

Chapter 20 Ordnance

20.1 Introduction

- 1 The term ordnance refers to military material such as weapons, ammunition, and equipment. Unexploded ordnance (UXO) represents weapons (including bombs and mines) that were deployed but did not activate. This poses a risk to all offshore engineering work due to the threat of an explosion when ordnance is disturbed and is a safety issue. In addition to this, the discovery of a suspected device during ongoing works can cause considerable delays in the project schedule and additional expense.
- 2 Several potential sources of explosive ordnance have been identified in the Outer Firth of Forth including: historic and modern army and naval firing ranges, British and German sea mines, unexploded air delivered bombs and anti-aircraft artillery projectiles. There are also two munitions dumping grounds within 12 km of the offshore site.
- 3 The objective of this chapter in the Environmental Statement (ES) is to define a baseline for unexploded ordnance known to have been historically deployed, used and discarded in the Outer Firth of Forth. This receptor is different to most covered in this ES as the issues are more related to the impact the UXO may have on the proposed development rather than the changes due to the development impacting the receptor. Consequently, this chapter provides a baseline description that is then followed by a risk assessment rather than a traditional impact assessment.

20.2 Guidance and Legislation

- 4 No specific legislation exists for the management and control of UXO risk in the UK construction industry. However, the issues regarding health and safety that arise from any ordnance risk associated with construction work is addressed under several regulatory instruments, such as the Health and Safety at Work etc. Act 1974 and the Construction (Design and Management) Regulations 2007. Other relevant legislation includes the Management of Health and Safety at Work Regulations 1999.
- 5 These legal instruments require risk assessments to derive control measures that are consistent with the as low as reasonably practicable (ALARP) principle and ensure that method statements and other provisions reflect these decisions.

20.2.1 The Health and Safety at Work Act 1974

- 6 The Act places a duty of care on an employer to put in place safe systems of work to address, as far as is reasonably practicable, all risks (to employees and the general public) that are reasonably foreseeable. As such, there is a shared responsibility from both the developer and contractor to ensure the UXO risk is properly assessed and mitigation used where appropriate. Non-conformities with health and safety legislation can lead to action such as warnings, fines, or imprisonment depending on the seriousness of the non-conformity.

20.2.2 Construction (Design and Management) Regulations 2007

- 7 This legislation defines the responsibilities of all parties including the client, the designers, the Construction Design and Management (CDM) Co-ordinator, the principal contractor and the other contractors involved with works.

- 8 Although UXO issues are not specifically addressed, the regulations effectively place obligations on all these parties to:

- Ensure that any potential UXO risk is properly assessed;
- Put in place appropriate risk mitigation measures if necessary;
- Keep all parties affected by the risk fully informed; and
- Prepare a suitably robust emergency response plan.

20.2.3 Guidelines for Onshore and Offshore Wind Farms: Health and Safety in the Wind Energy Sector

- 9 The guidelines published in 2010 by RenewableUK provides advice for the wind energy sector (RenewableUK, 2010). For site development and planning UXO should be considered as part of the process of designing a wind farm layout. At this stage developers should fulfil their statutory role as Clients under the Construction (Design and Management) Regulations 2007.

20.2.4 Role of the Authorities

- 10 In the event of ordnance being brought either ashore or to a port, the police have the responsibility of co-ordinating the emergency service response. If an item of UXO is discovered at sea within UK waters the find must be reported to the Maritime and Coastguard Agency (MCA). If the police or the MCA judge it necessary, they will impose a cordon/evacuation and call the military authorities (JSEODOC – Joint Services Explosive Ordnance Disposal Operation Centre).
- 11 The JSEODOC will assign a priority based upon the on-site risk assessment and respond accordingly. In high profile cases this will include the disposal of the ordnance threat. However, if the construction site has regular incidences of ordnance finds the JSEODOC may not treat each individual occurrence as an emergency and will encourage the construction company to put in place alternative procedures such as the appointment of a specialist contractor. In addition to pre-construction site surveys and clearances, a specialist contractor is able to provide a reactive service on construction sites. If high risk ordnance is discovered, actions will be co-ordinated with the authorities with the objective of causing the minimum possible disruption to site operations whilst putting immediate, safe and appropriate measures in place.

