Detailed Unexploded Ordnance (UXO) Risk Assessment

Project Name: Lennox Estate, London

Prepared for: A2 Site Investigations Limited

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Site: Lennox Estate, London, SW15 5LQ

Date: 17/02/2025

Document Name: INO5563 - Detailed UXO Risk Assessment - Lennox Estate, London

Version: INO5563-001

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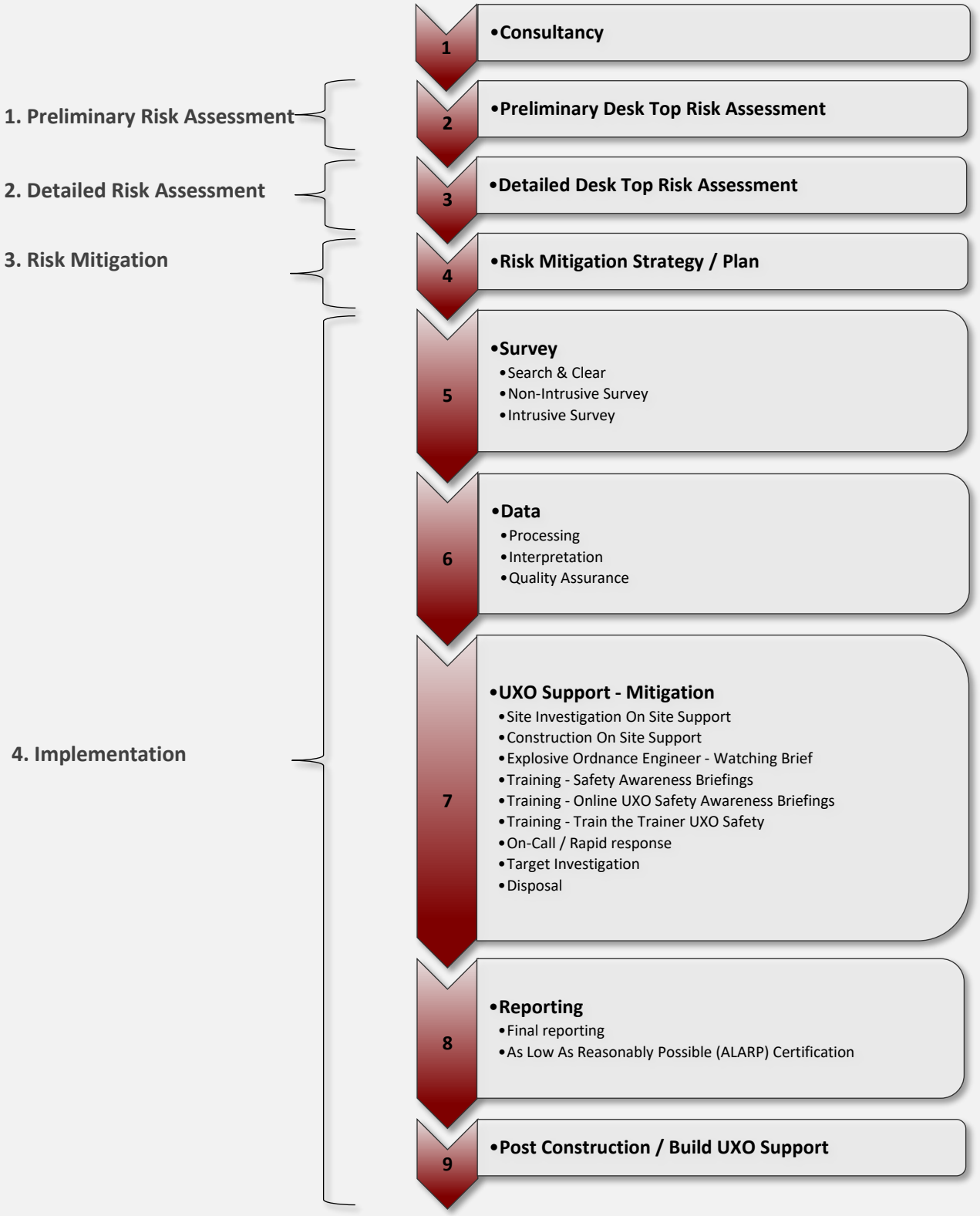
Acronyms & Abbreviations

AA	Anti-Aircraft
AAA	Anti-Aircraft Ammunition
ALARP	As Low As Reasonably Practicable
AOD	Above Ordnance Datum
ARP	Air Raid Precaution
AXO	Abandoned Explosive Ordnance
BD	Bomb Disposal
BDO	Bomb Disposal Officer
bgl	Below Ground Level
BGS	British Geological Survey
BH	Borehole
BPD	Bomb Penetration Depth
CDP	Cast Driven Piles
CFA	Continuous Flight Auger
CIRIA	Construction Industry Research and Information Association
CPT	Cone Penetration Testing
CS	County Series
EO	Explosive Ordnance
EOC	Explosive Ordnance Clearance
EOD	Explosive Ordnance Disposal
GI	Ground Investigation
GIS	Geographic Information Systems
GL	Ground Level
GP	General Purpose
GPS	Global Positioning Systems
HAA	Heavy Anti-Aircraft
HE	High Explosive
HO	Home Office
HSE	Health and Safety Executive
IB	Incendiary Bomb
kg	Kilograms
km	Kilometres
LAA	Light Anti-Aircraft
LCC	London County Council
LE	Low Explosive
LSA	Land Service Ammunition
m	Metres
MoD	Ministry of Defence
mm	Millimetres
NEQ	Net Explosive Quantity
NFF	National Filling Factory
NGR	National Grid Reference
OD	Ordnance Datum
OS	Ordnance Survey
PM	Parachute Mine
PoW	Prisoner of War
RADAR	Radio Detection And Ranging
RAF	Royal Air Force
RN	Royal Navy
RNAS	Royal Naval Air Service
ROF	Royal Ordnance Factory
SAA	Small Arms Ammunition
TA	Territorial Army
TNT	Trinitrotoluene
UK	United Kingdom
UN	United Nations
USAAF	United States Army Air Force
UXB	Unexploded Bomb
UXO	Unexploded Ordnance
V	Weapons Vergeltungswaffe– Vengeance Weapons
WD	War Department
WWI	World War One
WWII	World War Two
ZAA	'Z' Anti-Air Rocket Battery

UK UXO Risk Mitigation Process

CIRIA 681 Phases

RMS UXO Detailed Phases



1. Executive Summary

Site Overview

The client has specified the Site location as Lennox Estate, London, SW15 5RS and is approximately centred on the National Grid Reference: TQ 21492 75426.

RMS UXO Limited, (RMS UXO) was commissioned by A2 Site Investigation Limited to conduct an Unexploded Ordnance (UXO) Desk Study Risk Assessment for Lennox Estate, London, SW15 5RS. The primary objective of this document is to evaluate the UXO risks present at the specified site and its surrounding areas, in compliance with the Construction Industry Research and Information Association (CIRIA) C681 guide on 'Unexploded Ordnance (UXO), a Guide for the Construction Industry'.

Proposed Works

The proposed works outlined by the client include 2 standard Cable Percussive boreholes to 35m and 30m, 1 no. day Window Sampling locations (4 no. locations) to 5.0m depth, 2 no. hand excavated foundation pits, 1 no. BRE soakage pit, 8 no. CBR testing via TRL DCP (1.0m depth).

Summary of Available Information

- During WWII, the Borough of Wandsworth sustained a very high-density bombing campaign according to The National Archives statistics, with an average of 184 items of ordnance recorded per 1,000 acres.
- RMS UXO's geo-referenced database has identified 1 Pillbox within an approximate 1km radius and therefore the risk of Allied UXO is believed to be negligible.
- There are 17 bombing incidents are known to have occurred within an approximate 500m radius of the Site. The closest HE bomb strikes occurred on the north and south border of the Site. However, as a significant portion of the Site comprised open unmaintained ground there is a possibility that any further bomb strikes could have gone unrecorded and unobserved. It should be noted that incendiary bomb showers were not recorded within these records and therefore may also pose a risk to the Site. The entire Site being the main risk pathway. It should also be noted that abandoned bombs and UXBs were recorded in the wider surrounds to the Site.
- High-resolution aerial photographs around the Wandsworth area in 1940, 1944, 1946 and 1947 corroborate with pre-war OS mapping and reveal the Site comprised open, undeveloped ground. A high-resolution aerial photograph around the Wandsworth area in 2001 shows the Site comprised the structures and open ground that are on Site in its modern-day composition.
- It should be noted that the majority of the Site is anticipated to have received low levels of access and observation due to the open nature of the Site. During any bombing raids the anticipated levels of access and observation will have dropped significantly and it is unlikely any bombs on the Site will have been noticed and recorded.
- No evidence has been located to suggest that the site formerly had any military occupation or usage that could have led to contamination with items of British / Allied ordnance.

Risk Level
Medium

Table 1.1 - Risk Assessment					
Type of work	Potential Hazard	Probability (PE x PD = P)	Likelihood	Severity	Risk Rating
Future developments	HE	10	2	5	Medium
Future developments	HE	5	1	5	Low
Future developments	IBs	4	1	4	Low
***PE (Probability of Encounter), PD (Probability of Detonation), P (Overall Probability)**					

Recommendations

The below recommendation table is provided as an overview of the methods required to adequately mitigate the risk of UXO and is in accordance with the CIRIA 681 Guidelines.

	Table 1.2 MITIGATION METHOD – Medium Risk Areas	YES	NO	TBC*
1	**Project Specific Risk Mitigation Strategy** A project specific overarching strategy to manage UXO project risk on more complex sites. Developed in line with the client's construction plan and methods of construction to be used.	✓		
2	**Safety Awareness Briefings** Explosive Ordnance Safety and Awareness Training is provided to site personnel to make them aware of the potential threat from UXO on the work site, what UXO might look like and what to do if suspected UXO is encountered.	✓		
3	**Site Specific Safety Instructions – Emergency Response Plan** Provides site management teams the training, information and guidance to respond to a UXO related incident. Delivered by experienced EOD qualified personnel and often employed alongside an on-call offsite EOD responder.	✓		
4	**On-call EOD Engineer – Off-site Responder** A retained service whereby a qualified EOD engineer will respond to a suspicious find on-site.		✓	
5	**Onsite EOD Engineer – Support to Site Investigation** Providing Realtime on-site EOD support to site investigation activities. Delivering safety briefings & employing handheld survey instruments ahead of trial pit excavations, drilling activities etc.	✓		
6	**Onsite EOD Engineer- Watching Brief** Providing a reactive on-site support where pro-active UXO risk mitigation measures, are not practical. Supervising all open/bulk excavations, responding to suspicious finds & managing UXO related incidents.	✓		

	Table 1.2 MITIGATION METHOD – Medium Risk Areas	YES	NO	TBC*
7	**Non-Intrusive Survey** The collection of survey data which is then processed & interpreted offsite. The purpose of the survey is to locate sub-surface anomalies/targets which may be UXO related. Usually employed on greenfield sites or sites which have not previously been developed.	✓		
8	**Intrusive Survey** For sites where a non-intrusive UXO survey cannot reach the maximum depth of UXO risk, or the site is not suitable for a non-intrusive survey such as a brownfield site the intrusive UXO survey provides a suitable alternative. Designed to survey point specific locations where deep engineering works are being undertaken such a piling, pile clusters and sheet piled walls.	✓		
9	**Search & Clearance** For areas where a non-intrusive survey is not viable or cost effective two-man UXO Specialist teams can be deployed to conduct a manual Search & Clear operation of the site location with handheld UXO detection equipment.		✓	
10	**Data Management** Data processing, Interpretation or QA (of third-party survey data) The processing and interpretation of third-party survey data for the purpose of UXO clearance.	✓		
11	**Target Investigation** The investigation of anomalies/targets identified by previously undertaken surveys. Conducted by a two-man EOD team using handheld locators/detectors.			✓
12	**UXO Removal & Disposal** The removal from site of safe to move or inert items of UXO for disposal off-site.			✓

Note: The assessed level of risk does not apply within the existing structures and no further action is required for works within the existing structures. This risk applies only to below existing ground levels or beyond the basement level to maximum bomb penetration depth. The risk will also have been partially mitigated to the depths of repair of the damaged structures and post war development.

