Appendix VII
Marine Mammal
Risk Assessment

MARINE MAMMAL RISK ASSESSMENT OF PROPOSED DODDER PUBLIC TRANSPORTATION OPENING BRIDGE

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1 | INTRODUCTION

The Irish Whale and Dolphin Group (IWDG) was contracted by Roughan and O'Donovan to carry out a Marine Mammal Risk Assessment of the proposed Dodder Public Transportation Opening Bridge where the River Dodder joins the Liffey in Dublin City.

The proposed Dodder Public Transportation Opening Bridge is a three-span bridge which will span from Sir John Rogerson's Quay to the R131 adjacent to Tom Clarke Bridge. The bridge will accommodate pedestrians, cyclists, buses and taxis. The bridge accommodates an opening section adjacent to Sir John Rogerson's Quay which facilitates navigation of vessels between the river Liffey and the river Dodder / Grand Canal Basin. In the closed position, the bridge will accommodate a navigation envelope to permit the passage of small boats. An opening span is required to permit the passage of larger vessels between the Dodder River / Grand Canal Dock and the Liffey River.

Figure 1: Location of the proposed Dodder Public Transportation Opening Bridge

Proposed works

The proposed development consists of a new public transportation opening bridge over the River Dodder at its confluence with the River Liffey. The following elements are also included in the scope of the proposed development:

- The construction of the approach roads associated with the bridge
- The construction of a new control building for operating the bridge
- The provision of a new club house and facilities for the St Patrick's Rowing Club (SPRC)
- The reclamation of land to the west of Tom Clarke Bridge to facilitate the build; and

This development is anticipated to take 18 months to complete. Stage 1 which includes installing cofferdams will take around 3 months and Stage 2 around 12 months. Earliest start is late in 2021 or more likely mid-2022. Work is planned for 7 days a week with earlier finishes at the weekend compared to week days.

2 | METHODS

This risk assessment was based on a review of the available literature and original data collected by the IWDG during the Dublin Port Alexandra Basin Re-development Project (Russell *et al.* 2017, 2018; 2019; 2020). The marine mammal community adjacent to the proposed development site is well known following extensive survey and monitoring work over the past three years.

3 | LEGAL STATUS

Irish cetaceans and pinnipeds are protected under national legislation and under a number of international directives and agreements which Ireland is signatory to. All cetaceans as well as grey and harbour seals are protected under the Wildlife Act (1976) and amendments (2000, 2005, 2010 and 2012). Under the act and its amendments it is an offence to hunt, injure or wilfully interfere with, disturb or destroy the resting or breeding place of a protected species (except under license or permit). The act applies out to the 12 nm limit of Irish territorial waters.

All cetaceans and pinnipeds are protected under the EU Habitats Directive. All cetaceans are included in Annex IV of the Directive as species '*in need of strict protection*'. Under this Directive, the harbour porpoise (*Phocoena phocoena*), bottlenose dolphin (*Tursiops truncatus*), grey seal (*Halichoerus grypus*) and harbour seal (*Phoca vitulina*) are designated Annex II species which are of community interest and whose conservation requires the designation of special areas of conservation.

Ireland is also signatory to conservation agreements such as the Bonn Convention on Migratory Species (1983), the OSPAR Convention for the Protection of the Marine Environment of the northeast Atlantic (1992) and the Berne Convention on Conservation of European Wildlife and Natural Habitats (1979).

Under the EU Marine Strategy Framework Directive with respect to maintaining good environmental status (GES), "*human activities should occur at levels that do not adversely affect the harbour porpoise community at the site*" and "*proposed activities or operations should not introduce man-made energy at levels that could result in a significant negative impact on individuals and/or the community of harbour porpoise within the site*". This refers

to the "*aquatic habitats used by the species in addition to important natural behaviours during the species annual cycle*".

In 2007, the National Parks and Wildlife Service (NPWS) of the Department of Arts, Heritage and the Gaeltacht produced a '*Code of Practice for the Protection of Marine Mammals during Acoustic Seafloor Surveys in Irish Waters* (NPWS, 2007). These were subsequently reviewed and amended to produce '*Guidance to manage the risk to marine mammals from man-made sound sources in Irish waters*' (NPWS, 2014) which include mitigation measures specific to piling. The guidelines recommend that listed coastal and marine activities (including dredging) be subject to a risk assessment for anthropogenic sound-related impacts on relevant protected marine mammal species to address any area-specific sensitivities, both in timing and spatial extent, and to inform the consenting process. Once the listed activity has been subject to a risk assessment, the regulator may decide to refuse consent, to grant consent with no requirement for mitigation, or to grant consent subject to specified mitigation measures.

4 | BASELINE ENVIRONMENT

4.1 | Ambient Noise Levels

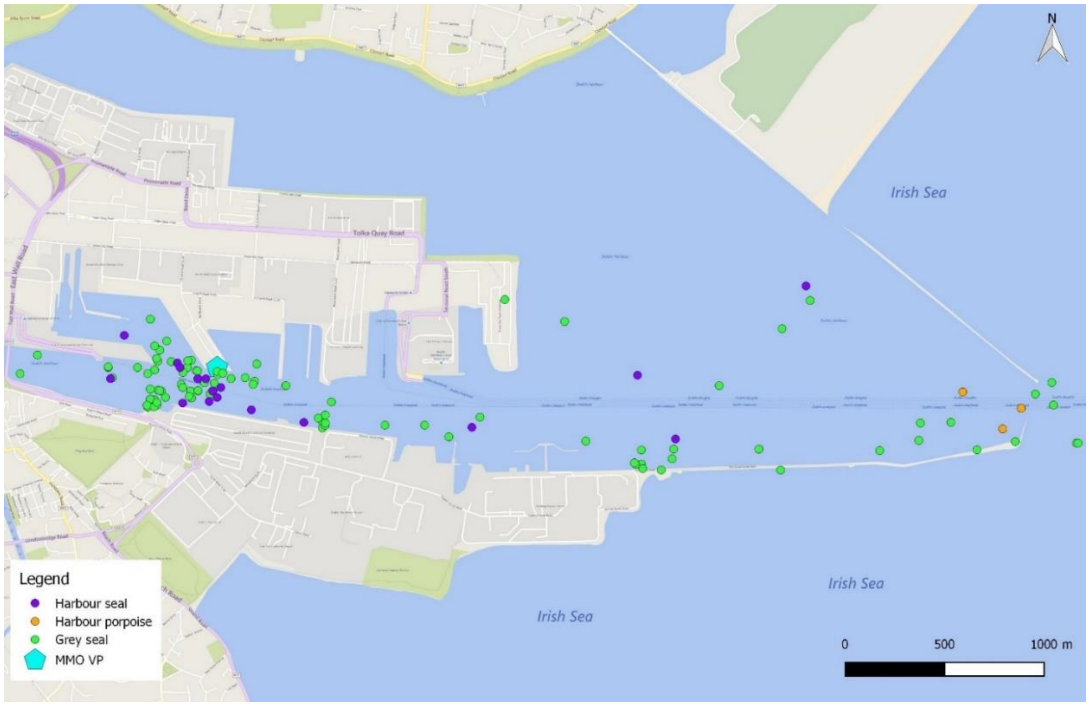
Ambient, or background noise, is defined as any sound other than the sound being monitored (primary sound) and, in the marine environment, is a combination of naturally occurring biologically and physical sound sources including sediment transfer, waves and rain and that of a biological origin including fish, crustaceans and from marine mammals. The impact of noise created by human activity is strongly influenced by background or ambient noise, the impact is less in a noisy environment compared to a quiet environment and it's the intensity and frequency of this increased noise compared to the ambient levels at a site, which defines its impact. As ambient noise levels increase, the ability to detect a biologically important sound decreases. The point at which a sound is no longer detectable over ambient noise is known as acoustic masking. The range at which an animal is able to detect these signals reduces with increasing levels of ambient noise (Richardson *et al.* 1995). This is important when considering the impact of sound sources on marine mammals by the proposed works.