20.3 Data Sources

- 12 A desk study and report for an Explosive Ordnance Threat Assessment (Appendix 20.1: Unexploded Ordnance Report; Bactec, 2011) has been carried out, this included the access of military records and archived material held in the public domain and by the Ministry of Defence (MOD). Information from the study has been used to inform this chapter.
- 13 Additionally material from the following sources was used to inform this chapter:
 - The National Archives, Kew;
 - United Kingdom Hydrographic Office (UKHO), Taunton;
 - Bactec's archives; and
 - Open sources such as published books, local historical records and the internet.

14 The accuracy and comprehensiveness of wartime records can be uncertain. Therefore, statements as to the exact location, quantity and nature of ordnance threat are not definitive and can only be based upon the accumulation of all currently accessible information. The conclusions of the Bactec Explosive Ordnance Threat Assessment report are presented in Appendix 20.1: Unexploded Ordnance Report.

20.4 Methodology

20.4.1 Survey Methodology

15 Desk based research was undertaken to determine the likely risk of UXO within the offshore works area (refer to Appendix 20.1: Unexploded Ordnance Report). No field surveys have been carried out to characterise UXO specifically. Detailed site investigations prior to construction may be necessary to augment this desk study and to produce an accurate picture of the seabed and sub-seabed conditions.

20.4.2 Impact Assessment Methodology

16 No impact assessment has been undertaken. Indicative baseline conclusions are presented to provide an understanding of the likely level of risk, although these are very subjective. Further detailed site investigations and/or assessments will be necessary prior to commencing construction. These field surveys will be discussed and consented separately to this ES.

20.5 Baseline Description

17 The possibility of UXO being present within the offshore works area arises from a number of sources including military action during the First and Second World Wars, live firing ranges and UK military munitions dumps.

18 German submarines operated in the North Sea in the First World War (WWI) and were present in the Outer Firth of Forth. In addition to this, wartime led to a greater presence of UK naval vessels. As a result of accidents during naval exercises in the area during WWI, there are two recognised naval wrecks within the Neart na Gaoithe site (refer to Chapter 19: Maritime Archaeology and Cultural Heritage).

19 Along the east coast, mines were used defensively by the British, and offensively by the Germans. Merchant and fishing vessels were also bombed and machine gunned from the air.

20 Coastal areas to the west of the Neart na Gaoithe site were bombed, including Granton Harbour, Edinburgh Gas Works and the Royal Navy Base at Rosyth. Whilst these areas are within the Forth, the returning Luftwaffe aircraft may potentially have passed over the offshore site, discarding unused bombs as they flew overhead.

20.5.1 Naval Mining of the North Sea

21 A naval mine is a self-contained explosive device placed in water to destroy ships and/or submarines. Like land mines, they are weapons laid and left until they are triggered by the approach of an enemy. Naval mines can be used offensively, to restrict enemy shipping by making navigation in and out of their own harbours more dangerous. Naval mines can also be used to defend friendly shipping and for the creation of 'safe' shipping lanes fenced by mines, the location of which are known only to friendly vessels.

22 During the Second World War (WWII), the Royal Navy laid extensive minefields along most of the north eastern coastline of the British Isles as a defence against German warships and U-boats. Such minefields include a broad British declared area named 'Rosyth' located 5 km to the east of the offshore site (see Figure 20.1). British declared areas are locations known to have been mined during WWII and therefore pose a risk from related UXO. The Rosyth area is part of the larger East Coast Mine Barrage put in place to protect the UK from attack via the North Sea. The East Coast Mine Barrage as a whole extended from Kinnairds Head, Scotland, almost to the mouth of the River Thames and is documented as the most extensive field ever laid, with between 25,000 and 100,000 mines estimated to have been deployed.

23 In response to the defensive mines laid by the British, the German Luftwaffe attempted to close the Firth of Forth to shipping by dropping acoustic and magnetic mines by parachute.

20.5.2 Types of Commonly Used Naval Mines

24 There are three classes of mine; ground, moored, and drifting. Detonation is achieved in one of two ways; through impact, or through influence. Impact detonation is achieved through direct contact between the mine and the target object while influence mines are triggered by some form of external non-contact influence such as magnetic, sound or pressure waves or, less commonly, through the use of timed fuses. Control mines are activated remotely either by electric wire or radio and there are some reports of these being used in the Forth estuary (East Lothian War, 2011).

