



1ST LINE DEFENCE



Detailed Unexploded Ordnance (UXO) Risk Assessment

Project Name	RSPB Higham Marshes
Client	RSPB South East
Site Address	RSPB Higham Marshes, Canal Road, Higham, ME3 7HU
Report Reference	DA15134-00
Date	10/03/2022
Originator	AS





Executive Summary

Site Location and Description

The site is located on Higham Marshes, Kent. It is bound by the Thames Estuary to the north, two large ponds and a parcel of open land to the east, the Hundreds of Hoo Railway line to the south, and Shorne Marshes to the west.

According to aerial photography dated 2020, the site comprises entirely marshland, with water ways intersecting the site at different angles.

The site is approximately centred on the OS grid reference: **TQ 70907 75051**.

Proposed Works

The exact scope of proposed works for the site is not currently known, although it is believed that it may involve drainage works and making provision for water.

Geology and Bomb Penetration Depth

The British Geological Society map shows the site to be underlain by multiple bedrock and superficial deposits, see [Section 8.1](#).

Site-specific geotechnical information was not available to 1st Line Defence at the time of the production of this report. An assessment of maximum bomb penetration depth can be made once such data becomes available, or by a UXO specialist during on-site support.

It should be noted that the maximum depth that a bomb could reach may vary across a site and will be largely dependent on the specific underlying geological strata and its density.

UXO Risk Assessment

1st Line Defence has assessed that there is an overall **Medium Risk** from German and anti-aircraft unexploded ordnance at the site of proposed works. There is also an assessed **Low Risk** from Allied unexploded ordnance.

Risk from German Aerial Delivered Ordnance:

- During WWII the site was situated within the Rural District of Strood which, according to official Home Office bombing statistics, sustained an overall low-moderate density of bombing, resulting in a total of 2,060 items of ordnance across the 48,811 acre district, or an average of 42.2 items per 1,000 acres.
- The sites position in Kent, along the Thames Estuary, suggests it was bombed both as a result of nearby targets, such as those outlined in Luftwaffe mapping (**Annex H**), and during 'tip and run' raids, whereby German bombers jettisoned surplus ordnance prior to flying back to base.
- Kent Daily Bomb Maps record both H.E and I.B incidents within the site boundary, mostly in the north and south of the site. Similarly, three sticks of H.E bombs are observable on the Chatham Observer Medway bomb map, again in the north and south of the site. These map editions plot bomb strikes on small-scale maps, therefore it is not possible to plot the exact locations of the strikes. However, given the large size of the site it is considered probable that these incidents did impact the site.
- The Strood War Diaries also references a number of bombing incidents across the site boundary, and in the wider site area. Within the site they are plotted in the north and south-east of the boundary. Similarly to mapping, the Kent War Diary uses Cassini map references to plot the locations of bombs, however these have an error margin of approximately 300m², again leading to ambiguous locations.
- An in-house data set records a 50kg abandoned bomb (UXB) approximately 300m to the west of the site; the position of this bomb is recorded as 'Shornemead Fort, Shorne, Nr Rochester, Kent. Exact location unknown'. It is considered likely this bomb was abandoned due to the marshy nature of the ground making it unrecoverable.
- Post-war aerial imagery of the site shows areas of discolouration/potential cratering in the north, central, and southern section of the site. Furthermore, according to the online resource *Heritage Gateway*, there are two WWII craters located on site. Grid references provided for these entries plot them in the centre of the site. It should be noted that the nature of the ground within the site could result in indicators of damage being obscured. This is because areas of marshland

**UXO Risk Assessment**

could have obscured indications of UXO, especially considering that a bomb entry hole could have been as small as 20cm in diameter and therefore easily obscured in such ground conditions.

- Given the lack of structures or features of significance on site, access to the site is anticipated to have been limited. This decreases the likelihood that evidence of UXO would have been spotted, reported and dealt with.
- In summary, there are a number of bomb strikes recorded within the site boundary, with more recorded in the wider site area; an abandoned bomb is located in proximity to the site; and bomb craters are visible in post-war aerial imagery. Furthermore, the nature of groundcover within the site boundary is considered to significantly reduce the chances of UXO being spotted and appropriately dealt with. It is thought likely that indicators of further damage within the site may have been obscured due to the waterlogged nature of the land. As such, the site has been assessed as being at a **Medium Risk** of German aerial-delivered UXO contamination.

Risk from Allied Ordnance:

- Positive evidence of defensive features within and surrounding the site boundary have been found, including three pillboxes, anti-tank blocks and part of an anti-tank ditch existed in the north-east corner of the site. There is a chance the pillboxes were manned, however owing to the lack of invasion, any access is likely to have been limited, and small arms ammunition is unlikely to have been stored or used within proximity to the site for any extended period of time.
- Outside of the site boundary, to the south-west, are records of an anti-tank buoy; while to the north-west was Shorenmead Fort, an LAA battery, coastal artillery battery, minefield, and minewatchers post. Given the distance of these features from the site, they are not expected to elevate the risk of Allied ordnance contamination. As such, the site has been assessed as **Low Risk** from Allied ordnance.

Post-War Redevelopment:

- According to post-war mapping and aerial imagery, the site has not undergone any development, remaining comprised entirely of marshland.
- The risk of UXO remaining is only considered to be mitigated at the location of and down to the depth of any post-war redevelopment on site. The risk will remain within virgin geology below and amongst these post-war works, down to the maximum bomb penetration depth.

Recommended Risk Mitigation Measures

The following risk mitigation measures are recommended to support the proposed works at RSPB Higham Marshes:

All Works

- UXO Risk Management Plan
- Site Specific UXO Awareness Briefings to all personnel conducting intrusive works.

Open Intrusive Works (trial pits, service pits, open excavations, shallow foundations etc.)

- UXO Specialist On-site Support

Boreholes and Piled Foundations

- Intrusive Magnetometer Survey of all borehole and pile locations/clusters down to maximum bomb penetration depth.

Glossary

Abbreviation	Definition
AA	Anti-Aircraft
AFS	Auxiliary Fire Service
AP	Anti-Personnel
ARP	Air Raid Precautions
DA	Delay-action
EOC	Explosive Ordnance Clearance
EOD	Explosive Ordnance Disposal
FP	Fire Pot
GM	G Mine (Parachute mine)
HAA	Heavy Anti-Aircraft
HE	High Explosive
IB	Incendiary Bomb
JSEODOC	Joint Services Explosive Ordnance Disposal Operation Centre
LAA	Light Anti-Aircraft
LCC	London County Council
LRRB	Long Range Rocket Bomb (V-2)
LSA	Land Service Ammunition
NFF	National Filling Factory
OB	Oil Bomb
PAC	Pilotless Aircraft (V-1)
PB	Phosphorous Bomb
PM	Parachute Mine
POW	Prisoner Of War
RAF	Royal Air Force
RCAF	Royal Canadian Air Force
RFC	Royal Flying Corps
RNAS	Royal Naval Air Service
ROF	Royal Ordnance Factory
SA	Small Arms
SAA	Small Arms Ammunition
SD2	Anti-personnel "Butterfly Bomb"
SIP	Self-Igniting Phosphorous
U/C	Unclassified bomb
UP	Unrotated Projectile (rocket)
USAAF	United States Army Air Force
UX	Unexploded
UXAA	Unexploded Anti-Aircraft
UXB	Unexploded Bomb
UXO	Unexploded Ordnance
V-1	Flying Bomb (Doodlebug)
V-2	Long Range Rocket
WAAF	Women's Auxiliary Air Force
X	Exploded



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1st Line Defence Limited

Detailed Unexploded Ordnance (UXO) Risk Assessment

Site: RSPB Higham Marshes

Client: RSPB South East

1. Introduction

1.1. Background

1st Line Defence has been commissioned by RSPB South East to conduct a Detailed Unexploded Ordnance (UXO) Risk Assessment for the works proposed at RSPB Higham Marshes.

Buried UXO can present a significant risk to construction works and development projects. The discovery of a suspect device during works can cause considerable disruption to operations as well as cause unwanted delays and expense.

UXO in the UK can originate from three principal sources:

1. Munitions resulting from wartime activities including German bombing in WWI and WWII, long range shelling, and defensive activities.
2. Munitions deposited as a result of military training and exercises.
3. Munitions lost, burnt, buried or otherwise discarded either deliberately, accidentally, or ineffectively.

This report will assess the potential factors that may contribute to the risk of UXO contamination. If an elevated risk is identified at the site, this report will recommend appropriate mitigation measures, in order to reduce the risk to as low as is reasonably practicable. Detailed analysis and evidence will be provided to ensure an understanding of the basis for the assessed risk level and any recommendations.

This report complies with the guidelines outlined in *CIRIA C681*, 'Unexploded Ordnance (UXO) A Guide for the Construction Industry.'

2. Method Statement

2.1. Report Objectives

The aim of this report is to conduct a comprehensive assessment of the potential risk from UXO at RSPB Higham Marshes. The report will also recommend appropriate site and work-specific risk mitigation measures to reduce the risk from explosive ordnance during the envisaged works to a level that is as low as reasonably practicable.

2.2. Risk Assessment Process

1st Line Defence has undertaken a five-step process for assessing the risk of UXO contamination:

1. The likelihood that the site was contaminated with UXO.
2. The likelihood that UXO remains on the site.
3. The likelihood that UXO may be encountered during the proposed works.
4. The likelihood that UXO may be initiated.
5. The consequences of initiating or encountering UXO.

In order to address the above, 1st Line Defence has taken into consideration the following factors:

- Evidence of WWI and WWII German aerial delivered bombing as well as the legacy of Allied occupation.
- The nature and conditions of the site during WWII.
- The extent of post-war development and UXO clearance operations on site.
- The scope and nature of the proposed works and the maximum assessed bomb penetration depth.
- The nature of ordnance that may have contaminated the proposed site area.

2.3. Sources of Information

Every reasonable effort has been made to ensure that relevant evidence has been consulted and presented in order to produce a thorough and comprehensible report for the client. To achieve this the following, which includes military records and archive material held in the public domain, have been accessed:

- The National Archives and Kent History and Library Centre.
- Historical mapping datasets.
- Historic England National Monuments Record.
- Relevant information supplied by RSPB South East.
- Available material from 33 Engineer Regiment (EOD) Archive (now 28 Regt).
- 1st Line Defence's extensive historical archives, library and UXO geo-datasets.
- Open sources such as published books and internet resources.

Research involved a visit to The National Archives and Kent History and Library Centre.

3. Background to Bombing Records

3.1. General Considerations of Historical Research

This desktop assessment is based largely upon analysis of historical evidence. Every reasonable effort has been made to locate and present significant and pertinent information. 1st Line Defence cannot be held accountable for any changes to the assessed risk level or risk mitigation measures, based on documentation or other data that may come to light at a later date, or which was not available to 1st Line Defence during the production of this report.

It is often problematic and sometimes impossible to verify the completeness and accuracy of WWII-era records. As a consequence, conclusions as to the exact location and nature of a UXO risk can rarely be quantified and are, to a degree, subjective. To counter this, a range of sources have been consulted, presented and analysed. The same methodology is applied to each report during the risk assessment process. 1st Line Defence cannot be held responsible for any inaccuracies or the incompleteness in available historical information.

3.2. German Bombing Records

During WWII, bombing records were generally gathered locally by the police, Air Raid Precaution (ARP) wardens and military personnel. These records typically contained information such as the date, the location, the amount of damage caused and the types of bombs that had fallen during an air raid. This information was made either through direct observation or post-raid surveys. The Ministry of Home Security Bomb Census Organisation would then receive this information, which was plotted onto maps, charts, and tracing sheets by regional technical officers. The collective record set (regional bomb census mapping and locally gathered incidents records) would then be processed and summarised into reports by the Ministry of Home Security Research and Experiments Branch. The latter were tasked with providing the government 'a complete picture of air raid patterns, types of weapons used and damage caused- in particular to strategic services and installations such as railways, shipyards, factories and public utilities.'¹

The quality, detail and nature of record keeping could vary considerably between provincial towns, boroughs and cities. No two areas identically collated or recorded data. While some local authorities maintained records with a methodical approach, sources in certain areas can be considerably more vague, dispersed, and narrower in scope. In addition, the immediate priority was mostly focused on assisting casualties and minimising damage at the time. As a result, some records can be incomplete and contradictory. Furthermore, many records were even damaged or destroyed in subsequent air raids. Records of raids that took place on sparsely or uninhabited areas were often based upon third party or hearsay information and are therefore not always reliable. Whereas records of attacks on military or strategic targets were often maintained separately and have not always survived.

3.3. Allied Records

During WWII, considerable areas of land were requisitioned by the War Office for the purpose of defence, training, munitions production and the construction of airfields. Records relating to military features vary and some may remain censored. Within urban environments datasets will be consulted detailing the location of munition production as well as wartime air and land defences. In rural locations it may be possible to obtain plans of military establishments, such as airfields, as well as training logs, record books, plans and personal memoirs. As with bombing records, every reasonable effort will be made to access records of, and ascertain any evidence of, military land use. However, there are occasions where such evidence is not available, as records may not be accessible, have been lost/destroyed, or simply were not kept in the first place.

¹ <http://www.nationalarchives.gov.uk/help-with-your-research/research-guides/bomb-census-survey-records-1940-1945/>.

4. UK Regulatory Environment and Guidelines

4.1. General

There is no formal obligation requiring a UXO risk assessment to be undertaken for construction projects in the UK, nor is there any specific legislation stipulating the management or mitigation of UXO risk. However, it is implicit in the legislation outlined below that those responsible for intrusive works (archaeology, site investigation, drilling, piling, excavation etc.) should undertake a comprehensive and robust assessment of the potential risks to employees and that mitigation measures are implemented to address any identified hazards.

4.2. CDM Regulations 2015

The Construction (Design and Management) Regulations 2015 (CDM 2015) define the responsibilities of parties involved in the construction of temporary or permanent structures.

The CDM 2015 establishes a duty of care extending from clients, principle co-ordinators, designers, and contractors to those working on, or affected by, a project. Those responsible for construction projects may therefore be accountable for the personal or proprietary loss of third parties, if correct health and safety procedure has not been applied.

Although the CDM does not specifically reference UXO, the risk presented by such items is both within the scope and purpose of the legislation. It is therefore implied that there is an obligation for parties to:

- Provide an appropriate assessment of potential UXO risks at the site (or ensure such an assessment is completed by others).
- Put in place appropriate risk mitigation measures if necessary.
- Supply all parties with information relevant to the risks presented by the project.
- Ensure the preparation of a suitably robust emergency response plan.

4.3. The 1974 Health and Safety at Work etc. Act

All employers have a responsibility under the Health and Safety at Work etc. Act 1974 and the Management of Health and Safety at Work Regulations 1999, to ensure the health and safety of their employees and third parties, so far as is reasonably practicable and conduct suitable and sufficient risk assessments.

4.4. CIRIA C681

In 2009, the Construction Industry Research and Information Association (CIRIA) produced a guide to the risk posed by UXO to the UK construction industry (CIRIA C681). CIRIA is a neutral, independent and not-for-profit body, linking organisations with common interests and facilitating a range of collaborative activities that help improve the industry.

The publication provides the UK construction industry with a defined process for the management of risks associated with UXO from WWI and WWII aerial bombardment. It is also broadly applicable to the risks from other forms of UXO that might be encountered. It focuses on construction professionals' needs, particularly if there is a suspected item of UXO on site, and covers issues such as what to expect from a UXO specialist. The guidance also helps clients to fulfil their legal duty under CDM 2015 to provide designers and contractors with project specific health and safety information needed to identify hazards and risks associated with the design and construction work. This report conforms to this CIRIA guidance and to the various recommendations for good practice referenced therein. It is

recommended that this document is acquired and studied where possible to allow a better understanding of the background to both the risk assessment process and the UXO issue in the UK in general.

4.5. Additional Legislation

In the event of a casualty resulting from the failure of an employer/client to address the risks relating to UXO, the organisation may be criminally liable under the Corporate Manslaughter and Corporate Homicide Act 2007.

5. The Role of Commercial UXO Contractors and The Authorities

5.1. Commercial UXO Specialists

The role of a UXO Specialist (often referred to as UXO Consultant or UXO Contractor) such as 1st Line Defence, is defined in CIRIA C681 as the provision of expert knowledge and guidance to the client on the most appropriate and cost-effective approach to UXO risk management at a site.

The principal role of UXO Specialists is to provide the client with an appropriate assessment of the risk posed by UXO for a specific project, and identify and carry out suitable methodology for the mitigation of any identified risks to reduce them to an acceptable level.

The requirement for a UXO Specialist should ideally be identified in the initial stages of a project, and it is recommended that this occur prior to the start of any detailed design. This will enable the client to budget for expenditure that may be required to address the risks from UXO, and may enable the project team to identify appropriate techniques to eliminate or reduce potential risks through considered design, without the need for UXO specific mitigation measures. The UXO Specialist should have suitable qualifications, levels of competency and insurances.

Please note 1st Line Defence has the capability to provide a complete range of required UXO risk mitigation services, in order to reduce a risk to as low as reasonably practicable. This can involve the provision of both ground investigation, and where appropriate, UXO clearance services.

5.2. The Authorities

The police have a responsibility to co-ordinate the emergency services in the event of an ordnance-related incident at a construction site. Upon inspection they may impose a safety cordon, order an evacuation, and call the military authorities Joint Services Explosive Ordnance Disposal Operation Centre (JSEODOC) to arrange for investigation and/or disposal. Within the Metropolitan Police Operational Area, SO15 EOD will be tasked to any discovery of suspected UXO. The request for Explosive Officer (Expo) support is well understood and practiced by all Metropolitan Boroughs. The requirement for any additional assets will then be coordinated by the Expo if required.

In the absence of a UXO specialist, police officers will usually employ such precautionary safety measures, thereby causing works to cease, and possibly requiring the evacuation of neighbouring businesses and properties.

