

# South East Strategic Reservoir Option Preliminary Environmental Information Report

# Appendix 10.3 - Desk study for unexploded ordnance and military uses

Date: October 2025





# **Desk Study for UXO & Military Uses**

Document Ref. P15306-25-R1

Revision D

**Project Title** 

**South East Strategic Reservoir** 

**Option (SESRO)** 

**Client** Arup Binnies JV

Date 4<sup>th</sup> April 2025

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Checked by Ellie Chaston and Kim Pelling

Authorised by Stefan Lang



#### **DESK STUDY FOR UXO & MILITARY USES**

#### **EXECUTIVE SUMMARY**

**Key findings:** Potential hazard from practice bombs and live Unexploded Bombs (UXB) on the central part of the Site.

**Key actions:** Non-intrusive Unexploded Ordnance (UXO) surveys and deep UXB detection surveys recommended in moderate and high UXO hazard zones. UXO awareness briefing for staff involved in excavation across the Site.

#### **Contaminants from military uses**

No significant contamination from military use of the Site have been identified.

The table below, reproduced as Table 4 in the main report, summarises the potential contamination resulting from military use and the associated risk. It is considered that the Site has a low risk of contamination resulting from military use.

#### Potential contamination from military use on the Site

Military use	Potential contamination	Risk		
Abingdon Common rifle range	Potential metalloid contamination within the former target butts.			
Steventon bombing decoy	Potential hydrocarbon contamination from the decoy fires.	Low		
No. 3 Maintenance Unit (MU) Steventon Depot				
United States (US) Army Ordnance Depot G-0677	Potential localised disposal or spillage of munitions. No potential contamination identified.	Low		
Anti-invasion defences	Potential localised disposal or spillage of munitions. No potential contamination identified.	Low		
Home Guard activity	Potential localised disposal or spillage of munitions. No potential contamination identified.	Low		
Royal Air Force (RAF) Grove (adjacent to the Site)	None identified.	N/A		
No. 3 MU Milton Depot (within 0.3km northwest of the Site (Harwell))	None identified.	N/A		
Aircraft crashes	None identified.	N/A		

#### **UXO** hazard assessment

During World War Two (WWII), Marcham bombing range was located on the central part of the Site. Although designated for practice bombing, it is known that live bombs were often used on such ranges during wartime.

The typical inner danger area for bombing ranges was 550 yards (yd), centred around the target marker. This part of the Site has been assigned a high UXO hazard level due to the likely presence of practice bombs at shallow depths and potentially live UXBs.



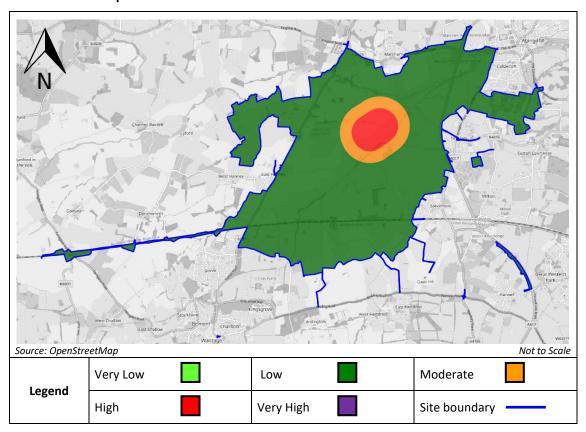
An outer danger area of up to 950yds was common. As such, a 400yd radius around main danger area has been assigned a moderate UXO hazard level to account for potential overspill.

The German bombing density on the Site was low and no other significant sources of UXO hazard or military uses have been identified. The remainder of the Site is assigned a low UXO hazard level.

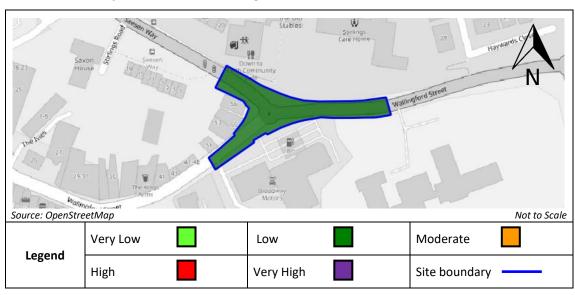
It is considered that the UXO hazard level on the Site can be zoned from low to high, as shown in the figure below, reproduced as Figure 6 to Figure 8 in the main report.

The UXO hazard zone plan of the Site is also given in the accompanying P15306-25-R1-MAP01-B.

#### UXO hazard zone plan of the Site

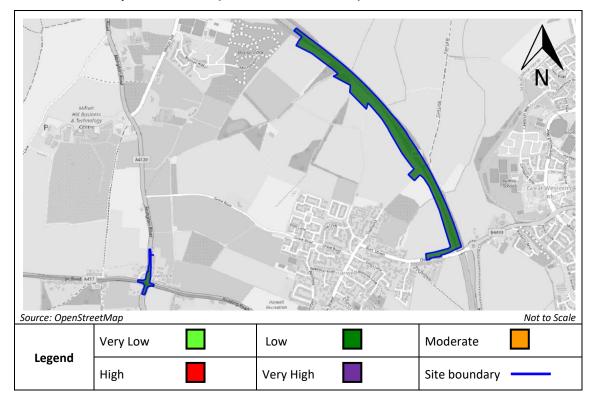


#### **UXO** hazard zone plan of the Site (Wantage)





#### **UXO** hazard zone plan of the Site (Rowstock and Harwell)



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.
- Between 1900 and 1934, 1No. 1,000yd rifle range was established on Abingdon Common, on the north-eastern part of Site. This provides a potential source of metalloid contamination to the Site.
- During WWII Marcham bombing range was established on the Site. Evidence indicates that this was extensively used.
- No. 3 MU Steventon Depot was located on the Site during WWII. Records indicate this stored aircraft parts. This provides a potential source of radiological contamination to the Site.
- In 1941, Steventon Bombing Decoy, designated Q219a, was established on the central part of the Site. This provides a potential source of hydrocarbon contamination on the Site.
- During WWII, the main strategic targets in the vicinity of the Site included military airfields and supply depots.
- Records have been found indicating that 36No. High Explosive (HE) bombs fell on the Site
  during WWII, representing a low bombing density. An unsuccessful bombing decoy was
  located on the Site.

#### **Proposed works**

It is understood that initial works on the Site comprise a ground investigation, including hand-dug inspection pits to 1.2 metres below ground level (bgl), 104No. boreholes up to 45m bgl, excavations up to 10m bgl, and Multi-channel Analysis of Surface Waves (MASW) surveys.

Future works may comprise the development of a fully bunded reservoir, the establishment of pumping stations, a tunnel, access roads, and new canals.

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#### Risk assessment

The table below, reproduced as Table 5 in the main report, provides a UXO risk assessment for the proposed works on the Site.

Further details on the risk assessment methodology are given in Section 7.2 of the main report.

#### **UXO** risk assessment for the Site

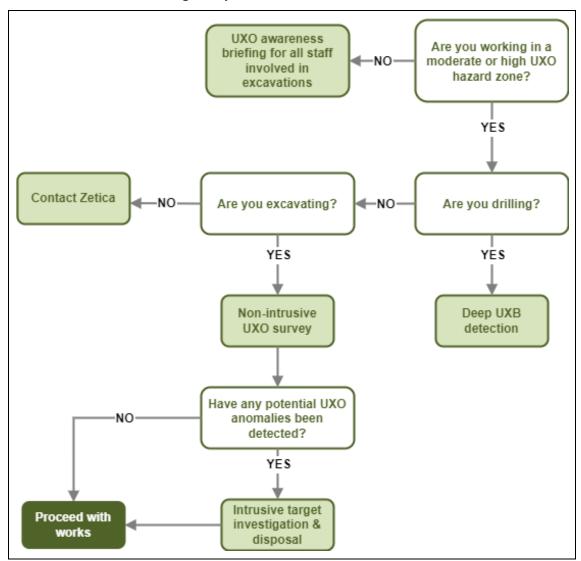
Hazard Zone	Potential UXO hazard	Anticipated Works	ЬЕ	ОА	P = PE x PD	Likelihood	Severity	Risk Rating	UXO Risk
	Live Duitiele	Excavations	3	2	6	3	5	15	Moderate
	Live British UXB	Boreholes	2	3	6	3	4	12	Moderate
	OVP	Non-intrusive surveys	1	1	1	1	5	5	Low
		Excavations	5	2	10	3	2	6	Moderate
High	Practice	Boreholes	4	3	12	3	2	6	Moderate
	Bombs	Non-intrusive surveys	1	1	1	1	2	2	Low
		Excavations	1	1	1	1	4	4	Low
	Other UXO	Boreholes	1	1	1	1	3	3	Low
		Non-intrusive surveys	1	1	1	1	4	4	Low
	Livo Dritich	Excavations	2	2	4	2	5	10	Moderate
	Live British UXB	Boreholes	1	3	3	2	4	8	Moderate
		Non-intrusive surveys	1	1	1	1	5	5	Low
	Practice	Excavations	4	2	8	3	2	6	Moderate
Moderate	e Bombs	Boreholes	3	3	9	3	2	6	Moderate
		Non-intrusive surveys	1	1	1	1	2	2	Low
		Excavations	1	1	1	1	4	4	Low
	Other UXO	Boreholes	1	1	1	1	3	3	Low
		Non-intrusive surveys	1	1	1	1	4	4	Low
	Live British UXB	Excavations	1	1	1	1	5	5	Low
		Boreholes	1	1	1	1	4	4	Low
	OVP	Non-intrusive surveys	1	1	1	1	5	5	Low
	Practice	Excavations	1	1	1	1	2	2	Low
Low	Bombs	Boreholes	1	1	1	1	2	2	Low
	DUITIUS	Non-intrusive surveys	1	1	1	1	2	2	Low
		Excavations	1	1	1	1	4	4	Low
	Other UXO	Boreholes	1	1	1	1	3	3	Low
		Non-intrusive surveys	1	1	1	1	4	4	Low
PE = Probability of Encounter, PD = Probability of Detonation, P = Overall Probability									

#### **UXO** risk mitigation plan

The Figure below, reproduced as Figure 9 in the main report, provides a risk mitigation plan to ensure that the UXO risk for the proposed works is reduced to As Low As Reasonably Practicable (ALARP).



#### Recommended UXO risk mitigation plan for the Site



#### **Contamination testing**

No significant sources of radiological or explosives contamination have been identified on the Site. If further comfort is required, radiological risk mitigation or explosives testing can be undertaken.

Further details on the recommended risk mitigation techniques are given in Section 8.2 of this report.

The Table below, reproduced as Table 6 in the main report, summarises the UXO risk for proposed works on the Site and recommended actions.



#### **Summary of UXO risk and mitigation recommendations**

Proposed Works	UXO Risk	Recommended Mitigation
Excavations		<b>UXO awareness briefing</b> – Given the military history of the Site it is recommended that a formal UXO awareness briefing is provided to staff involved in excvations.
Boreholes		Proceed with works
Non-intrusive surveys	<u>*</u>	Proceed with works
Excavations		Non-intrusive survey – where access allows, a non-intrusive UXO survey should be undertaken around proposed excavations to map shallow-buried UXO. Potential UXO targets detected can either be avoided or intrusively investigated and removed.
Boreholes		Deep UXB detection — to clear borehole locations of potential UXB, an intrusive magnetometer survey should be undertaken until either the maximum bomb penetration or maximum drilling/piling depth is reached.
Non-intrusive surveys	<u>*</u>	Proceed with works

In summary, in the moderate and high UXO hazard zones, a non-intrusive UXO survey is recommended in advance of excavations and drilling to map shallow-buried UXO. Deep UXB detection is recommend to clear borehole locations of deep-buried UXO.

An UXO awareness briefing is recommended for all staff involved in excavations.

#### What do I do next?

If you wish to proceed with UXO risk mitigation, contact us and we can help.



If you have requirements to identify other buried hazards (such as mapping utilities or obstructions) we can provide these surveys.

If proposed works on the Site change, or additional works are planned, contact Zetica for a reassessment of the UXO risk and the risk mitigation requirements.



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# **Accompanying GIS data**

P15306-25-R1-MAP01-B (Desk Study for UXO and Military Uses)



#### **ABBREVIATIONS**

AA Anti-Aircraft
AAF Army Air Forces

AERE Atomic Energy Research Establishment
ALARP As Low As Reasonably Practicable

ARP Air Raid Precaution

AT Anti-Tank

**AXO** Abandoned Explosive Ordnance

bgl Below ground levelBGS British Geological Survey

CIRIA Construction Industry Research and Information Association

**COD** Central Ordnance Depot

**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

GHQ General Headquarters
GWR Great Western Railway
HAA Heavy Anti-Aircraft

**HE** High Explosive

**HER** Historic Environment Record

IB Incendiary Bomb

**IBCC** International Bomber Command Centre

IEDImprovised Explosive DeviceIWMImperial War MuseumLAALight Anti-Aircraft

**LSA** Land Service Ammunition

MASW Multi-channel Analysis of Surface Waves

MoD Ministry of Defence MU Maintenance Unit

NARA National Archives & Records Administration
NCAP National Collection of Aerial Photography

OB Oil Bomb

OSNGR Ordnance Survey National Grid Reference

**PBR** Practice Bombing Range

PM Parachute Mine
RAF Royal Air Force
RFC Royal Flying Corps

SESRO South East Strategic Reservoir Option

UK United Kingdom
US United States

USAAF United States Army Air Forces
UXAA Unexploded Anti-Aircraft

UXB Unexploded Bomb
UXO Unexploded Ordnance

**WWTW** Waste Water Treatment Works

**WWI** World War One **WWII** World War Two



#### **DESK STUDY FOR UXO & MILITARY USES**

**Please read:** Zetica has colour coded each paragraph. Paragraphs with black text on a white background provide site-specific information or information specifically researched as part of this project.

Boxed paragraphs in a dark green text with a green background provide general information and, where appropriate, links to online resources giving further detail. These are all available at <a href="https://www.zeticauxo.com">www.zeticauxo.com</a>. If you cannot gain access to these resources, Zetica can forward them on request.

#### 1 INTRODUCTION

#### 1.1 Project outline

Zetica Ltd was commissioned by Arup Binnies JV to carry out a Desk Study for Unexploded Ordnance (UXO) and Military Uses for 5No. areas totalling approximately 3,900 hectares (ha) near Abingdon, Oxfordshire (the 'Site').