25 Ground mines are influence mines which were laid on the sea-floor and were activated by the magnetic signature or sound or pressure waves produced as a moving vessel passed within range. Moored mines are tethered either to the seabed or a weighted line and float on or near the sea surface. Predominantly these mines were activated by direct contact (impact) but some more sophisticated moored mines used sensory technologies similar to ground mines. Drifting mines are allowed to drift with the current and are typically deployed offensively in harbours, rivers or estuaries; drift mines are generally detonated through direct contact (Beale, 2011 pers.comm.).

20.5.3 U-Boats

26 Unterseeboot or U-boats were German military submarines widely used in WWI and WWII. The main role of the U-boat was in anti-shipping operations including the laying of sea mines. U-boats are known to have operated extensively in the North Sea and in particular the Firth of Forth area throughout both World Wars. Unfortunately, due to the covert nature of German mine laying operations, no records exist of specific locations for these mines.

27 The British defensive mining had some success in the region of the Neart na Gaoithe Offshore Wind Farm with three reported losses of German U-boats and a further two reported missing. Despite this there are no known German U-boat wrecks in the region.

20.5.4 British Defensive Mines

28 Reference to historical WWII chart data held by the UKHO Research Section - presented in Figure 20.1 - does not highlight any specific British or German minefields in the vicinity of the offshore site. However, an extensive British declared area lies approximately 5 km to the east, which is part of the East Coast Mine Barrage. It is likely that the boundary shown is only broadly indicative of the area in which mines were laid. In addition to the East Coast Mine Barrage, secondary sources detail 'considerable mine laying', 'suspected mine laying' and 'extensive mine laying' in the Firth of Forth estuary between August and November 1940 (Ramsey, 1987; 1988; 1990).

20.5.5 Post War Mine Clearing Operations

29 Several 'search channels' are depicted in Figure 20.1, a minefield map, showing the mine clearance activities by the Royal Navy in the vicinity of the offshore site. The chart shows that the centre of one of these cleared lines passes close to the northwestern extent of the offshore site in a northeast to southwest alignment. It is not clear however, whether this sweep includes an area within the offshore site as the width of the sweep from the centreline is not stated.

30 Known mine barrages were swept at the end of both World Wars, although it cannot be guaranteed that all of the mines in a barrage were successfully removed. Furthermore, some of the WWII-era mines were fitted with scuttling circuits which caused them to sink after a specified period of time, often before being swept. Some mines were fitted with self-sterilising mechanisms which stop the mine from being activated after a specified period of time. However, in many cases these systems failed to work after prolonged periods in the water and the mines remain live.

