BRIMSTONE

DETAILED UXO RISK ASSESSMENT

STAGE 2 DETAILED UXO RISK ASSESSMENT

Client:	London Square		
Project Ref:	LOSQ14R		
Site Name:	Leegate, Lewisham		
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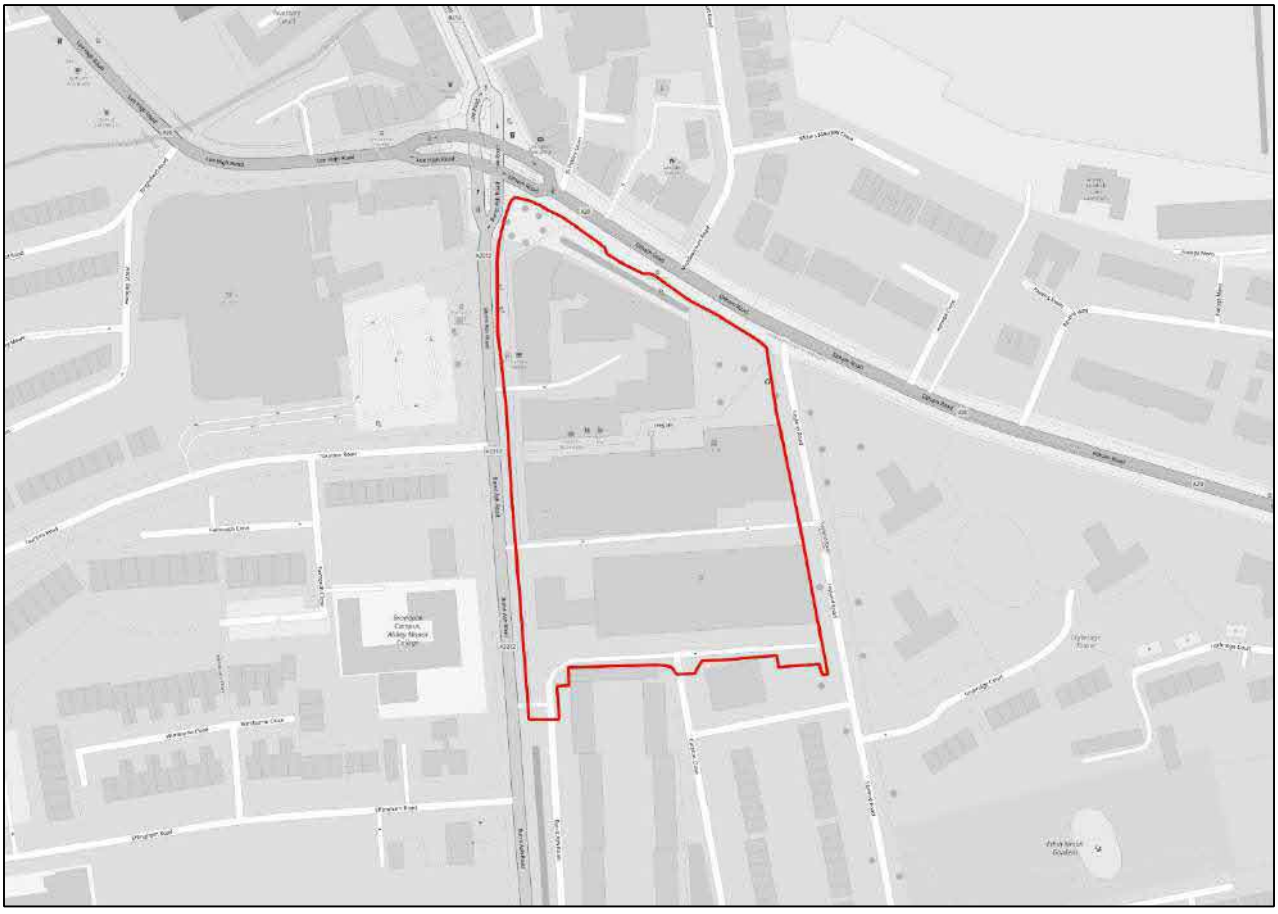


EXECUTIVE SUMMARY

RESULT: Brimstone concludes that unexploded ordnance (UXO) poses a LOW and MODERATE RISK to the proposed works.

THE SITE: The Site is located in Leegate, within the London Borough of Lewisham, approximately 580m north-west of Lee station. It is bound to the north by the A20, to the east by Leyland Road, to the south by a high-rise apartment block on Carston Close and residential structures on Burnt Ash Road, and to the west by the A2212 roadway.

The Site comprises Leegate shopping centre, consisting largely of low-rise commercial structures and hardstanding accessways / car parking. Three high-rise structures are present in the south-east and south-western extents; these are believed to be residential in nature. The high-rise Leegate House, in the north-west of the Site, is known to be commercial in nature.

Grid Reference: TQ 39923 74853 What3Words: claims.frozen.town

THE PROPOSED WORKS: Development works will comprise the demolition of existing buildings and the construction of buildings of up to 15 storeys. These will comprise residential units, flexible commercial floorspace, a community centre and a public house, alongside associated public realm, landscaping and highways improvements, vehicular access, car parking and servicing arrangements, cycle parking and stores, and other associated and ancillary works.

Site investigation (SI) works have already been undertaken on Site, comprising six cable percussion boreholes and two window sample boreholes. At the time of writing, Brimstone was not aware of any additional SI works proposed on Site.

UXO RISK ASSESSMENT:

German UXO:

London was the most frequently and heavily bombed British city during WWII, with most damage being sustained by the central and eastern boroughs. Whilst the Site was situated on the south-eastern periphery of the city, approximately 10km away from the primary Luftwaffe target area in the region (the City of London), the wider area would have been vulnerable to overspill or inaccurate bombing. Consequently, the wider Site area experienced a high bombing density, as indicated by official wartime figures.

Indeed, London bomb census mapping records 46 HE bomb strikes within an approximate 300m radius of the Site. One HE bomb is recorded in the north-east of the Site, with another directly along the southern Site boundary. In addition, two incendiary bomb 'showers' were also recorded within a 300m radius of the Site; one of these is partially recorded over the eastern extent of the Site. Furthermore, LCC bomb damage records structural clearance to a structure on Eltham Road in the north of the Site, with further structures in the south-western extent recorded as sustaining 'general blast damage- not structural'. The closest substantial damage within LCC mapping is approximately 20m west of the Site, where structures were 'damaged beyond repair'.

The recorded damage is largely corroborated by post-WWII aerial photography, in which structural clearance is visible in the northern extent of and approximately 20m west of the Site. In addition, roofing repairs are visible to structures in the north-west and east of the Site; these are highlighted at FIGURE 5. Whilst these structures have sustained superficial damage, they appear to have remained structurally intact, evidenced by their repair rather than being cleared completely. The structures in the north-west of the Site appear to have survived without sustaining a significant degree of damage; this is also corroborated by LCC damage mapping, which records no damage to these structures.

Any UXB strike to undamaged locations within the Site footprint would have likely caused incontrovertible evidence of its occurrence as it passed through the structure and into the ground beneath. This apparent lack of damage also indicates that these structures would have remained inhabited / in use throughout the war, suggesting regular access, although periods of temporary evacuation may have occurred following bomb damage in the area.

However, large areas of open ground in the form of residential gardens were present in the centre and south of the Site during WWII. The ground conditions in these areas were likely less conducive to the visual detection of UXBs when compared to the developed areas, and they likely experienced a less frequent level of access as a result. Therefore, it is feasible that a UXB strike to this location could have occurred unnoticed and unrecorded, its entry hole obscured by vegetation and filling in over time.

The same can be said for the area of structural clearance in the north of the Site. Following this substantial damage and subsequent clearance of these structures, the ground conditions are highly unlikely to have been conducive to the visual detection of UXBs, with any UXB entry holes becoming easily obscured in rubble / debris. Furthermore, the plots would have been cordoned off / abandoned following damage occurring; this marked drop in access creates a situation wherein a subsequent UXB strike could easily go unnoticed and unrecorded. Moreover, a UXB strike to either this location, or the open ground on Site, could feasibly have come to rest beneath the undamaged structures on Site due to the J-curve effect, whereby an item of ordnance may travel laterally beneath the surface from its point of entry.

In summary, evidence of bomb strikes within the Site boundary has been found. However, structures throughout the north, east and west of the Site appear to have survived externally structurally intact. They were therefore likely subject to a frequent level of access throughout the war, increasing the likelihood of a UXB strike being noticed at the time. As a UXB strike in these locations would have caused incontrovertible evidence of its occurrence, a Low Risk has been assessed in these areas.

British / Allied UXO:

No evidence of historic military activity within the Site boundary has been found and it is unlikely that any has occurred historically. Consequently, the risk from associated UXO is Low.

Numerous (>30) permanent heavy anti-aircraft (HAA) batteries were active within range of the Site during WWII. Luftwaffe activity was frequent and intense over the wider area and therefore these guns would have expended a vast quantity of ammunition. The risk of encountering unexploded HAA shells is considered to be homogenous with that of German UXBs and as such, has been assessed as Low and Moderate.

Likelihood of UXO Remaining and UXO Encounter:

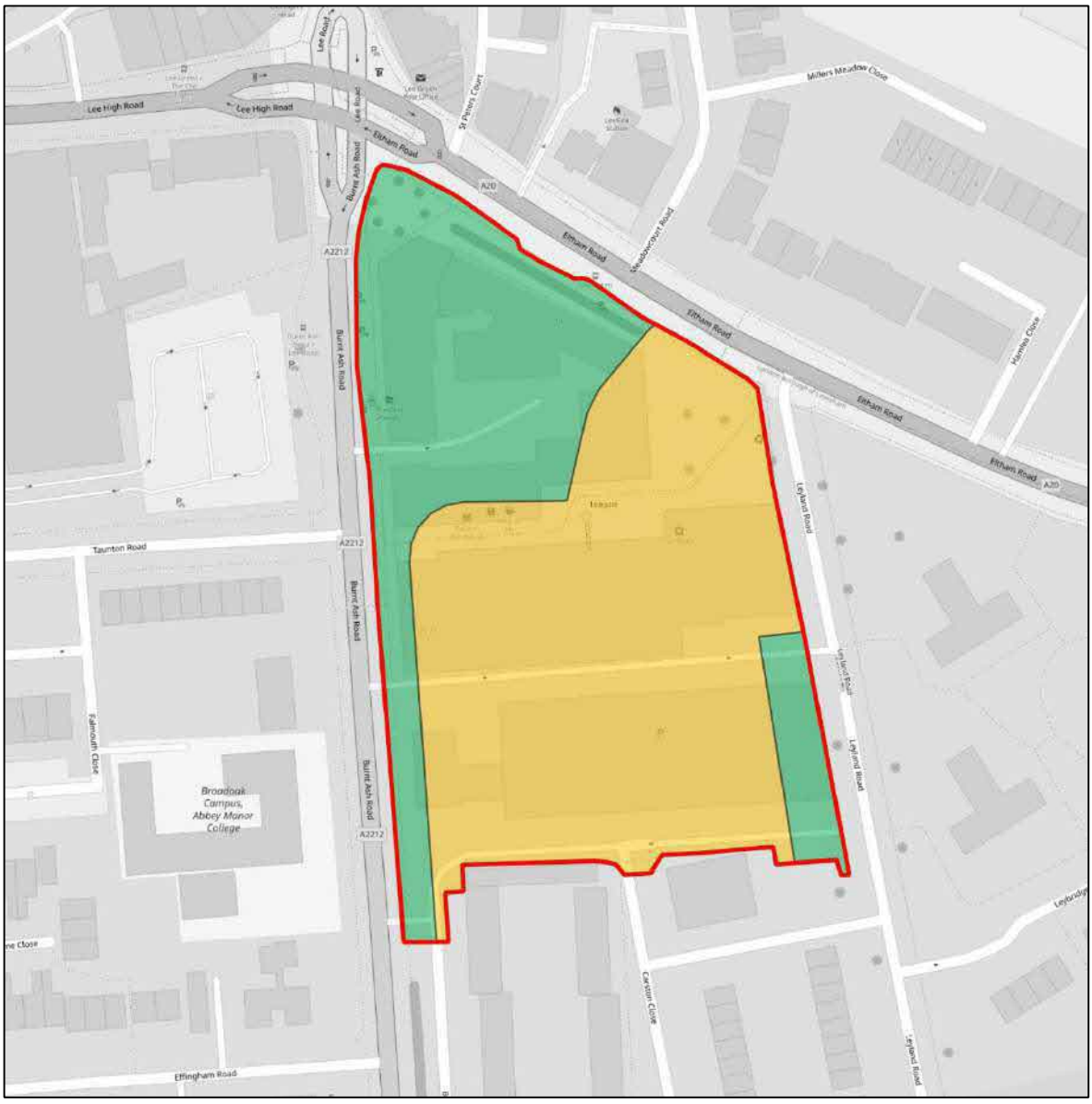
The risk associated with any deep buried German UXBs will likely have been mitigated in the locations of possible deep excavations in the north-west, south-east and south-west of the Site, although this cannot be confidently confirmed. The risk associated with any very shallow (<1m bgl) or shallow buried UXBs / HAA shells will have likely been mitigated with the clearance of pre-WWII structures and the subsequent construction of low-rise structures.

Please note, the risk of a UXO encounter can be considered mitigated in the exact locations and down to the exact depths of any post-WWII intrusive works.

RECOMMENDED RISK MITIGATION MEASURES: The measures detailed below are recommended to mitigate the risk to ALARP level.

Risk Mitigation Measure	Recommendation
UXO Safety Awareness Briefings	Prior to all intrusive works commencing.
Intrusive Magnetometer Probe Survey	Of all pile positions within the Moderate risk zone.
EOD Engineer - On Site Supervision	Watching brief of all open excavations and magnetometer survey of all borehole locations within the Moderate risk zone.

Risk Map



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QUALITY POLICY

Brimstone Site Investigation Ltd, known as Brimstone, is committed to the delivery of unexploded ordnance (UXO) risk mitigation services, including safe removal and disposal of explosive ordnance, in the UK and overseas. Since our incorporation in 2016 it has been our goal to provide unsurpassed and unbiased UXO risk mitigation services. Brimstone is a client-centric organisation, with the aim to provide the client the services they need, to the agreed requirement, in accordance with national and international standards or standard operating procedures.

We are committed to providing a safe, cost-effective, and quality service, underpinned by our core values:

- **Integrity:** We are unwavering in our commitment to providing pristine, unbiased counsel and superior services. Our ethical compass guides every interaction, ensuring we maintain the highest standards of conduct in all our endeavours.
- **Professionalism:** We embody professionalism at every level, conducting our business with unparalleled excellence. Our commitment to quality guarantees top-tier service and a seamless experience for every client.
- **Knowledge:** We are devoted to perpetual growth, consistently expanding our expertise to stay at the forefront of industry innovation and strategy. Our thirst for knowledge ensures we are equipped to lead and succeed in an evolving marketplace.
- **Innovation:** We champion innovation, continuously advancing our services and processes. Our pursuit of inventive strategies and pioneering solutions ensures we not only meet but exceed the evolving needs of our clients and the industry.

We are committed to the applicable requirements of the ISO 9001:2015 standards. We set and review quality monitoring objectives using the plan, do, check, act cycle to measure the performance of our quality management system. Brimstone wholly endorses the ethos of 'continual improvement efforts' and allocates resources to meet this requirement.

This policy applies to the whole of the Brimstone services and involves all personnel including the managing director. All personnel are responsible for helping manage quality, seeking improvement through constant review, and by encouraging supplier and subcontractor involvement. We are committed to achieving customer satisfaction using quality procedures, which will be operated to meet or exceed the applicable requirements of ISO 9001.

Aaron Florence
Founder and Managing Director
Brimstone Site Investigation Ltd.

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1 INTRODUCTION

1.1 Background

London Square (the Client) has commissioned Brimstone to carry out a Stage 2 Detailed Unexploded Ordnance Risk Assessment (DRA) of the proposed redevelopment works at the Leegate, Lewisham site (the Site).

1.2 Legislation

There are no regulations that specifically govern the UXO risk mitigation industry in the UK. However, there are two pieces of legislation that require consideration. It is industry best practice (and common sense) to frame your site in the context of UXO, and to put in place measures to protect people from risks. In 2009, CIRIA published Unexploded Ordnance (UXO) - A Guide for the Construction Industry C681. This publication, though not legally binding, provides the gold-standard framework to which UXO and construction companies operate.

1.2.1 Construction Design and Management Regulations (CDM) 2015

The regulations identify the client, the CDM coordinator, the designer, and the principal contractor as responsible parties. Under the regulations, responsible parties are held accountable for the way a construction project is managed and for the health and safety of workers. Responsible parties must:

Provide an appropriate assessment of potential UXO risks, or ensure an assessment is completed by another party.

Put in place appropriate risk mitigation measures if necessary.

Supply all parties with information relevant to the risks.

Ensure the preparation of an emergency response plan.

1.2.2 The Health and Safety at Work Act 1974

The Health and Safety at Work Act 1974 had a transformative impact on health and safety, saving thousands of lives since its enactment. Employers must consider their employees, workers not in their employment, and members of the public. The act places a duty on every employer 'as far as is reasonably practicable' to protect workers from risks. It also says that information must be provided about aspects of health and safety that affect their role.

1.3 Commercial Contractor and the Authorities

1.3.1 Commercial Contractors

If your site has been given a moderate or high-risk rating, then control measures will be recommended. The measures will be specific to the scope of works on site, usually in relation to the depth and extent of excavations, piling and similar activities. There are a range of different methods at Brimstone's disposal, including:

Non-intrusive surveying (including drone surveying)

Intrusive surveying

Search and clear

Watching brief

Support to geotechnical investigations

Target investigation

Site-specific training packages

Site safety briefings

Our UXO Engineers can assess suspicious items on site when they are found. This will avoid unnecessary site

evacuations. If our engineer(s) decide the item is UXO, they will coordinate with the authorities, manage disruptions, and advise on control measures, such as evacuations and a cordon.