2. Project Context

Project Rational & Scope

Objective

The objective of this assessment is to evaluate the potential for encountering unexploded ordnance (UXO) at the Lennox Estate, London, SW15 5RS during the proposed Borehole drilling, Window Sampling and Foundation Pits. This assessment adheres to the UXO risk management process and follows CIRIA Guidelines.

Aims

The primary aim of this report is to examine the likelihood of encountering explosive ordnance during the planned works at Lennox Estate, London, SW15 5RS. Based on the findings, risk mitigation measures will be recommended to either eliminate or minimize the threat from UXO.

Issues Addressed

The report will focus on the following key issues:

- The risk of UXO contamination at the Site.
- The possibility of remaining UXO on Site.
- The potential for encountering UXO during intrusive works.
- The risk of ordnance initiation.
- The consequences of initiating or encountering ordnance.
- Appropriate risk mitigation measures will be recommended, contingent on the assessed level of risk and specific site conditions.

Tasks:

- **Preliminary Site Assessment:** Conduct an initial review of historical data and previous studies related to the Site.
- **Data Collection:** Gather relevant data through field surveys etc.
- **Data Analysis and Risk Assessment:** Analyse the collected data to identify UXO threats and assess risks.
- **Mitigation Planning:** Develop a set of tailored risk mitigation measures.

Responsibilities:

- RMS UXO will be responsible for all data collection, analysis, and reporting.
- The client is responsible for providing access to the Site and any existing data or reports.

Limitations and Assumptions:

- The assessment is based on the data available at the time of the study.
- Any changes in project scope or site conditions must be communicated to RMS UXO for re-assessment.

3. Methodology

Methods

Risk Assessment Process

Our risk evaluation employs a systematic methodology, focusing on several crucial aspects:

- Assessing historical UXO contamination at the location.
- Assessing the likelihood – pathways for UXO to have contaminated the Site.
- Assessing the likelihood of UXO being still present
- Estimating the likelihood of encountering UXO during upcoming activities.
- Assessing the chances of UXO functioning as designed.
- Understanding the implications of either encountering or UXO detonating.

To comprehensively cover these aspects, we've considered:

- Past records of bombings and military engagements.
- Conditions and historical context of the Site during times of conflict.
- Post-conflict developments and any documented UXO removal efforts.
- The characteristics and scale of the planned activities.
- The variety of munitions that could have affected the area.

Sources of Information

To ensure a thorough and comprehensive report, material from the following sources has been consulted:

- The National Archives.
- Local Historical Archives.
- Relevant Government Departments.
- Information provided by client.
- RMS UXO's comprehensive historical archives and UXO geo-database.
- Open sources such as published books and internet resources.

Reliability and Limitations

As of the date this document was issued, all contained information is verified to be both current and accurate. Our databases undergo systematic updates to include the most recent data, and RMS UXO has employed rigorous precision and specialised expertise in the creation of this document.

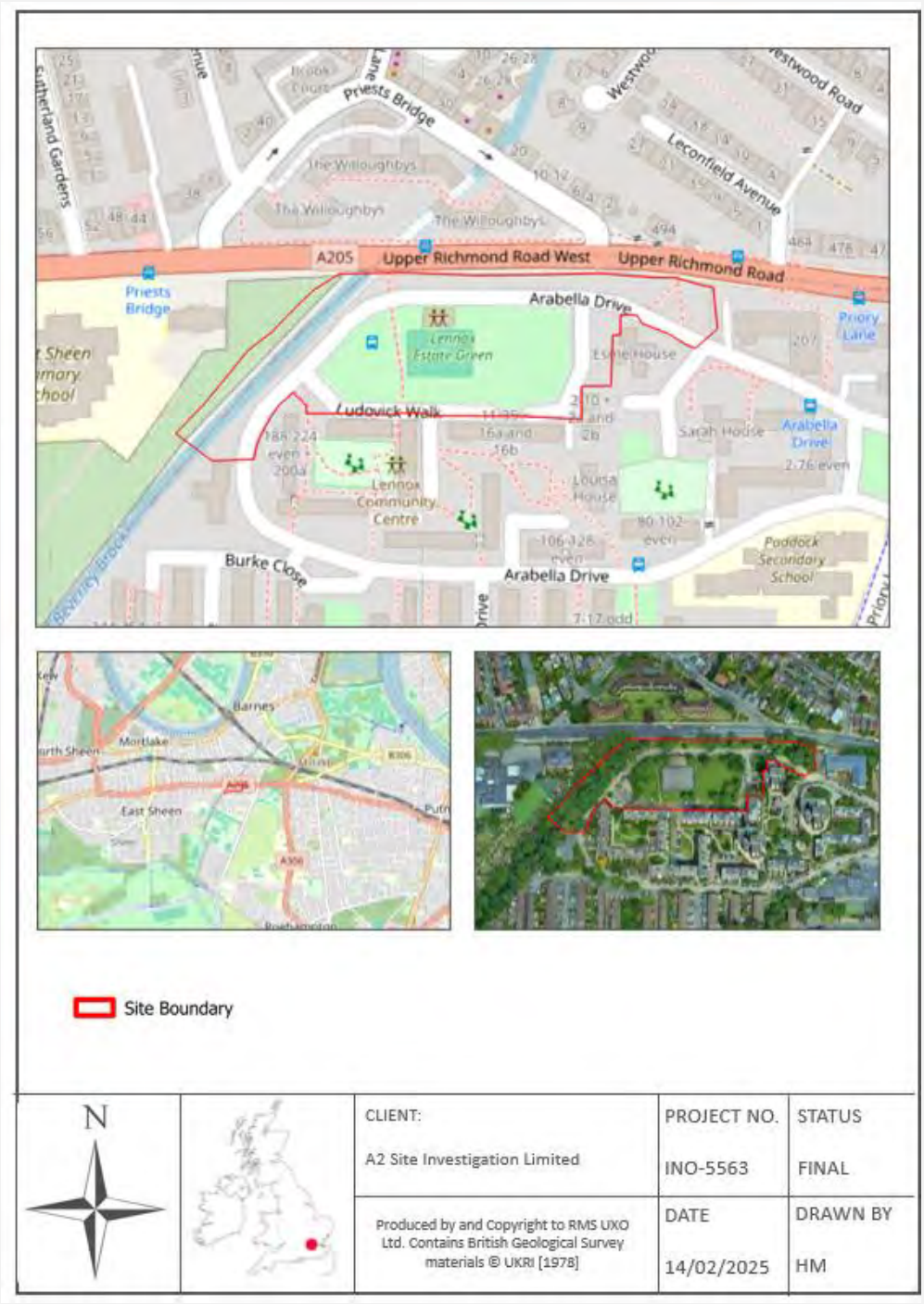
Our risk evaluations are grounded in thorough investigation and supported by data from multiple, verified external sources. While every measure has been taken to ensure the reliability of this data, it is understood that historical records may contain inherent limitations. Consequently, RMS UXO disclaims liability for any inaccuracies present in external data sets beyond our purview.

4. Site Profile

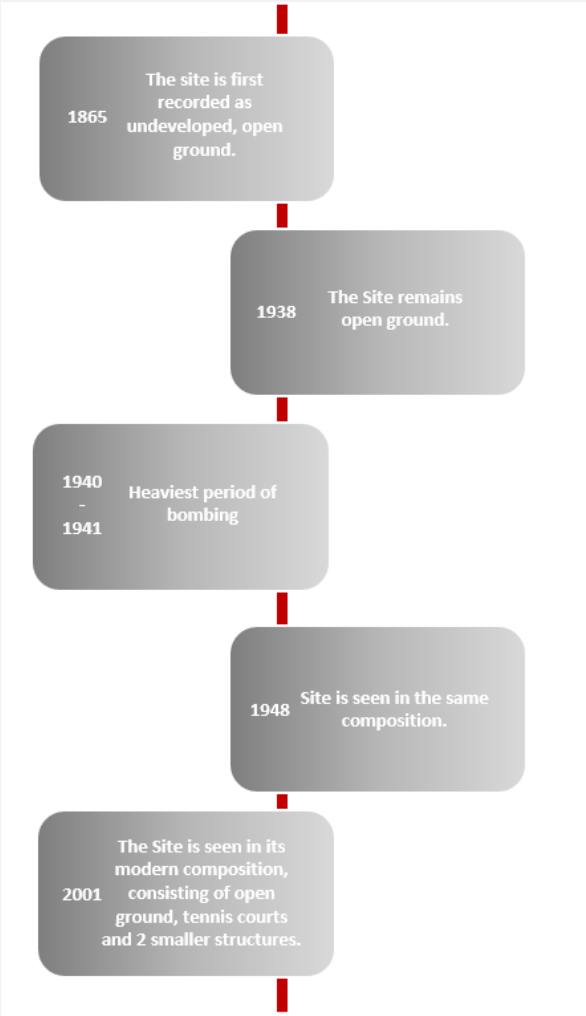
Location

The Client has defined the Site as Lennox Estate, London, SW15 5RS and is approximately centred on the National Grid Reference: TQ 21492 75426.

The Site is situated in the Borough of Wandsworth, approximately 630m south-west of Barnes Station.



Historical Context & Previous Studies



Military Activity & WWII Site Utilisation: The Site has not been identified as an area of military activity during the war. However, it should be noted that 1 Pillbox and 1 Loopholed wall are recorded within a 1km radius.

