Appendix 13.2

UXO Study

Issue	Date	Revision Details
1219991A	23/02/2021	Released

1ST LINE DEFENCE

Detailed Unexploded Ordnance (UXO) Risk Assessment

Project Name	Daer Reservoir, Biggar
Client	Natural Power
Site Address	Daer Reservoir, Biggar, Scotland, ML12 6TJ
Report Reference	DA10468-00
Date	28th February 2020
Originator	HOS

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Executive Summary

Site Location and Description

Comprising some 4,500 ha[2] of moorland, hills and forest, the site is located partly within the council of South Lanarkshire and partly within the council of Dumfries and Galloway. The site is bound by hills and moorland surrounding the hamlet of Wintercleugh to the north, whilst forest, the A74 and the towns of Moffat and Beattock bind the site to the east.

The site is bound by Harestanes Windfarm and the forest of Ae to the south, whilst moorland, forest and Daer Reservoir bind the site to the west.

The centre point of the site is approximately located on the OS grid reference: **NS 9942904371.**

Site location maps are presented in **Annex A**, whilst a recent aerial photograph and site plan are presented in **Annex B** and **Annex C** respectively.

Proposed Works

The exact scope and nature of proposed works was not available at the time of writing this report.

Geology and Bomb Penetration Depth

The British Geological Survey (BGS) map shows the underlying bedrock geology of the site to comprise the Gala Group-Wacke: sedimentary bedrock of the Silurian period. Superficial deposits across the site vary, with areas across the site recorded to have no superficial deposits, Till Diamicton of the Quaternary Period and Peat deposits also of the Quaternary Period.

Given the risk on site from German aerial delivered UXO has been assessed as minimal, a bomb penetration depth is not considered to be relevant.

UXO Risk Assessment

1st Line Defence has assessed that there is a **Low-Medium Risk** from items of Allied UXO in the northern & western parts of the site, with a **Medium Risk** from items of Allied UXO in the southern & eastern sections of the site. The risk from items of German aerial delivered UXO is considered to be **Negligible.**

Allied Military Ordnance

- During WWII, a large portion of the site is recorded to have been located within the boundary of a military range, Langholm Range. The exact designation and usage of this range could not be confirmed, however Air Ministry danger areas mapping suggests that the range had a danger height of 20,000 feet, suggesting that large calibre weapons may have been firing on the range.
- A large number of Explosive Ordnance Clearance Tasks are recorded within areas surrounding the site. The closest of these tasks was recorded to have taken place in the immediate area to the south-east of site, surrounding Ae Forest. Three tasks took place between 1986 and 1993. These appear to have been undertaken prior to tree planting; the closest of which was recorded approximately 1km from the proposed site boundary, however owing to the limitations of this data set, the exact locations of these tasks is not known, with the possibility that some tasks may have been undertaken within the site.
- Our experience has shown that some degree of UXO contamination nearly always occurs within areas of land previously situated within the boundary of historic artillery ranges. As a result, the areas of the proposed site recorded to have been located within the boundary of the range are considered to be at an elevated risk from historic allied UXO. Items of UXO were also recovered during the construction of Harestanes wind farm, see **Annex O4**.
- The general area encompassing the site is also recorded to have been used as a training area for British army troops of No.2 Commando. War diaries record troops engaging in night exercises, demolition training and collaboration with the Home Guard, potentially within the boundary of the site or within close proximity to it. As elite raiding troops, it is thought likely that such exercises and training would have involved the usage of live ordnance.
- Anecdotal evidence also suggests the presence of Auxiliary unit bases in the area of Moffat and Beattock. Whilst no positive evidence could be found to confirm the presence of these units within the site area, there is a possibility that training may have been undertaken within proximity to the site, owing to it being an established military range.

UXO Risk Assessment

- Based on these records, it is evident that items of Small Arms Ammunition and Land Service Ammunition were present and potentially being used on the site during war – conceivably across the whole area given the possibility of ground training. There is considered to be an elevated risk of UXO contamination (above that of the background level for the wider area) across the whole site area as a result. However, of most concern is the area of the site within the mapped bounds of the former WWII artillery range. Whilst it is not possible to discount that artillery could have ended up outside the designated range area, it is reasonable to assume that most of the unexploded and mis-fired projectiles will be within the range boundaries. The majority of any contamination is likely to be centred around a particular target area within the range – however it has not proved possible to ascertain where this was located.
- As a result of the above, the site area has been 'zoned' – see risk map **Annex XXX**. The southern section which falls within the mapped extents of the Langholm firing training area is deemed to be at **Medium Risk** of contamination. It has not been possible to entirely discount the risk of contamination in the northern section of the site which fell outside of the range boundary (given possible mis-firing and references to ground training in the general area), however the risk here is not considered to be as significant. This area is deemed to be at **Low-Medium Risk**.

German Aerial Delivered Ordnance

- During WWII, bombing in Scotland was generally concentrated on major urban areas such as Edinburgh and Glasgow, and on significant military and civilian industrial targets, like the military bases at Scapa Flow and the shipyard at Clydebank. Home Office statistics reflect this, indicating that Dumfriesshire and Lanarkshire both experienced an almost negligible bombing density, with only 0.1 and 0.6 items recorded per 1,000 acres respectively.
- Plots of missiles dropped in Scotland, do not record any bombs to have fallen within the area of the site, with the closest recorded bombing located some 5km to the north of the site. It is therefore considered very unlikely that unexploded German ordnance fell within the site boundary, though it cannot be completely discounted.

Recommended Risk Mitigation Measures

The most appropriate mitigation methodology would depend on the exact scope of works planned and factors such as access, ground cover and topography. This would need to be discussed with the client in order to put in place a bespoke solution. However, it is likely that the following measures would be viable options:

All Works

- **UXO Risk Management Plan**
- **Site Specific UXO Awareness Briefings to all personnel conducting intrusive works:** This will alert all workers as to the history of the area, what to look out for and what to do in the event that a suspect item is encountered.

Medium Risk Area

Open Intrusive Works (trial pits, service pits, open excavations, shallow foundations etc.)

- **Non-Intrusive UXO Magnetometer Survey and Target Investigation:** This is a walk-over survey undertaken by a two-man team. It requires clear ground (free from overgrown vegetation). It is suitable for ground which is relatively 'clean' and free from background ferrous contamination. The survey results in a 'false colour' map showing the locations of modelled ferrous anomalies. A report will be provided which details which of the total list of anomalies are recommended for investigation (those which have similar modelled characteristics to items of LSA). A two-man team can cover approximately 2ha per day in optimum conditions – this coverage will be reduced where there are complicated survey areas/shapes to mark up or many small survey boxes.
- For any areas within which a non-intrusive survey is not practicable, it is recommended that either **UXO Watch & Brief Support** is provided to monitor the works themselves, or that these areas are subject to **UXO Search & Clear** prior to works commencing.

As referenced, it is recommended that a meeting or conference call is arranged to discuss in detail the most appropriate and effective mitigation measures or combination of mitigation measures based on the exact scope or works, access, groundcover, topography etc.

Risk Map

Low-Medium Risk

Medium Risk

Low-Medium Risk Areas:

- UXO Risk Management Plan
- Site Specific Unexploded Ordnance Awareness Briefings to all personnel conducting intrusive works

Medium Risk Area:

- Non-intrusive Survey or Search & Clear exercise. Where this is not practicable:
- Unexploded Ordnance (UXO) Specialist Presence on Site to support shallow intrusive works

For indicative purposes – not to scale

Glossary

Abbreviation	Definition
AA	Anti-Aircraft
AFS	Auxiliary Fire Service
AP	Anti-Personnel
ARP	Air Raid Precautions
DA	Delay-action
EOC	Explosive Ordnance Clearance
EOD	Explosive Ordnance Disposal
FP	Fire Pot
GM	G Mine (Parachute mine)
HAA	Heavy Anti-Aircraft
HE	High Explosive
IB	Incendiary Bomb
JSEODOC	Joint Services Explosive Ordnance Disposal Operation Centre
LAA	Light Anti-Aircraft
LCC	London County Council
LRRB	Long Range Rocket Bomb (V-2)
LSA	Land Service Ammunition
NFF	National Filling Factory
OB	Oil Bomb
PAC	Pilotless Aircraft (V-1)
PB	Phosphorous Bomb
PM	Parachute Mine
POW	Prisoner Of War
RAF	Royal Air Force
RCAF	Royal Canadian Air Force
RFC	Royal Flying Corps
RNAS	Royal Naval Air Service
ROF	Royal Ordnance Factory
SA	Small Arms
SAA	Small Arms Ammunition
SD2	Anti-personnel “Butterfly Bomb”
SIP	Self-Igniting Phosphorous
U/C	Unclassified bomb
UP	Unrotated Projectile (rocket)
USAAF	United States Army Air Force
UX	Unexploded
UXAA	Unexploded Anti-Aircraft
UXB	Unexploded Bomb
UXO	Unexploded Ordnance
V-1	Flying Bomb (Doodlebug)
V-2	Long Range Rocket
WAAF	Women’s Auxiliary Air Force
X	Exploded

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1st Line Defence Limited
Detailed Unexploded Ordnance (UXO) Risk Assessment

Site: Daer Reservoir, Biggar
Client: Natural Power

1. Introduction

1.1. Background

1st Line Defence has been commissioned by Natural Power to conduct a Detailed Unexploded Ordnance (UXO) Risk Assessment for the works proposed at the Daer Reservoir, Biggar site.

Buried UXO can present a significant risk to construction works and development projects. The discovery of a suspect device during works can cause considerable disruption to operations as well as cause unwanted delays and expense.

UXO in the UK can originate from three principal sources:

1. Munitions resulting from wartime activities including German bombing in WWI and WWII, long range shelling, and defensive activities.
2. Munitions deposited as a result of military training and exercises.
3. Munitions lost, burnt, buried or otherwise discarded either deliberately, accidentally, or ineffectively.

This report will assess the potential factors that may contribute to the risk of UXO contamination. If an elevated risk is identified at the site, this report will recommend appropriate mitigation measures, in order to reduce the risk to as low as is reasonably practicable. Detailed analysis and evidence will be provided to ensure an understanding of the basis for the assessed risk level and any recommendations.

This report complies with the guidelines outlined in *CIRIA C681*, 'Unexploded Ordnance (UXO) A Guide for the Construction Industry.'

2. Method Statement

2.1. Report Objectives

The aim of this report is to conduct a comprehensive assessment of the potential risk from UXO at Daer Reservoir, Biggar. The report will also recommend appropriate site and work-specific risk mitigation measures to reduce the risk from explosive ordnance during the envisaged works to a level that is as low as reasonably practicable.

2.2. Risk Assessment Process

1st Line Defence has undertaken a five-step process for assessing the risk of UXO contamination:

1. The likelihood that the site was contaminated with UXO.
2. The likelihood that UXO remains on the site.
3. The likelihood that UXO may be encountered during the proposed works.
4. The likelihood that UXO may be initiated.
5. The consequences of initiating or encountering UXO.

In order to address the above, 1st Line Defence has taken into consideration the following factors:

- Evidence of WWI and WWII German aerial delivered bombing as well as the legacy of Allied occupation.
- The nature and conditions of the site during WWII.
- The extent of post-war development and UXO clearance operations on site.
- The scope and nature of the proposed works and the maximum assessed bomb penetration depth.
- The nature of ordnance that may have contaminated the proposed site area.

2.3. Sources of Information

Every reasonable effort has been made to ensure that relevant evidence has been consulted and presented in order to produce a thorough and comprehensible report for the client. To achieve this the following, which includes military records and archive material held in the public domain, have been accessed:

- The National Archives and National Archive of Scotland.
- Historical mapping datasets.
- Historic England National Monuments Record.
- Relevant information supplied by Natural Power.
- Available material from 33 Engineer Regiment (EOD) Archive (now 28 Regt).
- 1st Line Defence's extensive historical archives, library and UXO geo-datasets.
- Open sources such as published books and internet resources.

Research involved a visit to The National Archives and National Archive of Scotland.

3. Background to Bombing Records

3.1. General Considerations of Historical Research

This desktop assessment is based largely upon analysis of historical evidence. Every reasonable effort has been made to locate and present significant and pertinent information. 1st Line Defence cannot be held accountable for any changes to the assessed risk level or risk mitigation measures, based on documentation or other data that may come to light at a later date, or which was not available to 1st Line Defence during the production of this report.

It is often problematic and sometimes impossible to verify the completeness and accuracy of WWII-era records. As a consequence, conclusions as to the exact location and nature of a UXO risk can rarely be quantified and are to a degree subjective. To counter this, a range of sources have been consulted, presented and analysed. The same methodology is applied to each report during the risk assessment process. 1st Line Defence cannot be held responsible for any inaccuracies or the incompleteness in available historical information.

3.2. German Bombing Records

During WWII, bombing records were generally gathered locally by the police, Air Raid Precaution (ARP) wardens and military personnel. These records typically contained information such as the date, the location, the amount of damage caused and the types of bombs that had fallen during an air raid. This information was made either through direct observation or post-raid surveys. The Ministry of Home Security Bomb Census Organisation would then receive this information, which was plotted onto maps, charts, and tracing sheets by regional technical officers. The collective record set (regional bomb census mapping and locally gathered incidents records) would then be processed and summarised into reports by the Ministry of Home Security Research and Experiments Branch. The latter were tasked with providing the government 'a complete picture of air raid patterns, types of weapons used and damage caused- in particular to strategic services and installations such as railways, shipyards, factories and public utilities.'[1]

The quality, detail and nature of record keeping could vary considerably between provincial towns, boroughs and cities. No two areas identically collated or recorded data. While some local authorities maintained records with a methodical approach, sources in certain areas can be considerably more vague, dispersed, and narrower in scope. In addition, the immediate priority was mostly focused on assisting casualties and minimising damage at the time. As a result, some records can be incomplete and contradictory. Furthermore, many records were even damaged or destroyed in subsequent air raids. Records of raids that took place on sparsely or uninhabited areas were often based upon third party or hearsay information and are therefore not always reliable. Whereas records of attacks on military or strategic targets were often maintained separately and have not always survived.

3.3. Allied Records

During WWII considerable areas of land were requisitioned by the War Office for the purpose of defence, training, munitions production and the construction of airfields. Records relating to military features vary and some may remain censored. Within urban environments datasets will be consulted detailing the location of munition production as well as wartime air and land defences. In rural locations it may be possible to obtain plans of military establishments, such as airfields, as well as training logs, record books, plans and personal memoirs. As with bombing records, every reasonable effort will be made to access records of, and ascertain any evidence of, military land use. However, there are occasions where such evidence is not available, as records may not be accessible, have been lost/destroyed, or simply were not kept in the first place.

[1] http://www.nationalarchives.gov.uk/help-with-your-research/research-guides/bomb-census-survey-records-1940-1945/.

4. UK Regulatory Environment and Guidelines

4.1. General

There is no formal obligation requiring a UXO risk assessment to be undertaken for construction projects in the UK, nor is there any specific legislation stipulating the management or mitigation of UXO risk. However, it is implicit in the legislation outlined below that those responsible for intrusive works (archaeology, site investigation, drilling, piling, excavation etc.) should undertake a comprehensive and robust assessment of the potential risks to employees and that mitigation measures are implemented to address any identified hazards.

4.2. CDM Regulations 2015

The Construction (Design and Management) Regulations 2015 (CDM 2015) define the responsibilities of parties involved in the construction of temporary or permanent structures.

The CDM 2015 establishes a duty of care extending from clients, principle co-ordinators, designers, and contractors to those working on, or affected by, a project. Those responsible for construction projects may therefore be accountable for the personal or proprietary loss of third parties, if correct health and safety procedure has not been applied.

Although the CDM does not specifically reference UXO, the risk presented by such items is both within the scope and purpose of the legislation. It is therefore implied that there is an obligation on parties to:

- Provide an appropriate assessment of potential UXO risks at the site (or ensure such an assessment is completed by others).
- Put in place appropriate risk mitigation measures if necessary.
- Supply all parties with information relevant to the risks presented by the project.
- Ensure the preparation of a suitably robust emergency response plan.

4.3. The 1974 Health and Safety at Work etc. Act

All employers have a responsibility under the Health and Safety at Work etc. Act 1974 and the Management of Health and Safety at Work Regulations 1999, to ensure the health and safety of their employees and third parties, so far as is reasonably practicable and conduct suitable and sufficient risk assessments.

4.4. CIRIA C681

In 2009, the Construction Industry Research and Information Association (CIRIA) produced a guide to UXO for the UK construction industry (CIRIA C681). CIRIA is a neutral, independent and not-for-profit body, linking organisations with common interests and facilitating a range of collaborative activities that help improve the industry.

The publication provides the UK construction industry with a defined process for the management of risks associated with UXO from WWI and WWII aerial bombardment. It is also broadly applicable to the risks from other forms of UXO that might be encountered. It focuses on construction professionals' needs, particularly if there is a suspected item of UXO on site and covers issues such as what to expect from a UXO specialist. The guidance also helps clients to fulfil their legal duty under CDM 2015 to provide designers and contractors with project specific health and safety information needed to identify hazards and risks associated with the design and construction work. This report conforms to this CIRIA guidance and to the various recommendations for good practice referenced therein. It is recommended that this document is acquired and studied where possible to allow a better understanding of the background to both the risk assessment process and the UXO issue in the UK in general.

4.5. Additional Legislation

In the event of a casualty resulting from the failure of an employer/client to address the risks relating to UXO, the organisation may be criminally liable under the Corporate Manslaughter and Corporate Homicide Act 2007.

5. The Role of Commercial UXO Contractors and The Authorities

5.1. Commercial UXO Specialists

The role of a UXO Specialist (often referred to as UXO Consultant or UXO Contractor) such as 1st Line Defence is defined in CIRIA C681 as the provision of expert knowledge and guidance to the client on the most appropriate and cost-effective approach to UXO risk management at a site.

The principal role of UXO Specialists is to provide the client with an appropriate assessment of the risk posed by UXO for a specific project, and identify and carry out suitable methodology for the mitigation of any identified risks to reduce them to an acceptable level.

The requirement for a UXO Specialist should ideally be identified in the initial stages of a project, and it is recommended that this occur prior to the start of any detailed design. This will enable the client to budget for expenditure that may be required to address the risks from UXO, and may enable the project team to identify appropriate techniques to eliminate or reduce potential risks through considered design, without the need for UXO specific mitigation measures. The UXO Specialist should have suitable qualifications, levels of competency and insurances.

Please note 1st Line Defence has the capability to provide a complete range of required UXO risk mitigation services, in order to reduce a risk to as low as reasonably practicable. This can involve the provision of both ground investigation, and where appropriate, UXO clearance services.

5.2. The Authorities

The police have a responsibility to co-ordinate the emergency services in the event of an ordnance-related incident at a construction site. Upon inspection they may impose a safety cordon, order an evacuation, and call the military authorities Joint Services Explosive Ordnance Disposal Operation Centre (JSEODOC) to arrange for investigation and/or disposal. Within the Metropolitan Police Operational Area, SO15 EOD will be tasked to any discovery of suspected UXO. The request for Explosive Officer (Expo) support is well understood and practiced by all Metropolitan Boroughs. The requirement for any additional assets will then be coordinated by the Expo if required.

In the absence of a UXO specialist, police officers will usually employ such precautionary safety measures, thereby causing works to cease, and possibly requiring the evacuation of neighbouring businesses and properties.

The priority given to the police request will depend on the EOD teams judgement of the nature of the UXO risk, the location, people and assets at risk, as well as the availability of resources. The speed of response varies; authorities may respond immediately or in some cases it may take several days for the item of ordnance to be dealt with. Depending on the on-site risk assessment the item of ordnance may be removed from the site and/or destroyed by a controlled explosion.

Following the removal of an item of UXO, the military authorities will only undertake further investigations or clearances in high-risk situations. If there are regular UXO finds on a site the JSEODOC may not treat each occurrence as an emergency and will recommend the construction company puts in place alternative procedures, such as the appointment of a commercial contractor to manage the situation.

6. The Site

6.1. Site Location and Description

Comprising some 4,500 ha^2 of moorland, hills and forest, the site is located partly within the council of South Lanarkshire and partly within the council of Dumfries and Galloway. The site is bound by hills and moorland surrounding the hamlet of Wintercleugh to the north, whilst forest, the A74 and the towns of Moffat and Beattock bind the site to the east.

The site is bound by Harestanes Windfarm and the forest of Ae to the south, whilst moorland, forest and Daer Reservoir bind the site to the west.

The centre point of the site is approximately located on the OS grid reference: **NS 9942904371.**

Site location maps are presented in **Annex A**, whilst a recent aerial photograph and site plan are presented in **Annex B** and **Annex C** respectively.

7. Scope of the Proposed Works

7.1. General

The exact scope and nature of proposed works was not available at the time of writing this report.

8. Ground Conditions

8.1. General Geology

The British Geological Survey (BGS) map shows the underlying bedrock geology of the site to comprise the Gala Group- Wacke: sedimentary bedrock of the Silurian period. Superficial deposits across the site vary, with areas across the site recorded to have no superficial deposits, Till Diamicton of the Quaternary Period and Peat deposits also of the Quaternary Period.

8.2. Site Specific Geology

Site-specific geotechnical data was not available during the production of this report.

9. Site History

9.1. Introduction

The purpose of this section is to identify the composition of the site pre and post-WWII. It is important to establish the historical use of the site, as this may indicate the site's relation to potential sources of UXO as well as help with determining factors such as the land use, groundcover, likely frequency of access and signs of bomb damage.

9.2. Ordnance Survey Historical Maps

Relevant historical maps were obtained for this report and are presented in **Annex D.** See below for a summary of the site history shown on acquired mapping.

WWII		
Date	**Scale**	**Description**
1940	1:63,360	This map shows the site to be located within an area of hills, moors and streams. Few developed or settled areas are shows to have been located within the site area itself, with the largest being *Kinnelhead,* located within the south-easternmost section of the site. Some of the hills located within the site include, Mosshope Fell, Craig Hill and Shiel Hill, with streams including Cloffin Burn, Garpol water and White Burn.

Post-WWII		
Date	**Scale**	**Description**
1956	1:63,360	This map shows very little change to have taken place on site, with the site and surrounding area retaining much the same structural composition as it had during the early period of the war. The biggest changes can be seen in the labelling of wooded areas to the east of the site, now labelled as Greskine Forest, with several small farms and settled areas, Blairmack and Cowley can be seen towards the central section of the site. Additionally a large Dam across Daer water, the *Daer Dam* has been constructed adjacent to the north-westernmost portion of the site.

10. Introduction to Allied Explosive Ordnance

10.1. General

Many areas across the UK may be at risk from Allied UXO because of both wartime and peacetime military use. Typical military activities and uses that may have led to a legacy of military UXO at a site include former minefields, home guard positions, anti-aircraft emplacements, training and firing ranges, military camps, as well as weapons manufacture and storage areas. This section summarises the type of ordnance: see **section 11** for the likelihood of contamination.

Although land formerly used by the military were usually subject to clearance before they returned to civilian use, items of UXO are sometimes discovered and can present a potential risk to construction projects.

10.2. Land Service Ammunition

Owing to the recorded usage of the area encompassing the site for both an artillery range and for military training of troops including No.2 Commando **(see section 11)** it is anticipated that a variety of Land Service Ammunition would have been used within close proximity to the site. As part of their training, Army Commandos were taught specialist skills including demolition, sabotage and ambush tactics. Such training most commonly involved the usage of land service ammunition and explosives such as grenades, mortars and demolition charges.

