

Contents

Executive Summary.....	II
Glossary.....	IV
Contents.....	V
Annexes.....	VII
1. Introduction	1
1.1. Background.....	1
2. Method Statement	2
2.1. Report Objectives.....	2
2.2. Risk Assessment Process.....	2
2.3. Sources of Information.....	2
3. Background to Bombing Records	3
3.1. General Considerations of Historical Research.....	3
3.2. German Bombing Records.....	3
3.3. Allied Records.....	3
4. UK Regulatory Environment and Guidelines	4
4.1. General.....	4
4.2. CDM Regulations 2015.....	4
4.3. The 1974 Health and Safety at Work etc. Act.....	5
4.4. CIRIA C681.....	5
4.5. Additional Legislation.....	5
5. The Role of Commercial UXO Contractors and The Authorities	6
5.1. Commercial UXO Specialists.....	6
5.2. The Authorities.....	6
6. The Site	7
6.1. Site Location.....	7
6.2. Site Description.....	7
7. Scope of the Proposed Works	7
7.1. General.....	7
8. Ground Conditions	7
8.1. General Geology.....	7
8.2. Site Specific Geology.....	7
9. Site History	8
9.1. Introduction.....	8
9.2. Ordnance Survey Historical Maps.....	8
9.3. Historical Photography of the Site.....	9
Speakers' Corner and environs, Hyde Park, 1928	9
10. Introduction to German Aerial Delivered Ordnance	10
10.1. General.....	10
10.2. Generic Types of WWII German Aerial Delivered Ordnance.....	10
10.3. Failure Rate of German Aerial Delivered Ordnance.....	11
10.4. UXB Ground Penetration.....	11
10.4.1. The J-Curve Effect.....	11

10.4.2. WWII UXB Ground Penetration Studies.....	11
10.4.3. Site Specific Bomb Penetration Considerations.....	12
10.5. V-Weapons.....	12
11. The Likelihood of Contamination from German Aerial Delivered UXBs	13
11.1. World War I.....	13
11.2. World War II Bombing of Metropolitan Borough of Paddington.....	13
11.3. WWII Home Office Bombing Statistics.....	14
11.4. London Civil Defence Region Bomb Census Maps.....	15
11.5. London V-1 Pilotless Aircraft Bomb Census Reports.....	16
11.6. Paddington Bomb Census Reports – 6 May 1941 – 30 May 1942.....	16
11.7. Catholic Herald: Story of the Tyburn Nuns.....	17
11.8. London County Council Bomb Damage Map.....	17
11.9. WWII-Era Photography.....	18
11.10. Abandoned Bombs.....	19
11.11. Bomb Disposal Tasks.....	19
11.12. Evaluation of German Aerial Delivered UXO Records.....	20
12. Introduction to Allied Explosive Ordnance	22
12.1. General.....	22
12.2. Defending the UK From Aerial Attack.....	22
12.2.1. Anti-Aircraft Artillery (AAA).....	23
13. The Likelihood of Contamination from Allied Ordnance	24
13.1. Evaluation of Contamination Risk from Allied UXO.....	24
14. The Likelihood of UXO Contamination Summary	26
15. The Likelihood that UXO Remains	28
15.1. Introduction.....	28
15.2. UXO Clearance.....	28
15.3. Post-War Redevelopment.....	28
16. The Likelihood of UXO Encounter	29
16.1. Introduction.....	29
17. The Likelihood of UXO Initiation	30
17.1. Introduction.....	30
17.2. Initiating Aerial Delivered Ordnance.....	30
18. Consequences of Initiation/Encounter	31
18.1. Introduction.....	31
18.2. Consequences of Detonation.....	31
19. 1st Line Defence Risk Assessment	32
19.1. Risk Assessment Stages.....	32
19.2. Assessed Risk Level.....	32
20. Proposed Risk Mitigation Methodology	33
20.1. General.....	33
Bibliography	34