Bombing Decoys: Records indicate 1 bombing decoys in a 5km radius of the Site, approximately 2.5km south-west.

Air Delivered Ordnance: Archival records confirm the deployment of HE and Incendiary bombs via aerial delivery in the vicinity of Wandsworth between 1940 and 1945. At least 17 HE bomb strikes are known to have occurred within an approximate 500m radius of the Site; the closest of these being 2 HE bombs recorded on the north and south border of the Site. It should be noted that incendiary bomb showers were not recorded within these records and therefore may also pose a risk to the Site. The entire Site being the main risk pathway.

Anti-Aircraft Defences: There are 24 Heavy-Anti-Aircraft (HAA) gun batteries located within an approximate 15 kilometres radius from the site. These pose a risk of UXO contamination primarily due to storage of ammunition and partially due to searchlights rendering them clear targets for bombing at night. The closest is located approximately 1.4km south-west of the Site and the risk from buried ammunition is not deemed significant, however the main risk associated with this Site is that unexploded HAA shells can land up to an average of 15km from the firing point.

Aerial Photography: High-resolution aerial photographs around the Wandsworth area in 1940, 1944, 1946 and 1947 corroborate with OS mapping and reveal the Site comprised open ground.

Access to the Site: It should be noted that the majority of the Site is anticipated to have received low levels of access and observation due to the open nature of the Site. During any bombing raids the anticipated levels of access and observation will have dropped significantly and it is unlikely any bombs on the Site will have been noticed and recorded.

Bomb Damage Maps: London City Council bomb damage mapping does not indicate the Site sustained any damage from bombing. However, it should be noted that the bomb damage mapping was used to discover the cost of repair and as the Site was open ground it is unlikely that any damage will have been recorded.

Pre-WWII Maps: Historical maps dated 1938, have been consulted and show the Site comprised open, undeveloped ground.

Post-War Maps & Historical Records: A thorough review of post-WWII maps and historical records show post-war the Site retained its pre-war composition until at least 1967 as this is the last set of available mapping.

Modern Development: Further development has comprised the construction of hardstanding roadways around the boundary of the Site and a tennis court and associated small sports building in the centre of the Site by at least 2001. A garage structure is also seen constructed to the south-west of the Site by 2001.

Intentional or Unintentional Disposal: Records indicate no instances of disposal of UXO, within the confines of Site. However, due to UXO finds in the wider study area of Wandsworth this cannot be entirely discounted.

Proposed Work & Risk Pathways

The planned activities at Lennox Estate, London, SW15 5RS encompass various intrusive engineering tasks, such as Borehole drilling and Window Sampling. These tasks inherently create risk pathways for potential encounters with Unexploded Ordnance. The probability of encountering UXO is contingent upon the type and depth of the intrusive work being conducted. Consequences of UXO initiation could range from critical injuries to personnel to substantial damage to equipment and project delays. To mitigate these risks, a comprehensive approach will be employed, considering historical data, site-specific conditions, and previous UXO clearance operations. Tailored risk mitigation strategies will be developed to address the unique risk pathways associated with the proposed work. Considering the range of UXO that could exist within the site, boring and window sampling could introduce a [high-risk] scenario. While not every UXO encountered in this manner is guaranteed to activate upon contact, the discovery of one could have severe repercussions. These could range from endangering personnel and damaging equipment to causing substantial delays in project timelines.

Potential Hazards

German Air Delivered Ordnance

To gain a comprehensive understanding of the impact of air raids on Wandsworth during wartime, a comprehensive examination of record sets was conducted at the National Archives and within online sources.

World War I

London was bombed mainly by Zeppelin Airships and Gotha aircraft, with around 250 tons of ordnance dropped. WWI bombs were smaller and dropped from a lower altitude, resulting in limited penetration depths. The risk of encountering unexploded WWI bombs today is very low.

World War II

Primary strategic targets in Britain included airfields, depots, docks, warehouses, wharves, railways, factories, and power stations. Later in the war the Luftwaffe bombing started to include civilian areas and sites of cultural and historical significance.

The most intensive period of bombing over London occurred between October 1940 and May 1941, a phase known as "The Blitz." With an estimated total of 18,000 tons of bombs were dropped on London from 1940 to 1945.

WWII Home Office Bombing Statistics

The table below shows the quantity of German aerial delivered bombs (excluding 1kg incendiaries and anti-personnel bombs) dropped on the area of Wandsworth from 1940 to 1945.

Table 4.1 - Record of German Ordnance Dropped on Wandsworth	
Area (Acres)	9107
High Explosive Bombs	1437
Parachute Mines	5
Oil Bombs	38
Phosphorus Bombs	68
Fire Pots	1
V1	124
V2	6
Total	1679
Bombs per 1000 Acres	184

Records of the 1kg incendiary and anti-personnel bombs were not routine as they were too numerous to record. Although risk from IB's is less than that of HE bombs they were still designed to harm. Anti-personnel bombs are rare to find today but are potentially more dangerous. Although statistics for these bombs were not often recorded, it is important to carefully consider when evaluating risk to personnel and equipment.

Primarily HE bombs are most commonly associated with historical military activities in the area of Wandsworth. These UXO items are typically found in undisturbed soil, up to a standard depth of 9m.

4.2	Type of UXO	Characteristics
HE	High Explosive Bombs	The most commonly deployed German High Explosive (HE) bombs during WWII were the SC50, with 97% of all bombs dropped being in the 50kg, 250kg, and 500kg range. These bombs, which comprised 40-50% explosive fill, were capable of creating entry holes as small as 20cm in diameter and could easily penetrate the ground if they failed to detonate on impact. HE bombs were the primary ordnance used by the Luftwaffe in terms of weight. Post-air raid assessments often struggled to identify unexploded ordnance (UXO) due to the extensive damage caused by detonated bombs, which sometimes rendered the small entry holes of UXO undetectable, especially in certain ground conditions. This is further complicated as Air Raid Precautions (ARP) documents highlight the risk of misidentifying large UXO damage as resulting from an exploded 50kg bomb. As a result, UXO pose a significant risk to current intrusive works.
LIB	Large Incendiary Bombs	Large Incendiary Bombs (IBs) were less common than the 1kg variants but were used more frequently than Parachute Mines and Anti-Personnel bomblets. In instances where these large IBs penetrated the ground, complete combustion did not always take place. As a result, they could remain a hazard for any intrusive works, maintaining a risk due to their potential unburnt components.
IB	1kg Incendiary Bombs	In terms of the number of weapons dropped, small IBs were the most numerous. Millions of these were dropped throughout WWII. Large IB's were not as common as the 1kg IBs, although they were more frequently deployed than PMs and AP bomblets.

4.2	Type of UXO	Characteristics
PM	Parachute Mine or G Mine	These were deployed less frequently than HE and IBs due to size, cost, and the difficulty of deployment
AP	SD-2 Anti-Personnel Bomblets	Anti-Personnel (AP) bomblets, though not widely used, are generally regarded as posing a low risk to most operations in the UK. The SD2 bomblets, typically packed in containers with 6 to 108 submunitions, had limited ability to penetrate the ground. They would have likely been identified during post-raid surveys, barring instances where they landed in water, dense vegetation, or amidst bomb rubble, where their detection might have been more challenging
V-1	Vergeltungswaffe-1, Flying Bomb, Buzz Bomb, or Doodlebug	The V-1 was a pivotal advancement in military weaponry during WWII. It holds the distinction of being the first guided missile utilized in the conflict, serving as a precursor to modern cruise missiles. This innovative design was propelled by a pulsejet, marking a significant technological breakthrough at the time
V-2	Vergeltungswaffe 2 (Reprisal Weapon 2)	The V-2 was the first ballistic missile in military history. It was predominantly employed by the German Army against Belgian and British targets during the latter stages of World War II. Notably, the V-2 holds the distinction of being the first man-made object to reach space, achieving an altitude of 189 km (117 miles) during test flights in 1944.

German Air-delivered Ordnance Failure Rate

It has been estimated that approximately 10% of the HE bombs dropped during WWII failed to explode as designed. This estimate is probably based on the statistics of wartime recovered UXBs and therefore will not have taken account of the unknown numbers of UXBs that were not recorded at the time and is probably an underestimate.

The reasons for failures include:

- Fuse or gaine malfunction due to manufacturing fault, sabotage (by forced labour) or faulty installation.
- Clockwork mechanism failure in delayed action bombs.
- Failure of the bomber aircraft to arm the bombs (e.g. charge the electrical condensers which supplied the energy to initiate the detonation sequence) due to human error or equipment defect.
- Jettison of the bomb before it was armed or from a very low altitude.

Allied Explosive Ordnance

The potential risk of encountering Allied ordnance on construction sites is particularly high in areas with a history of military activity, including munitions from military exercises, poor disposal practices, or defensive placements against enemy occupation. Such areas may contain remnants like Land Service Ammunition (LSA) and Small Arms Ammunition (SAA).

While there's no evidence of military use at the specific site in question that could lead to contamination with Allied ordnance, urban areas like this one are still at risk from unexploded Anti-Aircraft projectiles from WWII. This is particularly relevant considering the Ministry of Defence's WWII defence tactics against the Luftwaffe, which involved heavy and light anti-aircraft artillery and 'Z' batteries to protect major towns, cities, and strategic locations. The table below offers further details on these defence systems and the associated risks.

