



Great North Road Solar and Biodiversity Park

Environmental Statement Report

Volume 4 – Technical Appendices

Technical Appendix A10.10 – Detailed Desk Study (Stage 2) for
potential UXO Contamination

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A10.10.1 INTRODUCTION

A10.10.1.1. SCOPE OF WORK

- 1 Tt RPS Explosives Engineering Services (Tt RPS EES), part of RPS Energy Ltd, has been commissioned by Elements Green Ltd to conduct a Stage 2, Detailed Desktop Study for potential Unexploded Ordnance (UXO) contamination for the GNR Solar and Biodiversity Park site (GNR; “the Development”), in line with CIRIA C681¹ Guidelines.
- 2 The assessment has been undertaken on an area of land larger than the current Order Limits, and is based on the previous Order Limits for the Preliminary Environmental Information Report (PEIR). The boundary to which this assessment has been made is shown in Figure 10.10.1: UXO Study Area, and comprises the former large Study Areas 1 to 8 that were defined at PEIR stage. Therefore this assessment is inclusive of the current Order Limits.

Table A10.10.1: Appraisal of UXO sources for the Study Area

Risk Source	Within Study Area Yes / No	Within 1km Yes / No	Within 5km Yes / No	Qualitative Probability of UXO encounter Negligible / Low / Moderate / High
Defensive Positions	No	Yes	Yes	Negligible
Anti-Aircraft Artillery	No	Yes	No	Negligible
Military Airfields	Yes	No	No	Low
Military Presence/Training	No	No	No	Negligible
Munitions Production Facilities	No	No	No	Negligible
Historic Bombing	No	Yes	Yes	Low
Decoy Sites	No	Yes	No	Negligible
Crashed Aircraft	No	Yes	Yes	Negligible

¹ CIRIA (2009). Unexploded Ordnance C681: A Guide for the Construction Industry. Available at: https://www.ciria.org/CIRIA/CIRIA/Item_Detail.aspx?iProductcode=C681 (accessed on 21.05.2025).
June 2025

Risk Source	Within Study Area Yes / No	Within 1km Yes / No	Within 5km Yes / No	Qualitative Probability of UXO encounter Negligible / Low / Moderate / High
UXO Taskings / Previous UXO Work	No	No	No	Negligible
Abandoned Bombs	No	No	No	Negligible
Media Reports of UXO	No	No	No	Negligible
Other (specify e.g., Chemical Munitions)	N/A	N/A	N/A	N/A

- 3 Based on a preliminary assessment of sources, the Study Area is considered to offer a potential explosives risk from:
- **Enemy Bombing:** Research has not identified any bombing on the Study Area. Bombing has been identified in four locations in proximity to the Study Area at Ossington, Caunton, Bathley and Averham. The bombing of these locations is not considered to have a significant impact on the Study Area.
 - **Allied Air Service Munitions:** Part of the northern section of the Study Area is located within the former RAF Ossington Airfield. The location of the Study Area is not in proximity to any areas where there is an identified UXO risk, but the existence of unexploded Allied Air Service Munitions cannot be completely discounted.

A10.10.1.2. DEFINITIONS

- 4 The term 'Study Area' refers to the area that encompasses the former larger Study Areas 1 to 8 that were defined for the previous Order Limits for the Preliminary Environmental Information Report, as supplied by the Applicant at that time, and therefore the assessment is based on a larger area than, and includes, the current Order Limits. This report will focus on the activities that occurred within the bounds of the Study Area and its immediate environment, which has been stated where relevant. The extents of the Study Area covered by this assessment is presented in Figure A10.10.1: UXO Study Area. Selected terminology referred to throughout this report is presented in Annex B.

A10.10.1.3. REPORTING CONDITIONS AND ARCHIVE LIMITATIONS

- 5 It must be emphasised that this detailed Desktop Study can only indicate the potential for UXO-related items to be present onsite. Dependent on the information identified throughout the desk-based process which does not include site visits, or any non-intrusive survey or intrusive site investigation

works at this stage, further UXO mitigation may be advised / recommended prior to and in support of any future redevelopment and / or works onsite. Any such recommendations are stipulated later in this document.

- 6 It should be recognised that any recommendations made may require alteration, or further mitigation may be advised, if information outside of that already documented within the Desk Study subsequently comes to light.
- 7 Records of air raids, bomb damage, casualties, and the locations of Unexploded Bombs (UXB) were rarely released into public domain in the interest of national security and morale; this is particularly pertinent with military establishments. Furthermore, details pertinent to these records are often difficult to locate. The records compiled were only as detailed and accurate as the availability of time, personnel, and the ease of access to information would allow. Densely populated areas, such as those associated with major cities, tended to have a greater number of records than those produced for the more provincial, or rural areas. Official records were often supplemented by press reports and local information. This source of information was sometimes discredited as being inadvertently inaccurate, or purposely made inaccurate, to confuse enemy intelligence. Even the accuracy of classified official records is somewhat dubious. This stance has been established based on the quantities of unrecorded German UXO and part-exploded ordnance discovered since 1945.
- 8 This study consists of a desk-based collation and review of accessible official records, relating to the possibility of UXO being present within the Study Area. Certain information acquired for the purpose of this study may be either classified or restricted material; therefore, summaries of such information have been provided.

A10.10.1.4. OBJECTIVES

- 9 The primary objective of this document is to ensure the safety of site personnel and members of the public within the vicinity of the Study Area with regards to possible impacts from potential UXO contamination, and to identify the potential risk of unearthing either buried UXO or explosive devices. Research into the history of the Study Area and its immediate environment has been undertaken to establish the following:
 - Frequency and intensity of bombing;
 - Bomb impacts and associated damage;
 - Review of military activities in the area;
 - Records of Explosive Ordnance Clearance (EOC) tasks or bomb disposal activities throughout and post-WWII;
 - The potential for UXO-related devices to remain on the Study Area; and
 - Site-specific assessment of the penetration depths of UXO to determine the risk horizon on the Study Area.
- 10 The main sources of information consulted are presented at Annex B.

A10.10.1.5. LEGISLATION

- 11 Whilst undertaking this desk study, the requirements of a number of pieces of legislation have been considered, as presented at Annex B.

A10.10.2 SITE DETAILS AND DESCRIPTION

A10.10.2.1. SITE LOCATION AND DESCRIPTION

- 12 The Development would be located to the north-west of Newark, in the Newark and Sherwood district, Nottinghamshire, East Midlands. The Development would be within an area bound by the Order Limits. The Order Limits are to the west of the A1, north of the A617, east of Eakring, and south of Egmanton, to the north and north-west of Staythorpe. The Development essentially consists of discrete land parcels proposed to be occupied by solar PV panels, BESS and associated infrastructure, and connected by cable route areas. The eastern side of the Development runs from the north of Norwell to Egmanton in the north (with additional parcels of land for mitigation/enhancement around North Muskham). The western side of the Development runs north-west from Staythorpe Power Station and then splits at Maplebeck, with spurs running to Eakring in the north-west and Kneesall to the north-north-east, then connecting with the eastern side of the Development.

A10.10.2.1. PROPOSED SCHEME OF WORK

- 13 This Detailed (Stage 2) UXO Study (UXO DTS) is being written to support ground disturbing activity in connection with the construction of solar and Biodiversity Park infrastructure.
- 14 All activities such as site investigation works, excavation, trenching, possible piling works, and installation of access and underground services have the potential to disturb buried UXO, should it be present within the Study Area.

A10.10.2.2. HISTORICAL SITE CONDITIONS

- 15 Historical map suites within the Study Area were examined, together with aerial photographs that were available within the public domain such as: Google Earth, Heritage England, the National Library of Scotland, and National Collection of Aerial Photography (NCAP) websites. The process was undertaken to develop a greater knowledge of the historical alterations experienced within the Study Area.
- 16 A selection of Historic mapping reviewed are presented in Annex C.

Table A10.10.2: Details of open-source historical map suites and aerial photographs

Date	Map/Photograph	Description of the Study Area
1920	Map	Quarter inch to the mile Midlands (N) sheet. The Study Area is located in largely undeveloped open land, crossing roads in some locations.
2024	Map	OS 1:25000 mapping. No significant development is detailed. The Study Area remains little changed from earlier mapping.

Date	Map/Photograph	Description of the Study Area
1946-1948	Air photography	Only partial coverage of the Study Area is available. The area of coverage evidences the Study Area as being open undeveloped land crossing roads in some locations.
1942-1946	Map/Satellite imagery	Showing the location of the wartime RAF Ossington airfield in context to the Study Area.
2024	Open-source LIDAR	Showing the location of the former RAF Ossington airfield. What is believed to be the airfield technical site is evident. Buildings and an area of revetment to the south of the Study Area may be associated with munitions or possibly fuel storage.

A10.10.2.2.1. Post-World War II (1939-1945) Alterations

- 17 No major development is evident.

A10.10.2.3. WWII ANTI-AIRCRAFT ARTILLERY (AAA) POSITIONS

- 18 No heavy anti-aircraft positions have been identified within 5 km of the Study Area. A WWII RAF airfield was located at Ossington in the northern section of the Study Area. This would likely have been defended by light anti-aircraft defences. The airfield is recorded as having been attacked on 1/2 September 1941. Given the lack of anti-aircraft defences in context with the Study Area and low level of recorded air attacks during WWII, Tt RPS has assessed the potential for encountering UXO from this source, at the Study Area, as Negligible.

