Land adjacent to Alpha Windows, Abenbury Way Wrexham Industrial Estate

Phase 2 Contaminated Land Assessment (Intrusive Investigation)

For: Alpha Windows

Date: November 2025

Report Ref: R3458-R02-v1

Smith Grant LLP, Bryn Estyn Business Centre (Suite 16), Bryn Estyn Road, Wrexham, LL13 9TY
T: 01978 822367 • E: consult@smithgrant.co.uk • **www.smithgrant.co.uk**
Members: K E Hawkins (Chairman), D Wayland, L Stock • Partnership No: OC 300776

DOCUMENT CONTROL SHEET

Report Title:	Land adjacent to Alpha Windows, Abenbury Way, Wrexham Industrial Estate Phase 2 Contaminated Land Assessment (Intrusive Investigation)
Client:	Alpha Windows
Report Reference Number:	R3458-R02
Report Status:	Final
Version:	v1
Report Date:	November 2025

for: Smith Grant LLP

	Name	Position	Signature	Date
Author	C McHugh BSc ISEP	Consultant	[redacted]	24.11.25
Reviewer	D Wayland BSc MSc AssocCIWM MCIWEM C.WEM	Partner	[redacted]	24.11.25

Document Revision Record:

Version	Report Status	Date	Details of Revision
v1	Final	24.11.25	For submission to LPA

This report has been prepared by Smith Grant LLP for the sole and exclusive use of Alpha Windows. All reasonable skill, care and diligence has been exercised within the terms of the contract with the client. We disclaim any responsibility to the client and others in respect of any matters outside the scope of the above. This report may be relied upon or transferred to any other parties only with the express written authorization of Smith Grant LLP, such consent as not being unreasonably withheld or delayed. If any Third Party comes into possession of this report, they rely on it at their own risk and the authors owe them no duty or care of skill.

Smith Grant LLP reserves the right to alter any of the foregoing information in the event of new information being disclosed or provided and in the light of changes to legislation, guidelines, and responses by the statutory and regulatory authorities.

LAND ADJACENT TO ALPHA WINDOWNS, ABENBURY WAY, WREXHAM INDUSTRIAL ESTATE

PHASE 2 CONTAMINATED LAND ASSESSMENT (INTRUSIVE INVESTIGATION)

For: Alpha Windows

Contents

1 Introduction
2 Background Information (Desk Study)
3 Investigation Methodology
4 Investigation Observation and Results
5 Revised Conceptual Site Model and Risk Assessment
6 Conclusions
7 Recommendations

Drawings

D01 Site Investigation Trial Pit Locations

Appendices

A Trial Pit Logs
B Photographic Record
C Laboratory Certificate
D Detailed UXO Risk Assessment

1 Introduction

1.1. Smith Grant LLP (SGP) understand that Alpha Windows have been granted planning permission (P/2022/0411) by Wrexham County Borough Council (WCBC) for the construction of an industrial unit within a parcel of land in Wrexham Industrial Estate. The land hereby referred to as 'Site' is located adjacent to Alpha Windows off Abenbury Road. Condition 8 and 9 of the planning permission requires a phased investigation to identify the extent of contamination, and any measures required to remediate the Site.

1.2. To partially satisfy the Conditions a Phase 1 Contaminated Land Assessment (Desk Study) of the Site was produced by SGP in August 2025 (re: R3458-R01-v1) with recommendations made for a limited site investigation. SGP were duly instructed to undertake the recommended Phase 2 Intrusive Investigation which is detailed within this report.

1.3. This report describes the work carried out by SGP including the ground conditions encountered, laboratory test results and discusses the contamination implications with regards to the proposed development.

1.4. Site details are:

Table 1.1: Site Details

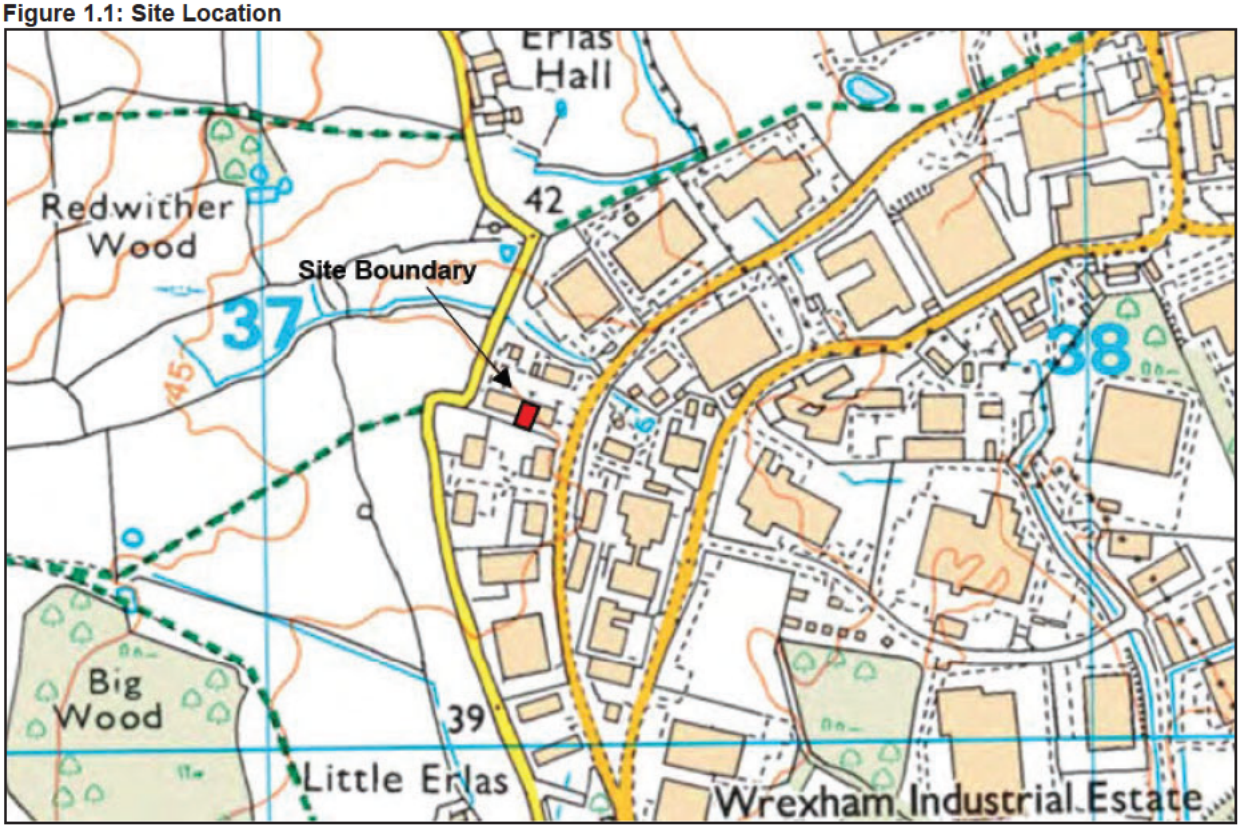
Address	Land adjacent to Alpha Windows, Abenbury Way, Wrexham Industrial Estate
National Grid Reference	337320 350468
Local Authority	Wrexham County Borough Council (WCBC)
Site Area	Approximately 0.07 Ha
Access	Off Abenbury Road
Current Use	The Site is currently unused grassed area located in between two industrial units with car parking to the south
Proposed Use	Construction of an industrial unit

1.5. The assessment methodology follows the framework described in the Environment Agency (EA) Land Contamination Risk Management (LCRM)[1] and has been prepared with reference to the Planning Practice Guidance provided in relation to land affected by contamination[2].

1.6. To provide an evaluation of the ground conditions and the extent of any potential soil contamination present on site, the assessment methodology was carried out in accordance with BS5930:2015 +A1:20203 and BS 10175:2011 +A2:20174.

[1] https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm
[2] Planning Practice Guidance (PPG): Land Affected by Contamination, issued 12 June 2014, last updated 22 July 2019, www.gov.uk
[3] British Standard 5930: Code of practice for ground investigations
[4] British Standard 10175: Investigation of Potentially Contaminated Sites - Code of Practice

Figure 1.1: Site Location



Reproduced with the permission of the Ordnance Survey @Crown Copyright Licence No. 100005799

2 Background Information

2.1. References

2.1.1. Reference should be made to the following report:

- SGP Phase 1 Contaminated Land Assessment (Desk Study) (ref: R3458-R01-v1)

2.1.2. The desk study includes a detailed historical review of the site, its setting, geology, hydrology and hydrogeology, and presents a preliminary conceptual site model, objectives and the rationale for this site investigation.

2.1.3. The findings of the report are summarised in brief below, but reference should be made to the complete report.

2.2. Historical Development

2.2.1. Historical mapping shows the Site to form part of a wider area of open fields likely in agricultural use until the 1982. Historical mapping shows the Site to be part of Wrexham Industrial Estate although no developments have taken place on the Site over its mapped history. The Site lies adjacent to a single industrial unit with a larger warehouse unit to the immediate south. There are no features mapped on Site from 1899-2003 according to Ordnance Survey historical maps. Reviewing aerial imagery from 2006 onwards there are no developments or features of note on Site; it is presented as a small parcel of grassed land lying adjacent to industrial units.

2.2.2. The surrounding land was largely undeveloped on historical mapping from 1899-1912. There is a significant gap in mapping coverage as the next mapping from 1961 shows a mineral railway siding to the east at approximately 180m. From 1982 mapping the area to the south and east of the Site had an already established small development composed of a few small detached commercial / industrial premises with associated access roads. This development forms part of the now wider Wrexham Industrial Estate. The Wrexham Industrial has been developed gradual between 1968 and 2025 located to the south and east of the Site. This included the construction of factories, industrial units, car parking and new roads. The land to the north and west of the Site has remained in agricultural use with a series of large open fields. To the far north-west lies the Redwither wood and Clays Farm.

2.1. Topography and Land Use

2.1.1. The Site is located approximately 3.8km from Wrexham Town Centre. The Site is located at an elevation of approximately 40m Above Ordnance Datum (AOD), with a flat, even topography as shown by spot heights on contemporary OS mapping.

2.1.2. The Site is a small vacant green space.

2.2. Soils and Geology

2.2.1. The published geology shows the Site to be underlain by Devensian Glacial Till (clay, sand, gravel). BGS mapping reports the presence of Early-Triassic Kinnerton Sandstone Formation. There is no made ground / artificial ground mapped on the Site, however BGS does report the land as 'known landscaped ground'. Described as either made ground, worked ground or disturbed ground with a variable composition.

2.3. UXO

2.3.1. A Pre-desk Study Assessment and Risk Map was produced by Zetica and reported the overall risk as low. However, in the surroundings the Site lies within an area of a former military land used by the ROF (1938-1945). Therefore, a detailed desk study was recommended to assess the UXO hazard level on the Site. A detailed UXO Risk Assessment report has been duly commissioned, the findings are summarised in Section 3.3.

2.4. Land Contamination

2.4.1. Potential for made / worked / disturbed ground to be present on Site of an unknown depth and composition. If present, and depending on the source and composition, made ground can contain contaminants including polyaromatic hydrocarbons (PAHs), heavy metals and asbestos fibres.

2.4.2. According to WCBC the Site falls within an area of former military land used by the ROF (1938-1945). The ROF undertook the manufacture of 'flashless' cordite, an explosive used in the Second World War. From review of the historical mapping and provided ROF layout plan, however, no buildings or infrastructure (such as mineral railway lines) were present on the Site. The risk of contamination associated with manufacturing of munitions on the Site is therefore considered as negligible.

2.4.3. The long-term risk to construction workers and future site users is considered low across the Site, however a limited site investigation is required to confirm this.

3. Investigation Methodology

3.1. Objectives and Rationale

3.1.1. An intrusive investigation was carried out by SGP to confirm the ground conditions underlying the Site and allow an assessment of its contamination status. The scope of works for the supplementary investigation was determined to achieve:

- assess the presence, extent, and nature of any made ground and associated soil contamination.
- confirm general shallow ground conditions underlying the Site with entries excavated on a 1 entry per 10m grid spacing to cover the whole Site (4 entries) to natural strata.
- Collect representative samples of shallow soils (including any made ground where encountered) and submission of samples for chemical analysis.
- provide recommendations for any further investigation or remedial works as considered necessary.

3.1.2. Sample collection was designed to:

- Include representative shallow soil samples (8 no) of topsoil / made ground (if encountered) and natural subsoil for a typical suite of urban contaminants including heavy metals, PAH-16, hydrocarbons and asbestos.
- Include BRE testing for shallow soil samples (4 no) of subsoils.

3.2. General

3.2.1. Prior to the commencement of the intrusive investigation, and as recommended within the Phase I Desk Study, a Detailed UXO Risk Assessment was commissioned. The findings are summarised in Section 3.3; however, it was determined that a tool-box talk was necessary prior to the commencement of the investigation to mitigate against the low but not negligible risk of UXO. Site SGP attended an online UXO safety briefing on the 15.10.25. In addition to the briefing, in advance of the Site investigation works service plans were obtained to ensure entry locations were located as a safe stand-off distances where anomalous readings or suspected utilities (following a review of service plans) were encountered.

3.2.2. The Site investigation works were completed in a single day. This involved the excavation of 4 trial pits and the collection of representative samples; these works were undertaken by C McHugh, Consultant on the 16.10.25. Locations of the Site investigation works are indicated on Drawing D01.

3.2.3. The works involved the excavation of 4 trial pits (TP1-TP4) to a maximum depth of 3m below ground level. The inspection and logging of ground conditions and the collection of representative soil samples and submitted to i2 Analytical for laboratory analysis under a typical testing suite (heavy metals, PAHs, hydrocarbons, asbestos).

3.3. Detailed UXO Assessment

3.3.1. Prior to the commencement of the intrusive investigation, a Detailed UXO Risk Assessment was produced by 1st Line Defence as recommended in the Phase I Desk Study. It was necessary to undertake this assessment to understand the potential risk from UXO and ensure appropriate mitigation measures were in place during the site investigation.

3.3.2. A copy of the Detailed UXO Assessment is presented in Appendix D, however in brief the assessment concluded a **Low Risk** from both German Air-Delivered UXO and Allied UXO.

3.3.3. The recommended risk mitigation measures to be adopted during the site investigation were:

- UXO Risk Management Plan
- Site-Specific UXO Awareness Briefing to all personnel conducting the intrusive works

3.3.4. SGP produced the UXO Risk Management Plan through support by 1st Line Defence and the Site-Specific UXO Awareness Briefing was undertaken virtually by the attending consultants and 1st Line Defence.

3.4. Chemical Analysis

3.4.1. Chemical analysis of soils was carried out by i2 Analytical, working where possible to MCERTS and / or ISO 17025 accreditation. Soil samples were stored in appropriate containers as advised by the laboratory, placed in chilled cool boxes, and delivered to the laboratory within 48 hours of collection. Chain of custody documentation was completed and is retained by SGP.

3.4.2. Summaries of the sampled strata, sample reference, depth and chemical test suite is provided below.

Table 3.1. Summary of Soil Chemical Analysis

Strata	Description	Sample ref	Depth (m bgl)	Analytical suite
Topsoil	Loose dark brown slightly sandy clayey TOPSOIL with frequent rootlets. Rare inclusions of course gravel fragments; fine to medium.	TP1-ES1 TP2-ES1 TP3-ES1	0.0.20m 0.20-0.90m 0-0.50m	SGP Standard Suite
Made ground	Very loose to loose, greyish brown gravelly sands with inclusions of plastic sheeting, brick, wood, metal wires and clay ceramic all present.	TP4-ES1	0.2-1m	SGP Standard Suite
Subsoil	Firm to stiff brown mottled greyish orange CLAY with occasional pockets of sand becoming stiff brown mottled grey slightly sandy CLAY.	TP1 – ES2 TP1-ES3 TP2-ES2 TP2-ES3 TP3-ES2 TP3-ES3 TP4-ES2 TP4-ES3	0.90-3m	BRE Suite SGP Standard Suite BRE Suite SGP Standard Suite BRE Suite SGP Standar Suite BRE Suite

SGP Standard Suite = pH, SOM, metals, PAHs (16 speciated), & TPH-CWG
BRE = total sulphate, soluble sulphate (2:1 extraction), pH, total sulphur, soluble nitrate, ammoniacal nitrogen, soluble chloride

3.4.2. The full soil chemical results are provided in Appendix C.

4. Investigation Observation and Results

4.1. Summary of Ground Conditions

4.1.1. Following the trial pitting, SGP has produced trial pit logs (Appendix A) and photographs of excavations (Appendix B). The Site investigation revealed that the general succession of strata can be generally represented by a layer of topsoil, followed by very sand to sandy clay overlying a firm to stiff clay with pockets of silty sand. Some variations of this were observed as described in more detail below.

4.1.2. All depths provided in the following sections are from ground levels contemporaneous with the site investigation dates. Classifications are based on field descriptions and laboratory results.

Topsoil

4.1.3. All 4 trial pits contained from surface level to 0.2 - 0.5m bgl of topsoil comprising of 'loose dark brown slightly sandy clayey TOPSOIL with frequent rootlets. Rare inclusions of course gravel fragments; fine to medium'.

Made ground

4.1.4. Made ground was identified in one entry at TP4 located in the north-east corner of the Site between 0.2 - 1m bgl. Comprising of very loose, greyish brown gravelly sands with inclusions of plastic sheeting, brick, wood, metal wires and clay ceramic all present.

Subsoil

4.1.5. The trial entries were terminated at depths between 3m and 3.6m bgl as natural strata was encountered. Subsoil was described within all four entries comprised of the following soil type:

- **CLAY** (TP1 to TP4): "Firm to stiff brown mottled greyish orange CLAY with occasional pockets of sand becoming stiff brown mottled grey slightly sandy CLAY".

4.2. Groundwater Conditions

4.2.1. Groundwater was encountered in two location (TP1 & TP2) at 2.5m bgl, in the south entries of the Site. This was observed as damp sands and slow water ingress through the sidewall.

4.3. Contamination Indicators

4.3.1. Soils were screened with a Photoionization Detector (PID) and no elevated readings were reported, readings were below detection limits (<0.1ppm) in all instances. No visual or olfactory evidence of contamination was observed.

4.3.2. Inert waste materials consisting of plastic sheeting, brick, wood, metal wires and ceramic were present within a discreet deposit of made ground within TP4.

4.4. Results of Soil Chemical Analysis

4.4.1. The complete soil analytical data is presented in Appendix C (i2 Laboratory refs: 25-056321). The results of the soil analyses are compared to human health critical values (CVs) for initial screening purposes. Given the proposed development is for industrial units with hardstanding, CVs derived for commercial, primarily from the LQM / CIEH Suitable for Use Levels (S4ULs)1, have been utilised; these are derived for a sandy loam soil. Reference is initially made to the S4ULs derived for a soil with 1% soil organic matter.

4.4.2. Where a DEFRA published Category 4 Screening Level (C4SL) is available this has been used to allow an initial screening for risk to human health in accordance with LCRM. This includes the provisional C4SL for lead in the absence of alternative published criteria. This is intended to demonstrate that land is not Contaminated Land as defined under Part IIA of the Environmental Protection Act.

4.4.3. The assessment criteria are intended for use for screening purposes only. Exceedances indicate that either more detailed site-specific risk assessment is required to better quantify risks to human health, or that remediation or mitigation is required to reduce risks by breaking the source-pathway-target relationship between solid phase contaminants and receptors. The results are summarised below:

Table 4.1 Summary of Soil Chemical Analysis

Contaminant	Number of Samples	Range of Concentrations (mg/kg or indicated)	Soil Standard Adopted and Concentration (mg/kg or indicated)	Exceedances
Asbestos ID	8	NAD	Visual identification /<0.001% by mass (LOD)	None
Arsenic	8	5.4-11	640 LQM/CIEH S4UL	None
Cadmium	8	<0.2-0.3	190 LQM/CIEH S4UL	None
Chromium (total)	8	23-38	8,600 LQM/CIEH S4UL	None
Copper	8	22-34	33 LQM/CIEH S4UL	None
Lead	8	19-57	68,000 S4UL	None
Mercury (inorganic)	8	<0.3	2,330 C4SL	None
Nickel	8	19-40	1,100 LQM/CIEH S4UL	None
Zinc	8	49-77	980 LQM/CIEH S4UL	None
Naphthalene	8	<0.05	730,000 LQM/CIEH S4UL	None
Acenaphthylene	8	<0.05	190 LQM/CIEH S4UL	None
Acenaphthene	8	<0.05	83,000 LQM/CIEH S4UL	None
Fluorene	8	<0.05	84,000 LQM/CIEH S4UL	None
Phenanthrene	8	<0.05-0.1	63,000 LQM/CIEH S4UL	None
Anthracene	8	<0.05	22,000 LQM/CIEH S4UL	None
Fluoranthene	8	<0.05-0.08	520,000 LQM/CIEH S4UL	None
Pyrene	8	<0.05-0.05	23,000 LQM/CIEH S4UL	None
Benzo(a)anthracene	8	<0.05	54,000 LQM/CIEH S4UL	None
Chrysene	8	<0.05	170 LQM/CIEH S4UL	None
Benzo(a)pyrene	8	<0.05	77 C4SL	None
Indeno(123cd)pyrene	8	<0.05	35 LQM/CIEH S4UL	None
Dibenzo(ah)anthracene	8	<0.05	3.5 LQM/CIEH S4UL	None
Benzo(ghi)perylene	8	<0.05	3,900 LQM/CIEH S4UL	None

Contaminant	Number of Samples	Range of Concentrations (mg/kg or indicated)	Soil Standard Adopted and Concentration (mg/kg or indicated)	Exceedances
Benzo(b)fluoranthene	8	<0.05	44 LQM/CIEH S4UL	None
Benzo(k)fluoranthene	8	<0.05	1,200 LQM/CIEH S4UL	None
Aliphatic >C5-C6	8	<0.01	3,200 LQM/CIEH S4UL	None
Aliphatic >C6-C8	8	<0.01	7,800 LQM/CIEH S4UL	None
Aliphatic >C8-C10	8	<0.01	2,000 LQM/CIEH S4UL	None
Aliphatic >C10-C12	8	<1	9,700 LQM/CIEH S4UL	None
Aliphatic >C12-C16	8	<2	59,000 LQM/CIEH S4UL	None
Aliphatic >C16-C21	8	<8	1,600,000 LQM/CIEH S4UL	None
Aliphatic >C21-C35	8	<8	1,600,000 LQM/CIEH S4UL	None
Aromatic >C5-C7	8	<0.01	26,000 LQM/CIEH S4UL	None
Aromatic >C7-C8	8	<0.01	56,000 LQM/CIEH S4UL	None
Aromatic >C8-C10	8	<0.02	3,500 LQM/CIEH S4UL	None
Aromatic >C10-C12	8	<1	16,000 LQM/CIEH S4UL	None
Aromatic >C12-C16	8	<2	36,000 LQM/CIEH S4UL	None
Aromatic >C16-C21	8	<10	28,000 LQM/CIEH S4UL	None
Aromatic >C21-C35	8	<10	28,000 LQM/CIEH S4UL	None
Benzene	8	<5	27 LQM/CIEH S4UL	None
Toluene	8	<5	56,000 LQM/CIEH S4UL	None
Ethylbenzene	8	<5	5,700 LQM/CIEH S4UL	None
m/p-xylene	8	<8	5,900 LQM/CIEH S4UL	None
o-xylene	8	<5	6,600 LQM/CIEH S4UL	None

Notes to table:

S4UL: Suitable for Use Levels published by Chartered Institute of Environmental Health and Land Quality Management Ltd, 'Commercial (1% SOM)'; copyright Land Quality Management Ltd reproduced with permission publication number S4UL3102. All rights reserved.