The priority given to the police request will depend on the EOD teams' judgement of the nature of the UXO risk, the location, people and assets at risk, as well as the availability of resources. The speed of response varies; authorities may respond immediately or in some cases it may take several days for the item of ordnance to be dealt with. Depending on the on-site risk assessment the item of ordnance may be removed from the site and/or destroyed by a controlled explosion.

Following the removal of an item of UXO, the military authorities will only undertake further investigations or clearances in high-risk situations. If there are regular UXO finds on a site the JSEODOC may not treat each occurrence as an emergency and will recommend the construction company puts in place alternative procedures, such as the appointment of a commercial contractor to manage the situation.

6. The Site

6.1. Site Location

The site is located on Higham Marsh, Kent. It is bound by the Thames Estuary to the north, two large ponds and a parcel of open land to the east, the Hundreds of Hoo Railway line to the south, and Shorne Marsh to the west.

The site is approximately centred on the OS grid reference: **TQ 70907 75051**.

Site location maps are presented in **Annex A**.

6.2. Site Description

According to aerial photography dated 2020, the site comprises entirely marshland, with water ways intersecting the site at different angles.

A recent aerial photograph and site plan are presented in **Annex B** and **Annex C** respectively.

7. Scope of the Proposed Works

7.1. General

The exact scope of proposed works for the site is not currently known, although it is believed that it may involve drainage works and making provision for water.

8. Ground Conditions

8.1. General Geology

The British Geological Survey (BGS) map shows the site to be underlain by the following:

British Geological Society Map		
Section of Site	Bedrock Geology	Superficial Deposits
Northern half	Seaford Chalk Formation - Chalk. Sedimentary Bedrock formed in the Cretaceous Period.	Alluvium - Clay, Silt, Sand And Peat. Superficial Deposits formed in the Quaternary Period.
Central band	Thanet Formation - Sand, Silt And Clay. Sedimentary Bedrock formed in the Palaeogene Period.	Alluvium - Clay, Silt, Sand And Peat. Superficial Deposits formed in the Quaternary Period.
Centre	Thanet Formation - Sand, Silt And Clay. Sedimentary Bedrock formed in the Palaeogene Period.	None recorded.
Southern border	Lambeth Group - Sand, Silt And Clay. Sedimentary Bedrock formed in the Palaeogene Period.	Alluvium - Clay, Silt, Sand And Peat. Superficial Deposits formed in the Quaternary Period.
South-west	Lambeth Group - Sand, Silt And Clay. Sedimentary Bedrock formed in the Palaeogene Period.	River Terrace Deposits, 1 - Sand And Gravel. Superficial Deposits formed in the Quaternary Period.

8.2. Site Specific Geology

Site-specific geotechnical data was not provided by the client during the production of this report.

9. Site History

9.1. Introduction

The purpose of this section is to identify the composition of the site pre and post-WWII. It is important to establish the historical use of the site, as this may indicate the site's relation to potential sources of UXO as well as help with determining factors such as the land use, groundcover, likely frequency of access and signs of bomb damage.

9.2. Ordnance Survey Historical Maps

Relevant historical maps were obtained for this report and are presented in **Annex D**. See below for a summary of the site history shown on acquired mapping.

Pre-WWII		
Date	Scale	Description
1915-1916	1:10,560	This map edition shows the site to comprise <i>Higham Marshes</i> , with a <i>Sheepfold</i> in the north of the site, <i>Barrow Hill</i> labelled in the centre of the site, and <i>Higham Common</i> intersecting the site from north to south. The site is bound by <i>Higham Saltings</i> to the north, further undeveloped/marsh land to the east, the <i>Hundred of Hoo</i> railway line to the south, and <i>Shorne Marsh</i> to the west.
1939	1:10,560	This map edition shows no change within the site boundary. Likewise, the site's surroundings remain largely unchanged with the exception of the <i>Higham Saltings</i> to the north, which are no longer present.

Post-WWII		
Date	Scale	Description
1954	1:10,560	This map edition is smaller-scale, and as a result shows fewer features. However, it does confirm the sites composition appears unchanged, remaining occupied by <i>Higham Marshes</i> , and <i>Barrow Hill</i> . In the south-west of the site <i>Beckley Hill</i> is also labelled. To the north of the site lies <i>Higham Saltings</i> and the Thames Estuary; to the east further open/marsh land and features associated with the <i>Works</i> ; to the south is a railway line; and to the west Shornmead Fort and Marshes.

10. Introduction to German Aerial Delivered Ordnance

10.1. General

During WWI and WWII, the UK was subjected to bombing which often resulted in extensive damage to city centres, docks, rail infrastructure and industrial areas. The poor accuracy of WWII targeting technology and the nature of bombing techniques often resulted in neighbouring areas to targets sustaining collateral damage.

In addition to raids which concentrated on specific targets, indiscriminate bombing of large areas also took place. This occurred most prominently in the London 'Blitz', though affected many other towns and cities. As discussed in the following sections, a proportion of the bombs dropped on the UK did not detonate as designed. Although extensive efforts were made to locate and deal with these UXBs at the time, many still remain buried and can present a potential risk to construction projects.

The main focus of research for this section of the report will concern German aerial delivered ordnance dropped during WWII, although WWI bombing will also be considered.

10.2. Generic Types of WWII German Aerial Delivered Ordnance

To provide an informed assessment of the hazards posed by any items of unexploded ordnance that may remain in situ on site, the table below provides information on the types of German aerial delivered ordnance most commonly used by the Luftwaffe during WWII. Images and brief summaries of the characteristics of these items of ordnance are listed in **Appendices i-iii**.

Generic Types of WWII German Aerial Delivered Ordnance		
Type	Frequency	Likelihood of detection
High Explosive (HE) bombs	In terms of weight of ordnance dropped, HE bombs were the most frequently deployed by the Luftwaffe during WWII.	Although efforts were made to identify the presence of unexploded ordnance following an air raid, often the damage and destruction caused by detonated bombs made observation of UXB entry holes impossible. The entry hole of an unexploded bomb can be as little as 20cm in diameter and was easily overlooked in certain ground conditions (see Annex E). Furthermore, ARP documents describe the danger of assuming that damage, actually caused by a large UXB, was due to an exploded smaller bomb. UXBs therefore present the greatest risk to present-day intrusive works.
1kg Incendiary bombs (IB)	In terms of the number of weapons dropped, small IBs were the most numerous. Millions of these were dropped throughout WWII.	IBs had very limited penetration capability and in urban areas would often have been located in post-raid surveys. If they failed to initiate and fell in water, on soft vegetated ground, or bombed rubble, they could easily go unnoticed.
Large Incendiary bombs (IB)	These were not as common as the 1kg IBs, although they were more frequently deployed than PMs and AP bomblets.	If large IBs did penetrate the ground, complete combustion did not always occur and in such cases they could remain a risk to intrusive works.
Aerial or Parachute mines (PM)	These were deployed less frequently than HE and IBs due to size, cost and the difficulty of deployment.	If functioning correctly, PMs would generally have had a slow rate of descent and were very unlikely to have penetrated the ground. Where the parachute failed, mines would have simply shattered on impact if the main charge failed to explode. There have been extreme cases when these items have been found unexploded. However, in these scenarios, the ground was either extremely soft or the munition fell into water.
Anti-personnel (AP) bomblets	These were not commonly used and are generally considered to pose a low risk to most works in the UK.	SD2 bomblets were packed into containers holding between 6 and 108 submunitions. They had little ground penetration ability and should have been located by the post-raid survey unless they fell into water, dense vegetation or bomb rubble.

10.3. Failure Rate of German Aerial Delivered Ordnance

It has been estimated that 10% of WWII German aerial delivered HE bombs failed to explode as designed. Reasons for why such weapons might have failed to function as designed include:

- Malfunction of the fuze or gain mechanism (manufacturing fault, sabotage by forced labour or faulty installation).
- Many were fitted with a clockwork mechanism that could become immobilised on impact.
- Failure of the bomber aircraft to arm the bombs due to human error or an equipment defect.
- Jettisoning the bomb before it was armed or from a very low altitude. This most likely occurred if the bomber aircraft was under attack or crashing.

From 1940 to 1945, bomb disposal teams reportedly dealt with a total of 50,000 explosive items of 50kg, over 7,000 anti-aircraft projectiles and 300,000 beach mines. Unexploded ordnance is still regularly encountered across the UK, see press articles in **Annex F**.

10.4. UXB Ground Penetration

An important consideration when assessing the risk from a UXB is the likely maximum depth of burial. There are several factors which determine the depth that an unexploded bomb will penetrate:

- Mass and shape of bomb.
- Height of release.
- Velocity and angle of bomb.
- Nature of the ground cover.
- Underlying geology.

Geology is perhaps the most important variable. If the ground is soft, there is a greater potential of deeper penetration. For example, peat and alluvium are easier to penetrate than gravel and sand, whereas layers of hard strata will significantly retard and may stop the trajectory of a UXB.

10.4.1. The J-Curve Effect Principle

J-curve is the term used to describe the characteristic curve commonly followed by an aerial delivered bomb dropped from height after it penetrates the ground. Typically, as the bomb is slowed by its passage through underlying soils, its trajectory curves towards the surface. Many UXBs are found with their nose cone pointing upwards as a result of this effect. More importantly, however, is the resulting horizontal offset from the point of entry. This is typically a distance of about one third of the bomb's penetration depth, but can be higher in certain conditions (see **Annex E**).

10.4.2. WWII UXB Ground Penetration Studies

During WWII the Ministry of Home Security undertook a major study on actual bomb penetration depths, carrying out statistical analysis on the measured depths of 1,328 bombs as reported by bomb disposal (BD) teams. Conclusions were drawn predicting the likely average and maximum depths of penetration of different sized bombs in different geological strata.

For example, the largest common German bomb (500kg) had a likely concluded penetration depth of 6m in sand or gravel but 11m in clay. The maximum observed depth for a 500kg bomb was 11.4m and for a 1,000kg bomb 12.8m. Theoretical calculations suggested that significantly greater penetration depths were probable.

10.4.3. Site Specific Bomb Penetration Considerations

When considering an assessment of the bomb penetration at the site of proposed works the following parameters have been used:

- WWII geology – The British Geological Society map shows the site to be underlain by multiple bedrock and superficial deposits, see [Section 8.1](#).
- Impact angle and velocity – 10-15° from vertical and 270 metres per second.
- Bomb mass and configuration – The 500kg SC HE bomb, without retarder units or armour piercing nose (this was the largest of the common bombs used against Britain).

It has not been possible to determine maximum bomb penetration capabilities at this stage due to the limitations of site-specific geotechnical information provided for the purpose of this report. An assessment can be made once further information becomes available or by an UXO Specialist on-site.

10.5. V-Weapons

Hitler's 'V-weapon' campaign began from mid-1944. It used newly developed unmanned cruise missiles and rockets. The V-1, known as the *flying bomb* or *pilotless aircraft*, and the V-2, a long range rocket, were launched from bases in Germany and occupied Europe. A total of 9,251 V-1s and 1,115 V-2s were recorded in the United Kingdom.

Although these weapons caused considerable damage, their relatively low numbers allowed accurate records of strikes to be maintained. These records have mostly survived. There is a negligible risk from unexploded V-weapons on land today. Even if the 1000kg warhead failed to explode, the weapons are so large that they would have been observed and dealt with at the time. Therefore, V-weapons are referenced in this report not as a viable risk factor, but primarily in order to help account for evidence of damage and clearance reported.

11. The Likelihood of Contamination from German Aerial Delivered UXBs

11.1. World War I

During WWI Britain was targeted and bombed by Zeppelin Airships as well as Gotha and Giant fixed-wing aircraft. The objective of these raids was to unnerve the British public, to destroy strategic targets and to ultimately attempt to coerce Britain's capitulation from the war. A WWI map of air raids and naval bombardments across the UK was consulted, see **Annex G**. This source does not record any WWI bombing incidents to have affected the site area.

WWI bombs were generally smaller and dropped from a lower altitude than those used in WWII. This resulted in limited UXB penetration depths. Aerial bombing was often such a novelty at the time that it attracted public interest and even spectators to watch the raids in progress. For these reasons there is a limited risk that UXBs passed undiscovered in the urban environment. When combined with the relative infrequency of attacks and an overall low bombing density, the risk from WWI UXBs is considered low and will not be further addressed in this report.

11.2. World War II Bombing of the Rural District of Strood

The Luftwaffe's main objective for the attacks on Britain was to inhibit the country's economic and military capability. To achieve this they targeted airfields, depots, docks, warehouses, wharves, railway lines, factories, and power stations. As the war progressed the Luftwaffe bombing campaign expanded to include the indiscriminate bombing of civilian areas in an attempt to subvert public morale.

During WWII the site was located within the Rural District of Strood, which sustained an overall low-moderate density of bombing, as represented by bomb density data figures below. This was mainly due to Kent's position in the south-east of the England, oftentimes being on the flight path of German aircraft travelling to targets in other areas of the country. Likewise, Kent was subject to 'tip and run' raids by German aircraft on their journeys back to their respective stations, with H.E bombs being indiscriminately dropped across the region.

In terms of targets in the wider site area, the Luftwaffe identified a number of features along the Thames Estuary and in the county of Kent as a whole, including an oil storage facility located approximately 6km north-east of the site boundary (see **Annex H1**). In addition to this, Chattenden 'Farm' Explosives Storage was located approximately 5km south-east of the site (see **Annex H2**). While these targets were of some distance from the site, the Thames Estuary was also targeted as it was an important thoroughfare for ships.

Records of bombing incidents in the civilian areas of the district were typically collected by Air Raid Precautions wardens and collated by Civil Defence personnel. Some other organisations, such as port and railway authorities, maintained separate records. Records would be in the form of typed or hand written incident notes, maps and statistics. Bombing data was carefully analysed, not only due to the requirement to identify those parts of the country most needing assistance, but also in an attempt to find patterns in the Germans' bombing strategy in order to predict where future raids might take place.

Records of bombing incidents are presented in the following sections.

11.3. WWII Home Office Bombing Statistics

The following table summarises the quantity of German aerial delivered bombs (excluding 1kg incendiaries and anti-personnel bombs) dropped on the Rural District of Strood between 1940 and 1945.

Record of German Ordnance Dropped on the Rural District of Strood		
Area Acreage		48,811
Weapons	High Explosive bombs (all types)	1,804
	Parachute mines	24
	Oil bombs	55
	Phosphorus bombs	117
	Fire pots	14
	Pilotless aircraft (V-1)	37
	Long range rocket bombs (V-2)	9
Total		2,060
Number of Items per 1,000 acres		42.2

Source: Home Office Statistics

This table does not include UXO found during or after WWII.

Detailed records of the quantity and locations of the 1kg incendiary and anti-personnel bombs were not routinely maintained by the authorities as they were frequently too numerous to record. Although the risk relating to IBs is lesser than that relating to larger HE bombs, they were similarly designed to inflict damage and injury. Anti-personnel bombs were used in much smaller quantities and are rarely found today but are potentially more dangerous. Although Home Office statistics did not record these types of ordnance, both should not be overlooked when assessing the general risk to personnel and equipment.

11.4. Kent Daily Bomb Census Maps

Bomb census mapping compiled by Kent Council was obtained from the Kent History and Library Centre. These maps recorded daily bombing incidents at the beginning of the war, however from 1942 onwards tended to be consolidated. Incidents plotted on these maps include H.E strikes, incendiary bombing, crashed German and British planes, shells, and aerial mines. As well as these, an additional map set was compiled by Kent Council using a similar format, however to record V-1 and shells.

The bombing incidents on these map editions were plotted on small scale maps, and bomb strikes for the whole county of Kent were recorded on single map sheets. The plotted bomb locations therefore cannot be considered accurate, and it has not been possible to determine the exact locations of individual strikes beyond identifying the general area within which the bomb fell. Maps that show bomb strikes within the site locality have been presented in **Annex I** and in an overlay in **Annex N**, and discussed below.

Kent Daily Bomb Census Maps	
Date	Comments
20 th October 1940	One H.E bomb strike is recorded in the north of the site.
4 th November 1940	One H.E bomb strike is recorded in the north of the site. It appears to be one of a stick of bombs which also impacted to the north-east and north-west of the site.

21 st February 1941	One H.E bomb strike is recorded along the north-east border of the site.
15 th March 1941	An incendiary bombing 'shower' is recorded over the north and central areas of the site – given the spread of an I.B shower it is probable this affected a larger area than is shown on mapping.
15 th April 1943	An incendiary bombing 'shower' is recorded in the west of the site, with additional I.Bs plotted outside of the site, also to the west.
4 th February 1944	One H.E bomb strike and an incendiary 'shower' is recorded in the south-east corner of the site.
24 th February 1944	A crashed German aircraft is recorded to the south-west of the site boundary.

11.5. The Kent Messenger 'Doodlebug Map'

This source is a bomb plot map showing the location of V-1 strikes within the County of Kent. It was compiled by the Kent Messenger in September 1944, before the end of the V-weapon campaign in March 1945. It therefore does not provide a comprehensive account of every strike, but is believed to cover the majority of strikes in the region. The section of the map which covers the area of the site was checked and a section of it is presented in **Annex J**.

The Kent Messenger 'Doodlebug Map'	
Date	Comments
Up to 15 th September 1944	This map shows a high density of V-1 bombing incidents in the county of Kent, including two within the Civil Parish of Higham, one of which appears to be within the site vicinity. However, given the large-scale of this map, it is not possible to identify the exact locations of V-1 strikes.

11.6. Chatham Observer Medway Bomb Maps

A local bomb map published on 5th June 1945 by the Chatham Observer newspaper shows bomb strikes on the area of Kent around the River Thames and Medway. This was obtained from Kent History & Library Centre. The section showing the area of the site is described in the table below and presented in **Annex K**.