A10.10.2.4. MILITARY / ROYAL AIR FORCE (RAF) AIRFIELDS

- 19 Approximately 2.6 km of the northern section of the Study Area is located within the site of the former RAF Ossington airfield. This airfield was constructed in 1941 as a base for bomber aircraft. In January 1942 it became a base for flying training with an operational training unit with bomber defence training flights based at the airfield. With demand for aircrew decreasing in the latter stages of the war and the subsequent reduction in training requirements, the airfield became a base for transport aircraft. The airfield closed in August 1946. By 1979 all the runways had been broken up for hardcore. The Study Area follows the path of runways and crosses the wider airfield area. Examination of LIDAR imagery shows what is believed to be part of the airfield technical site to the south of the Study Area. The site of buildings and what are believed to be revetments that may be associated with munitions storage or possibly fuel storage is evident. Taking into account the significant post war works at the airfield and

the recorded use largely for operational training/flying training/air transport and not in proximity to any identified areas of raised UXO risk the potential to encounter a UXO-related device associated with this source, at the Study Area, is Low.

A10.10.2.5. DECOY SITES

- 20 At the outbreak of WWII, a sophisticated system of decoy sites was deployed across Great Britain with the intention of diverting aerial attacks from major cities, military sites, and essential infrastructure. In the event of an imminent air-raid, beacons were ignited at the decoy sites. These were occasionally successful in misleading the Luftwaffe bombers into thinking it was their intended target, with ordnance jettisoned upon open, unoccupied landscapes.
- 21 One bombing decoy site has been identified at Upton approximately 116 m to west of the Study Area. Research has not identified any WWII bombing in context to this site. Tt RPS have determined that the potential to encounter a UXO-related device associated with this source at the Study Area is Negligible.

A10.10.2.6. AIR CRASHES

- 22 Military aircraft (dependant on type) carry live ordnance or practice bombs. There is therefore a potential to encounter UXO related to locations where crashes occurred. A number of air crashes are recorded at RAF Ossington but most of the incidents that took place were relatively minor (undercarriage collapses, collisions on the airfield etc and are unlikely to have had a potential UXO impact within the Study Area. Tt RPS therefore understand that the potential to encounter a UXO-related device associated with this source is Negligible.

A10.10.3 GERMAN AERIAL BOMBING

- 23 Successive sections present the relevant information that has been identified regarding German Aerial Bombardment of the UK (throughout historic periods of warfare). Additional information pertinent to these periods and the sources of information consulted are presented in the relevant annexes. Basic overviews of the German WWI and WWII bombing campaigns against the UK are presented at Annex B.

A10.10.3.1. WWI GERMAN BOMBING

- 24 In the latter phases of WWI (1914-1918), the Luftstreitkräfte utilised Zeppelin aircraft, and later Gotha G.V. and Zeppelin-Staaken R.VI bombers, to drop payloads of High Explosive (H.E.) and Incendiary Bombs (I.B.) in aerial assaults upon the UK. Most air-raid activities were experienced within the counties located on the South and East Coasts and within London; although, several isolated incidents have been registered in other counties. There is no evidence to show that the Study Area or areas in proximity to the Study Area were bombed during WWI; therefore, Tt RPS has determined that the potential to encounter a UXO-related device associated with this source, at the Study Area, is Negligible.

A10.10.3.2. WWII GERMAN BOMBING

A10.10.3.2.1. German Bombing Targets

- 25 . Research has not identified any bombing on the Study Area. Bombing has been identified in four locations in proximity to the Study Area at Ossington, Caunton, Bathley and Averham. The bombing of these locations is not considered to have had a significant impact on the Study Area. Tt RPS has determined that the potential to encounter a UXO-related device associated with this source, at the Study Area, is Low.
- 26 Classified records, Local Government reports, Air Raid Precaution (ARP) reports, and Tt RPS EES archival documents pertinent to local air-raids have been examined. It should be recognised that air-raid records in no way constitute an exhaustive account of the potential air-raids that could have occurred throughout WWII.
- 27 During WWII the Study Area was located within District of Southwell.

Table A10.10.3: Study Area bombing statistics from the Home Office

Administrative Area	Land Area		Numbers of items of Ordnance Recorded								Ordnance Density	
	Acres	Hectares	High Explosive Bombs	Parachute Mines	Oil Bombs	Phosphorus Bombs	Fire Pots	V1	V2	Total	Per 1,000 Acres	Per 100 ha
Southwell	118,586	48,027	119	2	2	0	0	0	0	123	1.0	0.3

A10.10.4 UXO CONTAMINATION RISK ASSESSMENT

A10.10.4.1. GENERAL

- 28 Risk assessment is a formalised process to assess the level of risk associated with a particular situation or action. It involves the identification of the hazards present and the potential receptor that could be affected by this hazard. The degree of risk is associated with the potential for a pathway to be present that links the hazard to the receptor. This relationship is usually summarised as the Source – Pathway – Receptor.

A10.10.4.2. SOURCE PROBABILITY ASSESSMENT

- 29 Each of the types of potential UXO that have been identified through the research have been assessed and given a probability of encounter Grade based on the following Level and Rationale.

Table A10.10.4: Probability Levels

Source Probability Assessment Levels		
Grade	Probability Level	Rationale
5	Highly Probable	Clear evidence that this type of munition would be encountered.
4	Probable	Significant evidence to indicate that this type of munition would be encountered.
3	Remote	Evidence suggest that these munitions have been found in the Wider Area of Interest area but not specifically within the Study Area.
2	Improbable	Not considered likely to encounter this type of munition within the Study Area, but not possible to discount completely.
1	Highly Improbable	No evidence that this type of munition would be encountered within the Study Area or the immediate vicinity.

A10.10.4.2.1. Risk zoning

- ³⁰ The probability assessment results will vary across the Study Area due to the geographical extent of the potential UXO sources identified in the research presented above. This results in a different risk profile across the Study Area based upon these affected areas. Tt RPS divide the Study Area into Risk Zones based upon the probability assessment results (in addition to planned activities) in order to ensure that a pragmatic approach is taken to the risk of presence of each ordnance type across the Study Area. The results of the probability assessment are shown in the table below.

A10.10.4.2.2. Probability Assessment Results

- ³¹ The research from the above sections has been used to determine the Probability of Encounter for each ordnance variety. The results are shown in the table below:

Table A10.10.5: Assessed probability levels for the Study Area

Probability Assessment Levels			
UXO		Probability	Area of encounter
Small Arms Ammunition		2	Improbable
Land Service Ammunition		2	Improbable
HE Bombs	Allied Origin	2	Improbable
	Axis Origin	2	Improbable
	Allied Origin	2	Improbable

Air Dropped Bomblets	Axis Origin	2	Improbable	Whole Study Area
Anti-Aircraft Projectiles		1	Highly Improbable	Whole Study Area
Dumped Conventional Munitions		1	Highly Improbable	Whole Study Area
Chemical Munitions		1	Highly Improbable	Whole Study Area
Missiles / Rockets		1	Highly Improbable	Whole Study Area

A10.10.4.3. SITE SPECIFIC ORDNANCE PENETRATION ASSESSMENT

- 32 Having established that there is a potential to encounter UXO onsite, it is necessary to determine, where possible, the risk horizon i.e., the depths below ground at which the identified UXO might be encountered.

A10.10.4.3.1. Geology

- 33 One of the principal factors in the assessment of the maximum ordnance penetration depth is to establish the geological stratigraphy of the Study Area. Ground conditions present will have a significant influence on the path of ordnance; therefore, the consistency and thickness of pre-WWII made ground should be considered as this would have the potential to restrict the penetration depth. The ordnance penetration calculation will be stipulated later in the document.
- 34 Tt RPS has reviewed open-source British Geological Survey (BGS) Geology viewer to understand the geological data.
- 35 The superficial deposits within the Study Area are unrecorded, but the substrate consists of Mercia mudstone. Very few borehole records are available for the Study Area, however, two records relate to boreholes, one located on the Study Area near Knapthorpe (Reference: SK75NW10, Date: 1945, Easting: 473239 Northing: 358005) and one located to the south of the Study Area near South Carlton (Reference: SK75/41B, Easting: 477510 Northing: 356350).
- 36 A summary of one of these boreholes is contained in the table below:

Table A10.10.6: Summary of Boreholes

Description	Depth below ground
Knapthorpe - SK75NW10	
Keuper	419 feet
Bunter	880 feet
Lower Mottled SST	930 feet
Middle Permian Marls	1135 feet
Magnesian LST	1232 feet
Coal Measures	2403 feet

Description	Depth below ground
Millstone Grit	2500 feet
South Carlton SK75/41B	
River Gravel	4.5 m
Keuper Mudstone – Mudstone - red and grey	9.0 m

A10.10.4.3.2. Risk Horizon

- 37 The risk horizon at a site will depend on the expected categories of ordnance to be encountered and the manner in which they may have been deposited at the site. Tt RPS typically assesses the bomb penetration for a site based on the typical penetration depths for a 500kg type German Sprengbombe Cylindrisch (SC) bomb (allied equivalent 1,102lb bomb). It should be acknowledged that the bomb penetration at the site would have been significantly deeper for bombs larger than this; however, comparatively, only a limited number of devices in excess of 500 kg were utilised throughout WWII Luftwaffe bombing campaigns.
- 38 When assessing the potential for ordnance ground penetration, it is essential not to rely solely on either an empirical, statistical, or arithmetical formula. Experience has shown that a realistic depth is determined through the consideration of a variety of factors such as the nature and level of development onsite, presence of services, alterations in ground conditions, supplemented, where available, by accounts of Bomb Disposal Tasks. Figure A10.10.2: Relative penetration depth of selected ordnance provides a basic simplified overview of the 'zones' within the ground where alternate classifications of ordnance may typically be encountered at onshore sites within the UK.
- 39 Tt RPS has reviewed open-source geotechnical information with regards to depths of strata in close proximity to the Study Area and determined that the probable maximum site-specific penetration for a 500kg HE bomb is theoretically 13.1m below ground level.
- 40 Any penetration depths detailed relate to the depths below ground level at the time of WWII. If levels have experienced significant variation post-WWII, this could influence the possible depths at which UXO-related items could be present, relative to current ground levels in the Study Area.

