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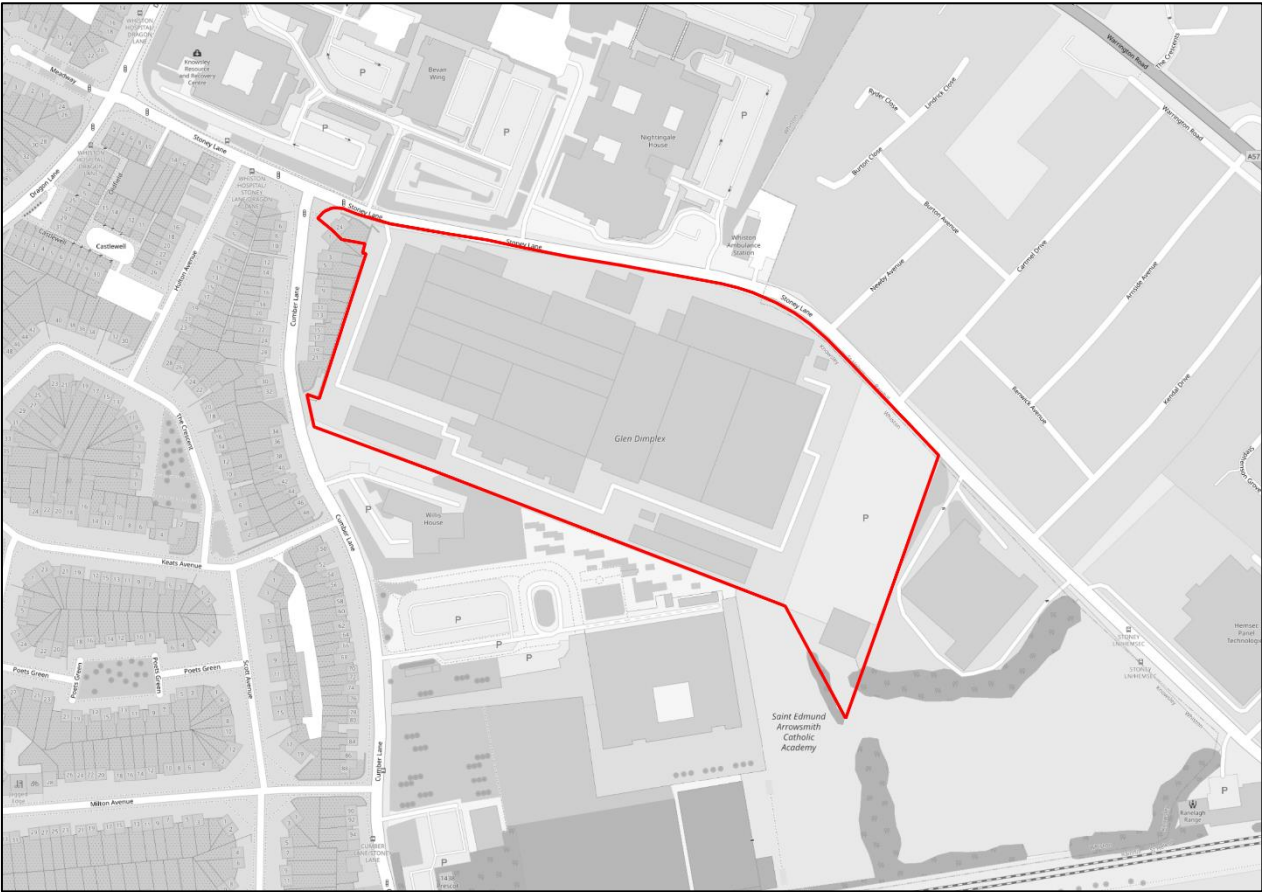
BRIMSTONE

**DETAILED UXO
RISK ASSESSMENT**



STAGE 2 DETAILED UXO RISK ASSESSMENT

Client:	Taylor Wimpey North West		
Project Ref:	TWNW25R		
Site Name:	Glen Dimplex, Prescott		
Report Ref:	DRA-25-1957-GlenDimplex,Prescot-TWNW25R		
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EXECUTIVE SUMMARY

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

THE SITE: The Site (approximately centred on the National Grid Ref: SJ 47997 91544) is located in Whiston, within the county of Lancashire, approximately 800m north-east of Whiston railway station. The Site is bound to the north by Stoney Lane, to the west by a commercial structure on Stoney Lane, to the south by mature vegetation and a hardstanding car park, and to the west by residential structures and associated garden areas on Cumber Lane.

The majority of the Site comprises the Glen Dimplex appliances factory, a two to three storey industrial structure present in the centre of the Site. A number of smaller structures, between one and two storeys, are present along the western, southern, and south-eastern Site boundaries. The majority of the remainder of the Site comprises hardstanding, with small areas of mature vegetation present in the north and south-east.

THE PROPOSED WORKS:

The future development works on Site comprise the demolition of the existing structure, and the construction of 204 residential units, including hardstanding accessways and soft landscaping.

UXO RISK ASSESSMENT:

German UXO:

- During WWII, the Site was located within the Rural District of Whiston, which experienced 9.5 bombs / 1,000 acres, a low bombing density. A large electrical engineering plant, approximately 1km north-west of the Site, was identified as a primary target by the Luftwaffe. It is also entirely possible that the industrial structure on Site provided an easily identifiable target of opportunity.
- County wide records covering Lancashire were consulted, and only three bombing incidents within a 1km radius of the Site were identified, accounting for two incendiary bombs, one unexploded high explosive bomb, and one unexploded anti-aircraft shell. The closest of these incidents, the HE UXB, occurred approximately 230m south-west of the Site. No anecdotal evidence suggesting the factory sustained significant bomb damage could be found; substantial damage to factories is typically well documented in online sources / histories.
- Furthermore, no evidence of significant bomb damage is visible on Site in post-WWII aerial photography. Light coloured roofing is visible to the large structure on Site; whilst this could feasibly be the result of repairs due to bomb damage, the roofing has been replaced in an organised fashion, and the design of the roofing has changed. Combined with the lack of recorded bombing in the area, this is considered more likely to have been planned redevelopment. Had this been the result of bomb damage, it is still thought likely that a UXB entry hole to the hardstanding floor of the factory beneath would have been instantly recognisable. No cratering is visible to the open ground on Site; however, these areas do appear poorly maintained, potentially masking evidence of bomb damage.
- In addition, the Site is considered likely to have experienced a frequent level of access throughout WWII. The factory on Site likely remained in use throughout and may have employed a team of fire watchers / ARP personnel responsible for recording and reporting bombing incidents. It is also possible that specific post-raid checks took place for unexploded / delayed action bombs, to ensure work at the factory could continue safely. This is especially pertinent in the areas occupied by railway tracks, which were often earmarked for such checks.

- However, areas of open, undeveloped ground are present around the periphery of the factory, particularly in the north, south and between the railway lines in the east. These areas appear poorly maintained in post-WWII aerial photography, and it cannot be assumed that these areas experienced a frequent level of access throughout WWII. It is therefore more likely that a UXB strike to these areas could potentially have occurred unrecorded as opposed to the areas of the Site occupied by structures / infrastructure. However, given the lack of bombing recorded in the Site area, this is not considered a significantly likely scenario.
- In summary, no evidence of the Site being affected by German bombing has been found. The Site is also anticipated to have experienced a high level of access and monitor, provided by employees of the factory on Site, which appears to have been active throughout WWII. It is therefore considered unlikely that a UXB could have landed on Site unnoticed and unrecorded. As such, a **Low Risk** from German UXBs has been assessed on Site.

British / Allied UXO:

- Evidence has been found to suggest that the factory on Site was utilised for the production of munitions during both WWI and WWII. However, no specific evidence detailing this activity or the types of munitions produced could be found during the production of this assessment. The production / use of live explosives was typically well documented, and it would be highly unusual for this to have occurred undocumented. Client provided information suggests that the factory may have been used for the production of ammunition boxes. The source of this information was discussions with Site personnel and therefore cannot be verified; however, this is consistent with the Site's historic usage as a sheet metal processing plant and would account for the lack of information available.
- However, had the factory been utilised for the production of ordnance, there is the potential for any unwanted / superfluous items to be disposed of in nearby open ground. Such an occurrence was not uncommon at facilities used for the production of ordnance, such as ROF Rotherwas in Herefordshire, where mortar shells have been encountered on multiple occasions. Areas of poorly maintained open ground were present in the north, south and east of the Site. It cannot be completely discounted that the disposal of potential ordnance present at the factory took place in these areas, given the lack of conclusive information available. However, in line with the ALARP principle, no specific evidence of this occurring, or of ordnance ever being present at the factory, has been found, and as such a **Low-Moderate Risk** from Allied UXO has been assessed.
- It should be noted that Allied UXO is typically encountered at very shallow (<1m bgl) and shallow (1-2m bgl) depths. Therefore, the risk can be considered mitigated within any ground which has been disturbed to these depths post-WWII.
- 20 permanent HAA batteries were active within range of the Site during WWII. LAA guns likely defended vulnerable points within the borough. Luftwaffe activity was infrequent over the wider area and therefore these guns would not have expended a vast quantity of ammunition. Consequently, it is unlikely (although still possible) that an unexploded AA shell struck the Site, potentially penetrating to a shallow depth within the areas of open ground on Site. Given the lack of Luftwaffe activity in the area, this risk is considered analogous with that of German UXBs, and a **Low Risk** has been assessed.