Ambient noise levels worldwide have been on the rise in recent decades with developments in industry and, in particular, in commercial shipping. In the North Pacific, low frequency background noise has approximately doubled in each of the past four decades (Andrew *et al.* 2002), resulting in at least a 15- to 20-dB increase in ambient noise. In recent years, interest has grown in the effects of anthropogenic noise on marine life. Ambient noise in Dublin Bay has been estimated at around 113 db by Beck *et al.* (2013) and by McKeown (2014). This level is higher than that reported from Galway Bay and the Shannon Estuary and reflects the greater vessel traffic at this site.

4.2 | Marine Mammals

Marine mammal mitigation has been carried out as part of the ABR project since 2016 (Russell *et al.* 2017, 2018; 2019; 2020). This involves carrying our pre-watches by experienced marine mammal biologists prior to any sound producing activities which may impact on marine mammals. During these pre-watches all marine mammal sightings are recorded. These pre-watches have occurred throughout the year.

a)



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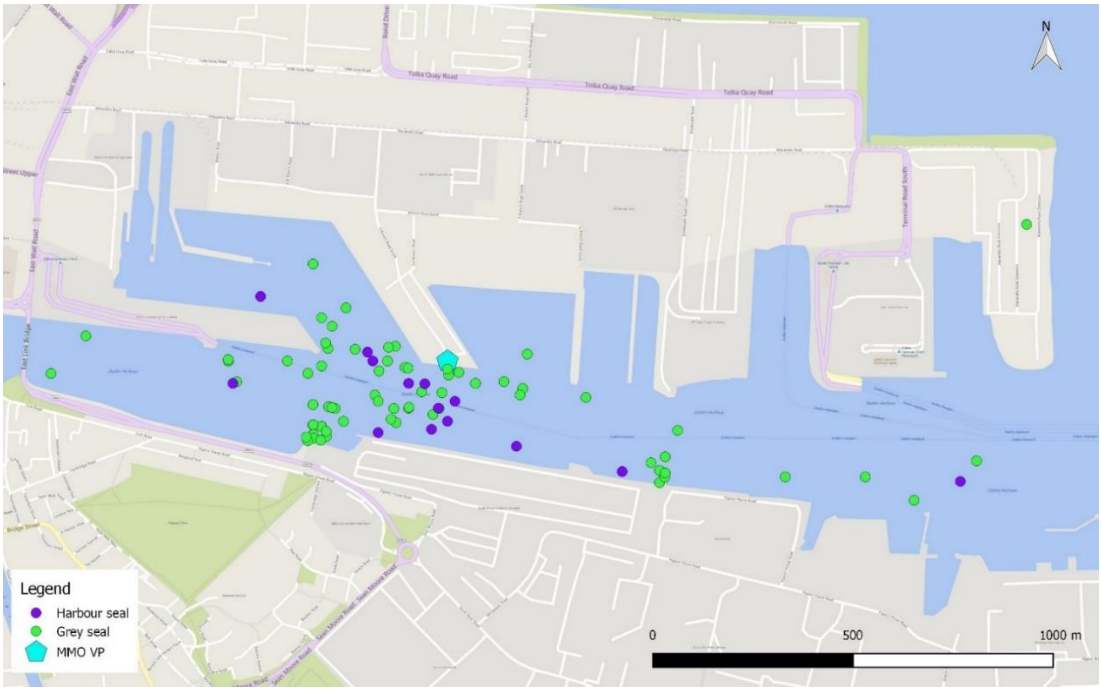

Figure 2: Sightings of marine mammals in the (a) outer basin and (b) inner basin from

Marine mammal sightings within Dublin Harbour are shown in Figure 2. Three species have been recorded. The only cetacean species was harbor porpoise and two species of seal; grey and common (harbour) seal. All three sightings of harbour porpoise were just inside the harbor entrance while seals were distributed through the harbor and especially in the inner basins (Fig. 2b).

Grey seals were more frequently observed than common seals and were the species recorded closest to the proposed bridge location. Grey seals have been observed with 50m of the proposed development (Fig 2b).

4.2.1. Harbour porpoise (*Phocoena phocoena*)

Harbour porpoise are the most widespread and abundant cetacean in inshore Irish waters, with highest abundances in the Irish Sea (Berrow *et al*. 2010). Harbour porpoise are the most frequently recorded cetacean species during Dublin Bay but are rarely seen within the harbour. O'Dwyer *et al.* (2016) reported three sightings within Dublin Harbour during maintenance dredging, but just inside the north and south walls.