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

Where appropriate, this hazard assessment includes:

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

It should be noted that some military activity providing a source of UXO hazard or other contamination may not be recorded and therefore there cannot be any guarantee that all UXO hazards or potential contaminants affecting the Site have been identified in this report.

#### 1.2 Sources of information

Zetica Ltd researched the World War One (WWI)/World War Two (WWII) bombing and military history of the Site and its surrounding area using a range of information sources. The main sources of information are detailed in the following sections and referenced at the end of this report.

#### 1.2.1 Zetica Ltd records

Zetica Ltd's in-house records were consulted, including the Zetica Ltd bomb risk maps (<a href="https://zeticauxo.com/guidance/risk-maps/">https://zeticauxo.com/guidance/risk-maps/</a>), previous requests for information from government bodies, reference books, and archive materials from past work in the region.

Relevant documents have been cited in the bibliography of this report.

#### 1.2.2 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, the US National Archives & Records Administration (NARA), the Imperial War Museum (IWM), Historic England, National Collection of Aerial Photography (NCAP), the Defence of Britain Project, the International Bomber Command Centre (IBCC) Archive, and relevant archaeological bodies.



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

#### 1.2.3 Local records

West Berkshire Council, Oxfordshire County Council, Berkshire Records Office, Oxfordshire History Centre, local historical groups, and the Berkshire and Oxfordshire Historic Environment Record (HER) were consulted for records.

#### 1.2.4 Client-provided information

T REP EO Survey Rev 1 - BACTEC Explosive Ordnance Survey Report, Upper Thames Major Resource Development,  $5^{th}$  January 2006 was consulted.

South East Strategic Reservoir Option – Ground Investigation Factual Report Phase 1 (J696-IT-A05C-ZZZZ-RP-CT-100001), July 2024 and Phase 2a (J696-IT-A05C-ZZZZ-RP-CT-100002), November 2024 were consulted.

#### 1.3 Data confidence level

In general, there is a high level of confidence in the researched information sources used for this report. Further detail is given in the text of the report where appropriate.

	Definitions of data confidence level						
Data Confidence Level		Definition					
Low		There are very few sources of information, and/or those available are lacking in detail.					
Moderate		There is a limited range of available sources of information, a key source of information is missing, and/or some sources may be contradictory or lacking in detail.					
✓	High	There is a wide range of available sources of information, which are detailed and corroborate each other.					



#### 2 THE SITE

#### 2.1 Site location

The Site is centred on Ordnance Survey National Grid Reference (OSNGR) SU 451937. It is located approximately 0.5km southwest of central Abingdon.

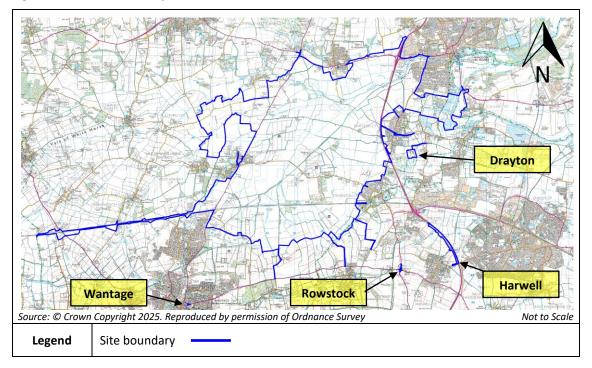
The Site largely comprises open farmland and a mainline railway. Some farm buildings and 2No. solar farms are present. The southern part of the Site is crossed by a mainline railway, Steventon Road, and Hanney Road. The western part of the Site is crossed by the A34.

4No. additional areas of the Site are located at Wantage, Rowstock, and Harwell, which comprise primarily roadway, and at Drayton, which comprises a Waste Water Treatment Works (WWTW).

The Site is bounded to the north by the village of Marcham and open ground, to the east by the towns of Abingdon, Drayton, and Milton, to the south by open ground, and to the west by the A338.

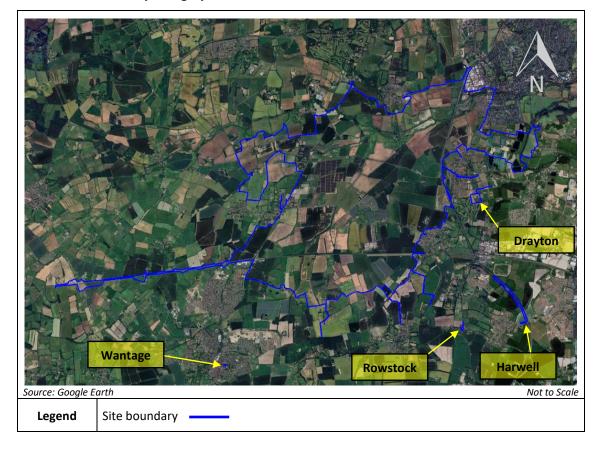
Figure 1 is a Site location map and Plate 1 is a recent aerial photograph of the Site.

Figure 1 Site location map





## Plate 1 Recent aerial photograph of the Site





#### **3 MILITARY USE**

The following sections outline the recorded military use on and in the vicinity of the Site. The potential UXO hazard from WWI and WWII bombing is detailed in Section 4.

#### 3.1 Firing ranges and military training areas

For further information on firing ranges and military training areas, and the potential UXO hazards associated with them, follow the links below:

- Artillery Ranges
- Bombing Ranges
- Military Training Areas
- Small Arms Ranges

During WWII, Marcham bombing range was established on the central part of the Site. A brief operational history of the range is given below.

#### 3.1.1 Marcham bombing range

During WWII, Marcham bombing range was established on the central part of the Site.

It was used by No. 10 Operational Training Unit (OTU) flying out of Royal Air Force (RAF) Abingdon (see Section 3.6.2), equipped with Armstrong Whitworth Whitley medium bomber aircraft. Training included high-level, low-level, and night practice bombing and flare dropping.

Plate 2 is an aerial photograph, dated the 8th March 1944. The directional arrow (SU452945) and target marker (SU 449943) have been identified. 1No. possible bomb crater has also been identified.

Plate 2 Aerial photograph of Marcham bombing range, 8th March 1944





Cratering may be indicative of live bombs being used on the bombing range. It may also indicate possible jettisoning of live bombs from German or British aircraft. It is known that during WWII aircraft from nearby airfields would sometimes jettison their bombs on bombing ranges.

During WWII, such ranges were sometimes used for mortar training. Whilst no records have been found to indicate mortar training was undertaken at Marcham, it cannot be totally discounted.

After WWII, Marcham bombing range became disused and reverted to agriculture.

Several items of UXO have been found at the former range since WWII (see Section 5.1).

#### Potential UXO hazard

Practice bombing ranges typically had an inner danger area of 550yds, within which most bombs are anticipated to have fallen. The greatest concentration of Unexploded Bombs (UXB) will be around the target marker.

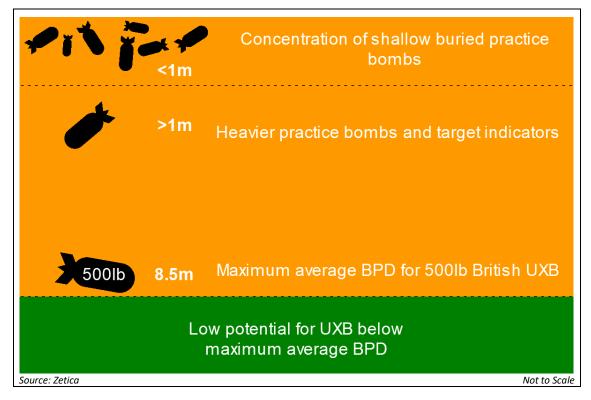
An outer danger area of up to 950yds was common to account for overspill. The potential to find UXB within this radius is elevated, although likely to be in less dense concentrations.

The most likely ordnance to remain on the Site is WWII practice bombs and associated target illumination devices. Such ordnance is likely to be shallow buried (<1.0m deep). However, larger target indicators may be buried deeper (>1.0m).

It should be noted that wartime ranges were commonly used for live practice and may have also been used by aircraft jettisoning their bombs. The potential for live UXB to be present cannot be discounted. These are likely to be buried at greater depths than practice bombs (up to approximately 8.5m below WWII ground level for a 500lb British bomb).

Figure 2 demonstrates the potential burial setting of ordnance on Marcham bombing range, based on the anticipated ground conditions (see Section 4.2.2) and average maximum penetration depths.

Figure 2 Potential burial setting of ordnance on Marcham bombing range





Records indicate that 1No. 500lb British practice bomb was discovered in fields near Drayton, on the Site (see Section 5.1). Although this is considered an isolated incident of a practice bomb falling significantly off target, the possibility of additional UXBs falling outside of the designated danger areas cannot be totally discounted.

Whilst post-WWII agricultural activity on the former range may have disturbed and removed potential UXO, it is also possible that ploughing and other agricultural activities could have resulted in UXO being moved across the Site, outside the designated danger areas. Items of UXO are known to have been found in hedgerows and ditches within the immediate vicinity of former bombing ranges.

Marcham bombing range is considered to provide a source of UXO hazard to the central part of the Site.

No other potential sources of contamination associated with Marcham bombing range have been identified.

#### 3.1.2 Abingdon Common rifle range

By 1900, 1No. 1,000yd rifle range was established on Abingdon Common, on the north-eastern part of Site. The direction of fire was in a northeast to southwest direction, towards the target butts at SU 467963.

Figure 3 is a historical map dating from 1914 showing the range.

Source: © Crown Copyright 2025. Reproduced by permission of Ordnance Survey

Rifle range

Target butts

Figure 3 Historical map of Abingdon Common rifle range, 1914

The rifle range remained in use during and after WWI. By 1934 the range was disused. Records indicate that the target butts remain extant on the Site.

#### **Potential UXO hazard**

There is an elevated potential of encountering Small Arms Ammunition (SAA) on and in the immediate vicinity of the former range. Any significant concentrations of SAA would be confined to sand of the target butts. Given that the range was operational for at least 34No. years, it is reasonable to expect a concentration of SAA within the target butts.

SAA is not considered to provide a significant source of UXO hazard (see Appendix 1).



Abingdon Common rifle range is not considered to provide a significant source of UXO hazard to the Site.

#### Potential metalloid contamination

Whilst SAA does not provide a kinetic hazard typical of other UXO (i.e. it relies on the firing of a metal bullet to cause harm rather than blast from high explosive), in large concentrations it may provide a source of metal contamination, particularly lead, antimony and arsenic (see Appendix 1).

SAA cartridge cases may also present a potential source of copper, nickel and zinc. Whilst these may have a low leachability, the phytotoxic nature of them may make them undesirable within topsoil.

Explosive contamination from expended SAA (unburnt propellant) cannot be totally discounted, but its presence in significant concentrations within topsoil is very unlikely.

#### 3.2 Explosives factories, munitions depots, and disposal areas

For further information on explosives factories, munitions depots and disposal areas, and the potential UXO hazards associated with them, follow the links below:

- Explosives Factories
- Munitions Depots
- Munitions Disposal Areas

Records indicate that 1No. munitions depot was established on the Site during WWII. Further details are provided below.

#### 3.2.1 United States (US) Army Ordnance Depot G-0677

In 1943 US Army Ordnance Depot G-0677 was established at Grove Park, on the Site. It was an ammunition sub-depot established ahead of the Normandy campaign in June 1944. The depot was manned by the 1954<sup>th</sup> Ordnance Company, stationed at RAF Grove (see Section 3.6.1).

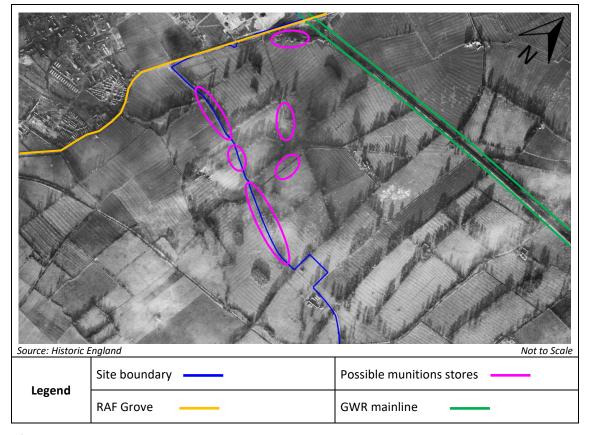
The main method of transporting the ordnance to the depot was via the Great Western Railway (GWR) mainline, on the southern part of the Site. Ordnance was also transported by road.

Once at the depot, ordnance was stored along roads and hedgerows within Grove Park.

Plate 3 is an aerial photograph of Grove Park, dated 8<sup>th</sup> March 1944. Several areas of possible munitions storage have been identified on and adjacent to the Site. The boundary of RAF Grove and the GWR mainline have also been identified.



Plate 3 Aerial photograph of Grove Park, 8th March 1944



After WWII, US Army Ordnance Depot G-0677 closed.

#### **Potential UXO hazard**

Although any munitions stored at US Army Ordnance Depot G-0677 would have been removed at the end of WWII, the possibility of localised disposal or spillage cannot be totally discounted.

No records of munitions disposal on the Site have been found and no evidence of disposal activities have been identified on the Site on historical aerial photography.

US Army Ordnance Depot G-0677 is not considered to provide a source of UXO hazard to the Site.

No other potential sources of contamination associated with US Army Ordnance Depot G-0677 have been identified.

#### 3.3 Aircraft crashes

For further information on military aircraft crashes, and the potential UXO hazards associated with them, follow the link below:

#### Aircraft Crashes

Records have been found to indicate that 3No. British aircraft crashed on the Site during WWII. Details are provided below.

#### 7<sup>th</sup> December 1940

1No. Handley Page H.P.52 Hampden (X3065) reconnaissance aircraft crashed on fields south of Marcham village, on the northern part of the Site, whilst returning from a patrol flight.



#### 26<sup>th</sup> February 1942

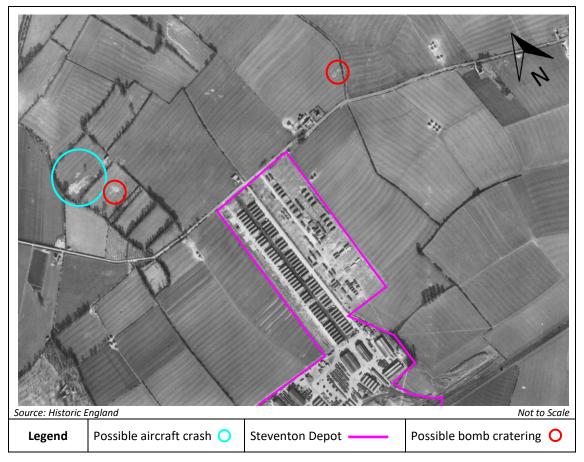
1No. Vickers 417 Wellington Mk. III (X3663) bomber aircraft crash-landed during a training exercise south of RAF Abingdon, on the north-eastern part of Site.