Likelihood of UXO Remaining and UXO Encounter:

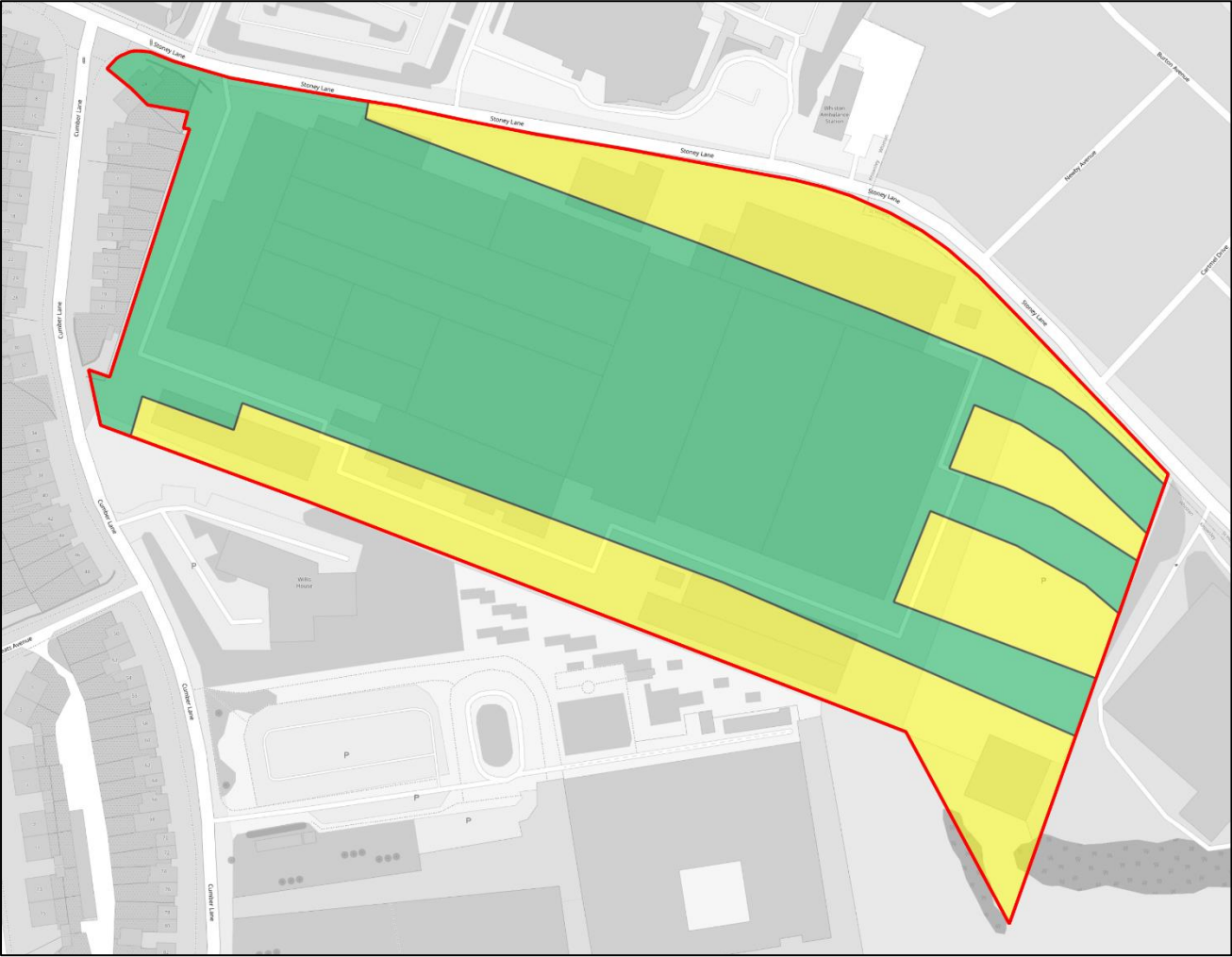
- The risk associated with any deep buried German UXBs will likely have been mitigated in the locations of deep excavations throughout the Site, outside the footprint of the factory. The risk associated with any very shallow or shallow buried Allied UXO will have been mitigated with the clearing of pre-WWII structures / railway lines, the construction of additional structures / extensions and the subsequent laying of hardstanding on previously undeveloped ground.

- 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.

Risk Map



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

LOW-MODERATE RISK: Slightly elevated likelihood of British UXO remaining here.

CONTENTS

EXECUTIVE SUMMARY	ii
QUALITY POLICY	2
1 INTRODUCTION.....	3
1.1 Background	3
1.2 Legislation	3
1.2.1 Construction Design and Management Regulations (CDM) 2015.....	3
1.2.2 The Health and Safety at Work Act 1974	3
1.3 Commercial Contractor and the Authorities	3
1.3.1 Commercial Contractors	3
1.3.2 UK Authorities	4
1.4 UXO Risk in the UK.....	4
1.5 UXO Detonations	4
2 ASSESSMENT METHODOLOGY	5
2.1 Introduction.....	5
2.2 Source, Pathway, Receptor, Consequence Risk Model	5
2.3 Assessment Structure	5
2.4 Information Sources	6
2.5 As Low as Reasonably Practicable Principle	6
2.6 Risk Tolerances	6
2.7 Reliance and Limitations.....	7
3 THE PROJECT	7
3.1 The Site	7
3.2 The Proposed Works.....	7
4 SITE HISTORY	7
4.1 Site Introduction	7
4.2 Mapping.....	7
4.3 Photography/Aerial Photography.....	8
4.4 Additional Site-Specific History.....	9
5 UXO RISK - GERMAN BOMBING	9
5.1 WWI Bombing History	9
5.1.1 Britain during WWI.....	9
5.1.2 Site Specific	9
5.2 WWII Bombing History	9
5.2.1 Merseyside	9
5.2.2 Site Specific	10
5.2.3 Bombing Decoy Sites	10
5.3 WWII Bombing Records	10
5.3.1 Introduction	10



5.3.2 Bombing Density Statistics	11
5.3.3 Original Bomb Plot Mapping	11
5.3.4 Lancashire ARP Bomb Map	11
5.3.5 Lancashire ARP Incident Reports.....	11
5.3.6 Lancashire UXB Register	12
5.3.7 Abandoned Bomb Register	12
5.3.8 Secondary Source / Anecdotal Evidence	12
5.4 Likelihood of UXB Contamination.....	13
5.5 Likelihood of Subsequent UXB Detection	14
6 WWII GERMAN BOMBS	15
6.1 Bombs Dropped on the UK	15
6.2 Bomb Failures	16
6.3 Bomb Ground Penetration	16
6.3.1 Introduction	16
6.3.2 The J-Curve Effect.....	17
6.3.3 Site Specific Geology	17
6.3.4 Site Specific Maximum Bomb Penetration Depth	17
7 UXO RISK - BRITISH/ALLIED ACTIVITY	18
7.1 Introduction	18
7.2 Potential Sources of UXO.....	18
7.2.1 Introduction	18
7.2.2 Munitions Factory	18
7.2.3 WWII Anti-Aircraft Fire.....	19
8 UXO RISK MITIGATING CIRCUMSTANCES	20
8.1 Introduction	20
8.2 Explosive Ordnance Clearance Tasks.....	20
8.3 Ground Works	20
8.4 Deductions.....	21
9 CONCLUSION	21
9.1 Accuracy of Historical Records	21
9.2 The Risk of UXO Contamination on Site	21
9.2.1 Key Findings – German UXO Risk	21
9.2.2 Key Findings - British UXO Risk.....	22
9.3 Site-Specific UXO Hazards.....	23
9.4 The Likelihood of UXO Encounter.....	23
9.4.1 Introduction	23
9.4.2 German UXBs	24
9.4.3 British / Allied UXO.....	24
9.4.4 Deductions	24



10 OVERALL RISK RATING25

11 RISK MITIGATION RECOMMENDATIONS26



FIGURES

- FIGURE 1:** Site Location Maps
- FIGURE 2:** Recent Aerial Photograph
- FIGURE 3:** Current Site Plan
- FIGURE 4:** Historical OS Mapping
- FIGURE 5:** Historical Aerial Photography
- FIGURE 6:** Lancashire ARP Bomb Map
- FIGURE 7:** Risk Map

APPENDICES

- APPENDIX 1:** Recent UXO Incidents and Historical Analysis
- APPENDIX 2:** Data Sheets - German WWII Air-Delivered Munitions
- APPENDIX 3:** Data Sheet - British WWII Anti-Aircraft Munitions
- APPENDIX 4:** Glossary
- APPENDIX 5:** Bibliography

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

Taylor Wimpey North West (the Client) has commissioned Brimstone to carry out a Stage 2 Detailed Unexploded Ordnance Risk Assessment (DRA) of the proposed redevelopment works at the Glen Dimplex, Prescott 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 of 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 (approximately centred on the National Grid Ref: SJ 47997 91544) is located in Whiston, within the county of Lancashire, approximately 800m north-east of Whiston railway station. The Site is bound to the north by Stoney Lane, to the west by a commercial structure on Stoney Lane, to the south by mature vegetation and a hardstanding car park, and to the west by residential structures and associated garden areas on Cumber Lane.

The majority of the Site comprises the Glen Dimplex appliances factory, a two to three storey industrial structure present in the centre of the Site. A number of smaller structures, between one and two storeys, are present along the western, southern, and south-eastern Site boundaries. The majority of the remainder of the Site comprises hardstanding, with small areas of mature vegetation present in the north and south-east.

FIGURE 1: Site Location Maps

FIGURE 2: Recent Aerial Photograph

3.2 The Proposed Works

The future development works on Site comprise the demolition of the existing structure, and the construction of 204 residential units, including hardstanding accessways and soft landscaping.

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	1845-1847	1:10,560	The majority of the Site comprises open, undeveloped ground, seemingly agricultural in nature. One small structure and a well are present in the south of the Site, with an associated accessway in the west. Two small ponds are recorded in the east and centre of the Site, and multiple tree-lined field boundaries are present throughout.

