer set-up: 2 hours Piling to full penetration (including mitigation soft start): 3.2 to 12.8 hours Moving piling hammer between piles: up to 3 hours	Hammer set-up: ~2 hours[2] Piling to full penetration: 5 hours, 95% CI [4.7, 5.3] Mean time to move hammer between piles: 49 minutes, 95% CI [45.1, 53.5]
Perform pile level measurements (pile metrology)	1 hour	1 hour
Recovery of the PIF	2.5 hours	1 hour
Total duration of foundation installation activities at each asset location	Approximately 28 - 38 hours	Circa 21 hours

[1] Duration presented as whole numbers.

[2] Hammer set up was not logged separately during the piling phase and therefore an accurate duration could not be calculated. The duration is therefore given as 2 hours as approximated in the PS.

The summary data in Table 3-1 show that the approximate durations of each stage of the foundation installation process, as presented in the PS, were consistently higher than the actual durations averaged over the 86 asset locations.

3.3 Foundation installation programme

The PS stated that foundation installation would take place between April 2017 and January 2018. The foundation installation phase commenced on 22nd March 2017 with the mobilisation of the Seaway Heavy Lifting (SHL) owned Heavy Lift Vessel (HLV) - the *Stanislav Yudin* – from the Port of Rotterdam. The piling phase commenced on 2nd April 2017. Overall foundation installation was completed on 2nd December 2017 and therefore piling occurred within the foundation installation window stated in the PS.

Mitigation to reduce the risk of injury to marine mammals was implemented under the PMP from the start of the piling phase and as and when required up to the 8th August 2017, at which point the mitigation strategy switched to the PPMS. Piling operations continued under the PPMS during a 12 day phase, over which time a total of six asset locations were piled. Mitigation reverted to the PMP on 26th August 2017 for the remainder of the piling phase.

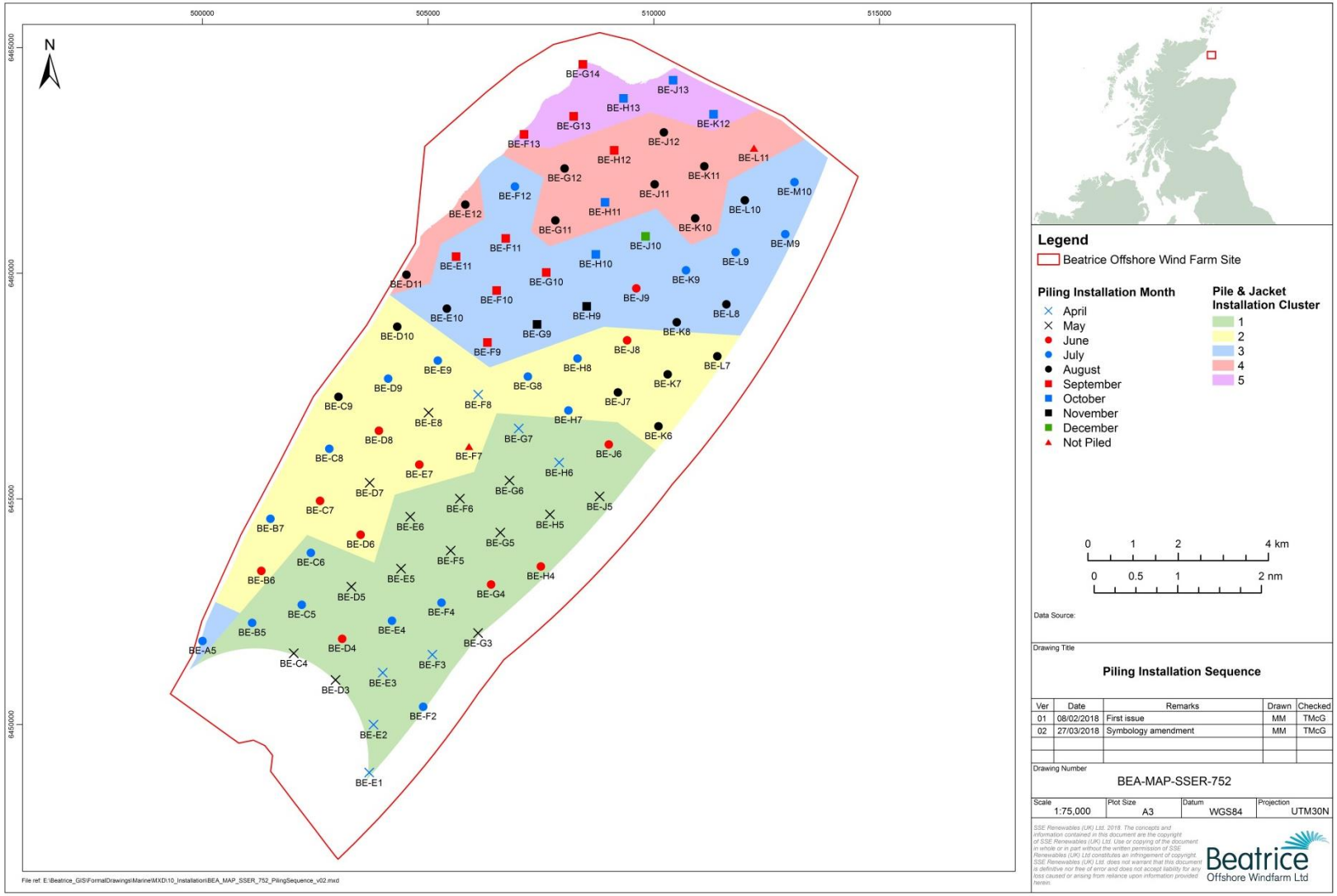
3.4 Planned and unplanned breaks

Most breaks during piling were planned breaks and did not exceed 2.5 hours in duration (i.e. the cut off duration for implementing the PMP from the beginning). There were a number of exceptions when unplanned breaks did occur during piling with the majority of these being the result of technical/mechanical issues with the HLV equipment.

3.5 Piling operations sequence

Figure 6.8 in PS shows the planned sequence in which asset locations would be piled across the Development site. The original plan was to install the foundations sequentially through each of the clusters 1 to 5. Whilst this was achieved to some extent there were variations in the sequence that were made because of logistical constraints. The sequence of foundation installation across the Development site, compared to the original plan, is illustrated in Figure 3-1.

Figure 3-1 Sequence of piling operations across the Development site.



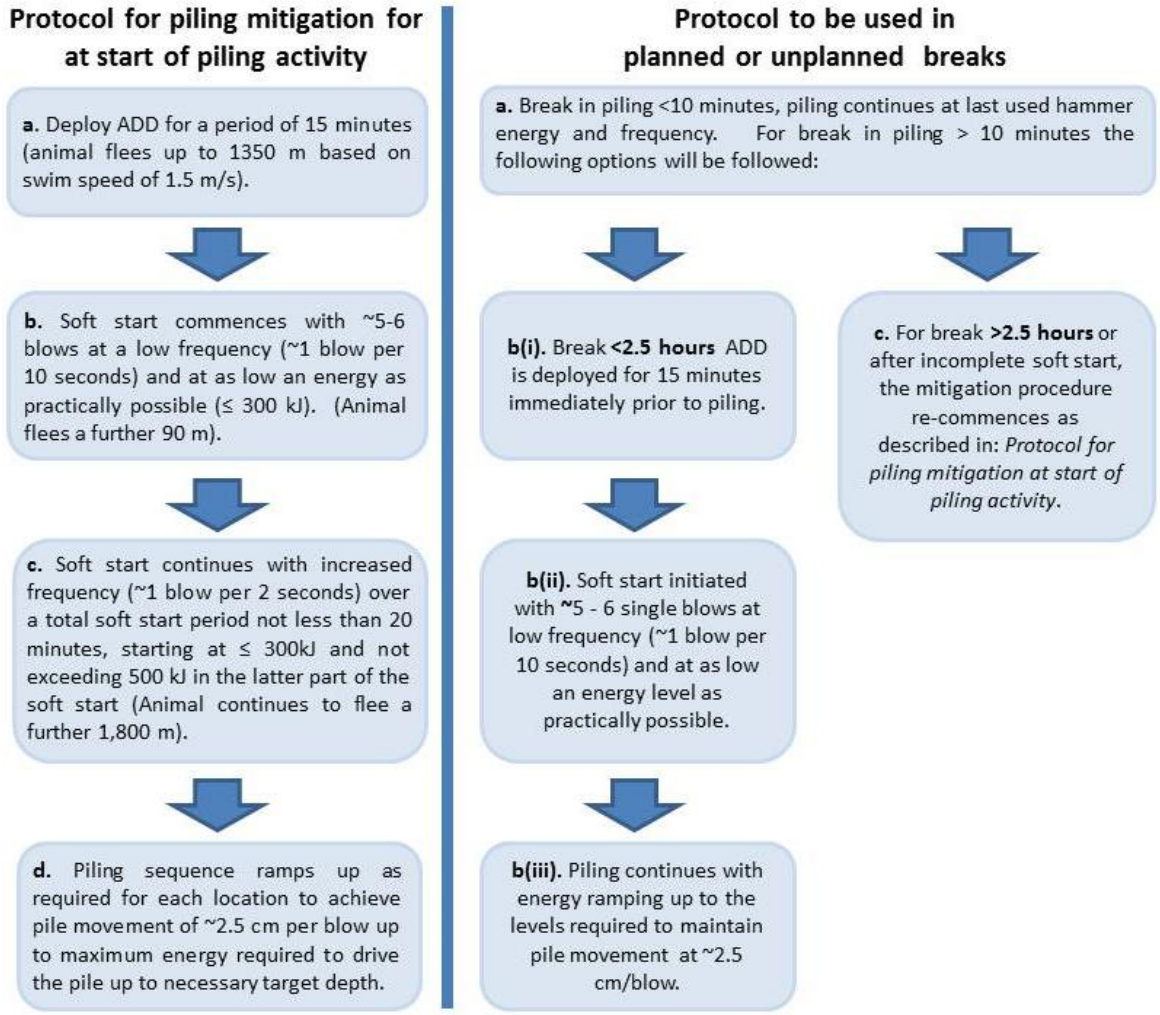
4 Implementation of piling mitigation protocol and associated reporting

4.1 Implementation of the Piling Mitigation Protocol

4.1.1 *Overview*

The site-specific mitigation protocol for piling involved the deployment of an ADD and the implementation of a piling soft start to deter marine mammals from the modelled injury zone before piling commences at full hammer energy. The PMP was undertaken by a Marine Mammal Mitigation Team (MMMT) from Gardline as illustrated by the following schematic (Figure 4-1; reproduced from Figure 10-1 of the PS).

Figure 4-1 Schematic showing Piling Mitigation Protocol



4.1.2 *Preparation for PMP implementation*

4.1.2.1 Set-Up

Prior to the mobilisation of the MMMT there were a number of logistical and operational procedures orchestrated to ensure effective set up. This process was driven by internal processes at a project management level within Gardline as well as adhering to external requirements of BOWL and SHL. This included (but was not limited to):

- equipment preparation and mobilisation;
- personnel requirements;
- reporting requirements; and
- Development site access permissions.

In relation to equipment, four Gardline MK1 systems comprising two hydrophones were selected as these are ideal for vertical deployments. Documents detailing the PAMS set-up and deployment on-board the HLV *Stanislav Yudin* were created prior to mobilisation. Prior to despatch each PAMS was function tested in Gardline's workshop and packed with suitable tools and consumables. All PAMS were freighted directly to the HLV *Stanislav Yudin* during mobilisation in Rotterdam. This was to allow set-ups to be finalised and allow a second function test to be performed during transit to the Development site.

Five Lofitech ADDs were supplied. Each ADD had a 100 m cable to allow for flexible deployment from the HLV *Stanislav Yudin* and ensure the transducer was placed mid-water column as per the requirements of the PMP. All systems were battery powered and again tested prior to despatch. The ADDs were split into two shipments, with two systems sent directly to the vessel in Rotterdam, and the remaining three sent to the UoA for checks as part of the Marine Mammal Monitoring Programme. The latter three systems were mobilised to the HLV *Stanislav Yudin* in Invergordon, prior to the vessel sailing to the Development site.