Chatham Observer Medway Bomb Maps	
Date Range	Comments
1940-1945	This map shows a number of bomb strikes within the site boundary, notably two sticks of four H.E bombs in the north of the site, and a stick of six bombs in the south of the site; with additional strikes immediately bordering the site, again to the north and south. Given the site was occupied by undeveloped marshland, there are no structures within or in the site vicinity which bomb strikes could be plotted against, such as roadways or structures, therefore it should be assumed that the locations of the strikes are not wholly accurate.

11.7. Kent V-2 Bomb Census Map

This source was obtained from Lewis Blake's *Bolts from the Blue* (1990). It is a consolidated map of V-2 rocket bombs across Kent and South East London. This is presented in **Annex L** and discussed below.

Kent V-2 Bomb Census Map	
Date Range	Comments
1940-1945	This map shows the density of V-2 rocket bombs in Kent. There are none recorded on or in the vicinity of the site.

11.8. Strood War Diaries

Written incident records were obtained from the Kent History and Library Centre. The War Diaries comprise a set of written records that detail the date, time, location, type of bomb, and damage caused for bombing incidents across Kent. Wartime Cassini grid references are often used within this record set in order to give an approximate location of incidents. Excerpts of relevant bombing incidents are presented in **Annex M**, with an overlay in **Annex N** showing the approximate locations of the Cassini map reference plots.

It should be noted there were numerous additional references to Upper Higham, and Shorne Marshes being bombed, however the locations are unspecified.

Strood War Diaries		
Date	Location	Comments
19 th September 1940	Strood Rural	Situation report. 18 th to 19 th . At 20.35 on 18 th approx. IB's at Leysdown MR 104 832. Higham MR 159 916, Shorne MR 142 917.
3 rd October 1940	Strood Rural	20.15. Several IB's Hoo Junction, MR 142 922
9 th October 1940	Medway Group	<u>Northfleet</u> At 16.45 hours Stone Bridge Road now open to single line traffic reported 06.10 hours. All other sub controls nothing of importance to report. First interim. Gillingham. Bombing 20.07 Darland Camp. 2 H.E's MR 227 851. One H.E Harris's Farm MR 226847. Cleave Road Strood Rural 21.05 IB's at following: Higham MR 157 916 and MR 151 915. Higham Marshes MR 169 938 , nr Shorne, MR 142 902. All fires extinguished.
20 th October 1940	Medway Group	One at rear of houses Ambrose Hill. Strood Rural at 21.20 hours, 6 H.E Higham MR 149 940
28 th October 1940	Strood Rural	At approx. 21.24 hours HEB's between Cliffe and Higham. [...] No. of bombs for this incident = 80
21 st September 1941	Strood Rural	At Cliffe MR 149 94
4 th April 1944	Strood Rural	Higham Barrow Hill MR 159 932.

11.9. Heritage Gateway

An online search returned the following results, which provide information relating to two Second World War bomb craters (Monument numbers 1531409 and 1531407). This resource provides grid references which plots the bomb craters within the site boundary, and these are observable in aerial photography from the 1960s (see **Annex P**).²

11.10. WWII-Era Aerial Photography

WWII-era aerial photography for the site area was obtained from the National Monuments Record Office (Historic England) and the Aerofilms Collection available from *Britain from Above*. This photography provides a record of the potential composition of the site during the war, as well as its condition immediately following the war (see **Annex O**. **Annexes O2** and **P** show overlays).

WWII-Era Aerial Photography	
Date/Title of Photograph	Description
1940s Aerial Photography	This imagery was taken by the RAF in the 1940s - the exact date it was taken is not known. It confirms the site comprised marshland, with hedgerows and water ways intersecting the site at various angles. There are two areas of discolouration/potential cratering observable within the site boundary, which are highlighted in Annex O2. The remainder of the site appears to be in good condition, though it should be noted that the nature of groundcover in marshes could result in indicators of damage being obscured. The site is bound by the Thames Estuary to the north, further marshland to the east and west, and a railway line and structures associated with the British Uralite Company to the south/south-west.
1960s Aerial Photography	This imagery was taken by the RAF in the 1960s, though the exact date it was taken is not known. It confirms the sites composition has not changed since 1940s-era imagery, remaining occupied by marshy land and bound by marshy land to the east and west, while the Thames Estuary binds the site to the north, and the Hundred of Hoo railway to the south. While not visible in earlier imagery, two bomb craters are observable in the centre of the site, and these are confirmed to be craters by Heritage Gateway (see Section 11.9), and are visible in current aerial imagery (see Annex P). Shorenmead Fort and adjoining minefield have been highlighted in this imagery, both of which are also still present in current imagery.

² https://www.heritagegateway.org.uk/Gateway/Results_Single.aspx?uid=02d5070d-782d-4ef4-8336-403f846ec70f&resourceID=19191 and https://www.heritagegateway.org.uk/Gateway/Results_Single.aspx?uid=189d1a1c-4b7e-43a6-8ce8-830c21c6d217&resourceID=19191

11.11. Abandoned Bombs

A post air-raid survey of buildings, facilities, and installations would have included a search for evidence of bomb entry holes. If evidence of an entry hole was encountered, Bomb Disposal Officer Teams would normally have been requested to attempt to locate, render safe, and dispose of the bomb. Occasionally, evidence of UXBs was discovered but due to a relatively benign position, access problems, or a shortage of resources the UXB could not be exposed and rendered safe. Such an incident may have been recorded and noted as an 'abandoned bomb'.

Given the inaccuracy of WWII records, and the fact that these bombs were 'abandoned', their locations cannot be considered definitive or the lists exhaustive. The MoD states that 'action to make the devices safe would be taken only if it was thought they were unstable'. It should be noted that other than the 'officially' abandoned bombs, there will inevitably be UXBs that were never recorded.

In-house records held by 1st Line Defence indicate an abandoned bomb is located to the west of the site, approximately 300m from the site boundary. This is recorded to be a 50kg phosphorous bomb, the location of which is stated as '*Shornemead Fort, Shorne, Nr Rochester, Kent. Exact location unknown*'. It is considered likely this bomb was abandoned due to the marshy nature of the ground making it unrecoverable.

11.12. Bomb Disposal Tasks

The information service from the Explosive Ordnance Disposal (EOD) Archive Information Office at 33 Engineer Regiment (EOD) (now 29 Regt) is currently facing considerable delay. It has therefore not been possible to include any updated official information regarding bomb disposal/clearance tasks with regards to this site. A database of known disposal/clearance tasks has been referred to which does not make reference to such instances occurring within the site of proposed works. If any relevant information is received at a later date, RSPB South East will be advised.

11.13. Evaluation of German Aerial Delivered UXO Records

Factors	Conclusion
Density of Bombing <i>It is important to consider the bombing density when assessing the possibility that UXBs remain in an area. High bombing density could allow for error in record keeping due to extreme damage caused to the area.</i>	During WWII the site was situated within the Rural District of Strood which, according to official Home Office bombing statistics, sustained an overall low-moderate density of bombing. This comprised 1,804 H.E bombs, 24 parachute mines, 55 oil bombs, 117 phosphorus bombs, 14 'fire pots', 37 V-1 pilotless aircraft bombs, and nine V-2 rocket bombs; resulting in a total of 2,060 items of ordnance across the 48,811 acre district, or an average of 42.2 items per 1,000 acres. A number of bomb plot maps have been consulted during the production of this report, however due to the large-scale of the map editions, it has not been possible to identify the exact locations of bomb strikes. Kent Daily Bomb Maps (Annex I) record both H.E and I.B incidents within the site boundary, mostly in the north and south of the site. Although the exact locations cannot be confirmed, as the site area is so large, it is probable that these incidents did occur within the site boundary. Similarly, three sticks of H.E bombs are observable on the Chatham Observer Medway bomb map (Annex K), again in the north and south of the site. Written records in the form of the Strood War Diaries were analysed also, and similarly exact locations of bombing incidents cannot be identified – this is due to the use of Cassini map references in plotting bomb strikes. Cassini map references have an error margin of approximately 300m². A number of references to bombing incidents has been found in this record set, two of which are plotted within the site boundary, while the others are in the immediate site vicinity. Due to the error margin, it cannot be discounted that some of the incidents plotted outside of the site may have impacted the site.
Damage <i>If buildings or structures on a site sustained bomb or fire damage, any resulting rubble and debris could have obscured the entry holes of unexploded bombs dropped during the same or later raids. Similarly, a high explosive bomb strike in an area of open agricultural land will have caused soil disturbance, increasing the risk that a UXB entry hole would be overlooked.</i>	1940s-era aerial photography of the site has been obtained, and two areas of discolouration/potential cratering are observable (highlighted in Annex O2). Furthermore, two Heritage Gateway entries have been found which confirm two WWII bomb craters in the centre of the site, these have been highlighted in 1960s imagery (Annex P). It should be noted that the nature of the ground within the site could result in indicators of damage being obscured.
Ground Cover <i>The nature of the ground cover present during WWII would have a substantial influence on any visual indication that may indicate UXO being present.</i>	It is generally considered that areas of open land were not conducive to the observation of evidence of UXO, and as the site was occupied by open marsh land, this further lessens the chances of UXO being spotted. Marshland is typically waterlogged and considering an UXB entry hole could be as small as 20cm in diameter, it is thought likely that indicators of UXO within the site boundary could be easily obscured and therefore remain unnoticed.



Access Frequency <i>UXO in locations where access was irregular would have a greater chance of passing unnoticed than at those that were regularly occupied. The importance of a site to the war effort is also an important consideration as such sites are likely to have been both frequently visited and subject to post-raid checks for evidence of UXO.</i>	Given the site was occupied entirely by marshland, with the exception of Burrow Hill, it is anticipated access would have been infrequent and post-raid checks would likely not have been carried out in this area. This decreases the likelihood that evidence of UXO would have been spotted, reported and dealt with.
Bomb Failure Rate	There is no evidence to suggest that the bomb failure rate in the locality of the site would have been dissimilar to the 10% normally used.
Abandoned Bombs	An in-house geo data set records a 50kg phosphorous abandoned bomb approximately 300m west of the site boundary, at Shornemead Fort. The position of this bomb is recorded as 'Shornemead Fort, Shorne, Nr Rochester, Kent. Exact location unknown'. It is considered likely this bomb was abandoned due to the marshy nature of the ground making it unrecoverable.
Bombing Decoy sites	1 st Line Defence could find no evidence of bombing decoy sites within the site vicinity. The nearest bombing decoy site was located approximately 2.2km north-west of the site, on the other side of the Thames Estuary, and was an NC series naval decoy site.
Bomb Disposal Tasks	1 st Line Defence could find no evidence of bomb disposal tasks within the site boundary and immediate area.

12. Introduction to Allied Ordnance

12.1. General

Many areas across the UK may be at risk from Allied UXO because of both wartime and peacetime military use. Typical military activities and uses that may have led to a legacy of military UXO at a site include former minefields, home guard positions, anti-aircraft emplacements, training and firing ranges, military camps, as well as weapons manufacture and storage areas.

Although land formerly used by the military was usually subject to clearance before returned to civilian use, items of UXO are sometimes discovered and can present a potential risk to construction projects.

It should be highlighted that there is no evidence that the site formerly had any military occupation or usage that could have led to contamination with such items of Allied ordnance. Despite this, urban areas, such as the location of the site, can be at risk from buried unexploded anti-aircraft projectiles fired during WWII – as addressed below.

12.2. Defending the UK From Aerial Attack

During WWII the War Office employed a number of defence tactics against the Luftwaffe from bombing major towns, cities, manufacturing areas, ports and airfields. These can be divided into passive and active defences (examples are provided in the table below).

Active Defences	Passive Defences
• Anti-aircraft gun emplacements to engage enemy aircraft. • Fighter aircraft to act as interceptors. • Rockets and missiles were used later during WWII.	• Blackouts and camouflaging to hinder the identification of Luftwaffe targets. • Decoy sites were located away from targets and used dummy buildings and lighting to replicate urban, military, or industrial areas. • Barrage balloons forced enemy aircraft to greater altitudes. • Searchlights were often used to track and divert adversary bomber crews during night raids.

Active defences such as anti-aircraft artillery present a greater risk of UXO contamination than passive defences. Unexploded ordnance resulting from dogfights and fighter interceptors is rarely encountered and difficult to accurately qualify.

12.2.1. Anti-Aircraft Artillery (AAA)

During WWII three main types of gun sites existed: heavy anti-aircraft (HAA), light anti-aircraft (LAA) and 'Z' batteries (ZAA). If the projectiles and rockets fired from these guns failed to explode or strike an aircraft they would descend back to land. The table below provides further information on the operation and ordnance associated with these type of weapons.

Anti-Aircraft Artillery				
Item	Description			
HAA	These large calibre guns such as the 3.7" QF (Quick Firing) were used to engage high flying enemy bombers. They often fired large HE projectiles, which were usually initiated by integral fuzes, triggered by impact, area, time delay or a combination of aforementioned mechanisms.			
LAA	These mobile guns were intended to engage fast, low flying aircraft. They were typically rotated between locations on the perimeters of towns and strategically important industrial works. As they could be moved to new positions with relative ease when required, records of their locations are limited. The most numerous of these were the 40mm Bofors gun which could fire up to 120 x 40mm HE projectiles per minute to over 1,800m.			
Variations in HAA and LSA Ammunition	Gun type	Calibre	Shell Weight	Shell Dimensions
	3.0 Inch	76mm	7.3kg	76mm x 356mm
	3.7 Inch	94mm	12.7kg	94mm x 438mm
	4.5 Inch	114mm	24.7kg	114mm x 578mm
	40mm	40mm	0.9kg	40mm x 311mm
Z-AA	The three inch unrotated rocket/projectile known as the UP-3 had initially been developed for the Royal Navy. The UP-3 was also used in ground-based single and 128-round launchers known as "Z" batteries. The rocket, containing a high explosive warhead was often propelled by cordite.			

The conditions in which anti-aircraft projectiles may have fallen unnoticed within a site area are analogous to those regarding aerial delivered ordnance. Unexploded anti-aircraft projectiles could essentially have fallen indiscriminately anywhere within range of the guns. The chance of such items being observed, reported and removed during the war depends on factors such as land use, ground cover, damage and frequency of access – the same factors that govern whether evidence of a UXB is likely to have been noted. More information about these factors with regards to this particular site can be found in the German Aerial Delivered Ordnance section of this report.

Illustrations of Anti-Aircraft artillery, projectiles and rockets are presented at **Appendix iv**.

13. The Likelihood of Contamination from Allied Ordnance

13.1. Introduction

There are several factors that may serve to either affirm, increase, or decrease the level of risk within a site with a history of military usage. Such factors are typically dependent upon the proximity of the proposed area of works to training activities, munition productions and storage, as well as its function across the years.

This section will examine the history of the proposed site and assess to what degree, if any, the site could have become contaminated as a result of the military use of the surrounding area.

13.2. Defensive Area Boundaries Map of Kent

A wartime map revealing defensive area boundaries across Kent was consulted from Kent History and Library Centre. It highlights the boundaries of areas of defensive priority and control in the county. An image of this map is presented in **Annex Q**. The Hoo Peninsula, where the site is located, is shaded in pink designating this region as a *Curfew Area*. This was an area of temporary military control during the early years of WWII in light of the German invasion threat planned as Operation Sealion. Curfew zones were coastal areas vulnerable to attack from an invasion force which saw strict military control with traffic inhibited by checkpoints through which only residents or defensive operations could pass. Whilst this might account for a greater number of ground defences in the wider area, because these curfew zones were vast and primarily concerned with restriction of movement, the presence of the site within it is unlikely to elevate the risk of contamination from allied UXO.

13.3. Map of 'Nodal' Defensive Positions in Kent

This wartime map gathered from Kent History and Library Centre reveals defensive 'nodal points' across Kent. These were designated strongpoints of home defence usually located at central positions in towns or villages controlling road access where defensive efforts on the ground could be concentrated against a German invasion in 1940 planned as Operation Sealion. Images of this map are visible in **Annex R**.

The map reveals that Hoo had a nodal point designated at the village of Cliffe and Higham, situated approximately 2.6m east and south-west of the site respectively; far enough for its activities to not have directly encroached upon the site. Even if defensive exercises did make use of surrounding marshland, it is not thought they were substantial in nature.

13.4. Evaluation of Contamination Risk from Allied UXO

1st Line Defence has considered the following potential sources of Allied ordnance contamination:

Sources of Allied UXO Contamination	Conclusion
Military Camps <i>Military camps present an elevated risk from ordnance simply due to the large military presence and likelihood of associated live ordnance training.</i>	1st Line Defence could find no evidence of a military camp within the site. Shornemead Fort and Cliffe Fort, located 0.3km west and 0.85km north-east of the site respectively, are the nearest military installations to the site. It is understood both were rearmed during WWII, with Cliffe being mounted with two 4" BL guns. Due to their distance from the site, it is not considered that these installations would elevate the risk of Allied UXO on site.
Anti-Aircraft Defences <i>Anti-Aircraft defences were employed across the country. Proximity to anti-aircraft defences increases the chance of encountering AA projectiles.</i>	1st Line Defence could find no evidence of Anti-Aircraft defences such as a HAA or LAA gun emplacement occupying or bordering the site. The closest HAA was located approximately 2.4km north-east of the site, in the vicinity of Cliffe Marsh. Despite this distance the maximum effective range of an AA projectile can be up to 15km. The conditions in which HAA or LAA projectiles may have fallen unnoticed within a site footprint are analogous to those regarding German aerial delivered ordnance.
Home Guard Activity <i>The Home Guard regularly undertook training and ordnance practice in open areas, as well as burying ordnance as part of anti-invasion defences.</i>	Evidence of Home Guard activity is often difficult to locate, owing to the ad-hoc nature of Home Guard activity within each local area. Such training was often conducted on a small scale at the discretion of individual commanders and as such was seldom recorded officially. As such, no positive evidence could be found to confirm the presence of HG units within proximity to the site.
Defensive Positions <i>Defensive positions suggest the presence of military activity, which is often indicative of ordnance storage, usage or disposal.</i>	An in-house geo data set indicates three pillboxes were situated within the site boundary, all located in the north-east corner of the site. Pillboxes were designed to provide a hard defensive point for troops in the event of invasion and were often equipped with mounts for crew-served weapons such as the Bren or Vickers machine gun. During 1940 a large number of pillboxes were constructed around potential defensive positions in preparation for potential German invasion following the defeat of the British Expeditionary Force (BEF) in France. It is possible that these positions may have been manned, but owing to the lack of invasion, any access is likely to have been limited, and small arms ammunition is unlikely to have been stored or used within proximity to the site for any extended period of time. In addition to these, anti-tank blocks and an anti-tank ditch, were also in the north-east of the site. In the wider site vicinity there were anti-tank buoys, to the south-west and north-west of the site. Also to the north west, approximately 0.4km from the site, was an LAA battery, coastal artillery battery, minefield, and minewatchers post.