1.3.2 UK Authorities

If Brimstone is not on site and a suspicious item is found, the local police must be immediately called on the non-emergency number. Police will visit the site. They will then inform the Joint Services Explosive Ordnance Disposal (JSEOD) office, which will coordinate the callout of an army or navy response team.

A precautionary cordon will initially be put into effect, with possible evacuation of homes and businesses, road and rail closures. The cordon may be extended following the advice from JSEOD's response team.

To manage their resources, JSEOD triages incidents. A consideration of the type, size and location of the UXO is made. If an incident is not given a high priority rating, a team may not be available for up to two days following the initial report.

The use of JSEOD is under the Military Aid to Civil Authorities (MACA) framework, therefore the budget and personnel is limited, and there are no statutory obligations made of the MOD. Often the MOD will recommend involvement of a commercial UXO contractor to manage the ongoing risk – this is especially true of former airfields and training areas where contact with land service ammunition can be frequent.

1.4 UXO Risk in the UK

Fortunately, to the best of our knowledge, there has not been a single post-war incident in the UK where a construction worker has been killed or injured because of an item of UXO exploding. There have been cases in mainland Europe where UXO had been struck and then exploded, killing workers. In 2019, a WWII general purpose bomb spontaneously detonated in a field north of Frankfurt, Germany.

However, the incident in Frankfurt is not comparable to the UK, due to the way different countries manufactured ordnance. Bombs made in different countries have different associated hazards. British WWII bombs, for example, have a fuzing system which uses chemicals which makes them very unsafe. Please see APPENDIX 1 for recent examples of UK UXO incidents.

Between 2013 and 2016 JSEOD responded to 7,500 callouts. These callouts range from falsely identified objects, inert objects, small items of UXO and large WWII German unexploded bombs (UXBs). Each year the construction industry inadvertently unearths UXO; often this goes unreported. UXO contamination comes from three main sources:

Enemy action: during WWI and WWII the air forces of Germany, and to a lesser extent Italy, bombed targets throughout the UK. The German navy bombarded several coastal targets in eastern England during WWI and then in WWII German long-range artillery on the French coast bombarded parts of Kent.

Allied military activity: during WWI and WWII several Allied nations used the UK as a staging area for military action in the European Theatre; predominantly the US and Canada.

UK military activity: domestic British Army, Royal Air Force (RAF) and Royal Navy (RN) training activities during peacetime and conflict as well as anti-aircraft gun and rocket batteries during WWI and WWII.

1.5 UXO Detonations

A detonation is a violent chemical reaction which creates a huge volume of gas. This reaction appears to happen instantaneously – the velocity of the shockwave moving is up to 9,000m per second. This chemical reaction is started using a small amount of very sensitive explosives called primary explosives. These types of explosives are highly sensitive to shock, friction, heat, and spark. As the explosive charge undergoes high order decomposition (detonation), the brisance, or shattering effect, causes the casing to splinter, projecting razor-sharp shrapnel across long distances.

The blast wave effect and the shrapnel effect can cause significant damage. Calculating safety distances is a

complex process. As a rule of thumb, in open ground, a 250kg explosive charge (as would be found inside a typical 500kg bomb) would require an omnidirectional safety distance of at least 1.6km.

Bombs work by amplifying the explosive charge from the sensitive primary explosive through to the main charge or fill of the item. This process is called an explosive train, if any link in that chain is broken, the item will fail to function as intended. This can be due to mechanical, electrical, or manufacturing tolerances or faults. Amongst other reasons, detonation of UXO could occur under the following circumstances:

UXO body impact: A substantial impact onto the main body of a UXO; borehole rigs, piling rigs, jack hammers and mechanical excavator buckets.

Fuse impact: Environmental conditions during decades of burial can result in the primary explosives located in the fuse pocket to crystallise and become shock sensitive. It would then take a relatively small impact or friction impact to cause the fuse to function and detonate the UXO.

Re-starting a timer: A small proportion of German WWII bombs used clockwork fuses. In 2002, an Army EOD Engineer reported that the clockwork fuse in a UXB re-started. Decades of burial causes substantial corrosion in WWII German UXBs and therefore an incident such as this is extremely rare.

2 ASSESSMENT METHODOLOGY

2.1 Introduction

This assessment has been produced in accordance with the relevant CIRIA guidelines; Unexploded Ordnance (UXO) - A Guide for the Construction Industry C681 (published in 2009). CIRIA C681 is a publication which originated from round table best practice discussions from industry leaders.

2.2 Source, Pathway, Receptor, Consequence Risk Model

The Source, Pathway, Receptor, Consequence (SPRC) risk model can be applied to buried UXO as follows:

Sources: UK and Allied UXO sources include military firing ranges, bases, storage depots, munitions factories, anti-aircraft batteries, amongst others. There are many wartime causes of UXO contamination. The source for enemy contamination is overwhelmingly from WWII German air raids.

Pathways: the pathway describes how the UXO reaches receptors. Usually, UXO is buried and therefore pathways can be any activity which involve breaking ground. Examples include ground investigation works, site enabling works and excavations.

Receptors: receptors are the people, assets and infrastructure that can be adversely affected by UXO exposure. This includes site personnel, plant, equipment, buildings, the general public, and the environment.

Consequence: the consequences of an inadvertent UXO detonation are catastrophic. They include injury and loss or life, as well as damage to property. Fortunately, the likelihood of UXO detonating is low, even when it is uncovered during works. However, another consequence to consider is delays to works, which itself can be a risk.

2.3 Assessment Structure

In accordance with CIRIA C681 this assessment addresses the following considerations in the appropriate order:

The likelihood that the site was contaminated with UXO.

The type of UXO that could have contaminated the site, and their associated hazards.

The likelihood that UXO remains on the site.

Theoretical bomb penetration depths.

The likelihood that UXO will be uncovered during the proposed works.

Risk rating and risk mapping (as appropriate).

Risk mitigation recommendations.

2.4 Information Sources

To complete this risk assessment, Brimstone has gathered information from a wide range of sources. Brimstone's research team has completed detailed historical research, including access of original archived records. The list below is a general list of information sources that are consulted during the research process. For Site-specific sources consulted for this risk assessment, please refer to APPENDIX 5.

The National Archives,

Local archive centres,

Ministry of Defence,

The Council for British Archaeology,

Groundsure mapping services,

Historical aerial photography (Historic England, Britain from Above, NCAP),

Google open-source mapping,

The British Geological Survey,

Open sources; published book, articles, web resources,

Site-specific information supplied by the Client,

Brimstone's library and historical database, and

Brimstone's former armed forces employees.

2.5 As Low as Reasonably Practicable Principle

The ALARP (as low as reasonably practicable) principle corresponds to the actions that should be taken to reduce risks. The term 'ALARP' is in the Health and Safety at Work Act 1974, which says that risks must be controlled in a reasonable way.

Infinite time, effort and money could be spent trying to eliminate risk entirely. HSE uses the example that spending £1m to prevent five employees bruising their knees is disproportionate, whereas spending the same amount to prevent an explosion which could kill 150 people is proportionate.

Using this principle, Brimstone aims to reduce client costs by recommending strategies that are proportionate to the assessed risks, if any elevated risk is found at all.

2.6 Risk Tolerances

The Brimstone risk assessment process divides UXO risk into two tolerances:

Tolerable: Low Risk and Low-Moderate Risk ratings are tolerable. Where the risk cannot be completely discounted, it may be a useful strategy to opt for a low-cost measure, such as a UXO safety briefing from a qualified UXO engineer.

Intolerable: Moderate, Moderate-High, and High-Risk ratings are intolerable. Proactive risk mitigation measures should be put in place. Various strategies are at Brimstone's disposal to meet your project-specific needs.

2.7 Reliance and Limitations

This report has been prepared using published information and information provided by the Client. Brimstone is not liable for any information which has become available following the publication of this report. No third-party liability or duty of care is extended. Any third-party using information contained in this assessment do so at their own risk.

3 THE PROJECT

3.1 The Site

The Site is located in Leegate, within the London Borough of Lewisham, approximately 580m north-west of Lee station. It is bound to the north by the A20, to the east by Leyland Road, to the south by a high-rise apartment block on Carston Close and residential structures on Burnt Ash Road, and to the west by the A2212 roadway.

The Site comprises Leegate shopping centre, consisting largely of low-rise commercial structures and hardstanding accessways / car parking. Three high-rise structures are present in the south-east and south-western extents; these are believed to be residential in nature. The high-rise Leegate House, in the north-west of the Site, is known to be commercial in nature.

Grid Reference: TQ 39923 74853 What3Words: claims.frozen.town

FIGURE 1: Site Location Maps FIGURE 2: Recent Aerial Photograph

3.2 The Proposed Works

Development works will comprise the demolition of existing buildings and the construction of buildings of up to 15 storeys. These will comprise residential units, flexible commercial floorspace, a community centre and a public house, alongside associated public realm, landscaping and highways improvements, vehicular access, car parking and servicing arrangements, cycle parking and stores, and other associated and ancillary works.

Site investigation (SI) works have already been undertaken on Site, comprising six cable percussion boreholes and two window sample boreholes. At the time of writing, Brimstone was not aware of any additional SI works proposed on Site.

FIGURE 3: Existing Site Plan

4 SITE HISTORY

4.1 Site Introduction

Site-specific history can be assessed by reviewing historical mapping, historical aerial photography and by carrying out additional Site-specific research where appropriate. Below are descriptions of a selection of records relevant to the Site:

4.2 Mapping

The below table describes the composition of the Site, structural changes in pre- and post-WWII Ordnance Survey (OS) editions, and relevant points of interest. All maps were retrieved from National Library Scotland (NLS) online database and the Landmark Promap OS database.

Period	Map Date	Map Scale	Review
Pre-WWI	1867	1:10,560	A majority of the Site comprises undeveloped ground, likely agricultural in nature. Lee Gate Farm is present in the north of the Site, comprising a cluster of small structures. Additional open ground was present to the immediate east and south, with Eltham Road to the north and Burnt Ash Road to the west.
	1893	1:1,056	The Site has undergone significant development. The north is now occupied by structures assumed to be of a commercial nature on Eltham Road, and the small cul-de-sac Carston Mews. An agricultural nursery is present in the north-west, and the centre and south of the Site is now occupied by residential structures and large garden areas, on Leyland Road in the east, and Burnt Ash Road in the west.
WWI	1916	1:2,500	FIGURE 4.1: No significant changes appear to have taken place on Site.
Pre-WWII	1938	1:10,560	Although this map is of small scale and lacks detail, it can be said that no significant changes have occurred on Site.
Post-WWII	1952	1:2,500	FIGURE 4.2: The Site appears to have largely retained its pre-war composition, although structures within the nursery in the north-west have been cleared. Furthermore, a large structure in the north of the Site, on Eltham Road, has been split into six smaller structures. An area of structural clearance is visible approximately 20m west of the Site, on Burnt Ash Road.

4.3 Photography/Aerial Photography

The below table describes the composition of the Site visible in post-WWII aerial photography, including areas of possible structural clearance, damage and other possible features of note. All photographs were retrieved from Historic England's (HE) Royal Air Force (RAF) Photography Archive.

Period	Photo Date	Review
	26th August 1945	FIGURE 5.1 & 5.2: This image, displaying the north-western extent of the Site, was taken during the final year of WWII. The composition of this section of the Site is largely consistent with that identified in OS mapping. However, a single structure in the north-west of the Site has been visibly cleared. Various degrees of roofing repairs can also be seen to a number of the structures on Site. In the north, substantial repairs have been carried out, with the entire roof of one structure seemingly being replaced. In the east, minor tiling repairs are visible; this can be indicative of fire damage caused by incendiary bombing.
Post-WWII	2nd April 1946	FIGURE 5.3 & 5.4: This vertical image, displaying the entire Site, was taken approximately a year after the end of WWII. Two additional instances of minor roofing repairs have been highlighted, approximately 30m south and 40m south-west of the Site. Furthermore, an area of structural clearance is visible approximately 20m west of the Site, on Burnt Ash Road. A large area of clearance, likely resulting from a V1 weapon strike (see FIGURE 8), is visible approximately 80m north of the Site. It should be noted that a majority of the structures on Site appear to have survived the war externally structurally intact. Associated garden areas are partially occupied by mature vegetation, obscuring the ground cover and preventing detailed analysis of these areas.

4.4 Additional Site-Specific History

Some sites will have been occupied by landmarks or significant buildings historically and in such cases specific written histories including significant wartime details are occasionally available in the public domain. No such information was available.

5 UXO RISK - GERMAN BOMBING

5.1 WWI Bombing History

5.1.1 Britain during WWI

During World War I (WWI), an estimated 9,000 German bombs were dropped on London, Eastern England and South-Eastern England during some 51 Zeppelin airship raids and 52 fixed-wing aircraft raids. London suffered the worst of the bombing with an estimated 250 tonnes of HE and incendiary bombs recorded across the Capital, over half of which fell on the City of London district.

The WWI bombing campaign waged by Germany was on a far smaller scale than the WWII campaign, in terms of the number of raids, the weight of ordnance dropped during each attack and the size of the bombs used. When coupled with the fact that most WWI-bombed locations have since been redeveloped, German WWI UXB finds are extremely rare. Furthermore, most air raids took place during daylight hours and as it was the first

time Britain had experienced strategic aerial bombardment, the raids often attracted public interest and even spectators, increasing the chances of any UXBs being reported.

5.1.2 Site Specific

A collection of written reports describing each air raid in the region was reviewed (I. Castle, 2024). Lewisham experienced multiple air raids during WWI; however, the closest bomb strike is recorded approximately 300m south-east of the Site, which is unlikely to have affected the Site.

5.2 WWII Bombing History

5.2.1 London

In the summer and autumn of 1940, the Luftwaffe targeted the RAF's airfields and support network with the intention of achieving air supremacy prior to a planned amphibious invasion of south-east England. The resulting Battle of Britain campaign (July to October) resulted in many air raids across England, although these were mainly concentred in the south-east. During this period, a few small-scale raids affected the outer London boroughs.

In early September 1940, the Luftwaffe changed their tactics and commenced an indiscriminate carpet-bombing campaign against London. The resulting nine-month Blitz began on 7th September 1940 and ended on 12th May 1941 - the heaviest raid of the Blitz. The vast majority of the Luftwaffe units based in occupied Europe were then redeployed to the Russian front.

During 1943, a number of small-scale fighter bomber raids were carried out against the Capital, then in 1944, the Luftwaffe commenced Operation Steinboch. This campaign comprised 31 major raids against London and other southern England targets, executed by inexperienced Luftwaffe crews, between January and May. However, poor navigation and improved defences resulted in unsustainable Luftwaffe losses, many formations being broken up by the RAF over the Home Counties. The final large-scale Luftwaffe raid on the Capital took place during May 1944, with all air raids ceased by the end of June.

Between 1940 and 1944, there were a total of 71 major air raids on Greater London resulting in some 190,000 bombs being dropped, killing over 29,000. In total some 50,000 tonnes of HE bombs and 110,000 tonnes of incendiary bombs (mainly of the 1kg type) were dropped during the Blitz over Britain. The army BDUs successfully dealt with approximately 40,000 UXBs during the war.

Immediately following the final air raids on London, the Luftwaffe launched the V Weapons campaign, commencing in June 1944. The V1 (Flying Bomb or Doodlebug) and later the V2 (Long Range Rocket) were launched from occupied Europe. 2,419 of the former and 517 of the latter were recorded in the London Civil Defence region.

Both carried a large 1,000kg HE warhead and were constructed of thin sheet steel, rather than the thick steel used on the Luftwaffe's free fall bombs. V Weapons were designed to detonate on the surface (like parachute mines), as opposed to free fall bombs which were designed to have some penetration ability through multi-storey buildings.

Consequently, any V Weapons which failed to detonate broke up on impact, resulting in an easily identifiable debris field. Although there is a negligible risk from unexploded V Weapons on land today, they caused widespread destruction throughout London and therefore, at V Weapon impact sites, the assessment of pre-1944 UXB risk can be hampered.

5.2.2 Site Specific

The Site is located approximately 11km south-east of the Luftwaffe's primary aiming point for indiscriminate air raids, the City of London. Therefore, in terms of individual targets, their proximity is more relevant than in other parts of the city because the study area experienced fewer large-scale raids indiscriminate raids than the City.

Luftwaffe records highlight the nearest target to the Site as RAF Kidbrooke, a non-combat RAF station utilised as a supply depot, approximately 750m north-east of the Site. Railway infrastructure approximately 500m south of the Site may have been identified as a target of opportunity.

5.2.3 Bombing Decoy Sites

In mid-1940 bombing decoys were introduced. The decoys used either:

- A system of lighting to simulate an urban area or a military airfield's runway,
- Deliberately started fires to simulate a previously bombed target,
- Dummy buildings and vehicles to simulate a military facility.

792 static decoy sites were built at 593 locations in Britain. They were estimated to have drawn at least 5% of the total weight of bombs away from their intended targets. No decoys were operational within a significant radius of the Site during WWII. The closest was approximately 13.5km to the north-east.

5.3 WWII Bombing Records

5.3.1 Introduction

The bomb census recorded the location and type of bomb strikes to help with intelligence gathering and planning. It was compiled using information recorded by ARP wardens. These records were gathered by the Ministry of Home Security to calculate bombing density within administrative areas.

The bomb census was unreliable in the early stages of the war, though by 1941 procedures had been standardised. The quality of the census records also depended on where in the UK the records were produced. Some records are held at the National Archives and some are held at local borough archives.

Relevant records held at the National Archives and the London Metropolitan Archives were obtained for this risk assessment.

5.3.2 Bombing Density Statistics

The table below records the Ministry of Home Security's bombing density calculation for the Metropolitan Borough of Lewisham. It gives a breakdown of the types of large German bombs reported and is understood to not include UXBs.