4.3	Type of UXO	Characteristics
LSA	Land Service Ammunition	LSA resulting from historic military activity is commonly encountered across the UK by the public and construction industry alike. Such finds are much more common in rural areas than in urban environments and can often be anticipated in areas such as former RAF stations or ranges. However, many such items are encountered entirely by surprise where the landowner or developer has no knowledge of any previous military use of the land.
	Mortars	A mortar is typically a simple, lightweight, man-portable, muzzle-loaded cannon, consisting of a smooth-bore metal tube fixed to a base plate (to spread out the recoil) with a lightweight bipod mount and a sight. Mortars are typically used as indirect fire weapons for close fire support with a variety of ammunition. Mortars launch high explosive or carrier shells in high-arching ballistic trajectories.
	Grenades	A grenade is a small explosive weapon typically thrown by hand (also called hand grenade) but can also refer to a shell (explosive projectile) shot from the muzzle of a rifle (as a rifle grenade) or a grenade launcher.
	Mines	A landmine is an explosive weapon often concealed under or camouflaged on the ground and designed to destroy or disable enemy targets as they pass over or near it. Land mines are divided into two types: anti-tank mines, which are designed to disable tanks or other vehicles; and anti-personnel mines, which are designed to injure or kill people
	Rockets	During World War II, a variety of rockets were mounted on planes, including air-to-air rockets, air-to-surface rockets, and guided bombs
SAA	Small Arms Ammunition	The most common type of ordnance encountered on land used by the military are items of Small Arms Ammunition (SAA). SAA refers to the complete round or cartridge designed to be discharged from varying sized hand-held weapons such as rifles, machine guns and pistols. SAA can include bullets, cartridge cases and primers/caps
	.303	It was the standard British and Commonwealth military cartridge for rifles and machine guns (Bren Gun) from 1889 until it was replaced by the 7.62×51mm NATO in the 1950s.
	7.92mm BESA	The British military's Besa machine gun was chambered for the 7.92×57mm Mauser and was used in armoured vehicles during World War II.
	9x19mm	These rounds were issued for use with Sten guns, the Lanchester sub machine gun and the Browning Hi Power pistol and were produced in huge quantities.
	20mm Hispano	Used in the Hispano 20mm Cannon, which was installed in various fighter planes including the spitfire and the hurricane.
	20mm Oerlikon	A semi-rimmed round that was used in the 20mm Oerlikon gun, which was a key weapon in defending ships and aircraft. During WWII, twin and quadruple Oerlikon mounts were developed, both for army and for navy use

4.4	Type of UXO	Characteristics
AAA	Anti-Aircraft Artillery	At the start of WWII, two types of AAA guns were deployed: Heavy Anti-Aircraft Artillery (HAA), firing large shells (3.7” plus calibre) and Light Anti-Aircraft Artillery (LAA) employing smaller calibre weapons, firing .303”, 20mm and 40mm shells.
LAA	Light Anti-Aircraft	The Light Anti-Aircraft (LAA) artillery, notably the 40mm Bofors and 20mm Oerlikon guns, played a significant role in WWII, primarily targeting fast, low-flying aircraft. These mobile units were strategically repositioned along town perimeters and near key industrial sites, enhancing their operational

4.4	Type of UXO	Characteristics
		flexibility. However, this mobility results in limited historical records regarding their exact locations. The 40mm Bofors gun, widely utilized due to its capacity to fire up to 120 projectiles per minute over a range of 1,800 meters, was a common fixture. The RAF Regiment initially employed the 20mm Oerlikon gun, capable of discharging up to 330 rounds per minute up to 4,000 meters, before gradually integrating the Bofors gun from 1943 onwards, often maintaining a mix of both types until the end of the war. All Allied military airfields were fortified with these LAA batteries, strategically placed in isolated positions to optimize defence during aerial attacks. The primary function of these batteries was to intercept fast, low-flying German fighter bombers. The ammunition used in LAA batteries consisted of small projectiles equipped with contact fuses and either a high-explosive or incendiary charge, designed to detonate upon impact. In instances where these projectiles failed to hit their intended targets, they would fall back to the ground with their charges intact. Despite their reduced risk compared to larger ordnance, the 40mm projectiles, resembling large-calibre small arms ammunition, still pose a considerable safety concern.
HAA	Heavy Anti-Aircraft	Heavy Anti-Aircraft (HAA) batteries, equipped with large guns like the 3.7" Quick Firing (QF), were strategically positioned for engaging high-flying bomber aircraft. These installations, often permanent gun emplacements, were a key component of the UK's aerial defence during WWII. In addition to firing large High Explosive (HE) projectiles, triggered by various fuses including impact, area and time delay mechanisms, local ammunition caches were commonly situated near strategic location like defended roadblocks or pillboxes. The closest HAA Batteries to the Site in question is located approximately 1.4 kilometres to the south-west, yet their effective range was up to 15km. This proximity and operational range underscore the potential risk of encountering Allied ordnance, especially in areas with a historical military presence.
ZAA	Z (Rocket) Batteries:	A Z-Battery comprised a grid formation of 64 rocket projectors which fired 2" and later 3" Unrotated Projectile (UP) rockets to a maximum altitude of 5,800m; a ground range of some 9,000m. They were deployed in cities all around the UK from 1941 and proved to be an effective addition to the existing AA guns. The rockets measured 0.9m (2") and 1.8m (3") in length with four stabilising fins at the base and were fitted with 3.5kg or 8.2kg HE warheads. The larger warhead had an effective airborne blast radius of up to 20m. Some variants deployed a form of aerial mine described as a "small yellow bomb" which was designed to detach from the rocket at height and descend on a parachute with the objective of becoming snagged on target aircraft and then detonating.

Site Geology & Bomb Penetration Depth

Assessing ground conditions is a key factor in determining both the maximum penetration depths of unexploded ordnance (UXO) and the likelihood of hidden munitions.

Should there be any changes in site investigation protocols, construction methods, or focus areas within the project Site, immediate communication with RMS UXO is advised. This action allows for a timely reassessment of existing UXO risks and the adjustment of risk mitigation plans. Certain soil and rock

conditions, such as iron-rich or mineralised soils, can impact the effectiveness of UXO risk reduction methods like magnetometer surveys. Identifying the source of altered soil types is essential for accurately assessing the ground state at the time of potential UXO contamination. This information aids in fine-tuning the calculations for average and maximum bomb penetration depths, thereby enabling more targeted risk reduction strategies in line with ALARP guidelines.

Table 4.5 - GROUND TYPE	DEPTH
Made Ground	0.0 – 1.7m
Clay Mottle	1.7 – 2.3m
Gravel	2.3 – 8.4m
Clay	8.4 – 18.5m

Following a review of the BGS borehole log "TQ27NW423 – METROPOLITAN WB BARNES 68" (located 60m north of the Site), RMS UXO have been able to provide an estimate of the likely maximum bomb penetration depth:

The estimated average bomb penetration depths accounting for ground composition are:

500kg	<8m

The estimated bomb penetration depth for 50kg and 250kg bombs would be expected to be at shallower depths.

The calculation of bomb penetration depths involves several key factors.

These factors include the bomb being dropped from a significant height, leading to an impact speed of 260 m/s from heights above 5,000m. The angle of impact with the ground varies between 10 and 15 degrees from the vertical, and the bomb remains stable during its descent and upon ground penetration. Additionally, no slowing mechanisms are attached to the bomb, and the soil composition is consistent. When released from a high altitude, the bomb generally enters the ground at an angle of 10 to 15 degrees to the vertical. It maintains this angle until its momentum is nearly depleted, at which point it shifts suddenly to a horizontal position before coming to rest. The term 'offset' refers to the gap between the centre of the entry hole and the bomb's final position. Significant sideways movement from the initial entry path is not uncommon. For attacks from lower altitudes, the angle of impact can be 45 degrees or more, often resulting in increased lateral movement during penetration.

The J-curve effect is an important aspect of bomb trajectory, primarily influenced by the bomb's interaction with the ground upon impact. Bombs would typically fall nose-first and result in a varied deceleration between the nose and tail upon contact with the ground with the nose slowing down before the tail. This differential in speeds leads to a notable shift in trajectory and often results in the bomb either achieving a horizontal orientation or, in certain scenarios, curving upward in a J-shaped trajectory.

Determining the average impact velocity of World War II bombs like the 50kg, 250kg, and 500kg high-explosive (HE) bombs is not straightforward due to several factors, including the altitude from which they were dropped, their design/shape, and the mediums they passed through.

5. Risk Analysis

Analysis

For each type of investigative method that might be used, RMS UXO has carried out unique calculations to rate the risks. The risks associated with encountering and activating UXO can vary widely. These variations depend on several factors, including the amount of high-explosive material in the UXO and the intensity with which it is encountered. Ground investigation specific to this research location have been prepared to help analyse these risks, as the likelihood of encountering UXO can differ based on the nature of the intrusive activities being conducted.

Risk Levels and Interpretation

Risk Rating

RMS UXO's Risk Assessment gauges and categorises the dangers presented by the most likely hazardous items during various operations on the site. The Hazard Assessment Score is calculated by evaluating the likelihood of coming across UXO and the potential outcomes of triggering it.

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

Table 5.1.1 - Probability of Encounter (PE)	Rating
Highly likely and frequent.	5
Probable and likely to happen.	4
Occasional, increased chance or probability.	3
Remote, unlikely to happen but could	2
Improbable, highly unlikely	1
Impossible	0

Table 5.1.2 - Probability of Detonation (PD)	Rating
Highly likely and frequent.	5
Probable and likely to happen.	4
Occasional, increased chance or probability.	3
Remote, unlikely to happen but could.	2
Improbable, highly unlikely.	1
Impossible	0

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

Table 5.2 P = PE x PD	Likelihood of Encounter and Detonation	Rating
21 to 25	Frequent, highly likely, almost certain.	5
16 to 20	Probable, more likely to happen than not.	4
10 to 15	Occasional, increased chance or probability.	3
6 to 9	Remote, unlikely to happen but could.	2
1 to 5	Improbable, highly unlikely.	1
0	Impossible	0

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

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

Table 5.3 - Severity (S)	Rating
Multiple fatalities	5
Major injury, long term health issues, single fatality	4
Minor injury, short term health issues, no fatalities.	3
First aid case but no lost time or ill health.	2
Minor injuries, no first aid.	1
No injuries.	0

This risk matrix is underpinned by historical data, site-specific conditions, and expert analysis. The likelihood and severity ratings assigned are not just theoretical estimates but are grounded in a detailed understanding of the Site's past and present characteristics. These factors combine to form a risk profile that guides our UXO mitigation strategy and ensures all necessary precautions are tailored to the Site's unique context.

The final risk assessment for the Site is given in Table 10.

Table 5.4	Severity (s)					
Likelihood (p)		1	2	3	4	5
	5	5	10	15	20	25
	4	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10
	1	1	2	3	4	5

Table 5.5 - Risk Assessment Table					
Type of work	Potential Hazard	Probability (PE x PD = P)	Likelihood	Severity	Risk Rating
Future developments	HE	10	2	5	Medium
Future developments	HE	5	1	5	Low
Future developments	IBs	4	1	4	Low
*PE (Probability of Encounter), PD (Probability of Detonation), P (Overall Probability)					

6. Risk Mitigation & Recommendations

Recommended Risk Mitigation Measures

The recommendation table below is provided as an overview of the methods required to adequately mitigate the risk of UXO and is in accordance with the CIRIA 681 Guidelines. All of the methods listed are acceptable methods of mitigating explosive risk but do have limitations and should be employed only if viable, interpretable data can be collected.

This is particularly true of intrusive surveys, carried out on sites which are not suitable for this type of method, be it as a result of the underlying strata not allowing sufficient depth penetration or the magnetic environment being too high for the sensors to adequately detect a bomb at the distances from the probe as specified. There is also a reluctance by UXO contractors to raise these constraints once identified on site as it is in their interest to have their survey rigs fully employed.

As this is a direct conflict of interest, RMS UXO has made the decision to not own survey rigs and offer this service, when appropriate, in partnership with UK market leading geotechnical providers – combining our UXO knowledge and our partners ground engineering expertise.

