Mallaig Outer Harbour Improvements
Marine Mammal and Basking Shark Risk Assessment

MALLAIG HARBOUR AUTHORITY

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MALLAIG HARBOUR AUTHORITY

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Contents

1 Introduction

1.1 Background

This document has been produced on behalf of Mallaig Harbour Authority (MHA) to support the European Protected Species (EPS) and Basking Shark licence applications for the proposed Mallaig Outer Harbour Improvements (MOHI) development, referred to as the MOHI development from herein. This document fulfils the requirement for a Marine Mammal Mitigation Plan (MMMP) requested within the Screening Opinion issued for the MOHI development. The MMMP includes basking sharks, on the premise that this document will be used to support both the European Protected Species (EPS) and Basking Shark licence applications. As such, this document is referred to as the Marine Mammal and Basking Shark Risk Assessment, which includes a Marine Mammal and Basking Shark Mitigation Plan.

MHA are proposing to carry out improvements to the Outer Harbour including the construction of a new splay berth and deepening of the waters within the Outer Harbour area. The development will cover a total area of 33,000m^2 and will provide additional berthing space, operational quayside, and laydown space, primarily for the fishing and aquaculture sectors. The harbour improvements will accommodate an increased number of vessels and the dredge will allow for deeper draughted vessels, including well boats, to enter the Outer Harbour in all tidal states.

The waters within the vicinity of the development are important to several species of marine mammal, including both cetacean and pinniped species and basking shark (*Cetorhinus maximus*). Marine mammals and basking shark are sensitive to anthropogenic underwater noise, and as such, the proposed pilling and blasting works during the development have the potential to disturb or cause harm to these species.

All UK cetacean species are listed under Annex IV of the European Habitats Directive and are therefore included in Schedule 2 of the Habitats Regulations 1994 as European Protected Species (EPS). Under regulation 39(1) of the Habitats Regulations 1994, it is an offence to deliberately or recklessly kill, injure, harass, or disturb an EPS.

Pinnipeds are not listed as Annex IV EPS species under the Habitats Directive however, both common and grey seals are included in Annex II, meaning that their core habitat must be protected under the Natura 2000 Network and managed in accordance with their ecological requirements. Under the Marine (Scotland) Act 2010, it is an offence to kill, injure or take a seal, as well as to deliberately or recklessly harass a seal at a significant haul out site.

The construction activities associated with the development require an EPS Licence and a Licence to Disturb Basking Shark, due to the potential to cause acoustic disturbance. The purpose of this Risk Assessment is to understand the potential risks and to identify appropriate mitigation regarding the activities which may cause injury or disturbance to marine mammals and basking shark during the MOHI development.

This document will seek to lay out the relevant information which concerns the following:

- The baseline information on marine mammals and basking shark in and/or around the area of development;

- The activities taking place which are most likely to cause injury and/or disturbance without mitigation;
- The likelihood of risk and potential impacts;
- The effects on the protected species of concern without mitigation; and
- The mitigation and management strategies implemented to prevent harm i.e., the Marine Mammal and Basking Shark Mitigation Plan.

An Environmental Supporting Document (Affric Limited, 2021a) has been completed for the project and the following sections are relevant to the EPS licence application:

- Section 4: Project Description
- Section 5: Environmental Considerations
  - Table 5.1.1: Construction Effects and Sensitivities
  - Section 5.1.1: Underwater Noise
- Section 6: Mitigation
  - Section 6.1.1: Underwater Noise and Vibration (Pre-construction)
  - Section 6.2.1: Underwater Noise and Vibration (Construction)
- Appendix 1: Screening Report (Provides baseline)
- Appendix 4: Underwater Noise Assessment

1.2 Scope of Work

The MOHI development will include multiple various construction activities, however only those giving rise to underwater noise and physical harm will be discussed. These include:

- Blasting works which will be carried out to break up bedrock and enable dredging to be carried out;
- Dredge Disposal which will be carried out following blasting within the Outer Harbour area to deepen the channel;
- Piling works which will be carried out to install tubular piles to support the suspended deck as part of the spay berth construction.

1.3 Construction Area

Mallaig is a port situated on the west coast of Scotland in the region of Lochaber. The town is situated approximately 42 miles from Fort William at the end of the A830, also known as the Road to the Isles. Mallaig harbour (National Grid Reference: NM 67585 97217) is a working fishing port and a ferry route to the Inner and Outer Hebrides, the Small Isles, and the Knoydart Peninsula. The harbour is managed by the MHA and the Harbour Limits encompass the whole of the Harbour basin and approach channel.

The MOHI works will be centred on grid reference NM 67585 97217. The areas which are proposed to be blasted and/or dredged are shown in Drawing MOHI-WS2175-XX-XX-D-C-9106 P01 (see Appendix 1), whilst the actual blasting and/or dredge areas are shown in Figure 1.1. The entire construction area will be bounded by Mean High Water Springs and the following points:

- N57°0.497′ W05°49.706′
- N57°0.495′ W05°49.704′
- N57°0.517′ W05°49.603′

- N57°0.511′ W05°49.574′
- N57°0.498′ W05°49.565′
- N57°0.501′ W05°49.552′
- N57°0.469′ W05°49.503′
- N57°0.459′ W05°49.548′
- N57°0.479′ W05°49.562′
- N57°0.476′ W05°49.575′
- N57°0.455′ W05°49.561′
- N57°0.430′ W05°49.683′
- N57°0.464′ W05°49.708′
- N57°0.462′ W05°49.721′

1.4 Schedule of Works

Blasting is scheduled to start approximately 4 weeks after the commencement of the works. Dredging will commence 28 weeks following the commencement of the works and piling 36 weeks. These activities are expected to last a total of 32, 30 and 28 weeks, respectively. The project is scheduled to be complete 18 months following commencement. Throughout the 32-week period assigned for blasting works, a maximum of 40-50 blasts are expected. Blasting is likely to be carried out 2-3 times a week with one blast likely to be carried out per day.

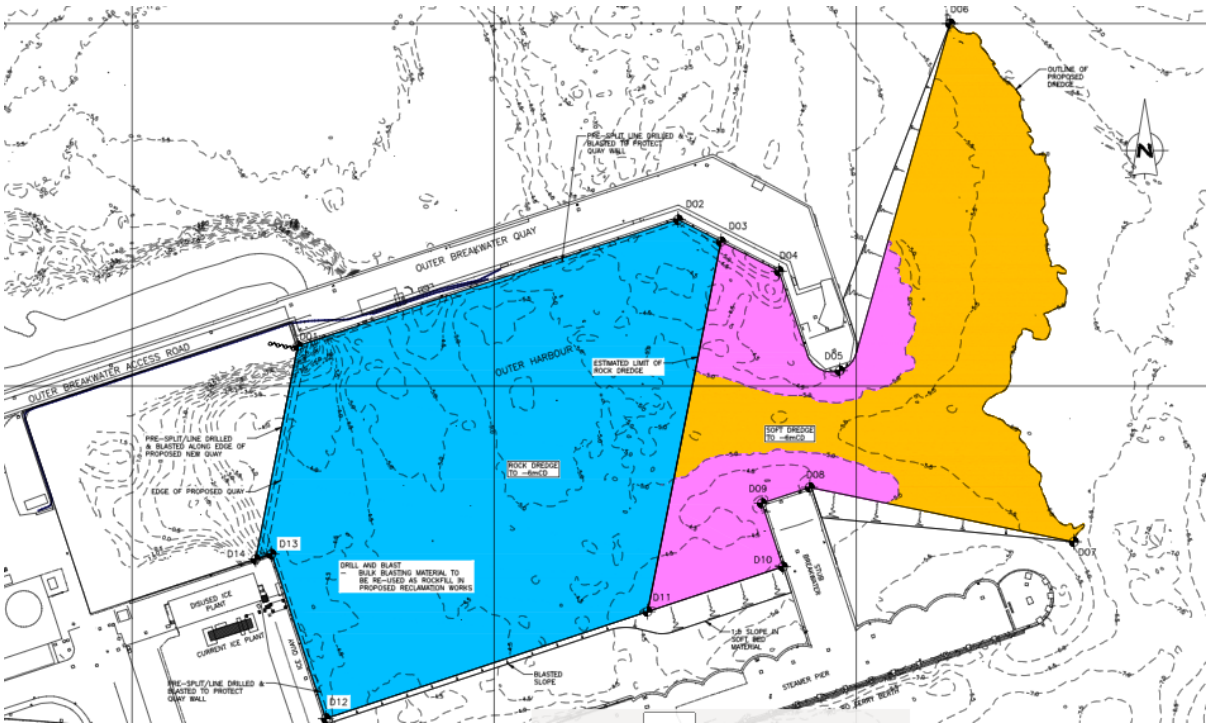

Figure 1.1: Location of the works. Blasting and Dredge Areas are indicated in blue and yellow respectively.

2 Description of Proposed Construction Works

2.1 Blasting

Blasting will be carried out to mobilise bedrock and allow for dredging. The area of bedrock which requires dredging is situated entirely within the confines of the harbour basin. Pre-split drill blast techniques will be used to form the edges of the dredge in advance of bulk blasting

of bedrock close to existing quay walls to prevent, as far as possible, any undercutting of structures and to limit transmission of vibration to those structures. Drilling and blasting are expected to be carried out from floating or jack-up plant. Drilling and blasting of the armour toe trench and concrete toe beam may also be carried out from marine plant or, could be carried out from a temporary bund of dredged or rock fill material deposited locally in the harbour basin. This would then be removed following the completion of blasting. The area to be drilled and blasted is shown in blue in Figure 1.1.

As part of blasting operations, the use of Acoustic Deterrent Devices (ADDs) may be required. The requirement for ADDs will be included on a case-by-case basis depending on the observations made by Marine Mammal Observers (MMOs). As blasts themselves will only occur 2 – 3 times per week, once per day, and will last seconds (<10s), the use of ADDs will also only be prescribed 2 – 3 times per week and once per day. The proposed use of ADDs as part of blasting operations is described in further detail in Section 5: Risk Assessment, Section 6: Consideration of Alternatives, and Section 7: Marine Mammal and Basking Shark Mitigation.

2.2 Dredging

Dredging is expected to be carried out by backhoe or grab dredger working from floating plant, and by long reach excavator working from shore, a temporary bund or quayside. Dredging will be carried out following blasting and a soft dredge will extend outwith the Outer Harbour confines. The total area of dredging is shown in Figure 1.1, indicated in blue and yellow.

2.3 Piling

Initial works preparing for piling will involve infill works followed by the installation of a concrete beam across the seabed to act as a support to the toe of the proposed rock armour revetment. Sockets will be cast within the beam to hold the toes of a front row of tubular steel bearing piles. These piles will support the front edge of the splay berth deck slab. The area behind the toe beam will be infilled and piles will be driven through the infill until they reach the rockhead surface below. These will then be driven for a short period to ensure full bearing capacity on rock is achieved. The tubular bearing piles that support the front edge of the quay slab will then be placed into the sockets within the concrete toe beam and driven for a short period to ensure full bearing capacity on rock is achieved.

Piling techniques will include pile placement into sockets for the piles located at the front of the quay, vibro installation through infill for all other piles and percussive piling to prove bearing. Percussive piling is estimated to be carried out for 5 to 15 minutes per pile. Approximately 60 – 65 tubular steel piles of 600 – 700mm diameter are expected to be installed to support the quay slab. As pile installation proceeds, drilling into grouted steel anchors or toe pins within some of the piles will be carried out where required by the design in order to secure pile toes to the rockhead.

It is also proposed that berthing for an additional ferry vessel will be constructed within the Outer Harbour, along the north edge of the Steamer Pier immediately inshore from the Stub Breakwater which is currently not fendered and unable to be used for berthing. This will involve the installation of steel bearing piles, construction of an access deck and the installation of fender piles to form a berthing face.