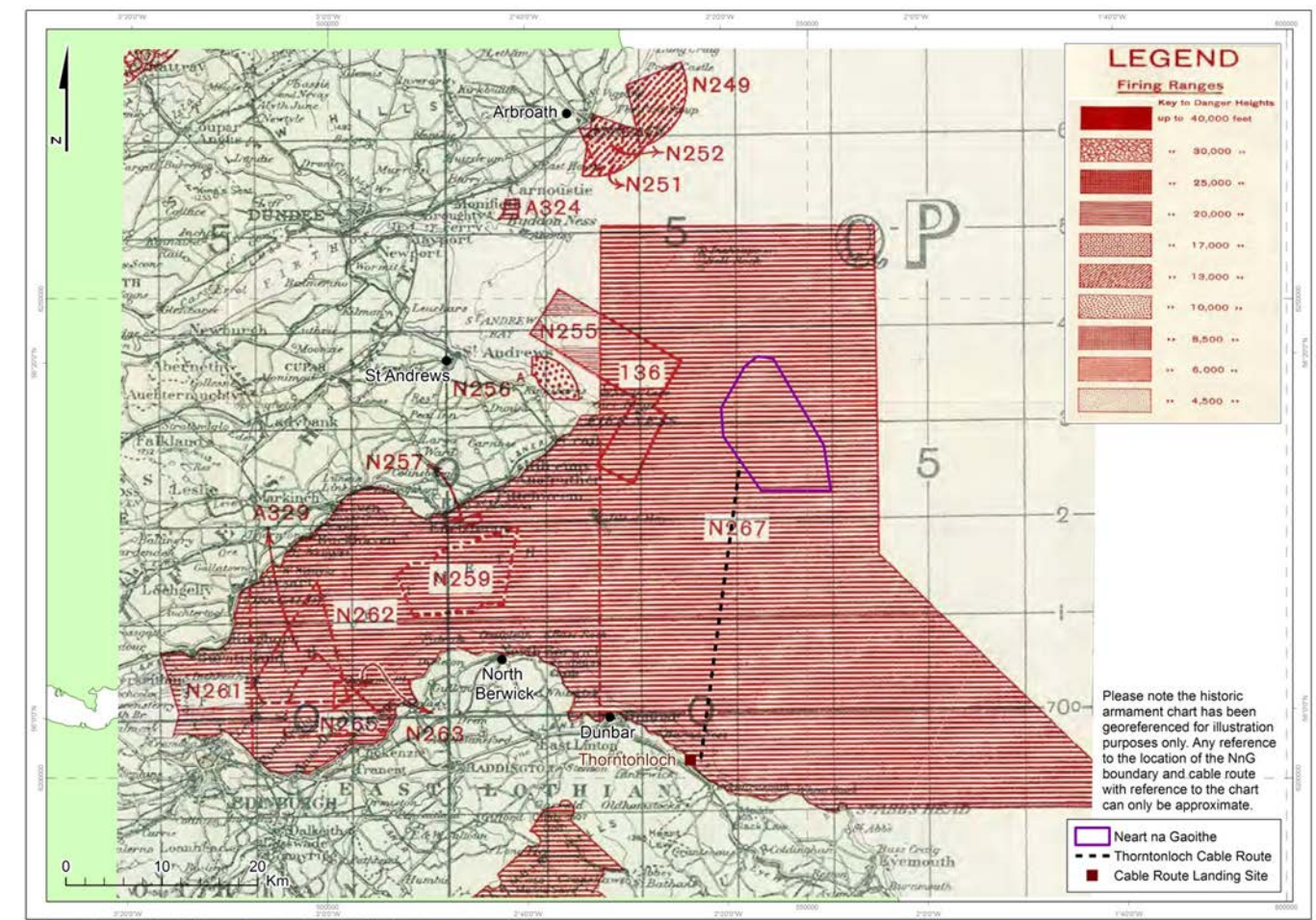