	Table 6.1 - MITIGATION METHOD – Medium Risk Areas	YES	NO	TBC*
1	**Project Specific Risk Mitigation Strategy** A project specific overarching strategy to manage UXO project risk on more complex sites. Developed in line with the client's construction plan and methods of construction to be used.	✓		
2	**Safety Awareness Briefings** Explosive Ordnance Safety and Awareness Training is provided to site personnel to make them aware of the potential threat from UXO on the work site, what UXO might look like and what to do if suspected UXO is encountered.	✓		
3	**Site Specific Safety Instructions – Emergency Response Plan** Provides site management teams the training, information and guidance to respond to a UXO related incident. Delivered by experienced EOD qualified personnel and often employed alongside an on-call offsite EOD responder.	✓		
4	**On-call EOD Engineer – Off-site Responder** A retained service whereby a qualified EOD engineer will respond to a suspicious find on-site.		✓	
5	**Onsite EOD Engineer – Support to Site Investigation** Providing Realtime on-site EOD support to site investigation activities. Delivering safety briefings & employing handheld survey instruments ahead of trial pit excavations, drilling activities etc.	✓		
6	**Onsite EOD Engineer- Watching Brief** Providing a reactive on-site support where pro-active UXO risk mitigation measures, are not practical. Supervising all open/bulk excavations, responding to suspicious finds & managing UXO related incidents.	✓		
7	**Non-Intrusive Survey** The collection of survey data which is then processed & interpreted offsite. The purpose of the survey is to locate sub-surface anomalies/targets which may be UXO related. Usually employed on greenfield sites or sites which have not previously been developed.	✓		

	Table 6.1 - MITIGATION METHOD – Medium Risk Areas	YES	NO	TBC*
8	**Intrusive Survey** For sites where a non-intrusive UXO survey cannot reach the maximum depth of UXO risk, or the site is not suitable for a non-intrusive survey such as a brownfield site the intrusive UXO survey provides a suitable alternative. Designed to survey point specific locations where deep engineering works are being undertaken such a piling, pile clusters and sheet piled walls.	✓		
9	**Search & Clearance** For areas where a non-intrusive survey is not viable or cost effective two-man UXO Specialist teams can be deployed to conduct a manual Search & Clear operation of the site location with handheld UXO detection equipment.		✓	
10	**Data Management** Data processing, Interpretation or QA (of third-party survey data) The processing and interpretation of third-party survey data for the purpose of UXO clearance.	✓		
11	**Target Investigation** The investigation of anomalies/targets identified by previously undertaken surveys. Conducted by a two-man EOD team using handheld locators/detectors.			✓
12	**UXO Removal & Disposal** The removal from site of safe to move or inert items of UXO for disposal off-site.			✓

Note: The assessed level of risk does not apply within the existing structures and no further action is required for works within the existing structures. This risk applies only to below existing ground levels or beyond the basement level to maximum bomb penetration depth. The risk will also have been partially mitigated to the depths of repair of the damaged structures and post war development.

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RMS UXO has consulted its internal databases, as well as reference books and archived information, to gather relevant data. Additionally, historic mapping and aerial photography were sourced from the National Archives and other relevant government offices. Information has also been obtained from local county councils and record offices.

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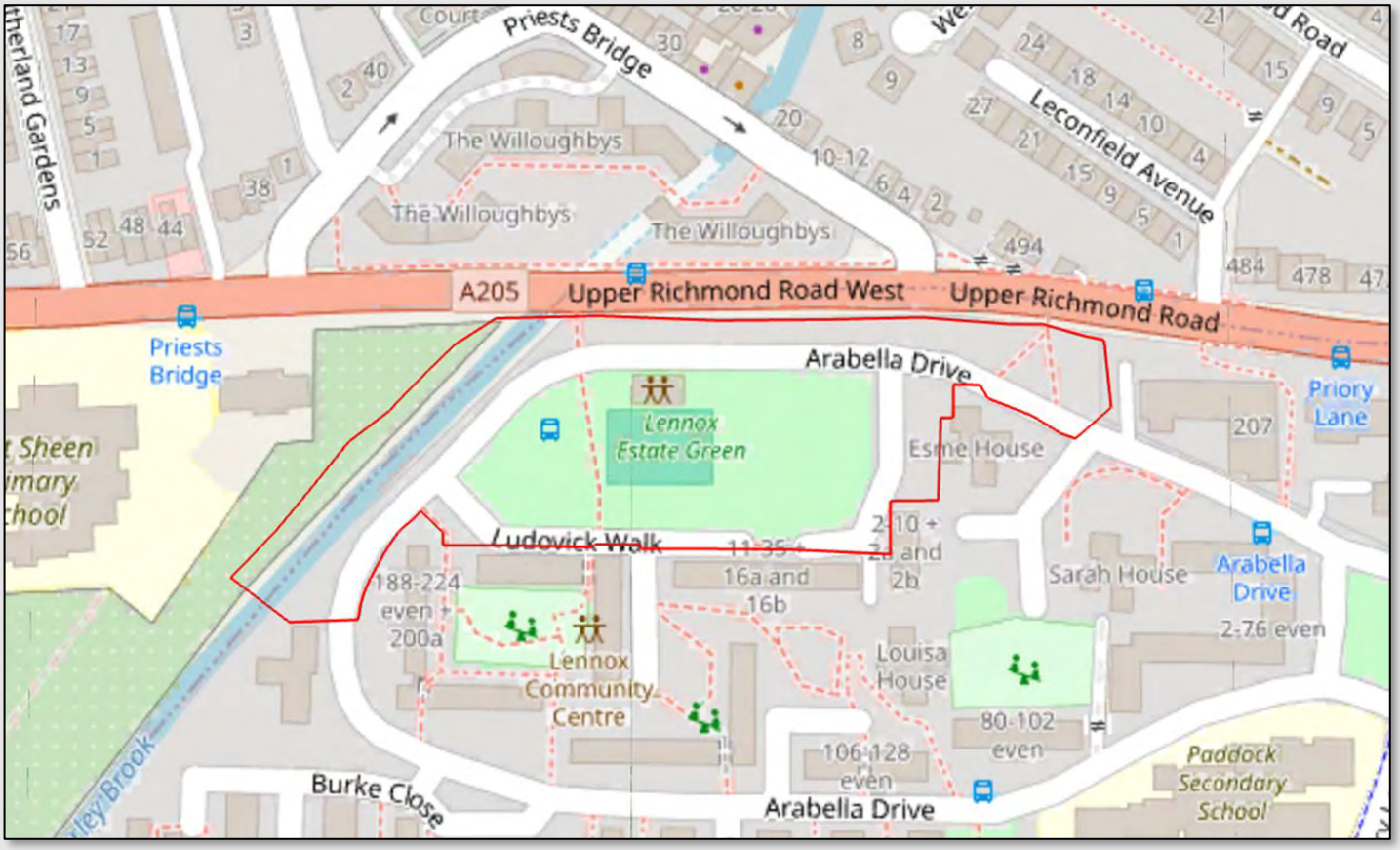
This report has been constructed with professional thought and care by RMS UXO. Historical data has been meticulously collected and reviewed from third party sources. The validity of this information has been checked to the best of our ability, but RMS UXO holds no accountability for errors resulting from missing or incomplete information. Moreover, despite best efforts to compile a comprehensive historical dataset RMS UXO disclaims responsibility for any subsequent modifications to risk evaluations or mitigation proposals that may be necessitated by the discovery of additional information post factum.

SITE LOCATION

A-1



Approx. Site Boundary:

RMS UXO Produced by and Copyright to RMS UXO Limited	**CLIENT:** A2 Site Investigations Limited	**PROJECT:** Lennox Estate, London	**DATE:** 17/02/2025
	SOURCE: Google Earth, OpenStreetMap	**REPORT REFERENCE:** INO5563	N

SITE LOCATION

A-2

Approx. Site Boundary:

RMS UXO

CLIENT:	PROJECT:	DATE:
A2 Site Investigations Limited	Lennox Estate, London	17/02/2025
SOURCE:	REPORT REFERENCE:	
OpenStreetMap	INO5563	

N

Wandsworth – August 1940

Wandsworth – August 1944

Approx. Site Boundary:

RMS UXO

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Wandsworth – March 1946

Wandsworth – May 1947

Approx. Site Boundary:

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Wandsworth – May 1962

Approx. Site Boundary:

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Historic England	INO5563	

BOMB STRIKES

A-6

Approx. Recorded Bomb Strike Locations:

Approx. Site Boundary:

RMS UXO

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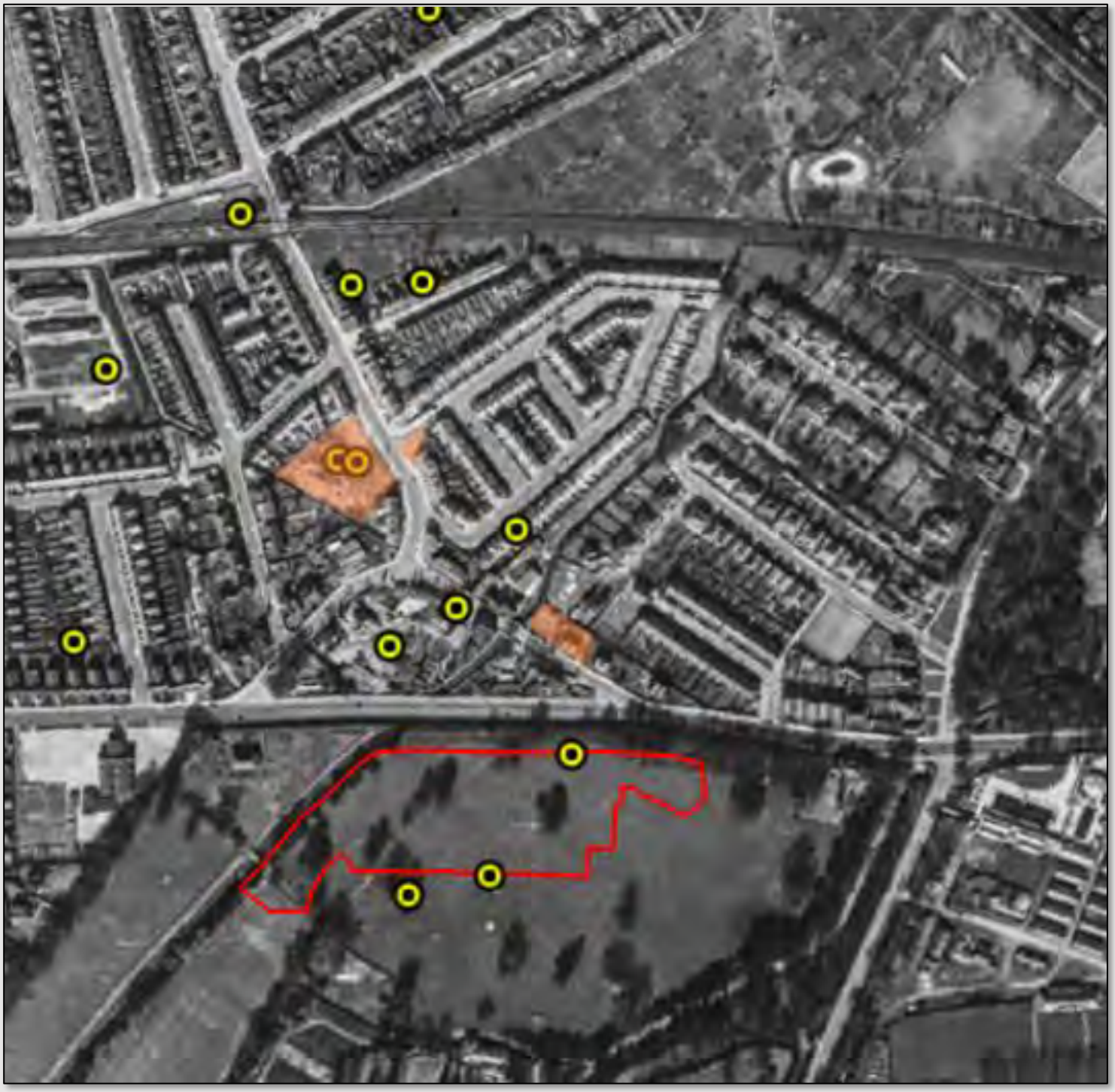
SOURCE:	REPORT REFERENCE:	
RMS UXO Limited	INO5563	