Admin Area	Lewisham
Area Acreage	7,015
High Explosive Bombs (all types/weights)	1,366
High Explosive Parachute Mines	15
Flam (Oil) Bombs	29
40kg Phosphorus Incendiary Bombs (IBs)	24
40kg 'Fire Pot' IBs	5
V1 Flying Bomb	115
V2 Long Range Rocket	12
Total (excluding V-Weapons and 1kg / 2kg IBs)	1,439
Bombs Per 1,000 Acres	205.1

1kg / 2kg incendiary bombs and 2kg anti-personnel (AP) bombs were often too numerous to record accurately and therefore are not included in the above figures. The latter were not dropped on London. Small IBs were however dropped in vast numbers (>100,000) over the capital.

5.3.3 Bomb Census Maps

Brimstone has reviewed a collection of original consolidated and weekly bomb census maps for the wider study area. These small-scale maps cover the entire bombing campaign and record all types of bomb. Relevant maps are displayed at FIGURE 6.

Approximately 46 'iron' bombs are plotted within a 300m radius of the Site. One of these strikes is recorded in the central extent of the Site, with another along the southern boundary.

One day-time air raid affected the study area, this resulted in a HE bomb strike approxiamtley 90m north of the Site.

Two 1kg / 2kg IB showers are plotted within 300m of the Site; one of these was recorded over the east of the Site. Note, no weekly plot maps are available for the 7th September to 7th October 1940 period and therefore it is not known whether IB showers affected the Site during this month.

5.3.4 LCC Bomb Damage Map

Brimstone has reviewed an original war damage map covering the study area. The map was produced by the Engineer and Surveyors Department of the London County Council and was updated throughout the bombing campaign. A section of the map covering the study area is displayed at FIGURE 7.

A vast majority of the structures on Site have not been shaded, indicating that the buildings did not sustain any degree of bomb damage. However, residential structures in the south-west of the Site, on Burnt Ash Road, have been shaded orange, indicating they sustained 'general blast damage – not structural'. One structure in the north-west of the Site is shaded blue, indicating it was an area of clearance.

Varying levels of damage are recorded to structures within the Site's surrounds. Multiple structures approximately 20m west are recorded as suffering 'total destruction', and structures approximately 80m north were recorded as 'damaged beyond repair', which corroborates the damage visible within FIGURES 4.2 and 5.3. Further structures approximately 20m west of the Site are recorded as sustaining 'general blast damage – not structural'.

5.3.5 V Weapons

Brimstone has reviewed a collection of original consolidated V1 Bomb Plot Maps, as well as a contemporary plot map of V2 Rocket incidents, produced using collections of original written incident reports. A V1 bomb map, covering the Borough of Lewisham, is presented at FIGURE 8.

One V1 strike is plotted within a close vicinity of the Site, approxiamtley 100m to the north. This strike (occurring on 27th July 1944), caused significant damage and resulted in a large area of structural clearance, displayed at FIGURES 5.3 & 5.4. However, several blocks of buildings that survived the conflict intact will have shielded the Site from the 1,000kg HE blast.

The closest V2 strike (8th March 1945) occurred 1.2km to the north; this incident did not occur in close enough proximity to the Site to be of concern. Therefore, these incidents are both insignificant with regards to UXO risk on Site.

5.3.6 Abandoned Bomb Register

Due to the overstretched bomb disposal units during WWII, many bombs were intentionally left undisturbed. UXBs were triaged based on where they were and how big they were. If they didn't pose a significant risk, they were 'abandoned'. The locations of these bombs were recorded on the abandoned bomb register.

The abandoned bomb register is a public record document held at the Parliamentary Archives of the House of Commons, from which Brimstone has obtained a copy. The register should not be relied on for completeness or accuracy. The closest abandoned bomb is recorded approximately 2.7km west of the Site.

5.3.7 Secondary Source / Anecdotal Evidence

A search of online resources, as well as a review of local history publications was carried out with the intention of locating any eyewitness accounts of local bombing incidents. However, no such evidence was found.

5.4 Likelihood of UXB Contamination

Where detailed bombing records exist, it is possible to predict whether any UXBs could be found on a site. This likelihood is discussed in the following table:

Density of Bombing	
Number of Air Raids in the Vicinity:	A comparison of the bombing incident records confirms that at least seven air raids affected the study area. Note, this number may be higher as central London was bombed many times during the first month of the Blitz, for which weekly plot maps are unavailable.
Intensity of these Air Raids:	All bombs dropped locally were likely part of medium or large-scale indiscriminate carpet-bombing raids, all of which were carried out at night.
Bomb Strike Positions	
Closest Bomb Strikes	HE bombs: On Site. 1kg / 2kg IBs: On Site.

Alignment of recorded Bomb Strikes:	For districts with a very high bombing density, such as that within which the Site was situated, accurate analysis for the alignment of bomb strikes is not always possible. However, multiple bomb sticks have been identified in the vicinity, although identified bomb sticks do not appear to straddle the Site. Despite this, it has not been possible to identify the majority of the bomb sticks over the Site area, there may have been multiple occasions during which a UXB (unobserved and unplotted) could have been released over and landed within the Site boundary. For most small IB spreads (covering a wide area) it is impossible to correctly identify the aircraft's flightpath and thus bomb-stick alignment. Furthermore, such bombs were significantly affected by the wind, further hampering analysis.
Bomb Failure Rate	
Evidence to suggest that the generally accepted failure rate of 10% differs in the vicinity of the Site:	None.
UXBs recorded in close proximity to the Site:	None recorded within a significant distance of the Site.

5.5 Likelihood of Subsequent UXB Detection

A range of circumstances determine whether a UXB strike location would have been identified, during and after the war. This is discussed in the following table. This includes level of access to the Site during WWII, bomb damage, as well as the ground cover during WWII. This is discussed in the following tables.

Historic Access
A UXB falling on a site which was frequently accessed would have had a better chance of being found. ARP Wardens actively searched for UXBs in heavily bombed residential areas. The importance of a site or nearby buildings and infrastructure was also a factor. Many industrial facilities had fire watchers tasked with extinguishing incendiary bombs and reporting UXBs.
As a majority of the air raids in the immediate vicinity occurred during the hours of darkness, there is a greater probability that any UXB strike to the Site could have occurred unobserved as residents / employees were inside. Furthermore, no evidence of fire watchers providing night-time observation in the vicinity was found. These factors decrease the likelihood that any UXB fall would have been witnessed and reported. Many of the structures on Site do not appear to have been subject to any damage. It is thought that undamaged structures would have been subject to at least a degree of access throughout WWII. Even if they had been temporarily evacuated, it is not thought likely that a UXB entry hole within their footprints would have been overlooked by returning residents / employees. Multiple structures on Site, however, sustained varying degrees of roof damage during the war. These are highlighted at FIGURE 5. Periods of temporary evacuation may have taken place whilst these repair works took place, reducing access levels. Furthermore, an area of structural clearance is visible in the north of the Site. Following this clearance, this plot would likely have been abandoned / cordoned off for the remainder of the war, resulting in a significant decrease in access, potentially ceasing altogether. Large areas of undeveloped ground were also present on Site, utilised as an agricultural nursery in the north-west, and garden areas throughout the remainder of the Site. These areas likely experienced lower levels of access comparatively to the developed areas, particularly if the associated commercial / residential structures were damaged and evacuated for a period. Note, access levels for garden areas will have depended on the individual landowner and likely varied significantly.

Bomb Damage
As the bombing campaign continued, damaged areas became vulnerable to unreported UXBs. Bomb site wreckage or soil disturbance at a bomb crater could obscure evidence of a subsequent UXB strike.
Multiple structures within the Site boundary appear to have suffered minor roofing damage and subsequent repairs; these are highlighted at FIGURE 5. Minor damage of this nature is indicative of fire damage due to incendiary bombing occurring, whilst the complete replacement of the roof of a structure in the north of the Site may be indicative of more substantial bombing. Furthermore, structural clearance is visible in the north of the Site, and approximately 20m west. Structural clearance is often indicative of substantial bomb damage occurring.

Ground Cover Type
A UXB which falls on open field could easily go unnoticed, whereas a UXB dropped on a hard-surfaced car park would have been easily observed.
Any UXB strike to the undamaged structures on Site would have caused incontrovertible evidence of its incidence as it passed the structures and into the ground beneath. This would also have likely been the case for the structures which sustained minor roof damage, assuming no prior severe structural damage. The same can be said for the majority of neighbouring undamaged structures and roads where (assuming no cratering) a HE UXB entry hole would have been persistent and easily recognisable. It is conceivable that the areas on Site which comprised undeveloped ground may have potentially been overgrown / unmaintained at some point during WWII. A small UXB entry hole could easily have been obscured within such ground cover. Over time, changing environmental conditions could have caused this hole to infill, erasing any evidence of a UXB's existence. Note, the diameter of the smallest German HE bomb (which was also the most commonly deployed over Britain) was 20cm, creating a small easily obscured entry hole.

6 WWII GERMAN BOMBS

6.1 Bombs Dropped on the UK

Nazi Germany used different types of ordnance against the UK for different effects. Some types were designed to cause fires, others for their destructive blast effect and other for their penetration capability. Each type of ordnance was fitted with at least one fuze. For some bombs multiple fuzes were used. Many different types of fuzes were available for use – each with its own set of associated hazards.

Data sheets on those bombs most likely to be encountered today are included at APPENDIX 2.

HE bombs – moderate NEQ (net explosive quantity): the most common types of HE bombs dropped were the SC (general purpose - GP) and SD (semi-armour piercing - SAP) series of bombs. The NEQ is between 30-50%. SAP bombs are engineered to attack light fortifications, whereas GP bombs are used in a mixed destructive blast and anti-personnel fragmentation role. 70% of bombs dropped on the UK were the 50kg type.

HE bombs – high NEQ: blast bombs and parachute mines have bodies made of thin steel, allowing for larger HE charges. These were designed to detonate above ground, maximising the blast effect. Parachute mines were weapons slowed by parachutes and designed to detonate without penetrating the ground. Although, in some marshland areas, partially buried parachute mines have been observed. Consequently, it is highly unlikely that any unexploded blast bombs remain buried in the UK today.

HE bombs – low NEQ: The PC series were armour piercing bombs used against heavy fortifications and reinforced bunkers. They were not commonly used over the UK.

Small incendiary bombs: The 1kg and 2kg incendiaries were the most dropped bomb. Up to 620 x 1kg incendiaries could be packed into the largest container unit, which opened at a pre-determined height scattering its payload over a wide area. These small bombs could fully penetrate soft ground due to their small diameter. Variants of the 1kg and 2kg incendiary bombs contained a small HE charge designed for an anti-personnel role, and to increase its incendiary effect.

Large incendiary bombs - Thick skinned: The C50 has a thick body and contained a mixture of incendiary liquids and white phosphorus. Another version of the C50 had a white phosphorus fill. The C50 'firepot' contained thermite incendiary containers (aka firepots) and a small HE charge.

Large incendiary bombs - Thin skinned: The Flam 250 and Flam 500 models had thin steel bodies designed to break up on impact, spreading their oil-incendiary mixture, which was ignited by a small HE charge. Consequently, it is highly unlikely that any unexploded Flam bombs remain buried in the UK today. Their unreliability meant withdrawal from frontline use by January 1941.

Submunitions: The SD2 'butterfly' bomb was a 2kg submunition dropped on several British cities and towns. It contained a 225gram HE charge. SD2s had no ground penetration ability so the vast majority were recovered at the time. However, SD2s are still found across Britain today.

V1 flying bombs and V2 rockets: In the final year of WWII Germany began using pilotless weapons against England. Both V Weapons had 1,000kg HE warheads. Due to their light-body construction, they had no penetration ability, and any impact left a noticeable debris field. As such, there is negligible risk from unexploded V Weapons today.

6.2 Bomb Failures

Records from September 1940 to July 1941 show that an average of 84 UXBs were dropped on civilian targets each day. Around 8% of these were time delay bombs – designed to strike the ground and start a predetermined countdown which could last days.

There is a generally accepted 10% failure rate for WWII German HE bombs. This is estimated from records gathered by bomb disposal units. These statistics do not account for UXBs that went by unnoticed.

Failures can happen for different reasons, including:

Equipment or human error in arming the bombs before release,

Failure of a mechanism within the fuze (out of tolerance),

Jettisoning payloads if the bomber was under attack or crashing, or

Partially functioned bombs (e.g. cracks in the cast TNT).

6.3 Bomb Ground Penetration

6.3.1 Introduction

Using data gathered during WWII by the Ministry of Home Security, estimations can be made about how deep a bomb is likely to penetrate the ground. Over one thousand incidents were reported by the bomb disposal units to support this research. Further tests were carried out, dropping bombs of different sizes into chalk and measuring the depths they reached. This research is held at the National Archives. The estimates are:

Bomb weight (kg)	Ground Type (m)									
	Sand		Gravel		Chalk		Clay		Sandstone	
	Average	Max.	Average	Max.	Average	Max.	Average	Max.	Average	Max.
50	2.8	7.8	2.8	7.8	3.5	7.7	4.0	9.1	2.7	6.0
250	4.8	13.7	4.8	13.7	6.0	13.1	6.8	15.8	4.6	10.4
500	6.0	17.3	6.0	17.3	7.6	16.4	8.7	19.8	5.8	13.1
1,000	7.6	21.9	7.6	21.9	9.6	20.7	10.9	24.9	7.3	16.5

Different layers of geology affect penetration depths. For example, 1m of made ground, then 1m of gravel before reaching clay – as is many areas of London – is not easily calculated from the data above.

When calculating how deep a bomb could have reached, we must make three assumptions:

Impact velocity: German bombing raids were carried out at altitudes in excess of 5,000m. The velocity of impact is roughly 313ms^{-1} (not accounting for resistance). It is the same velocity regardless of mass.

Impact angle: strike angles of 10 to 15 degrees to the vertical. It must be assumed that the bomb was stable at the moment of ground penetration.

Bomb design: Some larger German bombs were occasionally fitted with 'kopfrings' - a metal ring, triangular in cross section, fitted around the nose of the bomb to help prevent penetration. It must be assumed that no 'kopfrings' were fitted.

6.3.2 The J-Curve Effect

During WWII, Bomb Disposal Units (BDUs) reported that most buried UXBs were found horizontal or upturned. This observation confirmed the 'J-curve effect'. As an HE bomb penetrates the ground, slightly offset from the vertical, its passage underground creates a 'J' shape.

This is relevant because the J-curve effect results in a horizontal offset between the buried UXB and its point of entry. This distance is estimated to be one third of the theoretical penetration depth. A low altitude attack, meaning a low impact angle, could produce an even greater offset, of up to 15m.

6.3.3 Site Specific Geology

BGS Mapping	Superficial Deposits: Kempton Park Gravel Member (Sand, Gravel)	Bedrock Deposits: London Clay Formation (clay, silt, sand)
SI Data	The client has provided borehole logs from SI works which have previously been undertaken on Site. This SI (September 2020) encountered the following ground conditions: - 1.50m of made ground - 0.50m of stiff light orangish brown sandy gravelly clay - 1.00m of firm mottled light grey and brown clay - 1.00m of firm brownish grey clay - 1.45m of high strength dark grey slightly sandy silty clay - 7.00m of stiff dark brownish grey to grey silty clay - 0.85m of firm dark brownish grey clay - 0.90m of soft dark brownish grey gravels - 2.80m of stiff greyish brown silty clay - 2.00m of firm grey silty clay - 0.50m of light greyish white hard very shelly clay	

6.3.4 Site Specific Maximum Bomb Penetration Depth

During WWII, the Luftwaffe dropped many different types of HE bomb. The SC (general purpose) series was by far the most numerous and of this series, the SC 500 model (weighing 500kg) was the largest of the most commonly deployed and therefore this will be used as the benchmark weapon for the Site-specific bomb penetration depth calculations.

In order to calculate the most likely maximum depth to which a bomb would penetrate, Brimstone has taken the average of the average and maximum figures for the predominant Site-specific geology (clay) in the table above. This gives a likely maximum bomb penetration depth of 14.25m below WWII ground level for a 500kg bomb.

Note, the Ministry of Home Security data indicates that the maximum bomb penetration depth could be down to 19.8m for a 500kg bomb, or 24.9m for a 1,000kg bomb; however, in line with the ALARP principle, it is not considered to be a likely scenario that a bomb would penetrate so deeply. Furthermore, while evidence indicates that a 1800kg HE bomb could penetrate to over 30m, these types of bombs were not dropped frequently. For example, War Office statistics confirm that between October 1940 and May 1941 the majority of HE UXBs (>90%) were either 50kg or 250kg, with the 500kg bombs making up most of the remaining 10%.

7 UXO RISK - BRITISH/ALLIED ACTIVITY

7.1 Introduction

The table below lists potential sources of UXO (excluding enemy action). Those which are potentially relevant to the Site are discussed in the subsequent section(s).

Potential UXO Source	Potentially Significant
Army or RAF training areas / ranges	×
Military bases and other installations	×
Munitions and explosives factories	×
Military storage depots	×
Defensive fortifications	×
Wartime site requisitions	×
WWII defensive mining (landmines)	×
WWII Home Guard activity	×
Wartime anti-aircraft fire	Π

7.2 Potential Sources of UXO

7.2.1 Introduction

Research has not located any evidence of significant British or Allied army, RAF or Royal Navy activity specifically on Site and none is likely to have occurred historically. The only likely potential source of British UXO contamination is therefore WWII AA artillery fire.

7.2.2 WWII Anti-Aircraft Fire

Anti-Aircraft (AA) Command was a British Army command established in 1939 to defend the UK during the anticipated German bombing campaign. It controlled the Territorial Army AA artillery and searchlight units. From 1940 to 1945 BDUs dealt with 7,000 unexploded AA shells in Britain. There were three main types of AA battery used for home defence (see below). Data sheets on these AA defences are included at APPENDIX 3.

