SAFELANE
GLOBAL

Detailed Unexploded Ordnance
Risk Assessment

In Respect Of:
Hamble Airfield - Update

For:
CEMEX

Report Reference:
RA 9091

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SafeLane Global

Unit 3, The Courtyard, Campus Way, Gillingham Business Park, Gillingham, Kent, ME8 0NZ

Tel: +44 (0)1634 471340

Email: info@safelaneglobal.com

www.safelaneglobal.com

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Glossary of Terms

AAA	Anti-Aircraft Artillery
ARP	Air-raid Precautions
BDO	Bomb Disposal Officer
EOD	Explosive Ordnance Disposal (current term for "bomb" disposal)
HE	High Explosive
HG	Home Guard
IB	Incendiary Bomb
kg	Kilogram
LM	Land Mine
LSA	Land Service Ammunition (includes grenades, mortars, etc.)
Luftwaffe	German Air Force
m bgl	Metres Below Ground Level
MoD	Ministry of Defence
OB	Oil Bomb
PM	Parachute Mine
RAF	Royal Air Force
SI	Site Investigation
SAA	Small Arms Ammunition (small calibre cartridges used in rifles & machine guns)
UXB	Unexploded Bomb
UXO	Unexploded Ordnance
V-1	"Doodlebug" the first cruise type missile, used against London from June 1944. Also known as 'Flying Bomb'.
V-2	The first ballistic missile, used against London from September 1944
WWI	First World War (1914 -1918)
WWII	Second World War (1939 – 1945)

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Executive Summary

THE SITE:	
Address	Satchell Lane, Hamble-le-Rice, Southampton, SO31 4HP
OS National Grid Reference	SU 47793 07827
Details	The site comprises a large open field with areas of dense vegetation. It is bounded to the east by Satchell Lane, to the west by Hamble Lane and to the north by the railway line.
PROPOSED WORKS:	
The works involve the extraction of sand and gravel from the site. The top soils and overburden will be stripped from the site (approximate 2m depth of overburden) and stored around the perimeter of the site – in bunds of 3-5m high. The sand and gravel will then be extracted from the site in phases, using a long arm reach excavator down to a depth of 7.1m maximum. There will be no dewatering on the site.	
Risk Assessment Methodology: In accordance with CIRIA guidelines this assessment has carried out research, analysed the evidence and considered the risks that the site has been contaminated with unexploded ordnance; that such items remained on site; that they could be encountered during any intrusive works and the consequences that could result. Appropriate risk mitigation measures have been proposed.	
Explosive Ordnance Risk Rating	*MEDIUM*
GERMAN AIR-DELIVERED UXO:	

- Southampton and the wider area sustained a high density of bombing during WWII due to its extensive port infrastructure, ship building industries and most notably the Supermarine Works.
- The site occupied the North Airfield of RAF Hamble. This would have presented a strategic Luftwaffe bombing target, along with the Armstrong and Whitworth aircraft manufacturing factory present within the South Airfield, if the Luftwaffe were aware of their significance. Note that the oil terminal (located south of the site) is also likely to have posed a viable target.
- The WWII bomb plot map shows a high density of HE bomb strikes in the Hamble area, particularly in the proximity of the airfield and the Armstrong and Whitworth aircraft manufacturing factory. An estimate of 6 HE bombs have been recorded to have fallen within the site boundary, with several further in the vicinity. The site was also machine-gunned by the enemy aircraft and was subject to at least one 1kg IB shower.
- The site entirely comprised fields during WWII and will have contained a grass runway / flying field during the bombing raids over the area. Therefore, evidence of UXO may have been obscured and overlooked where access is likely to have been infrequent amongst the vegetation cover. Note that the entry hole of a 50kg HE UXB may have been as little as 20cm in diameter and easily obscured in such conditions.

BRITISH / ALLIED UXO:

- Opened in 1926, Hamble was utilised by aircraft manufacturers, comprising an aircraft training centre / flying school during WWII. As such there is still a residual threat of contamination in this area, as items of explosive ordnance are likely to have been stored, used and potentially disposed of in the vicinity.
- Given that RAF Hamble comprised an aircraft training centre during WWII, the possibility cannot be discounted that more remote areas at the peripheral areas of the airfield would have been used for practice bombing, although no records detailing where this may have taken place could be obtained.
- No evidence of waste disposal (possibly involving burning / burial of UXO), was evident in mapping and aerial photography of the site. Therefore, the possibility such activities were carried out across peripheral areas of the airfield (including those within the study area) cannot be discounted.
- The local factories and the airfield itself will have had their own Home Guard (HG) units. These men will have manned the AA guns, pillboxes and defences of the airfield.
- The site was occupied by open ground requisitioned for military use, typical of that used for HG training exercises. HG battalions would also often take part in invasions practice at airfield sites. Therefore, the possibility of these activities being carried out on site cannot be discounted.
- Two pillboxes were located within the study area, with a further two in close proximity to the western site boundary. During periods of increased risk of invasion, these would likely have been regularly manned by armed guards. Anecdotal evidence has implied that Hamble was protected by HG soldiers who manned the AA guns and protected the factory.
- Ground defence troops would have been armed with small arms weapons and issued with other LSA (such as grenades). Furthermore, these troops would likely have taken part in airfield defence training exercises, which were often carried out on scrubland and grass fields situated within the airfield perimeter. Consequently, it is possible such activities happened within the site boundary, increasing the possibility of localised UXO contamination.
- Experience has shown that the 'housekeeping' of WWII soldiers was often poor with ammunition often buried, misplaced or otherwise discarded in various locations at military bases.
- Three HAA batteries were located within a 5km radius of the airfield. However, additional Bofor AA guns were also positioned around Hamble on the shores of Southampton Water, the airfield and around Satchell Lane. During WWII, the majority of the site was occupied by undeveloped open soft ground. In such ground cover, an unexploded AA shell could conceivably have gone unnoticed, particularly at night.
- Hamble is named as an airfield that was pipe mined during WWII. It has been given a Type 1 Certificate which means that all mines were accounted for in the 1940s. Note, however, several instances of pipe mines being encountered on airfields in the past few years, the possibility that some pipe mines remained on site cannot be discounted. Clearance operations were not always well documented or thorough, and pipe mines can still be encountered on previously "cleared" sites today.
- A consolidation of historical sources records at least 16 air crashes in the Hamble area during WWII. It is unknown whether any of these aircraft would have been carrying large payloads of munitions, however the possibility cannot be discounted. During these incidents, it is conceivable that shrapnel, explosive materiel or unexploded items may have been dispersed across the locality of the crash.
- One record has been obtained of an official Explosive Ordnance Disposal task undertaken at Hamble Airfield between 14th January 1985 and 22nd August 1986, when six items of UXO were recovered from an area of 65ha, including two live items. The recovery of these items of UXO highlights the potential for further such items to remain buried in areas which were not subject to clearance.

THE RISK THAT UXO REMAINS ON SITE

Within the footprints of any post-war redevelopment on site, the risk of shallow buried UXO (especially AA shells and German 1kg incendiaries) remaining will have been partially mitigated since any such items could have been encountered and removed during soil stripping and levelling. As no such works appear to have taken place post-WWII, this is considered unlikely.

Only within the volume of any post-war level bulk excavations, extraction works and at the precise locations of any post-war pile foundations / boreholes, will the risk from deeper buried German HE UXBs have been completely mitigated. As no bulk excavations appear have been carried out onsite, the risk from deep buried UXO remains unmitigated to the maximum bomb penetration depth.

BOMB PENETRATION ASSESSMENT

It has been assessed that a 500kg bomb would have had an approximate maximum bomb penetration depth of between 10-12m below WWII ground level. Penetration depth could potentially have been greater if the UXB was larger (though only 4% of German bombs used in WWII over Britain were of that size). Note that UXBs may be found at any depth between just below the WWII ground level and the maximum penetration depth.

RECOMMENDED RISK MITIGATION MEASURES:

Site Specific Explosive Ordnance Safety and Awareness Briefings to all personnel conducting intrusive works	✓
The Provision of Unexploded Ordnance Site Safety Instructions	✓
Explosive Ordnance Disposal (EOD) Engineer presence on site to support shallow intrusive works	✓
Handheld Intrusive Magnetometer Survey of all borehole locations down to the maximum bomb penetration depth	✗
Non-Intrusive Magnetometer Survey and Target Investigation (greenfield land only)	✓
Intrusive Magnetometer Survey of all pile locations down to the maximum bomb penetration depth	✗

In making this assessment and recommending these risk mitigation measures, the proposed works outlined in the 'Scope of the Proposed Works' section were considered. Should the planned works be modified or additional intrusive engineering works be considered, Safelane Global should be consulted to see if re-assessment of the risk or mitigation recommendations is necessary.

Annexes

Detailed Unexploded Ordnance Risk Assessment

In Respect of

Hamble Airfield

1 Introduction

CEMEX has commissioned SafeLane Global Limited to conduct an updated Detailed Unexploded Ordnance Risk Assessment of Hamble Airfield.

Unexploded Ordnance (UXO) presents a significant threat to construction projects in parts of the UK as a result of enemy actions during the two 20th Century World Wars and historic British and Allied military activity.

One of the legacies of this conflict is buried unexploded air-dropped bombs or anti-aircraft projectiles resulting from the failure of a proportion of the weapons to function as designed. It is commonly accepted that the failure rate of these munitions was approximately 10% and, depending on their shape, weight, velocity and ground conditions, many penetrated the ground and came to rest at depth.

In addition, it is estimated that over 20% of the UK landmass has been used by the military at some point and between 2006 and 2009, over 15,000 items of British / Allied ordnance (excluding small arms ammunition) were found on UK construction sites (CIRIA).

Intensive efforts were made during and after the war to locate and render safe all UXO but, unsurprisingly, not all were found and dealt with. This is evidenced by the regular, on-going discoveries of UXO during construction-related intrusive ground works.

As a result of a generally increased risk awareness amongst professionals involved in ground engineering works and proactive health and safety measures, the threat to life and limb from UXO has been minimised. However even the simple discovery of a suspected device during on-going works can cause considerable disruption to production and cause unwanted delays and expense.

Such risks can be more fully addressed by a better understanding of the site-specific threat and the implementation of appropriate risk mitigation measures.

2 Construction Industry Duties and Responsibilities

2.1 The UK Regulatory Environment

There is no specific legislation covering the management and control of the UXO risk in the UK construction industry but issues regarding health and safety are addressed under a number of regulatory instruments, as outlined below.

In practice, the regulations impose a responsibility on the construction industry to ensure that they discharge their obligations to protect those engaged in ground-intrusive operations (such as archaeology, site investigation, drilling, piling or excavations) from any reasonably foreseeable UXO risk.

2.2 The Health and Safety at Work Act, 1974

The Act places a duty of care on an employer to put in place safe systems of work to address, as far as is reasonably practicable, all risks (to employees and the general public) that are reasonably foreseeable.

2.3 Construction (Design and Management) Regulations 2015

CDM 2015 ensures that health and safety within the construction industry is continually improved:

- Works are sensibly planned and managed.
- Competent staff are engaged in the works.
- Risks are identified and managed.
- All parties cooperate and coordinate activities.
- Communication flows to those who require it.
- Workers are consulted and engaged about risks and how they are being managed.

In line with CDM 2015 legislation, SafeLane Global Limited are able to assist parties in their discharge of CDM duties as follows:

- Assist Principal Designers with pre-construction information and risk assessments
- Assist the Designer with the Designer's Risk Assessment.
- Issue UXO risks as have been identified and manage risks accordingly.
- Assist the Principal Contractor with the construction phase information, in particular risk assessments and mitigation strategies.
- Plan, manage and monitor survey and clearance works under SafeLane Global Limited's control.

2.4 Other Legislation

Other relevant legislation includes the "Management of Health and Safety at Work Regulations 1999" and "The Corporate Manslaughter and Corporate Homicide Act 2007".

3 The Role of the Authorities and Commercial Contractors

3.1 The Authorities

The Police have the responsibilities for co-ordinating the emergency services in the case of an ordnance-related incident on a construction site. They will make an initial assessment (i.e. is there a risk that the find is ordnance or not?) and if they judge necessary impose a safety cordon and/or evacuation and call the military authorities (JSEODOC - Joint Services Explosive Ordnance Disposal Operations Centre) to arrange for investigation and/or disposal. In the absence of an EOD specialist on site many Police Officers will use the precautionary principle, impose cordon(s)/evacuation and await advice from the JSEODOC.

The priority given to the request by JSEODOC will depend on their judgement of the nature of the threat (ordnance, location, people and assets at risk) and the availability of resources. They will respond immediately or as resources are freed up. Depending on the on-site risk assessment the item of ordnance may be removed or demolished (by controlled explosion) in situ. In the latter case additional cordons and/or evacuations may be necessary.

Note, that the military authorities will only carry out further investigations or clearances in very high profile or high-risk situations. If there are regular ordnance finds on a site, the JSEODOC may not treat each occurrence as an emergency and will encourage the construction company to put in place alternative procedures (i.e. the appointment of a commercial contractor) to manage the situation and relieve pressure from the JSEOD disposal teams.

3.2 Commercial Contractors

In addition to pre-construction site surveys and follow-on clearance work, a commercial contractor is able to provide a reactive service on construction sites. The presence of a qualified EOD Engineer with ordnance recognition skills will avoid unnecessary call-outs to the authorities and the contractor will be able to arrange for the removal and disposal of low risk ordnance. If high risk ordnance is discovered actions will be co-ordinated with the authorities with the objective of causing the minimum possible disruption to site operations whilst putting immediate, safe and appropriate measures in place.

4 This Report

4.1 Aims and Objectives

The aim of this report is to examine the possibility of encountering any explosive ordnance during any intrusive works at the site. Risk mitigation measures will be recommended, if deemed necessary, to eliminate or reduce the threat from explosive ordnance during the envisaged works. The report follows the CIRIA Guidelines.

4.2 Risk Assessment Methodology

The following issues will be addressed in the report:

- The risk that the site was contaminated with unexploded ordnance.
- The risk that UXO remains on site.
- The risk that ordnance may be encountered during any intrusive works.
- The risk that ordnance may be initiated.
- The consequences of initiating or encountering ordnance.

Risk mitigation measures, appropriate to the assessed level of risk and site conditions, will be recommended if required.

4.3 Approach

In preparing this Explosive Ordnance Threat Assessment Report, SafeLane Global Limited has considered general and, as far as possible, site specific factors including:

- Evidence of German bombing and delivery of UXBs.
- Site history, occupancy and conditions during WWII.
- The legacy of Allied military activity.
- Details of any known EOD clearance activity.
- The extent of any post war redevelopment.
- Scope of the current proposed works.

4.4 Sources of Information

Safelane Global has carried out detailed historical research for this Explosive Ordnance Threat Assessment including accessing military records and archived material held in the public domain and in the MoD.

Material from the following sources has been consulted:

- The National Archives.
- Southampton Archives.
- Historic England.
- Relevant information supplied by the client.
- Available material from 33 Engineer Regiment (EOD) Archive.
- Safelane Global's extensive archives built up over many years of research and hands-on Explosive Ordnance Disposal activities in the UK.
- Open sources such as published books, local historical records and the internet.

4.5 Reliability of Historical Records

4.5.1 General Considerations

This report is based upon research of historical evidence. Whilst every effort has been made to locate all relevant material Safelane Global cannot be held responsible for any changes to the assessed level of risk or risk mitigation measures based on documentation or other information that may come to light at a later date.

The accuracy and comprehensiveness of wartime records is frequently difficult or impossible to verify. As a result, conclusions as to the exact location, quantity and nature of the ordnance threat can never be definitive but must be based on the accumulation and careful analysis of all accessible evidence. Safelane Global cannot be held responsible for inaccuracies or gaps in the available historical information.