#### 24th June 1942

1No. Vickers Wellington Mk. III (X3423) bomber aircraft crashed on fields off Hanney Road, on the southern part of the Site, whilst returning from operations.

Plate 4 is an aerial photograph dated 8<sup>th</sup> March 1944. It shows the possible crash location of Vickers Wellington X3423 on the southern part of the Site. No. 3 Maintenance Unit (MU) Steventon Depot has also been identified (see Section 3.5).

#### Plate 4 Aerial photograph, 8th March 1944



Debris from the crashes was later removed.

#### Potential UXO hazard

The Handley Page Hampden X3065 and the Vickers Wellington X3663 aircraft crashed during reconnaissance or training flights. They are unlikely to have been armed or carrying bombs.

The Vickers Wellington X3423 was returning from a successful bombing mission, so was unlikely to have had bombs remaining on board.

The Vickers Wellington X3423 crash may have resulted in the scatter of SAA from the aircraft guns over a wide area, including on the Site.

SAA is not considered to provide a significant UXO hazard (see Appendix 1).

No other potential sources of contamination associated with aircraft crashes have been identified.



#### 3.4 Defences

For further information on military defences, and the potential UXO hazards associated with them, follow the links below:

- Anti-Aircraft Guns
- Anti-Invasion Defences
- Barrage Balloons
- Bombing Decoys
- Home Guard
- Mined Locations
- Mortar & Gun Emplacements
- Pillboxes

Several military defences have been identified on the Site. Details are provided below.

#### 3.4.1 Bombing decoys

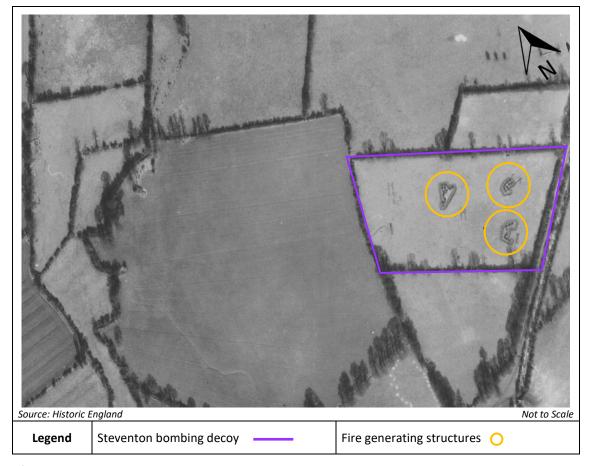
In 1941, Steventon Bombing Decoy, designated Q219a, was established on the central part of the Site (SU 445935). It was a 'QF' type decoy, comprising controlled fires lit during an air raid to simulate an airfield targeted by bombs. It was designed to divert bombing away from airfields in the region, such as RAF Abingdon, RAF Grove, and RAF Kingston Bagpuize.

The decoy was active between 1941 and 1942. No records have been found to indicate that the decoy was targeted.

Plate 5 is an aerial photograph dated the 8<sup>th</sup> March 1944 showing the fire-generating structures of the decoy.







After WWII, the decoy was removed.

Steventon Bombing Decoy is not considered to provide a source of UXO hazard to the Site.

#### **Potential chemical contamination**

The 'QF' type bombing decoy on the Site used controlled fires to simulate a burning airfield. These prolonged fires were generated using a variety of combustible materials, which may have caused some hydrocarbon contamination to soil in the vicinity of the former bombing decoy.

#### 3.4.2 Anti-invasion defences

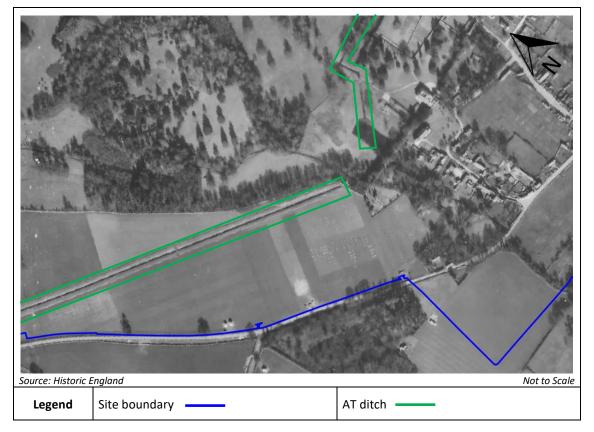
During WWII, in anticipation of an enemy invasion, stop lines were established across Berkshire and southeast England. They comprised anti-tank (AT) ditches, pillboxes, and gun emplacements.

The General Headquarters (GHQ) Line encroached on the northern part of the Site. It included 1No. AT ditch and 1No. FW3/28A-type AT gun emplacement armed with 2No. 2-pounder (pdr) guns (see Plate 7). Further AT blocks were established on the north-western part of the Site.

Plate 6 is an aerial photograph of the Frilford part of the Site, dated the 8<sup>th</sup> March 1944. 2No. AT ditches have been identified between approximately 0.1km and 0.3km north-northwest of the Site.



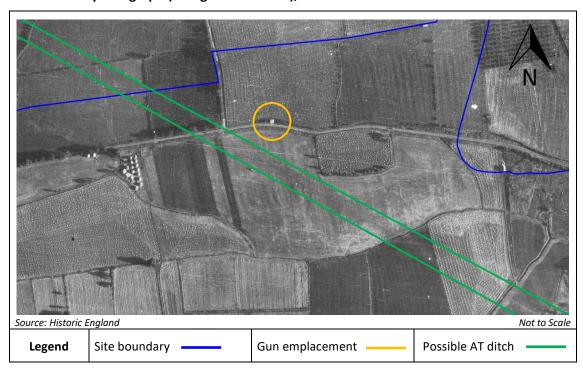
#### Plate 6 Aerial photograph (Frilford), 8th March 1944



By the end of 1944, the AT ditch encroaching on the north-eastern part of the Site had been infilled.

Plate 7 is an aerial photograph of the Abingdon Common part of the Site, dated the 9<sup>th</sup> June 1946. 1No. linear feature has been identified, encroaching on the north-eastern part of the Site, indicative of the filled-in AT ditch. The AT gun emplacement has also been identified.

Plate 7 Aerial photograph (Abingdon Common), 9th June 1946





After WWII, the anti-invasion defences were removed.

#### Potential UXO hazard

Anti-invasion defences sometimes had small munitions caches of SAA and Land Service Ammunition (LSA). Whilst such caches were typically removed at the end of WWII, the potential for localised spillage or disposal of ammunition around the gun emplacement cannot totally be discounted.

Anti-invasion defences are not considered to provide a significant source of UXO hazard to the Site

No potential sources of contamination associated with anti-invasion defences have been identified.

#### 3.4.3 Anti-Aircraft (AA) guns

During WWI there were no AA gun batteries within 10km of the Site.

During WWII there were 2No. Heavy AA (HAA) batteries within 10km of the Site. The nearest was located at Hinksey Hill (SP 499039), approximately 6.5km north-northeast of the Site. It was armed with 4No. 3-inch (") guns.

#### **Potential UXO hazard**

Given the presence of HAA gun batteries in the surrounding area during WWII, the potential for an UXAA shell to have fallen on the Site unnoticed, whilst unlikely, cannot be totally discounted.

No other potential sources of contamination associated with AA guns have been identified.

#### 3.4.4 Home Guard

During WWII, companies from the 1<sup>st</sup> Berkshire (Abingdon) Home Guard Battalion operated in the vicinity of the Site.

The Home Guard was responsible for patrolling local transport links and strategic targets, such as airfields (see Section 3.6), as well as manning anti-invasion defences (see Section 3.4.2).

H (Works) Company of the 1<sup>st</sup> Berkshire Battalion Home Guard were stationed at No. 3 MU Milton, within approximately 1.9km east of the Site, and were responsible for guarding the stores depot (see Section 3.5).

In July 1940, several Home Guard exercises took place near Steventon, included 1No. mock battle, on the southern part of the Site.

No detailed records of the exercises have been found, but it is likely that any ammunition used would have been limited to blank SAA and pyrotechnics.

#### **Potential UXO hazard**

Records have been found to indicate that Home Guard training exercises took place on and in the vicinity of the Site.

Typically, these exercises would have been limited to the use blank ammunition and pyrotechnics.

It should be noted that detailed records of Home Guard activities were rarely kept. Storage and disposal of munitions by the Home Guard was poorly documented and surplus supplies were often disposed of in an ad-hoc way.

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



Home Guard activities are not considered to provide a significant source of UXO hazard to the Site.

No other potential sources of contamination associated with Home Guard activity have been identified.

#### 3.5 Other military establishments

#### 3.5.1 No. 3 MU Stores Depots

In 1925, a Royal Flying Corps (RFC) stores depot was established at Milton, Berkshire, within approximately 0.8km north of the Site (Harwell). Named Milton Aircraft Stores Depot, it stored spare aircraft components and other miscellaneous RFC stores.

On the 1<sup>st</sup> April 1918, Milton Aircraft Stores Depot was renamed No. 3 Stores Depot, Royal Air Force (RAF). By 1933, the depot expanded to within 0.3km northwest of the Site (Harwell), and included workshops, maintenance facilities, and hangars for aircraft breaking. In April 1938, it was renamed to No. 3 MU Milton Depot, RAF.

During WWII, the depot continued to comprise spare aircraft component stores and workshops for aircraft repair.

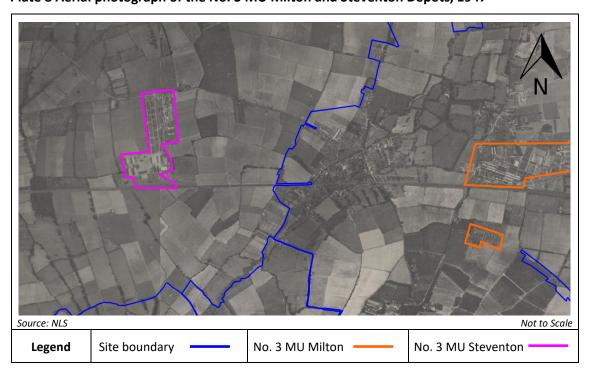
In August 1943, a new satellite depot was established west of Steventon, on the Site (see Plate 8), and named No. 3 MU Steventon Depot.

No. 3 MU Steventon Depot had buildings for staff accommodation and at least 105No. buildings for storing aircraft spares, including aerofoils, propellers, tires, engine components, and gun turrets.

After WWII, No. 3 MU Steventon Depot was used for a short period to store miscellaneous government equipment, including 50No. Bedford RLHZ Self Propelled Pumps, also known as 'Green Goddess' fire engines.

Plate 8 is an aerial photograph dating from 1947. It shows the location of No. 3 MU Milton Depot and the satellite No. 3 MU Steventon Depot.

Plate 8 Aerial photograph of the No. 3 MU Milton and Steventon Depots, 1947





In 1959, No. 3 MU Milton and Steventon Depots were sold. No. 3 MU Milton was developed into an industrial and science park. No. 3 MU Steventon Depot became a commercial storage facility.

#### Potential radiological contamination

No records have been found to indicate that aircraft parts were repaired or disposed of at No. 3 MU Steventon Depot.

Some aircraft parts that may have been stored at No. 3 MU Steventon Depot contained radioactive materials, such as luminescent paint and radium dials. Whilst unlikely, the possibility that aircraft parts were disposed of at No. 3 MU Steventon Depot cannot be totally discounted. This provides a potential source of radiological contamination in the vicinity of the former depot.

#### Potential hydrocarbon contamination

No significant source of hydrocarbon contamination has been identified on the Site. It is possible that localised hydrocarbon contamination may be present in the vicinity of No. 3 MU Steventon Depot due to spillages during refuelling of military vehicles.

#### Potential UXO hazard

No records have been found to indicate any ordnance was stored at No. 3 MU Steventon Depot, on the Site.

No. 3 MU Stores Depots (Milton and Steventon) are not considered to provide a source of UXO hazard to the Site.

#### 3.6 Military airfields

For further information on military airfields, and the potential UXO hazards associated with them, follow the link below:

#### Military Airfields

No records of any military airfields on the Site have been found.

During WWII the nearest operational airfield was RAF Grove, adjacent to the south-west of the Site. Brief operational histories of this airfield and RAF Abingdon are given below.

#### 3.6.1 RAF Grove

In 1941, construction of RAF Grove began, adjacent to the Site. By 1942 it began operating as a training airfield for Bomber Command and was used by No. 15 OTU as a satellite airfield.

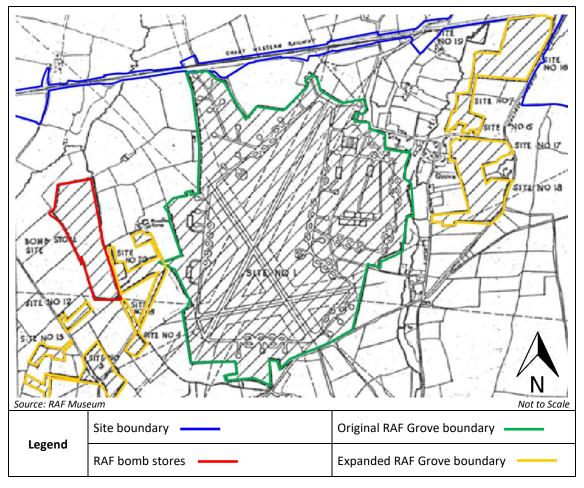
By 1943 the airfield had been transferred to the United States Army Air Forces (USAAF) and became known as AAF Station 519. The airfield expanded, with an additional area established adjacent to the Site. It accommodated the US 31<sup>st</sup> Transport Group as a major maintenance base for Curtiss C-46 Commando and Douglas C-47 Skytrain transport aircraft.

The USAAF presence at the airfield included 1954<sup>th</sup> Ordnance Company, who established US Army Ordnance Depot G-0677 at Grove Park, on the Site (see Section 3.2).

Figure 4 is a plan of RAF Grove dating from 1944. The original RAF Grove boundary, the RAF bomb stores, and subsequent areas of expansion have been identified.



Figure 4 Plan of RAF Grove, 1944



The USAAF left the airfield in early summer 1945 and the RAF resumed control.