Table A10.10.7: Site specific Risk Horizon for UXO

Source of Contamination	Risk Horizon Below Ground Level
General Purpose / HE bombs	Up to 13.1 m
Incendiary Bomb	Up to 1 m
British Anti-Aircraft Artillery	Up to 3 m

- 41 Background information on Bomb Penetration Depths can be observed at Annex B.

A10.10.4.4. PATHWAY

- 42 The pathway is described as the route as to which the hazard reaches the site personnel. Given the nature of the Study Area and the Development, the only pathways would be through:
- Enabling Works, including creation of compounds;
 - Intrusive Site Works (site investigations, trenching etc.); and
 - Excavations.

A10.10.4.5. RECEPTORS

- 43 Sensitive receptors applicable to the Study Area would be:
- People (Site Personnel, Construction Works, and General Public);
 - Plant and Equipment;
 - Structures (Including existing buildings and nearby properties); and
 - Environment.

A10.10.4.6. RISK ASSESSMENT

A10.10.4.6.1. Risk Assessment Matrix

- 44 Once the factors detailed above have been assessed for the Study Area, the consequence level is obtained from the table presented in the figure below, which provides a consequence rating from 1 to 5, depending upon the severity. The probability is also deduced and given a rating between 'Improbable' and 'Almost Certain'.
- 45 These two ratings are then combined to determine the final risk levels to the proposed site works from the various threat items, using the risk matrix in Annex B, taking into consideration the potential UXO threat items as detailed earlier. A risk assessment for the Study Area, prior to the implementation of any risk mitigation measure is presented within Figure A10.10.3: Risk Assessment Prior to Mitigation Measures. This figure shows the matrix for Intrusive activities prior to mitigation measures (German Bombing & Allied Air Service Munitions).

A10.10.4.7. RISK ASSESSMENT ANALYSIS

Bombing

- 46 The cable route extends to approximately 40.3km. Research has not identified any bombing on the Study Area. Bombing has been identified in four locations in proximity to the Study Area at Ossington, Caunton, Bathley and Averham. The bombing of these locations is not considered to have had a significant impact on the Study Area.

Allied Air Service Munitions

- 47 Certain types of land service munitions are used by all x3 services, as such they are reported collectively with air service munitions here. Part of the northern section of the Study Area is located within the former RAF Ossington Airfield. The location of the Study Area is not in proximity to any areas where there is an identified UXO risk, but the existence of unexploded Allied Air Service Munitions cannot be completely discounted.

A10.10.4.7.1. Final Risk Levels

- 48 Tt RPS was commissioned to produce an Unexploded Ordnance (UXO) Detailed Desktop Study for the Study Area. This study was conducted in accordance with CIRIA, Unexploded ordnance (UXO) A guide for the construction industry (C681) and CIRIA, Unexploded Ordnance (UXO) risk management guide for land-based projects (C785).
- 49 During its compilation, the study collated information of various explosives-based contamination sources known to affect sites within the United Kingdom. This information was integrated to establish the level of risk it posed to the reporting area. Finally, a site-specific risk mitigation solution was developed to ensure that the final risk level was deemed As Low as Reasonably Practicable (ALARP).

A10.10.5 SUMMARY OF FINAL RISK LEVEL

- 50 The GNR Solar and Biodiversity Park Area of Interest has been researched and reviewed in line with the CIRIA C681 'Best Practice Guidelines', enhanced by Tt RPS EES standard operating procedures. The findings of this research have been used to complete this UXO Detailed Risk Assessment (Stage 2) which is summarised in the following table:

Table A10.10.8: Final Risk Levels

Activity	Risk	Location
Intrusive activities including Ground Investigations, trenching, landscaping.	Low UXO risk	Whole Study Area
Intrusive activities including Ground Investigations, trenching, landscaping.	Low UXO risk	In the locality of the former RAF Ossington airfield only.
Non-intrusive processes, including public access.	Low UXO risk	Whole Study Area

- 51 Mitigation to reduce the final risk level to As Low as Reasonably Practicable (ALARP) is contained in the following section.

A10.10.6 RECOMMENDATIONS

A10.10.6.1. THE 'ALARP' PRINCIPLE

- 52 Based on the aforementioned risk assessment, Tt RPS has found there to be a **Low** UXO risk from German air dropped weapons generally across the Study Area and a **Low** risk from Allied air service munitions in the locality of the former RAF Ossington airfield.
- 53 On sites where a UXO-related risk has been identified, an aim must be to reduce the UXO risk to As Low as Reasonably Practicable (ALARP), considering safety and cost vs. benefit. Further detail and diagrammatic representations of the ALARP principles are presented at Annex B.

A10.10.6.2. SITE SPECIFIC MEASURES AND PHASING

- 54 Based on the assessed risk, the following measures are recommended to be implemented in support of works taking place across the Study Area.
- 55 Full descriptions of each of the recommendations are presented in Table A10.10.9.

Table A10.10.9: Risk Measures to be Considered by the Contractor

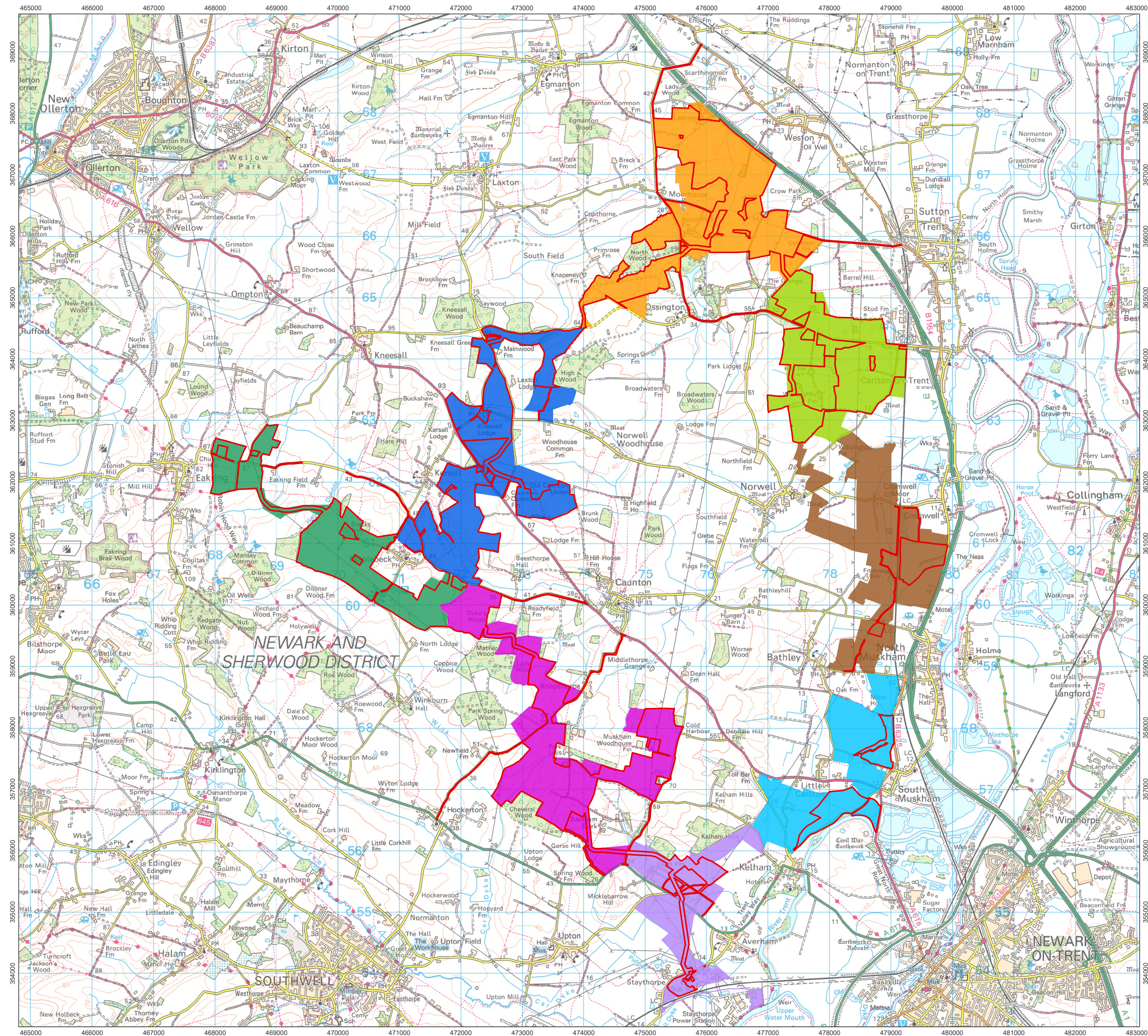
Phase	Mitigation	Responsibility
Pre-construction	The Principal Contractor should include UXO in their Risk Assessments and have Emergency Response Plans in place. Clear lines of communication and responsibilities are required to determine if and when UXO site presence is required.	Principal Contractor UXO Contractor
Construction	ESSG / UXO Toolbox Talks, and immediate response actions should be given as part of site induction. These sessions may need repeating for projects of long duration due to staff turnover.	Principal Contractor UXO Contractor
Post-construction	Although considered a rare occurrence, the Study Area may contain a residual risk of UXO, even in the event of non-discovery e.g., construction work may take place above the maximum Risk Zone or areas of suspected UXO contamination may have been avoided. This may carry commercial risk beyond the lifetime of the Development.	Principal Contractor








A10.10.6.3. SITE SPECIFIC MEASURES

A10.10.6.3.1. Explosives Safety & Awareness Briefings / Site Safety Guidelines

- 56 It is recommended that all personnel conducting intrusive works, in any part of the Study Area, should attend an **Explosives Safety & Awareness Briefing**. This should comprise part of the standard site induction briefing and would form a component of the Health and Safety Plan for the Study Area, adhering to the requirements of CDM regulations 2015. All personnel working onsite would be briefed on UXO recognition and made aware of the possible risks. They would be informed of the actions to take to alert the site manager and to keep people and equipment away from the hazard.
- 57 TA set of **Explosives Site Safety Guidelines** would be provided alongside the Explosives Safety and Awareness Briefing, and are designed to aid the Project Team to plan the proposed works and potentially deal with the event of a suspicious item / UXO discovery incident. The guidelines would also enable the Applicant to incorporate the Explosives Safety & Awareness Briefings into their standard site inductions.
- 58 The guidelines would address the risk to all the specific proposed works and would inform all personnel how to undertake the works safely and would refer to the specific risk items / hazards that have been identified for the Study Area.
- 59 It should be noted that if a significant / elevated risk is subsequently identified then a fully qualified Explosives Engineer should manage the situation on behalf of the Applicant.