4.2.2 Pinnipeds (Seals)

Grey seals (*Halichoerus grypus*) are regularly and frequently recorded within Dublin Harbour and up the River Liffey into Dublin city. They were the most frequently recorded marine mammal marine mammal monitoring within the harbor between 2016 and 2020 (Russell *et al.* 2018; 2019; 2020). Grey seals forage locally and it is likely seals encountered within the harbour are typically the same individuals with the harbour providing foraging opportunities as well as temporary haul out sites. They are known to haul out on Bull Island from May to November and pup at sites on Lambay Island, Ireland's Eye and Dalkey Island. Grey seals are still observed in the River Liffey during winter months during their breeding and moulting seasons.

Harbour (or Common) seals (*Phoca vitulina*) are observed less frequently recorded within Dublin Harbour (Russell *et al.* 2017; 2018; 2019; 2020). Harbour seals are known to haul out on Bull Island throughout the year and pup during the summer. Dublin Harbour may provide local foraging and it is likely seals encountered within the harbour are typically the same individuals with the harbour also providing temporary haul out sites.

4 | IMPACT ASSESSMENT

The potential effects of the proposed construction and especially piling on marine mammals was addressed by assessing the likelihood that marine mammals would be exposed, or interact, with the activity. Impacts assessed include likelihood of disturbance especially from noise emitted during piling operations. Acoustic disturbance includes the ability of the individual to detect increased noise levels over ambient levels, masking, Temporary Threshold Shift (TTS) and Permanent Threshold Shift (PTS) and behavioural impacts, i.e. resulting in a behavioural change by individuals. The potential effects of increased turbidity and indirect impacts on preferred prey are also considered.

5.1 | Description of Activities

5.1.1 Piling Operations

All foundations except the bridge approach retaining walls will be made up of in-situ reinforced concrete piles. Piles to the bridge will be bored, 800mm in diameter and socketed into bed rock. Piles for the reclaimed land will be bored, cast-in place, also 800mm in diameter and socketed into bedrock. The reclaimed land edges will be retained by permanent embedded sheet pile retaining walls. The sheet pile toes will be at bedrock level. All foundations and sheet pile toes will be deep. In-situ piles are reinforced concrete, grade to be chosen at detailed design. Permanent sheet piles are grade S275 or S355. Piles will be of Larssen type, size to be confirmed at the detailed design stage. Construction of both bored cast-in-place and drilled-in tubular steel piles is considered technically feasible at this site and could enable drilling into bedrock to achieve sufficient end bearing capacity.

Around 80-90 piles will be fitted in Stage 1 for land reclamation and around 40 for the bridge support.

5.1.2 Vessel noise

Construction of the transportation bridge may lead to an increase in vessel noise relative to the daily traffic accessing Dublin Port through provision of a jack up barge and safety boats. However the number and duration of noise making activities is very low and is unlikely to cause any significant disturbance as ferries, tankers, small recreational boats and other vessels regularly use the river and port area.

5.1.3. Impact of suspended material and contaminants

Seabed disturbance through can result in increased turbidity and creation of sediment plumes (Todd *et al.* 2014). Marine mammals often inhabit turbid environments and many utilize acoustic techniques to communicate and navigate. Disturbance to seals if it occurs will only be of very short duration and have no long-term effect.

5.1.5 Indirect impacts on prey

Indirect impacts may occur on marine mammals if the distribution or abundance of their preferred prey is impacted by piling and construction activities. The diet of seals in the River Liffey is not known but it is likely to be quite opportunistic including both benthic and pelagic or migratory fish species if available.

5.2 | Literature Review of Impacts and Mitigation

The NPWS '*Guidance to manage the risk to marine mammals from man-made sound sources in Irish waters – January 2014*' recommends that listed coastal and marine activities, undergo a risk assessment for anthropogenic sound-related impacts on relevant protected marine mammal species to address any area-specific sensitivities, both in timing and spatial extent, and to inform the consenting process. It is required that such an assessment must competently identify the risks according to the available evidence and consider (i) direct, (ii) indirect and (iii) cumulative effects of anthropogenic sound (NPWS, 2014).

Marine mammals and noise

Construction activity can have potential impacts on marine mammals through elevated noise levels leading to disturbance. Prolonged exposure to pile installation could lead to disturbance and TTS without mitigation measures. The main noise producing activities in the marine environment are

a) Pile installation activity and construction noise
b) Noise from additional vessels associated with the construction period

<u>Ambient Noise</u>

Ambient, or background noise, is defined as any sound other than the sound being monitored (primary sound) and, in the marine environment, is a combination of naturally occurring biologically and physical sound sources including sediment transfer, waves and rain and that of a biological origin including fish, crustaceans and from marine mammals. The impact of noise created by human activity is strongly influenced by background or ambient noise, the impact is less in a noisy environment compared to a quiet environment and it's the intensity and frequency of this increased noise compared to the ambient levels at a site, which defines its impact. As ambient noise levels increase, the ability to detect a biologically important sound decreases. The point at which a sound is no longer detectable over ambient noise is known as acoustic masking. The range at which an animal is able to

detect these signals reduces with increasing levels of ambient noise (Richardson *et al.* 1995). This is important when considering the impact of sound sources on marine mammals by the proposed works.

Ambient noise levels worldwide have been on the rise in recent decades with developments in industry and, in particular, in commercial shipping. In the North Pacific, low frequency background noise has approximately doubled in each of the past four decades (Andrew *et al.* 2002), resulting in at least a 15- to 20-dB increase in ambient noise. In recent years, interest has grown in the effects of anthropogenic noise on marine life. Ambient noise in Dublin Bay has been estimated at around 113 db by Beck *et al*. (2013) and by McKeown (2014). This level is higher than that reported from Galway Bay and the Shannon Estuary and reflects the greater vessel traffic at this site.

Marine mammals are often seen in close proximity to human activity and exhibit some tolerance to anthropogenic noise and other stimuli (Richardson *et al*. 1995). Baleen whales use shipping lanes and feed in rich fishing grounds occupied by large fishing vessels. Odontocetes are often even more tolerant, being repeatedly exposed to many vessels, small and large. Pinnipeds also exhibit much tolerance and often haul out on man-made structures where there is considerable human activity. This exposure may lead to some chronic exposure to man-made noise, with which they tolerate. Ecological or physiological requirements may leave some marine mammals with no choice but to remain in these areas and continue to become chronically exposed to the effects of noise. In areas with repeated exposure, mammals may become habituated with a decline in avoidance responses and thus become less sensitive to noise and disturbance (Richardson *et al*. 1995).