4.5.2 Bombing Records

During WWII, considerable efforts were expended in recording enemy air raids. Air Raid Precautions (ARP) wardens were responsible for making records of bomb strikes either through direct observation or by post-raid surveys. However, their immediate priority was to deal with casualties and limit damage, so it is to be expected that records are often incomplete and sometimes contradictory. Record keeping in the early days of bombing was not comprehensive and details of bombing in the early part of the war were sometimes destroyed in subsequent attacks. Some reports may cover a single attack, others a period of months or the entire war.

Records of raids that took place on sparsely or uninhabited areas were often based upon third party or hearsay information and are not always reliable; records of attacks on military or strategic targets were often maintained separately from the general records and have not always survived.

5 The Site and Scope of Proposed Works

Site Address	Satchell Lane, Hamble-le-Rice, Southampton, SO31 4HP
National Grid Reference Centre Point	SU 47793 07827
Site Description	The site comprises a large open field with areas of dense vegetation. It is bounded to the east by Satchell Lane, to the west by Hamble Lane and to the north by the railway line.
Proposed Works	The works involve the extraction of sand and gravel from the site. The top soils and overburden will be stripped from the site (approximate 2m depth of overburden) and stored around the perimeter of the site – in bunds of 3-5m high. The sand and gravel will then be extracted from the site in phases, using a long arm reach excavator down to a depth of 7.1m maximum. There will be no dewatering on the site.
Maximum Depth of Ground Works	7.1m bgl.
Site Location Maps, a Recent Aerial Photograph of the site and a Site Plan are presented in **Annexes A, B and C.**	

6 Ground Conditions

Data Source		Description
British Geological Survey Borehole	**Borehole Reference**	SU40NE142
	Location	On the western site boundary
	Date	January 1986
	Recorded Shallow Geology	• 2.0m of TOPSOIL (gravelly, with some brick fragments overlying grey and brown clayey fine SAND with some gravel and a few small roots. FILL) • 7.1m of SAND & CLAY (brown and grey clayey fine SAND or firm very fine sandy CLAY. Easily disturbed into a soft cohesive slurry. Possibly medium-dense in situ. Organic inclusions at top of stratum. Thinly-laminated structure 6 to 8.5m depth) • 5.9m of CLAY & SAND (firm or compact dark grey friable fine sandy CLAY and clayey fine SAND. Thinly laminated structure in places. Easily disturbed into a very soft clay / fine sand mixture)
British Geological Survey Mapping	**Superficial Deposits**	• River Terrace Deposits (SAND & GRAVEL)
	Bedrock	• Marsh Farm Formation bedrock (CLAY, SILT & SAND)

		• The south western extent is underlain by Selsey Sand Formation bedrock (SAND, SILT & CLAY)
Client Provided Data	**Factual Report[1]**	Trial Pits: CLAY underlain by GRAVEL or SAND to approximately 3m bgl.

7 Site History

7.1 Pre-WWII

The following pre-WWII OS map was reviewed.

Date	1932	**Scale**	1:10,560	**Source**	CEMEX
Observations	• The entirety of the site is occupied by open ground. • The northern boundary is adjacent to the railway line. • Several rows of houses border the site to the west and south-east. • The surrounding area is a mixture of residential and rural in nature.				
A section of the map showing the site and immediate surrounding area is presented in **Annex D-1**.					

7.2 Post-WWII

The following post-WWII OS map was reviewed.

Date	1962	**Scale**	1:10,560	**Source**	CEMEX
The following are indicative of serious bomb damage on early post-WWII OS mapping:					
Ruins	×	n/a			
Clearance	×	n/a			
Redevelopment	×	n/a			
Further Observations	No buildings are located within the site boundary, and therefore no clearance, redevelopment or *Ruins* are demarcated. However, two examples of redevelopment have been identified in the surrounding area south of the *Airfield*. The nearest is located approximately 100m south-west.				
A section of the map showing the site and immediate surrounding area is presented in **Annex D-2**.					

[1] *CEMEX Document: PE171428 HAMBLE AIRFIELD, HAMBLE-LE-RICE Factual Report*

8 The Threat from Aerial Bombing

8.1 General Bombing History of Hamble & Southampton

8.1.1 First World War

Southampton's port played a vital role in transporting millions of soldiers and war materiel to the frontline during WWI. However, no evidence could be found to indicate that Southampton sustained aerial bombardment during WWI.

WWI bombs were generally smaller than those used in WWII and were dropped from a lower altitude, resulting in limited UXB penetration depths. Aerial bombing was often such a novelty at the time that it attracted public interest and even spectators to watch the raids in progress. For these reasons there is a limited risk that UXBs passed undiscovered in the urban environment. When combined with the relative infrequency of attacks and an overall low bombing density the threat from WWI UXBs is considered to be negligible and will not be further addressed in this report.

8.1.2 Second World War

During WWII, Southampton was vital to the Allied war effort. The deep-water docks and extensive port infrastructure received soldiers and war materiel to be dispatched to North Africa and Europe via the highly developed rail infrastructure. The town also accommodated ship building industries and most notably the Supermarine Works at Woolston which produced Spitfire aircraft. Note therefore that the Hamble area would have been vulnerable to 'tip and run' incidents, whereby an enemy aircraft under heavy AA fire or fighter interception would prematurely jettison its bomb load in order to evade the defences or indiscriminately deposit unused ordnance whilst returning to bases in northern Europe.

At the start of WWII, the Luftwaffe planned to destroy key military installations, including RAF airfields during a series of daylight bombing raids. Annex E shows that the study area encompassed part of RAF Hamble (North Airfield). These airfields would have presented strategic Luftwaffe bombing targets, along with the Armstrong and Whitworth aircraft manufacturing factory present within the South Airfield, if the Luftwaffe were aware of their significance. Furthermore, note that the oil terminal (located approximately 550m south of the site) is likely to have posed a viable target.

Records of bombing incidents in the civilian areas were collected by the Air Raid Precautions wardens and collated by the Civil Defence Office. Some other organisations, such as port authorities and railways, maintained separate records.

Records would be in the form of typed or hand-written incident notes, maps and statistics. Bombing data was carefully analysed, not only due to the requirement to identify those parts of the capital most needing assistance, but also in an attempt to find patterns in the Germans' bombing strategy in order to predict where future raids might take place.

These various types of records of bombing incidents for the region are presented in the following sections.

8.2 Generic Types of WWII German Air-delivered Ordnance

The nature and characteristics of the ordnance used by the Luftwaffe allows an informed assessment of the hazards posed by any unexploded items that may remain today. Detailed illustrations of German air-delivered ordnance are presented at Annex F.

- HE Bombs: In terms of weight of ordnance dropped, HE bombs were the most frequent weapon deployed. Most bombs were 50kg, 250kg or 500kg (overall weight, about half of which was the

high explosive) though large bombs of up to 2,000kg were also used. HE bombs had the weight, velocity and shape to easily penetrate the ground intact if they failed to explode. Post-raid surveys would not always have spotted the entry hole or other indications that a bomb penetrated the ground and failed to explode and contemporary ARP documents describe the danger of assuming that damage, actually caused by a large UXB, was due to an exploded 50kg bomb. Unexploded HE bombs therefore present the greatest risk to present–day intrusive works.

- Blast Bombs/Parachute Mines: Blast bombs generally had a slow rate of descent and were extremely unlikely to have penetrated the ground. Non-retarded mines would have shattered on most ground types, if they had failed to explode. There have been extreme cases when these items have been found unexploded, but this was where the ground was either very soft or where standing water had reduced the impact. Safelane Global does not consider there to be a significant threat from this type of munition on land.
- Large incendiary bombs: This type of bomb ranged in size from 36kg to 255kg and had a number of inflammable fill materials (including oil and white phosphorus), and a small explosive charge. They were designed to explode and burn close to the surface but their shape and weight meant that they did have penetration capability. If they penetrated the ground, complete combustion did not always occur and, in such cases, they remain a risk to intrusive works.
- 1kg Incendiary Bombs (IB): These bombs, which were jettisoned from air-dropped containers, were unlikely to penetrate the ground and in urban areas would usually have been located in post-raid surveys. However, if bombs did not initiate and fell in water or dense vegetation or became mixed with rubble in bomb damaged areas they could have been overlooked. Some variants had explosive heads and these present a risk of detonation during intrusive works.
- Anti-personnel (AP) Bomblets: AP bombs had little ground penetration ability and should have been located by the post-raid survey unless they fell into water, dense vegetation or bomb rubble.
- Specialist Bombs (smoke, flare, etc): These types do not contain high explosive and therefore a detonation consequence is unlikely. They were not designed to penetrate the ground.

8.3 German Air-delivered Ordnance Failure Rate

Based on empirical evidence, it is generally accepted that 10% of the German HE bombs dropped during WWII failed to explode as designed. This estimate is probably based on the statistics of wartime recovered UXBs and therefore will not have taken account of the unknown numbers of UXBs that were not recorded at the time and is probably an underestimate.

The reasons for failures include:

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

War Office Statistics document that a daily average of 84 bombs which failed to function were dropped on civilian targets in Great Britain between 21st September 1940 and 5th July 1941. 1 in 12 of these (probably mostly fitted with time delay fuzes) exploded sometime after they fell; the remainder were unintentional failures.

From 1940 to 1945 bomb disposal teams dealt with a total of 50,000 explosive items of 50kg and over (i.e. German bombs), 7,000 AAA shells and 300,000 beach mines. These operations resulted in the deaths of 394 officers and men. However, UXO is still regularly encountered across the UK (see recent press articles, Annex G-1).

8.4 UXB Ground Penetration

8.4.1 General Considerations

The actual penetration depth of aerial delivered bombs into the ground will have been determined by the mass and shape of the bomb, the velocity and angle of the bomb on impact (dependent on the height of release) and the nature of the ground and ground cover; the softer the ground, the greater the potential penetration. Peat, alluvium and soft clays are easier to penetrate than gravel and sand. Bombs are brought to rest or are commonly deflected by bedrock or large boulders.

8.4.2 The "j" Curve Effect

An air-dropped bomb falling from normal bombing altitude (say 5,000m) into homogeneous ground will continue its line of flight but turn in an upwards curve towards the surface as it comes to rest. This offset from vertical is generally thought to be about one third of the penetration depth but can be up to 15m depending on ground conditions or the bomb's angle of impact.

8.4.3 Second World War Bomb Penetration Studies

During WWII, the Ministry of Home Security undertook a major study on actual bomb penetration depths, carrying out statistical analysis on the measured depths of 1,328 bombs as reported by Bomb Disposal, mostly in the London area. They then came to conclusions as to the likely average and maximum depths of penetration of different sized bombs in different geological strata.

The median penetration of 430 x 50kg German bombs in London Clay was 4.6m and the maximum penetration observed for the SC50 bomb was 9m.

They concluded that the largest common German bomb, 500kg, had a likely penetration depth of 6m in sand or gravel but 8.7m in clay. The maximum observed depth for a 500kg bomb was 10.2m and for a 1,000kg bomb 12.7m. Theoretical calculations suggested that significantly greater penetration depths were probable.

8.5 Initiation of Unexploded Bombs

Unexploded bombs do not spontaneously explode. All high explosive requires significant energy to create the conditions for detonation to occur. In the case of unexploded German bombs discovered within the construction site environment, there are a number of potential initiation mechanisms:

- Direct impact onto the main body of the bomb: Unless the fuze or fuze pocket is struck, there needs to be a significant impact (e.g. from piling or large and violent mechanical excavation) to initiate a buried iron bomb. Such violent action can cause the bomb to detonate.
- Re-starting the clock timer in the fuze: Only a small proportion of German WWII bombs employed clockwork fuzes. It is probable that significant corrosion has taken place within the fuze mechanism over the last 60 years that would prevent clockwork mechanisms from functioning, nevertheless it was reported that the fuze in a UXB dealt with by 33 EOD Regiment in Surrey in 2002 did re-commence.

- Induction of a static charge, causing a current in an electric fuze: The majority of German WWII bombs employed electric fuzes. It is probable that significant corrosion has taken place within the fuze mechanism over the last 60 years such that the fuze circuit could not be activated.
- Friction impact initiating the (shock-sensitive) fuze explosive: This is the most likely scenario resulting in the bomb detonating.

Annex G-2 details UXB incidents where intrusive works have caused UXBs to detonate, resulting in death or injury and damage to plant.

8.6 Second World War Bombing Statistics

The following table summarises the quantity of German bombs (excluding 1kg incendiaries and anti-personnel bombs) falling on the Municipal Borough of Winchester, within which the site was historically located, between 1940 and 1945:

Record of German Ordnance Dropped on the MB of Winchester	
Area Acreage	3,888
High Explosive Bombs (all types)	15
Parachute Mines	-
Oil Bombs	-
Phosphorus Bombs	-
Fire Pots	-
Pilotless Missile (V1)	-
Long Range Rocket (V2)	-
Total	15
Items Per 1,000 Acres	1.0

Source: Home Office Statistics

Detailed records of the quantity and locations of the 1kg incendiary and anti-personnel bombs were not routinely maintained by the authorities as they were frequently too numerous to record.

Although the incendiaries are not particularly significant in the threat they pose, they nevertheless are items of ordnance that were designed to cause damage and inflict injury and should not be overlooked in assessing the general risk to personnel and equipment. The anti-personnel bombs were used in much smaller quantities and are rarely found today but are potentially more dangerous. This table does not include UXO found during or after WWII.

Note, the Hamble area, although located in the MB of Winchester, was situated close to the water and on the flight path in to central Southampton. Also, the presence of military and industrial sites means that this locality was subject to a much higher bombing density than the remainder of the Winchester area.

8.7 Site Specific WWII Bombing Records

8.7.1 Southampton Bomb Plot Map

A small-scale bomb plot map of the County Borough of Southampton was obtained from Southampton Archives and is presented in Annex H. It is noted that the map plots the positions of all HE bombs, Parachute Mines and Flying Bombs dropped on Southampton during the entire war. However, due to inaccuracies in contemporary record-keeping and number of unexploded bombs going unreported, it cannot be considered that this is a full record of all items dropped over the area during the war.

This map illustrates a high density of HE bomb strikes in the surrounding area, particularly in the approximate location of the Armstrong and Whitworth aircraft manufacturing factory. Due to the small scale of the map, and the lack of geographical indicators, the site's position is approximate. However, an estimate of 6 x HE bombs within the study area, with several more in the vicinity.

8.7.1 Written ARP Bombing Incident Records

A collection of written ARP incident reports for Southampton, obtained from Southampton Archives, was reviewed. The following incidents were recorded near to the site.

Date	Location	Weapon	Details
27/07/1940	School Lane, Hamble (>385m south of the site)	3 x HE, 1 x UXB	Water mains exposed. UXB removed.
13/08/1940	Armstrong and Whitworth factory (>350m south-west of the site)	6 x HE, 1 x UXB and 2 IBs	UXB removed
31/08/1940	Junction of Hamble Lane and Satchell Lane (>400m north-west of the site)	2 x HE and enemy aircraft machine gunning	Senior School damaged
16/11/1940	Hamble (location not specified)	5 x HE, 1 x Magnetic Mine	Little damage caused, the magnetic mine failed to explode
23/11/1940	Hamble Airfield (possibly on site)	IB shower	None
09/01/1941	Hamble Aerodrome (possibly on site)	1 x HE	No damage
18/01/1941	Hamble Common (>850m south)	5 x HE	No damage
31/01/1941	Shell-Mex Installation, Hamble (>660m south-west)	Enemy aircraft machine gunning	No damage
11/05/1941	Bursledon (>2km north)	4 x HE	One house destroyed

Although this is considered to be a comprehensive record of bombing incidents during the war, it is possible that reports may be incomplete, missing, or were destroyed post-war. Additionally, some of the reports are partially illegible.

8.7.2 Secondary Source / Anecdotal Evidence

Anecdotal evidence of local bombing incidents was sought from publications and web resources. The following references to incidents on site or in the surrounding area were found.