N

Bomb Plots and Damaged Structures Overlain on 1946 Imagery

A-7



Approx. Recorded Bomb Strike Locations:

Damaged structures:

Approx. Site Boundary:

RMS UXO

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SOURCE:	REPORT REFERENCE:	N
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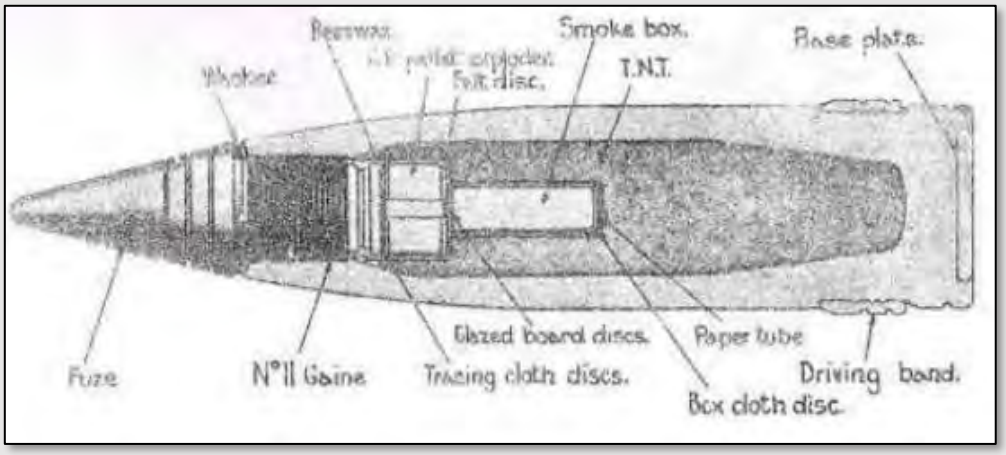
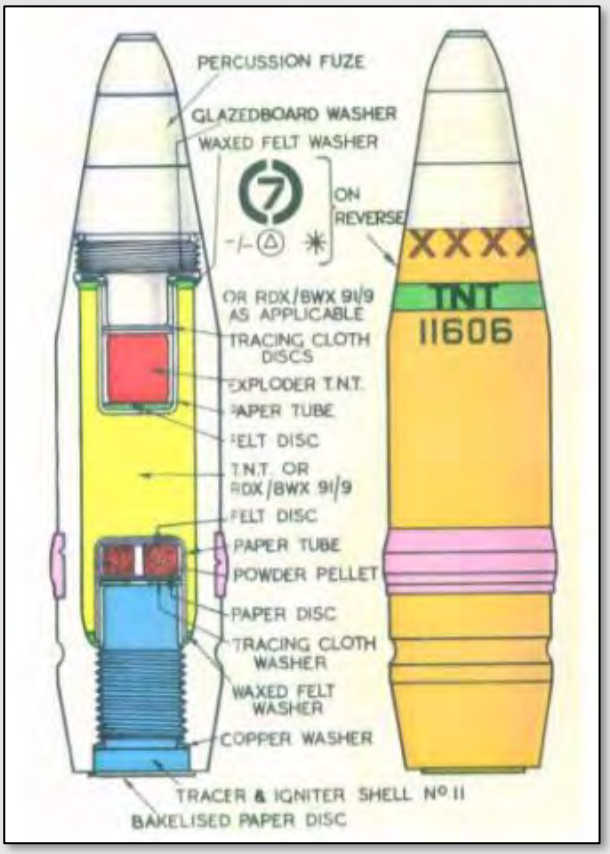
3.7 Inch QF Anti-Aircraft Projectile



Total Weight	Projectile Weight 28lb (12.6 kg) Explosive Weight 2.52lbs
Dimensions	3.7in x 14.7in (94mm x 360mm) Rate of Fire 10 to 20 rounds per minute
Fuse Type	Mechanical Time Fuze
Use	The 3.7in AA Mks 1-3 were the standard Heavy Anti-Aircraft guns of the British Army. Ceiling 30,000ft to 59,000ft

40mm Bofors Projectile



Total Weight	Projectile Weight 1.96lb (0.86kg) Explosive Weight 300g (0.6lb)
Dimensions	Dimensions 40 x 180mm
Fuse Type	Impact Fuze
Ceiling	23,000ft (7000m)
Remarks	Light quick fire high explosive antiaircraft projectile. Each projectile fitted with small tracer element. If no target hit, shell would explode when tracer burnt out. Designed to engage aircraft flying below 2,000ft

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3in Unrotated Projectile (UP) Anti-Aircraft Rocket (“Z” Battery)

This antiaircraft artillery, designed specifically for the Royal Navy, saw significant deployment in the initial stages of the Second World War. Known as the UP, it was not only utilised at sea but also found applications on land through single and 128-round launchers, commonly referred to as Z Batteries. The ammunition for this system features a cylindrical steel casing that tapers towards the bottom, equipped with external threading for secure attachment to the rocket motor's shell ring

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SC 50

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)

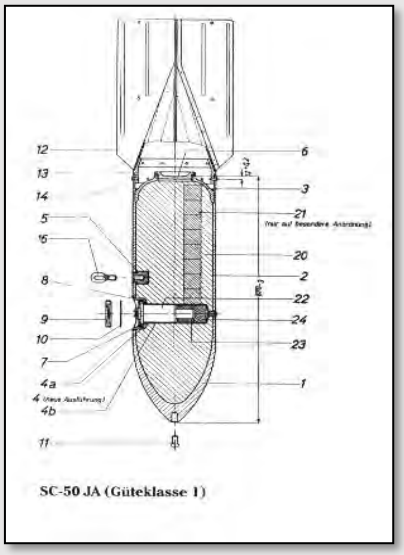
Body Diameter: 200mm (7.87in)

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.

50kg bomb, London Docklands

Minus tail section



SC 250

Bomb weight: 245-256kg (540-564lb)

Explosive weight: 125-130kg (276-287lb)

Fuze type: Electrical impact/mechanical time delay fuze.

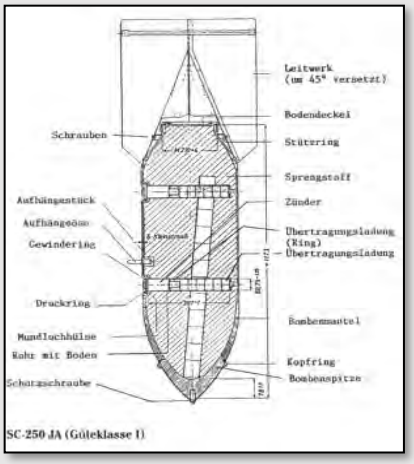
Post-1943 – Type 50 (Y) electric anti-disturbance fuze

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.

250kg bomb, Hawkinge



SC 500

Bomb weight: 480-520kg (1,058-1,146lb)

Explosive weight: 250-260kg (551-573lb)

Fuze type: Electrical impact/mechanical time delay fuze.

Post-1943 – Type 50 (Y) electric anti-disturbance fuze

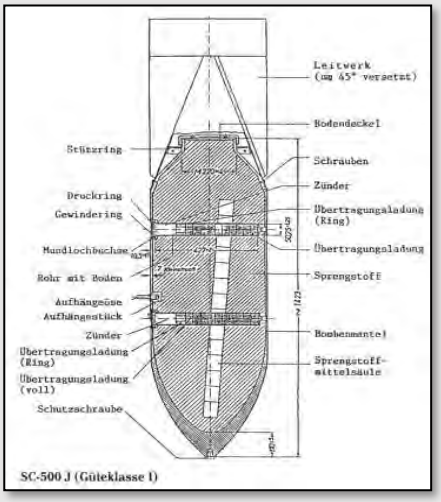
Bomb dimensions: 1957 x 640mm (77 x 25.2in)

Body Diameter: 470mm (18.5in)

Use: Against fixed airfield installations, hangars, assembly halls, flyovers, underpasses, high-rise buildings and below-ground installations.

50kg bomb included for size comparison (see above)

500kg bomb, Felixstowe beach, April 2008



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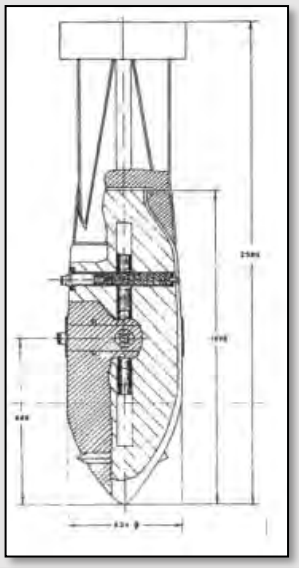
SC 1000

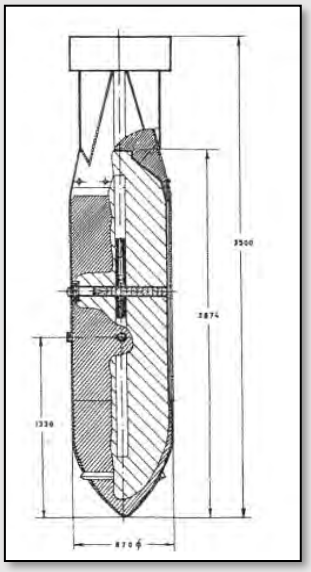
Bomb weight: 993-1,027kg (2189-2,264lb)
Explosive weight: 530-590kg (1,168-1,300lb)
Fuze type: Electrical impact fuze.
Bomb dimensions: 2,580 x 654mm (101.6 x 2.5in)
Body diameter: 654mm (25.75in)
Use: Against unarmoured sea and land targets
Remarks: Known as the 'Hermann'