C4SL: Category 4 Screening Levels published by CL:AIRE (C4SLs); 'Commercial' (1% SOM)

4.4.4. No exceedances of the commercial land use criteria were reported within 8 samples of topsoil, made ground or and subsoil taken across the Site. Concentrations of PAHs and hydrocarbons were typically below analytical detection levels in all instances.

4.4.5. There was also no asbestos identified within any of the samples.

4.5. Results of Soluble Sulphate Analysis and Concrete Classification

4.5.1. An assessment of the potential for aggressive conditions for concrete in accordance with BRE Special Digest 1 (20-09) has been based on soluble sulphate concentrations within the bearing strata of the Site. The results are summarised in the table below:

Table 4.2. Aggressive Chemical Environment for Concrete (ACEC) classification

Sample	Soluble Sulphate (mg/l)	pH	Design Sulphate Class	ACEC Class
TP1-ES3 (1-1.5m bgl)	30.1	8	DS-1	AC-1s
TP2-ES3 (0.9-1.5m bgl)	12.7	8	DS-1	AC-1s
TP3-ES3 (1-1.5m bgl)	8.07	8.2	DS-1	AC-1s
TP4-ES3 (1-1.5m bgl)	45.3	8	DS-1	AC-1s

4.5.2. Concrete classification risk assessment based on concentration of soluble sulphate within the bearing strata indicate a worst-case design of sulphate class (DC) of DS-1 and an Aggressive Environment for Concrete (ACEC) classification of AC-1s assuming static groundwater.

5. Revised Conceptual Site Model

5.1. Methodology

5.1.1. Information from the current site investigation has been used to refine the likely source-pathway-target relationships identified in the preliminary Conceptual Site Model (CSM). A Tier 1 risk assessment has been undertaken by comparison of contaminant concentrations in soils to generic screening criteria. These are values appropriate to the intended residential care-home end-use of the site and indicate whether potentially unacceptable risks to receptors are likely to exist, requiring either more detailed site-specific risk assessment or remediation to break the potential contaminant linkage.

5.2. Contamination Sources

5.2.1. The key potential source of contamination that could impact the site were identified in the Phase 1 Desk Study (possible widespread made ground). However, no significant contamination indicators such as odours, staining, or elevated PID readings were observed. A small pocket of localised made ground was observed in TP4 which appeared to be reworked natural soil with inert waste materials.Testing of the soils demonstrated no exceedances of the adopted criteria considered to be the most appropriate for the proposed land use (Commercial).

5.3. Potential Targets

5.3.1. The principal receptors considered, assuming residential development of the site, are:

- construction workers who may be exposed to contaminants during preparatory and construction works;
- future maintenance workers and employees;
- adjacent site users or visitors

6.4. Human Health Risk Assessment

6.4.1. The potential for significant contamination within the Site soils that may pose an acute risk to construction workers during the build-phase of the development is considered to be **negligible** across the Site based on the absence of contamination indicators.

6.4.2. The risk to future site occupants is considered **negligible** due to the absence of contamination indicators and no exceedances reported within tested soils.

6.5. Property Risk Assessment

6.5.1. The proposed development of the site will include a small industrial unit and limited associated infrastructure. The concrete classification risk assessment indicates a DS-1- AC-1 classification is appropriate.

6.6. Controlled Waters Risk Assessment

6.6.1. The risk to controlled waters is considered **negligible** due to the absence of contamination indicators.

6.7. Conceptual Site Model

6.7.1. The revised CSM is summarised below:

Table 5.1. Revised Conceptual Site Model

Receptor	Source / Contaminant	Pathway / Exposure	Severity / Consequence of Risk	Probability of Risk Occurring	Anticipated Risk (in absence of mitigation)	Further Works Recommended
1. humans – construction workers	Metals / metalloids / PAHs / hydrocarbons / asbestos	Dermal contact / ingestion / inhalation – short term exposure	Small	Unlikely – Whilst a localised deposit of made ground was observed on Site, this consistent of reworked natural soils with inert construction wastes. Chemical testing has confirmed the absence of elevated soil concentrations above generic screening values for a commercial land use.	Low	No further works required.
2. Humans – future site occupants/maintenance works	Metals / metalloids / PAHs / hydrocarbons / asbestos	Dermal contact / ingestion / inhalation – short term exposure	Medium	Unlikely – Whilst a localised deposit of made ground was observed on Site, this consistent of reworked natural soils with inert construction wastes. Chemical testing has confirmed the absence of elevated soil concentrations above generic screening values for a commercial land use.	Low	No further works required.
3. humans – adjacent site users	Metals / metalloids / PAHs / hydrocarbons / asbestos	windblown / dermal contact / ingestion / inhalation	Medium	Unlikely – Whilst a localised deposit of made ground was observed on Site, this consistent of reworked natural soils with inert construction wastes. Chemical testing has confirmed the absence of elevated soil concentrations above generic screening values for a commercial land use.	Low	Dust suppression to be used during preparatory / ground disturbance works during dry conditions as per standard working measures
4. property / services (Proposed commercial development and associated infrastructure)	pH / sulphate, organic contaminants	Chemical attack of buried concrete	Medium	Unlikely – Low risks to concrete based on the soil pH and soluble sulphate concentrations reported to date.	Low	Concrete classification of DS1-AC1 based on current data.
5. groundwater	leachable metals / metalloids / PAHs / hydrocarbons	migration via saturated zone	Negligible	Unlikely – Whilst a localised deposit of made ground was observed on Site, this consistent of reworked natural soils with inert construction wastes. No contamination with the potential to leachate or remobilise identified.	Low	None Required

6. Conclusion

6.1. Contaminated Land

6.1.1. The SGP intrusive investigation has confirmed that the ground conditions across the Site consist of a layer of topsoil, followed by slightly sandy, slightly gravelly clay soft becoming stiff. A localised deposit of made ground was encountered in TP4, consisting of reworked natural soils with inert construction materials.

6.1.2. No visual or olfactory evidence of contamination was observed. All arisings during the investigation were screened with a PID to detect the presence of organic vapours, readings were consistently below detection limits (<0.1ppm) in all instances.

6.1.3. Representative soil samples (total 8no.) were collected from the topsoil, made ground and subsoil, and were submitted for asbestos, fractioned hydrocarbons, speciated PAH, and heavy metal analysis. Further samples were collected of subsoils (total 4no.) were submitted for BRE testing (pH and soluble sulphate).

6.1.4. No exceedances were reported when the concentrations were compared to Generic Assessment Criteria (GACs) based on a commercial land use which is appropriate to the proposed end-use of the Site.

6.1.5. It is concluded that the overall risks to site receptors from contamination is negligible owing to the absence of any contamination and that further investigation, assessment or remediation is not required.

6.1.6. Analysis of foundation bearing strata has recorded pH and soluble sulphate concentrations corresponding to a Design Sulphate Class of DS-1 and Aggressive Chemical Environment for Concrete (ACEC) class AC-1.

6.1.7. It should also be noted that the Detailed UXO Risk Assessment considers the Site to be of Low but not negligible risk from UXO.

7. Recommendations

7.1. Contaminated Land

7.1.1. No specific remedial measures are required, however standard construction measures should be employed during construction works. Standard dust-suppression methods should be employed during ground disturbance / excavation works to reduce the likelihood of dust generation.

7.1.2. A copy of this report should be formally submitted to WCBC under an application to discharge Conditions 8 and 9.

7.2. Other Recommendations

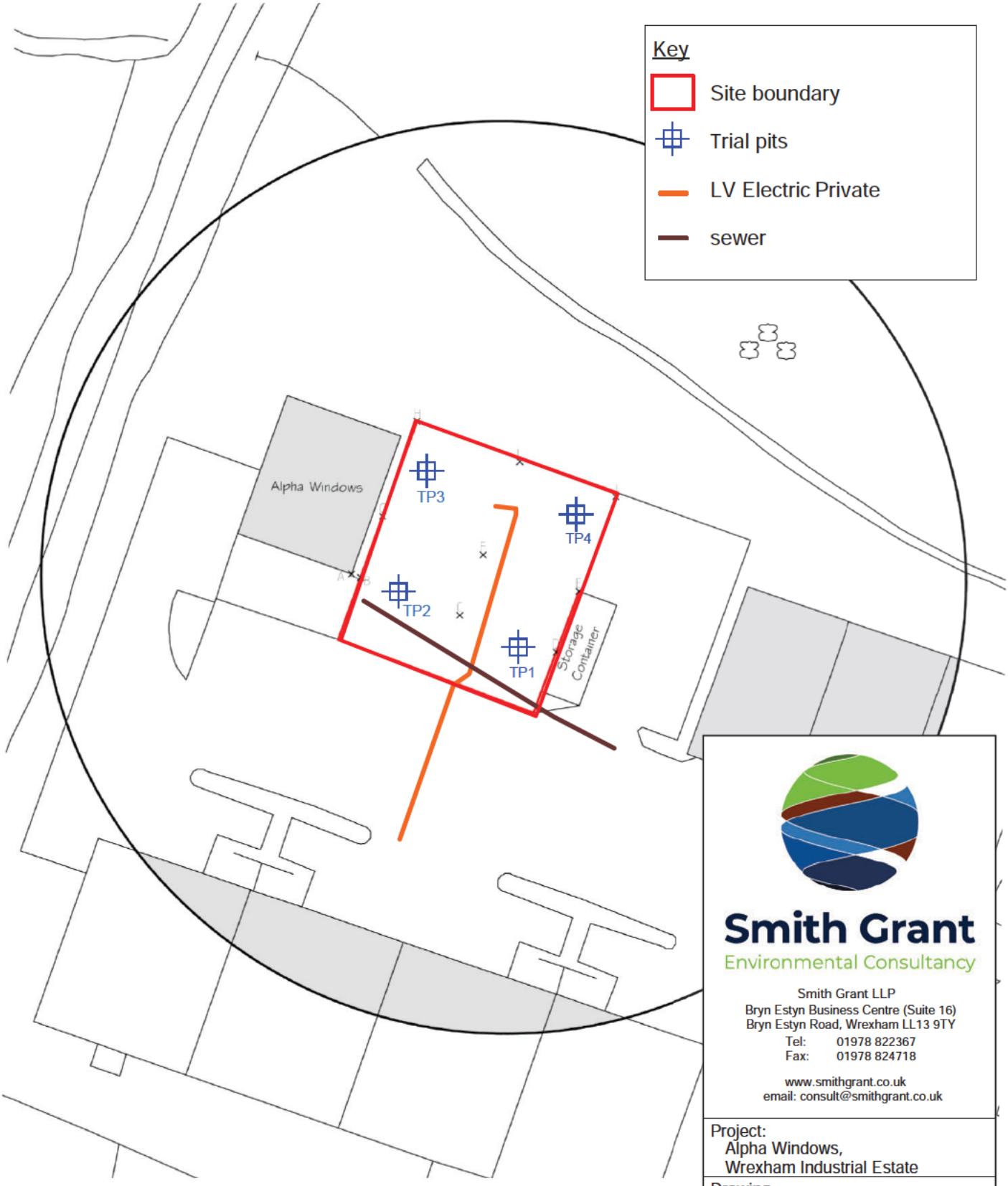
7.2.1. Whilst the risks from UXO have been assessed as being low, a copy of the Detailed UXO Assessment should be provided to any contractors undertaking excavation works so that an appropriate UXO Risk Management Plan can be incorporated into their own Method Statement and Risk Assessment.

7.3. Limitations

7.3.1. This report has been prepared by SGP for the sole and exclusive use of Alpha Windows. Reasonable skill, care and diligence has been exercised within the budget available, and in accordance with the technical requirements of the brief. Notwithstanding the efforts made by the professional team in undertaking the assessment and preparing this report, it is possible that other ground conditions and contamination as yet undetected may exist. Reliance on the findings of this report must therefore be limited accordingly. Such reliance must be based on the whole report and not on extracts which may lead to incomplete or incorrect conclusions when taken out of context.

7.3.2. SGP reserves the right to alter any of the foregoing information in the event of new information being disclosed or provided and in the light of changes to legislation, guidelines and responses by the statutory and regulatory authorities.

DRAWING



Smith Grant
Environmental Consultancy

Smith Grant LLP
Bryn Estyn Business Centre (Suite 16)
Bryn Estyn Road, Wrexham LL13 9TY
Tel: 01978 822367
Fax: 01978 824718

www.smithgrant.co.uk
email: consult@smithgrant.co.uk

Project: Alpha Windows, Wrexham Industrial Estate	
Drawing: Site Investigation Trial Pit Loactions	
Job No: R3458	Drawing No: D01
Date: 19.11.25	Scale: See scale bar
Drawn by: MJ / CM	Checked: DW

APPENDIX A

Trial Pit Logs

SHEET:	LOCATION:	PROJECT:	ENGINEER:	JOB NO.	TRIAL PIT NO.
1 of 1	Wrexham	Alpha Windows	CM / MJ	R3458	TP1
		EXCAVATED BY: 8-tonne Tracked Excavator	CLIENT: Alpha Windows Ltd	DATE: 16.10.2025	

DEPTH (m)	SAMPLES/ TESTING	FIELD RECORDS	DEPTH (m)	DESCRIPTION OF STRATA	LEGEND
0.2	TP1-ES1		0.00	Blackish brown very gravelly slightly sandy clay TOPSOIL with frequent rootlets; gravel is fine to medium sub-rounded to angular of mixed lithology	
		HV(S-P) = 136 kPa @ 0.5m HV(S-R) = 86.67 kPa @ 0.5m	0.2	Stiff light brown very gravelly CLAY with occasional inclusions of plastic rebar and clay pipework fragments; gravel is fine to medium subangular to angular.	
	TP1-ES2		1.00		
		HV(S-P) = 180 kPa @1m HV(S-R) = 65.33 kPa @1m			
1.2			1.2	Stiff brown mottled grey CLAY becoming slightly sandy CLAY at 2.5m.	
1.5	TP1-ES3				
		HV(S-P) = 110.67 kPa @1.5m HV(S-R) = 66.67 kPa @1.5m			
			2.00		
		HV(S-P) = 121.33 kPa @2m HV(S-R) = 49.33 kPa @2m			
			3.00 3	Trial pit terminated @ 3m	
		HV(S-P) = 121.33 kPa @ 3m HV(S-R) = 50.67 kPa @ 3m			
			4.00		
			5.00		

Smith Grant
Environmental Consultancy

Smith Grant LLP
Bryn Estyn Business Centre (Suite 16)
Bryn Estyn Road,
Wrexham, LL13 9TY

Tel: 01978 822367

www.smithgrant.co.uk
email: consult@smithgrant.co.uk

GROUND WATER:
None encountered

REMARKS:
No indicators of contamination (i.e. odours or staining) identified throughout strata
HV(S-P) = Average hand shear vane peak strength reading at depth specified with small vane attachment
HV(S-R) = Average hand shear vane residual strength reading at depth specified with small vane attachment

SCALE:	LOGGED BY:	FIGURE NO.
1:25	CM	1

SHEET:	LOCATION:	PROJECT:	ENGINEER:	JOB NO.	TRIAL PIT NO.
1 of 1	Wrexham	Alpha Windows	CM / MJ	R3458	TP2
		EXCAVATED BY: 8-tonne Tracked Excavator	CLIENT: Alpha Windows Ltd	DATE: 16.10.2025	

DEPTH (m)	SAMPLES/ TESTING	FIELD RECORDS	DEPTH (m)	DESCRIPTION OF STRATA	LEGEND
			0.00	Dark brown slightly sandy slightly clayey TOPSOIL with frequent rootlets and rare inclusions of brick plastic and coal fragments (reworked).	
			0.25	Firm to stiff light brown mottled grey reworked clay with rare glass bottle and clay pipework fragments (MADE GROUND)	
	TP2-ES1 (0.2-0.9m)	HV(S-P) = 130.67 kPa @ 0.5m HV(S-R) = 89.33 kPa @ 0.5m			
0.9			0.9		
		HV(S-P) = 145.33 kPa @ 1m HV(S-R) = 76 kPa @ 1m	1.00	Stiff light brown mottled grey CLAY with a pocket of light brown very silty SAND @ 2.5m becoming slightly sandy CLAY.	
	TP2-ES3 (0.9-1.5m)				
1.5					
		HV(S-P) = 152 kPa @ 1.6m HV(S-R) = 56 kPa @ 1.6m			
	TP2-ES3 (0.9-3.0m)		2.00		
		HV(S-P) = 121.33 kPa @ 2.5m HV(S-R) = 66.67 kPa @ 2.5m			
3			3.00 3		
		HV(S-P) = 76 kPa @ 3m HV(S-R) = 21.33 kPa @ 3m		Trial pit terminated @ 3m	
			4.00		
			5.00		

Smith Grant
Environmental Consultancy

Smith Grant LLP
Bryn Estyn Business Centre (Suite 16)
Bryn Estyn Road,
Wrexham, LL13 9TY

Tel: 01978 822367

www.smithgrant.co.uk
email: consult@smithgrant.co.uk

GROUND WATER:
encountered @2.5m

REMARKS:

No indicators of contamination (i.e. odours or staining) identified throughout strata

HV(S-P) = Average hand shear vane peak strength reading at depth specified with small vane attachment

HV(S-R) = Average hand shear vane residual strength reading at depth specified with small vane attachment

SCALE:	LOGGED BY:	FIGURE NO.
1:25	CM	1

SHEET:	LOCATION:	PROJECT:	ENGINEER:	JOB NO.	TRIAL PIT NO.
1 of 1	Wrexham	Alpha Windows	CM / MJ	R3458	TP3
		EXCAVATED BY: 8-tonne Tracked Excavator	CLIENT: Alpha Windows Ltd	DATE: 16.10.2025	

DEPTH (m)	SAMPLES/ TESTING	FIELD RECORDS	DEPTH (m)	DESCRIPTION OF STRATA	LEGEND
	TP3-ES1 (0-0.5m)		0.00	Dark brown slightly sandy clay TOPSOIL with frequent rootlets and rare gravel fragments; gravel is fine to medium with inclusions of brick and coal fragments (reworked)	
0.5		HV(S-P) = 106.67 kPa @ 0.5m HV(S-R) = 88 kPa @ 0.5m	0.5	Stiff light brown mottled greyish orange becoming dark brown stiff CLAY with occassional pockets of sand	
		HV(S-P) = 116 kPa @ 1m HV(S-R) = 79.33 kPa @ 1m	1.00		
	TP3-ES3 (1-1.5m)				
1.5		HV(S-P) = 116 kPa @ 1.5m HV(S-R) = 79.33 kPa @ 1.5m			
	TP3-ES2 (0.5-3m)		2.00		
		HV(S-P) = 157.33 kPa @ 2m HV(S-R) = 65.33kPa @ 2m			
		HV(S-P) = 178.67 kPa @ 2.5m HV(S-R) = 173.33 kPa @ 2.5m			
3		HV(S-P) = 137.33 kPa @ 3m HV(S-R) = 58.67 kPa @ 3m	3.00		
			3.2	Trial pit terminated @ 3.2m	
			4.00		
			5.00		

Smith Grant
Environmental Consultancy

Smith Grant LLP
Bryn Estyn Business Centre (Suite 16)
Bryn Estyn Road,
Wrexham, LL13 9TY

Tel: 01978 822367

www.smithgrant.co.uk
email: consult@smithgrant.co.uk

GROUND WATER:
None encountered

REMARKS:
No indicators of contamination (i.e. odours or staining) identified throughout strata
HV(S-P) = Average hand shear vane peak strength reading at depth specified with small vane attachment
HV(S-R) = Average hand shear vane residual strength reading at depth specified with small vane attachment

SCALE:	LOGGED BY:	FIGURE NO.
1:25	CM	1

SHEET:	LOCATION:	PROJECT:	ENGINEER:	JOB NO.	TRIAL PIT NO.
1 of 1	Wrexham	Alpha Windows	CM / MJ	R3458	TP4
		EXCAVATED BY: 8-tonne Tracked Excavator	CLIENT: Alpha Windows Ltd	DATE: 16.10.2025	

DEPTH (m)	SAMPLES/ TESTING	FIELD RECORDS	DEPTH (m)	DESCRIPTION OF STRATA	LEGEND
			0.00	Dark brown friable slightly sandy clay TOPSOIL with rare inclusions of ceramic and brick fragments (reworked)	
			0.2	Very loose greyish brown very silty gravel with inclusions of plastic sheeting brick cobbles of stone and rare inclusions of wood metal wire and clay tile	
	TP4-ES1 (0.2-1m)				
1			1.00 1		
		HV(S-P) = 176 kPa @ 1m HV(S-R) = 186.67 kPa @ 1m		Firm to stiff dark brown CLAY with occasional pockets of sand becoming brown mottled grey CLAY towards base	
	TP4-ES3 (1-1.5m)				
1.5		HV(S-P) = 149.33 kPa @ 1.5m HV(S-R) = 146.67 kPa @ 1.5m			
	TP4-ES2 (1-3.6m)	HV(S-P) = 160 kPa @ 2m HV(S-R) = 122.67 kPa @ 2m	2.00		
			3.00		
3.6		HV(S-P) = 106.67 kPa @ 3.5m HV(S-R) = 48 kPa @ 3.5m	3.6	Trial pit terminated @ 3.6m	
			4.00		
			5.00		

Smith Grant
Environmental Consultancy

Smith Grant LLP
Bryn Estyn Business Centre (Suite 16)
Bryn Estyn Road,
Wrexham, LL13 9TY

Tel: 01978 822367

www.smithgrant.co.uk
email: consult@smithgrant.co.uk

GROUND WATER:
None encountered

REMARKS:
Made ground identified @ 0.2-1m
HV(S-P) = Average hand shear vane peak strength reading at depth specified with small vane attachment
HV(S-R) = Average hand shear vane residual strength reading at depth specified with small vane attachment

SCALE:	LOGGED BY:	FIGURE NO.
1:25	CM	1

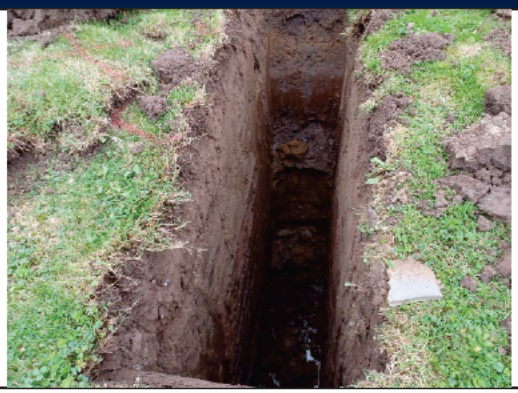
APPENDIX B

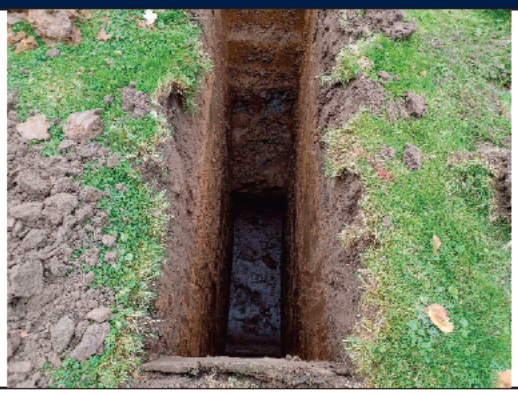
Site Investigation Photographs

Site investigation photographic record.