3 Marine Mammals Baseline

3.1 Cetaceans

3.1.1 Harbour Porpoise

The harbour porpoise (*Phocoena phocoena*) is distributed throughout temperate and subarctic waters of the North Pacific and North Atlantic oceans and is the most abundant cetacean to occur in northwest European shelf waters (Evans *et* al., 2003). They are the UK's smallest, and most abundant cetacean, widespread throughout coastal regions of the Hebrides. Harbour porpoise are found within Scottish waters throughout the year (Evans *et al.*, 2003; HWDT, 2021), with limited information on seasonal movements (Reid et al., 2003).

The West Scotland management unit includes the area of the proposed development. The most recent abundance estimate of harbour porpoise within this management unit is of 28,936 individuals (IAMMWG, 2021). Within this management unit lies the Inner Hebrides and Minches Special Area of Conservation (SAC) which is designated for harbour porpoise and provides protection to approximately 32% of the population found on the west coast of Scotland and contains the highest density of harbour porpoise in Scotland (NatureScot, 2020). The number of harbour porpoise in Hebridean waters has been recorded as amongst the highest in Europe (HWDT, 2021). For example, according to the SCANS III surveys which provides estimates of cetacean abundance, the survey block which includes Mallaig, estimated 0.397 harbour porpoise per km^2 (SCANS III, 2017).

The Inner Hebrides and Minches SAC is located approximately 180m to the west of the proposed MOHI development. Records of harbour porpoise have also been identified within the area close to Mallaig Harbour (NBN Atlas, 2021). As such they are expected to be one of the most frequently encountered cetaceans during construction of the proposed development.

3.1.2 Minke Whale

The minke whale (*Balaenoptera acutorostrata*) is the most common baleen species recorded in British shelf waters, and high densities are present off the west coast of Scotland, particularly in the Minch (Reid et al., 2003). Insufficient data on population size, however, has made it difficult to establish the conservation status of minke whales and as such, their conservation status is unknown (Marine Scotland Science, 2020).

The waters around the Hebrides have been reported as a hotspot for minke whales with photo identification studies over several years suggesting that many of these animals return to the areas year on year. Minke whales feed mainly in shallow waters (<200m) over the continental shelf, often appearing around sandbanks or where upwellings bring nutrients and fish close to the surface, or in strong currents around headlands and small islands (Reid *et al.*, 2003; NatureScot, 2021). They are considered a coastal species, often occurring within 7km of the coast (Macleod *et al.*, 2004).

The Celtic and Greater North Seas (CGNS) management unit includes the area of the proposed development. The most recent abundance estimate for minke whales in this management unit is 20,118 (IAMMWG, 2021).

The Sea of the Hebrides MPA (Marine Protected Area), designated in part for minke whales (*Balaenoptera acutorostrata*), is located 10.5km away from the proposed MOHI development. Minke whales range extends outwith 10.5km and this species are afforded protection when outwith the MPA. Records of minke whale have been identified within the area close to Mallaig Harbour (NBN Atlas, 2021) and according to the SCANS III surveys the survey block which includes Mallaig, estimated 0.0204 minke whale per km^2. As such, it can be anticipated that minke whales may be in the vicinity of the development however, it is unlikely they would be in close proximity due to the shallow waters surrounding the harbour.

3.1.3 Short-Beaked Common Dolphin

The short-beaked common dolphin (*Delphinus delphis*) tends to be a summer visitor to Scottish waters, mainly recorded between May and October, when food is most abundant (NatureScot, 2021). However, sightings have been reported across every month since 2014 (HWDT, 2021). Common dolphins are often found in groups of 10 to 30 individuals throughout the Hebrides (HWDT, 2021).

The Celtic and Greater North Seas (CGNS) management unit includes the area of the proposed development. The most recent abundance estimate for common dolphins in this management unit is 102,656 (IAMMWG, 2021). Numbers of common dolphins around the Hebrides have been reported to be increasing over recent years (HWDT, 2021). The abundance estimate for the CGNS management unit in 2015 was 56,556 (IAMMWG, 2015).

Records of common dolphin have been identified within the area close to Mallaig Harbour (NBN Atlas, 2021). It can be anticipated that common dolphin may, on occasion, be within close proximity to the proposed development.

No density estimates for short-beaked common dolphin in the survey block which includes Mallaig were provided as part of the SCANS III surveys.

3.1.4 Bottlenose Dolphin

Bottlenose dolphin (*Tursiops truncatus*) are present in UK waters all year round and can often be seen close to shore. Photo-identification studies have identified a population of 30 to 40 individuals inhabiting the Inner Hebrides, from Kintyre to the Isle of Skye and another of approximately 12 individuals around the Sound of Barra (HWDT, 2021).

The Coastal West Scotland and Hebrides (CWSH) management unit includes the area of the proposed development. The most recent abundance estimate for bottlenose dolphins in this management unit is 45 individuals (IAMMWG, 2021).

Records of bottlenose dolphin have been identified within the area close to Mallaig Harbour (NBN Atlas, 2021). The proposed development is situated along the coastline between Kintyre and the Isle of Skye, and it is anticipated that bottlenose dolphins could, on occasion, be within close proximity to the development.

No density estimates for bottlenose dolphin in the survey block which includes Mallaig were provided as part of the SCANS III surveys.

3.2 Pinnipeds

Although pinnipeds are not listed as Annex IV EPS species under the Habitats Directive, the Marine Mammal and Basking Shark Mitigation Plan will still apply to them. As such, they have been included in this document for information only.

3.2.1 Grey Seal

Grey seals (*Halichoerus grypus*) use coastal sites for breeding, pupping, and hauling out and use both inshore and offshore waters to forage and feed. No designated haul out sites for grey seals, designated under the Marine (Scotland) Act 2010, have been identified within the construction area. The closest haul out site however is located 11km to the south, around the skerries and coastline of Arisaig.

Grey seals occur only in the north Atlantic and Barents and Baltic Seas, with their main concentrations located along the Canadian and US eastern seaboards and in north east Europe. The UK contains around 38% of the total world breeding population of grey seals and 88% of those breeding in Scotland, with major concentrations in the Outer Hebrides and Orkney. In 2019 the total UK grey seal population was estimated to be 149,700 individuals (SCOS, 2020). The proposed development is located within the large West Scotland management unit, which has an estimated population of 4174 (SCOS, 2020). The population of grey seals in Scotland has continued to increase (Marine Scotland, 2020).

Grey seals are present year around in UK waters, breeding in Scotland during the autumn/winter season between September and December (Marine Scotland, 2021).

Records of grey seals have been identified within the harbour area itself (NBN Atlas, 2021) with anecdotal records also noting the presence of a grey seal frequenting the inner harbour area (Communication with Wallace Stone, 2020). It is expected that grey seal will be present within close proximity to the proposed development during construction.

3.2.2 Common Seal

Like grey seals, common seals (*Phoca vitulina*) also use coastal sites for breeding, pupping, hauling out and use both inshore and offshore waters to forage and feed. No designated haul outs for common seals have been identified within the construction area with the closest located 11km to the south around the skerries and coastline of Arisaig.

In UK waters, common seals are widespread around the west coast of Scotland, throughout the Hebrides and Northern Isles. On the east coast their distribution is more restricted with concentrations in the major estuaries of the Firth of Tay and the Moray Firth (SCOS, 2020). The UK common seal count population estimate for 2019 was 44,100 (SCOS, 2017). The West Scotland management unit, of which the proposed MOHI development sits within, has an estimated population of 15,600 harbour seals (SCOS, 2020). The population of common seals has been estimated to be stable, although the most recent surveys indicate an increase in West Scotland unlike populations in the North Sea and Northern Isles appear to be in decline (Marine Scotland, 2021).

Common seals are present year around in UK waters, the breeding period in Scotland is between June – July, and the moult occurs in August (Hammond *et al.,* 2003).

Records of common seal have been identified within the area close to Mallaig Harbour (NBN Atlas, 2020). It can be anticipated that common seals may on occasion be within close proximity to the proposed development.

4 Basking Shark Baseline

The basking shark (*Cetorhinus maximus)* is the largest coastal-pelagic shark found within Scottish waters, growing to lengths larger than 11 meters and weighing around 4 tonnes (Sims, 2008). The species is a 'ram filter-feeding shark' and feeds in areas of high plankton concentrations. Basking sharks are also selective zooplankton feeders, with research showing a preference for high energy calanoid copepods such as *Calanus finmarchicus* (Sims, Fox, & Merrett, 2005). Feeding generally occurs from surface waters to depths of 320m (Skomal, Wood, & Caloyianis, 2004). Monitoring of the species feeding behaviour shows that basking sharks aggregate in coastal waters of continental shelfs dominated by transitional waters, where steep bathymetry combined with strong ocean currents result in areas of high phytoplankton and zooplankton density (Drewery, 2012).

In Scottish waters, basking sharks are particularly prevalent on the west coast during summer months, with highest densities observed in the Sea of the Hebrides (Paxton et al., 2014). There is some evidence to suggest that relatively high summer densities of this species are also found in the waters to the west of the Outer Hebrides, although the sparse availability of data casts some doubt over this finding (Paxton et al., 2014). Basking shark are not expected to be present in high densities within the Minch, to the northwest of Mallaig, or within Mallaig itself, although some sightings have been recorded (Marine Scotland, 2020).

5 Risk Assessment

In order to assess the risk of underwater noise to marine mammals and basking shark, resulting from the construction activities outlined in Section 2: Description of Proposed Construction Works, it is necessary to address the following aspects:

- The sensitivity of the species most likely to be present within or close to the construction area;
- The frequency of the sounds that will be produced from the relevant construction activities;
- The risk of injury to marine mammals and basking shark;
- The risk of disturbance to marine mammals and basking shark;
- The risk of physical injury to marine mammals and basking shark.

As blasting represents the worst-case scenario for modelled underwater noise levels, the only construction method in which the risks of acoustic injury to marine mammals and basking shark at Mallaig (see Section 5.2) are those associated with blasting. Although piling is also discussed in Section 5.2, (specifically Section 5.2.2: Piling), it compares pile diameters and subsequently source levels of underwater noise from other projects. This was used to aid the approach in understanding the risks of auditory injury to marine mammals. Each of the construction techniques blasting, dredging, and piling (as discussed in Section 2) are considered in the risks to acoustic disturbance (see Section 5.3).

In addition, as mitigation measures associated with blasting may include the use of ADDs (see Section 7, which outlines when ADDs are likely to be used), the use of ADDs are also considered in this section as a potential impact to marine mammals.

5.1 Hearing Thresholds of Receptors and Underwater Construction Noise

This section identifies the significant noise sources and provides the details of sound pressure levels to be emitted by the construction activities, as noted in Section 2, in relation to the hearing thresholds of the marine mammals likely to be present.

The outputs of the noise modelling were compared with the latest marine mammal auditory injury criteria provided by Southall *et al* (2019) in order to estimate the ranges from the works at which different magnitudes of acoustic impact may occur. The criteria groups marine mammals into functional hearing groups and applies filters to the unweighted noise to approximate the hearing response of the receptor.

5.1.1 Receptor Hearing Thresholds

The hearing groups given by Southall *et al.* (2019) for marine mammals are summarised in Table 5.1. Table 5.1 also lists the species within each group most likely to be encountered within the vicinity of the development.

Table 5.1: Marine Mammal Hearing Groups (Southall *et al*, 2019).

