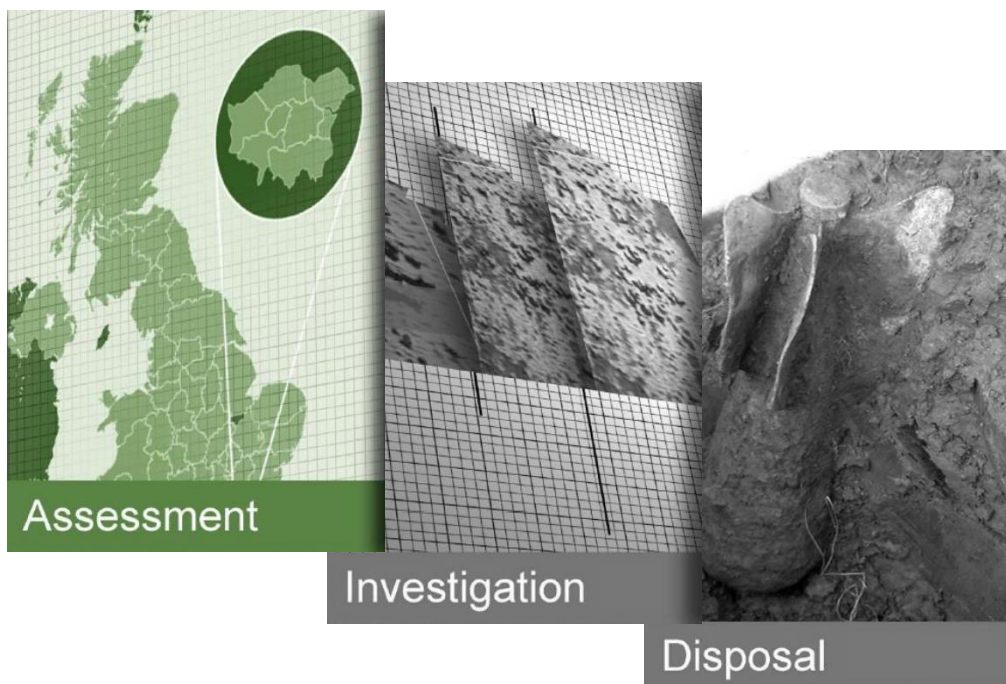


APPENDIX D

ZETICA LTD UXO DESK STUDY AND RISK ASSESSMENT

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St Mary's Road, Hayling Island - UXO Desk Study & Risk Assessment

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Checked by Stefan Lang
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Document Title UXO Desk Study & Risk Assessment
Document Ref. P6125-16-R1
Revision A
Project Location St Mary's Road, Hayling Island
Client The LK Group
Date 9th September 2016

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UXO DESK STUDY & RISK ASSESSMENT

St Mary's Road, Hayling Island

EXECUTIVE SUMMARY

Zetica Ltd was commissioned by The LK Group to carry out an Unexploded Ordnance (UXO) Desk Study and Risk Assessment for an approximately 11.9 hectare (ha) area adjacent to St Mary's Road, Hayling Island, Hampshire ('the Site').

The aim of this report is to gain a fair and representative view of the UXO hazard for the Site and its immediate surrounding area in accordance with the Construction Industry Research and Information Association (CIRIA) C681 'Unexploded Ordnance (UXO), a Guide for the Construction Industry'.

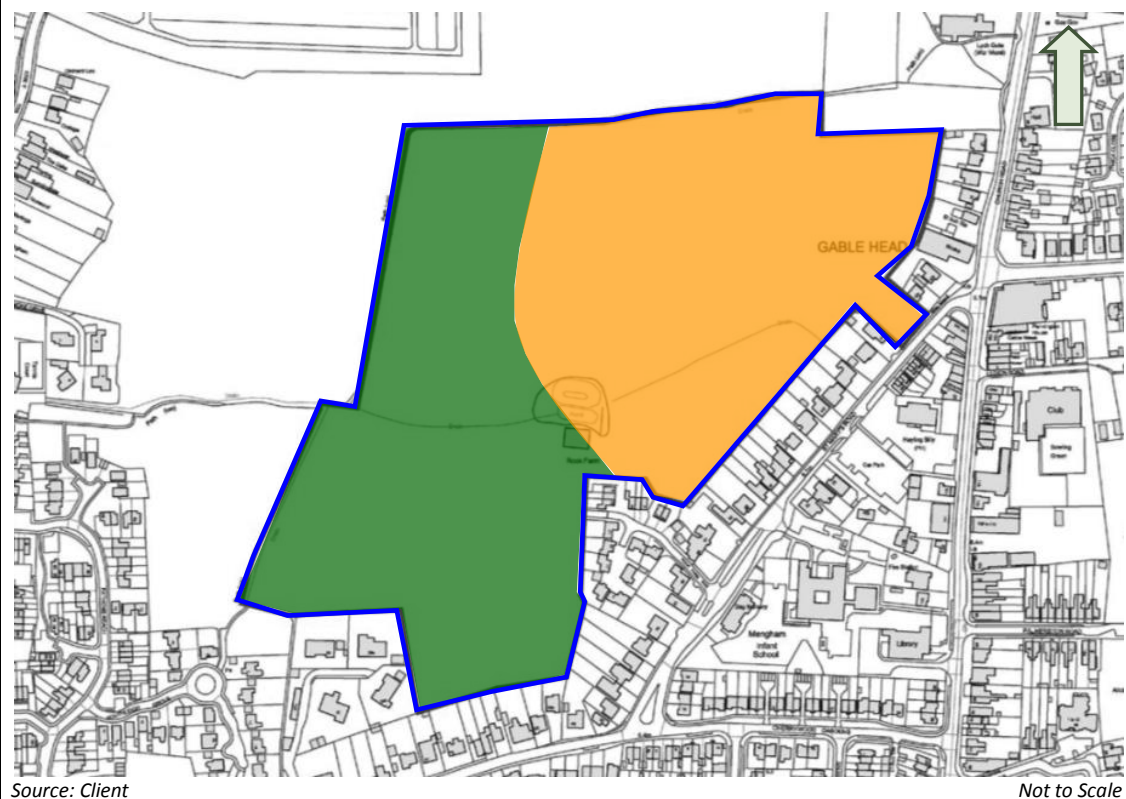
Records indicate that during World War Two (WWII) at least 13No. High Explosive (HE) bombs fell in the immediate vicinity of the Site, which was on the main flightpath towards the Royal Navy dockyards at Portsmouth. This included bombs falling during heavy raids in April 1941 and August 1943. The main concentration of bombing was in a southeast-northwest direction across the Site.

Given the elevated bombing density in this area, it is considered possible that an Unexploded Bomb (UXB) could have fallen unnoticed on the Site and remained in situ. Therefore, it is considered prudent to assign the northern and eastern parts of the Site a moderate UXO hazard level to account for the possibility that a UXB is present.

No evidence of significant bombing or other sources of UXO hazard has been identified on the remainder of the Site, which is assigned a low UXO hazard level

Given this, it is considered that the UXO hazard level on the Site can be tentatively zoned from low to moderate, as shown in the Figure below, reproduced as Figure 6 in the main report.

Figure UXO hazard zone plan of the Site



Legend	Very Low		Low		Moderate	
	High		Very High		Site boundary	

The main findings of the report are summarised below.

- No records of bombing or military activity on the Site during World War One (WWI) have been found.
- During WWII, the main strategic targets in the vicinity of the Site comprised military camps, transport infrastructure and Anti-Aircraft (AA) defences. There were also several bombing decoys on Hayling Island to deflect air raids away from Portsmouth.
- During WWII the Site was in the Urban District (UD) of Havant and Waterloo, which officially recorded a moderate regional bombing density.
- Records have been found indicating that at least 13No. HE bombs fell in the immediate vicinity of the Site during WWII.
- No significant post-WWII military activity is recorded on the Site.

The Table below, reproduced as Table 4 in the main report, provides a UXO risk assessment for potential work on the Site.

Further details on the methodology for the risk assessment are provided in Section 11.1 of the main report.

Table	UXO risk assessment for the Site								
Hazard Zone	Potential UXO Hazard	Anticipated Works	PE	PD	P = PE x PD	Likelihood	Severity	Risk Rating	UXO Risk
Mod	UXB	Shallow Excavations	3	2	6	3	5	15	Moderate
		Deep Excavations	4	3	12	3	5	15	Moderate
		Piling/boreholes	2	4	8	3	4	12	Moderate
	Other UXO	Shallow Excavations	1	1	1	1	4	4	Low
		Deep Excavations	1	1	1	1	4	4	Low
		Piling/boreholes	1	1	1	1	3	3	Low
Low	UXB	Shallow Excavations	1	1	1	1	5	5	Low
		Deep Excavations	1	1	1	1	5	5	Low
		Piling/boreholes	1	1	1	1	4	4	Low
	Other UXO	Shallow Excavations	1	1	1	1	4	4	Low
		Deep Excavations	1	1	1	1	4	4	Low
		Piling/boreholes	1	1	1	1	3	3	Low
PE (Probability of Encounter), PD (Probability of Detonation), P (Overall Probability)									
Shallow excavations defined as <1.0m below ground level (bgl).									
Risk Mitigation Recommendations									
To ensure that the UXO risk is reduced to As Low As Reasonably Practicable (ALARP) the following mitigation is advised:									
Low Risk									
Where a low risk of UXO encounter is anticipated, industry good practice is simply to raise the awareness of those involved in excavations so that in the unlikely event that a suspect item is discovered, appropriate action is taken. This can be achieved through UXO awareness briefings to site staff.									
Clearance certification for borehole or pile locations is considered prudent only if a zero tolerance to risk is adopted. Zero tolerance is commonly adopted for sites that have safety critical infrastructure such as nuclear establishments and oil refineries.									
Moderate Risk									
For all intrusive works, the raising of awareness (as per low risk) is considered essential.									
For excavations, non-intrusive UXO detection methods and intrusive investigation of identified targets is recommended.									
Where UXO detection is not feasible due to ground conditions, restricted access or programme, an Explosive Ordnance Clearance (EOC) Engineer can be used to supervise during excavation works. The EOC Engineer will carry out a visual assessment on any suspect items uncovered and classify them as potential UXO or other material.									
Clearance certification for any borehole or pile locations is considered essential. This can be achieved by advancing a magnetometer into the ground at the borehole or pile location in order to provide detection of ferrous metal targets such as UXB. Assuming no objects comparable to the UXB detection range are identified, then the borehole or pile position can be considered clear of UXB.									

Table 5 in the main report gives recommended actions in relation to the potential UXO risk level and the anticipated Site activity.

Further advice on the mitigation methods can be provided by Zetica on request.

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UXO DESK STUDY & RISK ASSESSMENT

St Mary's Road, Hayling Island

Note: To aid the reader of this report, Zetica has colour coded each paragraph. Paragraphs with black text on a white background are paragraphs that provide site-specific information or information specifically researched as part of this project.

Paragraphs in a dark green text with a green background are paragraphs containing background information or explanations which may appear as standard text in all similar reports.

1 INTRODUCTION

1.1 Project Outline

Zetica Ltd was commissioned by The LK Group to carry out an Unexploded Ordnance (UXO) Desk Study and Risk Assessment for an approximately 11.9 hectare (ha) area adjacent to St Mary's Road, Hayling Island, Hampshire ('the Site').

The aim of this report is to gain a fair and representative view of the UXO hazard for the Site and its immediate surrounding area in accordance with the Construction Industry Research and Information Association (CIRIA) C681 'Unexploded Ordnance (UXO), a Guide for the Construction Industry'.

This hazard assessment includes:

- Likelihood of ordnance being present.
- Type of ordnance (size, filling, fuze mechanisms).
- Quantity of ordnance.
- Potential for live ordnance (UXO).
- Probable location.
- Ordnance condition.

It is essential to note that the effects of military activity will often extend beyond the source of the activity. For example, a base for armed forces may use surrounding areas of open land outside the official or recorded military boundaries for practice and military related activities.

In addition, World War One (WWI) and World War Two (WWII) aerial bombardment was not discrete. 'Pinpoint' targeting did not exist in WWI or WWII. The effects of bombardment would be apparent in areas around the intended target.

It is for these reasons that it is important to address military activity both on the Site and in the relevant surrounding areas.

It should be noted that some military activity providing a source of UXO hazard may not be readily identifiable and therefore there cannot be any guarantee that all UXO hazards on the Site have been identified in this report.

1.2 The Site

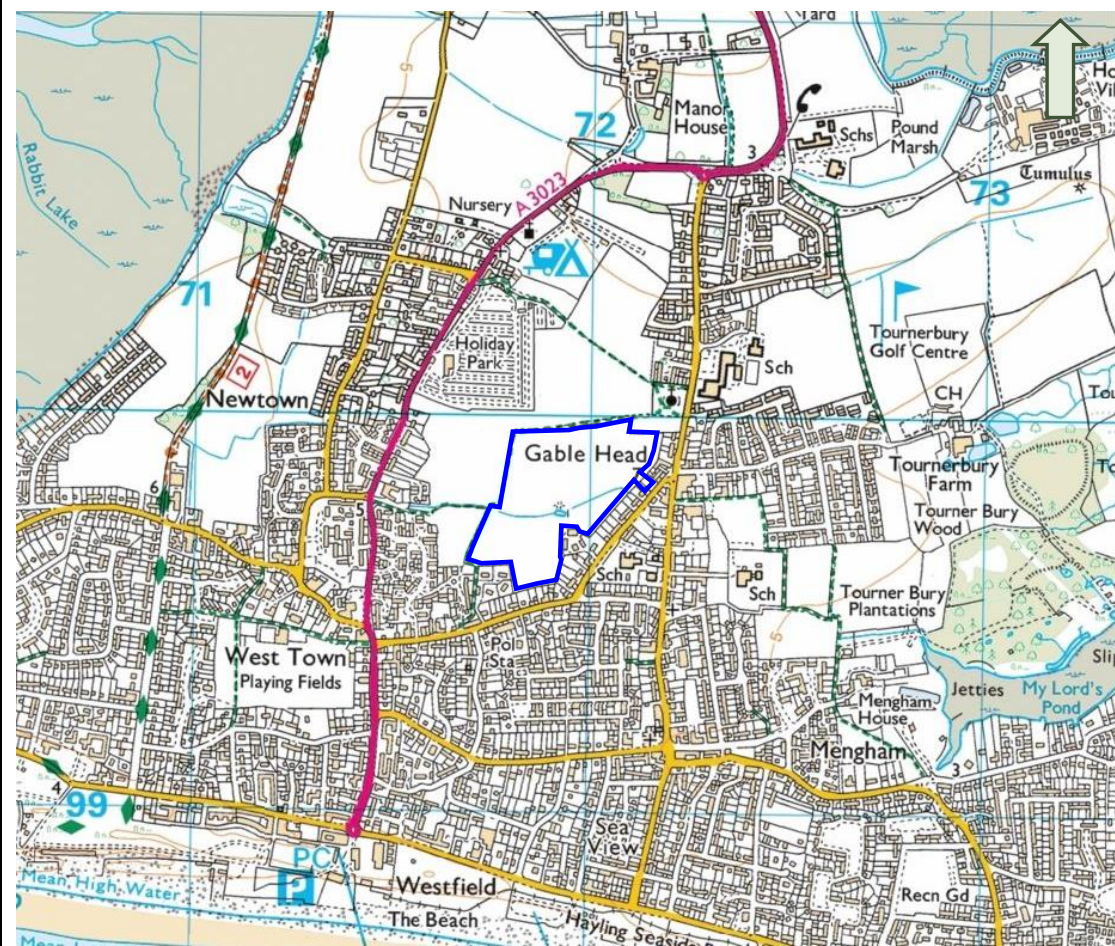
The Site is centred on Ordnance Survey National Grid Reference (OSNGR) SZ 719994. It is located in the Gable Head area of Hayling Island, approximately 1km southeast of Langstone Harbour, and approximately 8.1km east of Portsmouth city centre.

The Site comprises 2No. adjacent open fields. It is bounded to the east and south by housing, and by fields to the north and west. St Mary's Church is located adjacent to the north-eastern boundary of the Site.

It is understood that planned works on the Site may include intrusive ground investigations, excavations and piling associated with residential development.

Figure 1 is a Site location map and Plate 1 is a recent aerial photograph of the Site.