Date	Weapon	Details
12th July 1940	HEs	4 x bombs were dropped on Hamble. Three fell in fields in School Lane and one in the garden of 'Myrtles'.
23rd Nov 1940	IBs, Parachute flares	During a heavy raid on Southampton, a number of incendiary bombs fell onto the airfield, just after 6pm. A week later, parachute flares were seen descending onto the airfield.
9th January 1941	HE	Nine aircraft attacked Southampton. A large bomb was dropped in the middle of Hamble Airfield but, like the earlier IBs, it caused no damage to the buildings.
11th Apr 1941	PM	4 x Parachute Mines fell in the area during a raid on Southampton. One, which did not explode, landed amongst the storage tanks at Shell Mex.
9th Feb 1943	Machine Gun	Man fatally injured in a machine gun attack by a JU88 on 'A' Hangar. He was the only person in Hamble to be killed by enemy action.

8.7.3 WWII-era RAF Aerial Photography

The following WWII-era photography of the site was reviewed.

Source	Historic England	Image Type	Vertical	Quality	Small-scale
Date	10th November 1944				
Observations	• The site is as appears on OS mapping, comprising entirely of open fields. • Several aircraft are visible within the study area, particularly in the west of the site. • Furthermore, several hangars are located to the south of the site, along with the aircraft factory and the oil terminal. • The image is of small-scale and therefore an accurate assessment of bomb damage to the buildings / structures in the surrounding area is not possible. • However, no significant evidence of damage / cratering on site can be seen within the site boundary.				
This image is presented in **Annex I.**					

8.7.4 Abandoned Bombs

A post-air raid survey of buildings, facilities and installations would have included a search for evidence of bomb entry holes. If evidence were encountered, Bomb Disposal Officer teams would normally have been requested to attempt to locate, render safe and dispose of the bomb. Occasionally evidence of UXBs was discovered but due to a relatively benign position, access problems or a shortage of resources the UXB could not be exposed and rendered safe. Such an incident may have been recorded and noted as an Abandoned Bomb.

Given the inaccuracy of WWII records and the fact that these bombs were 'abandoned', their locations cannot be considered definitive, nor the lists exhaustive. The MoD states that 'action to make the devices safe would be taken only if it was thought they were unstable'. It should be noted that other than the 'officially' abandoned bombs, there will inevitably be UXBs that were never recorded.

Safelane Global holds no records of officially registered abandoned bombs at or near the site.	✘
Additional comments:	n/a

8.8 Site Specific Bomb Penetration Considerations

When considering an assessment of the bomb penetration at the site, the following parameters would be used:

- Geology – 2.0m of TOPSOIL / FILL, 13.0m of CLAY & SAND.
- Impact Angle and Velocity – 80-90^{O} from horizontal and 267 metres per second.
- Bomb Mass and Configuration – The 500kg SC (General Purpose) HE bomb, without retarder units or armour piercing nose. This was the largest of the common bombs used against Britain.

Taking into account the above-mentioned factors it has been assessed that a 500kg bomb would have had an approximate maximum bomb penetration depth of between 10-12m below WWII ground level. Penetration depth could potentially have been greater if the UXB was larger (though only 4% of German bombs used in WWII over Britain were of that size). Note that UXBs may be found at any depth between just below the WWII ground level and the maximum penetration depth.

8.9 Likelihood of Post-raid UXO Detection

Utilising the available historical bombing records as reviewed in *Section 8.7*, it is possible to make an assessment of the likelihood that evidence of UXO would have been noted on a site during the war and the incident dealt with or recorded at the time. Factors such as bombing density, frequency of access, ground cover, damage and failure rate have been taken into consideration.

8.9.1 Density of Bombing Assessment:

Bombing density is an important consideration for assessing the possibility that UXBs remain in an area. A very high density of bombs will have increased the likelihood of errors in record keeping at the time, as civil defence personnel and emergency services may have been overwhelmed. A higher density of bombing also increases the number of UXBs actually occurring in a given area.

The type and specific location of recorded bomb strikes is also an important consideration. If a stick of bombs (one individual aircraft's bomb load) is plotted in line with a site or is shown to straddle a site, then this raises the possibility that an unrecorded UXB from the same stick struck that site.

Density of Bombing Assessment	
Based on wartime records or secondary source information, what was the bombing density over the site?	Moderate
Was the site ever subjected to one or more large-scale (>100 tons of ordnance) night time Blitz raids?	No
Were any HE bomb strikes recorded on site?	Yes
What is the distance between the site boundary and the closest recorded large bomb strike?	On site
How many HE, Parachute Mine, Oil Incendiary, Phosphorus Incendiary or Fire Pot bombs (large bombs) were recorded within a 300m radius of the site?	At least 12
Were any nearby sticks of large bombs recorded in line with the site?	Yes
Were any 1kg incendiary bomb showers recorded over the site?	Yes
Additional comments:	Although the bombing density for Winchester MB is low, it is known that the Hamble area was targeted for its industrial development and airfield, therefore it is likely that the bombing density was significantly higher in these areas. Also, located close to Southampton Water, the flight path in to the city which was very heavily bombed, Hamble will have been subject to overspill or Tip and Run bombing.

8.9.2 Bomb Damage Assessment:

In Blitzed cities / towns throughout Britain, bomb sites were often not cleared of rubble until after the war and mid-war repairs to buildings were only carried out on the most vital facilities (power stations, gas works, weapons factories etc.). However, if a building only sustained bomb damage to its upper floors, any subsequent UXB strike to the structure will still have caused obvious damage, at ground floor level, which would have been reported and dealt with at the time.

HE bomb strikes to open ground will have resulted in a large crater and local soil disturbance. Any subsequent UXB strike will not have resulted in an easily identifiable entry hole and as such is likely to have gone unnoticed amongst the disturbed ground.

In London and south-east England, the German V1 Flying Bomb and V2 Long Range Rocket campaigns caused widespread devastation. However, as these weapons began to be utilised after the final significant Luftwaffe air raids had occurred, any serious damage caused by such weapons does not necessarily indicate an increased risk of Luftwaffe freefall UXB contamination. However, it is quite possible that serious damage inflicted during the 1940-1944 campaigns by Luftwaffe freefall bombs could have been erased by a subsequent V Weapon strike.

Bomb Damage Assessment	
A comparison of the historical records confirms that buildings within the site boundary sustained serious bomb damage.	✖
Direct or indirect evidence of HE bomb craters in open ground (within the site boundary) has been found.	Possibly (See additional comment)
Buildings on site were seriously damaged by a V1 and / or V2 strike.	✖
Buildings on site could have been seriously damaged prior to the nearby V1 or V2 strike?	n/a
Additional comments:	An Archaeology Desk Report[2], provided by CEMEX, states that a circular soil mark within the site may be a bomb crater resulting from a WWII air raid. This would correspond to the locations of the bomb strikes shown on bomb census mapping, and therefore this cannot be discounted.

8.9.3 Frequency of Access Assessment:

A UXB strike at a site where human access was infrequent would have had a lower chance of being observed, reported and recorded compared to a site which was developed and subject to regular access. UXB strikes during night time raids (when German planes could more easily evade anti-aircraft defences) are also more likely to have fallen unobserved than ones dropped during a daylight attack.

In frequently bombed cities / towns, ARP Wardens were tasked with carrying out searches for UXBs within recently bombed residential areas and schools. Similarly, many important home front facilities (factories, gas works, power stations, docks etc.) had their own dedicated ARP teams or Fire Watchers tasked with observing local air raids. Fire Watchers were mainly responsible for extinguishing 1kg incendiary bombs as well as reporting any UXB strikes. Anecdotal evidence however indicates that Fire Watchers did not always turn up for their shifts and therefore such UXB mitigating activities should not be assumed in the absence of site specific evidence. Less important buildings sustaining bomb damage would have been abandoned until after the German bombing campaign in that area had ceased and repairs could be made, greatly decreasing the level of access to that site.

Schools closed due to the evacuation of children were often requisitioned by the Civil Defence authorities to be utilised as night time First Aid posts and reception centres (providing emergency accommodation for bombed out civilians). Therefore, an increased level of access is likely at these locations.

[2] *CEMEX Document: Hamble Airfield AC Archaeology Desk Report 2010*

Frequency of Access Assessment	
The site was situated in a densely populated urban area during WWII and therefore would have been accessed at the outbreak of WWII.	✗
The site was exclusively or partially developed during WWII.	✗
Buildings on site survived WWII intact and therefore likely remained inhabited or in use, suggesting these localities and their immediate environs were accessed throughout the war.	n/a
The site was crossed by roads / pavements or footpaths which would have been regularly used / subject to daily footfall.	✗
The site was occupied by small residential back yards / gardens, likely to have been put to use for cultivation as a result of the government's Dig for Victory Campaign.	✗
The site was occupied by a school during WWII.	✗
Part of the site is likely to have been subject to post-raid searches for UXO.	Possibly
Buildings on site sustained serious bomb damage and as a result were likely abandoned (along with any associated gardens / open ground) for the remainder of the war.	n/a
The site was occupied by peripheral open ground / wasteland, with no apparent use, which may have been neglected.	✓
The site may have been occupied by recreational land / sports fields which may have only experienced seasonal access.	✗
The site was occupied by a graveyard which would have experienced limited access.	✗
The site was occupied by agricultural land, rural countryside or woodland which would not have been accessed in full, either regularly or frequently.	✗
The site was occupied by railway sidings which may not have been as regularly checked for buckling as mainline railway tracks.	✗
The site was occupied by soft railway embankments which are likely to have been neglected during the war.	✗
Additional comments:	The site was occupied by a flying field for Hamble. This would have been partially accessed on a regular basis, however much of the area may have been neglected.

8.9.4 Ground Cover Assessment:

The entry hole of a 50kg UXB (the most commonly deployed German HE bomb) could have been as little as 20cm in diameter. Wartime records also confirm that small German Incendiary Bombs, weighing just 1kg, were capable of significant penetration into soil, resulting in very small entry holes (5cm) or complete burial.

The quantity and type of ground cover present on a site during WWII would have had a significant effect, at ground level, on the visual evidence of buried UXO.

Evidence of UXO could be obscured in dense vegetation, soft ground, rubble, railway ballast or amongst stockpiled material (such as aggregate, coal or refuse heaps). A UXB strike to waterlogged ground or open water would have been immediately obscured from view beneath the waterline. Had such an incident occurred within a tidal mudflat or river bank, the resulting entry hole will have remained only temporarily, before becoming in-filled by water and sediment. Any HE UXB strike to elevated risk ground cover could potentially have come to rest beneath neighbouring undamaged buildings or hard-standing due to the 'J-Curve' Effect.

UXB strikes to undamaged/superficially damaged buildings and hard-surfaced ground will still have caused substantial damage or an easily identifiable and persistent entry hole. Similarly, it is unlikely that an HE UXB entry hole on well-maintained / manicured lawns (tennis courts, bowling greens, golf course fairways / greens, gardens in affluent areas etc), would have been overlooked. Such incidents would have been reported and the UXB subsequently removed.

Ground Cover Assessment	
The site was partially or entirely abandoned, due to bomb damage, resulting in associated open ground likely becoming overgrown.	✗
The site was occupied by dense, inaccessible vegetation during WWII.	Possibly
The site may have been susceptible to waterlogged conditions during WWII.	✓
The site was occupied by (possibly) unmaintained grass field during WWII.	✓
The site was part occupied by a canal, river, dock basin, lake or reservoir during WWII.	✓
The site was occupied by tidal mud or marshland during WWII.	✗
The site was occupied by railway tracks crossing soft ground during WWII.	✗
The site was occupied by stockpiled material during WWII.	✗
The site was occupied by buildings, hard-standing or other manmade structures that did not sustain any degree of bomb damage.	✗
A comparison of the historical records confirms that buildings on site sustained inconsequential minor / moderate damage.	n/a
The site was occupied by well-maintained, manicured lawn during WWII.	✗
Undamaged, developed parts of the site would have been vulnerable to the J-Curve Effect.	✓
Additional comments:	n/a

8.9.5 Bomb Failure Rate Assessment:

Based on empirical evidence, it is generally accepted that 10% of the German HE bombs dropped during WWII failed to explode as designed.

Note, due to manufacturing fault or failure of the bomber crew to correctly arm their munitions, whole bomb loads often failed to detonate. Therefore, the presence of reported UXBs increases the likelihood of an additional unrecorded UXB in the vicinity.

Bomb Failure Rate Assessment	
Evidence has been found which suggests that the bomb failure rate in the vicinity of the site would have been different from the "approximately 10%" figure normally used.	✗
Additional comments:	n/a

9 The Threat from Allied Military Ordnance

The following historical and modern facilities / activities / incidents have been found on site or in the surrounding area:

Potential Source of Contamination on Site	
Army, Navy and RAF Bases / Installations	✓
Military Training Areas / Weapons Ranges	✗
Ordnance / Explosives Factories and Storage Depots	✗
Sites Requisitioned for Military Use	✓
Military Fortifications and Coastal Defences	✗
Locations of Army Explosive Ordnance Clearance Tasks	✓
WWII Anti-Aircraft Batteries	✓
WWII Pipe Mined Locations and Beach Minefields	✗

The risk of contamination from Allied UXO on site is discussed below.

9.1 Hamble Airfield

The North airfield (the location of the study area) was opened in 1926. Early users were AVRO, Fairey Aviation, Simmonds Aircraft (who built aircraft at the Rolling Mills, Weston,) Vickers/Supermarine of Woolston, and the Resident Hampshire Aeroplane Club. The existing facilities built for the Admiralty Acceptance Depot, were used as workshops etc, the entrance to the site being approximately where Aquila Way is today.

On Sunday 15th May 1927, the Hampshire Air Pageant was held at Hamble, where many new aircraft were on show. A cover of a surviving programme shows that the South airfield was used for joyriding, while the North airfield was classed as the Pageant Aerodrome. The '5 shilling' enclosure was along the north side of the BP railway line, the '2/6d' behind Hampton Cottages, and the 'shilling' enclosure was to the north, alongside the Southern Railway cutting.

In January 1931, the Armstrong Whitworth Aircraft Reserve School moved to Hamble from Whitley, near Coventry, and became Air Service Training Ltd. A hangar was built at the eastern end of Verdon Avenue, the entrance being in Sydney Avenue. This building became 'B' Hangar, circa 1939. The school opened on 14th April 1931, the first aircraft fleet consisting of an AVRO 504, three DH 9J's, two AWA Siskins, three AWA Atlas Trainers, and two AVRO Tutors. One of the Siskins only lasted until 8th June 1931, when it was involved in a fatal accident at Sarisbury Green.

On the 20th July 1940, all three flying schools left Hamble. The airfield was now only used by aircraft undergoing repair and a detachment of Blackburn Sharks from HMS Raven at Eastleigh, which arrived earlier in the year.

In November 1941, part of Fleet Air Arm Squadron 780 arrived from Lee-on-Solent for training. They used canvas hangers situated above Hampton houses and the Southern Railway. The squadron then subsequently left in August 1942.

From October 1943, the AA gunners of the airfield left, followed by further squadrons and staff leaving afterwards. In August 1945, the airfield was full of Spitfires that needed to be scrapped. By the following October, 'F' Hanger closed and the airfield's WWII-era responsibilities had ceased.

However, on 1st August 1946, the first post-war training flight took place from A Hangar. B hangar was in use by the Aircraft Division for the conversion of York Transports into airliners for BOAC. By 1960, the Air Service Training closed and the Airfield came under the ownership of the College of Air Training.

In 1984 the aircraft, equipment and land were sold off. The last aircraft to fly out of Hamble did so on the 6th April 1986.

9.1.1 Ordnance / Ammunition Storage, Use and Disposal

9.1.1.1 WWII Storage and Disposal

During WWII, a wide range of ordnance and ammunition was stored, handled and disposed of at military airfields. Broadly speaking this would have included:

a) Bombs and Rockets: High Explosive, Incendiary, Shot, Smoke, Flares, Photoflash

b) Air-Delivered Maritime Weapons: Depth Charges, Torpedoes, Mines

c) Practice Bombs

d) Anti-Aircraft Artillery shells

e) Land Service Ammunition: Grenades, Mortars

f) Small Arms Ammunition: aircraft machine gun / canon, rifle, pistol

Anecdotal accounts suggest that faulty or surplus ordnance / ammunition on WWII military airfields would often be burnt, buried or otherwise disposed of locally. In many cases designated burning pits were sited at peripheral open ground within the airfield perimeter.