	1892	1:2,500	The two ponds on Site have been filled in, and a majority of the field boundaries are no longer visible. No other significant changes appear to have taken place on Site.
	1907	1:2,500	No significant changes appear to have taken place on Site.
Pre-WWII	1925	1:10,560	Two large industrial structures have been constructed, which now occupy a majority of the Site. This is labelled as an Iron Foundry. Associated railway lines are present between the two large structures, as well as to the north, south and east of the structures. Additional smaller structures are present in the west and south-west of the Site.
	1937	1:2,500	FIGURE 4.1: An industrial structure, and associated garden area, on the junction between Stoney Lane and Cumber Lane is now present in the north-west of the Site. The two large industrial structures are now labelled Rainhill Stove Works. No other significant changes appear to have taken place on Site.
Post-WWII	1956	1:2,500	FIGURE 4.2: The two large structures forming Rainhill Stove Works have combined into one structure, and a pond has been dug in the south of the Site. One of the railway lines in the south-east of the Site has been removed.

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
Pre-WWII	28th April 1935	FIGURE 5.1: This oblique image, taken in the inter-war period, displays the majority of the Site from the north-west. The composition of the Site matches that displayed in pre-WWII OS mapping, with the large industrial structures occupying a majority of the Site, along railway lines and peripheral areas of open, undeveloped ground. The areas of open ground do not appear to have an obvious purpose and appear to be poorly maintained.

Post-WWII	10 th August 1945	FIGURE 5.2: This vertical image was taken during the final year of WWII, and after the conclusion of the Luftwaffe bombing campaign in Britain. Light coloured roofing can be seen on the eastern half of the large factory on Site, as well as to peripheral structures in the north, west and south. Whilst this could feasibly be the result of repairs due to bomb damage, the roofing has been replaced in an organised fashion, and the design of the roofing has changed. Combined with the lack of recorded bombing in the area, this is considered more likely to have been planned development. No signs of bomb damage, i.e. cratering, are visible to the open ground on Site, although it should be noted the poor ground cover in the undeveloped areas may potentially mask evidence of a bomb / UXB strike.
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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). No evidence that Prescott was targeted by enemy bombing during WWI was uncovered.

5.2 WWII Bombing History

5.2.1 Merseyside

During WWII, Liverpool was home to the second largest port complex in the UK – the largest west facing port - and a Royal Navy base. As such, its destruction became a primary objective for the Luftwaffe. The city and its long stretch of docks were subjected to a concentrated bombing campaign which resulted in Liverpool becoming the second most heavily bombed area in Britain, behind London. The scale of these raids also led to extensive bomb damage in neighbouring Bootle, Wallasey and Birkenhead.

The first major air raid on Liverpool took place on 28th August 1940. 160 bombers dropped 350 tons of HE bombs, 30 HE parachute mines and 3,000 incendiary bombs. There were 50 raids during the first three months of the Luftwaffe campaign on the city. In September and October, Liverpool was subject to a raid almost every

other night. Most of these were minor, conducted by just a few aircraft; however, several attacks were executed by approximately 300 aircraft and lasted over ten hours.

The Christmas Blitz of 1940 was a series of three consecutive night raids, which were the heaviest attacks so far. Between 20th and 22nd December, 365 people were killed. Another heavy attack, aimed at the docks specifically, on 9th January was the only raid of that month.

Another period of devastation was known as the May Blitz of 1941, consisting of a seven-night bombardment. 500 roads were closed due to damage, over 6,500 homes were completely demolished and a further 190,000 sustained damaged. It involved 681 bombers dropping 870 tonnes of HE bombs and over 112,000 1kg incendiaries, the latter starting numerous fires throughout Merseyside. As a result of this assault, 70 out of 140 berths in Liverpool's docks were put out of action.

The May Blitz marked the end of concentrated raids over Merseyside. A few small-scale attacks followed with the final bombs falling on the night of 10th January 1942, the eightieth air raid over the city.

5.2.2 Site Specific

Luftwaffe target photography indicates that an electrical engineering plant, approximately 1km north-west of the Site, was identified as a primary target. It is possible that the industrial structure on Site provided an easily identifiable 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 5.2km to the south-west.

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 Lancashire 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 Rural District of Whiston. It gives a breakdown of the types of large German bombs reported and is understood to not include UXBs.

Admin Area	Whiston
Area Acreage	29,446
High Explosive Bombs (all types/weights)	274
High Explosive Parachute Mines	3
Flam (Oil) Bombs	3
40kg Phosphorus Incendiary Bombs (IBs)	0
40kg 'Fire Pot' IBs	0
V1 Flying Bomb	0
V2 Long Range Rocket	0
Total (excluding V-Weapons and 1kg / 2kg IBs)	280
Bombs Per 1,000 Acres	9.5

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.

5.3.3 Original Bomb Plot Mapping

The National Archives holds a collection of provincial Bomb Census maps for Britain. This collection does not include a map covering the study area.

5.3.4 Lancashire ARP Bomb Map

Brimstone has reviewed a county wide bombing incident map for WWII-era Lancashire, held at Lancashire Archives. This small-scale map covers all boroughs / districts throughout the WWII-era county, aside from County Boroughs, and relates to a set of written ARP incident records (discussed in the following section). Each plot point on the map is thought to represent one incident; however, due to the size of the plot points, the precise location of each incident is not discernible from the map alone. The section of the map covering the Site is displayed at **FIGURE 6**.

- Three bombing incidents are plotted within a 1km radius of the Site; the closest of these, labelled number 387, is approximately 50m south-west of the Site.

5.3.5 Lancashire ARP Incident Reports

Brimstone has reviewed a collection of written ARP incident records for WWII-era Lancashire, related to the bomb map discussed above in **Section 5.3.3**, and also held at Lancashire Archives. Details provided include the date, location, type of ordnance dropped and comments on damage and evacuation. It should be noted that due to the small scale of the related map, unless precise locations were given in written form, the exact locations of these incidents cannot be discerned. The three bombing incidents within a 1km radius of the Site are transcribed below.

Incident No.	Date	Bombs	Details
22	30/08/1940	2 x Incendiary	Rainhill, Hospital Farm & Holt Lane. No damage done. <i>Approximately 1km north-east of the Site.</i>
387	23/10/1940	1 x HE UXB	In the Orchard at Royal Oak Farm, south of Dragon Lane. Road closed while clearance takes place. <i>Approximately 230m west of the Site.</i>
412	27/10/1940	1 x UX AA Shell	Whiston, West of Pine Close. <i>Approximately 750m west of the Site.</i>

5.3.6 Lancashire UXB Register

Brimstone has reviewed a collection of written incident records recording the location of UXBs in WWII-era Lancashire, held at Lancashire Archives. These records provide the date, general location and action taken of each incident, but not the type of UXB discovered. However, no records pertaining to UXBs within a significant distance of the Site (<1km) were found.

5.3.7 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 440m south-west of the Site.

5.3.8 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. This is particularly significant due to the presence of a large factory on Site. In such locations, large scale bomb damage would typically be well documented. Multiple references to the works during WWII have been identified online¹²³, none of which mention the factory sustaining bomb damage.

¹ <https://www.stoves.co.uk/en-gb/our-heritage>

² <https://portal.ariadneinfrastructure.eu/resource/42eab6d25cdd20060cf6012fd2c590a8e81224785582a986a8c1689b346937f7>

³ <https://archives.knowsley.gov.uk/whiston/history-of-whiston/>

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 two air raids affected the study area (approximate 1km radius).
Intensity of these Air Raids:	All bombs dropped locally were likely part of small-scale opportunistic bombing raids, likely involving solitary aircraft given the small number of bombs dropped.
Bomb Strike Positions	
Closest Bomb Strikes	HE bombs: Approximately 230m west of the Site. 1kg / 2kg IBs: Approximately 1km north-east of the Site.
Alignment of recorded Bomb Strikes:	For districts with a low bombing density, such as that within which the Site was situated, accurate analysis for the alignment of bomb strikes is not always possible. As it has not been possible to identify bomb sticks over the Site, there may have been an occasion 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:	Closest plotted UXB strike to the Site is approximately 230m west 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 the majority of the air raids in the immediate vicinity likely 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, although it is entirely possible that Stoves works employed a unit of fire watchers. Nonetheless, these factors decrease the likelihood that any UXB fall would have been witnessed and reported. As the structures on Site do not appear to have been subject to significant bomb damage, it is thought that these 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 would have been overlooked by returning residents/employees. It is also possible that specific post-raid checks for UXBs or DA bombs were carried out to the railway lines on Site, prior to work resuming at the factory. This greatly increases the likelihood of a UXB strike to these areas of the Site being noticed and dealt with at the time. However, the areas of open/undeveloped ground in the northern and southern sections of the Site do not appear to have had an obvious use. Therefore, it is conceivable that these sections were less frequently accessed, although the presence of the factory and railway lines will likely have provided a degree of access / observation to the entire Site. The residential structure in the north-east of the Site also appears to have survived the war externally structurally intact, likely also remaining inhabited, and well accessed, throughout.
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.
Light coloured roofing is visible to the large factory on Site; such repairs can often be indicative of bomb damage occurring. However, due to the lack of recorded bombing in the vicinity of the Site, and the relatively uniform nature of the area of repairs, this is thought likely to have been planned development rather than a result of damage. Furthermore, no evidence of bomb damage was evident in post-WWII aerial photography in the areas of open/undeveloped ground on Site.

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 structures or railway lines on Site would have caused incontrovertible evidence of its incidence as it passed the structures / railway lines and into the ground beneath. The same can be said for the majority of neighbouring structures and roads to the north and west, where (assuming no cratering) a HE UXB entry hole would have been persistent and easily recognisable.

Undeveloped areas were present on-Site during WWII. Aerial photography indicates that these areas were poorly maintained, and it is possible that a UXB strike to these locations could have gone unnoticed, the entry hole obscured by vegetation / shifting environmental conditions and filling in over time.