Figure 1 Site location map



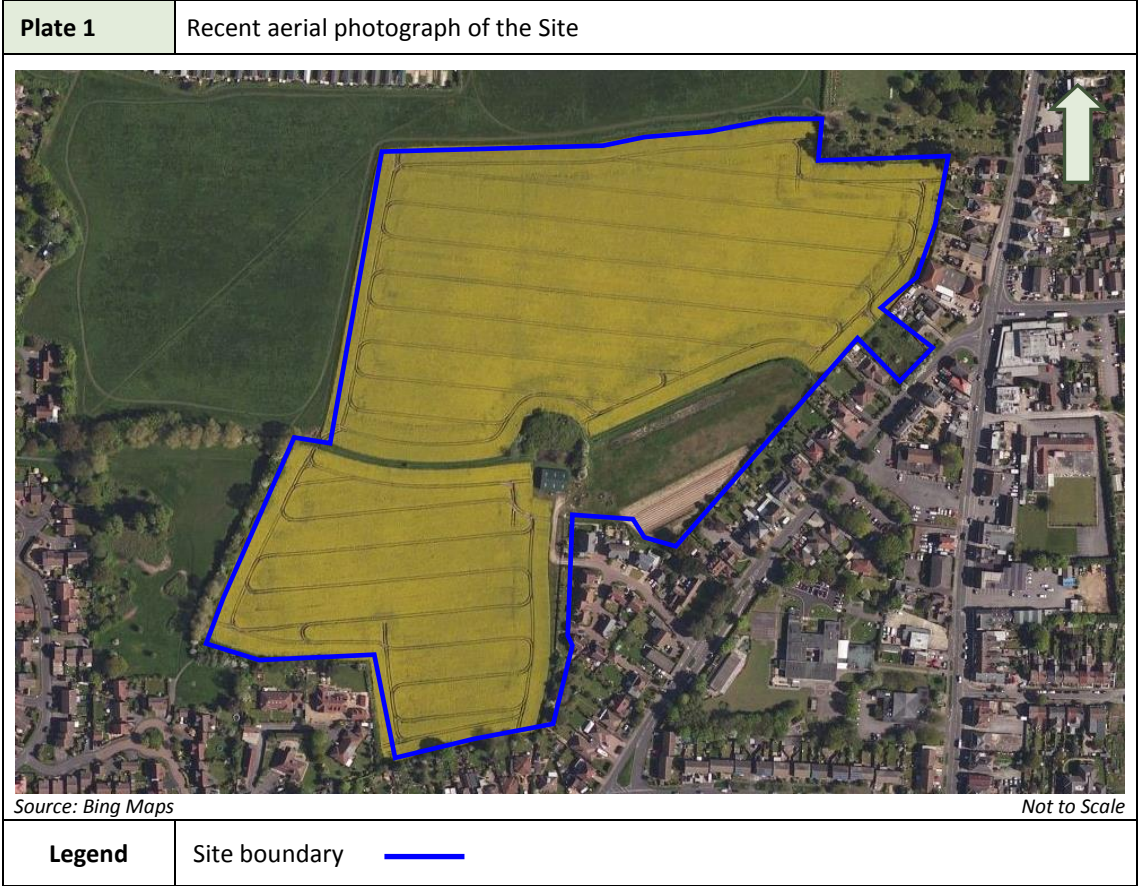
Source: © Crown Copyright 2016. Reproduced by permission of Ordnance Survey

Not to Scale

Legend

Site boundary





2 SOURCES OF INFORMATION

2.1 Historical Information

With most locations, the potential presence of UXO as a result of enemy action, unauthorised disposal or unrecorded military activity can never be totally discounted.

Detailed records of military activity are rarely released into the public domain. Even when military information is made public there may be gaps in the records because files have been lost or destroyed.

Records for periods such as WWII are only as detailed and accurate as the resources and working conditions would allow at the time. Densely populated areas tend to have a greater number of records than rural areas. Such records may be inaccurate due to the confusion surrounding continuous air raids.

Press records can supplement local information, although this source of information must be treated with caution, as inaccuracies do exist, either inadvertently or intentionally in order to confuse enemy intelligence. Classified official records can sometimes be considered inaccurate for the same reason.

Recent research indicates that England alone had 17,434No. recorded defence sites, of which 12,464No. were classified as defensive anti-invasion sites. The precise locations of many of these sites are still to be identified, illustrating the scale of the problem when establishing potential risks from limited historical data.

Zetica Ltd researched the military history of the Site and its surrounding area utilising a range of information sources. The main sources of information are detailed in the following sections and referenced at the end of this report.

2.2 Zetica Ltd Defence Related Site Records

Zetica Ltd's in-house records were consulted, including reference books and archived materials from past work in the region. Relevant documents have been cited within the bibliography of this report.

2.3 Zetica Ltd Bombing Density Records and Maps

Reference has been made to the Zetica Ltd bomb risk maps located on ZeticaUXO's website (<http://zeticauxo.com/guidance/uxb-risk-maps/>).

2.4 Ministry of Defence and Government Records

Various government departments and units within the Ministry of Defence (MoD) were approached for information of past and present military activity in the area. These included the Home Office records of abandoned bombs.

2.5 Other Historical Records, Maps and Drawings

Numerous reference documents including historical maps, aerial photographs and drawings have been consulted from sources such as the National Archives, Historic England and the Defence of Britain Project.

The British Geological Survey (BGS) was consulted for borehole information.

2.6 Local Authority Records

Information was obtained from Havant Borough Council and Hampshire County Council.

2.7 Local Record Offices and Libraries

Information was obtained from Hampshire Archives and Local Studies and the Portsmouth History Centre.

2.8 Local Historical and Other Groups

Local history groups and archaeological bodies were consulted.

2.9 Data Confidence Level

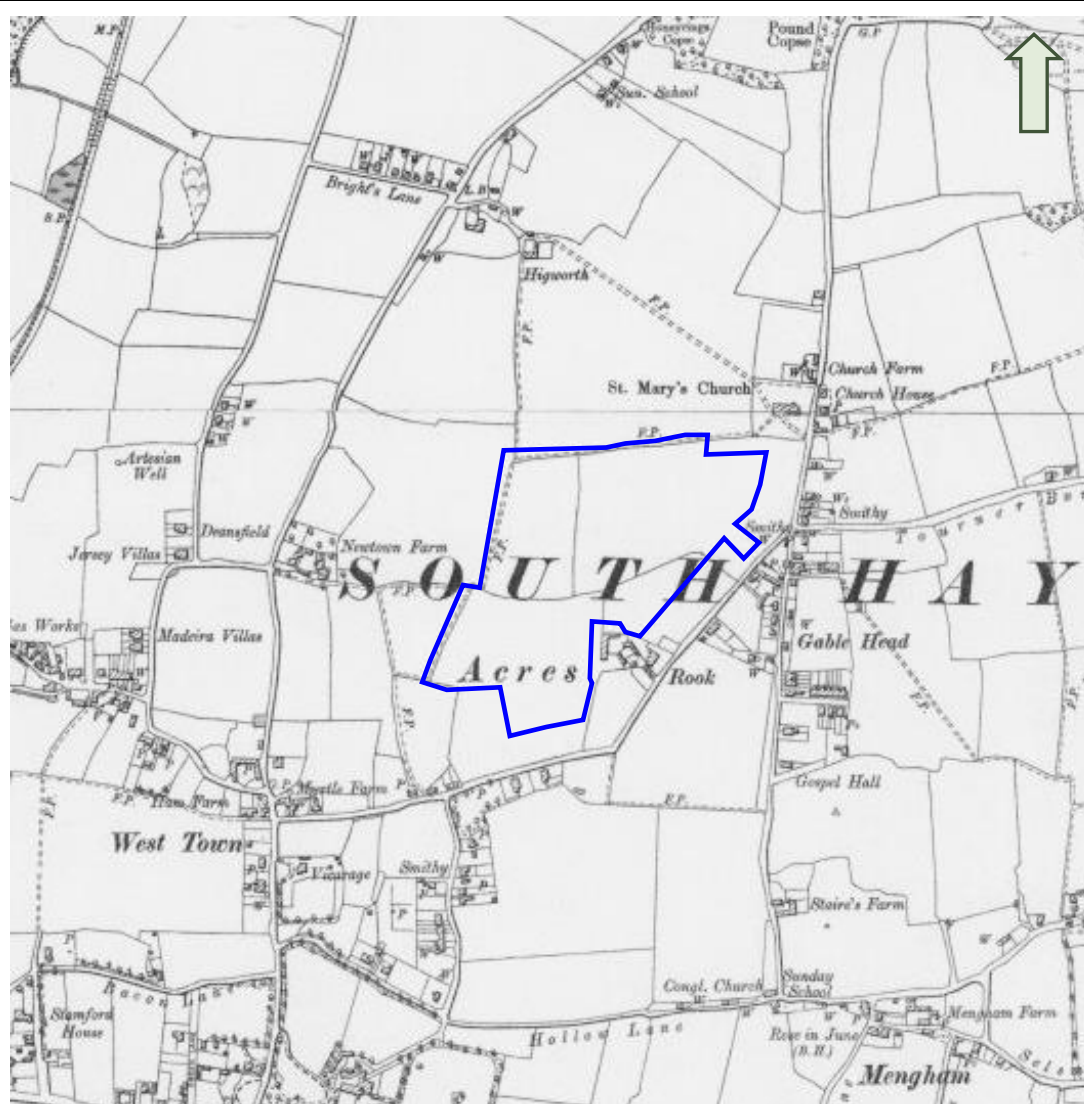
Several sources of WWII bombing records for Havant & Waterloo Urban District (UD) have been obtained, although few contained detailed locations of where bombs fell. Many bombs are simply recorded as falling 'in the vicinity' of a certain landmark with no further detail provided. It has therefore been difficult to determine the precise locations of all bomb impacts recorded in the UD.

Otherwise there is a high level of confidence in the researched information sources used for this report. Any exceptions to this are specifically detailed in the text of the report.

3.1 General History

The surrounding area was predominantly rural, with only scattered residential development.

Figure 2 Historical map, 1899



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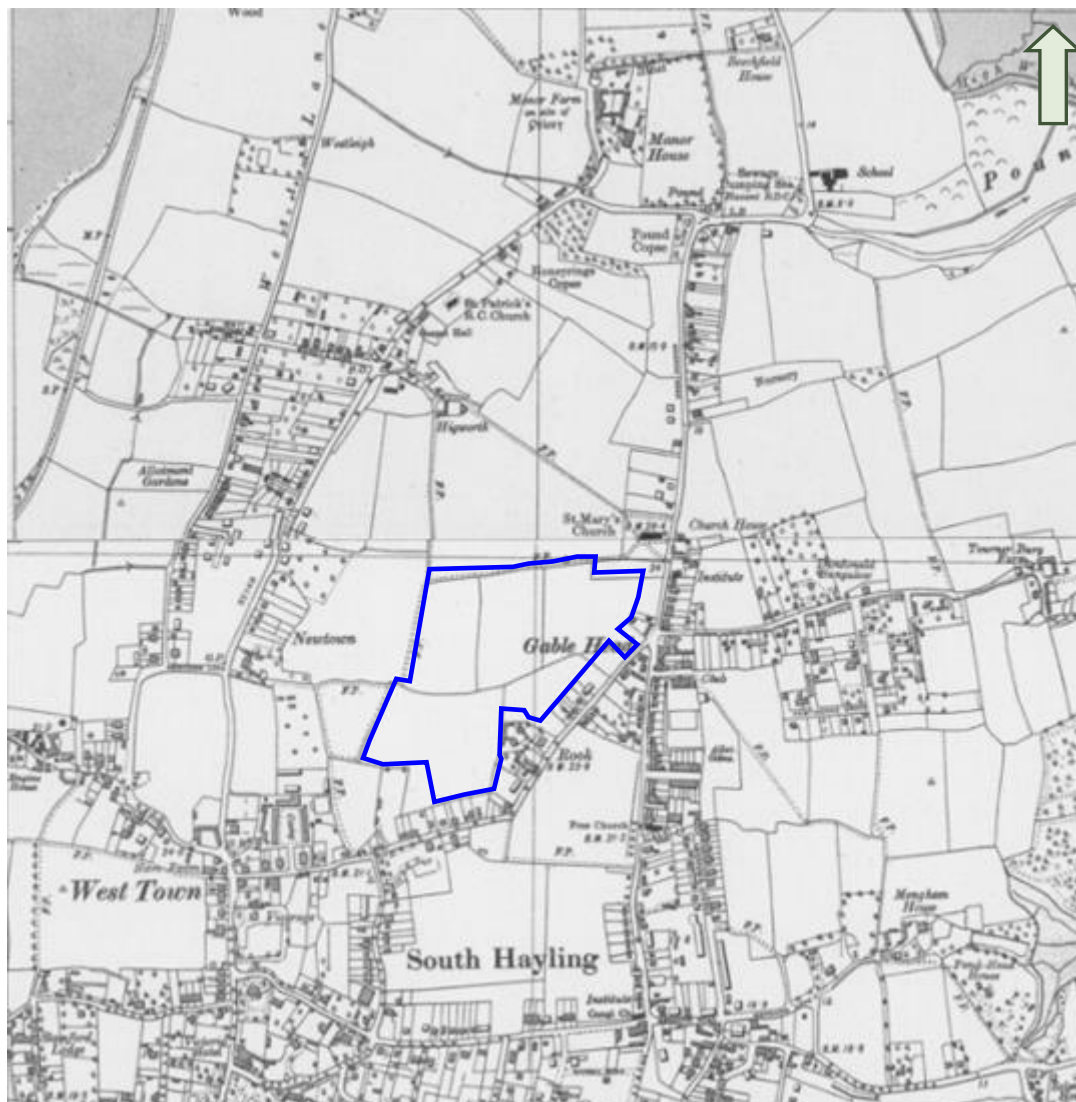
Not to Scale

Legend

Site boundary

Residential development had occurred in the surrounding area, particularly to the south of the Site.

Figure 3 Historical map, 1938



Source: © Crown Copyright 2016. Reproduced by permission of Ordnance Survey

Not to Scale

Legend

Site boundary —

Plate 2, an aerial photograph dated the 17th April 1951, shows that no significant changes had occurred on the Site post-WWII.

Plate 2	Aerial photograph, 17 th April 1951
	
Source: Historic England Not to Scale	
Legend	Site boundary —
The Site continued to remain open fields used for agricultural purposes after 1951, with no significant development occurring. Plate 3, an aerial photograph from 1999, shows that a pit had been excavated on the Site and a wooded area allowed to develop on its northern edge. Residential development had occurred throughout the area, with the holiday camp to the southwest of the Site having been redeveloped as a housing estate.	

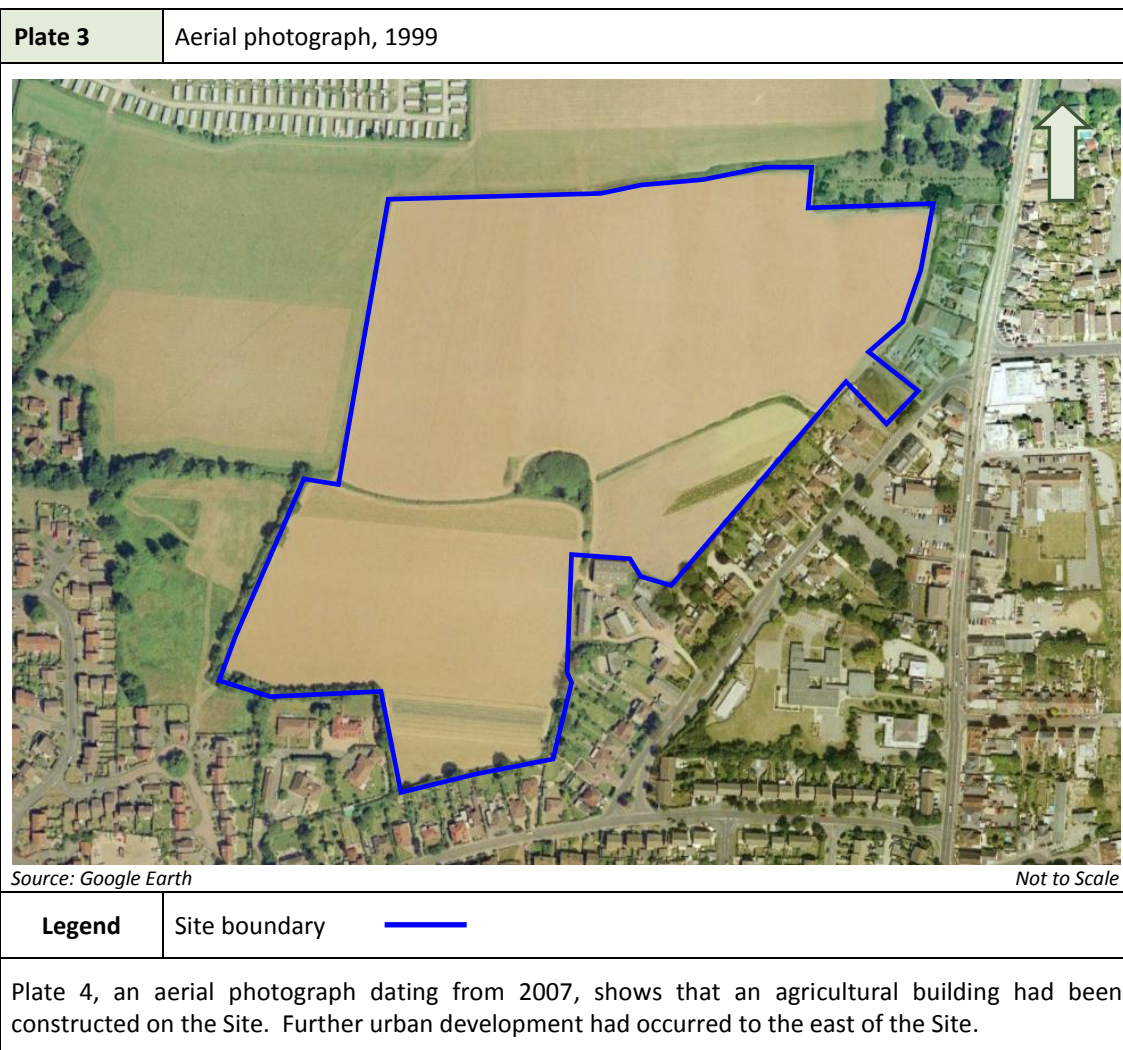


Plate 4	Aerial photograph, 2007
 Source: Google Earth Not to Scale	
Legend	Site boundary ———
There has been no significant development on the Site since 2007 (see Plate 1).	
3.2 Pre-WWI Military Activity	
No records of any significant pre-WWI military activity on or in close proximity to the Site have been found.	
3.3 WWI Military Activity	
No records of any significant WWI military activity on or in close proximity to the Site have been found.	
During WWI the School of Musketry ran training courses on Hayling Island. This included machine gun training on a 700 yard (yd) range established on Sinah Common, approximately 2.4km west-southwest of the Site.	
During WWI, an estimated 9,000No. German bombs were dropped over Britain during the course of 51No. airship and 52No. aircraft raids. It was the first time that strategic aerial bombardment had been used.	