The term LSA covers items of ordnance that are propelled, placed, or thrown during land warfare. These items may be filled or charged with explosives, smoke, incendiary, or pyrotechnics and can be divided into five main groups:

Land Service Ammunition	
Item	**Description**
Mortar Rounds	A mortar round is normally nosed-fused and fitted with its own propelling charge. Its flight is stabilised by the use of a fin. They are usually tear-drop shaped (though older variants are parallel sided), with a finned 'spigot tube' screwed or welded to the rear end of the body which houses the propellant charge. Mortars are either High Explosive or Carrier (i.e. smoke, incendiary, or pyrotechnic).
Grenades	A grenade is a short range weapon designed to kill or injure people. It can be hand thrown or fired from a rifle or a grenade launcher. Grenades either contain high explosive or smoke producing pyrotechnic compounds. The common variants have a classic 'pineapple' shape.
Projectiles	A projectile (or shell) is propelled by force, normally from a gun or artillery-piece, and continues in motion using its kinetic energy. The calibre of the gun such a projectile is fired from usually determines its size. A projectile contains a fuzing mechanism and a filling. Projectiles can be high explosive, armour piercing, incendiary/smoke or Shot (a solid projectile).
Rockets	Rockets were commonly designed to destroy heavily armoured military vehicles (anti-tank weapon). The device contains an explosive head (warhead) that can be accelerated using internal propellants to an intended target. Anti-aircraft rocket batteries were also utilised as part of air defence measures.
Landmines	A landmine is designed to be laid on or just below the ground to be exploded by the proximity, or contact of a person or vehicle. Landmines were often placed in defensive areas of the UK to obstruct potential invading adversaries.

In the UK unexploded or partially exploded mortars and grenades are the most common items of LSA encountered, as they could be transported and utilised anywhere. They are mostly encountered in areas used for military training and are often found discarded on or near historical military bases.

Examples of Mortars, Howitzers & Mines are presented in **Annex E, while** images of the most commonly found items of LSA are presented in **Annex F.**

10.3. Small Arms Ammunition

In order to prepare them for dangerous raids behind enemy lines, Commando and HG Auxiliary training ensured that troops were competent marksmen with a wide range of small arms weapons, both allied and axis. As such, areas connected with their training are likely to have seen practice involving small arms ammunition.

The most common type of ordnance encountered on land used by the military are items of Small Arms Ammunition (SAA). SAA refers to the complete round or cartridge designed to be discharged from varying sized hand-held weapons such as rifles, machine guns and pistols. SAA can include bullets, cartridge cases and primers/caps. Images of the most commonly found items of LSA are presented in **Annex G.**

10.4. Defending the UK From Aerial Attack

During WWII the War Office employed a number of defence tactics against the Luftwaffe from bombing major towns, cities, manufacturing areas, ports and airfields. These can be divided into passive and active defences (examples are provided in the table below).

Active Defences	Passive Defences
• Anti-aircraft gun emplacements to engage enemy aircraft. • Fighter aircraft to act as interceptors. • Rockets and missiles were used later during WWII.	• Blackouts and camouflaging to hinder the identification of Luftwaffe targets. • Decoy sites were located away from targets and used dummy buildings and lighting to replicate urban, military, or industrial areas. • Barrage balloons forced enemy aircraft to greater altitudes. • Searchlights were often used to track and divert adversary bomber crews during night raids.

Active defences such as anti-aircraft artillery present a greater risk of UXO contamination than passive defences. Unexploded ordnance resulting from dogfights and fighter interceptors is rarely encountered and difficult to accurately qualify.

10.4.1. Anti-Aircraft Artillery (AAA)

During WWII three main types of gun sites existed: heavy anti-aircraft (HAA), light anti-aircraft (LAA) and 'Z' batteries (ZAA). If the projectiles and rockets fired from these guns failed to explode or strike an aircraft they would descend back to land. The table below provides further information on the operation and ordnance associated with these type of weapons.

Anti-Aircraft Artillery				
Item	**Description**			
HAA	These large calibre guns such as the 3.7" QF (Quick Firing) were used to engage high flying enemy bombers, They often fired large HE projectiles, which were usually initiated by integral fuzes triggered by impact, area, time delay or a combination of aforementioned mechanisms.			
LAA	These mobile guns were intended to engage fast, low flying aircraft. They were typically rotated between locations on the perimeters of towns and strategically important industrial works. As they could be moved to new positions with relative ease when required, records of their locations are limited. The most numerous of these were the 40mm Bofors gun which could fire up to 120 x 40mm HE projectiles per minute to over 1,800m.			
Variations in HAA and LSA Ammunition	**Gun type**	**Calibre**	**Shell Weight**	**Shell Dimensions**
	3.0 Inch	76mm	7.3kg	76mm x 356mm
	3.7 Inch	94mm	12.7kg	94mm x 438mm
	4.5 Inch	114mm	24.7kg	114mm x 578mm
	40mm	40mm	0.9kg	40mm x 311mm
Z-AA	The three inch unrotated rocket/projectile known as the UP-3 had initially been developed for the Royal Navy. The UP-3 was also used in ground-based single and 128-round launchers known as ''Z'' batteries. The rocket, containing a high explosive warhead was often propelled by cordite.			

The closest recorded HAA to the site was located approximately 55km north-west of the site, with the site anticipated to be likely beyond the typical maximum range of 3.7" QF guns . The site may have been in range of mobile light anti-aircraft guns, although the presence of LAA guns in the vicinity of the site could not be confirmed.

The conditions in which anti-aircraft projectiles may have fallen unnoticed within a site area are considered analogous to those regarding aerial delivered ordnance. Unexploded anti-aircraft projectiles could essentially have fallen indiscriminately anywhere within range of the guns. The chance of such items being observed, reported and removed during the war depends on factors such as land use, ground cover, damage and frequency of access – the same factors that govern whether evidence of a UXB is likely to have been noted. More information about these factors with regards to this particular site can be found in the German Aerial Delivered Ordnance section of this report.

Illustrations of Anti-Aircraft artillery, projectiles and rockets are presented at **Annex H.**

11. The Likelihood of Contamination from Allied Ordnance

11.1. Introduction

When undertaking construction work within or immediately adjacent to a site with previous and/or current military use, it is often considered likely to contain an elevated risk of contamination from Allied UXO. This assumption of risk is based on the following reasoning:

- The clearance of ordnance from military camps, depots, storage facilities, ranges and training areas were not always effectively managed, or undertaken to equivalent degrees of certainty. In addition, search and detection equipment used over seventy years ago following WWII has proved ineffective both for certain types of UXO and at depths beyond capability.
- In the vast majority of cases, explosive ordnance would have been stored and available for use at military installations. Ordnance ranged from small arms and land service ammunition to weapons components and larger, aerial delivered items. During periods of heightened activity, ordnance was also frequently lost in transit, particularly between stores and assigned training locations.
- The military generally did not anticipate that their land would be later sold for civilian development, and consequently appropriate ordnance disposal procedure was not always adhered to. It was not uncommon for excess or unwanted ordnance to be buried or burnt within the perimeters of a military establishment as a means of disposal. Records of such practice were rarely kept.

There are several factors that may serve to either affirm, increase, or decrease the level of risk within a site with a history of military usage. Such factors are typically dependent upon the proximity of the proposed area of works to training activities, munition productions and storage, as well as its function across the years.

This section will examine the history of the proposed site and assess to what degree, if any, the site could have become contaminated as a result of the military use of the surrounding area.

11.2. Military Features in Dumfriesshire

Large numbers of military sites, including army camps/training grounds, RAF Stations, anti-aircraft batteries, decoy sites and a range of anti-invasion defences are recorded across large parts of rural Scotland; physical evidence of much of which still survives to this day. Historical records, including war office logs, defence mapping and a number of open sources were checked for any reference to any military features in the immediate site area. Any military sites found relevant to the site are discussed below:

11.3. Langholme Military Training Ranges

Available records suggest that during WWII, the site was partially situated within the boundary of a military training and firing range, Langholme Range, which is recorded to have been used by the Royal Artillery Regiment as well as troops of No.2 Commando. A number of other military ranges are also recorded to have been located in the surrounding vicinity, which was deemed an ideal training environment for specialist troops by the War Office. Such ranges were often used for weapons training, firing practice and military exercises designed to simulate combat situations.

Two Air Ministry maps were acquired from the National Archives showing military ranges and firing danger areas in the United Kingdom. These maps were checked for the presence of any military features within the site and its surrounding area. These maps are included in **Annex I** and are described below.

Military Range Maps	
Date Range	**Comments**
Air Ministry Map of Restricted Flying Areas, March 1943	This map indicates the site area is situated adjacent to a restricted flying area, Langholm Range, with a danger height of 20,000 feet. This significant height warning suggests the range was used to conduct firing exercises with artillery of a significant calibre, such as 25 pounder field guns or howitzers.
Air ministry Map of Armament Training Areas, May 1945	This map shows a large portion of the site to be situated within a designated armament training area, identified as Langholm Range. This range is highlighted to have a danger height of some 20,000 feet, suggesting it was used for practice by large calibre weapons such as artillery.

11.4. Langholme Artillery Range

1st Line Defence has obtained a range of military mapping and war office documentation covering the area of the site. However limited information was found in regard to the exact extent and nature of Langholm Artillery Range, which occupied a significant proportion of the proposed site. In particular Ministry of Defence records concerning historic defence estate land and byelaws in the Borders and Dumfries area were consulted but are currently unavailable. As a result little is currently known concerning the operational focus of this particular establishment and the type of weapons training that took place.

It is anticipated however that the section of Langholme Range covering the site was sizable in both scale and size and was employed as an artillery range, due to it's recorded 'danger height' of up to 20,000ft. It is also anticipated that Langholm Range was developed and expanded as part of a series of ranges created to train Allied forces prior to operations in Europe during the latter stages of the war. Large sections of the former artillery range, including land to the immediate south-east of the site, were later forested in the years following WWII by allied soldiers and form part of what is now the Ae Forest.

11.5. No.2 Commando Divisional Battle School, Moffat

Available evidence suggests that the countryside surrounding Moffat was designated as a training area of the British Army's No. 2 Commando, elite raiding troops tasked to attack axis targets and installations deep behind enemy lines. Photographs of Commando training in Scotland are presented in **Annex J**.

Official War Diaries for No.2 Commando dating from the formation of the unit in 1941 to its disbandment in 1945 were obtained from The National Archives. Whilst the records do refer to Commando training in the Moffat area, they are not considered comprehensive and only provide a brief description of exercises and training.

Extracts of this diary referring to the Moffat region and potentially the site area are listed in the table below, with original photographs of this record presented in **Annex K**, with areas of particular relevance to the site picked out in bold.

No.2 Commando War Diary 1941-1945	
Date Range	**Description**
3rd July 1941	20 officers and men flew over **troops camouflaged on ground at Moffat** and Lockerbie. Overall a very successful effort. Preliminary slips arranged for an **inter-commando exercise**.
14th July 1941	**Shooting on range. Combined exercises with the Home Guard and demolitions work.** Packing and carrying.
1st September 1941	Parties of troops out on **night exercises, which included exercises based on use of air photography of surrounding towns.**

11.6. Home Guard Auxiliary Units, Moffat and Beattock

Available evidence suggests that Home Guard Auxiliary Units were located at both Moffat[2] and Beattock[3] within proximity to the site. Auxiliary units were sanctioned by Winston Churchill to act as an organised Guerrilla fighting force, intended to fight on in the event that Britain was invaded.

Auxiliary units were specially trained in sabotage, ambush and demolition, and we heavily armed with a variety of special weapons including plastic explosives, American-made automatic weapons and high explosive and incendiary grenades.

GHQ Home Guard Auxiliary files were obtained from The National Archives. These files, collected by General Headquarters on instruction from the Cabinet Office, detail the organisation and weaponry carried by auxiliary units as well as information regarding their training. Whilst these files were consulted, no additional information was present regarding the Moffat and Beattock Units.

Examples of weapons and ordnance commonly issued to Home Guard Auxiliary Units is presented in **Annex L.**

[2] *https://www.coleshillhouse.com/moffat-auxiliary-unit-patrol.php*
[3] *https://www.coleshillhouse.com/beattock-auxiliary-unit-patrol.php*

11.7. Explosive Ordnance Clearance Tasks

A large number of Explosive Ordnance Clearance Tasks are recorded within areas surrounding the site. The closest of these tasks was recorded to have taken place in the immediate area to the south-east of site, surrounding Ae Forest. Three tasks took place between 1986 and 1993. These appear to have been undertaken prior to tree planting; the closest of which was recorded approximately 1km from the proposed site boundary, however owing to the limitations of this data set, the exact locations of these tasks is not known, with the possibility that some tasks may have been undertaken within the site.

The first task, in 1956, covered an area of approximately 40Ha and recovered 38 live and 106 expended items of ordnance. The second task, in 1987, also covered approximately 40Ha and recovered 21 live and 118 expended items of ordnance. A third task was planned within this area in 1993 but was not undertaken due to access limitations. An additional EOC task is also recorded approximately 2.2km south-east of the site at Stidrigg Farm in 1956, covering an area of approximately 0.2Ha. This task recovered 25 expended or inert items of ordnance.

Ten further EOC tasks are recorded to the north of Moffat, some 6km east of the site between 1984 and 1994. Whilst no indication of the nature and types of ordnance uncovered during these tasks could be found, the quantity of both live and expended items suggests that this UXO may have been SAA or LSA. Indeed, some 889 live and 1,869 expended items were found over the ten year period.

11.8. Evaluation of Contamination Risk from Allied UXO

1st Line Defence has considered the following potential sources of Allied ordnance contamination:

Sources of Allied UXO Contamination	Conclusion
Military Camps *Military camps present an elevated risk from ordnance simply due to the large military presence and likelihood of associated live ordnance training.*	Whilst no positive evidence could be found to confirm the presence of a military camp within the boundary of the site, it is possible that some form of temporary military camp was present within the site during its usage as a firing range, or during the potential usage of the site for commando training.
Anti-Aircraft Defences *Anti-Aircraft defences were employed across the country. Proximity to anti-aircraft defences increases the chance of encountering AA projectiles.*	1st Line Defence could find no evidence of Anti-Aircraft defences such as a HAA or LAA gun emplacement occupying or bordering the site. The closest HAA was located approximately 55km north-east of the site, however the range of a projectile can be up to 15km. The conditions in which HAA or LAA projectiles may have fallen unnoticed within a site footprint are analogous to those regarding German aerial delivered ordnance.
Home Guard Activity *The Home Guard regularly undertook training and ordnance practice in open areas, as well as burying ordnance as part of anti-invasion defences.*	Available records indicate the presence of two Home Guard Auxiliary units based in the area surrounding the site. These units were often heavily armed with a variety of small arms and ordnance, and operated from concealed underground operational bases. Although no positive evidence could be found, it is possible that Auxiliary forces may have been based within the site area. Additional information suggests that local Home Guard forces undertook exercises and demolition training alongside No. 2 Commando in the Moffat area, potentially within the site boundary.

Defensive Positions *Defensive positions suggest the presence of military activity, which is often indicative of ordnance storage, usage or disposal.*	No evidence could be found to positively confirm the presence of defensive features located on or bordering the site footprint.
Training or firing ranges *Areas of ordnance training saw historical ordnance usage in large numbers, often with inadequate disposal of expended and live items. The presence of these ranges significantly impact on the risk of encountering items of ordnance in their vicinity.*	Military mapping, including 'danger area mapping' and 'armament training areas mapping' indicate that Langholm Artillery range was situated directly within and in the immediate area during the latter stages of WWII and occupied two separate parcels of land. The exact nature of this range and the extent of its boundary is unclear from the information available, however it can be confirmed that the range had a 'danger height' of 20,000ft and that a large quantity of the site area was situated within the boundary of the range. Additional records suggest that British Army Commandos used the moors and forests surrounding Moffat for battle training, demolitions training and exercises, potentially involving the use of live ordnance.
Defensive Minefields *Minefields were placed in strategic areas to defend the country in the event of a German invasion. Minefields were not always cleared with an appropriate level of vigilance.*	There is no evidence of defensive minefields affecting the site.
Ordnance Manufacture *Ordnance manufacture indicates an increased chance that items of ordnance were stored, or disposed of, within a location.*	No positive evidence of ordnance being stored, produced, within the proposed site could be found.
Military Related Airfields *Military airfields present an elevated risk from ordnance simply due to the large military presence and likelihood of associated live ordnance training or bombing practice.*	The site was not situated within the perimeters or vicinity of a military airfield.
Explosive Ordnance Clearance Tasks	A number of Explosive Ordnance Clearance operations are however recorded to have taken place to the immediate south-east of the site, within what is now Ae Forest, between 1956 and 1993. Large quantities of both live and expended items of ordnance were discovered at two EOC tasks during this period. Additionally, a number of other tasks located to the north-east in the vicinity of Moffat unearthed a further 889 live and 1,869 expended items.

12. Introduction to German Aerial Delivered Ordnance

12.1. General

During WWI and WWII, the UK was subjected to bombing which often resulted in extensive damage to city centres, docks, rail infrastructure and industrial areas. The poor accuracy of WWII targeting technology and the nature of bombing techniques often resulted in neighbouring areas to targets sustaining collateral damage.

In addition to raids which concentrated on specific targets, indiscriminate bombing of large areas also took place, this occurred most prominently in the London 'Blitz', though affected many other towns and cities. As discussed in the following sections, a proportion of the bombs dropped on the UK did not detonate as designed. Although extensive efforts were made to locate and deal with these UXBs at the time, many still remain buried and can present a potential risk to construction projects.

The main focus of research for this section of the report will concern German aerial delivered ordnance dropped during WWII, although WWI bombing will also be considered.

12.2. Generic Types of WWII German Aerial Delivered Ordnance

To provide an informed assessment of the hazards posed by any items of unexploded ordnance that may remain in situ on site, the table below provides information on the types of German aerial delivered ordnance most commonly used by the Luftwaffe during WWII. Images and brief summaries of the characteristics of these items of ordnance are listed in **Annex M**.

Generic Types of WWII German Aerial Delivered Ordnance		
Type	**Frequency**	**Likelihood of detection**
High Explosive (HE) bombs	In terms of weight of ordnance dropped, HE bombs were the most frequently deployed by the Luftwaffe during WWII.	Although efforts were made to identify the presence of unexploded ordnance following an air raid, often the damage and destruction caused by detonated bombs made observation of UXB entry holes impossible. The entry hole of an unexploded bomb can be as little as 20cm in diameter and was easily overlooked in certain ground conditions (see **Annex N**). Furthermore, ARP documents describe the danger of assuming that damage, actually caused by a large UXB, was due to an exploded smaller bomb. UXBs therefore present the greatest risk to present–day intrusive works.
1kg Incendiary bombs (IB)	In terms of the number of weapons dropped, small IBs were the most numerous. Millions of these were dropped throughout WWII.	IBs had very limited penetration capability and in urban areas would often have been located in post-raid surveys. If they failed to initiate and fell in water, on soft vegetated ground, or bombed rubble, they could easily go unnoticed.
Large Incendiary bombs (IB)	These were not as common as the 1kg IBs, although they were more frequently deployed than PMs and AP bomblets.	If large IBs did penetrate the ground, complete combustion did not always occur and in such cases they could remain a risk to intrusive works.
Aerial or Parachute mines (PM)	These were deployed less frequently than HE and IBs due to size, cost and the difficulty of deployment.	If functioning correctly, PMs generally would have had a slow rate of descent and were very unlikely to have penetrated the ground. Where the parachute failed, mines would have simply shattered on impact if the main charge failed to explode. There have been extreme cases when these items have been found unexploded. However, in these scenarios, the ground was either extremely soft or the munition fell into water.
Anti-personnel (AP) bomblets	These were not commonly used and are generally considered to pose a low risk to most works in the UK.	SD2 bomblets were packed into containers holding between 6 and 108 submunitions. They 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.

12.3. Failure Rate of German Aerial Delivered Ordnance

It has been estimated that 10% of WWII German aerial delivered HE bombs failed to explode as designed. Reasons for why such weapons might have failed to function as designed include:

- Malfunction of the fuze or gain mechanism (manufacturing fault, sabotage by forced labour or faulty installation).
- Many were fitted with a clockwork mechanism that could become immobilised on impact.
- Failure of the bomber aircraft to arm the bombs due to human error or an equipment defect.
- Jettisoning the bomb before it was armed or from a very low altitude. This most likely occurred if the bomber aircraft was under attack or crashing.

From 1940 to 1945 bomb disposal teams reportedly dealt with a total of 50,000 explosive items of 50kg and over, 7,000 anti-aircraft projectiles and 300,000 beach mines. Unexploded ordnance is still regularly encountered across the UK, see press articles in **Annex O**.

12.4. UXB Ground Penetration

An important consideration when assessing the risk from a UXB is the likely maximum depth of burial. There are several factors which determine the depth that an unexploded bomb will penetrate:

- Mass and shape of bomb.
- Height of release.
- Velocity and angle of bomb.
- Nature of the ground cover.
- Underlying geology.

Geology is perhaps the most important variable. If the ground is soft, there is a greater potential of deeper penetration. For example, peat and alluvium are easier to penetrate than gravel and sand, whereas layers of hard strata will significantly retard and may stop the trajectory of a UXB.

12.4.1. The J-Curve Effect

J-curve is the term used to describe the characteristic curve commonly followed by an aerial delivered bomb dropped from height after it penetrates the ground. Typically, as the bomb is slowed by its passage through underlying soils, its trajectory curves towards the surface. Many UXBs are found with their nose cone pointing upwards as a result of this effect. More importantly however is the resulting horizontal offset from the point of entry. This is typically a distance of about one third of the bomb's penetration depth, but can be higher in certain conditions.

12.4.2. WWII UXB Ground 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 (BD) teams. Conclusions were made as to the likely average and maximum depths of penetration of different sized bombs in different geological strata.

For example, the largest common German bomb (500kg) had a likely concluded penetration depth of 6m in sand or gravel but 11m in clay. The maximum observed depth for a 500kg bomb was 11.4m and for a 1,000kg bomb 12.8m. Theoretical calculations suggested that significantly greater penetration depths were probable.

12.4.3. Site Specific Bomb Penetration Considerations

When considering an assessment of the bomb penetration at the site of proposed works the following parameters have been used:

- WWII geology – Gala Group Formation.
- Impact angle and velocity – 10-15° from vertical and 270 metres per second.
- Bomb mass and configuration – The 500kg SC HE bomb, without retarder units or armour piercing nose (this was the largest of the common bombs used against Britain).

It has not been possible to determine maximum bomb penetration capabilities at this stage due to the lack or limitations of site specific geotechnical information. An assessment can be made once such information becomes available or by an UXO Specialist on-site.

12.5. V-Weapons

Hitler's 'V-weapon' campaign began from mid-1944. It used newly developed unmanned cruise missiles and rockets. The V-1 known as the *flying bomb* or *pilotless aircraft* and the V-2, a long range rocket, were launched from bases in Germany and occupied Europe. A total of 9,251 V-1s and 1,115 V-2s were recorded in the United Kingdom.

Although these weapons caused considerable damage, their range was limited by their position of deployment across Europe and as a result the vast majority of V-weapon strikes were directed against targets in the south-east of England, predominantly in the London Boroughs and Home Counties. Whilst some V-1 Flying bombs were launched at further targets from modified Heinkel bombers on Christmas Eve 1944, targets beyond the Midlands were typically too far to be considered for V-weapon strikes by the Luftwaffe.

The risk from V-weapons is therefore considered negligible and will not be further addressed in this report.

13. The Likelihood of Contamination from German Aerial Delivered UXBs

13.1. World War I

During WWI Scotland was targeted and bombed by Zeppelin Airships as well as Gotha and Giant fixed-wing aircraft. A WWI map of air raids and naval bombardments across England and Scotland was consulted. This source does not record any WWI bombing incidents to have affected the region of the site.