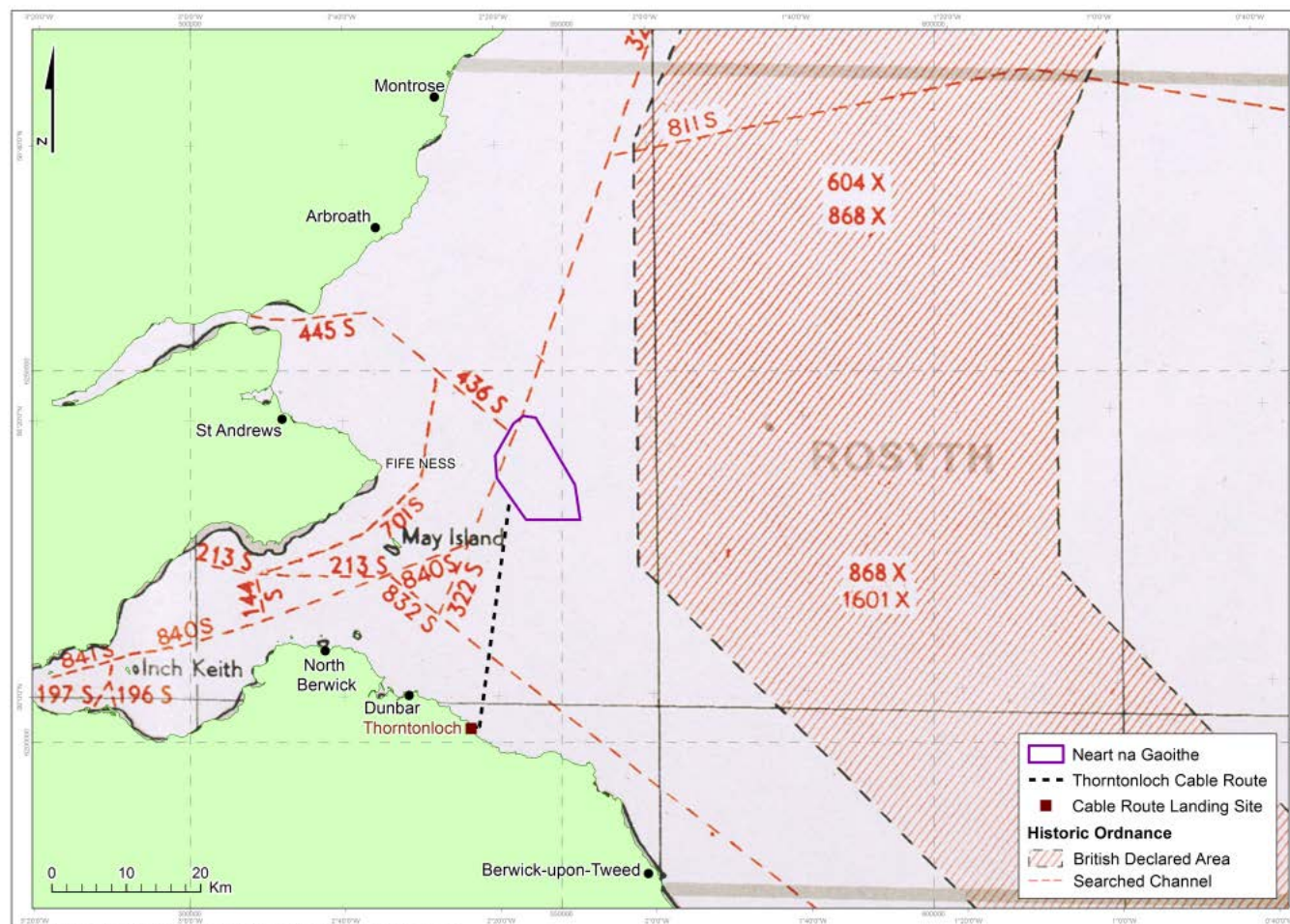