Training or firing ranges <i>Areas of ordnance training saw historical ordnance usage in large numbers, often with inadequate disposal of expended and live items. The presence of these ranges significantly impact on the risk of encountering items of ordnance in their vicinity.</i>	No evidence of training or firing ranges could be found within the site or surrounding area.
Defensive Minefields <i>Minefields were placed in strategic areas to defend the country in the event of a German invasion. Minefields were not always cleared with an appropriate level of vigilance.</i>	There is no evidence of defensive minefields affecting the site, however an in-house geo-data set indicates a minefield was present to the north-west of the site. This is also visible on 1960s aerial imagery presented in Annex P .
Ordnance Manufacture <i>Ordnance manufacture indicates an increased chance that items of ordnance were stored, or disposed of, within a location.</i>	No information of ordnance being stored, produced, or disposed of within the proposed site could be found. There was an explosive works located at Cliffe Marshes, approximately 2,8km north-east of the site.
Military Related Airfields <i>Military airfields present an elevated risk from ordnance simply due to the large military presence and likelihood of associated live ordnance training or bombing practice.</i>	The site was not situated within the perimeters or vicinity of a military airfield.

14. The Likelihood of UXO Contamination Summary

The following table assesses the likelihood that the site was contaminated by items of German aerial delivered and Allied ordnance. Factors such as the risk of UXO initiation, remaining, and encountering will be discussed later in the report.

UXO Contamination Summary	
Quality of the Historical Record	The research has evaluated pre- and post-WWII Ordnance Survey maps, Luftwaffe target/reconnaissance photography, various secondary source bomb maps such as the Chatham Observer, Kent daily bomb mapping, Kent war diaries, post-war aerial imagery, and defensive mapping. The record set is of generally mixed quality, with a variety of record sets – official, secondary, written and visual – available for consultation. However, the bomb plot maps available for the region are all on large-scale map editions, therefore it has not been possible to identify the exact locations of bomb strikes. Furthermore, written records which reference the site do so using Cassini grid references, which are known to have an error margin of approximately 300m². Despite the limitations to these record sets, given the large size of the site it is considered probable that these bombing incidents did in fact occur on site.
German Aerial Delivered Ordnance	- During WWII the site was situated within the Rural District of Strood which, according to official Home Office bombing statistics, sustained an overall low-moderate density of bombing, resulting in a total of 2,060 items of ordnance across the 48,811 acre district, or an average of 42.2 items per 1,000 acres. - The sites position in Kent, along the Thames Estuary, suggests it was bombed both as a result of nearby targets, such as those outlined in Luftwaffe mapping (Annex H), and during ‘tip and run’ raids, whereby German bombers jettisoned surplus ordnance prior to flying back to base. - Kent Daily Bomb Maps record both H.E and I.B incidents within the site boundary, mostly in the north and south of the site. Similarly, three sticks of H.E bombs are observable on the Chatham Observer Medway bomb map, again in the north and south of the site. These map editions plot bomb strikes on small-scale maps, therefore it is not possible to plot the exact locations of the strikes. However, given the large size of the site it is considered probable that these incidents did impact the site. - The Strood War Diaries also references a number of bombing incidents across the site boundary, and in the wider site area. Within the site they are plotted in the north and south-east of the boundary. Similarly to mapping, the Kent War Diary uses Cassini map references to plot the locations of bombs, however these have an error margin of approximately 300m², again leading to ambiguous locations. - An in-house data set records a 50kg abandoned bomb (UXB) approximately 300m to the west of the site; the position of this bomb is recorded as ‘<i>Shornemead Fort, Shorne, Nr Rochester, Kent. Exact location unknown</i>’. It is considered likely this bomb was abandoned due to the marshy nature of the ground making it unrecoverable. - Post-war aerial imagery of the site shows areas of discolouration/potential cratering in the north, central, and southern section of the site. Furthermore, according to the online resource <i>Heritage Gateway</i>, there are two WWII craters located on site. Grid references provided for these entries plot them in the centre of the site. It should be noted that the nature of the ground within the site could result in indicators of damage being obscured. This is because areas of marshland could have obscured indications of UXO, especially considering that a bomb entry hole could have been as small as 20cm in diameter and therefore easily obscured in such ground conditions.



	- Given the lack of structures or features of significance on site, access to the site is anticipated to have been limited. This decreases the likelihood that evidence of UXO would have been spotted, reported and dealt with. - In summary, there are a number of bomb strikes recorded within the site boundary, with more recorded in the wider site area; an abandoned bomb is located in proximity to the site; and bomb craters are visible in post-war aerial imagery. Furthermore, the nature of groundcover within the site boundary is considered to significantly reduce the chances of UXO being spotted and appropriately dealt with. It is thought likely that indicators of further damage within the site may have been obscured due to the waterlogged nature of the land. As such, the site has been assessed as being at a Medium Risk of German aerial-delivered UXO contamination.
Allied Ordnance	- Positive evidence of defensive features within and surrounding the site boundary have been found, including three pillboxes, anti-tank blocks and part of an anti-tank ditch existed in the north-east corner of the site. There is a chance the pillboxes were manned, however owing to the lack of invasion, any access is likely to have been limited, and small arms ammunition is unlikely to have been stored or used within proximity to the site for any extended period of time. - Outside of the site boundary, to the south-west, are records of an anti-tank buoy; while to the north-west was Shorenmead Fort, an LAA battery, coastal artillery battery, minefield, and mine watchers post. Given the distance of these features from the site, they are not expected to elevate the risk of Allied ordnance contamination. As such, the site has been assessed as Low Risk from Allied ordnance.

15. The Likelihood that UXO Remains

15.1. Introduction

It is important to consider the extent to which any explosive ordnance clearance (EOC) activities or extensive ground works have occurred on site. This may indicate previous ordnance contamination or reduce the risk that ordnance remains undiscovered.

15.2. UXO Clearance

1st Line Defence has found no evidence in the public domain or within internal records that any official ordnance clearance operations have taken place on site. Note however that we have not received confirmation of this fact from the 33 EOD Regiment Archive (now part of 29 Regt). It should also be noted that in addition to 29 Regt archival information, 1st Line Defence also do not currently have access to data that may be relevant including 5131(BD)SQN Archive, SD Training Technical Advisory Section (TAS) and MACA Records (bomb disposal callouts).

If such information is available at a later date, it is recommended that it be reviewed as it will assist with understanding both levels and types of contamination likely to be present, and may indicate risk reduction in certain areas.

15.3. Post-War Redevelopment

According to post-war mapping and aerial imagery, the site has not undergone any development, remaining comprised entirely of marshland. The risk of UXO remaining is only considered to be mitigated at the location of and down to the depth of any post-war redevelopment on site.. The risk will remain within virgin geology below and amongst these post-war works, down to the maximum bomb penetration depth.

16. The Likelihood of UXO Encounter

16.1. Introduction

For UXO to pose a risk at a site, there should be a means by which any potential UXO might be encountered on that site.

The likelihood of encountering UXO on the site of proposed works would depend on various factors, such as the type of UXO that might be present and the intrusive works planned on site. In most cases, UXO is more likely to be present below surface (buried) than on surface.

In general, the greater the extent and depth of intrusive works, the greater the risk of encountering. The most likely scenarios under which items of UXO could be encountered during construction works is during piling, drilling operations or bulk excavations for basement levels. The overall risk will depend on the extent of the works, such as the numbers of boreholes/piles (if required) and the volume of the excavations.

Generally speaking, the risk of encountering any type of UXO will be minimal for any works planned within the footprint and down to the depth of post-war foundations and excavations.

16.2. Encountering Aerial Delivered Ordnance

Since an aerial delivered bomb may come to rest at any depth between just below ground level and its maximum penetration depth, there is a chance that such an item (if present) could be encountered during shallow excavations (for services or site investigations) into the original WWII ground level as well as at depth.

17. **The Likelihood of UXO Initiation**

17.1. **Introduction**

UXO does not spontaneously explode. Older UXO devices will require an external event/energy to create the conditions for detonation to occur. The likelihood that a device will function can depend on a number of factors including the type of weaponry, its age and the amount of energy it is struck with.

17.2. **Initiating Aerial Delivered Ordnance**

Unexploded bombs do not spontaneously explode. All high explosive filling requires significant energy to create the conditions for detonation to occur.

In recent decades, there have been a number of incidents in Europe where Allied UXBs have detonated, and incidents where fatalities have resulted. There have been several hypotheses as to the reason why the issue is more prevalent in mainland Europe – reasons could include the significantly greater number of bombs dropped by the Allied forces on occupied Europe, the preferred use by the Allies of mechanical rather than electrical fuzes, and perhaps just good fortune. The risk from UXO in the UK is also being treated very seriously in many sectors of the construction industry, and proactive risk mitigation efforts will also have affected the lack of detonations in the UK.

There are certain construction activities which make initiation more likely, and several potential initiation mechanisms must be considered:

UXB Initiation	
Direct Impact	Unless the fuze or fuze pocket is struck, there needs to be a significant impact e.g. from piling or large and violent mechanical excavation, onto the main body of the weapon to initiate a buried iron bomb. Such violent action can cause the bomb to detonate.
Re- starting the Clock	A small proportion of German WWII bombs employed clockwork fuzes. It is probable that significant corrosion would have taken place within the fuze mechanism over the last 70+ years that would prevent clockwork mechanisms from functioning. Nevertheless, it was reported that the clockwork fuze in a UXB dealt with by 33 EOD Regiment in Surrey in 2002 did re-start.
Friction Impact	The most likely scenario resulting in the detonation of a UXB is friction impact initiating the shock-sensitive fuze explosive. The combined effects of seasonal changes in temperature and general degradation over time can cause explosive compounds to crystallise and extrude out from the main body of the bomb. It may only require a limited amount of energy to initiate the extruded explosive which could detonate the main charge.

18. Consequences of Initiation/Encounter

18.1. Introduction

The repercussions of the inadvertent detonation of UXO during intrusive ground works, or if an item or ordnance is interfered with or disturbed, are potentially profound, both in terms of human and financial cost. A serious risk to life and limb, damage to plant and total site shutdown during follow-up investigations are potential outcomes. However, if appropriate risk mitigation measures are put in place, the chances of initiating an item of UXO during ground works is comparatively low.

The consequences of encountering UXO can be particularly notable in the case of high-profile sites (such as airports and train stations) where it is necessary to evacuate the public from the surrounding area. A site may be closed for anything from a few hours to a week with potentially significant cost in lost time. It should be noted that even the discovery of suspected or possible item of UXO during intrusive works (if handled solely through the authorities), may also involve significant loss of production

18.2. Consequences of Detonation

When considering the potential consequences of a detonation, it is necessary to identify the significant receptors that may be affected. The receptors that may potentially be at risk from a UXO detonation on a construction site will vary depending on the site specific conditions but can be summarised as follows:

- People – site workers, local residents and general public.
- Plant and equipment – construction plant on site.
- Services – subsurface gas, electricity, telecommunications.
- Structures – not only visible damage to above ground buildings, but potentially damage to foundations and the weakening of support structures.
- Environment – introduction of potentially contaminating materials.

19. 1st Line Defence Risk Assessment

19.1. Risk Assessment Stages

Taking into account the quality of the historical evidence, the assessment of the overall risk from unexploded ordnance is based on the following five considerations:

1. That the site was contaminated with unexploded ordnance.
2. That unexploded ordnance remains on site.
3. That such items will be encountered during the proposed works.
4. That ordnance may be initiated by the works operations.
5. The consequences of encountering or initiating ordnance.

19.2. Assessed Risk Level

1st Line Defence has assessed that there is an overall **Medium Risk** from German and anti-aircraft unexploded ordnance at the site of proposed works. There is also an assessed **Low Risk** from Allied unexploded ordnance.

Ordnance Type	Risk Level			
	Negligible	Low	Medium	High
German Unexploded HE Bombs			✓	
German 1kg Incendiary Bombs			✓	
Anti-Aircraft Artillery Projectiles			✓	
Allied Land Service and Small Arms Ammunition		✓		

This report has been undertaken with due diligence, and all reasonable care has been taken to access and analyse relevant historical information. By necessity, when dealing historical evidence, and when making assessments of UXO risk, various assumptions have to be made which we have discussed and justified throughout this report. Our reports take a common-sense and practical approach to the assessment of risk, and we strive to be reasonable and pragmatic in our conclusions.

It should however be stressed that if any suspect items are encountered during the proposed works, 1st Line Defence should be contacted for advice/assistance, and to re-assess the risk where necessary. The mitigation measures outlined in the next section are recommended as a minimum precaution to alert ground personnel to the history of the site, what to look out for, and what measures to take in the event that a suspect item is encountered. It should also be noted that the conclusions of this report are based on the scope of works outlined in the 'Proposed Works' section of this report. Should the scope of works change or additional works be proposed, 1st Line Defence should be contacted to re-evaluate the risk.

20. Proposed Risk Mitigation Methodology

20.1. General

The following risk mitigation measures are recommended to support the proposed works at RSPB Higham Marshes:

Type of Work	Recommended Mitigation Measure
All Works	UXO Risk Management Plan It is recommended that a site-specific plan for the management of UXO risk be written for this site. This plan should be kept on site and be referred to in the event that a suspect item of UXO is encountered at any stage of the project. It should detail the steps to be taken in the event of such a discovery, considering elements such as communication, raising the alarm, nominated responsible persons etc. Contact 1st Line Defence for help/more information. Site Specific UXO Awareness Briefings to all personnel conducting intrusive works. As a minimum precaution, all personnel working on the site should be briefed on the basic identification of UXO and what to do in the event of encountering a suspect item. This should in the first instance be undertaken by a UXO Specialist. Posters and information on the risk of UXO can be held in the site office for reference.
Shallow Intrusive Works/Open Excavations	Unexploded Ordnance (UXO) Specialist Presence on Site to support shallow intrusive works When on site the role of the UXO Specialist would include: - Monitoring works using visual recognition and instrumentation, including immediate response to reports of suspicious objects or suspected items of ordnance that have been recovered by the ground workers on site. - Providing UXO awareness briefings to any uninformed staff and advise staff of the need to modify working practices to take account of the ordnance risk. - To aid incident management which would involve liaison with the local authorities and police should ordnance be identified and present an explosive hazard.
Borehole/Piles	Intrusive Magnetometer Survey of all borehole and pile locations down to a maximum bomb penetration depth: 1st Line Defence can deploy a range of intrusive magnetometer techniques to clear pile locations. The appropriate technique is influenced by a number of factors, but most importantly the site's ground conditions. The appropriate survey methodology would be confirmed once the enabling works have been completed.

In making this assessment and recommending these risk mitigation measures, if known, the works outlined in the 'Scope of the Proposed Works' section were considered. Should the planned works be modified or additional intrusive engineering works be considered, 1st Line Defence should be consulted to see if a re-assessment of the risk or mitigation recommendations is necessary.

1st Line Defence Limited

10/03/22

This Report has been produced in compliance with the Construction Industry Research and Information Association (CIRIA) C681 guidelines for the writing of Detailed UXO Risk Assessments.