WWI bombs were generally smaller than those used in WWII and were dropped from a lower altitude. This resulted 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 risk from WWI UXBs is considered low and will not be further addressed in this report.

13.2. World War II Bombing of Lanarkshire and Dumfriesshire

The Luftwaffe's main objective for the attacks on Britain was to inhibit the country's economic and military capability. To achieve this they targeted airfields, depots, docks, warehouses, wharves, railway lines, factories, and power stations. As the war progressed the Luftwaffe bombing campaign expanded to include the indiscriminate bombing of civilian areas in an attempt to subvert public morale.

During WWII, the site was located partly within the Land Authority (L.A.) of Lanarkshire and partly within the L.A. of Dumfries and Galloway, with both counties recorded to have sustained an overall very low density of bombing. This low density is anticipated to have largely been linked to the relative lack of strategic targets in the area, as well as its rural composition and sparse population.

Indeed, Luftwaffe bombing raids in Scotland were predominantly focused on targeting the large cities such as Edinburgh as well as strategic targets like the naval base at Scapa Flow or the dockyards at Clydebank, near Glasgow. The nearest significant target to the site is anticipated to have been RAF Dumfries, situated some 20km south of the site area.

Official records and documentation from the period indicate that this particular area of Scotland experienced a very low density bombing with only 88 items of ordnance recorded to have fallen across over 600,000 acres of rural land. No bombing was recorded in the large Burgh (town) of Dumfries, or in the nearby small Burghs of Moffat and Lochmaben. As a consequence the risk of encounter from German Air-Delivered Ordnance can be reduced at this particular location. Reference has been made to official Home Office statistics for the area and associated military documentation from the period, which are included in the following sections.

13.3. WWII Home Office Bombing Statistics

The following tables summarise the quantity of German bombs (excluding 1kg incendiaries and anti-personnel bombs) falling on the historic counties Dumfriesshire and Lanarkshire between 1940 and 1945. Please note that during this period the site was situated on the border of both regions.

Record of German Ordnance Dropped on Dumfriesshire		
Area Acreage		**683,612**
Weapons	High Explosive Bombs (all types)	71
	Parachute Mines	5
	Oil Bombs	0
	Phosphorus Bombs	0
	Fire Pot	12
	Pilotless Aircraft (V1)	0
	Long Range Rockets (V2)	0
Total		**88**
Number of Items per 1000 acres		**0.1**

Record of German Ordnance Dropped on Lanarkshire		
Area Acreage		**511,567**
Weapons	High Explosive Bombs (all types)	296
	Parachute Mines	26
	Oil Bombs	3
	Phosphorus Bombs	0
	Fire Pot	0
	Pilotless Aircraft (V1)	0
	Long Range Rockets (V2)	0
Total		**325**
Number of Items per 1000 acres		**0.6**

Source: Home Office Statistics
This table does not include UXO found during or after WWII.

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.

13.4. Plot of Missiles Dropped on Scotland, 1939-1945

A map plotting the locations of incidents of bombing across Scotland was obtained from the National Archives of Scotland. Broken down into separate counties, the positions plot the approximate location of incidents of bombing alongside the amount of bombs dropped during the particular raid. These then correspond with supplementary written records that provide further locational information and any notes on particulars such as bomb damage caused or action taken.

Mapping sheets covering Lanarkshire and Dumfriesshire were checked for any indication of bombing to the site area. No plots are visible within the general vicinity of the site area – see **Annex P**. The associated written records were checked to ensure no bombs were missed from the mapping, although no reference was found during this consultation.

As a result, this source suggests the area was not targeted by the Luftwaffe, which correlates with very low density recorded by Home Office bombing statistics.

13.5. Post-war Aerial Photography

Enquiries were made to obtain WWII-era aerial photography of the site, however unfortunately no photographs from this period were available. Instead, high-resolution scans of Post-war aerial photography for the site area (dating from 1988) were obtained from the National Collection of Aerial Photography. These photographs provide a record of the potential composition of the site during the war, as well as its condition following the war (**see Annex Q**).

Post-war Aerial Photography	
Image Number	**Description**
Image 1-9	These photographs depict the collective site area in the post-war period. The site is dominated by a mixture of open moorland, forest and hills, with the large Daer Reservoir binding the site in the north-west. The site itself appears to retain much the same structural composition, with very little visible development, aside from the construction of the Daer Dam and structures associated with the reservoir. The only discrepancy with mapping is a number of Sheepfolds visible within the north-easternmost section of the site.

13.6. 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 of an entry hole was 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 or 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.

1st Line Defence holds no records of officially registered abandoned bombs at or near the site of the proposed works.

13.7. Bomb Disposal Tasks

The information service from the Explosive Ordnance Disposal (EOD) Archive Information Office at 33 Engineer Regiment (EOD) (now 29 Regt) is currently facing considerable delay. It has therefore not been possible to include any updated official information regarding bomb disposal tasks with regards to this site. If any relevant official information is received at a later date, Natural Power will be advised.

Reference was however found to a number of Explosive Ordnance Clearance (EOC) tasks recorded to have taken place in the area surrounding the site. Further analysis of these tasks is presented in **Section 11.7.**

13.8. Evaluation of German Aerial Delivered UXO Records

Factors	Conclusion
Density of Bombing *It is important to consider the bombing density when assessing the possibility that UXBs remain in an area. High bombing density could allow for error in record keeping due to extreme damage caused to the area.*	Both Lanarkshire and Dumfries were subjected to an overall very low density of bombing, with respective averages of 0.6 and 0.3 bombs recorded per 1,000 acres, according to Home Office statistics. Available plots of missiles dropped on Scotland do not indicate any incidents to have affected the site or its wider surrounding area, with the closest bombing incidents recorded a number of kilometres to the south-west and north respectively. The very low density of bombing in these districts can likely accounted for by the lack of Luftwaffe strategic targets in the area as well as its rural composition.
Damage *If buildings or structures on a site sustained bomb or fire damage any resulting rubble and debris could have obscured the entry holes of unexploded bombs dropped during the same or later raids. Similarly, a high explosive bomb strike in an area of open agricultural land will have caused soil disturbance, increasing the risk that a UXB entry hole would be overlooked.*	Historical Ordnance Survey mapping does not highlight any significant changes to have taken place between pre- and post-war mapping, with the site remaining situated within an area of vacant ground both pre- and post-war. Additionally, no obvious indicators of damage, such as cratering ground disturbances, are visible on site or in the immediate vicinity within post-war aerial photography.
Access Frequency *UXO in locations where access was irregular would have a greater chance of passing unnoticed than at those that were regularly occupied. The importance of a site to the war effort is also an important consideration as such sites are likely to have been both frequently visited and subject to post-raid checks for evidence of UXO.*	Owing to the remote location of the site, within an area of sparsely occupied moors, hills and forest, the majority of the site is anticipated to have had very little access during WWII. Although the usage of the land by the military for training and as a firing range would have increased the degree of access, the exact locations and regularity of military exercises are not known. As such it is not possible to confirm to confidently anticipate the degree of military access to the site.
Ground Cover *The nature of the ground cover present during WWII would have a substantial influence on any visual indication that may indicate UXO being present.*	Being situated within an area of moors, hills and forest sparsely occupied by structures during and following WWII, the ground cover on site is anticipated to have been largely unconducive to the discovery of evidence of UXO.
Bomb Failure Rate	There is no evidence to suggest that the bomb failure rate in the locality of the site would have been dissimilar to the 10% normally used.
Abandoned Bombs	1st Line Defence holds no records of abandoned bombs at or within the site vicinity.
Bombing Decoy sites	1st Line Defence could find no evidence of bombing decoy sites within the site vicinity.
Bomb Disposal Tasks	1st Line Defence could find no evidence of bomb disposal tasks within the site boundary and immediate area.

14. The Likelihood of UXO Contamination Summary

The following table assesses the likelihood that the site was contaminated by items of German aerial delivered and Allied ordnance. Factors such as the risk of UXO initiation, remaining, and encountering will be discussed later in the report.

UXO Contamination Summary	
Quality of the Historical Record	The research has evaluated pre- and post-WWII Ordnance Survey maps, Luftwaffe reconnaissance imagery, Air Ministry mapping of Restricted Flying areas and armament training areas, No.2 Commando War Diaries, Home Guard Auxiliary records plots of missiles dropped on Scotland, Scottish bomb incident record, post-war aerial imagery, in-house data sets and Home Office statistics. The record set is of an overall poor quality. Whilst elements of the record set such as bombing records are detailed and appear comprehensive, many other record sets are lacking in detail and with regard to immediate post-war imagery are not available. This is anticipated to be the result of the very rural composition of the site, as well as the secretive nature of both commando and Home Guard Auxiliary activities. Owing to the limitations of the record set, it has not been possible to confirm or identify the precise locations of allied military activity. Equally it may be the case that additional military activity took place within the site area that was simply not recorded.
Allied Ordnance	• During WWII, a large portion of the site is recorded to have been located within the boundary of a military range, Langholm Range. The exact designation and usage of this range could not be confirmed, however Air Ministry danger areas mapping suggests that the range had a danger height of 20,000 feet, suggesting that large calibre weapons may have been firing on the range. • A large number of Explosive Ordnance Clearance Tasks are recorded within areas surrounding the site. The closest of these tasks was recorded to have taken place in the immediate area to the south-east of site, surrounding Ae Forest. Three tasks took place between 1986 and 1993. These appear to have been undertaken prior to tree planting; the closest of which was recorded approximately 1km from the proposed site boundary, however owing to the limitations of this data set, the exact locations of these tasks is not known, with the possibility that some tasks may have been undertaken within the site. • Our experience has shown that some degree of UXO contamination nearly always occurs within areas of land previously situated within the boundary of historic artillery ranges. As a result, the areas of the proposed site recorded to have been located within the boundary of the range are considered to be at an elevated risk from historic allied UXO. Items of UXO were also recovered during the construction of Harestanes wind farm, see **Annex O4**. • The general area encompassing the site is also recorded to have been used as a training area for British army troops of No.2 Commando. War diaries record troops engaging in night exercises, demolition training and collaboration with the Home Guard, potentially within the boundary of the site or within close proximity to it. As elite raiding troops, it is thought likely that such exercises and training would have involved the usage of live ordnance. • Anecdotal evidence also suggests the presence of Auxiliary unit bases in the area of Moffat and Beattock. Whilst no positive evidence could be found to confirm the presence of these units within the site area, there is a possibility that training may have been undertaken within proximity to the site, owing to it being an established military range. • Based on these records, it is evident that items of Small Arms Ammunition and Land Service Ammunition were present and potentially being used on the site during war – conceivably across the whole area given the possibility of ground

	training. There is considered to be an elevated risk of UXO contamination (above that of the background level for the wider area) across the whole site area as a result. However, of most concern is the area of the site within the mapped bounds of the former WWII artillery range. Whilst it is not possible to discount that artillery could have ended up outside the designated range area, it is reasonable to assume that most of the unexploded and mis-fired projectiles will be within the range boundaries. The majority of any contamination is likely to be centred around a particular target area within the range – however it has not proved possible to ascertain where this was located. • As a result of the above, the site area has been 'zoned' – see risk map in **Annex R**. The southern section which falls within the mapped extents of the Langholm firing training area is deemed to be at **Medium Risk** of contamination. It has not been possible to entirely discount the risk of contamination in the northern section of the site which fell outside of the range boundary (given possible mis-firing and references to ground training in the general area), however the risk here is not considered to be as significant. This area is deemed to be at **Low-Medium Risk**.
German Aerial Delivered Ordnance	• During WWII, bombing in Scotland was generally concentrated on major urban areas such as Edinburgh and Glasgow, and on significant military and civilian industrial targets, like the military bases at Scapa Flow and the shipyard at Clydebank. Home Office statistics reflect this, indicating that Dumfriesshire and Lanarkshire both experienced an almost negligible bombing density, with only 0.1 and 0.6 items recorded per 1,000 acres respectively. • Plots of missiles dropped in Scotland, do not record any bombs to have fallen within the area of the site, with the closest recorded bombing located some 5km to the north of the site. It is therefore considered very unlikely that unexploded German ordnance fell within the site boundary, though it cannot be completely discounted.

15. The Likelihood that UXO Remains

15.1. Introduction

It is important to consider the extent to which any explosive ordnance clearance (EOC) activities or extensive ground works have occurred on site. This may indicate previous ordnance contamination or reduce the risk that ordnance remains undiscovered.

15.2. UXO Clearance

Former military sites (or at least certain areas within their footprint) are often subject to clearance before they are returned to civilian use by the MoD. If a site is retained by the military, it is possible that no clearance operations have ever been undertaken. However, UXO is sometimes still discovered even on sites where clearance operations are known to have been undertaken. The detail and level of survey and targeted investigation undertaken by the military will depend on the former use of the site and purpose of the clearance (i.e. disposal, redevelopment, return to agriculture, etc.).[4] The level of clearance will also depend on the available technology, resources and practices of the day.

It therefore cannot be assumed that the risk of UXO remaining has been completely mitigated, even though EOC tasks have been undertaken at a former military site.

[4] *CIRIA C681*

15.3. Post-war Redevelopment

Very Little development has taken place on site in post-war years, with the site area comprising the same open woodland and moors that it had pre-war. The risk from deep-buried unexploded bombs is only considered mitigated at locations where post war piling or deep foundations have taken place.

16. Likelihood of UXO Encounter

16.1. Introduction

For UXO to pose a risk at a site, there should be a means by which any potential UXO might be encountered on that site.

The likelihood of encountering UXO on the site of proposed would depend on various factors, such as the type of UXO that might be present and the intrusive works planned on site. In most cases, UXO is more likely to be present below surface (buried) than on surface.

In general, the greater the extent and depth of intrusive works, the greater the risk of encountering. The most likely scenarios under which items of UXO could be encountered during construction works is during piling, drilling operations or bulk excavations for basement levels. The overall risk will depend on the extent of the works, such as the numbers of boreholes/piles (if required) and the volume of the excavations.

16.2. Land Service/Small Arms Ammunition Encounter

Items of LSA and SAA are mostly encountered in areas previously used for military training. Such items could have been lost, burnt, buried or discarded during being in use by the military. Due to this, LSA are most likely to be encountered at relatively shallow depths – generally in the top 1m below ground level. Therefore, such items are most likely to be encountered during open excavation works. In some cases, there is the potential that LSA or SAA may be present on the surface of the ground – especially in areas with active military use or were recently in use by the MoD.

17. The Likelihood of UXO Initiation

17.1. Introduction

UXO does not spontaneously explode. Older UXO devices will require an external event/energy to create the conditions for detonation to occur. The likelihood that a device will function can depend on a number of factors including the type of weaponry, its age and the amount of energy it is struck with.

17.2. Initiating Aerial Delivered Ordnance

Unexploded bombs do not spontaneously explode. All high explosive filling requires significant energy to create the conditions for detonation to occur.

In recent decades, there have been a number of incidents in Europe where Allied UXBs have detonated, and incidents where fatalities have resulted (some examples are presented in **Annex O**). There have been several hypotheses as to the reason why the issue is more prevalent in mainland Europe – reasons could include the significantly greater number of bombs dropped by the Allied forces on occupied Europe, the preferred use by the Allies of mechanical rather than electrical fuzes, and perhaps just good fortune. The risk from UXO in the UK is also being treated very seriously in many sectors of the construction industry, and proactive risk mitigation efforts will also have affected the lack of detonations in the UK.

There are certain construction activities which make initiation more likely, and several potential initiation mechanisms must be considered:

UXB Initiation	
Direct Impact	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, onto the main body of the weapon to initiate a buried iron bomb. Such violent action can cause the bomb to detonate.
Re- starting the Clock	A small proportion of German WWII bombs employed clockwork fuzes. It is probable that significant corrosion would have taken place within the fuze mechanism over the last 70+ years that would prevent clockwork mechanisms from functioning. Nevertheless, it was reported that the clockwork fuze in a UXB dealt with by 33 EOD Regiment in Surrey in 2002 did re-start.
Friction Impact	The most likely scenario resulting in the detonation of a UXB is friction impact initiating the shock-sensitive fuze explosive. The combined effects of seasonal changes in temperature and general degradation over time can cause explosive compounds to crystallise and extrude out from the main body of the bomb. It may only require a limited amount of energy to initiate the extruded explosive which could detonate the main charge.

17.3. Land Service /Small Arms Ammunition Initiation

Items of LSA generally do not become inert or lose their effectiveness with age. Time can 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.

If left alone, an item of LSA will pose little/no risk of initiation. Therefore, if it is not planned to undertake construction/intrusive works at the site, the risk of initiation of any LSA that may be present would be negligible. Similarly, those accessing a contaminated area would be at minimal risk if they do not interfere with any UXO present on the ground. Clearly for many end uses however, the presence of UXO anywhere on a site would not be acceptable as it could not be guaranteed that the items will not be handled, struck or otherwise affected, increasing the likelihood of initiation.

Items of SAA are much less likely to detonate than LSA or UXBs, but can be accidentally initiated by striking the casing, coming into contact with fire, or being tampered with/dismantled. It is likely that the detonation of an item of SAA would result in a small explosion, as the pressure would not be contained within a barrel. Detonation would only result in local overpressure and very minor fragmentation from the cartridge case.

18. Consequences of Initiation/Encounter

18.1. Introduction

The repercussions of the inadvertent detonation of UXO during intrusive ground works, or if an item or ordnance is interfered with or disturbed, are potentially profound, both in terms of human and financial cost. A serious risk to life and limb, damage to plant and total site shutdown during follow-up investigations are potential outcomes. However, if appropriate risk mitigation measures are put in place, the chances of initiating an item of UXO during ground works is comparatively low.

The consequences of encountering UXO can be particularly notable in the case of high-profile sites (such as airports and train stations) where it is necessary to evacuate the public from the surrounding area. A site may be closed for anything from a few hours to a week with potentially significant cost in lost time. It should be noted that even the discovery of suspected or possible item of UXO during intrusive works (if handled solely through the authorities), may also involve significant loss of production

18.2. Consequences of Detonation

When considering the potential consequences of a detonation, it is necessary to identify the significant receptors that may be affected. The receptors that may potentially be at risk from a UXO detonation on a construction site will vary depending on the site specific conditions but can be summarised as follows:

- People – site workers, local residents and general public.
- Plant and equipment – construction plant on site.
- Services – subsurface gas, electricity, telecommunications.
- Structures – not only visible damage to above ground buildings, but potentially damage to foundations and the weakening of support structures.
- Environment – introduction of potentially contaminating materials.

19. 1st Line Defence Risk Assessment

19.1. Risk Assessment Stages

Taking into account the quality of the historical evidence, the assessment of the overall risk from unexploded ordnance is based on the following five considerations:

1. That the site was contaminated with unexploded ordnance.
2. That unexploded ordnance remains on site.
3. That such items will be encountered during the proposed works.
4. That ordnance may be initiated by the works operations.
5. The consequences of encountering or initiating ordnance.

19.2. Assessed Risk Level

Taking into consideration the findings of this study, 1st Line Defence has assessed that the risk from Allied Ordnance is not homogenous across the site footprint. The area of the site recorded within Langholm range has been predominantly assessed as Medium Risk, with the remainder as Low-Medium Risk, resulting from potential military training. A Low Risk from German Air-delivered ordnance has been identified across the site.

Medium Risk – Area recorded within Langholm Range

The majority of the southern half of the site was recorded to have been located within the boundary of a WWII-era military range, and is considered to be a more elevated risk from Allied ordnance as a result.

Ordnance Type	Risk Level			
	Negligible	Low	Medium	High
German Unexploded HE Bombs		✓		
German 1kg Incendiary Bombs		✓		
Artillery Projectiles			✓	
Allied Military Land Service Ammunition (Grenades, Mortars etc.)			✓	
Allied Small Arms Ammunition			✓	

Low-Medium Risk – Area potentially used for military training

The majority of the northern section of the site area. This 'zone' comprises areas that may have been used during the recorded Commando exercises and military training.

Ordnance Type	Risk Level			
	Negligible	Low	Medium	High
German Unexploded HE Bombs		✓		
German 1kg Incendiary Bombs		✓		
Artillery Projectiles		✓		
Allied Military Land Service Ammunition (Grenades, Mortars etc.)		✓		
Allied Small Arms Ammunition		✓		

This report has been undertaken with due diligence, and all reasonable care has been taken to access and analyse relevant historical information. By necessity, when dealing historical evidence, and when making assessments of UXO risk, various assumptions have to be made which we have discussed and justified throughout this report. Our reports take a common-sense and practical approach to the assessment of risk, and we strive to be reasonable and pragmatic in our conclusions.

It should however be stressed that if any suspect items are encountered during the proposed works, 1st Line Defence should be contacted for advice/assistance, and to re-assess the risk where necessary. The mitigation measures outlined in the next section are recommended as a minimum precaution to alert ground personnel to the history of the site, what to look out for, and what measures to take in the event that a suspect item is encountered. It should also be noted that the conclusions of this report are based on the scope of works outlined in the 'Proposed Works' section of this report. Should the scope of works change or additional works be proposed, 1st Line Defence should be contacted to re-evaluate the risk.

20. Proposed Risk Mitigation Methodology

20.1. General

Owing to the complexity of the ground cover present across the site, it is recommended that 1st Line Defence Ltd. be contacted to discuss a bespoke methodology for mitigation measures across the site.

Recommended mitigation measures are likely to include:

Type of Work	Recommended Mitigation Measure
All Works	• **UXO Risk Management Plan** It is recommended that a site-specific plan for the management of UXO risk be written for this site. This plan should be kept on site and be referred to in the event that a suspect item of UXO is encountered at any stage of the project. It should detail the steps to be taken in the event of such a discovery, considering elements such as communication, raising the alarm, nominated responsible persons etc. Contact 1st Line Defence for help/more information. • **Site Specific UXO Awareness Briefings to all personnel conducting intrusive works.** As a minimum precaution, all personnel working on the site should be briefed on the basic identification of UXO and what to do in the event of encountering a suspect item. This should in the first instance be undertaken by a UXO Specialist. Posters and information on the risk of UXO can be held in the site office for reference.
Shallow Intrusive Works/Open Excavations in Medium Risk Area	The most appropriate mitigation methodology would depend on the exact scope of works planned and factors such as access, ground cover and topography. This would need to be discussed with the client in order to put in place a bespoke solution. However, it is likely that the following measures would be viable options: **A Non-Intrusive UXO Magnetometer Survey** • A Non-Intrusive survey is undertaken using a man-portable magnetometer. Data is recorded and then interpreted to map magnetic fields and model discrete magnetic anomalies which may show the characteristics of UXO. The anomalies can then be investigated by a target investigation team. Where this type of survey is not practical (due to for example terrain or ground conditions), on-site UXO specialist support is recommended. **Unexploded Ordnance (UXO) Specialist Presence on Site to support shallow intrusive works** When on site the role of the UXO Specialist would include: • Monitoring works using visual recognition and instrumentation, including immediate response to reports of suspicious objects or suspected items of ordnance that have been recovered by the ground workers on site. • Providing UXO awareness briefings to any uninformed staff and advise staff of the need to modify working practices to take account of the ordnance risk. • To aid incident management which would involve liaison with the local authorities and police should ordnance be identified and present an explosive hazard. **UXO Specialist Search & Clear Operation** • 1st Line Defence can deploy a UXO Specialist with hand held detection equipment to search for ferrous anomalies. The area to be searched is to be confirmed with the Client's site representative. The area will then be visually checked to ensure that all immediately identifiable scrap is removed to reduce spurious signals on the search instruments. The area will be searched in a systematic manner using the primary search instrument (usually a Foerster 4.021). • The targets can be investigated and identified. If the ground dictates that there is a high level of ferrous materials present, then that area can be marked and avoided if required. The client is to clearly demarcate the area to be surveyed prior to commencement and to highlight any known services / underground obstructions. It is important to note that the ground must be level, free of obstacles / obstructions where possible. Where necessary 1st Line Defence would require written approval from the landowner or client to operate on the site area.