Hearing Group	Relevant Receptors	Generalised Hearing Range
Low Frequency (LF) Cetacean	Minke Whale	7 Hz to 35 kHz
High Frequency (HF) Cetaceans	Common Dolphin Bottlenose Dolphin	150 Hz to 160 kHz
Very High Frequency (VHF) Cetaceans	Harbour Porpoise Inner Hebrides & the Minches SAC	275 Hz to 160 kHz
Phocid Carnivores in water (PCW)	Grey Seal Common Seal	50 Hz to 86 kHz

The latest 'Summary of Criteria for Physical Injury on Fish from Impact Piling Noise' (Popper et al., 2014) groups the types of fish into functional hearing groups as shown in Table 5.2. The specific fish receptors relevant to the MOHI development are summarised in Table 5.2.

Table 5.2: Functional Hearing Groups, and Relevant Fish Receptors (Popper *et al.* 2014)

Functional Hearing Group	Relevant Fish Receptors	Sensitivity to Underwater Noise
Fish: No Swim Bladder (P-)	Basking Shark	Least Sensitive
Fish: Swim Bladder Not Involved in Hearing (P-)	None	↓
Fish: Swim Bladder Involved in Hearing (P+)	None	Most Sensitive

5.1.2 Auditory Injury Criteria for Receptors

Southall *et al.* (2019) presents single strike, unweighted sound pressure level peak criteria (SPL_{peak}) and cumulative (i.e., more than a single sound impulse) weighted sound exposure level criteria (SEL_{cum}) for both permanent threshold shift (PTS), where unrecoverable hearing

damage may occur, and temporary threshold shift (TTS), where a temporary reduction in hearing sensitivity may occur for marine mammal species. It should be noted that, as blasting is a singular event, sound exposure levels can be considered as a single strike (SEL_{ss}) rather than cumulative.

Tables 5.3 and 5.4 present the Southall *et al*. (2019) criteria for the onset of PTS and TTS risk for each of the key marine mammal hearing groups when considering impulsive (blasting) and non-impulsive (dredging) noise sources.

Table 5.3: Impulsive criteria for PTS and TTS in marine mammals (Southall *et al*. 2019).

Functional Hearing Group	Impulsive			
	Unweighted SPL_{peak} (dB re 1 µPa)		Weighted SEL_{cum} (dB re 1 µPa²s)	
	PTS	TTS	PTS	TTS
LF Cetaceans	219	213	183	168
HF Cetaceans	230	224	185	170
VHF Cetaceans	202	196	155	140
PCW Pinnipeds	218	212	185	170

Table 5.4: Acoustic Injury Criteria for Marine Mammals in Relation to Non-Impulsive Noise (Southall *et al*, 2019).

Functional Hearing Group	Non-impulsive	
	Weighted SEL_{cum} (dB re 1 µPa²s)	
	PTS	TTS
LF Cetaceans	199	179
HF Cetaceans	198	178
VHF Cetaceans	173	153
PCW Pinnipeds	201	181

Table 5.5 shows a summary of the impact ranges specific to blasting at the MOHI development at which fish species, and more specifically basking shark, would be affected.

Table 5.5: Summary of the Impact Ranges from Borehole Blasting for fish using the Popper *et al.* (2014) SPL_{peak} Criteria for Explosions

Popper *et al.* (2014) Unweighted SPL_{peak} (Explosions)	
All fish groups and sea turtles Mortality and potential mortal injury	234 dB re 1 µPa
	229 dB re 1 µPa

5.2 Risk of Acoustic Injury

As previously noted, as blasting poses the greatest risk of acoustic injury to marine mammals, the risk of acoustic injury and hence was modelled as the worst case.

5.2.1 Blasting

Blasting will involve filling drilled holes with explosives, which are subsequently detonated to break up and loosen the bedrock. Modelling was undertaken using the largest blast charge

that could be anticipated, which was a TNT-equivalent charge weight of 60kg. The maximum instantaneous blast charge at a representative location within the Outer Harbour was used in the modelling as a worst-case scenario. This representative location was the harbour entrance.

It should be noted that the actual charge weights used by the Contractor in carrying out the works are considered likely to be lower than the maximum proposed (and modelled), depending on the Contractor's modelling of blasts and their findings when undertaking initial blasts for the works.

Noise modelling, however, can only be undertaken based on line-of-sight with the source, and as such, results from the borehole blasting noise modelling scenarios were restricted by the walls at the entrance to the harbour. Although underwater noise from blasting is likely to propagate further than that modelled, the presence of the harbour walls will help prevent extensive noise propagation. 'Leakage' of noise may still occur however, outwith the areas where the harbour walls are present. Where this occurs, noise levels will be considerably lower. Noise levels modelled directly outside and within the harbour entrance, where no barrier effects are in place, act as the worst-case scenario.

The unweighted source levels estimated for blasting are:

- 257.6 dB re 1 µPa (SPL_{peak}); and
- 230.3 dB re 1 μPa^2s (SEL_{ss}).

Figures 5.1 and 5.2 visually depict the unweighted source levels of borehole blasting.

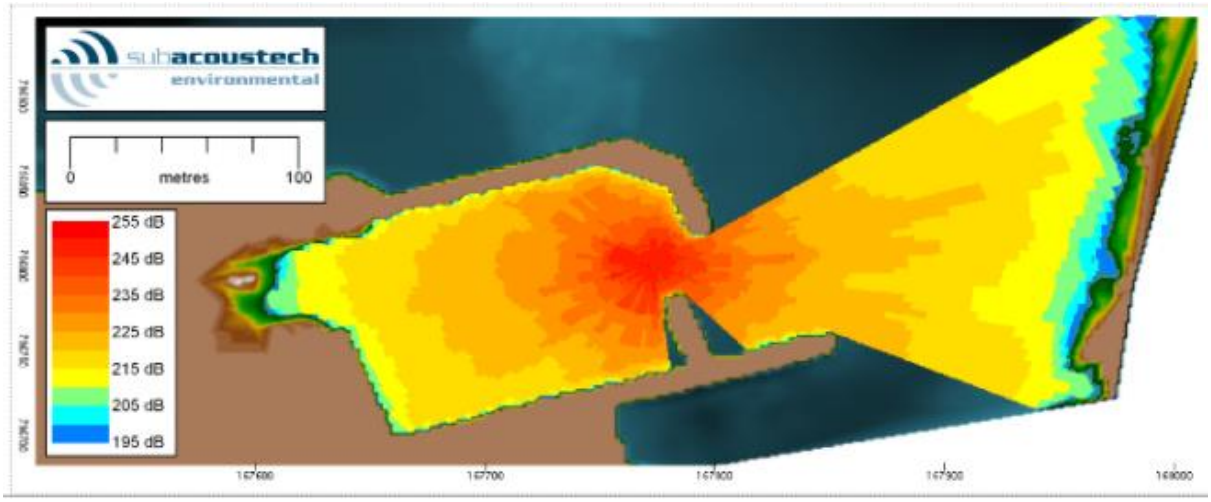

Figure 5.1: Contour plot showing the modelling unweighted SPL_{peak} noise from borehole blasting with a 60kg charge weight in the Outer Harbour of Mallaig Harbour.

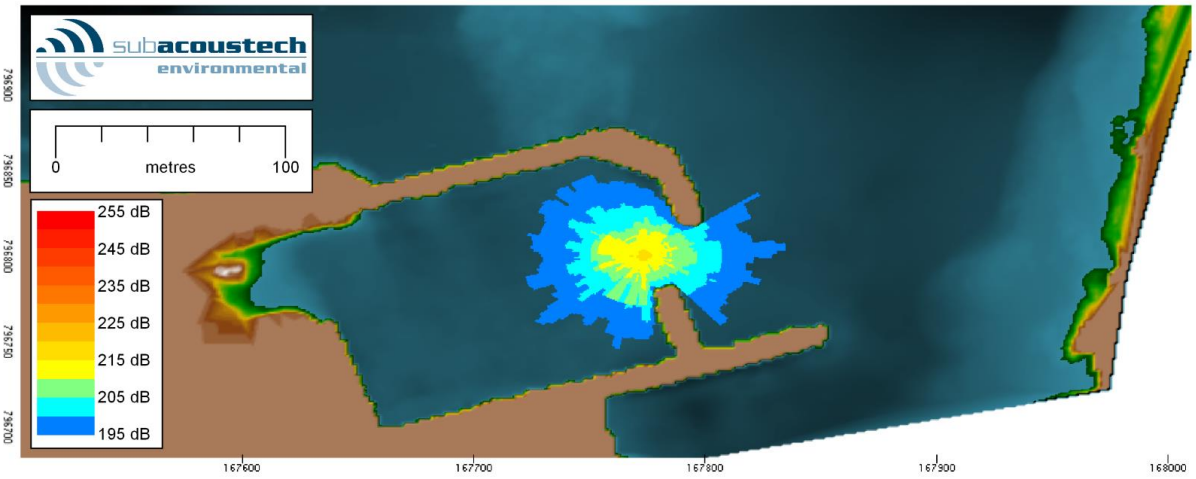

Figure 5.2: Contour plot showing the modelling unweighted SEL_{ss} noise from blasting with a 60kg charge weight in the Outer Harbour of Mallaig Harbour.

The selected position modelled for the blasting is close to the entrance of the harbour. Results for the maximum ranges (Tables 5.6 & 5.7) thus represent the maximum range to which the impact thresholds are reached at any trajectory from the entrance of the harbour. The coast opposite the entrance to the harbour is located approximately 260m away and therefore, zones of PTS or TTS listed as 260m mean that noise levels do not drop below the criteria outlined in Table 5.3, before they reach the coastline. Where charges are detonated further to the west of the harbour entrance, noise levels outwith the Outer Harbour will be lower than those modelled.

Table 5.6: Summary of the impact ranges from borehole blasting for marine mammals using the impulsive Southall et al. (2019) unweighted SPLpeak criteria.

Southall *et al*. (2019) Unweighted SPL_{peak} (Impulsive)			Maximum range (m)
PTS	LF cetacean	219 dB re 1 µPa	150m
	HF cetacean	230 dB re 1 µPa	60m
	VHF cetacean	202 dB re 1 µPa	260m
	Phocid pinniped	218 dB re 1 µPa	160m
TTS	LF cetacean	213 dB re 1 µPa	230m
	HF cetacean	224 dB re 1 µPa	90m
	VHF cetacean	196 dB re 1 µPa	260m
	Phocid pinniped	212 dB re 1 µPa	230m

Table 5.7: Summary of the impact ranges from borehole blasting for marine mammals using the impulsive Southall et al. (2019) weighted SELss criteria.

Southall *et al*. (2019) Weighted SEL_{ss} (Impulsive)			Maximum range (m)
PTS	LF cetacean	183 dB re 1 µPa	170m
	HF cetacean	185 dB re 1 µPa	30m
	VHF cetacean	155 dB re 1 µPa	240m
	Phocid pinniped	185 dB re 1 µPa	70m
TTS	LF cetacean	168 dB re 1 µPa	260m
	HF cetacean	170 dB re 1 µPa	110m
	VHF cetacean	140 dB re 1 µPa	260m

	Phocid pinniped	170 dB re 1 µPa	240m

The modelled impact ranges (zones of PTS and TTS using the weighted SEL_{ss} criteria), as outlined in Table 5.6, for each hearing group of marine mammals are displayed in Figures 5.3 – 5.6. Mitigation with respect to blasting as outlined in Section 6: Proposed Mitigation Strategy, is proportionate to the potential impacts outlined here.

For LF cetaceans, which in this case pertains to minke whales, blasting will have a range of PTS ~170m from the source and a range of TTS 260m from the source. However, given that water depths within 300m of the Outer Harbour do not exceed 20m, with areas within the Outer Harbour much shallower, it is extremely unlikely that minke whales will be present in areas where they may suffer PTS or TTS. In addition, the shallow nature of these areas does not provide a suitable environment for biologically important behaviours such as foraging.