Pile Installation and Construction noise

Piling is proposed to take place in two phases. In phase 1 piling is in the area of reclaimed land and will continue for three months with 70-80 piles required at an estimated piling rate of 2 piles per day. A second phase of piling associated with the cofferdams with 40-50 piles in the river will commence thereafter. Thus piling will be fairly continuous at the development site for a period of 18 months. The main impact of piling is from sound generated and the transmission of this sound into the marine environment.

Impacts of piling on marine mammals

If a marine mammal's received sound exposures, irrespective of the anthropogenic source (pulse or nonpulse), exceed the relevant criterion, auditory injury (PTS) is assumed to be likely. Pile driving is classed as a multi-pulse source of impulsive sound. Its measured effects on marine mammals are largely based on work by Southall *et al.* (2007), who proposed a dual criterion based on peak sound pressure level (SPL) and sound exposure level (SEL), where the level that is exceeded first is what should be used as the working injury criterion (i.e. the precautionary of the two measures) (Table 1). The potential impacts on marine mammals from piling activity include Permanent Threshold Shift (PTS), Temporary Threshold Shift (TTS) and behavioural disturbance; each of which have varying degrees of severity for exposed individuals.

As all marine mammals do not hear equally across all frequencies, the use of frequency weightings is applied to compensate for differential frequency responses of their sensory systems (Tables 2 and 3). The M-weighting (for marine mammals) is similar to the C-weighting for measuring high amplitude sounds in humans. At present there are no data available to represent the onset of PTS in marine mammals but Southall *et al.* (2007) estimated it as 6 dB above the SPL (unweighted) and 15 dB above the SEL (M-weighted according to the relevant marine mammal functional group, see Figure 1) based on the onset of TTS. Therefore, Southall *et al.* (2007) proposed SPL criteria of 230 dB re 1 µPa (peak broadband level) for PTS onset in cetaceans and 218 dB re 1 µPa for pinnipeds. They also recommended TTS can occur at 224 dB re 1 µPa (peak broadband level) for cetaceans and 212 dB re 1 µPa for

pinnipeds (Southall *et al.* 2007; Bailey *et al.* 2010) (Table 2). While, the SEL criteria proposed by Southall et al. (2007) include TTS onset at 183 dB re 1 µPa^2 -s for cetaceans and 171 dB re 1 µPa2 -s for pinnipeds, and PTS onset is expected at 15 dB additional exposure (Bailey *et al.* 2010) (Table 3).

Table 1. Functional marine mammal hearing groups, and group specific (m) frequency weightings (from Southall et al. 2007)

Functional hearing group	Estimated auditory bandwidth	Genera represented (Number species/subspecies)	Frequency-weighting network
Low-frequency cetaceans	7 Hz to 22 kHz	*Balaena, Caperea, Eschrichtius, Megaptera, Balaenoptera* (13 species/subspecies)	M_{lf} (lf: low-frequency cetacean)
Mid-frequency cetaceans	150 Hz to 160 kHz	*Steno, Sousa, Sotalia, Tursiops, Stenella, Delphinus, Lagenodelphis, Lagenorhynchus, Lissodelphis, Grampus, Peponocephala, Feresa, Pseudorca, Orcinus, Globicephala, Orcaella, Physeter, Delphinapterus, Monodon, Ziphius, Berardius, Tasmacetus, Hyperoodon, Mesoplodon* (57 species/subspecies)	M_{mf} (mf: mid-frequency cetaceans)
High-frequency cetaceans	200 Hz to 180 kHz	*Phocoena, Neophocaena, Phocoenoides, Platanista, Inia, Kogia, Lipotes, Pontoporia, Cephalorhynchus* (20 species/subspecies)	M_{hf} (hf: high-frequency cetaceans)
Pinnipeds in water	75 Hz to 75 kHz	*Arctocephalus, Callorhinus, Zalophus, Eumetopias, Neophoca, Phocarctos, Otaria, Erignathus, Phoca, Pusa, Halichoerus, Histriophoca, Pagophilus, Cystophora, Monachus, Mirounga, Leptonychotes, Ommatophoca, Lobodon, Hydrurga,* and *Odobenus* (41 species/subspecies)	M_{pw} (pw: pinnipeds in water)
Pinnipeds in air	75 Hz to 30 kHz	Same species as pinnipeds in water (41 species/subspecies)	M_{pa} (pa: pinnipeds in air)

Table 2. Proposed injury criteria for individual marine mammals from Southall et al. (2007)

Marine mammal group	Sound type		
	Single pulses	Multiple pulses	Nonpulses
Low-frequency cetaceans	Cell 1	Cell 2	Cell 3
Sound pressure level	230 dB re: 1 µPa (peak) (flat)	230 dB re: 1 µPa (peak) (flat)	230 dB re: 1 µPa (peak) (flat)
Sound exposure level	198 dB re: 1 µPa^2-s (M_{lf})	198 dB re: 1 µPa^2-s (M_{lf})	215 dB re: 1 µPa^2-s (M_{lf})
Mid-frequency cetaceans	Cell 4	Cell 5	Cell 6
Sound pressure level	230 dB re: 1 µPa (peak) (flat)	230 dB re: 1 µPa (peak) (flat)	230 dB re: 1 µPa (peak) (flat)
Sound exposure level	198 dB re: 1 µPa^2-s (M_{mf})	198 dB re: 1 µPa^2-s (M_{mf})	215 dB re: 1 µPa^2-s (M_{mf})
High-frequency cetaceans	Cell 7	Cell 8	Cell 9
Sound pressure level	230 dB re: 1 µPa (peak) (flat)	230 dB re: 1 µPa (peak) (flat)	230 dB re: 1 µPa (peak) (flat)
Sound exposure level	198 dB re: 1 µPa^2-s (M_{hf})	198 dB re: 1 µPa^2-s (M_{hf})	215 dB re: 1 µPa^2-s (M_{hf})
Pinnipeds (in water)	Cell 10	Cell 11	Cell 12
Sound pressure level	218 dB re: 1 µPa (peak) (flat)	218 dB re: 1 µPa (peak) (flat)	218 dB re: 1 µPa (peak) (flat)
Sound exposure level	186 dB re: 1 µPa^2-s (M_{pw})	186 dB re: 1 µPa^2-s (M_{pw})	203 dB re: 1 µPa^2-s (M_{pw})
Pinnipeds (in air)	Cell 13	Cell 14	Cell 15
Sound pressure level	149 dB re: 20 µPa (peak) (flat)	149 dB re: 20 µPa (peak) (flat)	149 dB re: 20 µPa (peak) (flat)
Sound exposure level	144 dB re: (20 µPa)^2-s (M_{pa})	144 dB re: (20 µPa)^2-s (M_{pa})	144.5 dB re: (20 µPa)^2-s (M_{pa})