> Heavy Anti-Aircraft (HAA): large-calibre guns (3.7" and 4.5") for engaging high-altitude bomber formations. Hundreds of permanent batteries were constructed in and around major cities and military bases during the 1930s. Some 2,000 of these guns were available during the Blitz. Each gun could fire between 10 and 20 rounds per minute and consequently HAA batteries could expend large quantities of shells during each engagement.

British time fuses were poorly manufactured during WWII, and this led to high failure rate for HAA shells, up to 30%. Unexploded HAA shells had the potential to land up to 27km from their battery, although more typically landed within a 15km radius.

Light Anti-Aircraft (LAA): smaller calibre guns for engaging dive bombers and low altitude intruders. As such, they were mostly used to defend specific industrial and military targets which were subject to precision bomber attack. LAA guns were either .303" calibre machine guns or 20mm and 40mm calibre cannon. The latter were fitted with simply impact fuses and small incendiary or HE bursting charges.

The 40mm Bofors gun could fire 120 x HE shells / minute to a ceiling of 1,800m. Each shell was designed to self-destruct if it didn't strike an aircraft, however, inevitably some failed and fell back to earth.

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.

Unlike bombs which were designed to strike the ground, AA projectiles and rockets were designed to function in the air. Due to their shape, and centre of gravity they would often not strike the ground nose first. This coupled with the lower mass of AA UXO resulted in shallower ground penetration depths, compared to UXBs. Although, in very soft conditions, unexploded AA projectiles have been found deeper than 1.5m bgl.

Numerous (>30) permanent HAA batteries were active within range of the Site during WWII. LAA guns likely defended vulnerable points within the borough. Luftwaffe activity was frequent and intense over the wider area and therefore these guns would have expended a vast quantity of ammunition. Consequently, there is an elevated likelihood of unexploded AA shells striking the Site and penetrating to a shallow depth within the open ground / footprint of severely damaged properties.

8 UXO RISK MITIGATING CIRCUMSTANCES

8.1 Introduction

Works on a UXO contaminated site could result in the partial or complete removal of UXO risk. Construction or earthworks may have uncovered any UXO contamination, which would then have been reported and removed by the authorities. A site may have been subject to an explosive ordnance clearance (EOC) task conducted by the armed forces. EOC tasks involve surveying, subsequent target investigation and removal of UXO. Although the effectiveness of historic EOC tasks will have often been unsatisfactory.

8.2 Explosive Ordnance Clearance Tasks

The division of EOC tasks has been complex throughout British military history. It used to be the case that anything under the water level would be dealt with by navy units, and anything on land would be dealt with by army units. In recent years, RAF Explosive Ordnance Disposal (EOD) capability has been discontinued, and now only the Royal Navy and the British Army have EOD units. In the army, the Royal Logistics Corps and Royal Engineer EOD units have been amalgamated to form 29 EOD & Search Group. Often taskings are assigned to either the naval or army elements based on where in the country the threat is and the nature of the threat.

Brimstone has access to a database of historic EOC tasks. This database is only complete up until the early 2000s and therefore does not include recent EOC tasks. No such database for the RAF and Royal Navy EOD units is easily accessible. A search of this database has not resulted in any Army EOC tasks in the vicinity of the Site.

UXO encounters on civilian land are often reported in the media and therefore a web search of local media outlets was also carried out. No recent incidents within close proximity to the Site were identified.

8.3 Ground Works

It is conceivable that some of the post-conflict ground works required deep (>2m bgl) excavations. Contemporary aerial photography indicates that all of the WWII-era structures on Site have been cleared, with high-rise structures subsequently constructed in the north-west, south-east and south-west of the Site. Further low-rise structures have been constructed across much of the remainder of the Site.

The construction of the post-WWII low-rise structures has likely disturbed WWII-era soil to shallow (1-2m bgl) depths. The grubbing out of foundations of pre-WWII structures would have disturbed soil down to the maximum depth of these foundations, thought to also be shallow.

8.4 Deductions

The risk associated with any deep buried German UXBs will likely have been mitigated in the locations of possible deep excavations in the north-west, south-east and south-west of the Site, although this cannot be confidently confirmed. The risk associated with any very shallow (<1m bgl) or shallow buried UXBs / HAA shells will have likely been mitigated with the clearance of pre-WWII structures and the subsequent construction of low-rise structures.

Please note, the risk of a UXO encounter can be considered mitigated in the exact locations and down to the exact depths of any post-WWII intrusive works.

9 CONCLUSION

9.1 Accuracy of Historical Records

Occasionally, the accuracy of some historical records can prove to be poor when compared with other sources of information. One significant consequence of this can be the possibility of unrecorded German bomb strikes in the study area. No such inconsistencies were noted within the records consulted for this report.

9.2 The Risk of UXO Contamination on Site

9.2.1 Key Findings – German UXO Risk

London was the most frequently and heavily bombed British city during WWII, with most damage being sustained by the central and eastern boroughs. Whilst the Site was situated on the south-eastern periphery of the city, approximately 10km away from the primary Luftwaffe target area in the region (the City of London), the wider area would have been vulnerable to overspill or inaccurate bombing. Consequently, the wider Site area experienced a high bombing density, as indicated by official wartime figures.

Indeed, London bomb census mapping records 46 HE bomb strikes within an approximate 300m radius of the Site. One HE bomb is recorded in the north-east of the Site, with another directly along the southern Site boundary. In addition, two incendiary bomb 'showers' were also recorded within a 300m radius of the Site; one of these is partially recorded over the eastern extent of the Site. Furthermore, LCC bomb damage records structural clearance to a structure on Eltham Road in the north of the Site, with further structures in the south-western extent recorded as sustaining 'general blast damage- not structural'. The closest substantial damage within LCC mapping is approximately 20m west of the Site, where structures were 'damaged beyond repair'.

The recorded damage is largely corroborated by post-WWII aerial photography, in which structural clearance is visible in the northern extent of and approximately 20m west of the Site. In addition, roofing repairs are visible to structures in the north-west and east of the Site; these are highlighted at FIGURE 5. Whilst these structures have sustained superficial damage, they appear to have remained structurally intact, evidenced by their repair rather than being cleared completely. The structures in the north-west of the Site appear to have survived without sustaining a significant degree of damage; this is also corroborated by LCC damage mapping, which records no damage to these structures.

Any UXB strike to undamaged locations within the Site footprint would have likely caused incontrovertible evidence of its occurrence as it passed through the structure and into the ground beneath. This apparent lack of damage also indicates that these structures would have remained inhabited / in use throughout the war, suggesting regular access, although periods of temporary evacuation may have occurred following bomb damage in the area.

However, large areas of open ground in the form of residential gardens were present in the centre and south of the Site during WWII. The ground conditions in these areas were likely less conducive to the visual detection of UXBs when compared to the developed areas, and they likely experienced a less frequent level of access as a result. Therefore, it is feasible that a UXB strike to this location could have occurred unnoticed and unrecorded, its entry hole obscured by vegetation and filling in over time.

The same can be said for the area of structural clearance in the north of the Site. Following this substantial damage and subsequent clearance of these structures, the ground conditions are highly unlikely to have been conducive to the visual detection of UXBs, with any UXB entry holes becoming easily obscured in rubble / debris. Furthermore, the plots would have been cordoned off / abandoned following damage occurring; this marked drop in access creates a situation wherein a subsequent UXB strike could easily go unnoticed and unrecorded. Moreover, a UXB strike to either this location, or the open ground on Site, could feasibly have come to rest beneath the undamaged structures on Site due to the J-curve effect, whereby an item of ordnance may travel laterally beneath the surface from its point of entry.

In summary, evidence of bomb strikes within the Site boundary has been found. However, structures throughout the north, east and west of the Site appear to have survived externally structurally intact. They were therefore likely subject to a frequent level of access throughout the war, increasing the likelihood of a UXB strike being noticed at the time. As a UXB strike in these locations would have caused incontrovertible evidence of its occurrence, a Low Risk has been assessed in these areas.

However, large areas of open ground are present on Site, alongside an area of structural clearance in the northern extent. A UXB strike in these locations, with the ground cover anticipated to have been unconducive to the visual detection of UXBs and experiencing an anticipated lower level of access, could have occurred unobserved and unrecorded, its entry hole obscured in rubble / debris. Furthermore, a UXB strike in these locations could have come to rest underneath undamaged structures on Site, owing to the J-curve effect. Therefore, areas of Moderate Risk have been assessed in the centre and south of the Site, including a 15m buffer to account for the J-curve distance from the open ground and ruins. These risk zones are presented on a risk map displayed at FIGURE 9.

9.2.2 Key Findings - British UXO Risk

No evidence of historic military activity within the Site boundary has been found and it is unlikely that any has occurred historically. Consequently, the risk from associated UXO is Low.

Numerous (>30) permanent heavy anti-aircraft (HAA) batteries were active within range of the Site during WWII. Luftwaffe activity was frequent and intense over the wider area and therefore these guns would have expended a vast quantity of ammunition. The risk of encountering unexploded HAA shells is considered to be homogenous with that of German UXBs and as such, has been assessed as Low and Moderate.

9.3 Site-Specific UXO Hazards

Different types of UXO pose differing types of hazard, depending on their structural design, Net Explosive Quantity (NEQ), fill type and likely contamination depth. The table below lists the main types of UXO most often encountered on urban UK sites and their relative hazard levels.

UXO Type	NEQ (NEQ Range)	Likely Burial Depth	Hazard Posed
WWII German General Purpose HE Bombs	25kg - 220kg (most commonly deployed bomb weights)	Deep burial (>2m)	HIGH
WWII British Heavy Anti-Aircraft Shells (HAA Shells)	1.1kg - 1.7kg	Shallow burial (1-2m)	MODERATE-HIGH
WWII British Land Service Ammunition (LSA)	<2kg	Shallow burial (1-2m)	
WWII German 2kg Incendiary / HE Bombs (IBs)	680g incendiary hazard + ~500g explosive hazard	Shallow burial (1-2m)	
WWII German 1kg IBs	680g (incendiary, not explosive hazard)	Shallow burial (1-2m)	MODERATE
WWII British Light Anti-Aircraft Shells (LAA Shells)	4g - 70g	Very shallow burial (<1m)	LOW-MODERATE
Small Arms Ammunition (SAA)	<1g	Very shallow burial (<1m)	LOW
Inert/Practice Item	0g	Very shallow burial (<1m)	

9.4 The Likelihood of UXO Encounter

9.4.1 Introduction

This report assesses the risk of UXO in relation to the proposed works, not simply the risk that UXO remains buried on Site. The likelihood of UXO encounter during intrusive ground works will vary depending on the type of UXO and the type of construction methods employed during the project. With increased soil disturbance i.e. more excavations, the likelihood of encountering UXO increases.

Within an area of elevated UXO contamination likelihood, the sub-surface volume of potential UXO contamination will comprise the natural soil / geology in between WWII ground level and the maximum bomb penetration depth. Therefore, any intrusions into this layer will be at risk of UXO encounter.

Any post-WWII fill material deposited on a site is unlikely to be contaminated with UXO and therefore the risk

of encountering UXO on such a site could vary with depth.

In the wake of the initial nine-month Blitz, many cities and towns were left with vast quantities of bomb site rubble that required removal and relocation. This material was put to use for in a variety of ways, for example >750,000 tons of London's rubble was used to build runways for new RAF and USAAF airfields and much of Liverpool's rubble was used to create and maintain sea / flood defences throughout Merseyside.

It is quite possible that unexploded British AA projectiles and German 1kg incendiaries were overlooked during removal, resulting in UXO contaminated fill material ending up on otherwise low UXO risk sites, possibly many miles from any high bombing density areas.

9.4.2 German UXBs

Although most German UXBs came to rest several metres below WWII ground level, these weapons can be found at any level between just below WWII ground level and the maximum bomb penetration depth. There are a number of reasons why these heavy bombs might be found at surprisingly shallow depths.

Tip and run: When enemy aircraft had to take evasive action to escape RAF fighter intercepts or AA defences, they often dropped their bomb loads from a reduced height, potentially resulting in extreme J-curve effect.

Deflection: the shape of German bomb nose sections meant they were susceptible to deflection when striking surface or shallow sub-surface obstacles, occasionally resulting in shallow burial or even UXBs skidding across hardstanding.

Aircraft Crash Site: if an aircraft was unable to dump its bomb load before impacting the ground, due to mechanical fault, any externally fitted bombs could have become buried on impact.

German 1kg / 2kg incendiaries were cylindrical and approximately 50mm in diameter. They had tail sections, and so landed nose first. Within soft ground this could result in full penetration of the bomb below the surface. Such UXBs are usually found close to the surface.

9.4.3 British / Allied UXO

The nature of British/Allied military activity involving LSA and SAA and the smaller size of these munitions (in relation to German HE bombs) indicates that any resulting UXO contamination on a site will be limited to shallow depths, usually within 1.5m of the surface, notwithstanding added material to raise the ground level.

Domestic military LSA and SAA contamination will either be the result of expending blinds (dud ammunition) which bury into the ground on impact or munitions purposefully buried, for a number of reasons. Either way, these types of UXO are all found at shallow depth.

9.4.4 Deductions

An elevated likelihood of UXO contamination (German) and likelihood of that UXO remaining up to the present day has been identified in areas of the Site. Therefore, all the proposed works within the Moderate Risk zone are considered to be exposed to a UXO encounter.

10 OVERALL RISK RATING

Ratings for the likelihood of UXO contaminating the Site, remaining within the Site up to the present day and being encountered during the proposed works, inform the overall risk rating. Please refer to the UXO hazard table presented in Section 9.3 for a breakdown of the most common hazards and their associated risk. The colour of each respective type of hazard indicates the associated risk, as defined within the aforementioned table. The UXO risk to the proposed works varies. Zones of Low Risk and Moderate Risk have been assessed, these are presented on a risk map at FIGURE 9, and in the table below.

Risk Table					
Risk Zone	UXO Type (Hazard)	Likelihood of UXO Contamination	Likelihood of UXO Remaining	Likelihood of UXO Encounter	Overall Risk Rating
Low	WWII German GP HE Bombs	Low	n/a		LOW
	HAA Shells	Low	n/a		
	LSA	Low	n/a		
	German 2kg IBs	Low	n/a		
	German 1kg IBs	Low	n/a		
	LAA Shells	Low	n/a		
	SAA	Low	n/a		
Moderate	WWII German GP HE Bombs	Moderate	Moderate-High	Moderate	MODERATE
	HAA Shells	Moderate	Moderate	Moderate-High	
	LSA	Low	n/a		LOW
	German 2kg IBs	Low	n/a		
	German 1kg IBs	Low	n/a		
	LAA Shells	Low	n/a		
	SAA	Low	n/a		

11 RISK MITIGATION RECOMMENDATIONS

Brimstone has identified an elevated UXO risk to some of the proposed works. The measures detailed below are recommended to mitigate the risk to ALARP level.

Risk Mitigation Measure	Recommendation
UXO Safety Awareness Briefings: To all personnel conducting intrusive works on Site. An essential part of the Health & Safety Plan for a site. Conforms to the requirements of CDM2015.	Prior to all intrusive works commencing.
EOD Engineer - On Site Supervision: Watching brief for open excavations below WWII ground level. Portable magnetometer instruments for clearing ground ahead of borehole positions and shallow excavations (where / when appropriate). Positive identification of suspicious (non UXO) objects. Liaison during confirmed UXO incidents. Provision of additional UXO Safety Awareness Briefings.	Watching brief of all open excavations and magnetometer survey of borehole locations within the Moderate Risk zone.
Intrusive Magnetometer Probe Survey: A range of intrusive magnetometer methodologies can be deployed to survey the ground (down to the maximum bomb penetration depth) prior to deep intrusive works; pile foundations. The appropriate technique is governed by a number of factors, the most important being the site-specific ground conditions.	Of all/any pile positions within the Moderate Risk zone.

