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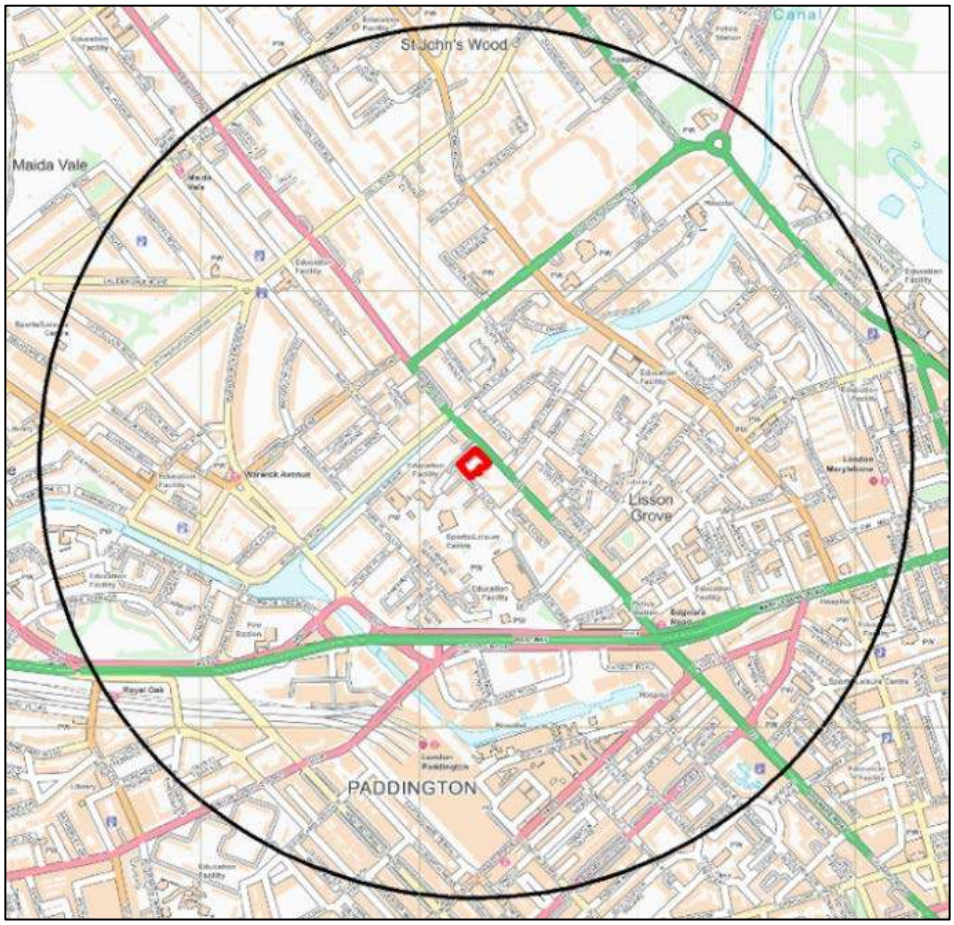
Detailed Unexploded Ordnance (UXO) Threat & Risk Assessment

Meeting the requirements of *CIRIA* C681 'Unexploded Ordnance (UXO) A guide for the Construction Industry' Risk Management Framework



6 ALPHA PROJECT NUMBER	SAMPLE	**ORIGINATOR**	R. Griffiths
LANDMARK ORDER NUMBER	SAMPLE	**REVIEWED BY**	B. Wilkinson
CLIENT REFERENCE	SAMPLE	**RELEASED BY**	L. Askham
SITE	Parsons North, Edgware Road, London, W2 1NE		
RATING	**MEDIUM** - This Site requires limited further action to reduce risk to ALARP during intrusive activities.		

Contents

Figures

Acronyms and Abbreviations

AA	Anti-Aircraft
AAA	Anti-Aircraft Ammunition
AAC	Army Air Corps
AFS	Advanced Flying School
ALARP	As Low As Reasonably Practicable
AOD	Above Ordnance Datum
ARP	Air Raid Precaution
ATS	Auxiliary Territorial Service
AXO	Abandoned Explosive Ordnance
BD	Bomb Disposal
BDO	Bomb Disposal Officer
bgl	Below Ground Level
BGS	British Geological Survey
BH	Borehole
BPD	Bomb Penetration Depth
CDP	Cast Driven Piles
CFA	Continuous Flight Auger
CIRIA	Construction Industry Research and Information Association
CPT	Cone Penetration Testing
CS	County Series
EFTS	Elementary Flying Training School
ELG	Emergency Landing Ground
EO	Explosive Ordnance
EOC	Explosive Ordnance Clearance
EOD	Explosive Ordnance Disposal
ERW	Explosive Remnants of War
FAA	Fleet Air Arm
FPP	Flight Pilot Pool
FTS	Flight Training School
GI	Ground Investigation
GIS	Geographic Information Systems
GL	Ground Level
GP	General Purpose
GPS	Global Positioning Systems
HAA	Heavy Anti-Aircraft
HE	High Explosive
HO	Home Office
HSE	Health and Safety Executive
IB	Incendiary Bomb
IED	Improvised Explosive Device
JSEODOC	Joint Service Explosive Ordnance Disposal Operations Centre
kg	Kilograms
km	Kilometres
LAA	Light Anti-Aircraft
lb	Pounds
LCC	London County Council
LDV	Local Defence Volunteers
LE	Low Explosive
LSA	Land Service Ammunition
m	Metres
MACP	Military Aid to the Civil Power
MoD	Ministry of Defence
mm	Millimetres
NATO	North Atlantic Treaty Organisation
NEQ	Net Explosive Quantity
NFF	National Filling Factory
NGR	National Grid Reference
OD	Ordnance Datum
OS	Ordnance Survey
OTU	Operational Training Unit
PBG	Polar Blasting Gelignite
PM	Parachute Mine
PoW	Prisoner of War
RADAR	Radio Detection And Ranging
RAF	Royal Air Force
RBL	Rifle Breach Loaded
RDX	Research Department Explosives
RFC	Royal Flying Corps
RML	Rifle Muzzle Loaded
RN	Royal Navy
RNAS	Royal Naval Air Service
ROF	Royal Ordnance Factory
SAA	Small Arms Ammunition
Sqn	Squadron
TA	Territorial Army
TNT	Trinitrotoluene
UK	United Kingdom
UN	United Nations
USAAF	United States Army Air Force
UXB	Unexploded Bomb
UXO	Unexploded Ordnance
V Weapons	*Vergeltungswaffe* – Vengeance Weapons
WAAF	Women's Auxiliary Air Force
WD	War Department
WWI	World War One
WWII	World War Two

EXECUTIVE SUMMARY

Study Site

The Client has defined the Study Site as "Parsons North, Edgware Road, London, W2 1NE". The Site is located at NGR 526630, 182110.