Land adjacent to Alpha Windows, Abenbury Way, Wrexham Industrial Estate

16.10.25

<table>
<tr><th colspan="2">Trial Pit 1</th></tr>
<tr><td></td><td></td></tr>
<tr><td>Turf / top layer of topsoil removed.</td><td>Extent of trial pit excavation.</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Arisings</td><td>Location</td></tr>
<tr><th colspan="2">Trial Pit 2</th></tr>
<tr><td></td><td></td></tr>
<tr><td>Subsoil level dig at TP2.</td><td>Slight ground ingress pictured at base of trial pit.</td></tr>
</table>

	
Arisings	Location
Trial Pit 3	
	
Topsoil arisings	Base of trial pit.
	
Arisings	Location
Trail Pit 4	
	
Turf / topsoil removed, brick and gravel fragments present.	Plastic sheeting, brick and gravel in the top 0.5m of TP4.



Made ground arisings



Location



Extent of trial pit, natural clays located under made ground like material.

NO PHOTOGRAPH

APPENDIX C

Laboratory Testing Results

Smith Grant LLP
Suite 16 - Bryn Estyn Business Centre
Bryn Estyn Road
LL13 9TY

t:

e: caitlin.mchugh@smithgrant.co.uk

i2 Analytical Ltd.
7 Woodshots Meadow,
Croxley Green
Business Park,
Watford,
Herts,
WD18 8YS

t: 01923 225404
f: 01923 237404
e: info-i2analytical@normecgroup.com

Analytical Report Number : 25-056321

Project / Site name:	Alpha Windows	**Samples received on:**	20/10/2025
Your job number:	R3458	**Samples instructed on/ Analysis started on:**	20/10/2025
Your order number:		**Analysis completed by:**	29/10/2025
Report Issue Number:	1	**Report issued on:**	29/10/2025
Samples Analysed:	12 soil samples		

[redacted]

Signed:

Anna Goc
PL Head of Reporting Team
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41-711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting
air	- once the analysis is complete

Excel copies of reports are only valid when accompanied by this PDF certificate.

Retention period for records and reports is minimum 6 years from the date of issue of the final report.
Some records may be kept for longer according to other legal/best practice requirements.

Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement.
Application of uncertainty of measurement would provide a range within which the true result lies.
An estimate of measurement uncertainty can be provided on request.

This certificate should not be reproduced, except in full, without the express permission of the laboratory.
The results included within the report are representative of the samples submitted for analysis.

Analytical Report Number: 25-056321
Project / Site name: Alpha Windows

Lab Sample Number				719372	719373	719374	719375	719376
Sample Reference				TP1-ES1	TP1-ES2	TP1-ES3	TP2-ES1	TP2-ES2
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Water Matrix				N/A	N/A	N/A	N/A	N/A
Depth (m)				0.00-0.20	0.20-1.20	1.00-1.50	0.20-0.90	0.90-3.00
Date Sampled				16/10/2025	16/10/2025	16/10/2025	16/10/2025	16/10/2025
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Test Limit of detection	Test Accreditation Status					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	0.01	NONE	12	12	12	13	19
Total mass of sample received	kg	0.1	NONE	0.8	0.8	0.6	1	1.2
Asbestos								
Asbestos in Soil Detected/Not Detected	Type	N/A	ISO 17025	Not-detected	Not-detected	-	Not-detected	Not-detected
Asbestos Analyst ID	N/A	N/A	N/A	WIK	WIK	-	WIK	WIK
Analysis completed	N/A	N/A	N/A	27/10/2025	27/10/2025	-	28/10/2025	28/10/2025
General Inorganics								
pH (L099)	pH Units	N/A	MCERTS	8	8.2	8	7.7	8.2
Water Soluble Sulphate as SO_4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	-	-	60	-	-
Water Soluble SO_4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	-	-	30.1	-	-
Water Soluble Chloride (2:1) (leachate equivalent)	mg/l	0.5	MCERTS	-	-	< 0.5	-	-
Organic Matter (automated)	%	0.1	MCERTS	4.4	1.2	-	0.9	1
Water Soluble Nitrate (2:1) as NO_3	mg/kg	2	NONE	-	-	< 2.0	-	-
Water Soluble Nitrate (2:1) as NO_3 (leachate equivalent)	mg/l	5	NONE	-	-	< 5.0	-	-
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05	< 0.05
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05	< 0.05
Anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	0.05	< 0.05	-	< 0.05	< 0.05
Pyrene	mg/kg	0.05	MCERTS	0.05	< 0.05	-	< 0.05	< 0.05
Benzo(a)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05	< 0.05
Chrysene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05	< 0.05
Benzo(b)fluoranthene	mg/kg	0.05	ISO 17025	< 0.05	< 0.05	-	< 0.05	< 0.05
Benzo(k)fluoranthene	mg/kg	0.05	ISO 17025	< 0.05	< 0.05	-	< 0.05	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	-	< 0.05	< 0.05
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	ISO 17025	< 0.80	< 0.80	-	< 0.80	< 0.80

This certificate should not be reproduced, except in full, without the express permission of the laboratory.
The results included within the report are representative of the samples submitted for analysis.

Analytical Report Number: 25-056321
Project / Site name: Alpha Windows

Lab Sample Number				719372	719373	719374	719375	719376
Sample Reference				TP1-ES1	TP1-ES2	TP1-ES3	TP2-ES1	TP2-ES2
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Water Matrix				N/A	N/A	N/A	N/A	N/A
Depth (m)				0.00-0.20	0.20-1.20	1.00-1.50	0.20-0.90	0.90-3.00
Date Sampled				16/10/2025	16/10/2025	16/10/2025	16/10/2025	16/10/2025
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Test Limit of detection	Test Accreditation Status					
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	8.3	11	-	5.4	10
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	0.2	< 0.2	-	< 0.2	< 0.2
Chromium (hexavalent)	mg/kg	1.8	MCERTS	< 1.8	< 1.8	-	< 1.8	< 1.8
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	25	38	-	32	33
Copper (aqua regia extractable)	mg/kg	1	MCERTS	22	30	-	22	27
Lead (aqua regia extractable)	mg/kg	1	MCERTS	40	23	-	19	24
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	-	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	21	40	-	28	36
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	73	69	-	49	65
Magnesium (leachate equivalent)	mg/l	2.5	NONE	-	-	15	-	-
Magnesium (water soluble)	mg/kg	5	NONE	-	-	30	-	-
Petroleum Hydrocarbons								
TPHCWG - Aliphatic >EC5 - EC6 $_{HS_1D_AL}$	mg/kg	0.01	MCERTS	< 0.010	< 0.010	-	< 0.010	< 0.010
TPHCWG - Aliphatic >EC6 - EC8 $_{HS_1D_AL}$	mg/kg	0.01	MCERTS	< 0.010	< 0.010	-	< 0.010	< 0.010
TPHCWG - Aliphatic >EC8 - EC10 $_{HS_1D_AL}$	mg/kg	0.01	MCERTS	< 0.010	< 0.010	-	< 0.010	< 0.010
TPHCWG - Aliphatic >EC10 - EC12 $_{EH_CU_1D_AL}$	mg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
TPHCWG - Aliphatic >EC12 - EC16 $_{EH_CU_1D_AL}$	mg/kg	2	MCERTS	< 2.0	< 2.0	-	< 2.0	< 2.0
TPHCWG - Aliphatic >EC16 - EC21 $_{EH_CU_1D_AL}$	mg/kg	8	MCERTS	< 8.0	< 8.0	-	< 8.0	< 8.0
TPHCWG - Aliphatic >EC21 - EC35 $_{EH_CU_1D_AL}$	mg/kg	8	MCERTS	< 8.0	< 8.0	-	< 8.0	< 8.0
TPHCWG - Aliphatic >EC5 - EC35 $_{EH_CU+HS_1D_AL}$	mg/kg	10	NONE	< 10	< 10	-	< 10	< 10
TPHCWG - Aromatic >EC5 - EC7 $_{HS_1D_AR}$	mg/kg	0.01	MCERTS	< 0.010	< 0.010	-	< 0.010	< 0.010
TPHCWG - Aromatic >EC7 - EC8 $_{HS_1D_AR}$	mg/kg	0.01	MCERTS	< 0.010	< 0.010	-	< 0.010	< 0.010
TPHCWG - Aromatic >EC8 - EC10 $_{HS_1D_AR}$	mg/kg	0.02	MCERTS	< 0.020	< 0.020	-	< 0.020	< 0.020
TPHCWG - Aromatic >EC10 - EC12 $_{EH_CU_1D_AR}$	mg/kg	1	MCERTS	< 1.0	< 1.0	-	< 1.0	< 1.0
TPHCWG - Aromatic >EC12 - EC16 $_{EH_CU_1D_AR}$	mg/kg	2	MCERTS	< 2.0	< 2.0	-	< 2.0	< 2.0
TPHCWG - Aromatic >EC16 - EC21 $_{EH_CU_1D_AR}$	mg/kg	10	MCERTS	< 10	< 10	-	< 10	< 10
TPHCWG - Aromatic >EC21 - EC35 $_{EH_CU_1D_AR}$	mg/kg	10	MCERTS	< 10	< 10	-	< 10	< 10
TPHCWG - Aromatic >EC5 - EC35 $_{EH_CU+HS_1D_AR}$	mg/kg	10	NONE	< 10	< 10	-	< 10	< 10
VOCs								
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	5	MCERTS	< 5.0	< 5.0	-	< 5.0	< 5.0
Benzene	µg/kg	5	MCERTS	< 5.0	< 5.0	-	< 5.0	< 5.0
Toluene	µg/kg	5	MCERTS	< 5.0	< 5.0	-	< 5.0	< 5.0
Ethylbenzene	µg/kg	5	MCERTS	< 5.0	< 5.0	-	< 5.0	< 5.0
p & m-Xylene	µg/kg	8	MCERTS	< 8.0	< 8.0	-	< 8.0	< 8.0
o-Xylene	µg/kg	5	MCERTS	< 5.0	< 5.0	-	< 5.0	< 5.0

U/S = Unsuitable Sample I/S = Insufficient Sample ND = Not detected

This certificate should not be reproduced, except in full, without the express permission of the laboratory.
The results included within the report are representative of the samples submitted for analysis.

Analytical Report Number: 25-056321
Project / Site name: Alpha Windows

Lab Sample Number				719377	719378	719379	719380	719381
Sample Reference				TP2-ES3	TP3-ES1	TP3-ES2	TP3-ES3	TP4-ES1
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Water Matrix				N/A	N/A	N/A	N/A	N/A
Depth (m)				0.90-1.50	0.00-0.50	0.50-3.00	1.00-1.50	0.20-1.00
Date Sampled				16/10/2025	16/10/2025	16/10/2025	16/10/2025	16/10/2025
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Test Limit of detection	Test Accreditation Status					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	18.6
Moisture Content	%	0.01	NONE	15	12	15	16	8.3
Total mass of sample received	kg	0.1	NONE	0.7	0.9	1	0.8	1.1
Asbestos								
Asbestos in Soil Detected/Not Detected	Type	N/A	ISO 17025	-	Not-detected	Not-detected	-	Not-detected
Asbestos Analyst ID	N/A	N/A	N/A	-	WIK	WIK	-	WIK
Analysis completed	N/A	N/A	N/A	-	28/10/2025	28/10/2025	-	28/10/2025
General Inorganics								
pH (L099)	pH Units	N/A	MCERTS	8	7.7	8.4	8.2	8.2
Water Soluble Sulphate as SO_4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	25	-	-	16	-
Water Soluble SO_4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	12.7	-	-	8.07	-
Water Soluble Chloride (2:1) (leachate equivalent)	mg/l	0.5	MCERTS	< 0.5	-	-	< 0.5	-
Organic Matter (automated)	%	0.1	MCERTS	-	4.1	1.2	-	2.2
Water Soluble Nitrate (2:1) as NO_3	mg/kg	2	NONE	< 2.0	-	-	< 2.0	-
Water Soluble Nitrate (2:1) as NO_3 (leachate equivalent)	mg/l	5	NONE	< 5.0	-	-	< 5.0	-
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	-	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	-	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	-	< 0.05
Fluorene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	-	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	-	0.1
Anthracene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	-	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	-	0.06	< 0.05	-	0.08
Pyrene	mg/kg	0.05	MCERTS	-	0.06	< 0.05	-	0.07
Benzo(a)anthracene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	-	< 0.05
Chrysene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	-	< 0.05
Benzo(b)fluoranthene	mg/kg	0.05	ISO 17025	-	< 0.05	< 0.05	-	< 0.05
Benzo(k)fluoranthene	mg/kg	0.05	ISO 17025	-	< 0.05	< 0.05	-	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	-	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	-	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	-	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	-	< 0.05	< 0.05	-	< 0.05
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	ISO 17025	-	< 0.80	< 0.80	-	< 0.80

This certificate should not be reproduced, except in full, without the express permission of the laboratory.
The results included within the report are representative of the samples submitted for analysis.

Analytical Report Number: 25-056321
Project / Site name: Alpha Windows

Lab Sample Number				719377	719378	719379	719380	719381
Sample Reference				TP2-ES3	TP3-ES1	TP3-ES2	TP3-ES3	TP4-ES1
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Water Matrix				N/A	N/A	N/A	N/A	N/A
Depth (m)				0.90-1.50	0.00-0.50	0.50-3.00	1.00-1.50	0.20-1.00
Date Sampled				16/10/2025	16/10/2025	16/10/2025	16/10/2025	16/10/2025
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Test Limit of detection	Test Accreditation Status					
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	-	8.8	9.3	-	7.9
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	-	< 0.2	0.2	-	0.3
Chromium (hexavalent)	mg/kg	1.8	MCERTS	-	< 1.8	< 1.8	-	< 1.8
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	-	23	32	-	23
Copper (aqua regia extractable)	mg/kg	1	MCERTS	-	31	26	-	33
Lead (aqua regia extractable)	mg/kg	1	MCERTS	-	43	22	-	57
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	-	< 0.3	< 0.3	-	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	-	19	37	-	20
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	-	77	65	-	70
Magnesium (leachate equivalent)	mg/l	2.5	NONE	6.2	-	-	6.8	-
Magnesium (water soluble)	mg/kg	5	NONE	12	-	-	14	-
Petroleum Hydrocarbons								
TPHCWG - Aliphatic >EC5 - EC6 $_{HS_1D_AL}$	mg/kg	0.01	MCERTS	-	< 0.010	< 0.010	-	< 0.010
TPHCWG - Aliphatic >EC6 - EC8 $_{HS_1D_AL}$	mg/kg	0.01	MCERTS	-	< 0.010	< 0.010	-	< 0.010
TPHCWG - Aliphatic >EC8 - EC10 $_{HS_1D_AL}$	mg/kg	0.01	MCERTS	-	< 0.010	< 0.010	-	< 0.010
TPHCWG - Aliphatic >EC10 - EC12 $_{EH_CU_1D_AL}$	mg/kg	1	MCERTS	-	< 1.0	< 1.0	-	< 1.0
TPHCWG - Aliphatic >EC12 - EC16 $_{EH_CU_1D_AL}$	mg/kg	2	MCERTS	-	< 2.0	< 2.0	-	< 2.0
TPHCWG - Aliphatic >EC16 - EC21 $_{EH_CU_1D_AL}$	mg/kg	8	MCERTS	-	< 8.0	< 8.0	-	< 8.0
TPHCWG - Aliphatic >EC21 - EC35 $_{EH_CU_1D_AL}$	mg/kg	8	MCERTS	-	< 8.0	< 8.0	-	< 8.0
TPHCWG - Aliphatic >EC5 - EC35 $_{EH_CU+HS_1D_AL}$	mg/kg	10	NONE	-	< 10	< 10	-	< 10
TPHCWG - Aromatic >EC5 - EC7 $_{HS_1D_AR}$	mg/kg	0.01	MCERTS	-	< 0.010	< 0.010	-	< 0.010
TPHCWG - Aromatic >EC7 - EC8 $_{HS_1D_AR}$	mg/kg	0.01	MCERTS	-	< 0.010	< 0.010	-	< 0.010
TPHCWG - Aromatic >EC8 - EC10 $_{HS_1D_AR}$	mg/kg	0.02	MCERTS	-	< 0.020	< 0.020	-	< 0.020
TPHCWG - Aromatic >EC10 - EC12 $_{EH_CU_1D_AR}$	mg/kg	1	MCERTS	-	< 1.0	< 1.0	-	< 1.0
TPHCWG - Aromatic >EC12 - EC16 $_{EH_CU_1D_AR}$	mg/kg	2	MCERTS	-	< 2.0	< 2.0	-	< 2.0
TPHCWG - Aromatic >EC16 - EC21 $_{EH_CU_1D_AR}$	mg/kg	10	MCERTS	-	< 10	< 10	-	< 10
TPHCWG - Aromatic >EC21 - EC35 $_{EH_CU_1D_AR}$	mg/kg	10	MCERTS	-	< 10	< 10	-	< 10
TPHCWG - Aromatic >EC5 - EC35 $_{EH_CU+HS_1D_AR}$	mg/kg	10	NONE	-	< 10	< 10	-	< 10
VOCs								
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	5	MCERTS	-	< 5.0	< 5.0	-	< 5.0
Benzene	µg/kg	5	MCERTS	-	< 5.0	< 5.0	-	< 5.0
Toluene	µg/kg	5	MCERTS	-	< 5.0	< 5.0	-	< 5.0
Ethylbenzene	µg/kg	5	MCERTS	-	< 5.0	< 5.0	-	< 5.0
p & m-Xylene	µg/kg	8	MCERTS	-	< 8.0	< 8.0	-	< 8.0
o-Xylene	µg/kg	5	MCERTS	-	< 5.0	< 5.0	-	< 5.0

U/S = Unsuitable Sample I/S = Insufficient Sample ND = Not detected

This certificate should not be reproduced, except in full, without the express permission of the laboratory.
The results included within the report are representative of the samples submitted for analysis.