During WWI Hayling Island was predominantly rural and contained no significant strategic targets. No records have been found indicating that the Site was bombed during WWI.

In response to the air raids, Anti-Aircraft (AA) guns were established. These were potential sources of Unexploded AA (UXAA) shells which could land up to 13km from the firing point, although more typically fell within 10km during WWI.

Records indicate that 9No. static AA gun batteries were located within 10km of the Site during WWI. The nearest was located at Fort Cumberland (SZ 682992), approximately 3.4km west-southwest of the Site. It was armed with 1No. 3-inch (") gun and 1No. 6-pounder Hotchkiss gun.

WWI military activity is not considered to provide a source of UXO hazard to the Site.

3.4 WWII Military Activity

During WWII Hayling Island became a militarised area and many of its larger buildings were requisitioned for use by the armed forces and civil defence organisations, mainly the Royal Navy and the Royal Marines.

This included the requisitioning of the island's holiday camps, including Southleigh Holiday camp, adjacent to the southeast corner of the Site, which became HMS Northney 2. HMS Northney 2 was used as an accommodation area by the Royal Navy.

The Site was located on the south coast, on Luftwaffe flight paths to Portsmouth and Southampton, making it vulnerable to tip and run raids and jettisoned bombs. Details of recorded air raids in the vicinity of the Site are provided in Section 4 and Appendix 1.

Numerous defensive and offensive military structures were built in the vicinity of the Site. These included lines of defences (Stop Lines), pillboxes, bombing decoys and AA guns. Further details are given in Section 5.

Other military establishments in the vicinity of the Site, are described in Sections 6 to 8.

3.5 Post-WWII Military Activity

No records of any significant post-WWII military activity on or in close proximity to the Site have been found.

4 WWII BOMBING

Bombing raids began in the summer of 1940 and continued until the end of WWII. Bombing densities generally increased towards major cities or strategic targets such as docks, industrial premises, power stations and airfields.

The German bombing campaign saw the extensive use of both High Explosive (HE) bombs and Incendiary Bombs (IBs). The most common HE bombs were the 50kg and 250kg bombs, although 500kg were also used to a lesser extent. More rarely 1,000kg, 1,400kg and 1,800kg bombs were dropped.

The HE bombs tended to contain about half of their weight in explosives and were fitted with one or sometimes two fuzes. Not all HE bombs were intended to explode on impact. Some contained timing mechanisms where detonation could occur more than 70 hours after impact.

Incendiary devices ranged from small 1kg thermite filled, magnesium bodied bombs to a 250kg 'Oil Bomb' (OB) and a 500kg 'C300' IB. In some cases, the IBs were fitted with a bursting charge. This exploded after the bomb had been alight for a few minutes causing burning debris to be scattered over a greater area. The C300 bombs were similar in appearance to 500kg HE bombs, although their design was sufficiently different to warrant a specially trained unit of the Royal Engineers to deal with their disposal.

Anti-Personnel (AP) bombs and Parachute Mines (PMs) were also deployed. 2No. types of anti-personnel bombs were in common use, the 2kg and the 12kg bomb. The 2kg bomb could inflict injury across an area up to 150m away from the impact, within 25m of this, death or fatal injury could occur.

PMs (which were up to 4m in length) could be detonated either magnetically or by noise/vibration. Anti-shipping parachute mines were commonly dropped over navigable rivers, dockland areas and coastlines. The Royal Navy was responsible for ensuring that the bombs were made safe. Removal and disposal was still the responsibility of the Bomb Disposal Unit of the Royal Engineers.

WWII bomb targeting was inaccurate, especially in the first year of the war. A typical bomb load of 50kg HE bombs mixed with IBs which was aimed at a specific location might not just miss the intended target but fall some considerable distance away.

It is understood that the local Civil Defence authorities in urban areas had a comprehensive system for reporting bomb incidents and dealing with any UXO. In more rural areas, fewer bombing raids occurred. It is known that Air Raid Precaution (ARP) records under-represent the number and frequency of bombs falling in rural and coastal areas.

Bombs were either released over targets or as part of 'tip and run' raids where bomber crews would drop their bombs to avoid Anti-Aircraft fire or Allied fighter aircraft on the route to and from other strategic targets. Bombs dropped as a result of poor targeting or 'tip and run' raids on rural, river, marsh or coastal areas were often unrecorded or entered as 'fell in open country', 'fell in the sea' or 'fell in the river' and left little evidence of the fall.

4.1 WWII Bombing in Hayling Island

From prior to the declaration of war in 1939, Britain was subjected to reconnaissance flights by the Luftwaffe which was building up a photographic record of potential targets. Early in WWII German aircraft attempted to lay magnetic mines to destroy and disrupt shipping off the coast.

Whilst Hayling Island did not contain a concentration of significant strategic targets, it was located on Luftwaffe flightpaths to Portsmouth, Gosport and Southampton, making it vulnerable to jettisoned bombs and opportunistic attacks. It also accommodated several bombing decoys, which were designed to divert bombing raids away from the valuable docks and naval bases of Portsmouth.

The heaviest bombing on Hayling Island occurred during 1941. On the night of 17th/18th April 1941 approximately 311 tonnes of HE bombs fell on the island. Bombing became less intense in 1942, though air raids continued on the island until 1944.

4.2 Strategic Targets

The presence of strategic targets significantly increased the likelihood of bombing within the local area. Airfields, docks, industrial facilities, transport infrastructure and anti-invasion defences were all targeted by Luftwaffe bombers. The inherent bombing inaccuracies at the time meant that areas surrounding the targets were often subjected to bombing.

Details of the main targets in the vicinity of the Site are described in the following sections.

4.2.1 Military Targets

There were several AA defences on Hayling Island, including a searchlight battery in the area that is now bordered by Cherrywood Gardens, St Mary's Road and Elm Grove, approximately 0.2km southeast of the Site.

Several holiday camps on Hayling Island were requisitioned by the Royal Navy (RN), 4No. of these camps were named HMS Northney 1,2,3 and 4.

HMS Northney 2, formerly Southleigh Civil Service Holiday Camp, was situated adjacent to the south-western corner of the Site.

HMS Northney 3, now Mill Rythe Holiday Village, was approximately 1km northeast of the Site, and Coronation Camp, renamed HMS Northney 4, approximately 1.7km east-southeast of the Site.

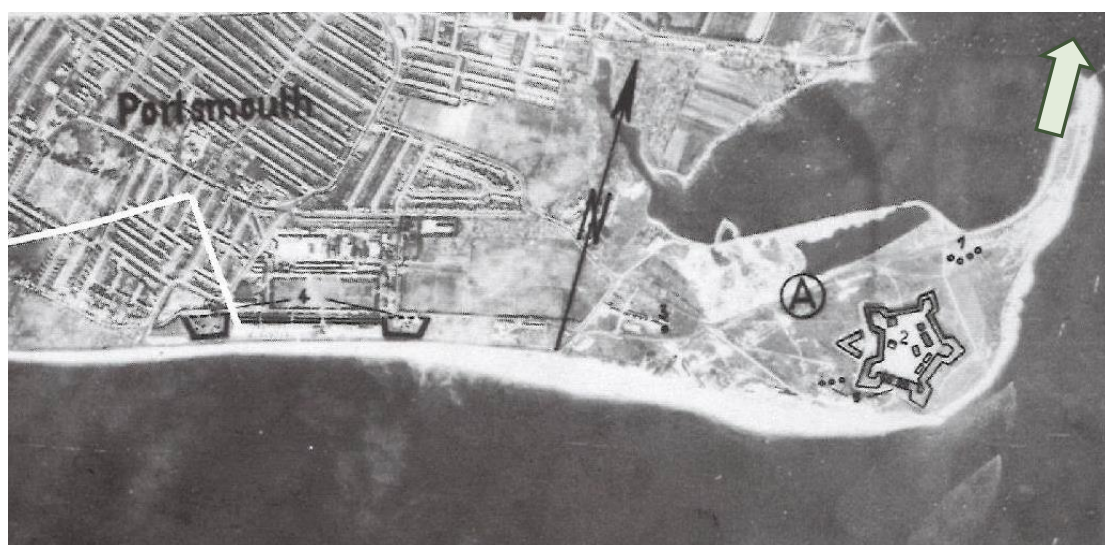
The camps were used to accommodate RN personnel and the Royal Marines. They were also used to house troops and vessels preparing for the D-Day landings in 1944.

Fort Cumberland, approximately 3.2km west of the Site, was used to accommodate Royal Marines and was designated by the Luftwaffe as Target GB 1611. Plate 5 is a Luftwaffe target photograph identifying Fort Cumberland, dated the 28th August 1939.

Eastney Barracks, approximately 4.8km west of the Site, have also been identified.

Plate 5

Luftwaffe target photograph of Fort Cumberland, 28th August 1939



Source: Clarke

Not to Scale

4.2.2 Transport Infrastructure

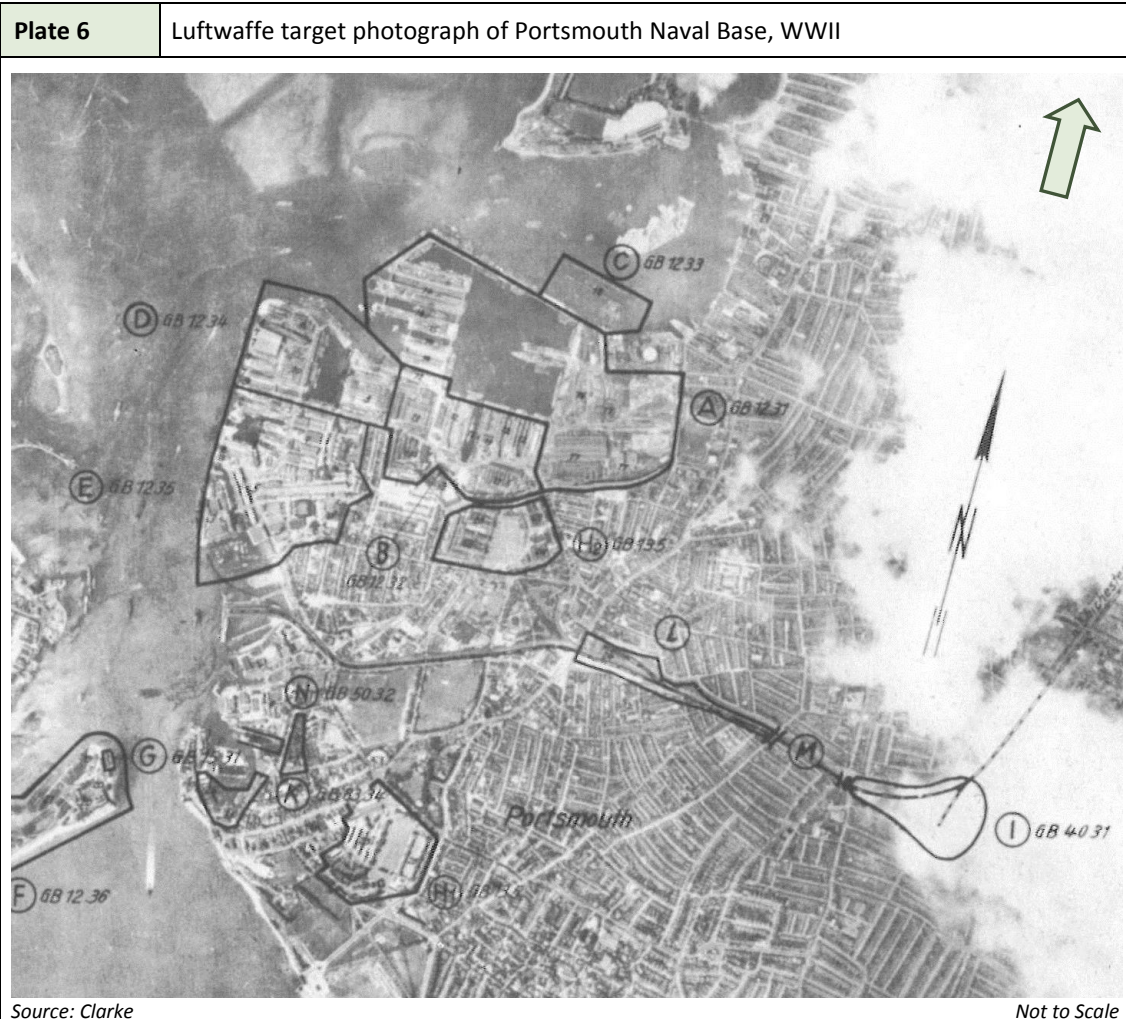
The Southern Railway (SR) Hayling Island branch line ran to South Hayling Station, approximately 0.9km west of the Site.

4.2.3 Shipyards, Docklands and Naval Facilities

The RN established a shipyard on Hayling Beach, approximately 2.5km west of the Site, to assemble pre-fabricated Mulberry Harbours, which were used to unload supplies in the aftermath of the D-Day landings.

There were concentrations of major naval facilities in Portsmouth and Gosport, approximately 8.8km west of the Site, which attracted heavy bombing to the region. The Royal Naval Dockyard at Portsmouth was one of the most important naval bases in the UK and had extensive dry docks, repair yards and associated warehouses.

Plate 6 is a Luftwaffe target photograph of Portsmouth Naval Base.



4.3 Bombing Density and Incidents

Table 1 gives details of the overall bombing statistics recorded for the Local Authority Districts of the Site and surrounding districts. These were categorised as County Boroughs (CB), Municipal or Metropolitan Boroughs (MB), Urban Districts (UD) and Rural Districts (RD). The Site was located in Havant & Waterloo UD.

The figures for West Ham CB, generally considered to represent a high regional bombing density, are included for comparison.

Table 1	Bombing Statistics				
Area	Bombs Recorded				
	High Explosive	Parachute Mines	Other	Total	Bombs per 405ha (1,000 acres)
Havant and Waterloo UD	375	39	9	423	35.0
Portsmouth CB	1,221	34	7	1,262	136.8
Chichester RD	1,154	38	29	1,221	11.9
West Ham CB	1,498	45	47	1,590	334.0

Note that Table 1 excludes the figures for AA shells and IBs. Discrepancies between this list and other records, such as bomb clearance records, demonstrate that this data is likely to under-represent actual bombing.

The majority of the bombs falling in Havant & Waterloo UD fell on Hayling Island, giving the vicinity of the Site a considerably higher bombing density than the more rural districts to the north.

The nearest recorded incidents to the Site are described below. Appendix 1 provides details of further air raid incidents in the vicinity of the Site.

August 1940 (date unspecified)

1No. HE bomb fell on the western end of Palmerston Road, approximately 0.2km east-southeast of the Site.

5th January 1941

1No. AA shell fell on St Mary's Road, within approximately 0.1km east-southeast of the Site. This was recorded as an Unexploded AA (UXAA) shell.

20th January 1941

1No. HE bomb fell on a field in the vicinity of St Mary's Church, within approximately 0.2km of the Site.

13th March 1941

1No. HE bomb fell near Tournurbury Lane, within approximately 0.4km east of the Site. It was recorded as a UXB.

17th April 1941

On the night of 17th/18th April 1941 the decoys on Hayling island attracted a significant number of Luftwaffe bomber aircraft away from Portsmouth. In the heaviest raid of WWII on Hayling Island, approximately 311 tonnes of HE bombs were dropped.

The nearest incidents to the Site during this raid are described below.

HE bombs (unspecified number) fell on Tournurbury Lane, within approximately 0.4km east of the Site.

1No. PM and several IBs fell on Hollow Lane, approximately 0.4km south of the Site.

1No. PM fell on Brights Lane, approximately 0.4km north-northwest of the Site. This was recorded as a UXPM.

23rd April 1941

3No. HE bombs fell on the searchlight battery at Gable Head, within approximately 0.1km south of the Site.

1No. HE bomb fell near St Patrick's Church, within approximately 0.3km north of the Site. It was recorded as a UXB.

2nd May 1941

2No. HE bombs fell in the vicinity of St Mary's Church, within approximately 0.2km of the Site.