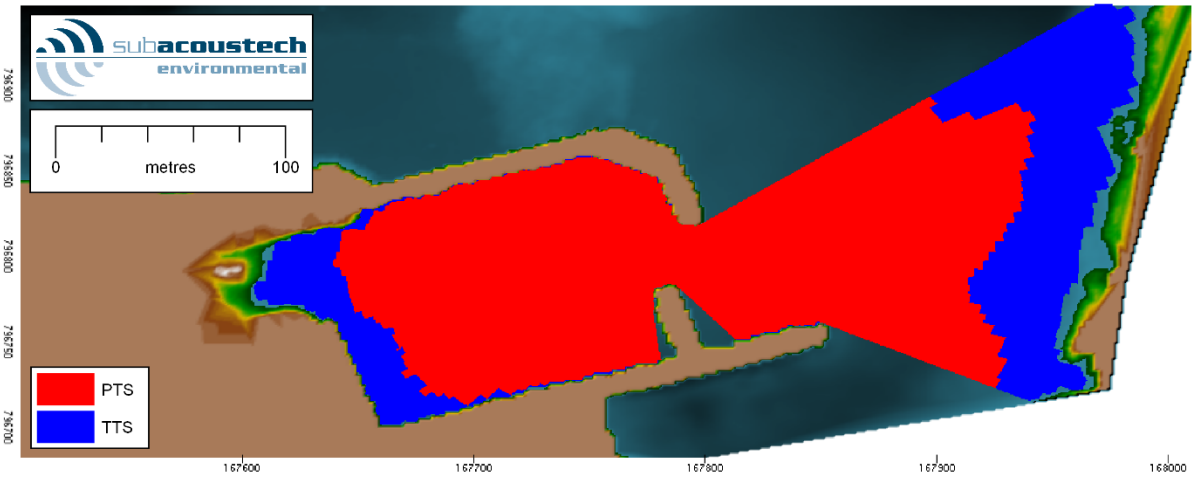

Figure 5.3: Modelled impact range contour plot for a 60kg charge borehole blast considering PTS and TTS in Low-Frequency Cetaceans (LF) using the Southall et al. (2019) weighted SEL_{ss} criteria.

For HF cetaceans, which in this case pertains to short-beaked common and bottlenose dolphins, blasting will have a range of PTS ~30m from the source and a range of TTS ~110m from the source. However, given that water depths within 300m of the Outer Harbour do not exceed 20m, with areas within the Outer Harbour much shallower, it is extremely unlikely that high-frequency cetaceans will be present in the area where they may suffer PTS or TTS. In addition, like with LF cetaceans, the shallow nature of these areas does not provide a suitable environment for biologically important behaviours such as foraging.

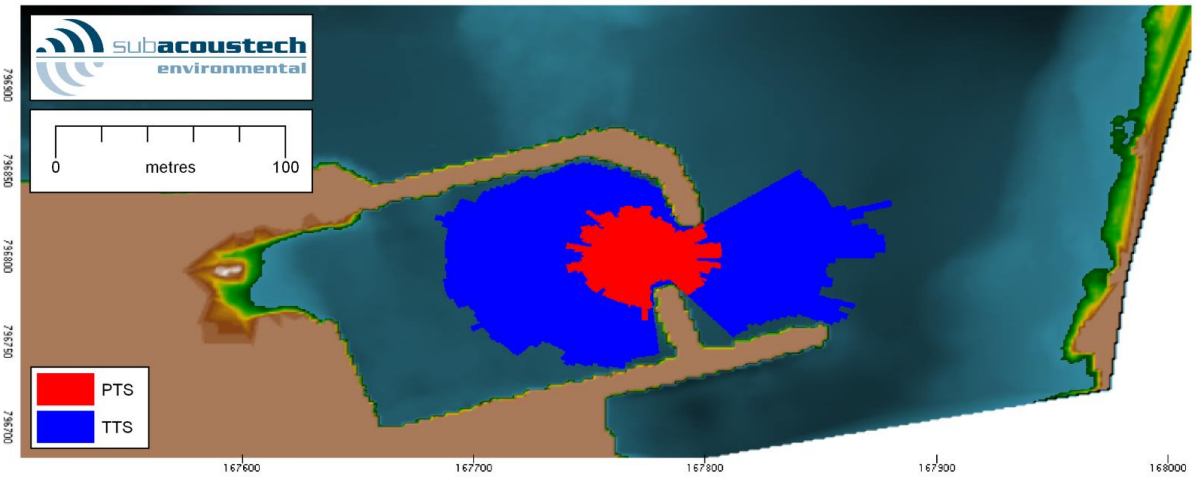

Figure 5.4: Modelled impact range contour plot for a 60kg charge borehole blast considering PTS and TTS in High-Frequency Cetaceans (HF) using the Southall et al. (2019) weighted SEL_{ss} criteria.

For VHF cetaceans (i.e., harbour porpoise), blasting will have a range of PTS ~240m from the source and a range of TTS 260m from the source. Due to the nature of, and characteristics of the Outer Harbour area however, it is unlikely that harbour porpoise will be present within areas of PTS or TTS. These areas provide unsuitable habitat for harbour porpoise and are generally much shallower (~ 0-20m water depth) than their preferred foraging depths (~20 – 50m). Although the impact ranges will not encroach and extend into the area designated as the Inner Hebrides and The Minches SAC for harbour porpoise, due to the proximity of the Inner Hebrides and The Minches SAC to the Outer Harbour, their presence within areas of disturbance cannot be ruled out.

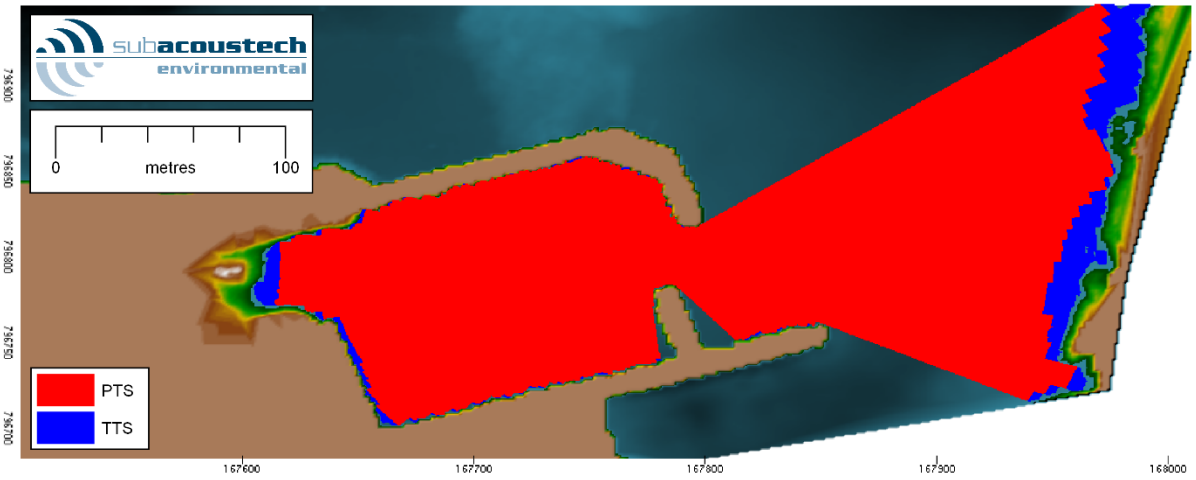

Figure 5.5: Modelled impact range contour plot for a 60kg charge borehole blast considering PTS and TTS in Very High-Frequency Cetaceans (VHF) using the Southall et al. (2019) weighted SEL_{ss} criteria.

With regards to pinnipeds (PW), the zone of PTS extended to approximately ~70m from the source, with zones of TTS extending to areas as far as ~240m from the source. Low density distributions of common seals have been recorded within Mallaig Harbour and as such, are extremely unlikely to be present during blasting works. Grey seals are known to be present

within the Mallaig Harbour area for much of the year. As such, it can be anticipated that grey seals will be within close proximity to the proposed development.

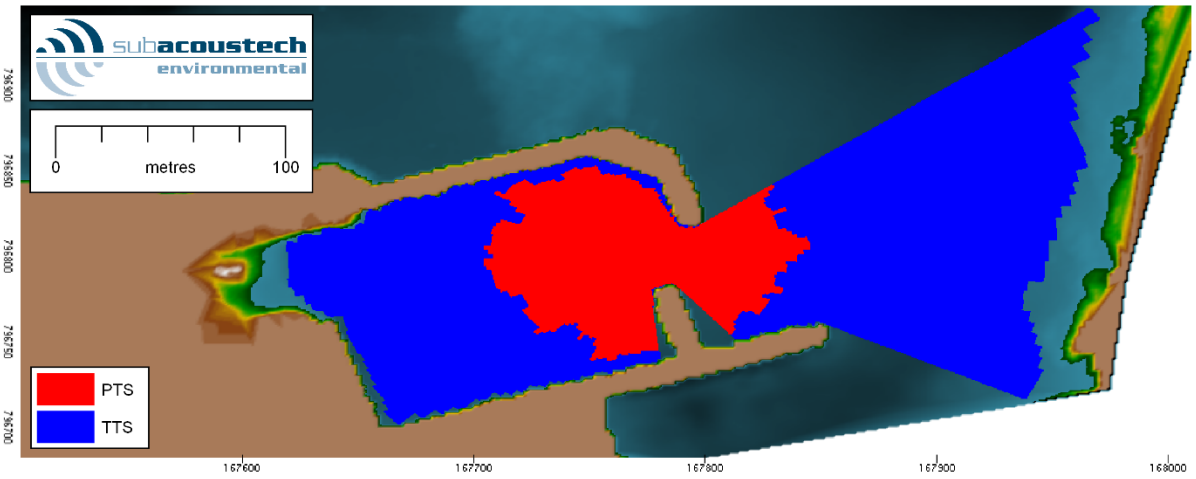

Figure 5.6: Modelled impact range contour plot for a 60kg charge borehole blast considering PTS and TTS in Phocid Pinnipeds in Water (PCW) using the Southall et al. (2019) weighted SEL_{ss} criteria.

With regards to basking shark, basking sharks do not have swim bladders, making them less sensitive to underwater noise than diadromous receptors that do (Table 5.2). In order to suffer either mortal or recoverable injury, a basking shark would need to be within 70m of a single blast. Given that water depths within 100m of the works are <10m deep, and extremely confined, these areas are unsuitable for such a large fish. Therefore, basking sharks are not anticipated to be present in the area where they may be subject to acoustic injury.

5.2.2 Piling

Noise modelling was not specifically carried out for piling (vibration or procession piling), as it was recognised that the noise levels associated with piling would be much lower than those associated with blasting. For example: impact piling (150kJ) of a 910mm diameter pile would be expected to give rise to an unweighted SEL_{SS} of 181.6dB re1µPa^2s (Affric, 2019), whereas the 60kg TNT blast unweighted source had SEL_{SS} of 230.3dB re1µPa^2s. The piles to be utilised in the Mallaig development are likely to be 600 to 700mm diameter and hence will have an even lower associated noise source level. Vibro-piling techniques give rise to lower noise source levels than percussion piling and this technique will be employed for the majority of the works.

The location of the blast modelled was at the entrance to the harbour, whereas the pilling locations are within the slot 130m further inside the Outer Harbour, and alongside the steamer pier which is behind the Stub Breakwater.

Due to the tidal nature of the slot the piling activities will be carried out in shallow water, minimising the transmission of power from the pile into the water column in the form of noise. As such, it is deemed highly unlikely that the SEL_{CUM} PTS and TTS will be breached outwith the Outer Harbour area. Hence it is unlikely that these works will have the potential to cause acoustic injury to marine mammals.