Figure 20.1: Minefields chart for the Neart na Gaoithe Offshore Wind Farm (Source: UKHO)

Figure 20.2: Armament training area map in 1945 (Source: UKHO)

20.5.6 Military Practice Areas

- 31 The offshore site lies within the confines of an extensive historic naval firing range (N267) as well as being close to fourteen further firing or minefield areas in the region during the WWII-era shown in Figures 20.1 and 20.2. The southern portion of the offshore site lies within the Firth of Forth (Middle) X5641 Practice Area (Figure 20.3). The cable route crosses the same practice area as the proposed wind farm. Consequently, it is likely that related munitions will be present within the boundary of the offshore site and along the proposed cable route. It is also likely that many such munitions may have migrated in and out of the area, given the strong currents in the area.
- 32 The calibre of projectiles fired in the historic range areas is unconfirmed; however, the majority of items fired are likely to have been relatively small (Bactec, 2011). They are therefore not likely to pose a significant risk to construction of turbine foundations and other offshore substructures. However, such items may pose a risk to cable laying operations (both export and inter-array) and dredging where they may come into closer contact with personnel.

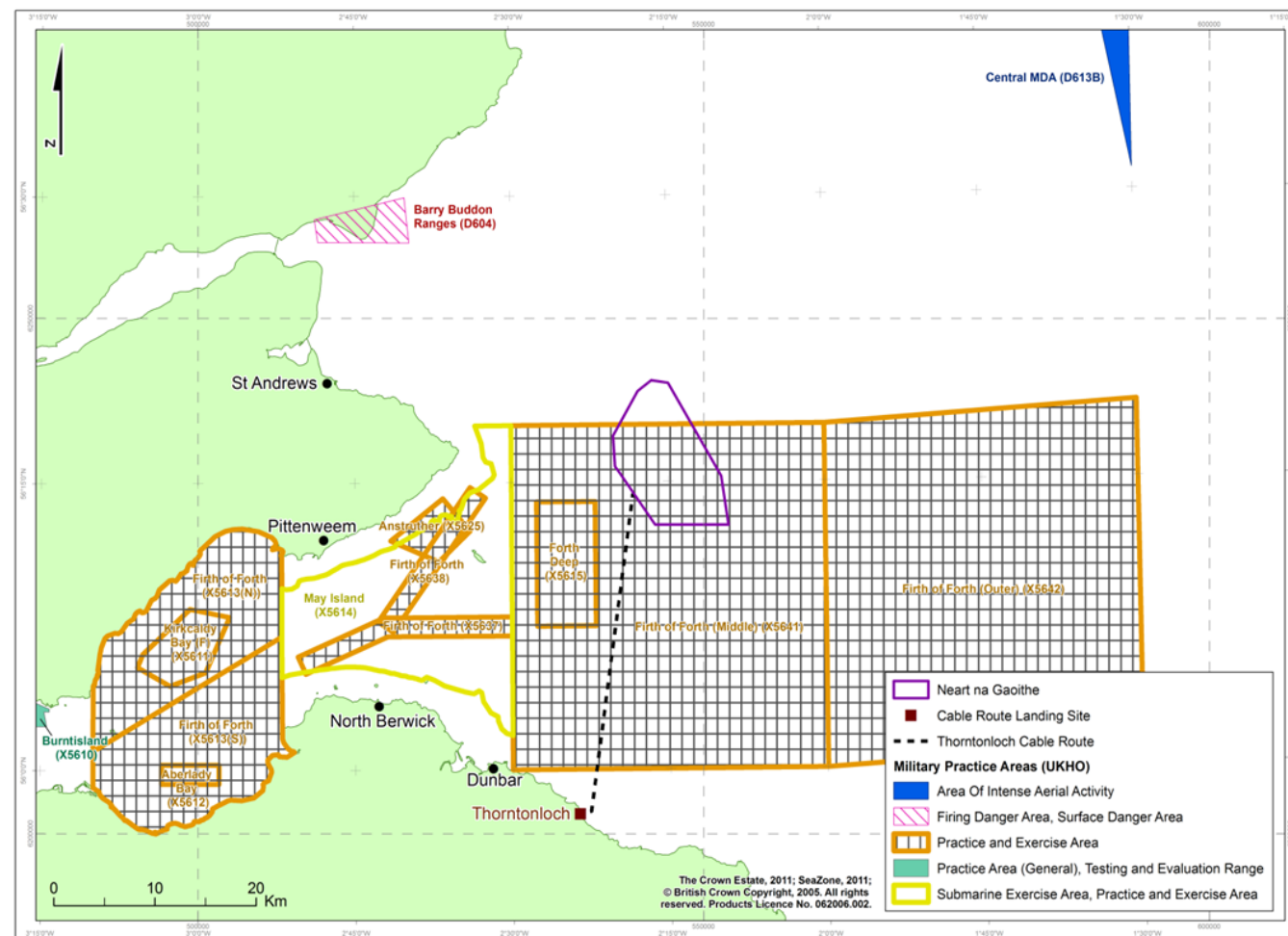


Figure 20.3: Modern military practice areas

20.5.7 Shipwrecks

- 33 None of the wrecks listed in the Neart na Gaoithe site are listed as dangerous or classified as military vessels by the UKHO, although five of the wrecks date from 1914-1918 or 1939-1945 and include two references to British submarines, both sunk after collisions during the ‘Battle of May Island’. The UKHO classifies wrecks as dangerous (hazardous) in accordance with their risk to navigation and does not include any risk assessment for disturbance of UXO that may be present.
- 34 The data sheets (see Appendix 20.1: Unexploded Ordnance Report) detail the *Ballochbute* and the *Einar Jarl* to have been sunk by a torpedo (1917) and mine (1941), respectively. This supports evidence from Section 20.5.4 that defensive mine laying took place close to, and possibly within, the Neart na Gaoithe Offshore Wind Farm site. The wrecks identified by the UKHO within the offshore works area are shown in Figure 20.4. Further information on shipwrecks in the region is provided in Chapter 19: Maritime Archaeology and Cultural Heritage.
- 35 It should also be noted that the vessel named the *Einar Jarl* is mentioned in two separate wreck reports, at two different locations, 2.7 km apart, within the offshore site. Prior to a diver survey, this large and collapsed single propeller steamship wreck (approximately 89 m long and 21 m wide) was thought to be *HMS Rockingham*, which was significantly different in design. The previous location recorded for the *Einar Jarl* is now thought to be erroneous.