Risk Level

MEDIUM

Potential Threat Sources

The most probable UXO threat is posed by WWII *German* HE bombs, whilst IBs and *British* AAA projectiles (which were used to defend against *German* bombing raids) pose a residual threat.

Risk Pathway

Given the types of UXO that might be present on-site, all types of aggressive intrusive engineering activities may generate a significant risk pathway.

Key Findings

During WWII, the Study Site was situated within *Paddington Metropolitan Borough* and *St. Marylebone Metropolitan Borough*, which recorded 54 and 67 HE bombs per 100 hectares respectively, both very high levels of bombing.

Luftwaffe aerial reconnaissance photography associated with the Site did not identify any primary bombing targets on-site or within 1,000m of it. Nonetheless, an electricity supply station, coal sidings, works, a goods station, a warehouse and various wharves located in the vicinity may have been considered secondary bombing targets.

ARP records associated with the Site did not register any HE bomb strikes within it, nonetheless seven were recorded within 100m; the closest of which was located 30m to the south-east. In addition, a UXB disposal task was recorded 125m to the north-west of the Site. Furthermore, whilst IBs may have fallen within the Study Site, they fell in such large numbers they were considered ubiquitous and accurate record keeping was either non-existent or perfunctory therefore, from an examination of the records, their prospective presence cannot be either corroborated or discounted.

An analysis of the LCC maps associated with the Site shows "blast damage, minor in nature" and "general blast damage – not structural" to buildings within the Site boundary. In addition, "damage beyond repair" and "total destruction" was recorded to buildings located immediately south of the Site. Furthermore, an analysis of the post-WWII mapping associated with the area shows numerous "ruins" within the Site's vicinity, which is likely to be attributed to bombing.

Pre-WWII mapping (1938) and aerial photography (1945) associated with the Site shows that it was located within a densely developed urban area during WWII and comprised residential housing and a milk depot. Therefore, it is plausible that a local resident would have observed and reported any UXB entry hole following any raids. However, given the development of the Site combined with the bomb damage recorded, it is considered probable that UXB entry holes may have been masked by bomb damage debris, and therefore may have gone unnoticed.

In the early 1970s, all structures were demolished from the Site and superseded with a basement car park, which covers the entire Site. As a result, it is highly likely that any UXO within the structural footprint of the basement car park would have been discovered and removed; however, the potential for deep buried UXO to be present below these foundations is assessed to remain remotely extant. The client has stated the proposed works will be carried out within the footprints of the existing post-war basement car park and therefore within previously disturbed ground i.e. that which has been previously excavated, probed, drilled or otherwise intrusively disturbed since it had potentially become contaminated with UXO. As a result, the risk of UXO discovery at this Site has been mitigated. However, if works are to extend below the existing basement, *6 Alpha* should be informed so that the risk can be re-calculated and the appropriate mitigations can be applied.

EXECUTIVE SUMMARY (…continued)

Recommended Risk Mitigation

All Groundworks in All Areas:

1. **Operational UXO Risk Management Plan;** appropriate Site Management documentation should be held on-site to guide and plan for the actions which should be undertaken in the event of a suspected or real UXO discovery, (this plan can be supplied by *6 Alpha*);

2. UXO Safety & Awareness Briefings; the briefings are essential when there is a possibility of explosive ordnance encounter and are a vital part of the general safety requirement. All personnel working on the Site should receive a briefing on the identification of a UXB, what actions they should take to keep people and equipment away from such a hazard and to alert Site management. Information concerning the nature of the UXB threat should be held in the Site office and displayed for general information on notice boards, both for reference and as a reminder for ground workers. The safety and awareness briefing is an essential part of the Health & Safety Plan for the Site and helps to evidence conformity with the principles laid down in the CDM regulations 2015, (this briefing can be supplied by *6 Alpha*).

For further information, please contact *Envirocheck*:

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ASSESSMENT METHODOLOGY

Approach

6 Alpha Associates is an independent, specialist risk management consultancy practice, which has assessed the risk of encountering UXO (as well as buried bulk high explosives) at this Site, by employing a process advocated for this purpose by *CIRIA*. The *CIRIA* guide for managing UXO risks in the construction industry (C681) not only represents best practice but has also been endorsed by the *HSE*. Any risk mitigation solution is recommended *only* because it delivers the Client a risk reduced to ALARP at best value.

UXO hazards can be identified through the investigation of local and national archives associated with the Site, *MoD* archives, local historical sources, historical mapping as well as contemporaneous aerial photography (if it is available). Hazards will have only been recorded if there is specific information that could reasonably place them within the boundaries of the Site. The amalgamation of information is then assessed to enable the researcher to provide relevant and accurate risk mitigation practices.

The assessment of UXO risk is a measure of *probability of encounter* and *consequence of encounter*; the former being a function of the identified hazard and proposed development methodology; the latter being a function of the type of hazard and the proximity of personnel (and/or other 'sensitive receptors', such as equipment) to the hazard, at the moment of encounter.