The risks of acoustic injury when considering basking shark are limited when compared with blasting, and as such, do not require more detailed consideration. It is recognised however,

that piling does have the potential to impact basking shark and as such, mitigation is proposed in Section 7.

5.2.3 Acoustic Deterrent Devices (ADDs)

As the mitigation measures proposed in Section 7 may include the use of ADDs to deter marine mammals away from harmful stimuli (i.e., blasting), their use and potential acoustics impacts on marine mammal receptors during mitigation are assessed here.

It is recognised that the use of ADDs as a mitigation method add an additional noise source to the underwater soundscape. ADDs produce mid-to-high frequency sounds (2 – 40 kHz) (Lepper et al., 2014) and are audible to both pinnipeds and HF/VHF cetaceans. Where ADDs produce sounds at loud source levels (≥ 185 dB re 1 µPa RMS) (Findlay et al., 2021), exposure to ADD noise has the potential to exceed levels estimated to cause TTS (Schaffeld et al., 2019) and PTS.

For example, a recent study by Findlay et al. (2021) demonstrated that exceedance of PTS thresholds and TTS thresholds in stationary harbour porpoise may be up to 500m and >1 km from an ADD source operating for 24 hours, respectively. By comparison, exposure to an ADD for 45 seconds to 48 minutes (depending on the model of the ADD used), is predicted to cause TTS in harbour seals when animals are less than 10 m from the sound source (Götz & Janik, 2013). During the same short-term exposure scenarios, HF cetaceans (i.e. bottlenose dolphins) would be subject to TTS at up to 3m distance and harbour porpoise potentially up to 89m (Götz & Janik, 2013).

When considering how ADDs will be used within the marine mammal mitigation proposed, it is unlikely that ADD use will exceed ~2 hours per day, 2 – 3 times per week (see Section 7). As such, it is anticipated that TTS and PTS thresholds based on a stationary mammal will be over much shorter ranges than those predicted in Findlay *et al.,* (2021) and exceedance of PTS and TTS thresholds for all hearing groups of marine mammals are unlikely to reach the distance set out as the mitigation zone for blasting (300m, see Section 7). In addition, when considering the shallow nature of the Mallaig harbour areas, transmission loss effects are likely to further reduce the distances at which PTS and TTS thresholds are exceeded for stationary mammals. On the basis that mammals will move away from the ADD, it is highly unlikely that any individual shall be subject to acoustic injury.

5.3 Risk of Acoustic Disturbance

There is the potential that the blasting, piling, and dredging operations could cause disturbance to marine mammals and basking shark within the construction area. A disturbance effect, as defined under the European Habitats Directive, will occur if animals incur sustained or chronic disruptions to behaviour, that are likely to impair an individual's ability to survive, breed, reproduce, or raise young, or that are likely to result in that individual being displaced from an area for a longer period than would occur during normal behaviour (Joint Nature Conservation Committee, 2010).

The risks of acoustic disturbance, when considering each construction technique, are considered below.

5.3.1 Blasting

Blasting is expected to be carried out over a period of 32 weeks. Although sound does not propagate beyond the line-of-sight of the modelling location in Figures 5.3 – 5.6, it does not mean that sound from the blasting will not enter these areas. From the line-of-sight modelling location, noise could still propagate both north and southwards at levels which cause acoustic disturbance. As such, the zones, and thus, risk of acoustic disturbance to marine mammals, will be greater than that of acoustic injury when considering noise propagation through the direct path.

It is, however, likely that a much lower level of noise will be transmitted through and under the harbour walls into the open water to the north of the Outer Harbour. The contribution of noise from this additional path is expected to be negligible compared to the direct path as the worst-case scenario. Although it is possible that marine mammals and basking shark may be identified within the areas where increased noise levels which could cause disturbance (such as startle/panic responses), these areas of disturbance to marine mammals and basking shark will be limited.

Although effects of disturbance are not predicted to be directly injurious, it is possible for sound levels to create a disturbance effect known as masking. Masking occurs when sound interferes with a marine mammals' ability to perceive and distinguish different sounds. Although it is still relatively unclear on how masking affects each marine mammal species in particular, it is understood that masking could inhibit vocalisations relating to foraging and breeding success (National Research Council (U.S.), 2003). Some researchers however have shown that marine mammals may have the ability to increase the amplitude of their vocalisations as a short-term response to increased noise levels (Clark et al., 2009; Parks, 2011) and prevent inhibition from occurring.

Overall, the chance of disturbance causing effects at a level to impact upon an individual's ability to survive, breed, reproduce or raise young is unlikely. As aforementioned in Section 5.2.1, mitigation with respect to blasting as outlined in Section 7: Proposed Mitigation Strategy, is proportionate to the potential impacts outlined here.

5.3.2 Dredging

When considering sound exposure levels of dredging activity, the ranges at which marine mammals and basking shark are at risk to acoustic injury from dredging are far less than that of blasting. As such, the ranges at which marine mammals and basking shark are likely to be at risk to acoustic disturbance from dredging will also be less. Therefore, the chances of acoustic disturbance causing effects at a level to impact upon an individual's ability to survive, breed, reproduce or raise young are highly unlikely.

5.3.3 Piling

Piling noise source levels will be lower than that of blasting and as such, zones of disturbance are therefore likely to be lower for each marine mammal species, and basking shark, during piling operations when compared with blasting of rock. In addition, the areas to be piled are located within the confines of the Outer Harbour walls with piles being installed into pre-drilled sockets and through reclaimed ground. Noise will be absorbed in part by infill material and the harbour walls, resulting in limited propagation of sound outwith the Outer Harbour area.

Due to masking effects from the harbour walls of the Outer Harbour, the chance of disturbance causing effects at a level similar to that of blasting, and to also impact upon an individual's ability to survive, breed, reproduce or raise young, is unlikely. Mitigation with respect to piling activities only are therefore amended proportionate to the risks of disturbance (see Section 7).

5.3.4 Acoustic Deterrent Devices (ADDs)

ADDs, as outlined in Section 6: Consideration of Alternative Techniques and Section 7: Marine Mammal and Basking Shark Mitigation Plan, will be utilised to help deter seals from being present within the mitigation zones prior to blasting. Although these disturbance effects arising from ADDs are to ensure that seals are not present in the Mallaig harbour area prior to blasting, it is recognised that they have to potential to also disturb cetaceans. As such, disturbance effects on cetaceans such as habitat exclusion (Morton & Symonds, 2002; Kyhn et al., 2015) or behavioural changes (Mikkelsen et al., 2017) are considered here.

When considering how ADDs will be used within the marine mammal mitigation proposed, it is unlikely that ADD use will exceed ~2 hours per day, 2 – 3 times per week (see Section 7). Thompson *et al.* (2020) demonstrated that although harbour porpoise can be displaced by ADDs used in mitigation measures, re-entry of porpoise into the habitat can be observed again after a minimum of 133 minutes and within 1 km of the noise source. Therefore, levels of disturbance will be short-term, reversible and will not be chronic.

The chance of disturbance from ADDs causing effects at a level similar to that of blasting (without mitigation), and to also impact upon an individual's ability to survive, breed, reproduce or raise young, is unlikely.

5.4 Risk of Physical Injury

Disturbance effects inducing startle/panic responses in marine mammals, as described in Section 5.3.1, have the potential to increase collision risks with stationary items and cause harm to themselves. Mitigation measures to mediate the risks of startle/panic responses are outlined in Section 7.1.

During dredged spoil disposal operations, there is the potential for a marine mammal, or basking shark, to be directly under the disposal vessel when the spoil is released. In this event, the animal could be injured or killed by falling debris.

The closest dredge disposal site at Armadale (HE070) is situated within the Inner Hebrides and Minches SAC, designated for harbour porpoise. Other marine mammals and basking sharks could also be encountered in this area.

Mitigation measures will include the implementation of a Marine Mammal and Basking Shark protocol where observations are carried out prior to disposal at sea to ensure no animals are present prior to the deposit of dredged material (see Section 7.3).

5.5 Summary of Risks

Table 5.6 provides a summary of the risks of acoustic injury and disturbance to marine mammals likely to be present close to the MOHI works.

Where the assumed range for risks of acoustic injury and disturbance have been assumed, the number of individuals likely to be affected can be assumed. This is calculated by using the following equation:

$$\boldsymbol{D} \times \boldsymbol{A} = \boldsymbol{N}$$

Whereby *D* is the density of animals per km^2; *A* is the affected area (i.e. hearing threshold or disturbance range in km); and *N* is the number of animals affected in the specified area, *A*. This value has been shown in Table 5.6 for each species likely to be present close to the MOHI works.

It is important to note, however, that density estimates do not provide accurate representations on the actual number of individuals likely to be affected if animals enter the range of risk.

Table 5.6: Summary of the risks of acoustic injury and disturbance to marine mammals*

Species	Construction Technique	PTS Range / Density Affected (*Da*)	TTS Range / Density Affected (*Da*)	Disturbance Range / Density Affected (*Da*)
Harbour Porpoise	Blasting	240m / 0.095	260m / 0.103	>300m / 0.119
	Piling	<50m / 0.019	<100m / 0.039	<300m / 0.119
Short-Beaked Common Dolphin	Blasting	60m / NA	90m / NA	>300m / NA
	Piling	<50m / NA	<100m / NA	<300m / NA
Bottlenose Dolphin	Blasting	60m / NA	90m / NA	>300m / NA
	Piling	<50m / NA	<100m / NA	<300m / NA
Minke Whale	Blasting	150m / 0.003	230m / 0.004	>300m / 0.006
	Piling	<50m / 0.001	<100m / 0.002	<300m / 0.006
Seal species	Blasting	160m / NA	230m / NA	>300m / NA
	Piling	<50m / NA	<100m / NA	<300m / NA

***Note: Not all species had density estimates available and thus, the number of individuals could not be calculated. Where the number of individuals could not be calculated, 'Not Applicable (NA)' has been used.**

6 Consideration of Alternative Techniques

As the MOHI development will provide additional berthing space, operational quayside, and laydown space, primarily for the fishing and aquaculture sectors, plus a berth for an additional CalMac ferry, a do-nothing approach was not considered. The harbour improvements will accommodate an increased number of vessels and the dredge will allow for deeper draughted vessels, including well boats, to enter the Outer Harbour in all tidal states.

Alternatives to blasting, piling and dredge-disposal activities however, were considered.

6.1 Blasting

Consideration was given to alternative techniques to blasting for the removal of seabed material in the MOHI development. Alternative methods of rock removal were considered including the use of a rock cutter drum or a hydraulic breaker, mounted on a backhoe dredger. Consultation with a specialist dredging contractor established that the rock types present at Mallaig Harbour are too hard, and the thickness of rock to be removed too great, for effective use of a rock cutter drum. Rock removal by hydraulic breaker was considered and would be possible, however this approach would be very slow and would produce continuous underwater percussive noise over an extended period of time. The proposed method of drilling will emit low level underwater noise with blasting emitting higher levels but over a very short duration (approximately <10 seconds). Combined, this option will be completed over a significantly shorter duration than removal using a hydraulic breaker and was considered the most appropriate option.