SC 1800

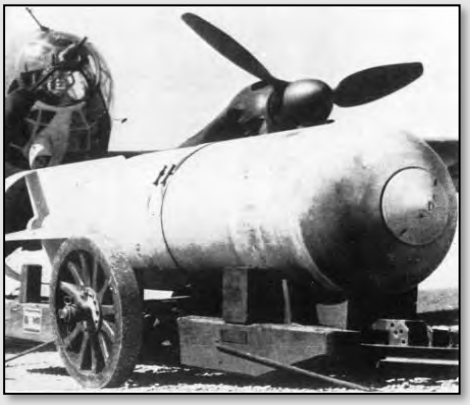
Bomb weight: 1,767-1,879kg (3,896-4,142lb)
Explosive weight: 1,000kg (2,205lb)
Fuze Type: Electrical impact fuze
Bomb Dimensions: 3500 x 670mm (137 x 26in)
Use: Against building complexes and large merchant vessels
Remarks: Known as the 'Satan'

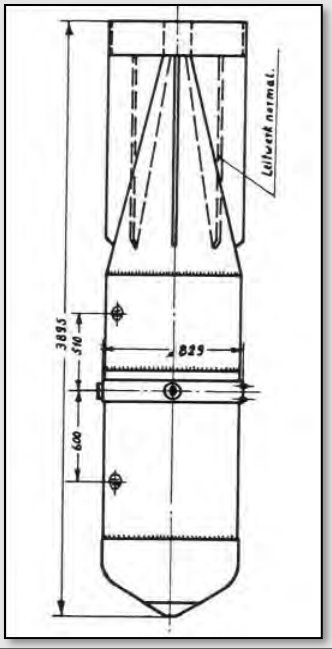
1800kg bomb, Bristol, 1941



SC 2500

Bomb Weight: Bomb weights have been quoted as 1,950kg (4,300lb) and 2,500kg (5,512lb)
Explosive Weight: 1,700kg (3,748lb)
Fuze Type: Electrical impact fuze
Bomb Dimensions: 3,895 x 829mm (153.3 x 32.6in)
Body Diameter: 829mm (32.6in)
Use: Against building complexes and merchant vessels.
Remarks: The SC 2500 has an aluminium body with a welded head and tailpiece. Known as the 'Max'. Only a limited number were deployed.





1kg Incendiary Bomb

Bomb weight: 1.0 and 1.3kg (2.2 and 2.87lb)

Filling: 680gm (1.3lb) Thermite

Fuze type: Impact fuze

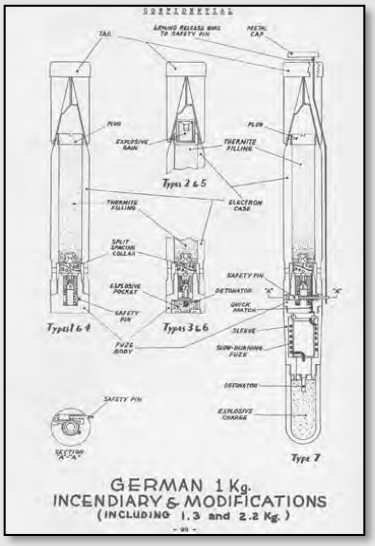
Bomb dimensions: 350 x 50mm (13.8 x 1.97in)

Body diameter: 50mm (1.97in)

Use: As incendiary – dropped in clusters against towns and industrial complexes

Remarks: Jettisoned from air-dropped containers. Magnesium alloy case. Sometimes fitted with high explosive charge

1. Scaffold pipe
2. Incendiary 1kg bomb
3. Incendiary bomb recently found on site in UK



C-50 A Phosphorous Bomb

Bomb weight: 41kg (90.4lb)

Explosive weight: 0.03kg (0.066lb)

Incendiary filling: 12kg (25.5lb) liquid filling with phosphor igniters in glass phials

Fuze type: Electrical impact fuze

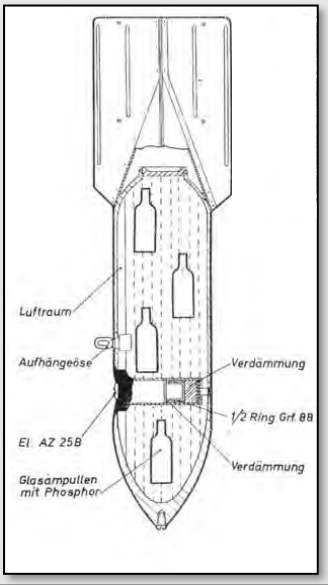
Bomb dimensions: 1,100 x 2800mm (43.3 x 11in)

Body diameter: 200mm (2.87in)

Use: Against all targets where an incendiary effect is to be expected

Remarks: Early fill was a phosphorous/carbon disulphide incendiary mixture

Phosphorous Bomb, M25/A2, Kent



Flam C-250 'Oil Bomb'

Bomb weight: 125kg (276lb)

Explosive weight: 1kg (2.2lb)

Flammable weight: 74kg (163lb)

Filling: Mixture of 30% petrol and 70% crude oil

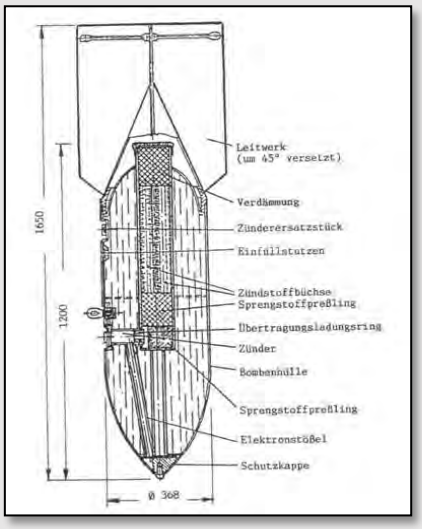
Fuze type: Super-fast electrical impact fuze

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

Remarks: Thin casing – not designed for ground penetration



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A2 Site Investigation

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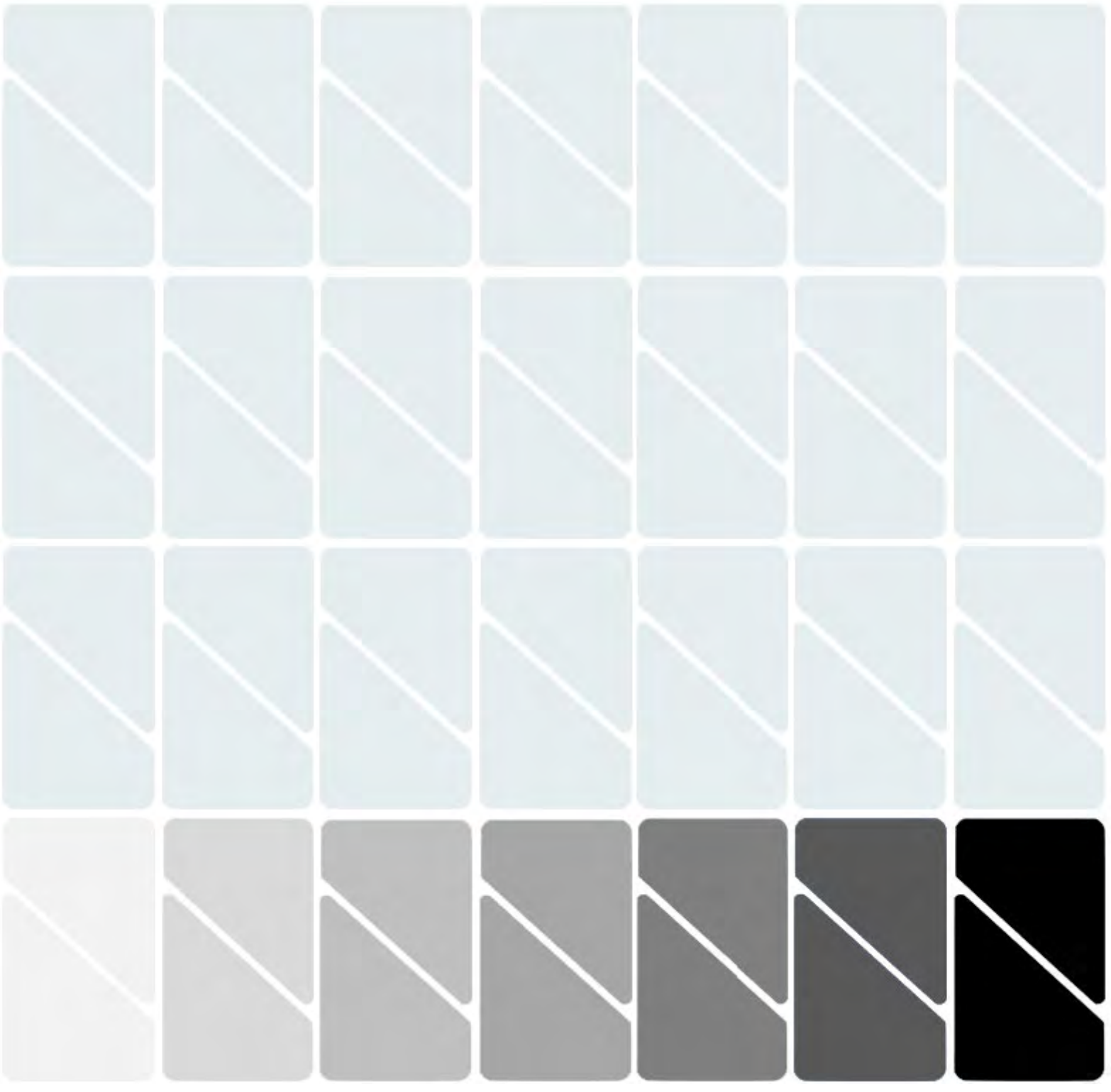

Appendix B: Geo-environmental Risk Assessment Matrix

A2SI qualitative risk assessment for geo-environmental purposes is undertaken in accordance with *CIRIA C552: Contaminated Land Risk Assessment, A Guide to Good Practice (Rudland et al., 2001)*. The CIRIA C552 risk categories and the assessment methodology are summarised below in Table B.1, Table B.2 and Table B.3. Potential magnitude and potential likelihood are both classified to enable a risk rating to be assessed. Potential magnitude takes into account the potential consequences should a complete source–pathway–receptor linkage be present. Potential magnitude is classified as per Table B.1.

Table B.1 Definition of potential magnitude of consequence

Category	Definition
Severe	Acute risks to human health, catastrophic damage to buildings / property, major pollution to controlled waters.
Medium	Chronic risk to human health, pollution of sensitive controlled waters, significant effects on sensitive ecosystems or species, significant damage to buildings or structures.
Mild	Pollution of non-sensitive waters, minor damage to buildings or structures.
Minor	Damage to non-sensitive ecosystems or species.