If UXO risks are identified, the methods of mitigation we have recommended are considered reasonably and sufficiently robust to reduce them to ALARP. We advocate the adoption of the legal ALARP principle because it is a key factor in efficiently and effectively ameliorating UXO risks. It also provides a ready means for assessing the Client's tolerability of UXO risk. In essence, the principle states that if the cost of reducing a risk significantly outweighs the benefit, then the risk may be considered tolerable. This does not mean that there is never a requirement for UXO risk mitigation, but that any mitigation must demonstrate that it is beneficial. Any additional mitigation that delivers diminishing benefits and that consume disproportionate time, money and effort are considered *de minimis* and thus unnecessary. Because of this principle, UXB and UXO risks will rarely be reduced to zero (nor need they be).

Important Notes

Key source material is referenced within this document, whilst secondary/anecdotal information may be available upon request.

Although this report is up to date and accurate at the time of writing, our databases are continually being populated as and when additional information becomes available. Nonetheless, *6 Alpha* have exercised all reasonable care, skill and due diligence in providing this service and producing this report.

The assessment levels are based upon our professional opinion and have been supported by our interpretation of historical records and third party data sources. Wherever possible, *6 Alpha* has sought to corroborate and to verify the accuracy of all data we have employed, but we are not accountable for any inherent errors that may be contained in third party data sets (e.g. *National Archive* or other library sources), and over which *6 Alpha* cannot exercise control.

STAGE ONE – SITE LOCATION AND DESCRIPTION

Study Site

The Client has described the Study Site as "Parsons North, Edgware Road, London, W2 1NE". The Site is located at NGR 526630, 182110. The Site location and Site boundary are presented at *Figures 1* and *2* respectively.

Location Description

The Study Site is situated within the Metropolitan Boroughs of *Paddington* and *St. Marylebone* and covers an area of 0.21 hectares (ha).

Furthermore, the Site is bounded by:

- Northwest: *Crompton Street;*
- Northeast: *Edgware Road;*
- Southeast: *Parsons House* and hardstanding;
- Southwest: *Hall Place*.

Aerial Photography (Current) (*Figure 3*)

Current aerial photography shows that the Site is situated within a densely developed urban area and consists of hardstanding concrete, which serves as the roof of a basement car park below.

Proposed Works

The Client provided the following information regarding the works that will be carried out:

- Breaking out of the roof and columns of existing car park to slab level;
- Installation of piles;
- The new building is a five-storey structure plus basement car park within the same footprint and to the same ground level as the existing car park.

As a result, *6Alpha* will assume that excavations and piling will be carried out within current foundations and in particular within the curtilage of the existing building and previously disturbed ground.

Ground Conditions

It is important to establish the specific ground conditions in order to determine the maximum *German* UXB penetration depth as well as the potential for other types of munitions to be buried.

If the Site investigations and/or construction methodologies change, and/or if a specific methodology is to be employed, and/or if the scope of work is focused upon a specific part of the Site, then *6 Alpha* are to be informed so that the prospective UXO risks and the associated risk mitigation methodology might be re-assessed. Certain ground conditions may also constrain certain types of UXO risk mitigative works e.g. magnetometer survey is adversely affected in mineralised and made ground.

The Client has described the ground conditions as follows: *'Hackney Gravel Member over London Clay. Site is currently a basement car park.'*

STAGE ONE – SITE LOCATION AND DESCRIPTION (…continued)

Ground Conditions

BGS borehole log "TQ28SE356 – G.P.O. BH8 St. Marylebone" (located 50m to the northwest), recorded the following strata

Depth bgl (m)	Strata	Description
0m to 3.05m	Fill	Hardcore and rubble, stiff mottled brown clay
3.05m to 3.35m	Clay	Soft-firm mottled brown clay
3.95m to 6.85m	Clay	Stiff fissured mottled brown clay, containing gypsum crystals
6.85m to 7.15m	Clay	Stiff mottled brown-blue clay
7.15m to 45m	Clay	Very stiff fissured blue silty clay containing occasional gypsum crystals and claystone boulders.

STAGE TWO – REVIEW OF HISTORICAL DATASETS

Sources of Information Consulted

The following primary information sources have been used in order to establish the background UXO threat:

1. *6 Alpha*'s *Azimuth* Database;
2. *Home Office* WWII Bomb Census Maps;
3. WWII and post-WWII aerial photography;
4. Official Abandoned Bomb Register;
5. *LCC* Bomb Damage maps;
6. Information gathered from the *National Archives* at *Kew*;
7. Historic UXO information provided by *33 Engineer Regiment* (Explosive Ordnance Disposal) at *Carver Barracks, Wimbish*.

Potential Sources of UXO Contamination

In general, there are several activities that might contaminate a site with UXO but the three most common ways are: legacy munitions from military training/exercises; deliberate or accidental dumping (AXO) and ordnance resulting from war fighting activities (also known as the Explosive Remnants of War (ERW)).

During WWII, the *Luftwaffe* undertook bombing campaigns all over the *UK*. The most common type of UXO discovered today is the aerially delivered high explosive (HE) bomb, which are comparatively thick-skinned and dropped from enemy aircraft. If the bomb did not detonate when it was dropped, the force of impact enabled the UXO to penetrate the ground, often leaving behind it a UXB entry hole. These entry holes were not always apparent and some went unreported, leaving the bomb buried and unrecorded. More rarely, additional forms of *German* UXO are occasionally discovered including *inter alia V1* and *V2* rockets, Incendiary Bombs (IBs), and Anti-personnel (AP) bomblets.

Although the *Luftwaffe* had designated primary bombing targets across the *UK*, their high-altitude night bombing was not accurate. As a result, thousands of buildings were damaged and civilian fatalities were common. Bombs were also jettisoned over opportunistic targets and residential areas were sometimes struck.

As the threat of invasion lingered over *Britain* during WWII, defensive actions were undertaken. The *British* and *Allied Forces* requisitioned large areas of land for military training and bomb storage (including HE bombs, naval shells, artillery and tank projectiles, explosives, LSA and SAA). Thousands of tonnes of these munitions were used for the *Allied Forces* weapon testing and military training alone. It has been estimated that at least 20 per cent of the *UK*'s land has been used for military training at some point.