6.2 Piling

Consideration was also given to alternative techniques to piling in supporting the proposed infrastructure for the MOHI development. Wave conditions within the Outer Harbour basin require the new splay berth to be constructed with a rock armoured slope beneath it which will limit wave resonance within the harbour basin. An open piled deck with rock armour beneath, as opposed to a solid quay wall, is therefore required. The piles supporting the deck will be founded on rockhead which is generally exposed without overburden below the footprint of the quay. Consideration was given to limiting the use of percussive piling with it being proposed to drill and socket piles into the rockhead where they are not adequately restrained by the filled revetment beneath the rock armour. The first three seaward rows of piles will be installed using this method. Piles inshore of these will be vibro installed through infill material and driven by an impact hammer for a short duration as they reach rockhead to ensure the required installation. The use of sockets to restrain piles where sufficient fill or overburden is not available is considered to be the most effective way to minimise marine noise generated by the piling. A similar system of drilled sockets into rockhead is proposed for installation of fender piles. This will be formed with sheet piles supported on tubular steel piles. Tubular piles will again be vibro-installed and then drilled and socketed into rock, whilst sheet piles will be vibro-installed to required depth over or to rockhead. Piles for the fendering and access deck for the proposed ferry overnight berth on the face of the steamer pier will be installed in a similar manner to those installed for the splay berth, vibro installed to reach rockhead, and then impact driven for a short time to prove bearing, or where overburden depths are inadequate, drilled and socketed into rock. These options have attempted to remove percussive piling and limit underwater noise as far as reasonably possible and are considered the most appropriate methods.

6.3 Dredging

Consideration was also given to alternative techniques to dredge-disposal in supporting the proposed infrastructure for the MOHI development. These included:

- Re-use within the development; and
- Re-use in other developments.

A Best-Practicable Environment Options report was authored to identify the best practice for dealing with dredge spoil material (Affric Limited, 2021b). The comparison of options from the BPEO is outlined below.

6.3.1 Comparison of Options

The reuse of dredge spoil within the development scored the highest out of the three options assessed (which included dredge-disposal), with deposit at HE070 scoring second highest and reuse in other developments scoring lowest.

As the option to reuse dredge spoil within the development scored highest, it is the preferred option, however the quantity of material required (46,000t) is less than the anticipated total dredge quantity (75,000t), and only the hard dredge (35,000t) is physically suitable for reuse within the development. Hence, an alternative option is required for the remaining soft dredge (40,000t) material. As such, the two remaining options were considered for the management of the remaining spoil.

The reuse in other developments option scored high against alignment with policy, while deposit at sea scored low as waste disposal is low on the waste hierarchy. Reuse scored well against environmental affects, while deposit at sea scored slightly lower due to potential environmental impacts associated with the dredge deposit site being located within the Inner Hebrides and Minches SAC.

With regards to the impacts on the timescales and harbour operations reuse in other developments scored lower than deposit at HE070. This is due to the requirement to identify a receiving site which will fall within the construction timescale, ideally avoiding storage whereas disposal will be carried out within the construction programme. Reuse in other developments will have an impact on harbour operations as material will require landing and processing in an area of limited space.

Reuse within other developments would score higher if a nearby development was identified aligning to the construction programme. If this can be achieved, this will be a preferred second option with it aligning to policy, being the more environmentally friendly option making use of a product which could potentially be classed as a waste and reducing transport. It is also preferred as it will provide a cost saving for a local development.

It is noted that some of the soft dredge may be removed by land-based plant, this material would be most accessible for onshore export. Material removed by floating plant will be harder to bring ashore and more likely to interfere with harbour operations. If a project can be found, it is assumed that only around 25% of the dredge material could be reused without impacting on the construction timeline or wider harbour operations.

The BPEO is therefore, a combination of the three options discussed.

- Every endeavour should be made to utilise dredged spoil as aggregate in the development as infill. This is expected to be in the order of 35,000t of spoil.
- As much of the remaining dredged spoil (40,000t) as is practicable should be retained where possible, ideally transported to a local development for reuse or potentially stored before being utilised as aggregate in other developments.
- However, if this is not feasible for all or part of the soft dredge material, the remaining dredged spoil should be deposited at sea in the existing Armadale spoil ground (HE070).

The combined approach ensures that the dredging can be completed cost effectively, within project timeframes, with minimal impact on harbour operations and the environment.

6.4 Pinniped Mitigation (Blasting)

As discussed in Section 3.2.1, grey seals are known to frequent the inner and outer harbour areas at Mallaig and there is the concern that blasting could therefore induce startle/panic responses which in turn, have the potential to increase collision risks with stationary items. Mitigation measures to mediate the risks of startle/panic responses are therefore considered within the marine mammal and basking shark mitigation plans, to ensure pinnipeds are not present within the harbour area prior to blasting.

Primary marine mammal mitigation during blasting involves the use of two MMOs and is the preferred option to ensure that mitigation zones are clear of all marine mammals prior to blasting. The use of MMOs only is the preferred option of mitigation during blasting, as it does

not add additional sources of underwater noise to the marine soundscape. However, as it is recognised that grey seals are known to be present within the Mallaig Harbour area for much of the year, in cases where the mitigation zone during blasting becomes difficult to clear, i.e, the mitigation zone proposed is very rarely free of pinnipeds, then alternative mitigation measures will be required to be introduced such as ADDs.

Where the mitigation zone is rarely free of pinnipeds, the introduction ADDs will be necessary to ensure there are not ongong or regular delays to blasting and that the blasting programme is maintained. If there are no issues with regard to maintaining the blasting programme however, then the use of MMOs only will be maintained throughout the mitigation plan.

When ADDs are deployed to encourage pinnipeds to leave the harbour area, they will be only utilised on days in which blasts occur, and will therefore be used infrequently (utilised 2 – 3 times a week). This will reduce the duration in which the underwater soundscape is subject to additional noise sources and ADD use will be minimised.

Although ADD use aims to encourage pinnipeds to leave the blasting mitigation zones, and is likely to do so for other marine mammals within HF and/or VHF marine mammal hearing groups, the frequencies in which ADDs operate at are likely to be inaudible to some taxa i.e. LF cetacean hearing groups and basking shark. As such, ADDs will not ensure exclusion of all marine species from the mitigation zones and it cannot be assumed that the area is clear. As such the use of ADD doesn't exclude the need for MMOs during blasting.

7 Marine Mammal and Basking Shark Mitigation Plan

The underwater noise modelling showed that there is the potential for blasting and piling operations to cause disturbance and auditory injury, and for disposal of dredge material to cause injury, to the marine mammal species, and basking shark, likely to be present in the vicinity of the development site.

In line with best practice, the piling marine mammal and basking shark mitigation will apply to all marine mammal species, basking shark (*Cetorhinus* maximus) and otter (*Lutra lutra*). Basking sharks are afforded full protection under Schedule 5 of the Wildlife and Countryside Act 1981. Otter are listed as a European Protected Species and are afforded full protection under the European Directive 92/43/EEC (the Habitats Directive). It is possible that both species may also be present within the vicinity of the proposed development. Records of basking shark and otter have been identified within close proximity to Mallaig Harbour (NBN Atlas, 2021).

The mitigation measures are based on the Joint Nature Conservation Committee's (JNCC) Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise (JNCC, 2010).

7.1 Blasting Marine Mammal and Basking Shark Protocol

7.1.1 Mitigation Strategy

The use of two MMOs has been proposed due to the nature of blasting being a loud impulsive and potentially startling sound. During blasting, no vessels will be moving within the inner and outer harbour areas. Blasts themselves will occur 2 – 3 times per week, once per day, and will last seconds (<10s). However, it is recognised that a startled/panicked animal could still collide with a stationary item and cause harm to itself. Therefore, a 300m mitigation zone will be

established around the location of the blast, which includes the inner harbour area and will be required to be clear of marine mammals prior to a blast taking place.

As it is recognised that grey seals are known to be present within the Mallaig Harbour area for much of the year, in cases where the mitigation zone during blasting becomes difficult to clear, i..e, the mitigation zone proposed is very rarely free of marine mammals, then acoustic deterrent devices (ADDs) will be utilised.

7.1.2 Mitigation Plan

This blasting mitigation plan outlines the marine mammal mitigation protocols for instances where both the Mallaig Harbour Area is often free of marine mammals, and therefore does not require the use of ADDs, and where the Mallaig Harbour Area is not often free of marine mammals, and ADDs are required to be used to ensure the area is clear prior to blasting.

7.1.2.1 Marine Mammal Observers Only

The blasting mitigation, where only MMOs are required, is as follows:

- A 300m mitigation zone will be established around the location of the blast (see Drawing 69.01.07 in Appendix 2). In addition, the mitigation zone will include the inner harbour area;
- Trained MMOs will conduct a 20-minute pre-watch prior to the commencement of blasting operations;
    - One of these MMOs will be positioned on the outer quay throughout the entire watch, providing a view to the north and the inner harbour area.
    - A second MMO will be mobile, walking the coastline or, on a boat within the inner harbour, checking the inner harbour area including the marina, around vessels and below the fish pier where seals are known to reside.
    - If the 300m mitigation zone and inner harbour remains clear of marine mammals during the watches, permission will be given to commence blasting.
    - During the pre-watch, should marine mammals be sighted within the 300m mitigation zones or inner harbour area prior to blasting, then there will be a 10-minute delay period to the start of blasting.
    - Watches must be carried out in visible conditions and appropriate sea state (i.e., light, no fog/harr reducing visibility, sea state ≤3 (Beaufort <4). It should be noted however, that a Beaufort level of >3 does not necessarily correspond to sea states in which visual observations cannot be undertaken.

All marine mammal observations will be recorded using the JNCC marine mammal reporting forms template.

7.1.2.2 Marine Mammal Observers and ADD use

The blasting mitigation, where MMOs and ADD use are required, is as follows:

- At least 2 hours prior to blasting, MMOs will be notified of the proposed blast time to ensure that ADDs in the harbour area can be switched on and have been operating for at least 1 hour prior to blasting;
- A 300m mitigation zone will be established around the location of the blast (see Drawing 69.01.07 in Appendix 1). In addition, the mitigation zone will include the inner harbour area;

- Trained MMOs will conduct a 20-minute pre-watch prior to the commencement of blasting operations to ensure that the operating ADDs have cleared both the 300m mitigation zone and inner harbour areas;
    - One of these MMOs will be positioned on the outer quay throughout the entire watch, providing a view to the north and the inner harbour area.
    - A second MMO will be mobile, walking the coastline or, on a boat within the inner harbour, checking the inner harbour area including the marina, around vessels and below the fish pier where seals are known to reside.
    - If the 300m mitigation zone and inner harbour remains clear of marine mammals during the watches, permission will be given to commence blasting.
    - Watches must be carried out in visible conditions and appropriate sea state (i.e., light, no fog/harr reducing visibility, sea state ≤3 (Beaufort <4). It should be noted however, that a Beaufort level of >3 does not necessarily correspond to sea states in which visual observations cannot be undertaken.
- As soon as is practicably possible following blast completion, the MMOs will be required to switch off the ADDs to ensure that no unnecessary underwater noise sources are still operating.

All marine mammal observations will be recorded using the JNCC marine mammal reporting forms template.

7.2 Piling Marine Mammal and Basking Shark Mitigation

7.2.1 Mitigation Strategy

A Piling Marine Mammals and Basking Shark Protocol will be implemented during piling works in order to minimise the risk of disturbance to animals which may be in the vicinity of the proposed development site.

The mitigation measures are based on the Joint Nature Conservation Committee's (JNCC) Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise (JNCC, 2010). It is recognised that the standard Joint Nature Conservation Committee (JNCC) piling protocol is designed for offshore windfarm piling (JNCC 2010) and therefore the mitigation has been adapted as appropriate for piling within the confines of the Outer Harbour at Mallaig.

The JNCC protocol currently provides a disproportionate level of mitigation for the proposed piling works, which is not justified by the perceived risk to marine mammals (see Section(s) 4.2.2 & 4.2.3). As such, the JNCC protocols has been modified in order to ensure the piling marine mammal mitigation is proportionate to the perceived risk to marine mammals, and not unduly restrictive. A summary of the changes made to the JNCC protocols, together with the supporting rationale is provided in Table 7.1.

