BRIMSTONE

DETAILED
UXO RISK ASSESSMENT

INTEGRITY PROFESSIONALISM KNOWLEDGE

STAGE 2 DETAILED UXO RISK ASSESSMENT

Client:	TEC Ltd
Project Ref:	TWEE89R
Site:	Project Dragon, Port Talbot
Report Ref:	DRA-23-1532-TWEE89R-ProjectDragon,PortTalbot
Revision:	1
Status:	Final
Release Date:	19th April 2023

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EXECUTIVE SUMMARY

RESULT: Brimstone concludes that German UXBs and unexploded HAA shells poses a **LOW-MODERATE AND MODERATE RISK** to the proposed works. See **FIGURE 7** for risk mapping.

THE SITE: The Site comprises three separate areas, known as Site A (west), Site B (south) and Site C (east). These will be referred to collectively as 'the Site' for the purposes of this assessment, when not discussed individually.

The Site (approximately centred on the National Grid Refs: SS 76427 88669 (Site A), SS 76871 88433 (Site B) SS 77015 88744 (Site C)) is located in Port Talbot, within the county borough of Neath Port Talbot, Wales. Port Talbot Parkway railway station is located approximately 700m north of the Site.

Site A primarily comprises undeveloped land – consisting of grassy areas and mature vegetation – intermixed with brownfield land. A section of the docks and an unnamed roadway are located in the north, while a disused railway line lies in the south. It is bound to the north by water and a cement works factory, to the east by additional industrial structures, while open ground lies to the west and south.

Site B consists of undeveloped land with mature vegetation throughout; a hardstanding layby is located in the east. It is bound to the north by undeveloped land and an industrial area, to the east by a hardstanding roadway and a metal works and to the south and west by open ground and pipelines.

Site C consists of hardstanding brownfield land with an entrance to an unnamed roadway in the south and the entrance to a river runoff in the north. It is bound to the north by the hardstanding river run off, to the east by an unnamed roadway connecting to Harbour Way, to the south by an unnamed roadway and to the west by a vegetated border to the docks.

THE PROPOSED WORKS: Ground investigation works are proposed, although specific works were not provided.

Brimstone was not made aware of any future redevelopment works.

UXO RISK ASSESSMENT:

German UXO:

- Port Talbot was a key industrial hub during World War II, with its steelworks and coal production facilities playing a vital role in supporting the British war effort. The Margam Steelworks, within which Site C was located, were involved in the production of steel for munitions, tanks, ships, and other war materials. Consequently, the town and its industries became targets for German air raids carried out by the Luftwaffe. Indeed, Luftwaffe target photography indicates industries on Site and nearby were identified as primary bombing targets. A railway yard/storage station was recorded on target photography (Site A and B) and a steel works which made up Site C. This is further recorded within Luftwaffe target mapping, which highlights the copper works (Kupferworke) and hard coal briquettes (Steinkohlenbrikettebrik) within Site A as bombing targets, as well as the iron foundry (Eisengießerel) within which Site C was located.
- The majority of the official records obtained for Port Talbot did not specifically state the location of the incidents occurring, with many entries merely referring to bombing occurring over the town as a whole. It is of note, however, that one of the records reports an incident occurring at a copper works, a facility which consulted OS mapping confirms was present on and immediately adjacent to Site A, as well as waste ground and railway sidings in the vicinity (encompassed by / adjacent to Sites A and B), suggesting that bombing may have occurred on Site or in the immediate surrounds. Furthermore, bombing at the docks appears to have occurred on several occasions, with the south side referenced as sustaining a number of bombs, some of which were delayed action. A failure with the clockwork mechanism within the fuze of the delayed-action bombs is one cause of UXBs remaining in-situ. Sites A and B were located on the south side of the docks. The Margam Steelworks and/or its surrounding area is also stated to have been bombed on several occasions.

- No evidence of bomb damage to the copper works in Site A, the structure in Site B, nor the section of the steelworks in Site C has been identified within historical aerial imagery and OS mapping, i.e. areas of clearance, missing roofs, repair works. Similarly, no obvious evidence of bomb damage was evident in the areas of open/undeveloped ground on Site; however, such evidence is typically less easily identifiable amongst open ground.
- However, evidence of repair works to the metal refinery in Site A has been observed within 1940 and 1946 aerial imagery, suggesting that bomb damage may have occurred early during WWII. The extent of this possible damage cannot be accurately discerned, although the whole roof appears to have been replaced. The coal briquette works, located approximately 50m north-west of Site B, may have sustained serious damage as identified within aerial and oblique imagery. However, given the homogenous nature of this potential damage, it may be that the structure itself is incomplete or intended to have been built in this way. A possible bomb crater has been identified approximately 30m south-west of Site A.
- Wartime conditions across the Site varied during WWII. Site A comprised a metal refinery, a section of a copper works, and railway infrastructure, Site B comprised an unknown structure and railway infrastructure, and Site C comprised a section of the Margam Steelworks. Any UXB strike to the undamaged structures on each of the Sites would have caused incontrovertible evidence of its incidence as it passed the structures and into the ground beneath. Similarly, a UXB strike to the railway sidings on/adjacent to each of the Sites is likely to have been identifiable at the time. Fire watchers were likely present at the industries located within Site A and C, while the railway infrastructure located within/adjacent to each of the Sites was likely subject to post-raid checks for evidence of UXO. Indeed, given the lack of identified damage in Site C within high-resolution 1946 aerial imagery, as well as to the copper works in the north-west of Site A, access is likely to have remained frequent in these areas. These factors increase the likelihood of bombing and subsequent evidence of UXO being observed in these areas.
- However, visual evidence of repair works to the metal refinery in Site A (white/brighter roofing) suggests that bomb damage may have occurred at this location. Evidence of a subsequent UXB strike at this location, which may have been damaged early during WWII, could conceivably have been obscured amongst existing damage and debris. It is conceivable that access may have been reduced for a time, depending on the extent of the damage. The majority of both Site A and Site B also comprised undeveloped open ground during WWII. Subsequently, any potential evidence of UXO is thought likely to have been less noticeable, with a UXB's descent into open land less obvious than through a structure or roadway, for example. Indeed, the entry hole of a 50kg UXB may be as little as 20cm in diameter and can therefore become easily obscured by growing vegetation. Furthermore, it is unlikely that the undeveloped open ground which comprised the majority of Sites A and B will have been accessed to a significant degree; these areas appear largely unused and unmaintained in 1940s aerial imagery. Evidence of a UXB strike in these areas may not have been observed, becoming obscured over time.
- With regard to the water-based area in the north of Site A, any UXB falling here will have disappeared beneath the waterline immediately and have been obscured from sight. Access in this location will have been limited to watercraft and subsequently, any such strike is unlikely to have been noticed and reported at the time. Consequently, a UXB could feasibly remain in situ in this location. It is also possible that due to environmental factors, any UXB falling in the wider water-based dock area could have migrated within the Site footprint, although UXBs typically do not migrate large distances, which is considered even less likely within a dock.

- In summary, factors pertinent to the risk of UXO contamination vary across each Site. As discussed above, the ground conditions within the majority of Sites A and B was unconducive to the detection of UXO. Bombs, including those with delayed-action fuzes, are recorded across the south of the docks, potentially on Sites A and B. Indeed, potential repair works indicative of bomb damage has been observed to the metal refinery in Site A. As a result, the majority of Site A and all of Site B has been assessed at a **Moderate Risk** from German UXBs. While evidence of a UXB will have been more readily observed amongst the undamaged structures and railway infrastructure within this zone, the potential for the J-Curve effect, whereby a UXB may travel laterally from its point of penetration, indicates that the risk from the open ground also presents at the footprint of the WWII structures and railway sidings. A buffer zone has therefore been added to account for this possibility.
- No evidence of damage to the copper works or railway sidings in Site A, nor the structures in Site C, has been identified. The presence of significant and important infrastructure in these locations indicate that a UXB strike will have been observed and dealt with at the time. However, given recorded bombing to the copper works and the steelworks, the risk from German UXBs is slightly elevated and has been assessed as **Low-Moderate**.

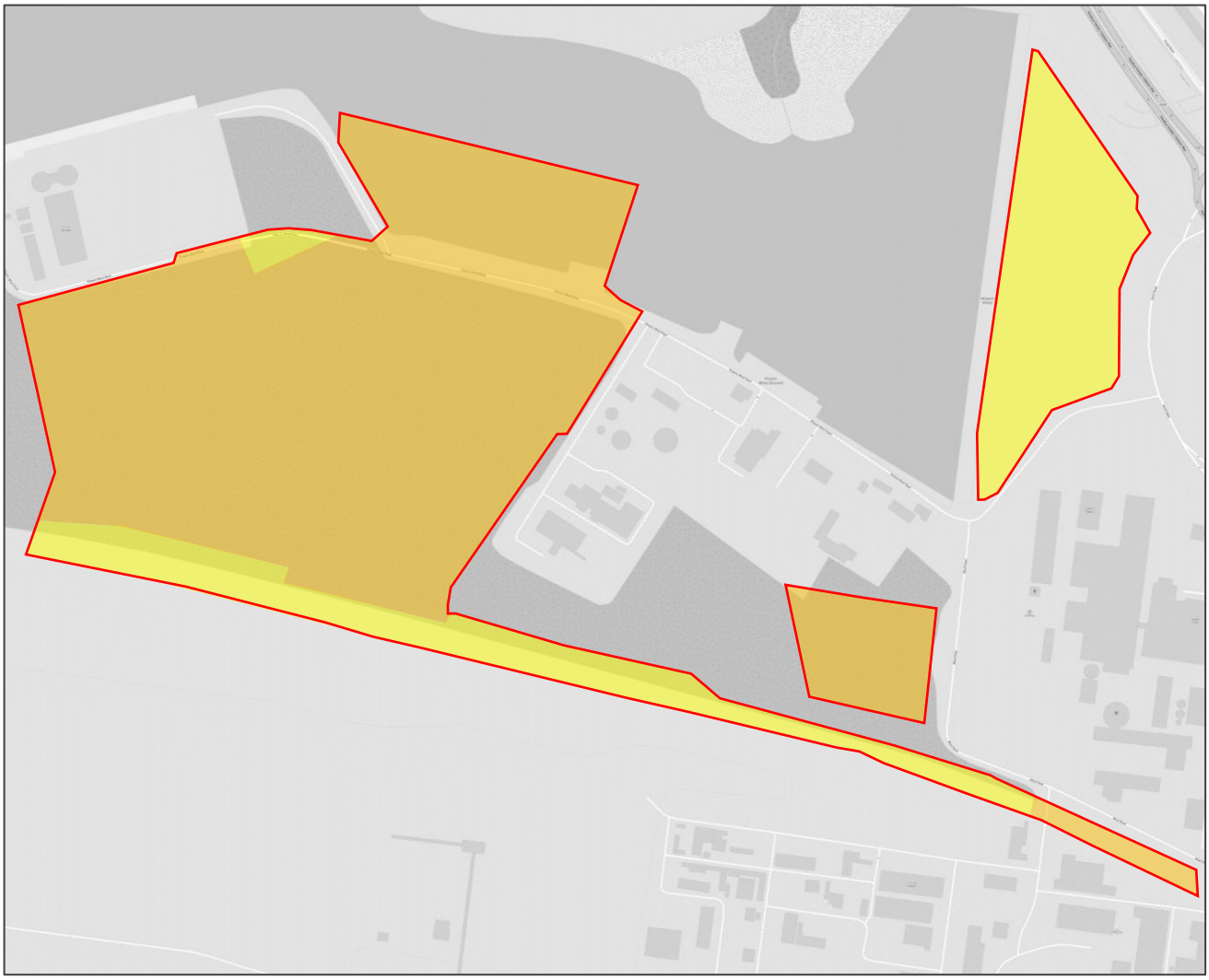
British / Allied UXO:

- Evidence indicates that the Margam Steelworks, within which Site C was located during WWI and WWII, was purpose built during WWI for war production. Further research suggests that the steelworks produced steel utilised for munitions, tanks, ships and other war materials. Three WWII-era bombs/shells have been uncovered at Tata Steel in the 21st century (none have been recorded on Site, although specific locations are unknown). No evidence has been found to suggest that shells were filled at the steelworks in Port Talbot. It is likely that the aforementioned shells consisted solely of the outer casing, given that each of them was certified inert and no mention was made of a high-explosive fill. Therefore, the risk from Allied UXO is assessed to be **Low** across the Site.
- Although all shells uncovered within the wider Tata Steel works have been found to be inert and are believed to be shell casings only, not ordnance, it cannot be assumed to be the case for any potential future items that may encountered. Any suspicious items should be assumed to be live / hazardous. If such an item is encountered on Site, the relevant authorities should be contacted in order to carry out an immediate investigation and initiate the necessary safety procedures.
- 16 permanent HAA batteries were active within range of the Site during WWII. LAA guns likely defended Port Talbot, within which the Site was located. Luftwaffe activity in the region was relatively infrequent. It is possible that an unexploded AA shell struck the open areas of the Site, and the risk is considered to be analogous to that of German UXBs.

Likelihood of UXO Remaining and UXO Encounter:

- Post-conflicts ground works for all three Sites have comprised the clearance of all WWII-era structures and railway lines. This would have consisted of grubbing out the foundations of the former structures, likely mitigating the risk in these areas to shallow depths (1-2m bgl). It is possible that the clearing of some structures may have required deep (>2m) intrusions, although this has not been possible to confirm. The open areas of the Site are likely to have to received minimal post-WWII ground works, which will likely have been to very shallow depths (<1m bgl). The northern section of Site A, occupied by the docks, is not anticipated to have been subject to and ground disturbances.
- The risk associated with (any) very shallow and shallow buried UXO will have been partially mitigated in areas of WWII-era structures and infrastructure. The risk associated with (any) deep buried UXO likely remains unmitigated.

Risk Map:



Low-Moderate Risk from German UXBs & HAA Shells

Moderate Risk from German UXBs & HAA Shells

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.
Non-Intrusive Magnetometer Probe Survey	Open excavations on greenfield land within the **Moderate Risk** zone.
Intrusive Magnetometer Probe Survey	Of all pile positions within the **Moderate Risk** zone.
EOD Engineer - On Site Supervision	Watching brief of all open excavations and magnetometer survey of all borehole locations within the **Moderate Risk** zone.

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QUALITY MANAGEMENT

Brimstone is committed to the provision of UXO risk mitigation services, including the safe removal and disposal, in the UK and overseas. Since our inception in 2016 it has been our goal to provide unsurpassed UXO risk mitigation services. Brimstone is a client-driven organisation, we aim to provide the client the services they need, to the agreed requirement, in accordance with national and international standards.

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

- Integrity in advice, information and the manner in which we conduct ourselves and our operations,
- Professionalism in the way we handle our operations, people and processes, and
- Knowledge in new skills and information, to ensure we remain at the forefront of innovation and strategy.

We are committed to the applicable requirements of the ISO 9001 standards. We set and review quality monitoring objectives 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 affects roles from the managing director down. All staff 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

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1 INTRODUCTION

1.1 Background

TEC Ltd (the Client) has commissioned Brimstone to carry out a Stage 2 Detailed Unexploded Ordnance Risk Assessment (DRA) of the proposed redevelopment works at the Project Dragon, Port Talbot site (the Site).