In relation to personnel requirements, it was stipulated in the PMP that two ADD operators would be required to implement the mitigation protocols. Each ADD Operator would need to be a JNCC-accredited MMO and trained PAMS Operator with a minimum of three years' experience in the field. BOWL agreed with Gardline that a third operator would be required to support the fairly fast-paced piling activities, but primarily to provide an element of contingency in the MMMT should any of the ADD operators have fallen ill or been unable to perform their duties. In order to increase the pool of personnel available for the project, it was decided the third operator would only require a minimum of one year's field experience as they would be supported by two experienced field staff.

In relation to reporting requirements, Gardline were responsible for providing regular reporting to the BOWL Environmental Clerk of Works (ECoW) throughout the foundation installation phase; the templates and timelines of which were established prior to mobilisation. A summary of each document type and the details captured in the document is provided in Section 4.2. All document types and associated timelines were discussed during the pre-job meeting and disseminated to the field staff.

4.1.2.2 Pre-mobilisation preparation

On 9th January 2017 a kick-off meeting was held with Gardline, BOWL, SHL, and UoA in order to discuss the requirements of the MMMT. On 7th February 2017 a concept meeting

was held with the aforementioned parties where the practical implementation of the PS was discussed, including a review of the piling task plans in Appendix B of the PS.

4.1.2.3 Preparation whilst on the HLV Stanislav Yudin

Once on-board the HLV *Stanislav Yudin,* it was important to establish clearly defined roles for each member of the MMMT and structure of management both within the MMMT and between the MMMT, SHL offshore operations team and the ECoW.

Preparation on-board the HLV *Stanislav Yudin* therefore involved an induction of SHL's operational crew and BOWL's Client Representative by the lead ADD operator to describe the mitigation protocol and communication requirements. The lead ADD operator established and maintained contact with the SHL Operations Assistant Superintendent to ensure lines of communications were clear. This contact was especially important as often crew changes did not occur in parallel. If new crew, who were not familiar with the mitigation protocol, joined the vessel a toolbox talk would be held led by the lead ADD operator.

4.1.3 *ADD deployment*

The procedure for deployment of the ADD was followed according to the ADD Deployment Protocol (Appendix B in the PS). This included:

- Adherence to the task plans set out in the ADD Deployment Protocol and documented adaptation of the plans where necessary to ensure effective mitigation (circulated to the SHL Project Engineer, Operations Superintendent and Assistant Superintendent and ECoW);
- Ensuring enough devices and spare batteries were available to carry out the mitigation in a fail-safe manner;
- Testing to ensure that the ADD was functioning effectively and monitoring the functionality using a suitable software; and
- Ensuring that the ADD was deployed for the required period and that the correct procedure was followed according to either the protocol to be used at the start of piling or the protocol to be used for planned or unplanned breaks.

In line with the PS the ADD was deployed immediately prior to the anticipated commencement of each piling event. An ADD Function Test was conducted prior to the first ADD deployment at each asset location to ensure the proper functioning of the ADD. The ADD Function Test comprised a brief activation of the ADD (typically <1 minute) during which the signal emitted was inspected aurally and visually on the PAMS. These periods of activation have not been included in the log of total ADD duration.

There were 16 occasions when the ADD was deployed prior to the anticipated commencement of piling however operations did not begin on time due to technical delays. In addition, there was one occasion where the ADD was erroneously not reactivated after a break in piling. Corrective measures were undertaken to address this immediately: ADD Operators were re-briefed on the correct protocol, including a recap on the different scenarios under the PMP. Any deviations from the agreed protocol were logged and reported to MS-LOT by the ECoW.

4.1.4 *Soft start procedure*

In line with the protocol outlined in the PS, two types of soft starts were conducted during the PMP. A full, 20 minute soft start was conducted prior to the installation of the first pin pile at

a given asset location. A "mini soft start" was conducted after a break in piling of between 10 minutes and 2.5 hours in duration.

A total of 86 full soft starts and 273 mini soft starts were completed during the PMP. During the full soft starts, the first blows were followed by the incremental increase in hammer energy not exceeding 500 kJ over a period of not less than 20 minutes. Table 4-1 demonstrates that for the most part the soft start duration was between 20 to 30 minutes and the hammer energy remained below 500 kJ. Where there was a deviation from the planned protocol for soft start, e.g. a very small exceedance of hammer energy due to technical issues, this was logged and reported to MS-LOT by the ECoW.

A total of 18 full soft starts and eight mini soft starts were completed during the PPMS (Table 4-1).

In all piling operations a gradual ramp up was then implemented (as described in the PMP) as the required energy to drive the pile into the substrate was not known until piling began. Further details on the piling ramp up are presented later in this report (Section 5.5).

Table 4-1 Summary of soft start durations at each asset location across the Development site. Shaded cells represent period of Stage 1 of the PPMS (light pink) and Stage 2 of the PPMS (dark pink). The number of piling events includes situations where a break of greater than 2.5 hours has led to a complete restart of the PMP on the same pin pile and is therefore treated as a separate piling event.

Date	Asset location	Number of piling events	Soft start piling		Date	Asset location	Number of piling events	Soft start piling	
			Total duration (min)	Maximum hammer energy (kJ)				Total duration (min)	Maximum hammer energy (kJ)
02/04	BE-G7 (OTM1)	5	38	313	20/06	BE-H5	4	26	462
07/04	BE-F8 (OTM2)	4	26	545	21/06	BE-J6	4	26	266
09/04	BE-E1	4	26	356	22/06	BE-D4	4	26	349
14/04	BE-E2	7	32	452	01/07	BE-E4	7	36	607
16/04	BE-F3	4	26	461	03/07	BE-F2	4	26	420
19/04	BE-E3	4	30	496	04/07	BE-F4	4	26	406
20/04	BE-H6	4	26	404	05/07	BE-F12	4	26	266
04/05	BE-J5	4	54	398	06/07	BE-H8	4	26	266
05/05	BE-G6	4	26	367	07/07	BE-G8	4	26	337
10/05	BE-G5	4	26	367	08/07	BE-H7	7	32	413
11/05	BE-F6	4	30	365	10/07	BE-C6	4	26	449
17/05	BE-F5	4	37	491	11/07	BE-C5	4	26	415
18/05	BE-E6	4	26	381	12/07	BE-B5	4	26	521
19/05	BE-E5	4	28	447	14/07	BE-A5	4	26	425
21/05	BE-D3	8	34	479	15/07	BE-E9	4	26	356

Date	Asset location	Number of piling events	Soft start piling		Date	Asset location	Number of piling events	Soft start piling	
			Total duration (min)	Maximum hammer energy (kJ)				Total duration (min)	Maximum hammer energy (kJ)
22/05	BE-C4	8	36	465	16/07	BE-D9	4	26	500
26/05	BE-D5	4	44	459	17/07	BE-C8	6	30	471
27/05	BE-G3	4	62	432	18/07	BE-B7	4	26	407
30/05	BE-E8	4	26	418	24/07	BE-L8	4	26	481
31/05	BE-D7	4	26	443	27/07	BE-M9	4	26	434
01/06	BE-E7	4	26	459	28/07	BE-M10	4	26	477
02/06	BE-D8	4	26	454	29/07	BE-L10	5	52	407
11/06	BE-J8	4	44	454	30/07	BE-L9	4	26	468
13/06	BE-D6	9	36	422	31/07	BE-K8	4	26	393
14/06	BE-C7	8	34	366	03/08	BE-J9	4	26	457
16/06	BE-B6	4	26	361	05/08	BE-K9	4	26	505
17/06	BE-G4	7	32	385	06/08	BE-J7	7	32	419
18/06	BE-H4	4	26	379	07/08	BE-K6	4	26	420
07/08	BE-K7	4	26	431	10/09	BE-F13	4	26	419
08/08	BE-L7	4	26	420	13/09	BE-G13	4	26	490
12/08	BE-D11	4	80	386	13/09	BE-G14	4	26	433
13/08	BE-E12	4	80	464	18/09	BE-E11	6	30	510
18/08	BE-G12	4	80	531	19/09	BE-F10	4	26	472
19/08	BE-G11	4	26	465	20/09	BE-G10	4	26	420
20/08	BE-K10	4	44	481	21/09	BE-F9	4	26	567
24/08	BE-K11	6	23	355	07/10	BE-H13	4	26	414
26/08	BE-J11	4	26	420	08/10	BE-J13	4	26	442
27/08	BE-J12	4	26	443	09/10	BE-K12	4	26	399
28/08	BE-C9	4	26	461	10/10	BE-H11	4	26	336
31/08	BE-D10	4	26	475	26/10	BE-H10	5	28	309
01/09	BE-E10	8	51	491	04/11	BE-G09	4	26	470
07/09	BE-F11	4	26	491	14/11	BE-H09	4	26	376
09/09	BE-H12	4	26	458	02/12	BE-J10	4	26	447

4.2 Reporting

4.2.1 *Field records during piling and compliance reports*

All reporting has been carried out as set out in Section 13 of the PS. Table 4-2 below details the Gardline specific documents issued to BOWL during the foundation installation phase.

Table 4-2 Gardline specific documents

Document type	Details captured in the document	Sent to whom by whom	Frequency of submission
Daily Progress Reports (DPRs)	Ship's midnight position and status, summary of daily events, time spent conducting mitigation activities and piling operations, prevailing weather conditions, Health and Safety summary, marine mammal sightings and detections, anticipated activities of next 24 hours, record of equipment testing, and open section for comments by personnel.	MMMT field to Gardline office, ECoW, UoA, BOWL	Daily
Non-Compliance Report (NCR)	A record of each non-compliance with the stipulated mitigation protocol, detailing the nature of the compliance issue, actions taken by ADD/PAMS Operator and SHL offshore operations team, and recommendations to avoid similar non-compliances. These were submitted by the ADD/PAMS Operator and checked by the BOWL Client Representative.	MMMT field to Gardline office, ECoW, UoA, BOWL	As soon as practicable after the event
PS and PPMS compliance report	Summary of piling events, implemented mitigation, monitoring effort, sightings during operations, weather conditions, and compliance with the relevant mitigation strategy being implemented (maximum hammer energies, soft-start procedures, and duration of piling).	MMMT field to Gardline office, ECoW, BOWL	Weekly (ECoW issued to MS-LOT, Marine Scotland Science (MSS) and SNH fortnightly during PMP and weekly during PPMS)
Hammer logs	A record of the time, count, and energy of each hammer blow at each completed piling location.	MMMT field to Gardline office, ECoW, UoA, BOWL	Weekly
Record of ADD Function Tests	Audio (.wav) files of the ADD signal recorded on the PAMS during the Function Test conducted prior to the start of piling.	MMMT field to Gardline office, ECoW, UoA, BOWL	Weekly
Sighting forms	A record of any sightings (separated into incidental and casual) which included details of the time, method of detection, observer name, location, species, number of individuals, and any acoustic activity at the time. If taken, photographs were also included in the sightings form.	MMMT field to Gardline office, ECoW, BOWL	Weekly (when sightings occurred)
ADD quality assurance test	Records of testing of each of the five ADDs present on the vessel, including screenshots of the signal on the PAMS, if test was in water.	MMMT field to Gardline office, ECoW, UoA, BOWL	Monthly

On a daily basis, the MMMT sent Daily Progress Reports (DPRs) to a specified BOWL and Gardline recipient list.

As described in Section 13.3 of the PS and on a weekly basis, Gardline processed PS and PPMS compliance reports to the ECoW using the field documents provided by the MMMT. The compliance reports were accompanied by other datasets including the hammer logs, sightings forms, ADD Function Test in the form of .wav files. These data have been analysed and presented as the basis of this Report.