FIGURES: 1 - 9

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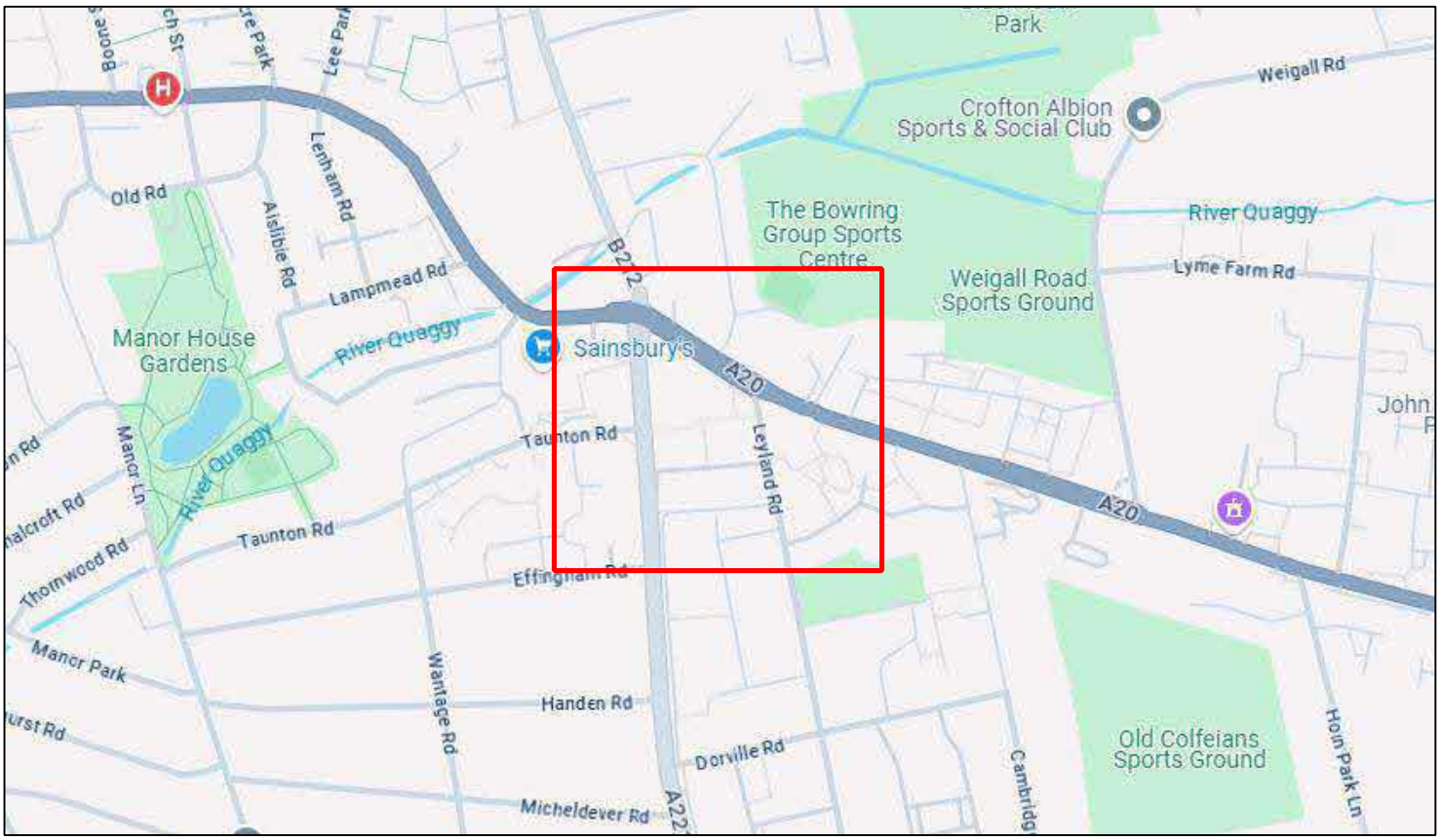
N	Title:	Site Location Maps	FIGURE: 1



Project:	Leegate, Lewisham
Client:	London Square
Report Ref:	DRA-25-1870
General Site Location:	Info Source: Google (open-source)

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Title: Recent Aerial Photograph

FIGURE: 2

Project:	Leegate, Lewisham
Client:	London Square
Report Ref:	DRA-25-1870
Approx. Site Boundary:	
Info Source:	Google (open-source)

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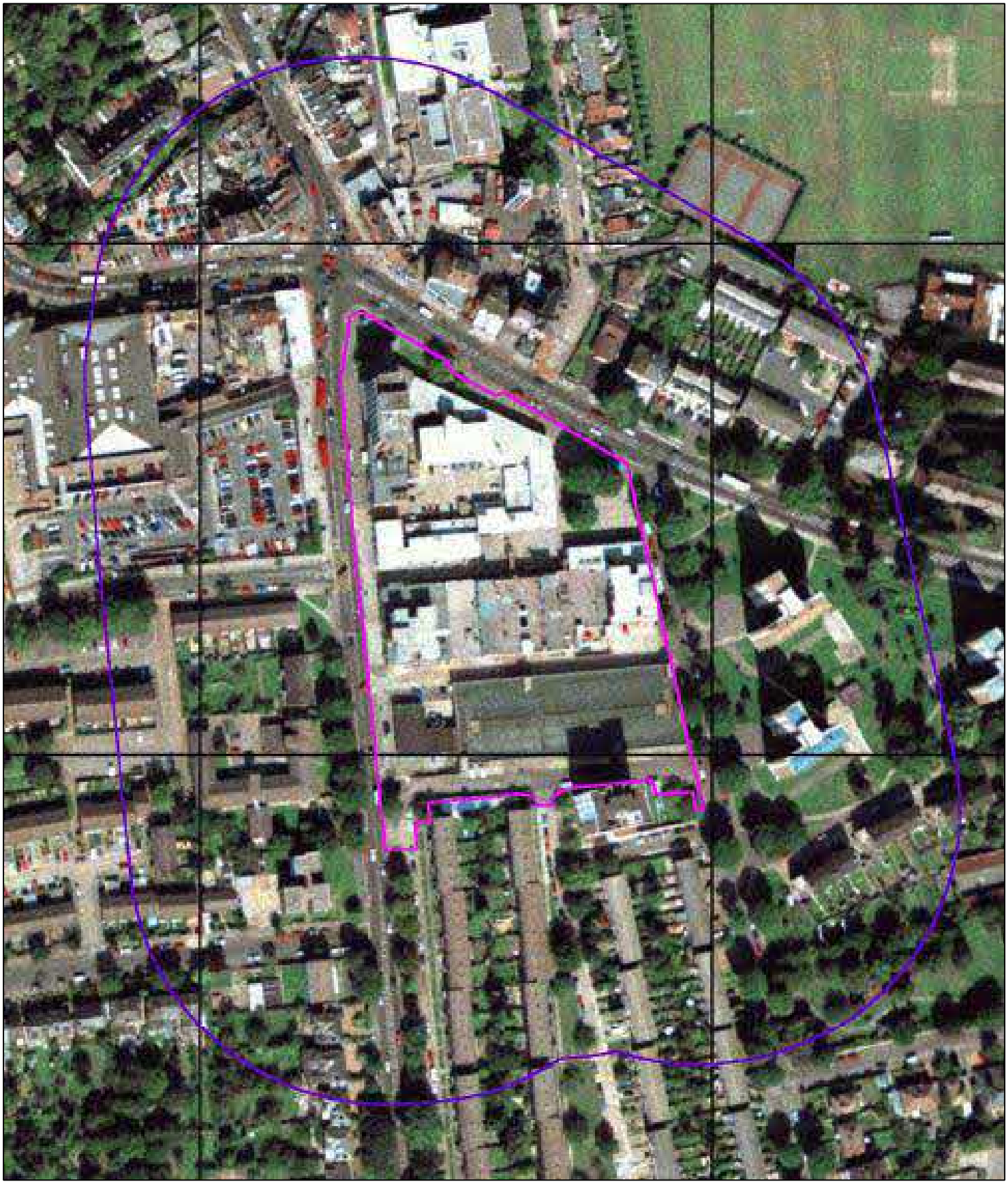
Title: Existing Site Plan

FIGURE: 3



Project:	Leegate, Lewisham
Client:	London Square
Report Ref:	DRA-25-1870
Site Boundary:	Info Source: London Square

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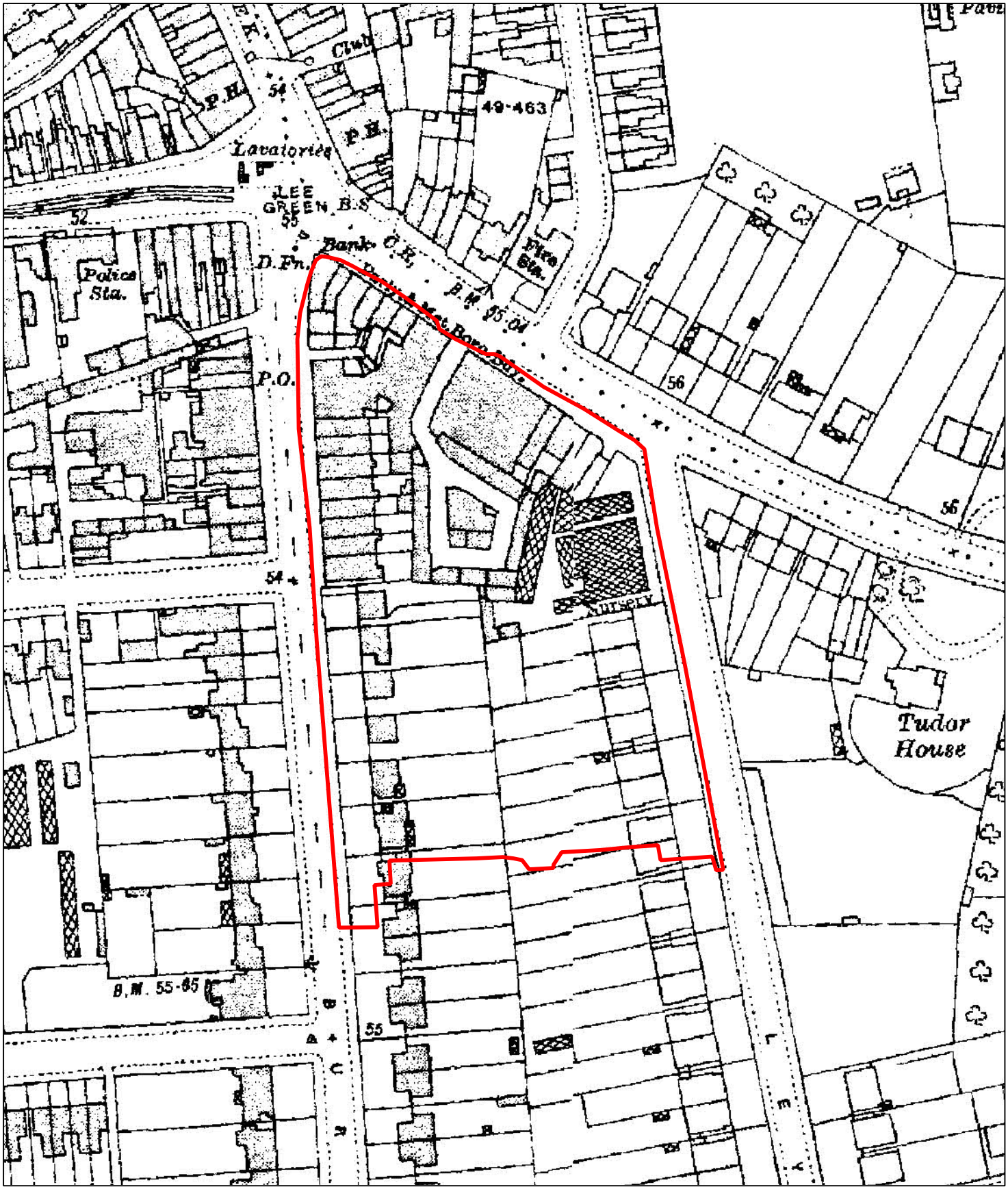
Title: Historical OS Mapping – 1916

FIGURE: 4.1



Project:	Leegate, Lewisham
Client:	London Square
Report Ref:	DRA-25-1870
Approx. Site Boundary:	Info Source: Landmark Maps

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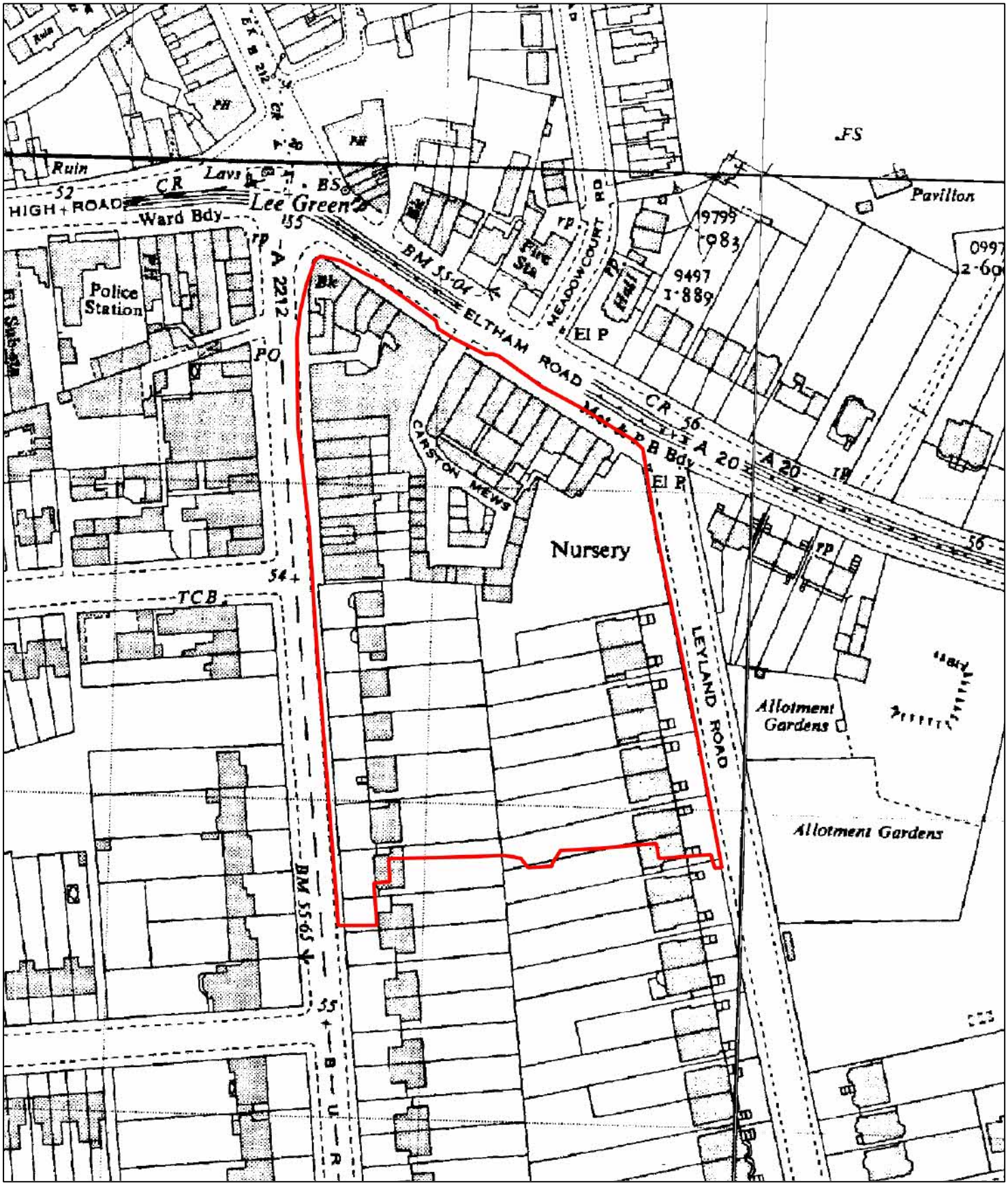
Title: Historical OS Mapping – 1950-1951 FIGURE: 4.2



Project:	Leegate, Lewisham
Client:	London Square
Report Ref:	DRA-25-1870
Approx. Site Boundary:	Info Source: Landmark Maps

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Title:	Historical Aerial Photography – 26th August 1945	FIGURE: 5.1

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Client:	London Square
Report Ref:	DRA-25-1870
Partial. Site Boundary:	Info Source: Historic England

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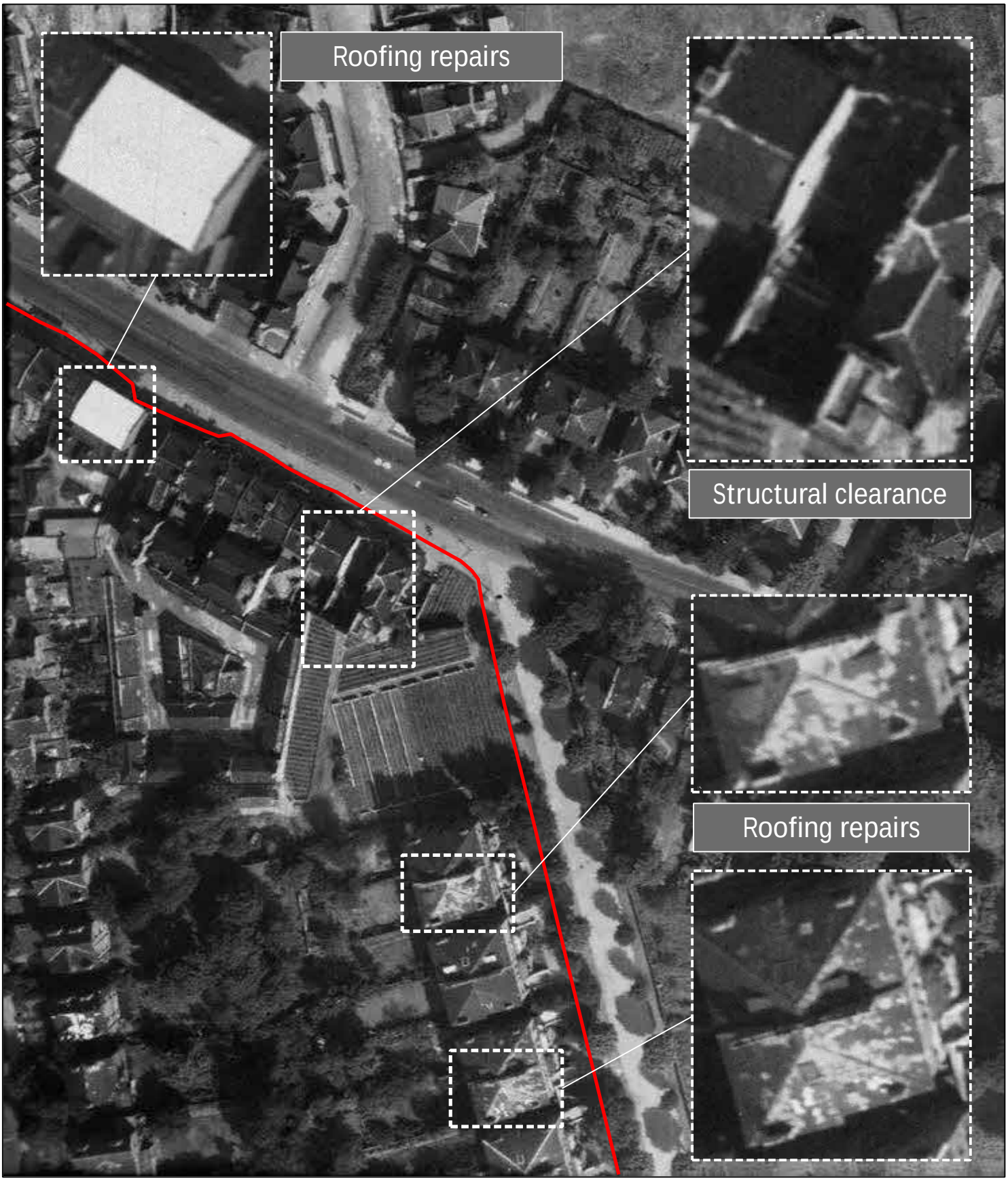
Title:	Historical Aerial Photography – 26th August 1945	FIGURE: 5.2