The best practice guide for dealing with your UXO risks on land (CIRIA publication C681) suggests that approximately 10 per cent of all munitions deployed failed to function as designed. ERW are therefore, still commonly encountered, especially whist undertaking construction and civil engineering groundwork.

Furthermore, in exceptional circumstances, UXO is discovered unexpectedly and without apparent rational explanation. There are several ways this might occur:

- When *Luftwaffe* aircraft wished to swiftly escape e.g. from an aerial attack, they would jettison some or all of their bombs and flee. This is commonly referred to as *tip and run* and it has resulted in bombs being found in unexpected locations;
- Transportation of aggregate containing munitions to an area that was previously free of UXO, usually related to construction activities employing material dredged from a contaminated offshore borrow site;
- Poor precision during targeting (due to high altitude night bombing and/or poor visibility) resulted in bombs landing off target, but within the surrounding area.
- *British* decoy sites were also constructed to deliberately cause incorrect targeting. For obvious reasons, such sites were often built in remote and uninhabited areas.

STAGE TWO – REVIEW OF HISTORICAL DATASETS (…continued)

Site History

From an analysis of the CS and OS historical mapping associated with the Site, the following Site history can be deduced:

Year	On-Site	Vicinity
1896 CS Map	The Study Site consisted of residential housing and gardens.	The Site was situated in a densely developed urban area, predominantly consisting of residential housing.
1915 CS Map	A large structure was constructed in the centre of the Site.	The large on-site structure extended to the south-east of the Site.
1936 CS Map	Residential housing was demolished in the south-eastern sector of the Site and superseded but a larger structure.	Residential housing was demolished to the north-east of the Site and superseded but a larger structure.
1954 OS Map	The large central structure was labelled as a Milk Depot and *Kingsbury House* was labelled in the south-east of the Site. *Ward's Flats* were labelled on the north-western boundary.	Several '*ruins*' and missing buildings were identified in the vicinity.
1962 OS Map	A surgery was labelled in the northern sector of the Site and the Milk Depot was re-labelled as a Garage.	Buildings to the west of the Site were redeveloped.
1973 OS Map	All buildings within the Site were demolished and replaced with concrete hardstanding.	*Parsons House* was labelled immediate to the south of the Site.
1985 OS Map	Changes were not recorded at the Study Site.	Changes were not recorded in the vicinity.
1991 OS Map	Changes were not recorded at the Study Site.	Changes were not recorded in the vicinity.
1999 OS Map	Changes were not recorded at the Study Site.	Changes were not recorded in the vicinity.
2017 OS Map	Changes were not recorded at the Study Site.	Changes were not recorded in the vicinity.

WWII Site Use

The CS mapping prior to WWII (1938), shows that the Study Site was located within a heavily developed urban area and consisted of residential housing and a milk depot.

Aerial Photography (1945) (*Figure 4*)

The aerial photography (1945) associated with the Site shows that it consisted of several small structures within a heavily developed area. That said, the resolution of the photograph is not sufficient enough to be able to accurately identify the features and/or structures within the Site at that time.

WWII Bombing of *London*

The most intensive period of bombing over *London* was the nine months between October 1940 and May 1941, known as 'The Blitz'. During this period, the *Luftwaffe* attempted to overwhelm *Britain's* air defences, destroy key military and industrial facilities, as well as logistical capabilities, prior to invasion.

A total of 18,000 tons of bombs were dropped on *London* between 1940 and 1945. Many residential, commercial and industrial buildings were targeted during air raids and sustained large scale damage. Public services were also affected, with gas, electricity and water supplies often cut-off following damage to either the installations themselves or to the supply infrastructure. In addition, thousands of civilians were killed and injured, and many were forced to evacuate as their homes were destroyed.

STAGE TWO – REVIEW OF HISTORICAL DATASETS (…continued)

WWII Luftwaffe Bombing Targets (*Figure 5)*

Prior to WWII, the *Luftwaffe* conducted numerous aerial photographic reconnaissance missions over *Britain*, recording key military, industrial and commercial facilities for attack, in the event of war. In addition, logistics infrastructure and public services, such as railways, canals, power stations, reservoirs, water and gas works were also considered viable bombing targets.

Luftwaffe aerial reconnaissance photography associated with the Site did not identify any primary bombing targets on-site or within 1,000m of it. Nonetheless, an electricity supply station, coal sidings, works, a goods station, a warehouse and various wharves located in the vicinity may have been considered secondary bombing targets.

WWII HE Bomb Strikes (*Figure 6*)

During WWII, ARP wardens compiled detailed logs of bomb strikes across their respective districts. ARP records associated with the Site did not register any HE bomb strikes within it, nonetheless seven were recorded within 100m; approximately 30m to the south-east, 50m to the south, 55m to the east-south-east, 75m to the north-north-east, 85m to the south-south-east, 85m to the north-east and 95m to the south-east. Furthermore, whilst IBs may have fallen within the Study Site, they fell in such large numbers they were considered ubiquitous and accurate record keeping was either non-existent or perfunctory therefore, from an examination of the records, their prospective presence cannot be either corroborated or discounted.

In addition to IBs and HE bomb strikes, during the latter part of the war when aerial bombing had significantly declined, the main threat came from '*V*' type weapons. These rockets were thin-skinned, unmanned and inaccurate weapons. ARP records identify a *V1* rocket 360m to the north-east of the Site.

WWII Bomb Damage (*Figure 7*)

An analysis of the LCC bomb damage maps associated with the Site identifies "blast damage, minor in nature" and "general blast damage – not structural" to buildings located within the Site. In addition, "damage beyond repair" and "total destruction" were recorded to buildings located immediately to the south of the Site.

Furthermore, an analysis of the post-WWII mapping associated with the area shows numerous "ruins" within the Site's vicinity, which is likely to be attributed to bombing.