At the former locations of an airfield's bomb stores and / or ammunition stores there is a higher likelihood of UXO contamination as such items would have frequently transited to and from / been handled within these areas.

9.1.1.2 Post-WWII Storage and Disposal

In the immediate aftermath of WWII, the RAF (and British based USAAF) were left with a vast quantity of surplus ordnance and ammunition. Several RAF Maintenance Units (MUs) specialising in weapons servicing were tasked with their long-term storage and eventual disposal. Bombs and ammunition were stacked up on the runways and in any spare buildings at a number of military airfields in Britain.

Although the quantities were vast, these large-scale storage activities are unlikely to have resulted in UXO contamination, partly due to the secure nature of the dumps (being guarded by armed troops) and also due to the size of the stored items; relatively large individual bombs and crates of ammunition / sub-munitions.

9.1.1.3 WWII Usage

During armament procedures, when ground crews prepared aircraft for a sortie, problems would occur with bombs, ammunition and fuzes. As this operation had to be carried out very quickly there was no time to deal with the defects immediately and consequently faulty items were removed and discarded in the immediate vicinity.

Similarly, once aircraft had returned from their missions, they were disarmed of any unused ordnance and cleaned. Post-WWII finds suggest that ammunition cases and unused rounds from the machine guns / canons were often dropped on the ground and not necessarily cleared up.

These operations often took place at the hard-surfaced aircraft dispersal pans / loops or on the grass flying field.

9.1.1.4 RAF Hamble

- The main role of Hamble Airfield during World War II was the repair and overhaul of Spitfires (a total of 2,575 over that period). Owing to Hamble's proximity to the Supermarine works at Eastleigh and Woolston, parts were transported to Hamble for assembly and ferry flights. These

ferry flights were carried out by No. 3 Air Transport Auxiliary (ATA), many of whom were women. During the war years other aircraft up to B-17 Flying Fortress size were handled. Other aircraft types repaired at Hamble included Handley Page Hampden, Avro Lancaster and York, de Havilland Mosquito and North American P-51 Mustang.

- As a result, it is conceivable that fighter and bomber aircraft were armed and disarmed on the airfield, particularly in areas of dispersal. However, as no offensive bombing operations are known to have flown from this airfield it is considered highly unlikely that these activities took place regularly.
- No evidence of waste disposal (possibly involving burning / burial of UXO), was evident in mapping or photography of the site. However, the possibility such activities were carried out across peripheral areas of the airfield (including those within the study area) cannot be discounted.

9.1.2 WWII Ground Defence

If a military airfield was constructed either prior to WWII or during 1940 / 1941 (the period of anticipated German invasion), provision was made for ground defence.

9.1.2.1 Soldier Accommodation

During WWII Army, Royal Marine and Home Guard detachments were temporarily accommodated at some RAF airfields for training and / or defence purposes. Soldiers could face serious disciplinary action if found to have misplaced ammunition, therefore it was not uncommon historically for troops to hoard extra items of ammunition to make up for any lost during exercises. Once these surplus items became redundant, they were often buried, hidden. This is substantiated by the following:

Anecdotal evidence confirms that a grenade was found in an accommodation block drain pipe within the Rowcroft Barracks (Ashford, Kent). Also, whilst Safelane Global carried out EOD clearance works at Church Crookham Barracks near Fleet, a search and clear dog team sent into a disused barracks building discovered a grenade. In 2003 Safelane Global encountered a grenade hidden in the roofing of another disused barrack block at Colchester Garrison.

9.1.2.2 Defensive Fortifications

RAF airfields were typically fortified with pillboxes, defence huts, trenches, weapons / ammunition caches. Pillboxes were small brick or concrete built structures, strategically placed to cover angles of likely attack and designed to provide a machine gun team with protection. Many airfields had a small concrete Battle Headquarters bunker on site used to coordinate the defence in the event of ground or airborne attack.

During the period when the threat of enemy invasion was high, such positions would have been manned by armed troops and therefore the likelihood of UXO contamination is locally higher at these localities.

9.1.2.3 Battle Training

Anti-invasion exercises were frequent at WWII airfields operational during the period of anticipated German invasion. It was not uncommon for Allied Army or Marine units to visit airfields to test the base's defences during mock attacks.

Such exercises were both beneficial to the Home Guard / Army troops manning the defences as well as the attacking forces who were often in training for upcoming combat tours overseas. During these attacks live ammunition was sometimes used, as were pyrotechnic training aids to create realistic battle conditions.

This is substantiated by an eye witness account associated with a WWII-era RAF Bomber Command airfield. A young boy who moved to Methwold village in 1942 notes that whilst exploring the areas around RAF Methwold, he would 'sometimes come across live ammunition'.[3]

9.1.2.4 Improvised Mines

This type of ground attack counter measure was employed on some military airfields during WWII. It involved deliberately burying RAF HE bombs (GP or MC types) in strategic locations in and around the airfield perimeter. The bombs would have been buried in a way that allowed easy access to the nose or tail delay action fuzes, i.e vertically orientated. In the event of a German ground attack the bombs could be detonated using a long detonation cord from a sheltered position.

In 2006, Safelane Global encountered an example of this. A 1,000lb GP bomb and a 500lb MC bomb were located in a peripheral field during a non-intrusive magnetometer survey at RAF Oakington.

9.1.2.5 RAF Hamble

- Two pillboxes were located within the study area, with a further two in close proximity to the western site boundary. During periods of increased risk of invasion, these would likely have been regularly manned by armed guards. Anecdotal evidence has implied that Hamble was protected by HG soldiers who manned the AA guns and protected the factory.
- Ground defence troops would have been armed with small arms weapons and issued with other LSA (such as grenades). Furthermore, these troops would likely have taken part in airfield defence training exercises, which were often carried out on scrubland and grass fields situated within the airfield perimeter. Consequently, it is possible such activities happened within the site boundary, increasing the possibility of localised UXO contamination.
- Experience has shown that the 'housekeeping' of WWII soldiers was often poor with ammunition often buried, misplaced or otherwise discarded in various locations at military bases.

9.1.3 Airfield Denial Measures - Pipe Mines

9.1.3.1 General

At the beginning of WWII, during the period of anticipated enemy invasion, a solution was sought to deny the use of RAF runways to enemy gliders and transport aircraft in the event of a German airborne attack, and so the Canadian Pipe Mine was devised by the 1st Canadian Tunnelling Company.

The Canadian pipe mines used during WWII comprised 50-70mm steel pipes inserted into the ground using hydraulic pipe pushing equipment. They were laid in a criss-cross pattern, mainly under the concrete runways / grass flying fields of RAF airfields, approximately 6ft beneath the surface. They were subsequently filled with explosives.

Only nine airfields were identified for mining initially but this rose to include other locations and by the end of 1942, after the threat of invasion had receded, 30 locations were mined, not all of them airfields. It is estimated that over 40,000ft of pipe mines were installed.

[3] *https://joemasonspage.wordpress.com/2013/07/16/memories-of-methwold/*

During the war some of the pipe mines were made safe and removed because of the deterioration of the explosive filler but most were left in situ. After the war Canadian engineers were tasked with removal but this was never completed in full. Note, during this period one clearance effort resulted in the death of a Ukrainian worker.

In 1981 WWII documents relating to pipe mined airfields were re-investigated by an Army EOD unit tasked with the clearance of all remaining airfield pipe mines in the UK - Operation Crabstick. However Crabstick did not always provide complete clearance of all pipe mines at the former airfields, as evidenced by Safelane Global pipe mine finds at two WWII airfields, previously subject to Crabstick clearance.

Recent Army re-investigation of a number of airfield sites found that they had not been entirely cleared (for example HMS Daedalus and RAF Hawkinge) while on some sites, more pipe mines were placed than were recorded in the original wartime installation plans, and some were encountered in the wrong place.

9.1.3.2 RAF Hamble

Hamble is named as an airfield that was pipe mined during WWII. It has been given a Type 1 Certificate which means that all mines were accounted for in the 1940s.

Note, however, for the reasons discussed above, the possibility that some pipe mines remained on site cannot be discounted. Clearance operations were not always well documented or thorough, and pipe mines can still be encountered on previously "cleared" sites today.

9.1.4 Practice Bombing

9.1.4.1 General

WWII-era RAF bomber airfields (particularly Operational Training Unit airfields) often had a practice bombing target situated in an unused, peripheral part of the airfield or in a requisitioned field just outside its perimeter.

These targets were used for low altitude bomber aiming training. The small, mainly inert practice bombs used by the Allied air forces had the potential to penetrate soft ground and therefore may have not always been recovered from the target area.

Safelane Global experience at a number of WWII RAF airfields has shown that practice bombs tend to be one of the more common and numerous types of UXO find.

9.1.4.2 RAF Hamble

Given that RAF Hamble comprised an aircraft training centre during WWII, the possibility cannot be discounted that more remote areas at the peripheral areas of the airfield would have been used for practice bombing, although no records detailing where this may have taken place could be obtained.

9.1.5 Weapons Testing / Training

9.1.5.1 General

Military airfields generally had small arms firing ranges (for pistol and rifle practice), aircraft gun test butts (for aligning wing mounted guns in Fighters) and, at bomber stations, turret training facilities where airmen could practice firing from aircraft machine gun turrets whilst on the ground.

Such facilities were usually sited in a peripheral, relatively isolated position at the airfield. Potential contamination in and around these ranges would include live rounds, heavy metals (such as Lead, Antimony, Barium, Copper), explosive propellant residues and possibly other munitions.

Note, historically it was not uncommon for gunnery ranges to double up as small training areas for other weaponry. Some airfields also made provision for defence soldiers to practice grenade throwing. Potential contamination at such localities could include unspent smoke, phosphorus, fragmentation or blast grenades, as well a partially expended or faulty grenades.

9.1.5.2 RAF Hamble

No evidence of weapons test ranges has been found within the perimeter of the North Airfield at Hamble.

9.1.6 Mustard Gas

9.1.6.1 General

Britain stockpiled large quantities of Mustard Gas during WWII. In 1940-41, plans were put in place to use chemical weapons to help repel any German invasion of the Britain. More stocks were amassed in 1942-43, in case they were needed to bomb Germany and then again in 1944, in the lead up to the D-Day landings, as a deterrent and for retaliation. More stocks were produced after the war, in response to the Soviet threat, however the build-up ceased from the mid-1950s, when nuclear weapons became readily available to Britain.

Historically there were four Mustard Gas production facilities in the UK, four forward filling facilities and >60 storage sites, mainly former RAF and USAAF bases, where operational records show Mustard Gas was stored and then disposed of. However, some of these latter sites, declared as clear / safe by the MOD have since yielded up to 120 Mustard Gas artillery shells.

Note, due to the secrecy and sensitivity relating to chemical warfare during WWII, information relating to such matters was not always put on public record, hampering present day research.

Attempts to clean up the 60-plus sites over the last 40 years were often botched, leaving significant amounts of the highly corrosive, persistent chemical agent in the soil. Furthermore, detailed records of the chemicals stored at the sites appear to have been misplaced.

9.1.6.2 RAF Hamble

No record of chemical weapons storage / processing at the airfield was found.

9.1.7 Aircraft Crashes

9.1.7.1 General

Aircraft crashes at WWII airfields were a common occurrence. The relatively short Allied pilot training programs during this conflict meant that a pilot only had a very limited number of flying hours under his belt (on a small trainer aircraft) before commencing training on their chosen bomber or fighter aircraft.

In the case of bombers, this was further compounded by the very heavy weapon loads and fuel loads, which greatly hampered take-off (the most dangerous manoeuvre), resulting in many crashes.

Furthermore, during the Allied bombing campaign over occupied Europe, numerous aircraft would return with damage from German AA defences and this led to many crash landings, particularly at the coastal airfields closest to France, Germany and the Low Countries.

In the event of a high-speed crash, the substantial impact could result in high density objects, such as the engine(s) and bombs / rocket warheads being buried in the ground to a significant depth. Following such an incident, complete salvage would not have been made a priority and therefore it is conceivable that Allied ordnance could remain buried at such a locality.

9.1.7.2 RAF Hamble

A consolidation of historical sources records at least 16 air crashes in the Hamble area during WWII.[4] It is unknown whether any of these aircraft would have been carrying large payloads of munitions, however the possibility cannot be discounted. During these incidents, it is conceivable that shrapnel, explosive materiel or unexploded items may have been dispersed across the locality of the crash.

9.2 Home Guard Activity

The Home Guard (HG) was a defence organisation of the British Army, operational between 1940 and 1944. It comprised 1.5 million local volunteers, otherwise ineligible for military service and acted as a secondary defence force in case of enemy invasion. The HG guarded the coastal areas of Britain and other important facilities such as airfields, factories and explosives stores. They were also active in county towns and cities.

Official records were rarely kept by the HG and therefore any present-day evidence is usually anecdotal. However, it is known that HG personnel often carried out training (including weapons training) in open countryside on the outskirts of cities / towns. Today, items of ordnance related to the HG are occasionally encountered by members of the public and the construction industry in the British countryside. This suggests a culture of ill-discipline regarding live ammunition within HG units.

HG personnel are known to have purposefully buried caches of ammunition and weapons in tactical positions, to be exhumed and used in case of invasion. Records of such caches were not rigorously kept and some were therefore forgotten about. This is substantiated by several recent HG UXO finds (see Annex J).

Home Guard Activity		
Nearest HG Battalion to the site	21st Hampshire (4 SR) and 12th Hampshire (Southampton East) HG Battalions	
Site Specific Details	• The local factories and the airfield itself will have had their own Home Guard platoon also. These men will have manned the AA guns of the airfield and the pillboxes and defences. • The site was occupied by open ground requisitioned for military use, typical of that used for HG training exercises. Home Guard battalions would also often take part in invasions practice at airfield sites. Therefore, the possibility of these activities being carried out on site cannot be discounted.	
There is a risk of land service / small arms ammunition contamination on site.		✓

[4] *http://www.hampshireairfields.co.uk/hancrash.html*

9.2.1 Anti-Aircraft Gun Batteries

At the start of the war two types of AAA guns were deployed: Heavy Anti-Aircraft Artillery (HAA) and Light Anti-Aircraft Artillery (LAA). The LAA batteries were intended to engage fast low flying aircraft and were typically deployed around airfields or strategic installations. These batteries were mobile and could be moved to new positions with relative ease when required. With four guns per battery firing several rounds per minute, AA batteries could expel numerous shells in even the shortest engagements. Numerous unexploded AAA shells were recovered during and following WWII and are still occasionally encountered on sites today.

The maximum ceiling height of fire at that time was around 11,000m however, as the war progressed, improved variants of the 3.7" gun were introduced and, from 1942, large 5.25 inch weapons were brought into service. These had significantly improved ceiling heights of fire reaching over 18,000m.

When the supply of clockwork fuses from Switzerland was cut off, Britain was forced to make its own. After four years of war, the country still lacked the engineering skills to produce a reliable fuse. This resulted in a considerable number of AA projectiles exploding prematurely, killing the gunners or failing to explode at all and falling to the ground as UXBs. In January 1944, more people in London were killed by HAA shells than by German bombs.

Anti-Aircraft Gun Batteries		
Number of HAA batteries within 5km of the site	3	
Additional Comments	• Additional Bofor AA guns were positioned around Hamble on the shores of Southampton Water, the airfield and around Satchell Lane. • During WWII, the majority of the site was occupied by undeveloped open soft ground. In such ground cover, an unexploded AA shell could conceivably have gone unnoticed, particularly at night.	
There is a risk of unexploded AA shells contamination on site.		✓

9.3 The Threat Posed by British Unexploded Ordnance

9.3.1 Land Service Ammunition (LSA)

9.3.1.1 General

The term Land Service Ammunition covers all items of ordnance that are propelled, placed or thrown during land warfare. They may be filled or charged with explosives, smoke, incendiary or pyrotechnics. They can be broken into five main groups:

a. Mortars

b. Grenades

c. Projectiles

d. Rockets

e. Landmines

Unexploded or partially unexploded Mortars and Grenades are among the most common items of UXO encountered in the UK and therefore the possibility cannot be discounted that they were stores on site. They are commonly encountered in areas used by the military for training and are often found discarded on or near historic military bases. Examples of Grenades, Mortars and Home Guard weapons are presented in Annex K.