From 1946 until 1958 RAF Grove was used by MUs, including No. 3 MU at Milton (see Section 3.5).

From 1955 part of the airfield was used by the Atomic Energy Association as a support base for the Atomic Energy Research Establishment (AERE) at Harwell.

The airfield closed in 1969 and the land was sold.

The majority of RAF Grove has since been redeveloped for housing. The northeast part of the former airfield now comprises engineering works.

#### Potential UXO and contamination hazard

No records have been found to indicate that military uses associated with the airfield encroached on the Site. Defensive exercises would have taken place on and in the vicinity of RAF Grove, in the vicinity of the Site, to test the airfield defences. These exercises likely involved local Home Guard units (see Section 3.4.4).

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

No other potential sources of contamination associated with RAF Grove have been identified.

#### 3.6.2 RAF Abingdon

In 1932, RAF Abingdon opened approximately 0.6km north of the Site. The airfield was initially used as a bomber training station.



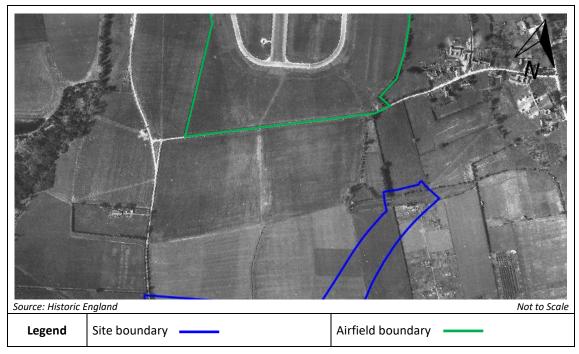
By 1939, several operational bomber squadrons including Nos. 97 and 166 Squadrons were based at the airfield, taking part in bombing operations over Europe.

By 1944, RAF Abingdon was expanded to approximately 0.3km north of the Site. 2No. concrete runways were constructed to accommodate heavy bomber aircraft.

After WWII, the airfield was under control of Transport Command and was primarily used for logistical operations.

Plate 9 is an aerial photograph of RAF Abingdon dated the 12<sup>th</sup> April 1946. The airfield boundary has been identified.

#### Plate 9 Aerial photograph of RAF Abingdon, 12th April 1946



During the 1970s, the airfield was given over to Support Command and used for a combined role of maintenance, repair, salvage, and storage for the RAF.

In July 1992, RAF Abingdon closed. It was subsequently taken over by the British Army for accommodation purposes and renamed Dalton Barracks.

RAF Abingdon is not considered to provide a source of UXO hazard to the Site.



#### 4 BOMBING

#### 4.1 WWI bombing

For further information on WWI bombing in the UK, and the potential UXO hazard associated with it, see Appendix 2.4 or use the following link.

#### WWI Bombing

No records have been found indicating that the Site was bombed during WWI.

#### 4.2 WWII bombing

For further information on WWII bombing in the UK, and the potential UXO hazard associated with it, see Appendix 2.5 or use the following link.

#### • WWII Bombing

Records have been found indicating that the Site was bombed during WWII. Details of WWII bombing on and in the vicinity of the Site are provided in the following sections.

#### 4.2.1 Bombing in Berkshire

WWII bombing densities for Berkshire are generally lower than most other counties in the United Kingdom.

Bombing raids were predominantly aimed at the operational airfields in the region, such as RAF Grove, adjacent to the Site, and RAF Abingdon, approximately 0.3km north of the Site. Additional raids targeted military stores depots, such as No. 3 MU Milton, within approximately 0.3km northwest of the Site (Harwell). Records for raids on many of the region's military targets were suppressed until after WWII.

The area surrounding the Site was subjected to some 'tip and run' bombing raids and aircraft jettisoning bombs on their return flights.

It should be noted that although rural areas were bombed less heavily than urban districts, Air Raid Precaution (ARP) records may under-represent the number and frequency with which bombs fell in rural areas.

#### 4.2.2 Strategic targets

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.

The Site was in an area which contained numerous potential strategic targets, including military airfields and supply depots.

Plate 10 is a Luftwaffe target photograph of Abingdon, dated the 8<sup>th</sup> July 1940.

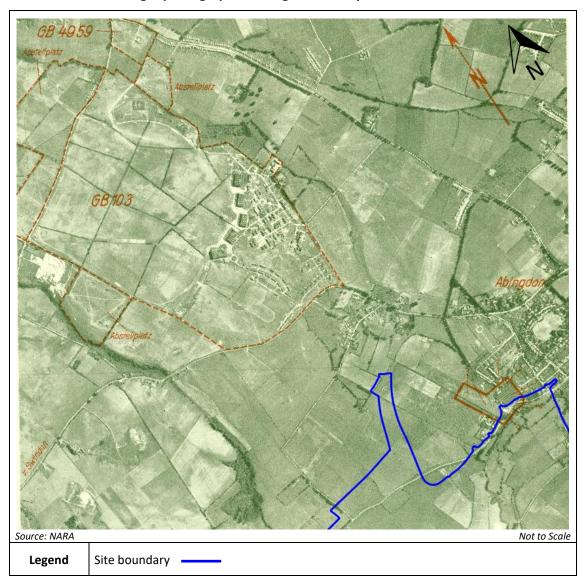
Several targets are identified, as summarised in Table 1.

Table 1 Luftwaffe targets in the vicinity of the Site

Target No.	Target
GB 4959	Radio station
GB 103	RAF Abingdon
Abstellplatz	Aircraft parking
1-5	M.G. Car Company Ltd.



Plate 10 Luftwaffe target photograph of Abingdon, 8th July 1940



#### 4.2.3 Bombing densities and incidents

Table 2 gives details of the overall bombing statistics recorded for the Local Authority Districts of the Site (highlighted by bold text) and surrounding districts. These were categorised as Rural Districts (RD), Urban Districts (UD), Municipal Boroughs (MB), Metropolitan Boroughs (MetB), and County Boroughs (CB). WWII bomb density levels are defined below:

- <5 bombs per 405ha is a Very Low regional bombing density.
- 5-15 bombs per 405ha is Low.
- 15-50 bombs per 405ha is Moderate.
- 50-250 bombs per 405ha is High.
- >250 bombs per 405ha is Very High.

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.



Note that Table 2 excludes the figures for Incendiary Bombs (IBs). Discrepancies between the below list and other records, such as bomb clearance records, demonstrate that this data is likely to under-represent actual bombing.

**Table 2 Bombing statistics** 

	Bombs Recorded					
Area	High Explosive	Parachute Mines	Other	Total	Bombs per 405ha (1000 acres)	
Abingdon RD	160	0	2	162	3.9	
Bullingdon RD	260	2	6	268	3.0	
Wantage RD	142	0	5	147	2.0	
Wantage UD	1	0	1	2	0.7	
Abingdon MB	0	0	0	0	0.0	
Faringdon RD	99	0	3	102	1.8	
Wallingford RD	23	2	0	25	1.1	

It should be noted that during WWII, many Unexploded Bombs (UXBs) 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 UXBs were probably removed and only a much smaller number were actually registered as officially abandoned bombs.

Details of the nearest recorded bombing incidents to the Site are given in the following section.

#### 16th August 1940

10No. High Explosive (HE) bombs fell on the railway line near Steventon salvage dump, approximately 0.4km east of the Site.

#### 27th - 28th August 1940

3No. HE bombs fell on fields near Venn Mill crossroads, on the Site.

#### 16th September 1940

1No. HE bomb fell on a field south of Marcham, on the Site.

#### 30th September - 1st October 1940

1No. HE bomb fell in the River Ock, on the Site.

8No. HE bombs fell on open fields between Milton Hill and East Hanney, on and within the vicinity of the Site.

3No. HE bombs fell on fields near Drayton, within approximately 0.5km east-northeast of the Site.

1No. Oil Bomb (OB) fell on land to the rear of No. 3 MU Milton Depot, approximately 1.2km northeast of the Site (Harwell).

9No. HE bombs fell on RAF Milton, within approximately 0.6km north of the Site (Harwell).

#### 26th October 1940

6No. HE bombs and 1No. OB fell on fields between Manor Farm, Drayton, to Building's Farm, Marcham, on and adjacent to the Site.

#### 27th October 1940

19No. HE bombs fell on fields between Charney Bassett and Garford, on and within approximately 1.8km west of the Site. These were all recorded as UXBs.



#### 19th November 1940

1No. HE bomb fell on open ground south of Drayton village, approximately 0.3km southwest of the Site (Drayton). This was recorded as a UXB.

#### 23<sup>rd</sup> November 1940

1No. HE bomb fell on the railway line at Milton, approximately 0.6km north of the Site (Harwell).

18No. HE bombs fell on open ground near Milton, approximately 0.8km south of the Site (Drayton).

1No. HE bomb fell on No. 3 MU Milton Depot, approximately 1.2km east of the Site.

#### 3<sup>rd</sup> December 1940

5No. HE bombs fell on open ground outside No. 3 MU Milton Depot, within approximately 1.1km east of the Site.

6No. HE bombs fell on fields south of the railway between Milton railway bridge and Foxhall railway bridge, within approximately 0.9km northeast of the Site (Harwell).

8No. HE bombs fell on RAF Abingdon, approximately 0.4km northeast of the Site.

#### 14th December 1940

1No. HE bomb fell on open ground east of Belmont Farm, approximately 0.7km north-northwest of the Site (Wantage).

#### 14<sup>th</sup> February 1941

3No. HE bombs and 50No. IBs fell on Barrow Lane, Sutton Wick, on the Site.

#### 17<sup>th</sup> April 1941

6No. HE bombs fell on fields in a line from west of Drayton to South of Frilford, on the Site.

#### **Date unspecified**

1No. HE bomb fell on a field east of Marcham Mill, on the Site.

Figure 5 is a map showing the approximate location of recorded bomb impacts in the immediate vicinity of the Site. IBs shown are indicative of larger numbers of similar devices that fell within the given area.

The map has been compiled from different sources, including air raid incident reports, historical aerial photographs, and bomb census maps.

The bomb map is also given in the accompanying P15306-25-R1-MAP01-B.



Figure 5 Compiled bomb impact map for the vicinity of the Site

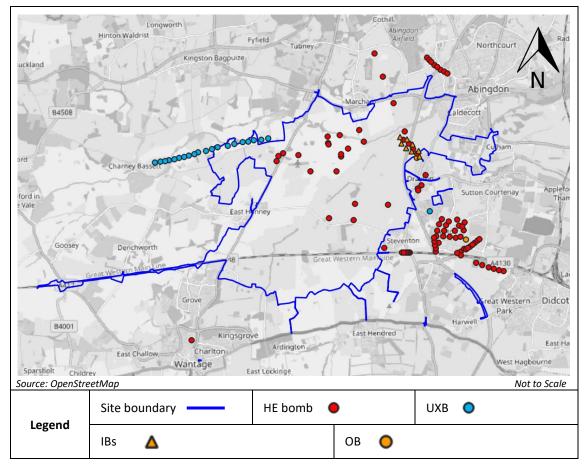


Plate 11 to Plate 21 are aerial photographs dating from 1943 to 1946. Several possible bomb craters have been identified on parts of the Site. These are consistent with bombs dropped on the Site by enemy aircraft during WWII.

Several other features have been identified.



Plate 11 Aerial photograph, 12<sup>th</sup> April 1946 (SU 417946)

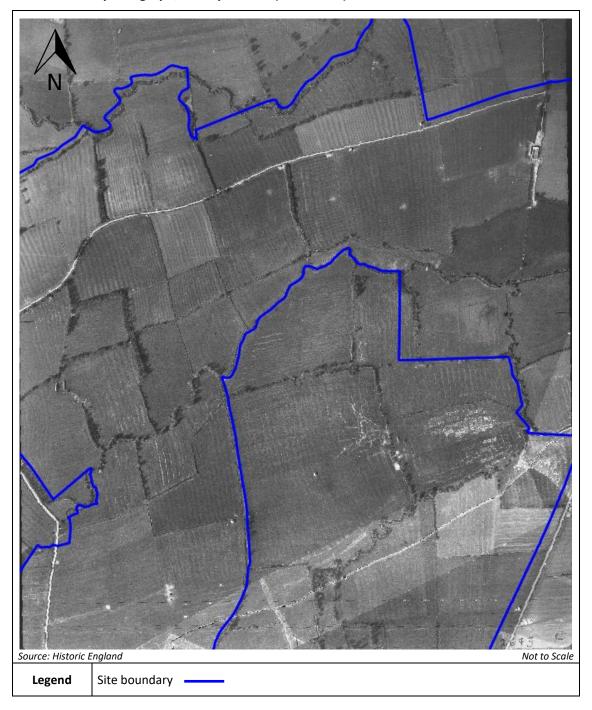




Plate 12 Aerial photograph, 8<sup>th</sup> March 1944 (SU 451949)

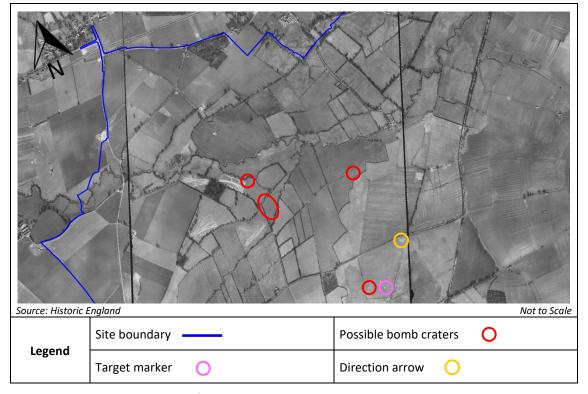


Plate 13 Aerial photograph, 13<sup>th</sup> December 1943 (SU 493952)





Plate 14 Aerial photograph, 8th March 1944 (SU 460939)

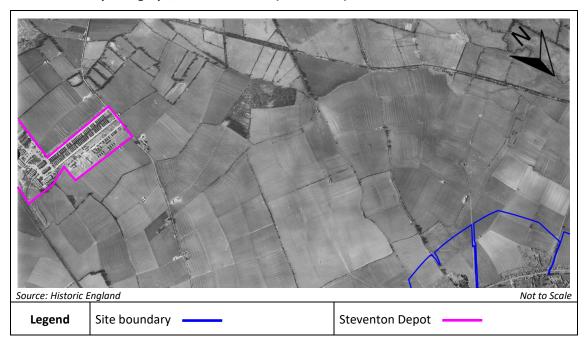
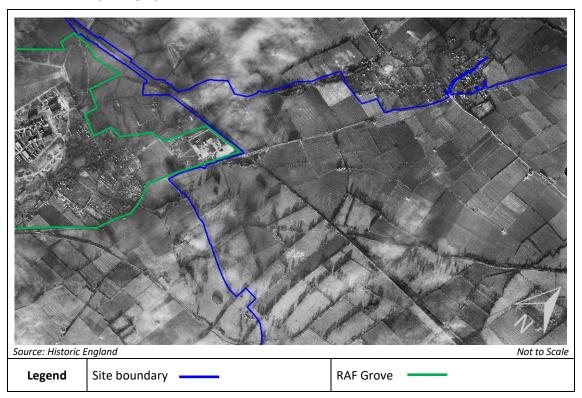