Annexes

List of Report Annexes

Annex A	Site Location Mapping
Annex B	Recent Aerial Photography
Annex C	Client Provided Site Plan
Annex D	Pre and Post-WWII Historical Mapping
Annex E	1928 Oblique Photography
Annex F	Examples of German Aerial Delivered Ordnance
Annex G	The 'J-Curve' Effect Principle
Annex H	Examples of UXO Incidents
Annex I	London WWI Bomb Plot Mapping
Annex J	WWI London Raid Mapping
Annex K	London WWII Bomb Density Mapping
Annex L	Luftwaffe Reconnaissance Photography
Annex M	Consolidated London Bomb Census Mapping
Annex N	Weekly London Bomb Census Mapping
Annex O	London V-1 Flying Bomb Mapping
Annex P	London V-1 Pilotless Aircraft Bomb Census Reports
Annex Q	London Bomb Census Reports – 6 May 1941 – 30 May 1942
Annex R	London County Council Bomb Damage Mapping
Annex S	Post-War Photography
Annex T	Examples of Anti-Aircraft Projectiles

1st Line Defence Limited Detailed Unexploded Ordnance (UXO) Risk Assessment

Site: 2 Hyde Park Place, London
Client: GEA Ltd

1. Introduction

1.1. Background

1st Line Defence has been commissioned by GEA Ltd to conduct a Detailed Unexploded Ordnance (UXO) Risk Assessment for the works proposed at the 2 Hyde Park Place, London site.

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:

- Munitions resulting from wartime activities including German bombing in WWI and WWII, long range shelling, and defensive activities.
- Munitions deposited as a result of military training and exercises.
- 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 2 Hyde Park Place, London. 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 the City of Westminster Archives.
- Historical mapping datasets.
- Historic England National Monuments Record.
- Relevant information supplied by GEA Ltd.
- 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 the City of Westminster Archives.

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.'²

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.

² <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 C/RIA 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 situated in St. George's Fields, Westminster.

Recent aerial imagery dated 2019 shows the site is bordered to the north by structures built along Stanhope Place and bound to the east by an end-of-terrace property built at the junction of Hyde Park Place and Stanhope Place. The Hyde Park Place roadway represents the southern perimeter and another multi-storey terraced property forms the western boundary.

The site is approximately centred on the OS grid reference: **TQ.2756380957**.

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

6.2. Site Description

Recent aerial imagery dated 2019 shows the site is occupied by a Georgian style, multi-storey terraced structure and associated rear garden.

A recent aerial photograph and site plan are presented in **Annex B** and **Annex C1** respectively.

An existing floor plan of the site, demonstrating the areas to be demolished is presented in **Annex C2**.

7. Scope of the Proposed Works

7.1. General

Information provided by the client indicates that the scope of proposed works involves borehole work to a maximum depth of 10m.

8. Ground Conditions

8.1. General Geology

The British Geological Survey (BGS) map shows the bedrock geology to be formed by the London Clay Formation – clay, silt, and sand of the Palaeogene Period. No superficial deposits were recorded in this source.³

8.2. Site Specific Geology

Site-specific geotechnical data was not available during the production of this report.

³ <http://mapapps.bgs.ac.uk/geologyofbritain/home.html>

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
1916	1:2,500	The site was developed, having been occupied by single, terraced structure. Much of the northern, eastern, and western vicinities were also occupied by terraced properties with many structures having been recorded on either side of a single roadway: <i>Stanhope Place</i> . Only one structure – a <i>convent</i> – was identified and was situated four buildings to the west of the site. The area to the south was largely undeveloped, having been predominantly occupied by parkland. A large roadway running adjacent to the site represented the primary southern development.

Post-WWII		
Date	Scale	Description
1953-1954	1:2,500	Due to a distortion in the mapping, the site has been rotated slightly to allow for a clearer comparison between this and the previous edition. The site has not changed since the previous mapping edition. Much of the northern vicinity was not recorded, however the observable structures were not altered. The area to the east was similarly unchanged although a structure along <i>Stanhope Place</i> was now identified as <i>Stanhope Court</i> . The southern vicinity was unchanged since the previous mapping edition. To the west of the site, Nos. 4, 5, 6, and 7 appeared to have either been demolished or severely altered with No. 4 and a <i>ruin</i> the only remaining buildings in this section of the terrace.