1.2 Legislation

There are no regulations that specifically govern the UXO risk mitigation industry in the UK. There are however 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 detonating 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 9000m 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 cause 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 SPRC Risk Model

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

- **Sources:** UK and allied UXO sources include military firing ranges, bases, storage depots, munitions factories, anti-aircraft batteries, amongst others. There are many wartime causes of UXO contamination. The source for enemy contamination is overwhelmingly from WWII German air raids.
- **Pathways:** the pathway describes how the UXO reaches receptors. Usually UXO is buried and therefore pathways can be any activity which involve breaking ground. Examples include ground investigation works, site enabling works and excavations.
- **Receptors:** receptors are the people, assets and infrastructure that can be adversely affected by UXO exposure. This includes site personnel, plant, equipment, buildings, the general public, , and the environment.
- **Consequence:** the consequences of an inadvertent UXO detonation are catastrophic. They include injury and loss or life, as well as damage to property. Fortunately, the likelihood of UXO detonating is low, even when it is uncovered during works. Another consequence to consider however 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 following is a general list of information sources that are consulted during the research process:

- 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, Bluesky),
- Google open-source mapping,
- The British Geological Society,
- 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 ALARP 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:** negligible risk or low 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 risk or 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 comprises three separate areas, known as Site A (west), Site B (south) and Site C (east). These will be referred to collectively as 'the Site' for the purposes of this assessment, when not discussed individually.

The Site (approximately centred on the National Grid Refs: SS 76427 88669 (Site A), SS 76871 88433 (Site B) SS 77015 88744 (Site C)) is located in Port Talbot, within the county borough of Neath Port Talbot, Wales. Port Talbot Parkway railway station is located approximately 700m north of the Site.

Site A primarily comprises undeveloped land – consisting of grassy areas and mature vegetation – intermixed with brownfield land. A section of the docks and an unnamed roadway are located in the north, while a disused railway line lies in the south. It is bound to the north by water and a cement works factory, to the east by additional industrial structures, while open ground lies to the west and south.

Site B consists of undeveloped land with mature vegetation throughout; a hardstanding layby is located in the east. It is bound to the north by undeveloped land and an industrial area, to the east by a hardstanding roadway and a metal works and to the south and west by open ground and pipelines.

Site C consists of hardstanding brownfield land with an entrance to an unnamed roadway in the south and the entrance to a river runoff in the north. It is bound to the north by the hardstanding river run off, to the east by an unnamed roadway connecting to Harbour Way, to the south by an unnamed roadway and to the west by a vegetated border to the docks.

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

3.2 The Proposed Works

Ground investigation works are proposed, although specific works were not provided.

Brimstone was not made aware of any future redevelopment works.

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

Period	Map Date	Map Scale	Review
Pre-WWI	1896-1897	1:10,560	Site A comprises open water in the north, mud and heathland in the centre, and a section of railway in the south. Site B comprises mud and heathland. Site C comprises heathland, railway sidings and two minor structures, with small areas of open water in the west.
Pre-WWI / WWI	1913-1914	1:10,560	The composition of Site A varies. The north comprises a section of the docks, while a coal works and copper works lie within the central and north-western sections, encompassed by undeveloped open ground. Both of these works are linked to extensive railway infrastructure, which also lies within the southern section of Site A. The majority of Site A consists of either undeveloped open ground or open water. The rest of the dock and copper works lie to the north of Site A, railway infrastructure and heathland lie to the east and west with solely railway sidings to the south. Mud is no longer recorded. Site B mainly comprises heathland, with an unnamed structure in the south-east, and railway sidings which bisect Site B south-west to north-east. An additional minor structure lies within the south-west of Site B. Site B is bound on all sides by undeveloped heathland, with railway infrastructure located to the east and south, and an unlabelled structure to the north-west Site C comprises railway sidings and undeveloped heathland, as well as a section of Military Road.
WWII	1939-1940	1:2,500	**FIGURE 4.1:** A metal refinery works has replaced the coal works in Site A. The open ground is now all labelled as heathland, while a large railway embankment and associated sidings lie within the south. No significant change is recorded within Site B. Site C now comprises a section of the Margam steel works, with associated industrial buildings in the eastern and northern areas, as well as railway sidings in the north. The west/south-west of the Site comprises undeveloped open ground. Railway infrastructure lies to the north, additional industrial buildings to the east and partially to the south alongside heathland, while the Copper Works Railway lies to the west.
Post-WWII	1947-1949	1:2,500	**FIGURE 4.2:** Additional railway infrastructure, a new structure in the east, and an extension to the metal refinery works (now labelled as a Steel Ceilings Factory) are recorded within Site A. A large section of railway has also been cleared, while several ponds and gravel pits are not recorded in the west. The previously unlabelled structure in the south-east of Site B is now recorded as an electrical substation. Additional railway sidings, constructed on either side of those previously recorded, are now present. Structures in the north-west of Site C have been cleared, with a travelling crane replacing them and the previously undeveloped open ground in the west/south-west. The east of Site C remains occupied by industrial structures; however, the structural layout has changed in areas, with several structures replaced as well as newer additions recorded.

4.3 Photography/Aerial Photography

Period	Photo Date	Review
WWII	21st December 1940	**FIGURE 5.1 & 5.2:** This low-resolution photograph was taken early during WWII. The layout of each Site aligns with pre-WWII OS mapping. Site A comprises open ground and water, as well as railway infrastructure and two industrial works in the north-west. Site B also consists mainly of open ground, as well as a structure in the south-east and railway sidings. Site C comprises numerous structures associated with a large steelworks. Possible repair works have been identified to the metal refinery in Site A, as well as potential severe damage to a structure approximately 50m to the north-west of Site B. A possible bomb crater is located approximately 30m south-west of Site A.
Post-WWII	7th June 1946	**FIGURE 5.3:** No significant change has been observed within this high-resolution photograph, taken less than a year after the end of WWII. No evidence of bombing or associated damage, other than that already discussed above, has been identified.

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. Site C was located within the Margam Steelworks during WWII, which played a significant role in munitions production during World War II. The steel produced at Margam was used for various purposes, including the manufacturing of munitions, tanks, ships, and other war materials. The steelworks, along with the wider industrial infrastructure of Port Talbot, contributed to the British war effort.

5 UXO RISK - GERMAN BOMBING

5.1 WWII Bombing History of the Site

5.1.1 Port Talbot

Port Talbot, a town in South Wales, was a key industrial hub during World War II, with its steelworks and coal production facilities playing a vital role in supporting the British war effort. The Margam Steelworks, in particular, were involved in the production of steel for munitions, tanks, ships, and other war materials. Consequently, the town and its industries became targets for German air raids carried out by the Luftwaffe.

During the course of the war, Port Talbot experienced several air raids by the Luftwaffe, resulting in damage to its infrastructure, industries, and residential areas. While the town did not face the same level of bombardment as some larger British cities, it still faced disruption and destruction due to its strategic importance.

The air raids on Port Talbot led to the loss of lives, damage to property, and disruption of vital industrial operations. The local community faced significant challenges in coping with the aftermath of the bombings, including rebuilding efforts and the ongoing threat of further attacks. Despite these setbacks, the town and its industries continued to contribute to the British war effort throughout the conflict.

5.1.2 Site Specific

Luftwaffe target photography indicates that Port Talbot, within which the Sites are located, was a primary target. A railway yard/storage station was recorded on target photography (Site A and B) and a steel works which made up Site C. This is further recorded within Luftwaffe target mapping (**FIGURE 6**), which highlights the copper works (Kupferworke) and hard coal briquettes (Steinkohlenbrikettebrik) within Site A as bombing targets, as well as the iron foundry (Eisengießerel) within which Site C was located.

5.1.3 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 2.5km to the south.

5.2 WWII Bombing Records

5.2.1 Introduction

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

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

Relevant records held at the National Archives and the West Glamorgan Archive Service were obtained for this risk assessment.

5.2.2 Bombing Density Statistics

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

Admin Area	**Port Talbot**
Area Acreage	23,444
High Explosive Bombs (all types/weights)	87
High Explosive Parachute Mines	1
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)	91
Bombs Per 1,000 Acres	**3.9**

1kg / 2kg incendiary bombs (IBs) and 2kg anti-personnel (AP) bombs were often too numerous to record accurately and therefore are not included in the above figures.

5.2.3 Wales Air Raid Summaries of Occurrences

These summaries, obtained from the National Archives, provide general summaries of air raids across Wales. Only vague locations are recorded, with the number of bombs sometimes listed.

Port Talbot is mentioned on three occasions, affected by incendiary bombing, a UXB and HE bombing. No specific details are provided.

5.2.4 Air Raid Summaries of Occurrences

This record set, obtained from the National Archives, provides specific details pertaining to air raids across Wales. These details include the place, assumed target, number of bombs, and the specifics regarding damage caused. One record was found related to the Site, see below for details.

Place	Assumed Target	No. of Bombs	Details
Port Talbot	Morgam Steel Works	9	Most of the nine bombs appear to have affect residential areas, although bombs 7 and 8 were dropped on 'waste ground (G.W.R)' and bomb 9 was dropped 'on railway siding'.

5.2.5 Luftwaffe Attacks On South Wales And Surrounding Bridgend Area[1]

This online source provides a timeline of air raids in south Wales, providing specific details where possible. See below for relevant incidents pertaining to the Site.

Date	Bomb(s)	Location (*relevant to the Site)*
29/06/1940	1 x UXB	Port Talbot. *Precise location unknown.*
29/06/1940	1 x HE	Near the Grand Hotel. *Located approximately 710m to the north-west of Site C.*
29/06/1940	1 x HE	In the station approach. *Located approximately 710m to the north-west of Site C.*
29/06/1940	1 x HE	On the railway sidings near Port Talbot Steelworks. *Precise location unknown, railway sidings were located immediately to the west of Site C and within Site B; however, the bomb could have affected railway sidings on the eastern side of the works.*
29/06/1940	1 x HE	Between Margam Coke Ovens and Richard Thomas Steelworks. *Precise location unclear, likely within either the Margam Steel Works, in close proximity to Site C, or the Port Talbot Steel Works, approximately 550m to the north of Site A.*
29/06/1940	1 x HE	Talbot House. *Precise location unknown.*
29/06/1940	1 x HE	Between the Steelworks and Dock Ferry. *Precise location unknown, potentially near the Site.*
29/07/1940	3 x HE	Port Talbot harbour gates. *Located approximately 600m to the west of Site A.*
20/08/1940	HEs (number unspecified)	Port Talbot Docks. *Precise location unknown, potentially on/near Site A.*
24/08/1940	HEs (number unspecified)	Aluminium and Copper Works and docks at Port Talbot. *Precise location unknown, the affected copper works may be located partially within the north-west of Site A. Bombs on the docks could conceivable be on near Site A.*
25/08/1940	HEs (number unspecified)	Port Talbot. *Precise location unknown.*

[1] http://www.islandfarm.wales/Luftwaffe_Attacks_On_South_Wales.htm

26/09/1940	HEs (number unspecified)	Port Talbot. *Precise location unknown.*
09/10/1940	HEs (number unspecified)	Swansea and Port Talbot bombed. *Precise location unknown.*
17/01/1941	HEs (number unspecified)	Port Talbot Docks. *Precise location unknown, potentially on/near Site A.*

5.2.6 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.

An online source detailing the WWII history of the Port Talbot docks provides useful information pertaining to bombing during the period. See below for relevant excerpts.[2]

- 'The docks at Port Talbot were exceedingly fortunate in that they experience very few attacks from the air, and consequently suffered relatively little air-raid damage.'
- 'The first of the air raids occurred in the early hours of 29th June and 1st July 1940, when a number of bombs were dropped on the **docks**, some falling close to Messrs. Guest Keen & **Baldwins' Margam Works**, but fortunately there was not significant damage.'
- 'One lone raider appeared over the docks at 9.52 a.m. on 20th August 1940 and dropped a number of bombs on the **south side of the docks**, causing damage to dock railway lines, electricity cables and wagons of coal, etc.'
- 'Four days later, incendiary bombs and high explosive time bombs were dropped on No. 2 Grid. All traffic working on the **south side of the dock** was held up for two days until the unexploded bombs were recovered.'

5.2.7 Abandoned Bomb Register

Due to the overstretched bomb disposal units during WW2, 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 11.4km north-west of the Site.

[2] http://www.swanseadocks.co.uk/docksnewsite/ptwar.html

5.3 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 eight air raids affected the study area. This number may be higher as no comprehensive official bombing records for Port Talbot have been uncovered.
Intensity of these Air Raids:	All bombs dropped locally were likely part of so called “tip and run” raids, or aircraft jettisoning their remaining ordnance loads before the return journey to continental Europe. Small-scale targeted raids may also have taken place.
Bomb Strike Positions	
Closest Bomb Strikes	HE bombs: potentially on Site A/B. 1kg / 2kg IBs: unknown.
Alignment of recorded Bomb Strikes:	For areas with no bomb plot mapping or comprehensive written records, accurate analysis for the alignment of bomb strikes is not always possible. However, evidence obtained within an online source indicates that a stick of delayed-action HE bombs were dropped on the south side of the docks, potentially referring to Sites A and B. Additional attacks on the docks and the Margam steelworks are also referred to. This indicates that multiple aircraft may have flown over each of the Sites, elevating the possibility for a UXB to have been dropped overhead.
Bomb Failure Rate	
Evidence to suggest that the generally accepted failure rate of 10% differs in the vicinity of the site:	None.
UXBs recorded in close proximity to the site:	None.

5.4 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.

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 all air raids in the immediate vicinity are thought to have 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. However, fire watchers were likely present at the industries located within Site A and C, while the railway infrastructure located within/adjacent to each of the Sites was likely subject to post-raid checks for evidence of UXO. Indeed, given the lack of identified damage in Site C within high-resolution 1946 aerial imagery, as well as to the copper works in the north-west of Site A, access is likely to have remained frequent in these areas. These factors increase the likelihood of bombing and subsequent evidence of UXO being observed in these areas. However, visual evidence of repair works to the metal refinery in Site A (white/brighter roofing) suggests that bomb damage may have occurred at this location. It is conceivable that access may have been reduced for a time, depending on the extent of the damage. Furthermore, it is unlikely that the undeveloped open ground which comprised the majority of Sites A and B will have been accessed to a significant degree; these areas appear largely unused and unmaintained in 1940s aerial imagery. Evidence of a UXB strike in these areas may not have been observed, becoming obscured over time. Access to the water-based area of Site A will have been limited to watercraft and subsequently, any such strike is unlikely to have been noticed and reported at the time. Consequently, a UXB could feasibly remain in situ in this location.