ANNEX A – FIGURES



-  Order Limits
-  Study Area 1
-  Study Area 2
-  Study Area 3
-  Study Area 4
-  Study Area 5
-  Study Area 6
-  Study Area 7
-  Study Area 8

1:60,000 Scale @ A3

0 0.5 1 2 km

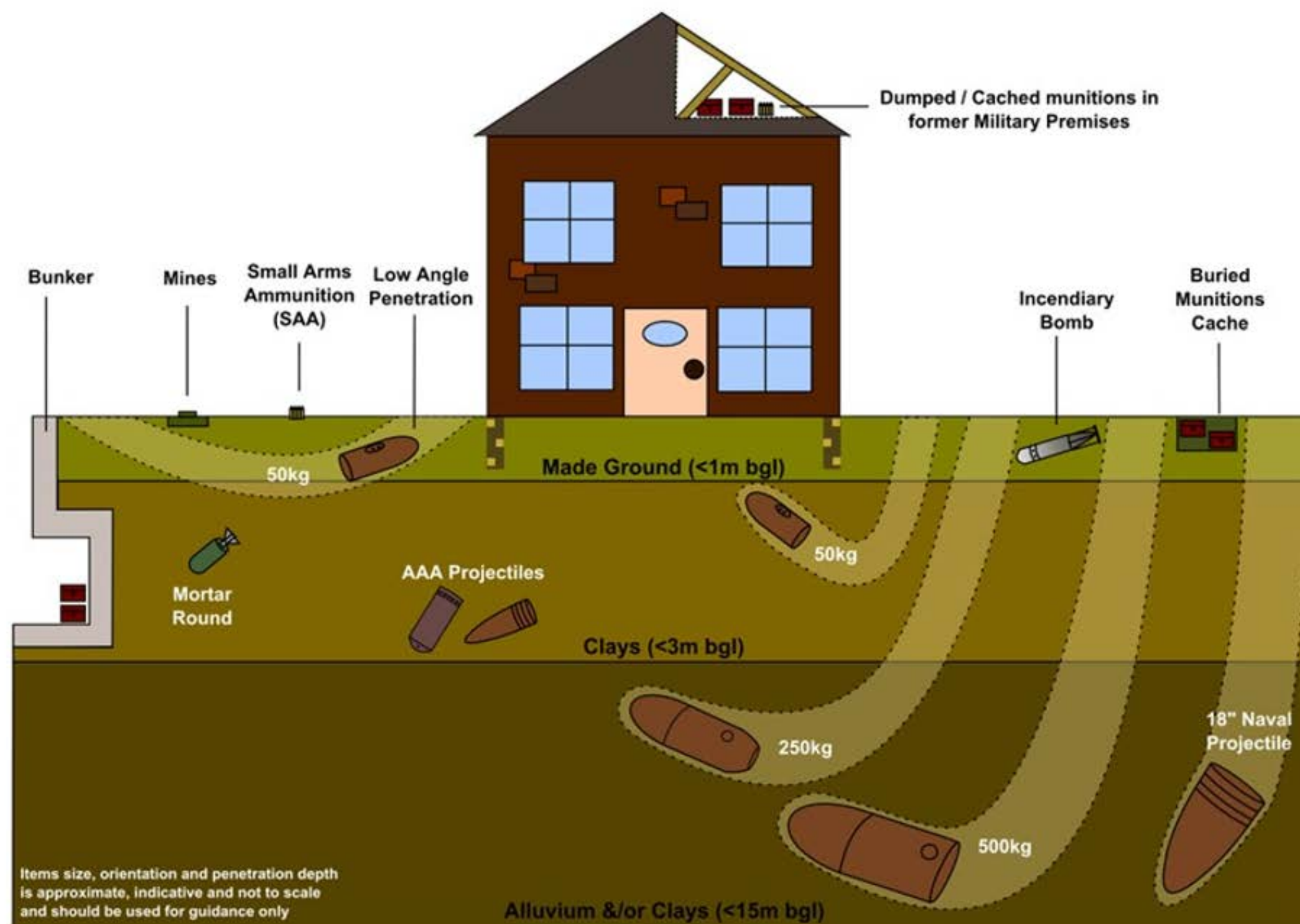


Ref: NP12850

Date: 12/06/2025

**UXO Study Area
Figure A10.10.1**

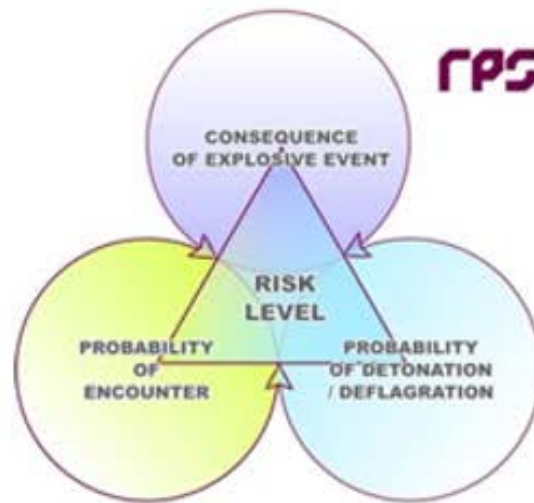
**Great North Solar and
Biodiversity Park
Environmental Statement**



Date: 21/05/2025

Relative Penetration Depth of
Selected Ordnance
Figure A10.10.2

Great North Road Solar and
Biodiversity Park
Environmental Statement



Stage 2—Potential Consequence of Explosive Event

Consequence Level	Potential Consequences of Detonation/Deflagration				
	People	Environment	Assets	Reputation	
			Plant and Equipment	Structures	
1	No Injury / First aid injury	Minor disturbance.	No noticeable effect	No noticeable effect	No significant impact
2	Lost time injury < 3 days	Significant disturbance.	Slight superficial damage	Slight superficial damage	Slight impact
3	Serious debilitating injury	Moderate damage to habitats.	Minor component replacement repair	Repairs - non-structural	Moderate impact
4	Localised fatalities	Moderate damage of habitats. Some long term effects.	Significant component replacement repair	Repairs - structural	Major impact
5	Multiple fatalities over extended area	Localised destruction of habitats. Moderate long-term effects.	Unit loss, un-repairable damage	Localised structural failure and collapse	Massive impact

Stage 1—Probability of Explosive Event

		Probability of Detonation/Deflagration				
		1 Highly Improbable	2 Improbable	3 Remote	4 Probable	5 Highly Probable
Probability of Encounter *	1 Highly Improbable	1	2	3	4	5
	2 Improbable	2	4	6	8	10
	3 Remote	3	6	9	12	15
	4 Probable	4	8	12	16	20
	5 Highly Probable	5	10	15	20	25

Result carried forward

		Consequence of Explosive Event				
		1	2	3	4	5
Probability of Explosive Event	≤6	6	12	18	24	30
	≤12	12	24	36	48	60
	≤16	16	32	48	64	80
	≤20	20	40	60	80	100
	≤25	25	50	75	100	125

Risk Level Key:	
High	High
Low	Low
Moderate	Moderate
High	High



Date: 21/05/2025

Risk Assessment Prior to Mitigation Measures
Figure A10.10.3

Great North Road Solar and Biodiversity Park
Environmental Statement

ANNEX B - TERMINOLOGY, LEGISLATION, GENERAL BACKGROUND AND METHODOLOGIES

Terminology

- 60 Explosive Ordnance Disposal (EOD) – The detection, identification, evaluation, rendering safe, recovery and disposal of UXO.
- 61 Fuse - A designed and manufactured mechanism to activate munitions. It can be designed for use by electrical, chemical or mechanical systems, by push, pull, pressure, release and time activation, singly or in combination. Usually consists of an igniter and detonator.
- 62 High Explosive (HE) - An explosive that normally detonates rather than burns; that is, the rate of detonation exceeds the velocity of sound.
- 63 Initiation - A physical process that sets in motion a cascade of chemical reactions of ever increasing energy (the explosive chain) that will eventually generate sufficient energy (the velocity of detonation) to allow the main charge to detonate in a violent, explosive chemical reaction, releasing energy in the form of heat and blast.
- 64 Unexploded Bomb (UXB) -The term UXB refers to any WWII aerial-delivered unexploded bomb, torpedo, projectile or mine consisting of a complete ferrous casing (without tailfins) weighing 50kg or greater.
- 65 Unexploded Ordnance (UXO) - Explosive Ordnance that has been primed, fused, armed or otherwise prepared for action, and which has been fired, dropped, launched, projected or placed in such a manner as to constitute a threat to the safety and/or security of people, animals, property or material and remains unexploded either by malfunction or design or for any other reason.
- 66 UXO Contamination - UXO that is present, within any given physical context that is considered to be an impediment to the safe on-going or intended use of a facility, including geological features. Safety in this instance is measured against an acceptable level of exposure to the potential risks that UXO present.