Analytical Report Number: 25-056321
Project / Site name: Alpha Windows

Lab Sample Number				719382	719383
Sample Reference				TP4-ES2	TP4-ES3
Sample Number				None Supplied	None Supplied
Water Matrix				N/A	N/A
Depth (m)				1.00-3.60	1.00-1.50
Date Sampled				16/10/2025	16/10/2025
Time Taken				None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Test Limit of detection	Test Accreditation Status		
Stone Content	%	0.1	NONE	< 0.1	< 0.1
Moisture Content	%	0.01	NONE	16	12
Total mass of sample received	kg	0.1	NONE	1	0.8

Asbestos

Asbestos in Soil Detected/Not Detected	Type	N/A	ISO 17025	Not-detected	-
Asbestos Analyst ID	N/A	N/A	N/A	WIK	-
Analysis completed	N/A	N/A	N/A	28/10/2025	-

General Inorganics

pH (L099)	pH Units	N/A	MCERTS	8.3	8
Water Soluble Sulphate as SO_4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	-	91
Water Soluble SO_4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	-	45.3
Water Soluble Chloride (2:1) (leachate equivalent)	mg/l	0.5	MCERTS	-	< 0.5
Organic Matter (automated)	%	0.1	MCERTS	1.2	-
Water Soluble Nitrate (2:1) as NO_3	mg/kg	2	NONE	-	< 2.0
Water Soluble Nitrate (2:1) as NO_3 (leachate equivalent)	mg/l	5	NONE	-	< 5.0

Speciated PAHs

Naphthalene	mg/kg	0.05	MCERTS	< 0.05	-
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	-
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	-
Fluorene	mg/kg	0.05	MCERTS	< 0.05	-
Phenanthrene	mg/kg	0.05	MCERTS	< 0.05	-
Anthracene	mg/kg	0.05	MCERTS	< 0.05	-
Fluoranthene	mg/kg	0.05	MCERTS	< 0.05	-
Pyrene	mg/kg	0.05	MCERTS	< 0.05	-
Benzo(a)anthracene	mg/kg	0.05	MCERTS	< 0.05	-
Chrysene	mg/kg	0.05	MCERTS	< 0.05	-
Benzo(b)fluoranthene	mg/kg	0.05	ISO 17025	< 0.05	-
Benzo(k)fluoranthene	mg/kg	0.05	ISO 17025	< 0.05	-
Benzo(a)pyrene	mg/kg	0.05	MCERTS	< 0.05	-
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05	-
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	-
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	-

Total PAH

Speciated Total EPA-16 PAHs	mg/kg	0.8	ISO 17025	< 0.80	-

This certificate should not be reproduced, except in full, without the express permission of the laboratory.
The results included within the report are representative of the samples submitted for analysis.

Analytical Report Number: 25-056321
Project / Site name: Alpha Windows

Lab Sample Number				719382	719383
Sample Reference				TP4-ES2	TP4-ES3
Sample Number				None Supplied	None Supplied
Water Matrix				N/A	N/A
Depth (m)				1.00-3.60	1.00-1.50
Date Sampled				16/10/2025	16/10/2025
Time Taken				None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Test Limit of detection	Test Accreditation Status		
Heavy Metals / Metalloids					
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	11	-
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	-
Chromium (hexavalent)	mg/kg	1.8	MCERTS	< 1.8	-
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	31	-
Copper (aqua regia extractable)	mg/kg	1	MCERTS	34	-
Lead (aqua regia extractable)	mg/kg	1	MCERTS	22	-
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	-
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	34	-
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	65	-
Magnesium (leachate equivalent)	mg/l	2.5	NONE	-	12
Magnesium (water soluble)	mg/kg	5	NONE	-	24
Petroleum Hydrocarbons					
TPHCWG - Aliphatic >EC5 - EC6 $_{HS_1D_AL}$	mg/kg	0.01	MCERTS	< 0.010	-
TPHCWG - Aliphatic >EC6 - EC8 $_{HS_1D_AL}$	mg/kg	0.01	MCERTS	< 0.010	-
TPHCWG - Aliphatic >EC8 - EC10 $_{HS_1D_AL}$	mg/kg	0.01	MCERTS	< 0.010	-
TPHCWG - Aliphatic >EC10 - EC12 $_{EH_CU_1D_AL}$	mg/kg	1	MCERTS	< 1.0	-
TPHCWG - Aliphatic >EC12 - EC16 $_{EH_CU_1D_AL}$	mg/kg	2	MCERTS	< 2.0	-
TPHCWG - Aliphatic >EC16 - EC21 $_{EH_CU_1D_AL}$	mg/kg	8	MCERTS	< 8.0	-
TPHCWG - Aliphatic >EC21 - EC35 $_{EH_CU_1D_AL}$	mg/kg	8	MCERTS	< 8.0	-
TPHCWG - Aliphatic >EC5 - EC35 $_{EH_CU+HS_1D_AL}$	mg/kg	10	NONE	< 10	-
TPHCWG - Aromatic >EC5 - EC7 $_{HS_1D_AR}$	mg/kg	0.01	MCERTS	< 0.010	-
TPHCWG - Aromatic >EC7 - EC8 $_{HS_1D_AR}$	mg/kg	0.01	MCERTS	< 0.010	-
TPHCWG - Aromatic >EC8 - EC10 $_{HS_1D_AR}$	mg/kg	0.02	MCERTS	< 0.020	-
TPHCWG - Aromatic >EC10 - EC12 $_{EH_CU_1D_AR}$	mg/kg	1	MCERTS	< 1.0	-
TPHCWG - Aromatic >EC12 - EC16 $_{EH_CU_1D_AR}$	mg/kg	2	MCERTS	< 2.0	-
TPHCWG - Aromatic >EC16 - EC21 $_{EH_CU_1D_AR}$	mg/kg	10	MCERTS	< 10	-
TPHCWG - Aromatic >EC21 - EC35 $_{EH_CU_1D_AR}$	mg/kg	10	MCERTS	< 10	-
TPHCWG - Aromatic >EC5 - EC35 $_{EH_CU+HS_1D_AR}$	mg/kg	10	NONE	< 10	-
VOCs					
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	5	MCERTS	< 5.0	-
Benzene	µg/kg	5	MCERTS	< 5.0	-
Toluene	µg/kg	5	MCERTS	< 5.0	-
Ethylbenzene	µg/kg	5	MCERTS	< 5.0	-
p & m-Xylene	µg/kg	8	MCERTS	< 8.0	-
o-Xylene	µg/kg	5	MCERTS	< 5.0	-

U/S = Unsuitable Sample I/S = Insufficient Sample ND = Not detected

This certificate should not be reproduced, except in full, without the express permission of the laboratory.
The results included within the report are representative of the samples submitted for analysis.

Analytical Report Number : 25-056321
Project / Site name: Alpha Windows

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
719372	TP1-ES1	None Supplied	0.00-0.20	Brown loam and clay with gravel and vegetation
719373	TP1-ES2	None Supplied	0.20-1.20	Brown clay with vegetation
719374	TP1-ES3	None Supplied	1.00-1.50	Brown loam and clay with vegetation
719375	TP2-ES1	None Supplied	0.20-0.90	Brown clay and sand
719376	TP2-ES2	None Supplied	0.90-3.00	Brown clay
719377	TP2-ES3	None Supplied	0.90-1.50	Brown clay
719378	TP3-ES1	None Supplied	0.00-0.50	Brown loam and clay with gravel and vegetation
719379	TP3-ES2	None Supplied	0.50-3.00	Brown clay
719380	TP3-ES3	None Supplied	1.00-1.50	Brown clay
719381	TP4-ES1	None Supplied	0.20-1.00	Brown loam and clay with vegetation and stones
719382	TP4-ES2	None Supplied	1.00-3.60	Brown clay and sand
719383	TP4-ES3	None Supplied	1.00-1.50	Brown loam and clay with gravel and vegetation

This certificate should not be reproduced, except in full, without the express permission of the laboratory.
The results included within the report are representative of the samples submitted for analysis.

Analytical Report Number : 25-056321
Project / Site name: Alpha Windows

Water matrix abbreviations:
Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Waters Heating/Cooling (PrW) DI Process Water (DI PrW)
Final Sewage Effluent (FSE) Landfill Leachate (LL)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Asbestos identification in Soil	Asbestos Identification with the use of polarised light microscopy in conjunction with dispersion staining techniques	In-house method based on HSG 248, 2021	A001B	D	ISO 17025
Organic matter (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate (Walkley Black Method)	In-house method	L009B	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically (up to 30°C)	In-house method	L019B	W	NONE
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight	In-house method based on British Standard Methods and MCERTS requirements.	L019B	D	NONE
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil	L038B	D	MCERTS
Speciated PAHs and/or Semi-volatile organic compounds in soil	Determination of semi-volatile organic compounds (including PAH) in soil by extraction in dichloromethane and hexane followed by GC-MS	In-house method based on USEPA 8270	L064B	D	MCERTS
BTEX and/or Volatile organic compounds in soil	Determination of volatile organic compounds in soil by headspace GC-MS	In-house method based on USEPA 8260	L073B	W	MCERTS
Total petroleum hydrocarbons with carbon banding by GC-FID in soil	Determination of total petroleum hydrocarbons in soil by GC-FID with carbon banding aliphatic and aromatic	In-house method	L076B	D	MCERTS
Total petroleum hydrocarbons with carbon banding by GC-FID/GC-MS HS in soil (Summed Bands)	Determination of total petroleum hydrocarbons in soil by GC-FID/GC-MS HS with carbon banding aliphatic and aromatic (Summed Bands).	Calculation	L076B/L088-PL	D/W	NONE
Hexavalent chromium in soil	Determination of hexavalent chromium in soil by extraction in NaOH and addition of 1,5 diphenylcarbazide followed by colorimetry	In-house method	L080-PL	W	MCERTS
Total petroleum hydrocarbons with carbon banding by HS-GC/MS in soil	Determination of total petroleum hydrocarbons in soil by HS-GC/MS with carbon banding aliphatic and aromatic	In-house method	L088-PL	W	MCERTS
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement	In-house method	L099-PL	D	MCERTS
Soil Descriptions	Textural classification	In-house method	L019B	W	NONE
Magnesium, water soluble, in soil	Determination of water soluble magnesium by extraction with water followed by ICP-OES	In-house method based on TRL 447	L038B	D	NONE
Sulphate, water soluble, in soil (16hr extraction)	Sulphate, water soluble, in soil (16hr extraction)	In-house method	L038B	D	MCERTS
Water Soluble Nitrate (leachate equivalent)	Determination of nitrate by reaction with sodium salicylate and colorimetry	In-house method based on Examination of Water and Wastewatern & Polish Standard Method PN-82/C-04579.08, 2:1 extraction	L078-PL	W	NONE

This certificate should not be reproduced, except in full, without the express permission of the laboratory.
The results included within the report are representative of the samples submitted for analysis.

Analytical Report Number : 25-056321
Project / Site name: Alpha Windows

Water matrix abbreviations:
Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Waters Heating/Cooling (PrW) DI Process Water (DI PrW)
Final Sewage Effluent (FSE) Landfill Leachate (LL)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Nitrate, water soluble, in soil	Determination of nitrate by reaction with sodium salicylate and colorimetry	In-house method based on Examination of Water and Wastewatern & Polish Standard Method PN-82/C-04579.08, 2:1 extraction	L078-PL	W	NONE
Chloride, water soluble, in soil	Determination of Chloride colorimetrically by discrete analyser	In-house method	L082B	D	MCERTS

For method numbers ending in 'UK' or 'A' analysis have been carried out in our laboratory in the United Kingdom (Watford).
For method numbers ending in 'F' analysis have been carried out in our laboratory in the United Kingdom (East Kilbride).
For method numbers ending in 'PL' or 'B' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.
Unless otherwise indicated, site information, order number, project number, sampling date, time, sample reference and depth are provided by the client. The instructed on date indicates the date on which this information was provided to the laboratory.

Quality control parameter failure associated with individual result applies to calculated sum of individuals.
The result for sum should be interpreted with caution

This certificate should not be reproduced, except in full, without the express permission of the laboratory.
The results included within the report are representative of the samples submitted for analysis.

Analytical Report Number : 25-056321
Project / Site name: Alpha Windows

This deviation report indicates the sample and test deviations that apply to the samples submitted for analysis.Please note that the associated result(s) may be unreliable and should be interpreted with care.

Key: a - No sampling date b - Incorrect container/Insufficient material provided c - Holding time d - Headspace e - Temperature

Sample ID	Other ID	Sample Type	Lab Sample Number	Sample Deviation	Test Name	Test Ref	Test Deviation
TP2-ES2	N/A	S	719376	b	BTEX and/or Volatile organic compounds in soil	L073B	b

This certificate should not be reproduced, except in full, without the express permission of the laboratory.
The results included within the report are representative of the samples submitted for analysis.

APPENDIX D

Detailed UXO Risk Assessment



Detailed Unexploded Ordnance (UXO) Risk Assessment

Project Name	Land Adjacent to Alpha Windows
Client	Smith Grant LLP
Site Address	Land Adjacent to Alpha Windows, Wrexham LL13 9UZ
Report Reference	DA2353a-00
Date	19/09/2025
Author	RS
Quality Assurance	HW
Final Check	AT

1st Line Defence
3 Maple Park, Essex Road, Hoddesdon. EN11 0EX
Tel +44 (0) 1992 245 020 Email info@1stlinedefence.co.uk
Web www.1stlinedefence.co.uk Company Reg No. 07717863

1ST LINE DEFENCE

Executive Summary

Site Location and Description

The site is situated within the Wrexham Industrial Estate, within Wrexham County Borough.

Vegetated ground occupies the area north of the site. Warehouses occupy the area east and west of the site with an access way to the south.

According to recent aerial imagery, the site is occupied by undeveloped ground.

The site is approximately centred on the OS grid reference: **SJ 37321 50472**.

Proposed Works

Information provided by the client indicates that proposed works are to include an intrusive investigation involving the excavation of 4 trial-pits to maximum depth of 3m bgl, logging of ground conditions, screening arisings with a PID to detect the presence of organic vapours and the collection of soil samples for a typical suite of urban contaminants. Production of Quantitative Risk Assessment with recommendations for additional works or likely remedial requirements to address ground contamination issues.

Geology and Bomb Penetration Depth

The British Geological Survey (BGS) map shows the bedrock geology of the site to be underlain by Kinnerton Sandstone Formation – Sandstone formed during the Triassic period. Superficial deposits on site are recorded as Till, Devensian – Diamicton formed during the Quaternary period.

Site-specific geotechnical information was not available to 1st Line Defence at the time of the production of this report. An assessment of maximum bomb penetration depth can be made once such data becomes available, or by a UXO specialist during on-site support.

It should be noted that the maximum depth that a bomb could reach may vary across a site and will be largely dependent on the specific underlying geological strata and its density.

UXO Risk Assessment

1st Line Defence has assessed that there is an overall **Low Risk** from German and anti-aircraft unexploded ordnance at the site of proposed works. There is an assessed **Low Risk** from Allied unexploded ordnance.

The Risk from German Air-Delivered UXO

- During WWII, the site was situated within the Rural District of Wrexham. According to official Home Office bombing statistics, the district sustained an overall very low density of bombing with an average of 3.8 items of ordnance recorded per 1,000 acres. Any bombing in the region that did occur appears to have been largely opportunistic and as a result of its position on the flight path to the important target of Liverpool. The only viable bombing target in the area was the nearby Royal Ordnance Factory (ROF) Wrexham.
- Anecdotal sources attest that while the Luftwaffe may have been aware of the presence of ROF Wrexham (see **Annex H**), it was never struck by German bombing. This may have been due to its relatively isolated location. Despite the available source base being somewhat limited, no evidence of any bombing within the site footprint or the wider vicinity could be found.
- 1946 aerial photography does not indicate any distinct signs of damage such as cratering or scattered earth on or within close proximity of the site. Additionally, the ground cover appears to be well maintained and in good condition.
- Given the undeveloped nature of the site and immediate surrounding area, ground cover is not anticipated to have been conducive towards the detection of evidence of UXO. 50kg UXB entry holes could be as small as 20cm in diameter which in areas of undeveloped ground could go unnoticed. However, this is considered to have been somewhat mitigated by the very low density of bombing in the district as well as the close proximity of a firewatcher's post situated approximately 70m south of the site.
- Similarly, access is considered to have been infrequent throughout WWII due to a lack of structures on and within immediate proximity of the site, with any monitoring of the area limited to the use of the firewatchers post.

© 1st Line Defence®

- In summary, given the very low bombing density within the district and lack of positive evidence to suggest bombing occurred within ROF Wrexham or its vicinity, the site is not considered to be at an elevated risk of contamination from German aerial-delivered items of UXO. As such, the site has been assessed as **Low Risk** from German UXO.

The Risk from Allied UXO

- The site is within close proximity to the former Royal Ordnance Factory, Wrexham, a WWII-era propellant factory. This factory produced cordite during the war, a propellant used in munitions. The site covered over 1000 acres and was in operation from early 1941 until the end of the war in 1945. Official records of the factory appear to have been destroyed post-war, and the workers at the time were sworn to secrecy, so most information available on the site is from anecdotal sources written or recorded years after the factory was shut down.
- RAF aerial photography, obtained from the Central Register of Aerial photography for Wales, shows that during the war, the site area appears to have been occupied by well-maintained undeveloped fields, used for farming. OS historical mapping, obtained from both Landmark Maps and the National Library of Scotland, show that the site area was not built on during the construction of the Royal Ordnance Factory and has remained undeveloped. All of the available evidence indicates that the site was outside of the boundary of the factory, at a distance of approximately 275m, separated from it by further agricultural fields.
- There is no evidence that any ordnance manufacture took place within the site boundary, as the site area appears to have been occupied by a clearly bordered area of undeveloped farmland throughout the war. No buildings, trackways, roads, infrastructure or any other such features of interest are noted within the site area on post-war photography. Whilst it is considered very likely that areas within the historic bounds of the factory itself would have become contaminated within ordnance and explosive materials (through disposal, burial, burning etc.), no evidence was found to indicate that this is likely to have occurred within the site area. As such, the risk from Allied UXO on site has been assessed as **Low**.

Post-WWII Redevelopment

- According to recent aerial imagery, no significant development has taken place on site post WWII. However, the surrounding area has been subject to development of industrial structures and accessways.
- The risk of UXO remaining is considered to be mitigated at the location of and down to the depth of any post-war redevelopment on site. For example, the risk from deep buried UXO will only have been mitigated within the volumes of any post-war pile foundations or deep excavations for basement levels. The risk will however remain within virgin geology below and amongst these post-war works, down to the maximum bomb penetration depth.

Recommended Risk Mitigation Measures

The following risk mitigation measures are recommended to support the proposed works at the Land Adjacent to Alpha Windows site:

Activity	Recommended Risk Mitigation Measure
All Works	• UXO Risk Management Plan • Site Specific UXO Awareness Briefings to all personnel conducting intrusive works.

© 1st Line Defence®

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

© 1st Line Defence®

Contents

Executive Summary ii
Glossary iv
Contents v
Annexes vii
Appendices vii
1. Introduction 1
1.1. Background 1
2. Method Statement 2
2.1. Report Objectives 2
2.2. Risk Assessment Process 2
2.3. Sources of Information 2
3. Background to Bombing Records 3
3.1. General Considerations of Historical Research 3
3.2. German Bombing Records 3
3.3. Allied Records 3
4. UK Regulatory Environment and Guidelines 4
4.1. General 4
4.2. CDM Regulations 2015 4
4.3. The 1974 Health and Safety at Work etc. Act 4
4.4. CIRIA C681 4
4.5. Additional Legislation 4
5. The Role of Commercial UXO Contractors and The Authorities 5
5.1. Commercial UXO Specialists 5
5.2. The Authorities 5
6. The Site 6
6.1. Site Location 6
6.2. Site Description 6
7. Scope of the Proposed Works 6
7.1. General 6
8. Ground Conditions 6
8.1. General Geology 6
8.2. Site-Specific Geology 6
9. Site History 7
9.1. Introduction 7
9.2. Ordnance Survey Historical Maps 7
10. Introduction to German Air Delivered Ordnance 8
10.1. General 8
10.2. Generic Types of WWII German Air Delivered Ordnance 8
10.3. Failure Rate of German Air Delivered Ordnance 9
10.4. UXB Ground Penetration 9
10.4.1. The J-Curve Principle 9
10.4.2. WWII UXB Ground Penetration Studies 9
10.4.3. Site Specific Bomb Penetration Considerations 10

© 1st Line Defence®

10.5. V-Weapons 10
11. The Likelihood of Contamination from German Air Delivered UXBs 11
11.1. World War I 11
11.2. World War II Bombing of the Rural District of Wrexham 11
11.3. WWII Home Office Bombing Statistics 12
11.4. Bombing of ROF Wrexham 12
11.5. Anecdotal Evidence of ROF Wrexham 13
11.6. WWII-Era Aerial Photography 13
11.7. Abandoned Bombs 14
11.8. Bomb Disposal Tasks 14
11.9. Evaluation of German Air Delivered UXO Records 15
12. Introduction to Allied Ordnance 16
12.1. General 16
12.2. Defending the UK From Aerial Attack 16
12.3. Royal Ordnance Factories 17
12.4. Anti-Aircraft Artillery (AAA) 18
13. The Likelihood of Contamination from Allied Ordnance 19
13.1. Introduction 19
13.2. ROF Wrexham 19
13.3. The Defence of ROF Wrexham 19
13.4. Official Records of ROF Wrexham 19
13.5. Wartime Anecdotal Evidence, ROF Wrexham 20
13.6. WWII-era Aerial Photography 20
13.7. Evaluation of Contamination Risk from Allied UXO 21
14. The Likelihood of UXO Contamination Summary 22
15. The Likelihood that UXO Remains 24
15.1. Introduction 24
15.2. UXO Clearance 24
15.3. Post-War Redevelopment 24
16. The Likelihood of UXO Encounter 25
16.1. Introduction 25
16.2. Encountering Air Delivered Ordnance 25
17. The Likelihood of UXO Initiation 26
17.1. Introduction 26
17.2. Initiating Air Delivered Ordnance 26
18. Consequences of Initiation/Encounter 27
18.1. Introduction 27
18.2. Consequences of Detonation 27
19. 1st Line Defence Risk Assessment 28
19.1. Risk Assessment Stages 28
19.2. Assessed Risk Level 28
20. Proposed Risk Mitigation Methodology 29
20.1. General 29
Bibliography 30

© 1st Line Defence®

Annexes

List of Report Annexes	
Annex A	Site Location Maps
Annex B	Recent Aerial Photography
Annex C	Client Provided Site Plan
Annex D	Pre and Post-WWII Historical Maps
Annex E	Example of UXO Entry Hole / The 'J-curve' Effect Principle
Annex F	Examples of UXO Incidents
Annex G	WWI Bomb Plot Map, London
Annex H	Written Bomb Incident Records
Annex I	WWII-era RAF Aerial Photography of the Site
Annex J	ROF Wrexham Boundary
Annex K	Recent Photography of the Former ROF Wrexham

Appendices

List of Report Appendices	
Appendix i-iii	Examples of German Air-Delivered Ordnance
Appendix iv	Examples of Anti-Aircraft Projectiles

© 1st Line Defence®

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

Site: Land Adjacent to Alpha Windows
Client: Smith Grant LLP

1. Introduction

1.1. Background

1st Line Defence has been commissioned by Smith Grant LLP to conduct a Detailed Unexploded Ordnance (UXO) Risk Assessment for the works proposed at Land Adjacent to Alpha Windows.