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.
No evidence of bomb damage to the copper works in Site A, the structure in Site B, nor the section of the steelworks in Site C has been identified within historical aerial imagery and OS mapping, i.e. areas of clearance, missing roofs, repair works. Similarly, no obvious evidence of bomb damage was evident in the areas of open/undeveloped ground on Site; however, such evidence is typically less easily identifiable amongst open ground. Evidence of repair works to the metal refinery in Site A has been observed within 1940 and 1946 aerial imagery, suggesting that bomb damage may have occurred early during WWII. The extent of this possible damage cannot be accurately discerned, although the whole roof appears to have been replaced. The coal briquette works, located approximately 50m north-west of Site B, may have sustained serious damage as identified within aerial and oblique imagery (see **FIGURES 5.2 & 5.4** for enlarged images of this structure). However, given the homogenous nature of this potential damage, it may be that the structure itself is incomplete. A possible bomb crater has been identified approximately 30m south-west of Site A.

Ground Cover Type
A UXB which falls on open field could easily go unnoticed, whereas a UXB dropped on a hard-surfaced car park would have been easily observed.
Any UXB strike to the undamaged structures on each of the Sites would have caused incontrovertible evidence of its incidence as it passed the structures and into the ground beneath. Similarly, a UXB strike to the railway sidings on/adjacent to each of the Sites is likely to have been identifiable at the time. Evidence of a UXB strike amongst the metal refinery in Site A, which may have been damaged early during WWII, could conceivably have been obscured amongst existing damage and debris. The majority of both Site A and Site B also comprised undeveloped open ground during WWII. Subsequently, any potential evidence of UXO which may have fallen at this time is thought likely to have been less noticeable, with a UXB's descent into open land less obvious than through a structure or roadway, for example. Indeed, the entry hole of a 50kg UXB may be as little as 20cm in diameter and can therefore become easily obscured by growing vegetation. With regard to the water-based area in the north of Site A, any UXB falling here will have disappeared beneath the waterline immediately and have been obscured from sight, leaving no evidence of its occurrence.

5.5 Bombing During WWI

During 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.

A collection of written reports describing each air raid in the region was reviewed.[3] The wider Site area, however, did not experience any air raids during WWI. As such, the associated UXO risk is considered negligible and will not be further addressed.

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.

[3] https://www.iancastlezeppelin.co.uk/

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	
	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
250	4.8	13.7	4.8	13.7	6.0	13.1	6.8	15.8
500	6.0	17.3	6.0	17.3	7.6	16.4	8.7	19.8
1,000	7.6	21.9	7.6	21.9	9.6	20.7	10.9	24.9

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 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 is 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:** Tidal Flat Deposits – Clay, Silt and Sand	**Bedrock Deposits:** South Wales Middle Coal Measures Formation - Mudstone
SI Data	Recent SI data was provided by the Client. One of the boreholes on Site (BH01 – April 2022) encountered the following ground conditions: - 0.20m of very gravelly sand. Gravel of slag and concrete (made ground). - 1.00m of gravelly, silty sand with occasional silt. Gravel of slag, mudstone and rare brick fragments (made ground). - 1.00m of gravelly silty sand. Gravel of mudstone. - 2.00m of sandy silt. - 1.00m of sandy gravelly silt with low cobble content. - 0.80m of silt with low cobble content and frequent pockets of peat. - 3.30m of sandy silt. - 0.20m of peat. - 10.10m of sand with medium cobble content.	

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.

To calculate an accurate maximum bomb penetration depth, Brimstone would normally take the average of the averages of the figure for the predominant Site-specific geologies (silt, sand, gravel), in the table above. However, given the lack of BPD data for silt, as well as for mudstone and sandstone, this has not proved possible on this occasion. While dense gravel presents at depths of 10-14m bgl, a UXB will first have travelled through clay, silt or sand beforehand, indicating that the dampening effect of the dense gravel on the descent of a UXB will be marginal and near the tail-end. As a result of the variance of the geological conditions on Site, with areas of predominantly clay, silt and sand identified, the maximum penetration depth could be up to 14.25m.

NB: theoretically penetration depths could be greater if the UXB was larger, however, 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 has not located any evidence of significant British or Allied army, RAF or Royal Navy activity specifically on Site and none is likely to have occurred historically. However, evidence indicates that the Margam Steelworks, within which Site C was located during WWI and WWII, was purpose built during WWI for war production. The potential sources of British UXO contamination are therefore munitions factories and WWII AA artillery fire.

7.2.2 Margam Steelworks

Evidence indicates that the Margam Steelworks, within which Site C was located during WWI and WWII, was purpose built during WWI for war production. Further research suggests that the steelworks produced steel utilised for munitions, tanks, ships and other war materials. Three WWII-era bombs/shells have been uncovered at Tata Steel in the 21st century. The first, referred to as a 'bomb' within an in-house geo dataset, was encountered approximately 1.8km to the south-east of Site A in 2008 during excavation works; the area was

cordoned off and an EOD squad attended the scene, although the device was found to be inert. A 'shell' was discovered near the main railway line in 2011, which is located approximately 170m to the east of Site C at its closest point, although was likely encountered further to the south. It is unclear whether the shell was filled and fuzed and bomb disposal personnel carried out a controlled detonation.[4] Another 'shell' was uncovered in 2020 (precise location unknown) and was declared without a fuze and therefore inert by Army personnel; however, it is unknown whether it was filled with high explosives. [5]

No evidence has been found to suggest that shells were filled at the steelworks in Port Talbot. It is likely that each of the aforementioned shells consisted solely of the outer casing, produced by the Margam Steelworks, given that each of them was certified inert.

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.

  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.

16 permanent HAA batteries were active within range of the Site during WWII. LAA guns likely defended Port Talbot, within which the Site was located. Luftwaffe activity in the region was relatively infrequent. It is possible that an unexploded AA shell struck the open areas of the Site.

[4] https://www.bbc.co.uk/news/uk-wales-south-west-wales-13877272

[5] https://www.walesonline.co.uk/news/local-news/port-talbot-tata-steel-bomb-17621716

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 EOD 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 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. Three inert bombs/shells have been encountered at Tata Steel in the 21st century, see ***Section 7.2.2*** above for additional information.

8.3 Ground Works

Post-conflicts ground works for all three Sites have comprised the clearance of all WWII-era structures and railway lines. This would have consisted of grubbing out the foundations of the former structures, likely mitigating the risk in these areas to shallow depths (1-2m bgl). It is possible that the clearing of some structures may have required deep (>2m) intrusions, although this has not been possible to confirm. The open areas of the Site are likely to have to received minimal post-WWII ground works, which will likely have been to very shallow depths (<1m bgl). The northern section of Site A, occupied by the docks, is not anticipated to have been subject to and ground disturbances.

8.4 Deductions

The risk associated with (any) very shallow and shallow buried UXO will have been partially mitigated in areas of WWII-era structures and infrastructure. The risk associated with (any) deep buried UXO likely remains unmitigated.

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 comprehensive bombing records nor bomb plot mapping was available for the WWII-era Municipal Borough of Port Talbot during the production of this report from national and local archives. While anecdotal accounts provide the locations of various bombing incidents, 87 HE bombs are recorded as falling within the borough during WWII and therefore the locations of the vast majority of these are unknown. While an accurate risk level can be determined without the need for comprehensive records, their unavailability leads to uncertainty regarding whether bombs fell on/near the Site, resulting in an additional risk factor to consider.

9.2 The Risk of UXO Contamination on Site

9.2.1 Key Findings – German UXO Risk

- Port Talbot was a key industrial hub during World War II, with its steelworks and coal production facilities playing a vital role in supporting the British war effort. The Margam Steelworks, within which Site C was located, were involved in the production of steel for munitions, tanks, ships, and other war materials. Consequently, the town and its industries became targets for German air raids carried out by the Luftwaffe. Indeed, Luftwaffe target photography indicates industries on Site and nearby were identified as primary bombing targets. A railway yard/storage station was recorded on target photography (Site A and B) and a steel works which made up Site C. This is further recorded within Luftwaffe target mapping, which highlights the copper works (Kupferworke) and hard coal briquettes (Steinkohlenbrikettebrik) within Site A as bombing targets, as well as the iron foundry (Eisengießerel) within which Site C was located.
- The majority of the official records obtained for Port Talbot did not specifically state the location of the incidents occurring, with many entries merely referring to bombing occurring over the town as a whole. It is of note, however, that one of the records reports an incident occurring at a copper works, a facility which consulted OS mapping confirms was present on and immediately adjacent to Site A, as well as waste ground and railway sidings in the vicinity (encompassed by / adjacent to Sites A and B), suggesting that bombing may have occurred on Site or in the immediate surrounds. Furthermore, bombing at the docks appears to have occurred on several occasions, with the south side referenced as sustaining a number of bombs, some of which were delayed action. A failure with the clockwork mechanism within the fuze of the delayed-action bombs is one cause of UXBs remaining in-situ. Sites A and B were located on the south side of the docks. The Margam Steelworks and/or its surrounding area is also stated to have been bombed on several occasions.
- No evidence of bomb damage to the copper works in Site A, the structure in Site B, nor the section of the steelworks in Site C has been identified within historical aerial imagery and OS mapping, i.e. areas of clearance, missing roofs, repair works. Similarly, no obvious evidence of bomb damage was evident in the areas of open/undeveloped ground on Site; however, such evidence is typically less easily identifiable amongst open ground.
- However, evidence of repair works to the metal refinery in Site A has been observed within 1940 and 1946 aerial imagery, suggesting that bomb damage may have occurred early during WWII. The extent of this possible damage cannot be accurately discerned, although the whole roof appears to have been replaced. The coal briquette works, located approximately 50m north-west of Site B, may have sustained serious damage as identified within aerial and oblique imagery. However, given the homogenous nature of this potential damage, it may be that the structure itself is incomplete or intended to have been built in this way. A possible bomb crater has been identified approximately 30m south-west of Site A.
- Wartime conditions across the Site varied during WWII. Site A comprised a metal refinery, a section of a copper works, and railway infrastructure, Site B comprised an unknown structure and railway infrastructure, and Site C comprised a section of the Margam Steelworks. Any UXB strike to the undamaged structures on each of the Sites would have caused incontrovertible evidence of its incidence as it passed the structures and into the ground beneath. Similarly, a UXB strike to the railway sidings on/adjacent to each of the Sites is likely to have been identifiable at the time. Fire watchers were likely present at the industries located within Site A and C, while the railway infrastructure located within/adjacent to each of the Sites was likely subject to post-raid checks for evidence of UXO. Indeed, given the lack of identified damage in Site C within high-resolution 1946 aerial imagery, as well as to the copper works in the north-west of Site A, access is likely to have remained frequent in these areas. These factors increase the likelihood of bombing and subsequent evidence of UXO being observed in these areas.

- However, visual evidence of repair works to the metal refinery in Site A (white/brighter roofing) suggests that bomb damage may have occurred at this location. Evidence of a subsequent UXB strike at this location, which may have been damaged early during WWII, could conceivably have been obscured amongst existing damage and debris. It is conceivable that access may have been reduced for a time, depending on the extent of the damage. The majority of both Site A and Site B also comprised undeveloped open ground during WWII. Subsequently, any potential evidence of UXO is thought likely to have been less noticeable, with a UXB's descent into open land less obvious than through a structure or roadway, for example. Indeed, the entry hole of a 50kg UXB may be as little as 20cm in diameter and can therefore become easily obscured by growing vegetation. Furthermore, it is unlikely that the undeveloped open ground which comprised the majority of Sites A and B will have been accessed to a significant degree; these areas appear largely unused and unmaintained in 1940s aerial imagery. Evidence of a UXB strike in these areas may not have been observed, becoming obscured over time.
- With regard to the water-based area in the north of Site A, any UXB falling here will have disappeared beneath the waterline immediately and have been obscured from sight. Access in this location will have been limited to watercraft and subsequently, any such strike is unlikely to have been noticed and reported at the time. Consequently, a UXB could feasibly remain in situ in this location. It is also possible that due to environmental factors, any UXB falling in the wider water-based dock area could have migrated within the Site footprint, although UXBs typically do not migrate large distances, which is considered even less likely within a dock.
- In summary, factors pertinent to the risk of UXO contamination vary across each Site. As discussed above, the ground conditions within the majority of Sites A and B was unconducive to the detection of UXO. Bombs, including those with delayed-action fuzes, are recorded across the south of the docks, potentially on Sites A and B. Indeed, potential repair works indicative of bomb damage has been observed to the metal refinery in Site A. As a result, the majority of Site A and all of Site B has been assessed at a **Moderate Risk** from German UXBs. While evidence of a UXB will have been more readily observed amongst the undamaged structures and railway infrastructure within this zone, the potential for the J-Curve effect, whereby a UXB may travel laterally from its point of penetration, indicates that the risk from the open ground also presents at the footprint of the WWII structures and railway sidings. A buffer zone has therefore been added to account for this possibility.
- No evidence of damage to the copper works or railway sidings in Site A, nor the structures in Site C, has been identified. The presence of significant and important infrastructure in these locations indicate that a UXB strike will have been observed and dealt with at the time. However, given recorded bombing to the copper works and the steelworks, the risk from German UXBs is slightly elevated and has been assessed as **Low-Moderate**.

9.2.2 Key Findings - British UXO Risk

- Evidence indicates that the Margam Steelworks, within which Site C was located during WWI and WWII, was purpose built during WWI for war production. Further research suggests that the steelworks produced steel utilised for munitions, tanks, ships and other war materials. Three WWII-era bombs/shells have been uncovered at Tata Steel in the 21st century (none have been recorded on Site, although specific locations are unknown). No evidence has been found to suggest that shells were filled at the steelworks in Port Talbot. It is likely that the aforementioned shells consisted solely of the outer casing, given that each of them was certified inert and no mention was made of a high-explosive fill. Therefore, the risk from Allied UXO is assessed to be **Low** across the Site.
- Although all shells uncovered within the wider Tata Steel works have been found to be inert and are believed to be shell casings only, not ordnance, it cannot be assumed to be the case for any potential future items that are encountered. Any suspicious items should be assumed to be live / hazardous. If such an item is encountered on Site, the relevant authorities should be contacted in order to carry out an immediate investigation and initiate the necessary safety procedures.

- 16 permanent HAA batteries were active within range of the Site during WWII. LAA guns likely defended Port Talbot, within which the Site was located. Luftwaffe activity in the region was relatively infrequent. It is possible that an unexploded AA shell struck the open areas of the Site, and the risk is considered to be analogous to that of German UXBs.

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)	Likely deep burial (>2m)	HIGH RISK
WWII British Heavy Anti-Aircraft Shells	1.1kg - 1.7kg	Shallow burial (1-2m)	MODERATE-HIGH RISK
WWII British Land Service Ammunition	<2kg	Shallow burial (1-2m)	
WWII German 2kg Incendiary / HE Bombs	680g incendiary hazard + ~500g explosive hazard	Shallow burial (1-2m)	
WWII German 1kg IBs	680g (incendiary, not explosive hazard)	Shallow burial (1-2m)	MODERATE RISK
WWII British Light Anti-Aircraft Shells	4g - 70g	Very shallow burial (<1m)	LOW-MODERATE RISK

9.4 The Likelihood of UXO Encounter

9.4.1 Introduction

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

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

Any post-WWII fill material deposited on a site is unlikely to be contaminated with UXO and therefore the risk of encountering UXO on such a site could vary with depth.