Items of ordnance do not become inert or lose their effectiveness with age. Time can indeed cause items to become more sensitive and less stable. This applies equally to items submerged in water or embedded in silts, clays or similar materials. The greatest risk occurs when an item of ordnance is struck or interfered with. This is likely to occur when mechanical equipment is used or when unqualified personnel pick up munitions.

9.3.1.2 Mortars

A mortar bomb is a fin-stabilised munition, normally nose-fuzed and fitted with its own propelling charge (primary cartridge). Range is increased by adding extra propellant (augmenting charges). They are either HE or Carrier and generally identified by their tear-dropped shape (older variants however are parallel sided) and a finned 'spigot tube' screwed or welded to the rear end of the body housing the propellant charge.

A mortar relies on a striker hitting a detonator for explosion to occur. It is possible that the striker may already be in contact with the detonator and that only a slight increase in pressure would be required for initiation. Discarded augmenting charges are often encountered around mortar firing areas/bases.

9.3.1.3 Grenades

A grenade is a short-range weapon which may be thrown by hand, fired from the end of a rifle or projected/propelled from a special purpose grenade launcher. They are divided into two categories; HE and Carrier (generally smoke). As with mortars, a grenade striker may either be in contact with the detonator or still be retained by a spring under tension, and therefore shock may cause it to function. A grenade can have an explosive range of 15-20m. Common older variants have a classic 'pineapple' shape; modern grenades tend to be smooth-sided.

9.3.2 Small Arms Ammunition (SAA)

The most likely type of ordnance to be encountered on site are items of SAA (bullets), especially .303" ammunition which was the standard British and Commonwealth military cartridge from 1889 until the 1950s.

However even if an item such as this functioned, the explosion would not be contained within a barrel and detonation would only result in local overpressure and very minor fragmentation from the cartridge case.

Some LAA guns and RAF fighter cannons in use with British forces during WWII utilised the 20mm round. These bullets had a small fuse and a ~4gram HE or incendiary charge. Although small, this fill quantity still has the potential to cause serious injury. Images of SAA are presented in Annex L.

9.3.3 Anti-Aircraft Shells

At the start of the war two types of AAA guns were deployed: Heavy Anti-Aircraft Artillery (HAA) using large calibre weapons such as the 3.7" QF (Quick Firing) gun and Light Anti-Aircraft Artillery (LAA) using smaller calibre weapons such as 40mm Bofors gun which could fire up to 120 x 40mm HE shells per minute to over 1,800m. During the early war period there was a severe shortage of AAA so older WWI 3" and modified naval 4.5" guns were also deployed.

These shells are frequently mistakenly identified as small German air-delivered bombs, but are differentiated by the copper driving band found in front of the base. Although the larger unexploded projectiles could enter the ground they did not have great penetration ability and are therefore likely to be found close to WWII ground level. With a HE fill and fragmentation hazard these items of UXO also present a significant risk if encountered.

The smaller 40mm projectiles are similar in appearance and effect to small arms ammunition and, although still dangerous, present a lower risk. Pictures of AAA projectiles are presented in Annex M. Details of the most commonly deployed WWII AAA projectiles are shown below:

Gun type	Calibre	Shell Dimensions	Shell Weight	HE Fill Weight
3.7 Inch	94mm	94mm x 438mm	12.7kg	1.1kg
4.5 Inch	114mm	114mm x 578mm	24.7kg	1.7kg
40mm	40mm	40mm x 311mm	0.84kg	70g

10 Ordnance Clearance and Post-WWII Ground Works

10.1 General

The extent to which any ordnance clearance activities have taken place on site or extensive ground works have occurred is relevant since they may indicate previous ordnance contamination but also may have reduced the risk that ordnance remains undiscovered.

10.2 EOD Bomb Disposal and Clearance Tasks

Safelane Global holds a number of official records of explosive ordnance disposal operations during and following WWII, obtained from the Explosive Ordnance Disposal (EOD) Archive Information Office at 33 Engineer Regiment (EOD), British Army.

Records were found to indicate that any Army EOD tasks have taken place on site	✓
Further Comments	One record has been obtained of an official Explosive Ordnance Disposal task undertaken at Hamble Airfield, within the study area, between 14th January 1985 and 22nd August 1986, when six items of UXO were recovered from an area of 65ha, including two live items.
Records of recent local ordnance finds were found	✗
Further Comments	n/a
SafeLane Global Limited have encountered UXO in the local area	✗
Further Comments	n/a

10.3 Post War Redevelopment

The nature of post-WWII ground works, redevelopment and construction has been considered. Significant structural redevelopment on site can, in some cases, provide a level of mitigation, particularly from shallow buried items. However, if a site has not undergone any extent of redevelopment, the risk of UXO remaining within its boundaries can remain.

The site has been redeveloped post-WWII	✖
Further details	Since WWII, the site does not appear to have been subject to any significant redevelopment.

11 The Overall Explosive Ordnance Threat Assessment

11.1 General Considerations

Taking into account the quality of the historical evidence, the assessment of the overall threat to any intrusive works from UXO must evaluate the following risks:

- That the site was contaminated with unexploded ordnance
- That UXO remains on site
- That such items could be encountered during any intrusive works
- That ordnance may be activated by the works operations
- The consequences of encountering or initiating ordnance

11.2 The Risk that the Site was Contaminated with Unexploded Ordnance

For the reasons discussed in *Section 9 and 10* Safelane Global believes that there is a risk that UXO contaminated the study area. This is based on the following:

GERMAN AIR-DELIVERED UXO
• Southampton and the wider area sustained a high density of bombing during WWII due to its extensive port infrastructure, ship building industries and most notably the Supermarine Works. • The site occupied the North Airfield of RAF Hamble. This would have presented a strategic Luftwaffe bombing target, along with the Armstrong and Whitworth aircraft manufacturing factory present within the South Airfield, if the Luftwaffe were aware of their significance. Note that the oil terminal (located south of the site) is also likely to have posed a viable target. • The WWII bomb plot map shows a high density of HE bomb strikes in the Hamble area, particularly in the proximity of the airfield and the Armstrong and Whitworth aircraft manufacturing factory. An estimate of 6 HE bombs have been recorded to have fallen within the site boundary, with several further in the vicinity. The site was also machine-gunned by the enemy aircraft and was subject to at least one 1kg IB shower. • The site entirely comprised fields during WWII and will have contained a grass runway / flying field during the bombing raids over the area. Therefore, evidence of UXO may have been obscured and overlooked where access is likely to have been infrequent amongst the vegetation cover. Note that the entry hole of a 50kg HE UXB may have been as little as 20cm in diameter and easily obscured in such conditions.

BRITISH / ALLIED UXO

- Opened in 1926, Hamble was utilised by aircraft manufacturers, comprising an aircraft training centre / flying school during WWII. As such there is still a residual threat of contamination in this area, as items of explosive ordnance are likely to have been stored, used and potentially disposed of in the vicinity.
- Given that RAF Hamble comprised an aircraft training centre during WWII, the possibility cannot be discounted that more remote areas at the peripheral areas of the airfield would have been used for practice bombing, although no records detailing where this may have taken place could be obtained.
- No evidence of waste disposal (possibly involving burning / burial of UXO), was evident in mapping and aerial photography of the site. Therefore, the possibility such activities were carried out across peripheral areas of the airfield (including those within the study area) cannot be discounted.
- The local factories and the airfield itself will have had their own Home Guard (HG) units. These men will have manned the AA guns, pillboxes and defences of the airfield.
- The site was occupied by open ground requisitioned for military use, typical of that used for HG training exercises. HG battalions would also often take part in invasions practice at airfield sites. Therefore, the possibility of these activities being carried out on site cannot be discounted.
- Two pillboxes were located within the study area, with a further two in close proximity to the western site boundary. During periods of increased risk of invasion, these would likely have been regularly manned by armed guards. Anecdotal evidence has implied that Hamble was protected by HG soldiers who manned the AA guns and protected the factory.
- Ground defence troops would have been armed with small arms weapons and issued with other LSA (such as grenades). Furthermore, these troops would likely have taken part in airfield defence training exercises, which were often carried out on scrubland and grass fields situated within the airfield perimeter. Consequently, it is possible such activities happened within the site boundary, increasing the possibility of localised UXO contamination.
- Experience has shown that the 'housekeeping' of WWII soldiers was often poor with ammunition often buried, misplaced or otherwise discarded in various locations at military bases.
- Three HAA batteries were located within a 5km radius of the airfield. However, additional Bofor AA guns were also positioned around Hamble on the shores of Southampton Water, the airfield and around Satchell Lane. During WWII, the majority of the site was occupied by undeveloped open soft ground. In such ground cover, an unexploded AA shell could conceivably have gone unnoticed, particularly at night.
- Hamble is named as an airfield that was pipe mined during WWII. It has been given a Type 1 Certificate which means that all mines were accounted for in the 1940s. Note, however, several instances of pipe mines being encountered on airfields in the past few years, the possibility that some pipe mines remained on site cannot be discounted. Clearance operations were not always well documented or thorough, and pipe mines can still be encountered on previously "cleared" sites today.
- A consolidation of historical sources records at least 16 air crashes in the Hamble area during WWII. It is unknown whether any of these aircraft would have been carrying large payloads of munitions, however the possibility cannot be discounted. During these incidents, it is conceivable that shrapnel, explosive materiel or unexploded items may have been dispersed across the locality of the crash.
- One record has been obtained of an official Explosive Ordnance Disposal task undertaken at Hamble Airfield between 14th January 1985 and 22nd August 1986, when six items of UXO were recovered from an area of 65ha, including two live items. The recovery of these items of UXO highlights the potential for further such items to remain buried in areas which were not subject to clearance.

11.3 The Risk that Unexploded Ordnance Remains on Site

Within the footprints of any post-war redevelopment on site, the risk of shallow buried UXO (especially AA shells and German 1kg incendiaries) remaining will have been partially mitigated since any such items could have been encountered and removed during soil stripping and levelling. As no such works appear to have taken place post-WWII, this is considered unlikely.

Only within the volume of any post-war level bulk excavations, extraction works and at the precise locations of any post-war pile foundations / boreholes, will the risk from deeper buried German HE UXBs have been completely mitigated. As no bulk excavations appear have been carried out onsite, the risk from deep buried UXO remains unmitigated to the maximum bomb penetration depth.

11.4 The Risk that Ordnance may be Encountered during the Works

The most likely scenarios under which a UXO could be encountered during mineral development works is during stripping or bulk excavations for mineral extraction. The overall risk is determined by the extent of the works, such as the volume of the excavations.

Client provided information indicates that the maximum depth of excavation will be 7.16m, with an average depth of 4.57m.

Since an air-dropped bomb may come to rest at any depth between just below ground level and its approximate penetration depth, there is also a chance that such an item could be encountered during shallow excavations into the original WWII ground level.

At any location on site where excavation works are due to be undertaken within post-war fill material / post-war made ground, the risk of encountering WWII UXBs is low. However, as the proposed site works are to be undertaken below WWII ground level, this risk is significantly higher.

11.5 The Risk that Ordnance may be Initiated

The risk that UXO could be initiated if encountered will depend on its condition, how it is found and the energy with which it is struck. The most violent activity on most construction sites is percussive piling. As a result, items that are shallow buried present a slightly lower risk than those that are deep buried, since the force of impact is usually lower and they are more likely to be observed – when immediate mitigating actions can be taken.

11.6 The Consequences of Encountering or Initiating Ordnance

Clearly the consequences of an inadvertent detonation of UXO during extraction operations would be catastrophic with a serious risk to life, damage to plant and a total site shutdown during follow-up investigations.

Since the risk of initiating ordnance is significantly reduced if appropriate mitigation measures are undertaken, the most important consequence of the discovery of ordnance will be economic. This would be particularly so in the case of high profile locations and could involve the evacuation of the public.

The unexpected discovery of ordnance may require the closing of the site for any time between a few hours and a week with a potentially significant cost in lost time. Note also that the suspected find of ordnance, if handled solely through the authorities, may also involve loss of production since the first action of the Police in most cases will be to isolate the locale whilst awaiting military assistance, even if this turns out to have been unnecessary.

11.7 Safelane Global's Assessment

Taking into consideration the findings of this study, Safelane Global considers the UXO risk at the site to be Medium:

	Level of Risk		
Type of Ordnance	Low	Medium	High
German High Explosive Bombs		✓	
German 1kg Incendiary Bombs		✓	
British Anti-Aircraft Shells		✓	
British Small Arms and Land Service Ammunition		✓	
Pipe Mines		✓	
Allied Practice Bombs		✓	

12 Proposed Risk Mitigation Strategy

Safelane Global recommends the following minimum risk mitigation measures be deployed to support the proposed ground works at the site:

Scope-Specific Recommended Risk Mitigation Measures	
Site Specific Explosive Ordnance Safety and Awareness Briefings to all personnel conducting intrusive works	✓
A specialised briefing is always advisable when there is a possibility of explosive ordnance contamination. It is an essential component of the Health & Safety Plan for the site and conforms to requirements of CDM Regulations 2015. All personnel working on the site should be instructed on the identification of UXB, actions to be taken to alert site management and to keep people and equipment away from the hazard. Posters and information of a general nature on the UXB threat should be held in the site office for reference and as a reminder.	
The Provision of Unexploded Ordnance Site Safety Instructions	✓
These written instructions contain information detailing actions to be taken in the event that unexploded ordnance is discovered. They are to be retained on site and will both assist in making a preliminary assessment of a suspect object and provide guidance on the immediate steps to be taken in the event that ordnance is believed to have been found.	
Explosive Ordnance Disposal (EOD) Engineer presence on site to support shallow intrusive works	✓
When on site the role of the EOD Engineer would include; monitoring works using visual recognition and instrumentation and immediate response to reports of suspicious objects or suspected items of ordnance that have been recovered by the ground workers on site; providing Explosive Ordnance Safety and Awareness briefings to any staff that have not received them earlier and advise staff of the need to modify working practices to take account of the ordnance threat, and finally to aid Incident Management which would involve liaison with the local authorities and Police should ordnance be identified and present an explosive hazard.	
Handheld Intrusive Magnetometer Survey of all borehole locations down to the maximum bomb penetration depth	✘
As part of the EOD Engineer presence on site, Safelane Global Ltd can deploy intrusive magnetometry techniques to provide staged clearance ahead of all the borehole locations.	
Non-Intrusive Magnetometer Survey and Target Investigation (greenfield land only)	✓

This survey is carried out using caesium vapour magnetometers linked to a data logger. Data is interpreted using advanced proprietary software which is capable of modelling the magnetic anomalies for mass, depth and location, thus providing information which can be used to locate discrete buried objects that may be ordnance. The system will typically locate buried ordnance to a depth of up to 4m for a 50kg bomb (the smallest HE bomb used by the Luftwaffe) and deeper for larger bombs. Additionally, the survey will locate any buried services with a magnetic signature, will indicate areas of gross magnetic "contamination" (which may indicate unknown underground obstructions) and provide information on archaeological features	
Intrusive Magnetometer Survey of all pile locations down to the maximum bomb penetration depth	
Safelane Global can deploy a range of intrusive magnetometry techniques to clear ahead of all the pile locations. The appropriate technique is governed by a number of factors, but most importantly the site's ground conditions. The appropriate survey methodology would be confirmed once the enabling works have been completed. A site meeting would be required between SAFELANE GLOBAL and the client to determine the methodology suitable for this site. Target investigation or avoidance will be recommended as appropriate.	✘
In making this assessment and recommending these risk mitigation measures, the proposed works outlined in the 'Scope of the Proposed Works' section were considered. Should the planned works be modified or additional intrusive engineering works be considered, Safelane Global should be consulted to see if re-assessment of the risk or mitigation recommendations is necessary.	