Project:	Leegate, Lewisham
Client:	London Square
Report Ref:	DRA-25-1870
Approx. Site Boundary:	Info Source: Historic England

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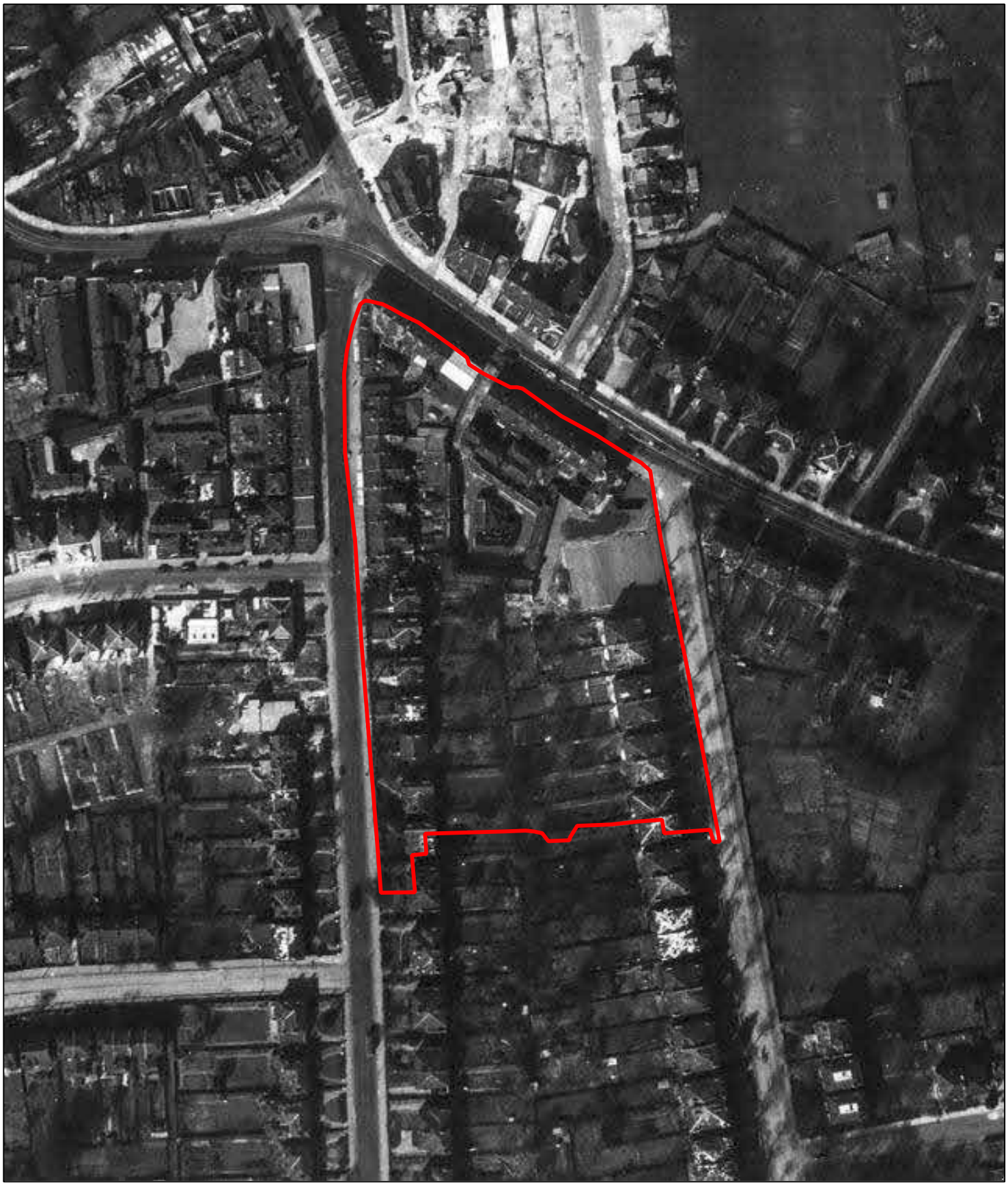
Title: Historical Aerial Photography – 2nd April 1946

FIGURE: 5.3



Project:	Leegate, Lewisham
Client:	London Square
Report Ref:	DRA-25-1870
Approx. Site Boundary:	Info Source: Historic England

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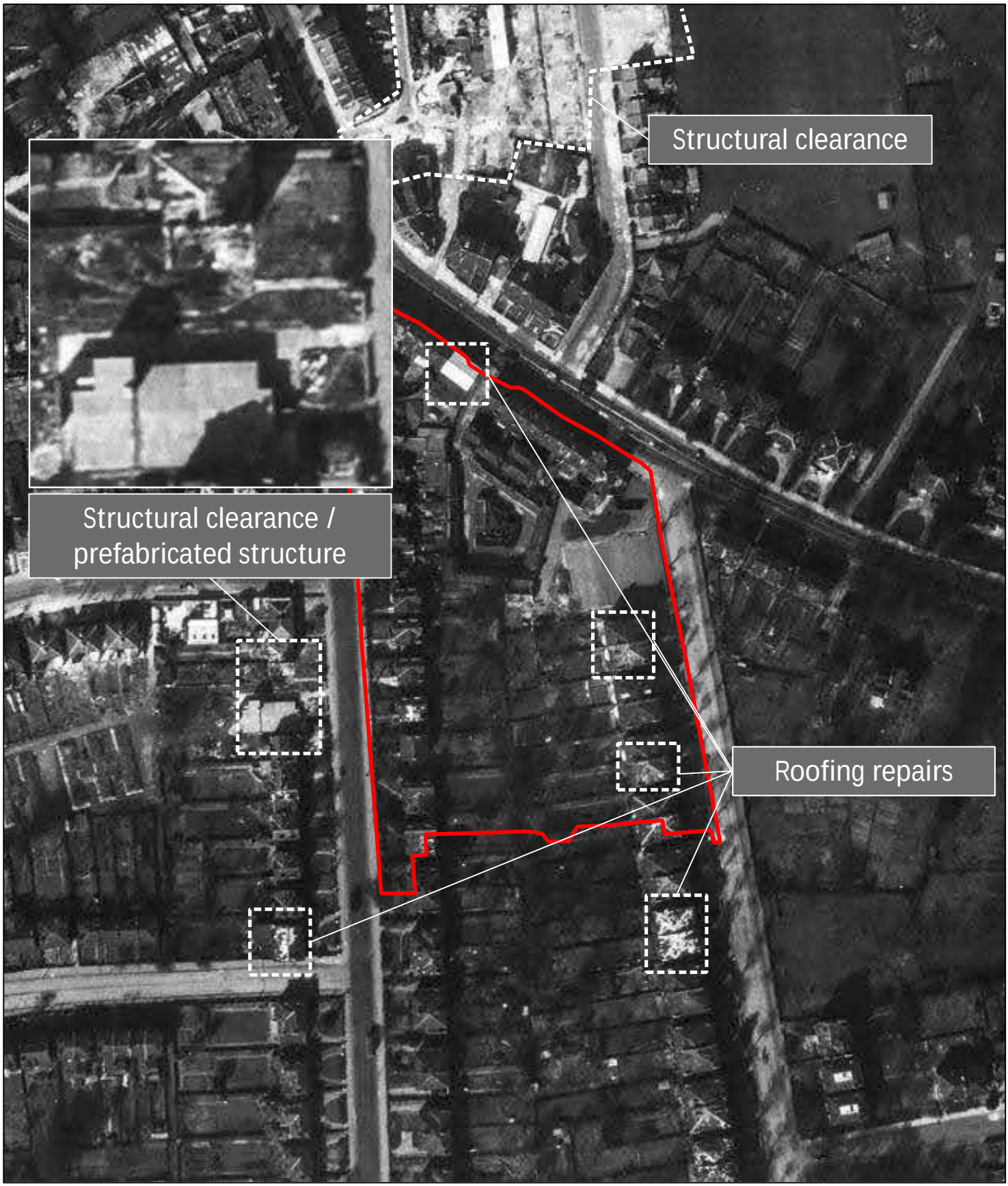
Title: Historical Aerial Photography – 2nd April 1946

FIGURE: 5.4



Project:	Leegate, Lewisham
Client:	London Square
Report Ref:	DRA-25-1870
Approx. Site Boundary:	Info Source: Historic England

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Title: Consolidated Bomb Census Mapping – Night Bombing up to 07/10/1940

FIGURE: 6.1

● 'Iron' bomb

● Parachute Mine

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Client:	London Square
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Approx. Site Boundary:	Info Source: The National Archives

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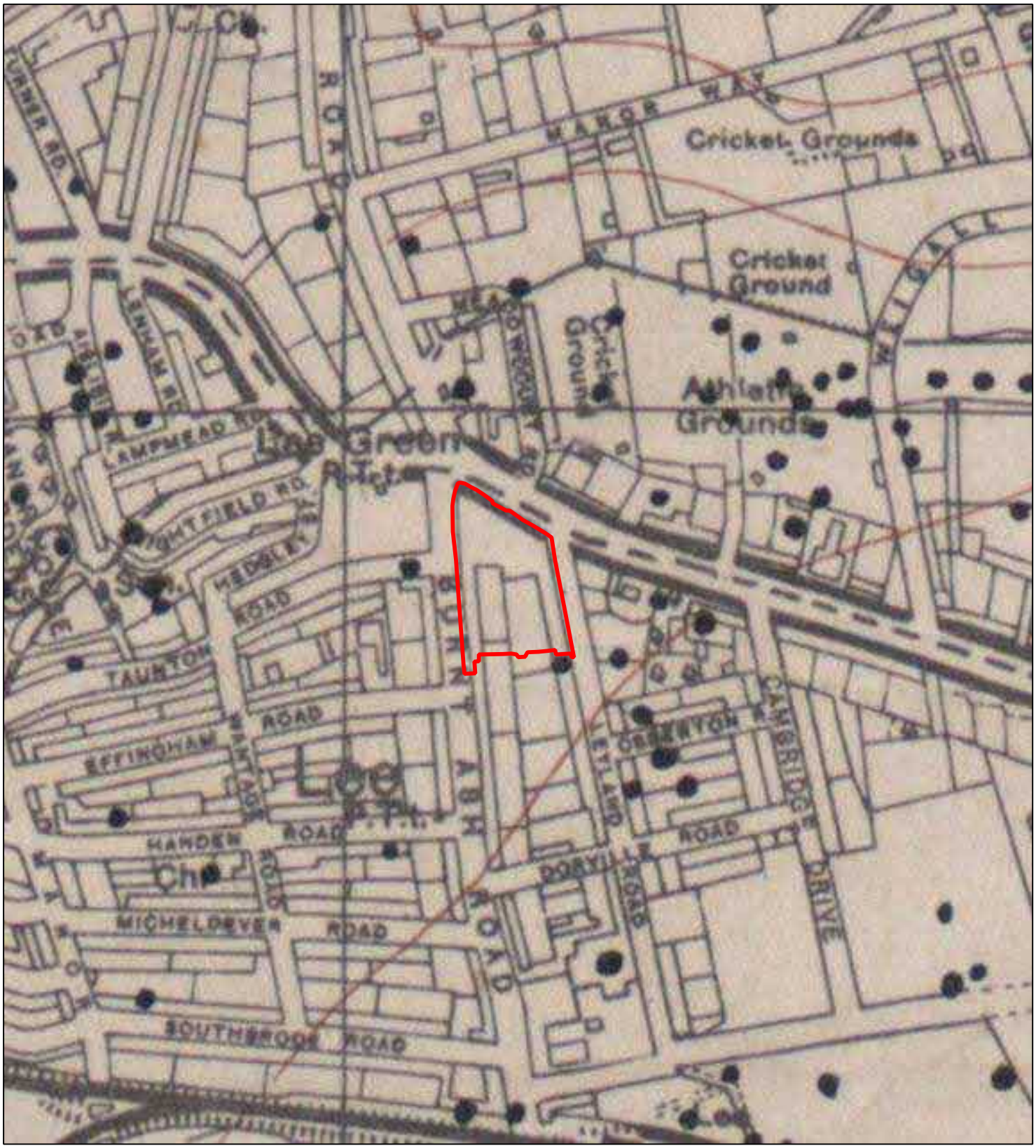
Title: Consolidated Bomb Census Mapping – Night Bombing 07/09/1940 - 28/07/1941

FIGURE: 6.2



● 'Iron' bomb

● Parachute Mine

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Client:	London Square
Report Ref:	DRA-25-1870
Approx. Site Boundary:	Info Source: The National Archives

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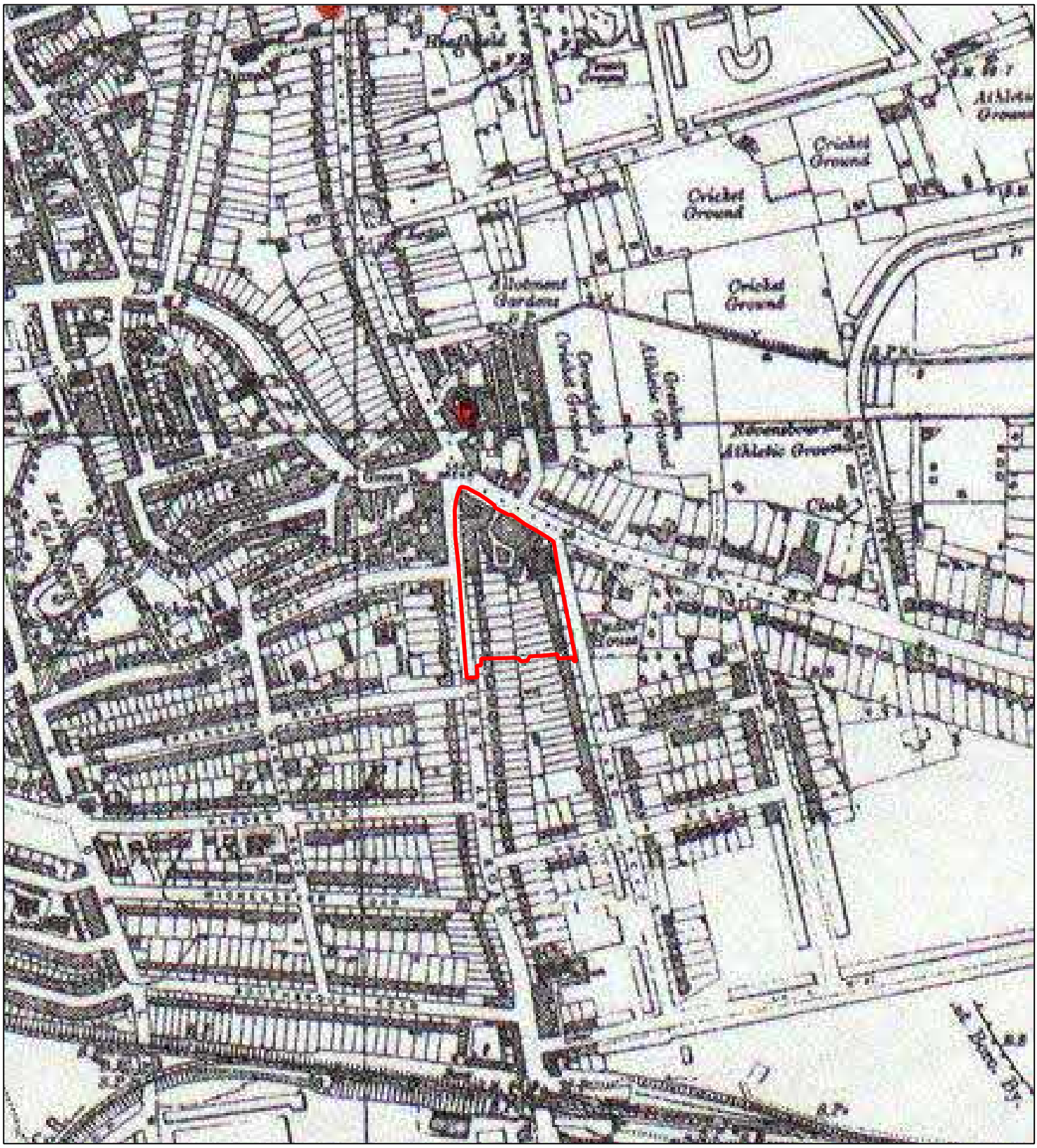
Title: Consolidated Bomb Census Mapping – Day Bombing 08/10/1940 - 31/12/1941

FIGURE: 6.3



● 'Iron' bomb

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Client:	London Square
Report Ref:	DRA-25-1870
Approx. Site Boundary: —— Info Source:	The National Archives