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

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

9.4.2 German UXBs

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

- **Tip and run:** When enemy aircraft had to take evasive action to escape RAF fighter intercepts or AA defences, they often dropped their bomb loads from a reduced height, potentially resulting in extreme J-curve effect.
- **Deflection:** the shape of German bomb nose sections meant they were susceptible to deflection when striking surface or shallow sub-surface obstacles, occasionally resulting in shallow burial or even UXBs skidding across hardstanding.
- **Aircraft Crash Site:** if an aircraft was unable to dump its bomb load before impacting the ground, due to mechanical fault, any externally fitted bombs could have become buried on impact.

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

9.4.3 British / Allied UXO

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

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

9.4.4 Deductions

An elevated likelihood of UXO contamination (German) and likelihood of that UXO remaining up to the present day has been identified across the majority of Site A and all of Site B. Therefore, some of the proposed works are considered to be exposed to a UXO encounter.

10 OVERALL RISK RATING

Ratings for the likelihood of UXO contaminating the Site, remaining within the Site up to the present day and being encountered during the proposed works, inform the overall risk rating. The UXO risk to the proposed works varies. **Low-Moderate** and **Moderate Risk** zones for German UXBs and unexploded HAA shells have been identified, with a **Low Risk** from Allied UXO across the Site. These are illustrated within the risk mapping displayed at **FIGURE 7**.

Risk Table: Low-Moderate Risk				
UXO TYPE (ASSOCIATED HAZARD)	**LIKELIHOOD OF UXO CONTAMINATION**	**LIKELIHOOD OF UXO REMAINING**	**LIKELIHOOD OF ENCOUNTER**	**OVERALL RISK RATING**
WWII German 'Iron' Bombs	Low-Moderate	Moderate-High	Moderate	**Low-Moderate**
WWII British Heavy Anti-Aircraft Shells	Low-Moderate	Moderate-High	Moderate-High	
WWII British Land Service Ammunition	Low	n/a		**Low**
WWII German 2kg Incendiary / HE Bombs	Low	n/a		
WWII German 1kg Incendiary Bombs	Low	n/a		
WWII British Light Anti-Aircraft Shells	Low	n/a		
WWII British Small Arms Ammunition	Low	n/a		

Risk Table: Moderate Risk				
UXO TYPE (ASSOCIATED HAZARD)	LIKELIHOOD OF UXO CONTAMINATION	LIKELIHOOD OF UXO REMAINING	LIKELIHOOD OF ENCOUNTER	OVERALL RISK RATING
WWII German 'Iron' Bombs	Moderate	Moderate-High	Moderate	**Moderate**
WWII British Heavy Anti-Aircraft Shells	Moderate	Moderate-High	Moderate-High	
WWII British Land Service Ammunition	Low	n/a		**Low**
WWII German 2kg Incendiary / HE Bombs	Low	n/a		
WWII German 1kg Incendiary Bombs	Low	n/a		
WWII British Light Anti-Aircraft Shells	Low	n/a		
WWII British Small Arms Ammunition	Low	n/a		

11 RISK MITIGATION RECOMMENDATIONS

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

Risk Mitigation Measure	Recommendation
UXO Safety Awareness Briefings: To all personnel conducting intrusive works on Site. An essential part of the Health & Safety Plan for a site. Conforms to the requirements of CDM2015.	Prior to all intrusive works commencing.
EOD Engineer - On Site Supervision: Watching brief for open excavations below WWII ground level. Portable magnetometer instruments for clearing ground ahead of borehole positions and shallow excavations (where / when appropriate). Positive identification of suspicious (non UXO) objects. Liaison during confirmed UXO incidents. Provision of additional UXO Safety Awareness Briefings.	Watching brief of all open excavations and magnetometer survey of borehole locations within the **Moderate Risk** zone.
Intrusive Magnetometer Probe Survey: A range of intrusive magnetometer methodologies can be deployed to survey the ground (down to the maximum bomb penetration depth) prior to deep intrusive works; pile foundations. The appropriate technique is governed by a number of factors, the most important being the site-specific ground conditions.	Of any pile positions within the **Moderate Risk** zone.
Non-Intrusive Magnetometer Survey: A range of non-intrusive magnetometer methodologies can be deployed to survey large areas of land to a limited depth. Such surveys can typically detect a 50kg WWII bomb at a depth of 4.5m, in "clean" ground. This survey is only appropriate for greenfield land where "magnetic noise" is negligible. To extend survey range, a reduced dig and secondary survey can be carried out.	Open excavations on greenfield land within the **Moderate Risk** zone.

Figures: 1 - 7

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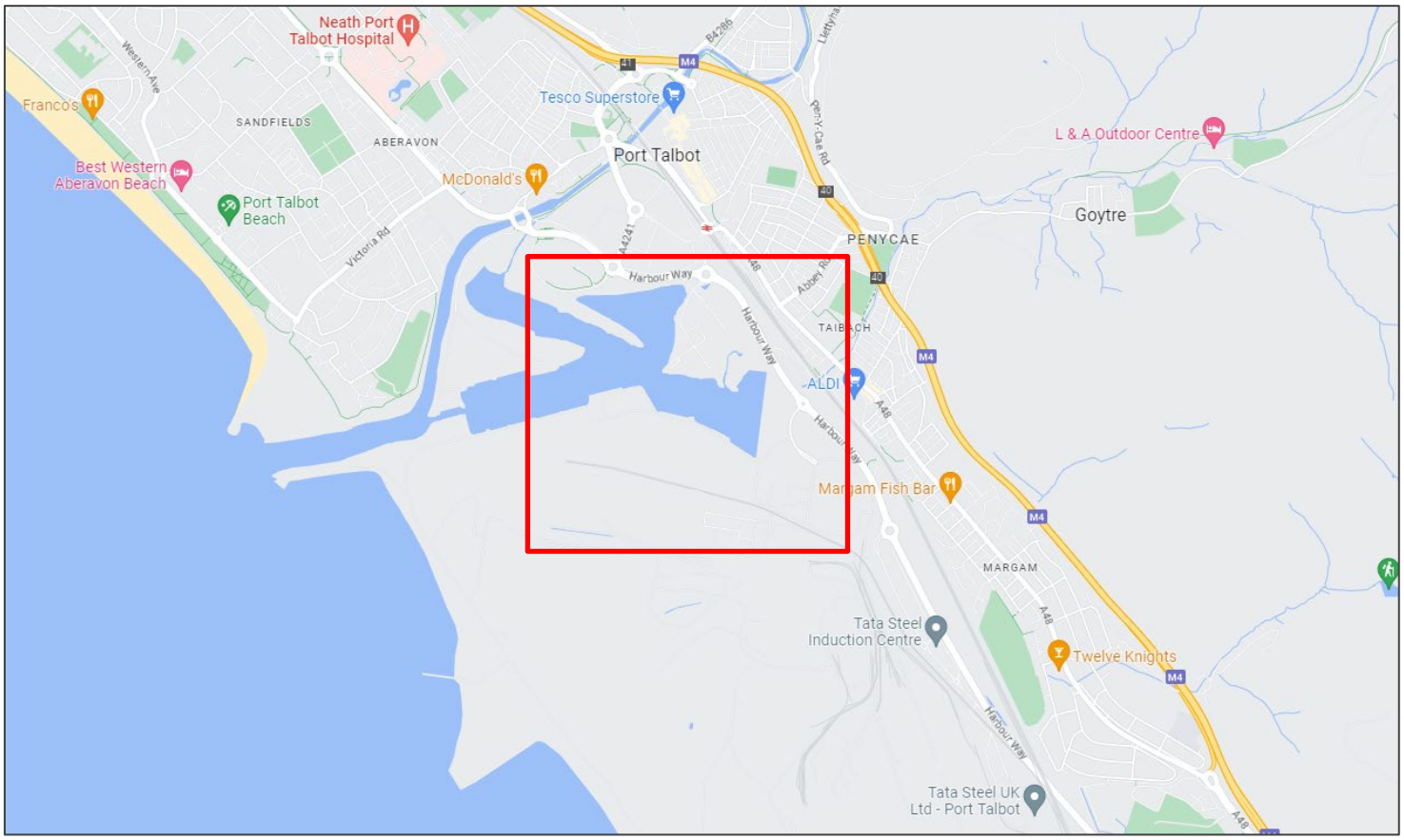
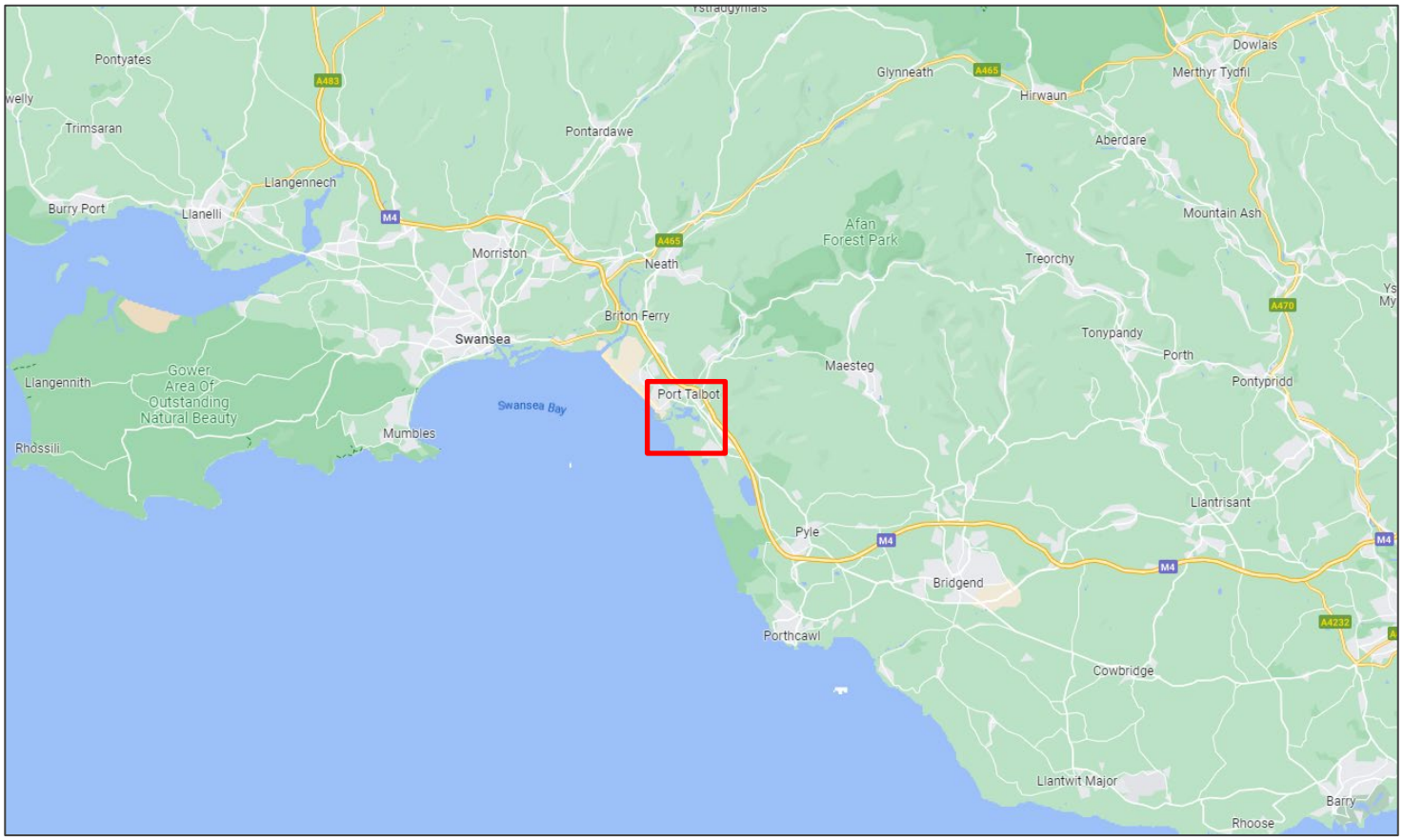
Title:	Site Location Maps	FIGURE: 1





N

Project	**Project Dragon, Port Talbot**
Client:	**TEC Ltd**
Report Ref:	**DRA-23-1532**
General Site Location	Info Source: Google (open-source)

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Title:	Recent Aerial Photograph	FIGURE: 2

N

Project	**Project Dragon, Port Talbot**
Client:	**TEC Ltd**
Report Ref:	**DRA-23-1532**
Approx. Site Boundary	Info Source: Google (open-source)

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Title:	Existing Site Plan	FIGURE: 3

N	Project	Project Dragon, Port Talbot
	Client:	TEC Ltd
	Report Ref:	DRA-23-1532
	Site Boundary	Info Source: TEC Ltd

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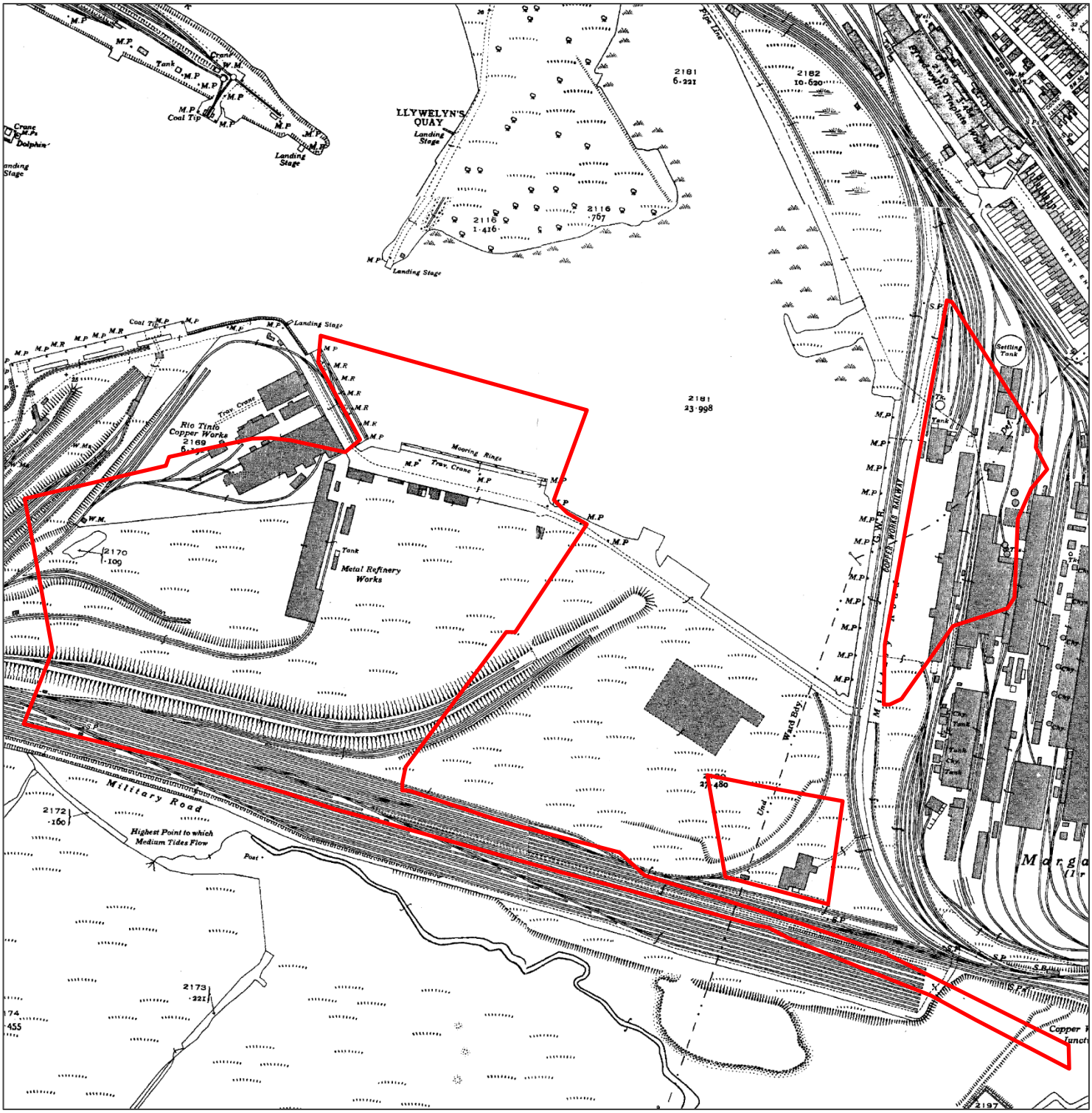
Title:	Historical OS Mapping – 1939-1940	FIGURE: 4.1