Table 3. Proposed behavioral response criteria for individual marine mammals exposed to various sound types

Marine mammal group	Sound type		
	Single pulses	Multiple pulses	Nonpulses
Low-frequency cetaceans	Cell 1	Cell 2[1]	Cell 3[b]
Sound pressure level	224 dB re: 1 µPa (peak) (flat)	Tables 6 & 7	Tables 14 & 15
Sound exposure level	183 dB re: 1 µPa²-s (M_{lf})	Not applicable	Not applicable
Mid-frequency cetaceans	Cell 4	Cell 5[c]	Cell 6[f]
Sound pressure level	224 dB re: 1 µPa (peak) (flat)	Tables 8 & 9	Tables 16 & 17
Sound exposure level	183 dB re: 1 µPa²-s (M_{mf})	Not applicable	Not applicable
High-frequency cetaceans	Cell 7	Cell 8[g]	Cell 9[h]
Sound pressure level	224 dB re: 1 µPa (peak) (flat)	[Tables 18 & 19]	Tables 18 & 19
Sound exposure level	183 dB re: 1 µPa²-s (M_{hf})	Not applicable	Not applicable
Pinnipeds (in water)	Cell 10	Cell 11[e]	Cell 12[g]
Sound pressure level	212 dB re: 1 µPa (peak) (flat)	Tables 10 & 11	Tables 20 & 21
Sound exposure level	171 dB re: 1 µPa²-s (M_{pw})	Not applicable	Not applicable
Pinnipeds (in air)	Cell 13	Cell 14[g]	Cell 15[gg]
Sound pressure level	109 dB re: 20 µPa (peak) (flat)	Tables 12 & 13	Tables 22 & 23
Sound exposure level	100 dB re: (20 µPa)²-s (M_{pw})	Not applicable	Not applicable

Bailey *et al.* (2010) found that based on the broadband peak to peak sound level during piling for offshore windfarms, PTS onset would have occurred within 5m of the pile-driving operation for cetaceans and within 20m for pinnipeds. The level for TTS onset would have been exceeded within 10m and 40m of the pile-driving for cetaceans and pinnipeds respectively. They found that the closest measurement of the pile-driving noise recorded at 100m, had an M-weighted SEL of 166 dB re 1 µPa2 –s which was less than the PTS and TTS SEL criteria for cetaceans and pinnipeds. They suggest that this indicated that no form of injury or hearing impairment should have occurred at ranges greater than 100m from the pile-driving operation. The piles to be used in the proposed development are much smaller than those in this study and sound exposure levels will be less.

Based on work by Southall *et al.* (2007), it is possible that harbour porpoise can experience behavioural disturbance up to 70km from the pile-driving, while Bailey *et al.* (2010) presented results which indicated that strong avoidance behaviour would only be expected within 20km of the sound source. They also suggested that bottlenose dolphins and minke whales may exhibit behavioural disturbance within 50km and 40km from the source respectively (Bailey *et al.* 2010). Regarding pinnipeds, this zone is smaller, estimated within 14km of the source. Based on this literature piling has the potential to impact on common and grey seals and harbour porpoise within Dublin Harbour. Due to the nature of the harbor with the North and South Walls at the entrance, sound generated during piling is very unlikely to travel outside the harbor walls.

McKeown (2014) carried out measurements of underwater noise from pile driving activities at Alexandra Basin East in June 2014 to determine the ensonification of the underwater environment (i.e. acoustic noise) during pile driving in the Alexandra Basin East. The measurements on which this report is based took place while H-section piles with a cross sectional area of 333 cm^2 were being driven to depths of 35m in Alexandra Basin East (ABE). Noise measurements were made at four stations (A-D) in Alexandra Basin East: along a transect (Transect 1) from the piling location in the ABE, across the channel to the opposite pier (Figure 3). Measurements were also made at three stations (D-H) in the River Liffey Channel: along a transect (Transect 2) starting upriver from the source and continuing parallel to the channel, to Location H, 3.5 km from the source (Figure 3).