WWII HE Bomb Density (*Figure 8*)

The Study Site was located within the *Paddington Metropolitan Borough* and *St. Marylebone Metropolitan Borough,* which recorded 54 and 67 HE bombs per 100 hectares respectively, both very high levels of bombing

Abandoned Bombs

An examination of the official abandoned bomb records did not identify any abandoned bombs within 1,000m of the Study Site.

Records of WWII UXB Disposal Tasks

An examination of the civil defence records listing UXBs dealt within in the *Paddington Metropolitan Borough* from 1940-45 has identified the following tasks within the Site's vicinity:

- One UXB was burnt in-situ from *14 Maida Vale* (located approximately 125m to the north-west) on the 21st February 1944;
- One UXB was removed from *26 Warwick Avenue* (located approximately 420m to the west) on the 21st February 1944;
- One UXB was removed from *12 Orsett Mews* (situated 820m to the south-west) on the 17th March 1944;
- One UXB was removed from *212 Gloucester Terrace* (located approximately 845m to the south-west) on the 23rd February 1944.

STAGE TWO – REVIEW OF HISTORICAL DATASETS (…continued)

Records of Post-WWII UXB Disposal Tasks

An examination of the post-WWII BDO tasks associated with the area has not identified any BDO operations within the Site itself, however the following tasks were undertaken in the area:

- The collection of one IB from *Paddington Green Police Station* (located 450m to the south-east) on the 27th January 1956;
- The collection of one IB from *Paddington Green Police Station* (located 450m to the south-east) on the 22nd January 1957.

STAGE THREE – DATA ANALYSIS

Was the ground undeveloped during WWII?

No; according to the CS mapping prior to WWII (1938), the Study Site consisted of residential housing and a milk depot and was situated in a heavily developed urban area.

Is there a reason to suspect that the immediate area was a bombing target during WWII?

No; *Luftwaffe* aerial reconnaissance photography associated with the Site did not identify any primary bombing targets on-site or within 1,000m. Nonetheless, an electricity supply station, coal sidings, works, a goods station, a warehouse and various wharves located in the vicinity may have been considered secondary bombing targets. As WWII progressed, major towns and cities became targets within their own right as the *Luftwaffe* switched from specifically targeting industrial and military facilities to a more general method of '*carpet bombing*', and as a result, suburban and residential areas were frequently bombed.

Is there firm evidence that ordnance landed on-site?

No; ARP records associated with the Site did not register any HE bomb strikes within it, nonetheless seven were recorded within 100m; approximately 30m to the south-east, 50m to the south, 55m to the east-south-east, 75m to the north-north-east, 85m to the south-south-east, 85m to the north-east and 95m to the south-east. In addition, a UXB disposal task was recorded 125m to the north-west of the Site.

Furthermore, whilst IBs may have fallen within the Study Site, they fell in such large numbers they were considered ubiquitous and accurate record keeping was either non-existent or perfunctory therefore, from an examination of the records, their prospective presence cannot be either corroborated or discounted.

Is there firm evidence of bomb damage on-site?

Yes; an analysis of the LCC maps associated with the Site shows "blast damage, minor in nature" and "general blast damage – not structural" to buildings within the Site. In addition, "damage beyond repair" and "total destruction" were recorded to buildings located immediately to the south of the Site.

Furthermore, an analysis of the post-WWII mapping associated with the area shows numerous "*ruins*" and missing buildings within the Site's vicinity, which is likely to be attributed to bombing.

Would a UXB entry hole have been observed and reported during WWII?

Possibly; the Site did comprise residential housing and a milk depot during WWII and therefore, it is plausible that a local resident would have observed and reported any UXB entry hole following any raids. However, given the development of the Site and with the bomb damage recorded, it is possible that UXB entry holes may have been masked by debris resulting from subsequent bomb strikes, and therefore may have gone unnoticed.

Is there any reason to suspect that live firing or military training may have occurred at this location?

No; there is no supporting evidence to suggest that military training, guns or associated artillery (or other types of) munitions were ever stored, manufactured, located and/or fired from this Site during WWII nor subsequently.

What is the expected level of UXO contamination?

The most likely source of UXO contamination is from *German* aerially delivered ordnance, which ranges from small IBs through to large HE bombs (the latter forms the principal threat). Additional residual contamination may be present from *British* AAA projectiles (which were used to defend the UK against *German* bombing raids).

STAGE THREE – DATA ANALYSIS (…continued)

Would previous earthwork have removed the potential for UXO to be present?

Probably; from an analysis of post-WWII mapping associated with the Site, the following phases of Site activity were evident:

1954 OS Map - The large central structure was labelled as a Milk Depot and *Kingsbury House* was labelled in the south-east of the Site. *Ward's Flats* were labelled on the north-western boundary.

1962 OS Map - A surgery was labelled in the northern sector of the Site and the Milk Depot was re-labelled as a Garage.

1973 OS Map - All buildings within the Site were demolished and replaced with concrete hardstanding.

On this evidence, it is apparent that the Site has not been subjected to any significant post-war redevelopment until the early 1970s when the Site was cleared and a basement car park was constructed. As a result, it is highly likely that any UXO within the structural footprint of the basement car park would have been discovered and removed; however, the potential for deep buried UXO to be present below these foundations is assessed to remain remotely extant.

Does the probability of a UXO discovery vary across the Site?

Yes; the probability of discovering UXO has been largely mitigated within the footprints of the existing foundations. However, it is considered remotely possible that UXO may be present below the existing foundations and within previously undisturbed ground (see stage 4).

STAGE FOUR – RISK ASSESSMENT

Threat Items

The most probable UXO threat items are *German* HE bombs, whilst IBs and *British* AAA projectiles pose a residual threat. The consequences of initiating *German* HE bombs are more severe than initiating IBs or AAA projectiles, and thus they pose the greatest prospective risk to intrusive works.

Maximum Bomb Penetration Depth

Considering the ground conditions (highlighted in Stage 1), the average BPD for a 250kg *German* HE bomb within clays is assessed to be approximately 7m bgl, with the maximum BPD considered to be approximately 16m bgl. Although it is possible that the *Luftwaffe* deployed larger bombs in the area, their deployment was infrequent, and to use such larger (or the largest) bombs for BPD calculations are not justifiable on either technical or risk management grounds.