N	Project	Project Dragon, Port Talbot	
	Client:	TEC Ltd	
	Report Ref:	DRA-23-1532	
	Approx. Site Boundary	Info Source:	Promap

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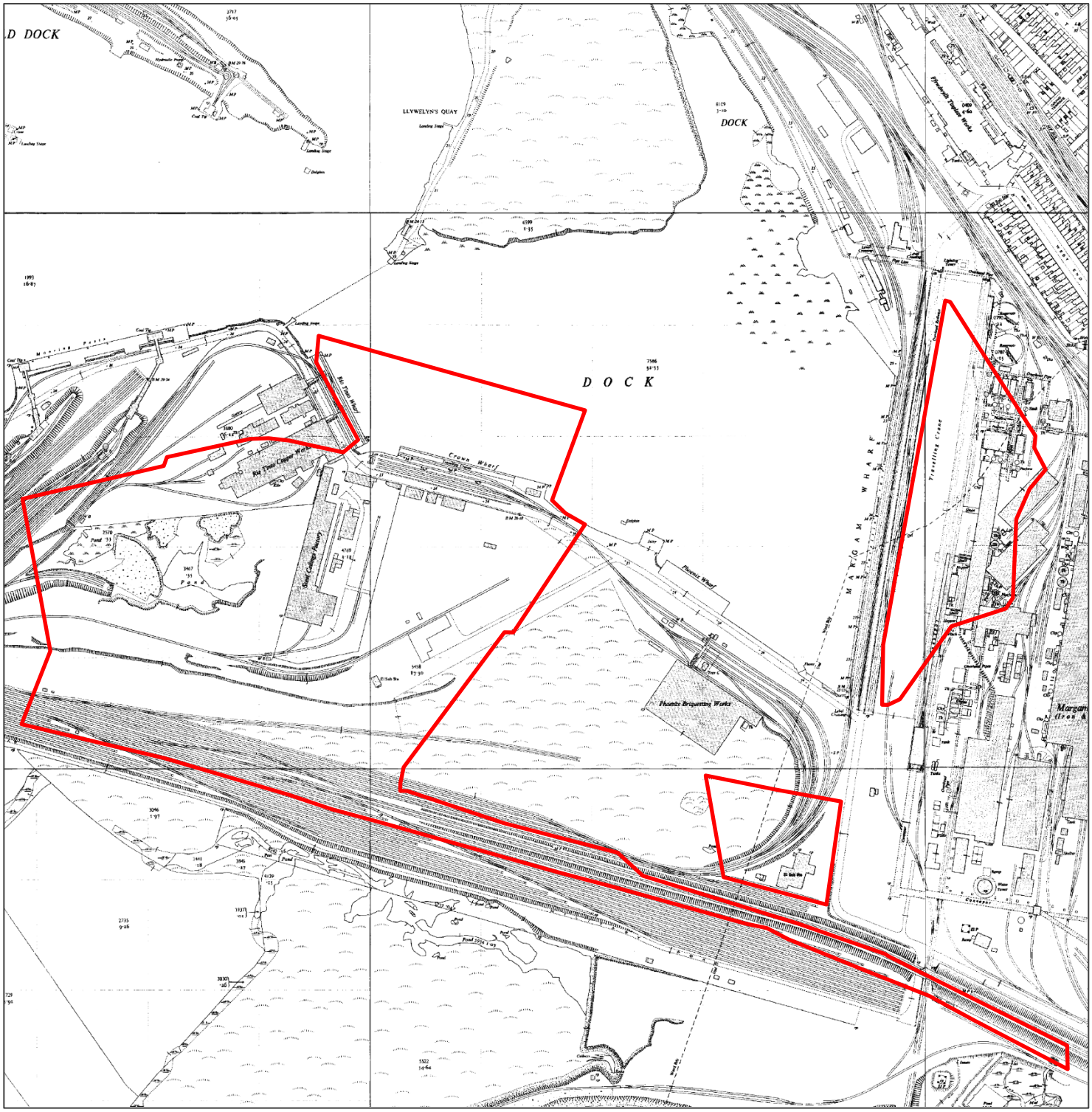
Title:	Historical OS Mapping – 1947-1949	FIGURE: 4.2



N

Project	Project Dragon, Port Talbot
Client:	TEC Ltd
Report Ref:	DRA-23-1532
Approx. Site Boundary	Info Source: Promap

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Title:	Historical Aerial Photography – 21st December 1940	FIGURE: 5.1

Project	Project Dragon, Port Talbot	
Client:	TEC Ltd	
Report Ref:	DRA-23-1532	
Approx. Site Boundary	Info Source: NCAP	

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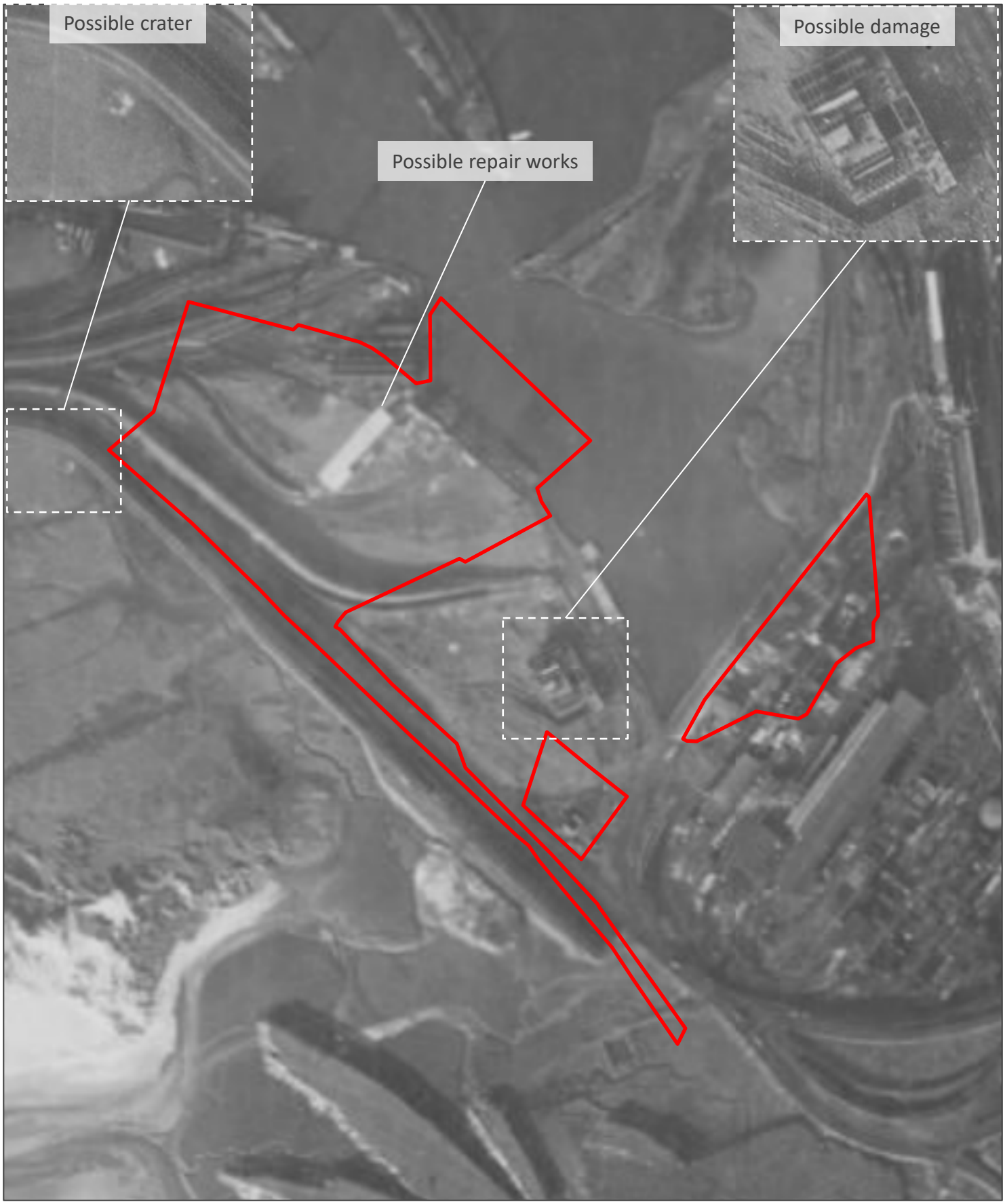
Title:	Historical Aerial Photography – 21st December 1940	FIGURE: 5.2



Project	Project Dragon, Port Talbot	
Client:	TEC Ltd	
Report Ref:	DRA-23-1532	
Approx. Site Boundary	Info Source: NCAP	

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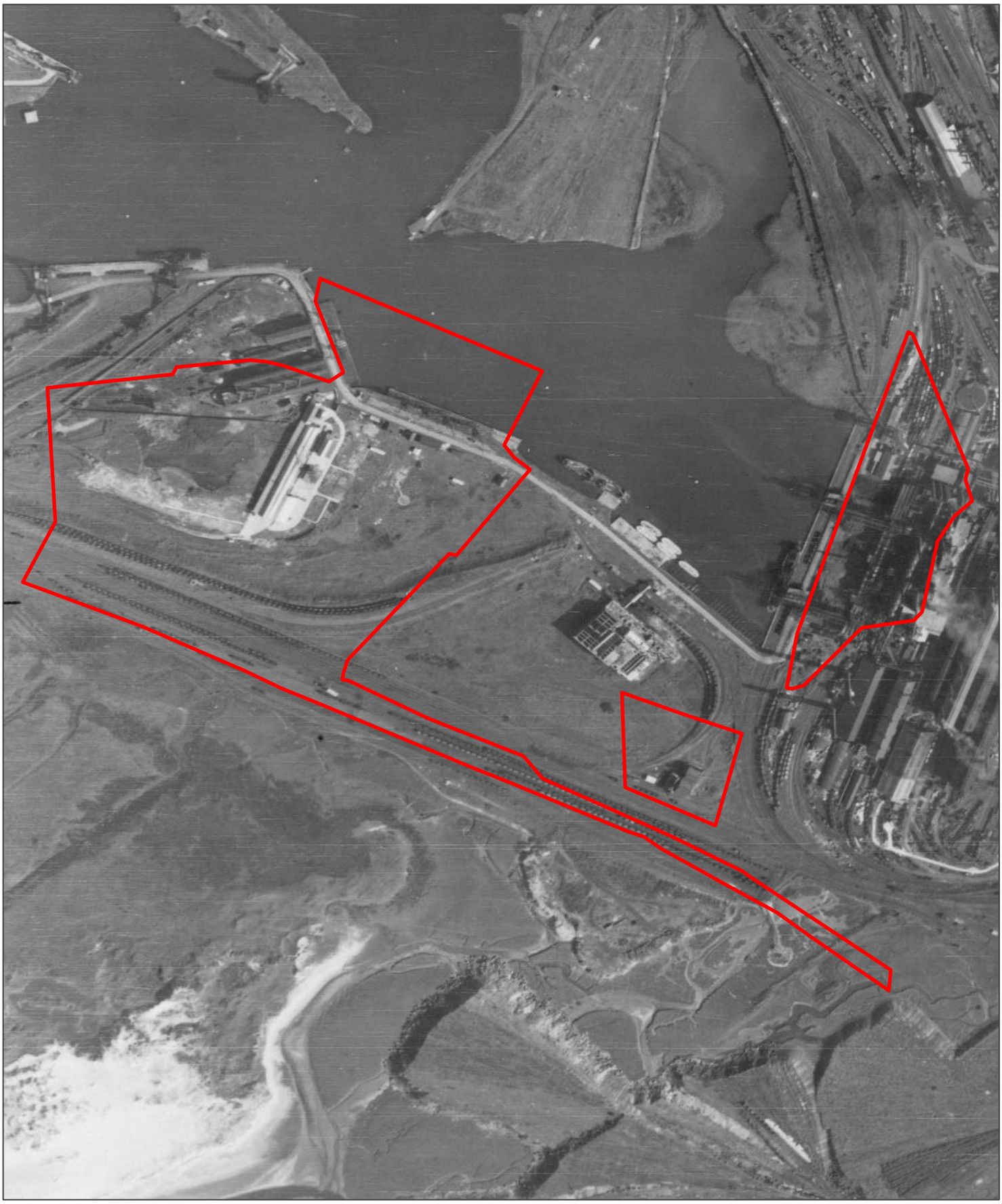
Title:	Historical Aerial Photography – 7th June 1946	FIGURE: 5.3



N

Project	Project Dragon, Port Talbot
Client:	TEC Ltd
Report Ref:	DRA-23-1532
Approx. Site Boundary	Info Source: Historic England