Table 7.1: Summary of Modifications to the JNCC Piling Marine Mammal Protocols

Aspect	Change	Rationale
Mitigation Zone Radius	The mitigation zone has been amended from a 500m radius a to a zone appropriate to the complexity of the	Piling noise source levels will be lower than that of blasting. Zones of PTS and TTS are therefore likely to be lower for each marine mammal species during piling operations when compared with blasting of rock. In addition, the areas to be piled are located within the

Aspect	Change	Rationale
	marine landscape, see Figure 6.2.	confines of the Outer Harbour walls with piles being installed into pre-drilled sockets and through reclaimed ground. Noise will be absorbed in part by infill material and the harbour walls, resulting in limited propagation of sound outwith the Outer Harbour area. As such, the mitigation zone will only encompass the area within the Outer Harbour walls, and a small area immediately outwith the Outer Harbour area. The zone outwith the Outer Harbour is bounded by the coastline to the east, the Inner Harbour to the south and a shallow channel to the north with skerries bordering it, see Figure 7.1.
Pre-Watch Duration	The duration of the pre watch (both visual and acoustic) is reduced from 30min to 20min.	The 30min pre watch is designed to maximise detection probability within the mitigation and allow for deeper diving marine mammals which may be present in the zone, but submerged and undetectable for extended periods. However, given that water depths within the 300m zone do not exceed 20m, so prolonged deep dives cannot occur. In addition, the reduction of the mitigation zone to 300m increases detection probability within the mitigation zone. Therefore, a 20min watch is sufficient to ensure the mitigation zone is clear of marine mammals. A 30min watch will not increase detection probability but will result in unwarranted delays to operations.
Delays After Detection in Mitigation Zone	The delay following a detection within the mitigation zone during the pre-watch is reduced from 20min to 10min.	For the reasons stated above, a period of 10min following the last detection within the mitigation zone provides sufficient confidence that the mitigation zone is clear of marine mammals, allowing piling to commence.
Soft Start	No soft start will be provided.	The purpose of the soft start is to allow animals which may be present (but undetected) within the injury zones to move away before full power piling is reached. However, given the shallow waters, significantly reduced acoustic injury zones (compared to windfarm piling operations), the mitigation zone, and low anticipated marine mammal densities, the risk of an animal being present but undetected within the injury zone is extremely low. As such, additional delays resulting from implementing a soft start is not justified by a meaningful reduction in marine mammal risk for this development. It should be noted that vibro piling will be used with percussive only used in final stages and therefore vibro piling in itself would act as a soft start.

7.2.2 Mitigation Plan

The piling mitigation is as follows:

- Mitigation zones are established within the Outer Harbour walls, and a small area immediately outwith the Outer Harbour area. The zone outwith the Outer Harbour is bounded by the coastline to the east, the Inner Harbour to the south and a shallow channel to the north with skerries bordering it (see Figure 6.2.1);
- A single trained marine mammal observer (MMO) will conduct a 20-minute pre-watch prior to the commencement of piling operations;
    - The MMO will be positioned on the outer breakwater quay throughout the entire watch where the confines of the Outer Harbour, the waters to the north of the Outer harbour, and the waters to the east can all be observed to the north;
    - If the designated mitigation zones remain clear of marine mammals during the watches, permission will be given to commence piling;
    - Watches must be carried out in visible conditions and appropriate sea state (i.e., light, no fog/harr reducing visibility, sea state ≤3 (<Beaufort 4). As aforementioned, a Beaufort level of >3 does not necessarily correspond to sea states in which visual observations cannot be undertaken. As such, care should be taken to ensure that visual techniques are utilised as much as possible to maximise the probability of detection of non-vocalising species within mitigation zones.

All Marine Mammal Observations will be recorded using the JNCC marine mammal reporting forms template.

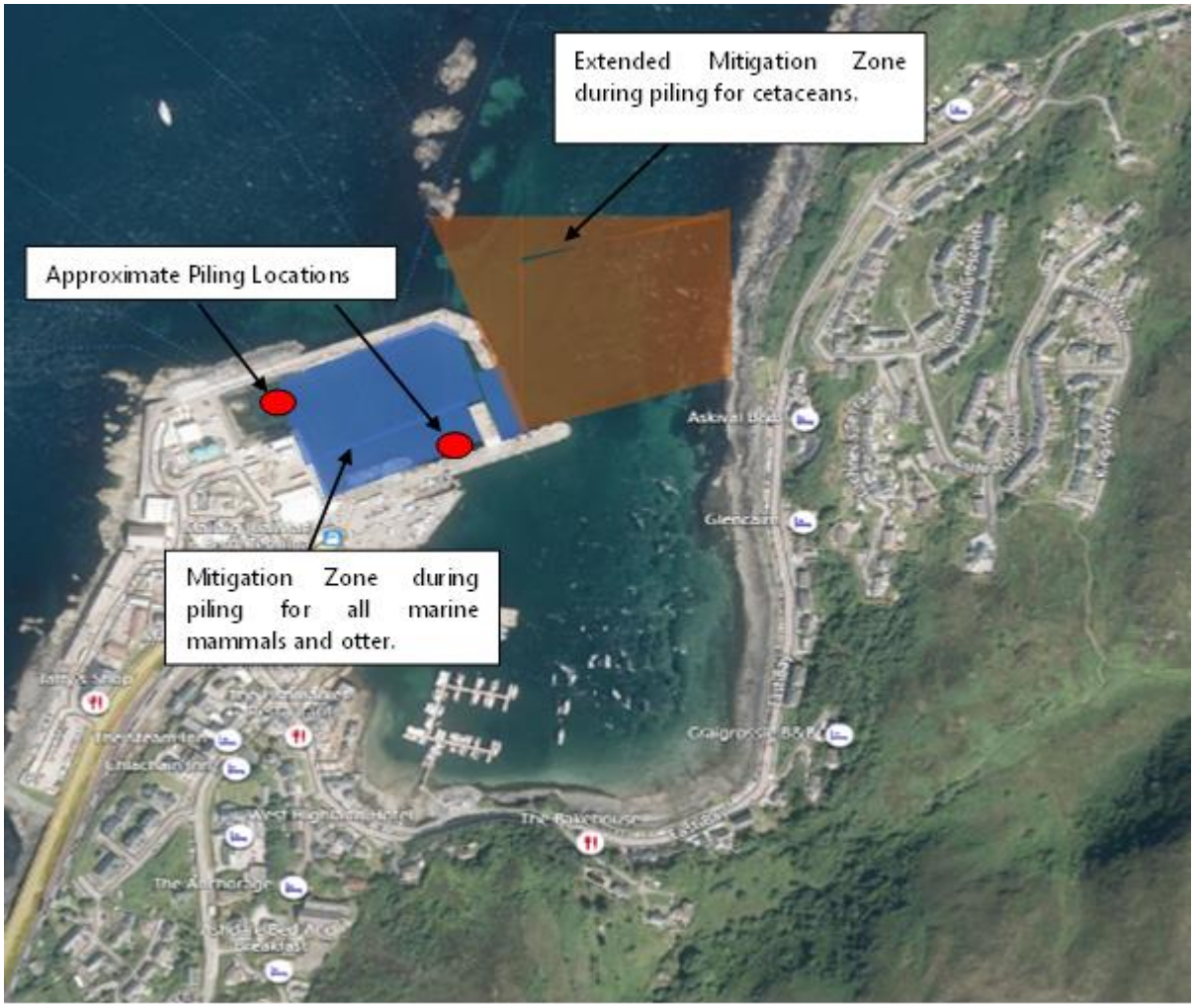

Figure 7.1: Amended mitigation zone for Mallaig Harbour during piling works

7.3 Spoil Disposal Marine Mammal and Basking Shark Mitigation

7.3.1 Mitigation Strategy

As the Armadale spoil ground is situated approximately ~250m from land, consideration can be given in conducting marine mammal watches from land to remove the need for watches to be conducted from the vessel. Passive Acoustic Monitoring (PAM) will not be required during spoil disposal, as disposal activities are unlikely to take place during the night or in adverse weather conditions. In addition, PAM systems will not detect basking shark, seals, or otter. However, if the spoil disposal contractor wishes to dispose during the night, then it would be up to the contractor to arrange a PAM system to be in place during these disposal events.

7.3.2 Mitigation Plan

At this stage, spoil disposal marine mammal mitigation will provide the following measures and will apply to cetaceans (whales, dolphins, porpoise), seals, basking shark, and otter:

- A 250m mitigation zone will be established around the disposal vessel during disposal. A mitigation zone is placed around the vessel as opposed to the disposal site as the vessel will be in transit during disposal;

- Trained marine mammal observers (MMO) will conduct a 20min pre-watch prior to the commencement of spoil disposal, either on board the disposal vessel or from land. Should the MMO undertake the watch from land adequate elevation will be required to do this effectively, such as the location identified in Figure 7.2. Regardless:
    - If the 250m mitigation zone remains clear of marine mammals and/or basking shark during the watch, permission will be given to commence disposal; and
    - If animals are sighted within the mitigation zone, disposal will be delayed until the zone has been clear of marine mammals for at least 10-minutes.
    - Spoil disposal events will only occur when the visible conditions and sea state are conducive for visual mitigation practices (i.e., daylight hours, visibility to 500m from the observation point on land, and graded sea states of ≤3 (Beaufort <4). As aforementioned, a Beaufort level of >3 does not necessarily correspond to sea states in which visual observations cannot be undertaken. As such, care should be taken to ensure that visual techniques are utilised as much as possible to maximise the probability of detection of non-vocalising species within mitigation zones.

If the spoil disposal contractor wishes to dispose during the night, then:

- Passive acoustic monitoring (PAM) will be utilised by a trained PAM operator to monitor the mitigation zone, should disposals be occurring;
    - A PAM watch of the mitigation zone will have a minimum duration of 20min;
    - If a marine mammal is detected within the mitigation zone during a PAM watch, disposal will be delayed until the zone has been clear of marine mammals, basking sharks and/or otter for at least 10-minutes.

All MMO/PAM operations will be recorded using the JNCC marine mammal reporting forms template and submitted to Marine Scotland once the works are complete.