SafeLane Global Limited 1st December 2021

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The key sources consulted during this assessment are listed below;

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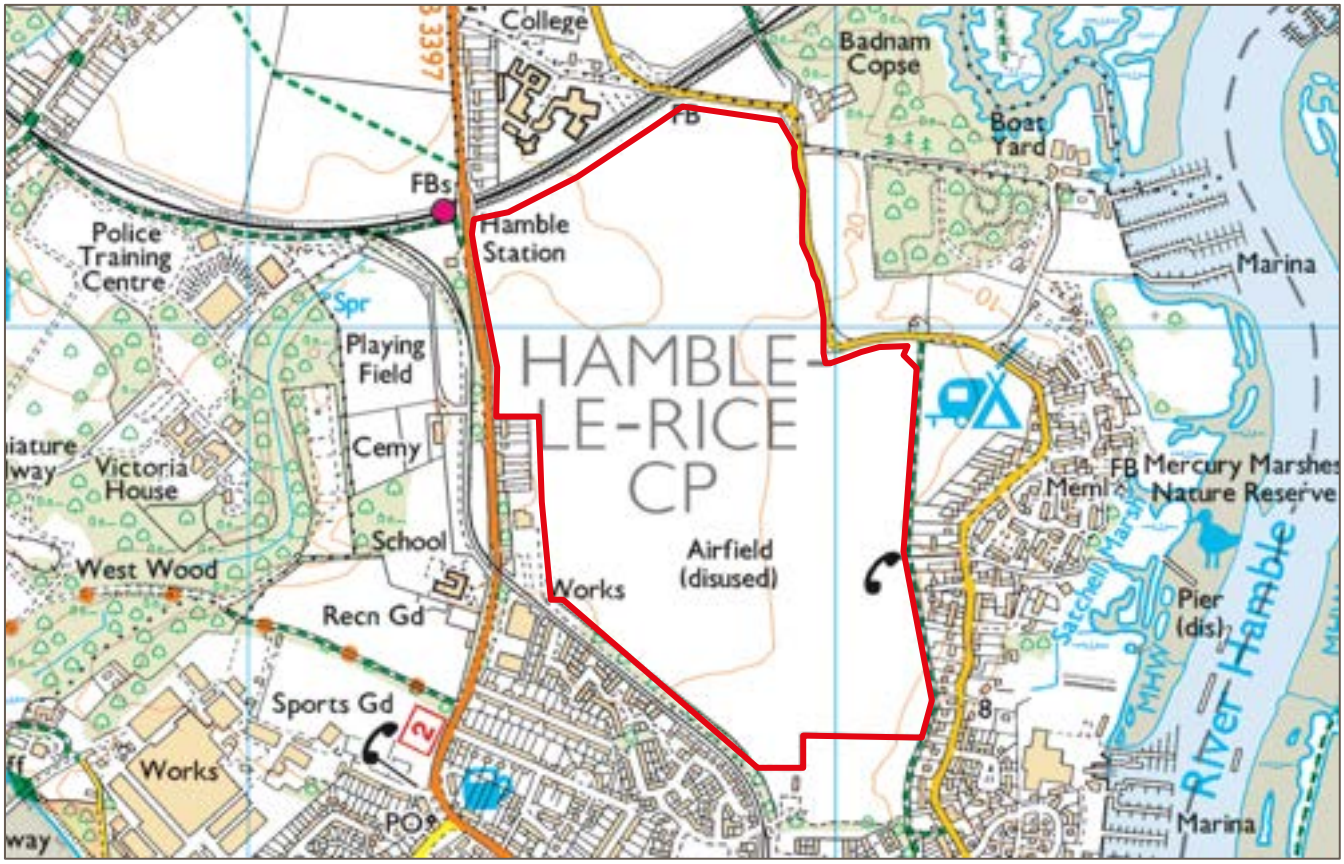
North



Report Reference:	Client:	
RA 9091	CEMEX	SAFELANE® GLOBAL
	Project: Hamble Airfield - Update	

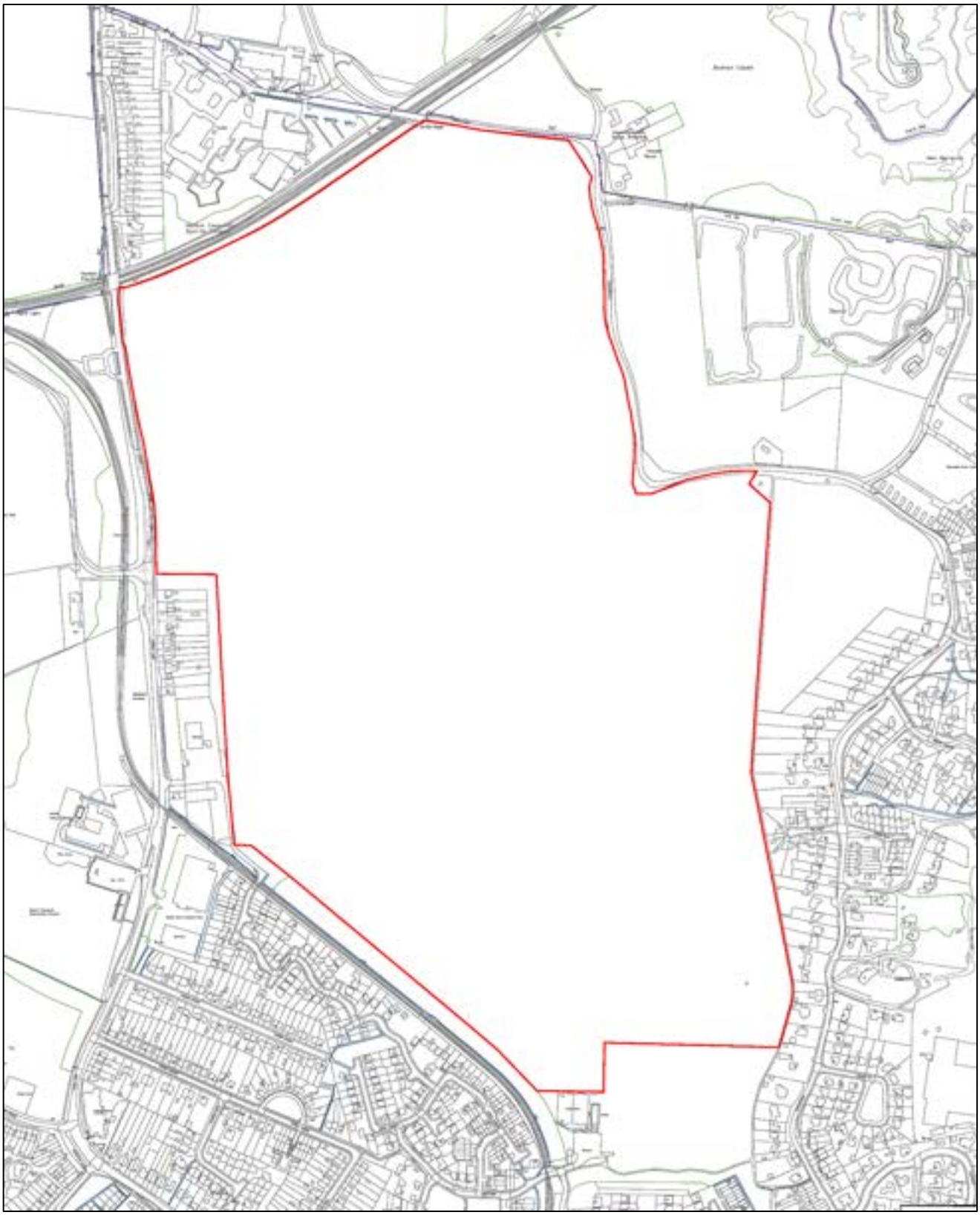
North

Approximate site boundary

Report Reference:	Client:	
RA 9091	CEMEX	SAFELANE® GLOBAL
	Project: Hamble Airfield - Update	

Source: Google Earth ™ Mapping Services

North



Site boundary

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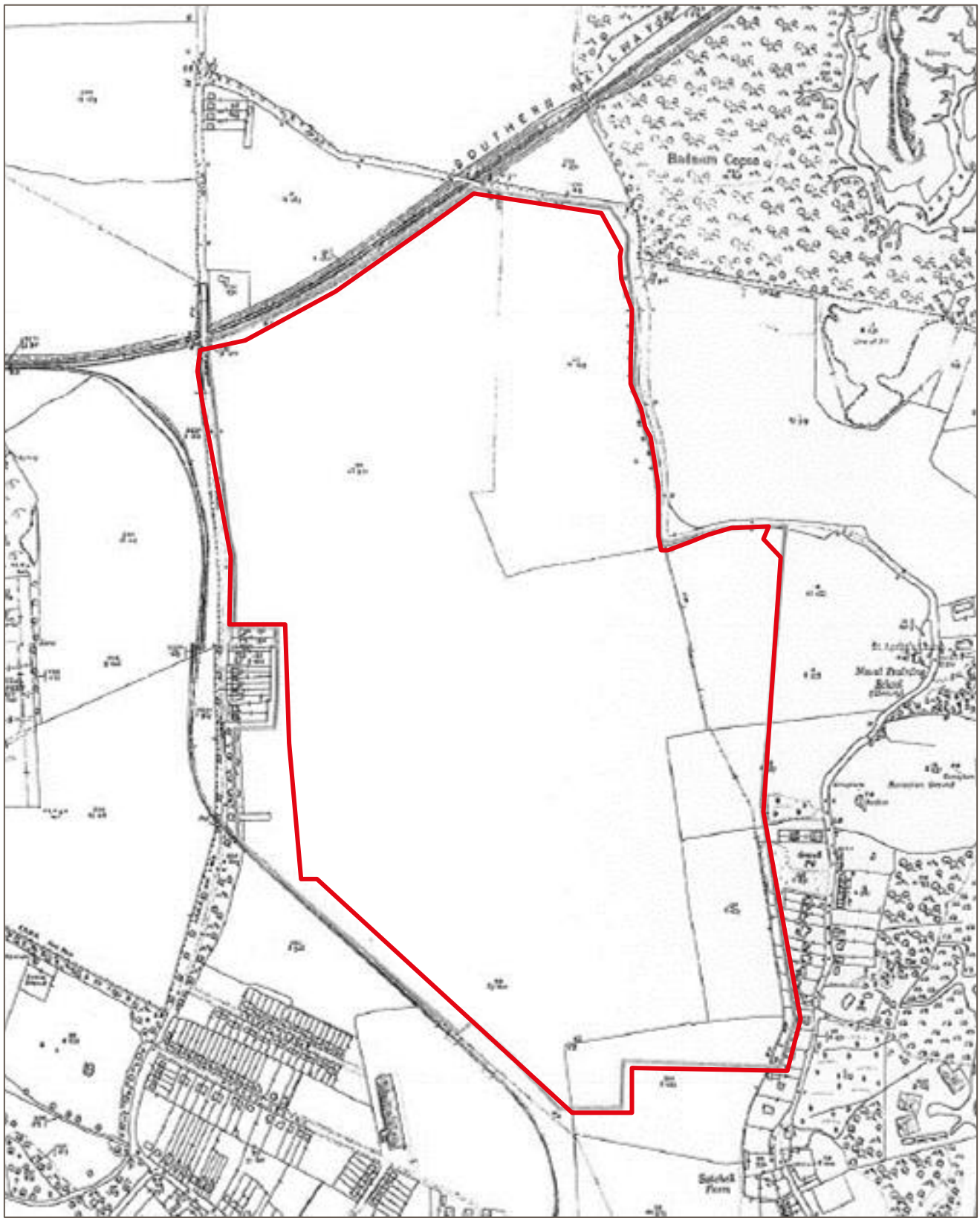
	Project: Hamble Airfield - Update	

Source: CEMEX

North



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	Project: Hamble Airfield - Update	

Source: CEMEX

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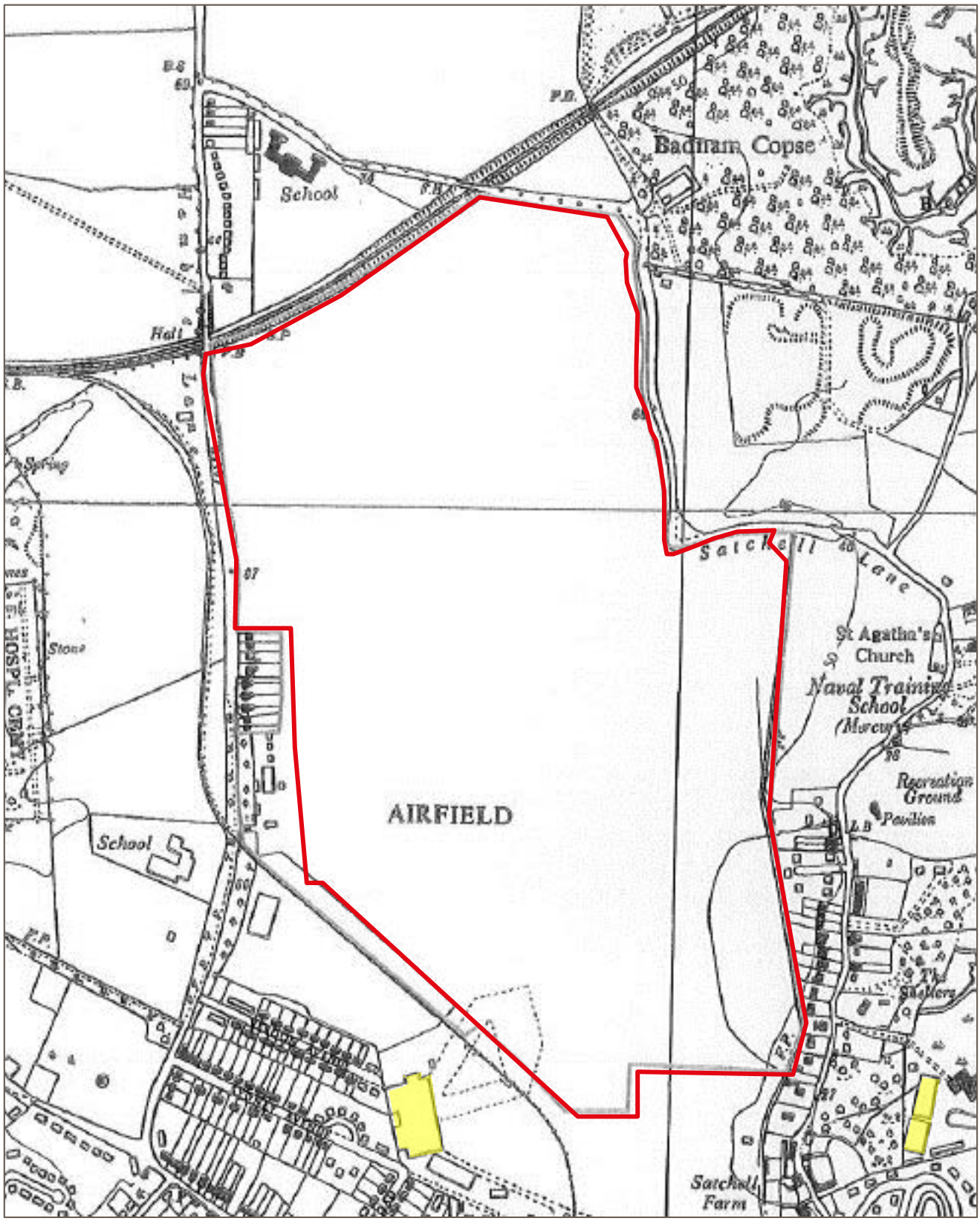


Approximate site boundary

Redevelopment

Report Reference:	Client:	
RA 9091	CEMEX	SAFELANE® GLOBAL
	Project: Hamble Airfield - Update	

Source: CEMEX

North

- Approximate site boundary
- Approximate area of South Airfield
- Armstrong and Whitworth Factory
- Approximate area of North Airfield

Report Reference:	Client:	
RA 9091	CEMEX	SAFELANE® GLOBAL
	Project: Hamble Airfield - Update	

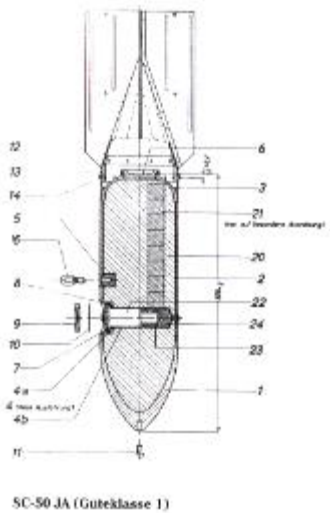
Source: http://tinyurl.com/9v6ne9t & Dynasafe BACTEC Limited

SC 50

Bomb Weight:	40-54kg (110-119lb)
Explosive Weight:	c25kg (55lb)
Fuze Type:	Impact fuze/electro - mechanical time delay fuze
Bomb Dimensions:	1,090 x 280mm (42.9 x 11.0in)
Body Diameter:	200mm (7.87in)
Use:	Against lightly damageable materials, hangars, railway rolling stock, ammunition depots, light bridges and buildings up to three stories.
Remarks: conventional German	The smallest and most common bomb. Nearly 70% of bombs dropped on the UK were 50kg.