Glossary

- 67 AAA Anti-Aircraft Artillery
- 68 Allied Forces The Allies of World War II were the countries officially opposed to the Axis powers during the Second World War
- 69 ARP Air-raid Precautions
- 70 BD Bomb Disposal (historic term for EOD)
- 71 BDO Bomb Disposal Officer
- 72 bgl Below Ground Level
- 73 EOC Explosive Ordnance Clearance
- 74 EOD Explosive Ordnance Disposal
- 75 FP Fire Pot (Incendiary bomb)
- 76 HE High Explosive
- 77 IB Incendiary Bomb
- 78 Kg Kilogram
- 79 LSA Land Service Ammunition
- 80 Luftwaffe German Air Force
- 81 mbgl Metres Below Ground Level
- 82 MoD Ministry of Defence
- 83 OB Oil Bomb
- 84 PM Parachute Mine
- 85 RAF Royal Air Force
- 86 RPS RPS Group Plc
- 87 SC Sprengbombe-Cylindrisch, thin cased General Purpose Bomb
- 88 SD Sprengbombe-Dickwandig, Semi-Armour-Piercing Fragmentation Bomb
- 89 SI Site Investigation
- 90 Sqm Square Metres
- 91 USAAF United States Army Air Forces
- 92 UXB Unexploded Bomb
- 93 UXO Unexploded Ordnance
- 94 WWI First World War (1914 -1918)
- 95 WWII Second World War (1939 – 1945)

Legislation

- 96 Whilst undertaking this desk study the requirements of a number of pieces of legislation have been borne in mind, as below:
- Explosive Regulations 2014;
 - Manufacture and Storage of Explosives Act 2005;
 - Health & Safety at Work etc Act 1974;
 - Construction (Design & Management) Regulations 2015;
 - Control of Substances Hazardous to Health (COSHH) Regulations 2002; and
 - Personal Protective Equipment at Work Regulations 1992.
- 97 The Manufacture and Storage of Explosives Act 2005 does not specifically relate to UXO, but rather to the safety procedures and requirements associated with the storage and manufacturing of items containing explosive compounds. Even though this legislation is not directly applicable to site works where UXO may be encountered, there are several pertinent points which may be borne in mind when undertaking works on sites which pose a risk from encountering UXO, for example:
- Disposal of explosives and decontamination of explosive-contaminated items
 - Any person who disposes of explosives shall ensure, so far as is reasonably practicable, that they are disposed of safely.
 - Any person who decontaminates explosive-contaminated items shall ensure, so far as is reasonably practicable, that they are decontaminated safely.
 - No person shall store explosives unless he holds a licence for their storage and complies with the conditions of that licence.
- 98 A low UXO has been identified at the Study Area, and therefore a set of ESSG will be prepared. Where a higher / significant risk is identified, trained Explosives Safety Personnel will be present during the works to reduce the risk posed by UXO, and be on hand to handle the situation in the event of a suspicious item / UXO discovery.
- 99 The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995 (RIDDOR), place a legal duty on:
- Employers;
 - Self-employed people;
 - People in control of premises; and
 - To report work-related deaths, major injuries or over-three-day injuries, work related diseases, and dangerous occurrences (near miss accidents).
- 100 These regulations do not directly apply to UXO, but RIDDOR legislation states that as an employer, a person who is self-employed, or someone in control of work premises you must report “dangerous occurrences - where something happens that does not result in an injury, but could have done”. As such, where a site has been shown to present a risk from UXO this legislation should be borne in mind if an eventuality occurs where an item of UXO is uncovered.

- 101 Although the Health & Safety at Work etc Act 1974 and Construction (Design & Management) Regulations 2015 do not specifically require a search for unexploded ordnance, there is an obligation on those responsible for intrusive works to ensure that comprehensive assessment and risk measures are taken with regard to all underground hazards on a site. The potential risk to UXO for the Study Area has been identified as Low through a desk-based UXO assessment and it has concluded that the risk measures to be implemented as part of the intrusive works are to include the preparation of a set of Explosives Site Safety Guidelines and attendance of an Explosives Safety and Awareness Briefing.
- 102 The Health & Safety at Work etc Act 1974 - Section 3, states:
- 103 *"It shall be the duty of every employer to conduct his undertaking in such a way as to ensure, so far as is reasonably practicable, that persons not in his employment who may be affected thereby are not thereby exposed to risks to their health or safety."*
- 104 *It shall be the duty of every self-employed person to conduct his undertaking in such a way as to ensure, so far as is reasonably practicable, that he and other persons (not being his employees) who may be affected thereby are not thereby exposed to risks to their health or safety."*
- 105 *In such cases as may be prescribed, it shall be the duty of every employer and every self-employed person, in the prescribed circumstances and in the prescribed manner, to give to persons (not being his employees) who may be affected by the way in which he conducts his undertaking the prescribed information about such aspects of the way in which he conducts his undertaking as might affect their health or safety."*
- 106 Construction (Design & Management) Regulations 2015 - Regulation 10 states:
- *"(2) The pre-construction information shall consist of all the information in the client's possession (or which is reasonably obtainable), including –*
 - *(a) Any information about or affecting the site or the construction works."*
- 107 In addition to the above, the importance of adhering to safe systems of work will be borne in mind, and explosives and their residues may have implications for PPE requirements and COSHH.

German Bombing Campaign Overview

WWI German Bombing

- 108 During the First World War (WWI) Zeppelin airships followed by 'Gotha' and 'Giant' bombers conducted a succession of attacks dropping high explosive (HE) and incendiary bombs on Britain. The level of enemy bombing seen during WWI does not compare to that of WWII, nevertheless bombs were dropped on Britain.

WWII German Bombing

- 109 From the onset of WWII the German Air Force's (Luftwaffe) primary goals were to destroy key military assets such as airfields, during a series of daylight bombing raids. Shortly after, their plans changed to include targets such as economic and industrial sites, railway infrastructure, power stations, weapon manufacturing plants and gas works. Eventually, the amount of daylight raids were reduced and the attacking of targets commenced under the cover of darkness. Ultimately, the Germans resorted to attacking civilian areas through the 'carpet bombing' of major towns and cities, most notably during "The Blitz", which was in retaliation to the Allied bombing campaign.
- 110 The records reviewed as part of this assessment indicate that the German bombing campaign during WWII saw the extensive use of a series of High Explosive (HE) filled bombs ranging in size from the relatively small 50kg bomb through to the 250kg, 500kg, 1,000kg and 1,800kg bombs to the largest at 2,500kg. The Luftwaffe also used parachute mines, incendiary/fuel bombs and anti-personnel bomblets. In the later stages of the war, vengeance weapons namely the V1 (doodle bug) and V2 (Long Range Rockets) were used. The V2 rocket contained a 980kg high explosive filled warhead.
- 111 Available records suggest that most bombs dropped over the majority of targets during WWII were 50kg to 500kg HE bombs and incendiary devices. It is a general industry accepted rule, where no specific statistics are available, that on average, around 10% of the German HE bombs dropped during WWII failed to explode. This percentage is based on empirical data collected and collated during WWII by the ARP, and derived from bombing records. This statistic is primarily based on statistics from the London area (where the actual statistics vary widely across the region), but on average the failure rate amounted to around 10%.

Background on Bomb Penetration Depths

- 112 There are a number of reasons/factors applicable to bomb penetration depths, which can lead to variations in the bomb penetration depths for aerial delivered ordnance, as follows:
- Shape & Weight of Ordnance – variations in the design of the delivered ordnance have a large impact on the depths to which it is able to penetrate. Generally speaking, the heavier the ordnance, the deeper the penetration, and when constructed in a streamlined shape this can also lead to an increased penetration depth.
 - Geological Strata – variations in the composition, thickness and homogeneity of the geological strata can lead to significant variations in penetration depths.
 - Height of delivery – the altitude at which the ordnance was released can lead to variations its final penetration depth. For example, in low level attacks, or where a fleeing aircraft has had to ditch its payload, it is likely for penetration to have been much shallower due to any ordnance having not reached its terminal velocity and appropriate penetration angle (for maximum depth burial).
 - Deflection – should an item of ordnance have impacted onto an obstruction/structure prior to penetration into the ground, it may have

deflected and as such behaved anomalously upon penetration, and thus the final resting position may potentially be atypical to what is normally expected.

- 113 The following table provides a guide on average & probable maximum penetration depths of bombs in geological conditions that are typical in most areas of the United Kingdom. This is based on a survey & calculations undertaken by the Ministry of National Security in October 1949.
- 114 The following table is based on sums conducted by the Ministry on a data set from 1,304 bombs dealt with between January 1st to May 14th, 1941 (along with 24 bombs experimentally dropped on chalk). Only incidents with a definitive soil type, without structures on the surface, were used.