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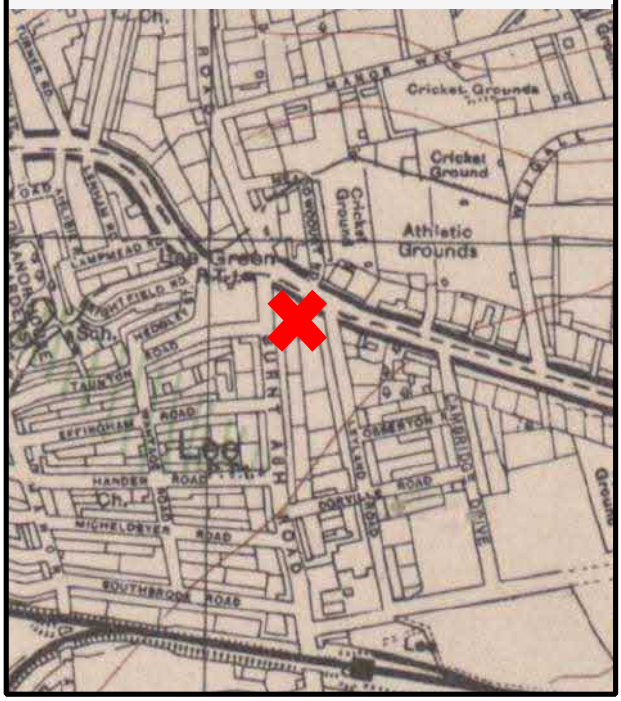
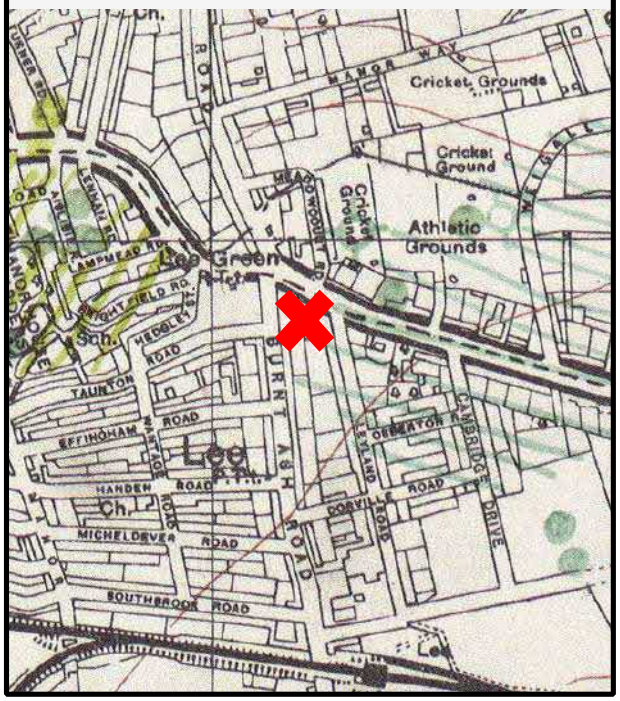
Title: Weekly Bomb Census Mapping –18/11/1940 - 24/03/1941

FIGURE: 6.4

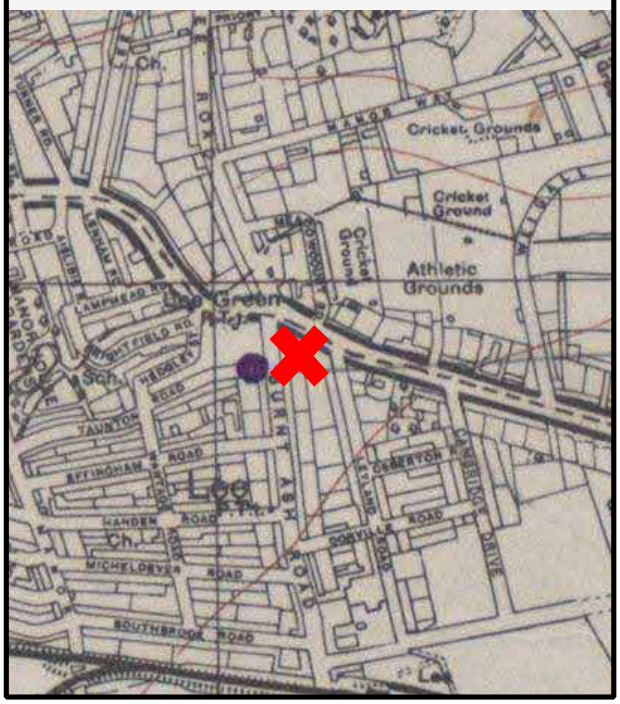
18/11/1940 – 25/11/1940



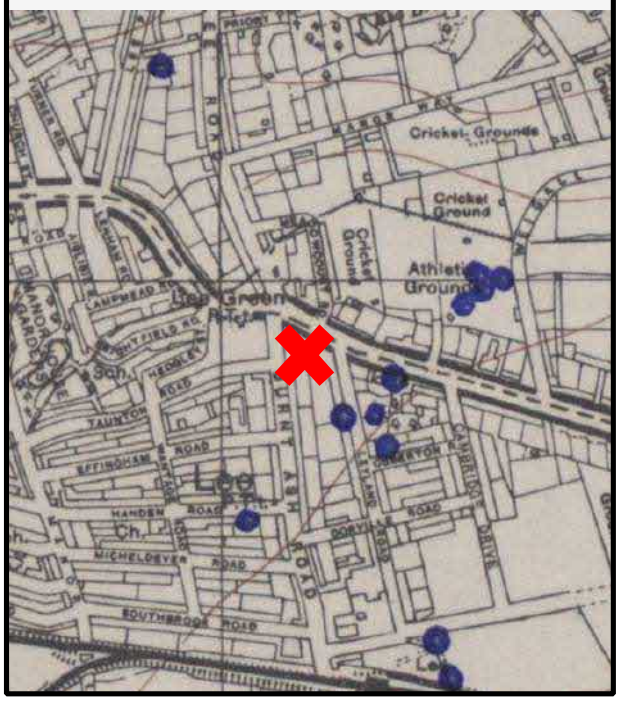
23/10/1940 – 30/12/1940



10/03/1941 – 17/03/1941



17/03/1941 –24/03/1941



Key:

Bomb strike (any colour)

Incendiary bombing (any colour)

Potential bomb stick

Project:	Leegate, Lewisham
Client:	London Square
Report Ref:	DRA-25-1870
Approx. Site Location: ✖	Info Source: The National Archives

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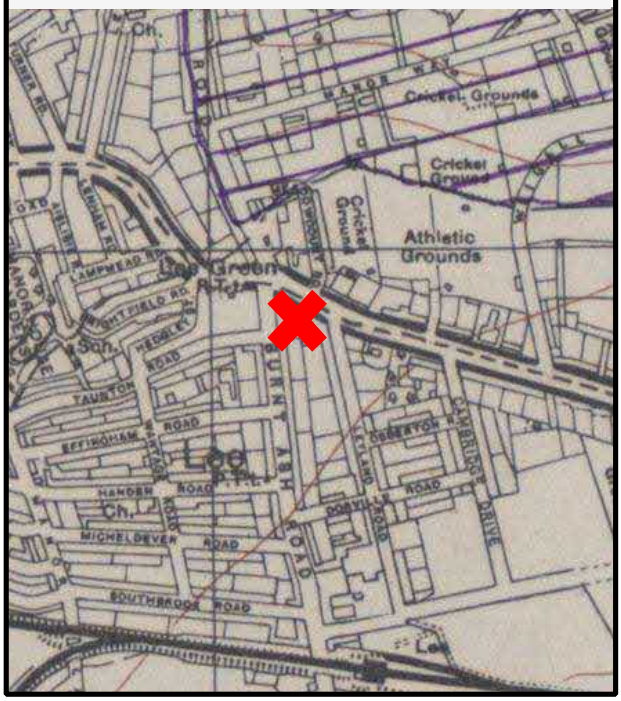
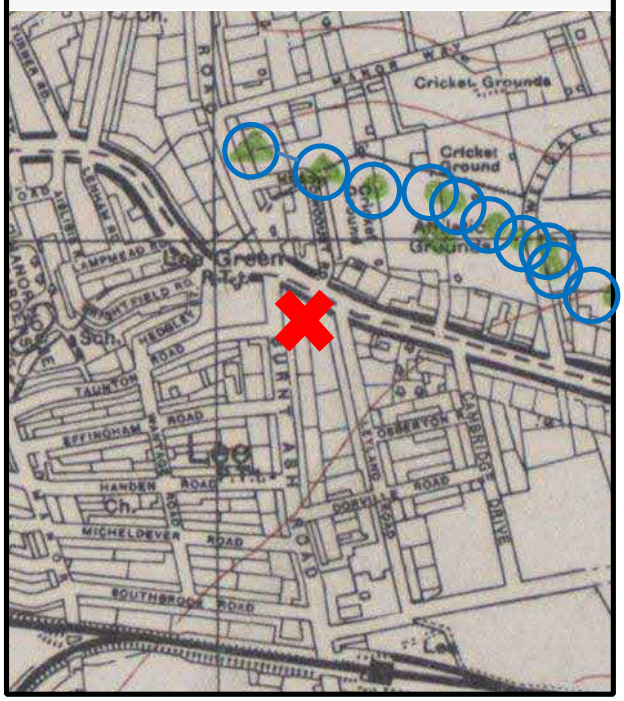
Title: Weekly Bomb Census Mapping –05/05/1941 – 24/10/1943

FIGURE: 6.5

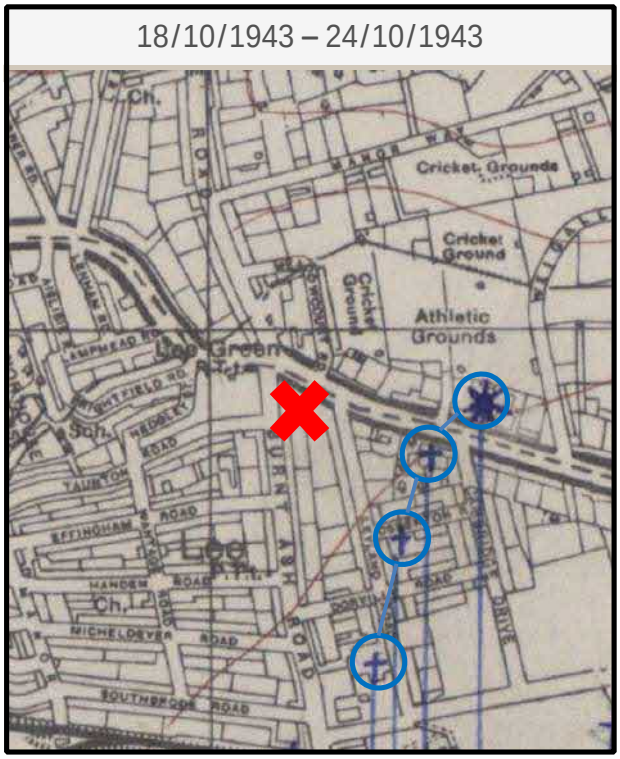
05/05/1941 – 12/05/1941



21/07/1941 – 28/07/1941



18/10/1943 – 24/10/1943



Key:

Bomb strike (any colour)

Incendiary bombing (any colour)

Potential bomb stick

Project:	Leegate, Lewisham
Client:	London Square
Report Ref:	DRA-25-1870
Approx. Site Location: ✖	Info Source: The National Archives

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Title: London / Middlesex County Council Bomb Damage Map

FIGURE: 7

Key:

- Black: Total destruction
- Purple: Damaged beyond repair
- Dark red: Seriously damaged – doubtful if repairable
- Light red/pink: Seriously damaged – repairable at cost
- Orange: General blast damage – not structural
- Yellow: Blast damage – minor in nature
- Light green: Clearance areas
- Small circle: V2 long-range rocket strike
- Large circle: V1 flying bomb strike

Project:	Leegate, Lewisham
Client:	London Square
Report Ref:	DRA-25-1870
Approx. Site Boundary:	Info Source: London Metropolitan Archive

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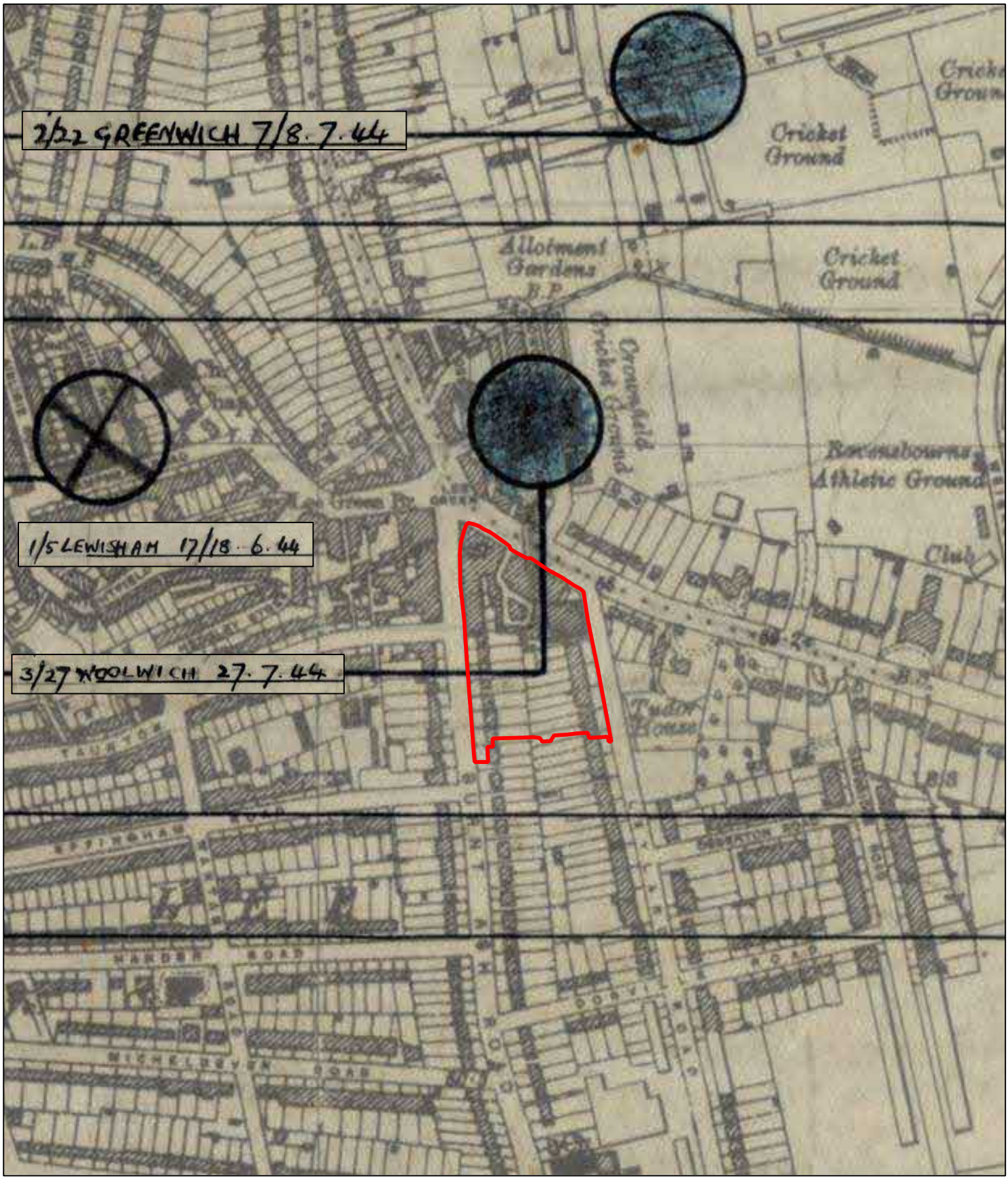
Title: Lewisham V1 Mapping

FIGURE: 8



Project:	Leegate, Lewisham
Client:	London Square
Report Ref:	DRA-25-1870
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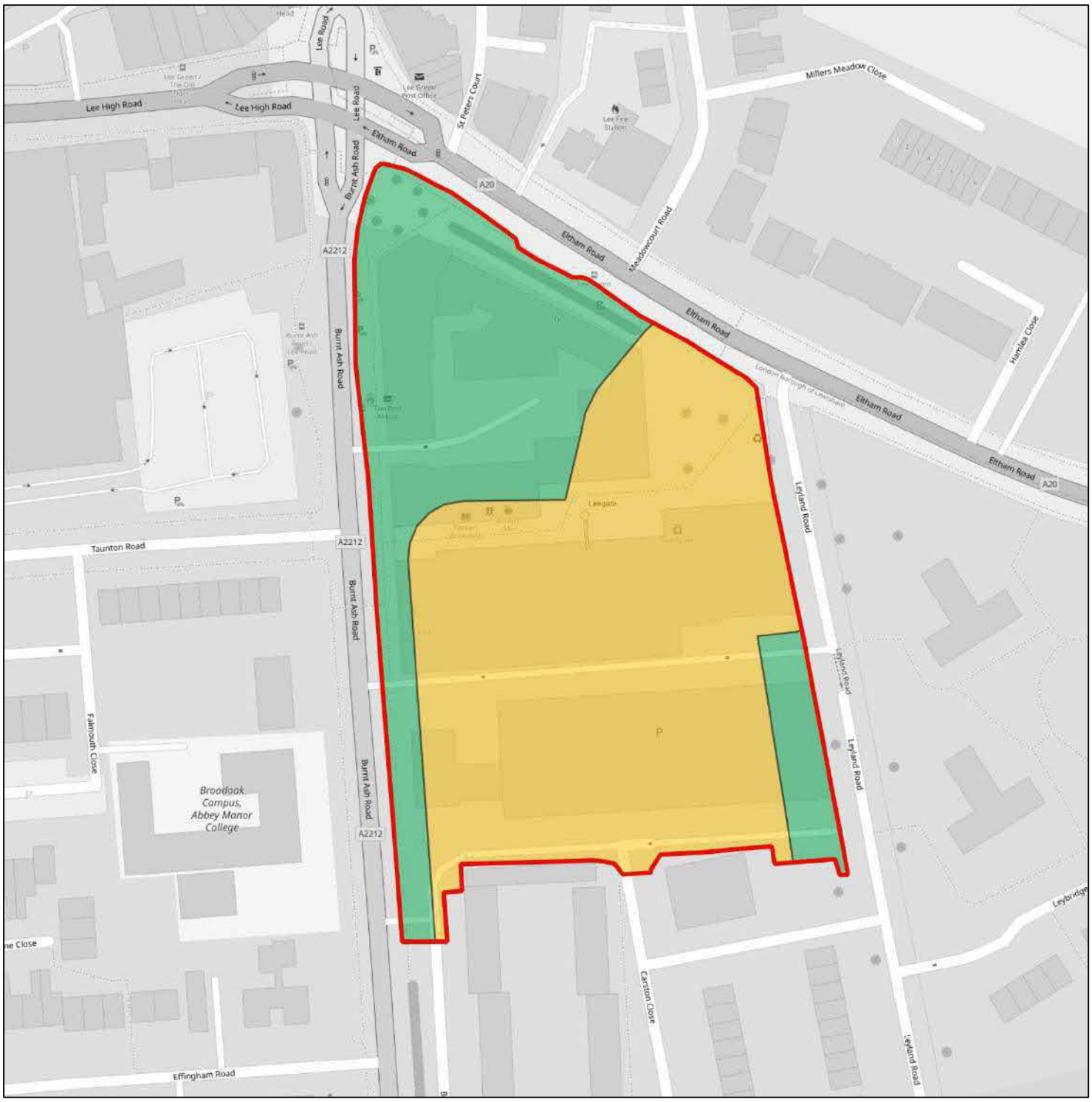
N	Title:	Risk Map	FIGURE: 9.1



LOW RISK: Low likelihood of German and British UXO remaining here.