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: Till, Devensian (Diamicton)	Bedrock Deposits: Kinnerton Sandstone Formation (Sandstone)
SI Data	Recent SI borehole logs on Site have been provided by the client. This SI (June 2024) encountered the following ground conditions: - 2.70m of made ground - 6.00m of sandy clay - 0.39m of bedrock (sandstone)	

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, sand and sandstone) in the table above. This gives a likely maximum bomb penetration depth of 11.80m below WWII ground level for a 500kg bomb.

However, any UXB striking the structures on Site will have first passed through multiple storeys. This will have caused the bomb to lose kinetic energy prior to ground penetration. Furthermore, in each of the borehole logs, made ground was encountered at very shallow (<1m bgl) depths, and bedrock was encountered at varying depths (between 4 - 9.37m bgl) across the Site. These factors indicate that sections of the Site will have had a maximum bomb penetration depth significantly shallower than 11.80m bgl. However, the combination of these actors makes calculating an accurate depth impossible.

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	✓

7.2 Potential Sources of UXO

7.2.1 Introduction

Research suggests that the large industrial structure in the centre of the Site was initially constructed for aid in the production of munitions, and again was requisitioned to support the war effort during WWII. Potential sources of historic UXO contamination are discussed below.

7.2.2 Munitions Factory

Anecdotal evidence, within client provided information, Merseyside HER⁴ and a history of Stoves⁵, indicate that the Rainhill factory Site was initially developed for the production of WWI-era munitions, and that during WWII the factory was once again requisitioned to assist in the war effort with the production of munitions. However, in each of these sources, no specific details about the types of munitions produced were available, or the nature of the munitions themselves, whether they be ammunition, weapons or associated equipment e.g. ammunition boxes.

It was commonplace for factories to be requisitioned during both world wars to assist in the war effort; however, it is highly unusual for a factory to be used for the construction / filling of live ordnance, with no information regarding the types of shells / weapons available. The vast majority of the munitions produced were constructed and filled at the large National Filling Factories (NFF) during WWI, and Royal Ordnance Factories (ROF) during WWII. All relevant local and national archives have been contacted, as has the Merseyside HER, and no positive evidence to suggest that live ordnance / explosives were ever present on Site could be found. As the production and use of explosives was relatively noteworthy in local communities, it is

⁴ <https://archaeologydataservice.ac.uk/archsearch/record?titleId=3574218>

⁵ <https://www.stoves.co.uk/en-gb/our-heritage>

considered likely that if this occurred in substantial quantities, more information regarding the usage would be available.

Client provided information suggests that the factory may have been used for the production of ammunition boxes. The source of this information was discussions with Site personnel so cannot be verified; however, this is consistent with the Sites historic usage as a sheet metal processing plant and would account for the lack of information available. Furthermore, the Stoves online history indicates that during WWII the factory ‘supported’ the munitions manufacturing effort, potentially suggesting that the munitions themselves were not produced at the factory, and supporting the hypothesis that the factory was used for producing ammunition boxes.

However, had the production of live ordnance taken place on Site, this raises the potential of unwanted / superfluous ordnance to have been disposed of in an improper manner in the open ground on Site. Such an occurrence was not uncommon at ordnance factories, as evidenced by UXO finds throughout the country today, such as at Rotherwas, Herefordshire⁶, where multiple mortars have been encountered within the boundary of the former ROF Rotherwas. Due to the suggestion that the Site may also have been used for the production of ordnance, such an occurrence within the open ground on Site cannot be completely discounted. The only likely locations for this to take place on Site are the areas of open ground with no obvious purpose, which appear poorly maintained in WWII-era photography. It is highly unlikely that any unwanted ordnance could have been disposed of within the footprint of the factory or the railway lines.

7.2.3 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.

⁶ <https://zeticauxo.com/news/mortar-shell-found-at-former-ordnance-factory-in-hereford/>

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.

20 permanent HAA batteries were active within range of the Site during WWII. LAA guns likely defended vulnerable points within the borough. However, Luftwaffe activity was infrequent over the wider area and therefore these guns would not have expended a vast quantity of ammunition. Consequently, it is unlikely (although still possible) that an unexploded AA shell struck the Site, potentially penetrating to a shallow depth within the areas of open ground on Site.

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

By 1999, the factory had been extended slightly, and small ancillary structures had been constructed along the southern and western Site boundaries, with an additional structure present in the south-east. The railway lines had been removed, and the entire eastern extent of the Site had been paved over to form a hardstanding car park.

It is likely that the extension to the main factory, and the construction of the ancillary structures, have disturbed ground to shallow (1-2m bgl) depths. The removal of railway lines and the laying of hardstanding on previously undeveloped ground has likely disturbed soil to a very shallow (<1m bgl) depth.

SI works have been completed on Site, all of which disturbed ground to a deep (>2m bgl) depth. These consisted of 12 shallow window sample boreholes to 5m bgl, two cable percussive boreholes to 10m bgl and two rotary open boreholes to 20m bgl.

8.4 Deductions

The risk associated with any deep buried German UXBs will likely have been mitigated in the locations of deep excavations throughout the Site, outside the footprint of the factory. The risk associated with any very shallow or shallow buried Allied UXO will have been mitigated with the clearing of pre-WWII structures / railway lines, the construction of additional structures / extensions and the subsequent laying of hardstanding on previously undeveloped ground.

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

- During WWII, the Site was located within the Rural District of Whiston, which experienced 9.5 bombs / 1,000 acres, a low bombing density. A large electrical engineering plant, approximately 1km north-west of the Site, was identified as a primary target by the Luftwaffe. It is also entirely possible that the industrial structure on Site provided an easily identifiable target of opportunity.
- County wide records covering Lancashire were consulted, and only three bombing incidents within a 1km radius of the Site were identified, accounting for two incendiary bombs, one unexploded high explosive bomb, and one unexploded anti-aircraft shell. The closest of these incidents, the HE UXB, occurred approximately 230m south-west of the Site. No anecdotal evidence suggesting the factory sustained significant bomb damage could be found; substantial damage to factories is typically well documented in online sources / histories.
- Furthermore, no evidence of significant bomb damage is visible on Site in post-WWII aerial photography. Light coloured roofing is visible to the large structure on Site; whilst this could feasibly be the result of repairs due to bomb damage, the roofing has been replaced in an organised fashion, and the design of the roofing has changed. Combined with the lack of recorded bombing in the area, this is considered more likely to have been planned redevelopment. Had this been the result of bomb damage, it is still thought likely that a UXB entry hole to the hardstanding floor of the factory beneath would have been instantly recognisable. No cratering is visible to the open ground on Site; however, these areas do appear poorly maintained, potentially masking evidence of bomb damage.
- In addition, the Site is considered likely to have experienced a frequent level of access throughout WWII. The factory on Site likely remained in use throughout and may have employed a team of fire watchers / ARP personnel responsible for recording and reporting bombing incidents. It is also possible that specific post-raid checks took place for unexploded / delayed action bombs, to ensure work at the factory could continue safely. This is especially pertinent in the areas occupied by railway tracks, which were often earmarked for such checks.

- However, areas of open, undeveloped ground are present around the periphery of the factory, particularly in the north, south and between the railway lines in the east. These areas appear poorly maintained in post-WWII aerial photography, and it cannot be assumed that these areas experienced a frequent level of access throughout WWII. It is therefore more likely that a UXB strike to these areas could potentially have occurred unrecorded as opposed to the areas of the Site occupied by structures / infrastructure. However, given the lack of bombing recorded in the Site area, this is not considered a significantly likely scenario.
- In summary, no evidence of the Site being affected by German bombing has been found. The Site is also anticipated to have experienced a high level of access and monitor, provided by employees of the factory on Site, which appears to have been active throughout WWII. It is therefore considered unlikely that a UXB could have landed on Site unnoticed and unrecorded. As such, a **Low Risk** from German UXBs has been assessed on Site.

9.2.2 Key Findings - British UXO Risk

- Evidence has been found to suggest that the factory on Site was utilised for the production of munitions during both WWI and WWII. However, no specific evidence detailing this activity or the types of munitions produced could be found during the production of this assessment. The production / use of live explosives was typically well documented, and it would be highly unusual for this to have occurred undocumented. Client provided information suggests that the factory may have been used for the production of ammunition boxes. The source of this information was discussions with Site personnel and therefore cannot be verified; however, this is consistent with the Site's historic usage as a sheet metal processing plant and would account for the lack of information available.
- However, had the factory been utilised for the production of ordnance, there is the potential for any unwanted / superfluous items to be disposed of in nearby open ground. Such an occurrence was not uncommon at facilities used for the production of ordnance, such as ROF Rotherwas in Herefordshire, where mortar shells have been encountered on multiple occasions.⁷ Areas of poorly maintained open ground were present in the north, south and east of the Site. It cannot be completely discounted that the disposal of potential ordnance present at the factory took place in these areas, given the lack of conclusive information available. However, in line with the ALARP principle, no specific evidence of this occurring, or of ordnance ever being present at the factory, has been found, and as such a **Low-Moderate Risk** from Allied UXO has been assessed.
- It should be noted that Allied UXO is typically encountered at very shallow (<1m bgl) and shallow (1-2m bgl) depths. Therefore, the risk can be considered mitigated within any ground which has been disturbed to these depths post-WWII.
- 20 permanent HAA batteries were active within range of the Site during WWII. LAA guns likely defended vulnerable points within the borough. Luftwaffe activity was infrequent over the wider area and therefore these guns would not have expended a vast quantity of ammunition. Consequently, it is unlikely (although still possible) that an unexploded AA shell struck the Site, potentially penetrating to a shallow depth within the areas of open ground on Site. Given the lack of Luftwaffe activity in the area, this risk is considered analogous with that of German UXBs, and a **Low Risk** has been assessed.