The ECoW interrogated the reports and then reported on compliance to the BOWL Consent and Licensing Team (CLT). The PS and PPMS compliance reports were then issued to MS-LOT, Marine Scotland Science (MSS) and SNH, together with provision of marine mammal observation records and hydrophone files (where requested). The final PS and PPMS compliance report (Revision 19 dated 15th December 2017), produced following completion of the foundation installation phase, was issued to MS-LOT on 29th December 2017.

The ECoW reported on compliance throughout the piling phase in the Monthly ECoW Compliance Reports submitted to MS-LOT and SNH. Where a NCR had been recorded then the ECoW detailed the scale of the non-compliance. The ECoW held monthly compliance calls and quarterly compliance meetings in which the PS and PPMS compliance reports were listed on the agenda and NCRs were discussed. Should a NCR be of sufficient scale then the ECoW would prepare a separate ECoW NCR which included details on the incident, the process of notification and the corrective measure undertaken/proposed. The ECoW NCR was submitted to MS-LOT for determination in consultation with SNH and MSS.

4.2.2 *Noise registry reporting*

The PS (Section 13.4) sets out the requirement, under the Marine Strategy Regulations (2010), to submit interim closeout reports to JNCC and MS-LOT (as the Licensing Authority) on a quarterly basis and a completed noise reduction registry form within 12 weeks of completion of the piling works.

The interim closeout reports were submitted on 29th June 2017.

The completed noise reduction registry form was submitted on 18th December 2017 to JNCC and were copied to MS-LOT.

MS-LOT informed the BOWL CLT by letter that the Marine Licence conditions were discharged as follows:

- 19th July 2017: conditions 3.2.3.9 and 3.2.4.7 of the Offshore Transmission Works (OfTW) Marine Licence (licence number 04461/16/0), 'Noise Registry' were satisfied; and
- 26th January 2018: conditions 3.2.2.6 and 3.2.3.5 of the Offshore Wind Farm Marine Licence (licence number 04462/16/0) 'Noise Registry' were satisfied.

4.2.3 *Final piling report*

Section 13.5 of the PS set out the requirement for a final piling report to be submitted to MS-LOT on completion of the construction phase. The submission of this Report to MS-LOT therefore satisfies the final requirement.

5 Key outputs and results

5.1 Overview

Analyses of the piling data allowed a comparison of the measured parameters (hammer energies and piling durations) with those predicted for in the ES/SEIS and subsequently refined and presented in the PS. This section therefore provides comparisons between predicted and actual piling parameters.

5.2 Design envelope

Refinements were made to the design envelope from those originally submitted for assessment in the ES/SEIS (see Table 9.1 of the PS). Whilst the Development was consented on the basis on the parameters presented in the ES/SEIS (i.e. maximum hammer energy of 2,300 kJ with a total piling duration of 33.4 weeks over a three year piling phase; Table 5-1) the refinements led to a reduction in a number of key engineering parameters. This subsequently resulted in anticipated significant reductions in the worst case scenario originally predicted as demonstrated in Table 5-1. Further detail on the anticipated engineering parameters, specifically in relation to hammer energy and duration, are provided in Sections 5.3.1 and 5.4.1.

Table 5-1 Refinements in design envelope (see also Table 9.1 of the PS).

Engineering parameter	ES/SEIS worst case	Refined design envelope (PS)	Anticipated reduction of key engineering parameters from worst case	
			Reduction from ES/SEIS worst case	Reduction from ES/SEIS worst case as a %
Number of piles	1,120 (277 WTGs, 3 met masts (monopiles), 3 OSPs)	352 (84 WTGs, 2 OTMs (plus 2 spare WTG locations only to be used if necessary))	768	69%
Anticipated maximum hammer energy at each asset location	2,300 kJ @ all locations	1,200 kJ @ 72 locations 1,800 kJ @ 11 locations 2,300 kJ @ 5 locations	1,100 kJ @ 72 locations 500 kJ @ 11 locations 0 kJ @ 5 locations	48% 22% 0%
Anticipated piling duration (per pile)	5 hours	Up to 3.2 hours	1.8 hours	36%

Engineering parameter	ES/SEIS worst case	Refined design envelope (PS)	Anticipated reduction of key engineering parameters from worst case	
			Reduction from ES/SEIS worst case	Reduction from ES/SEIS worst case as a %
Anticipated duration piling for the entire Development	33.4 weeks	Up to 6.8 weeks	26.6 weeks	80%
Total piling programme	3 years (36 months)	14 months (split into two phases of 8 and 6 months)	22 months	61%

5.3 Hammer energy

5.3.1 *Predicted hammer energies*

The Development was consented on the basis that the maximum hammer energy required to install a pile could be up to 2,300 kJ as set out in the ES/SEIS (Table 5-1). Following refinements to the design envelope, a pile-driveability study was undertaken using geotechnical data to determine the maximum anticipated hammer energy that would be required at each asset location across the Development site (Section 7.2 of the PS). The results of the full geotechnical investigation predicted that for most asset locations, a maximum hammer energy of 1,200 kJ would be required for installing the piles, with only one location where the maximum hammer energy of 2,300 kJ was predicted (Table 5-2).

Data recorded in the field showed there were fewer than anticipated asset locations where the maximum hammer energy was less than 1,200 kJ and more than anticipated locations where the maximum hammer energy was less than 1,800 kJ and 2,300 kJ (Table 5-2). However, this does not reflect the fact that, on average, the maximum hammer energy experienced in the field was lower than predicted by the geotechnical data. A more detailed comparison of the actual hammer energies achieved for each pin pile driven at each asset location with the predicted hammer energies is provided below (Section 5.3.2).

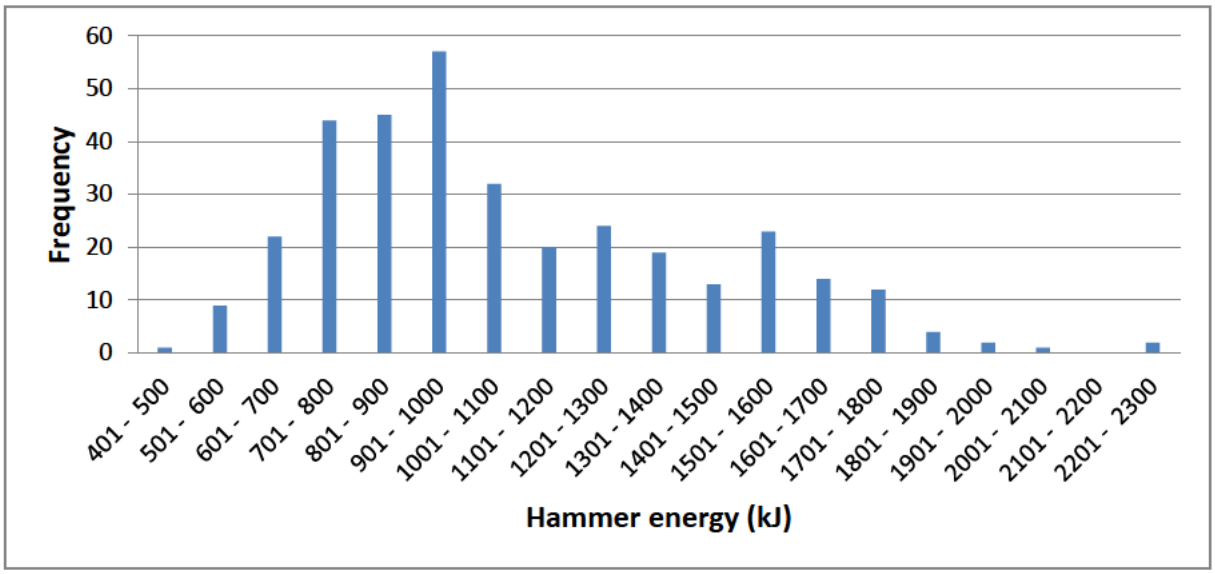
Table 5-2 Number of asset locations that fell within each maximum anticipated hammer energy range across the Development site.

Maximum hammer energy required (maximum energy in kJ)	Number of asset locations predicted from full geotechnical study	Actual number of asset locations equal to or less than the maximum required energy
1200	81	51
1800	6	29
2300	1	6
Total	**88 (86 + 2 spare)**	**86**

5.3.2 *Actual hammer energies*

The maximum energy required to install a pin pile varied considerably across the Development site. The maximum hammer required to drive a pin pile to full penetration ranged between 435 kJ at the lower end to 2,299 kJ at the upper end. On average, across all pin piles, the mean maximum hammer energy recorded was 1,088 kJ per pin pile (95% CI [1050, 1124]), although this was positively skewed (i.e. driven by a few high values), and the modal average lay between 900 to 1,000 kJ (Figure 5-1). The mean and modal averages are considerably lower than the worst case assessed in the ES/SEIS of 2,300 kJ and lower than the smallest hammer energy of 1,200 kJ maximum predicted in the PS based on geotechnical data. Summary data showing maximum hammer energy for each of the asset locations is provided in Appendix A.

Figure 5-1 Histogram of maximum hammer energy (kJ) used across all pin-piles (n= 344).



Hammer energy varied over the course of the piling phase with lower than maximum energies required at the start and towards the end of the piling phase (Figure 5-2). Maximum hammer energies were recorded on 27th and 28th May 2017 at 2,299 kJ and 2,295 kJ

respectively. The maximum energies recorded at each asset location are presented in Table 5-3 below.

Figure 5-2 Variation in maximum hammer energy achieved across all pin piles (n = 344) over the piling phase.

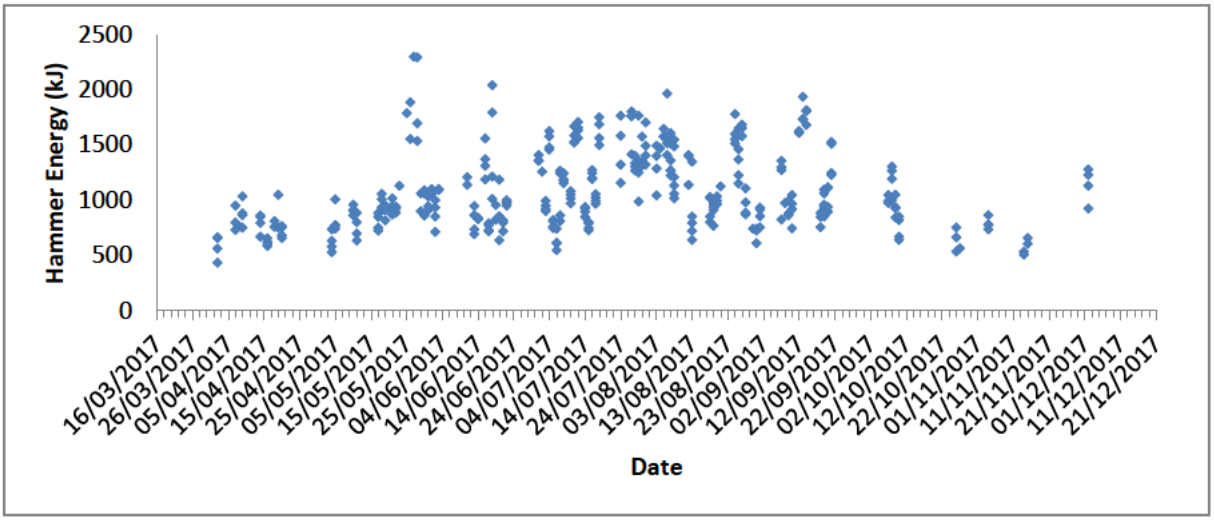


Table 5-3 Summary of maximum hammer energies and duration of impact piling across the Development site. Shaded cells represent period of Stage 1 of the PPMS (light pink) and Stage 2 of the PPMS (dark pink). The number of piling events includes situations where a break of greater than 2.5 hours has led to a complete restart of the PMP on the same pin pile and is therefore treated as a separate piling event.