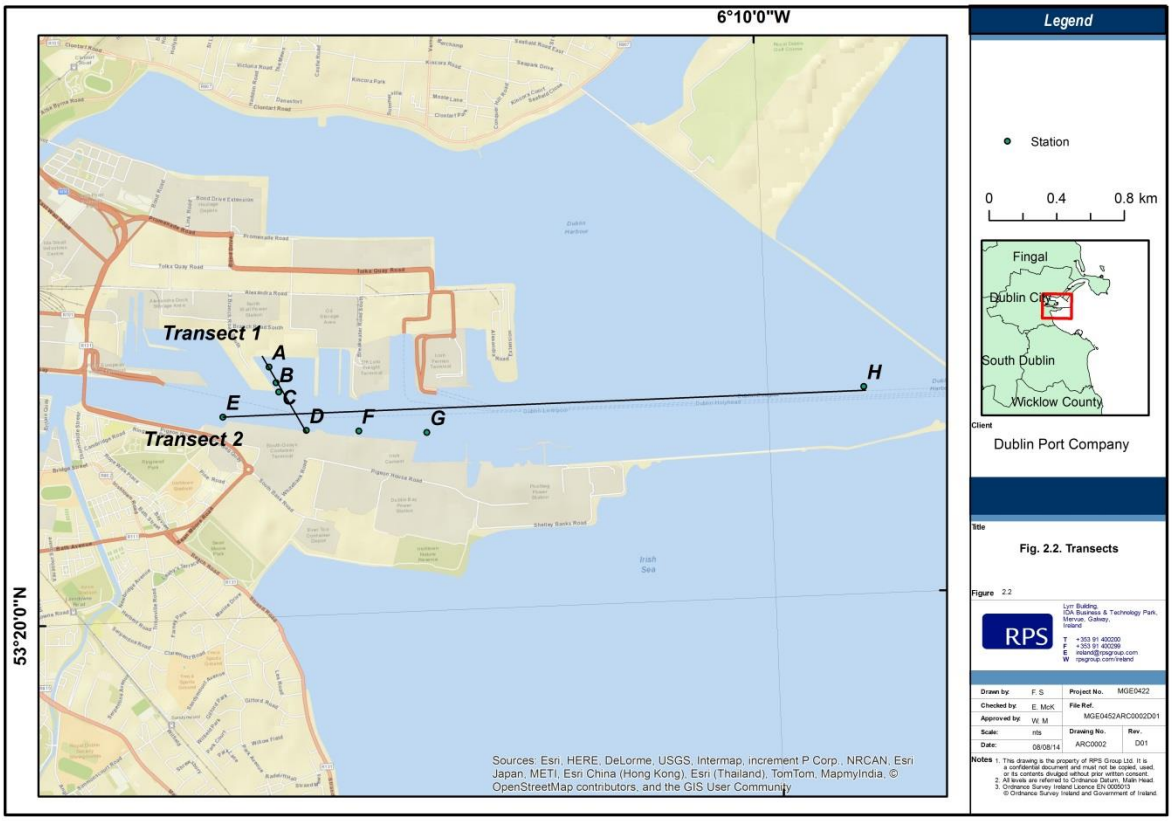

Figure 3. Location of noise measurements taken during piling (McKeown 2014)

The SCOOTER code was based on open water propagation, with losses spreading in all directions (McKeown 2014). The Alexandra Basin and Dublin Port navigation channel operates as a confined environment with significant reverberation within the basin and the channel. The surfaces within this area are comprised of hard quay walls which act as near perfect reflectors. The model will therefore overestimate the transmission loss close to the source due to the reverberation. In the river and navigation channel the transmission losses revert to modelled rates albeit with an over-estimate of initial values (McKeown 2014).

The measured values at Location C and D across the river channel and Locations E and F a short distance up and down river from the Alexandra Basin. At Locations C and D the SPL averages 140 dB whereas at Location E (500m upriver) the SPL was 108 dB which was at background levels. The SEL at this location is 156 dB. At Location F (300m downriver) the SPL was 127 dB and the SEL was 173 dB.

Within 500m of the source the intensity decreased rapidly at increasing range. Close to source the sound was highly broadband. Peak sound energy occurred at below 1000Hz but there was substantial energy up to 10 kHz. High frequencies were rapidly attenuated with distance and beyond 500m the majority of the impulsive pile driving sound was attenuated. This study suggests that noise from piling reduces to background levels somewhere between 300 and 500m from the source in Alexandra Basin. Noise levels arising from 1.6m diameter piles being driven in the Alexandra Basin in the River Liffey channel and the Alexandra Basin area will be higher by approximately 6 dB. The levels in this area are significantly increased due to the reverberation within the confined space. At distances beyond this the noise level attenuates rapidly so that at 500m the levels are at background noise levels (McKeown 2014).

5.2.2 Turbidity

Sedimentation and any increases in turbidity are unlikely to affect marine mammals, which use echolocation. Marine mammals often inhabit turbid environments, and many utilise sophisticated sonar systems to sense the environment around them (Au *et al.* 2000). Pinnipeds do not produce sonar for prey detection purposes, however Newby *et al.* (1970) reported apparent blindness in three harbour seals on Gertrude Island, Puget Sound, Washington and found them to appear healthy suggesting their ability to forage was unaffected by blindness. McConnell *et al.* (1999) tracked grey seals in the North Sea and included one blind seal in their study. No significant difference in foraging behaviour was found indicating vision is not essential to pinnipeds' survival or ability to forage.

5.2.3 Preferred prey

A fish survey of the inner basin was carried out as part of the ABR project (Morgan 2014). The inner basin sites were notable for such species as solitary sea squirts (Ascidians) and comparatively low fish diversity densities. Several benthic species are resident in this part of the river basin including juvenile mullet at Ringsend. Seasonally species such as salmon, trout and lamprey and eels pass through the site when transiting the river. A trawl survey indicated a low diversity of widely occurring fish species occurred (Morgan 2014). The surface layer contained all the associated macroinvertebrate infauna which most of the more abundant species taken in trawls namely dab, plaice and sand gobies feed on. Small shoaling fish that occur regularly in the diet of seals and porpoises (Rogan 2008) and are unlikely to be affected during operations.

4.3 Risk Assessment

The potential impacts of this project are prolonged elevated noise levels associated with piling. The piling element is likely to take 18 months to complete while additional vessel traffic could occur throughout the construction period but is very unlikely to have any potential impacts.

4.3.1 Acoustic disturbance

Noise associated with piling

The potential for disturbance to marine mammals is greatest when elevated levels of underwater noise are considered. Marine mammals, especially cetaceans, have well developed acoustic capabilities and are sensitive to sound at much higher frequencies than humans (Richardson *et al.* 1995). They are less sensitive to the lower frequencies but there is still great uncertainty over the effects of sound pressure levels on marine mammals and thus the assessment of its impact.

Pile driving emits a low-frequency impulsive sound with peak energy between 100 and 200 Hz (OSPAR 2009). Source levels from pile driving activity depends on many factors and levels as high as 243–257 dB (P-P) re 1 µPa at 1 m (Nedwell *et al.* 2004) have been reported. Source levels are dependent on a number of factors including the diameter of the pile. Smaller piles tend to have higher frequency noise emissions.

Audiograms for bottlenose dolphins show peak sensitivity between 50-60 kHz and no sensitivity below 2 kHz and above around 130 Khz (Richardson *et al.* 1995). Because of rapid attenuation of low frequencies in shallow water dredge noise normally is undetectable underwater at ranges beyond 20-25km (Richardson *et al.* 1995). The effects of low frequency (4-8 kHz) noise level and duration in causing threshold shifts in bottlenose dolphins were

predicted by Mooney *et al.* (2009). They found that if the Sound Exposure Level was kept constant significant shifts were induced by longer duration exposures but not for shorter exposures.

NPWS (2014) identify increased sound pressure levels above ambient do occur due to piling which could be detected up to 10km from shore. These levels could potentially cause TTS if marine mammals are within 10-20m during full sound production and masking or behavioural effects at greater distances but are not thought to cause injury to a marine mammal.

5.3.2 Noise associated with shipping

Shipping produces low broadband and "tonal" narrowband sounds. The primary sources are propeller cavitation and singing and propulsion of other machinery (Richardson *et al.* 1995). For large and medium vessels tones dominate up to around 50Hz and broadband components may extend to 100Hz.