17th May 1941

1No. HE bomb fell in the vicinity of St Mary's Church, within approximately 0.2km of the Site. It was recorded as a UXB.

14th June 1941

3No. Delayed Action Bombs (DABs) fell on St Mary's Road, within approximately 0.1km southeast of the Site. They later exploded.

15th August 1943

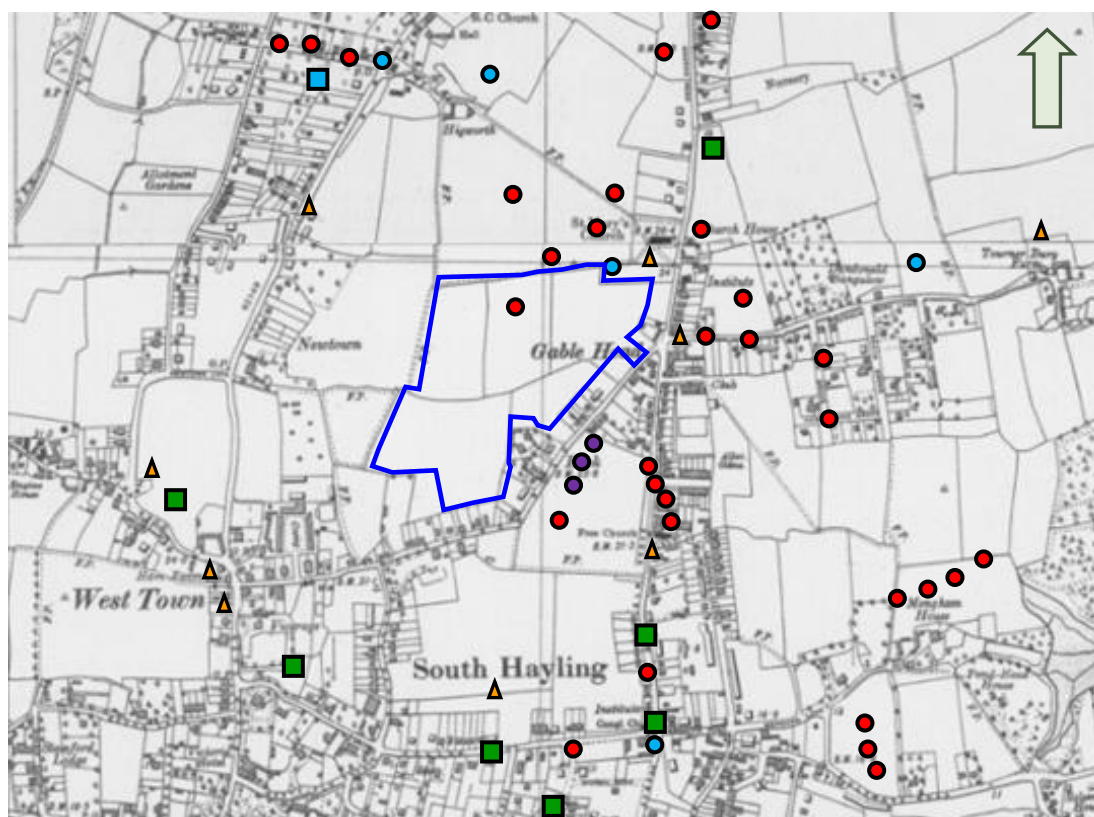
1No. 250kg HE bomb fell north of Tournerbury Lane, approximately 80m east of the Site.

1No. 50kg HE bomb fell on the meadow northwest of St Mary's Church, approximately 0.2km northwest of the Site.

It should be noted that during WWII, many UXB were mapped and subsequently removed as and when conditions and demands on Bomb Disposal teams allowed. Their removal was not always accurately recorded and sometimes records were later destroyed. In practice, most UXB were probably removed and only a much smaller number were actually registered as officially abandoned bombs.

Figure 4 is a map showing the approximate location of bomb impacts in the vicinity of the Site. IBs shown are indicative of larger numbers of these devices that fell within the given area. AA shells have been omitted for clarity. The map has been compiled from a number of different sources, including air raid incident reports, historical aerial photographs and bomb census maps.

Note that air raid incident reports did not always record precise locations, often only indicating on which street, area or farm a bomb fell.

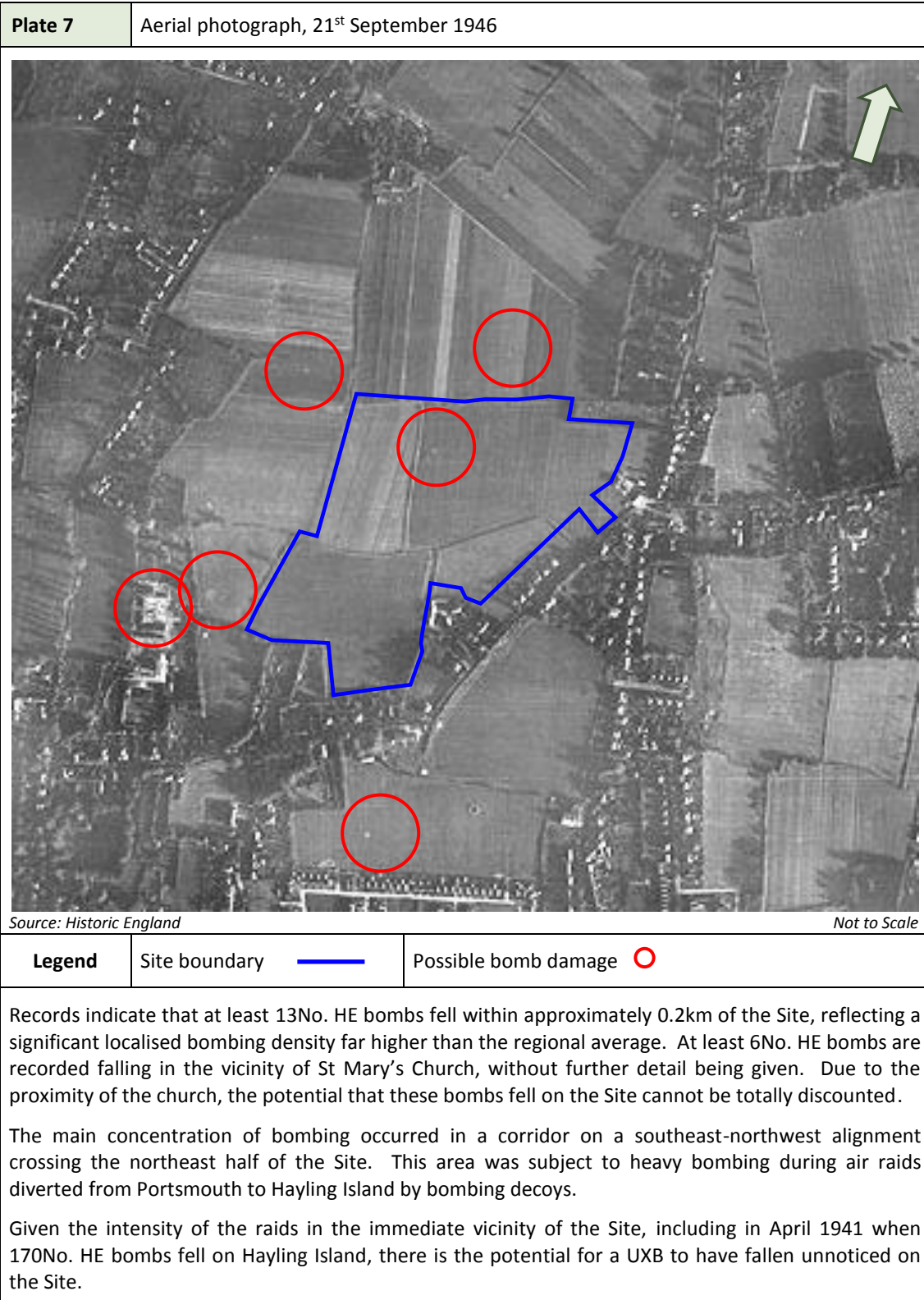


Source: © Crown Copyright 2016. Reproduced by permission of Ordnance Survey

Not to Scale

Legend	Site boundary	HE bomb	UXB	PM	UXPM	IBs
	DAB					

Plate 7 is an aerial photograph dated the 21st September 1946. Some possible residual bomb damage has been identified on and in close proximity to the Site.



WWII bombing is considered to provide a possible source of UXO hazard to the north-eastern part of the Site.

4.4 Geology and Bomb Penetration Depths

It is important to consider the geological materials present at the time that a bomb was dropped in order to establish its maximum penetration depth. The British Geological Survey (BGS) 1:50,000 Sheet 331 Portsmouth (Solid & Drift) and BGS borehole records were consulted.

The geology of the Site during WWII comprised River Terrace Deposits of sand, gravel and clay, overlying the London Clay Formation.

Table 2 provides an estimate of average maximum bomb penetration depths for the Site assuming WWII ground conditions of 2m of soft to firm clay over 1m of gravel, overlying more than 20m of stiff clay.

Table 2 Estimated average maximum bomb penetration depths

Estimated average bomb penetration depths for anticipated geology		
Bomb Weight	50kg	6.0m
	500kg	12.5m
	1,000kg	14.0m

The estimated bomb penetration depths given in Table 2 are from the WWII ground level and are based on the following assumptions:

- High level release of the bomb resulting in an impact velocity of 260m/s (>5,000m altitude).
- A strike angle of 10 to 15 degrees to the vertical.
- That the bomb is stable, both in flight and on penetration.
- That no retarding units are fitted to the bomb.
- That the soil type is homogenous.

A high altitude release of a bomb will result in ground entry at between 10° and 15° to the vertical with the bomb travelling on this trajectory until momentum is nearly lost. The bomb will then turn abruptly to the horizontal before coming to rest. The distance between the centre of the entry hole and the centre of the bomb at rest is known as the 'offset'. A marked lateral movement from the original line of entry is common.

Low-level attacks may have an impact angle of 45° or more, which will frequently lead to a much greater amount of offset movement during soil penetration.

The average offset is one third of the penetration depth, i.e. an offset of 2m may be expected for a 50kg bomb in dry silts and clays. If hard standings or Made Ground were present during WWII, bomb penetration depths would have been significantly reduced but offset distances may have been up to four times greater.

In low level attacks over deep water bodies, the offset distances from the point of entry at the water surface may be considerably enhanced due to hydrodynamic effects before the bomb penetrates or settles on the sea bed. Shallow water has little effect on bomb penetration depths during high level attacks.

5 WWII DEFENCES

5.1 Bombing Decoys

In order to draw enemy aircraft away from towns and other strategically important targets, a series of decoys were developed between 1940 and 1941.

They were estimated to have drawn at least 5% of the total weight of bombs away from their intended targets. Approximately 792No. static decoy sites were built at 593No. locations in England. In addition, numerous temporary and mobile decoys were deployed.

Several different types of decoy were devised:

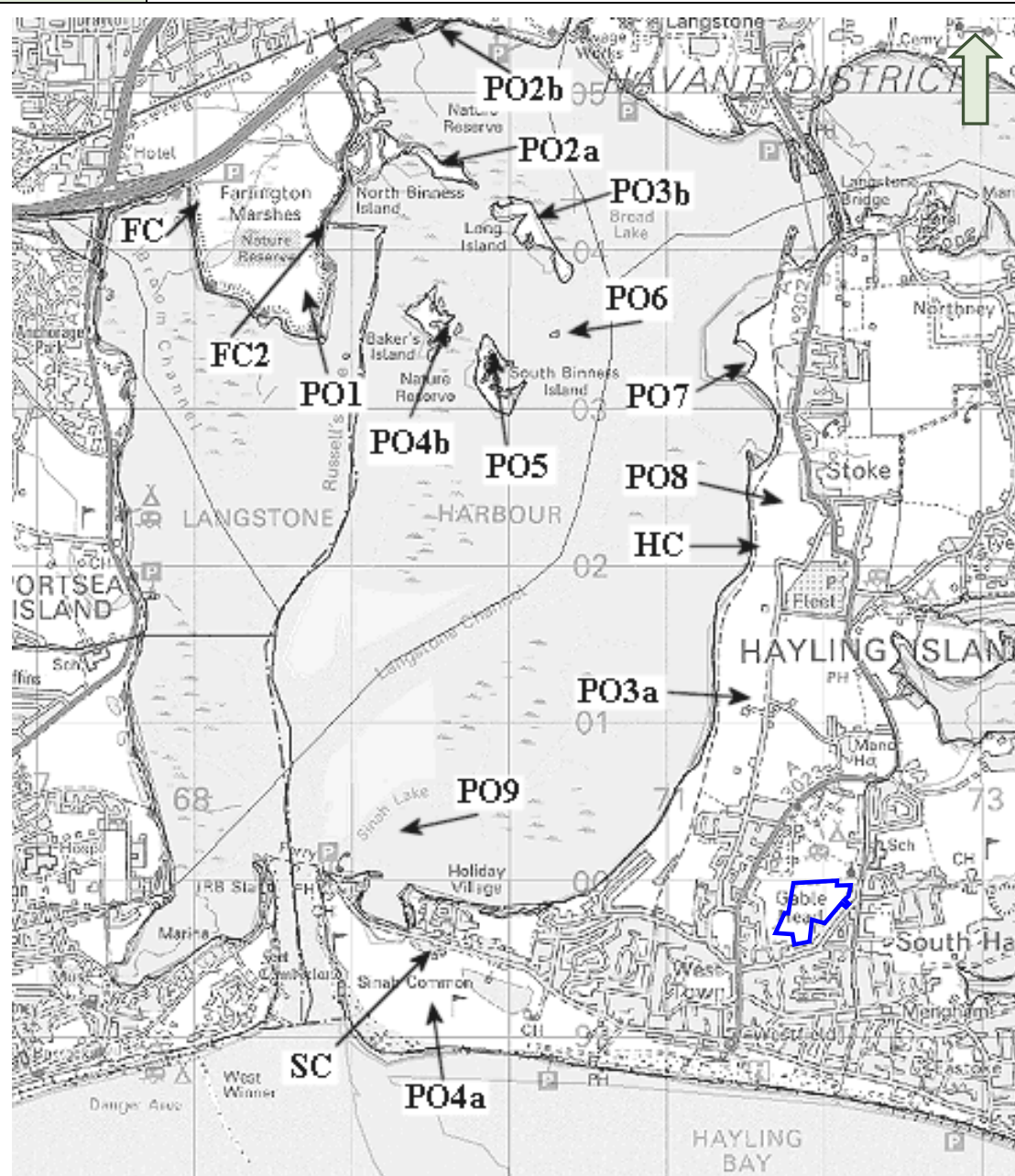
- Night time dummy airfields (Q sites).
- Daytime dummy airfields (K sites).
- Diversionary fires to simulate successful bombing raids on airfields (QF sites), petroleum depots (P sites) and major towns and cities (Starfish or SF sites).
- Simulated urban lighting (QL sites).
- Dummy Heavy Anti-Aircraft (HAA) batteries, factories and buildings (C series).
- Mobile decoys representing 'hards' for troop embarkation (MQLs), tanks and other vehicles.

Machine gun emplacements and Light Anti-Aircraft (LAA) guns were used to prevent possible enemy landings at decoy airfields.

By their nature, decoy sites provide a potential risk from Unexploded Bombs (UXB), both within the decoy site boundary and in the surrounding areas.

Due to the strategic importance of Portsmouth, numerous bombing decoys were established around Langstone Harbour. Figure 5 is a map showing the location of bombing decoys in the area surrounding the Site.

Figure 5 Plan of bombing decoys around Langstone Harbour, WWII



Source: Portsdown Tunnels

Not to Scale

Legend Site boundary

The nearest recorded bombing decoy was PO3a west of West Lane (SU 714012), approximately 1.2km northwest of the Site.

PO3a was part of an elaborate system of decoys designed to deflect bombing away from the docks and naval base at Portsmouth.

Records indicate that all the Portsmouth decoys were successful, and this accounts for the majority of the bombing on Hayling Island, including the raids of the 17th April 1941 and 16th May 1944.

Overspill from raids on these bombing decoys is considered to provide a possible source of UXO hazard to the Site.

5.2 Anti-Aircraft Defences

Anti-Aircraft (AA) gun batteries were targeted by the Luftwaffe. They were also a source of Unexploded AA (UXAA) shells which could land up to 27km from the firing point during WWII, although more typically fell within 15km. These could be distributed over a wide area.

AA batteries present a potential source of UXO hazard as a result of the storage, use and disposal of ordnance associated with the armaments used. They may have a risk from small caches of ammunition buried locally to them. 3No. types of AA batteries existed:

- Heavy Anti-Aircraft (HAA) batteries of large guns designed to engage high flying bomber aircraft. These tended to be relatively permanent gun emplacements.
- Light Anti-Aircraft (LAA) weaponry, designed to counter low flying aircraft. These were often mobile and were moved periodically to new locations around strategic targets such as airfields.
- Rocket batteries (ZAA) firing 3" or 3.7" AA rockets with a maximum altitude of 5,800m and a ground range of 9km were also relatively permanent emplacements.

Many AA batteries were associated with searchlights and consequently 'visible' at night, providing clear targets to the Luftwaffe bombers and a potential for UXB.