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Project: **Higham Marshes**

Ref: **DA15134-00**

Source: Google Maps

 **Approximate site boundary**





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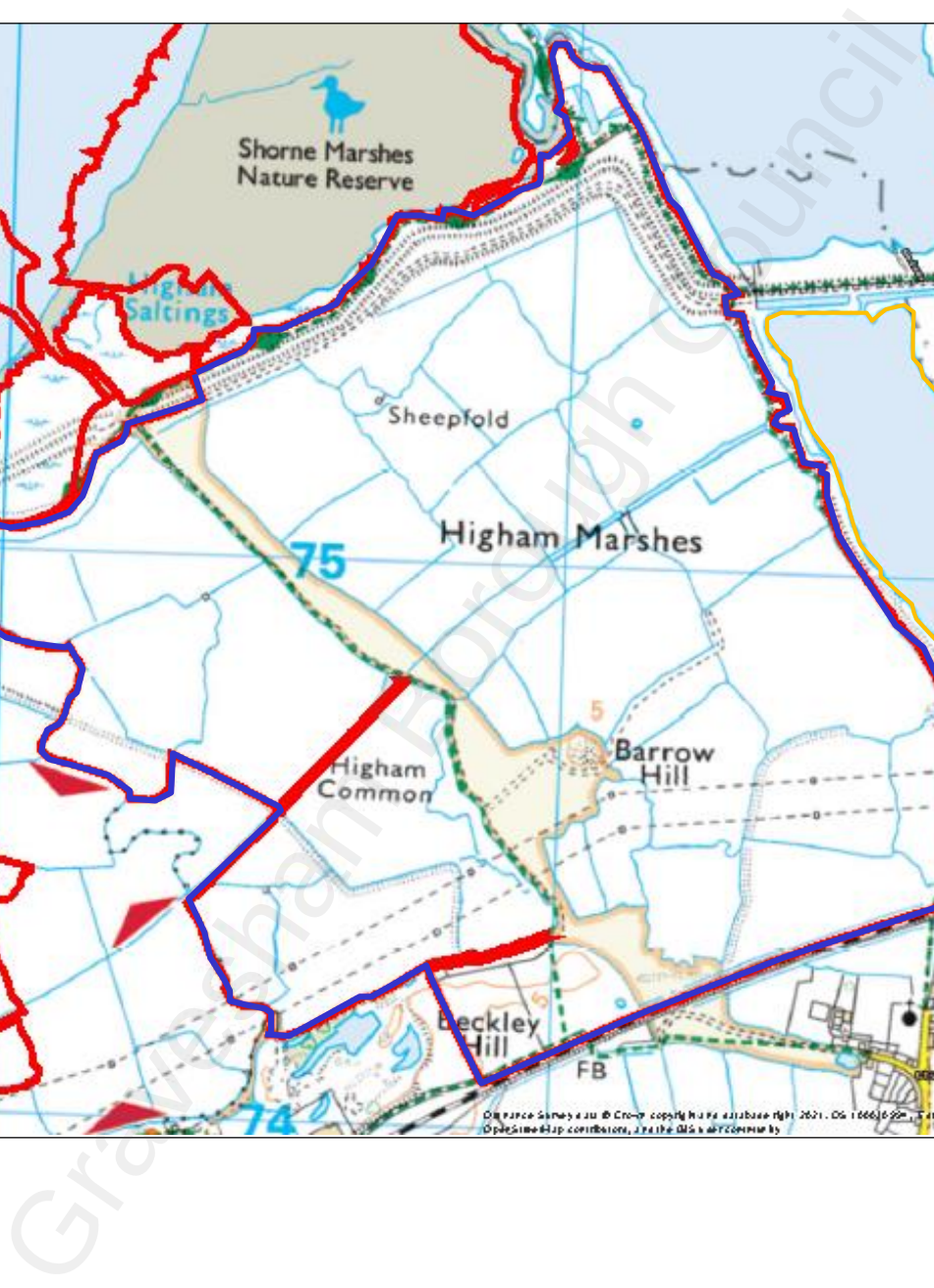
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Ref: **DA15134-00**

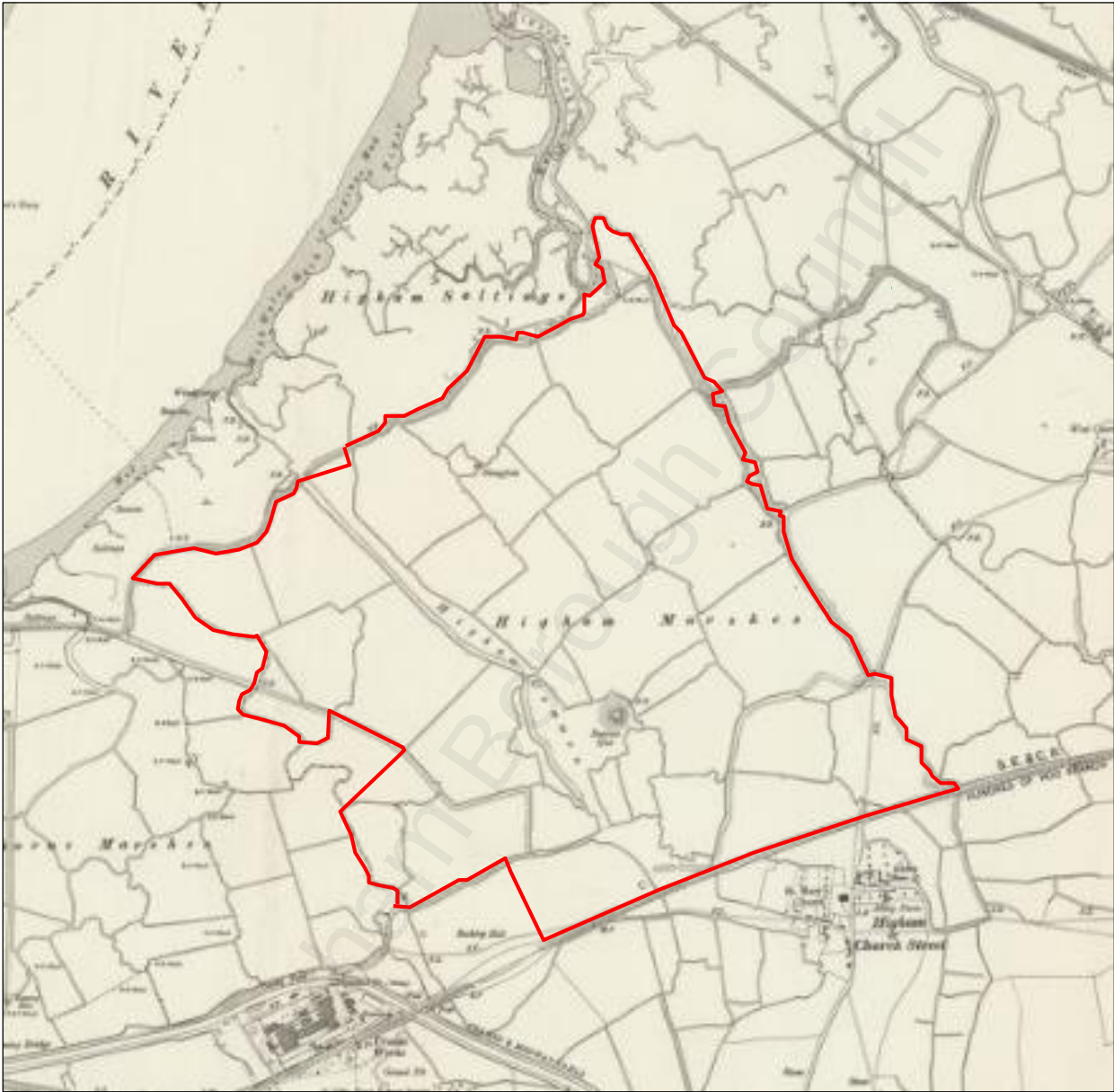
Source: Google Earth™ Mapping Services

 **Approximate site boundary**





6 inch map



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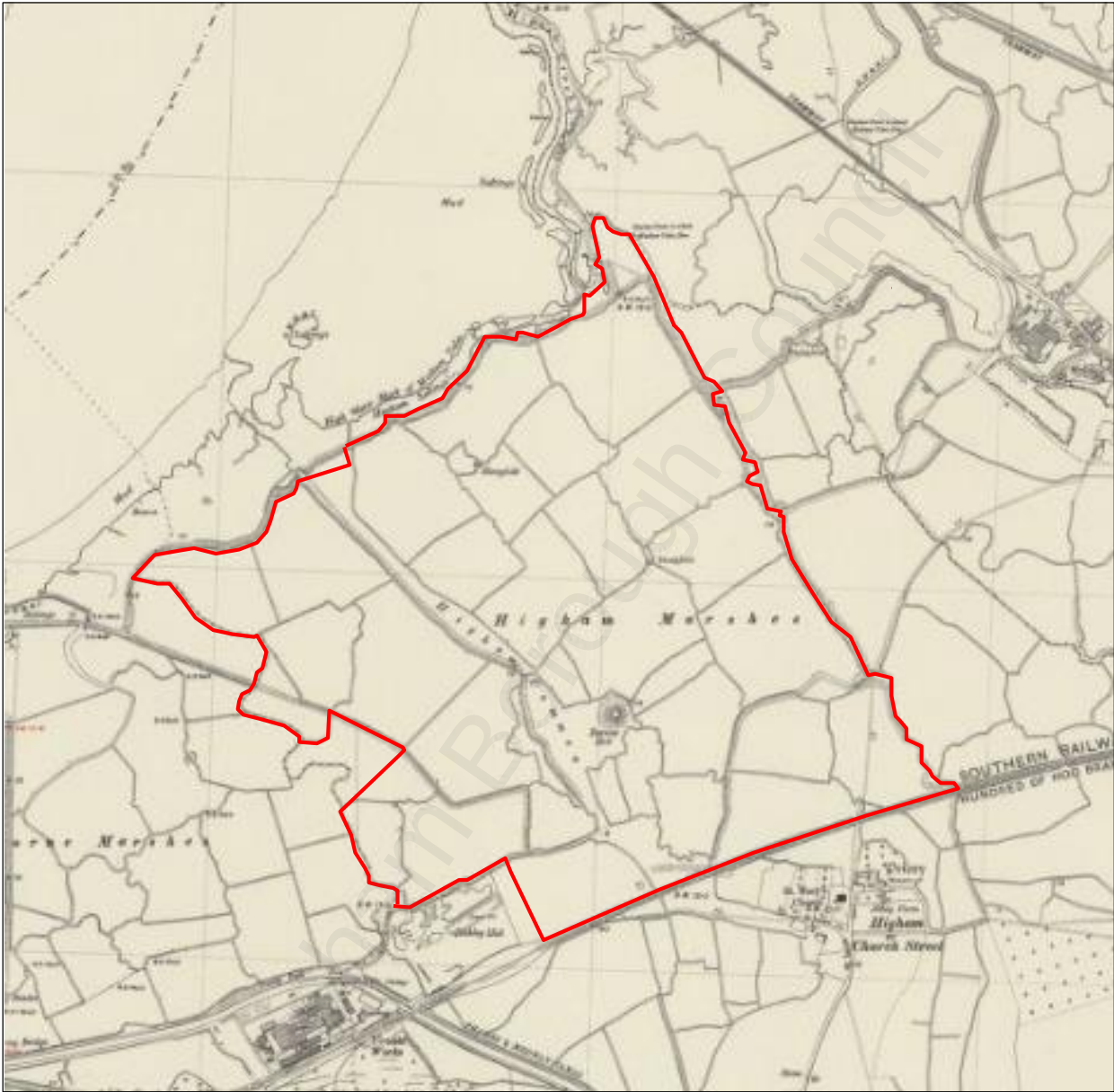
Ref: DA15134-00

Source: Landmark Maps

— Approximate site boundary



6 inch map



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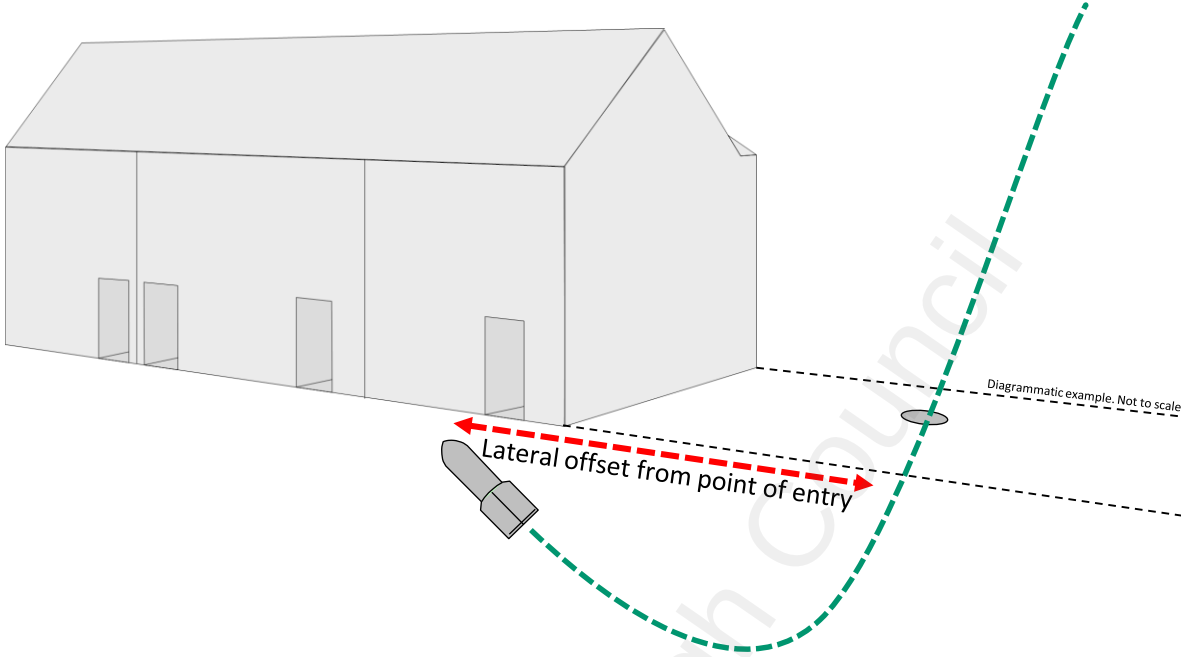
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Ref: **DA15134-00**

Source: **Landmark Maps**

 **Approximate site boundary**

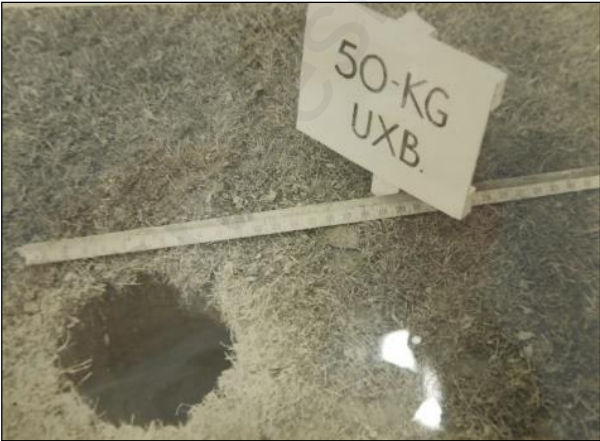








Top: J-curve Effect - Due to angle of entry, unexploded bombs would often end their trajectory at a lateral offset from point of entry, often ending up beneath adjacent extant structures/sites. The photograph above shows 250kg bomb found in Bermondsey pointing upwards, demonstrating 'J-curve'



One of the most common scenarios for UXO going unnoticed was when a UXB fell into a 'bomb site' (such as the area shown **Top Left**), the entry hole of the bomb obscured by any debris and rubble present. Note that the entry hole of a 50kg UXB could be as little as 20cm in diameter (**Left**).



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Project: Higham Marshes		
Ref: DA15134-00	Source: Various sources	



Bermondsey bomb: World War Two device safely removed



An unexploded World War Two bomb found in south London has been driven away safely under police and Army escort.

The 500lb (250kg) device was found on a building site in Grange Walk, Bermondsey on Monday.

March 2015



Bethnal Green WW2 bomb: Experts remove unexploded device



An unexploded World War Two bomb that prompted the evacuation of 700 people in east London has been made safe and removed by the military.

Families spent the night in a school hall after the 500lb bomb was found in the basement of a building site on Temple Street, in Bethnal Green, on Monday afternoon.

A 200m (650ft) exclusion zone was set up around the device.

August 2016



Bath WW2 bomb scare: Device defused, police say



A 500lb World War Two bomb found on the site of a former school in Bath has been defused and made safe.

The discovery of the bomb on Thursday led to the evacuation of hundreds of homes and many road closures in the Lansdown area of the city.

A cordon around the site was lifted on Friday evening, more than 24 hours after residents were asked to leave their homes.

May 2016



London City Airport reopens after WW2 bomb moved



London City Airport has reopened after an unexploded 500kg World War Two bomb was safely moved from the area.

The device was discovered at the King George V Dock on Sunday during planned work at the east London airport.

All flights were cancelled on Monday after an exclusion zone was put in place, with the closure affecting up to 16,000 passengers and nearby residents being evacuated from their homes.

May 2015



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Ref: DA15134-00	Source: BBC News	

BASF has confirmed that an explosive device, most likely a World War II-era bomb, caused the blast that left one person injured Tuesday at a plant construction site in Germany.

The explosion was reported at BASF's Ludwigshafen toluene diisocyanate (TDI) plant, which recently broke ground for a 300,000 metric tons per year TDI production plant and other construction to expand its facilities.



BASF Provides Some Details

Responding to a request from *PaintSquare News* for more information on Wednesday (Feb. 27), BASF's manager of media relations and corporate communications Europe, Ursula von Stetten, wrote in an email, "So here [are] the facts: The detonation took place at 10:00 a.m. One person was injured; the injury is not serious. He will be kept in the hospital for some days.

"Cause of the detonation was an explosive device, presumably a bomb deriving from the Second World War. The device detonated when grounding work was done. No details on [a] delay [are] available. At the moment, the exact circumstances of the incident are [being] evaluated."

1st March 2013

SPIEGEL ONLINE

Blast Kills One
World War II Bomb Explodes on German Motorway

A highway construction worker in Germany accidentally struck an unexploded World War II bomb, causing an explosion which killed him and wrecked several passing cars.



A World War II bomb has exploded during construction work on a German highway, killing one worker and injuring several motorists who were driving past, police said.

The worker had been cutting through the road surface near the south-western town of Aschaffenburg when his machine struck the bomb and triggered it. Police said they weren't sure yet what type of bomb it was. "The explosion seems to have been too small for it to have been an aircraft bomb," a police spokesman said.

23rd October 2006

WWII bomb injures 17 at Hattingen construction site



Seventeen people were injured on Friday when a construction crew unwittingly detonated a buried World War II-era bomb in Hattingen.

An excavator apparently drove over a 250-kilogramme (550 pound) American bomb, damaging surrounding buildings. Most of the injured suffered auditory trauma from the blast, and the excavator operator suffered injuries to his hands, police in the German state of North Rhine-Westphalia said.

"The hole was astoundingly small for such a large bomb full of so many explosives," Armin Gebhard, head of the Arnsberg department for military ordnance removal, told The Local. "But of course it damaged all the surrounding buildings too. We are really happy it wasn't worse."