50kg bomb, London Docklands

Minus tail section



SC-50 JA (Gutsklasse 1)

SC 250

Bomb weight:	245-256kg (540-564lb)
Explosive weight:	125-130kg (276-287lb)
Fuze type:	Electrical impact/mechanical time delay fuze.
Bomb dimensions:	1640 x 512mm (64.57 x 20.16in)
Body diameter:	368mm (14.5in)
Use:	Against railway installations, embankments, flyovers, underpasses, large buildings and below-ground installations.

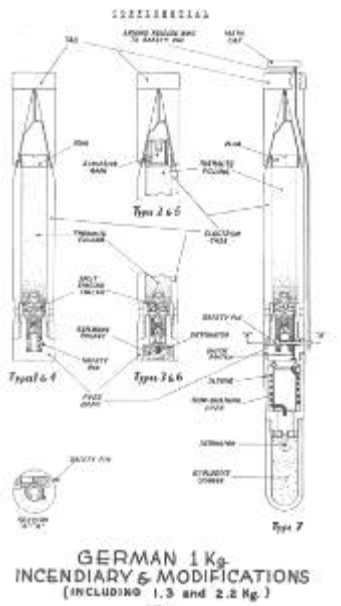
250kg bomb, Hawkinge

SC 250 JA (Gütekl. I)

1kg Incendiary Bomb

Bomb weight:	1.0 and 1.3kg (2.2 and 2.87lb)
Filling:	680gm (1.3lb) Thermite
Fuze type:	Impact fuze
Bomb dimensions:	350 x 50mm (13.8 x 1.97in)
Body diameter:	50mm (1.97in)
Use:	As incendiary – dropped in clusters against towns and industrial complexes
Remarks:	Jettisoned from air-dropped containers. Magnesium alloy case. Sometimes fitted with high explosive charge

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



EveningStandard. 2017

Pictured: Unexploded World War II bomb found in Brondesbury Park

BBC NEWS 2017

Unexploded bomb shuts Aston Expressway

EveningStandard. 2017

Bomb disposal expert reveals dramatic details of how huge WW2 bomb found in Thames was detonated

The Telegraph 2015

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Giant WWII bomb dug up by builders in London

A massive evacuation procedure is carried out in Bermondsey, south London, after the 1,000lb explosive measuring 5ft long was uncovered

Mail Online 2016

Hundreds of people evacuated after a massive WWII bomb was found in the grounds of a Bath school face a weekend away from their homes

Top Left: 500lb UXB found in Brondesbury Park, London – March 2017.
Bottom Left: UXB discovered in the Thames near the Houses of Parliament – February 2017.
Top Right: The discovery of a 500lb UXB in Priory Road, Aston resulted in the closure of nearby Aston Expressway – May 2017
Middle Right: A 400m cordon was established after a 1,000lb UXB was found in Grange Walk, Bermondsey – March 2015
Bottom Right: 500lb UXB discovered in Lansdown, Bath – May 2016

1994

RESCUE workers search for survivors after a Second World War bomb exploded at a building site in Berlin, killing three people and injuring at least eight others.

A fire brigade spokesman said he feared the final death toll could be higher. One worker was still missing, believed to be trapped under a machine. "We've found human remains 100 metres away but we can't tell if they belong to the dead already found," the spokesman said.

The blast, set off by drilling work on Frankfurter Allee, one of east Berlin's busiest avenues, trapped workers under building machinery and sent huge chunks of concrete tumbling through the air.

A large office block was being built on the site of the explosion which sent shoppers scrambling for shelter and paralysed dense afternoon traffic. One eyewitness said: "There was a bang, then silence, and then it started raining stones and dirt."

Dozens of cars within a 250-metre radius were wrecked and the top two floors of a nearby apartment block caved in.

Radio reports claimed that the total number of injured stood at 14.

Blown up by history

2006

World War II bomb kills three in Germany

Three people have been killed and six injured trying to defuse a World War II bomb in central Germany.

Workers building a sports stadium had earlier unearthed the bomb in the town of Goettingen.

It was not immediately clear why the bomb, reportedly weighing 500kg (1,100lb), had detonated.

2010

2006

2014

A World War Two bomb has exploded at a construction site near a west German town, killing a man and injuring eight others, police say.

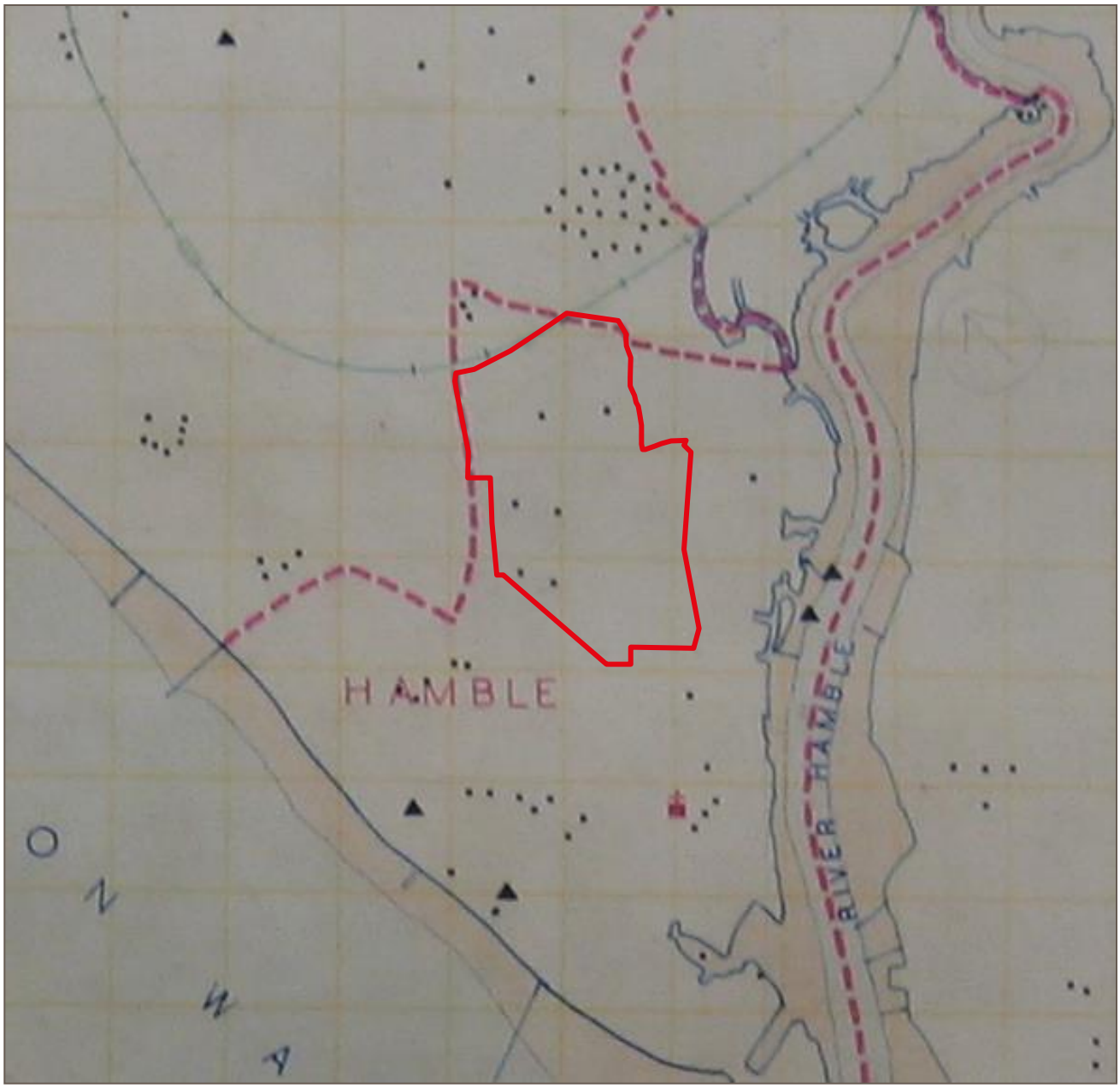
The explosion occurred after a digger accidentally struck the device during excavation work in Euskirchen in the state of North Rhine-Westphalia.

2008

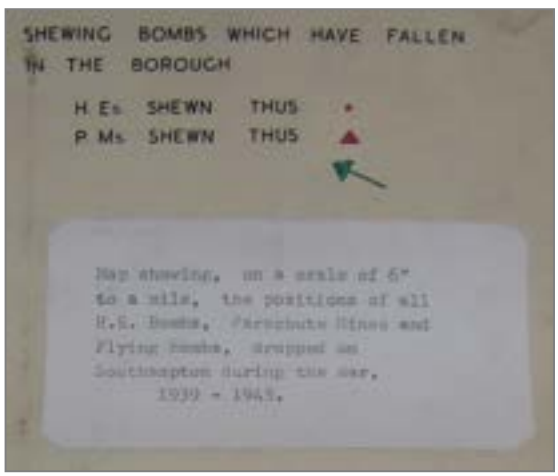
I dead, 2 critical after explosion at Malaysia MRT construction site caused by WWII bomb

2017

Top Left: WWII bomb killed 3 and injured 8 in Berlin – 1994.
Middle Left: WWII bomb killed 3 in Goettingen, Germany – 2010.
Bottom Left: Excavator operator killed by WWII bomb in Euskirchen, Germany – 2014.
Top Right: A highway construction worker in Germany accidentally struck a WWII bomb, killing himself and wrecking several passing cars – 2006.
Middle Right (Top) : Destroyed piling rig and dump truck after detonation of WWII UXB in Austria – 2006.
Middle Right (Bottom): WWII bomb injures 17 at construction site in Hattingen, Germany – 2008.
Bottom Right: A buried WWII-era bomb exploded during construction works in Bandar Malaysia, Kuala Lumpur – 2017.



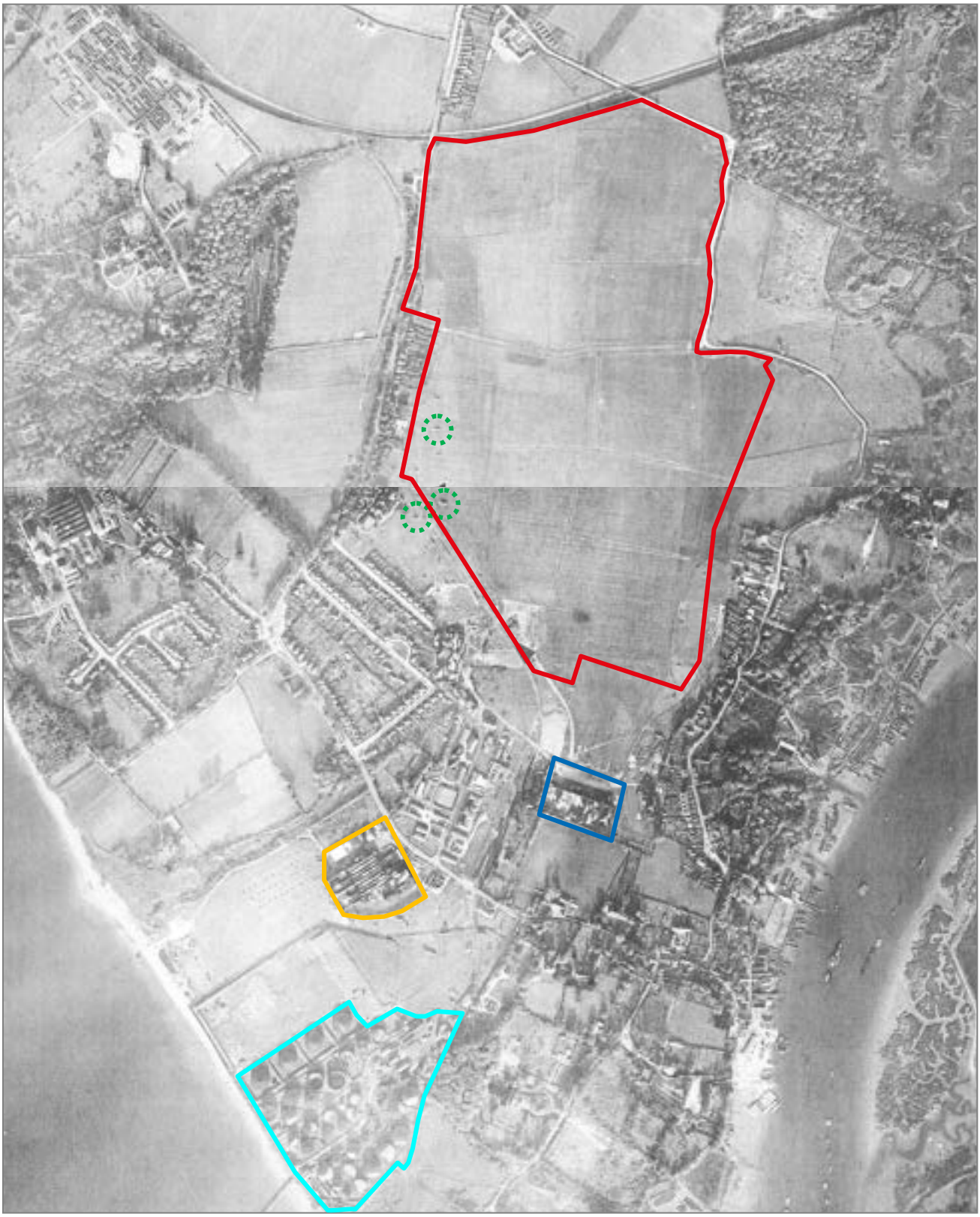
Approximate site boundary



Report Reference:	Client:	
RA 9091	CEMEX	SAFELANE GLOBAL
	Project: Hamble Airfield - Update	

Source: Southampton Archives

North



Approximate site boundary

Aircraft

Aircraft hangar

Aircraft factory

Oil Terminal

Report Reference:	Client:	
RA 9091	CEMEX	SAFELANE® GLOBAL
	Project: Hamble Airfield - Update	

Source: Historic England

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NEWS

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23 July 2010 Last updated at 16:28

Covert British troops 'could have buried' WWII devices

World War II incendiary devices found on a building site in Gloucestershire could have been left by covert British troops, according to researchers.

The bombs were put into vats of water to make them safe

More than 20 phosphorus bombs were unearthed in Birdlip after a digger hit one, causing it to burst into flames.

A former worker at the site said he saw a Home Guard officer burying objects there 65 years ago.