Many odontocetes show considerable tolerance to vessel traffic. Harbour porpoise are frequently observed near vessels but tend to change behaviour and move away and this avoidance may occur up to 1-1.5km from a ship but is stronger with 400m (cited from Richardson *et al.* 1995). Seals show considerable tolerance to vessel activity but this does not exclude the possibility that it has an effect.

5.3.5 Physical Disturbance

The risk of injury or mortality is considered extremely low as marine mammals in Dublin Harbour are exposed to considerable vessel traffic on a daily basis and would be aware of their presence.

5.3.6 Turbidity

Short term increase in turbidity caused during the construction period at worse may have a very local impact of short duration and will have no impact on marine mammals or their preferred prey. Even when increased turbidity has been shown to substantially reduce visual acuity in seals, which are not known to use sonar for prey detection, there is no evidence of reduced foraging efficiency (*Todd et al.* 2015).

5.3.7 Indirect impacts on preferred prey

No adverse effects on fish species is expected from proposed operations.

5.3.8 Potential disturbance to life-cycle

The construction of the proposed transportation bridge across the Dodder will not cause any adverse effects on cetaceans or seals in the area providing mitigation measures are in place. Any displacement resulting from indirect impacts on available prey will be short-term and local, with fish returning to the area at the completion of piling activity.

5.3.10. Cumulative Effects

There is potential for cumulative effects as there is other piling activity within the inner harbour. The proposed construction will take 18 months to complete and the earliest start is late in 2021 or more likely mid-2022. Piling and demolition at Dublin port is underway or planned. These include:

- Piling associated with the ABR Project
    - Piling Berth 34 and 35: September – November 2020
- Dredging associated with the ABR Project
    - Dredging in Alexandra Basin West: November 2019 – February 2021
    - Maintenance Dredging: April August – September 2022
    - Capital Dredging: October 2021- March 2022
- Demolition of Ramp 3 at Dublin Port
    - 2021-2022

Depending on the actual timing of the proposed bridge at the River Dodder, piling for ABR should be finished but dredging campaigns will still be underway. There are no cumulative impacts between pressures associated with dredging and piling but it is recommended that piling for other adjacent projects has been completed prior to piling starting on this project.

6 | Mitigation Measures

Potential mitigation measures during the piling operation are limited. Similar activities both nationally and internationally have been monitored through the provision of a Marine Mammal Observer (MMO) who ensures that there are no marine mammals within a pre-agreed distance prior to piling during daylight hours. The MMO can also record any reaction to the piling operation. However, this mitigation measure will only be effective during daylight hours.

Figure 4. Proposed Mitigation Zone (1000m) as recommended by NPWS (2014)

The National Parks and Wildlife Service recommend a distance of 1000m radial distance of the piling sound source in water depths of <200m (NPWS 2014) on commencement. Noise measurements by McKeown (2014) suggests an exclusion zone of 1000m is sufficient, beyond which marine mammals are unlikely to detect the activity over ambient noise. If a significant negative change in behaviour are recorded such as rapid movement away from vessel or distress then the MMO should have the authority to cease operations. Marine mammals are allowed to enter the buffer zone once piling has reached maximum sound output.

It is expected that animals would habituate to additional vessels and would not be displaced. Any disturbance due to piling will be short-term and temporary and seals would return to affected areas when operations area completed.

6.1 Disturbance

The most effective way of mitigating the potential effects of disturbance is through the provision of an MMO ensuring no marine mammals are present within an agreed Mitigation Zone.

6.2 Collision, injury and mortality

The most effective way of mitigating the potential effects of injury and/or mortality is through the provision of an MMO ensuring no marine mammals are present within an agreed Mitigation Zone.

6.3 Disruption of normal behaviour

Piling activity is local to the inner basin and of relatively short duration resulting in any displacement being short term. Monthly seal counts at a haul out site on Bull Island are underway by Dublin port as part of the ABR project. This will continue throughout the proposed construction period. Sound exposure levels from piling are below to cause TTS to a marine mammal and the potential to cause low level disturbance, masking or behavioural impacts. With mitigation it is very unlikely to have a significant impact on marine mammals, though it may lead to short term displacement of seals from the dump site.

7 | NPWS Assessment Criteria

1. **Do individuals or populations of marine mammal species occur within the proposed area?**

   Grey seals are the most frequently observed marine mammal species at the construction site followed by common seals. Harbour porpoise are only found in the outer basin at the entrance to Dublin Harbour. There is an important haul out site for grey and harbor seals nearby on Bull Island. All marine mammals are part of a larger population and are very mobile.

2. **Is the plan or project likely to result in death, injury or disturbance of individuals?**

   The project will not cause injury or death but could lead to very local disturbance of seals, from noise associated with the project.

Noise Impact

The activities proposed during this project, which could lead to negative impacts, consist of piling operations. It is extremely unlikely any noise generated will be capable of causing permanent or temporary hearing injury to a marine mammal. Localised disturbance to marine mammals in the works area may occur during operations.

Physical Impact

The risk of injury or mortality is considered extremely low as marine mammals in the immediate vicinity of the construction site (seals) are exposed to human activity on a daily basis and would be accommodated.

3. Is it possible to estimate the number of individuals of each species that are likely to be affected?

Abundance estimates for marine mammals exposed to the proposed activity are limited to only the occasional seal within 100m and low numbers within Dublin Harbour. Monitoring during the ABR Project suggest some 10's of seals may occur within Dublin Port. Abundance estimates are available for grey and harbour seals from a haul out site at Bull Island immediately north of the harbour. The numbers of grey seals ranged from 2-19 between May and November and harbour seals from 2-22 and occur throughout the year (Russell *et al.* 2017; 2018; 2019; 2020). Monitoring of Bull Island haul out site consistent records peak counts of 20-25 grey seal and a similar number of harbour seals but peaking at different times of year (Russell *et al.* 2017; 2018; 2019; 2020).

Abundance of grey seals at nearby Lambay Island was estimated at 49 pups, with small numbers of pup's present (<3) at Irelands Eye, Dalkey Island and St. Patricks Island during a national census in 2005 (Ó Cadhla *et al.* 2007). A further Island. Further surveys 77 pups were recorded on Lambay Island and Ireland's Eye in 2009 (Ó Cadhla *et al.* 2013). Abundance of harbour seals during at nearby Lambay Island, was estimated at approximately 30 during a national census in 2003 (Cronin *et al.* 2004) and 2012 (Duck and Morris, 2012).