WWII *German* bombs have a greater penetration depth when compared to IBs and AAA projectiles, which are unlikely to be encountered at depths greater than 1m bgl.

Given the development of the Site during WWII, the BPDs may vary from those stated above as structures may have reduced the penetration into the ground.

Risk Pathway

Given the types of UXO that might be present on Site, all types of aggressive intrusive engineering activities (i.e. excavations and piling) may generate a significant risk pathway. Whilst not all UXO encountered aggressively will initiate upon contact, such a discovery could lead to serious impact on the project especially in terms of critical injury to personnel, damage to equipment and project delay.

Prospective Consequences

Consequences of UXO initiation include:

1. Fatally injure personnel;
2. Severe damage to plant and equipment;
3. Deliver blast and fragmentation damage to nearby buildings;
4. Rupture and damage underground utilities/services.

Consequences of UXO discovery include:

1. Delay to the project and blight;
2. Disruption to local community/infrastructure;
3. The expenditure of additional risk mitigation resources and EOD clearance;
4. Incurring additional time and cost.

UXO RISK CALCULATION

Site Activities

Although there is some variation in the probability of encountering and initiating items of UXO when conducting different types of intrusive activities, a number of construction methodologies have been described for analysis at this Site. The consequences of initiating UXO vary greatly, depending upon, *inter alia* the mass of HE in the UXO and how aggressively it might be encountered. For this reason, *6 Alpha* has conducted separate risk rating calculations for each construction methodology that might be employed.

Risk Rating Calculation

6 Alpha's Semi-Quantitative Risk Assessment assesses and rates the risks posed by the most probable threat items when conducting a number of different activities on the Site. Risk Rating is determined by calculating the probability of encountering UXO and the consequences of initiating it.

STAGE FOUR - RISK ASSESSMENT (…continued)

UXO RISK CALCULATION TABLE – ALL AREAS

Activity	Threat Item	Probability (SHxEM=P)	Consequence (DxPSR=C)	Risk Rating (PxC=RR)
Excavations (Within Existing Foundations)	HE Bombs	1x3=3	3x2=6	3x6=18
	AAA Projectiles	1x3=3	3x1=3	3x3=9
	IBs	1x3=3	3x1=3	3x3=9
Piling (Within Existing Foundations)	HE Bombs	1x2=2	3x3=9	2x9=18
	AAA Projectiles	1x2=2	3x1=3	3x3=9
	IBs	1x2=2	3x1=3	3x3=9

Abbreviations – Site History (SH), Engineering Methodology (EM), Probability (P), Depth (D), Consequence (C), Proximity to Sensitive Receptors (PSR) and Risk Rating (RR).

STAGE FIVE – RECOMMENDED RISK MITIGATION MEASURES

If a geophysical survey is required are the ground conditions an issue?

Non-Intrusive Methods of Mitigation – Magnetometer results will be affected by the concrete basement car park, in which case the Site would need to be excavated and cleared for non-intrusive methods of mitigation to be effective on this Site.

Intrusive Methods of Mitigation – The Site would also need to be cleared in order for intrusive magnetometry to be effective on this Site, as the concrete basement would create a 'hardstop' for CPT technology. Beyond the basement such a survey should prove effective prior to piling especially.

MITIGATION MEASURES TO REDUCE RISK TO 'ALARP'

Activity/Area	Risk Mitigation Measures	Final Risk Rating
All Activities in All Areas	**1. Operational UXO Emergency Response Plan;** appropriate Site Management documentation should be held on Site to guide and plan for the actions which should be undertaken in the event of a suspected or confirmed UXO discovery (this plan can be supplied by *6 Alpha*); **2. UXO Safety & Awareness Briefings;** the briefings are essential when there is a possibility of an UXO / UXB encounter and are a vital part of the general safety requirement. All personnel working on the Site should receive a briefing on the identification of an UXO / UXB, what actions they should take to keep people and equipment away from such a hazard and to alert Site management. Information concerning the nature of the UXO / UXB threat should be held in the Site office and displayed for general information on notice boards, both for reference and as a reminder for ground workers. The Safety & Awareness briefing is an essential part of the *Health & Safety Plan* for the Site and helps to evidence conformity with the principles laid down in the *CDM* regulations 2015 (this briefing can be delivered directly, or in some cases remotely, by *6 Alpha*).	**ALARP**

This assessment has been conducted based on the information provided by the Client, should the proposed works change then *6 Alpha* should be re-engaged to refine this risk assessment