19th September 2013



World War II bomb kills three in Germany



A special commission is investigating the causes of the explosion, while prosecutors are considering whether the team leader should face charges of manslaughter through culpable negligence, the BBC's Oana Lungescu reports from Berlin.

The blast happened an hour before the defusing operation was due to start.

Officials said the three men who died were experienced sappers, or combat engineers, who over 20 years had defused up to 700 bombs.

More than 7,000 people were immediately evacuated when the 500kg bomb was found. Several schools, a kindergarten and local companies remain closed.

2nd June 2010



June 2006



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Client: RSPB			
Project: Higham Marshes			
Ref: DA15134-00	Source: Various news sources		
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Unexploded Second World War bomb discovered under Somerset footpath

By Western Daily Press | Posted: January 21, 2014



The unexploded bomb was found in Somerset.

Comments (8)

An unexploded bomb dropped in Britain during the Second World War has finally been discovered – underneath a popular footpath in Somerset.



21 August 2014 Last updated at 15:01

Unexploded WW2 bomb found at Kenfig Pool, Bridgend

Dean Smith believes the shell was made in Germany

Bomb experts have been called to a south Wales nature reserve after an unexploded World War Two shell was discovered by a walker in Bridgend.

Dean Smith, 38, of Pyle, was walking near Kenfig Pool on Saturday when he saw a tin sticking out of the sand.

He reached down to pick it up, but ending up falling and landed with the 25-long (0.6m) bomb on top of him.

The site has been cordoned off by police and the Royal Logistics Corps will carry out a controlled explosion.

Related Stories

'Panic' as dog nearly thrown grenade

WW2 bomb found at wind farm exploded

WWII bomb found in kitchen cupboard

Mortar thought to be from WWII found on Oshawa's Camp-X grounds

August 24, 2016 | 5:42 am



What is believed to be a World War II mortar has been discovered in south Oshawa. A man out in Intrepid Park, the site of the Camp-X Second World War training grounds, discovered the round with his metal detector on Tuesday evening. Durham police are held the scene overnight awaiting military officials from Trenton to come and properly detonate the mortar.

Holiday beach cordoned off after landslide sends more than a THOUSAND Second World War bombs and rockets tumbling onto the sands

- Bad weather led to ground movement which exposed the huge arsenal at Mableton, East Riding
- A dog walker stumbled across the deadly find on Saturday and 15 controlled explosions were carried out
- Rockets, mortar bombs and 25-pounder bombs were recovered after they were fired into the cliffs by RAF aircraft during the war
- Most of the devices were dummy rounds used for bombing practice but contain enough explosives to cause terrible injuries



Bomb Beach Alley: Rockets were found after a landslide on Mableton beach in 2012

Unexploded bomb found in farmer's field

17 May 2010



A live Second World War mortar shell was blown up by Army experts after a farmer found it in his field. The discovery was made in the field alongside the A20 between Folkestone and Dover.

The mortar shell, which was around a foot long and 3in in diameter, was around 50ft from the main road.

The farmer alerted police and PC Trevor Moody and PCSO Michelle Brady went to the field.

PC Moody contacted the Army who sent in a bomb disposal unit.

An Army officer confirmed the live shell was from the Second World War and was packed with high explosives.

They moved it a safe distance away from the A20 and carried out a controlled explosion.

PC Moody said: "Given that we live in an area that saw much action during the Second World War, it is not uncommon for us to be alerted about unexploded bombs."

The incident was on Thursday.

Click here for more news from Kent.

Royal Navy bomb disposal experts remove a World War Two shell discovered in a nature reserve

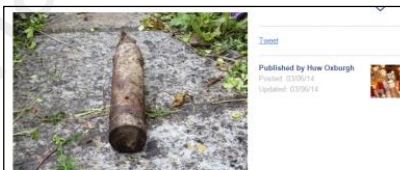
- A World War Two bomb was discovered in a Plymouth nature reserve
- Amateur metal detector found the shell and partially dug it up
- Royal Navy experts carried the explosive away before disposing of it

By VALERIE EDWARDS FOR MAILONLINE
PUBLISHED: 01:29, 13 January 2016 | UPDATED: 09:51, 13 January 2016

A World War Two bomb was reportedly found at Efford Nature Reserve in Plymouth after a member of the public was metal detecting and partially dug it up.

The Royal Navy Bomb Disposal team was called in to remove the bomb and police have closed off Military Lane, with the possibility of Military Road also being closed.

Police were called at around 1.30pm yesterday after what appeared to be a shell was discovered and partially dug up near Military Lane, Efford.

**Unexploded bomb found in Axminster**

Update: The bomb disposal unit has made the device safe and the road has re-opened

Six homes have been evacuated today after the discovery of an unexploded device in Axminster.

A Royal Navy bomb disposal team have been called to the scene after a 'historic German device' was discovered in a garden.

Police have set up a 20m cordon around the garden in Alexandra Road and evacuated homes in the surrounding area as a precaution.

Storms and floods unearth unexploded wartime bombs

By Claire Marshall
BBC environment correspondent

There has been a dramatic increase in the number of wartime bombs unearthed because of the winter storms and flooding.

Bomb disposal teams in the South West have dealt with double the number of unexploded ordnance than in the same period last year.

Since mid-December, the Royal Navy's Southern Dive Unit has recovered or disposed of 244 items of ordnance.

During the same period last year, they dealt with just 108 items.

Almost 70 years after the end of WWII, one legacy of that conflict continues to turn up on beaches and harbours around Britain.

Unexploded shells, bombs and mines continue to be discovered every year, and the Royal Navy's Southern Dive Unit is tasked with making these devices safe.

Its area of responsibility stretches for some 2,250km (1,400 miles). It begins from the highwater mark in Hull and proceeds seaward to the territorial limit, and then runs clockwise around the British Isles - including the Isle of Wight, Channel Islands, and Isles of Scilly - to finish in Liverpool.



The storms have uncovered a lethal past

Related Stories

Ancient trees revealed by storms



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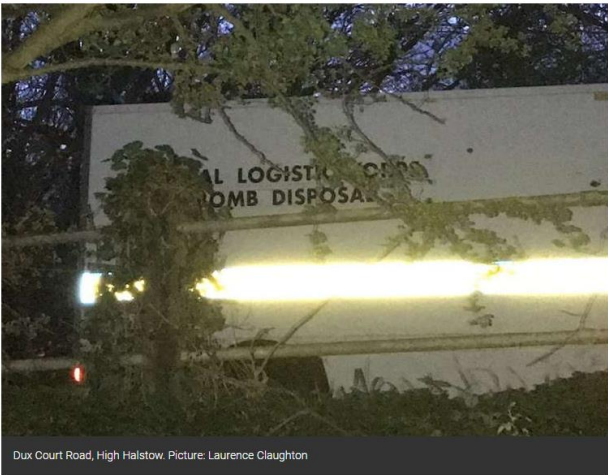
Bomb disposal squad called to Dux Court Road, High Halstow

Published: 08:17, 03 April 2017

Bomb squad experts have carried out a controlled explosion on a military mine found in High Halstow.

Police today tweeted that the MoD is in Dux Court Road, High Halstow after the military hardware was discovered yesterday.

They said this morning: "The MoD is in attendance and no premises will be affected. Residents nearby are likely to hear a series of loud bangs, but no cause for alarm."



Dux Court Road, High Halstow. Picture: Laurence Cloughton

It comes after neighbours were shocked to see the bomb disposal van in woodland last night.

A police spokesman said last night: "Police received a call at 5.41pm on Sunday 2 April 2017 from a member of the public who reported finding what they believed to be an old military shell or mine on private land near to Dux Court Road at Hoo.

Police confirmed this morning that the controlled explosion had been conducted and the operation was finished.



Unexploded bomb alert in Gillingham

Published: 13:01, 29 May 2009 | Updated: 16:09, 02 May 2019

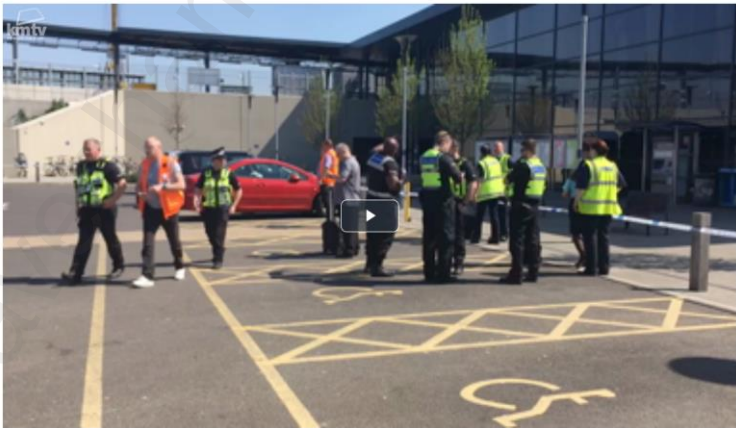
A suspected unexploded Second World War bomb has been found in Gillingham. Police have set up a cordon in The Vineries area and some homes have been evacuated.

Officers were called at about 11.30am to a garden in which the device was found. The bomb was removed at 1.30pm by bomb disposal experts and the cordon taken down.

Speaking during the incident, Mick Booker, from Poppy Close, said: "The police came to the front door and asked us to evacuate our building because of a bomb they found. "Now they have cordoned off Speedwell Close and Poppy Close and the top end of the Vineries. "There are a few people watching and waiting to see what is happening, it is very, very scary. "They have not said where it is or anything, just that it is an unexploded device." Mr Booker said police cars had been stationed in a number of the roads in the area.

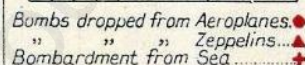
A recent report for Medway Council assessed the risk of German bombs still being found in Chatham. Chatham Dock - which is a short distance from the vineries - was attacked in both World Wars.

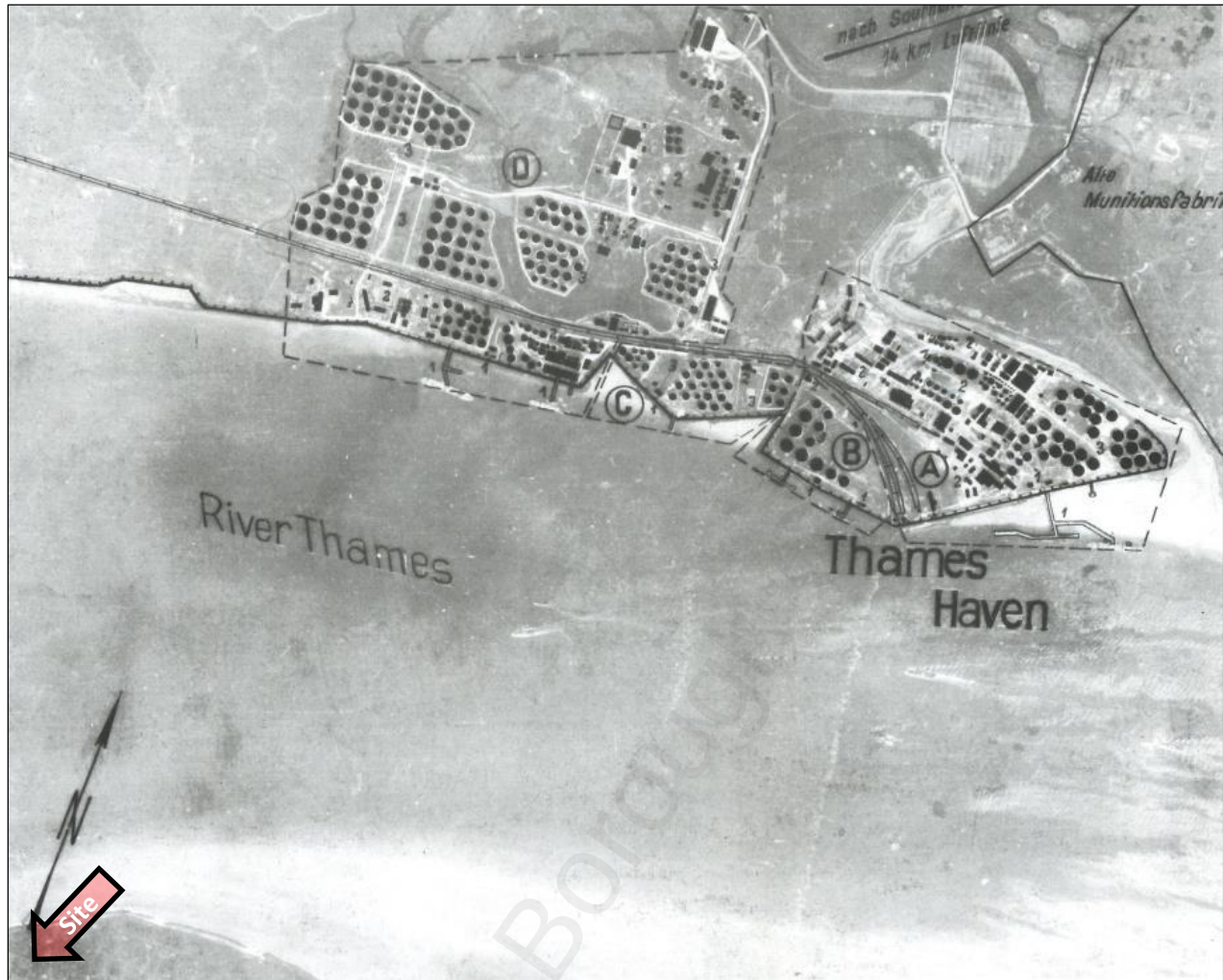




Unexploded WW2 Bomb found in Rochester

What is believed to be an unexploded World War 2 bomb has been uncovered in Rochester. Police are at the scene at Rochester Train Station. MoD explosive disposal experts have been contacted and are en route.





Thames Haven - Essex
Tank farm (oil storage)
TN75

The northern-eastern site boundary is located approximately 6km south-east of the Thames Haven and Shell Haven refineries shown here, on the opposite side of the River Thames.



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Source: Nigel J. Clarke, "Adolf Hitler's Home Counties Holiday Snaps"





Chatham – Kent
1st August 1940
Naval Shipyards

A. Chattenden ‘Farm’ Explosives Storage (GB 22 2). This is located 5km south-east of the southern site boundary.

GB 831 ‘Steelyard?’ - St. Mary’s Island, Chatham Royal Dockyard
GB 743 Military land including Upnor Castle, sea plane station (GB 18189), & engine factory (GB 741)



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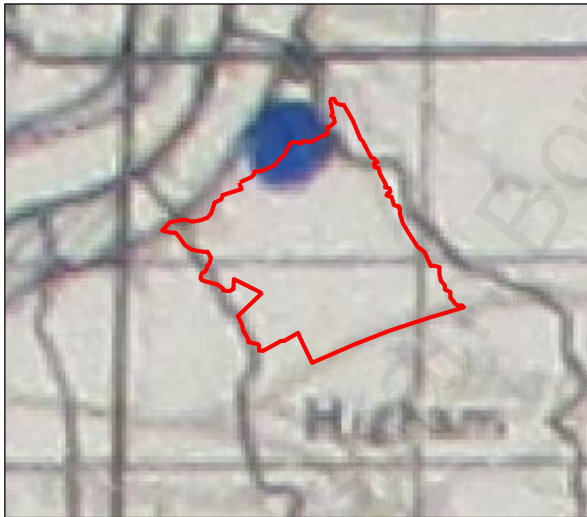
20th October 1940



4th November 1940



21st February 1941



15th March 1941



Incendiary Bomb



H.E Bomb



Parachute Mine



German Plane



H.E Bomb



British Plane



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Source: Kent History and Library Centre

 **Approximate site boundary**



15th April 1943



4th February 1944



24th February 1944



Incendiary Bomb



H.E Bomb



Parachute Mine



German Plane



H.E Bomb



British Plane



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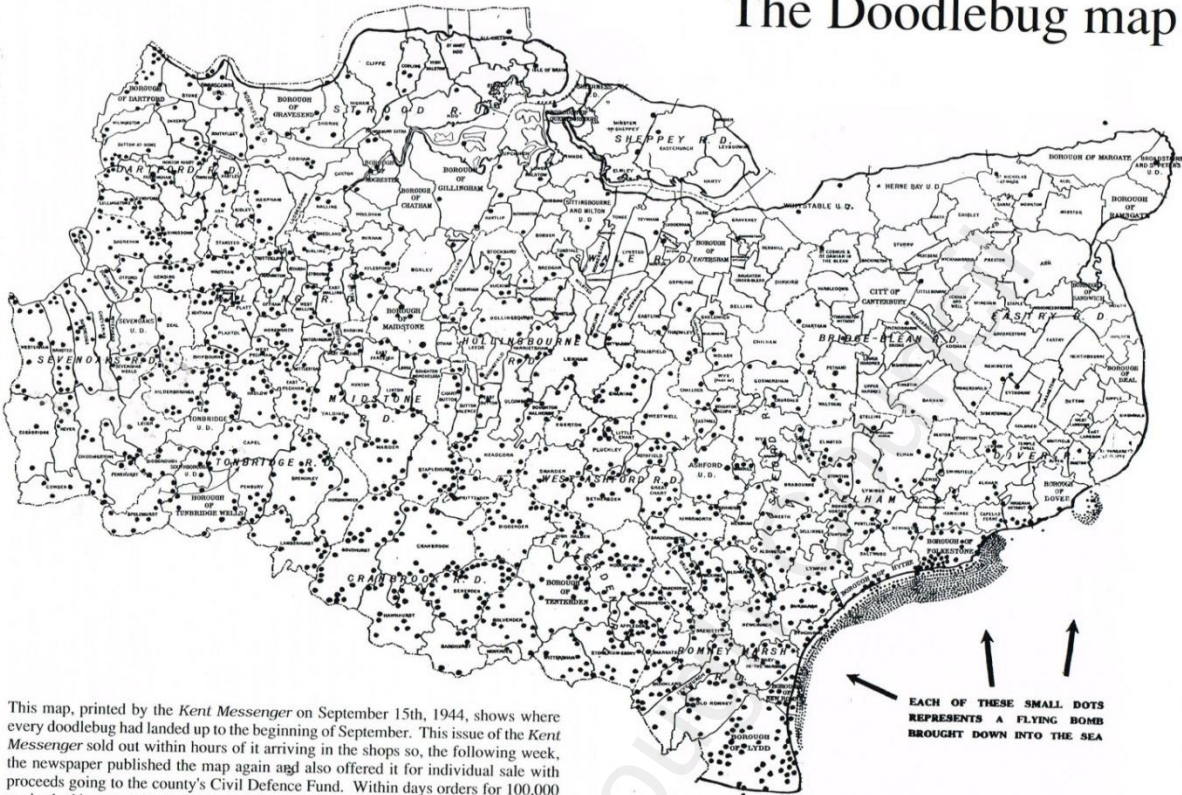
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Source: Kent History and Library Centre