9.3. Historical Photography of the Site

Historical photography has been obtained from the Aerofilms collection available from *Britain From Above*. This imagery provides a view of the site in 1928 (**Annex E**). See below for a description:

Title of Photograph	Comments
Speakers' Corner and environs, Hyde Park, 1928	The site was occupied by a multi-storey structure – shown to have been the second of six, relatively uniform buildings in the same terrace. A wider view correlates with what was recorded in historical OS mapping (Section 9.2): the northern, eastern, and western vicinities were largely developed through uniform terraced structures while the area to the south was occupied by parkland.

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 **Annex F**.

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 G). 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 bombs.	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) bombs	These were not commonly used and are generally considered to pose a low risk to most works in the UK.	SD2 bombs were packed into containers holding between 6 and 108 sub-munitions. 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 H**.

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

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 (**Annex G**).

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 – London Clay Formation.
- 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 lack or limitations of site-specific geotechnical information currently available. 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 2,419 V-1s and 517 V-2s were recorded in the London Civil Defence region alone.

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. An estimated 250 tons of ordnance (high explosive and incendiary bombs) was dropped on Greater London, more than half of which fell on the City of London (see **Annex I** for a WWI bomb plot map of London). This source does not record any WWI bombing incidents to have directly affected the site, although numerous incidents are noted across the wider area. This correlates with various mapping sets (**Annex J**) wherein individual nearby raids were recorded. The closest such incident appeared to have been located approximately 250m to the north along Edgware Road.

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 Metropolitan Borough of Paddington

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 Metropolitan Borough of Paddington, which sustained an overall very-high density of bombing with an average of 255.7 items of ordnance falling per 1,000 acres according to official Home Office bombing statistics (**Annex K**). This was largely due to its close proximity to London city-centre and the River Thames – often used by aircraft as a navigational aide. Targets of particular prominence in the vicinity of the proposed site included London Paddington Railway Station, located approximately 900m north-west of the site (**Annex L**). In addition, the wider area surrounding Paddington also contained the Pear Street Gas Light and Coke Company, Holborn Drainage and Coal Storage, Surrey Commercial Docks, and the West India Docks. Neighbouring areas would often be affected by the presence of such a target, partly due to proximity and the fact that Luftwaffe bomber aircraft would often deploy any remaining bombs on adjacent areas.

Records of bombing incidents in the civilian areas of the Metropolitan Borough of Paddington 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 Metropolitan Borough of Paddington between 1940 and 1945.

Record of German Ordnance Dropped on Metropolitan Borough of Paddington		
Area Acreage	1,357	
Weapons	High Explosive bombs (all types)	298
	Parachute mines	3
	Oil bombs	7
	Phosphorus bombs	33
	Fire pots	0
	Pilotless aircraft (V-1)	6
	Long range rocket bombs (V-2)	0
Total	347	
Number of Items per 1,000 acres	255.7	

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. London Civil Defence Region Bomb Census Maps

During WWII, the ARP Department within the Research and Experiments Branch of the Ministry of Home Security produced both consolidated and weekly bomb census maps for the London Civil Defence Region, as well as census mapping of V-1 pilotless aircraft. These maps collectively show the approximate locations of bombs, mines and rockets dropped in the region. The site area was checked on each available map sheet. Those showing bomb incidents on and in the immediate vicinity of the site are discussed below and are presented in **Annex M-O**.

Consolidated London Bomb Census Mapping	
Date Range	Comments
Night Bombing up to 7 October 1940	No incidents were recorded either on or in the immediate vicinity of the site.
Night Bombing from 7 October 1940 to 28 th July 1941	Four incidents were recorded in the vicinity. The closest was situated approximately 10m to the west of the site along Hyde Park Lane. Of the remaining three bomb strikes, two were located in the east, and one in the west.
Day Bombing from 7 October 1940 – 31 December 1940	No incidents were recorded either on or in the immediate vicinity of the site.