In making this assessment and recommending these risk mitigation measures, if known, the 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, 1st Line Defence should be consulted to see if a re-assessment of the risk or mitigation recommendations is necessary.

1st Line Defence Limited **28th February 2020**

This Report has been produced in compliance with the Construction Industry Research and Information Association (CIRIA) C681 guidelines for the writing of Detailed UXO Risk Assessments.

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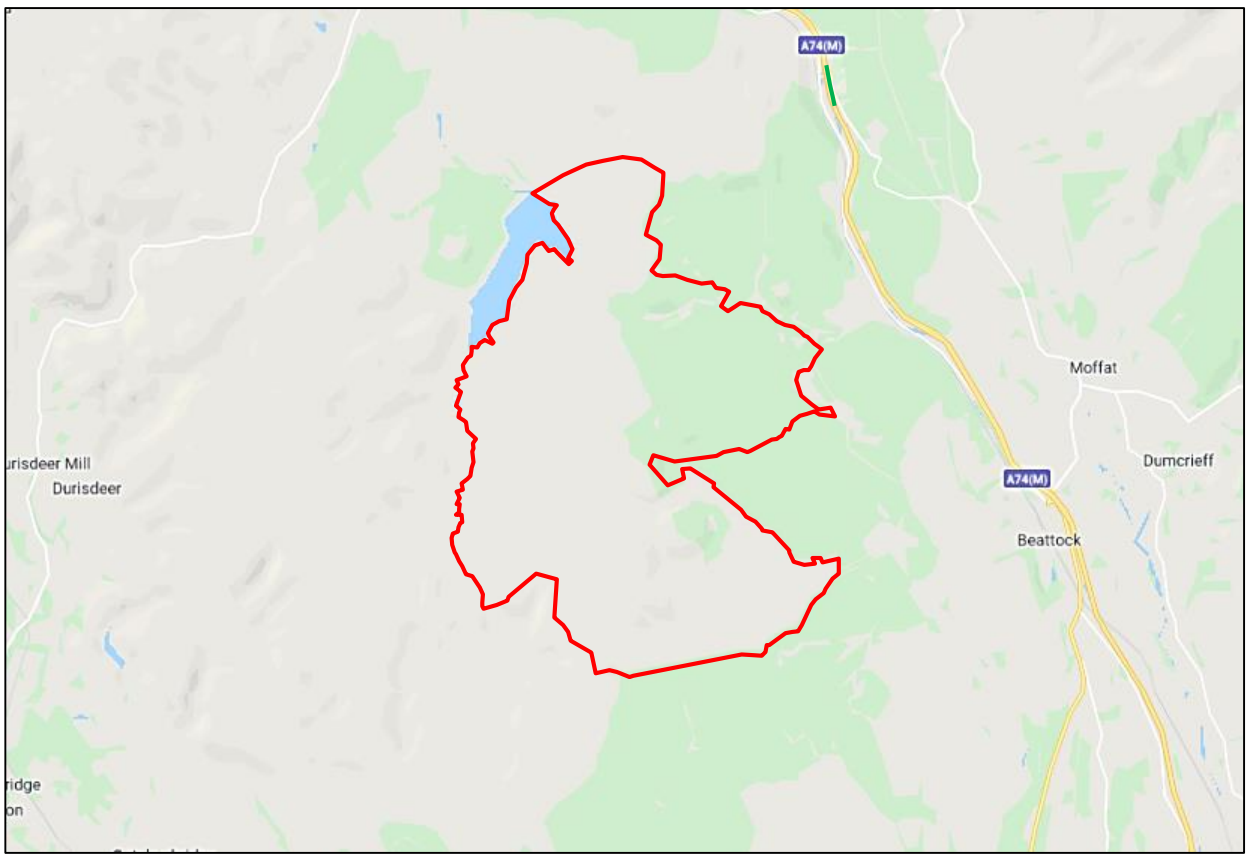
This report has been prepared by 1st Line Defence Limited with all reasonable care and skill. The report contains historical data and information from third party sources. 1st Line Defence Limited has sought to verify the accuracy and comprehensiveness of this information where possible but cannot be held accountable for any inherent errors. Furthermore, whilst every reasonable effort has been made to locate and access all relevant historical information, 1st Line Defence cannot be held responsible for any changes to risk level or mitigation recommendations resulting from documentation or other information which may come to light at a later date.

Site Location Maps

Annex: **A**



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Client: **Natural Power**

Project: **Daer Reservoir, Biggar**

Ref: **DA10468-00**

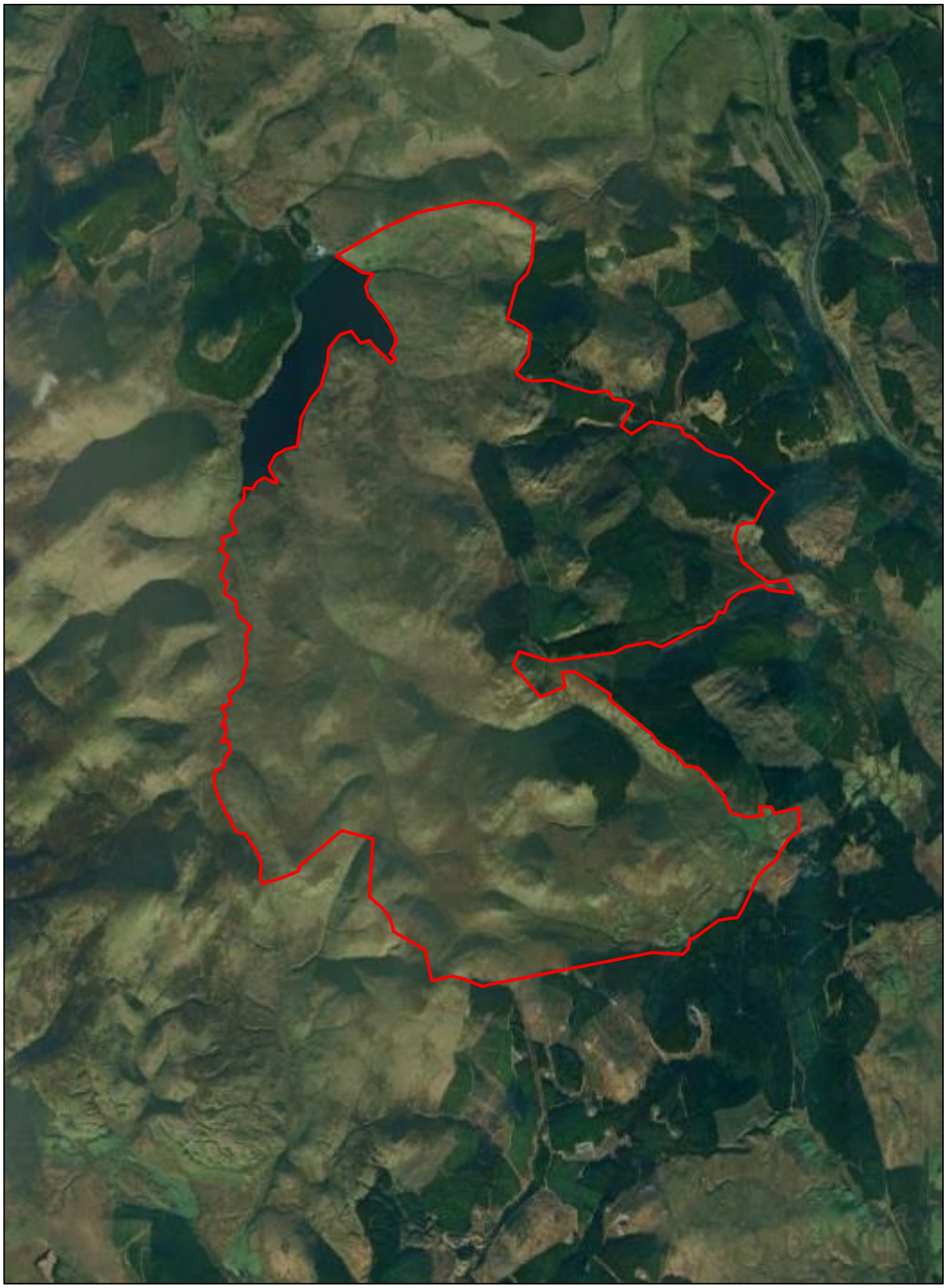
Source: Google Maps

Approximate site boundary

N

Recent Aerial Photography

Annex: **B**



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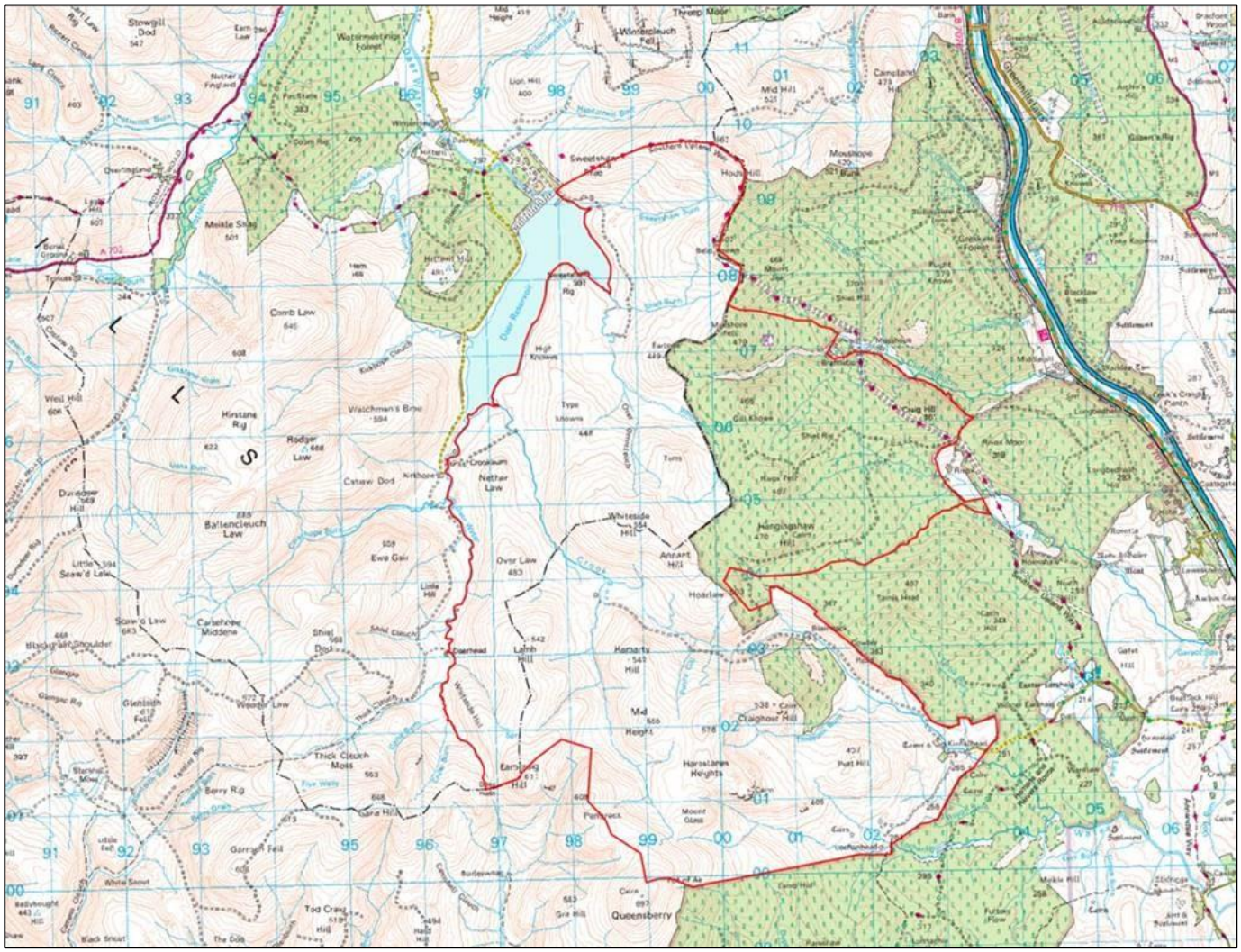
Source: Google Earth ™ Mapping Services

Approximate site boundary

N

Client Provided Site Plan

Annex: **C**



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Approximate site boundary

N

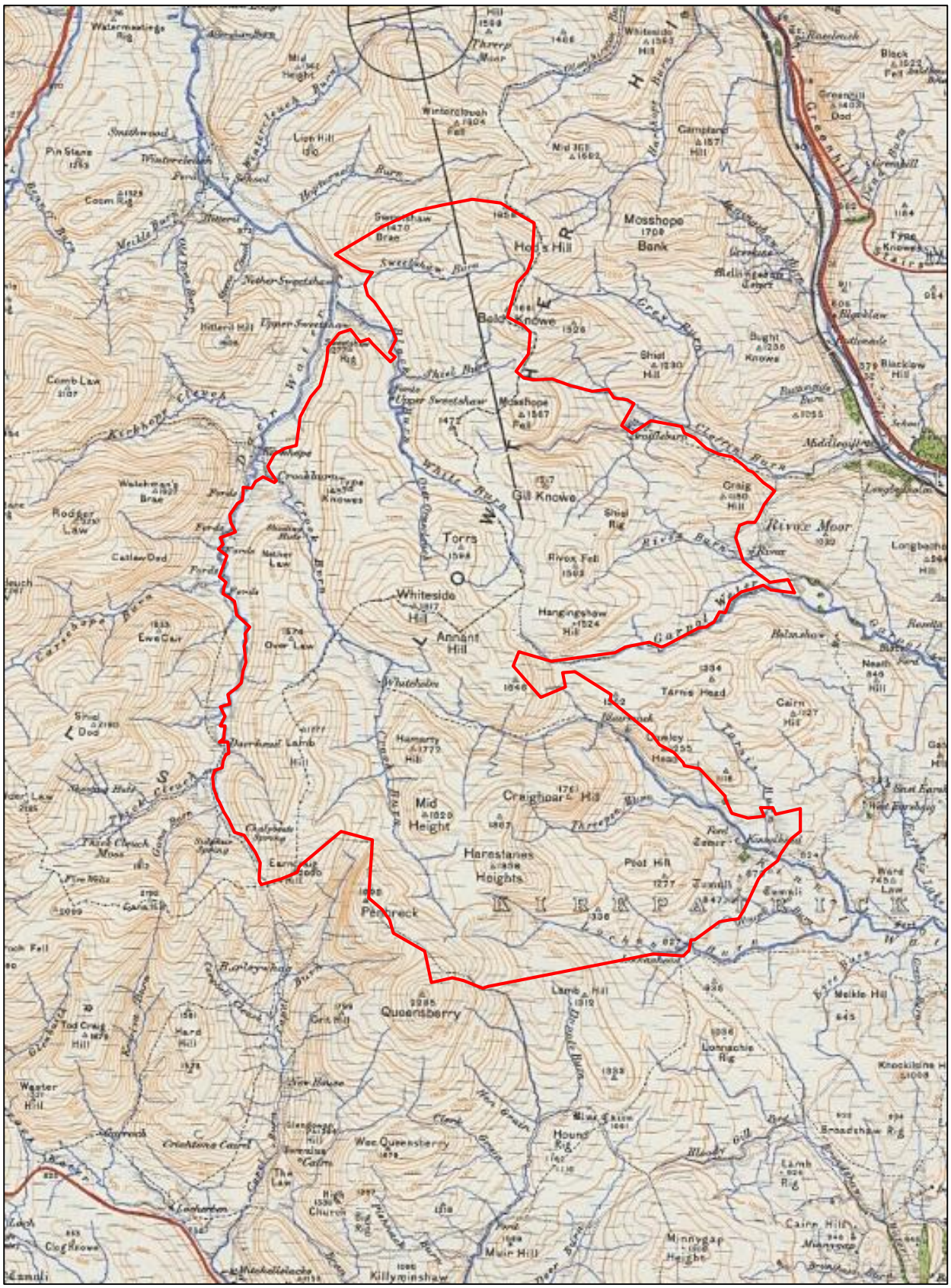
Project: **Daer Reservoir, Biggar**

Ref: **DA10468-00**

Source: Natural Power

1940 Historical Map

Annex: **D1**



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Project: **Daer Reservoir, Biggar**

Ref: **DA10468-00**

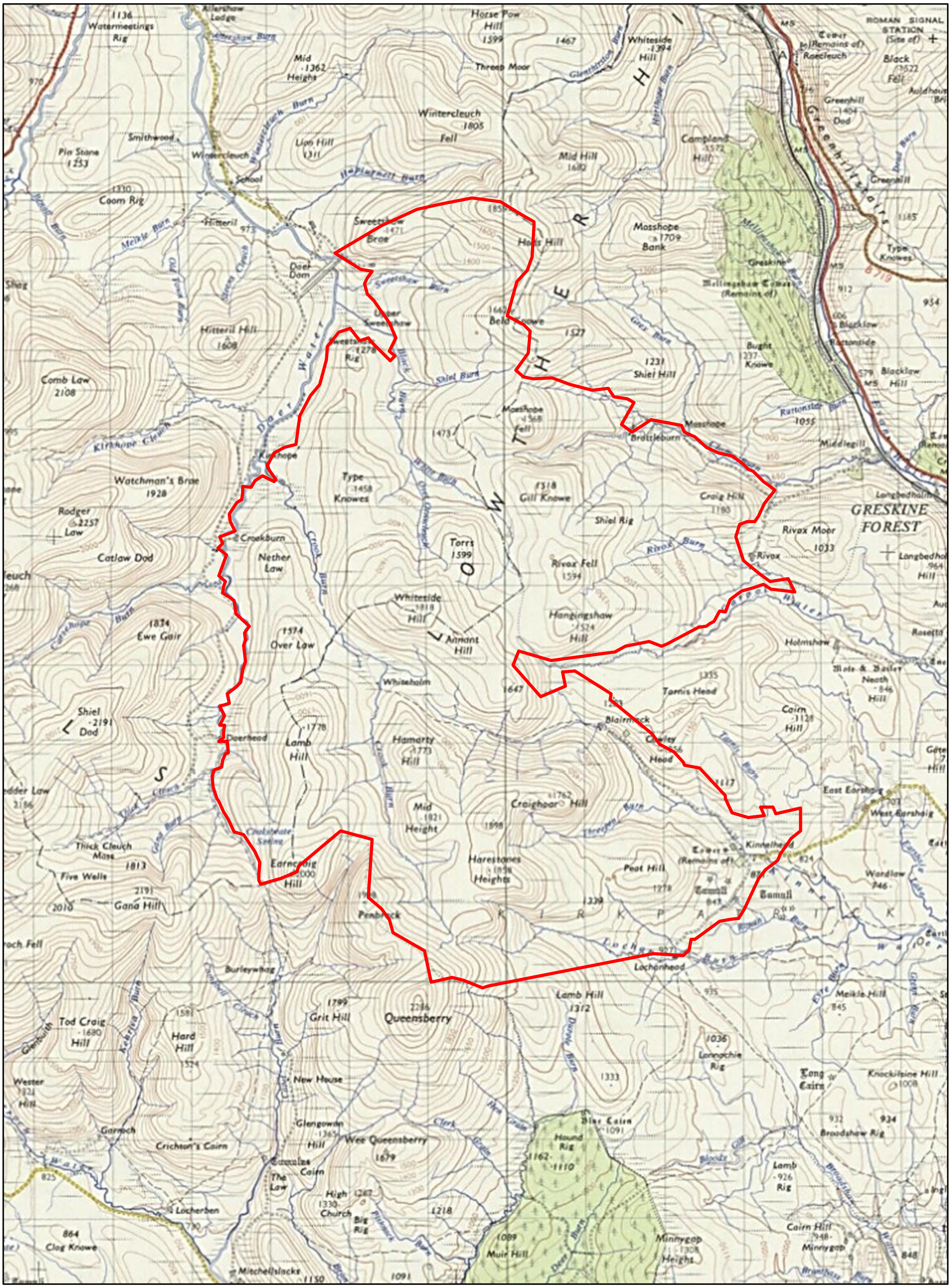
Source: National Library of Scotland

Approximate site boundary

N

1956 Historical Map

Annex: **D1**



1ST LINE DEFENCE	Client: **Natural Power**	**Approximate site boundary**
	Project: **Daer Reservoir, Biggar**	N
	Ref: **DA10468-00**	Source: National Library of Scotland

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2-Pounder Anti-Tank Gun

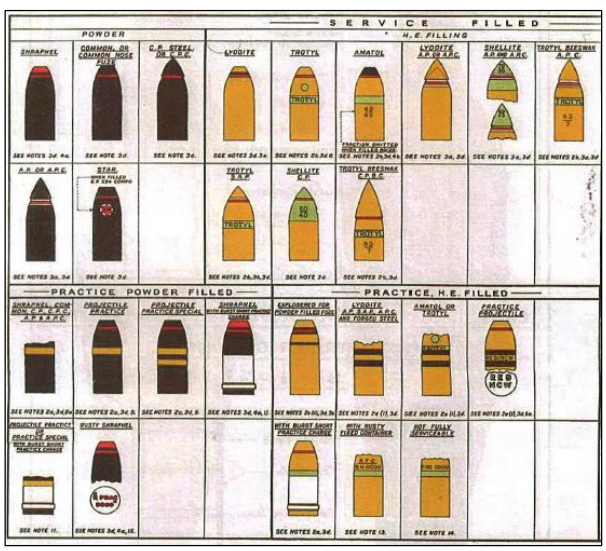
Total Weight	2lb (0.98kg) or 1.8lb (0.82kg)
Dimensions	40mm x 304mm
Fuze Type	Percussion
Filling	Lyddite charge. Bursting Charge - 0.04lb to 0.14lb Propellant Charge - 0.56lb to 0.67 Total - 0.6lb to 0.81lb
Use	The 2-Pounder was an anti tank field artillery piece. The 2-Pounder was used extensively in Europe between 1939 and 1945
Remarks	The anti-tank 2-Pounder had many Mks, most with minor modifications to improve the efficiency of the weapon and the ease of production. The gun was often mounted on armoured vehicles and tanks.

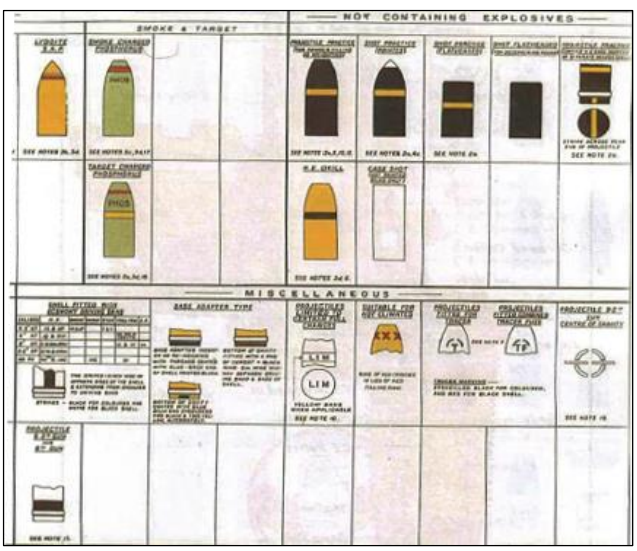
25-Pounder Field Gun

Total Weight	20lb – 25lb (9.07kg – 11.39kg)
Dimensions	Approx. 14” x 3.5” Maximum (355mm x 89mm) Approx. 9.2” x 3.5” Minimum (233mm x 89mm)
Fuze Type	No. 117 DA (Direct Action) fuze although CVT and Proximity fuzes were used later in the war.
Filling	Filing varied dependent on Mk. The HE variety contained amatol or TNT.
Use	The 25-Pounder was an all purpose field gun and saw widespread use throughout the war.
Remarks	A wide variety of 25-Pounder shells were used throughout the war. Versions of the shell included high explosive, armour piercing and smoke.