Approximate site boundary

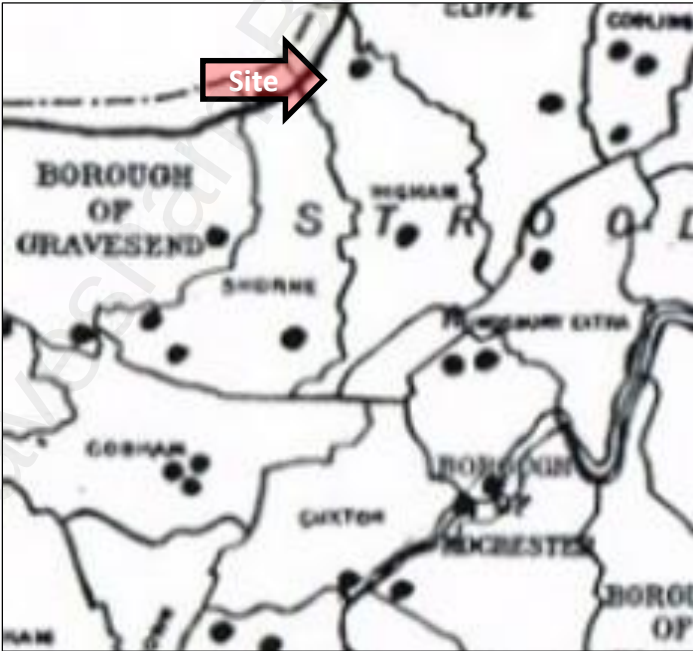


The Doodlebug map



This map, printed by the *Kent Messenger* on September 15th, 1944, shows where every doodlebug had landed up to the beginning of September. This issue of the *Kent Messenger* sold out within hours of it arriving in the shops so, the following week, the newspaper published the map again and also offered it for individual sale with proceeds going to the county's Civil Defence Fund. Within days orders for 100,000 copies had been received but the strict rationing on newsprint made it impossible for the *Kent Messenger* to meet all the enquiries. Today, the "Doodlebug Map" is a treasured memento in thousands of homes throughout the county.

EACH OF THESE SMALL DOTS REPRESENTS A FLYING BOMB BROUGHT DOWN INTO THE SEA



● V-1 flying bomb



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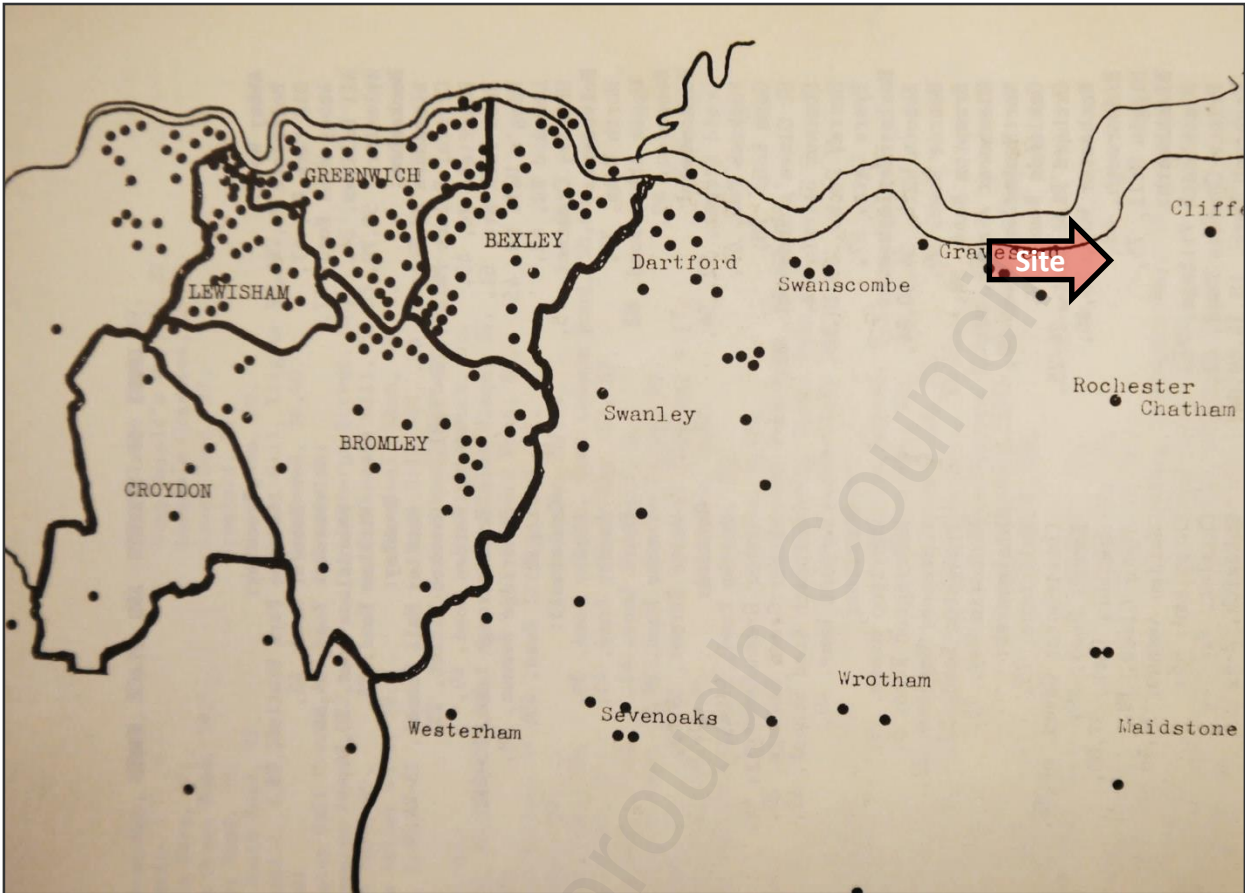
Ref: DA15134-00

Source: B.Ogley, *Kent at War*, Froglets Publications Ltd. 1994





Consolidated map of V2 rockets across Kent and South East London



● V-2 Rockets



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Source: *Lewis Blake, Bolts from the Blue, 1990*



19th September 1940

1	16.	19.9.40	06:15	06:59	M.G.C.	SITUATION REPORT. 1/8K TO 1/9K.			
					STROOD ROAD.	AT 20:33, ON 1/8A, APPROX. 1.0'S AT KEYSDOWN. M.R. 104 822.			
						HIGHAM M.R. 16 9976. CHARGE M.R. 142917.	NIL	NIL	

3rd October 1940

2	75.	8.10.40.	2040	2044	Ang. S.	at 15:17 hrs. 2 at 1.15's in field. P.O. 2. 2015. Personal 1/80. 1/100 Junction M.R. 102,922.	NIL	NIL	No action ✓
---	-----	----------	------	------	---------	---	-----	-----	-------------

9th October 1940

3	62.	9-10-40	17:55	18:24	MEDWAY G.	CONT. SHEET II NORTH-FLEET AT 1645 HOURS STONE BRIDGE ROAD NOW OPEN TO SINGLE LINE TRAFFIC REPORTED IN 0610 HOURS. ALL OTHER SUB CONTROLS NOTHING OF IMPORTANCE TO REPORT.			NONE	Q13
	77	9-10-40.	21:22	21:28	"	FIRST INTERIM. Gillingham. Bombing. 20 OT. Darland Camp 2 H.B.'s. M.R. 227851. One H.B. Harris's Farm. M.R. 226847.	NIL			
	82	9-10-40.	22:52	22:58	"	Clear Road One G.1.15. + One H.B. M.R. 222855. Strood Rural. 21.05. 1.15's at following. Higham. M.R. 157916. + M.R. 151915. Higham Marshes. M.R. 169938 Nr. Rhove. M.R. 142902. All fires extinguished.	NIL	NIL ONE HOUSE DEMOLISHED. ONE BALLY CHARGED WATER AND ONE NAME DAMAGED.		

20th October 1940

4	69	20.10.40	"	"	"	1 at rear of houses - Rubens Hill Strood Road. At 21:20 hrs. 6 H.B. - Higham M.R. 149940 at 22:40 hrs. 3 H.B. at Haver	NIL		slight damage	
							NIL		NIL	

28th October 1940

5	16	28-10-40	11:00	11:06	Strood R.	at approx. 21:24 hrs. H.B.'s between Cliffe + Higham.			Electricity supply damaged.	NIL
	4	28/10/40	05:45	06:01	METROPOL. Rd. 21.15	No. of bombs for this incident = 80	NIL		Slight damage to property	"

21st September 1941

6	56	21.2.41	17-07	17-14	STROOD R.D.	NIGHT OF 20/21 H.E. 3 8 AT CLIFFE M.M.R. 149947.	NIL	L	DAMAGE TO SEA WALL.	NO ACTION	R13
---	----	---------	-------	-------	-------------	--	-----	---	------------------------	-----------	-----

4th April 1944

7	181	4-2-44	2049	2059	Strood R.	333948, 333949, 332949 Higham. Barrow Hill Higham M.R. 159932	NIL	NIL	NOTED	
---	-----	--------	------	------	-----------	---	-----	-----	-------	--



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Source: The National Archives



- High Explosive Bombs (Kent Daily Bomb Maps)
- Incendiary Bombs (Kent Daily Bomb Maps)
- Numbers relating to Incident Records



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Source: 1st Line Defence

Approximate site boundary





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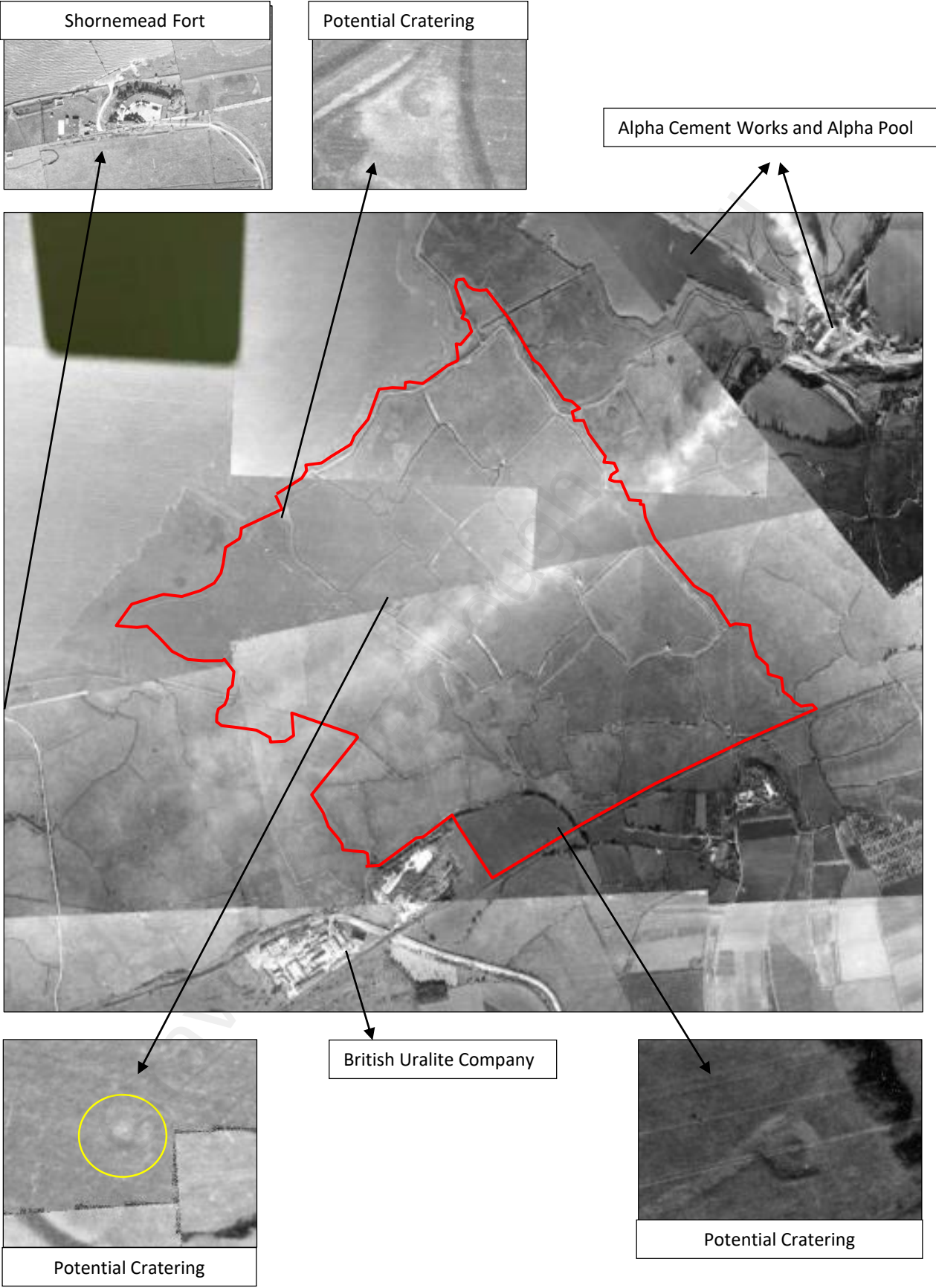
Project: **Higham Marshes**

Ref: **DA15134-00**

Source: Google Earth™ Mapping Services

 **Approximate site boundary**





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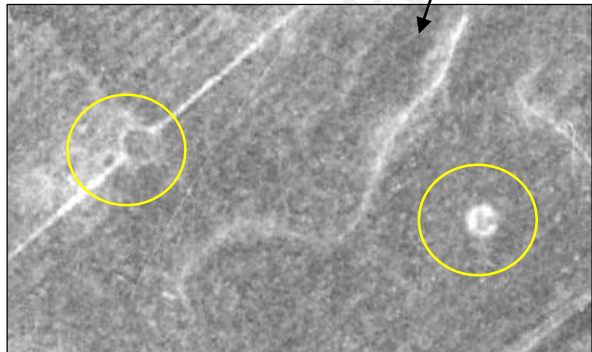
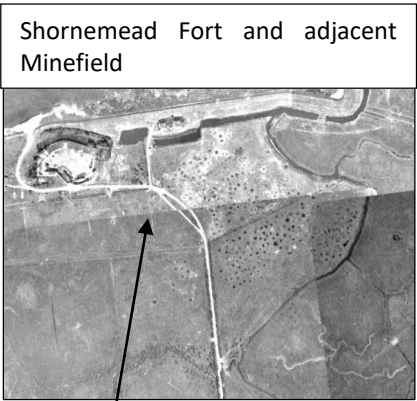
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Approximate site boundary