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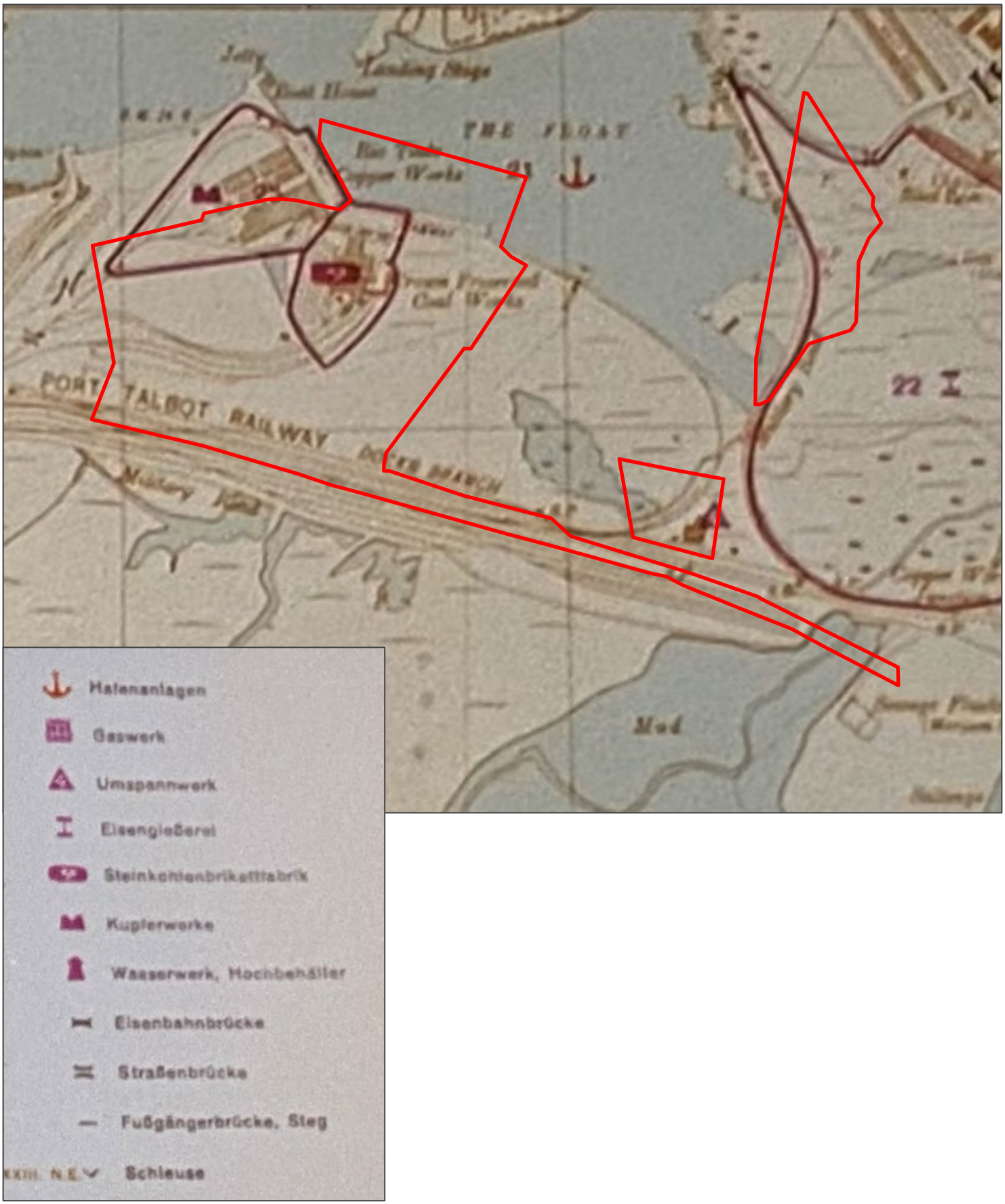
Title:	Luftwaffe Target Map – September 1940	FIGURE: 6



N	Project	Project Dragon, Port Talbot
	Client:	TEC Ltd
	Report Ref:	DRA-23-1532
	Approx. Site Boundary	Info Source: Historic England

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Title:	Risk Map – Recent Aerial Photograph	FIGURE: 7.1

Low-Moderate Risk from German UXBs & HAA Shells

Moderate Risk from German UXBs & HAA Shells

N

Project	**Project Dragon, Port Talbot**
Client:	**TEC Ltd**
Report Ref:	**DRA-23-1532**
Approx. Site Boundary	Info Source: Google (open-source)

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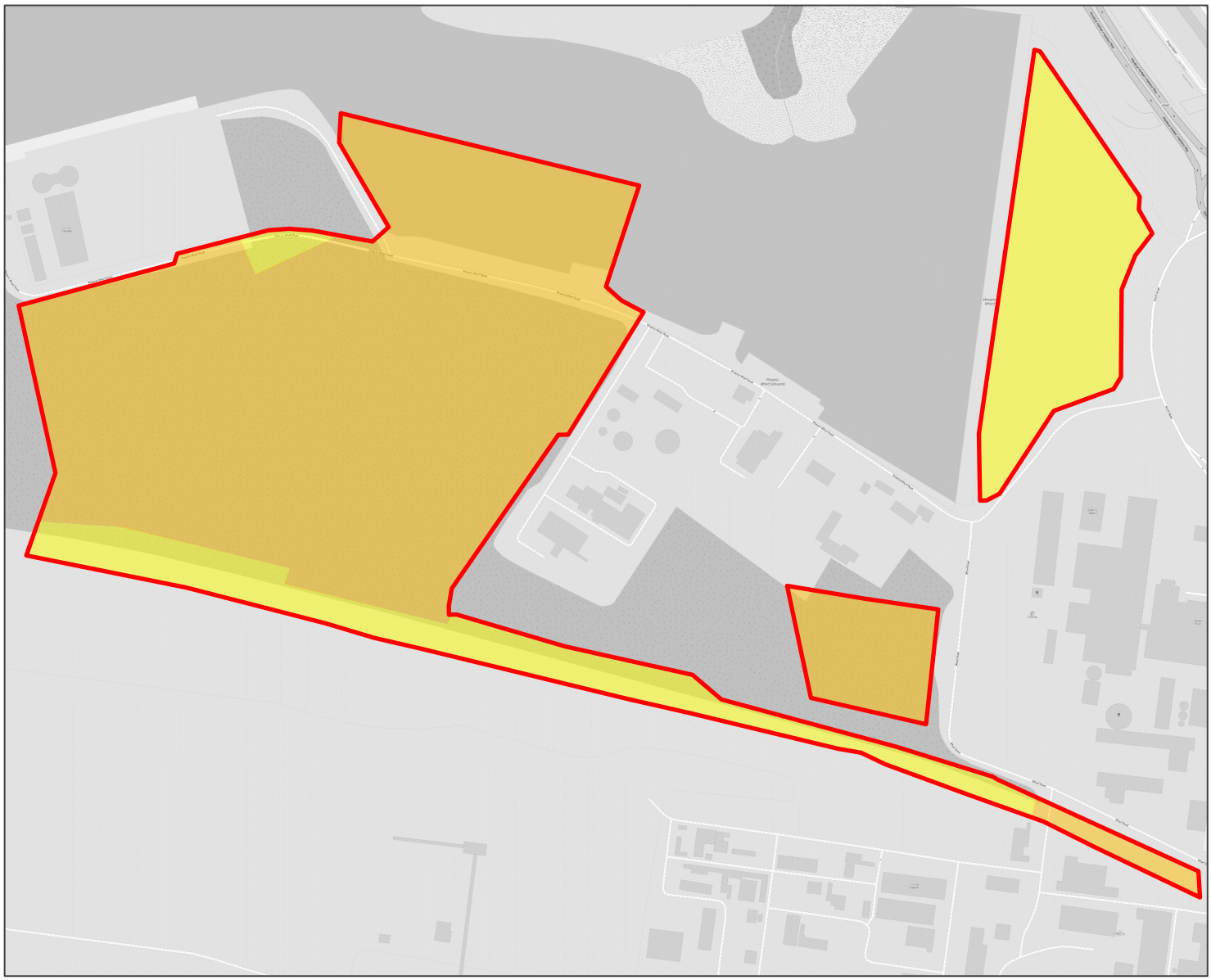
Title:	Risk Map – OpenStreetMap	FIGURE: 7.2



Low-Moderate Risk from German UXBs & HAA Shells

Moderate Risk from German UXBs & HAA Shells

N

Project	**Project Dragon, Port Talbot**
Client:	**TEC Ltd**
Report Ref:	**DRA-23-1532**
Approx. Site Boundary	Info Source: OpenStreetMap

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Appendices: 1 - 5

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Recent German UXB Finds in the UK + Historical Analysis

- ***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.*
- ***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.*
- ***19th January 2017*** - An SD50 (semi-armour piercing 50kg HE bomb) was dredged from the Thames during barge dredging works near Westminster Bridge, London.
- ***12th May 2016*** - A 500kg HE bomb was found buried just 1m below the playground of the former Royal High Junior School in Bath. *Historical Analysis: The UXB landed in a plot of neglected, unmaintained vegetation in between the school gym and main school building.*
- ***23rd September 2015*** - A 1,000kg HE bomb was encountered by a mechanical excavator on a building site in Paradise Street, Coventry. *Historical Analysis: the UXB landed in a large residential back garden occupied by dense vegetation. A two storey building was built on top of the UXB post-WWII.*
- ***10th August 2015*** - A 250kg HE bomb was found immediately beneath a basement floor during refurbishment works in Temple Street, Bethnal Green (London). *Historical Analysis: The UXB struck a house that had been damaged beyond repair during a previous air raid. The existing house was then built on top of UXB post-WWII.*
- ***21st May 2015*** - An SC50 (general purpose 50kg HE bomb) was found during deep excavations at a construction site in Wembley, London. *Historical Analysis: UXB landed in a large residential back garden.*
- ***23rd March 2015*** - A 250kg HE bomb was found during deep excavations at a building site in Grange Walk, Bermondsey (London). *Historical Analysis: inconclusive - reported UXB position is likely inaccurate.*

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).

Initiation of WWII Allied Bombs

- ***6th January 2014*** - Mechanical excavator stuck a WWII bomb in Euskirchen (Germany) causing it to explode, killing the operator and injuring 13 more, two critically. The explosion was so large it damaged buildings 400m away.
- ***1st March 2013*** - During piling at a construction site in Ludwigshafen (Germany) a small buried WWII bomb exploded, injuring one worker.
- ***2nd June 2010*** - A British 500kg bomb detonated whilst being defused, killing three EOD engineers in Goettingen, Germany. The bomb was found as builders dug the foundations for a new sports hall. Several houses had their fronts blown off by the blast.
- ***19th September 2008*** - Seventeen people were injured and buildings were damaged when an excavator apparently drove over and set off a 250kg American bomb at a construction site in Hattingen, Germany.
- ***23rd October 2006*** - A construction worker breaking up tarmac at the side of a highway near the south-western German town of Aschaffenburg was killed when his machine struck and detonated a WWII bomb. In addition, the blast injured several motorists who were driving past.
- ***2006*** - A piling rig and dump truck were destroyed when a piling rig struck an Allied bomb on a construction site in Austria.
- ***2003*** - In the Austrian city of Salzburg, two people were killed while attempting to defuse a 250kg Allied bomb.
- ***1994*** - At a central Berlin construction site a piling rig struck a large WWII Allied bomb. 3 were killed and 14 more were injured. Dozens of cars in a 250m radius were wrecked, the top 10 floors of neighbouring office building collapsed and human remains were found 100m away.
- ***1990*** - In Wetzlar (Germany) two EOD engineers were blown up as they removed the detonator of an allied WWII UXB.

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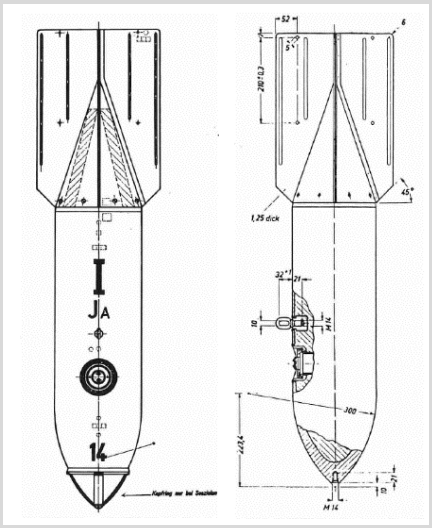
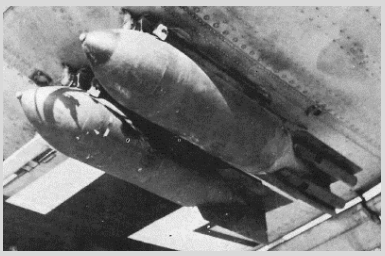
SC 50

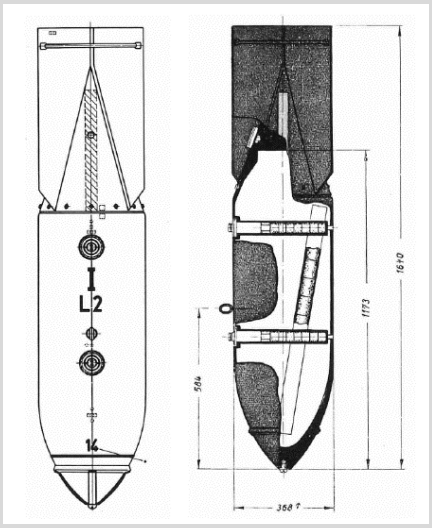
Bomb Weight:	40-54kg (110-119lb)
Explosive Weight:	25kg (55lb)
Filling:	TNT, Amatol or Trialen
Charge/Weight Ratio:	46%
Fuse Type:	Electrical impact fuse or mechanical delayed action fuse
Body Dimensions:	1,100mm length x 200mm diameter
Appearance:	Bomb body and tail painted grey/green with a yellow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





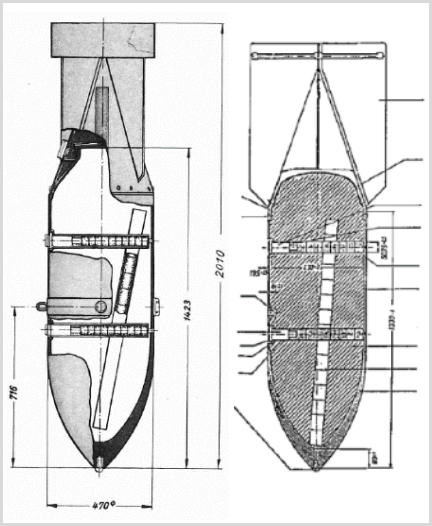
SC 250

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.



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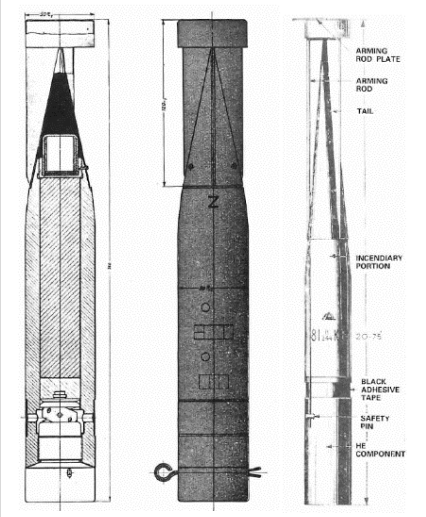
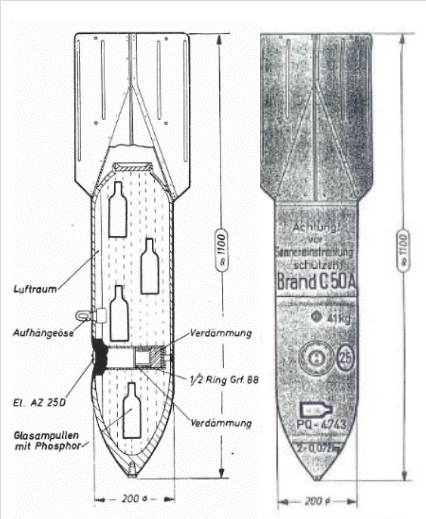
B-1E Sub-Munition

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.