MODERATE RISK: Elevated likelihood of German UXO remaining here.

Project:	Leegate, Lewisham
Client:	London Square
Report Ref:	DRA-25-1870
Approx. Site Boundary:	Info Source: Brimstone

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Title: Risk Map FIGURE: 9.2

LOW RISK: Low likelihood of German and British UXO remaining here.

MODERATE RISK: Elevated likelihood of German UXO remaining here.

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Client:	London Square
Report Ref:	DRA-25-1870
Approx. Site Boundary:	Info Source: Brimstone

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APPENDICES: 1 - 5

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Recent German UXB Finds in the UK + Historical Analysis

The Ministry of Defence (MOD) says that bomb disposal teams around the UK deal with approximately 60 German WWII-era UXBs per year.

- 20th February 2024 – An SC500 (standard 500kg HE bomb) was found during shallow excavations in a residential garden in Keyham, Plymouth. Historical Analysis: The UXB landed in a small residential back garden belonging to an undamaged terraced house. It came to rest at approximately 1 to 2m bgl.
- 10th February 2023 – An SC250 (standard 250kg HE bomb) was dredged out of the River Yare in Great Yarmouth. The UXB detonated unexpectedly in situ during an attempt to disarm it. Historical Analysis: The UXB landed in the River Yare; the precise location of its initial impact is unknown. UXBs in water are often affected by migration, whereby the item can travel along the riverbed.
- 26th February 2021 – An SC1000 (standard 1,000kg HE bomb) was discovered during shallow excavations in Exeter, adjacent to the University of Exeter. The item was detonated in situ and caused structural damage to nearby properties, leaving some inhabitable. Historical Analysis: The UXB landed in undeveloped land of no obvious significance. It came to rest at approximately 2 to 3m bgl with its nose facing upwards, highlighting the potential of J-curve occurring.
- 23rd May 2019 - An SC250 (standard 250kg HE bomb) was found during shallow excavations at a building site in Kingston upon Thames, London. Historical Analysis: The UXB landed in a small residential back garden belonging to an undamaged terraced house. It came to rest approximately 3 to 4m bgl.
- 11th February 2018 – An SC500 (standard 500kg bomb) was discovered in George V Dock in London during planned work at London City Airport. Historical Analysis: George V Dock was identified as a primary target by the Luftwaffe during WWII and was bombed on multiple occasions.
- 15th May 2017 - An SC250 (standard 250kg HE bomb) was found during shallow excavations at a building site in Aston, Birmingham. Historical Analysis: The UXB landed in a small back garden belonging to a terraced house, part of a row. It J-Curved under a neighbouring garden and came to rest at just 1.4m bgl. NB: These houses had not sustained bomb damage.
- 2nd March 2017 - A 250kg HE bomb was found during deep excavations at a building site in Brondesbury Park, London. Historical Analysis: UXB landed in a large residential back garden. A single storey building was built on top of the UXB post-WWII.

Recent Allied UXB finds in Europe

- 27th June 2024 – A 250kg HE UXB of Allied origin was discovered in a wooded area in Gruenheide (Germany).
- 26th April 2024 – A 500kg American HE UXB was discovered during construction work in Mainz (Germany), nearby the MEWA Arena stadium.
- 3rd April 2024 – A 500kg UXB of Allied origin was discovered during construction work on a shipping channel in Deutz, Cologne (Germany). The device was defused in situ.
- 28th March 2024 – A 500lb American HE UXB was discovered during construction work in Aachen (Germany). The device was defused in situ.
- 11th August 2023 – A 250kg HE UXB of Allied origin was discovered in Lublin (Poland). The device was discovered in an area where an aircraft factory had been located prior to WWII.
- 8th August 2023 – An unexploded "one-tonne shell" (1000kg HE UXB) of anticipated Allied origin was discovered near Dusseldorf city zoo (Germany).
- 5th July 2023 – A UXB of unspecified origin and calibre (alleged to have been Russian but no confirmation) was discovered on a construction site in Hohenschönhausen, Berlin (Germany). The device was defused in situ.
- 17th March 2022 – A farmer ploughing a field discovered a British INC30 (incendiary) bomb, which contained phosphorous, in Viersen (Germany). The plough became embedded in the device, which did not explode.

NB: Domestic UXO finds in the UK are too numerous to list. Between 2006 and 2009, over 15,000 items of British / Allied UXO (excluding small arms ammunition) were found on UK construction sites (CIRIA).

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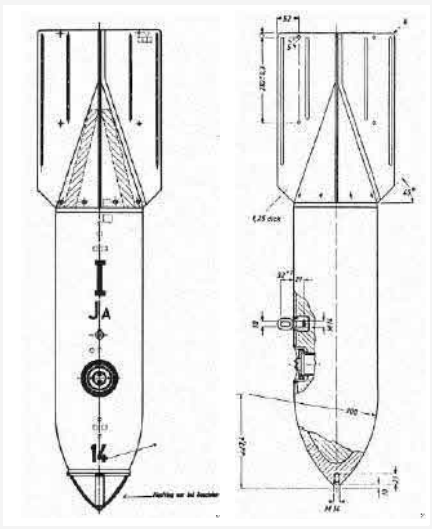
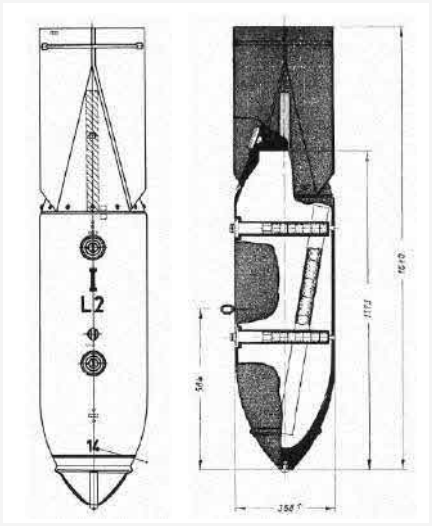
SC 50

Bomb Weight:	40-54kg (110-119lb)
Explosive Weight:	25kg (55lb)
Filling:	TNT, Amatol or Trialen
Charge/Weight Ratio:	46%
Fuse Type:	Electrical impact fuse or mechanical delayed action fuse
Body Dimensions:	1,100mm length x 200mm diameter
Appearance:	Bomb body and tail painted grey/green with a yellow stripe on the tail unit. Steel construction.
Variants:	8 x variants. Additional fittings: Kopfring nose for limited penetration and Stabbo nose for dive-bombing.



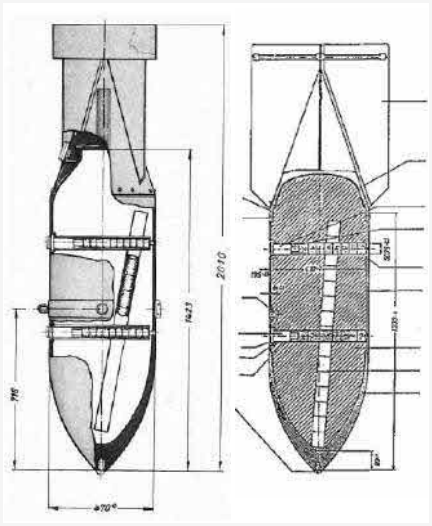
SC 250

Bomb Weight:	245-256kg (540-564lb)
Explosive Weight:	125-130kg (276-287lb)
Filling:	TNT, Amatol and Trialen mix
Charge/Weight Ratio:	44%
Fuse Type:	1 or 2 electrical impact fuse(s) or mechanical delayed action fuse(s)
Body Dimensions:	1,173mm length x 368mm diameter
Appearance:	Bomb body and tail painted grey/green with a yellow stripe on the tail unit. Steel construction.
Variants:	8 x variants. Kopfring nose for limited penetration. Stabbo nose for dive-bombing.



SC 500

Bomb Weight:	480-520kg (1,058-1,146lb)
Explosive Weight:	220kg (485lb)
Filling:	TNT, Amatol and Trialen mix
Charge/Weight Ratio:	44%
Fuse Type:	2 electrical impact fuses or mechanical delayed action fuses
Body Dimensions:	1,423mm length x 470mm diameter
Appearance:	Bomb body and tail painted grey/green or buff with a yellow stripe on the tail unit. Steel construction.
Variants:	3 x variants. Kopfring nose for limited penetration.



Project:	Leegate, Lewisham
Client:	London Square
Report Ref:	DRA-25-1870
Info Source:	W, Ramsey.1988 / various news sources

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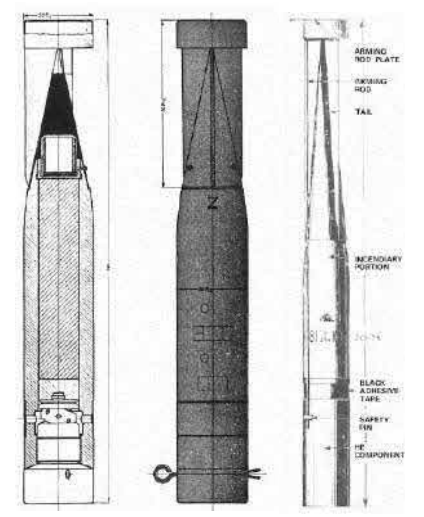
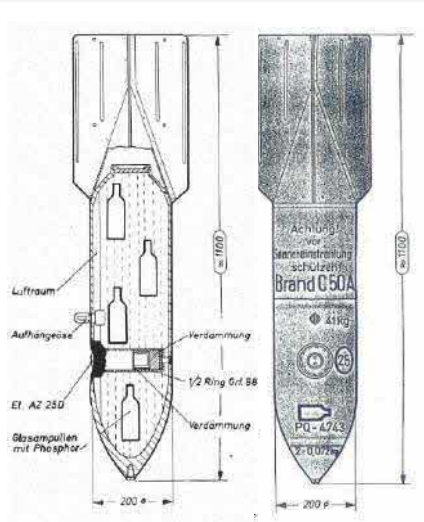
B-1E Sub-Munition

Bomb Weight:	1-1.3kg (2.2-2.87lb)
Incendiary Weight:	680g (1.4lb)
Filling:	Thermite
Fuse Type:	Simple impact fuse
Body Dimensions:	247mm length x 50mm diameter
Appearance:	Grey body and dark green painted tail unit. Magnesium alloy case.
Operation:	Small percussion charge ignites Thermite (>1,000°C burn).
Variants:	Most common variant: B 2EZ (2kg) included a small HE charge
Remarks:	Drop containers varied in size. The smallest cluster bomb held 36 x B-1Es and the largest 620 x B-1Es.



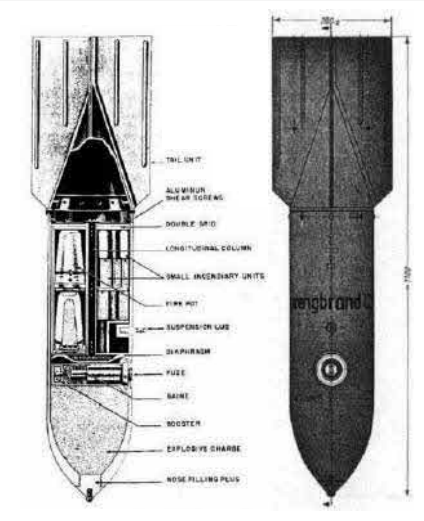
Brand C50

Bomb Weight:	41kg (90.4lb)
Incendiary Weight:	13kg (30lb)
Filling:	Main fill (86% Benzine, 10% Rubber) plus 4% Phosphorus in glass bottles
Fuse Type:	1 x electrical impact fuse
Bomb Dimensions:	762mm length x 203mm diameter
Appearance:	bomb body and tail painted grey or green with the rear of the bomb painted red and a red band around the centre of the body.
Variants:	C 50 B: 77% White Phos fill C 250 A: 87.7% Petroleum, 11.7% Polystyrene, 0.5% White Phos (185kg version)



Spreng-Brand C50 - Fire Pot

Bomb Weight:	34kg (75lb)
Explosive Weight:	9kg (20lb)
Filling:	TNT burster charge, 6 x Thermite containers (fire pots) and 67 x small triangular incendiary elements.
Fuse Type:	1 x electrical impact fuses or aerial burst fuse
Bomb Dimensions:	711mm length x 203mm diameter
Appearance:	Bomb body and tail painted grey/green or pale blue with red base plug and red or green incendiary markings. Steel construction.
Operation:	A charge blows off the base plate, firing a plume of incendiary mixture 100 yds. Approx 1 second later the HE charge detonates.



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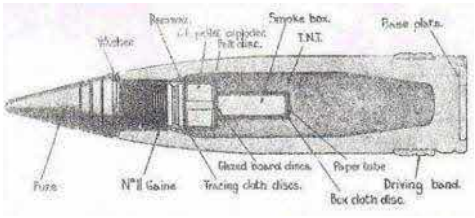
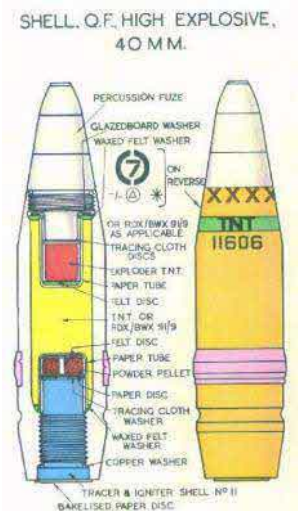
HAA Battery - 3.7" QF Shell

Shell Weight:	12.7kg
Shell Dimensions:	94mm x 438mm
Fill Weight:	1.1kg
Fill Type:	TNT
Fuse Type:	Mechanical Time Delay fuse
Appearance:	Grey body, copper driving bands, brass neck
Rate of Fire:	10 - 20 rpm
Ceiling:	9,000 - 18,000m
Variants:	HE or shrapnel shells. Note, the 4.5" gun was also used in an HAA role throughout the UK.



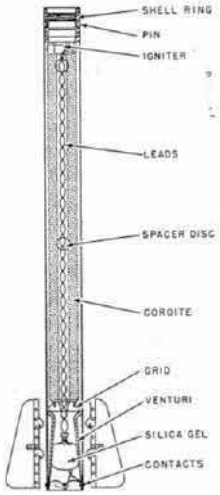
LAA Battery - 40mm Bofors Shell

Shell Weight:	0.84kg
Shell Dimensions:	40mm x 180mm
Fill Weight:	70g
Fill Type:	TNT
Fuse Type:	Impact fuse
Appearance:	Grey body, copper driving bands, brass neck
Rate of Fire:	120 rpm
Ceiling:	7,000m
Variants:	HE or AP shells. Both with rear tracer compartment



Z Battery - 3" U.P Rocket

Rocket Weight:	24.5kg
Warhead Weight:	1.94kg
Filling:	TNT warhead. Black Powder solid fuel rocket motor.
Fuse Type:	Mechanical Time Delay fuse
Rocket Dimensions:	1,930mm x 76mm
Ceiling:	6,770m
Operation:	Fired from single, tandem and (later) 36 x rail launchers (Z Batteries). Limited use throughout the UK.



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AA	Anti-Aircraft (defences)
AFS	Auxiliary Fire Service
AP	Anti-Personnel
ARP	Air Raid Precautions
ASW	Anti-Submarine Warfare
BDU	Bomb Disposal Unit (historic term for EOD)
Bgl	Below Ground Level
EOC	Explosive Ordnance Clearance
EOD	Explosive Ordnance Disposal
FP	Fire Pot (German bomb)
GI	Ground Investigation
HAA	Heavy Anti-Air (gun battery)
Ha	Hectare (10,000m2)
HE	High Explosive
IB	Incendiary Bomb
Kg	Kilogram
LAA	Light Anti Air (gun battery)
LCC	London County Council
LRRB	Long Range Rocket Bomb (V2)
LSA	Land Service Ammunition
Luftwaffe	German Air Force
OB	Oil Bomb (German bomb)
PM	Parachute Mine (German bomb)
RAF	Royal Air Force
RFC	Royal Flying Corps
RN	Royal Navy (British)
RNAS	Royal Naval Air Service
ROF	Royal Ordnance Factory
SAA	Small Arms Ammunition
SD2	2kg AP bomb (German bomb)
SI	Site Investigation
U/C	Unclassified (German) bomb
UP	Unrotating Projectile (British 3″ AA rocket)
USAAF	United States Army Air Force
UX	Unexploded
UXB	Unexploded Bomb
UXO	Unexploded Ordnance
V1	German Flying (pilotless) bomb - "Doodlebug"
V2	German LRRB - "Big Ben"
WAAF	Women's Auxiliary Air Force
WWI	World War One
WWII	World War Two

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- HO 196/10/112: D. Christopherson. (1941-1942) Penetration of unexploded bombs in earth, Ministry of Home Security

<u>London Metropolitan Archive</u>

- MCC-ES-PL-1-3 – War Damage Map

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