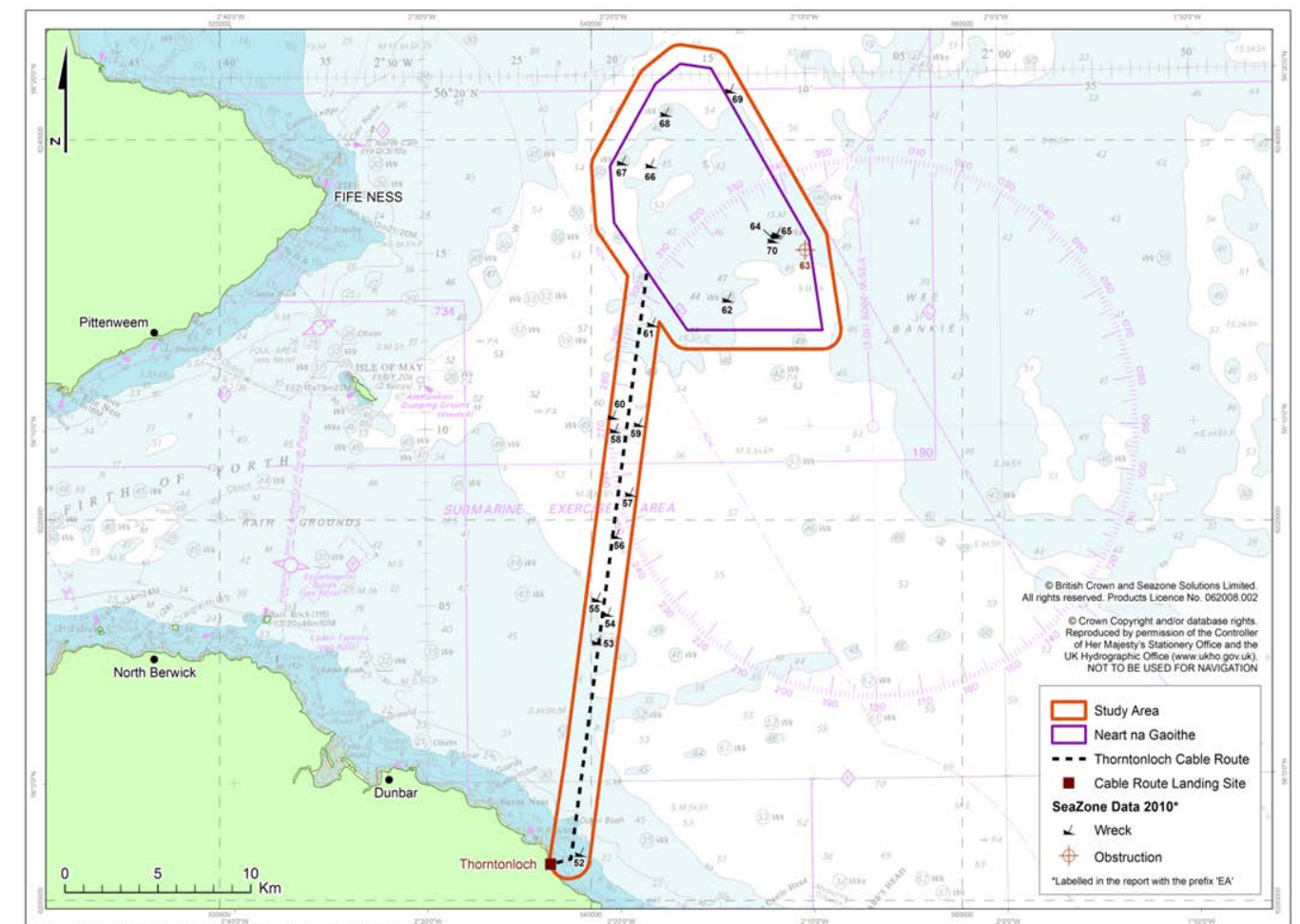


Figure 20.4: Wreck locations within the offshore works study area

20.5.8 Torpedo and Depth Charges

- 36 During WWII, all classes of ship (including submarines) and aircraft could be armed with torpedoes. Failed torpedoes sink to the seabed when they run out of fuel, with their warheads intact. Several have been recovered from the waters around the UK in recent years. Such torpedoes have the potential to be within the offshore site.
- 37 Depth charges were also used off the coast of Britain during WWII, but to a much lesser extent than torpedoes. By the end of WWII depth charges were typically set to detonate at depths between 153 m and 226 m to counter diving U-boats. Due to this, it is considered that such ordnance was unlikely to be used in the relatively shallow waters of the offshore works area.

20.5.9 Ammunition Dumping Grounds

- 38 Admiralty chart no. 190 (Montrose to Fife Ness) shows both an ammunition dumping ground (disused), and an ammunition and boom gear dumping ground (disused), approximately 12 to 13 km to the southwest of the site. The areas partially overlap and lie approximately 2 km east of the Isle of May. Official MOD sources document the sites to lie at 56°11'24"N 02°29'00"W and 56°10'45"N 02°30'15"W respectively (see Appendix 20.1: Unexploded Ordnance Report for details).