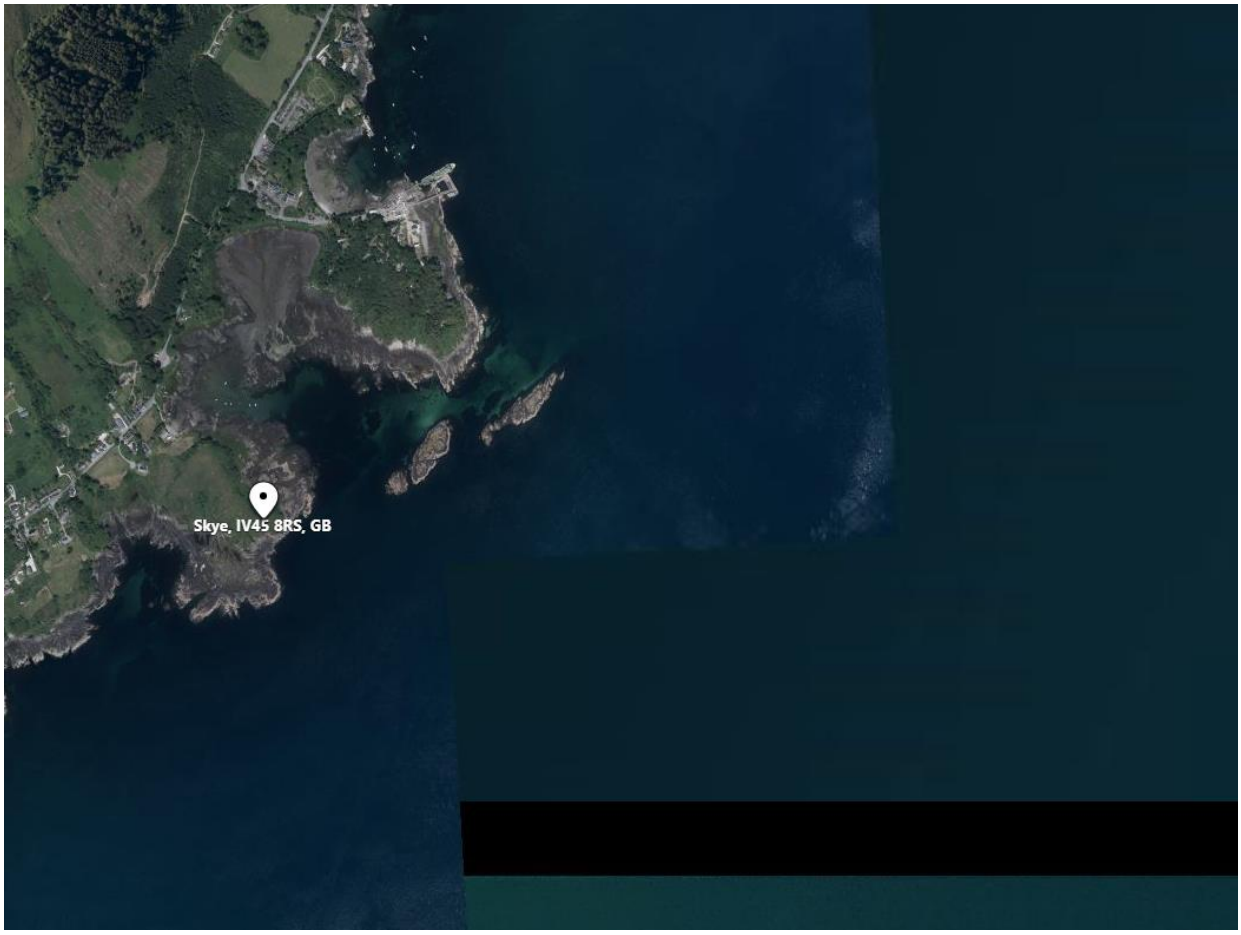

Figure 7.2: Predicted MMO location if observations undertaken from land. Provides ~10m elevation.

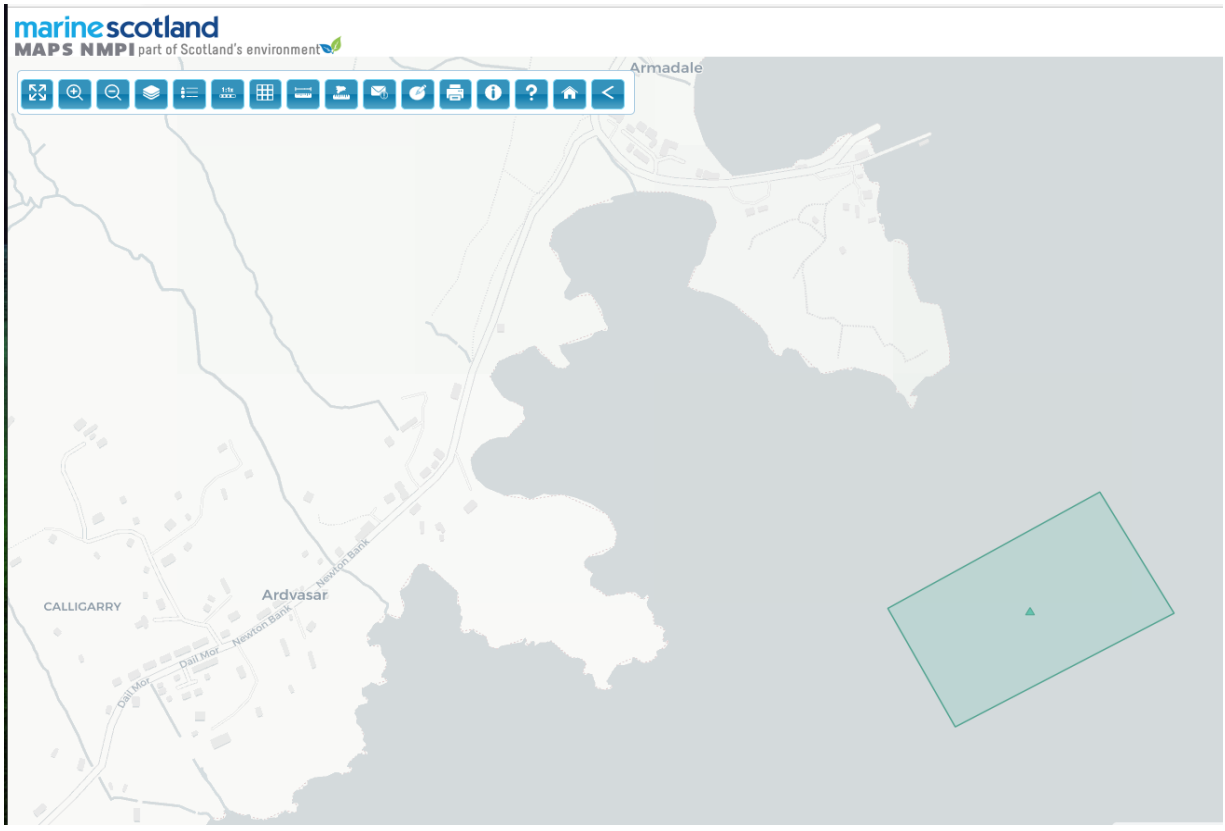

Figure 7.3: Location of Armadale Spoil Disposal Ground.

8 Conclusion

This report has demonstrated that the proposed MOHI development, through the adoption of effective and proportionate marine mammal mitigation during the construction of the development poses no risk of injury and limited risks of disturbance to marine mammals. Marine mammals may experience some disturbance however due to the location and limited extent and duration of the disturbance; it is very unlikely that this will be significant to individual animals or at a population level.

Considerations of alternative techniques have been taken, however, the activities required to be performed are imperative to the outer harbour improvements and as such, there is justification to carry out these activities with appropriate mitigation.

The Marine Mammal and Basking Shark Mitigation Plan proposed to mitigate the limited risks of disturbance to marine mammals, will reduce this risk. It is therefore concluded that with mitigation, the blasting and piling required for the MOHI will not significantly affect any marine mammal species at individual or population level.

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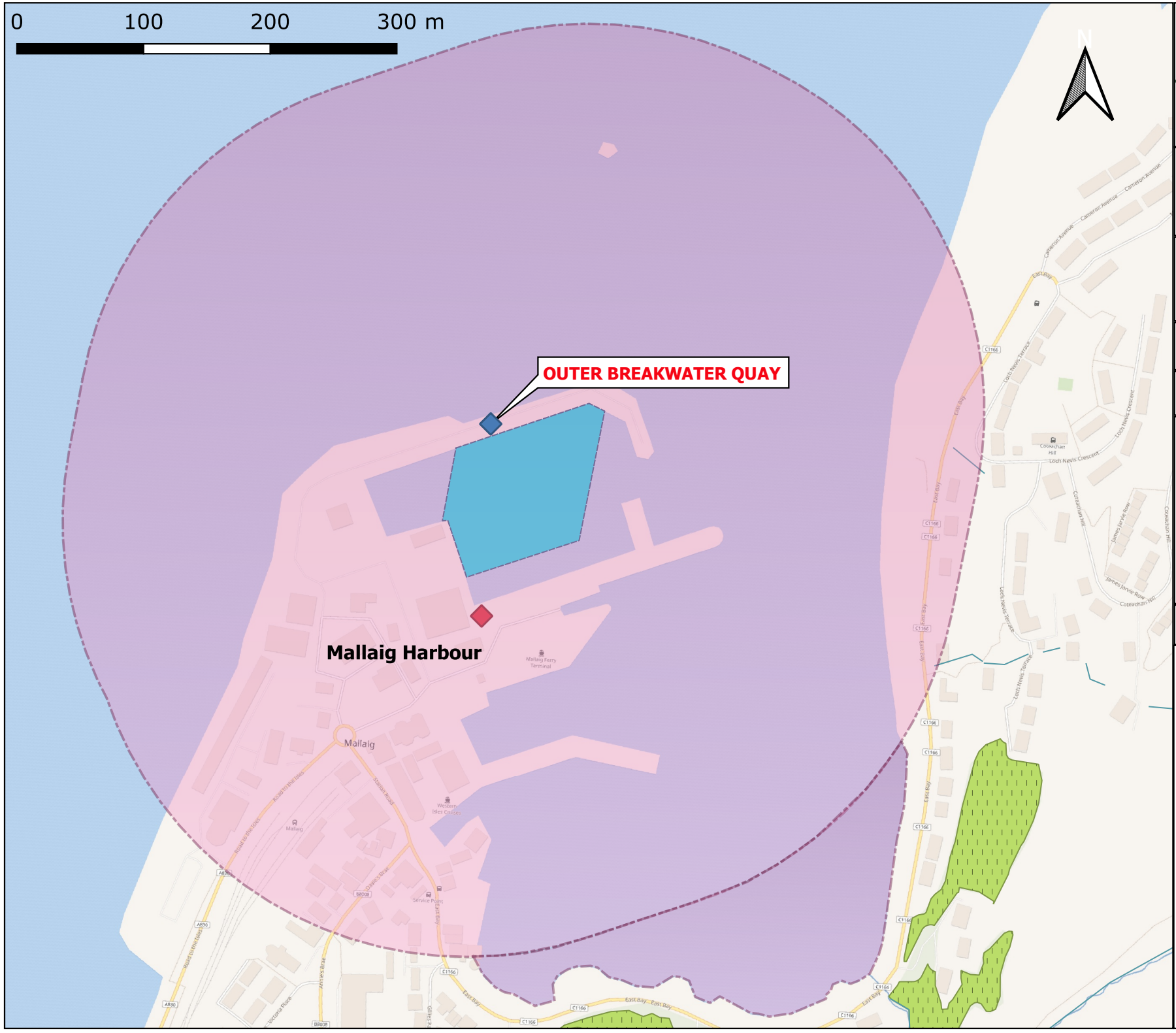
10 Glossary

Acronym	Definition
CEMD	Construction Environmental Management Document
CGNS	Celtic and Greater North Seas
CWSH	Coastal West Scotland and Hebrides
dB	Decibels
EPS	European Protected Species
HF	High Frequency Cetaceans
Hz	Hertz
JNCC	Joint Nature Conservation Committee
kg	kilograms
kHz	kilo Hertz
km	kilometres
LF	Low Frequency cetaceans
m	metres
MF	Mid-Frequency cetaceans
MOHI	Mallaig Outer Harbour Improvements
MMO	Marine Mammal Observer
MPA	Marine Protected Area
NBN	National Biodiversity Network
Pa	Pascal
PAM	Passive Acoustic Monitoring
PCW	Phocid Carnivores in Water
PTS	Permanent Threshold Shift
SAC	Special Area of Conservation
SEL_{cum}	Cumulative Sound Exposure Level
SEL_{ss}	Single Strike Sound Exposure Level
SPL	Sound Pressure Level
SPL_{peak}	Peak Sound Pressure Level
TNT	Trinitroluene
TTS	Temporary Threshold Shift
VHF	Very High Frequency Cetaceans

Appendix 1



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Title: 69.01.07 Marine Mammal Exclusion Zone

Projection: OSGB 1936/British National Grid EPSG: 27700

Page 1	Rev No: 1	Drawing Date: 28/02/2022

- Mallaig Harbour Location
- Blast Area
- MMO Watch Zone
- Tidal Water