Examples of 25-Pounder shells. From left to right: Smoke, Armour-piercing, HE (RDX/TNT), HE (Amatol), Smoke (WWII)

Distinguishing Markings for Gun and Howitzer Projectiles





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Ref: **DA10468-00**

Source: Various sources

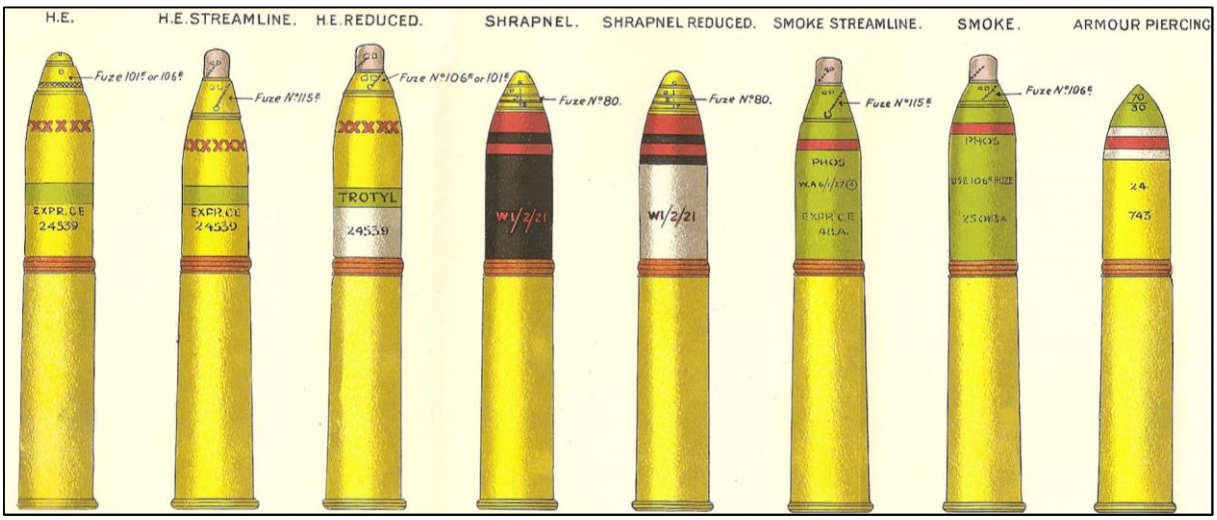
18lbs General Purpose HE Howitzer Shell

Weight	18lbs (8 kg)
Explosive Weight	13oz (0.3g)
Fuze Type	Impact
Dimensions	21.7 inches.
Use	The 18lbs howitzer was the most commonly deployed British field artillery in WWI. The HE shell was used to bombard German trenches prior to assaults, for clearing barbed wire, and supporting attacks.
Remarks	Typically a Amatol of Trotyl filling.

18lbs Shrapnel Shell

Weight	18lbs (8 kg)
Explosive Weight	13oz (0.3g)
Fuze Type	Impact
Dimensions	21.7 inches.
Use	The 18lbs shell could be modified to contain shrapnel. Shrapnel pellets would disperse upon detonation.
Remarks	A decreased Amatol of Trotyl filling, filled also with pellets.

18" Variants



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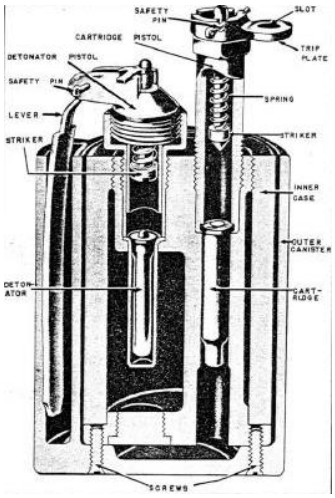
Source: Various sources

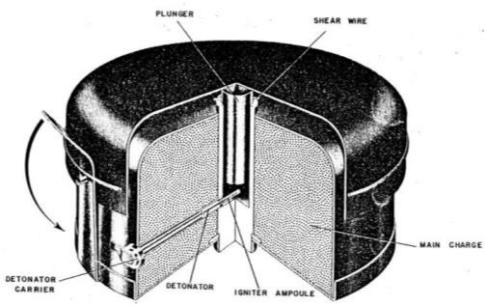
AP Shrapnel Mine MkI/II

Weight	10lb total, 1lb explosive weight
Dimensions	3 ½ x 5 ½ inches
Fuze	E.P. Mk II Mine Fuze
Filling	Amatol
Use	This mine is a bounding anti-personnel mine designed to cause casualties up to 30 yards.
Identification	The Mk II mine consist of the following components: the outer mine canister, the inner case, the detonator-pistol mechanism and the cartridge-pistol mechanism. They are yellow in colour.



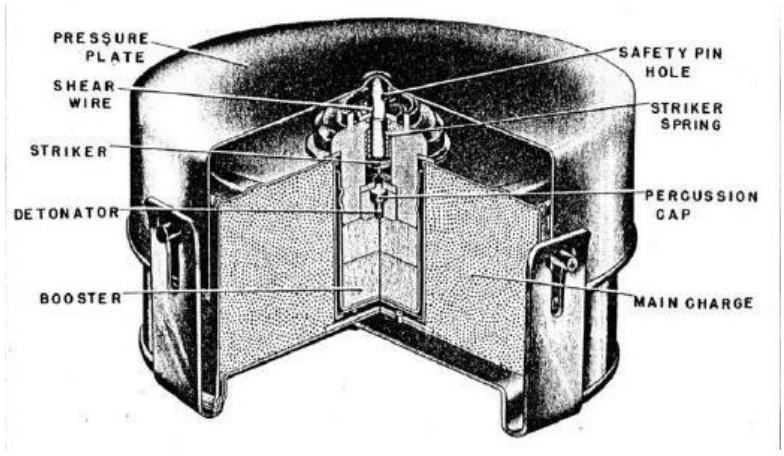
AT Mine EP MkII

Weight	4 ½ explosive
Dimensions	10 x 4 inches
Fuze	Mine Fuze E.P. Mk II
Filling	TNT
Use	Used as a defence against armoured cars, tanks and other vehicles.
Identification	This mine has three main components,: the loaded mine body, the mine cover and the mine fuzing arrangement. They should not be disarmed and should be destroyed if found.



AT Mine GS MkIV

Weight	12 ½ lb total, 8 ¼ lb explosive weight
Dimensions	8 x 5 inches
Fuze	A/T Contact Mine Fuze No.3 Mk I
Filling	TNT or Baratol
Use	Used as a defence against armoured cars, tanks and other vehicles.
Identification	The mine body is cylindrical in shape and contains a central well for the insertion of the fuze.



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Client: **Natural Power**

Project: **Daer Reservoir, Biggar**

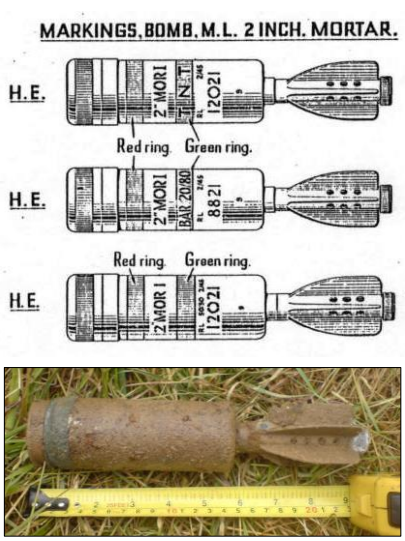
Ref: **DA10468-00**

Source: Various sources

Examples of Land Service Ammunition – Mortars

2 inch Mortar High Explosive

Weight	Approx. 1.02kg (2.25lb)
Maximum Range	460m (500yards)
Filling	200g RDX/TNT
Dimensions	51 x 290mm (2in x 11.4 in)
Fuze Type	An impact fuze which detonates the fuze booster charge and in turn the high explosive charge.
Use	It had greater range and firepower over hand and rifle grenades, and was used to attack targets behind cover with high explosive rounds.
Identification	HE has a rounded edge to a flat back. Can either be a black body colour with red and yellow band or dark green with yellow band. Brass cap on top. Practice will have hole all the way through the top.



2 inch Mortar Smoke

Weight	Approx. 910g (2lb)
Maximum Range	460m (500yards)
Filling	White phosphorus and smoke fill
Dimensions	51 x 290mm (2in x 11.4 in)
Fuze Type	An impact fuze which initiates a bursting charge. This ruptures the mortar bomb's body and disperses the phosphorus filler
Identification	Smoke mortars have a recess and emission holes. May still see light green body paint. Look for stained ground around munition.
Use	As a screening devices for unit movement or to impair enemy field of vision.

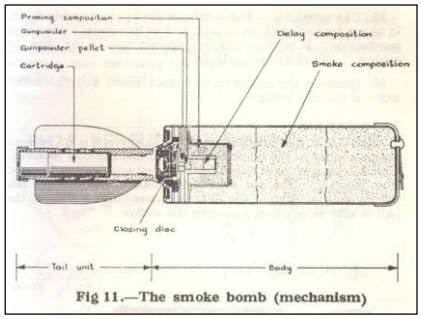
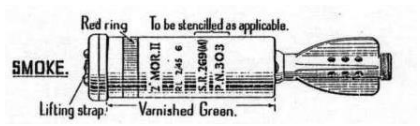
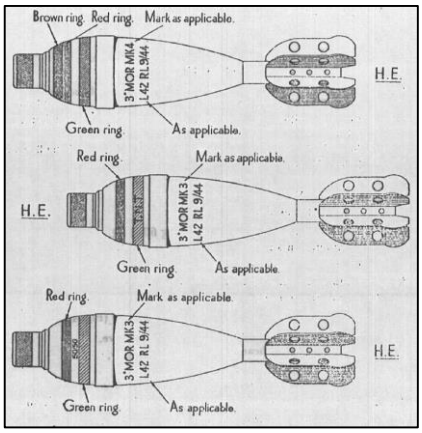


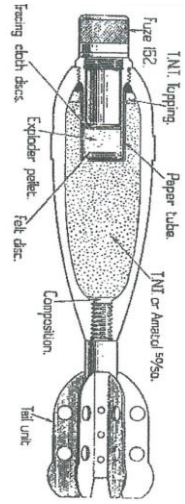
Fig 11.—The smoke bomb (mechanism)



3 inch Mortar High Explosive

Weight	Approx. 4.5kg (10lb)
Maximum Range	1,460 (Mk1) – 2,560m (Mk2) (1,600 – 2,800yds)
Dimensions	81mm (3in)
Filling	Amatol
Firing Mechanism	Drop, fixed striker
Remarks	Fin-stabilised bomb fired by means of a charge consisting of a primary cartridge in the tail and four secondary cartridges
Identification	An old style mortar. No way of telling if HE or practice so treat as HE





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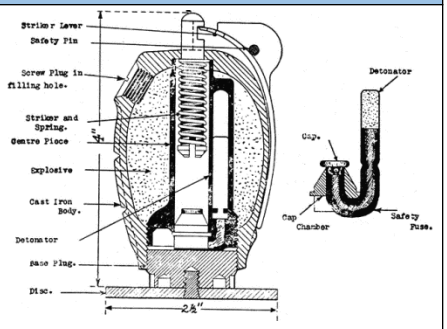
Source: Various sources

Examples of Land Service Ammunition – Grenades

No. 36 'Mills' Grenade

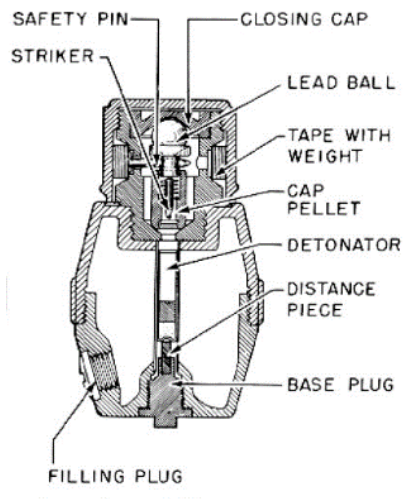
Weight	Approx. 765g filled (1lb 11.25oz)
Explosive Weight	71g (2oz) filling.
Fuze Type	4-7 second delay hand-throwing fuze. No. 6 Detonator
Dimensions	95 x 61mm (4 x 2.4in)
Use	Fragmentation explosive at approx. 30m range 100m range of damage.
Remarks	First introduced in 1915 its classic grooved, cast-iron 'pineapple' design was designed to provide uniform fragmentation. The detonator is inserted before use after removing the base plug.



Left: baseplate and detonator removed

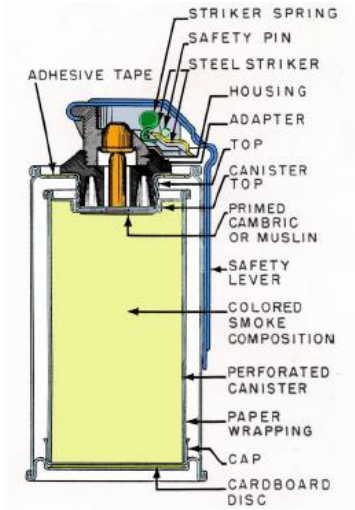
No. 69 Grenade

Weight	Approx. 383g (13.5oz)
Fill Weight	93g (3.25 oz) of either Amatol, Baratol or Lyddite
Fuze Type	'All-ways' Fuze. Compromised of a safety cap, a weighted streamer attached to a steel ball bearing and a safety bolt designed to detonate from any point of impact.
Dimensions	115 x 60mm (4.5 x 2 .4 in)
Use	A blast grenade for use as an offensive weapon. Detonator was inserted before use.
Remarks	Introduced December 1940 and made from the plastic Bakelite as opposed to conventional metals. Detection is difficult due to this low metal content.



No. 83 Smoke Grenade

Weight	Approx. 680g (1.5lb)
Explosive Weight	Approx. 170-200g. (6-7 oz)
Fuze Type	Originally used a friction system using a match head composition. Later developed to a striker lever ignition system.
Dimensions	Approx. 62 x 140mm (2.44 x 5.5 in)
Use	Use as a target or landing zone marking device and as a screening method for troop / unit movement.
Remarks	This basic design stayed relatively unchanged up to the 1980's. The letters CCC were often etched into the body of the grenade in the colour of the smoke.



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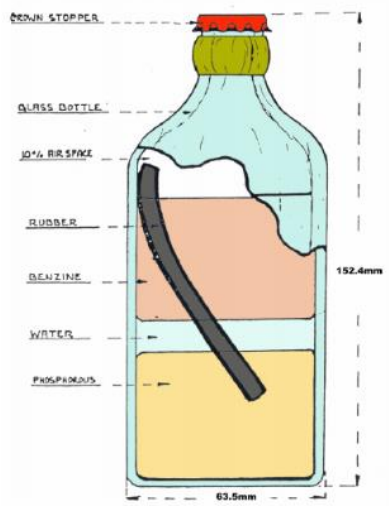
Source: Various sources

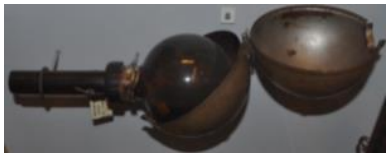
No. 76 Self Igniting Phosphorous (SIP) Grenade

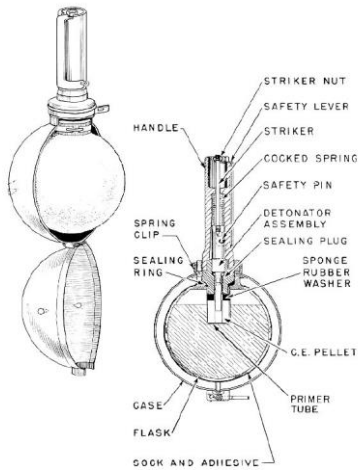
Weight	Approx. 1lb 3oz
Filling	White Phosphorous and Benzene
Design	The filling was contained in a ½ pint sized glass bottle with water and a strip of rubber. Over time the rubber dissolved to create a sticky which would self ignite when the bottle broke.
Use	Originally intended as an anti-tank incendiary weapon deployed by hand. Designed to be produced cheaply without consuming materials needed to produce armaments on the front line.
Remarks	The Home Guard hid caches of these grenades during the war. Not all locations were officially recorded and some caches were lost and encountered post-war. In all cases, the grenades are still found to be dangerous.



No. 74 Grenade ("Sticky Bomb") Mk1

Weight	Approx. 1.1kg (2.25lb)
Filling	Approx. 600g Nobel's No.283 (Nitro-glycerine) (1.33lb)
Design	A glass ball on the end of a Bakelite (plastic) handle. The inside of the ball would contain the explosive filling and the outside a very sticky adhesive coating.
Use	An anti-tank grenade primarily issued to the home guard. It required the user to come in very close proximity with the target and smash the glass explosive container against it.
Remarks	Timer fuze was located in the handle. This would explode after 3-6 secs. 9.5in Long 4.5in Diameter





Flame Fougasse Bomb

Weight	Various
Filling	Initially a mixture of 40% petrol and 60% gas. Ammonal provided the propellant charge.
Design	Usually constructed from a 40-gallon drum dug into a roadside and camouflaged.
Use	As an improvised anti-tank bomb. When triggered the Fougasse could project a beam of burning sticky fuel in a fixed direction from up to 3m (10ft) wide and 27m (30yards) long.
Remarks	A highly unorthodox weapon designed by the Petroleum Warfare Department to address a critical lack of weapons in 1940. 50,000 are estimated to have been distributed around the UK.

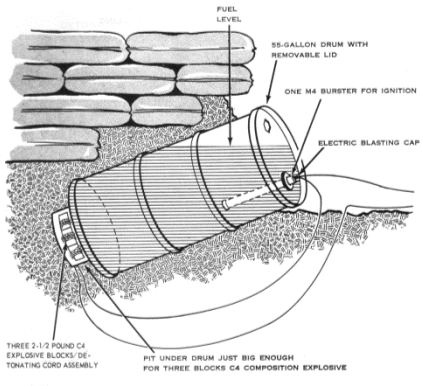


Figure 22. Flame fougasse (55-gallon drum).

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Ref: **DA10468-00**

Source: Various sources

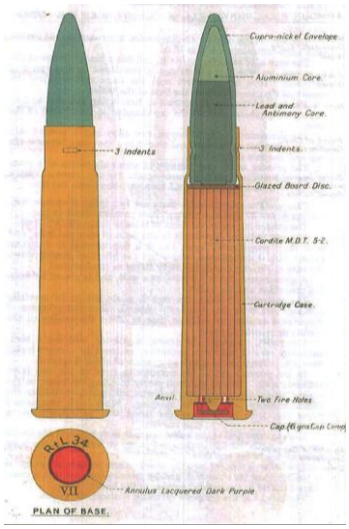
Examples of Small Arms Ammunition

Examples of British Small Arms Ammunition

.303 Rifle

Bullet Diameter	7.92mm
Case length	56.44mm
Overall length	78.11mm
Type	Rifle Ammunition
Propellant	Originally black powder. Later Cordite followed by Nitrocellulose
Remarks	First produced in 1889 and still in use today, the .303inch cartridge has progressed through ten 'marks' which eventually extended to a total of around 26 variations.

Bullet Type	Colour of tip	Colour of Annulus
Armour Piercing	Green	Green
Ball	None	Purple
Incendiary	Blue	Blue
Observing	Black	Black
Proof	None	Yellow
Tracer Short Range	White	Red
Tracer Dark Ignition	Grey	Red



Buried and Decayed Ammunition

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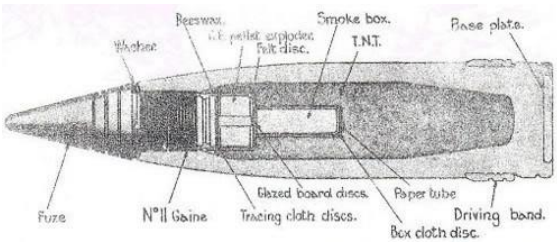
Source: Various sources

Examples of Anti-Aircraft Projectiles

Annex: H

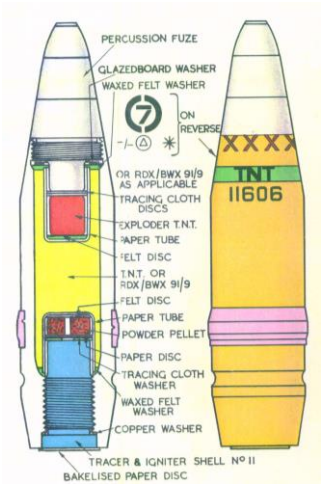
3.7 Inch QF Anti-Aircraft Projectile

Projectile Weight	28lb (12.6 kg)
Explosive Weight	2.52lbs
Fuze Type	Mechanical Time Fuze
Dimensions	3.7in x 14.7in (94mm x 360mm)
Rate of Fire	10 to 20 rounds per minute
Use	The 3.7in AA Mks 1-3 were the standard Heavy Anti-Aircraft guns of the British Army.
Ceiling	30,000ft to 59,000ft



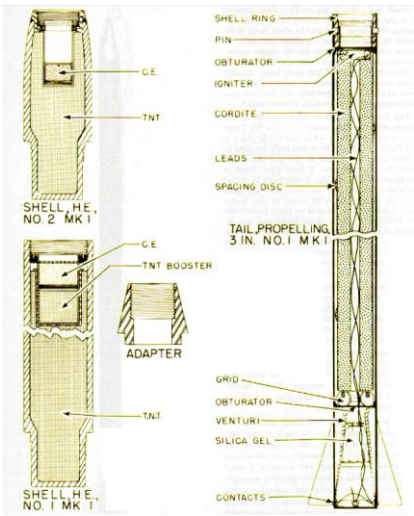
40mm Bofors Projectile

Projectile Weight	1.96lb (0.86kg)
Explosive Weight	300g (0.6lb)
Fuze Type	Impact Fuze
Rate of Fire	120 rounds per minute
Projectile Dimensions	40 x 180mm
Ceiling	23,000ft (7000m)
Remarks	Light quick fire high explosive anti-aircraft projectile. Each projectile fitted with small tracer element. If no target hit, shell would explode when tracer burnt out. Designed to engage aircraft flying below 2,000ft



3in Unrotated Projectile (UP) Anti-Aircraft Rocket ("Z" Battery)

HE Projectile Weight	3.4kg (7.6lb)
Explosive Weight	0.96kg (2.13lb)
Filling	High Explosive – TNT. Fitted with aerial burst fuzing
Dimensions of projectile	236 x 83mm (9.29 x 3.25in)
Remarks	As a short range rocket-firing anti-aircraft weapon developed for the Royal Navy. It was used extensively by British ships during the early days of World War II. The UP was also used in ground-based single and 128-round launchers known as Z Batteries. Shell consists of a steel cylinder reduced in diameter at the base and threaded externally to screw into the shell ring of the rocket motor