During WWII the Site was within the range of guns deployed in the Portsmouth and Chichester Gun Defended Areas (GDAs). Table 3 is a list of recorded HAA and ZAA batteries within 10km of the Site.

Table 3		WWII HAA and ZAA batteries within 10km of the Site		
Grid Reference	Serial No.	Location	Armament	Approximate Distance and Direction from Site
SZ 701997	P2	Sinah	4 x 4.5" guns	1.6km W
SZ 745988	CH10	Eastoke Farm	Unknown	2.5km ESE
SU 722037	P5	Hayling	4 x 5.25" guns	3.7km N
SU 673022	P24	Highgrove	4 x 3.7" guns	5.0 km NW
SZ 781978	CH9	West Wittering	Unknown	6.2km ESE
SU 648035	A	North End	UP tubes	7km NW
SU 686070	P11	Moorlands	4 x 3.7" guns	7.7km NNW
SU 793035	CH5	Childham	4 x 3.7" guns	7.9km NE
SZ 636987	B	Southsea Common	UP tubes	8.1km W
SZ 636989	P1	Southsea Common	4 x 4.5" guns	8.2km W
SU 728091	P20	Prospect Farm	Unknown	9.1km N

It should be noted that the lack of official records of HAA batteries or armaments cannot be taken to imply their absence because many units were mobile and were moved around as operational requirements dictated. Records have been found indicating that mobile batteries were positioned on Sinah Common, approximately 1.5km west-southwest of the Site.

Records have been found indicating that a mobile searchlight battery operated in the area that is now bordered by Cherrywood Gardens, St Mary's Road and Elm Grove, approximately 0.1km southeast of the Site.

Given the number of gun batteries in the surrounding area, the potential for a UXAA shell to have fallen unnoticed on the Site, whilst unlikely, cannot be totally discounted.

5.3 Barrage Balloons and Anti-Landing Obstacles

Balloon barrages were flown in many British towns and cities to protect against air raids. Their presence deterred low flying aircraft, making it more difficult for bombs to reach their intended targets. Barrage balloon sites can be a source of UXO as they were targeted by the Luftwaffe. They also often had a small explosive charge fitted with tilt fuzes attached approximately 50m from each end of the balloon cables and designed to detonate if the cables were hit by an aircraft.

Measures were also taken to prevent enemy aircraft landing in the event of invasion. Obstructions were constructed around airfields and on other open sites deemed fit for use as landing grounds. Solid obstructions (such as concrete blocks), posts or stakes, felled trees, haystacks, scaffolding with wire and trenching were the main measures used.

No records of any barrage balloons or anti-landing obstacles on or in close proximity to the Site have been found.

5.4 Anti-Invasion Defences

Defence structures are a potential source of UXB as they were especially targeted by low flying enemy aircraft, particularly during 'tip and run' raids which were common in industrialised regions. These defences may also be associated with small caches of UXO in the form of small arms, used by the troops manning the emplacement.

The rapid advance of German Troops into France, Holland and Belgium after the start of WWII prompted the War Office to review the vulnerability of the UK to invasion and a decision was taken to begin work on a national plan of anti-invasion defences. Static defences were built to interrupt and delay the progress of any invading force.

Coastal defences were strengthened (the 'Coastal Crust'). These defences included barbed wire entanglements and minefields, which were often combined to give defence in depth.

Inland, lines of defence structures were constructed along 'Stop Lines' in order to impede enemy progress for long enough to allow mobile defending forces to counter-attack.

Stop Lines included the fortification of key 'centres of resistance', such as river crossings and important road or rail junctions that could seriously hamper the enemy's advance across country. Bridges were mined for demolition and tank traps installed.

Stop Lines were further integrated into a network of fortified nodal points and 'Anti-Tank (AT) Islands'.

No records of anti-invasion defences on or in close proximity to the Site have been found.

5.5 Pillboxes, Mortar and Gun Emplacements

Defences also included spigot mortar positions and gun emplacements.

Spigot mortars, also known as Blacker Bombards, were used primarily in an anti-tank role at road blocks or to defend airfields. Typically, they fired a 20 pound (lb) HE mortar bomb. The fixed positions, in weapons pits with ammunition lockers, were frequently positioned near pillboxes.

Spigot Mortar positions could be either fixed or mobile.

No records of any spigot mortar or gun emplacements on or in close proximity to the Site have been found.

Pillboxes provide a potential UXO hazard both from the storage, use and disposal of ordnance associated with them and from UXB because they were targeted by enemy aircraft.

Pillboxes were common along Stop Lines, perimeters of airfields, potential land invasion sites and around important civil sites. Several different designs existed including Seagull Trenches (semi-buried structures), Alan Williams and Tett Turrets (small prefabricated pillboxes). Fortified sites, buildings or loop-holed walls also functioned as pillboxes.

At least 25No. pillboxes were established on Hayling Island.

1No. pillbox was located on the Site at approximately SZ720999, but no exact location is available. This pillbox was manned by armed personnel from HMS Northney 2, the camp immediately adjacent to the southeast corner of the Site. The pillbox has since been demolished. The Navy also had a guard post on Church Road.

Pillboxes and gun emplacements would have had small munitions stores, which would likely have been removed and transferred to ammunition depots at the end of WWII, although the possibility that munitions were disposed of locally cannot be completely discounted.

Pillboxes and gun emplacements are not considered to provide a source of UXO hazard to the Site.

5.6 Home Guard and Auxiliary Units

Local Defence Volunteers (LDV) units, later known as the Home Guard, were located in all cities, towns and large villages.

Anti-invasion defences were to be defended by the Home Guard and regular Army troops for as long as possible in the event of an invasion. The troops were issued with 'No Withdrawal' orders.

Important elements of the ordnance supply for the use of the Home Guard included substantial supplies of Mills bombs (fragmentation grenades) and Self Igniting Phosphorus (SIP) grenades as well as machine gun and small arms ammunition.

In October 2006 a cache of 76No. SIP grenades was found in a garden at Seend, Wiltshire. In October 2008, a further 26No. SIP grenades were discovered in a garden in Wimborne, Dorset.

Similar caches were discovered in October 2009 in Hove, Sussex and during May 2010 in Halesowen in the West Midlands, and a further cache of 20No. was uncovered on a construction site at Birdlip, Gloucestershire, in July 2010. Also in July 2010, a box of 24No. SIP grenades was found on Cogden Beach, Dorset. In April 2012, more than 8No. SIP grenades were found on a construction site in Banbury and destroyed by members of the Army Royal Logistic Corps (RLC).

More recently, in March 2015, 80No. SIP grenades were found at a building site in Eastbourne, some of which exploded before they could be made safe by a Bomb Disposal unit.

In all 8No. cases, the bottles were in good condition and exploded in flames when broken.

Most recently, in May 2016, 1No. No. 76 SIP grenade was found during excavation at Chapel Point, Lincolnshire forcing works to be delayed. During WWII, the site was occupied by a pillbox and gun emplacement associated with the heavily-defended 'Coastal Crust', manned by Home Guard units. The device was removed safely.

In addition to the regular Home Guard, Auxiliary Units existed which were made up of guerrilla troops trained in sabotage and assassination in case of invasion. Sites used by these Units were Top Secret and many locations are still unknown.

The 16th Hampshire (Havant) Home Guard Battalion operated in the local area, patrolling local transport infrastructure and manning anti-invasion defences.

The Home Guard carried out rifle, grenade and mortar training on a range in Tournurbury, approximately 0.7km east of the Site.

Home Guard activity is not considered to provide a source of UXO hazard to the Site.

5.7 Minefields and Mined Locations

Minefields were laid along the coast, in estuaries and along the banks of major rivers to deter infantry invasion. Strategic points such as bridges and gaps in cliffs were mined to impede enemy advance.

Most of the mined locations in the UK have been cleared and the risk of finding UXO in these areas is considered to be low.

No records of any minefields on or in close proximity to the Site have been found.

6 MILITARY AIRFIELDS

Military airfields offer the potential for significant UXO hazards due to the use, storage and disposal of ordnance and as a result of enemy bombing during WWI and WWII.

Airfields active during WWII were targeted by the Luftwaffe, providing a potential source of UXB on the airfield.

As bombing accuracy was so poor during WWII, it is likely to find UXB in the surrounding areas. Aircraft crashes are also associated with operational airfields.

No records of any military airfields on or in close proximity to the Site have been found.

The nearest operational airfield was Royal Air Force (RAF) Thorney Island (SU 762023), approximately 4km northeast of the Site. It was an RAF Coastal Command airfield but was also used by Fighter Command during the Battle of Britain.

The airfield continued to operate after WWII, until it was closed in 1976. In 1982 it was reopened by the Royal Artillery (RA), which still operates the facility today as Baker Barracks.

Military airfields are not considered to provide a source of UXO hazard to the Site.

6.1 Aircraft Crashes

Aircraft crash sites are a known UXO hazard. The MoD advises that if crashed aircraft are found, the safest policy is to leave them alone where possible. Unless disturbed there is no statutory requirement for the MoD to clear such sites.

No records of any military aircraft crashes on or in close proximity to the Site have been found.

7 EXPLOSIVES AND MUNITIONS ESTABLISHMENTS AND DEPOTS

Explosives and munitions manufacturing or storage sites offer a particularly high risk from both explosive substances and UXO. Standard procedures of explosive/ordnance disposal through burial or burning means that explosive and UXO hazards will be present in some areas of such establishments.

In addition, UXB hazards may be present as a result of enemy bombing during WWI and WWII.

7.1 Explosives and Ordnance Factories

No records of any explosives or ordnance factories on or in close proximity to the Site have been found.

7.2 Munitions Stores

Local ammunition caches would have been present near to defended road blocks, pillboxes, HAA and LAA sites. Most of those associated with the anti-invasion sites are understood to have been cleared.

No records of any official munitions stores on or in close proximity to the Site have been found.

1No. pillbox was located on the Site at approximately SZ720999, but no exact location is available. This pillbox was manned by armed personnel from HMS Northney 2, the camp immediately adjacent to the southeast corner of the Site. The pillbox has since been demolished.

Pillboxes and gun emplacements would have had small munitions stores, which would likely have been removed and transferred to ammunition depots at the end of WWII, although the possibility that munitions were disposed of locally cannot be completely discounted.

Pillboxes and gun emplacements are not considered to provide a source of UXO hazard to the Site.

7.3 Informal Munitions Depots

Informal munitions depots, often made by requisitioning roadside lay-bys or parks. Other informal munitions depots were commonly located in areas of woodland or on train wagons along sidings in marshalling yards.

No records of any informal munitions depots on or in close proximity to the Site have been found.

7.4 Munitions Disposal Areas and Bomb Cemeteries

Munitions disposal areas were often made by requisitioning open areas of land, usually away from habitation. Marshland, beaches or sand dunes were frequently used for this purpose. Disposal of munitions was carried out in many different ways, ranging from destruction to burial. Full records were not necessarily maintained for these locations, and so they can potentially be a source of UXO.

No records of any munitions disposal areas on or in close proximity to the Site have been found.

8 FIRING RANGES AND MILITARY TRAINING AREAS
By their nature, firing ranges and military training areas represent a potential source of UXO due to associated training activities. The training will involve both practice and live munitions and will offer a significant risk from a very wide range of potential UXO.
8.1 Small Arms Ranges
Small arms ranges (such as rifle ranges) and close combat ranges (such as mortar and grenade ranges) are likely to provide a significant source of UXO. It should be noted that even on small arms ranges, larger munitions such as mortars or grenades cannot be discounted.
No records of any small arms ranges on or in close proximity to the Site have been found. The Home Guard had a rifle, grenade and mortar range in Tournurbury, approximately 0.7km east of the Site. During WWI a 700yd range was established on Sinah Common, approximately 2.4km west-southwest of the Site, which was used for machine gun training. It was abandoned after WWI. Small arms ranges are not considered to provide a source of UXO hazard to the Site.
8.2 Artillery Ranges
Artillery ranges will have utilised a wide range of munitions, predominantly shells, although close combat munitions such as mortars, or larger munitions such as bombs, cannot be discounted.
No records of any artillery ranges on or in close proximity to the Site have been found.
8.3 Bombing Ranges
Bombing ranges will have primarily used bombs, although other munitions such as shells and close combat munitions such as mortars cannot be totally discounted.
No records of any bombing ranges on or in close proximity to the Site have been found.
8.4 Training Areas
Training areas will have primarily used blank ammunition or practice shells in 'dry' areas, although live munitions such as shells and close combat munitions such as mortars cannot be discounted in any training area.
No records of any military training areas on or in close proximity to the Site have been found. In May 1944, the 50th (Northumbrian) Infantry Division staged a mock amphibious landing, designated as Exercise Fabius II, on Hayling Beach, approximately 0.7km south of the Site, in preparation for the D-Day landings. Training areas are not considered to provide a source of UXO hazard to the Site.

9 EXPLOSIVE ORDNANCE CLEARANCE ACTIVITIES

Official UK bombing statistics have been compiled from both British and German sources. There were differences in the way the figures were originally reported and collated which has led to discrepancies in the summary data.

Based on data from 1939 to 1945, War Office statistics indicate that 200,195No. HE bombs exploded within Great Britain. Additionally, 25,195No. HE bombs (representing 11%) were recorded as UXBs. However, records from the Royal Engineers who were responsible for bomb disposal at the time indicate that as of 27th February 1946 upwards of 45,000No. UXBs were disposed of.

On average 8.5% UXBs later self-exploded. In some cases, the bombs had delayed action fuzes or were never intended to explode, their purpose being to cause inconvenience and fear.

Given the discrepancy in records and the fact that UXBs are still being found unexpectedly, it is clear that the original figures are understated and provide only an approximation of the number of potential UXBs in the UK.

War Office statistics also show that between October 1940 and May 1941 most of the UXBs (93%) were either 50kg or 250kg. It should be noted that details of the recovery and the size of the UXB were not always accurately reported.

The larger WWII UXBs are often difficult to recover due to both penetration depths and the presence of two or more fuzes, combined with more sensitive fillings of explosive mixtures including Amatol and Trialen.

9.1 Abandoned Bombs

No records of any officially registered abandoned bombs on the Site have been found.

9.2 EOC Tasks

Zetica Ltd holds the following records of post-WWII EOC tasks taking place in the vicinity of the Site.

19th August 2002

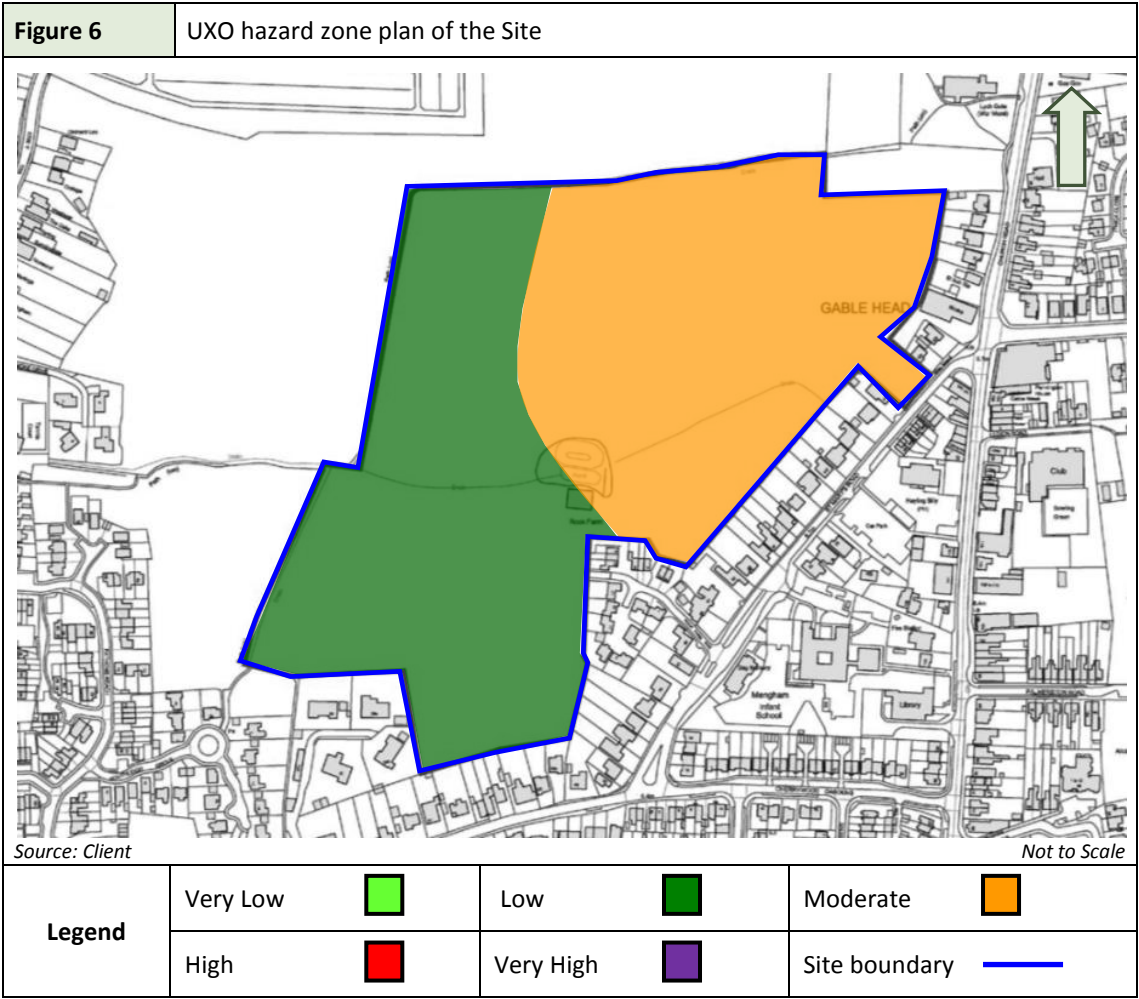
1No. WWII shell washed up on the beach near the Ferry Boat Inn, approximately 2.8km west of the Site. It was detonated in situ.