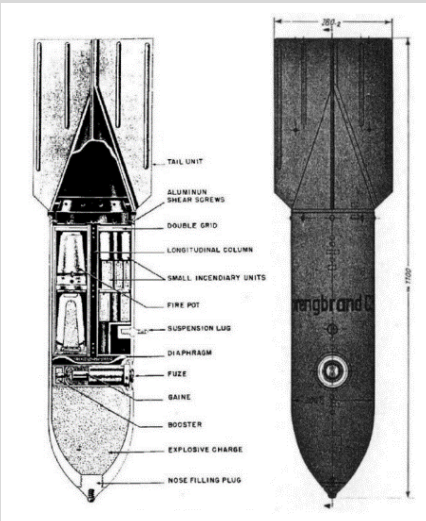
Brand C50

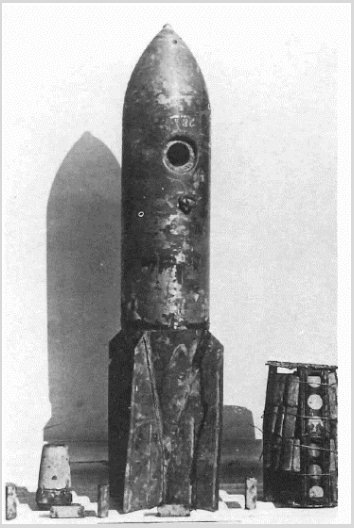
Bomb Weight:	41kg (90.4lb)
Incendiary Weight:	13kg (30lb)
Filling:	Main fill (86% Benzine, 10% Rubber) plus 4% Phosphorus in glass bottles
Fuse Type:	1 x electrical impact fuse
Bomb Dimensions:	762mm length x 203mm diameter
Appearance:	bomb body and tail painted grey or green with the rear of the bomb 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	**Project Dragon, Port Talbot**	
Client:	**TEC Ltd**	
Report Ref:	**DRA-23-1532**	
	Info Source:	*W, Ramsey.1988 / various news sources*

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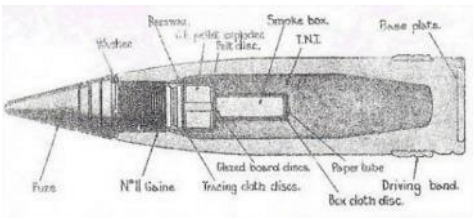
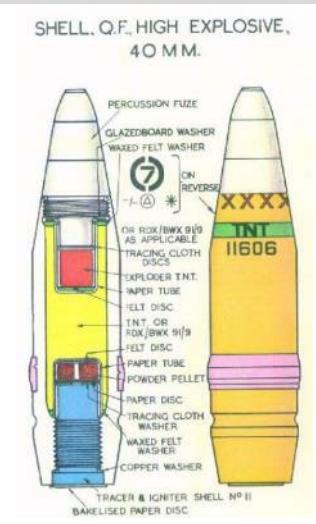
HAA Battery - 3.7" QF Shell

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



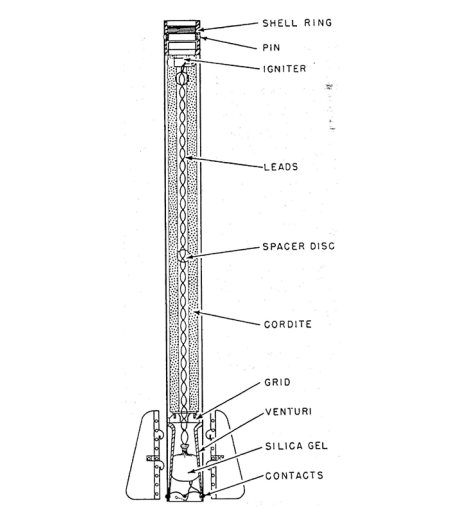
LAA Battery - 40mm Bofors Shell

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



Z Battery - 3" U.P Rocket

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



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

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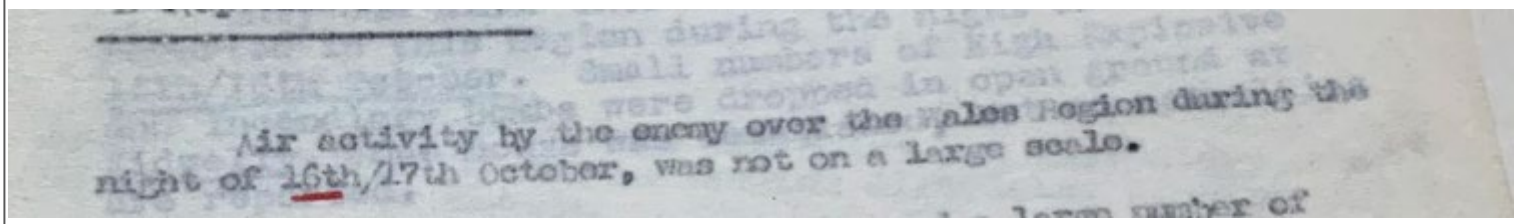
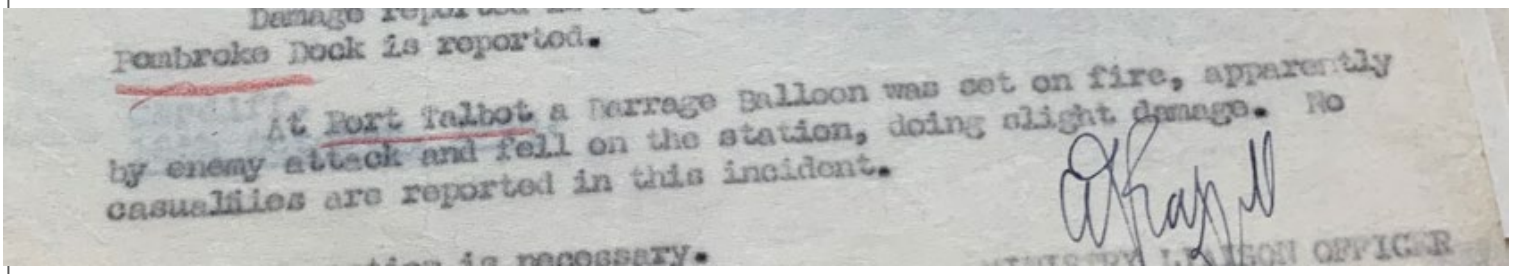


Air activity by the enemy over the Wales Region during the night of 16th/17th October, was not on a large scale.

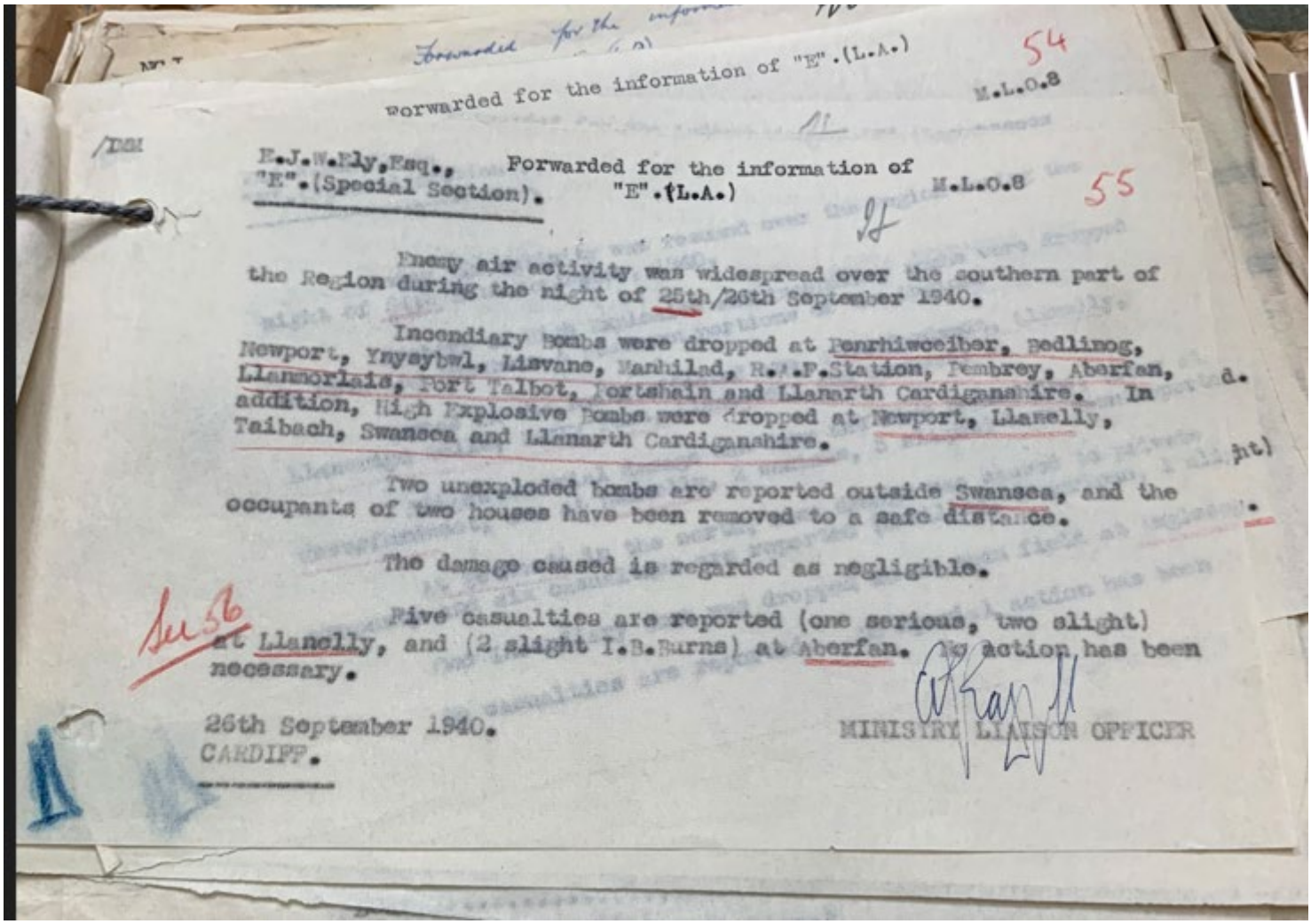


Pembroke Dock is reported.

At Port Talbot a Barrage Balloon was set on fire, apparently by enemy attack and fell on the station, doing slight damage. No casualties are reported in this incident.

No action is necessary.

MINISTRY LIAISON OFFICER



Forwarded for the information of "E".(L.A.) 54

M.L.O.8

/RM

R.J.W.Fly,Esq., "E".(Special Section).

Forwarded for the information of "E".(L.A.) M.L.O.8 55

Enemy air activity was widespread over the southern part of the Region during the night of 25th/26th September 1940.

Incendiary Bombs were dropped at Penrhiwceiber, Pedlinog, Newport, Ynysybwl, Llwyne, Manhilad, R.A.F.Station, Pembrey, Aberfan, Llanmorlais, Port Talbot, Porthcain and Llanarth Cardiganshire. In addition, High Explosive Bombs were dropped at Newport, Llanelly, Taibach, Swansea and Llanarth Cardiganshire.

Two unexploded bombs are reported outside Swansea, and the occupants of two houses have been removed to a safe distance.

The damage caused is regarded as negligible.

Five casualties are reported (one serious, two slight) at Llanelly, and (2 slight I.B.Burns) at Aberfan. No action has been necessary.

26th September 1940.
CARDIFF.

MINISTRY LIAISON OFFICER

Project	Project Dragon, Port Talbot	
Client:	TEC Ltd	
Report Ref:	DRA-23-1532	
	Info Source:	

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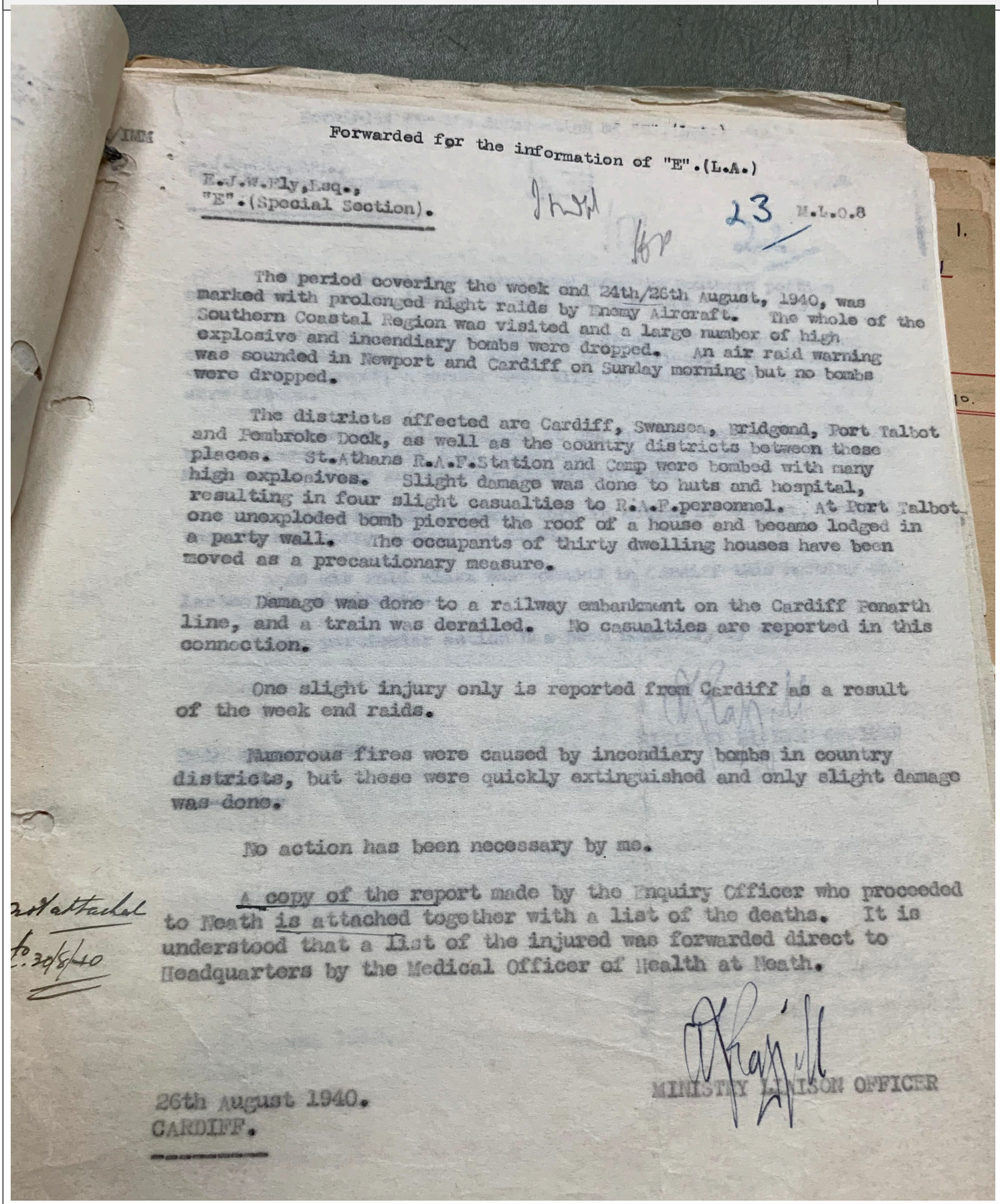

Forwarded for the information of "E".(L.A.)