⁷ <https://www.herefordtimes.com/news/18134013.bomb-squad-called-hereford-industrial-estate/>

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

A slightly elevated likelihood of UXO contamination (British) and likelihood of that UXO remaining up to the present day has been identified across sections of the Site. Therefore, it is conceivable that proposed works within the Low-Moderate Risk zone could be exposed to a UXO encounter, although this is not considered to be a significant possibility.

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. Areas of **Low Risk** and **Low-Moderate Risk** have been identified. These are displayed on a Risk Map at **FIGURE 7**, 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		
Low-Moderate	WWII German GP HE Bombs	Low	n/a		LOW
	HAA Shells	Low	n/a		
	LSA	Low-Moderate	Low-Moderate	Moderate	LOW-MODERATE
	German 2kg IBs	Low	n/a		LOW
	German 1kg IBs	Low	n/a		
	LAA Shells	Low	n/a		
	SAA	Low	n/a		



11 RISK MITIGATION RECOMMENDATIONS

Brimstone has not identified an elevated UXO risk to 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.

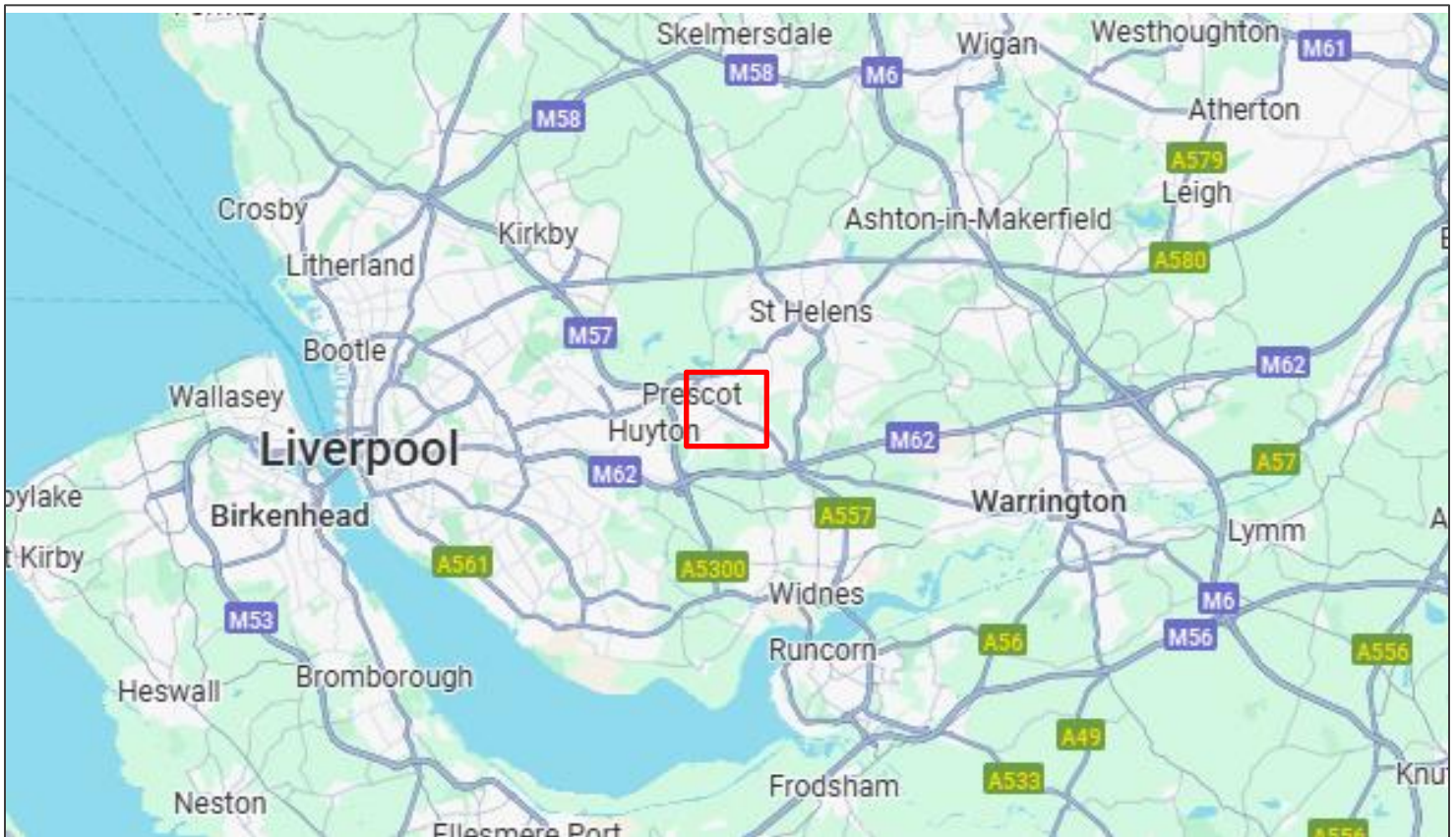
FIGURES: 1 - 7



Title:

Site Location Maps

FIGURE: 1



Project:	Glen Dimplex, Prescott	
Client:	Taylor Wimpey North West	
Report Ref:	DRA-25-1957	
General Site Location:		Info Source: Google (open-source)

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Title:

Recent Aerial Photograph

FIGURE: 2



Project:

Glen Dimplex, Prescot

Client:

Taylor Wimpey North West

Report Ref:

DRA-25-1957

Approx. Site Boundary: 

Info Source:

Google (open-source)



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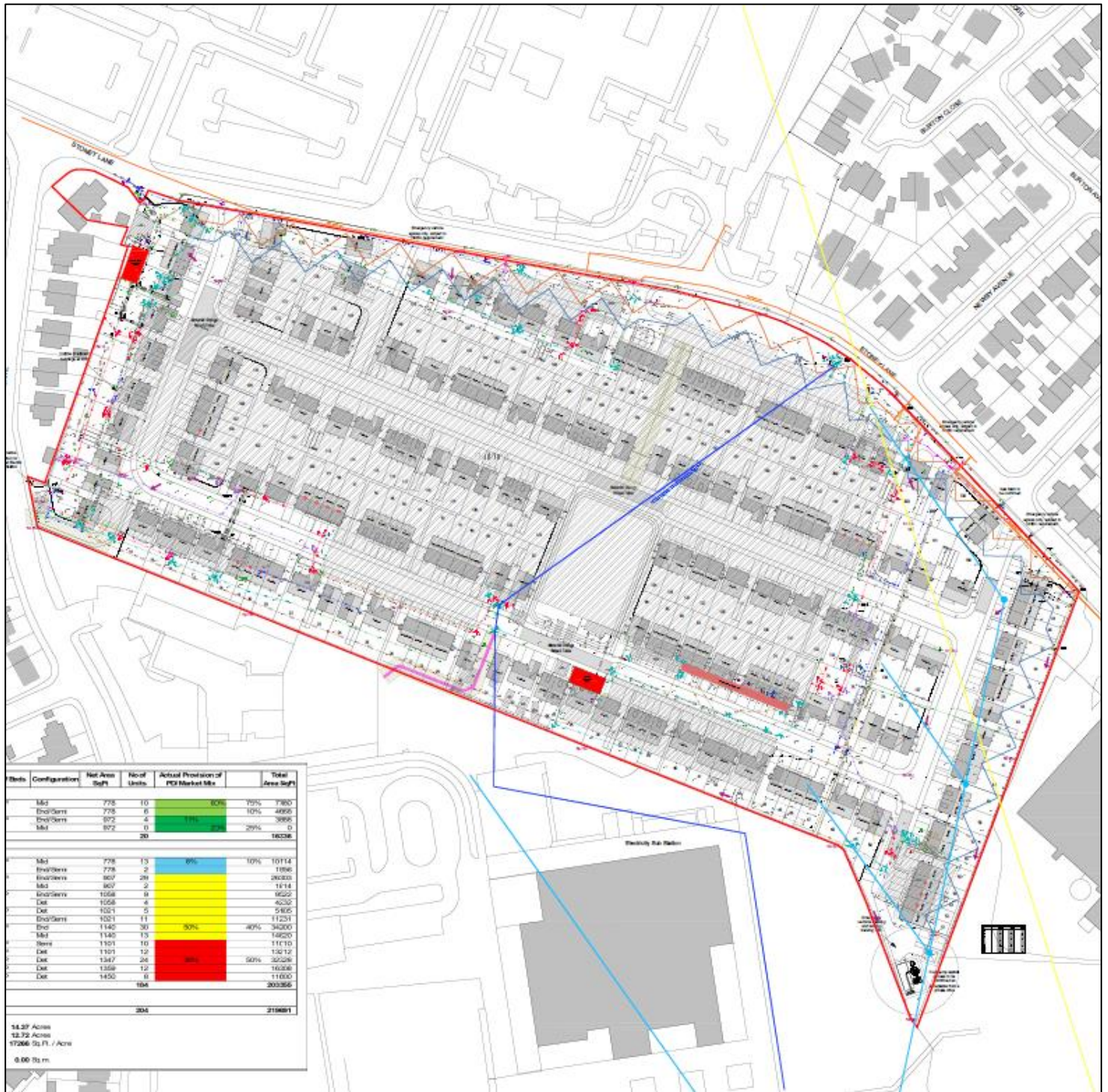
enquire@brimstoneuxo.com