Report Figures

www.envirocheck.co.uk - +44 (0) 844 844 9952
customerservice@envirocheck.co.uk

Figure One

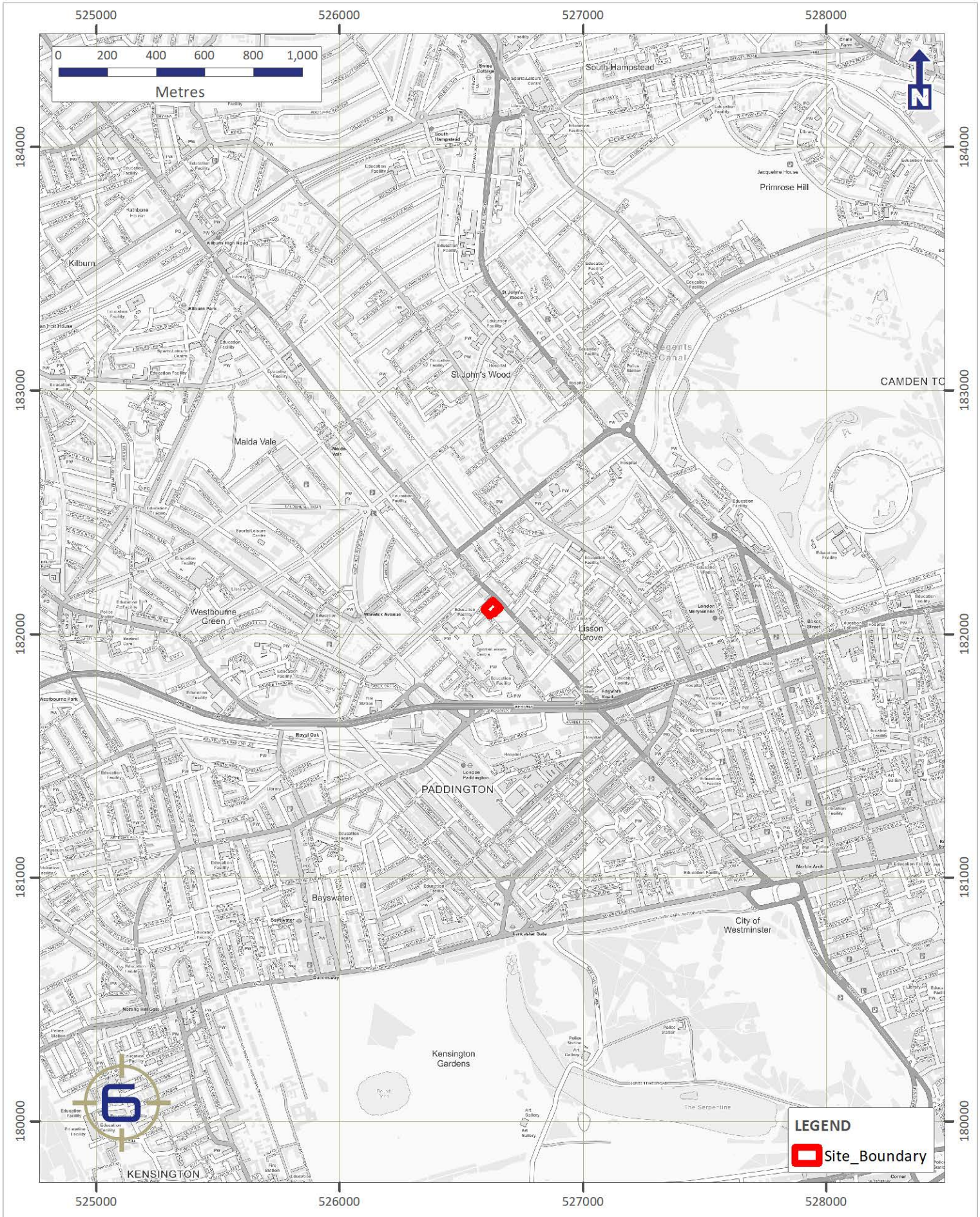
Site Location

PARSONS NORTH, EDGWARE ROAD, LONDON, W2 1NE

Site Location

BRITISH NATIONAL GRID

BOMB SEARCH
WWW.6ALPHA.COM



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SAMPLE	1	RG	CC	18 January 2018	Contains Ordnance Survey data © Crown copyright and database right 2017	Produced by and Copyright to 6 Alpha Associates Ltd. Users noting any errors please notify 6 Alpha.	alpha ASSOCIATES

Figure Two

Site Boundary

PARSONS NORTH, EDGWARE ROAD, LONDON, W2 1NE

Site Boundary

BRITISH NATIONAL GRID

BOMB SEARCH
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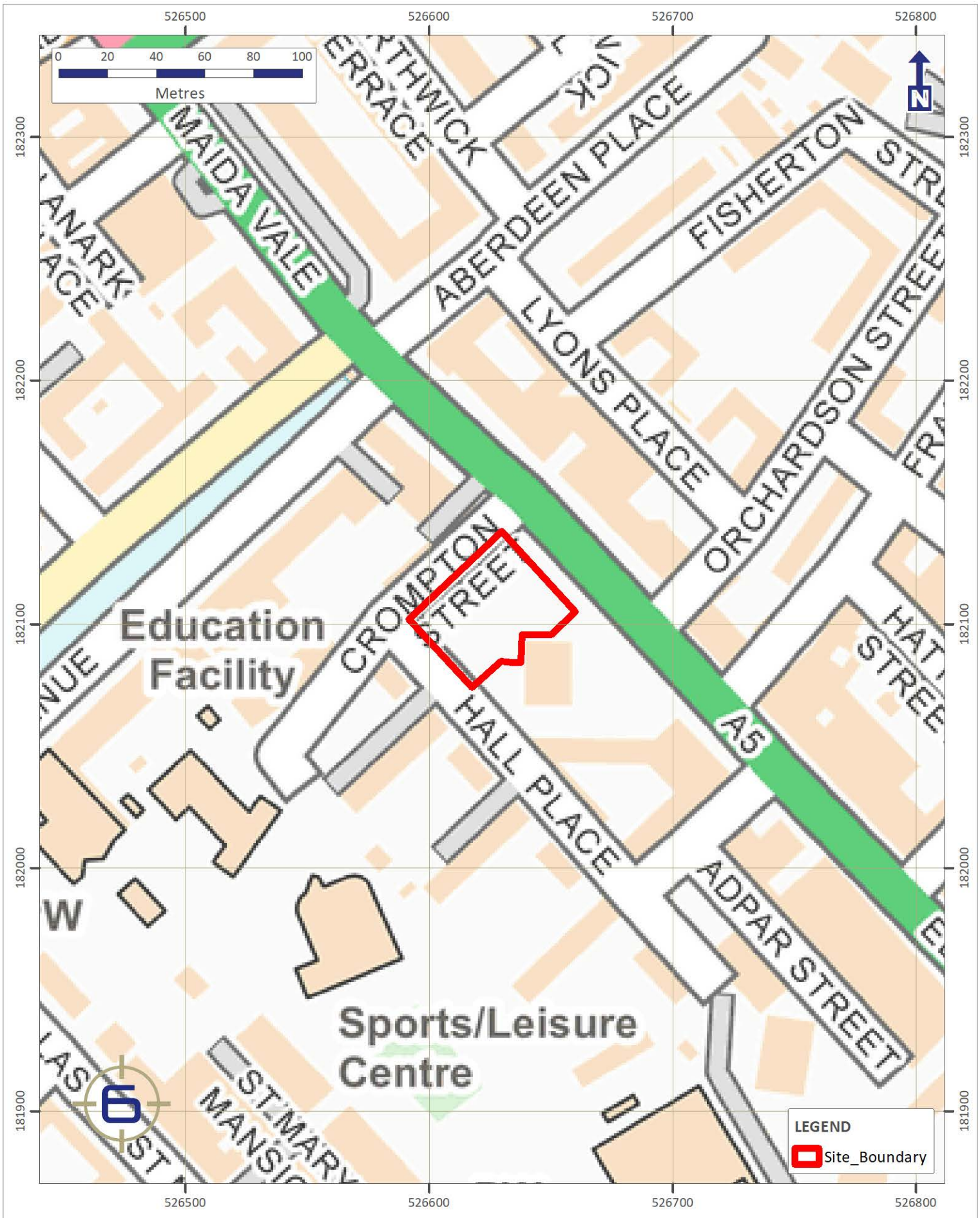