E.J.W.Fly,Esq.,
"E".(Special Section).

23 M.L.O.8

The period covering the week end 24th/26th August, 1940, was marked with prolonged night raids by Enemy Aircraft. The whole of the Southern Coastal Region was visited and a large number of high explosive and incendiary bombs were dropped. An air raid warning was sounded in Newport and Cardiff on Sunday morning but no bombs were dropped.

The districts affected are Cardiff, Swansea, Bridgend, Port Talbot and Pembroke Dock, as well as the country districts between these places. St.Athans R.A.F.Station and Camp were bombed with many high explosives. Slight damage was done to huts and hospital, resulting in four slight casualties to R.A.F.personnel. At Port Talbot one unexploded bomb pierced the roof of a house and became lodged in a party wall. The occupants of thirty dwelling houses have been moved as a precautionary measure.

Damage was done to a railway embankment on the Cardiff Penarth line, and a train was derailed. No casualties are reported in this connection.

One slight injury only is reported from Cardiff as a result of the week end raids.

Numerous fires were caused by incendiary bombs in country districts, but these were quickly extinguished and only slight damage was done.

No action has been necessary by me.

A copy of the report made by the Enquiry Officer who proceeded to Neath is attached together with a list of the deaths. It is understood that a List of the injured was forwarded direct to Headquarters by the Medical Officer of Health at Neath.

not attached
to 30/8/40

MINISTRY LIAISON OFFICER

26th August 1940.
CARDIFF.

Project	Project Dragon, Port Talbot	
Client:	TEC Ltd	
Report Ref:	DRA-23-1532	
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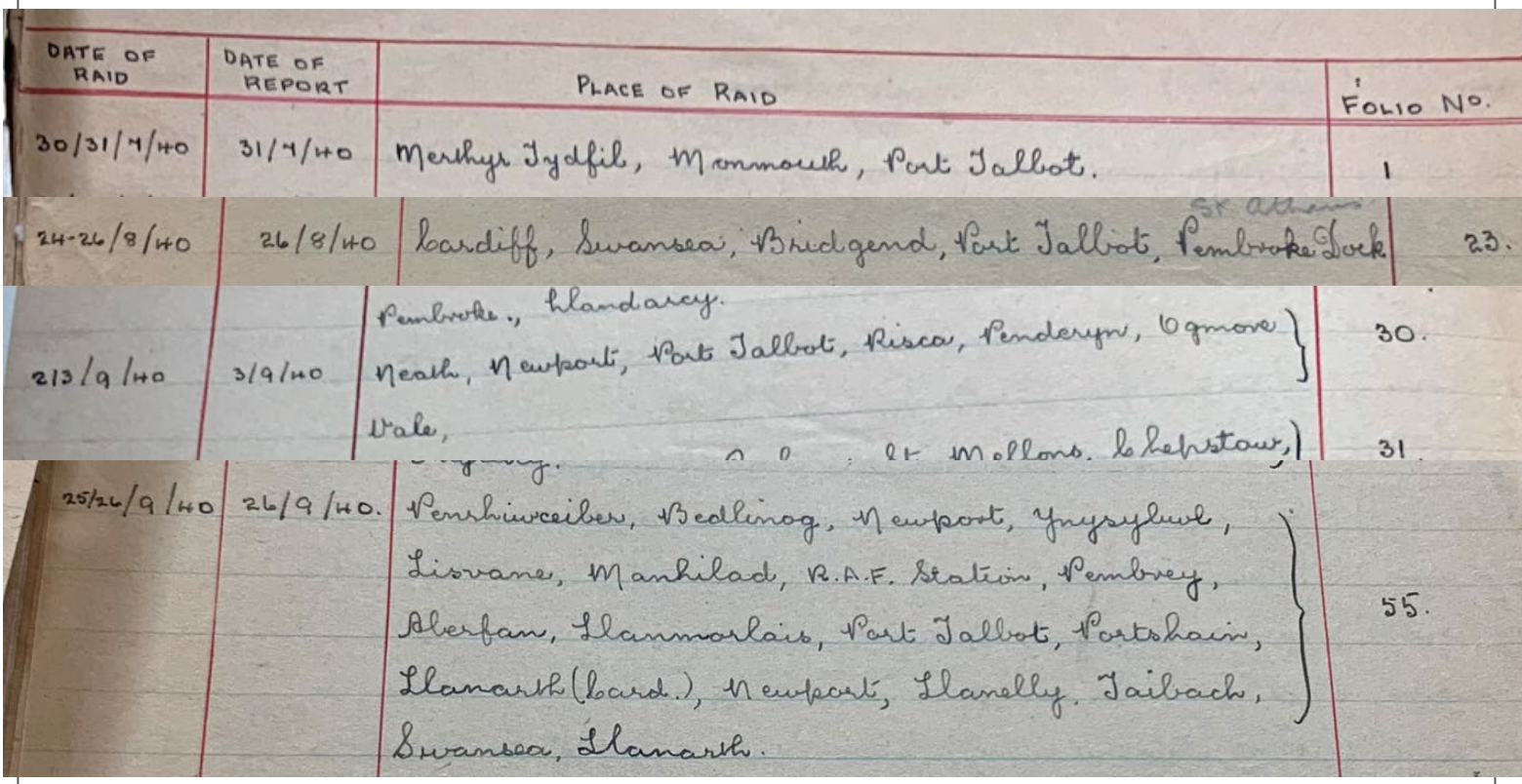

DATE OF RAID	DATE OF REPORT	PLACE OF RAID	FOLIO No.
30/31/4/40	31/4/40	Merthyr Tydfil, Monmouth, Port Talbot.	1
24-26/8/40	26/8/40	Cardiff, Swansea, Bridgend, Port Talbot, Pembroke Dock	23.
2/3/9/40	3/9/40	Pembroke., Llandarcy. Neath, Newport, Port Talbot, Risca, Penderyn, Ogmore Vale, [illegible] St Mellons. Chepstow,	30. 31.
25/26/9/40	26/9/40.	Penrhiwceiber, Bedlinog, Newport, Ynysybwl, Lisvane, Manhilad, R.A.F. Station, Pembrey, Aberfan, Llanmorlais, Port Talbot, Portskewin, Llanarth (Card.), Newport, Llanelly. Taibach, Swansea, Llanarth.	55.

Project	Project Dragon, Port Talbot	
Client:	TEC Ltd	
Report Ref:	DRA-23-1532	
	Info Source:	

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Title:

SECRET

R&E RECORDS.
RAID SUMMARY

FILE NO. T K 5/2/4(5) OCC. NO. 320

Place	Type of District	Date	Time
Port Talbot, Glamorganshire.	Industrial	29.6.40	0100

Indxd.	Assumed Target	Details of Attack	Subject Index
	Margam Steel Works	Aircraft at 12000'-15000' above searchlight range. Densely populated area.	S.18
	No.H.E.Bombs Wt. kg.		

SECRET

R.S
S 15

Bomb 5.

On tarmac road. Two-storey building (cafe) at 10 ft. Plate glass window blown out. No other damage.

Bomb 6.

In garden. Single-storey building (estate office) at 20 ft. Windows shattered and few coping stones fell. No other damage. No damage to another building (hotel) at 50 ft. on opposite side of road.

Bombs 7 and 8.

On waste ground (G.W.R.).

Bomb 9.

2 On railway siding. Dame to a short length of track. No details given.

Bombs 1,2 & 3?).

Bomb 4.

On pair of semi-detached houses @ 6'. 11" cavity wall de-molished, apparently sucked outwards. No windows shattered in either house (no houses opposite).

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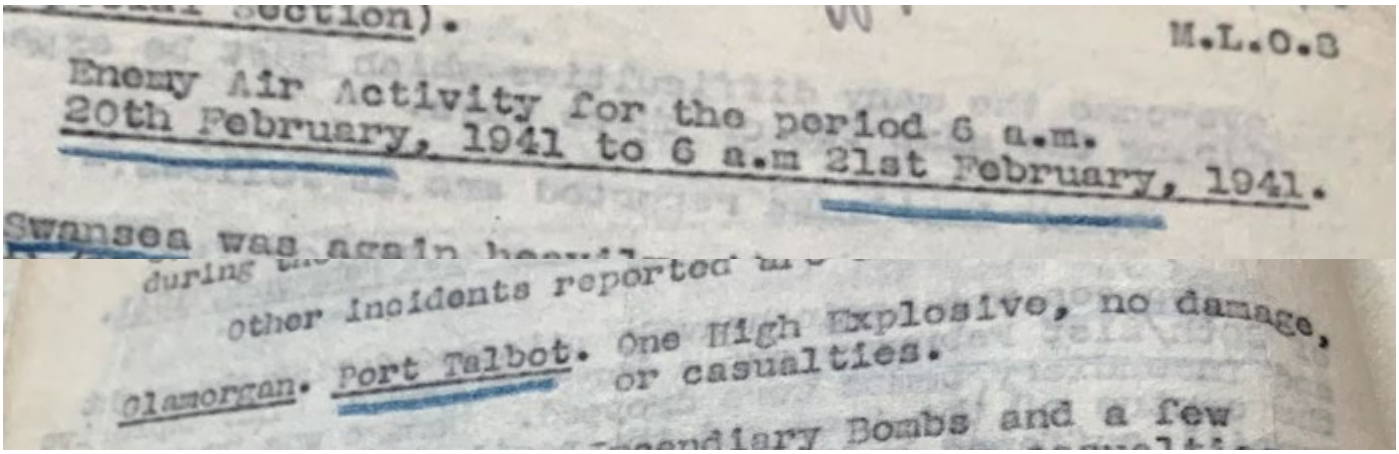

section).

M.L.O.3

Enemy Air Activity for the period 6 a.m. 20th February, 1941 to 6 a.m 21st February, 1941.

Swansea was again heavily during the night.

other incidents reported

Glamorgan. Port Talbot. One High Explosive, no damage, or casualties.

Incendiary Bombs and a few

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1940

- 29th June. Unexploded bomb (UXB) at Port Talbot with a further 9 bombs exploded on:
  - Tydraw Hill
  - Oakwood Street
  - Near the Grand Hotel
  - In the station approach
  - On the railway sidings near Port Talbot Steelworks
  - Between Margam Coke Ovens and Richard Thomas Steelworks
  - Talbot House
  - Between the Steelworks and Dock Ferry
  - Dinas Powis

- 29th July. Incendries and explosives on Baglan Moors, 3 high explosives near Port Talbot harbour gates, bombs on The Leys Aberthaw

- 20th August. Bombs near:
  - Carbide works at Kenfig
  - Port Talbot docks

- 24th August. Bombed:
  - The new Aluminium and Copper Works at Port Talbot
  - Port Talbot docks

- 25th August. Bombs at:
  - Port Talbot

- 26th September. Bombs at Port Talbot

- 9th October. Swansea and Port Talbot bombed

- 17th January. Bombs at Port Talbot docks

- **25th January. Lightning struck the barrage balloon at Sandfields, Port Talbot. It burst into flames and fell into a house setting it on f**
- 25th January. Shell crater found at 3/4 mile NW of Cornelly believed to be from the defensive barrage fired over Port Talbot on January 17th

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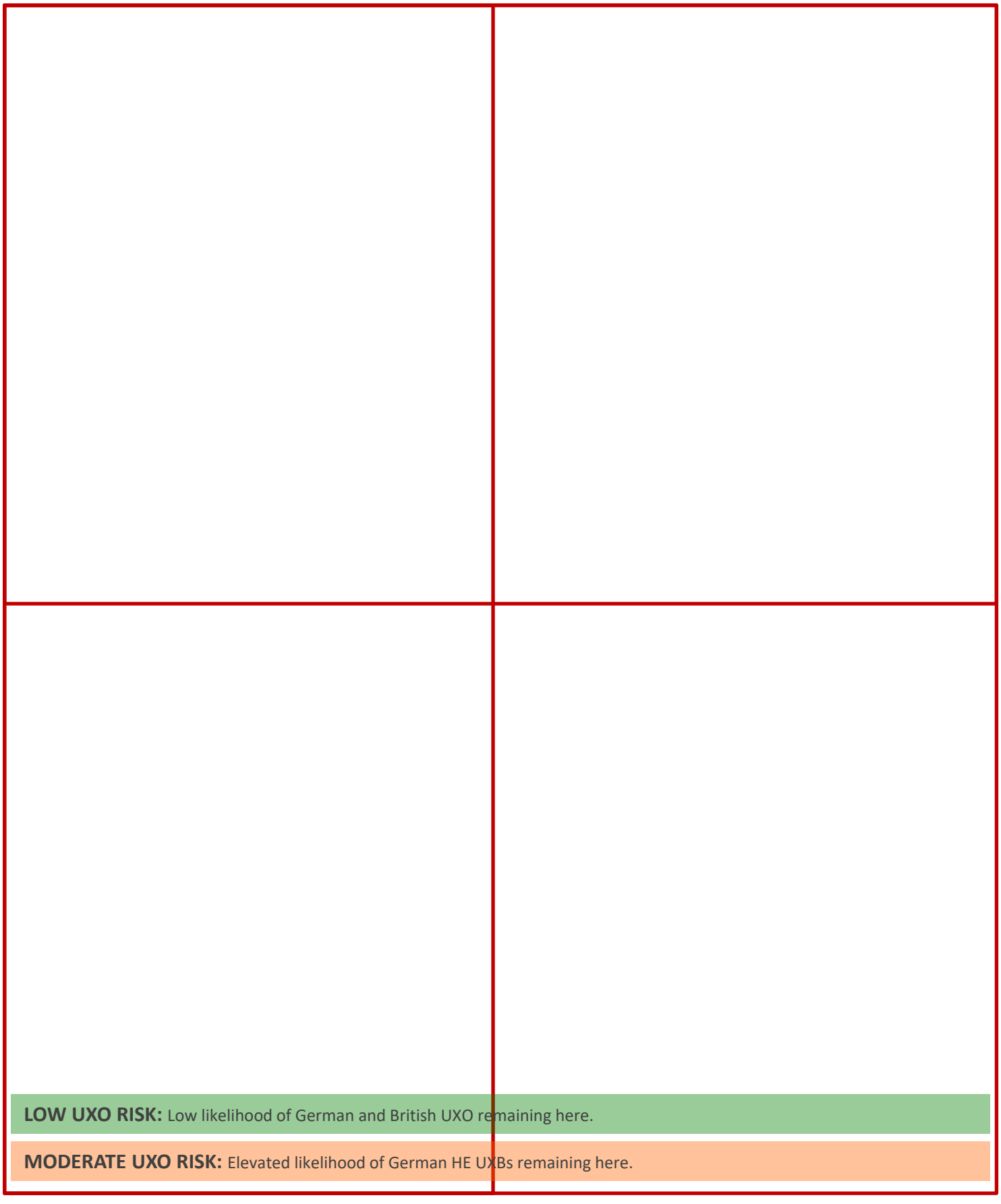
Title:	Risk Map	FIGURE: 8.2



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

MODERATE UXO RISK: Elevated likelihood of German HE UXBs remaining here.

N

Project	**Project Dragon, Port Talbot**
Client:	**TEC Ltd**
Report Ref:	**DRA-23-1532**
Approx. Site Boundary	Info Source: n/a

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