4. Will individuals be disturbed at a sensitive location or sensitive time during their life cycle?

The proposed works that could impact on marine mammals are to be carried out for an 18 month period. This includes both grey and common seal pupping and breeding seasons. As grey seals are only known to pup at Lambay Island which is >15km from Dublin Harbour it is unlikely to have any effect as grey seal pups remain ashore for the first 3 weeks of life. Adults rearing calves may forage great distances from the breeding site and may include Dublin Harbour. Harbour seals are also only known to pup at Lambay Island and occasionally on Bull Island. It is unlikely that construction work will have any effect as harbour seal pups remain close to shore and females forage close to pupping sites during this period.

5. Are the impacts likely to focus on a particular section of the species' population, e.g., adults vs. juveniles, males vs. females?

There are no data to suggest that any particular gender or age group for seals or cetaceans predominates in the area. As temporary haul out sites for seals occur in Dublin Harbour it is likely all age groups and both gender occur.

6. **Will the plan or project cause displacement from key functional areas, e.g., for breeding, foraging, resting or migration?**

As seals occasionally occur at the construction site and may be exposed to noise associated with piling, there may be temporary disturbance to some individuals. However, they are accommodated to human activities and are likely to not be affected.

7. **How quickly is the affected population likely to recover once the plan or project has ceased?**

While there may be temporary disturbance of some seals in the area, they are accommodated to human activities and are likely to recover from any temporary disturbance within hours or days.

8| Mitigation

Timing of Piling

Both grey seals and harbour porpoise can potentially be affected by proposed piling operations and are listed on Annex II of the EU Habitats Directive. Piling at worse may lead to TTS if close to the site at start up and temporary disturbance. To minimise any disturbance effects on seals and harbour porpoise we recommend adoption of the NPWS Guidelines for minimising impacts of man –made sounds in Irish waters.

Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters

The mitigation measures recommended by the NPWS are for the presence of a trained and experienced Marine Observer (MMO) and the use of "ramp up" procedures for noise and vibration emitting operations. The proposed mitigation measures (Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters) recommended by the Department of Arts, Heritage and the Gaeltacht in 2014 are designed to mitigate any possible effects.

The following mitigation measures are proposed to minimise the potential impacts on marine mammals and to allow animals move away from the area of piling operations:

1. A qualified and experienced marine mammal observer (MMO) shall be appointed to monitor for marine mammals and to log all relevant events using standardised data forms.

2. Unless information specific to the location and/or plan/project is otherwise available to inform the mitigation process (e.g., specific sound propagation and/or attenuation data) and a distance modification has been agreed with the Regulatory Authority, pile driving activity shall not commence if marine mammals are detected within a **1,000m radial distance of the pile driving sound source**, i.e., within the Monitored Zone.

3. **Pile driving activities shall only commence in daylight hours where effective visual monitoring, as performed and determined by the MMO, has been achieved**. Where effective visual monitoring, as

determined by the MMO, is not possible the sound-producing activities shall be postponed until effective visual monitoring is possible.

4. An agreed and clear on-site communication signal must be used between the MMO and the Works Superintendent as to whether the relevant activity may or may not proceed, or resume following a break. It shall only proceed on positive confirmation with the MMO.

5. In waters up to 200m deep, the MMO shall conduct **pre-start-up constant effort monitoring at least 30 minutes before the sound-producing activity is due to commence**. Sound-producing activity shall not commence until at least 30 minutes have elapsed with no marine mammals detected within the Monitored Zone by the MMO.

6. This prescribed Pre-Start Monitoring shall subsequently be followed by an appropriate Ramp-Up Procedure which should include continued monitoring by the MMO.

7. In commencing a pile driving operation where the output peak sound pressure level (in water) from any source including equipment testing exceeds 170 dB re: 1µPa @1m an appropriate Ramp-up Procedure (i.e., "soft-start") must be used. The procedure for use should be informed by the risk assessment undertaken giving due consideration to the pile specification, the driving mechanism, the receiving substrate, the duration of the activity, the receiving environment and species therein, and other information.

8. Where it is possible according to the operational parameters of the equipment and materials concerned, the underwater acoustic energy output shall commence from a lower energy start-up (i.e., a peak sound pressure level not exceeding 170 dB re: 1µPa @1m) and thereafter be allowed to gradually build up to the necessary maximum output over a period of 20-40 minutes.

9. This controlled build-up of acoustic energy output shall occur in consistent stages to provide a steady and gradual increase over the ramp-up period.

10. Where the measures outlined in steps 8 and 9 are not possible, alternatives must be examined whereby the underwater output of acoustic energy is introduced in a consistent, sequential and gradual manner over a period of 20-40 minutes prior to commencement of the full necessary output.

11. In all cases where a Ramp-Up Procedure is employed the delay between the end of ramp-up and the necessary full output must be minimised to prevent unnecessary high-level sound introduction into the environment.

12. Once an appropriate and effective Ramp-Up Procedure commences, there is no requirement to halt or discontinue the procedure at night-time, nor if weather or visibility conditions deteriorate nor if marine mammals occur within a 1,000m radial distance of the sound source, i.e., within the Monitored Zone.

13. **If there is a break in pile driving sound output for a period greater than 30 minutes** (e.g., due to equipment failure, shut-down or location change) then all Pre-Start Monitoring and a subsequent Ramp-up Procedure (where appropriate following Pre-Start Monitoring) must be undertaken.

14. For higher output pile driving operations which have the potential to produce injurious levels of underwater sound as informed by the associated risk assessment, there is likely to be a regulatory requirement to adopt a shorter 5-10 minute break limit after which period all Pre-Start Monitoring and a subsequent Ramp-up Procedure (where appropriate following Pre-Start Monitoring) shall recommence as for start-up.

8.1| Residual Impacts

With implementation of the above mitigation measures, it is very unlikely that there will be negative residual impacts from the proposed works on marine mammals in the area. It is also very unlikely that any animals will be injured as a result of the proposed works. Seals using the area are likely to be tolerant of vessel noise and any displaced animals can be expected to quickly re-establish use of the area following cessation of the works.

9 | SUMMARY

Dublin Harbour is frequently used by marine mammals in small numbers, especially grey and common/harbour seals with harbour porpoise very occasionally observed just within the harbour entrance. Adjacent to the site only single seals have been recorded. As seals are protected and could be impacted on by piling activities we recommend the NPWS (2014) Guidelines are implemented to minimise the acoustic impacts which will result in no significant impacts to marine mammals.

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