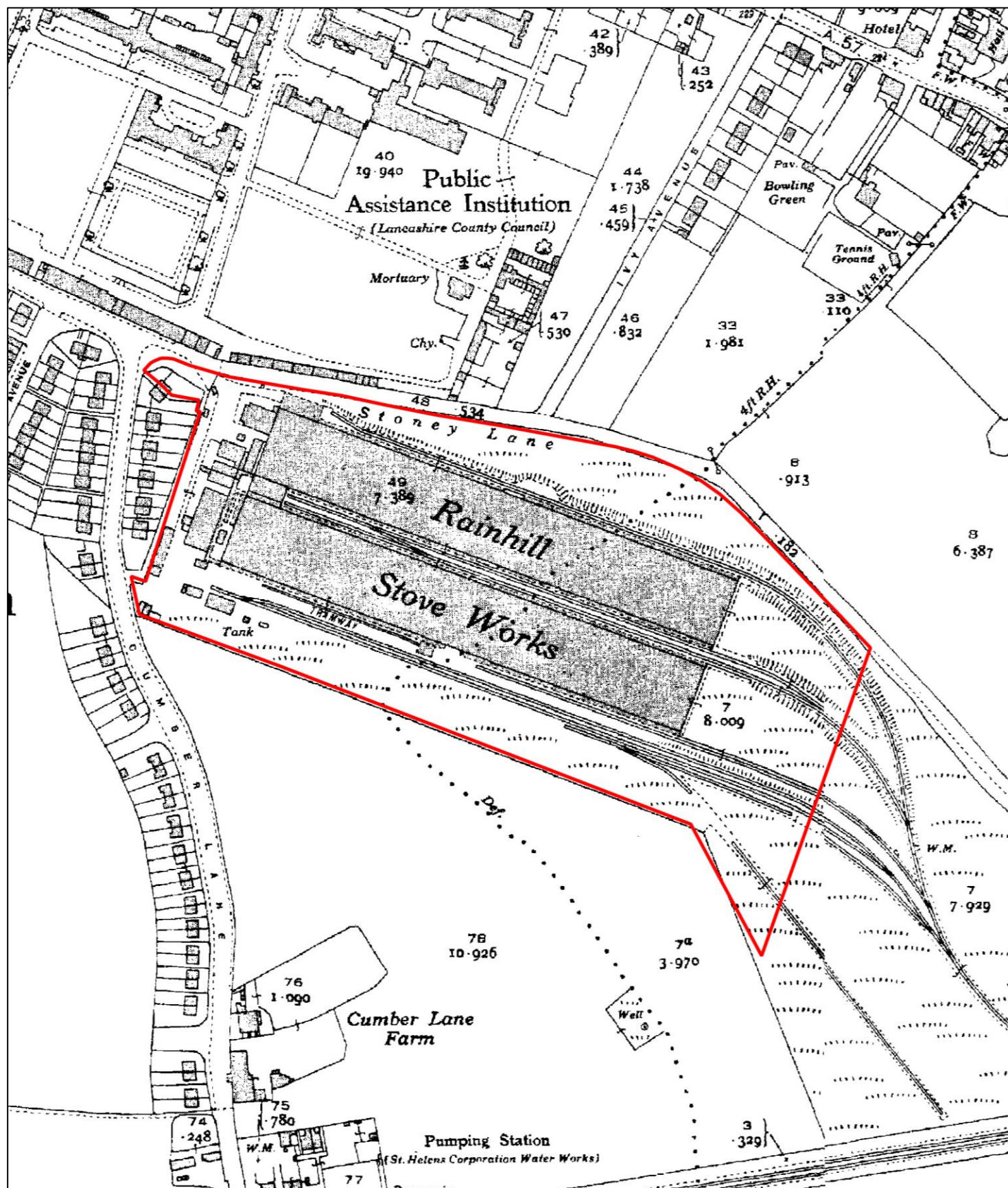


Title:

Existing Site Plan

FIGURE: 3





Project: Glen Dimplex, Prescott

Client: Taylor Wimpey North West

Report Ref: DRA-25-1957

Approx. Site Boundary:  Info Source:

Promaps

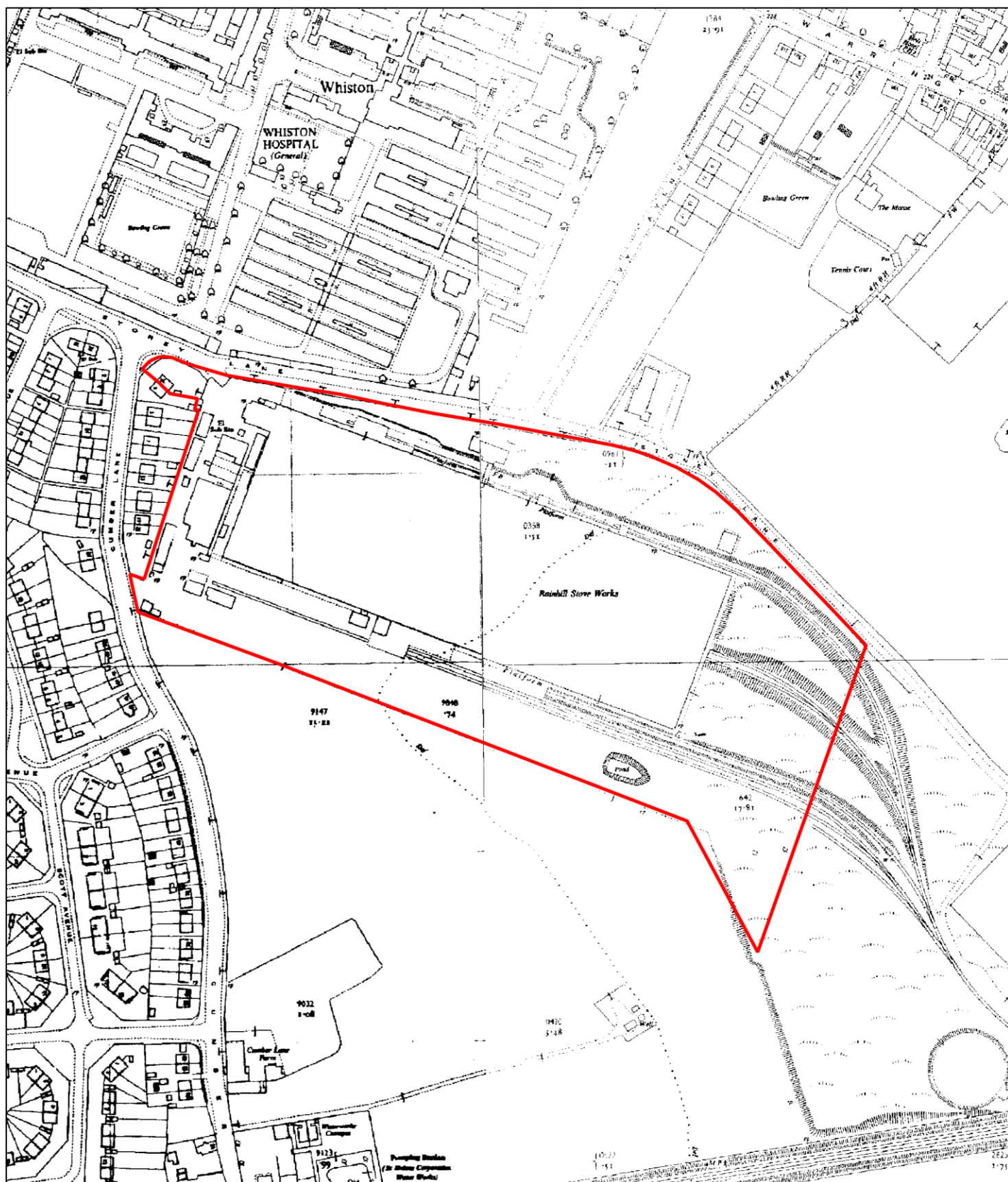
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Title:

Historical OS Mapping - 1956

FIGURE: 4.2



Project:

Glen Dimplex, Prescot

Client:

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Report Ref:

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Approx. Site Boundary: 

Info Source:

Promaps



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Title:

Historical Aerial Photography – 28th April 1935

FIGURE: 5.1



Project:

Glen Dimplex, Prescot

Client:

Taylor Wimpey North West

Report Ref:

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Partial Site Boundary: 

Info Source:

Britain from Above



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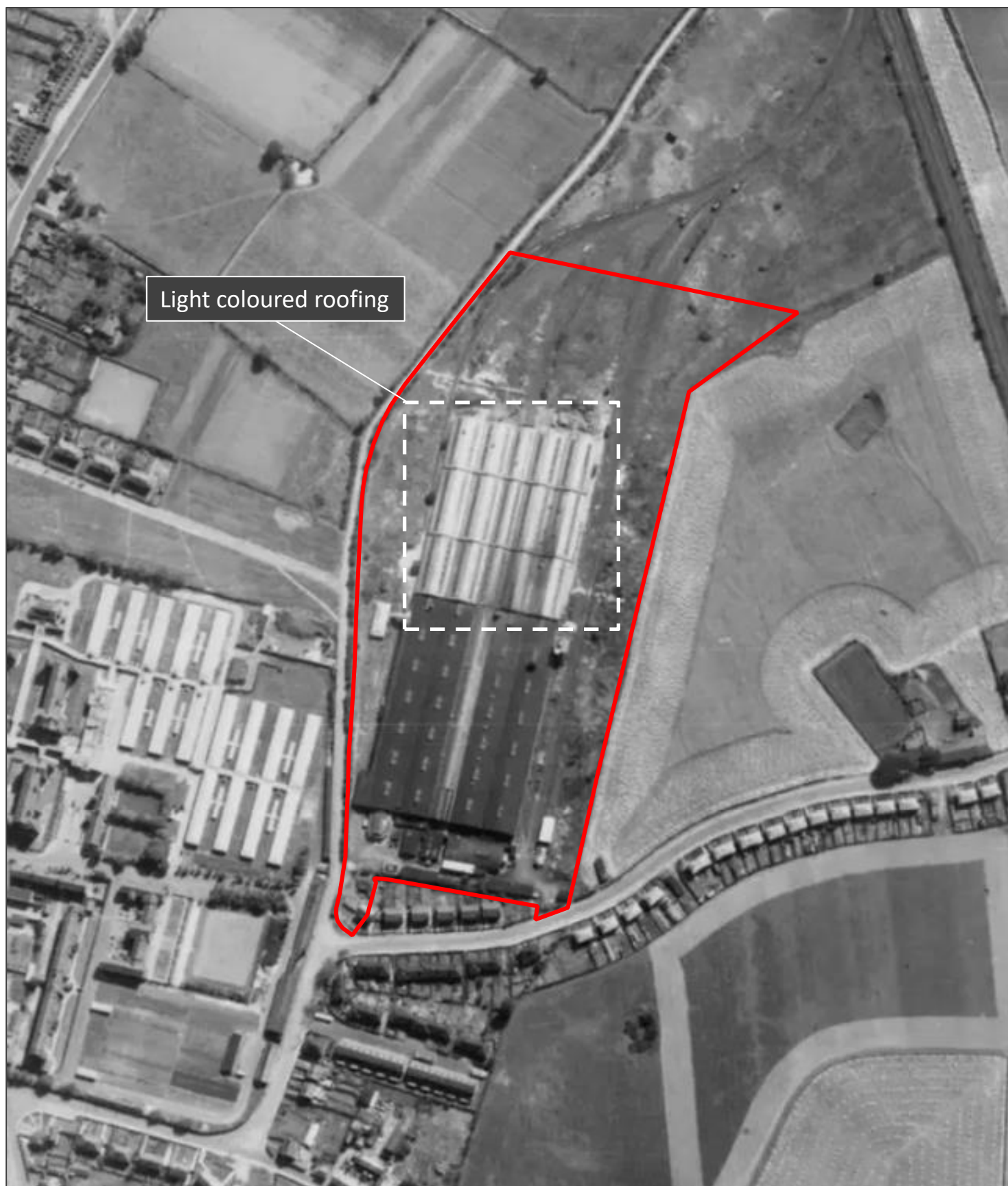
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Title:

Historical Aerial Photography – 10th August 1945

FIGURE: 5.2



Project:	Glen Dimplex, Prescot	
Client:	Taylor Wimpey North West	
Report Ref:	DRA-25-1957	
Approx. Site Boundary: 	Info Source:	Historic England

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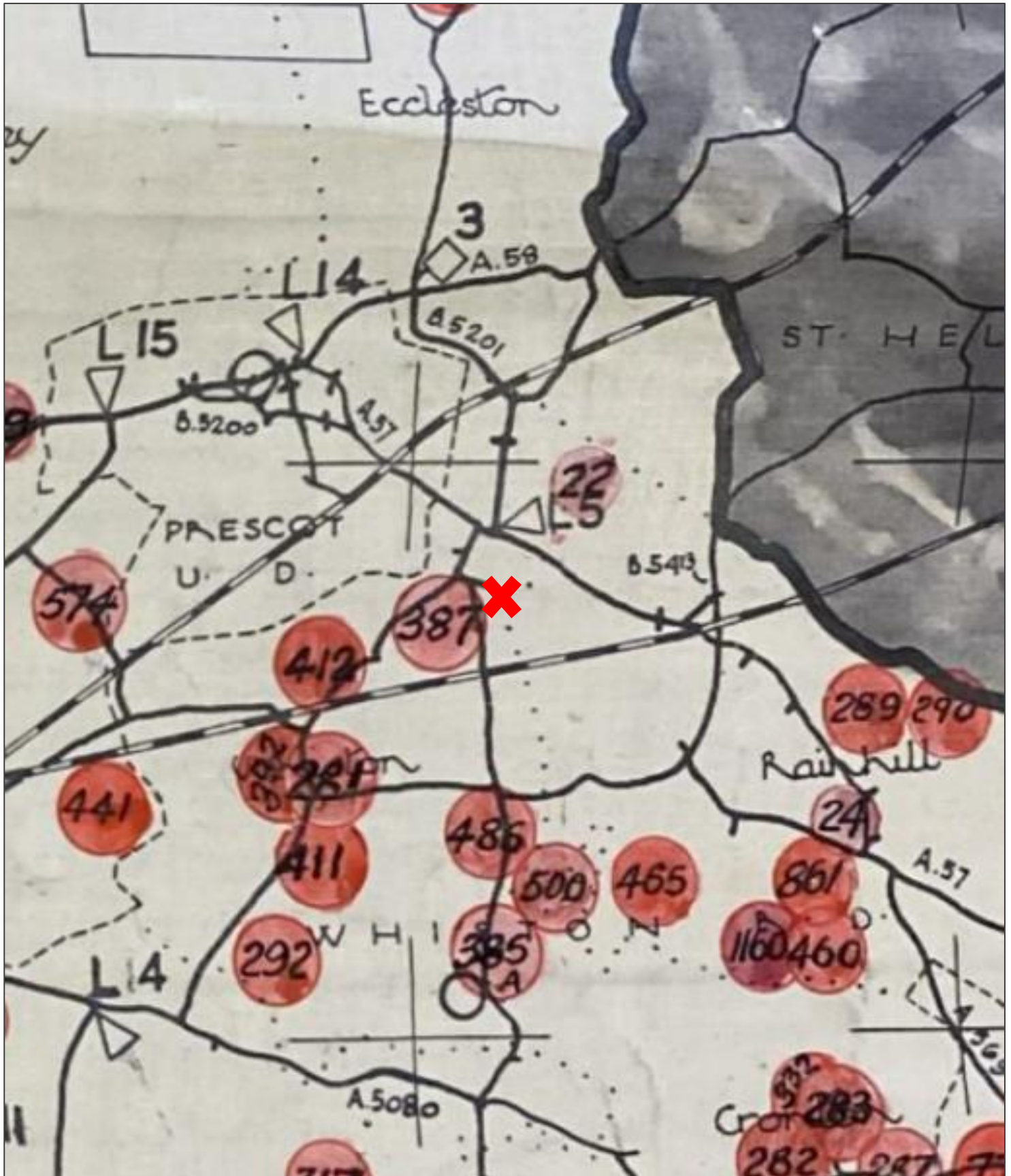
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Title:

Lancashire ARP Bomb Map

FIGURE: 6



Project: Glen Dimplex, Prescott

Client: Taylor Wimpey North West

Report Ref: DRA-25-1957

Approx. Site Location:  Info Source: Lancashire Archives



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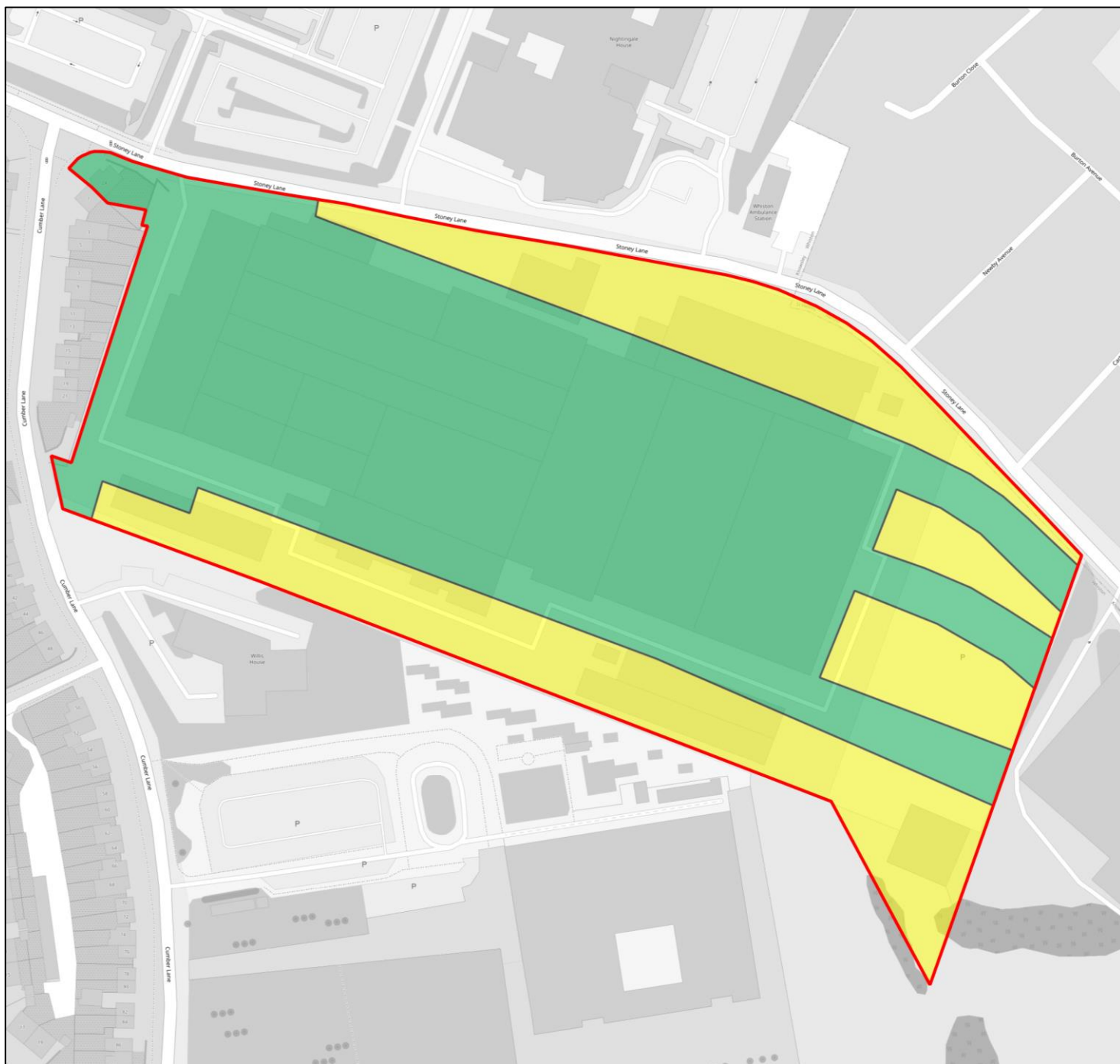
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Title:

Risk Map

FIGURE: 7.1



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

LOW-MODERATE RISK: Slightly elevated likelihood of British UXO remaining here.