9th August 2012

1No. grenade was discovered at a caravan site near Itchenor Road, approximately 2.5km east-southeast of the Site.

The MoD has provided no additional information on official EOC tasks on the Site.

10 UXO HAZARD ASSESSMENT	
10.1 UXO Hazard Level	
The definitions for the levels of UXO hazard are provided below.	
Definitions of UXO Hazard Level for a Site	
Hazard Level	Definition
Very Low	There is positive evidence that UXO is not present, e.g. through physical constraints or removal.
Low	There is no positive evidence that UXO is present, but its occurrence cannot be totally discounted.
Moderate	There is positive evidence that ordnance was present and that other uncharted ordnance may be present as UXO.
High	There is positive evidence that UXO is present.
Very High	As high, but requires immediate or special attention due to the potential hazard.
Records indicate that during WWII at least 13No. HE bombs fell in the immediate vicinity of the Site, which was on the main flightpath towards the Royal Navy dockyards at Portsmouth. This included bombs falling during heavy raids in April 1941 and August 1943. The main concentration of bombing was in a southeast-northwest direction across the Site. Given the elevated bombing density in this area, it is considered possible that a UXB could have fallen unnoticed on the Site and remained in situ. Therefore, it is considered prudent to assign the northern and eastern parts of the Site a moderate UXO hazard level to account for the possibility that a UXB is present. No evidence of significant bombing or other sources of UXO hazard has been identified on the remainder of the Site, which is assigned a low UXO hazard level Given this, it is considered that the UXO hazard level on the Site can be tentatively zoned from low to moderate, as shown in Figure 6.	



11 UXO RISK ASSESSMENT

11.1 UXO Risk Level

A UXO risk assessment has been undertaken for the proposed works, taking into consideration the identified UXO hazard.

Firstly, the probability of encountering UXO (PE) has been considered and rated for the different construction techniques, as detailed below.

Probability of Encounter (PE)	Rating
Frequent, highly likely, almost certain.	5
Probable, more likely to happen than not.	4
Occasional, increased chance or probability.	3
Remote, unlikely to happen but could.	2
Improbable, highly unlikely.	1
Impossible	0

Secondly, the probability of detonating a UXO (PD) has been considered and rated for the different construction techniques, as detailed below.

Probability of Detonation (PD)	Rating
Frequent, highly likely, almost certain.	5
Probable, more likely to happen than not.	4
Occasional, increased chance or probability.	3
Remote, unlikely to happen but could.	2
Improbable, highly unlikely.	1
Impossible	0

Next, the probability of encountering and detonating the UXO (PE x PD) have been used to generate an overall likelihood rating (P).

P = PE x PD	LIKELIHOOD of Encounter and Detonation	Rating
20 to 25	Frequent, highly likely, almost certain.	5
13 to 19	Probable, more likely to happen than not.	4
6 to 12	Occasional, increased chance or probability.	3
2 to 5	Remote, unlikely to happen but could.	2
1	Improbable, highly unlikely.	1
0	Impossible	0

P ranges from 25, a certainty of UXO being encountered and detonated on the Site by engineering activity, to 0, a certainty that UXO does not occur on the Site and will not be detonated by engineering activity.

The likelihood of encountering and detonating UXO during site works is multiplied by the severity of such an event occurring (P x S), in order to provide a risk level using the following matrix.

Severity (S)	Rating
Multiple fatalities	5
Major injury, long term health issues, single fatality.	4
Minor injury, short term health issues, no fatalities.	3
First aid case but no lost time or ill health.	2
Minor injuries, no first aid.	1
No injuries.	0

UXO Risk Matrix							
LIKELIHOOD (P)	SEVERITY (S)						
		5	4	3	2	1	0
	5	25	20	15	10	5	0
	4	20	16	12	8	4	0
	3	15	12	9	6	3	0
	2	10	8	6	4	2	0
	1	5	4	3	2	1	0
	0	0	0	0	0	0	0

The final risk assessment for the Site is given in Table 4.

Table 4	UXO risk assessment for the Site								
Hazard Zone	Potential UXO Hazard	Anticipated Works	PE	PD	P = PE x PD	Likelihood	Severity	Risk Rating	UXO Risk
Mod	UXB	Shallow Excavations	3	2	6	3	5	15	Moderate
		Deep Excavations	4	3	12	3	5	15	Moderate
		Piling/boreholes	2	4	8	3	4	12	Moderate
	Other UXO	Shallow Excavations	1	1	1	1	4	4	Low
		Deep Excavations	1	1	1	1	4	4	Low
		Piling/boreholes	1	1	1	1	3	3	Low
Low	UXB	Shallow Excavations	1	1	1	1	5	5	Low
		Deep Excavations	1	1	1	1	5	5	Low
		Piling/boreholes	1	1	1	1	4	4	Low
	Other UXO	Shallow Excavations	1	1	1	1	4	4	Low
		Deep Excavations	1	1	1	1	4	4	Low
		Piling/boreholes	1	1	1	1	3	3	Low
PE (Probability of Encounter), PD (Probability of Detonation), P (Overall Probability)									
Shallow excavations defined as <1.0m below ground level (bgl).									

UXO Risk	Matrix Rating	Definition
Very Low	0-1	Little action is required by the client provided that suitable records and procedures are in place to ensure appropriate action is undertaken should the UXO risk level change.
Low	2-5	Tolerable to the client as engineering activity need not alter if UXO related procedures and controls are strictly adhered to.
Moderate	6-15	May be tolerable for the client, but it is prudent to reduce the risk where cost effective and reasonably practicable.
High	16-20	Tolerable to the client only where further risk reduction is impracticable or disproportionate to the risk involved. Essential that all practicable measures are taken to reduce the level of risk.
Very High	21-25	Unacceptable to the client except in extraordinary circumstances. Imperative that all control measures are taken.

11.2 Risk Mitigation Recommendations

To ensure that the UXO risk is reduced to As Low As Reasonably Practicable (ALARP) the following mitigation is advised:

Low Risk

Where a low risk of UXO encounter is anticipated, industry good practice is simply to raise the awareness of those involved in excavations so that in the unlikely event that a suspect item is discovered, appropriate action is taken. This can be achieved through UXO awareness briefings to site staff.

Clearance certification for borehole or pile locations is considered prudent only if a zero tolerance to risk is adopted. Zero tolerance is commonly adopted for sites that have safety critical infrastructure such as nuclear establishments and oil refineries.

Moderate Risk

For all intrusive works, the raising of awareness (as per low risk) is considered essential.

For excavations, non-intrusive UXO detection methods and intrusive investigation of identified targets is recommended.

Where UXO detection is not feasible due to ground conditions, restricted access or programme, an Explosive Ordnance Clearance (EOC) Engineer can be used to supervise during excavation works. The EOC Engineer will carry out a visual assessment on any suspect items uncovered and classify them as potential UXO or other material.

Clearance certification for any borehole or pile locations is considered essential. This can be achieved by advancing a magnetometer into the ground at the borehole or pile location in order to provide detection of ferrous metal targets such as UXB. Assuming no objects comparable to the UXB detection range are identified, then the borehole or pile position can be considered clear of UXB.

Table 5 gives recommended actions in relation to the potential UXO risk level and the anticipated Site activity.

Further advice on the mitigation methods can be provided by Zetica on request.

Table 5		Risk mitigation for assumed Site activities			
Risk Level	Typical Future Activity on the Site				
	None	Shallow Excavations (<1.0m)	Deep Excavations (>1.0m)	Boreholes or Pile Construction	
Very low	Ensure suitable records and procedures are in place to highlight the risk should future development be planned.	Ensure site staff, are informed as part of the site safety induction that the potential presence of UXO cannot be discounted. Appropriate action is required to be detailed within site procedures.	Ensure site staff, are informed as part of the site safety induction that the potential presence of UXO cannot be discounted. Appropriate action is required to be detailed within site procedures.	Ensure site staff, are informed as part of the site safety induction that the potential presence of UXO cannot be discounted. Appropriate action is required to be detailed within site procedures.	
Low	As very low.	As very low. + It is considered prudent to include some UXO awareness training in site inductions.	As very low. + It is considered prudent to include some UXO awareness training in site inductions.	As very low. +Clearance certification for borehole or pile locations would be considered prudent only if a zero tolerance to risk is adopted. Zero tolerance is commonly adopted for sites that have safety critical infrastructure such as nuclear establishments and oil refineries.	
Moderate	As very low.	As low. +Non-intrusive investigation methods considered prudent where practical. +Alternatively, EOC Engineer supervision is considered prudent.	As low. +Non-intrusive investigation methods considered prudent where practical. +Alternatively, EOC Engineer supervision is considered prudent.	As low. +Clearance certification for borehole or pile locations is considered essential.	
High	As very low.	As moderate. +Non-intrusive investigation methods considered essential where practical. + Alternatively, EOC Engineer supervision is considered essential.	As moderate. +Non-intrusive investigation methods considered essential where practical. + Alternatively, EOC Engineer supervision is considered essential.	As moderate.	
Very High	Requires immediate or special attention.	Requires immediate or special attention.	Requires immediate or special attention.	Requires immediate or special attention.	
The above table is for guidance only.					

Appendices

Appendix 1 WWII Bombing Incident List

August 1940 (date unspecified)

1No. HE bomb fell on the western end of Palmerston Road, approximately 0.2km east-southeast of the Site.

1No. HE bomb fell on Hollow Lane, approximately 0.4km south of the Site.

2No. HE bombs fell on the junction of Manor Road and Havant Road, approximately 0.7km north-northeast of the Site.

25th August 1940

4No. HE bombs fell on Elm Grove, approximately 0.4km south-southeast of the Site.

September 1940 (date unspecified)

IBs fell on Tourner Farm, approximately 0.7km east of the Site.

1No. HE bomb fell on Hayling Golf Course, approximately 1km southwest of the Site.

9th September 1940

2No. HE bombs fell on Church Road, approximately 0.5km north of the Site.

5th January 1941

1No. AA shell fell on St Mary's Road, less than 0.1km east-southeast of the Site. It was recorded as a UXAA shell.

9th January 1941

An AA searchlight position on Elm Grove, approximately 0.2km southeast of the Site, was strafed with machine gun fire.

20th January 1941

1No. HE bomb fell on a field in the vicinity of St Mary's Church, within approximately 0.2km of the Site.

10th March 1941

4No. HE bombs fell in the open near Mengham, within approximately 0.5km to the southeast of the Site.

1No. HE bomb fell on St Helen's Road, approximately 1.2km southwest of the Site. It was recorded as a UXB.

11th March 1941

4No. HE bombs fell near Mengham House, approximately 0.7km southeast of the Site.

13th March 1941

1No. HE bomb fell near Tournerbury Lane, within approximately 0.4km east of the Site. It was recorded as a UXB.

9th April 1944

5No. HE bombs fell on open ground behind Hayling Council School, approximately 0.9km northeast of the Site.

17th April 1941

On the night of 17th/18th April 1941 the decoys on Hayling island attracted a significant number of Luftwaffe bomber aircraft away from Portsmouth. In the heaviest raid of WWII on Hayling Island, approximately 311 tonnes of HE bombs were dropped.

HE bombs (unspecified number) fell on Tournurbury Lane within approximately 0.4km east of the Site.

1No. PM and several IBs fell on Hollow Lane, approximately 0.4km south of the Site.

1No. PM fell on Brights Lane, approximately 0.4km north-northwest of the Site. It was recorded as a UXPM.

2No. PMs and several IBs fell on Elm Grove, 0.5km east-southeast of the Site.

5No. PMs fell on fields west of St Patrick's Church, within approximately 0.7km north-northwest of the Site.

1No. PM fell near Manor House, approximately 0.8km north of the Site. It was recorded as a UXPM.

1No. HE bomb fell on South Hayling Station, approximately 0.8km west of the Site. It was recorded as a UXB.

1No. PM and several IBs fell on Station Road (exact location unspecified), within approximately 0.8km of the Site.

1No. PM fell near Hayling Council School, approximately 0.9km northeast of the Site. It was recorded as a UXPM.

HE bombs (unspecified number) and IBs fell across St Catherine's Road, approximately 1km west of the Site.

1No. PM fell near the junction between St Catherine's Road and Park Road, approximately 1km west of the Site. It was recorded as a UXPM.

23rd April 1941

3No. HE bombs fell on the searchlight battery at Gable Head, within approximately 0.1km south of the Site.

1No. HE bomb fell near St Patrick's Church, within approximately 0.3km north of the Site. It was recorded as a UXB.

26th April 1941

Many IBs fell on South Hayling within 0.2km south of the Site.

2nd May 1941

2No. HE bombs fell in the vicinity of St Mary's Church, within approximately 0.2km of the Site. Several HE bombs fell on Brights Lane, approximately 0.5km north-northwest of the Site. 1No. was recorded as a UXB.

4th May 1941

Several HE bombs fell near the junction between Park Road and St Catherine's Road, approximately 1.1km west of the Site.

17th May 1941

1No. HE bomb fell in the vicinity of St Mary's Church, within approximately 0.2km of the Site. It was recorded as a UXB.

14th June 1941

3No. Delayed Action Bombs (DABs) fell on St Mary's Road, in the immediate vicinity of the south-eastern boundary of the Site. They later exploded.

2No. HE bombs fell near Mengham within 1km southeast of the Site.

1No. DAB fell near Mengham within 1km southeast of the Site. It exploded the next day.

26th June 1941

2No. PMs fell on Chichester Avenue, approximately 0.5km south of the Site.

Unspecified Dates between June and September 1941

1No. AA shell fell on Elm Close, approximately 0.4km south of the Site. It was recorded as a UXAA shell.

1No. HE bomb fell southwest of the Regal Cinema, approximately 0.5km southeast of the Site. It was recorded as a UXB.

21st September 1941

1No. HE bomb fell on the beach in Hayling Bay, approximately 0.8km south of the Site.

6th December 1942

1No. PM fell west of Church Road, near St Mary's Church, approximately 0.3km northeast of the Site.

11th December 1942

1No. AA shell fell on Westfield Avenue, approximately 0.4km south of the Site. It was recorded as a UXAA shell.

29th January 1943

1No. AA shell fell northwest of South Hayling Station, approximately 0.8km west of the Site. It was recorded as a UXAA shell.

15th August 1943

1No. 250kg HE bomb fell north of Tournurbury Lane, approximately 80m east of the Site.

1No. 50kg HE bomb fell on the meadow north of St Mary's Church, approximately 0.2km north of the Site.

1No. HE bomb fell on Poplar Grove approximately 0.4km east of the Site.

1No. 500kg HE bomb fell on Hawthorne Grove, approximately 0.4km east of the Site.

2No. HE bombs and IBs fell west of West Lane, approximately 0.5km west of the Site.

1No. 1,000kg HE bomb fell on the Manor Farm Cottages garden, approximately 0.6km north of the Site.

2No. 50kg HE bombs fell on fields northwest of Manor House, approximately 0.8km north of the Site.

1No. 50kg HE bomb fell on an orchard adjacent to Manor Farm, approximately 1km north of the Site.

16th May 1944

6No. HE bombs fell near South Hayling Station, approximately 0.8km west of the Site.

Appendix 2 UXO Hazard and Ordnance Types

When assessing the risk from UXO including UXB, it is important to be aware of ordnance type and function. The following Section briefly describes the more common types of UXO. More data on these can be found at <http://zeticauxo.com/guidance/ordnance-data-sheets/>.

A2.1 Small Arms Ammunition

Small Arms Ammunition (SAA) is one of the more recognisable categories of ordnance which is primarily designed for anti-personnel use. SAA include items such as bullets, generally up to a calibre (diameter) of 20mm.

Larger calibre small arms munitions can contain fuze mechanisms and high explosives or pyrotechnic fillings and may have been used for anti-aircraft or anti-vehicle purposes.

Generally small arms ordnance has a relatively low risk as UXO, although the larger calibre categories may have the same detonation risk as larger high explosive ordnance. SAA is often associated with discarded ammunition boxes around firing practice ranges. The Plate below illustrates some common SAA.

Plate

Photograph of typical WWII small arms ammunition



Source: Google Images

A2.2 Hand Grenades

Hand grenades can be filled with explosives or chemicals and have 3No. main parts, a body, a fuze with a pull ring and a safety-clip assembly. Fragmentation grenades are the most common and have a metal or plastic body filled with an explosive. Most use a burning delay fuze that functions for 3 to 5 seconds after the safety lever is released.