Plate 15 Aerial photograph, 1st December 1944 (SU 421917)





# Plate 16 Aerial photograph, 12th April 1946 (SU 353905)

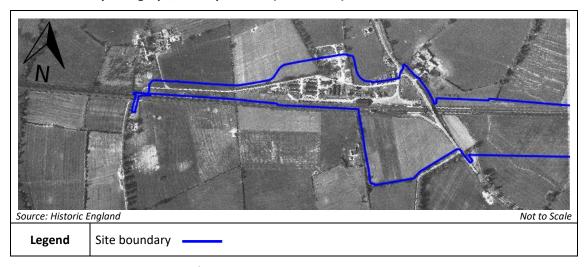


Plate 17 Aerial photograph, 12th April 1946 (SU 464917)

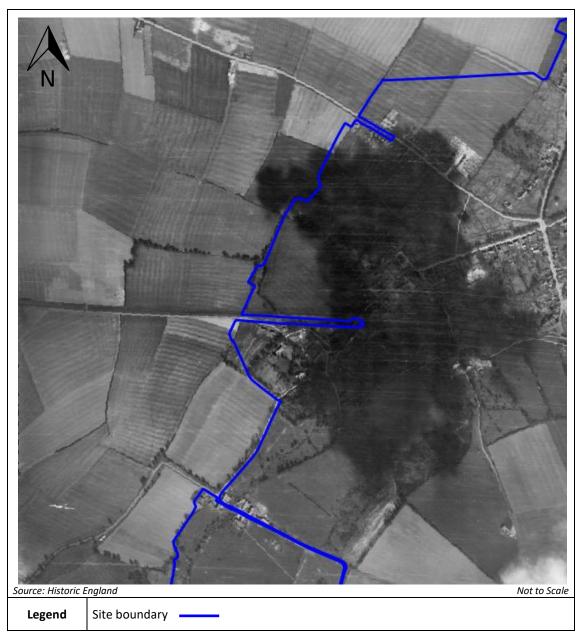




Plate 18 Aerial photograph, 12th April 1946 (Drayton, SU 482934)

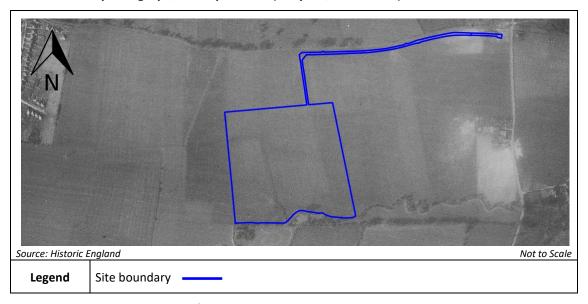


Plate 19 Aerial photograph, 12th April 1946 (Harwell, SU 494900)





Plate 20 Aerial photograph, 12<sup>th</sup> April 1946 (Rowstock, SU 478891)

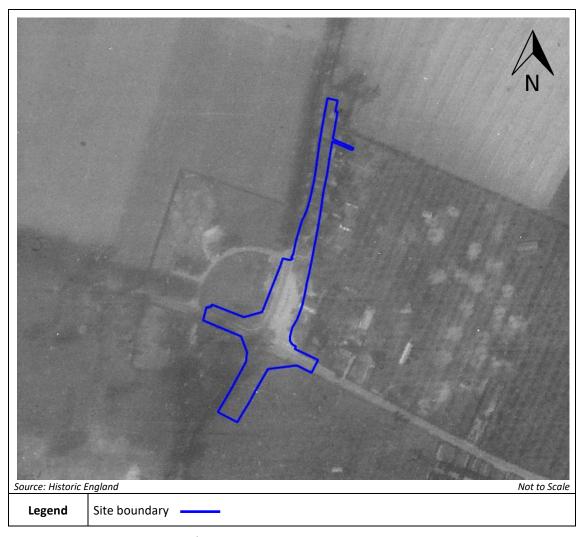
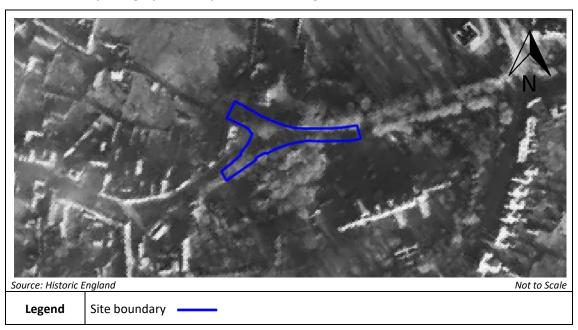


Plate 21 Aerial photograph, 12<sup>th</sup> April 1946 (Wantage, SU 401879)





#### Potential UXO hazard

The Site was subjected to several minor raids typically carried out by single aircraft dropping small numbers of bombs.

Whilst the potential for a German UXB to have fallen unnoticed on the Site cannot be discounted, the probability is considered low.

WWII German bombing is not considered to provide a significant source of UXO hazard to the Site.

### 4.2.4 Abandoned bombs

No records have been found indicating that any officially abandoned bombs are located on the Site. The nearest is described below.

#### 20th November 1940

1No. HE bomb fell on fields half a mile south of Drayton village, in close proximity to the eastern boundary of the Site. It was recorded as an UXB. It was declared abandoned on the 2<sup>nd</sup> April 1941 and given the designation A.B.4. No clearance certificate for A.B.4 has been found.

A.B.4 is not on the officially abandoned bomb register, indicating it was removed or discredited.

The indicated location of A.B.4 in historical records, and the lack of UXB finds during the post-WWII construction of the A34, suggest that A.B.4 is not on the Site.

### 4.2.5 Bomb penetration depths

It is important to consider the geological materials present at the time that a bomb was dropped to establish its maximum penetration depth.

Client-provided information, BGS 1:50,000 Sheet 253 Abingdon (Solid & Drift) and BGS borehole records from on the Site and nearby investigations have been consulted to get an indicative overview of the Site geology.

The WWII geology of the Site is understood to consist of topsoil, over sand and gravel, overlying mudstone, sandstone, and limestone formations.

Table 3 provides an estimate of average maximum bomb penetration depths for the Site assuming WWII ground conditions of 15m of stiff clay, over 3m of sand, over 4m of stiff clay, overlying more than 20m of weak rock.

Table 3 Estimated average maximum bomb penetration depths

Estimated average bomb penetration depths for anticipated geology				
Romb	50kg	5.5m		
Bomb	250kg	8.5m		
Weight	500kg	14.0m		

These calculations can be refined on receipt of further Site-specific information.

The estimated bomb penetration depths given in Table 3 are from the WWII ground level and are based on the following assumptions:

- a) High-level release of the bomb resulting in an impact velocity of 260m/s (>5,000m altitude).
- b) A strike angle of 10 to 15  $^{\circ}$  to the vertical.
- c) That the bomb is stable, both in flight and on penetration.
- d) That no retarding units are fitted to the bomb.



e) That the soil type is homogenous.

Assuming the above, a bomb will enter the ground and travel on the same trajectory until momentum is nearly lost. The bomb will then turn abruptly to the horizontal before coming to rest. The horizontal distance between the centre of the entry hole and the centre of the bomb at rest is known as the 'offset'. A marked horizontal 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. If hardstanding 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.



## 5 POST-WWII EXPLOSIVE ORDNANCE CLEARANCE (EOC) ACTIVITIES

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

On average, 8.5% of 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.

WO statistics also show that between October 1940 and May 1941 most UXBs (93%) were either 50kg or 250kg. It should be noted that details of the recovery and 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.

#### 5.1 EOC tasks

Zetica holds the following records of post-WWII EOC tasks having taken place on and in the vicinity of the Site.

#### 2006

Several 8.5 pound (Ib) British practice bombs, British 4.5" reconnaissance flares, and fragments of British 250lb bomb casings were removed at the former Marcham bombing range, on the central part of the Site. This was undertaken by a UXO specialist supporting intrusive ground investigation works. The items were removed for disposal.

### 16th September 2008

6,000No. AA shells were discovered during excavations at Milton Park Industrial Estate, Didcot, approximately 1.6km east of the south-eastern part of the Site. These were removed for disposal.

### 5<sup>th</sup> April 2020

1No. British 500lb practice bomb was discovered during ploughing of fields near Drayton, on the Site. After investigation it was found to be empty and was destroyed in situ by an Explosive Ordnance Disposal (EOD) team.

Plate 22 is a photograph of the UXB.



## Plate 22 Photograph of UXB discovered near Drayton, April 2020



## 2024 - 2025

Several British practice bombs and associated fragmentation were found at the former Marcham bombing range, on the central part of the Site, during ground investigation works.



## **6 UXO HAZARD AND MILITARY USES ASSESSMENT**

### 6.1 UXO hazard level

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 or 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.			

## **Contaminants from military uses**

No significant contamination from military use of the Site have been identified.

Table 4 summarises the potential contamination resulting from military use and the associated risk. It is considered that the Site has a low risk of contamination resulting from military use.

Table 4 Potential contamination from military use on the Site

Military use	Potential contamination	Risk
Abingdon Common rifle range	Potential metalloid contamination within the former target butts.	Low
Steventon bombing decoy	Potential hydrocarbon contamination from the decoy fires.	Low
No. 3 MU Steventon Depot	Potential radiological contamination from radium dials and luminescent paint associated with storage of aircraft parts.  Potential hydrocarbon contamination from refuelling of military vehicles.	Low
United States (US) Army Ordnance Depot G-0677	Potential localised disposal or spillage of munitions. No potential contamination identified.	Low
Anti-invasion defences	Potential localised disposal or spillage of munitions. No potential contamination identified.	Low
Home Guard activity	Potential localised disposal or spillage of munitions. No potential contamination identified.	Low
RAF Grove (adjacent to the Site)	None identified.	N/A
No. 3 MU Milton Depot (within 0.3km northwest of the Site (Harwell))	None identified.	N/A
Aircraft crashes	None identified.	N/A



#### **UXO** hazard assessment

During WWII, Marcham bombing range was located on the central part of the Site. Although designated for practice bombing, it is known that live bombs were often used on such ranges during wartime.

The typical inner danger area for bombing ranges was 550yds, centred around the target marker. This part of the Site has been assigned a high UXO hazard level due to the likely presence of practice bombs at shallow depths and potentially live UXBs.

An outer danger area of up to 950yds was common. As such, a 400yd radius around main danger area has been assigned a moderate UXO hazard level to account for potential overspill.

The German bombing density on the Site was low and no other significant sources of UXO hazard or military uses have been identified. The remainder of the Site is assigned a low UXO hazard level.

It is considered that the UXO hazard level on the Site can be zoned from low to high, as shown in Figure 6 to Figure 8.

The UXO hazard zone plan of the Site is also given in the accompanying P15306-25-R1-MAP01-B.

Figure 6 UXO hazard zone plan of the Site

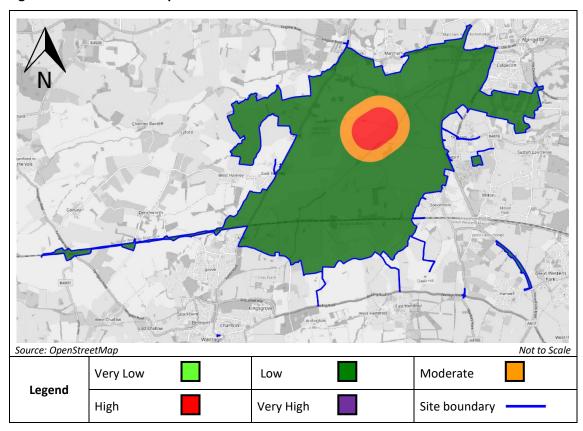




Figure 7 UXO hazard zone plan of the Site (Wantage)

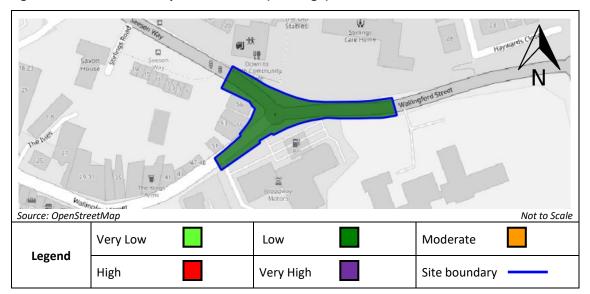
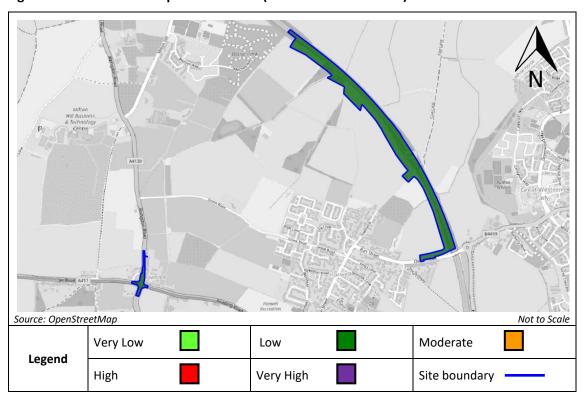


Figure 8 UXO hazard zone plan of the Site (Rowstock and Harwell)





### 7 UXO RISK ASSESSMENT

### 7.1 Proposed works

It is understood that initial works on the Site comprise a ground investigation, including hand-dug inspection pits to 1.2 metres below ground level (bgl), 104No. boreholes up to 45m bgl, excavations up to 10m bgl, and Multi-channel Analysis of Surface Waves (MASW) surveys.

Future works may comprise the development of a fully bunded reservoir, the establishment of pumping stations, a tunnel, access roads, and new canals.