Weekly London Bomb Census Mapping	
Date Range	Comments
6 January 1941 – 13 January 1941	An incendiary bombing shower was recorded over the site, as well as the areas to the north and west.
5 May 1941 – 12 May 1941	A small incendiary bombing shower was recorded shortly to the west of the site. One HE bomb was plotted approximately 30m to the east along Hyde Park Lane. It is possible that a second HE bomb was plotted on this mapping edition underneath the aforementioned incendiary bombing shower, however due to the quality of the mapping, this cannot be confirmed.
13 March 1944 – 19 March 1944	An oil bomb was plotted to the immediate west. Part of the oil bomb appeared to overlap slightly with the site.
2 June 1944 – 9 June 1944	A parachute mine was plotted to the immediate west. A large section of the parachute mine appeared to overlap slightly with the site.

V-1 Pilotless Aircraft Bomb Census Mapping	
Date Range	Comments
1944-45	One V-1 flying bomb was recorded over both the site and the immediate vicinity. The incident was noted to have occurred on 18 June 1944.

11.5. London V-1 Pilotless Aircraft Bomb Census Reports

Bomb census reports compiled by the Research and Experiments Branch of the Ministry of Home Security during WWII were consulted at The National Archives. These reports recorded information such as the date, time, type and damage caused by V-1 pilotless aircraft bomb incidents for a selected time period in the region and are therefore not often comprehensive.

A transcript of the associated written records of bomb incidents in the site area is presented in the table below. Only those recorded incidents on or in close proximity to the site have been highlighted. An example of this record is presented in **Annex P**.

London V-1 Pilotless Aircraft Bomb Census Reports			
Date	Location	Type of Bomb(s)	Comments
18 June 1944	No. 7 Hyde Park Place	1 x V-1 pilotless aircraft bomb	Fell on pavement and penetrated into cellar beneath. Blast damage through adjoining cellars and pavement up to approximately 93ft. Heavy blast damage to adjoining properties. Building had suffered previous bomb damage.

11.6. Paddington Bomb Census Reports – 6 May 1941 – 30 May 1942

Bomb census reports compiled by the Research and Experiments Branch of the Ministry of Home Security during WWII were consulted at The National Archives. These reports recorded information such as the date, time, type and damage caused by bomb incidents for a selected time period in the region and are therefore not often comprehensive.

A transcript of the associated written records of bomb incidents in the site area is presented in the table below. Only those recorded incidents on or in close proximity to the site have been highlighted. An example of this record is presented in **Annex Q**.

Paddington Bomb Census Reports – 6 May 1941 – 30 May 1942			
Date	Location	Type of Bomb(s)	Comments
10 May 1941 – 11 May 1941	No. 4 Hyde Park Place	1 x 250kg High Explosive	Five storey mansion flats, well built with basement. Direct hit and demolished. 40ft of the upper part of No. 5 Hyde Park Place also damaged. No other blast damage of note.

11.7. Catholic Herald: Story of the Tyburn Nuns

The newspaper, the Catholic Herald, was consulted during the production of this report. In this source an article was published, titled *Story of the Tyburn Nuns* which documented events involving the Tyburn Convent on 18 June 1944. In regards to the site, the following passage has been taken into account:

At 5.30 a.m. on Sunday, June 18, 1944, a flying-bomb thundered across Hyde Park. Opinions differ as to what exactly did happen, but one thing is certain; instead of hitting the upper storeys of the convent to which it was heading, it hit the trees bordering the opposite side of the road, tearing off its wings and inevitably breaking its force. It then precipitated itself nose downwards into Hyde Park Place and exploded.⁴

11.8. London County Council Bomb Damage Map

A map created by London County Council (LCC), showing the extent of bomb damage in the city, was compiled during/after WWII. The section showing the area of the site is described in the table below and presented in **Annex R**.

London County Council Bomb Damage Map	
Date Range	Comments
1940-1945	The site was recorded as having been <i>damaged beyond repair</i> . The adjacent structures to the north and east, as well as all observable buildings to the west were listed as either <i>damaged beyond repair</i> or <i>seriously damaged; doubtful if repairable</i> . A V-1 flying bomb strike was recorded over both the site, and the wider area including every structure discussed above

⁴ <http://archive-ust.catholicherald.co.uk/article/20th-april-1953/3/story-of-the-tyburn-nuns>