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.'

© 1st Line Defence®

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 Land Adjacent to Alpha Windows. 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 air 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 Wrexham Archives.
- Historical mapping datasets.
- Historic England National Monuments Record.
- Relevant information supplied by Smith Grant LLP.
- Available material from 33 Engineer Regiment (EOD) Archive (part of 29 Explosive Ordnance and Disposal and Search Group).
- 1st Line Defence's extensive historical archives, library and UXO geo-datasets.
- Open sources such as published books and internet resources.

© 1st Line Defence®

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.'

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.

© 1st Line Defence®

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 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 for 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 the risk posed by UXO to 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 air 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.

© 1st Line Defence®

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.

© 1st Line Defence®

6. The Site

6.1. Site Location

The site is situated within the Wrexham Industrial Estate, within Wrexham County Borough.

Vegetated ground occupies the area north of the site. Warehouses occupy the area east and west of the site with an access way to the south.

The site is approximately centred on the OS grid reference: **SJ 37321 50472**.

Site location maps are presented in **Annex A**.

6.2. Site Description

According to recent aerial imagery, the site is occupied by undeveloped ground.

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

Information provided by the client indicates that proposed works are to include an intrusive investigation involving the excavation of 4 trial-pits to maximum depth of 3m bgl, logging of ground conditions, screening arisings with a PID to detect the presence of organic vapours and the collection of soil samples for a typical suite of urban contaminants. Production of Quantitative Risk Assessment with recommendations for additional works or likely remedial requirements to address ground contamination issues.

8. Ground Conditions

8.1. General Geology

The British Geological Survey (BGS) map shows the bedrock geology of the site to be underlain by Kinnerton Sandstone Formation – Sandstone formed during the Triassic period. Superficial deposits on site are recorded as Till, Devensian – Diamicton formed during the Quaternary period.

8.2. Site-Specific Geology

Site-specific geotechnical data was not provided by the client during the production of this report.

© 1st Line Defence®

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.

Pre-WWII		
Date	Scale	Description
1938	1:10,560	This map indicates that the site was occupied and surrounded by undeveloped ground. *Erlas Lane* is indicated to have been situated approximately 20m west of the site.

Post-WWII		
Date	Scale	Description
1961-62	1:2,500	This map does not indicate any significant developments on site when compared with 1938 OS mapping.

© 1st Line Defence®

10. Introduction to German Air Delivered Ordnance

10.1. 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 air delivered ordnance dropped during WWII, although WWI bombing will also be considered.

10.2. Generic Types of WWII German Air 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 air 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 **Appendices i-iii**.

Generic Types of WWII German Air 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 E**). 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 would generally 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.

© 1st Line Defence®

10.3. Failure Rate of German Air Delivered Ordnance

It has been estimated that 10% of WWII German air 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, 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 F**.

10.4. 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.

10.4.1. The J-Curve Principle

J-curve is the term used to describe the characteristic curve commonly followed by an air 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 (see **Annex E**).

10.4.2. 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 drawn predicting 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.

© 1st Line Defence®

10.4.3. Site Specific Bomb Penetration Considerations

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

- WWII geology – Kinnerton Sandstone 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 limitations of site-specific geotechnical information provided for the purpose of this report. An assessment can be made once further information becomes available or by an UXO Specialist on-site.

10.5. 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 relatively low numbers allowed accurate records of strikes to be maintained. These records have mostly survived. There is a negligible risk from unexploded V-weapons on land today. Even if the 1,000kg warhead failed to explode, the weapons are so large that they would have been observed and dealt with at the time. Therefore, any V-weapons referenced in this report are referenced not as a viable risk factor, but primarily in order to help account for evidence of damage and clearance reported.

© 1st Line Defence®

11. The Likelihood of Contamination from German Air Delivered UXBs

11.1. World War I

During WWI Britain was targeted and bombed by Zeppelin Airships as well as Gotha and Giant fixed-wing aircraft. The objective of these raids was to unnerve the British public, to destroy strategic targets and to ultimately attempt to coerce Britain's capitulation from the war. A WWI map of air raids and naval bombardments across the UK was consulted, see **Annex G**. This source does not record any incidents within proximity of the site.

WWI bombs were generally smaller and dropped from a lower altitude than those used in WWII. 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.

11.2. World War II Bombing of the Rural District of Wrexham

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 within the Rural District of Wrexham, which sustained an overall very low density of bombing, as represented by bomb density data figures, see **Section 11.3**. North East Wales was originally thought to be out of range of enemy bombers, but the Fall of France meant the Luftwaffe bomber's range expanded. 29 people were killed in North East Wales during WWII by enemy bombers, with a further 95 injured persons. Liverpool, situated approximately 40km north of Wrexham, suffered devastating attacks in May 1941 prior to the transferring of German air power to the east for the start of Operation Barbarossa. The city had been singled out as one of the main Luftwaffe targets, and North East Wales suffered some bombing due to the flight paths of bombers heading to or returning from Liverpool.

On the night of the 30th / 31st of August 1940, German aircraft jettisoned incendiary bombs on Mienra Mountain, causing a large fire within the mountain's shrubbery. The fire was allowed to burn until 28 square miles of mountain were alight, and for the following two nights further bombers on their way to Liverpool were attracted by the blaze, believing it to be an important target, and dropped further bombs on the mountain. From these attacks, an unexploded bomb landed in Osborne Street, Rhos, (likely Rhosllannerchrugog), which later detonated and caused a fatality.

Another source states that the reason for the bombing of the mountain was because of an unknown pilot who put lanterns on the mountain with the intention of fooling the bombers into believing they were bombing Liverpool. This airman has a memorial on the mountain, and craters from the bombing can still be seen. A third source claims that it was the Home Guard who lit fires on the mountains in the hope of tricking the enemy into bombing uninhabited areas. This source also confirms the unexploded bomb on Osbourne Street in Rhos on the 30th / 31st August 1940 and claims that around six or seven people were killed by the bomb which exploded early in the morning. A final source claims that on the 31st of August 1940, bombs fell on Rhos, Plas Ucha and Gresford. Nine people died after a delayed action bomb went off in Gresford. Bombs were also dropped close to the Palace Cinema, Brymbo, and the Steelworks. A few months later in 1940, a German bomber was shot down, crashing into trees near Cefn Park, scattering UXBs across the field.

Records of bombing incidents in the civilian areas of the district were typically collected by Air Raid Precautions wardens and collated by Civil Defence personnel. Some other organisations, such as port and railway authorities, maintained separate records. Records would be in the form of typed or hand written incident notes, maps and statistics. Bombing data was carefully analysed, not only due to the requirement to identify those parts of the country most needing assistance, but also in an attempt to find patterns in the Germans' bombing strategy in order to predict where future raids might take place.

Records of bombing incidents are presented in the following sections.

© 1st Line Defence®

11.3. WWII Home Office Bombing Statistics

The following table summarises the quantity of German air delivered bombs (excluding 1kg incendiaries and anti-personnel bombs) dropped on the Rural District of Wrexham between 1940 and 1945.

Record of German Ordnance Dropped on the Rural District of Wrexham		
Area Acreage		73,370
Weapons	High Explosive bombs (all types)	273
	Parachute mines	4
	Oil bombs	1
	Phosphorus bombs	0
	Fire pots	0
	Pilotless aircraft (V-1)	0
	Long range rocket bombs (V-2)	0
Total		278
Number of Items per 1,000 acres		3.8
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 risk relating to IBs is lesser than that relating to larger HE bombs, they were similarly designed to inflict damage and injury. Anti-personnel bombs were used in much smaller quantities and are rarely found today but are potentially more dangerous. Although Home Office statistics did not record these types of ordnance, both should not be overlooked when assessing the general risk to personnel and equipment.

11.4. Bombing of ROF Wrexham

The nature of the ROFs, spaced out over large areas as to avoid damage from any munition explosion, made the factories almost ideal to resist aerial attack. Many of the key buildings were duplicated and their flat concrete roofs resisted incendiary bombing. Such was the need for these factories that often the workers would continue through air-raid warnings and would only take shelter if the factory was going to be targeted.

Wrexham Archives were contacted about ROF Wrexham and any bombing of the ordnance factory during the war. Information received from them shows that the site area was photographed by the Luftwaffe in September 1940, and was noted as a potential target.

Despite this, by the time the factory was fully running, the Luftwaffe's attention had been turned elsewhere, and consequently the complex was never hit by bombing, as any raids in the area missed the works. The way the site was constructed, with large spaces between the buildings in case of any cordite explosion, would have meant that any standard bombing of the site area would have not caused as much damage as attacking a densely built up city centre. The only way to seriously damage the site area would be saturation bombing, which the Luftwaffe was not equipped to carry out.[1] This record is presented in **Annex H**.

Other villages close to Wrexham were hit by bombing, but these were likely only occasional 'tip and run' raids, likely as a consequence of bombers returning from Liverpool. Given that ROF Wrexham was not bombed during the war, and other incidents within the area appear to have been recorded across multiple sources, it is unlikely that the site area sustained any bombing.

[1] *Encyclopaedia of Wrexham, Page 273 (see bibliography)*

© 1st Line Defence®

11.5. Anecdotal Evidence of ROF Wrexham

Below are a selection of anecdotes from the BBC People's War website, which collected people's memories of wartime experiences. These snippets about the factory during the war have been taken from larger stories.

*"During my years at the **ROF I used to have to fire watch at least once a week or a fortnight. Well, we had to be on standby and keep looking out in case of any flames coming... you know, incendiary bombs, used to be dropping towards the end."**[2]*

*"I left school when I was nearly 17, and I managed to get a job in the Royal Ordnance Factory. That was 1941- about August, I should think. **If the blinking Germans had got that instead of Minera Mountain I wouldn't be here to tell this tale now**. It was where the Trading Estate is now, all that area was the ROF- in Marchwiel, just off the Holt Road."*[3]

11.6. WWII-Era Aerial Photography

WWII-era aerial photography for the site area was obtained from the National Monuments Record Office (Historic England) / the Aerofilms Collection available from Britain from Above. This photography provides a record of the potential composition of the site during the war, as well as its condition immediately following the war (see **Annex I**).

WWII-Era Aerial Photography	
Date/Title	Description
2nd May 1946	This photograph confirms that the site was occupied and surrounded by undeveloped ground. No distinct signs of damage such as cratering or scattered earth is visible on or within wider proximity of the site.

[2] http://www.bbc.co.uk/history/ww2peopleswar/stories/28/a9023528.shtml
[3] http://www.bbc.co.uk/history/ww2peopleswar/stories/29/a9023429.shtml

© 1st Line Defence®

11.7. 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.

11.8. Bomb Disposal Tasks

The information service from the Explosive Ordnance Disposal (EOD) Archive Information Office at 33 Engineer Regiment (now part of 29 EOD & Search Group) no longer processes commercial requests for information. It has therefore not been possible to include any updated official information regarding bomb disposal/clearance tasks with regards to this site. A database of known disposal/clearance tasks has been referred to which does not make reference to such instances occurring within the site of proposed works.

If any relevant information is received at a later date, Smith Grant LLP will be advised.

© 1st Line Defence®

11.9. Evaluation of German Air Delivered UXO Records

German Air Delivered UXO Records Summary	
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.*	During WWII, the site was situated within the Rural District of Wrexham. According to official Home Office bombing statistics this distrct sustained an overall vey low density of bombing with an average of 3.8 items of recorded ordnance per 1,000 acres. This density of bombing in the district can largely be attributed the absence of strategic targets in the north-east of Wales. While the Wrexham Royal Ordnance Factory was no doubt a viable target in its own right, the factory as well as the site area appear to have escaped bombing during the war. This is supported by an excerpt from the *Encyclopaedia of Wrexham,* which suggests the ROF to have survived the war unscathed (see **Annex H**).
Damage *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.*	1946 aerial photography does not indicate any distinct signs of damage such as cratering or scattered earth on or within the wider vicinity of the site. The ground cover appears to generally be well maintained and in good condition.
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.*	Given the undeveloped nature of the site and immediate surrounding area, ground cover is anticipated to have not been conducive towards the detection of evidence of UXO. 50kg unexploded bomb entry holes could be as small as 20cm in diameter which in areas of vegetation and shifting earth could go unnoticed and unreported.
Access Frequency *UXO in locations where access was irregular would have a greater chance of passing unnoticed than at those that were regularly occupied.*	Access on site is considered to have been infrequent throughout WWII given the lack of structures on and within close proximity to the site.
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.

© 1st Line Defence®

12. Introduction to Allied Ordnance

12.1. 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.

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

It should be highlighted that there is no evidence that the site formerly had any military occupation or direct usage for ordnance production, which could have led to contamination with items of Allied ordnance. However, due to its close proximity to a WWII-era Royal Ordnance Factory (No.35 Wrexham) this section of the report provides a general background on Royal Ordnance Factories and discusses the generic types of Allied ordnance typically encountered at these features. The potential risk from buried unexploded anti-aircraft projectiles fired during WWII has also been considered.

12.2. 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.

© 1st Line Defence®

12.3. Royal Ordnance Factories

The site was situated in the locality of the former ROF Wrexham, which was used predominately to manufacture propellant (cordite) during WWII. The main types of war-time Royal Ordnance Factories recorded in the UK are presented below:

Anti-Aircraft Artillery	
Item	Description
Propellant Manufacture	These factories mainly dealt in cordite, a smokeless propellant. Sometimes these factories only produced single-base nitrocellulose propellants, but often different variations of cordite were needed to meet specific propellant needs. These factories replaced the outmoded and vulnerable factory at Waltham Abbey.
High Explosives Manufacture	There were three types of these sites – TNT, RDX & Tetryl. These factories provided high explosives, often used in the heavy bomber offensive against Germany.
Filling Factories	These factories took the explosives made by the propellant and high explosives factories and added them into shells or bombs, ready to be used on the frontline.

Royal Ordnance Factories (ROFs) was the collective name of the UK government's munitions factories in and after World War II. Until privatisation in 1987 they were the responsibility of the Ministry of Supply and later the Ministry of Defence.

The factories were built in locations throughout the country after the threat of aerial bombing forced the government to decentralise munitions production away from the Royal Arsenal at Woolwich. Royal Ordnance factories could be permanent, temporary, or only in use for the duration of the war. However all facilities were involved in munitions production and storage for at least a period of WWII.

The majority of the ROFs were built in the re-armament period just before the start of the 1939-45 World War to enhance the capacity of the Royal Arsenal, Woolwich, the Royal Gunpowder Factory (RGPF) Waltham Abbey, Essex and the Royal Small Arms Factory, (RSAF) Enfield. Until the Munich Agreement in September 1938, public opinion, political opposition, and treasury controls were against any big spending on defence. After this, the economy went to a war footing, with explosives and arms manufacture becoming a priority.

Since the mid-1930's. It had been desirable to move production away from the Royal Arsenal in Woolwich, which was seen as highly vulnerable to air raids. For this reason, sites in the west of Britain were preferred. Later on, it was decided that it was desirable to locate new factories in areas of economic depression. Other considerations included the provision of an adequate labour supply, water supply, good rail communications, and large open sites for the spacing of buildings. Pre-existing field boundaries were often left in an attempt to break up the outline. ROF's were also often situated for political reasons in areas with high unemployment. Good railway links were essential for transport between factories. The 'Phony War' between September 1939 and June 1940 was critical in establishing the new ROF's which were approved at the beginning of the war.

All of the ROF factories were joined to railway main lines by spurs and loops. Within their boundaries, most had an internal standard-gauge railway system. Trucks were moved around by the factories own locomotives, usually steamless fuel or diesel to avoid any sparks. Some instead used narrow-gauge tramways for transport, while barges and electric road trolleys were uncommon.

The safety record for explosives manufacture had improved drastically since World War I, thanks to better internal design and better understanding of handling explosives. The confidential nature of this work makes any exact figures hard to obtain, but from information available, 134 people lost their lives in the filling factories, compared to 20 in the explosives factories.

© 1st Line Defence®

12.4. 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 LAA 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	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.			

The conditions in which anti-aircraft projectiles may have fallen unnoticed within a site area are analogous to those regarding air 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 Air Delivered Ordnance section of this report.

Illustrations of Anti-Aircraft artillery, projectiles and rockets are presented at **Appendix iv**.

© 1st Line Defence®

13. The Likelihood of Contamination from Allied Ordnance

13.1. Introduction

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.

13.2. ROF Wrexham

When war seemed likely in the late 1930s, it was noted that the dated factory at Waltham Abbey which was isolated geographically, would be inadequate for a future war. A second new cordite factory, after the first in Bishopton near Glasgow was approved in August 1939 and was sited at Marchwiel, south-east of Wrexham, in an area currently occupied by the Wrexham Industrial Estate. This was a huge 1730 acre factory area, cut in two by the river Clywedog. Pre-existing field boundaries and woodland were left untouched to break up the factory's outline. This area was chosen to alleviate local unemployment, but it was also connected sufficiently by rail to the ROF filing factories in South Wales and the West of England, as well as being far enough away from the continent to deter bombing raids. The cordite section of the factory was served by three nitro-glycerine factories, and two large nitrocellulose sections. Two smaller and inter-connected mounded units in the south-western section of the factory are believed to have been a tetryl nitration plant.

To connect the factory to the national rail network, a large marshalling yard was constructed, which connected to the work's internal rail lines. Diesel engines were preferred over steam engines, as they were less likely to ignite stray cordite. After the war, the production of cordite ceased and the factory almost immediately shut down, causing major redundancies in the area .

An approximation of the site in relation to ROF Wrexham's perimeter has been overlaid on 1949 OS mapping presented in **Annex J**.

13.3. The Defence of ROF Wrexham

The factory had significant ground and air defences. On the ground, several Type 22 and 24 Pillboxes were constructed. The factory was also located around 1.7km south-east of RAF Wrexham airfield. The ROF complex also contained a number of passive defences, buildings were purposely spread over a large area and to minimise damage from both aerial attacks and any exploding munitions. The buildings had earth banks to channel any explosion upwards. Exiting farm buildings were left untouched while the main buildings were camouflaged to deter reconnaissance. The buildings were designed to resist both incendiary bombs and blast damage.

Aerial photography, and historical mapping all show that the site boundary was approximately 200m north-west of the site.

13.4. Official Records of ROF Wrexham

The Wrexham Archives and Local Studies Service was contacted and queried to see if any official records of the factory still exist. According to the information received from them, the factory was at the time highly confidential, and the workers of the factory had to sign the Official Secrets Act, and few ever spoke of their work there at the time. Because of the Official Secrets Act, the official records of the factory were apparently almost immediately destroyed post-war. Few photographs of the factory during the war exist as photography would have been a breach of the Act.

Modern-day photography of the abandoned ROF can be seen in **Annex K**.

13.5. Wartime Anecdotal Evidence, ROF Wrexham

Below are a selection of anecdotes from the BBC People's War website, which collected people's memories of wartime experiences. Snippets about the factory during the war have been taken from larger stories.

"I was sent to the admin block at the Royal Ordnance Factory, and I did the income tax, national insurance, and national savings...There were about sixty wages clerks in our office. There were 3 tables of cordite girls, because that was the biggest factory... During my years at the ROF I used to have to fire watch at least once a week or a fortnight. Well, we had to be on standby and keep looking out in case of any flames coming... you know, incendiary bombs, used to be dropping towards the end."[4]

"I think it must have been just pre-war, and they decided to build a Royal Ordnance Factory on the outskirts of Wrexham, and they took a lot of farmland to build it on. They left those farms there because it was camouflage when they started to build those factories, because they had cordite and gun cotton and a nitro-glycerine plant, and there was a great big chemist block. It was a very big factory and they employed thousands... I left school when I was nearly 17, and I managed to get a job in the Royal Ordnance Factory. That was 1941- about August, I should think. If the blinking Germans had got that instead of Minera Mountain I wouldn't be here to tell this tale now. It was where the Trading Estate is now, all that area was the ROF- in Marchwiel, just off the Holt Road."[5]

Two transcripts of interviews were received from Wrexham Archives. Information from these transcripts is written below. Both of these interviews were undertaken by researchers from the Museum Record Office.

"I remember gun cotton came in large sacks, it was then weighed and put in white sacks where it was transported to various units... The gun cotton was first put into large vats where it was sprayed with acetone... The result was known as Hot Cordite. It was then transported to another block where it was made into sheets then taken into another section where it was made into strips."[6]

"There were two cordite plants and they also made an explosive similar to nitro-glycerine, which was stored in underground huts covered in earth... Mr Clarke used to work in the Transport and he remembers taking the liquid nitro in jerry cans by convoy all over the country."[7]

13.6. WWII-era Aerial Photography

As introduced in **Section 11.5**, WWII-era aerial photography for the site area was obtained from the Central Register of Aerial Photography for Wales. This photography was also analysed in relation to the potential risk of Allied UXO, see the table below.

WWII-era Aerial Photography	
Item	Description
2nd May 1946	This photograph confirms that the site was not situated within the area of the Royal Ordnance Factory and remained undeveloped during WWII.