Some, such as smoke grenades, are activated instantly when the lever is released. The Plate below illustrates the typical character and condition of No. 36 hand grenades (Mills Bombs) that have been excavated from a site.

Plate	Photographs of a typical and an excavated WWII No. 36 hand grenades
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Source: Google Images



Source: Zetica Ltd

A2.3 Projected Grenades

Projected grenades are among the most commonly found UXO items, particularly the 40mm type. These contain high explosives and use a variety of fuzes, including some of the most sensitive internal impact-fuzing systems. They are extremely dangerous and can explode if moved or handled.

A2.4 Mortars

A mortar is a short tube designed to fire a projectile at a steep angle. Mortars can range from approximately 50mm to 280mm in diameter and can be filled with explosives, toxic chemicals, white phosphorous or illumination flares. They generally have a thinner metal casing than projectiles, but use the same types of fuzing and stabilisation.

During WWII there are records that the target areas of RAF practice bombing ranges were occasionally used for mortar training.

The Plate below shows a typical 2-inch mortar bomb found (left) and a demonstration 3-inch mortar bomb (right).

Plate	Photographs of WWII 2-inch and 3-inch mortars
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Source: Daily Mail



Source: Zetica Ltd

A2.5 Shells

Shells are a projectile containing an explosive charge designed to burst the casing that can contain High Explosives, pyrotechnic compounds or other chemicals.

Shells can be found in a range of sizes, from <20mm to several times this size. The most likely shells to be found on the Site are Small Arms Ammunition (SAA) or UXAA shells that have fallen back to the ground unexploded.

Most commonly used anti-aircraft shells were 2" and 3.7" HE shells.

If fired and found as UXO, shells can offer a particular hazard from accidental detonation as they can have sensitive fuze mechanisms. A fuze is a device which incorporates mechanical, electrical, chemical or hydrostatic components to initiate a train of fire or detonation.

The Plate below is a photograph of a 3.7" UXAA shell found in Camberwell, London.

Plate	Photograph of a recently excavated 3.7" AA shell
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Source: Zetica Ltd

A2.6 Incendiary Bombs

Incendiary Bombs (IBs) ranged from small 1kg thermite filled, magnesium bodied bombs to a 250kg 'Oil Bomb' (OB) and a 500kg 'C300' IB. By far the most common air dropped devices across the UK during WWII were small 1kg to 2kg IBs.

In some cases, the IBs were fitted with a very small High Explosive (HE) bursting charge. This exploded after the bomb had been alight for a few minutes causing burning debris to be scattered over a greater area. The C300 bombs were similar in appearance to 500kg HE bombs.

The small amount of HE, if any, and the almost negligible potential for IBs to remain active after more than 65 years in the ground means that these items have very little prospect of causing damage. In the majority of cases if IBs are found in the ground, the incendiary materials have deteriorated to such an extent that they are considered to provide a low UXO hazard level.

However, since magnesium and phosphorus were common components in IBs, some localised chemical contamination may occur where the contents have leached out of the IB into the surrounding soil.

The Plate below shows a typical variety of fragmentary remains of IBs and 2No. IBs recovered by the Civil Defence during WWII.

Plate	Photographs of typical fragmentary remains of IBs and a UXIB
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Source: Swansea Museum



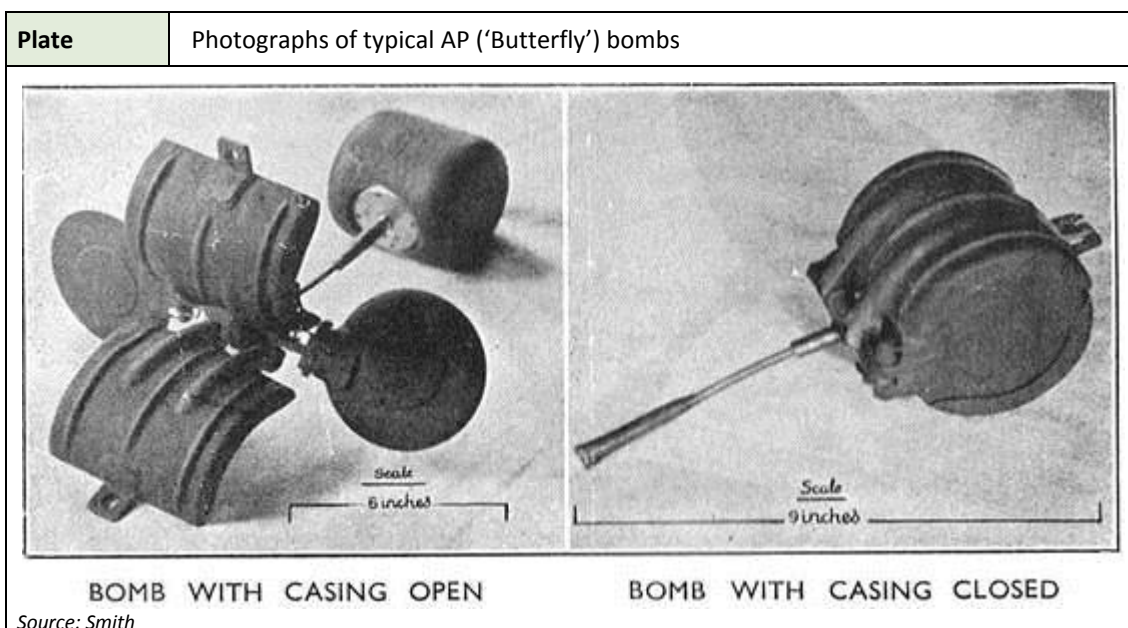
Source: Museum of London

A2.7 Anti-Personnel Bombs

2No. types of Anti-Personnel (AP) bombs were in common use, the 2kg and the 12kg bomb. The 2kg bomb could inflict injury across an area up to 150m away from the impact, within 25m of this, death or fatal injury could occur.

In the majority of cases WWII AP bombs were so sensitive to disturbance that none have been found since WWII as UXAPB and it is considered very unlikely that such an item would be found buried as an UXAPB

The Plate below shows typical AP ('Butterfly') bombs recovered by the Civil Defence during WWII.



Source: Smith

A2.8 German High Explosive Bombs

Probably the most common and certainly most publicised UXOs to be found in the UK are bombs. Air dropped bombs, as a result of WWII enemy action, are found on a relatively frequent basis as UXO. They tend to be highly publicised (at least on a local basis) due to the common disruption where an evacuation of the potentially affected area is put in place.

The amount of High Explosive and the potential for a fuze to still be activated means that these devices have the prospect of causing some of the most widespread damage. WWII bombs were particularly sophisticated for their time, with anti-tamper fuzes.

Many German bombs were designed to not explode on impact and instead to cause disruption as a UXB. Some fuzes were set with a delay time of over 70 hours. During this time, an anti-tamper fuze could also be activated to detonate should it be disturbed.

The most commonly used bombs during WWII were the 50kg and 250kg sized general purpose bombs. Less frequently, the 500kg bomb was also used. Larger bombs were used, but so infrequently that any assessment of hazard is more typically based on bombs ranging up to 500kg only.

It should be noted that the June 2008 find of a 1000kg bomb in London, does demonstrate that larger bombs can be found and any risk mitigation measures should consider this.

The Plate below shows the variety of UXB recovered by the Civil Defence during WWII.

Plate	Photograph of a variety of UXB recovered by the Civil Defence during WWII
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Source: Imperial War Museum

A2.9 Detonators, Gains and Fuzes

Bomb components such as detonators, gains and fuzes were stored at operational airfields during WWII and typically contained some type of explosive charge to initiate the detonation of a munition.

A wide variety of these components were used and examples of some common fuzes are shown in the Plate below.

Plate	Photographs showing examples of WWII fuzes
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Source: Zetica Ltd

A2.10 Land Mines

Wartime activities provide numerous sources of UXO within the land environment. Whilst efforts have been made to clear the known British minefields, it was common for mines to become lost for a variety of reasons and so not recovered. Additionally, such munitions might have been disposed of on an unofficial basis and so no records were kept.

Most of the mined beaches and other land areas in the UK have been cleared by the MoD. Occasionally, wave action or activities such as bombing caused mines to become displaced and these were missed as part of any past clearance activities.

The Plate below is a photograph of a typical WWII land mine used on the land area, beaches and cliffs around Britain. This example was found at Gatwick Airport formerly RAF Gatwick.

Plate

Photographs of original and recently excavated WWII land mines



Source: Google Images



Source: Zetica Ltd

A2.11 Flame Barrels (Flame Fougasse)

Flame barrels were 40 gallon oil drums concealed by roadsides with built-in explosive charges designed to blast the flaming barrel onto the road in the path of oncoming enemy vehicles. The barrels were filled with oil and petrol, and a fulminate of mercury detonator was placed in the explosive charge.

A2.12 Home Guard Weapons

Initially, the Home Guard's armoury was largely second-hand and much of it was of WWI vintage. Personal weapons (such as shotguns) and home-made devices were also employed.

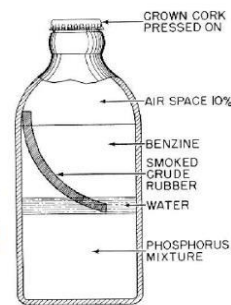
By the end of WWII, some units were well equipped with a wide variety of small arms and munitions.

These included .32, .38 and .455 revolvers, .303 P14, .300 P17 and .303 Canadian Ross rifles, anti-tank rifles and a variety of Sub- Machine Guns (SMG) such as the .45 Thompson and 9mm Sten Guns.

Other heavier Machine Guns (MG) at their disposal included Browning, Hotchkiss, Lewis, Vickers and Marlin MG. Sub-artillery weapons were developed for them, including grenade throwers (the Northover Projector) and spigot mortars (the Blacker Bombard). 2-pdr anti-tank guns and Projector, Infantry Anti Tank (PIAT) weapons were in circulation amongst some units, and the Home Guard also manned AA guns later in WWII.

Explosives were available to some Home Guard units and were used and stored by all Auxiliary Unit patrols. As well as the flame fougasse and hand grenades detailed in this Appendix, the Home Guard had stocks of Molotov Cocktails, Sticky Bombs and SIP grenades.

The Plate below is a photograph of a No. 76 SIP grenade (LHS) with an explanatory leaflet produced by ZeticaUXO for site staff (RHS).

Plate	Photograph of the No. 76 SIP grenade
	zeticauxo Information Data Sheet Category Grenades Type No. 76 Self-Igniting Phosphorus Grenade Variants - Dimensions 152.4mm x 63.5mm (6" x 2.5") Weight 1lb Fuze Self-igniting upon breakage Material Glass Description Glass bottle filled with white phosphorus, benzene, water and crude rubber. Function Introduced as an emergency anti-tank measure for the Home Guard early in WWII. Intended to ignite the engine compartment of advancing tanks.  

Source: Zetica Ltd

Given the irregular nature of Home Guard activity, the possibility of items of UXO or weapons being discovered at any locations occupied or used for training by them can never be totally discounted.

A2.13 UXO Migration

It is possible for explosive material, UXO or ordnance scrap to migrate to a site during landfill or dredging operations or other ground works which import Made Ground or natural materials already containing UXO. It is important to understand the nature and age of such landfill or dredging operations when assessing the potential UXO hazard level on the site.

A2.14 Effects and Consequences

There have been a limited number of recorded incidents in the UK since WWII where bombs have detonated during engineering works, though a significant number of bombs have been discovered. Incidents involving smaller ordnance are, however, relatively common in the UK.

In the UK, there are no recorded incidents since the decade after WWII, of a UXB accidentally detonating. In recent years, bombs have been found that have fuze mechanisms that have started to operate indicating that given the right conditions a UXB may still function.

In June 2008 the UXB uncovered in the Lea Valley caused difficulty to No. 33 Regiment (Explosive Ordnance Disposal) Royal Engineers because the fuze mechanism started to operate.

The 1,000kg 'Hermann' bomb, the first of this size to be found in over 30 years, took 5 days to deactivate. This demonstrates that larger bombs can be found and any risk mitigation measures should provide the option to deal with this size of device. Since WWII, UXBs have been found on a regular basis in London.

Since WWII, UXBs have been found on a regular basis throughout Britain. Some of the most recent cases are described below.

In May 2009 1No. 50kg WWII bomb was found on a building site in Bexhill-on-Sea, Sussex, and on the 16th August 2009, 1No. 250kg WWII bomb was found near Ebberston, North Yorkshire. Both of these were destroyed in controlled explosions by Bomb Disposal Units.

On the 8th March 2010 1No. 500kg WWII bomb was found at Bowers Marsh in Essex by Zetica EOC operatives following a Zetica desk study concluding a high risk of UXB on the site. The bomb was demolished in situ by members of the Army Royal Logistics Corps (RLC).

The Plate below is a photograph of the bomb in situ.

Plate	Photograph of the 500kg WWII UXB at Bowers Marsh, 8 th March 2010
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Source: Zetica Ltd

On the 23rd February 2011, 1No. WWII UXB was found on a building site in Nottle Street in Plymouth City centre. The bomb was removed by EOD personnel and demolished at sea.

On the 22nd July 2012, a landslip in the cliffs at Mappleton in the East Riding of Yorkshire exposed over 1,000No. UXO items, including practice bombs, mortars, rockets, shells and grenades. The cliff was part of a former bombing and artillery range, used during WWII and until the 1970s.

UXO items were removed by Explosive Ordnance Disposal (EOD) officers from Catterick and MoD staff from Leconfield. 15No. controlled explosions were undertaken by the Royal Engineers (RE) to detonate the more volatile items in situ, while other less hazardous UXO devices were left in place to be dealt with at a later date.

1No. WWI bomb (shown in the Plate below) was found on the Isle of Sheppey on the 2nd August 2012 during a geophysical survey following desk study research by Zetica Ltd which had established that a previously unknown WWI bombing range existed on the site. A further WWI bomb was found in the same location in August 2015.

Plate

Photograph of WWI bomb, Isle of Sheppey, 2nd August 2012



Source: Zetica Ltd

On the 23rd March 2015, 1No. WWII 500kg UXB was found on a building site in The Grange, Bermondsey. The bomb was made safe by EOD personnel and removed for demolition.

On the 21st May 2015, 1No. 50kg UXB was found on a building site near Wembley Stadium, London Borough of Brent. The bomb was made safe by EOD personnel and removed for demolition.

On the 10th August 2015, 1No. 250kg UXB was found under the basement of a building site at Bethnal Green, London Borough of Tower Hamlets. It was made safe and removed by an EOD team from the RLC.

On the 21st September 2015, 1No. UXB was uncovered on a construction site in Cheylesmore, Coventry, by the operator of a mechanical digger. It was destroyed in situ by an EOD team from the RLC.

In January 2016, Zetica discovered 3No. 500lb British UXB at a former airfield in Cambridgeshire. These were destroyed in controlled explosions. The Plate below is a photograph of one of the bombs.

Plate	Photograph of a recently excavated WWII British 500lb GP bomb
	
<i>Source: Zetica Ltd</i>	
On the 12th May 2016, 1No. 250kg UXB was found on a building site in Bath. It was made safe and then taken to a local quarry for demolition. There is a long list of incidents during construction work in Germany that in some cases have led to the deaths of workers. In June 2010, 3No. members of a bomb disposal team were killed, and 6No. others injured, whilst attempting to defuze an unexploded WWII bomb in Goettingen, Central Germany. The bomb, the second found in Goettingen in the space of a few days, was unearthed at a depth of 7.5m during excavations for a sports stadium. In September 2008, 17No. people were injured and considerable damage occurred to adjacent buildings when a bomb exploded on a construction site in Hattingen, Germany. In October 2006 during road works on a motorway near Aschaffenburg in Bavaria, southern Germany, a bomb was struck by a machine and detonated. The plant driver was killed and 5No. others injured, including passing motorists. In a similar incident in October 2004 in Linz, Austria a bomb exploded injuring 3No. workers and causing considerable damage to plant. In the same month, a WWII bomb under a back garden in Vienna, Austria, was detonated without warning by a minor earth tremor, after remaining undiscovered for over 60 years. Incidents involving UXO are also reported from the marine areas around the North Sea. For example, on 6th April 2005, 3No. Dutch fishermen were killed when they accidentally trawled up a WWII UX bomb which exploded when it hit the deck. More recently, an unexploded HE bomb was trawled from the sea floor off South Shields on the 25th February 2015 but caused no damage. Further details of similar finds can be found at http://zeticauxo.com/news/.	

The effects of a partial or full detonation of ordnance are usually shock, blast, heat and shrapnel damage. A 50kg buried bomb can damage brick / concrete structures up to a distance of approximately 16m away. Unprotected personnel on the surface up to 70m away from the blast could also be seriously injured. Larger ordnance would obviously be more destructive.

Explosives rarely lose effectiveness with age, although over time mechanisms such as fuzes and gaines can become more sensitive and therefore more prone to detonation, regardless of whether the device has been submersed in water or embedded in silt, clay or similar materials.

The effects of a detonation of explosive ordnance are usually extremely fast, often catastrophic and invariably traumatic to any personnel involved.