Potential likelihood takes into account the presence of the hazard and receptor as well as the integrity of the pathway for exposure, i.e., whether a source-pathway-receptor linkage is present or not. Potential likelihood is classified as per Table B.2.

Table B.2 Definition of potential likelihood of exposure

Category	Definition
High Likelihood	Pollutant linkage may be present and is almost certain to occur in the long-term. Or there is evidence of harm to the receptor.
Likely	Pollutant linkage may be present, and it is probable that it will occur over the long-term.
Low Likelihood	Pollutant linkage may be present, and there is a possibility that it will occur, although there is no certainty that it will do so.
Unlikely	Pollutant linkage may be present, but it is improbable that it will occur.

The potential magnitude of consequence and the potential likelihood of exposure are assessed in accordance with the risk matrix presented in Table B.3.

Table B.3 Geo-environmental risk assessment matrix

		Potential Magnitude of Consequence			
		Severe	Medium	Mild	Minor
Potential Likelihood of Exposure	High Likelihood	Very High	High	Moderate	Low to Moderate
	Likely	High	Moderate	Low to Moderate	Low
	Low Likelihood	Moderate	Low to Moderate	Low	Very Low
	Unlikely	Low to Moderate	Low	Very Low	Very Low

Appendix C: GQRA Screening Tables

A2 Site Investigation

Land Use Category:	Residential Without Home Grown Produce
SOM:	1.0%
Averaging area	n/a
Chemical group	All analysed
Chemical subgroup	All analysed
Sample depth (mbgl) range	0.2 to 0.6
SOM (%) in range, min to max (avg)	2.4 to 3.4 (2.8)
pH in range, min to max (avg)	7.4 to 8.3 (7.9)

Screen

Contaminant	GAC Source	GAC (mg/kg)	Min recorded (mg/kg)	Max recorded (mg/kg)	No. Samples analysed	No. Samples <LOD	No. Samples exceeding GAC
Antimony	C4SL	550	0.017	0.017	1	1	0
Arsenic	C4SL	40	0.01	15	6	1	0
Barium	C4SL	1300	0.12	110	6	0	0
Beryllium	S4UL	1.7	0.64	0.85	5	0	0
Boron	S4UL	11000	0.3	0.7	5	0	0
Cadmium	C4SL	150	0.001	0.5	6	3	0
Chromium (III)	S4UL	910	17	30	5	0	0
Chromium (VI)	C4SL	21	1.8	1.8	5	5	0
Copper	S4UL	7100	0.12	48	6	0	0
Lead	C4SL	310	0.076	190	6	0	0
Inorganic Mercury	C4SL	300	0.005	0.4	6	3	0
Molybdenum	C4SL	670	0.0111	1.2	6	0	0
Nickel	S4UL	180	0.014	19	6	0	0
Selenium	S4UL	430	0.04	1	6	6	0
Vanadium	S4UL	1200	39	44	5	0	0
Zinc	S4UL	40000	0.13	160	6	0	0
Acenaphthene	S4UL	3000	0.05	0.07	6	5	0
Acenaphthylene	S4UL	2900	0.05	0.13	6	5	0
Anthracene	S4UL	31000	0.05	0.32	6	4	0
Benzo(a)anthracene	S4UL	11	0.17	2.8	6	0	0
Benzo(a)pyrene	C4SL	5.3	0.26	4.5	6	0	0
Benzo(b)fluoranthene	S4UL	3.9	0.42	4.8	6	0	1
Benzo(g,h,i)perylene	S4UL	360	0.13	2.2	6	0	0
Benzo(k)fluoranthene	S4UL	110	0.1	2.2	6	0	0
Chrysene	S4UL	30	0.22	3	6	0	0
Dibenz(a,h)anthracene	S4UL	0.31	0.05	0.48	6	3	1
Fluoranthene	S4UL	1500	0.33	3.7	6	0	0
Fluorene	S4UL	2800	0.05	0.07	6	5	0
Indeno(1,2,3-cd)pyrene	S4UL	45	0.11	2.1	6	0	0
Naphthalene	C4SL	15	0.05	0.09	6	5	0
Phenanthrene	S4UL	1300	0.19	0.95	6	0	0
Pyrene	S4UL	3700	0.31	3.9	6	0	0
TPH Aliphatics >C5-6	S4UL	42	0.01	0.01	5	5	0
TPH Aliphatics >C6-8	S4UL	100	0.01	0.01	5	5	0
TPH Aliphatics >C8-10	S4UL	27	0.01	0.01	5	5	0
TPH Aliphatics >C10-12	S4UL	130	1	1	5	5	0
TPH Aliphatics >C12-16	S4UL	1100	2	2	5	5	0
TPH Aliphatics >C16-35	S4UL	65000	16	16	5	5	0
TPH Aliphatics >C35-40	S4UL	65000	10	10	5	5	0
TPH Aromatics >C5-7	S4UL	370	0.01	0.01	5	5	0
TPH Aromatics >C7-8	S4UL	860	0.01	0.01	5	5	0
TPH Aromatics >C8-10	S4UL	47	0.02	0.02	5	5	0
TPH Aromatics >C10-12	S4UL	250	1	1	5	5	0
TPH Aromatics >C12-16	S4UL	1800	2	2	5	5	0
TPH Aromatics >C16-21	S4UL	1900	10	13	5	4	0
TPH Aromatics >C21-35	S4UL	1900	10	30	5	4	0
Benzene	C4SL	0.89	0.005	0.005	6	6	0
Toluene	S4UL	880	0.005	0.005	6	6	0
Ethylbenzene	S4UL	83	0.005	0.005	6	6	0
O-Xylene	S4UL	88	0.005	0.005	6	6	0
Methyl tert-butyl ether (MTBE)	C4SL	73	0.005	0.005	5	5	0

A2 Site Investigation

Averaging area	n/a
Chemical group	All analysed
Chemical subgroup	All analysed
Asssessment criteria	Environmental Quality - Fresh Water
pH	7.1 to 8.3 (7.8)
Hardness	No data, hardness dependant GAC based on 200mg/l

Screen

Contaminant	GAC Source	GAC (ug/l)	Min recorded (ug/l)	Max recorded (ug/l)	No. Samples analysed	No. Samples <LOD	No. Samples exceeding GAC
Arsenic	UK EQS	50	0.5	0.83	2	0	0
Boron	EA operational target	2000	69	200	2	0	0
Cadmium	EU EQS (Class 1)	0.08	0.02	0.04	2	1	0
Chromium (III)	UK EQS	4.7	5	5	2	2	0
Chromium (VI)	UK EQS	3.4	5	5	2	2	0
Copper	UK EQS (bioavailable)	1	1.5	2.5	2	0	2
Phenol	UK EQS	7.7	0.05	0.05	2	2	0
Nickel	EU EQS	4	2.4	5.5	2	0	1
Vanadium	EA operational target (bioavailable)	20	0.3	0.4	2	0	0
Zinc	UK EQS	10.9	1.6	2.7	2	0	0
Anthracene	EU EQS	0.1	0.01	0.01	2	2	0
Benzo(a)pyrene	EU EQS (Max. is 0.27)	0.0002	0.01	0.01	2	2	0
Benzo(b)fluoranthene	EU EQS (or 0.017 - Max. not AA)	0.0002	0.01	0.01	2	2	0
Benzo(g,h,i)perylene	EU EQS (or 0.00082 - Max. not AA)	0.0002	0.01	0.01	2	2	0
Benzo(k)fluoranthene	EU EQS (or 0.017 - Max. not AA)	0.0002	0.01	0.01	2	2	0
Fluoranthene	EU EQS	0.0063	0.01	0.01	2	2	0
Indeno(1,2,3-cd)pyrene	EU EQS (Max. not AA)	0.0002	0.01	0.01	2	2	0
Naphthalene	EU EQS	2	0.01	3	4	4	0
TPH Aliphatics >C5-6	Ethylbenzene EQS used as surrogate	20	1	1	2	2	0
TPH Aliphatics >C6-8	Ethylbenzene EQS used as surrogate	20	1	1	2	2	0
TPH Aliphatics >C8-10	Ethylbenzene EQS used as surrogate	20	1	1	2	2	0
TPH Aliphatics >C10-12	Ethylbenzene EQS used as surrogate	20	10	10	2	2	0
TPH Aliphatics >C12-16	Ethylbenzene EQS used as surrogate	20	10	10	2	2	0
TPH Aromatics >C5-7	Benzene EU EQS used as surrogate	10	1	1	2	2	0
TPH Aromatics >C7-8	Toluene EU EQS used as surrogate	74	1	1	2	2	0
TPH Aromatics >C8-10	Ethylbenzene EQS used as surrogate	20	1	1	2	2	0
TPH Aromatics >C10-12	Naphthalene EU EQS used as surrogate	2	10	10	2	2	0
TPH Aromatics >C12-16	Naphthalene EU EQS used as surrogate	2	10	10	2	2	0
TPH Aromatics >C16-21	Anthracene EU EQS used as surrogate	0.1	10	10	2	2	0
TPH Aromatics >C21-35	Benzo(a)pyrene EU EQS used as surrogate	0.0002	10	10	2	2	0
Benzene	EU EQS	10	1	1	2	2	0
Toluene	UK EQS	74	1	1	2	2	0
Ethylbenzene	Proposed EQS (Dangerous Substances Directive)	20	1	1	2	2	0
Styrene	EA operational target	50	3	3	2	2	0
1,2-Dichloroethane	EU EQS	10	3	3	2	2	0
1,1,1-Trichloroethane	EA operational target	100	3	3	2	2	0
1,1,2-Trichloroethane	EA operational target	400	3	3	2	2	0
Tetrachloromethane (Carbon Tetra Chloride)	EU EQS	12	3	3	2	2	0
Chloroform	EU EQS	2.5	3	3	2	2	0
Hexachlorobutadiene (HCBD)	EU EQS (Max. not AA)**	0.6	0.05	3	4	4	0
Diethylphthalate	EA operational target	200	0.05	0.05	2	2	0
Butylbenzylphthalate	UK EQS	7.5	0.05	0.05	2	2	0
Di-N-Butyl Phthalate	EA operational target	8	0.05	0.05	2	2	0
1,4-Dichlorobenzene	EA operational target	20	0.05	3	4	4	0
1,2,4-Trichlorobenzene	EU EQS	0.4	0.05	3	4	4	0
Hexachlorobenzene (HCB)	EU EQS (Max. not AA)**	0.05	0.05	0.05	2	2	0
2-Chlorophenol	EA operational target	50	0.05	0.05	2	2	0
2,4-Dichlorophenol	UK EQS	4.2	0.05	0.05	2	2	0
4-Chloro-3-Methylphenol	EA operational target	40	0.05	0.05	2	2	0
Dimethylphthalate	EA operational target	800	0.05	0.05	2	2	0
Lead	EU EQS	1.2	0.2	0.2	2	2	0

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