## 7.2 Risk assessment methodology

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

Firstly, the probability of encountering UXO (PE) has been considered and rated for the proposed 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 an item of UXO (PD) has been considered and rated for the proposed 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
21 to 25	Frequent, highly likely, almost certain.	5
16 to 20	Probable, more likely to happen than not.	4
6 to 15	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 (P) is multiplied by the severity (S) of such an event occurring (P x S), 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 M	atrix						
				SEVERITY (S)	1		
_		5	4	3	2	1	0
( <u>a</u>	5	25	20	15	10	5	0
QO	4	20	16	12	8	4	0
Ŷ	3	15	12	9	6	3	0
<u> </u>	2	10	8	6	4	2	0
LIKE	1	5	4	3	2	1	0
_	0	0	0	0	0	0	0

## 7.3 UXO risk level

The UXO risk assessment for proposed works on the Site is given in Table 5.

Table 5 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
	Live Duitiele	Excavations	3	2	6	3	5	15	Moderate
	Live British UXB	Boreholes	2	3	6	3	4	12	Moderate
	OVP	Non-intrusive surveys	1	1	1	1	5	5	Low
		Excavations	5	2	10	3	2	6	Moderate
High	Practice Bombs	Boreholes	4	3	12	3	2	6	Moderate
	BOTTIDS	Non-intrusive surveys	1	1	1	1	2	2	Low
		Excavations	1	1	1	1	4	4	Low
	Other UXO	Boreholes	1	1	1	1	3	3	Low
		Non-intrusive surveys	1	1	1	1	4	4	Low
	Live British	Excavations	intrusive surveys 1 1 1 1 1 vations 2 2 4 2 holes 1 3 3 2	2	5	10	Moderate		
	UXB	Boreholes	1	3	3	2	4	8	Moderate
	OVP	Non-intrusive surveys	1	1	1	1	5	5	Low
	Practice	Excavations	4	2	8	3	2	6	Moderate
Moderate	Bombs	Boreholes	3	3	9	3	2	6	Moderate
	BOITIUS	Non-intrusive surveys	1	1	1	1	2	2	Low
		Excavations	1	1	1	1	4	4	Low
	Other UXO	Boreholes	1	1	1	1	3	3	Low
		Non-intrusive surveys	1	1	1	1	4	4	Low
	Live British	Excavations	1	1	1	1	5	5	Low
	UXB	Boreholes	1	1	1	1	4	4	Low
	OVP	Non-intrusive surveys	1	1	1	1	5	5	Low
	Practice	Excavations	1	1	1	1	2	2	Low
Low	Bombs	Boreholes	1	1	1	1	2	2	Low
	5011103	Non-intrusive surveys	1	1	1	1	2	2	Low
		Excavations	1	1	1	1	4	4	Low
	Other UXO	Boreholes	1	1	1	1	3	3	Low
		Non-intrusive surveys	1	1	1	1	4	4	Low
PE = Probabili	ty of Encounte	er, PD = Probability of I	Deton	ation,	, P = C	verall	Prob	ability	1



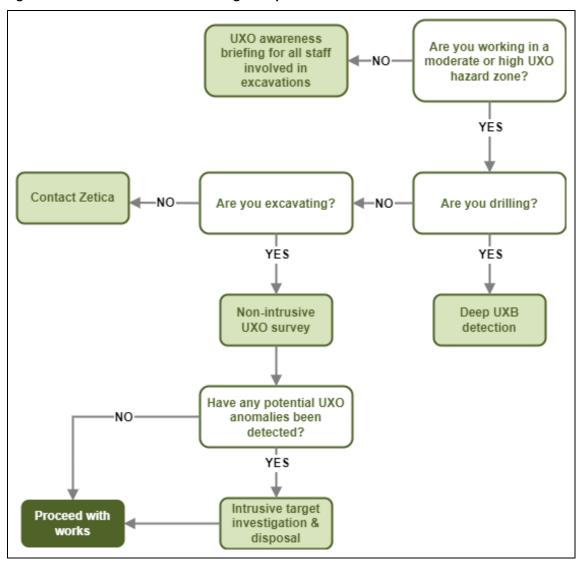
### 8 RISK MITIGATION PLAN

**Key findings:** Potential hazard from practice bombs and live UXBs on the central part of the Site.

**Key actions:** Non-intrusive UXO surveys and deep UXB detection surveys recommended in moderate and high UXO hazard zones. UXO awareness briefing for staff involved in excavation across the Site.

Figure 9 outlines the recommended steps to reduce the UXO risk to As Low As Reasonably Practicable (ALARP).

Figure 9 Recommended UXO risk mitigation plan for the Site



### 8.1 UXO risk summary

Table 6 summarises the UXO risk for proposed works on the Site and recommended actions.



Table 6 Summary of UXO risk and mitigation recommendations

Proposed Works	UXO Risk	Recommended Mitigation
Excavations		<b>UXO awareness briefing</b> – Given the military history of the Site it is recommended that a formal UXO awareness briefing is provided to staff involved in excvations.
Boreholes		Proceed with works
Non-intrusive surveys	<u>*</u>	Proceed with works
Excavations		Non-intrusive survey – where access allows, a non-intrusive UXO survey should be undertaken around proposed excavations to map shallow-buried UXO. Potential UXO targets detected can either be avoided or intrusively investigated and removed.
Boreholes		Deep UXB detection — to clear borehole locations of potential UXB, an intrusive magnetometer survey should be undertaken until either the maximum bomb penetration or maximum drilling/piling depth is reached.
Non-intrusive surveys	<u>*</u>	Proceed with works

In summary, in the moderate and high UXO hazard zones, a non-intrusive UXO survey is recommended in advance of excavations and drilling to map shallow-buried UXO. Deep UXB detection is recommend to clear borehole locations of deep-buried UXO.

A UXO awareness briefing is recommended for all staff involved in excavations.

### 8.2 Risk mitigation techniques

## 8.2.1 Non-intrusive survey

To proactively mitigate the UXO risk, it is recommended that a non-intrusive magnetometer survey is undertaken to detect potential shallow-buried UXB.

Analysis of the survey data should be undertaken in the office by a suitably trained and qualified geophysics specialist to determine the limits of detection and enable effective target selection. From this, a priority ranking can be established for those targets most likely to be an UXB.

On completion of the survey, potential UXO targets can be avoided (where practical) or investigated and removed by an EOC team.



Depending on the proposed depth of excavations and the maximum detection depth for an UXB on the Site, it may be necessary to undertake the non-intrusive survey in layers.

Further details on survey design can be provided on receipt of ground investigation results and the final construction plan.

#### 8.2.2 Deep UXB detection

On completion of the non-intrusive survey, an intrusive magnetometer survey should be undertaken to clear any borehole locations.

The survey should be carried out to either the maximum bomb penetration depth or maximum drilling depth, whichever is shallower.

There are two main systems available:

MagDrill – this is a system that is suitable for working with ground investigation drillers.

It allows a magnetometer to be lowered into the borehole to ensure the route is clear of potential UXB.

Where large numbers of boreholes are conducted, it may be more economical to deploy MagCone systems.

**MagCone** – this is a CPT-based system that facilitates the pushing of a magnetometer into the ground at the proposed borehole location.

MagCone is suitable for cohesive/loose soils and has a much higher speed of operation compared to MagDrill. It should be noted that where dense soils or buried obstructions are encountered, MagCone is unlikely to be able to penetrate to the required depth.

**Detection** - Typical radius of detection should be assumed as approximately 1.0m for a 50kg UXB until site conditions are confirmed.

Assuming no objects comparable to the UXB detection range are identified, then the borehole position can be considered clear of UXB.

If any ferrous anomalies are identified at the borehole position, then it may need to be relocated or the anomaly investigated.

It should be noted that in Made Ground or close to buried/adjacent structures, effective UXB detection is compromised due to geophysical noise.

A clearance report should be issued on completion of the site works.

### 8.2.3 UXO awareness briefing

It is recommended that all staff involved in excavations are provided with a formal UXO awareness briefing.

The briefing should offer some recognition skills for typical UXO, and suitably sensitise staff to be vigilant during site works.

A UXO awareness briefing ensures that in the unlikely event that UXO is encountered:

- All site staff take appropriate action.
- A support mechanism and points of contact are established.
- The likelihood of harm to people or property is reduced.
- Significant delays to site work are prevented.



### 8.2.4 Radiological risk mitigation

No significant sources of radiological contamination have been identified on the Site. If further comfort is required for areas where radiological sources may have been used (e.g. military depots), it is recommended that advice is sought from a health physics specialist.

### 8.2.5 Explosives testing

No significant sources of explosives contamination have been identified on the Site. If further comfort is required for areas where explosive residues may be present (e.g rifle ranges), soil samples can be taken for laboratory analysis. A standard testing suite is recommended to cover typical explosives found in the UK.

### 8.3 What do I do next?

If you wish to proceed with UXO risk mitigation, contact us and we can help.



If you have requirements to identify other buried hazards (such as mapping utilities or obstructions) we can provide these surveys.

If proposed works on the Site change, or additional works are planned, contact Zetica for a reassessment of the UXO risk and the risk mitigation requirements.



### **APPENDICES**

## **Appendix 1 Anticipated ordnance types**

For a more comprehensive set of ordnance data sheets, see <a href="https://zeticauxo.com/guidance/ordnance-data-sheets/">https://zeticauxo.com/guidance/ordnance-data-sheets/</a>.

# Information Data Sheet

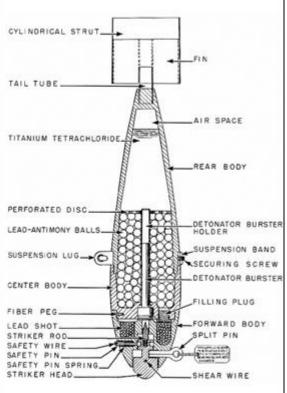


# 8.5lb Practice Bomb









	Specifi	cations	
Description	Pear shaped with single suspension lug and ring-bound four-fin tail	Function	Training (Smoke or Flash)
Dimensions	Total 406mm x 76mm (16" x 3")  Body 305mm x 76mm (12" x 3")	Activation by	Impact fuze
Material	Bakelite body, sheet metal tail	Variations	3 <del>.</del>





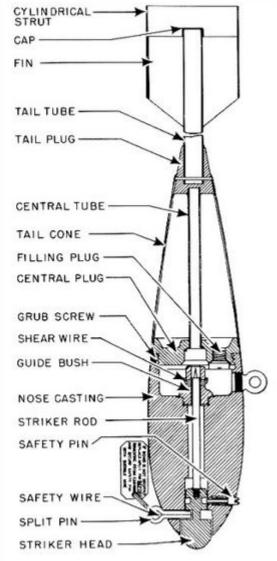
# 10lb Practice Bomb











	Specifi	cations	
Description	Pear shaped with single suspension lug and ring-bound four-fin tail	Function	Training (Smoke or Flash)
Dimensions	Total 457mm x 76mm (18" x 3")  Body 178mm x 76mm (7" x 3")	Activation by	Impact fuze
Material	Iron body, sheet metal tail	Variations	Variants with Bakelite tail





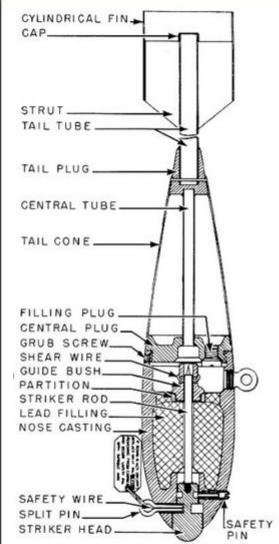
# 11.5lb Practice Bomb











	Specifi	cations	
Description	Pear shaped with single suspension lug and ring-bound four-fin tail	Function	Training (Smoke or Flash)
Dimensions	Total 457mm x 76mm (18" x 3")  Body 178mm x 76mm (7" x 3")	Activation by	Impact fuze
Material	Steel body, sheet metal tail	Variations	Variants with thicker tails or Bakelite construction



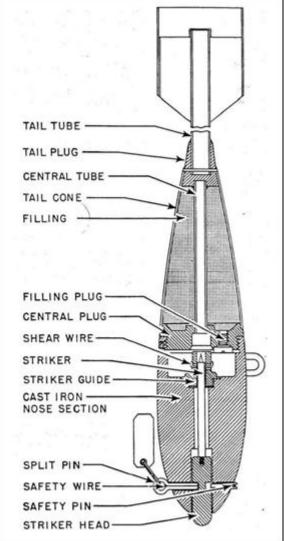


# 25lb Practice Bomb







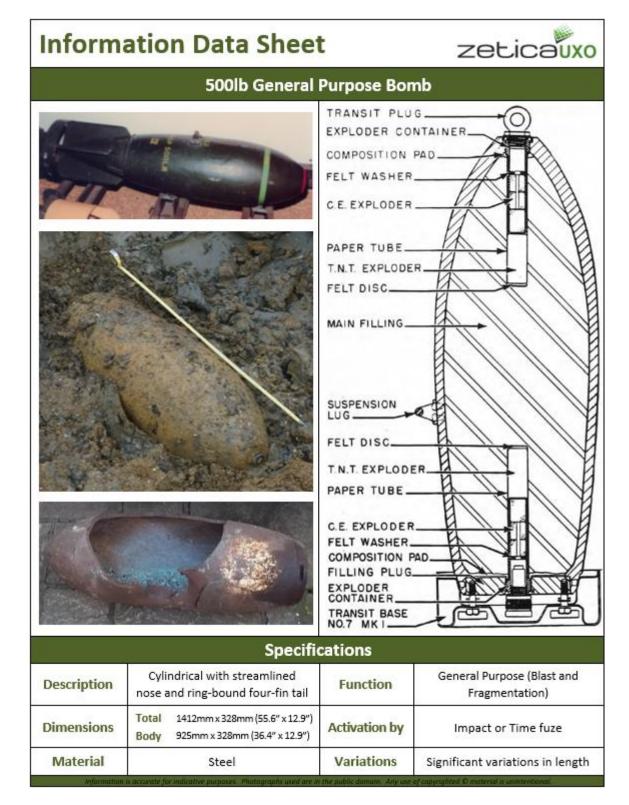


Description	Pear shaped with single suspension	Function	Tesisine (Conclus on Flack)	
Description	lug and ring-bound four-fin tail	runction	Training (Smoke or Flash)	
Dimensions	Total 559mm x 102mm (22" x 4")  Body 229mm x 102mm (9" x 4")	Activation by	Impact fuze	
Material	laterial Iron nose, sheet metal tail		9 <u>5</u> 8	



# zeticauxo Information Data Sheet 250lb General Purpose Bomb RETAINING SHEAR PIN TAIL PLUG SECURING SCREW DETONATOR HOLDER TAIL CONE LOCATING PIN -GLAND NUT -CONE RING -SEALING COMPOSITION FILLING PLUG-FELT WASHER MAIN FILLING CENTRAL TUBE COMPOSITION NOSE BUSH-SECURING SCREW NOSE PLUG-Specifications Cylindrical with streamlined General Purpose (Blast and Description Function nose and ring-bound four-fin tail Fragmentation) Total 1377mm x 262mm (54.2" x 10.3") Dimensions Activation by Impact or Time fuze Body 711mm x 262mm (28" x 10.3") Material Variations Steel Minor variations in size









### **Small Arms Ammunition**









.303" British SAA

Spent SAA cartridges

Loose SAA

Relted 0 5" SAA

Small Arms Ammunition (SAA) refers to a wide variety of cartridges with projectiles up to ~12.7mm (0.5") in calibre. Weapons using SAA may be man-portable or mounted on vehicles such as tanks and aircraft.