Date	Asset location	Number of piling events	Impact piling		Date	Asset location	Number of piling events	Impact piling	
			Total duration (min)	Maximum hammer energy (kJ)				Total duration (min)	Maximum hammer energy (kJ)
02/04	BE-G7 (OTM1)	5	387	662	20/06	BE-H5	4	358	1186
07/04	BE-F8 (OTM2)	4	320	951	21/06	BE-J6	4	303	818
09/04	BE-E1	4	262	1035	22/06	BE-D4	4	348	999
14/04	BE-E2	7	193	861	01/07	BE-E4	7	442	1408
16/04	BE-F3	4	263	655	03/07	BE-F2	4	333	993
19/04	BE-E3	4	224	1048	04/07	BE-F4	4	319	1626
20/04	BE-H6	4	272	766	05/07	BE-F12	4	215	819
04/05	BE-J5	4	369	737	06/07	BE-H8	4	184	740
05/05	BE-G6	4	346	1007	07/07	BE-G8	4	239	1267
10/05	BE-G5	4	317	958	08/07	BE-H7	7	257	1243
11/05	BE-F6	4	308	887	10/07	BE-C6	4	310	1082
17/05	BE-F5	4	242	884	11/07	BE-C5	4	356	1671

Date	Asset location	Number of piling events	Impact piling		Date	Asset location	Number of piling events	Impact piling	
			Total duration (min)	Maximum hammer energy (kJ)				Total duration (min)	Maximum hammer energy (kJ)
18/05	BE-E6	4	228	1059	12/07	BE-B5	4	375	1709
19/05	BE-E5	4	165	954	14/07	BE-A5	4	277	940
21/05	BE-D3	8	194	1018	15/07	BE-E9	4	238	799
22/05	BE-C4	8	211	942	16/07	BE-D9	4	395	1272
26/05	BE-D5	4	406	1888	17/07	BE-C8	6	328	1054
27/05	BE-G3	4	467	2299	18/07	BE-B7	4	365	1750
30/05	BE-E8	4	193	1091	24/07	BE-L8	4	302	1765
31/05	BE-D7	4	257	1035	27/07	BE-M9	4	204	1805
01/06	BE-E7	4	280	1099	28/07	BE-M10	4	203	1399
02/06	BE-D8	4	237	999	29/07	BE-L10	5	181	1350
11/06	BE-J8	4	328	1209	30/07	BE-L9	4	208	1577
13/06	BE-D6	9	387	947	31/07	BE-K8	4	239	1704
14/06	BE-C7	8	255	838	03/08	BE-J9	4	251	1492
16/06	BE-B6	4	308	1560	05/08	BE-K9	4	184	1647
17/06	BE-G4	7	209	790	06/08	BE-J7	7	206	1966
18/06	BE-H4	4	280	2042	07/08	BE-K6	4	171	1360
07/08	BE-K7	4	213	1608	10/09	BE-F13	4	150	1045
08/08	BE-L7	4	163	1208	13/09	BE-G13	4	264	1735
12/08	BE-D11	4	323	1409	13/09	BE-G14	4	287	1936
13/08	BE-E12	4	251	853	18/09	BE-E11	6	341	883
18/08	BE-G12	4	131	1029	19/09	BE-F10	4	263	1096
19/08	BE-G11	4	251	965	20/09	BE-G10	4	241	1117
20/08	BE-K10	4	216	1125	21/09	BE-F9	4	210	1527
24/08	BE-K11	6	260	1780	07/10	BE-H13	4	180	1045
26/08	BE-J11	4	220	1462	08/10	BE-J13	4	239	1304
27/08	BE-J12	4	254	1684	09/10	BE-K12	4	194	1049
28/08	BE-C9	4	387	1106	10/10	BE-H11	4	191	851
31/08	BE-D10	4	284	740	26/10	BE-H10	5	250	753
01/09	BE-E10	8	387	934	04/11	BE-G09	4	291	864
07/09	BE-F11	4	242	1356	14/11	BE-H09	4	215	657
09/09	BE-H12	4	275	993	02/12	BE-J10	4	241	1278

5.4 Duration of piling

5.4.1 *Predicted durations*

The Development was consented on the basis that the total piling duration may be up to 5 hours per pile, or 20 hours per asset location as set out in the ES/SEIS (Table 5-1). Following refinements to the design envelope, the anticipated duration of piling was calculated from the pile-driveability study (Section 7.2 of the PS). The PS described the anticipated minimum, maximum and mean piling durations, including soft start, (per pile and per asset location) across all asset locations to be piled (Table 5-4). These metrics, including the maximum piling durations presented in the PS, were all lower than those predicted by the ES/SEIS, with up to 3.2 hours per pile and 12.8 hours per asset location predicted as a maximum (Table 5-4).

Comparison with the durations of piling recorded in the field showed that in all cases the actual durations of piling were lower than those predicted by the geotechnical data presented in the PS (Table 5-4). A more detailed evaluation of duration per pin pile is below (Section 5.4.2).

Table 5-4 Anticipated and actual (maximum, minimum and mean) duration of piling (soft start plus impact piling) predicted across asset locations.

		Maximum duration		Minimum duration		Mean duration	
		Per pile	Per asset location	Per pile	Per asset location	Per pile	Per asset location
Anticipated	mins	193	772	47	188	90	360
	hrs	3.2	12.8	0.8	3.1	1.5	6.0
Actual	mins	165	529	19	176	75	300
	hrs	2.75	8.8	0.32	2.9	1.25	5.0

5.4.2 *Actual durations*

The total piling duration (soft start plus impact piling) varied considerably, both for a single pin pile and a single asset location (Table 5-4). The duration of impact piling recorded at each asset location (summed across all pin piles) is presented in Table 5-3 and the duration of soft start piling is presented in Section 4.1.4).

The total duration of piling (soft start plus impact piling) at a single pin pile ranges from a minimum of 19 minutes up to a maximum of 2 hours 45 minutes. For a single asset location the minimum was recorded as 2 hours 56 minutes and maximum was 8 hours 49 minutes. On average, the piling duration was recorded as 1 hour 15 minutes per pin pile and 5 hours per location (Table 5-4). The duration required to pile-drive a pin pile was most frequently recorded between 61 to 75 minutes (1 hour 1 minute to 1 hour 15 minutes) (Figure 5-3).

The total piling duration varied considerably over the piling phase. Figure 5-4 illustrates that total piling duration at the majority of asset locations fell within the range 200 to 400 minutes (3.3 hours to 6.7 hours). Most of the piling was completed by the end of September 2017 with only eight asset locations completed between October and December 2017. The gaps in piling towards the end of the foundation installation phase were due to weather downtime.

Figure 5-3 Frequency distribution of maximum duration of piling per pin pile (n=344).

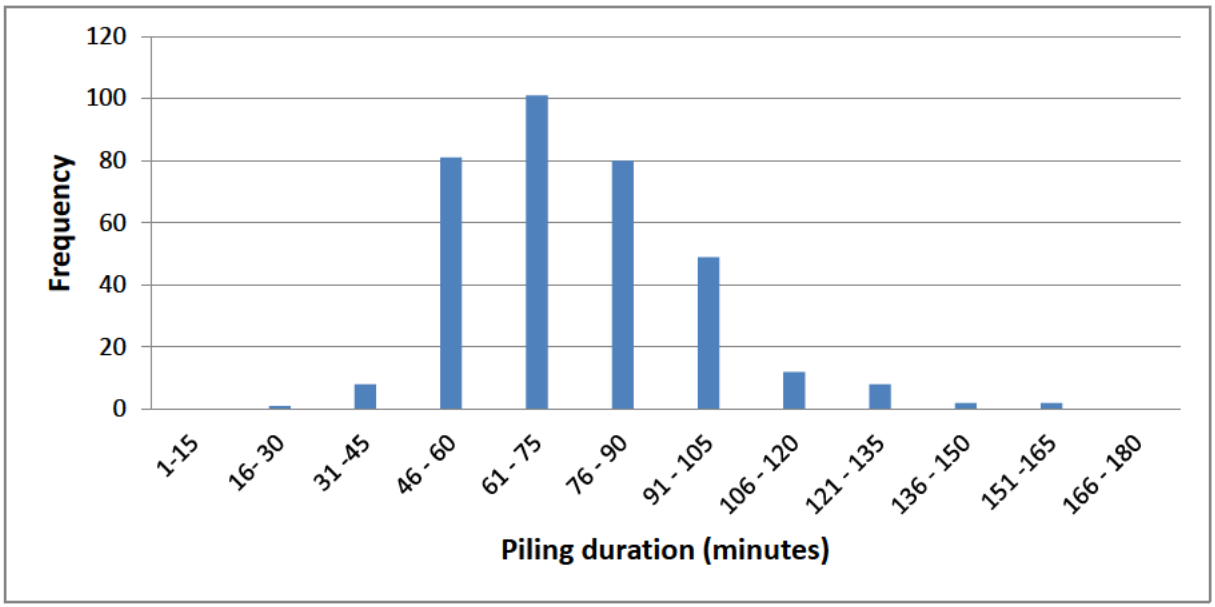
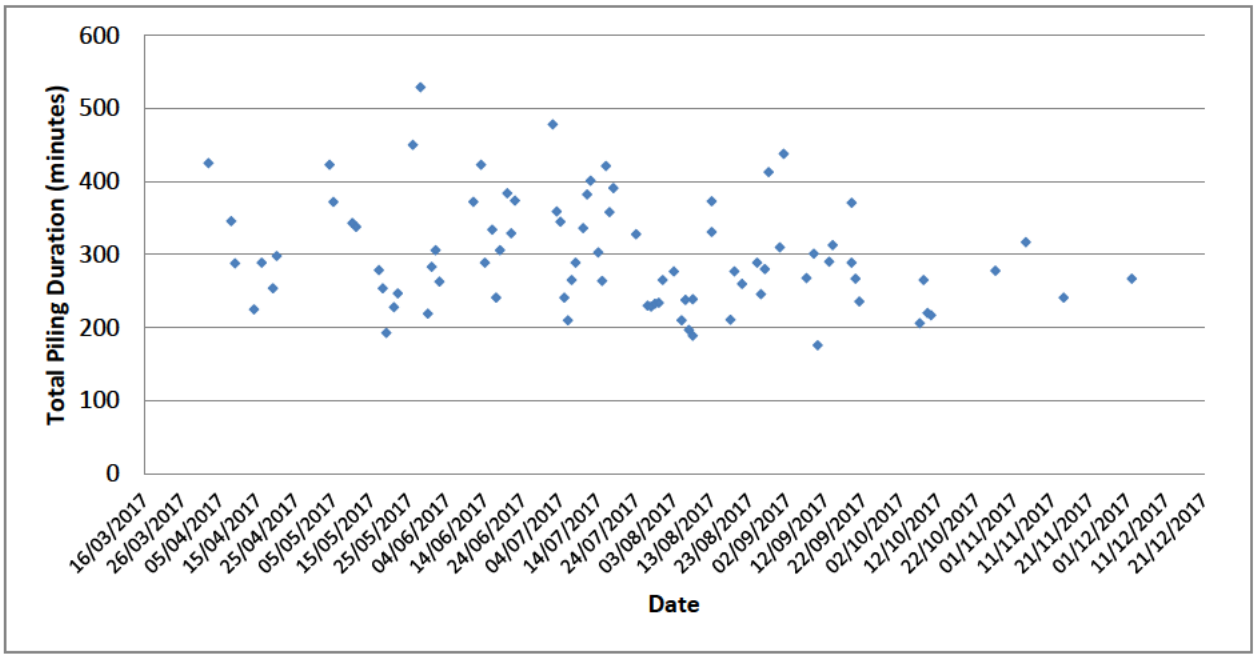


Figure 5-4 Total duration of piling at each asset location across the Development site (n=86).



5.5 Piling profiles

The piling profile is defined as the incremental increase in hammer energy over time as the pile is installed. A total of 344 piling profile graphs were produced representing each of the piles installed across 86 asset locations. In order to report on a 'typical' piling profile, a random sample of 10% of the 344 graphs was reviewed and a number of general observations were noted, as described below.

Typically, hammer energy was initiated at <300 kJ and continued at this low level for approximately 12 minutes (range 4 – 18 minutes). The hammer energy then gradually increased by approximately 17 kJ per minute, 95% CI [6, 32], thereby keeping it below the maximum 500 kJ allowed for during the 20 minute mitigation soft start period.