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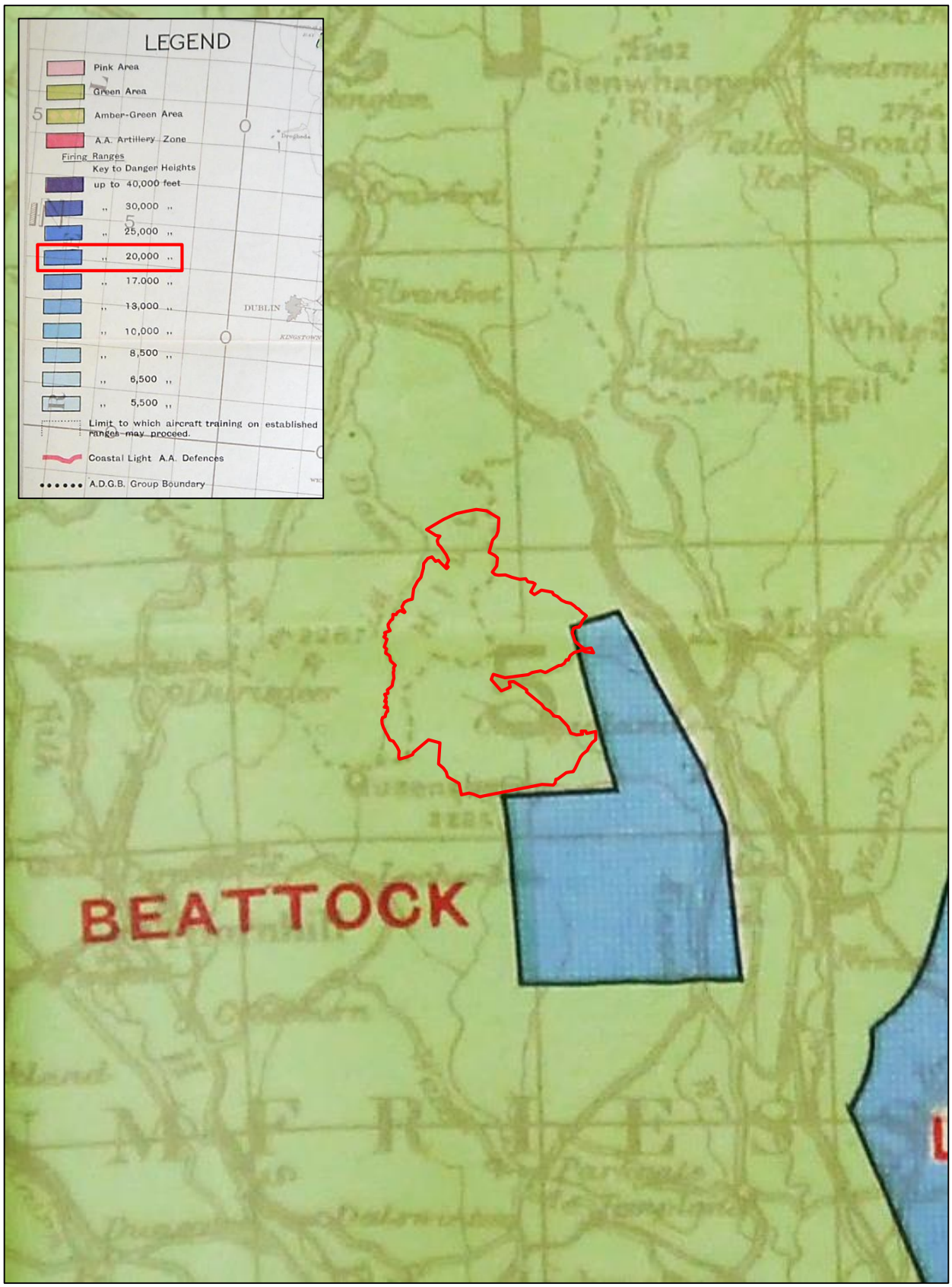
Ref: **DA10468-00**

Source: Various sources

Air Ministry Map of Restricted Flying Areas: March 1943

Annex: I1



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Client: **Natural Power**

Approximate site boundary

N

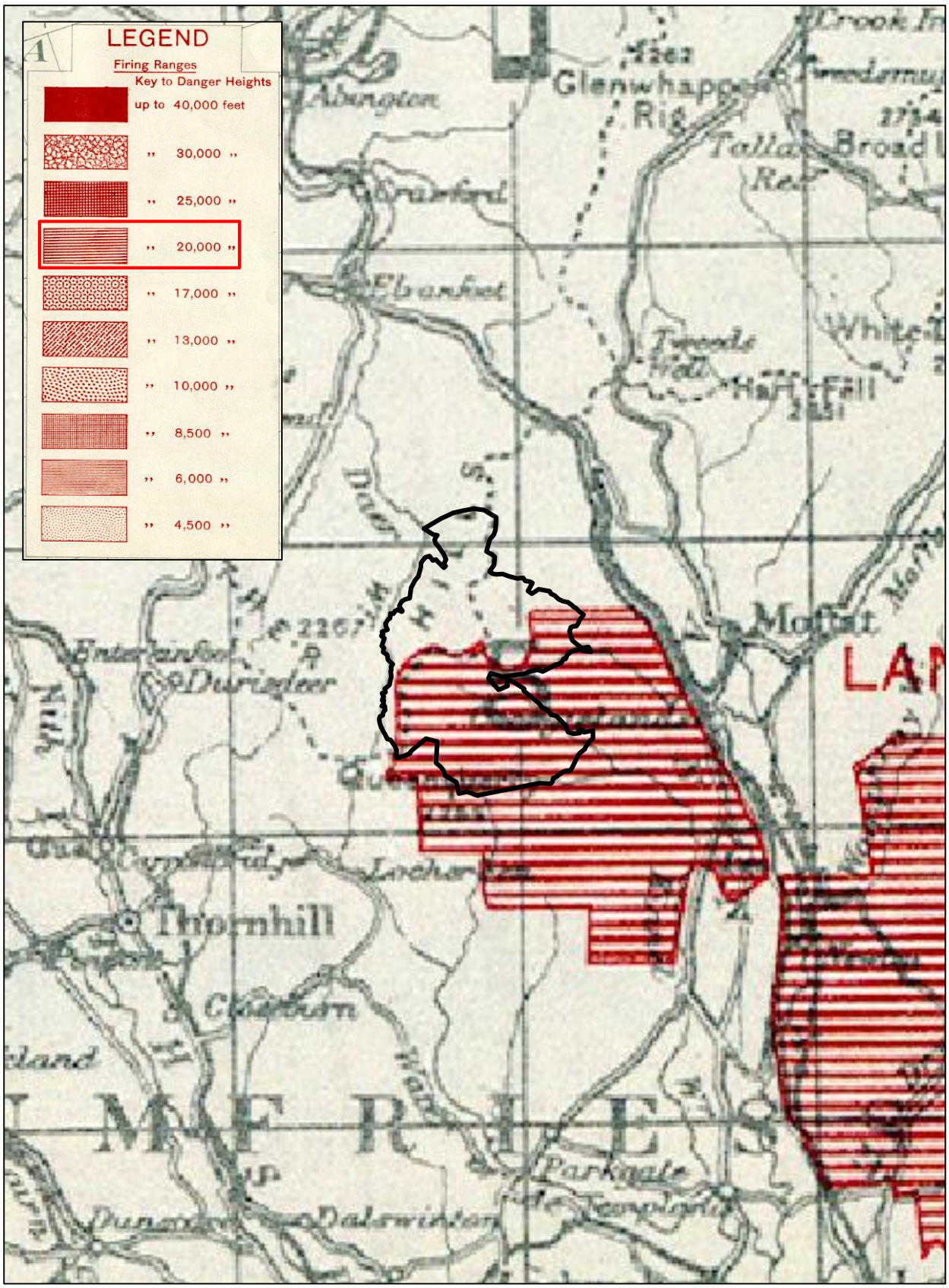
Project: **Daer Reservoir, Biggar**

Ref: **DA10468-00**

Source: The National Archives

Air Ministry Map of Armament Training Areas: May 1945

Annex: I2



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Ref: **DA10468-00**

Source: The National Archives

Approximate site boundary

N

(Left) Commandos training in Scotland practice an amphibious assault under simulated enemy fire.

(Right) Commandos practicing marksmanship with the Bren light machinegun.

(Left) Commandos conducting indirect fire training with the ML 3" mortar.

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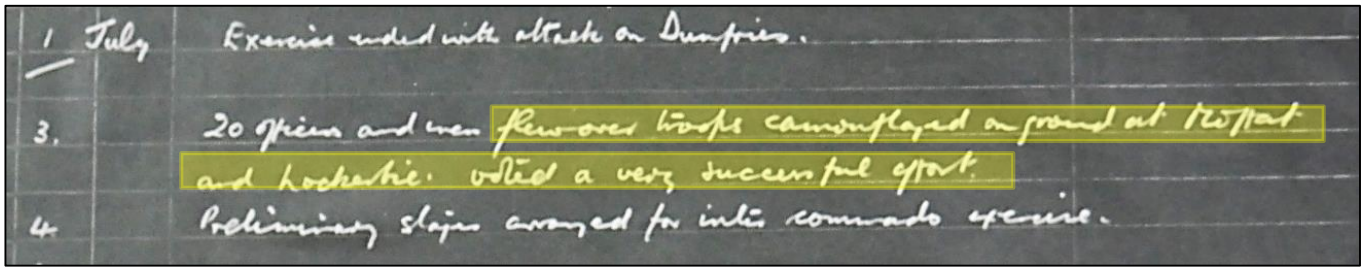
Source: Various

3rd July 1941

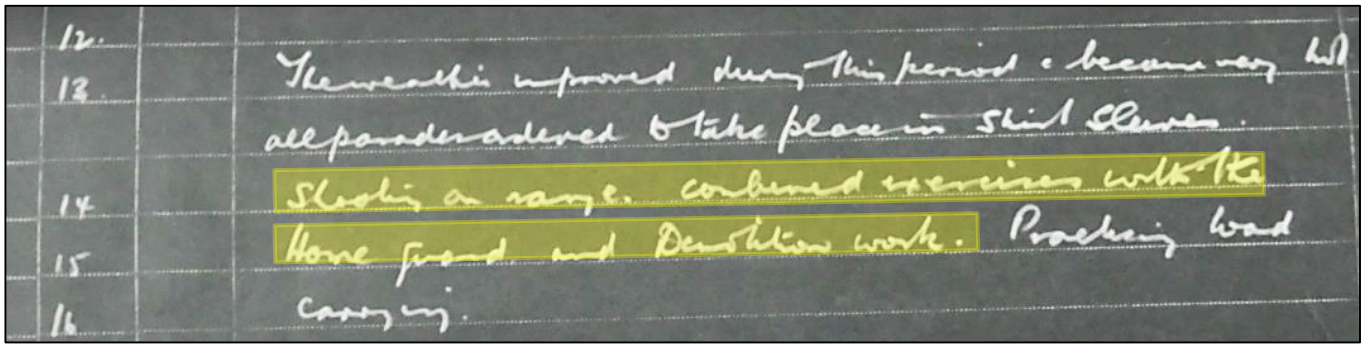


1 July — Exercise ended with attack on Dumfries.

3. 20 officers and men flew over troops camouflaged on ground at Moffat and Lockerbie. which a very successful effort.

4. Preliminary steps arranged for intro commando exercise.

14th July 1941



12.

13. Weather improved during this period. became very hot all parades ordered to take place in shirt sleeves.

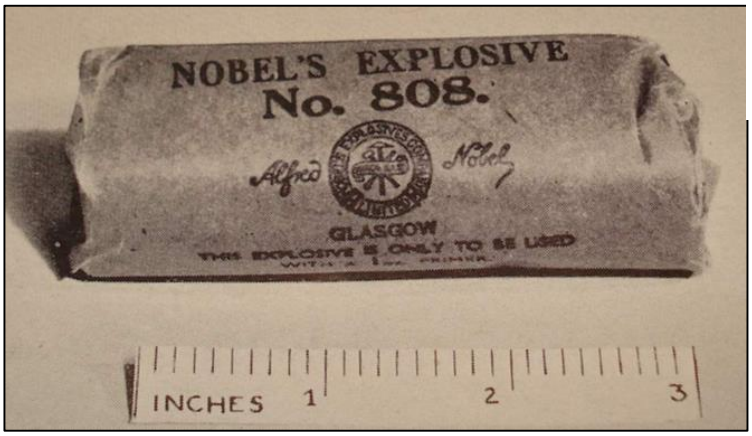
14. Shooting on ranges. combined exercises with tks Horse ground and Demolition work. Practising load

15. carrying.

16.

1st September 1941

1. — Parties of troops out on night exercises. which included exercises based on use of air photographs of surrounding towns.



(Left) Nobel 'No.808' Plastic Explosive, as issued to Auxiliary Patrols

(Right) M1928A1 Thompson Submachinegun, a US made weapon heavily used by Auxiliary patrols.

Model 1928AC Submachine Gun

Selective Action—Full Automatic Firing or Single Shots

GENERAL SPECIFICATIONS: Calibre .45. Weight, 9 lbs. 13 ounces. Length, 33 inches. Length of barrel, with Compensator, 12½ inches; without Compensator, 10½ inches. Equipped with Lyman sights and wind gauge. 20 and 50 cartridge capacity magazines. Ammunition calibre .45 Colt Automatic Pistol Ball Cartridges (230 grain bullet cartridges only). Rate of fire—Semi-automatic (a single shot for each separate pull of the trigger) up to the rate of 100 single aimed shots a minute—Full automatic 700 to 725 shots a minute.

(Below) PIAT (Projector, Infantry Anti-Tank), a rudimentary anti-tank weapon that used a spring to hurl a 2.5lb shape-charge was issued to Auxiliary Units to combat enemy armour.

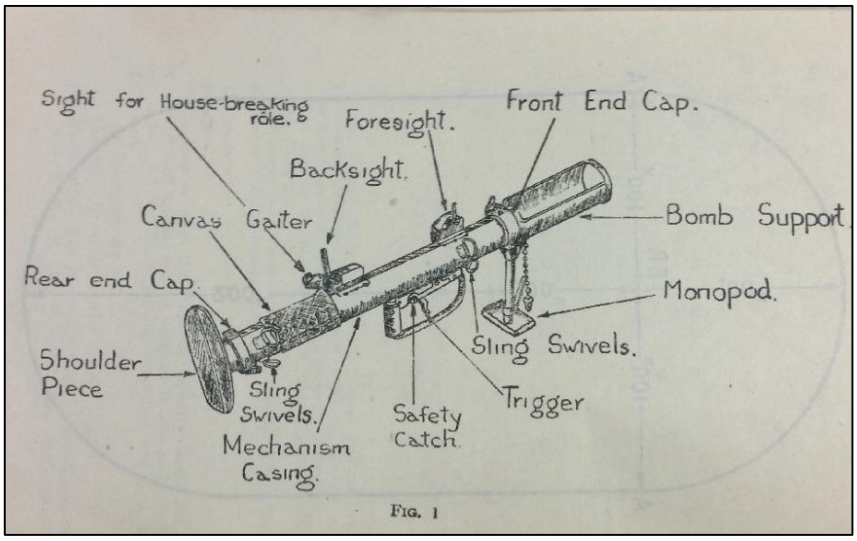
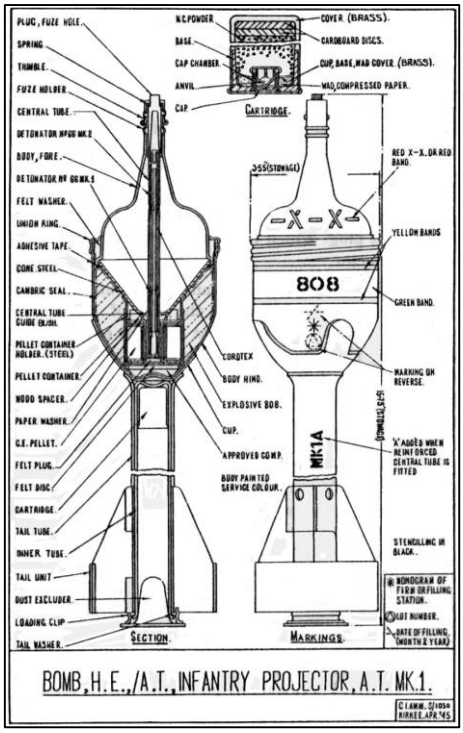


FIG. 1



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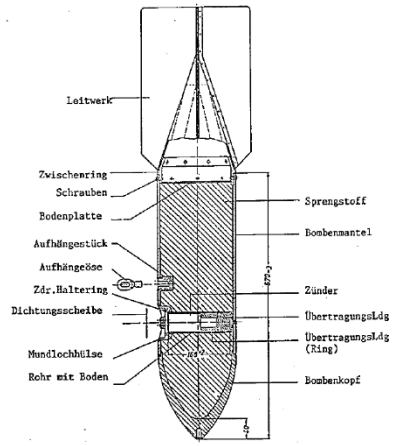
Source: Various sources

Examples of German Air-Delivered Ordnance

Annex: M1

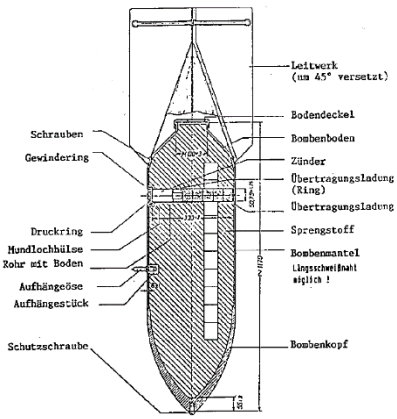
SC 50kg High Explosive Bomb

Bomb Weight	40-54kg (88-119lb)
Explosive Weight	25kg (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	The smallest and most common conventional German bomb. Nearly 70% of bombs dropped on the UK were 50kg.



SC 250kg High Explosive Bomb

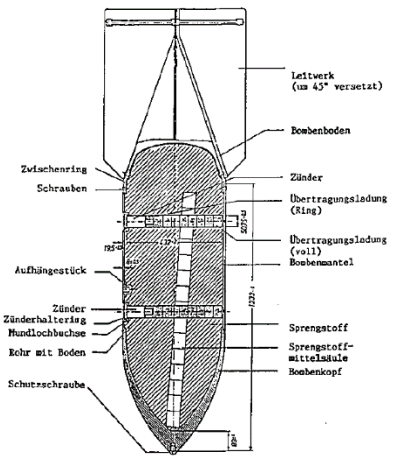
Bomb Weight	245-256kg (540-564lb)
Explosive Weight	125-130kg (276-287lb)
Fuze Type	Electrical impact/mechanical time delay fuze.
Bomb Dimensions	1640 x 512mm (64.57 x 20.16in)
Body Diameter	368mm (14.5in)
Use	Against railway installations, embankments, flyovers, underpasses, large buildings and below-ground installations.
Remarks	It could be carried by almost all German bomber aircraft, and was used to notable effect by the Junkers Ju-87 Stuka (Sturzkampfflugzeug or dive-bomber).

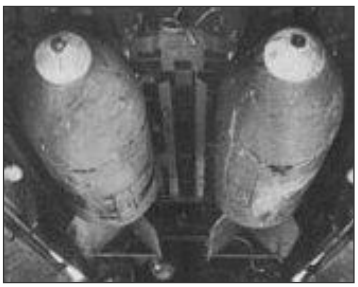


SC250 bomb being loaded onto German bomber

SC 500kg High Explosive Bomb

Bomb Weight	480-520kg (1,058-1,146lb)
Explosive Weight	250-260kg (551-573lb)
Fuze Type	Electrical impact/mechanical time delay fuze.
Bomb Dimensions	1957 x 640mm (77 x 25.2in)
Body Diameter	470mm (18.5in)
Use	Against fixed airfield installations, hangars, assembly halls, flyovers, underpasses, high-rise buildings and below-ground installations.
Remarks	40/60 or 50/50 Amatol TNT, trialene. Bombs recovered with Trialen filling have cylindrical paper wrapped pellets 1-15/16 in. in length and diameter forming





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Project: **Daer Reservoir, Biggar**

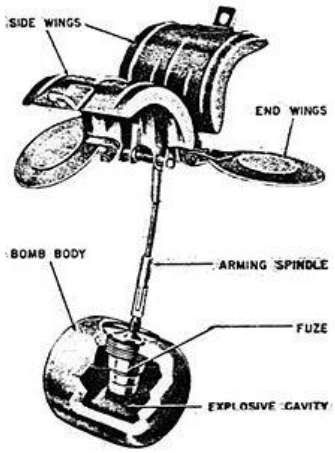
Ref: **DA10468-00**

Source: Various sources

Examples of German Air-Delivered Ordnance

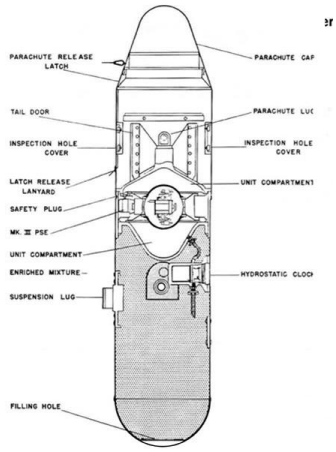
SD2 Anti-Personnel 'Butterfly Bomb'

Bomb Weight	Approx. 2kg (4.41lb)
Explosive Weight	Approx. 7.5oz (225 grams) of Amatol surrounded by a layer of bituminous composition.
Fuze Type	41 fuze (time) , 67 fuze (clockwork time delay) or 70 fuze (anti-handling device)
Body Diameter	3in (7.62 cm) diameter, 3.1in (7.874) long
Use	Designed as an anti-personnel/ fragmentation weapon. They were delivered by air, being dropped in containers of 23-144 sub-munitions that opened at a predetermined height, thus scattering the bombs.
Remarks	Very rare. First used against Ipswich in 1940, but were also dropped on Kingston upon Hull, Grimsby and Cleethorpes in June 1943, amongst various other targets in UK. As the bombs fell the outer case flicked open by springs which caused four light metal drogues with a protruding 5 inch steel cable to deploy in the form of a parachute & wind vane which armed the device as it span.



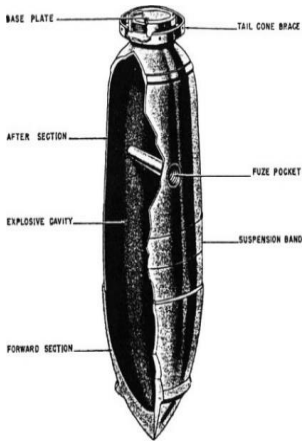
Parachute Mine (Luftmine B / LMB)

Bomb Weight	Approx. 990kg (2176lb)
Explosive Weight	Approx. 705kg (1,554lb)
Fuze Type	Impact/ Time delay / hydrostatic pressure fuze
Dimensions	2.64m x 0.64m (3.04m with parachute housing)
Use	Against civilian, military and industrial targets. Used as blast bombs and designed to detonate above ground level to maximise damage to a wider area.
Remarks	Deployed a parachute when dropped in order to control its descent. Had the potential to cause extensive damage in a 100m radius.