Markings confirmed to be bomb craters by the online resource *Heritage Gateway*



Cratering still visible in current aerial imagery



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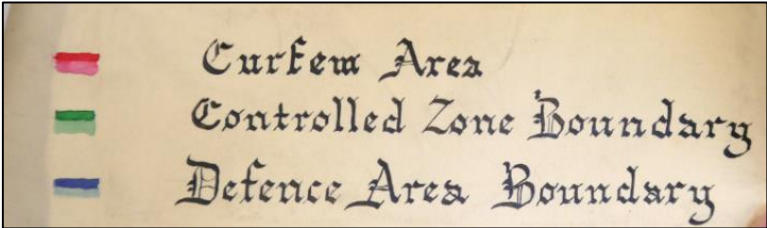
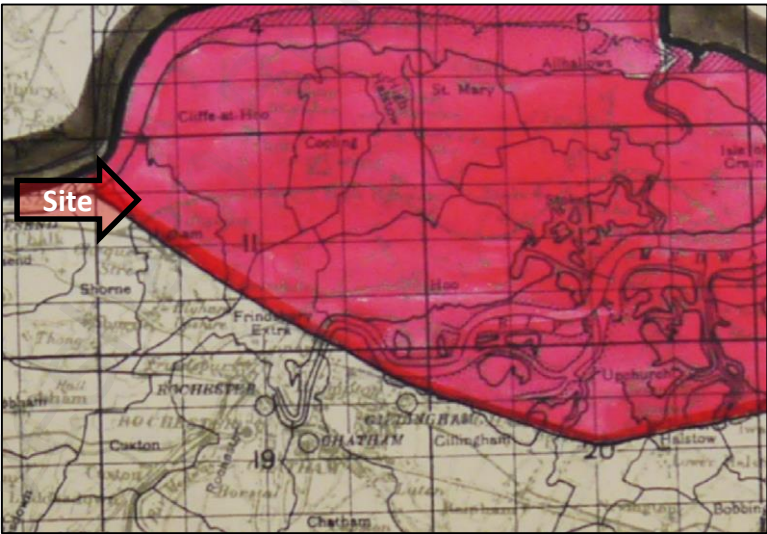
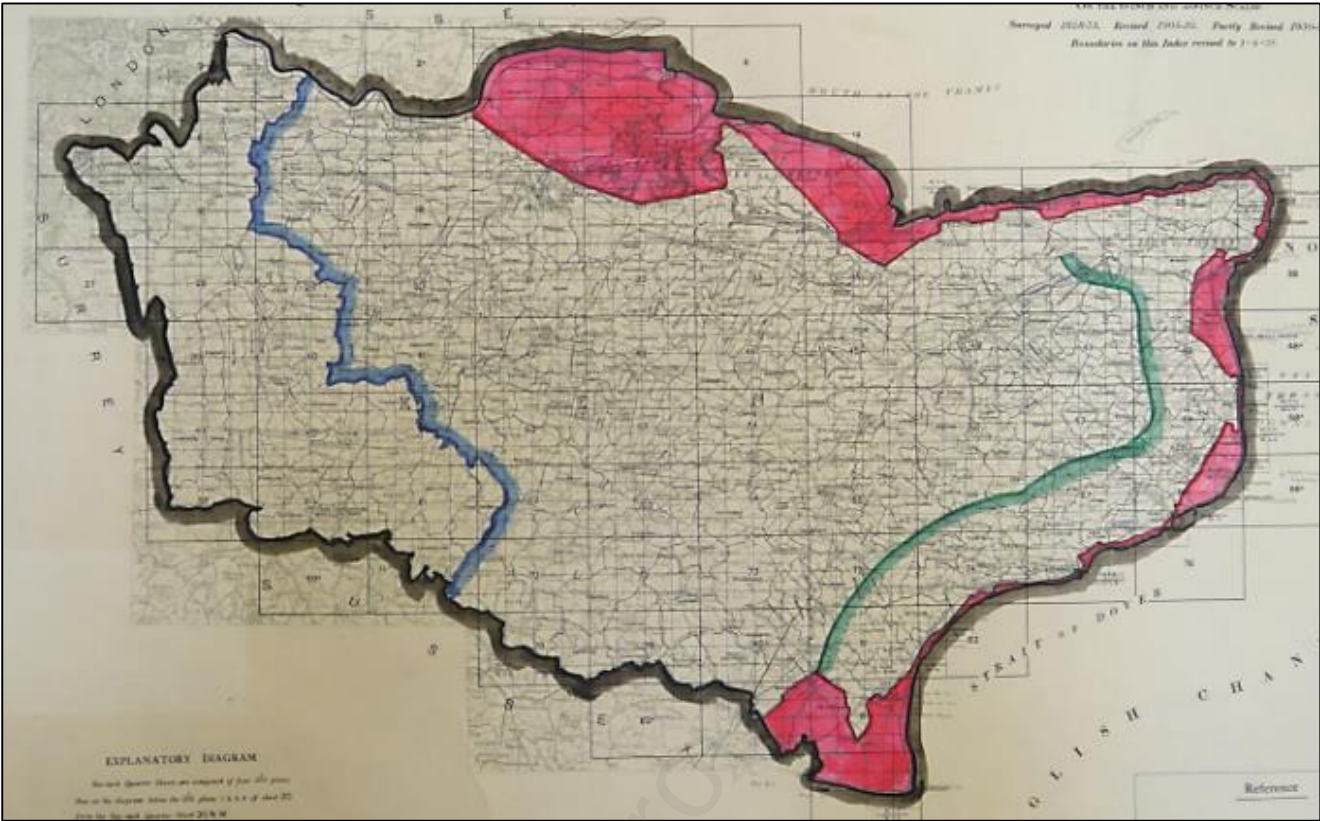
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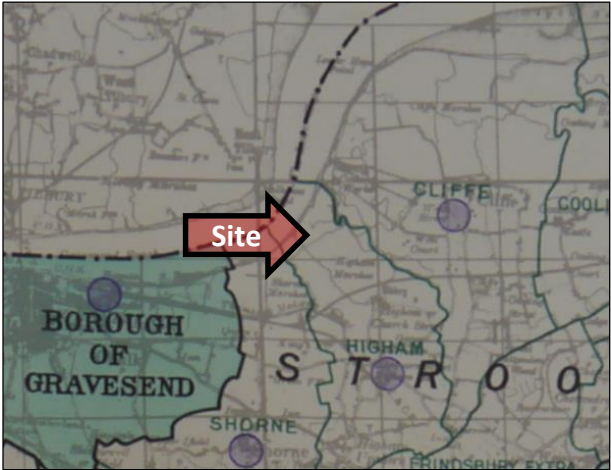
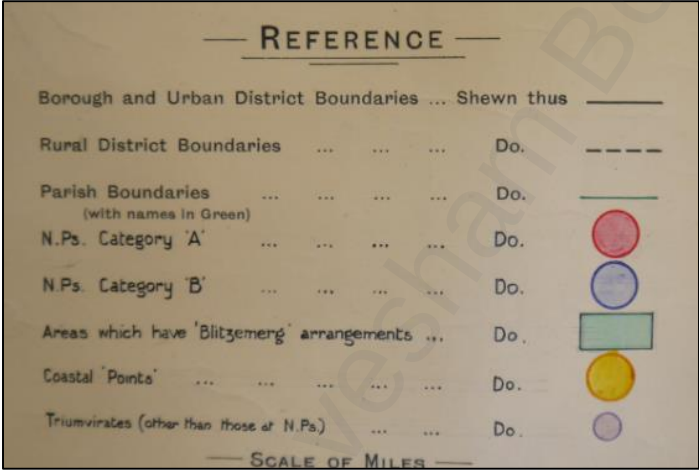
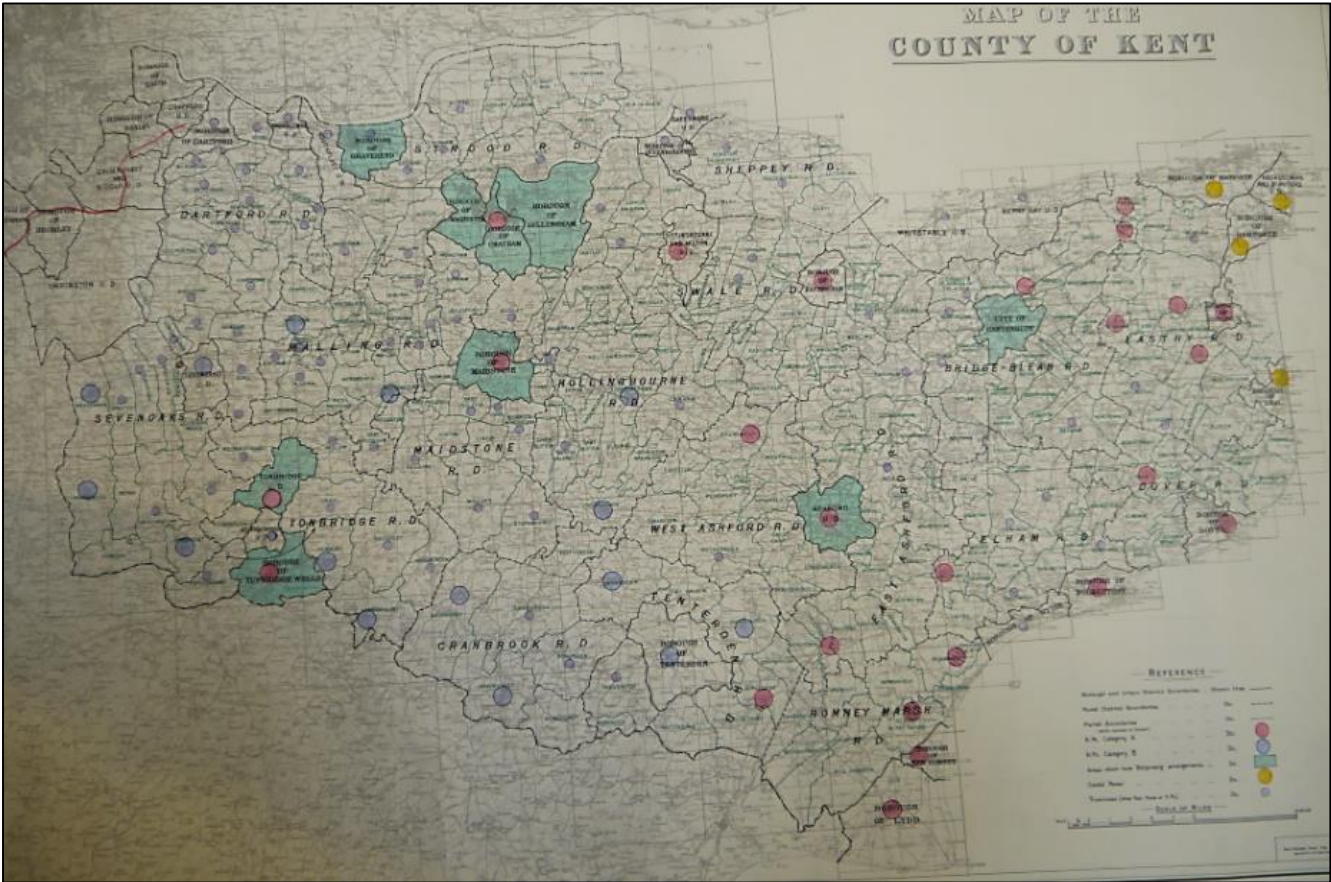
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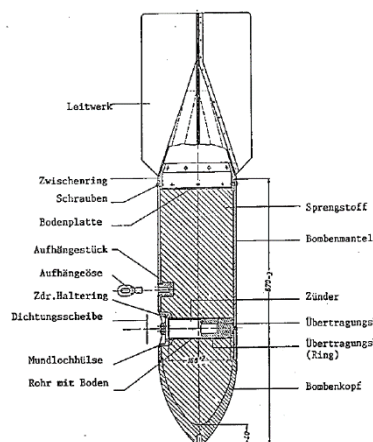
Source: Kent History and Library Centre



Examples of German Bombs - HE

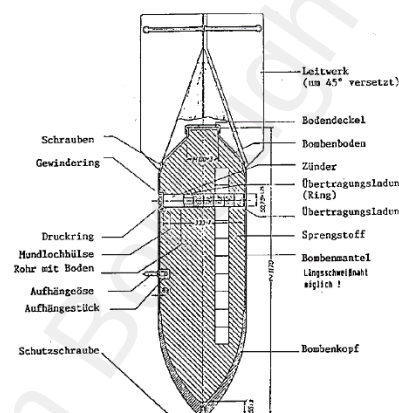
SC 50kg

Bomb Weight	40-54kg (110-119lb)
Explosive Weight	c25kg (55lb)
Fuze Type	Impact fuze/electro-mechanical time delay fuze
Bomb Dimensions	1,090 x 280mm (42.9 x 11.0in)
Body Diameter	200mm (7.87in)
Use	Against lightly damageable materials, hangars, railway rolling stock, ammunition depots, light bridges and buildings up to three stories.
Remarks	The smallest and most common conventional German bomb. Nearly 70% of bombs dropped on the UK were 50kg.



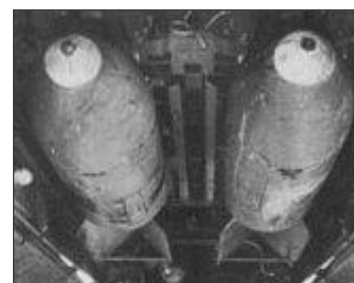
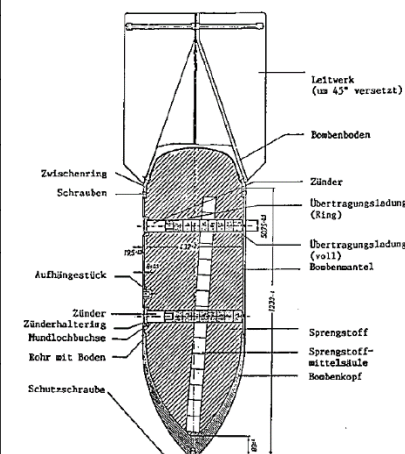
SC 250kg

Bomb Weight	245-256kg (540-564lb)
Explosive Weight	125-130kg (276-287lb)
Fuze Type	Electrical impact/mechanical time delay fuze.
Bomb Dimensions	1640 x 512mm (64.57 x 20.16in)
Body Diameter	368mm (14.5in)
Use	Against railway installations, embankments, flyovers, underpasses, large buildings and below-ground installations.
Remarks	It could be carried by almost all German bomber aircraft, and was used to notable effect by the Junkers Ju-87 Stuka (Sturzkampfflugzeug or dive-bomber).



SC 500kg

Bomb Weight	480-520kg (1,058-1,146lb)
Explosive Weight	250-260kg (551-573lb)
Fuze Type	Electrical impact/mechanical time delay fuze.
Bomb Dimensions	1957 x 640mm (77 x 25.2in)
Body Diameter	470mm (18.5in)
Use	Against fixed airfield installations, hangars, assembly halls, flyovers, underpasses, high-rise buildings and below-ground installations.
Remarks	40/60 or 50/50 Amatol TNT, trialene. Bombs recovered with Trialene filling have cylindrical paper wrapped pellets 1-15/16 in. in length and diameter forming


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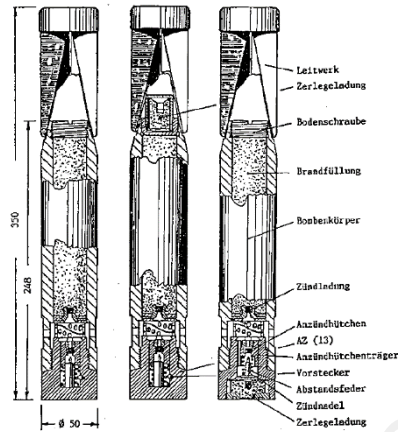
Source: Various sources

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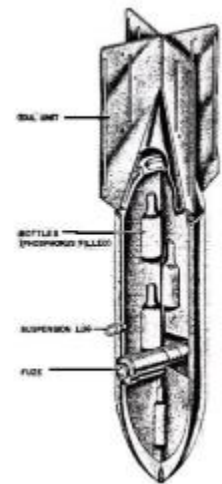
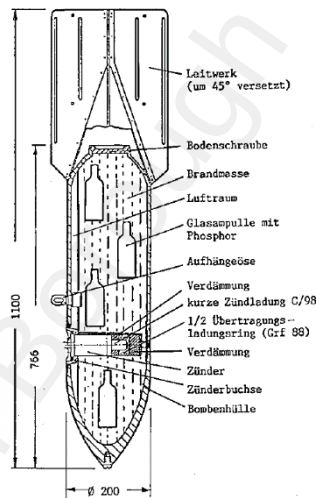
1kg Incendiary Bomb

Bomb Weight	1.0 and 1.3kg (2.2 and 2.87lb)
Explosive Weight	680gm (1.3lb) Thermite
Fuze Type	Impact fuze
Bomb Dimensions	350 x 50mm (13.8 x 1.97in)
Body Diameter	50mm (1.97in)
Use	As incendiary – dropped in clusters against towns and industrial complexes
Remarks	Magnesium alloy case. Sometimes fitted with high explosive charge. The body is a cylindrical alloy casting threaded internally at the nose to receive the fuze holder and fuze.



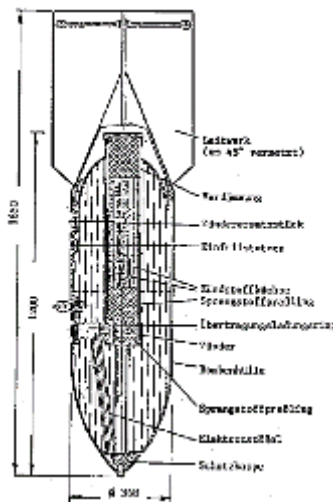
C50 A Incendiary Bomb

Bomb Weight	c41kg (90.4lb)
Explosive Weight	0.03kg (0.066lb)
Incendiary Filling	12kg (25.5lb) liquid filling with phosphor igniters in glass phials. Benzine 85%; Phosphorus 4%; Pure Rubber 10%
Fuze Type	Electrical impact fuze
Bomb Dimensions	1,100 x 280mm (43.2 x 8in)
Use	Against all targets where an incendiary effect is to be expected
Remarks	Early fill was a phosphorous/carbon disulphide incendiary mixture



Flam C-250 Oil Bomb

Bomb Weight	125kg (276lb)
Explosive Weight	1kg (2.2lb)
Fuze Type	Super-fast electrical impact fuze
Filling	Mixture of 30% petrol and 70% crude oil
Bomb Dimensions	1,650 x 512.2mm (65 x 20.2in)
Body Diameter	368mm (14.5in)
Use	Often used for surprise attacks on living targets, against troop barracks and industrial installations. Thin casing – not designed for ground penetration



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Client: **RSPB**

Project: **Higham Marshes**

Ref: **DA15134-00**

Source: Various sources

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QF 3.7 Inch WWII Anti-Aircraft Projectile

Projectile Weight	28lb (12.6 kg)
Explosive Weight	2.52lbs
Fuze Type	Mechanical Time Fuze
Dimensions	3.7in x 14.7in (94mm x 360mm)
Rate of Fire	10 to 20 rounds per minute
Use	High Explosive Anti-Aircraft projectile. 4.5in projectiles were also used in this role.
Ceiling	30,000ft to 59,000ft



40mm Bofors Projectile

Projectile Weight	1.96lb (0.86kg)
Explosive Weight	300g (0.6lb)
Fuze Type	Proximity and Mechanical Time Fuze
Rate of Fire	120 rounds per minute
Projectile Dimensions	40mm x 310mm (1.6in x 12.2in)
Ceiling	23,000ft (7000m)



Unrotated Projectile (UP) – Z Battery

Projectile Weight	84lb (24.5kg)
Warhead Weight	4.28lb (1.94kg)
Warhead	Aerial Mine with a No. 700 / 720 fuze
Filling	High Explosive
Dimensions	1930mm x 82.6mm (76 x 3.25in)
Use	As a short range rocket-firing anti-aircraft weapon developed for the Royal Navy. It was used extensively by British ships during the early days of World War II. The UP was also used in ground-based single and 128-round launchers known as Z Batteries.



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