As hammer energy ramped up after the soft start, the rate of increase fluctuated, which meant that piling profiles rarely exhibited smooth, linear inclines, but often comprised 'saw-tooth' profiles. Once hammering reached the maximum energy required at any given location, it was maintained for an average of approximately 10 minutes, 95% CI [2, 24].

Piling at maximum energy often fluctuated or was broken by a three to five minute break in hammering activity to allow for pile penetration depth assessment.

In the context of total piling duration, hammering at full energy occurred for an average of 14%, 95% CI [3, 34], not including any breaks in piling activity. Note that for all piles hammered at maximum energy for greater than 14% total duration in the sample examined, the maximum energy reached was 1,650 kJ.

Of the 344 piling profiles plotted, four graphs (Figures 5-5 to 5-8) were extracted to provide examples of where the maximum hammer energy reached and total piling duration at any one pile were: a) the lowest (minimum) across all piles; b) the highest (maximum) across all piles; c) the middle value (median) across all piles; and d) the average (mean) across all piles (see Table 5-5 for details).

Table 5-5 Summary of graphs showing examples of where the piling profiles represented the near minimum, maximum, median and mean for maximum hammer energy and total duration per pin pile.

Graph	Description	Date	Asset location	Pile position	Maximum hammer energy (kJ)	Total duration (minutes
Figure 5-5	Near minimum	06/07/17	BE-H8	A1	546	50
Figure 5-6	Near maximum	27/05/17	BE-G3	A2	2299	154
Figure 5-7 5-7	Near median	20/08/17	BE-K10	A2	994	70
Figure 5-8	Near mean	19/09/18	BE-F10	B1	1096	71

Figure 5-5 Example of a piling profile for a pile where the maximum hammer energy reached and total duration was close to the minimum value estimated across all piles.

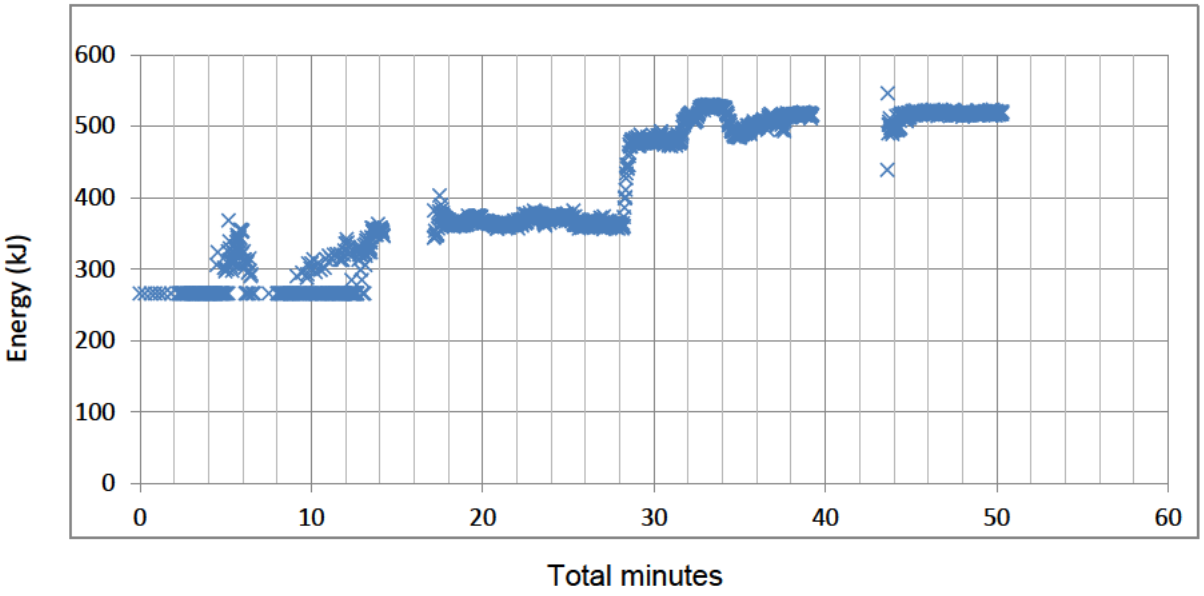


Figure 5-6 Example of a piling profile for a pile where the maximum hammer energy reached and total duration was close to the maximum value estimated across all piles.

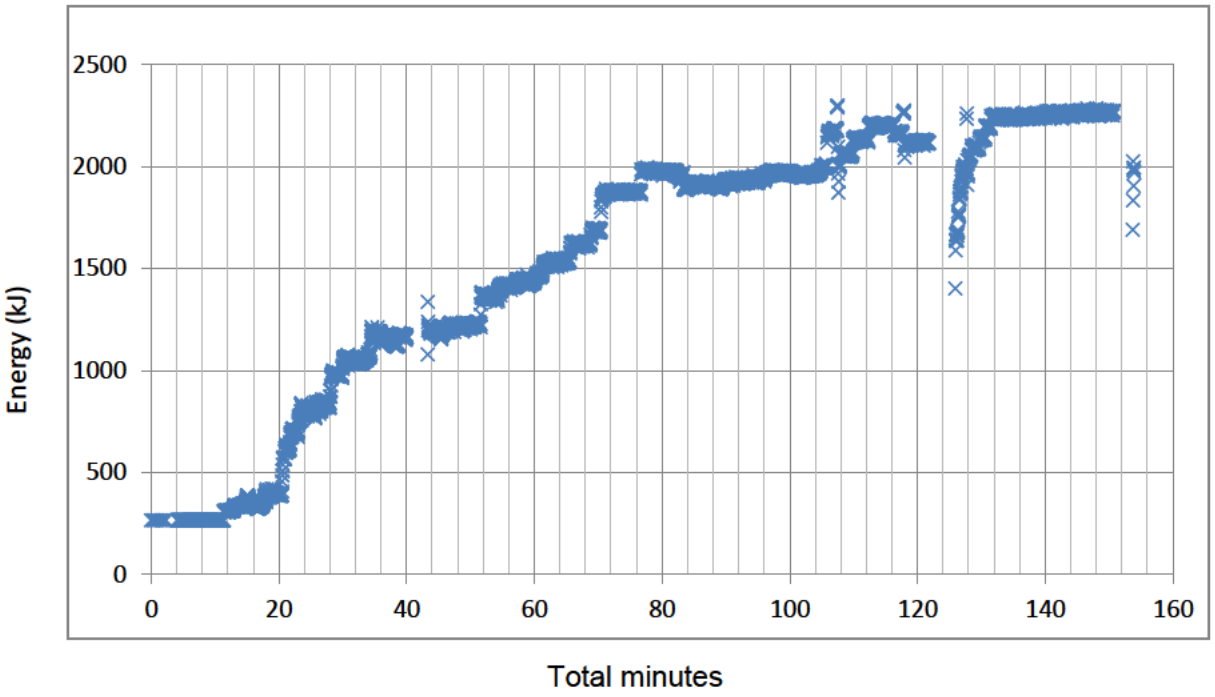


Figure 5-7 Example of a piling profile for a pile where the maximum hammer energy reached and total duration was close to the median value estimated across all piles.

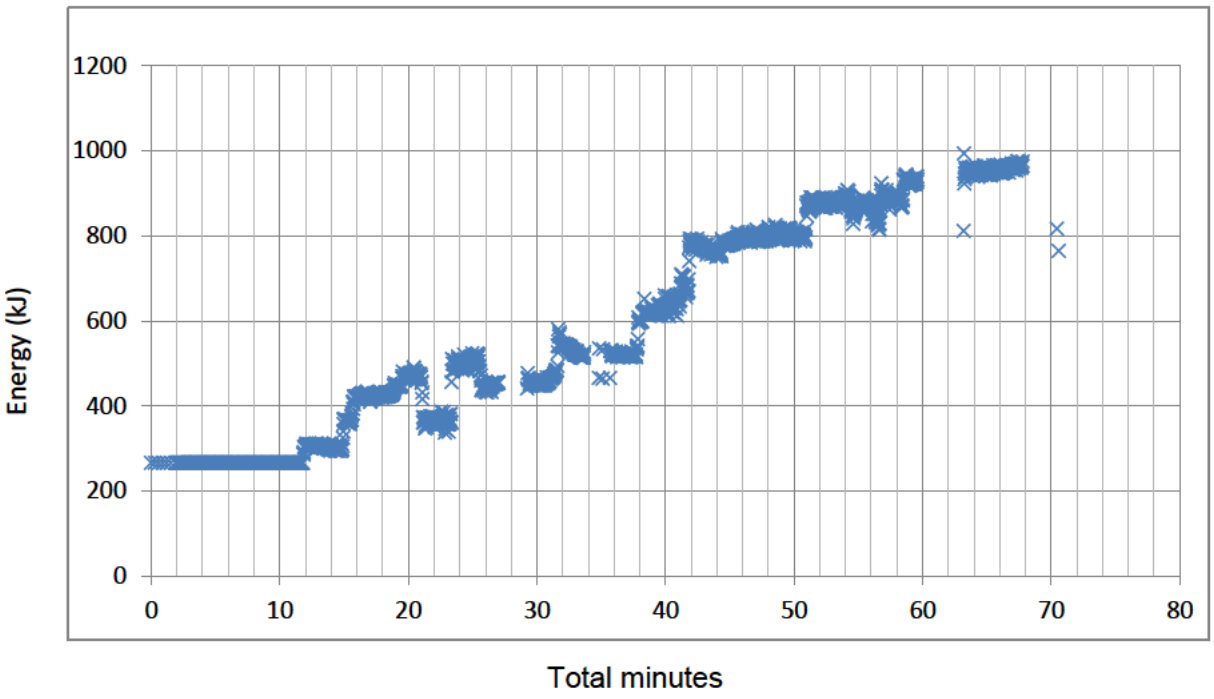
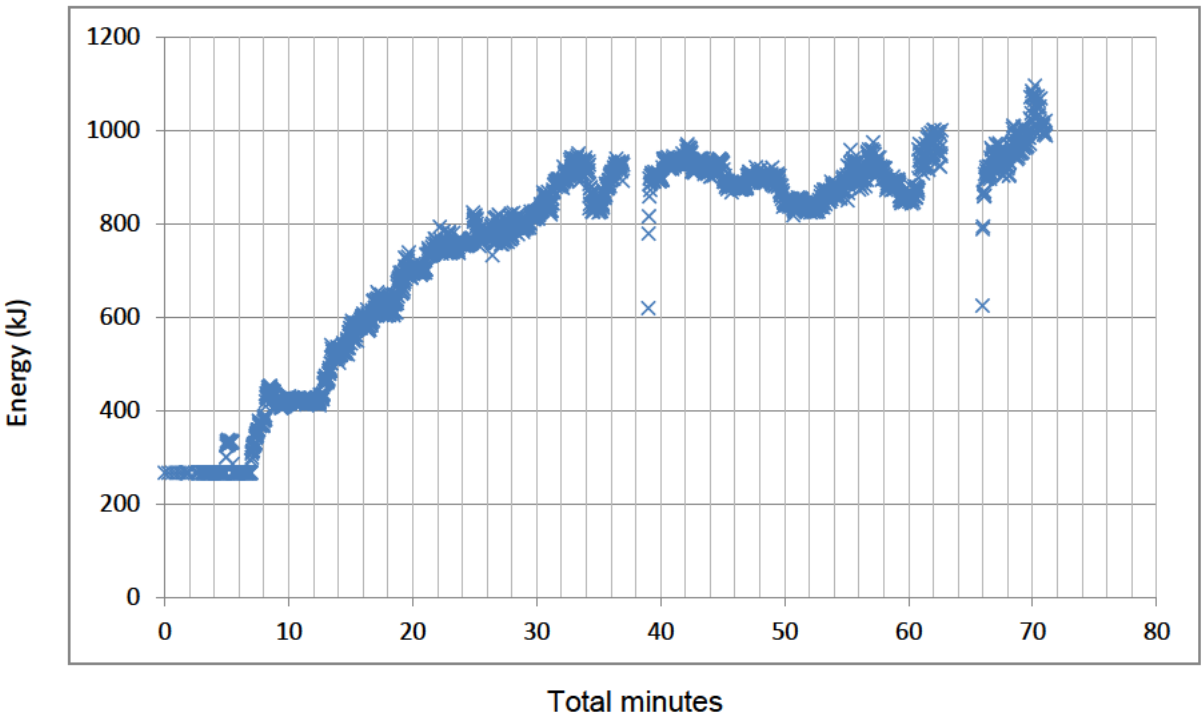


Figure 5-8 Example of a piling profile for a pile where the maximum hammer energy reached and total duration was close to the mean value estimated across all piles.