SC 1000kg

Bomb Weight	Approx. 993-1027kg (2,189-2,264lb)
Explosive Weight	Approx. 530-620kg (1168-1367lb)
Fuze Type	Electrical impact/mechanical time delay fuze.
Filling	Mixture of 40% amatol and 60% TNT, but when used as an anti-shipping bomb it was filled with Trialen 105, a mixture of 15% RDX, 70% TNT and 15% aluminium powder.
Bomb Dimensions	2800 x 654mm (110 x 25.8in)
Body Diameter	654mm (18.5in)
Use	SC type bombs are General Purpose Bombs used primarily for general demolition work. Constructed of parallel walls with comparatively heavy noses. They are usually of three piece welded construction



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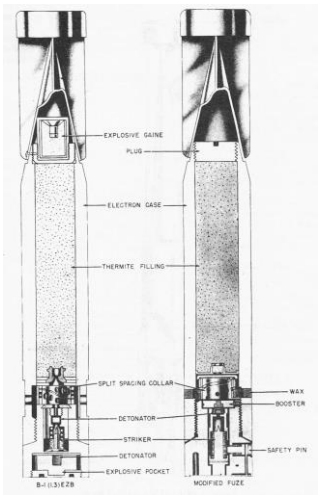
Source: Various sources

German Incendiary Bombs

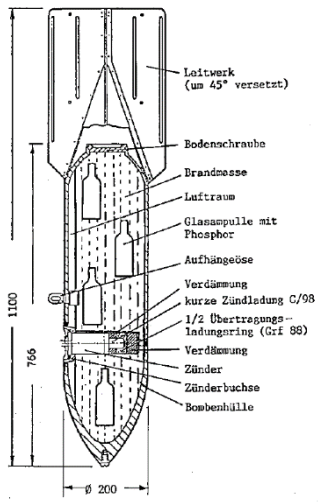
1kg Incendiary Bomb

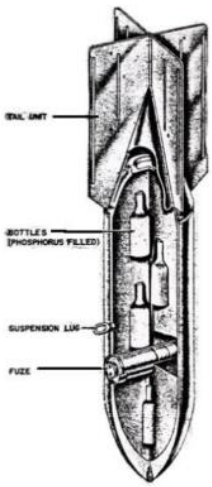
Bomb Weight	Approx. 1.0 - 1.3kg (2.2 and 2.9lb)
Explosive Weight	Approx. 680g (1.5lb) Thermite 8-15gm Explosive Nitropenta
Fuze Type	Impact fuze
Bomb Dimensions	350 x 50mm (13.8 x 1.97in)
Body Diameter	50mm (1.97in)
Use	As incendiary – dropped in clusters on towns and industrial complexes
Remarks	Magnesium alloy case. Sometimes fitted with high explosive charge. The body is a cylindrical alloy casting threaded internally at the nose to receive the fuze holder and fuze.



C50 A Incendiary Bomb

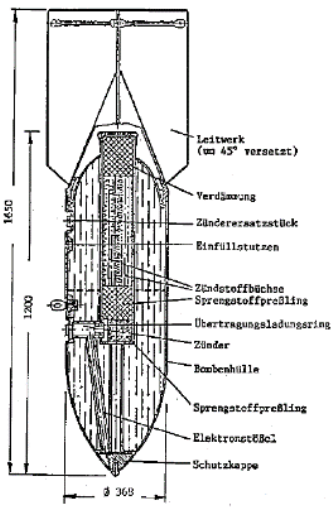
Bomb Weight	Approx. 41kg (90.4lb)
Explosive Weight	Approx. 0.03kg (0.066lb)
Incendiary Filling	12kg (25.5lb) liquid filling with phosphor igniters in glass phials. Benzine 85%; Phosphorus 4%; Pure Rubber 10%
Fuze Type	Electrical impact fuze
Bomb Dimensions	1,100 x 280mm (43.2 x 8in)
Use	Against any targets where an incendiary effect is required
Remarks	Early fill was a phosphorous/carbon disulphide incendiary mixture





Flam C-250 Oil Bomb

Bomb Weight	Approx. 125kg (276lb)
Explosive Weight	Approx. 1kg (2.2lb)
Fuze Type	Super-fast electrical impact fuze
Filling	Mixture of 30% petrol and 70% crude oil
Bomb Dimensions	1,650 x 512.2mm (65 x 20.2in)
Body Diameter	368mm (14.5in)
Use	Often used for surprise attacks on ground troops, against troop barracks and industrial installations. Thin casing – not designed for ground penetration



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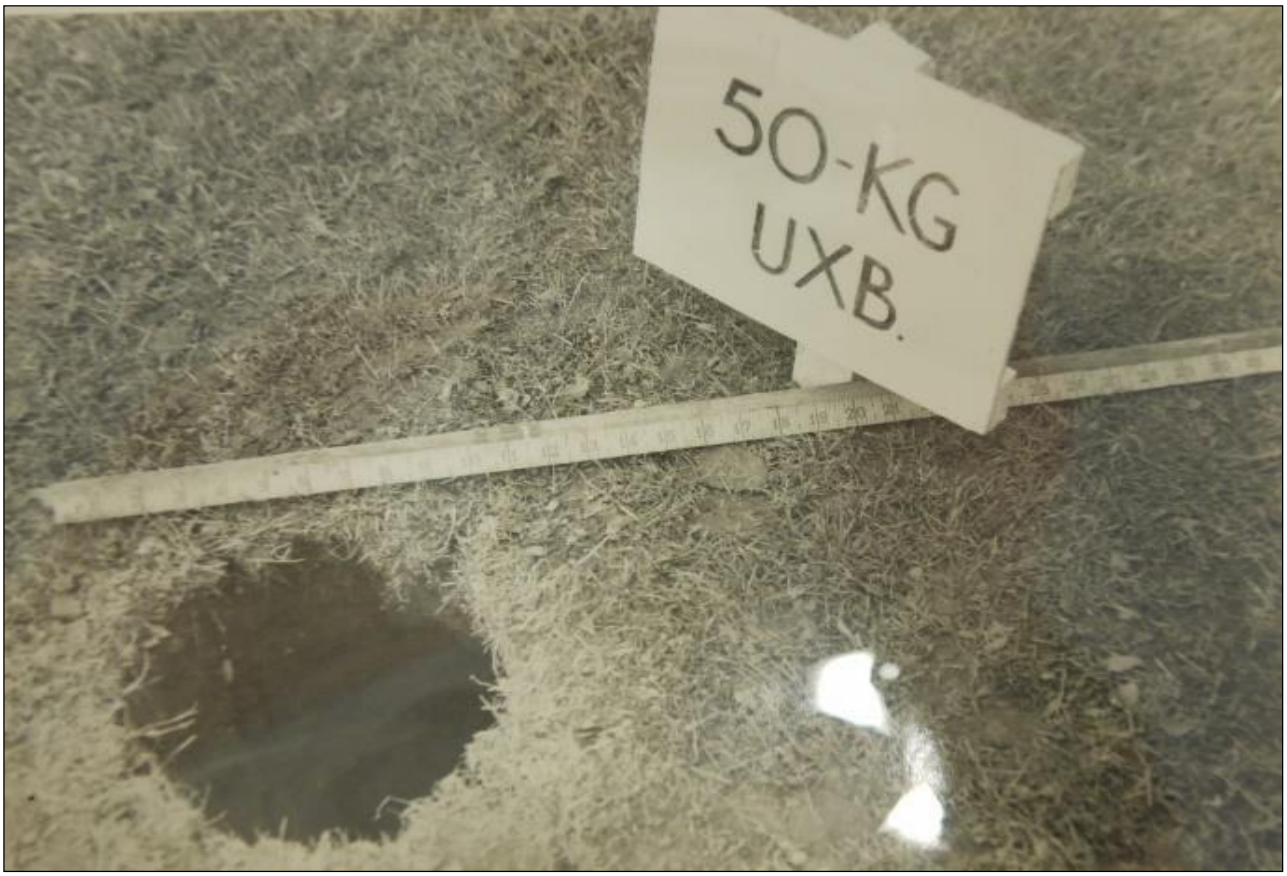
Source: Various sources

Unexploded Bomb Entry Hole Example

Annex: **N**



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Source: The National Archives

Recent Unexploded Bomb Finds, UK

Annex: **O1**

BBC NEWS

Bermondsey bomb: World War Two device safely removed

An unexploded World War Two bomb found in south London has been driven away safely under police and Army escort.

The 500lb (250kg) device was found on a building site in Grange Walk, Bermondsey on Monday.

March 2015

BBC NEWS

Bethnal Green WW2 bomb: Experts remove unexploded device

An unexploded World War Two bomb that prompted the evacuation of 700 people in east London has been made safe and removed by the military.

Families spent the night in a school hall after the 500lb bomb was found in the basement of a building site on Temple Street, in Bethnal Green, on Monday afternoon.

A 200m (650ft) exclusion zone was set up around the device.

August 2016

BBC NEWS

Bath WW2 bomb scare: Device defused, police say

A 500lb World War Two bomb found on the site of a former school in Bath has been defused and made safe.

The discovery of the bomb on Thursday **led to the evacuation of hundreds of homes** and many road closures in the Lansdown area of the city.

A cordon around the site was lifted on Friday evening, more than 24 hours after residents were asked to leave their homes.

May 2016

BBC NEWS

London City Airport reopens after WW2 bomb moved

London City Airport has reopened after an unexploded 500kg World War Two bomb was safely moved from the area.

The device was discovered at the King George V Dock on Sunday during planned work at the east London airport.

All flights were cancelled on Monday after an exclusion zone was put in place, **with the closure affecting up to 16,000 passengers and nearby residents being evacuated from their homes.**

May 2015

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Project:	**Daer Reservoir, Biggar**		
Ref:	**DA10468-00**	Source:	BBC News

Examples of Unexpected Detonation of WWII Bombs

Annex: O2

BASF has confirmed that an explosive device, most likely a World War II-era bomb, caused the blast that left one person injured Tuesday at a plant construction site in Germany.

The explosion was reported at BASF's Ludwigshafen toluene diisocyanate (TDI) plant, which recently broke ground for a 300,000 metric tons per year TDI production plant and other construction to expand its facilities.

BASF Provides Some Details

Responding to a request from *PaintSquare News* for more information on Wednesday (Feb. 27), BASF's manager of media relations and corporate communications Europe, Ursula von Stetten, wrote in an email, "So here [are] the facts: The detonation took place at 10:00 a.m. One person was injured; the injury is not serious. He will be kept in the hospital for some days.

"Cause of the detonation was an explosive device, presumably a bomb deriving from the Second World War. The device detonated when grounding work was done. No details on [a] delay [are] available. At the moment, the exact circumstances of the incident are [being] evaluated."

1st March 2013

SPIEGEL ONLINE

Blast Kills One

World War II Bomb Explodes on German Motorway

A highway construction worker in Germany accidentally struck an unexploded World War II bomb, causing an explosion which killed him and wrecked several passing cars.

A World War II bomb has exploded during construction work on a German highway, killing one worker and injuring several motorists who were driving past, police said.

The worker had been cutting through the road surface near the south-western town of Aschaffenburg when his machine struck the bomb and triggered it. Police said they weren't sure yet what type of bomb it was. "The explosion seems to have been too small for it to have been an aircraft bomb," a police spokesman said.

23rd October 2006

WWII bomb injures 17 at Hattingen construction site

Seventeen people were injured on Friday when a construction crew unwittingly detonated a buried World War II-era bomb in Hattingen.

An excavator apparently drove over a 250-kilogramme (550 pound) American bomb, damaging surrounding buildings. Most of the injured suffered auditory trauma from the blast, and the excavator operator suffered injuries to his hands, police in the German state of North Rhine-Westphalia said.

"The hole was astoundingly small for such a large bomb full of so many explosives," Armin Gebhard, head of the Arnsberg department for military ordnance removal, told The Local. "But of course it damaged all the surrounding buildings too. We are really happy it wasn't worse."

19th September 2013

BBC NEWS

World War II bomb kills three in Germany

A special commission is investigating the causes of the explosion, while prosecutors are considering whether the team leader should face charges of manslaughter through culpable negligence, the BBC's Oana Lungescu reports from Berlin.

The blast happened an hour before the defusing operation was due to start.

Officials said the three men who died were experienced sappers, or combat engineers, who over 20 years had defused up to 700 bombs.

More than 7,000 people were immediately evacuated when the 500kg bomb was found. Several schools, a kindergarten and local companies remain closed.

2nd June 2010

June 2006

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Source: Various news sources

Examples of Land Service Ammunition finds in the UK

Annex: O3

Unexploded Second World War bomb discovered under Somerset footpath

By Western Daily Press | Posted: January 21, 2014

The unexploded bomb was found in Somerset

Comments (0)

An unexploded bomb dropped in Britain during the Second World War has finally been discovered – underneath a popular footpath in Somerset.

23 August 2014 Last updated at 15:01

Unexploded WW2 bomb found at Kenfig Pool, Bridgend

Dean Smith believes the shell was made in Germany

Bomb experts have been called to a south Wales nature reserve after an unexploded World War Two shell was discovered by a walker in Bridgend.

Dean Smith, 38, of Pyle, was walking near Kenfig Pool on Saturday when he saw a fin sticking out of the sand.

He reached down to pick it up, but ending up falling and landed with the 2ft-long (0.6m) bomb on top of him.

The site has been cordoned off by police and the Royal Logistics Corps will carry out a controlled explosion.

Related Stories

'Panic' as dog nearly thrown grenade

WW2 bomb found at wind farm exploded

WWII bomb found in kitchen cupboard

Mortar thought to be from WWII found on Oshawa's Camp-X grounds

August 24, 2016 | 5:42 am

What is believed to be a World War II mortar has been discovered in south Oshawa. A man out in Intrepid Park, the site of the Camp-X Second World War training grounds, discovered the round with his metal detector on Tuesday evening. Durham police are held the scene overnight awaiting military officials from Trenton to come and properly detonate the mortar.

Unexploded bomb found in farmer's field

17 May 2010

A live Second World War mortar shell was blown up by Army experts after a farmer found it in his field.

The discovery was made in the field alongside the A20 between Folkestone and Dover.

The mortar shell, which was around a foot long and 3in in diameter, was around 50ft from the main road.

The farmer alerted police and PC Trevor Moody and PCSO Michelle Brady went to the field.

PC Moody contacted the Army who sent in a bomb disposal unit.

An Army officer confirmed the live shell was from the Second World War and was packed with high explosives.

They moved it a safe distance away from the A20 and carried out a controlled explosion.

PC Moody said: "Given that we live in an area that saw much action during the Second World War, it is not uncommon for us to be alerted about unexploded bombs."

The incident was on Thursday.

Click here for more news from Kent.

Royal Navy bomb disposal experts remove a World War Two shell discovered in a nature reserve

- A World War Two bomb was discovered in a Plymouth nature reserve
- Amateur metal detector found the shell and partially dug it up
- Royal Navy experts carried the explosive away before disposing of it

By VALERIE EDWARDS FOR MAILONLINE

PUBLISHED: 01:29, 13 January 2016 | **UPDATED:** 09:51, 13 January 2016

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A World War Two bomb was reportedly found at Efford Nature Reserve in Plymouth after a member of the public was metal detecting and partially dug it up.

The Royal Navy Bomb Disposal team was called in to remove the bomb and police have closed off Military Lane, with the possibility of Military Road also being closed.

Police were called at around 1.30pm yesterday after what appeared to be a shell was discovered and partially dug up near Military Lane, Efford.

Holiday beach cordoned off after landslip sends more than a THOUSAND Second World War bombs and rockets tumbling onto the sands

- Bad weather led to ground movement which exposed the huge arsenal at Mappleton, East Riding
- A dog walker stumbled across the deadly find on Saturday and 15 controlled explosions were carried out
- Rockets, mortar bombs and 25-pounder bombs were recovered after they were fired into the cliffs by RAF aircraft during the war
- Most of the devices were dummy rounds used for bombing practice but contain enough explosives to cause terrible injuries

© Jonathan Pow

Bomb Beach Alley: Rockets were found after a landslide on Mappleton beach in 2012

Army bomb disposal team called to Blacksole Bridge in Herne Bay

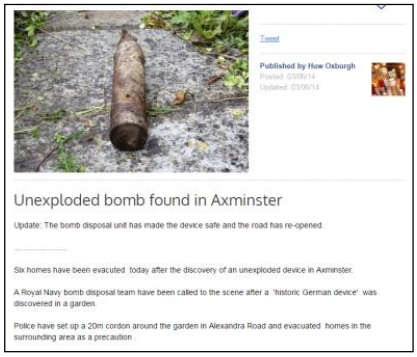
by Aidan Barlow abarlow@thekmgroup.co.uk 08 July 2015

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.

The scene at Blacksole Bridge after wartime explosives were found in the railway cutting



Tweet

Published by Huw Oxburgh

Posted: 03/06/14

Updated: 03/06/14

Unexploded bomb found in Axminster

Update: The bomb disposal unit has made the device safe and the road has re-opened.

Six homes have been evacuated today after the discovery of an unexploded device in Axminster.

A Royal Navy bomb disposal team have been called to the scene after a 'historic German device' was discovered in a garden.

Police have set up a 20m cordon around the garden in Alexandra Road and evacuated homes in the surrounding area as a precaution.

Storms and floods unearth unexploded wartime bombs

By Claire Marshall

BBC environment correspondent

There has been a dramatic increase in the number of wartime bombs unearthed because of the winter storms and flooding.

Bomb disposal teams in the South West have dealt with double the number of unexploded ordnance than in the same period last year.

Since mid December, the Royal Navy's Southern Dive Unit has recovered or disposed of 244 items of ordnance.

During the same period last year, they dealt with just 108 items.

The storms have uncovered a lethal past

Almost 70 years after the end of WWII, one legacy of that conflict continues to turn up on beaches and harbours around Britain.

Unexploded shells, bombs and mines continue to be discovered every year, and the Royal Navy's Southern Dive Unit is tasked with making these devices safe.

Its area of responsibility stretches for some 2,250km (1,400 miles). It begins from the highwater mark in Hull and proceeds seaward to the territorial limit, and then runs clockwise around the British Isles - including the Isle of Wight, Channel Islands, and Isles of Scilly - to finish in Liverpool.

Related Stories

Ancient trees revealed by storms

Land Service Ammunition (LSA) resulting from historic military activity is commonly encountered across the UK by the public and construction industry alike. Such finds are much more common in rural areas than in urban environments, and can often be anticipated in areas such as former RAF stations or ranges. However, many such items are encountered entirely by surprise where the landowner or developer has no knowledge of any previous military use of the land.

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Project: **Daer Reservoir, Biggar**

Ref: **DA10468-00**

Source: Various news sources

News › Local News › Dumfries

Energy minister praises windfarm

MSP Fergus Ewing welcomes job creation

SHARE

By Stephen Temlett
08:57, 3 JUL 2014

College students Kieran McLatchie and Andrew Black with Keith Anderson, head of ScottishPower, Renewables; Fergus Ewing MSP; Xabier Vitteri, head of Iberdrola Renewables at Harestanes

The windfarm, which was granted permission in 2007, covers an area of 20 square kilometres in the forest of Ae and should produce enough renewable energy to meet the demands of 73,000 homes a year.

Keith Anderson, head of ScottishPower Renewables, said: "Harestanes is one of the largest onshore windfarms in Scotland, and it is fantastic to see the project fully completed after a number of years of planning and preparation.

"As well as overcoming many hurdles during the planning process, we also had to manage the discovery of unexploded WW2 bombs during construction and we were delighted to finish the project on schedule."

He added: "Over the lifetime of the project, we will need highly skilled technicians to operate and maintain the windfarm and millions of pounds will be invested in the local area.

"We hope to see some of the newly qualified technicians from Dumfries College coming in to the industry and working on projects like this after graduation."

Developers listed contracts for local businesses, 11km of new tracks and paths and a new trail for the 7stanes cycle route among the benefits of the windfarms.