[4] http://www.bbc.co.uk/history/ww2peopleswar/stories/28/a9023528.shtml
[5] http://www.bbc.co.uk/history/ww2peopleswar/stories/29/a9023429.shtml
[6] Interview with Mrs Wright of Chirk, 4th December 1985
[7] Interview with Mr J Clarke of Ponciau, 18th February 1986

© 1st Line Defence®

13.7. Evaluation of Contamination Risk from Allied UXO

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

Allied UXO Records Summary	
Sources of Allied UXO Contamination	Conclusion
Military Camps.	1st Line Defence could find no evidence of a military camp within the site.
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 12km north-west of the site. Despite this distance the maximum effective range of an AA projectile can be up to 15km. The conditions in which HAA or LAA projectiles may have fallen unnoticed within a site footprint are generally analogous to those regarding German air 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.*	Evidence of Home Guard activity is often difficult to locate, owing to the ad-hoc nature of Home Guard activity within each local area. Such training was often conducted on a small scale at the discretion of individual commanders and as such was seldom recorded officially. As such, no positive evidence could be found to confirm the presence of HG units within proximity to the site.
Defensive Positions *Defensive positions suggest the presence of military activity, which is often indicative of ordnance storage, usage or disposal.*	There is no evidence of any pillbox, emplacement or other defensive features formerly located on or bordering the site footprint. In-house records indicate a firewatchers post pillbox to have been situated approximately 70m south of the site. This feature is not considered to have had any impact on the risk of UXO on site.
Training or firing ranges	No evidence of training or firing ranges could be found within the site or surrounding area.
Defensive Minefields	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 evidence of ordnance manufacture could be found within the site area. The site does appear to be within close proximity of the Royal Ordnance Factory, Wrexham, a WWII-era propellant factory. Despite this, there is no evidence that any ordnance manufacture took place within the site boundary, as the site area appears to have been a separate area of undeveloped farmland throughout the war.
Military Related Airfields	The site was not situated within the perimeters or vicinity of a military airfield.

© 1st Line Defence®

14. The Likelihood of UXO Contamination Summary

The following table assesses the likelihood that the site was contaminated by items of German air 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, RAF aerial photography, online articles and modern-day photography of the site's wider vicinity. Information obtained from Wrexham archives indicates that ROF Wrexham was not bombed during the war. Other bombing incidents within Wrexham Rural District have been well recorded in both official sources and anecdotal evidence due to their relative infrequency. Because of this, it seems unlikely that the site area sustained any unrecorded bombing. Official records of ROF Wrexham were apparently destroyed post-war, and a lack of available records of bombing campaigns of the largely rural areas of Wrexham meant the record set available for consultation was limited.
German Air-Delivered Ordnance	• During WWII, the site was situated within the Rural District of Wrexham. According to official Home Office bombing statistics, the district sustained an overall very low density of bombing with an average of 3.8 items of ordnance recorded per 1,000 acres. Any bombing in the region that did occur appears to have been largely opportunistic and as a result of its position on the flight path to the important target of Liverpool. The only viable bombing target in the area was the nearby Royal Ordnance Factory (ROF) Wrexham. • Anecdotal sources attest that while the Luftwaffe may have been aware of the presence of ROF Wrexham (see **Annex H**), it was never struck by German bombing. This may have been due to its relatively isolated location. Despite the available source base being somewhat limited, no evidence of any bombing within the site footprint or the wider vicinity could be found. • 1946 aerial photography does not indicate any distinct signs of damage such as cratering or scattered earth on or within close proximity of the site. Additionally, the ground cover appears to be well maintained and in good condition. • Given the undeveloped nature of the site and immediate surrounding area, ground cover is not anticipated to have been conducive towards the detection of evidence of UXO. 50kg UXB entry holes could be as small as 20cm in diameter which in areas of undeveloped ground could go unnoticed. However, this is considered to have been somewhat mitigated by the very low density of bombing in the district as well as the close proximity of a firewatcher's post situated approximately 70m south of the site. • Similarly, access is considered to have been infrequent throughout WWII due to a lack of structures on and within immediate proximity of the site, with any monitoring of the area limited to the use of the firewatchers post. • In summary, given the very low bombing density within the district and lack of positive evidence to suggest bombing occurred within ROF Wrexham or its vicinity, the site is not considered to be at an elevated risk of contamination from German aerial-delivered items of UXO. As such, the site has been assessed as **Low Risk** from German UXO.

© 1st Line Defence®

Allied Ordnance	• The site is within close proximity to the former Royal Ordnance Factory, Wrexham, a WWII-era propellant factory. This factory produced cordite during the war, a propellant used in munitions. The site covered over 1000 acres and was in operation from early 1941 until the end of the war in 1945. Official records of the factory appear to have been destroyed post-war, and the workers at the time were sworn to secrecy, so most information available on the site is from anecdotal sources written or recorded years after the factory was shut down. • RAF aerial photography, obtained from the Central Register of Aerial photography for Wales, shows that during the war, the site area appears to have been occupied by well-maintained undeveloped fields, used for farming. OS historical mapping, obtained from both Landmark Maps and the National Library of Scotland, show that the site area was not built on during the construction of the Royal Ordnance Factory and has remained undeveloped. All of the available evidence indicates that the site was outside of the boundary of the factory, at a distance of approximately 275m, separated from it by further agricultural fields. • There is no evidence that any ordnance manufacture took place within the site boundary, as the site area appears to have been occupied by a clearly bordered area of undeveloped farmland throughout the war. No buildings, trackways, roads, infrastructure or any other such features of interest are noted within the site area on post-war photography. Whilst it is considered very likely that areas within the historic bounds of the factory itself would have become contaminated within ordnance and explosive materials (through disposal, burial, burning etc.), no evidence was found to indicate that this is likely to have occurred within the site area. As such, the risk from Allied UXO on site has been assessed as **Low**.

© 1st Line Defence®

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

1st Line Defence has found no evidence in the public domain or within internal records that any official ordnance clearance operations have taken place on site. Note however that we have not received confirmation of this fact from the 33 EOD Regiment Archive (now part of 29 EOD & Search Group). It should also be noted that in addition to 29 EOD & Search Group archival information, 1st Line Defence also do not currently have access to data that may be relevant including 5131(BD)SQN Archive, SD Training Technical Advisory Section (TAS) and MACA Records (bomb disposal callouts).

If such information is available at a later date, it is recommended that it be reviewed as it will assist with understanding both levels and types of contamination likely to be present, and may indicate risk reduction in certain areas.

15.3. Post-War Redevelopment

According to recent aerial imagery, no significant development has taken place on site post WWII. However, the surrounding area has been subject to development of industrial structures and accessways.

The risk of UXO remaining is considered to be mitigated at the location of and down to the depth of any post-war redevelopment on site. For example, the risk from deep buried UXO will only have been mitigated within the volumes of any post-war pile foundations or deep excavations for basement levels. The risk will however remain within virgin geology below and amongst these post-war works, down to the maximum bomb penetration depth.

© 1st Line Defence®

16. The 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 works 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.

Generally speaking, the risk of encountering any type of UXO will be minimal for any works planned within the footprint and down to the depth of post-war foundations and excavations.

16.2. Encountering Air Delivered Ordnance

Since an air delivered bomb may come to rest at any depth between just below ground level and its maximum penetration depth, there is a chance that such an item (if present) could be encountered during shallow excavations (for services or site investigations) into the original WWII ground level as well as at depth.

© 1st Line Defence®

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 Air 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. 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.

© 1st Line Defence®

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.

© 1st Line Defence®

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

1st Line Defence has assessed that there is an overall **Low Risk** from German and anti-aircraft unexploded ordnance at the site of proposed works. There is an assessed **Low Risk** from Allied unexploded ordnance.

Ordnance Type	Risk Level			
	Negligible	Low	Medium	High
German Unexploded HE Bombs		✓		
German 1kg Incendiary Bombs		✓		
Anti-Aircraft Artillery Projectiles		✓		
Allied Land Service and Small Arms Ammunition		✓		

Please note – although the risk from unexploded ordnance on this site has been assessed as 'Low', this does not mean there is 'no' risk of encountering UXO. 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.

© 1st Line Defence®

20. Proposed Risk Mitigation Methodology

20.1. General

The following risk mitigation measures are recommended to support the proposed works at Land Adjacent to Alpha Windows:

Recommended Risk Mitigation Measures	
Activity	Recommended Risk 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.

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 **19th September 2025**

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.

© 1st Line Defence®

Bibliography

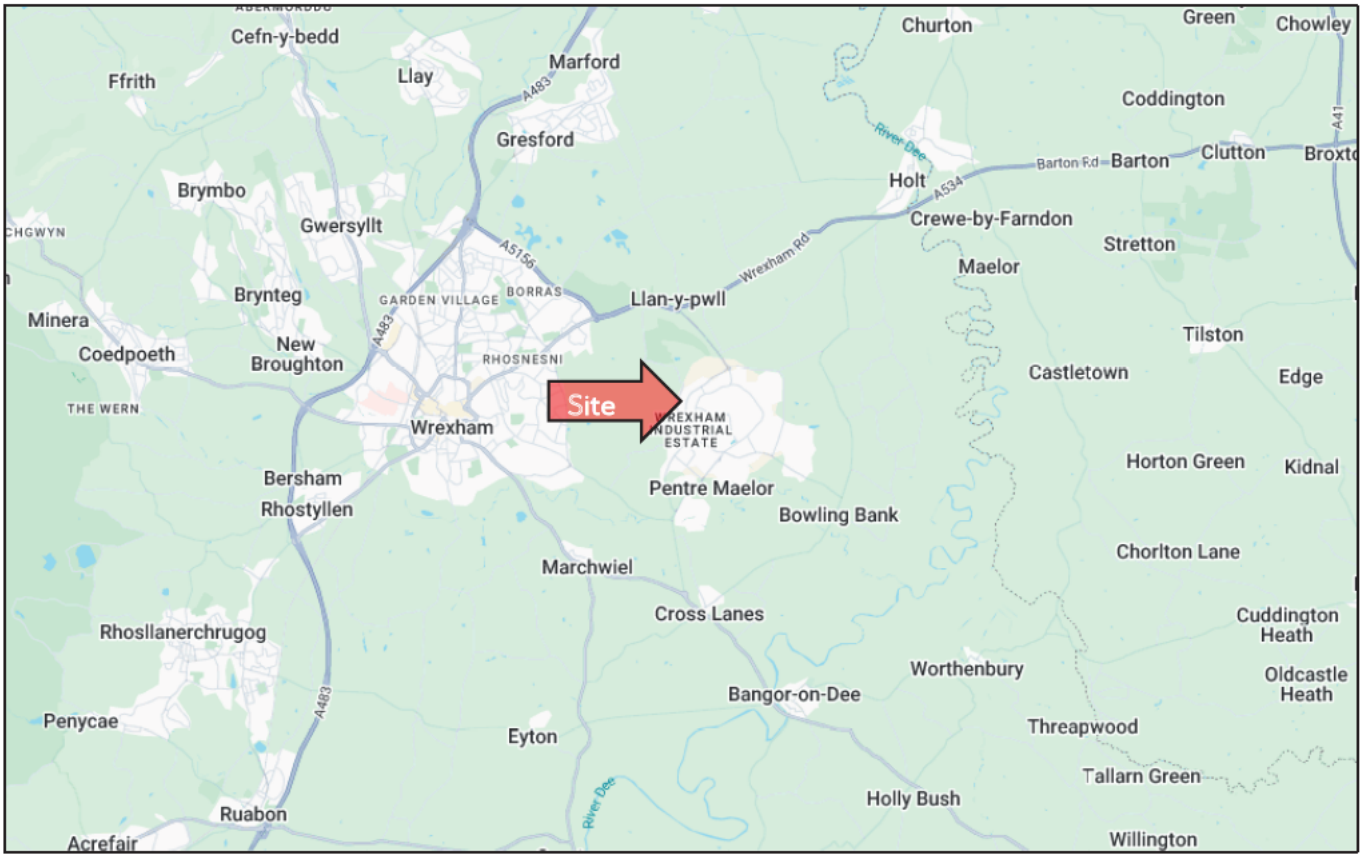
- Bates, H. E., Flying Bombs over England, Frogletts Publications Ltd., 1994
- Clarke, N. J., Adolf's British Holiday Snaps: Luftwaffe Aerial Reconnaissance Photographs of England, Scotland and Wales, Fonthill Media Ltd., 2012
- Dobinson, C., AA Command: Britain's Anti-Aircraft Defences of the Second World War, Methuen., 2001
- Fegan, T., The 'Baby Killers': German Air raids on Britain in the First World War, Leo Cooper Ltd., 2002
- Fleischer, W., German Air-Dropped Weapons to 1945, Midland Publishing., 2004
- Jappy, M. J., Danger UXB: The Remarkable Story of the Disposal of Unexploded Bombs during the Second World War, Channel 4 Books., 2001
- Morris, J., German Air Raids on Britain: 1914 – 1918, The Naval & Military Press., 1993
- Price, A., Blitz on Britain, The Bomber Attacks on the United Kingdom 1939 – 1945, Purnell Book Services Ltd., 1977
- Ramsey, W., The Blitz Then and Now, Volumes 1,2 & 3, Battle of Britain Prints International Ltd., 1987, 1988 & 1990
- Scofield, J., Modern Military Matters., Council for British Archaeology., 2004
- Stone, K., et al., Unexploded Ordnance (UXO) A Guide For The Construction Industry (C681)., CIRIA, 2009
- Whiting, C., Britain Under Fire: The Bombing of Britain's Cities 1940-1945, Pen & Sword Books Ltd., 1999
- Williams, W. A., *The Encyclopaedia of Wrexham*, Bridge Books, 2001

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.

This report was written by, is owned by and is copyrighted to 1st Line Defence Limited. It contains important 1st Line Defence information which is disclosed only for the purposes of the client's evaluation and assessment of the project to which the report is about. The contents of this report shall not, in whole or in part be used for any other purpose apart from the assessment and evaluation of the project; be relied upon in any way by the person other than the client, be disclosed to any affiliate of the client's company who is not required to know such information, nor to any third party person, organisation or government, be copied or stored in any retrieval system, be reproduced or transmitted in any form by photocopying or any optical, electronic, mechanical or other means, without prior written consent of the Managing Director, 1st Line Defence Limited, Unit 3, Maple Park, Essex Road, Hoddesdon EN11 0EX. Accordingly, no responsibility or liability is accepted by 1st Line Defence towards any other person in respect of the use of this report or reliance on the information contained within it, except as may be designated by law for any matter outside the scope of this report.

Site Location Maps

Annex: A





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: Smith Grant LLP

Project: Land Adjacent to Alpha Windows

Ref: DA2353a-00

Source: Google Maps

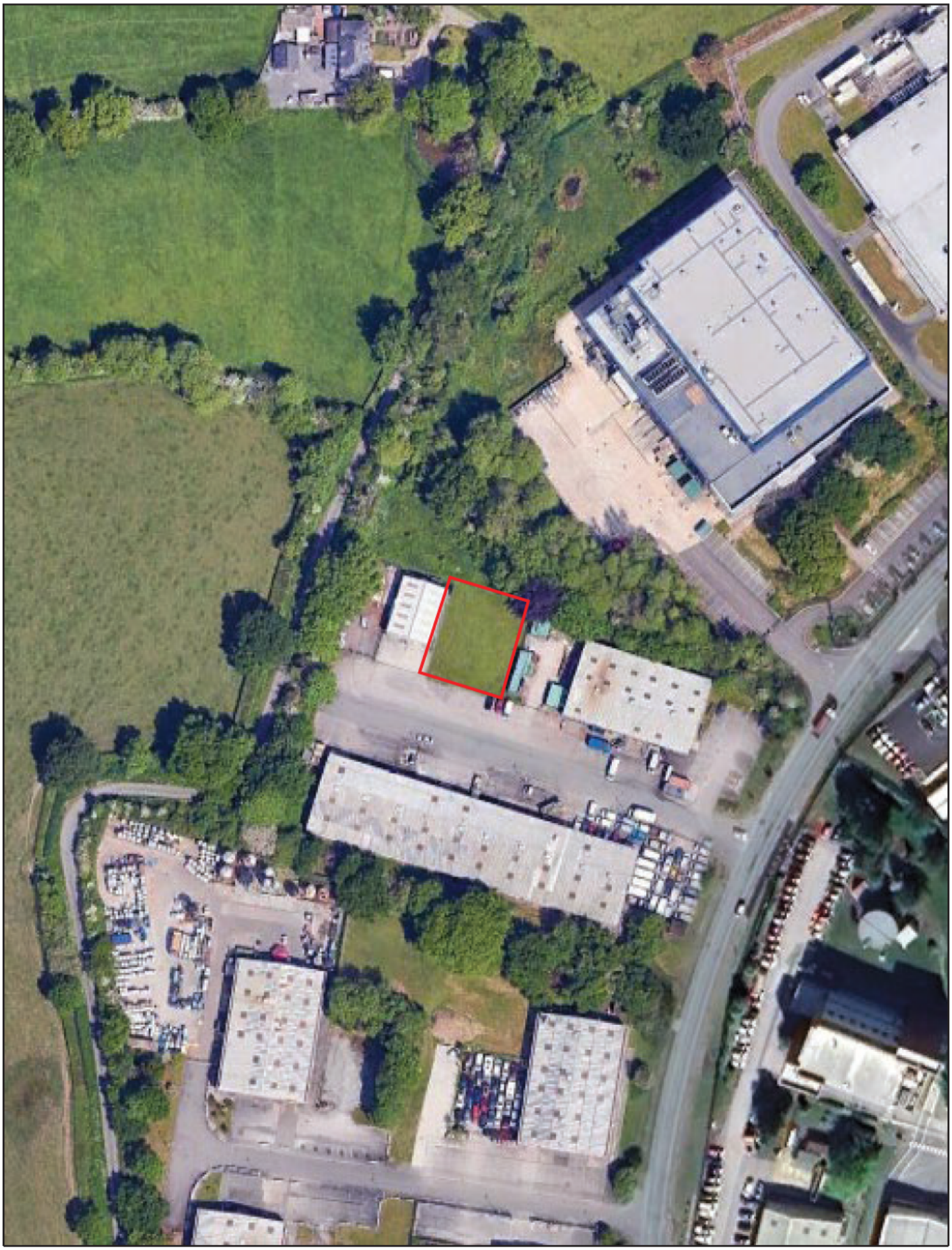
Approximate site boundary

N

Produced by and Copyright to 1st Line Defence® Ltd. Registered in England and Wales with CRN: 7717863. VAT No: 128 8833 79.

Recent Aerial Photography

Annex: B



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: Smith Grant LLP

Approximate site boundary

N

Project: Land Adjacent to Alpha Windows

Ref: DA2353a-00

Source: Google Earth

Produced by and Copyright to 1st Line Defence® Ltd. Registered in England and Wales with CRN: 7717863. VAT No: 128 8833 79.



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: Smith Grant LLP

Approximate site boundary

Project: Land Adjacent to Alpha Windows

N

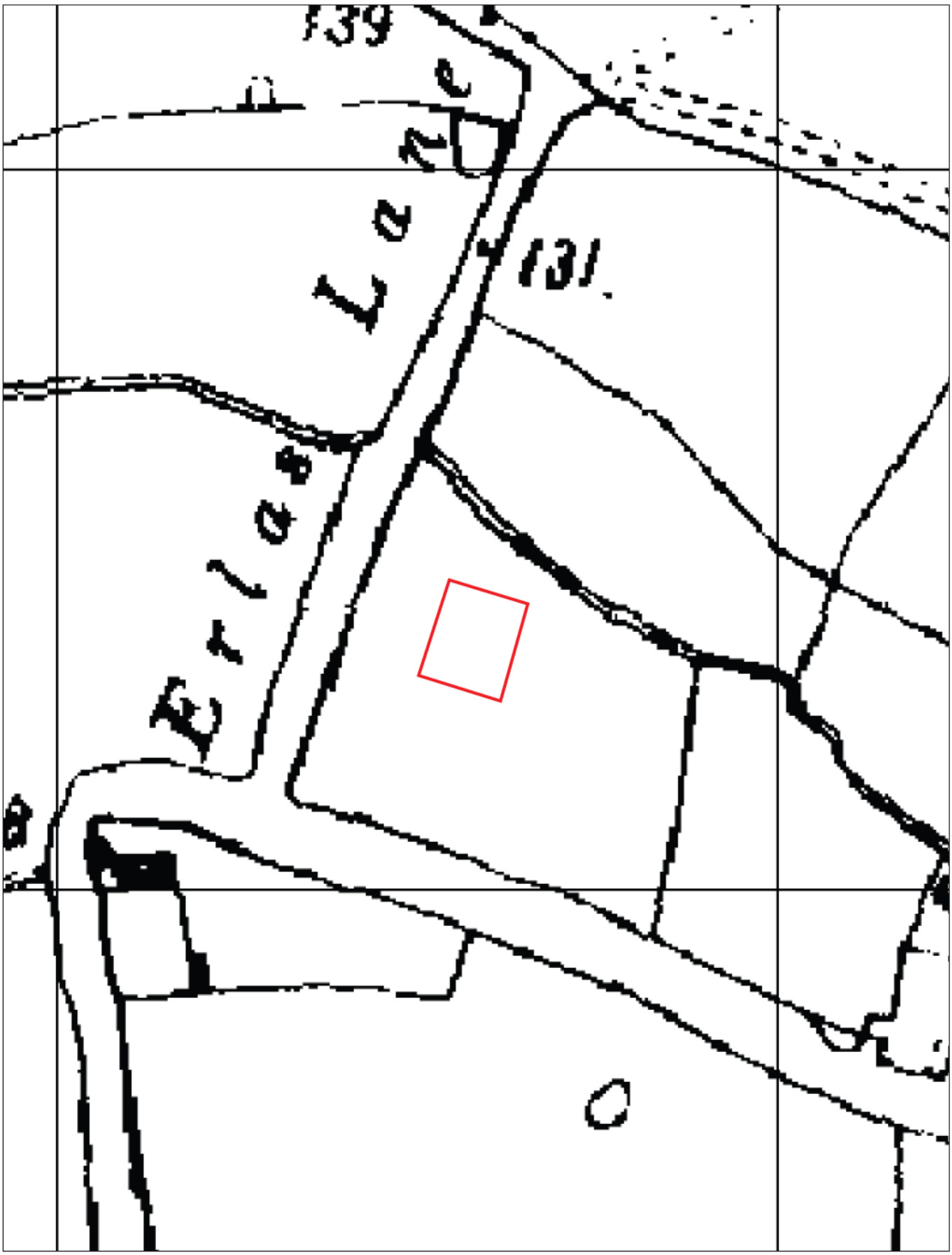
Ref: DA2353a-00

Source: Smith Grant LLP

Produced by and Copyright to 1st Line Defence® Ltd. Registered in England and Wales with CRN: 7717863. VAT No: 128 8833 79.