Weight of Bomb Kg	Sandstone		Sand		Gravel (Mixed)		Chalk (Soft)		Clay (Wet)		Average Probable Penetration	Average Probable Maximum Penetration
	Average Penetration	Probable Maximum	Average Penetration	Probable Maximum	Average Penetration	Probable Maximum	Average Penetration	Probable Maximum	Average Penetration	Probable Maximum		
	m	m	m	m	m	m	m	m	m	m	m	m
50	2.7	6.1	2.8	7.8	2.8	7.8	3.5	7.6	4.0	9.1	3.2	7.7
250	4.6	10.4	4.8	13.7	4.8	13.7	6.0	13.1	6.9	15.8	6.9	13.4
500	5.8	13.1	6.0	17.4	6.0	17.4	7.6	16.5	8.7	19.8	8.7	16.8
1000	7.3	16.5	7.6	21.9	7.6	21.9	9.6	20.7	11.0	25.0	11.0	21.2
1400	8.2	18.3	8.5	24.4	8.5	24.4	10.7	23.2	12.3	27.7	12.3	23.6
1800	9.0	20.3	9.4	27.0	9.4	27.0	11.8	25.5	13.5	30.5	13.5	26.0

UXO Detonations

- 115 The major effects of partial or full detonation of a device are shock, blast, heat and shrapnel damage. It should be noted that the detonation of a 50kg buried bomb would damage brick or concrete structures up to 16m away and unprotected personnel on the surface up to 70 m away. Larger ordnance is obviously more destructive, with an accepted safety distance for a 500kg HE device being 1km.
- 116 Once initiated, the effects of the detonation of explosive ordnance such as shells or bombs are usually extremely fast, often catastrophic and invariably traumatic to the personnel involved. The degradation of a shell or bomb may also offer a source of explosive contamination into the underlying soils. Although this contamination may still present an explosion hazard, it is not generally recognised that explosives offer a significant toxicological risk at concentrations well below that at which a detonation risk exists.
- 117 Unexploded ordnance does not spontaneously explode in the conditions experienced in the UK. UXBs have lain un-disturbed for some 80 years and should not detonate unless they are significantly disturbed. All HE requires is sufficient energy to create the conditions for detonation to occur. Intense impacts in intrusive engineering such as drilling / piling and mechanical excavations could initiate a detonation. There

are a number of scenarios that may occur on sites which may potentially lead to the detonation of an encountered item of UXO, as follows:

- *Direct on the main body of the UXO* – needs to be significant impact e.g. In the case of piling or large scale excavations.
- *Re starting clock timer in a fuse* – contact or vibration applied to a clock timer, in certain situations, may cause it to reinitiate. However, in the case of WWII (and pre-WWII) ordnance it is likely that such devices would be corroded and no longer able to function.
- *Initiating Fuse Explosive* – environmental factors, such as introduction of temperature fluctuation and water, can lead to degradation of explosives within items of UXO, which may then exude from the main body of the device and crystallise. Certain resultant compounds from such processes can be very sensitive and volatile, and through application of a small amount of movement / energy through either vibration or impact, may result in detonation of the main charge.

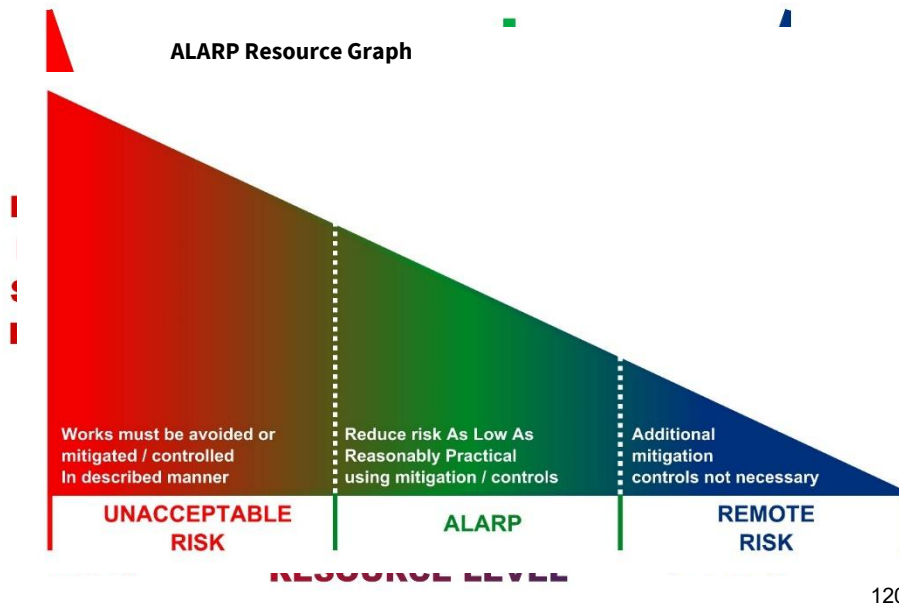
¹¹⁸ Apart from the explosives risk, the main concerns from UXBs are threefold, these are:

- Heavy metal (Copper, Zinc etc) contamination from the bomb's casing.
- Organic aromatics (Toluene, Nitrosamines, daughter products etc) contamination from the degradation of the explosive charge.
- Heavy metal (Lead, Mercury) contamination from the degradation of the detonator charge.

Risk Assessment Matrices

‘ALARP Principle’

¹¹⁹ ALARP has particular connotations in UK Health and Safety law and the core concept of what is “reasonably practicable”. This involves weighing a risk against the effort, time and costs needed to control it. For a risk to be reduced in line with ALARP it must be possible to demonstrate that the cost involved in reducing the risk further would be “grossly disproportionate” to the benefit gained. The ALARP principle arises from the fact that it would be possible to spend infinite time, effort and money attempting to reduce a risk to zero. Importantly, it is not simply a quantitative measure of benefit against detriment but a common practice of “judgment” of the balance of risk and social benefit.



120

Sources of Information

- Tt RPS related site records.
- Tt RPS Company records.
- Central and Local Government records.
- National Archives
- Historic maps, photographs and records.
- Internet Research.

Supplemental Sources of Historical Information Consulted:

121 The following additional sources were consulted for general background information:

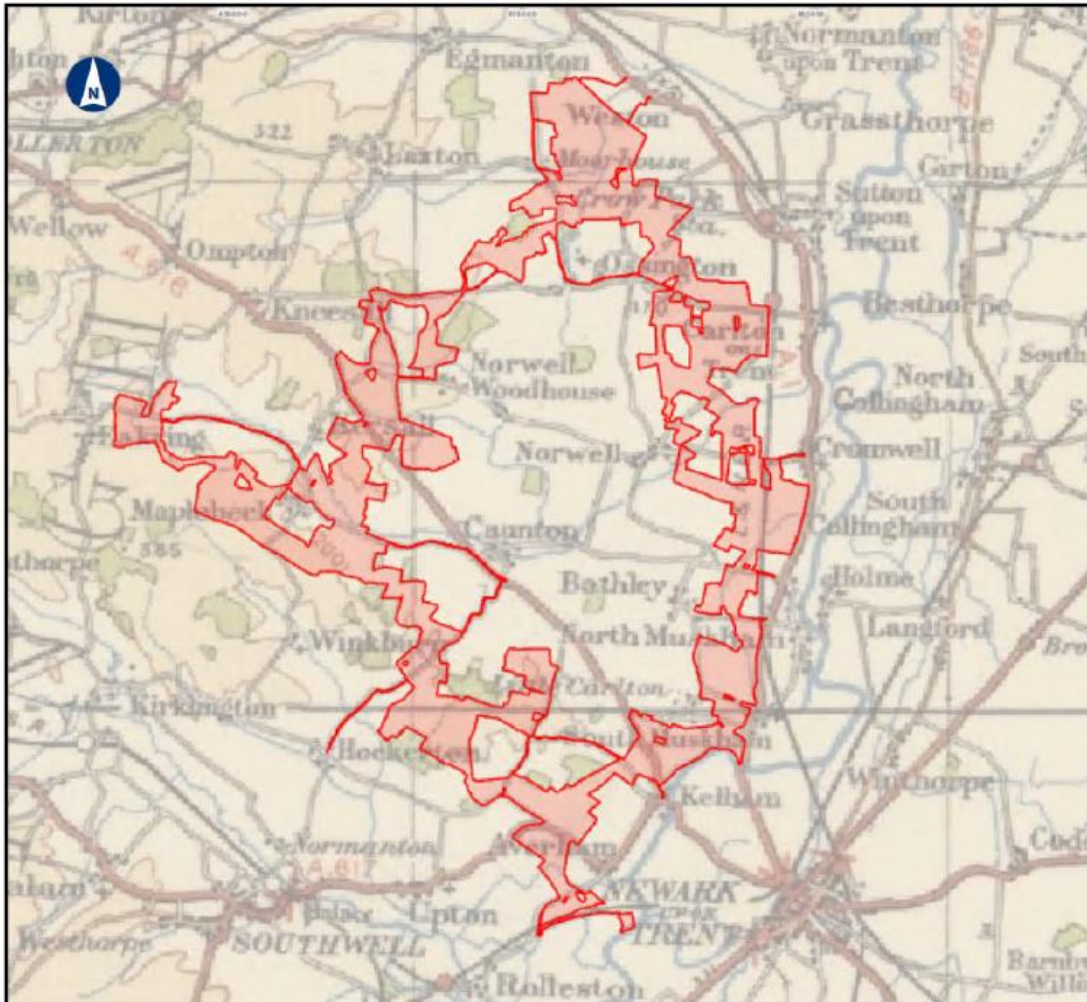
- Fleischer, W (2003) German Air Dropped Weapons to 1945. Midland Publishing and Stephen Thompson Associates;
- Morris J (1993) German Air Raids on Britain 1914-1918. Naval & Military Press;
- Fegan T (2002) The 'Baby Killers. Pen and Sword military publishing;
- Dobson, C (2001) AA Command, Britain's Anti-Aircraft Defences of the Second World War. Methuen;
- Dobson C (2000) Fields of Deception, Britain's Bombing Decoys of World War 2. Methuen; and
- Halfpenny, B (1981) Action stations 2. Military Airfields of Lincolnshire and the East Midlands.