5.6 Application of PS mitigation by species

Under the Consents, the PS needed to demonstrate how mitigation would be provided for the following key species: bottlenose dolphin, harbour seal, Atlantic salmon, cod, and herring. The following sub-sections summarises the mitigation that was undertaken for each of the key species listed in the Consents whilst Section 6.2 in this Report provides a summary of the monitoring that was carried out during foundation installation.

5.6.1 *Bottlenose dolphin and harbour seal*

A six-step procedure was taken to minimise the potential for injury to occur to bottlenose dolphin and harbour seal during piling (see Section 10.2 of the PS).

Step 1 (optimised hammer energies) was described in Section 7 of the PS, which presented information on the anticipated hammer energies and duration of piling across the Development site. Steps 2 to 6 were dealt with via the PMP (Appendix C of the PS) and implementation of this is described in relevant sections of this Report.

The following observations were made in applying the six-step procedure:

- Step 1: Optimised hammer energies: the average of the maximum hammer energy achieved across pin piles was lower than the smallest hammer energy predicted by the geotechnical data (1,200 kJ) (see Section 5.3).
- Step 2: Injury zone: There were no vocalisations recorded using PAM prior to or during the piling soft start. In addition, there were no incidental or casual observations of marine mammals in the Development site during piling activity (see Section 6.1).
- Step 3: Mitigation protocol: the ADD was deployed during piling as part of the PMP (see Section 4.1.3).
- Step 4: Protocol for planned/unplanned breaks: planned breaks occurred moving from one pile to the next, whilst unplanned breaks arose due to either technical/mechanical issues or weather downtime; in all cases the protocol was adhered to (see Sections 3.4 and 4.1.1).
- Step 5: Monitoring and auditing: this Report presented data gathered as part of the monitoring and auditing system. Section 4.2 provides an overview of the reporting undertaken.
- Step 6: Risk assessment: the assessment in Annex 3 of the PMP (Appendix C of the PS) showed that the risk of animals being within a range that would result in death or injury was negligible, and the lack of any vocalisations corroborated this as no marine mammals were recorded by the PAMS. For harbour seal, a re-assessment of the population model based on the Harbour Seal Framework (Thompson *et al.*, 2011) showed that even in the unlikely event of death or injury, there would be no long term population effect.

5.6.2 *Cod*

Piling did not overlap with key cod spawning period in the Moray Firth in February and March (BOWL, 2014a). Therefore, as discussed in Section 10.3 of the PS, no mitigation was necessary for cod.

5.6.3 *Atlantic salmon*

Mitigation measures were not proposed in the PS given that only a small proportion of the Atlantic salmon habitat in the Moray Firth would be affected, and that piling noise would not form a 'barrier' to salmon migration (Section 10.3 of the PS).

5.6.4 *Herring*

The 2014 and 2015 technical herring spawning survey reports (BOWL 2014b and 2016b) and final summary report (BOWL, 2016c) demonstrated that the peak herring spawning activity occurred in the first three weeks of September and that the spawning occurs in the in the spawning grounds to the west of Orkney and the Shetland Islands. Therefore, due to the distance from the key spawning ground, subsea noise arising during piling at the Development site in the Moray Firth was considered unlikely to affect spawning herring (summarised in Section 8.4 of the PS). MS-LOT subsequently confirmed that no piling mitigation was required for herring, thus discharging Condition 34 of the S36 Consent (MS-LOT letter dated 26 February, 2016; [http://www.gov.scot/Resource/0049/00499205.pdf]). MS-LOT also confirmed discharge of Condition 27 in relation to monitoring of herring and confirmed that no further construction, or post-construction, mitigation or monitoring was required.

6 Observations and monitoring during foundation installation

6.1 Observations in the field during implementation of the PMP

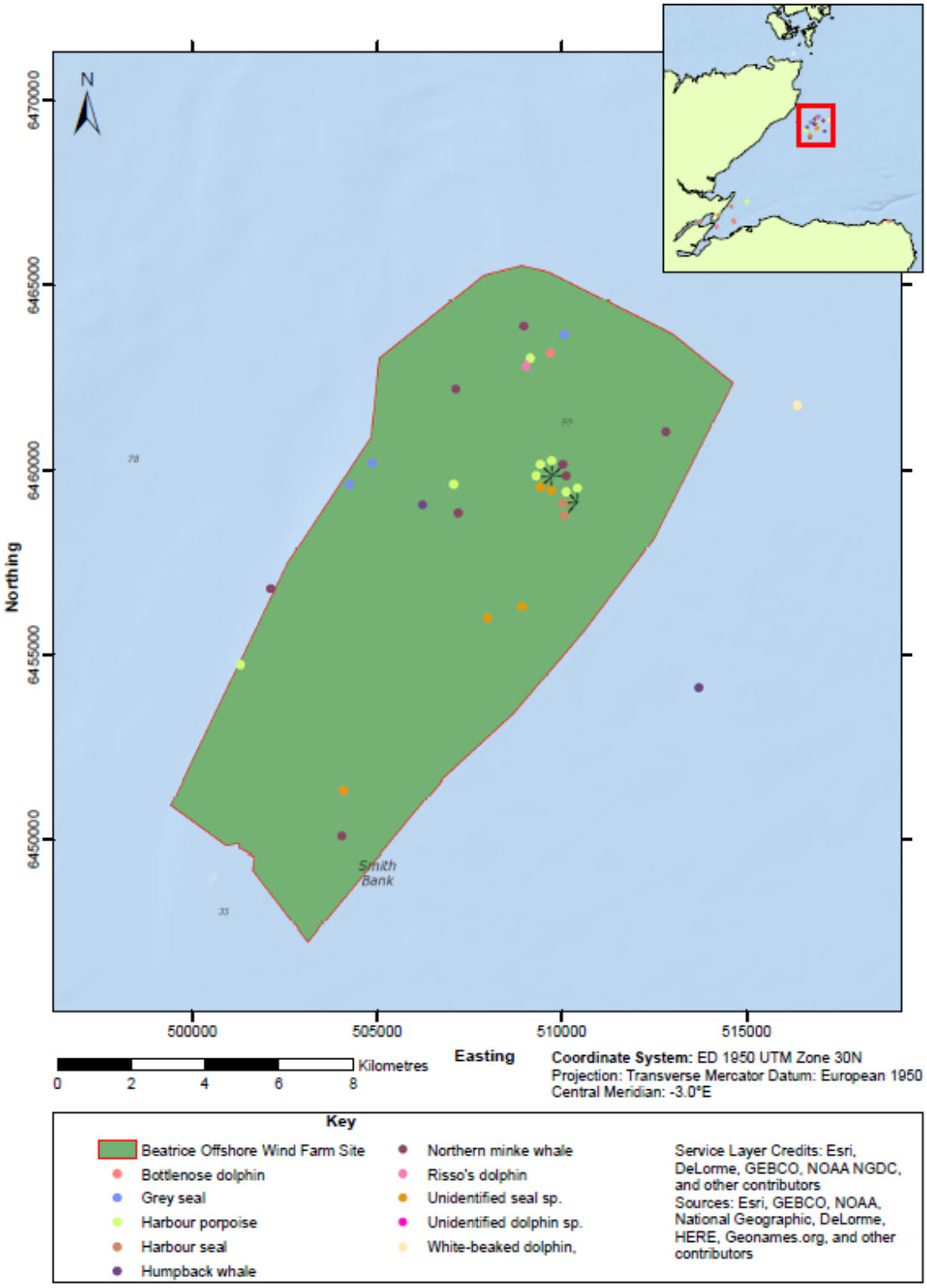
Although the PMP did not require any marine mammal monitoring to be undertaken as part of the mitigation plan, it was agreed between BOWL and MS-LOT that the MMMT would conduct two daily scans for marine animals outside of PMP dedicated effort. The scans were required during daylight hours and good visibility; however, the duration of the scans was not specified in the PS. It was subsequently agreed between Gardline and BOWL that each daily scan should be one hour in duration, with one performed in the morning and one in the afternoon. The daily scan was performed by at least one ADD Operator, dependent on their availability and shift patterns. Any sightings during these two daily scans were classed as 'incidental', and recorded in a separate sighting form to any 'casual' observations of marine animals outside these scans. There were 39 incidental sightings of marine mammals (Appendix B) whilst the MMOs were on watch for the daily scans. The species comprised harbour porpoise, harbour seal, bottlenose dolphin, humpback whale *Megaptera novaeangliae*, northern minke whale, Risso's dolphin, and grey seal *Halichoerus grypus*. All sightings occurred outside of piling operations; therefore no mitigating actions were required. Of these 39 incidental sightings, 13 occurred in the Development site although none were observed during piling activity. The remaining 26 sightings of marine mammals were recorded when the vessel was out-with the Development site (e.g. transiting back to port).

In addition, there were also 19 casual sightings of marine mammals which occurred outside of the daily scans conducted by the MMOs (Appendix C). The species comprised harbour porpoise, harbour seal, bottlenose dolphin, humpback whale, northern minke whale, white-beaked dolphin, and grey seal. Of these 19 casual sightings, 16 occurred in the Development site although none were observed during piling activity. Therefore, no actions were required in respect of mitigation.

The three most commonly sighted species during the scans were harbour porpoise, harbour seal and grey seal (Figure 6-1). Bottlenose dolphins were sited infrequently and other species had just one sighting associated with them. These results are reflective of the baseline described in the ES/SEIS in terms of which species were most likely to be encountered within the Development site.

PAM undertaken prior to piling and during soft start did not record any vocalisations of marine mammals during implementation of the PMP.

Figure 6-1 Map showing observations (incidental and casual) during implementation of the PMP. (Note: black lines link sightings that were made in one place).



6.2 Monitoring and survey programmes

As described in Section 1.1, under the Consents, an outline of the monitoring that would be undertaken for the key species was presented within the PS.

In relation to marine mammals, BOWL have been participating in, and continues to participate in, the strategic regional MMMP for the Moray Firth. Four work packages (WPs) were carried out during the foundation installation phase of the Development:

- WP1: Harbour seal monitoring;
- WP2: Bottlenose dolphin monitoring;
- WP3: Monitoring responses to deployment of ADDs and soft start piling; and
- WP4: Noise measurement and modelling.

WP1 and WP2 are a continuation of monitoring that had been undertaken pre-construction, whilst WP3 and WP4 were undertaken during the foundation installation phase only.

In relation to key fish species, BOWL have undertaken a number of additional surveys including a salmon smolt study (BOWL, 2017c), a pre-construction cod spawning survey (BOWL, 2014a) and a post-construction cod spawning survey (BOWL, *in prep*).

Full details of the monitoring programme are provided in the Project Environment Monitoring Plan (PEMP) v.2.0 (BOWL, 2017d).

7 Conclusions

This Piling Strategy Implementation Report demonstrates that the foundation installation phase of the Beatrice Offshore Wind Farm was carried out in accordance with the procedures and protocols described in the PS.

This Report provides detailed information on the implementation of the PMP, with specific information on the preparation required by the field team, the ADD deployment approach and the soft start procedures. The Report demonstrates the extensive preparation that was undertaken to achieve successful implementation of the PMP; highlighting the procedure for on-going reporting to MS-LOT throughout the foundation installation phase.