Pre-WWII Historical Map 1938

Annex: D1



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: Smith Grant LLP

Approximate site boundary

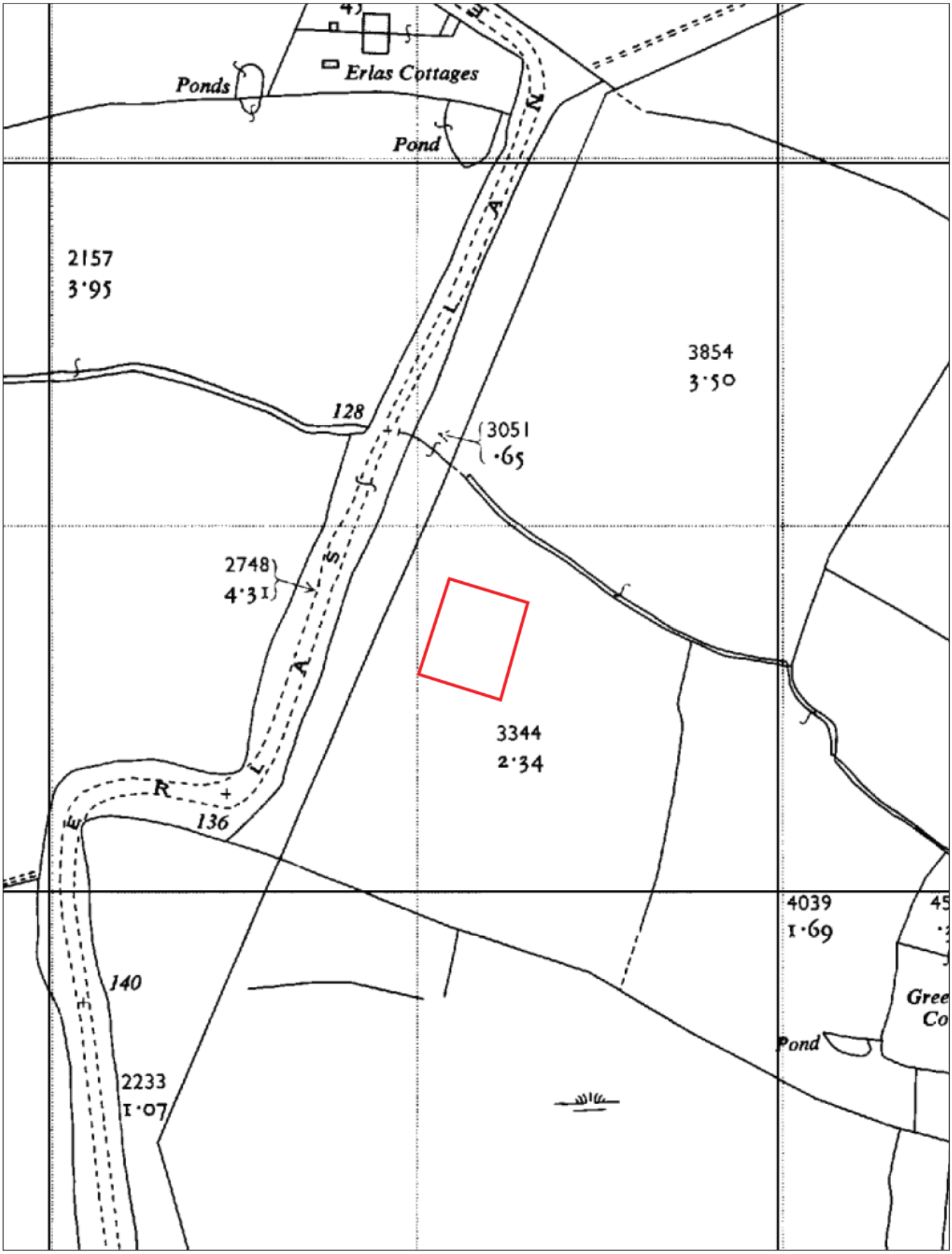
Project: Land Adjacent to Alpha Windows

N

Ref: DA2353a-00

Source: Landmark Maps

Produced by and Copyright to 1st Line Defence® Ltd. Registered in England and Wales with CRN: 7717863. VAT No: 128 8833 79.



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: Smith Grant LLP

Approximate site boundary

Project: Land Adjacent to Alpha Windows

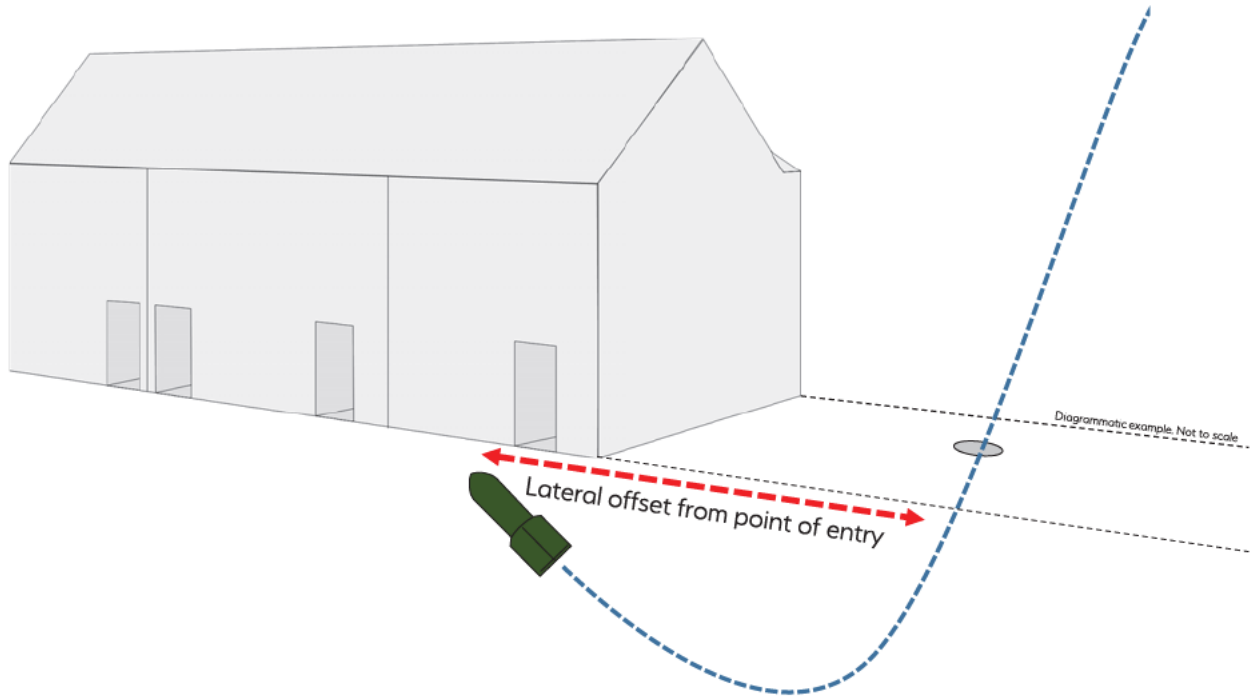
N

Ref: DA2353a-00

Source: Landmark Maps

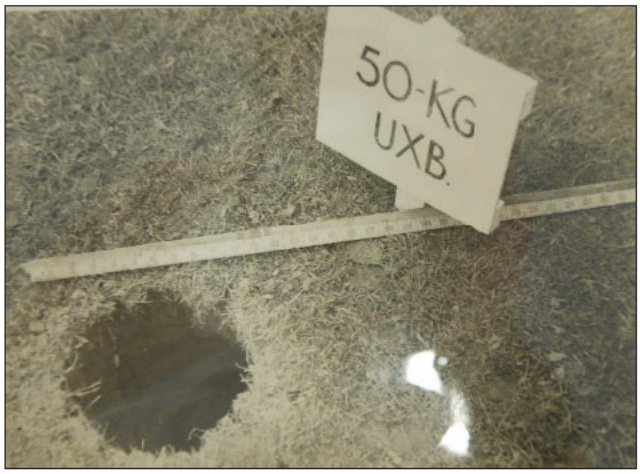
Produced by and Copyright to 1st Line Defence® Ltd. Registered in England and Wales with CRN: 7717863. VAT No: 128 8833 79.

Example of UXO Entry Hole / The 'J-curve' Effect Principle









Top: J-curve Effect - Due to angle of entry, unexploded bombs would often end their trajectory at a lateral offset from point of entry, often ending up beneath adjacent extant structures/sites.

The photograph **above** shows a 250kg unexploded bomb found in Bermondsey in 2015, pointing upwards, demonstrating 'J-curve'.

One of the most common scenarios for UXO going unnoticed was when a UXB fell into a 'bomb site' (such as the area shown **Top Left**), the entry hole of the bomb obscured by any debris and rubble present. Note that the entry hole of a 50kg UXB could be as little as 20cm in diameter (**Left**).

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: Smith Grant LLP

Project: Land Adjacent to Alpha Windows

Ref: DA2353a-00 Source: Various sources

Produced by and Copyright to 1st Line Defence® Ltd. Registered in England and Wales with CRN: 7717863. VAT No: 128 8833 79.

BBC NEWS

WW2 bomb found near London City Airport blown up



An unexploded World War Two bomb found near London City Airport has been detonated.

The 500kg device was discovered at the King George V Dock on Sunday during planned work at the airport.

It was closed and all flights were cancelled on Monday after an exclusion zone was put in place.

The detonation, which took take place off Shoeburyness, Essex, was postponed on Tuesday because of high winds and dangerous conditions for divers.

The 1.5m-long German bomb - which was found in a bed of silt, 15m underwater - was carefully removed from the Thames and placed in a secure location a mile away from the coast of Essex.

500kg German HE Bomb, February 2018

BBC NEWS



Exeter WW2 bomb is detonated after homes evacuated

More than 2,600 households and 12 university halls of residence were cleared before the 2,200lb (1,000kg) device **was destroyed** on Saturday.

Police said the blast left a crater about the size of a double-decker bus.

Police have reported large pieces of metal debris hitting buildings and said some properties in the 100m (330ft) exclusion zone had sustained "structural damage".



1000kg German HE bomb, February 2021

BBC NEWS



Great Yarmouth: Huge blast after unplanned WW2 bomb detonation

A World War Two bomb found in Great Yarmouth has detonated while work was being done to defuse it, causing a huge blast that was heard for miles.

Army specialists were attempting to disarm it when there was an unplanned detonation at about 17:00 GMT.

People on social media said they heard a loud bang and felt buildings shake 15 miles (24km) away.

There have been no reports of injuries among the Army, emergency services or the public, Norfolk Police said.

Cordons were put in place when the bomb was first discovered close to two gas pipes on Tuesday, and work began to make it safe.

250kg German HE Bomb, February 2023

BBC NEWS



Plymouth unexploded WW2 bomb: Thousands of people displaced

A 500kg (1,102lb) German World War Two bomb that forced the evacuation of thousands of people in Plymouth has been detonated at sea.

The unexploded device was **found in a garden** on St Michael Avenue on Tuesday, sparking four days of disruption.

On Friday police closed roads and rail and bus services were stopped as the bomb was transported 1.4 miles (2.3km) through the city's streets.

The device was taken by boat beyond the breakwater and detonated at 21:51 GMT.





500kg German HE Bomb, February 2024

Produced by and Copyright to 1st Line Defence® Ltd. Registered in England and Wales with CRN: 7717863. VAT No: 128 8833 79.

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

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."

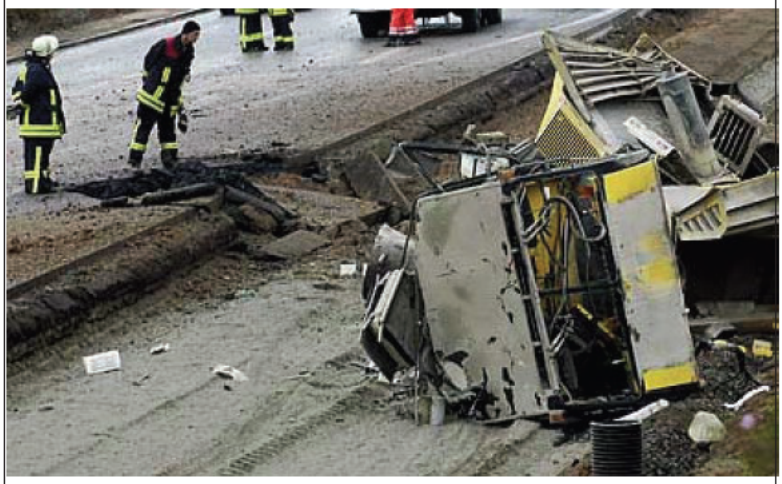
19th September 2013

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

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

Produced by and Copyright to 1st Line Defence® Ltd. Registered in England and Wales with CRN: 7717863. VAT No: 128 8833 79.

Wrexham wartime bomb alert drama

Published date: 15 July 2010 | Published by: Phil Robinson
Read more articles by Phil Robinson



TWO wartime shells sparked a bomb alert near Wrexham.

Army bomb disposal experts removed the anti-aircraft shells from Rhostyllen.

A Ministry of Defence spokesman said: "The team were called out to the Rhostyllen area, just off the A483 Wrexham bypass, to deal with two eight-and-a-half pound anti-aircraft shells, which dated back to the Second World War.

The spokesman said a team of experts from the Explosive Ordnance Device Corps were called to the area at 11.36pm on Monday.

They remained on the site until 11.30am the following day.

Leader readers reported seeing the vehicle near the Croesfoel roundabout of the A483.

The MoD spokesman said: "The shells were found to be inert. They were safely collected and taken back to the unit's base."

The spokesman refused to say exactly where the shells were found or who discovered them. However he confirmed that the bomb disposal team only responds to calls from the police and not members of the public.

Business premises in the area, including the Evans Halshaw and Dickens car dealerships and the Travelodge Hotel, said they had not heard anything about the emergency.

There is therefore speculation that the shells were taken away from a private address in the area.

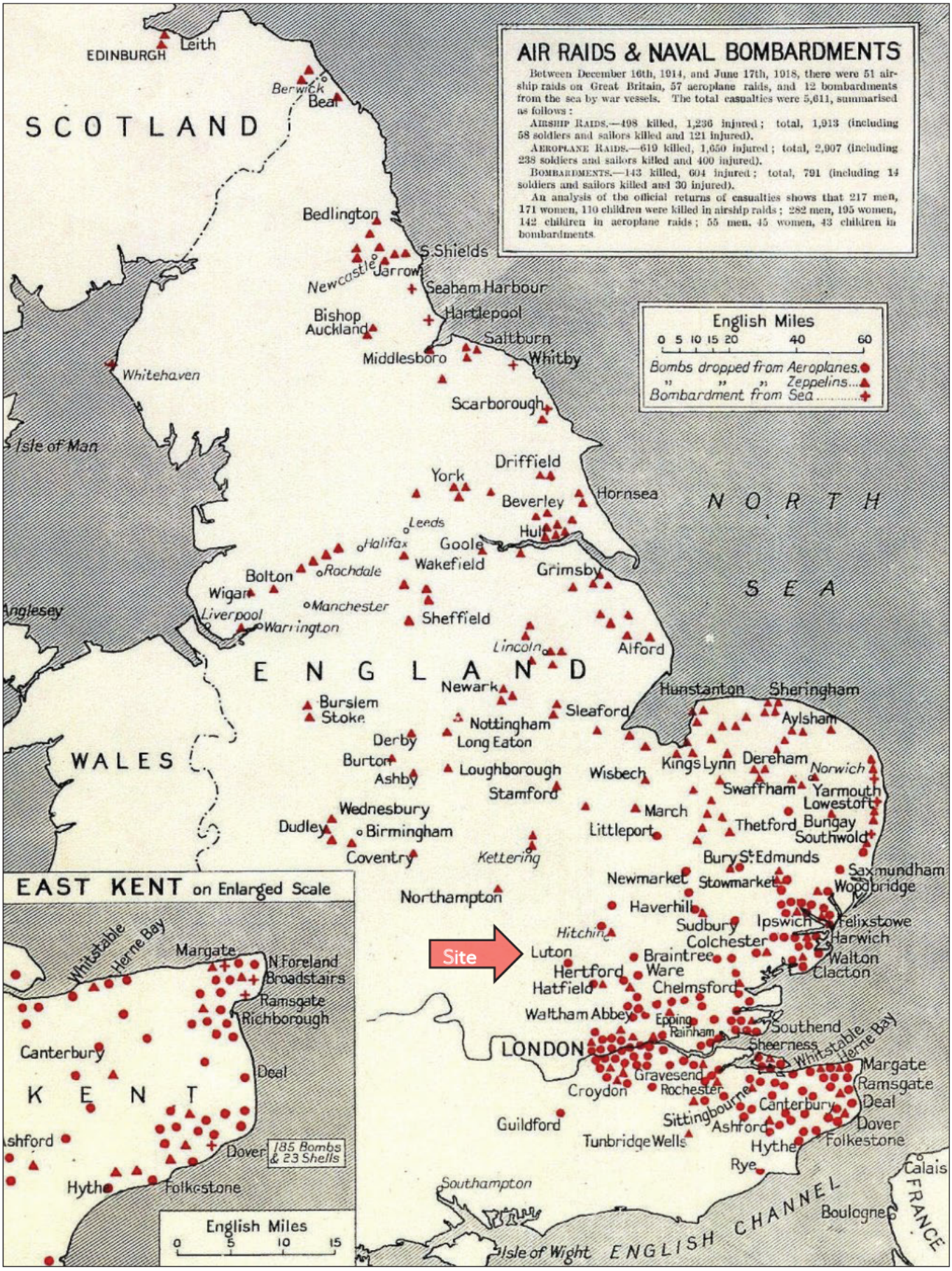
Local military historian Peter Stubbs said the shells were possibly 3.7-inch ammunition for the huge artillery pieces – known as ack-ack guns – which protected Britain from raids by the German Luftwaffe during the Second World War.

Peter said: "It is quite possible that an anti-aircraft battery was operating in Rhostyllen during the war.

"There were a number of strategic sites around the Wrexham area in those days, such as the munitions factory in Marchwiel.

"The ack-ack battery wouldn't necessarily have been sited permanently in Rhostyllen as they tended to be mobile units."

Produced by and Copyright to 1st Line Defence® Ltd. Registered in England and Wales with CRN: 7717863. VAT No: 128 8833 79.



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: Smith Grant LLP

Project: Land Adjacent to Alpha Windows

Ref: DA2353a-00

Source: J. Morris, German Air Raids on Britain

N

Produced by and Copyright to 1st Line Defence® Ltd. Registered in England and Wales with CRN: 7717863. VAT No: 128 8833 79.

Royal Ordnance Factory, Marchwiel

Approved in August 1939, the massive Royal Ordnance Factory, Marchwiel, covered an area of *c*.1,730 acres (700 ha). Existing field boundaries and woodland were left in situ in an attempt to break up the outline of the site and hinder aerial reconnaissance. A casual glance at aerial photographs of the site clearly show that this attempt at concealment was non-effective. The site was chosen for a number of reasons:

1. high local unemployment
2. ground relief meant ease of building
3. distance from a large urban conurbation
4. distance from mainland Europe
5. good railway links

Built by M^c^Alpine at a cost of £10.9 million, the factory began production of propellants in March 1941. The cordite section was supplied by three units producing nitroglycerine and two units producing nitrocellulose. To the south-west of the main factory complex were two smaller tetryl nitration plants. Employing 10,000 workers (many of whom were brought in to the area from other factories, most notably the ROF Waltham Abbey) the ROF had its own internal railway system which was powered by diesel engines to avoid the danger of sparks igniting the munitions. One stop was at the Parkey Gate Station (at the east end of the North Marshalling Yard). The buildings were dispersed over a wide area, thereby reducing the danger of a chain-reaction explosion and also making bombing from the air almost impossible as a hit on one building would have little or no effect on any others. German *Luftwaffe* records show that factory was photographed by a Heinkel HeIII in September 1940 but the ensuing raids in the area failed to hit the works. By the time the factory was fully 'on-line' the *Luftwaffe's* attention was being focussed elsewhere and, due to the design of the site, only saturation bombing — which the *Luftwaffe* was not equipped to carry out — could have inflicted serious damage.

The buildings were steel-framed with reinforced concrete and brick in-fill and most were only single-storey. The largest buildings in terms of height were the acid section which were three or four storeys high but internally open to the roof. They housed acid towers used for the concentration of sulphuric acid or de-nitrification of spent acids and were ventilated by means of large metal circular vents or louvred roofs.

Workers at the ROF were subject to the Official Secrets Act and, such was their adherence to it, that few ever spoke about their work there. The workers wore the ROF badge of crossed bombs with the motto 'Front Line Duty'. Closed shortly after the end of hostilities, the bulk of the records of the ROF Marchwiel were destroyed almost immediately and the site was converted into the embryo Wrexham Industrial Estate. Today, many of the ROF buildings still survive. Some have been converted to modern industrial use while others stand isolated and empty. Proposals to expand the Industrial Estate in the near future could well lead to many more buildings disappearing from the landscape. (See also William Sylvester, GC and photograph overleaf)

Produced by and Copyright to 1st Line Defence® Ltd. Registered in England and Wales with CRN: 7717863. VAT No: 128 8833 79. www.1stlinedefence.co.uk



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: Smith Grant LLP

Approximate site boundary

N

Project: Land Adjacent to Alpha Windows

Ref: DA2353a-00

Source: National Monuments Record Office (Historic England)

Produced by and Copyright to 1st Line Defence® Ltd. Registered in England and Wales with CRN: 7717863. VAT No: 128 8833 79.