Internet Sources:

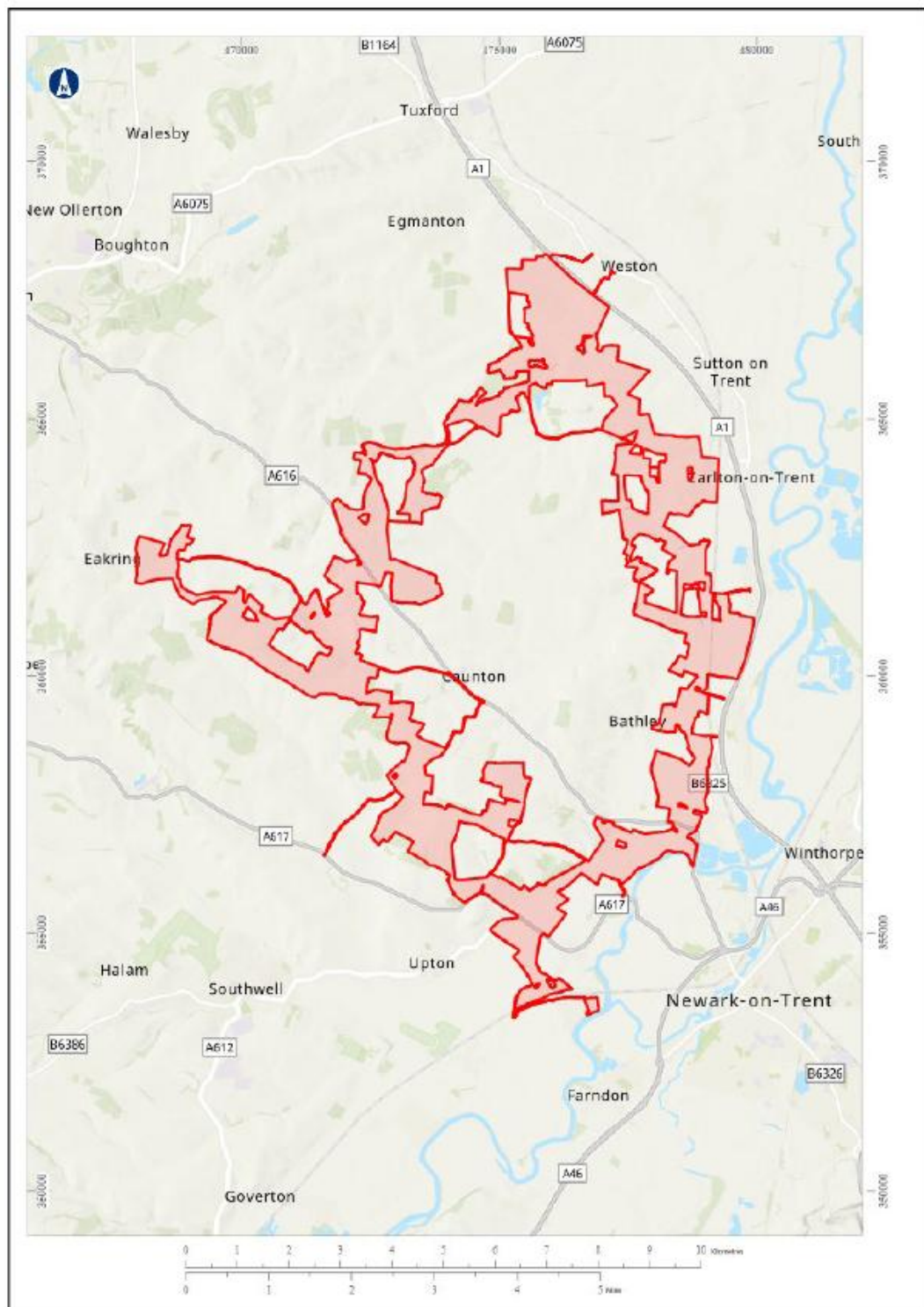
- British Geological Survey Map viewers - British Geological Survey (bgs.ac.uk); and
- Sheffield Hallam University Research Archive.

ANNEX C - SITE-SPECIFIC INFORMATION (MAPPING, AERIAL PHOTOGRAPHS)

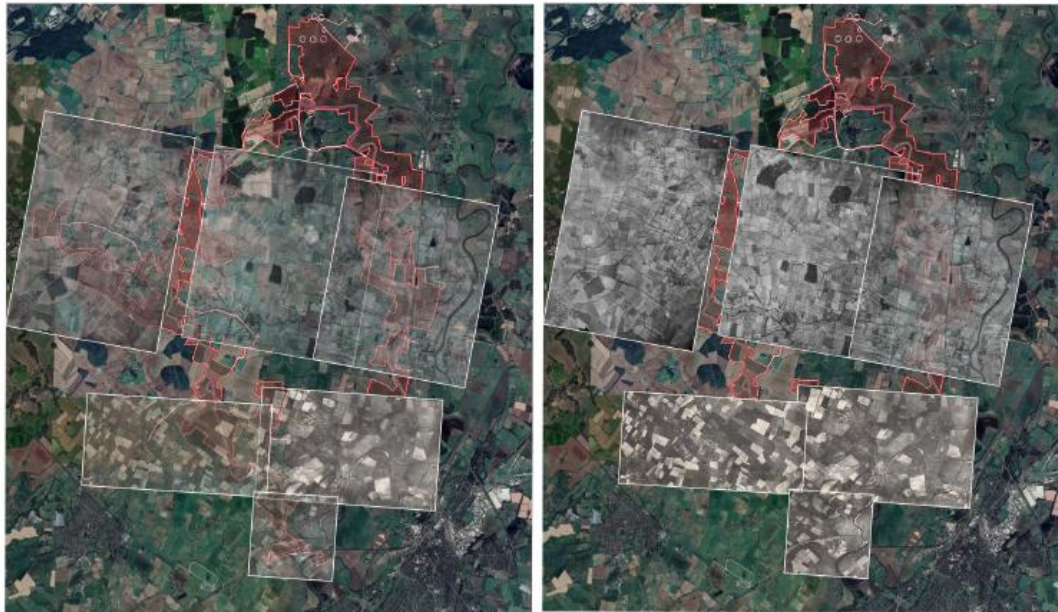
Historical Maps and Aerial Images



Showing the Study Area in 1935 dated mapping



Showing the Study Area in 2025 dated mapping



Showing the Study Area in 1946/1948 from available air photographs

RAF Ossington

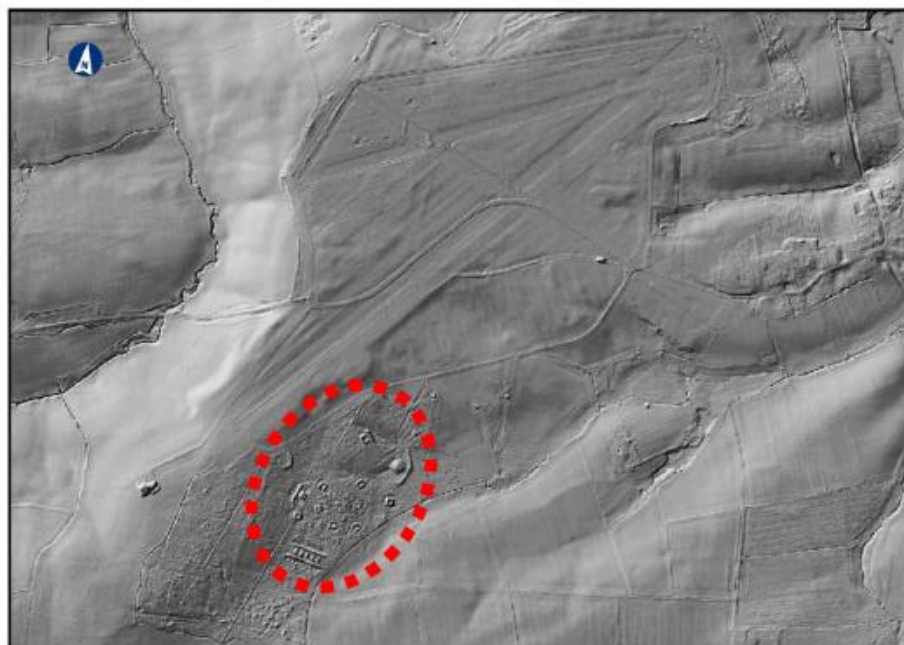
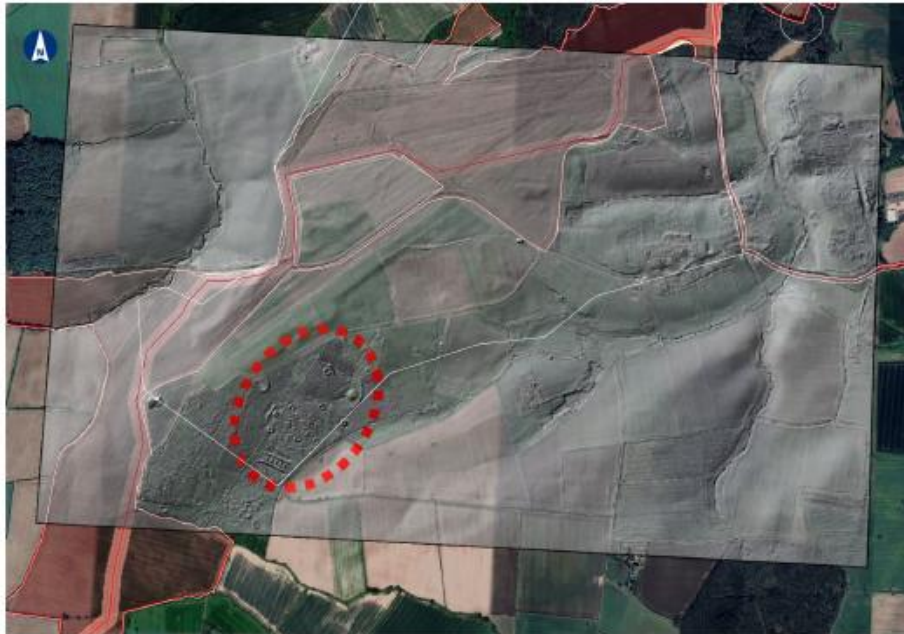
AIRFIELD NAME:	OSSINGTON.	OPENED :	1942.
COUNTY :	Nottinghamshire.	CLOSED :	1946.
COMMAND :	Bomber.		
FORMATION :	93 Grp(Egginton) :	GRID REF:	F 208846(46)
FUNCTION :	Operational Training Unit.	O.S. REF.:	SK 780413.
LOCALITY :	8 miles NNW of Newark-on-Trent.		
RAILWAY STN.	Newark-on-Trent (LNER & LMS)		
LATITUDE :	53 10 30N.	HEIGHT ASL :	211'
LONGITUDE :	00 53 00W.	FLYING CONTROL :	Yes.
		RADIO :	GDM.
LANDMARKS :	R Trent about 4 miles.		
DAY.			
LANDMARKS :	As day.		
NIGHT			
OBSTRUCTIONS :	Trees on approach to GDM 240&268 R/W.		
LANDING AREA :	Concrete.		
SURFACE :	GDM: 240.	LENGTH X WIDTH:	2000 x 50yds. EXT. TO: -
	: 268.		: 1400 x 50yds. : -
	: 318.		: 1400 x 50yds. : -
	:		:

EXTENSIBILITY :	None possible except 200yds. to SW.
ACCOMMODATION :	Temporary.
HANGARS :	T2-4.
HARDSTANDINGS :	Heavy bomber-30.
R.A.F. :	OFFICERS: 205. S.N.C.O's: 456. O.R's: 1461. TOTAL: 2122.
W.A.A.F.:	* : 9. * : 5. * : 327. * : 341.
AFFILIATED AIRFIELDS :	-
PRESENT USE (1985) :	Agriculture.



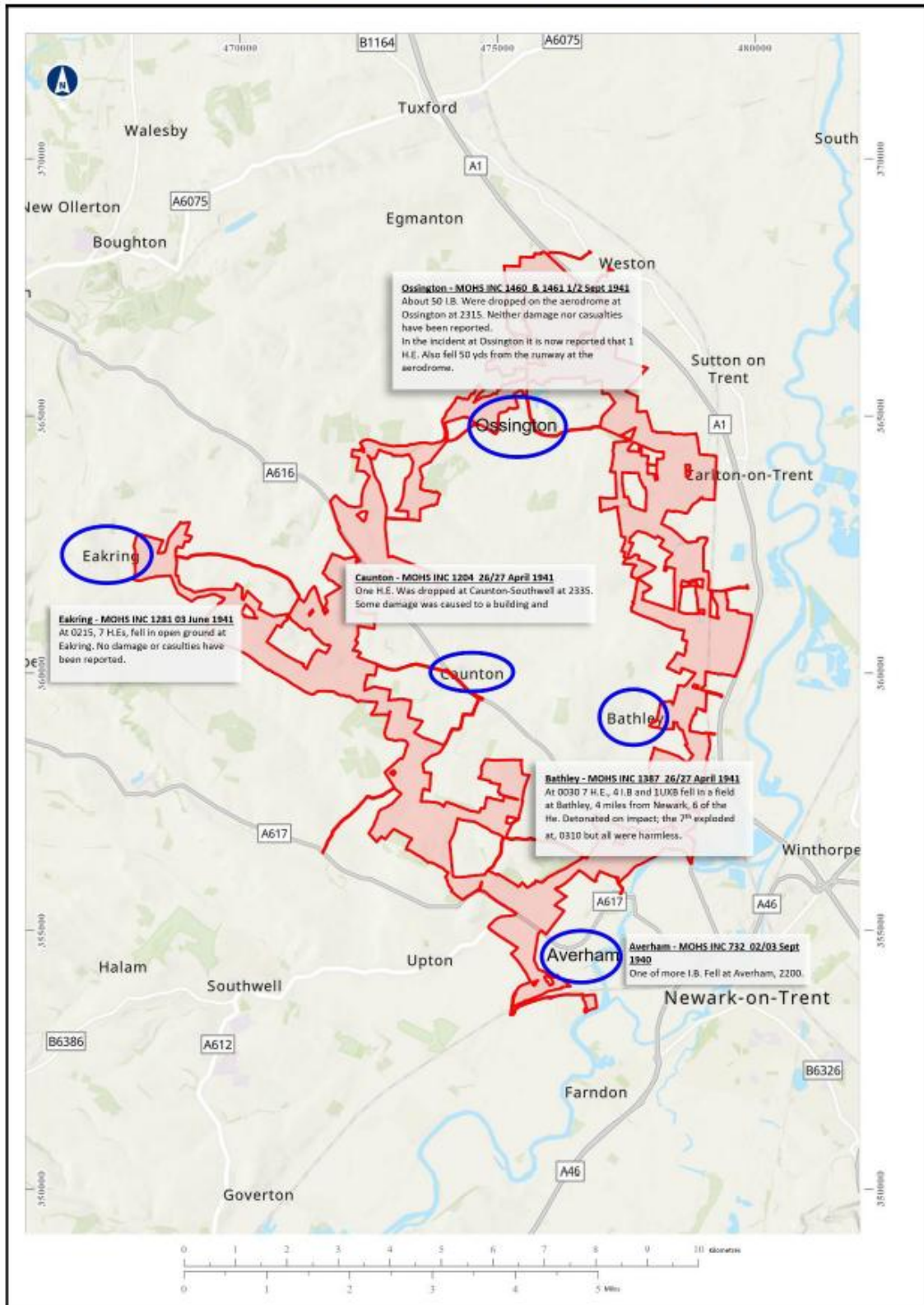
Showing RAF Ossington airfield in context to the Study Area (overlain on satellite imagery)

RAF Ossington



Showing Light Detection and Ranging (LIDAR) imagery showing the airfield in context to the Study Area. What is believed to be the technical area of the RAF base, is located to the south of the Study Area and circled in red. The site of buildings and an area of revetment to the south of the Study Area may be associated with munitions or possibly fuel storage.

WW2 Ministry of Home Security Incidents

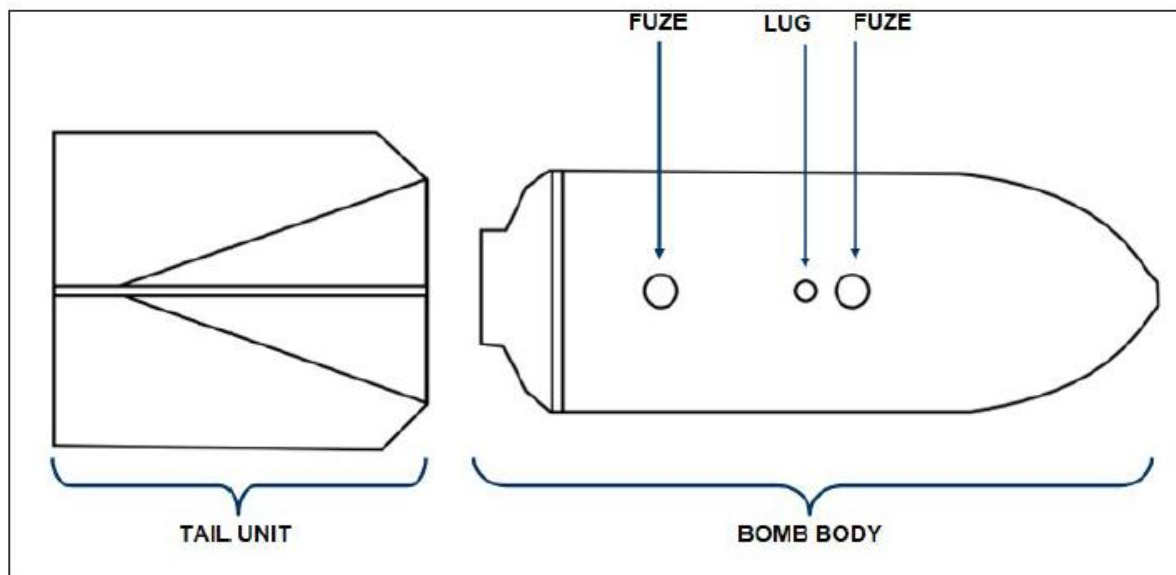


Showing WWII Ministry of Home Security incidents in context to the Study Area

ANNEX D – EXAMPLES OF SITE-SPECIFIC ORDNANCE

High Explosive / General Purpose Bombs

- 123 General-purpose bombs come in many shapes and sizes depending on the intention of the bombing mission. Generally, all these bombs are constructed the same and consist of a metal container (iron construction), a fuse (mainly transverse i.e. in the middle of the bomb), and a stabilizing device. The metal container (called the bomb body) holds the high explosive content. The body may be in one or in multiple pieces.
- 124 The main components of a bomb are:
- 125 **Bomb Body** – This is the main item referred to as an Unexploded Bomb (UXB). General Purpose bombs have a typical bomb shape with parallel sides. Given their age and environmental conditions most bombs are found corroded. It is possible to mistake them for old gas cylinders or boiler tanks.
- 126 **Tail Unit** – As the UXB enters the ground this section is removed. The presence of a tail unit may indicate that an UXB is buried at depth in the region.
- 127 **Fuze** – With a German UXB it is most likely that the bomb would have a mechanical or electrical transverse fuze. In some cases a bomb may contain two fuzes. On a German UXB the fuzes were of an alloy construction which contrasted visually from the bomb body.



TYPICAL WWII GERMAN AERIAL DELIVERED BOMB COMPONENTS



An Example of a 50kg German Bomb



**50kg SC HE Bomb discovered by RPS on a
construction site in London (2006)**

Incendiary Bombs and Bomblets



An Example of a German B-1 1kg incendiary bomblet

Land Service Ammunition



3 Inch HE Mortar



4.2 Inch mortar



3 Inch HE Mortars



2 Inch Mortars