SAA may be found loose, or in belts, magazines, or clips. Rounds may be spent (fired) or unspent (intact). Encounters with SAA are particularly common around military establishments such as ranges, training areas, and airfields. Aircraft crashes and shipwrecks are other common sources of SAA encounter.

Generally, SAA presents a low risk to Site works, but it should still be treated with respect. Any SAA encountered should be stored in a metal box kept in a secure location. Once ~12 rounds have accumulated, they should be handed to police with an explanation of how and where they were found.

Some varieties of SAA may contain fuzes and/or explosive fillings (e.g., High Explosive/Incendiary (HE/I)). This is most common for rounds with projectiles over 10mm (0.4") in calibre. Where these varieties of SAA are anticipated or encountered, any SAA found should be treated in the same way as larger UXO.



The above is an indicative selection of some of the most common calibres of SAA. It is not exhaustive. The appearance of SAA can vary considerably depending on their origin and intended purpose.

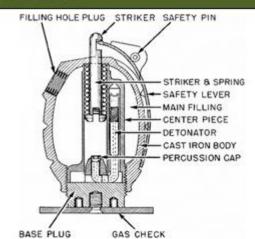




# 'Mills Bomb' Grenade



No. 5 (c. 1916) and No. 36 (c. 1940) 'Mills Bomb' Grenades











	Specifi	cations		
Description	Segmented egg-shaped body with base plug and safety lever	Function	Anti-Personnel (Fragmentation) Time fuze	
Dimensions	95mm x 58mm (3.7" x 2.3")	Activation by		
Material Steel		Variations	Optional gas check baseplate or rod for use as a Rifle Grenade	



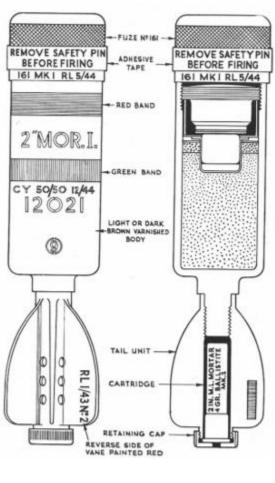


# 2" Mortar









	Specifi	cations		
Description	Cylindrical body with six- or eight-vane perforated tail	Function	Anti-Personnel (Fragmentation), Incendiary, Smoke, or Illumination	
Dimensions	Total 290mm x 50mm (11.4" x 2") Body 145mm x 50mm (5.7" x 2")	Activation by	Impact or Time fuze	
Material	Steel	Variations	Minor variations in length and shape dependent on function	





## Improvised Grenades







Production of improvised grenades

Improvised grenades and launcher

Home Guard with improvised grenades

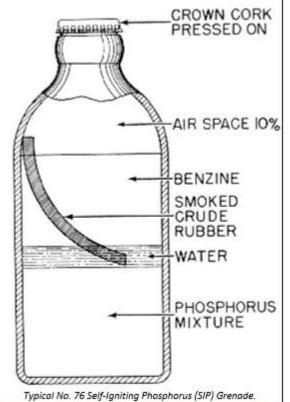
During WWII, improvised grenades were created by combining suitable containers with explosive or incendiary fillings. Such weapons were often made to cover munitions shortages. They were widespread among units such as the Home Guard and include the colloquially named 'Molotov Cocktail'.

The most common British improvised grenade was the No. 76 Self-Igniting Phosphorus (SIP) Grenade (or 'AW Bomb'). These were glass bottles (typically 284ml or ½ pint) containing a mix of White Phosphorus, Benzene, Water, and Rubber, which would self-ignite on contact with air. They could be hand-thrown or fired from a Northover Projector. Approximately 6,000,000No. SIP Grenades had been produced by August 1941.

Improvised grenades may not be immediately obvious as items of UXO. It is important to maintain recognition skills and exercise additional caution in areas where they may be encountered.







Information is accurate for indicative purposes. Photographs used are in the public domain. Any use of capyrighted © inoterial is unintentional.



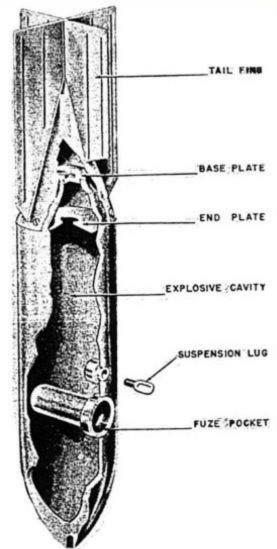


# 50kg High Explosive Bomb









	Specific	cations		
Description	Cylindrical with pointed nose and four-fin tail	Function	General Purpose (Blast and Fragmentation)	
Dimensions	Total 1090mm x 280mm (42.9" x 11")  Body 766mm x 200mm (30.2" x 7.9")	Activation by	Impact, Time, or Tamper fuze	
Material Steel		Variations	Minor variations in length	



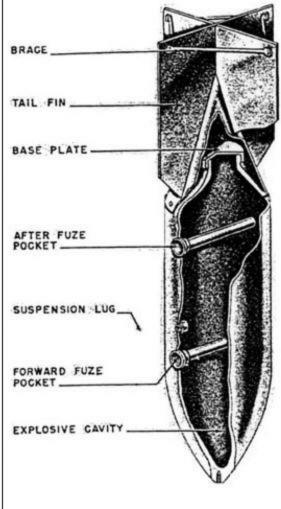


# 250kg High Explosive Bomb









	Specific	cations		
Description	Cylindrical with pointed nose and braced four-fin tail	Function	General Purpose (Blast and Fragmentation) Impact, Time, or Tamper fuze	
Dimensions	Total 1640mm×512mm (64.6" × 20.2")  Body 1172mm × 368mm (46" × 14.5")	Activation by		
Material	Steel	Variations	Minor variations in length	



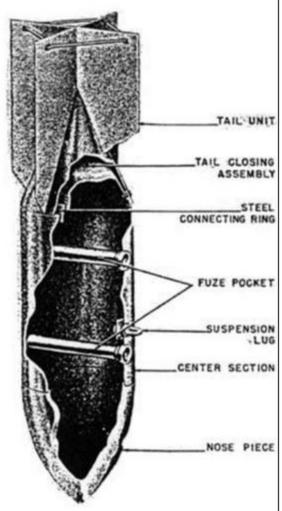


# 500kg High Explosive Bomb









	эреспи	cations	
Description	Cylindrical with pointed nose and braced or ring-bound four-fin tail	Function	General Purpose (Blast and Fragmentation)
Dimensions	Total 1957mm x 640mm (77" x 25.2") Body 1423mm x 470mm (56" x 18.5")	Activation by	Impact, Time, or Tamper fuze
Material Steel body, Steel or Magnesium Alloy tail		Variations	Minor variations in length





# **Anti-Aircraft Shells**







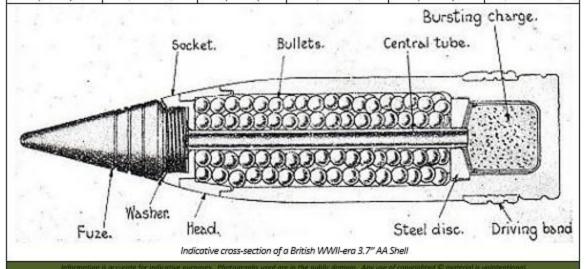




AA Nose Fuze

Anti-Aircraft (AA) guns are artillery pieces designed to engage aircraft. They may be classed as Heavy AA (HAA) or Light AA (LAA). HAA shells are typically streamlined, made of steel, and equipped with driving bands. They usually carry a High Explosive (HE) or shrapnel filling and use time or proximity fuzes. LAA guns are often autocannons. Indicative specifications for common British HAA shells are given below.

		Speci	fications		
Shell	Dimensions	Shell	Dimensions	Shell	Dimensions
6-pdr	307mm x 57mm	13-pdr	294mm x 76mm	3.7"	675mm x 94mm
(c WWI)	(12.1" x 2.2")	(c. WWI)	(11.6" x 3")	(c. WWII)	(26.6" x 3.7")
75mm	350mm x 75mm	3"	420mm x 76mm	4.5"	695mm x 113mm
(c <i>WWI</i> )	(13.8" x 3")	(c. WWI)	(16.5" x 3")	(c. WWII)	(27.4" x 4.5")
12-pdr	445mm x 102mm	4"	445mm x 102mm	5.25"	782mm x 133mm
(c WWI)	(17.5" x 4")	(c. WWI)	(17.5" x 4")	(c. WWII)	(30.8" x 5.25")





### **Appendix 2 Sources of UXO hazard**

The sections below provide background information on the potential sources of UXO hazard affecting the Site. For a more comprehensive set of UXO information sheets, see <a href="https://zeticauxo.com/guidance/uxo-hazard-sources/">https://zeticauxo.com/guidance/uxo-hazard-sources/</a>.

#### Appendix 2.1 Bombing ranges

## Information Data Sheet

## Category Bombing Ranges

#### Description

Bombing ranges primarily use practice and live bombs, although other munitions such as shells and rocket projectiles are also commonly used.

Bombing ranges have been established since WWI, when aerial strategic bombing was first used. Many practice bombing targets were located at airfields, allowing resident squadrons to practice close to their base.

During WWII, a significant number of new bombing ranges were established. This included live ranges (often along the coast), practice ranges and air-to-ground ranges which also involved the firing of projectiles from aircraft.

Despite being designated for practice bombs, many ranges also used live bombs, particularly during wartime.



Retrieving practice bombs from a range in an estuary during WWII

#### Hazard

Bombing ranges provide a potential UXO hazard from live and practice bombs, in addition to other projectiles that may have failed to detonate during training. In the marine environment, in particular, the removal of unexploded bombs is less likely to have taken place.

Practice bombs contain a small explosive charge and produce a coloured powder plume for daylight operations and a light flash for night operations.

Typically, the greatest concentration of ordnance at an artillery range will be around any target/impact area, which are often recorded on range templates or evident from aerial photographs.

The inherent inaccuracy of practice bombing means that bombs can be found in areas surrounding designated bombing ranges. Inexperienced RAF bombing squadrons and cavalier American bomb-aimers often missed the target by some distance.

Today, there is a much more rigid protocol for clearing bombing ranges of UXO and, with improved equipment and techniques, clearance is far more thorough than on wartime ranges.



### Appendix 2.2 Bombing decoys

# Information Data Sheet

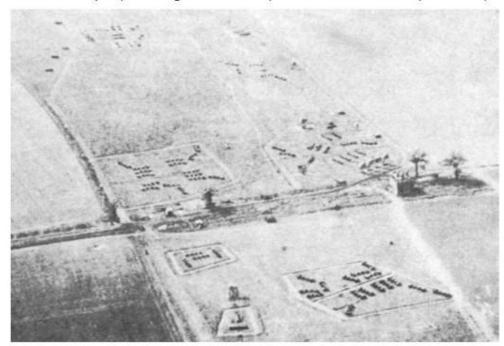
## Category Bombing Decoys

#### Description:

Bombing decoys were developed between 1940 and 1941, designed to create false bombing targets realistic enough to divert enemy aircraft away from the authentic ones. The decoy system proved successful in many areas of the UK, with at least 5% of the total weight of bombs drawn away from their intended targets. Approximately 792No. static bombing decoys were built at 593No. locations across the UK.

Several different types of decoy existed:

- Dummy airfields for daytime ('K sites') and night-time ('Q sites'). These would include dummy aircraft, and landing lights and flare paths to simulate airfield lighting.
- Diversionary fires on airfields ('QF sites'), petroleum depots ('P sites'), and major towns and cities ('Starfish (SF) sites'). These would comprise frames of combustible material that would be lit to simulate successful bombing raids.
- Simulated urban lighting ('QL sites').
- Dummy Heavy Anti-Aircraft (HAA) batteries, factories, and buildings ('C series').
- Mobile decoys representing 'hards' for troops embarkation and tanks ('MQL sites')



SF decoy site

#### Hazard:

By their nature, bombing decoys provide a potential hazard from Unexploded Bombs (UXB), both within the decoy boundary and in the surrounding areas. Many decoys were established on greenfield sites, meaning seemingly innocuous fields may have a potential UXB hazard.

The most important thing to understand is if a bombing decoy was successful, as whilst many were attacked, some were not and therefore will not constitute an UXB hazard.



### Appendix 2.3 Home Guard and Auxiliary Units

# Information Data Sheet

## Category Home Guard and Auxiliary Units

### Description:

Local Defence Volunteers (LDV) units, later known as the Home Guard, were in almost all towns and villages. They were made up of civilians not in military service, volunteering to take on a home defence role. Units were also raised by social clubs and factories from their members and workers.



In the event of an invasion, Home Guard units would man anti-invasion defences, factories, and important infrastructure alongside the regular Army, and were issued with 'No Withdrawal' orders.

The Home Guard was initially poorly equipped with pikes, machine guns, and revolvers from World War One (WWII). They were later equipped with Mills bomb grenades and Self Igniting Phosphorus (SIP) grenades, as well as inheriting weapons no longer in use by the regular Army.

In addition to regular Home Guard, Auxiliary Units were established as small groups of guerrilla troops, trained in sabotage and assassination in case of invasion. Top secret Operational Bases were provided for each patrol and hidden underground, usually in woodland, with a camouflaged entrance and emergency escape tunnel. Auxiliary Units were given a selection of weapons, including explosive incendiary devices, and were expected to attack invading forces. Patrols often investigated country houses that could be used by German officers.