Project:	Glen Dimplex, Prescot	
Client:	Taylor Wimpey North West	
Report Ref:	DRA-25-1957	
Approx. Site Boundary: 	Info Source:	Brimstone

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Title:

Risk Map

FIGURE: 7.2



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

LOW-MODERATE RISK: Slightly elevated likelihood of British UXO remaining here.

Project:	Glen Dimplex, Prescot
Client:	Taylor Wimpey North West
Report Ref:	DRA-25-1957
Approx. Site Boundary: 	Info Source: Brimstone

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APPENDICES: 1 - 5

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).

Project:	Glen Dimplex, Prescott
Client:	Taylor Wimpey North West
Report Ref:	DRA-25-1957
Info Source:	Various

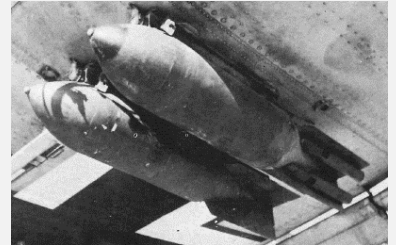
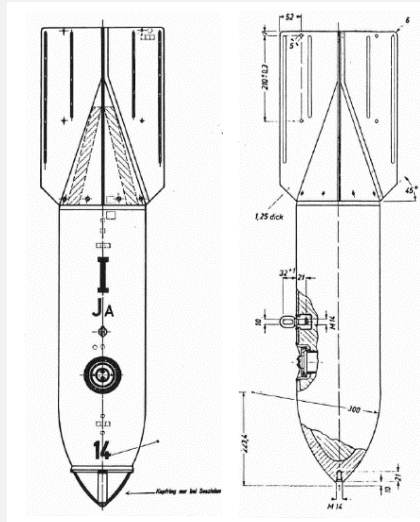

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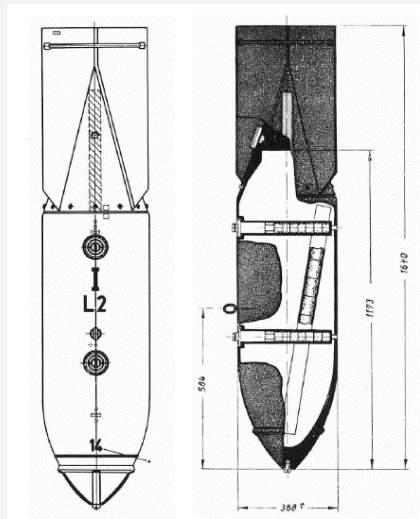
SC 50

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.



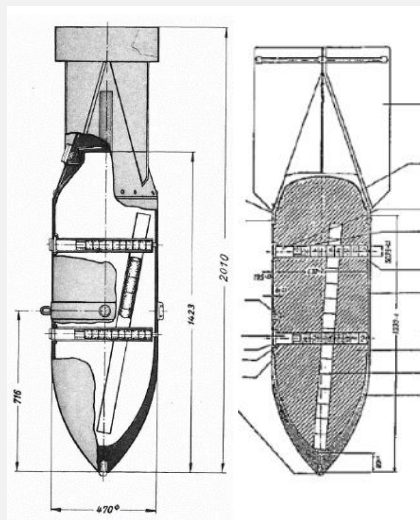
SC 250

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.

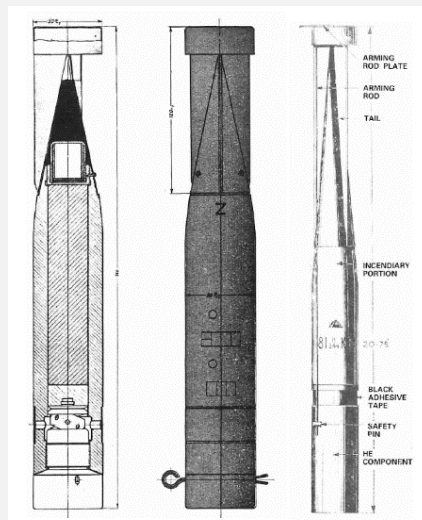


Project: Glen Dimplex, Prescott
 Client: Taylor Wimpey North West
 Report Ref: DRA-25-1957
 Info Source: W, Ramsey.1988 / various news sources

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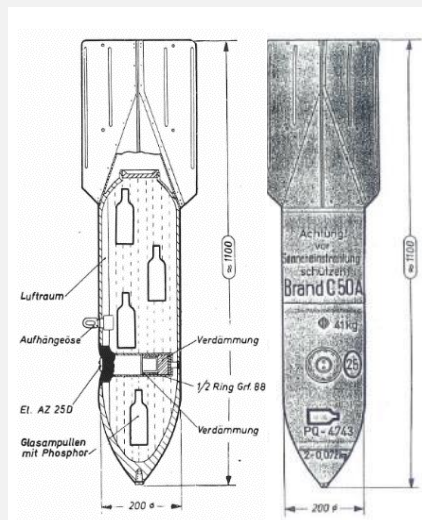
B-1E Sub-Munition

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.



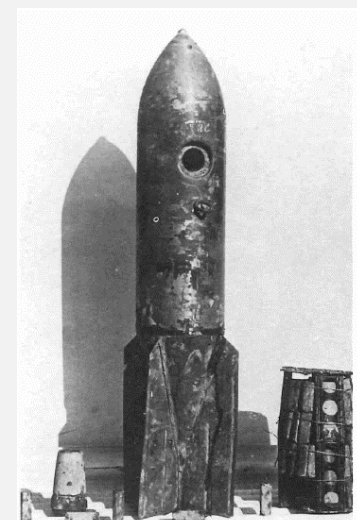
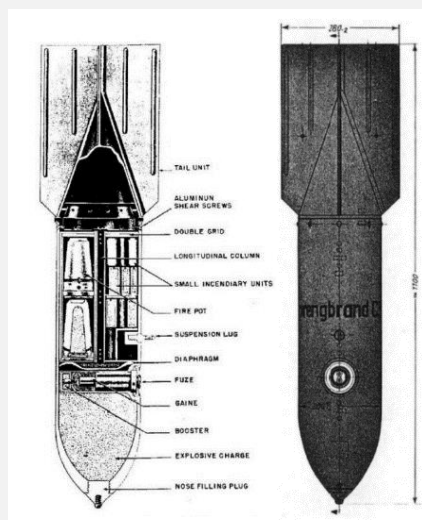
Brand C50

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

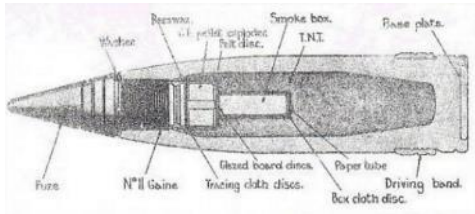
Bomb Weight:	34kg (75lb)
Explosive Weight:	9kg (20lb)
Filling:	TNT burster charge, 6 x Thermite containers (fire pots) and 67 x small triangular incendiary elements.
Fuse Type:	1 x electrical impact fuses or aerial burst fuse
Bomb Dimensions:	711mm length x 203mm diameter
Appearance:	Bomb body and tail 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.



Project:	Glen Dimplex, Prescott
Client:	Taylor Wimpey North West
Report Ref:	DRA-25-1957
Info Source:	W, Ramsey.1988 / various news sources

HAA Battery - 3.7" QF Shell

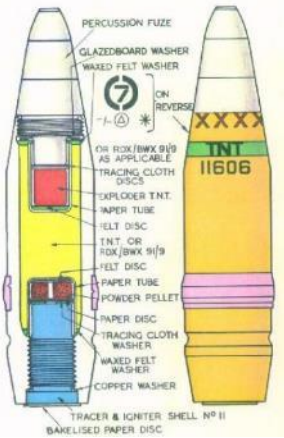
- Shell Weight:12.7kg
- Shell Dimensions:94mm x 438mm
- Fill Weight:1.1kg
- Fill Type:TNT
- Fuse Type:Mechanical Time Delay fuse
- Appearance:Grey body, copper driving bands, brass neck
- Rate of Fire:10 - 20 rpm
- Ceiling:9,000 - 18,000m
- Variants:HE or shrapnel shells.
Note, the 4.5" gun was also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



LAA Battery - 40mm Bofors Shell

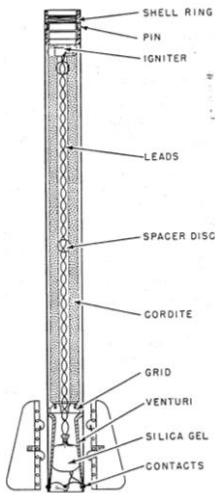
- Shell Weight:0.84kg
- Shell Dimensions:40mm x 180mm
- Fill Weight:70g
- Fill Type:TNT
- Fuse Type:Impact fuse
- Appearance:Grey body, copper driving bands, brass neck
- Rate of Fire:120 rpm
- Ceiling:7,000m
- Variants:HE or AP shells. Both with rear tracer compartment

SHELL, Q.F., HIGH EXPLOSIVE, 40 MM.



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.



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

Project:	Glen Dimplex, Prescot
Client:	Taylor Wimpey North West
Report Ref:	DRA-25-1957
Info Source:	n/a



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Project:	Glen Dimplex, Prescott
Client:	Taylor Wimpey North West
Report Ref:	DRA-25-1957
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Project: Glen Dimplex, Prescott

Client: Taylor Wimpey North West

Report Ref: DRA-25-1957

Info Source: n/a



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