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: Smith Grant LLP

Project: Land Adjacent to Alpha Windows

Ref: DA2353a-00

Source: National Monuments Record Office (Historic England)

Approximate site boundary

N

Produced by and Copyright to 1st Line Defence® Ltd. Registered in England and Wales with CRN: 7717863. VAT No: 128 8833 79.



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: Smith Grant LLP

Project: Land Adjacent to Alpha Windows

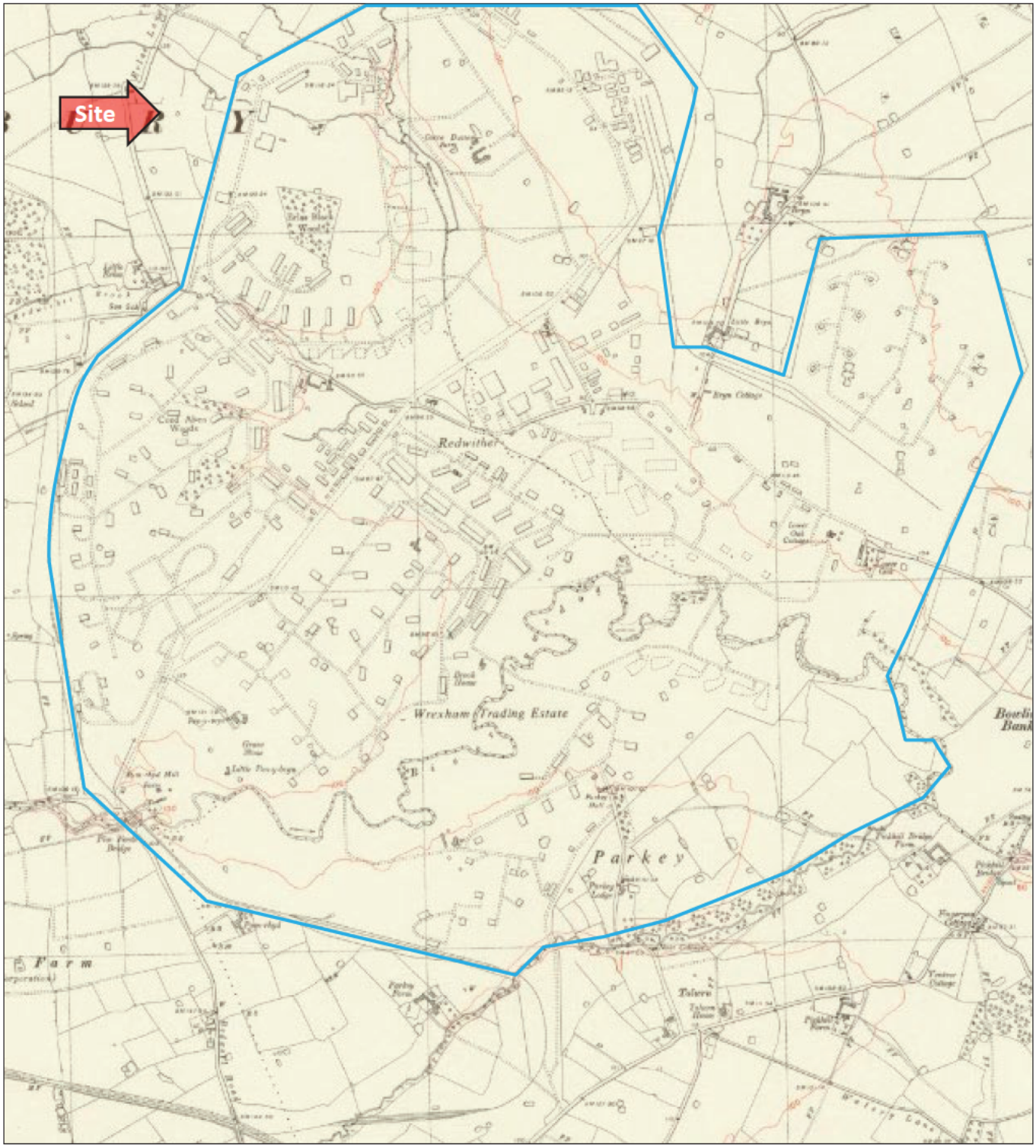
Ref: DA2353a-00

Source: National Monuments Record Office (Historic England)

Approximate site boundary

N

Produced by and Copyright to 1st Line Defence® Ltd. Registered in England and Wales with CRN: 7717863. VAT No: 128 8833 79.



Approximate border of ROF Wrexham on 1949 OS mapping

The site is situated approximately 275m west of the ROF border

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: Smith Grant LLP

Project: Land Adjacent to Alpha Windows

N

Ref: DA2353a-00

Source: http://www.nls.uk/ (National Library of Scotland)

Produced by and Copyright to 1st Line Defence® Ltd. Registered in England and Wales with CRN: 7717863. VAT No: 128 8833 79.





1ST LINE DEFENCE

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

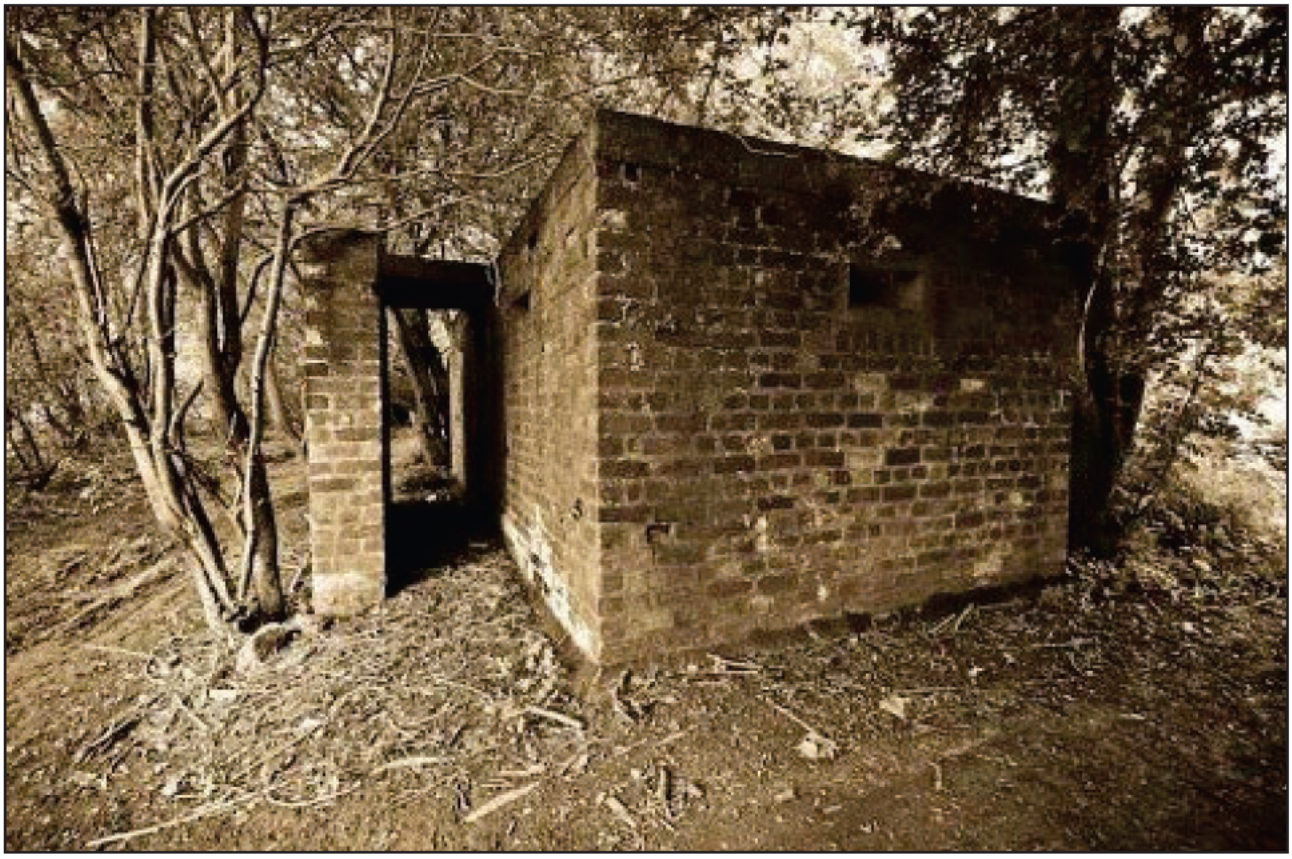
Client: Smith Grant LLP

Project: Land Adjacent to Alpha Windows

Ref: DA2353a-00

Source: www.wrexham.com, *The History of Wrexham's Royal Ordnance Factory*

Produced by and Copyright to 1st Line Defence® Ltd. Registered in England and Wales with CRN: 7717863. VAT No: 128 8833 79.





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: Smith Grant LLP

Project: Land Adjacent to Alpha Windows

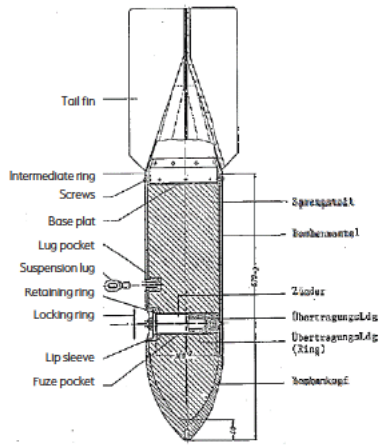
Ref: DA2353a-00

Source: www.wrexham.com, *The History of Wrexham's Royal Ordnance Factory*

Produced by and Copyright to 1st Line Defence® Ltd. Registered in England and Wales with CRN: 7717863. VAT No: 128 8833 79.

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.

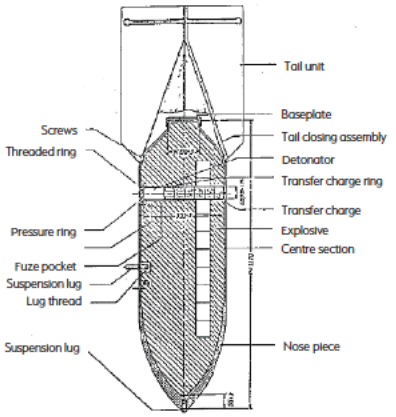






SC 250kg High Explosive Bomb

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).

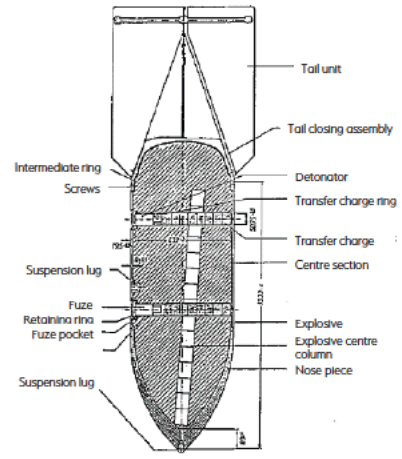




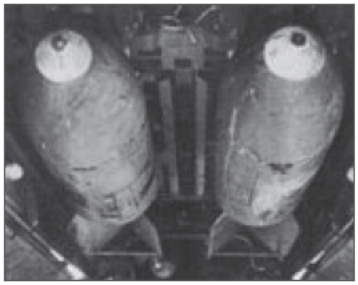


SC 500kg High Explosive Bomb

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, 1-15/16in. in length and diameter.







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: Smith Grant LLP

Project: Land Adjacent to Alpha Windows

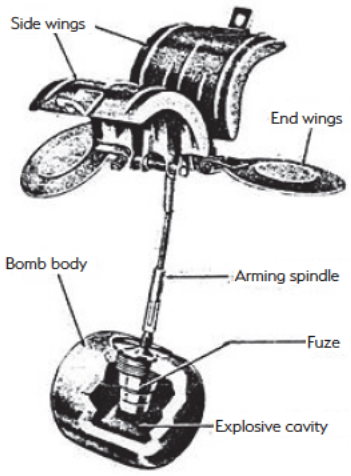
Ref: DA2353a-00

Source: Various sources

Produced by and Copyright to 1st Line Defence® Ltd. Registered in England and Wales with CRN: 7717863. VAT No: 128 8833 79.

SD2 Anti-Personnel 'Butterfly Bomb'

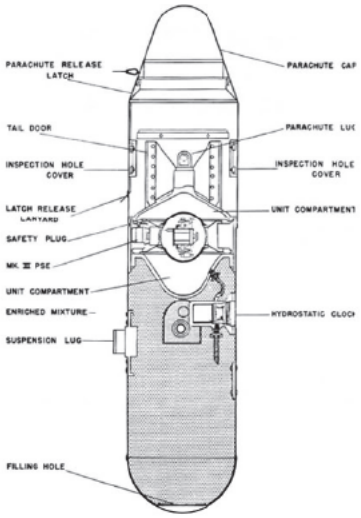
Bomb Weight	Approx. 2kg (4.41lb)
Explosive Weight	Approx. 7.5oz (225 grams) of Amatol surrounded by a layer of bituminous composition.
Fuze Type	41 fuze (time), 67 fuze (clockwork time delay) or 70 fuze (anti-handling device)
Body Diameter	3in (7.62 cm) diameter, 3.1in (7.874) long
Use	Designed as an 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	Quite 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 via 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.

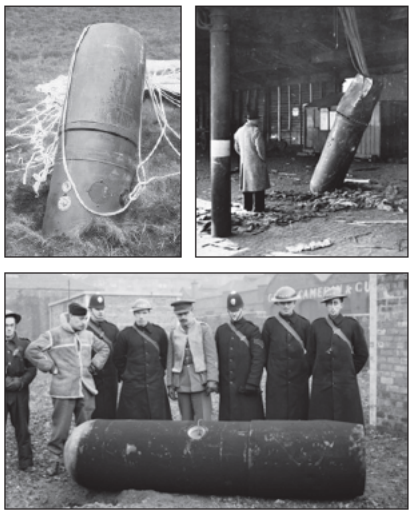




Parachute Mine (Luftmine B / LMB)

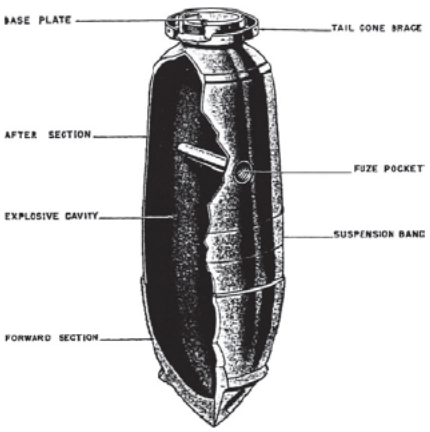
Bomb Weight	Approx. 990kg (2176lb)
Explosive Weight	Approx. 705kg (1,554lb)
Fuze Type	Impact/time delay/hydrostatic pressure fuze
Dimensions	2.64m x 0.64m (3.04m with parachute housing)
Use	Against civilian, military and industrial targets. Used as blast bombs and designed to detonate above ground level 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 within a 100m radius.





SC 1000kg High Explosive Bomb

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 were 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.





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: Smith Grant LLP

Project: Land Adjacent to Alpha Windows

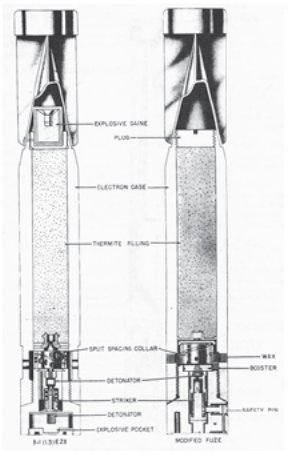
Ref: DA2353a-00

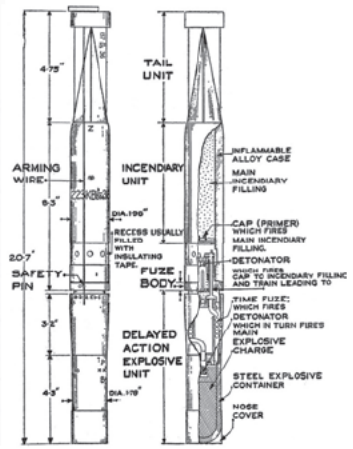
Source: Various sources

Produced by and Copyright to 1st Line Defence® Ltd. Registered in England and Wales with CRN: 7717863. VAT No: 128 8833 79.

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.

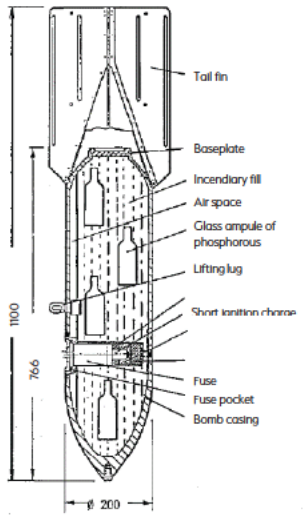


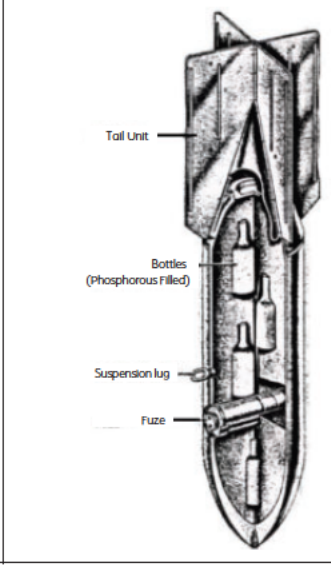




C50 A Incendiary Bomb

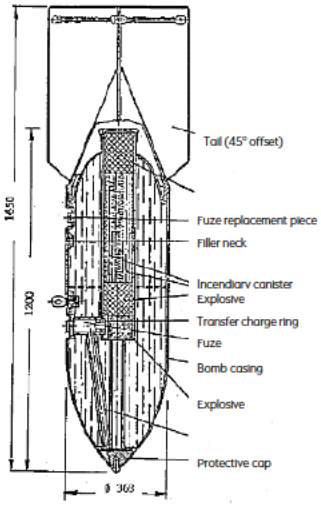
Bomb Weight	Approx. 41kg (90.4lb)
Explosive Weight	Approx. 0.03kg (0.066lb)
Incendiary Filling	12kg (25.5lb) liquid filling with phosphor igniters in glass phials. Benzine 85%; Phosphorus 4%; Pure Rubber 10%
Fuze Type	Electrical impact fuze
Bomb Dimensions	1,100 x 280mm (43.2 x 8in)
Use	Against any targets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

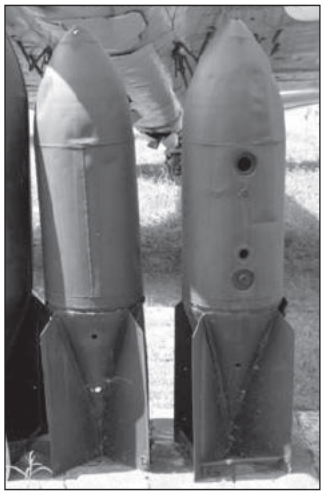




Flam C-250 Oil Bomb

Bomb Weight	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, 1-15/16in. in length and diameter.





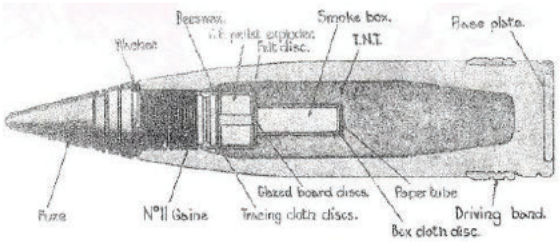
Produced by and Copyright to 1st Line Defence® Ltd. Registered in England and Wales with CRN: 7717863. VAT No: 128 8833 79.

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 and were commonly used on the Home Front.
Ceiling	30,000ft to 59,000ft





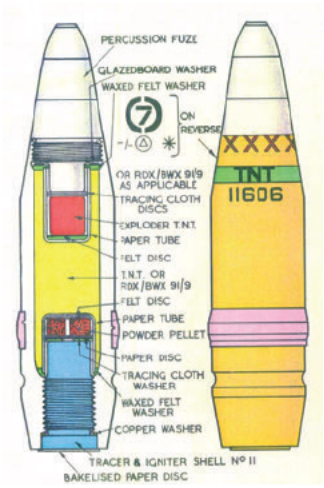


40mm Bofors Projectile

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.



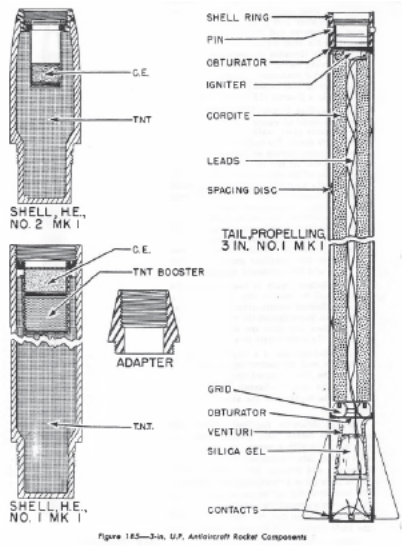




3in Unrotated Projectile (UP) Anti-Aircraft Rocket ("Z" Battery)

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.





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: Smith Grant LLP

Project: Land Adjacent to Alpha Windows

Ref: DA2353a-00

Source: Various sources

Produced by and Copyright to 1st Line Defence® Ltd. Registered in England and Wales with CRN: 7717863. VAT No: 128 8833 79.

1st Line Defence

Unit 3, Maple Park
Essex Road, Hoddesdon
Hertfordshire EN11 0EX

Call +44 (0) 1992 245 020
Email info@1stlinedefence.co.uk
Web www.1stlinedefence.co.uk



Front cover image credit: London Bomb Census Mapping, The National Archives (HO 193)