Emergency escape tunnel of a base

#### Hazard:

Records of the Home Guard and Auxiliary Unit activities were rarely kept, and training activities were usually unofficial or unsanctioned. Storage and disposal of munitions by the Home Guard and Auxiliary Units was poorly documented and surplus supplies were often buried or dumped in adhoc locations, such as in lakes and ponds or close to anti-invasion defences.



### Appendix 2.4 WWI bombing

# Information Data Sheet

## Category World War One (WWI) Bombing

### Description:

During WWI, significant bombing took place across some areas of the UK. An estimated 9,000No. German bombs were dropped on Britain during the course of 51No. airship and 52No. aircraft raids. It was the first time that strategic aerial bombardment had been used.

Nearly 100No. air raids were carried out on London and Southeast England, over 40No. of which were by Zeppelin airships. Areas along the East Coast was also targeted regularly due to their proximity to the European continent. Bombing raids further inland were rare and West England and Wales were out of reach for German aircraft of the time.

Aerial bombing during WWI initially relied on visual aiming, with bombsights not developed until later in the war. The inaccuracy inherent in this method meant that bombs often fell some way from their intended targets.

The first recorded raid against England occurred on the 21<sup>st</sup> December 1914 when 2No. High Explosive (HE) bombs fell near the Admiralty Pier at Dover. Zeppelin raids intensified during 1915 and 1916, with aircraft raids becoming more frequent after 1917. The last raid of WWI took place on the 19<sup>th</sup> May 1918, when 38 Gotha and 3 Giant aircraft bombed London and surrounding districts, dropping a total of more than 2,500lbs of bombs.



A variety of WWI German bombs

#### Hazard:

The potential of coming across an Unexploded Bomb (UXB) from WWI is far less likely than an UXB from World War Two (WWII), given the lower bombing densities during raids in WWI.

Some areas which were subjected to sustained bombing raids recorded a higher number of UXBs. In these areas, where there has been no significant development for the last century, the potential of a UXB remaining from WWI cannot be totally discounted.



### Appendix 2.5 WWII bombing

# Information Data Sheet

## Category World War Two (WWII) Bombing

### Description:

Bombing raids began in summer 1940 and continued until the end of WWII. Bombing densities generally increased towards major cities, such as London, Birmingham, Coventry, and Hull, or strategic targets such as docks, harbours, industrial areas, and airfields. Coastal towns, such as Eastbourne, and cathedral cities, such as Canterbury were also heavily targeted.

The German bombing campaign saw the extensive use of both High Explosive (HE) bombs and Incendiary Bombs (IBs). 50kg and 250kg HE bombs were most commonly used, although 500kg were also used to a lesser extent. More rarely 1,000kg, 1,400kg and 1,800kg bombs were dropped. HE bombs tended to contain about half of their weight in explosives and were fitted with one or two fuzes. Not all HE bombs were intended to explode on impact and some contained timing mechanisms where detonation could occur more than 70 hours after impact.

Incendiary devices ranged from small 1kg thermite filled, magnesium bodied IBs, to 250kg and 500kg Oil Bombs (OB). Occasionally IBs were fitted with a bursting charge which exploded after the bomb had been alight for a few minutes, causing burning debris to be scattered over a greater area. Large OBs were similar in appearance to HE bombs, although their design was sufficiently different to warrant a specially trained unit of the Royal Engineer (RE) to deal with their disposal.



Variety of WWII bombs

Anti-Personnel (AP) bombs and Parachute Mines (PMs) were also deployed. The most common AP bombs were 1kg and 2kg, which could inflict injury across an area up to 150m away from the impact. PMs could be up to 4m in length and were typically detonated either magnetically or by noise/vibration. Anti-shipping PMs were commonly dropped over navigable rivers, dockland areas, and coastlines. Whilst the Royal Navy (RN) was responsible for ensuring that anti-shipping PMs were made safe, their removal and disposal was still the responsibility of the RE.



In 1944, new offensive weapons were introduced. The Flying Bomb (V1), a pilotless guided missile, exploded on impact and could cause significant damage. The Long Range Rocket (V2), a ballistic missile rocket, travelled at such speed that no one could see or hear its approach.

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

Local Civil Defence authorities in urban areas typically had a comprehensive system for reporting bomb incidents and dealing with Unexploded Bombs (UXB). In more rural and coastal areas where fewer bombing raids occurred, it is known that Air Raid Precaution (ARP) records under-represent the number and frequency of bombs falling. Bombs could be released as part of 'tip and run' raids where bomber crews would drop their bombs to avoid Anti-Aircraft (AA) fire or Allied fighter aircraft, on route to and from other strategic targets. Bombs dropped as a result of poor targeting or 'tip and run' raids often went unrecorded or were recorded as 'fell in open country' or 'fell in the sea'. The Luftwaffe are thought to have dropped approximately 75,000 tons of bombs on Britain throughout WWII and an estimated 11% of all bombs dropped during the war failed to detonate.



Removal of an UXB

#### Hazard:

The potential for a UXB hazard to exist on a site depends on a variety of factors:

- Were their strategic targets in the surrounding area?
- · Was the site bombed and how heavy were the raids?
- · Could an UXB impact have been missed, masked by rubble or debris?

Even in rural areas, the potential for UXBs cannot be totally discounted and therefore it is essential that detailed local bombing records are obtained when assessing the UXB hazard on any site.



### Appendix 2.6 Anti-Aircraft defences

# Information Data Sheet

## Category Anti-Aircraft (AA) Defences

### Description:

As aerial bombardment first began during World War One (WWI), AA gun batteries were gradually established throughout much of England to counter German bombing raids. By June 1916, there were approximately 271No. AA guns and 258No. searchlight installations defending London alone.

Common WWI AA defences included 3", 75mm, 6-pounder (pdr), and 1pdr guns. Many of these guns were mobile and would follow the course of an airship, firing from areas of open land.

During WWI, Unexploded AA (UXAA) shells, could land up to 13km from the firing point, although they more typically fell within 10km.





WWI 3-pdr mobile Vickers AA gun

WWII 3.7" static AA gun

During World War Two (WWII), AA gun batteries were used extensively to counter the threat posed by enemy aircraft. AA shells could be distributed over a wide area and could land up to 27km from the firing point, although they more typically fell within 15km.

3No. types of AA batteries existed:

- Heavy AA (HAA) typically 3.7", 4.5", and 5.25" calibre guns designed to engage high flying bomber aircraft. These tended to be permanent gun emplacements.
- Light AA (LAA) typically used 40mm shells and machine gun ammunition and designed to counter low flying aircraft. These were often mobile and were moved periodically.
- Rocket AA (ZAA) fired 3" or 3.7" AA rockets with a maximum altitude of 5,800m and a
  ground range of 9km. These tended to be permanent gun emplacements.

#### Hazard:

AA batteries had munitions stores which stored shells for the batteries and Small Arms Ammunition (SAA) for troops manning the position. Such stores were typically removed at the end of WWII, although some disposal may have occurred in the immediate vicinity of the gun battery.

In areas heavily protected by AA batteries, it is prudent to consider the potential for UXAA shells in the area surrounding a battery, taking into consideration the likely extent within which shells would have fallen. Finding an UXAA shell immediately adjacent to a former gun battery is less likely.



### **Appendix 3 Recent UXO finds**

# Information Data Sheet

### Category Recent UXO Finds

UXO finds in the UK are a regular occurrence, although they almost never result in an accidental detonation.

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

Zetica Ltd, and other commercial EOD companies, uncover and make safe thousands of items of UXO each year, though details are rarely made public knowledge.

Publicly recorded discoveries also occur regularly, as shown by the list of recent significant UXO finds in the UK below. Click here to keep up to date with the latest UXO finds.

On the 20<sup>th</sup> February 2024, 1No. 500kg UXB was discovered in a garden in Plymouth (see below). An exclusion zone was put in place, evacuating approximately 3,250No. people over a course of 4No. days. On the 24<sup>th</sup> February the UXB was moved and detonated at sea by EOD teams.



500kg German UXB discovered in Plymouth, 2024

On the 20th March 2024, 1No. unexploded IB was discovered at Joyden's Wood, Bexley. The IB was removed by an EOD team for controlled detonation.

On the 4<sup>th</sup> April 2024, several items of UXO including practice bomb heads and 20mm rounds, were discovered on Medmerry Beach, West Sussex. An EOD team detonated the items in situ. These are the latest in a series of UXO finds at Medmerry Beach, which was a bombing and air-to-ground firing range in WWII.

On the 9<sup>th</sup> May 2024, 1No. item of UXO was discovered at Ashdown House, Hastings. An MoD EOD team attended and identified the device as a 105mm shell. The device was detonated in situ.

On the 6<sup>th</sup> June 2024, 1No. 120mm high-explosive squash head practice round was discovered in a field at Winchelsea Beach, East Sussex. It was detonated in situ.



On the 1<sup>st</sup> July 2024, 1No. Mills Bomb (No. 36 Hand Grenade) was discovered in a garden on Bordesley Green Road, Birmingham. It was found to be inert and removed for safe disposal.

On the 15<sup>th</sup> August 2024, 1No. 500kg UXB was discovered at the building site in Newtownards, County Down (see below). A 400m exclusion zone was put in place, ahead of the planned detonation. On the 20<sup>th</sup> August, the UXB was detonated in situ by an Army EOD team.



500kg German UXB discovered in Newtownards, 2024

On the 20<sup>th</sup> September 2024, 1No. item of UXO was discovered on a beach at Ynyslas, Ceredigion. It was detonated in situ by an EOD team the following day.

On the 18<sup>th</sup> October 2024, 1No. WWII-era practice bomb was found in a garden in Thelwall, Cheshire. It was removed and destroyed in a controlled explosion.

On the 3<sup>rd</sup> December 2024, 1No. 1,000kg UXB was discovered during coastal defence works near the Clarence Esplanade in Southsea, Portsmouth. The UXB was removed and detonated at sea.





1,000kg German UXB discovered in Southsea, 2024

On the 17<sup>th</sup> January 2025, 1No. unexploded IB was discovered in a garden in Wellow, the Isle of Wight. It was removed and detonated in a controlled explosion in a nearby field.

During construction works in January and February 2025, approximately 176No. practice bombs were discovered at a children's park in Wooler, Northumberland. Anecdotal accounts indicate the area was used as a Home Guard training ground during WWII. The practice bombs were removed safely, and construction is ongoing.



## **Appendix 4 Glossary and definitions**

Abandoned		
<b>Explosive Ordnance</b>		
(AXO)		

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.

**Demil** 

Derived from the term 'Demilitarisation', demil 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** 

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** 

Compounds forming energetic materials that under certain conditions chemically react, rapidly producing gas, heat, and pressure. These are extremely dangerous and should only be handled by qualified professionals.

Explosive Ordnance (EO)

All munitions containing explosives, nuclear fission or fusion materials, and biological and chemical agents. This includes bombs and warheads, missiles, artillery, mortar, rocket, Small Arms Ammunition, mines, torpedoes, depth charges, pyrotechnics, cluster bombs and dispensers, cartridge and propellant devices, electro-explosive devices, clandestine and improvised explosive devices, and all related items/components which are explosive in nature.

**Explosive Ordnance** Clearance (EOC)

The operation of ordnance detection, investigation, identification, and removal, with Explosive Ordnance Disposal being a separate operation.

Explosive Ordnance Disposal (EOD)

The detection, identification, on-site evaluation, rendering safe, recovery, and final disposal of Unexploded Ordnance.

Explosive Ordnance Reconnaissance (EOR) The detection, identification, and on-site evaluation of Unexploded Ordnance before Explosive Ordnance Disposal.

Explosive Remnants of War (ERW)

Unexploded Ordnance and Abandoned Explosive Ordnance, excluding landmines.

Explosive
Substances &
Articles (ESA)

Explosive substances are solid or liquid substances (or a mixture) which are either: capable by a chemical reaction of producing gas at a speed, temperature, and pressure to cause damage to the surroundings; or designed to produce an effect by heat, light, sound, gas, or smoke (or a combination) as a result of a non-detonative, self-sustaining, exothermic reaction.

One or more explosive substances form an explosive article.



Fuze 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 especially 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.

A range of methods that can be used to detect objects or identify **Geophysical survey** 

> ground conditions without the need for intrusive methods (such as excavation or drilling). This is particularly suited to ordnance, as

disturbance of ordnance is to be avoided where possible.

High Explosive (HE) Secondary explosives (commonly known as 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 (Ammonium nitrate

and TNT), gunpowder, and Cyclotrimethylenetrinitramine (RDX).

**Land Service** Items of ordnance thrown, propelled, or placed during land warfare, to **Ammunition (LSA)** include grenades, mortar bombs, projectiles, rockets, and landmines.

Munition The complete device charged with explosives,

> pyrotechnics, initiating composition, or nuclear, biological, or chemical material for use in military operations, including demolitions. This includes those munitions that have been modified for use in training,

ceremonial, or non-operational purposes.

These fall into three distinct categories: inert (contain no explosives), live (contain explosives and have not been fired), and blind (have fired

but failed to function as intended.)

**Primary Explosive** Explosives used to initiate less sensitive explosives and usually

> extremely sensitive to friction, heat, and pressure. Primary explosives are commonly found in detonators. Examples of primary explosives are

lead azide, lead styphnate, and mercury fulminate.

**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 in flake form, and cordite, often in string form.

**Pyrotechnic** An explosive article or substance designed to produce an effect by heat,

light, sound, gas, or smoke (or a combination), as a result of non-

detonative, self-sustaining, exothermic chemical reactions.

**Small Arms** Projectiles around 12mm or less in calibre and no longer than

**Ammunition (SAA)** approximately 100mm. They are fired from a variety of weapons,

including rifles, pistols, shotguns, and machine guns.



Unexploded Anti-Aircraft (UXAA) Shell Ordnance containing High Explosives, although they can also contain pyrotechnic compounds that produce smoke. They ranged from 2" to 5.25" calibre, although most common were 3.7" and 4.5" HE shells.

Unexploded Bomb (UXB)

A common term for unexploded air-dropped munitions.

Unexploded
Ordnance (UXO)

Explosive ordnance that has been primed, fuzed, armed, or prepared for use and 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.

V1 The Vergeltungswaffe-1, also designated Fieseler Fi 103/FZG-76, known

colloquially in English as the Flying Bomb, Pilotless Aircraft, Buzz Bomb, or Doodlebug, was the first guided missile used in WWII and the

forerunner of today's cruise missile.

V2 The Vergeltungswaffe 2 ('Reprisal Weapon 2') was the first ballistic

missile. It was used primarily against Belgian and British targets during the later stages of WWII. It was also the first man-made object

launched into space, during test flights in 1944.



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