Analyses of the data gathered in the field demonstrate that, in practice, the average maximum hammer energy and total piling duration were below the averages set out in the ES/SEIS and also below those predicted by the full geotechnical investigation and presented in the PS. The mean values calculated from the field records show that the maximum hammer energy was, on average, 1,088 kJ per pin pile, whilst the average duration of piling per pin pile was 1 hour 15 minutes (5 hours per asset location). In addition, on no occasion did the maximum hammer energy exceed the maximum allowable hammer energy of 2,300 kJ.

An assessment of the piling profiles showed that the hammer energy ramped up incrementally over time, with only a small proportion of the time (on average 14%) where piling was undertaken at the full hammer energy required for a particular location. Therefore, impacts on key sensitive species are likely to be considerably lower than predicted in both the ES/SEIS and PS.

Marine mammals observations and PAM made prior to and during piling indicated that there were no marine mammals within the Development site during piling, indeed the majority of marine mammal observations were recorded outside of the Development site (i.e. transiting back to port). The species recorded were typical of the marine mammal baseline described for the Moray Firth, with harbour porpoise, harbour seal and grey seal the most frequently recorded species.

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Appendix A: Summary of piling operations across the Development site.

Date	Asset location	Pile position	Max hammer energy (kJ)	Total minutes
02/04/2017	BE-G7 (OTM1)	A2	658	88
02/04/2017	BE-G7 (OTM1)	A1	561	165
02/04/2017	BE-G7 (OTM1)	B1	435	81
02/04/2017	BE-G7 (OTM1)	B2	662	91
07/04/2017	BE-F8 (OTM2)	A2	951	81
07/04/2017	BE-F8 (OTM2)	A1	796	91
07/04/2017	BE-F8 (OTM2)	B1	731	79
08/04/2017	BE-F8 (OTM2)	B2	766	95
09/04/2017	BE-E1	A2	750	84
09/04/2017	BE-E1	A1	880	73
09/04/2017	BE-E1	B1	864	72
09/04/2017	BE-E1	B2	1035	59
14/04/2017	BE-E2	B2	793	19
14/04/2017	BE-E2	A2	849	70
14/04/2017	BE-E2	A1	861	70
14/04/2017	BE-E2	B1	670	66
16/04/2017	BE-F3	A2	655	76
16/04/2017	BE-F3	A1	623	83
16/04/2017	BE-F3	B1	584	71
16/04/2017	BE-F3	B2	603	59
18/04/2017	BE-E3	A1	758	64
18/04/2017	BE-E3	B2	812	60
19/04/2017	BE-E3	B1	1048	59
19/04/2017	BE-E3	A2	750	71
20/04/2017	BE-H6	A1	658	80
20/04/2017	BE-H6	B1	681	74
20/04/2017	BE-H6	B2	754	77
20/04/2017	BE-H6	A2	766	67
04/05/2017	BE-J5	A2	578	125
04/05/2017	BE-J5	A1	737	94
04/05/2017	BE-J5	B1	529	113
04/05/2017	BE-J5	B2	630	91
05/05/2017	BE-G6	A1	772	80
05/05/2017	BE-G6	B1	1007	71
05/05/2017	BE-G6	B2	741	77
05/05/2017	BE-G6	A2	773	144
10/05/2017	BE-G5	A2	905	85

Date	Asset location	Pile position	Max hammer energy (kJ)	Total minutes
10/05/2017	BE-G5	A1	958	84
10/05/2017	BE-G5	B1	910	87
10/05/2017	BE-G5	B2	863	87
11/05/2017	BE-F6	A2	800	85
11/05/2017	BE-F6	A1	887	77
11/05/2017	BE-F6	B1	698	89
11/05/2017	BE-F6	B2	635	87
17/05/2017	BE-F5	A2	749	59
17/05/2017	BE-F5	A1	723	63
17/05/2017	BE-F5	B1	849	85
17/05/2017	BE-F5	B2	884	72
18/05/2017	BE-E6	A2	909	66
18/05/2017	BE-E6	A1	937	69
18/05/2017	BE-E6	B1	1008	55
18/05/2017	BE-E6	B2	1059	64
19/05/2017	BE-E5	A2	816	60
19/05/2017	BE-E5	A1	954	50
19/05/2017	BE-E5	B1	907	39
19/05/2017	BE-E5	B2	921	44
21/05/2017	BE-D3	A2	1018	54
21/05/2017	BE-D3	A1	910	58
21/05/2017	BE-D3	B1	947	59
21/05/2017	BE-D3	B2	869	57
22/05/2017	BE-C4	A1	942	58
22/05/2017	BE-C4	B2	886	68
22/05/2017	BE-C4	A2	937	58
22/05/2017	BE-C4	B1	923	63
23/05/2017	BE-D5	A2	1130	135
25/05/2017	BE-D5	A1	1789	116
26/05/2017	BE-D5	B1	1554	88
26/05/2017	BE-D5	B2	1888	111
27/05/2017	BE-G3	A2	2299	154
28/05/2017	BE-G3	A1	2295	144
28/05/2017	BE-G3	B1	1697	126
28/05/2017	BE-G3	B2	1536	105
29/05/2017	BE-E8	A2	901	66
29/05/2017	BE-E8	A1	1061	52
30/05/2017	BE-E8	B1	1091	49

Date	Asset location	Pile position	Max hammer energy (kJ)	Total minutes
30/05/2017	BE-E8	B2	1061	52
30/05/2017	BE-D7	A2	860	81
31/05/2017	BE-D7	A1	909	63
31/05/2017	BE-D7	B1	945	71
31/05/2017	BE-D7	B2	1035	68
01/06/2017	BE-E7	A2	1099	80
01/06/2017	BE-E7	A1	1094	69
01/06/2017	BE-E7	B1	1097	78
01/06/2017	BE-E7	B2	1060	79
02/06/2017	BE-D8	A2	712	67
02/06/2017	BE-D8	A1	852	70
02/06/2017	BE-D8	B1	999	64
02/06/2017	BE-D8	B2	932	62
03/06/2017	BE-J8	B2	1093	83
03/06/2017	BE-J8	A2	1101	93
11/06/2017	BE-J8	B1	1209	105
11/06/2017	BE-J8	A1	1139	91
13/06/2017	BE-D6	B2	691	124
13/06/2017	BE-D6	A2	947	100
13/06/2017	BE-D6	A1	735	102
13/06/2017	BE-D6	B1	862	97
14/06/2017	BE-C7	B2	838	85
14/06/2017	BE-C7	A2	831	67
14/06/2017	BE-C7	A1	830	67
14/06/2017	BE-C7	B1	837	70
16/06/2017	BE-B6	B2	1560	90
16/06/2017	BE-B6	A2	1309	81
16/06/2017	BE-B6	A1	1371	85
16/06/2017	BE-B6	B1	1189	78
17/06/2017	BE-G4	B1	790	58
17/06/2017	BE-G4	B2	772	59
17/06/2017	BE-G4	A2	718	60
17/06/2017	BE-G4	A1	731	64
18/06/2017	BE-H4	B2	2042	93
18/06/2017	BE-H4	A2	1214	77
18/06/2017	BE-H4	A1	1010	62
18/06/2017	BE-H4	B1	1796	74
19/06/2017	BE-H5	B2	824	93

Date	Asset location	Pile position	Max hammer energy (kJ)	Total minutes
19/06/2017	BE-H5	A2	955	98
20/06/2017	BE-H5	A1	1186	94
20/06/2017	BE-H5	B1	856	99
20/06/2017	BE-J6	B2	637	88
21/06/2017	BE-J6	A2	798	73
21/06/2017	BE-J6	A1	818	86
21/06/2017	BE-J6	B1	718	82
22/06/2017	BE-D4	B2	976	100
22/06/2017	BE-D4	A2	982	90
22/06/2017	BE-D4	A1	951	93
22/06/2017	BE-D4	B1	999	91
01/07/2017	BE-E4	A2	1408	116
01/07/2017	BE-E4	A1	1359	104
01/07/2017	BE-E4	B1	1356	134
02/07/2017	BE-E4	B2	1257	124
03/07/2017	BE-F2	A2	993	100
03/07/2017	BE-F2	A1	902	92
03/07/2017	BE-F2	B1	950	82
03/07/2017	BE-F2	B2	921	85
04/07/2017	BE-F4	A2	1458	77
04/07/2017	BE-F4	A1	1578	97
04/07/2017	BE-F4	B1	1626	80
04/07/2017	BE-F4	B2	1479	91
05/07/2017	BE-F12	A2	748	83
05/07/2017	BE-F12	A1	819	57
05/07/2017	BE-F12	B1	809	51
05/07/2017	BE-F12	B2	760	50
06/07/2017	BE-H8	A2	740	58
06/07/2017	BE-H8	A1	546	50
06/07/2017	BE-H8	B1	610	49
06/07/2017	BE-H8	B2	615	53
07/07/2017	BE-G8	A2	1267	71
07/07/2017	BE-G8	A1	1244	59
07/07/2017	BE-G8	B1	811	71
07/07/2017	BE-G8	B2	862	64
08/07/2017	BE-H7	B2	1189	69
08/07/2017	BE-H7	A2	1154	76
08/07/2017	BE-H7	A1	1177	69

Date	Asset location	Pile position	Max hammer energy (kJ)	Total minutes
08/07/2017	BE-H7	B1	1243	75
10/07/2017	BE-C6	A2	1082	88
10/07/2017	BE-C6	A1	972	81
10/07/2017	BE-C6	B1	1017	85
10/07/2017	BE-C6	B2	1053	82
11/07/2017	BE-C5	A2	1671	103
11/07/2017	BE-C5	A1	1528	87
11/07/2017	BE-C5	B1	1523	93
11/07/2017	BE-C5	B2	1586	99
12/07/2017	BE-B5	A2	1632	101
12/07/2017	BE-B5	A1	1709	99
12/07/2017	BE-B5	B1	1657	103
12/07/2017	BE-B5	B2	1564	98
14/07/2017	BE-A5	A2	896	73
14/07/2017	BE-A5	A1	927	76
14/07/2017	BE-A5	B1	940	82
14/07/2017	BE-A5	B2	849	72
15/07/2017	BE-E9	B2	799	71
15/07/2017	BE-E9	A2	728	61
15/07/2017	BE-E9	A1	747	66
15/07/2017	BE-E9	B1	790	66
16/07/2017	BE-D9	A2	1192	101
16/07/2017	BE-D9	A1	1199	122
16/07/2017	BE-D9	B1	1246	103
16/07/2017	BE-D9	B2	1272	95
17/07/2017	BE-C8	B1	968	95
17/07/2017	BE-C8	B2	1023	88
17/07/2017	BE-C8	A2	1054	91
17/07/2017	BE-C8	A1	993	84
18/07/2017	BE-B7	A2	1498	111
18/07/2017	BE-B7	A1	1564	89
18/07/2017	BE-B7	B1	1750	94
18/07/2017	BE-B7	B2	1688	97
24/07/2017	BE-L8	B2	1155	109
24/07/2017	BE-L8	A2	1323	80
24/07/2017	BE-L8	A1	1765	83
24/07/2017	BE-L8	B1	1583	56
27/07/2017	BE-M9	B2	1416	76