Appendix 3 Abbreviations	
AA	Anti-Aircraft
ACPO	Association of Chief Police Officers
ALARP	As Low As Reasonably Practicable
ARP	Air Raid Precaution
ASACS	Air Surveillance and Control System
AXO	Abandoned Explosive Ordnance
BD	Bomb Disposal
BDO	Bomb Disposal Officer
BDU	Bomb Disposal Unit
CBRN	Chemical, Biological, Radiological and Nuclear
CMD	Conventional Munitions Disposal
DCLG	Department of Communities and Local Government
EO	Explosive Ordnance
EOC	Explosive Ordnance Clearance
EOR	Explosive Ordnance Reconnaissance
ERW	Explosive Remnants of War
ESA	Explosive Substances and Articles
FFE	Free From Explosives
HAA	Heavy Anti-Aircraft
HE	High Explosive
HSE	Health and Safety Executive
JSEODOC	Joint Services EOD Operations Centre
IB	Incendiary Bomb
IED	Improvised Explosive Device

IEDD	Improvised Explosive Device Disposal
LAA	Light Anti-Aircraft
MoD	Ministry of Defence
PUCA	Pick Up and Carry Away
RAF	Royal Air Force
SIP	Self-Igniting Phosphorous
TEP	Time Expired Pyrotechnics
USAAF	United States Army Air Forces
UXB	Unexploded Bomb
UXO	Unexploded Ordnance

Appendix 4 Glossary & Definitions	
Abandoned Explosive Ordnance (AXO)	Abandoned Explosive Ordnance is explosive ordnance that has not been used during an armed conflict, that has been left behind or disposed of by a party to an armed conflict, and which is no longer under control of that party. Abandoned explosive ordnance may or may not have been primed, fuzed, armed or otherwise prepared for use.
Camouflet	The type of cavity produced when a charge explodes underground without breaking the surface of the earth to form a crater.
Demil	Derived from the term 'Demilitarisation', it refers to the break down and the recycling or disposal of ordnance components.
Detonation	The high-speed chemical breakdown of an energetic material producing heat, pressure, flame and a shock wave.
Device	This term is used for any component, sub-assembly or completed ordnance, which may or may not have an explosive risk. It can apply to detonators, primers, gaines, fuzes, shells or bombs.
Explosive	The term explosive refers to compounds forming energetic materials that under certain conditions chemically react, rapidly producing gas, heat and pressure. Obviously, these are extremely dangerous and should only be handled by qualified professionals.
Explosive Ordnance (EO)	Explosive Ordnance is all munitions containing explosives, nuclear fission or fusion materials and biological and chemical agents. This includes bombs and warheads, guided and ballistic missiles, artillery, mortar, rocket, small arms ammunition, mines, torpedoes, depth charges, pyrotechnics, cluster bombs & dispensers, cartridge & propellant actuated devices, electro-explosive devices, clandestine & improvised explosive devices, and all similar or related items or components explosive in nature.
Explosive Ordnance Clearance (EOC)	Explosive Ordnance Clearance is a term used to describe the operation of ordnance detection, investigation, identification and removal, with EOD being a separate operation.
Explosive Ordnance Disposal (EOD)	Explosive Ordnance Disposal is the detection, identification, on-site evaluation, rendering safe, recovery and final disposal of unexploded explosive ordnance.
Explosive Ordnance Reconnaissance (EOR)	Explosive Ordnance Reconnaissance is the detection, identification and on-site evaluation of unexploded explosive ordnance before Explosive Ordnance Disposal.

Explosive Remnants of War (ERW)	Explosive Remnants of War are Unexploded Ordnance (UXO) and Abandoned Explosive Ordnance (AXO), excluding landmines.
Explosive Substances and Articles (ESA)	Explosive substance are solid or liquid substance (or a mixture of substances), which is either: - capable by chemical reaction in itself of producing gas at such a temperature and pressure and at such a speed as to cause damage to the surroundings. - designed to produce an effect by heat, light, sound, gas or smoke, or a combination of these as a result of a non-detonative, self-sustaining, exothermic reaction. Explosive article is an article containing one or more explosive substances.
Fuze	A fuze is the part of an explosive device that initiates the main explosive charge to function. In common usage, the word fuze is used indiscriminately, but when being specific (and in particular in a military context), fuze is used to mean a more complicated device, such as a device within military ordnance.
Gaine	Small explosive charge that is sometimes placed between the detonator and the main charge to ensure ignition.
High Explosive	Secondary explosives (commonly known as High Explosives (HE)) make up the main charge or filling of an ordnance device. They are usually less sensitive than primary explosives. Examples of secondary explosives are: Nitro glycerine (NG), Trinitrotoluene (TNT), AMATOL (Ammonia nitrate + TNT), Gunpowder (GP), and Cyclotrimethylenetrinitramine (RDX).
Munition	Munition is the complete device charged with explosives, propellants, pyrotechnics, initiating composition, or nuclear, biological or chemical material for use in military operations, including demolitions. This includes those munitions that have been suitably modified for use in training, ceremonial or non-operational purposes. These fall into three distinct categories:- - inert - contain no explosives whatsoever. - live - contain explosives and have not been fired. - blind - have fired but failed to function as intended.
Primary Explosive	Primary explosives are usually extremely sensitive to friction, heat, and pressure. These are used to initiate less sensitive explosives. Examples of primary explosives are: Lead Azide, Lead Styphnate, and Mercury Fulminate. Primary explosive are commonly found in detonators.

Propellants	Propellants provide ordnance with the ability to travel in a controlled manner and deliver the ordnance to a predetermined target. Propellants burn rapidly producing gas, pressure and flame. Although usually in solid form they can be produced in liquid form. Examples of propellants are: Ballistite often found in a flake form and Cordite used in small arms ammunition.
Pyrotechnic	A pyrotechnic is an explosive article or substance designed to produce an effect by heat, light, sound, gas or smoke, or a combination of any of these, as a result of non-detonative, self-sustaining, exothermic chemical reactions.
Unexploded Ordnance (UXO)	UXO is explosive ordnance that has been either primed, fused, armed or prepared for use and has been subsequently fired, dropped, launched, projected or placed in such a manner as to present a hazard to operations, persons or objects and remains unexploded either by malfunction or design.

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APPENDIX E

STUDY AREA RECONNAISSANCE

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Study Area Reconnaissance – Land off St. Mary’s Road, Hayling Island



Photograph 1 (P1)
Access to the study area from St. Mary’s Road in the east.



Photograph 2 (P2)
Northeast of the study area showing arable farmland.



Photograph 3 (P3)
Facing south from the north of the study area, showing arable farmland.



Photograph 4 (P4)
Western study area boundary in the north, showing arable farmland.



Photograph 5 (P5)
Western study area boundary in the south, showing arable farmland and adjacent ditch.



Photograph 6 (P6)
Arable farmland in the south of the study area.



Photograph 7 (P7)
Farm building in the centre of the study area.



Photograph 8 (P8)
Above ground fuel tank in the centre of the study area.



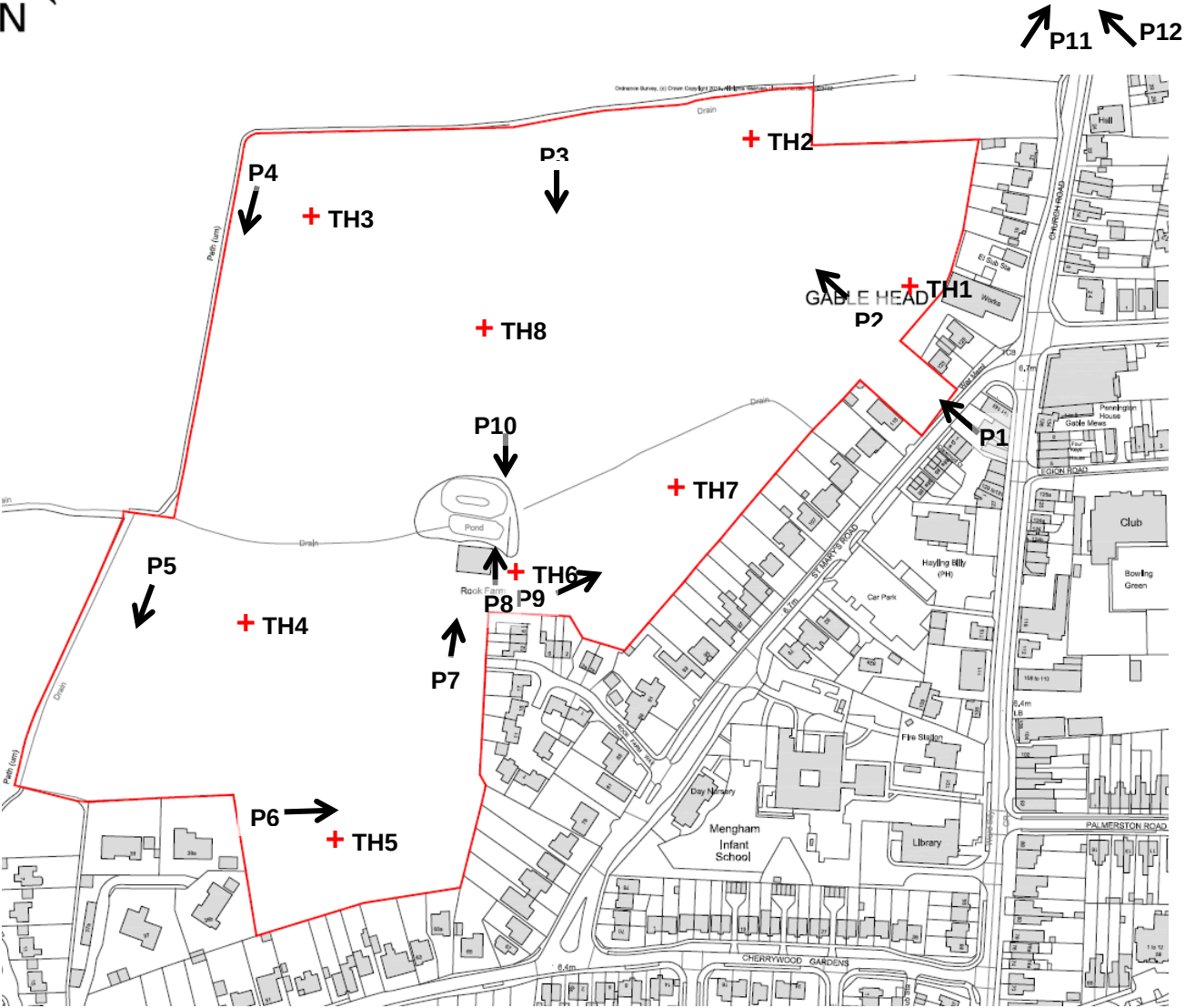
Photograph 9 (P9)
Embankments and farm equipment in the east of the study area.



Photograph 10 (P10)
Mound in the centre of the study area.

- Trial Hole 1 (TH1)**
- Made ground (brown slightly sandy gravelly clay with rare plastic fragments) to 0.3m
 - Light brown slightly sandy gravelly clay to 0.5m.
- Trial Hole 2 (TH2)**
- Made ground (brown slightly sandy gravelly clay) to 0.2m
 - Light brown slightly sandy gravelly clay to 0.4m.
- Trial Hole 3 (TH3)**
- Made ground (brown slightly sandy gravelly clay) to 0.25m
 - Light brown slightly gravelly clay to 0.4m.
- Trial Hole 4 (TH4)**
- Made ground (brown slightly sandy gravelly clay) to 0.25m
 - Light brown slightly gravelly clay to 0.4m.

- Trial Hole 5 (TH5)**
- Made ground (dark brown slightly sandy gravelly clay with rare brick fragments) to 0.25m
 - Light brown slightly sandy gravelly clay to 0.4m.
- Trial Hole 6 (TH6)**
- Made ground (light slightly gravelly clay with rare ash, brick and plastic fragments) to 0.2m
 - Light brown slightly sandy gravelly clay to 0.6m.
- Trial Hole 7 (TH7)**
- Made ground (light slightly gravelly clay with rare ash and brick fragments) to 0.3m
 - Light brown slightly sandy gravelly clay to 0.5m.
- Trial Hole 8 (TH8)**
- Made ground (brown slightly sandy gravelly clay) to 0.2m
 - Light brown slightly sandy gravelly clay to 0.4m.



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APPENDIX F

RISK EVALUATION

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Risk Evaluation

The method for risk evaluation is a qualitative method of interpreting the output from the risk estimation stage of the assessment, based on CIRIA 552¹⁰. It involves the classification of the:

- Magnitude of the potential consequence (severity) of the risk occurring (Table F-1).
- Magnitude of the probability (likelihood) of the risk occurring (Table F-2).

Consequence (Severity)		
Classification	Definition	Example
Severe	- Short term (acute) risk to human health likely to result in 'significant harm' as defined by the Environment Protection Act 1990, Part IIA. - Short term risk of pollution (note: water Resources Act contains no scope for considering significance of pollution) of sensitive water resource. - Catastrophic damage to buildings/properties. - A short term risk to a particular ecosystem, or organism forming part of such ecosystem (note: the definition of ecological systems within the Draft Circular on Contaminated Land, DETR, 2000).	- High Concentrations of cyanide on the surface of an informal recreation area. - Major spillage of contaminants from site into controlled waters. - Explosion, causing building collapse (can also equate to short term human health risk if buildings are occupied).
Medium	- Chronic damage to Human Health ('significant harm' as defined in DETR, 2000). - Pollution of sensitive water resources (note Water Resources Act contains no scope for considering significance of pollution). - A significant change in a particular ecosystem, or organism forming part of such ecosystem.	- Concentrations of a contaminant from site exceed generic, or site specific assessment criteria. - Leaching of contaminants from a site to a major or minor aquifer (Principal and Secondary). - Death of a species within a designated nature reserve.
Mild	- Pollution of non-sensitive water resources. - Significant damage to crops, buildings, structures and services ('significant harm' as defined in DETR, 2000). - Damage to sensitive buildings/structures/services or the environment.	- Pollution of non-classified groundwater. - Damage to building rendering it unsafe to occupy (e.g. foundation damage resulting in instability).
Minor	- Harm, although not necessarily significant harm, which may result in a financial loss, or expenditure to resolve. - Non-permanent health effects to human health (easily prevented by means such as personal protective clothing etc). - Easily repairable damage to buildings, structures and services.	- The presence of contaminants at such concentrations that protective equipment is required during site works. - The loss of plants in a landscaping scheme. - Discoloration of concrete.

Table F-1: Classification of Consequence.

¹⁰ CIRIA C552 (2001) Contaminated Land Risk Assessment - A guide to good practice.

Probability (Likelihood)	
Classification	Definition
High Likelihood	- There is a pollutant linkage and an event that either appears very likely in the short term and almost inevitable over the long term, or there is evidence at the receptor of harm or pollution.
Likely	- There is a pollutant linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. - Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.
Low Likelihood	- There is a pollutant linkage and circumstances are possible under which an event could occur. - However it is by no means certain that even over a longer period such event would take place, and is less likely in the shorter term.
Unlikely	- There is a pollutant linkage but circumstances are such that it is improbable that an event would occur in the very long term.

Table E-2: Classification of Probability.

These classifications are then compared to indicate the risk presented by each pollutant linkage (Table F-3). It is important that this classification is only applied where there is a possibility (which can range from high likelihood to unlikely) of a pollutant linkage existing.

		Consequence			
		Severe	Medium	Mild	Minor
Probability	High Likelihood	Very High Risk	High Risk	Moderate Risk	Moderate / Low Risk
	Likely	High Risk	Moderate Risk	Moderate / Low Risk	Low Risk
	Low Likelihood	Moderate Risk	Moderate / Low Risk	Low Risk	Very Low Risk
	Unlikely	Moderate / Low Risk	Low Risk	Very Low Risk	Very Low Risk

Table F-3: Comparison of Consequence against Probability.

Once the risk has been determined the corresponding action can be assessed (Table F-4).

Risk	Action Required
Very High Risk	There is a high probability that severe harm could arise to a designated receptor from an identified hazard, OR, there is evidence that severe harm to a designated receptor is currently happening. This risk, if realised, is likely to result in a substantial liability. Urgent investigation (if not already undertaken) and remediation are likely to be required.
High Risk	Harm is likely to arise to a designated receptor from an identified hazard. Realisation of the risk is likely to present a substantial liability. Urgent investigation (if not undertaken already) is required and remedial works may be necessary in the short term and are likely over the longer term.
Moderate Risk	It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild. Investigation (if not already undertaken) is normally required to clarify the risk and to determine the potential liability. Some remedial works may be required in the longer term.
Low Risk	It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild.
Very Low Risk	There is a low possibility that harm could arise to a receptor. In the event of such harm being realised it is not likely to be severe.

Table F-4: Description of the Classification and Likely Action Required.

Where the risk falls into the moderate/low risk, LKC will undertake an assessment to establish what category the pollutant linkage will fall into (i.e. moderate or low risk will be chosen).

Where LKC identifies a moderate or higher risk intrusive work or precautionary remedial measures will be recommended.

Where LKC identified a low to very low risk either limited intrusive investigation work, a watching brief (during construction work) or no investigation work will be recommended. This will be dependent on the nature of the site and the proposed development.

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