The Coleshill Auxiliary Research Team said auxiliary officers often used Home Guard uniforms as cover.

Thursday, September 10 2015

KM KentOnline

The UK's fastest-growing regional news network

Army bomb disposal team called to Blacksole Bridge in Herne Bay

It was like a scene from Dad's Army when Army bomb disposal experts found wartime explosives made by the Home Guard in makeshift bottles.

A team was called to the Blacksole Bridge in Herne Bay after the wartime bombs were found.

The team from the Royal Logistics Corps set up a 30 metre exclusion zone for pedestrians around the railway embankment after the suspected homemade phosphorous bombs were found.

Mail Online

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Treasure hunter stumbles on deadly Dad's Army bomb cache

By MAIL ONLINE REPORTER
Last updated at 4:06 PM on 9th July 2010

Comments (0) | Add to My Stories

A treasure hunter escaped serious injury when he unearthed a cache of bombs that were buried by the Home Guard during the darkest days of World War 2.

The weapons - primed to go off when they made contact with the air - were secreted on a beach by a Captain Mainwaring of the day.

Loaded with dangerous benzene and phosphorus, the Dad's Army-style team would have used them in battle against Nazi troops in the event of invasion.

Eastbourne Herald

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VIDEO: Explosion after 80 grenades detonated in Eastbourne

16:31 Monday 13 April 2015

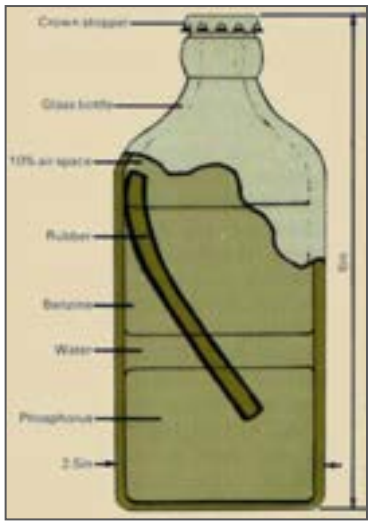
Marked 'AW Bomb 1940' the grenades were thought to have been phosphorus incendiary grenades created as improvised anti-tank weapons when Britain was facing invasion following the army's evacuation from Dunkirk in 1940.

He said, "I remember the grenades being buried. It was part of the Home Guard stash, it was put there in case we were invaded. It had to be in 1943. There were a lot of them [stashes], they were all over the place."

Self Igniting Phosphorous (SIP) Grenades

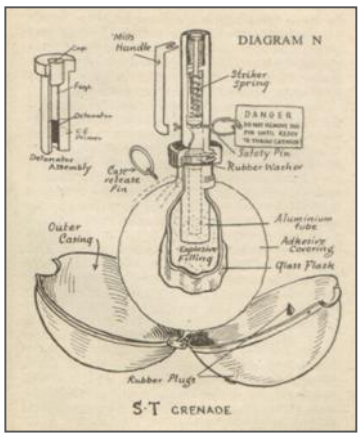
Filling: White Phosphorous and Benzene

Remarks: The grenade comprised a glass bottle with a total volume of approximately one pint. It was filled with White Phosphorus, benzene, a piece of rubber and water. Over time the rubber dissolved to create a sticky fluid which would self ignite when the bottle broke. Fired by hand or Northover Projector. Sometimes called the "A & W" (Albright & Wilson) grenade.



No 74 Grenade (Sticky Bomb)

Remarks: Designed as an anti-tank grenade and used by the Home Guard. The grenade consisted of a glass ball on the end of a Bakelite (plastic) handle. Inside the glass ball was an explosive filling whilst on the outside was a very sticky adhesive covering. Until used, this adhesive covering was encased in a metal outer casing.



Flame Fougasse Bomb

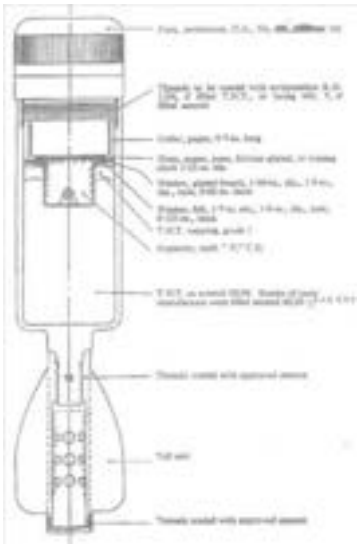
Remarks: A Flame Fougasse was a weapon in which the projectile was a flammable liquid, typically a mixture of petrol and oil. It was usually constructed from a 40- gallon drum dug into the roadside and camouflaged. Ammonal provided the propellant charge which, when triggered, caused the weapon to shoot a flame 3m (10ft) wide and 27m (30 yards) long. Initially a mixture of 40% petrol and 60% gas oil was used, this was later replaced by an adhesive gel of tar, lime and petrol known as 5B.

Report Reference:	Client:	
RA 9091	CEMEX	SAFELANE® GLOBAL
	Project: Hamble Airfield - Update	

Source: SafeLane Global Limited and various historical sources

Typical 2 inch High Explosive Mortar

Bomb Weight:	1.02kg (2.25lb)
Type:	High Explosive
Dimensions:	51 x 290mm (2in x 11.4in)
Filling:	200g RDX/TNT
Maximum Range:	457m (500yds)
Remarks:	Fitted with an impact fuze which detonates the fuze booster charge (exploder) and, in turn, the high explosive charge. The main charge shatters the mortar bomb body, producing near optimum fragmentation and blast effect at the target.

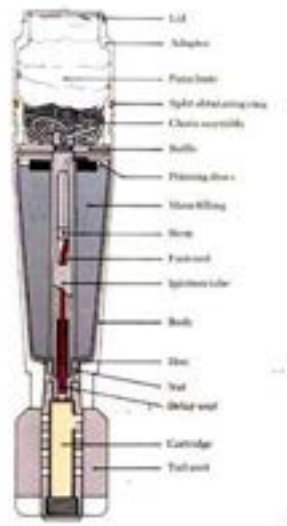


Typical 3 inch Smoke Mortar

Type:	Smoke
Dimensions:	c490 x 76mm (19.3in x 3in)
Filling:	Typically white phosphorous
Maximum Range:	2515m (2,750yds)
Remarks:	On impact, the fuze functions and initiates the bursting charge. The bursting charge ruptures the mortar bomb body and disperses the white phosphorous filler. The white phosphorous produces smoke upon exposure to the air.

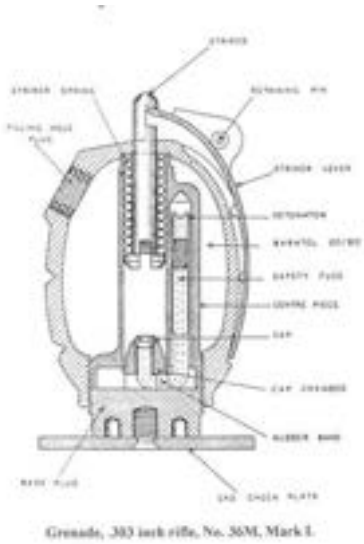
Typical 2 inch Illuminating Mortar

Type:	Illum.
Dimensions:	51 x 290mm
Filling:	Various
Remarks:	The expulsion charge ignites and ejects the candle assembly. A spring ejects the parachute from the tail cone. The parachute opens, slowing the descent of the burning candle which illuminates the target.



No. 36 'Mills' Grenade

Weight:	0.7kg filled (1lb 6oz)
Type:	Hand or discharger, fragmentation
Dimensions:	95 x 61mm (3.7 x 2.4in)
Filling:	Alumatol, Amatol 2 or TNT
Remarks:	4 second hand-throwing fuse with approximate 30m range. First introduced May 1918.



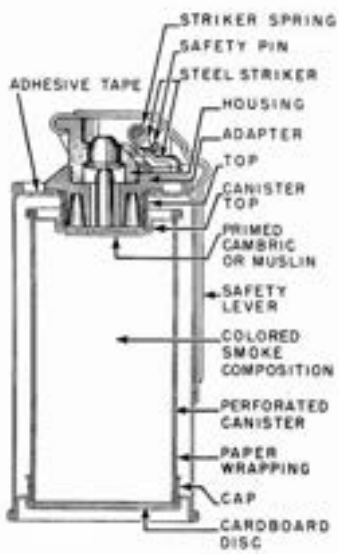
Grenade, .303 inch rifle, No. 36M, Mark I.

No. 69 Grenade

Weight:	0.38kg filled (0.8lb)
Type:	Percussion/Blast
Date Introduced:	December 1940
Remarks:	Black Bakelite body. Blast rather than fragmentation type. After unscrewing the safety cap, a tape is held when throwing the grenade releasing the safety bolt in the throwing motion. Detection is problematic due to its very low metal content.

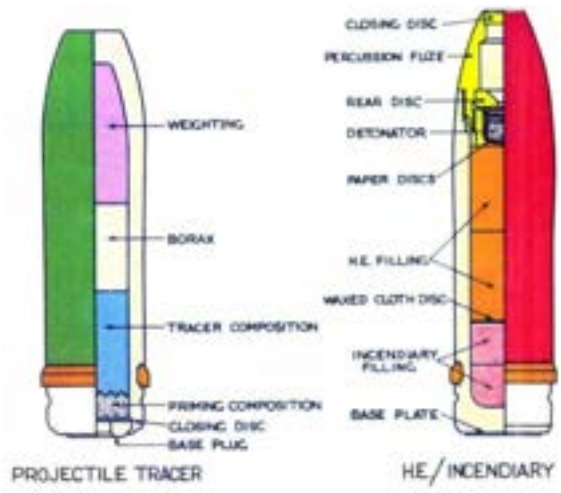
Typical Smoke Grenade

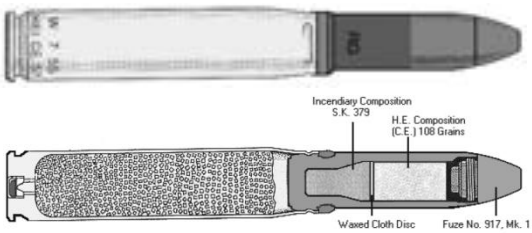
Dimensions:	Approx. 65 x 115mm (2.5 x 4.5in)
Type:	Smoke
Date Introduced:	Current MoD issue
Remarks:	Smoke grenades are used as ground-to-ground or ground-to-air signalling devices, target or landing zone marking devices, and screening devices for unit movement.



20mm Hispano HEI Ammunition

Type:	Live cannon round
Markings:	Upper half of projectile painted 'buff' colour, lower half is red.
Cartridge Weight:	256 grams
Dimensions:	Total cartridge / projectile length - 182mm
Fuzed:	Contact fuze – No.253, No.254 or No.917
Filling:	108 grains of contact explosive + 68 grains of SR.379 incendiary composition.
Threat:	Explosives within unspent cartridge as well as the projectile.
Deployment:	Royal Navy, RAF and British Army Light Anti- Aircraft guns. Also RAF aircraft cannons.
Remarks:	Cartridges are belted or supplied lose in cartons.





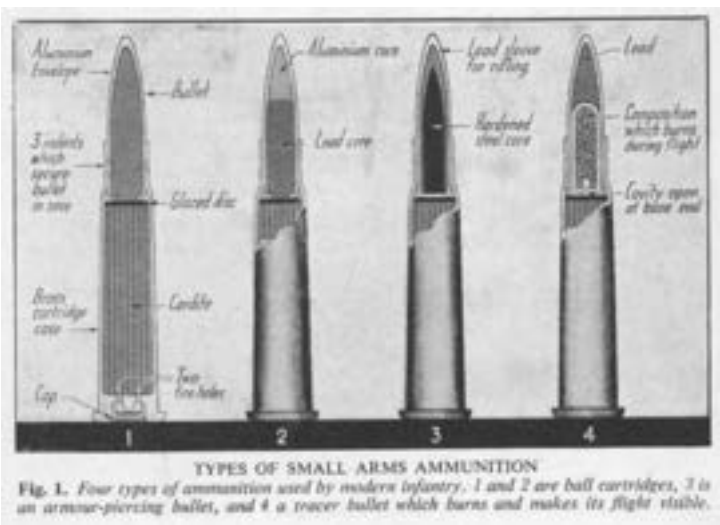
COLOUR IDENTIFICATION

BRITISH

NATURE OF SHELL	H.E.FILLING	COLOUR
H.E. TRACER	T.N.T.	
H.E.	T.N.T.	
PROJ. PRACTICE		
PROJ. TRACER		
H.E. INCENDIARY	T.N.T.	
H.E.INCENDIARY TRACER	T.N.T.	

.303" Ammunition

Type:	Rifle / machine gun round
Markings:	Regular round - none. Tracer round – red Primer
Bullet Weight:	150 - 180 grams
Dimensions:	Total cartridge /projectile length - 78mm
Filling:	Regular round – none. Tracer round - small incendiary fill
Threat:	Explosive cordite within unspent cartridge
Deployment:	Royal Navy, RAF and British Army Light Anti- Aircraft guns, machine guns and rifles. Standard British and Commonwealth military cartridge from 1889 until the 1950s.
Remarks:	Cartridges are belted or supplied lose in cartons.

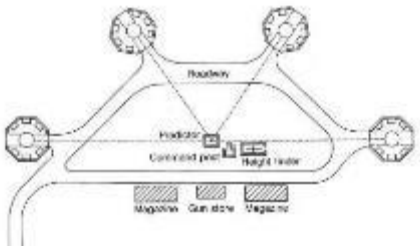


TYPES OF SMALL ARMS AMMUNITION

Fig. 1. *Four types of ammunition used by modern infantry. 1 and 2 are ball cartridges, 3 is an armour-piercing bullet, and 4 a tracer bullet which burns and makes its flight visible.*

3.7 inch Anti-Aircraft Projectile

Weight:	12.7kg (28lb)
Dimensions:	94 x 360mm (3.7 x 14.7in)
Carriage:	Mobile and Static Versions
Rate of Fire:	10-20 rounds per minute
Ceiling:	9-18,000m (29-59,000ft)
Muzzle Velocity:	792m/s (2,598ft/s)
Remarks:	4.5 inch projectiles were also commonly utilised



Layout plan for a typical HAA battery site.

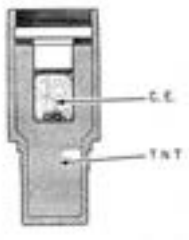
Slade Green's HAA battery, Dartford showing typical size and layout of the installation.

Hyde Park 1939 3.7 Inch QF gun on mobile mounting

3.7 inch AA Projectile Minus Fuze

Rockets / Unrotated Projectiles

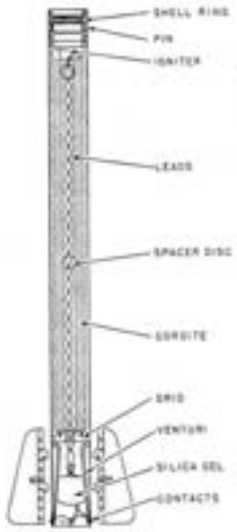
Weight:	Overall: 24.5kg (54lb) Warhead: 1.94kg (4.28lb)
Dimensions:	1930mm x 82.6mm (76 x 3.25in)
Carriage:	Mobile – transported on trailers
Ceiling:	6770m (22,200ft)
Maximum Velocity:	457mps (1,500 fps)



MK II HE Shell (3.5kg)

Rocket Battery in action

Home Guard soldiers load an anti-aircraft rocket at a 'Z' Battery



2" U.P AA Rocket

40mm Bofors Gun Projectile

Weight:	0.86kg (1.96lb)
Dimensions:	40mm x 310mm (1.6in x 12.2in)
Rate of Fire:	120 rounds per minute
Ceiling:	23,000ft (7000m)
Muzzle Velocity:	2,890 ft/s (881m/s)
Remarks:	Mobile batteries – normally few records of where these guns were located

Unexploded 40mm Bofors projectile

40mm Bofors gun and crew at Stanmore in Middlesex, 28 June 1940.