Date	Asset location	Pile position	Max hammer energy (kJ)	Total minutes
27/07/2017	BE-M9	A2	1805	55
27/07/2017	BE-M9	A1	1759	52
27/07/2017	BE-M9	B1	1765	47
28/07/2017	BE-M10	A2	1335	70
28/07/2017	BE-M10	A1	1399	69
28/07/2017	BE-M10	B1	1305	46
28/07/2017	BE-M10	B2	1270	44
29/07/2017	BE-L10	B1	1765	47
29/07/2017	BE-L10	B2	988	78
29/07/2017	BE-L10	A2	1350	58
29/07/2017	BE-L10	A1	1292	50
29/07/2017	BE-L9	B1	1250	47
30/07/2017	BE-L9	B2	1577	72
30/07/2017	BE-L9	A2	1352	58
30/07/2017	BE-L9	A1	1317	57
31/07/2017	BE-K8	B2	1492	86
31/07/2017	BE-K8	A2	1321	67
31/07/2017	BE-K8	A1	1407	54
31/07/2017	BE-K8	B1	1704	105
03/08/2017	BE-J9	A2	1399	84
03/08/2017	BE-J9	A1	1286	53
03/08/2017	BE-J9	B1	1042	62
03/08/2017	BE-J9	B2	1492	78
04/08/2017	BE-K9	A2	1471	62
05/08/2017	BE-K9	A1	1577	52
05/08/2017	BE-K9	B1	1647	48
05/08/2017	BE-K9	B2	1576	48
06/08/2017	BE-J7	B2	1409	64
06/08/2017	BE-J7	A2	1515	66
06/08/2017	BE-J7	A1	1966	54
06/08/2017	BE-J7	B1	1570	54
07/08/2017	BE-K6	A2	1223	52
07/08/2017	BE-K6	A1	1270	41
07/08/2017	BE-K6	B1	1360	50
07/08/2017	BE-K6	B2	1271	54
07/08/2017	BE-K7	A2	1512	64
07/08/2017	BE-K7	A1	1608	61
08/08/2017	BE-K7	B1	1486	58

Date	Asset location	Pile position	Max hammer energy (kJ)	Total minutes
08/08/2017	BE-K7	B2	1549	56
08/08/2017	BE-L7	A2	1057	54
08/08/2017	BE-L7	A1	1134	42
08/08/2017	BE-L7	B1	1017	47
08/08/2017	BE-L7	B2	1208	46
12/08/2017	BE-D11	A2	1140	115
12/08/2017	BE-D11	A1	1399	92
12/08/2017	BE-D11	B1	1409	67
13/08/2017	BE-D11	B2	1348	99
13/08/2017	BE-E12	A2	853	83
13/08/2017	BE-E12	A1	720	82
13/08/2017	BE-E12	B1	641	83
13/08/2017	BE-E12	B2	795	83
18/08/2017	BE-G12	A2	801	53
18/08/2017	BE-G12	A1	852	52
18/08/2017	BE-G12	B1	1019	53
18/08/2017	BE-G12	B2	1029	53
19/08/2017	BE-G11	A2	910	71
19/08/2017	BE-G11	A1	768	66
19/08/2017	BE-G11	B1	965	58
19/08/2017	BE-G11	B2	939	82
20/08/2017	BE-K10	A2	994	70
20/08/2017	BE-K10	A1	966	58
20/08/2017	BE-K10	B1	1035	67
21/08/2017	BE-K10	B2	1125	65
25/08/2017	BE-K11	A2	1780	73
25/08/2017	BE-K11	A1	1512	65
25/08/2017	BE-K11	B1	1550	68
25/08/2017	BE-K11	B2	1600	83
26/08/2017	BE-J11	A2	1367	58
26/08/2017	BE-J11	A1	1462	57
26/08/2017	BE-J11	B1	1151	63
26/08/2017	BE-J11	B2	1225	68
26/08/2017	BE-J12	A2	1650	76
27/08/2017	BE-J12	A1	1580	64
27/08/2017	BE-J12	B1	1654	70
27/08/2017	BE-J12	B2	1684	70
28/08/2017	BE-C9	A2	980	101

Date	Asset location	Pile position	Max hammer energy (kJ)	Total minutes
28/08/2017	BE-C9	A1	1106	96
28/08/2017	BE-C9	B1	872	106
28/08/2017	BE-C9	B2	887	110
30/08/2017	BE-D10	A2	740	81
31/08/2017	BE-D10	A1	723	72
31/08/2017	BE-D10	B1	740	72
31/08/2017	BE-D10	B2	612	85
01/09/2017	BE-E10	B2	854	110
01/09/2017	BE-E10	A2	753	115
01/09/2017	BE-E10	A1	934	100
01/09/2017	BE-E10	B1	917	113
07/09/2017	BE-F11	A2	1356	72
07/09/2017	BE-F11	A1	1272	69
07/09/2017	BE-F11	B1	1300	64
07/09/2017	BE-F11	B2	826	63
08/09/2017	BE-H12	A2	974	92
09/09/2017	BE-H12	A1	993	64
09/09/2017	BE-H12	B1	863	69
09/09/2017	BE-H12	B2	879	76
10/09/2017	BE-F13	A2	1045	41
10/09/2017	BE-F13	A1	918	41
10/09/2017	BE-F13	B1	968	39
10/09/2017	BE-F13	B2	744	55
12/09/2017	BE-G13	A2	1609	85
12/09/2017	BE-G13	A1	1626	66
13/09/2017	BE-G13	B1	1735	72
13/09/2017	BE-G13	B2	1735	67
13/09/2017	BE-G14	A2	1936	79
14/09/2017	BE-G14	A1	1807	74
14/09/2017	BE-G14	B1	1814	77
14/09/2017	BE-G14	B2	1682	83
18/09/2017	BE-E11	A2	883	99
18/09/2017	BE-E11	B1	756	93
18/09/2017	BE-E11	B2	849	92
19/09/2017	BE-E11	A1	851	132
19/09/2017	BE-F10	A2	943	76
19/09/2017	BE-F10	A1	958	62
19/09/2017	BE-F10	B1	1096	71

Date	Asset location	Pile position	Max hammer energy (kJ)	Total minutes
19/09/2017	BE-F10	B2	1060	80
20/09/2017	BE-G10	A2	1117	75
20/09/2017	BE-G10	A1	1117	72
20/09/2017	BE-G10	B1	896	56
20/09/2017	BE-G10	B2	939	64
21/09/2017	BE-F9	B2	1511	62
21/09/2017	BE-F9	A2	1527	61
21/09/2017	BE-F9	A1	1245	54
21/09/2017	BE-F9	B1	1230	59
07/10/2017	BE-H13	A2	989	52
07/10/2017	BE-H13	A1	995	53
07/10/2017	BE-H13	B1	1045	50
07/10/2017	BE-H13	B2	975	51
08/10/2017	BE-J13	A2	1000	69
08/10/2017	BE-J13	A1	1195	67
08/10/2017	BE-J13	B1	1268	67
08/10/2017	BE-J13	B2	1304	62
09/10/2017	BE-K12	A2	842	55
09/10/2017	BE-K12	A1	937	61
09/10/2017	BE-K12	B1	1049	52
09/10/2017	BE-K12	B2	928	52
10/10/2017	BE-H11	A2	670	51
10/10/2017	BE-H11	A1	639	60
10/10/2017	BE-H11	B1	820	53
10/10/2017	BE-H11	B2	851	53
26/10/2017	BE-H10	A2	535	71
26/10/2017	BE-H10	A1	753	70
26/10/2017	BE-H10	B1	662	59
27/10/2017	BE-H10	B2	563	78
04/11/2017	BE-G09	A2	777	84
04/11/2017	BE-G09	A1	864	82
04/11/2017	BE-G09	B1	779	69
04/11/2017	BE-G09	B2	736	82
14/11/2017	BE-H09	A2	532	80
14/11/2017	BE-H09	A1	507	60
15/11/2017	BE-H09	B1	606	51
15/11/2017	BE-H09	B2	657	50
02/12/2017	BE-J10	A2	923	67

Date	Asset location	Pile position	Max hammer energy (kJ)	Total minutes
02/12/2017	BE-J10	A1	1230	67
02/12/2017	BE-J10	B1	1278	68
02/12/2017	BE-J10	B2	1131	65

Appendix B: Summary of incidental sightings of marine mammals

Date	Time of sighting (UTC)	Species	Number of individuals	Piling activity	Development site?
19/04/2017	13:45 - 13:50	Unidentified seal sp.	1	None	Yes
06/05/2017	17:35	Harbour porpoise	1	None	No
06/05/2017	17:35 - 17:56	Harbour porpoise	1	None	No
06/05/2017	17:38	Harbour porpoise	2	None	No
06/05/2017	17:51	Harbour porpoise	1	None	No
06/05/2017	17:54 - 17:56	Harbour seal	2	None	No
06/05/2017	18:11 - 18:12	Harbour seal	1	None	No
06/05/2017	18;14	Harbour seal	1	None	No
20/06/2017	11:58 - 11:59	Unidentified seal sp.	1	None	Yes
19/07/2017	08:50 - 08:51	Harbour seal	1	None	No
19/07/2017	12:30 - 12:31	Bottlenose dolphin	2	None	No
25/07/2017	11:36 - 11:44	Grey seal	1	None	Yes
25/07/2017	12:05 - 12:10	Harbour porpoise	1	None	Yes
26/07/2017	17:51	Humpback whale	1	None	No
27/07/2017	04:25 - 04:26	Northern minke whale	1	None	Yes
31/07/2017	05:39 - 05:41	Harbour porpoise	2	None	Yes
31/07/2017	05:53 - 05:54	Harbour seal	1	None	Yes
31/07/2017	05:55 - 05:58	Harbour porpoise	1	None	Yes
11/08/2017	05:51 - 05:52	Northern minke whale	1	None	Yes
02/09/2017	05:14 - 05:15	Harbour porpoise	2	None	Yes
08/09/2017	05:18 - 05:22	Risso's dolphin	3	None	Yes
24/09/2017	08:20 - 08:35	Bottlenose dolphin	5	None	Yes
25/09/2017	06:38 - 06:39	Grey seal	1	None	Yes
28/09/2017	07:45 - 08:05	Grey seal	1	None	No
28/09/2017	07:5208:13	Grey seal	2	None	No
28/09/2017	08:16 - 08:25	Grey seal	2	None	No
16/10/2017	07:44 - 07:55	Grey seal	1	None	No
25/10/2017	15:15 - 15:20	Unidentified dolphin sp.	2	None	No
16/11/2017	09:16 - 09:18	Bottlenose dolphin	2	None	No
27/11/2017	08:33	Grey seal	1	None	No
27/11/2017	08:45	Unidentified seal sp.	1	None	No
27/11/2017	14:52 - 15:16	Harbour seal	1	None	No
27/11/2017	15:07 - 15:08	Grey seal	1	None	No
28/11/2017	08:25 - 09:25	Grey seal	1	None	No
28/11/2017	08:54 - 09:25	Harbour seal	1	None	No
28/11/2017	08:56 - 09:25	Grey seal	1	None	No
28/11/2017	15:00	Grey seal	1	None	No
29/11/2017	14:27 - 14:52	Harbour seal	1	None	No
29/11/2017	15:00	Harbour seal	1	None	No

Appendix C: Summary of casual sightings of marine mammals

Date	Time of sighting (UTC)	Species	Number of individuals	Piling activity	Seen in Development site?
14/04/2017	11:00 - 11:15	Northern minke whale	1	None	Yes
18/04/2017	08:35 - 09:00	Grey seal	1	None	Yes
20/04/2017	06:00 - 06:05	Unidentified seal sp.	1	None	Yes
06/06/2017	08:44 - 08:46	Bottlenose dolphin	4	None	No
25/07/2017	17:15 - 17:16	Northern minke whale	1	None	No
25/07/2017	18:15 - 18:28	Grey seal	1	None	Yes
26/07/2017	07:30	Northern minke whale	1	None	Yes
31/07/2017	10:39	Harbour seal	1	None	Yes
02/08/2017	05:46	Northern minke whale	1	None	Yes
02/08/2017	05:54 - 06:06	Northern minke whale	2	None	Yes
02/08/2017	06:08 - 06:09	Harbour porpoise	1	None	Yes
02/08/2017	06:17 - 06:19	Unidentified seal sp.	1	None	Yes
02/08/2017	06:51 - 06:53	Harbour porpoise	3	None	Yes
02/08/2017	08:25 - 08:30	Unidentified seal sp.	1	None	Yes
02/08/2017	09:30 - 09:50	Harbour porpoise	2	None	Yes
02/09/2017	06:58 - 07:20	Harbour porpoise	1	None	Yes
02/09/2017	07:45	Northern minke whale	1	None	Yes
03/09/2017	06:55 - 07:21	Humpback whale	1	None	Yes
17/09/2017	06:40 - 06:55	White-beaked dolphin	12	None	No