Plots of Missiles Dropped on Scotland 1939-1945

Annex: P1

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Approximate site boundary

Project: **Daer Reservoir, Biggar**

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Ref: **DA10468-00**

Source: National Archives of Scotland

Plots of Missiles Dropped on Scotland 1939-1945

Annex: P2

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Client: **Natural Power**

Project: **Daer Reservoir, Biggar**

Ref: **DA10468-00**

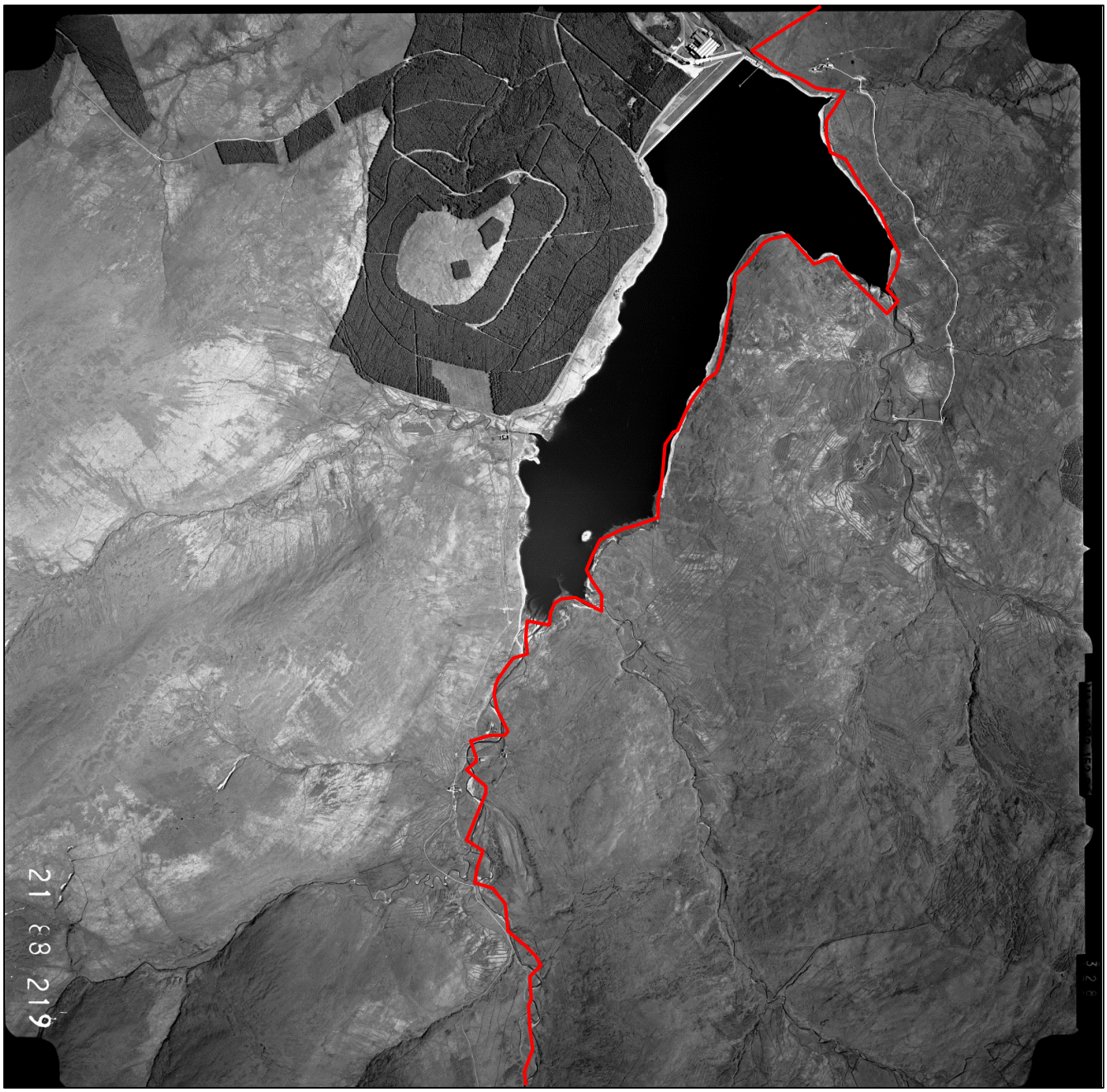
Source: National Archives of Scotland

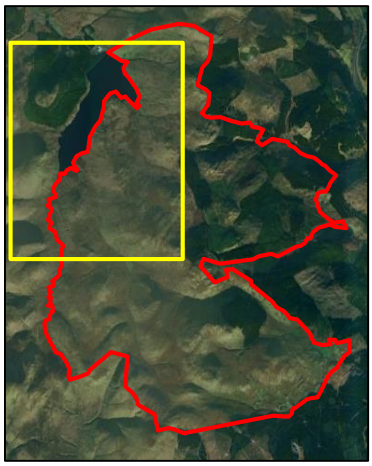
Approximate site boundary

N

RAF Aerial Photography 1988- Image 1

Annex: **Q1**





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Approximate site boundary

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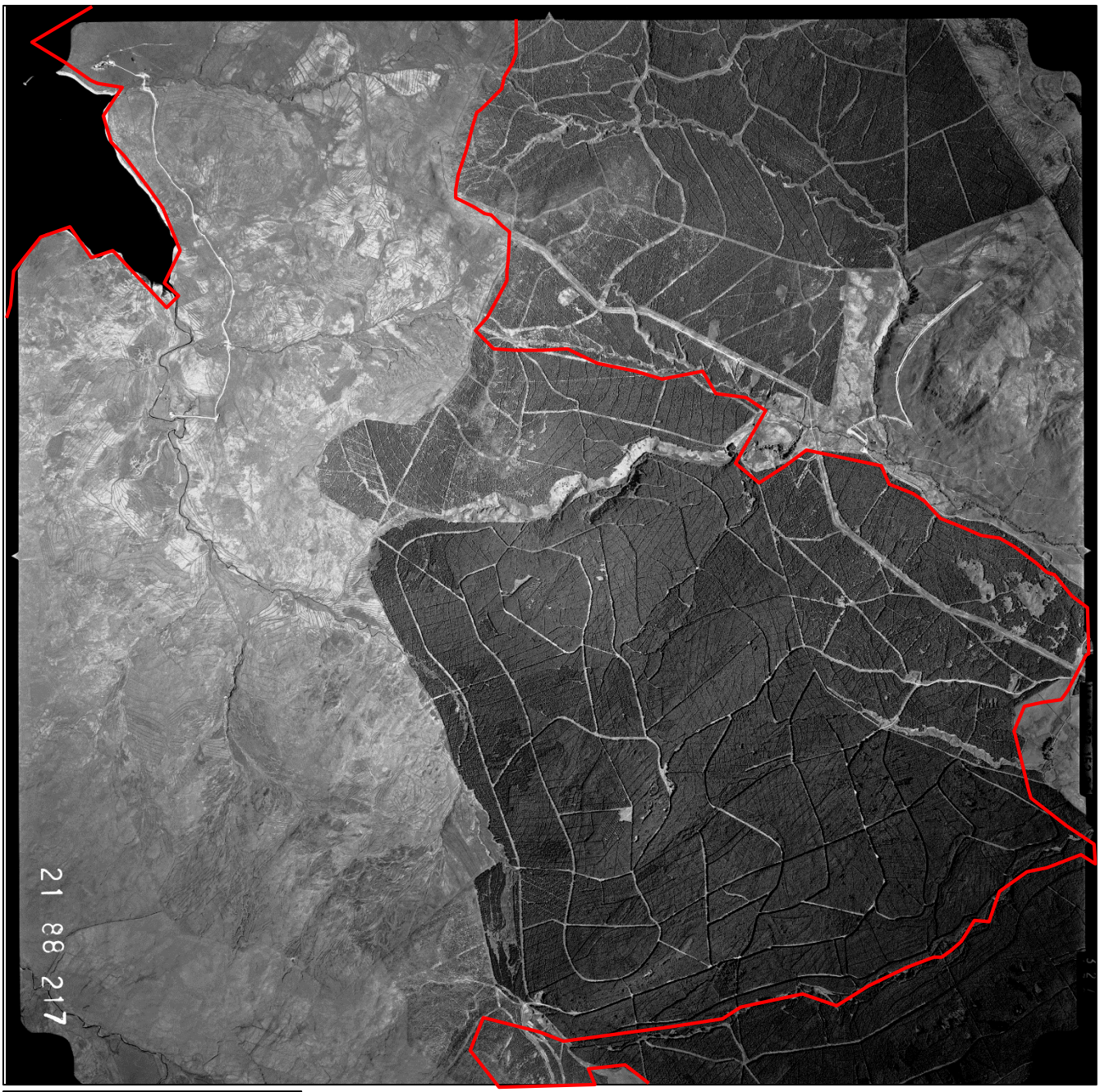
Project: **Daer Reservoir, Biggar**

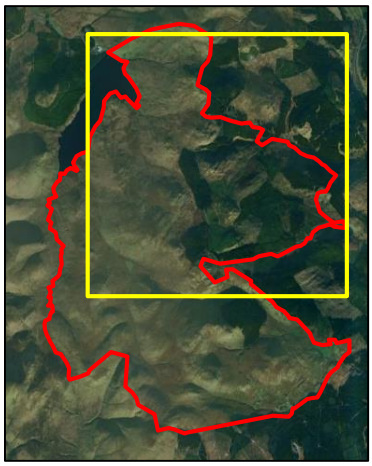
Ref: **DA10468-00**

Source: National Collection of Aerial Photography (NCAP)

RAF Aerial Photography 1988- Image 2

Annex: **Q2**





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Approximate site boundary

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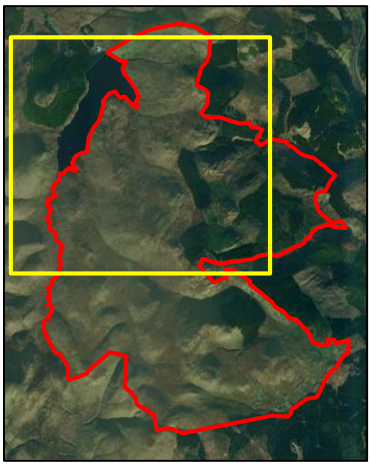
Source: National Collection of Aerial Photography (NCAP)

RAF Aerial Photography 1988- Image 3

Annex: **Q3**



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Source: National Collection of Aerial Photography (NCAP)

Approximate site boundary

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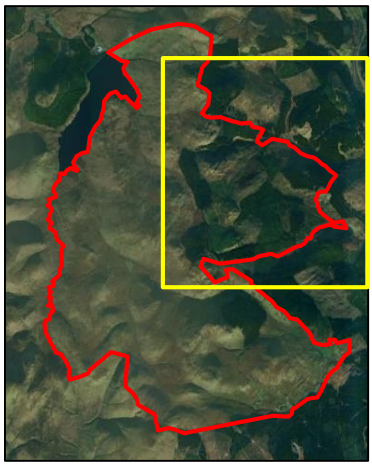
RAF Aerial Photography 1988- Image 4

Annex: **Q4**



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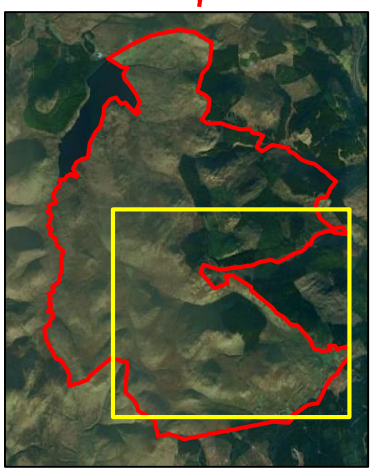
Project: **Daer Reservoir, Biggar**

Ref: **DA10468-00**

Source: National Collection of Aerial Photography (NCAP)

RAF Aerial Photography 1988- Image 5

Annex: Q5



1ST LINE DEFENCE

Unit 3, Maple Park
Essex Road, Hoddesdon,
Hertfordshire. EN11 0EX
Email: info@1stlinedefence.co.uk
Tel: +44 (0)1992 245 020

Client: **Natural Power**

Project: **Daer Reservoir, Biggar**

Ref: **DA10468-00**

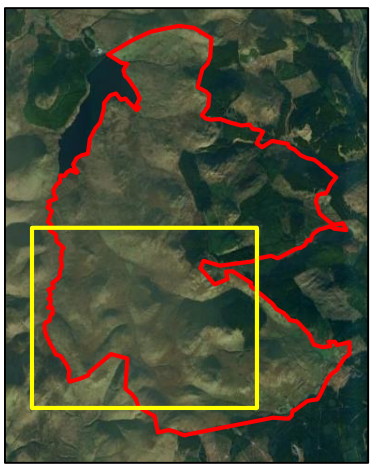
Source: National Collection of Aerial Photography (NCAP)

Approximate site boundary

N

RAF Aerial Photography 1988- Image 6

Annex: **Q6**



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Hertfordshire. EN11 0EX
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Client: **Natural Power**

Project: **Daer Reservoir, Biggar**

Ref: **DA10468-00**

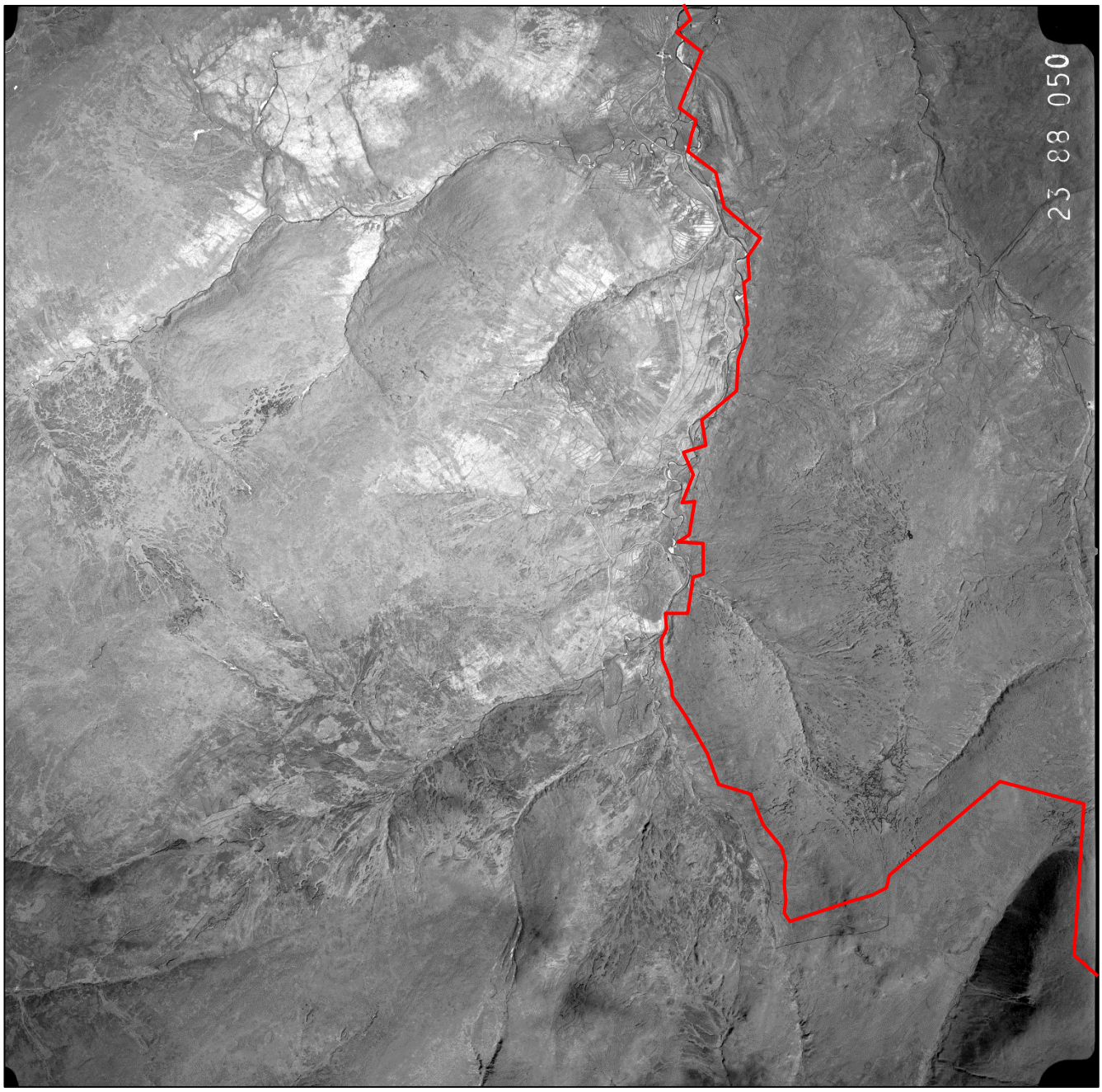
Source: National Collection of Aerial Photography (NCAP)

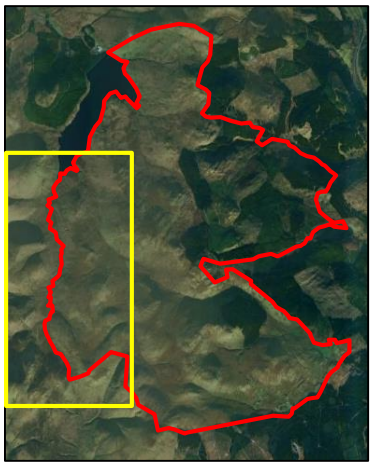
Approximate site boundary

N

RAF Aerial Photography 1988- Image 7

Annex: **Q7**





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Hertfordshire. EN11 0EX
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Tel: +44 (0)1992 245 020

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Project: **Daer Reservoir, Biggar**

Ref: **DA10468-00**

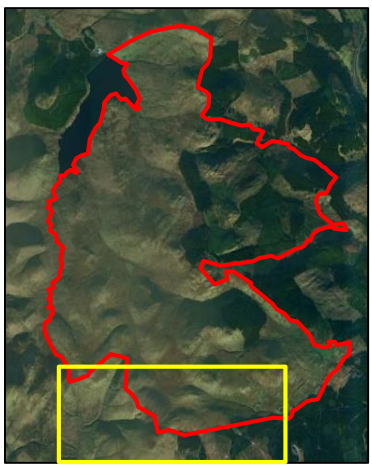
Source: National Collection of Aerial Photography (NCAP)

Approximate site boundary

N

RAF Aerial Photography 1988- Image 8

Annex: Q8



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Tel: +44 (0)1992 245 020

Client: **Natural Power**

Project: **Daer Reservoir, Biggar**

Ref: **DA10468-00**

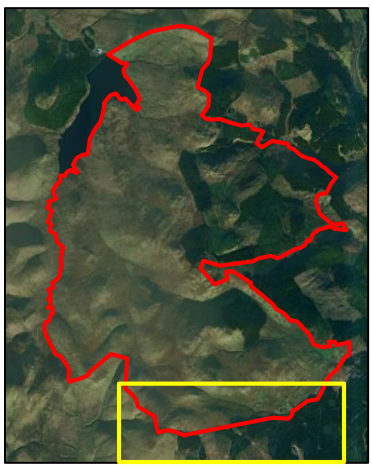
Source: National Collection of Aerial Photography (NCAP)

Approximate site boundary

N

RAF Aerial Photography 1988- Image 9

Annex: Q9



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Tel: +44 (0)1992 245 020

Client: **Natural Power**

Project: **Daer Reservoir, Biggar**

Ref: **DA10468-00**

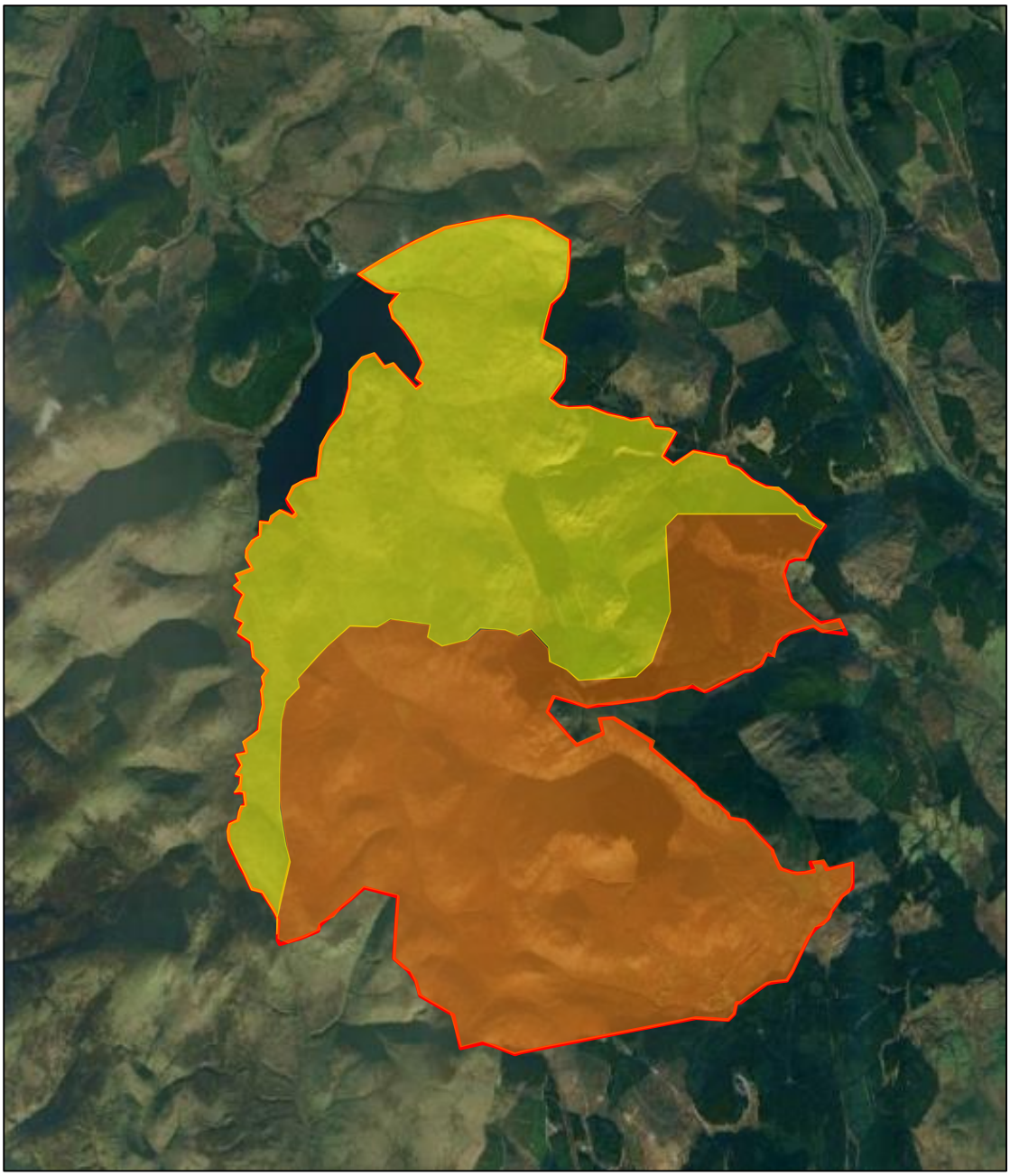
Source: National Collection of Aerial Photography (NCAP)

Approximate site boundary

N

Risk Map – Aerial Photography Overlay

Annex: **R1**



Low-Medium Risk

Medium Risk

Low-Medium and Medium Risk Areas:

- UXO Risk Management Plan
- Site Specific Unexploded Ordnance Awareness Briefings to all personnel conducting intrusive works

Medium Risk Area:

- Non-intrusive Survey or Search & Clear exercise. Where this is not practicable:
- Unexploded Ordnance (UXO) Specialist Presence on Site to support shallow intrusive works

For indicative purposes – not to scale

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Email: info@1stlinedefence.co.uk
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Client: **Natural Power**

Approximate site boundary

N

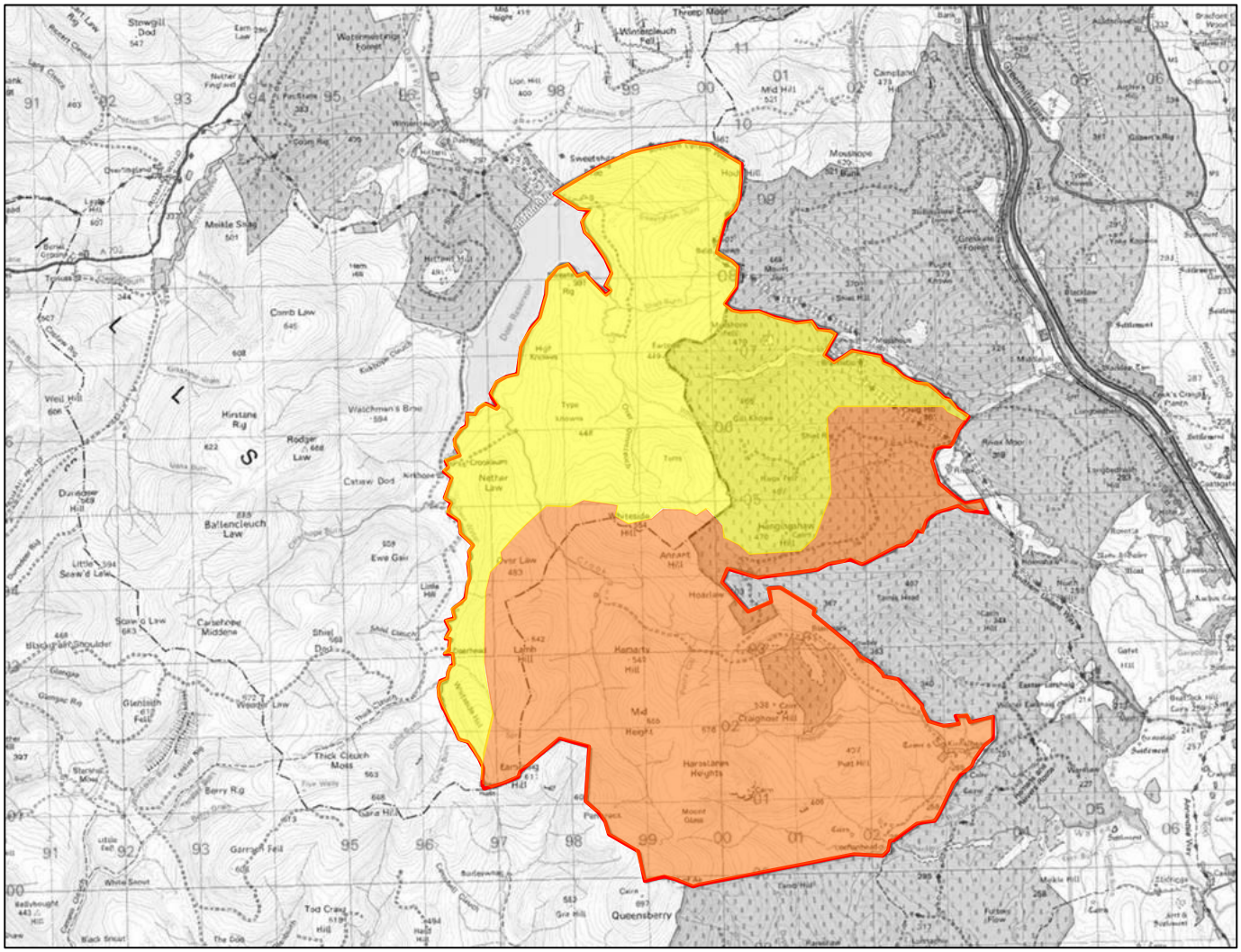
Project: **Daer Reservoir, Biggar**

Ref: **DA10468-00**

Source: 1st Line Defence

Risk Map – Site Plan Overlay

Annex: **R2**



Low-Medium Risk

Medium Risk

Low-Medium and Medium Risk Areas:

- UXO Risk Management Plan
- Site Specific Unexploded Ordnance Awareness Briefings to all personnel conducting intrusive works

Medium Risk Area:

- Non-intrusive Survey or Search & Clear exercise. Where this is not practicable:
- Unexploded Ordnance (UXO) Specialist Presence on Site to support shallow intrusive works

For indicative purposes – not to scale

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Approximate site boundary

N

Project: **Daer Reservoir, Biggar**

Ref: **DA10468-00**

Source: 1st Line Defence

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