20.5.10 Aerial Bombing

- 39 Due to the maximum flying range of aircraft in WWI, there was no recorded bombing in the vicinity of the offshore site and the WWI Air Raid and Naval Bombardments Map from the National Archives does not cover the Neart na Gaoithe offshore works area. There are two reports of Zeppelin attacks around Edinburgh, but the furthest north that aerial bombing attacks are recorded to have reached in WWI was Littleport in Cambridgeshire. Therefore, it is unlikely that any ordnance from bombing during WWI will be present in the offshore works area.
- 40 During WWII, the Luftwaffe extensively attacked infrastructure, industrial facilities and military bases. In terms of weight of ordnance dropped, high explosive (HE) bombs were the most deployed weapon. Most bombs were 50 kg, 250 kg or 500 kg, though large bombs of up to 2,000 kg were also used. Approximately half of the total weight of the bomb came from the explosive charge. Due to the prolific use of these weapons and the high ratio of explosive material contained in each bomb, HE bombs are considered to present the greatest risk in coastal areas close to targets of Luftwaffe bombing raids (cities, ports and military bases).
- 41 There are eight Air Raid Precautions (ARP) reports¹ () of bombing missions in the region of the offshore site. During these raids the offshore site would have been at risk from 'tip and run'. Records indicate that if a Luftwaffe pilot did not find his intended target or came under fighter or anti-aircraft attack, he would often drop his bomb load before returning to base – an occurrence known as a 'tip and run'. The offshore site is located in close proximity to the flight path for bombers aiming for industrial targets such as Granton Harbour, Edinburgh Gas Works and the Royal Naval Base at Rosyth in the Forth Estuary and it is considered feasible that UXOs in the areas may be as a result of these 'tip and run' incidents.

20.5.11 Aircraft Activity and Crashes

- 42 In WWII the Luftwaffe bomber crews were engaged on route to UK coastal targets by British fighter planes. The bomber crews were also sometimes protected by their own fighter escort which would engage British fighters. During such battles, planes were shot down and crashed in the North Sea with their bomb and machine gun loads intact.
- 43 Because of the strategic importance of the Firth of Forth, the area was targeted during WWII. Two German Heikels were shot down over the Firth of Forth during the first air attack of the war in October 1939, which targeted the Royal Naval base at Rosyth. National Monument Records of Scotland record a World War II Bristol Beaufighter north of Skateraw harbour (approximately 1.9 km northwest of the export cable landfall at Thorntonloch). Although the positions of these recorded losses are not accurate, there is nonetheless some potential for their remains to be discovered within the offshore works, with the potential for ordnance still to remain aboard.

20.5.12 Offshore Incidents Involving Munitions

- 44 Historically, fishing and aggregate dredging have seen the most incidences of ordnance being found in the North Sea. Such incidences have led to explosions and even the loss of life in UK waters. There have been recorded instances of ordnance finds in the Firth of Forth by fishing vessels; however, there have been no reported cases of ordnance being found in the Neart na Gaoithe offshore works area.

20.6 Summary

- 45 The offshore works area for the project is located in an area of the North Sea which is potentially at risk from ordnance due to military activity, especially from activity which occurred during WWII. Ordnance may be from practice ranges, torpedoes, or combat mines. In addition, the location of the area overlaps with current military firing ranges. Some wrecks in the area date from the WWI or WWII era and as such may contain UXO.

¹ ARP was an organisation set up at the start of WWII for the defence of towns and cities against air raids - the reports are held by the national archives

20.7 Recommendations

- 46 The baseline identifies several potential sources of UXO that could exist within the Neart na Gaoithe Offshore Wind Farm and along the export cable route. The site overlaps with several military practice areas, both historic and current, within which ordnance will have been used and could remain. Other risks exist from activities during WWI and WWII. These include wrecks containing ordnance as well as the possibility of bombs tipped by Luftwaffe pilots returning from missions in the area.
- 47 Due to the potential for ordnance within the vicinity of the site, a risk assessment will be carried out prior to construction and full sea bed magnetometer scan, or other industry accepted method of UXO identification, may be undertaken prior to construction.

20.8 References

Admiralty chart no. 190, entitled 'Scotland – East Coast, Montrose to Fife Ness including the Isle of May'.

Beale, C., (Bactec), 2011. *Discussion on Bactec's work on Unexploded Ordnance with relation to Neart na Gaoithe* [email] (personal communication, 26 January, 2011).

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Appendices

Appendix 20.1: Unexploded Ordnance Report