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Figure Three

Aerial Photography (Current)

PARSONS NORTH, EDGWARE ROAD, LONDON, W2 1NE

Aerial Photography (Current)

BRITISH NATIONAL GRID

BOMB SEARCH
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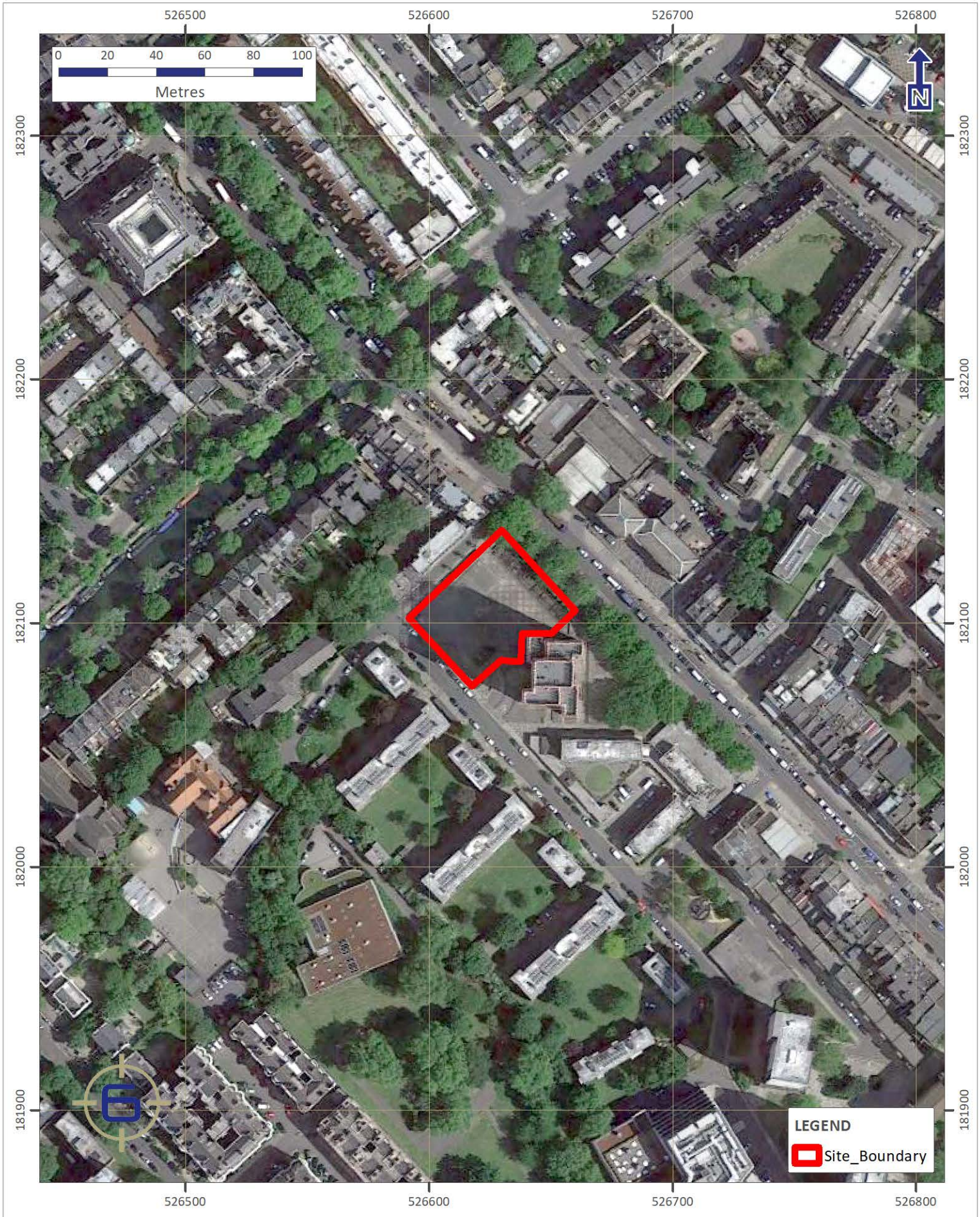

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SAMPLE	3	RG	CC	18 January 2018	Map data: Google	Produced by and Copyright to 6 Alpha Associates Ltd. Users noting any errors please notify 6 Alpha.

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Figure Four

Aerial Photography (1945)

PARSONS NORTH, EDGWARE ROAD, LONDON, W2 1NE

Aerial Photography (1945)

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SAMPLE	4	RG	CC	18 January 2018	Map data: Google, The GeoInformation Group	Produced by and Copyright to 6 Alpha Associates Ltd. Users noting any errors please notify 6 Alpha.

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Figure Five

WWII Luftwaffe Bombing Targets

PARSONS NORTH, EDGWARE ROAD, LONDON, W2 1NE

WWII Luftwaffe Bombing Targets

BRITISH NATIONAL GRID

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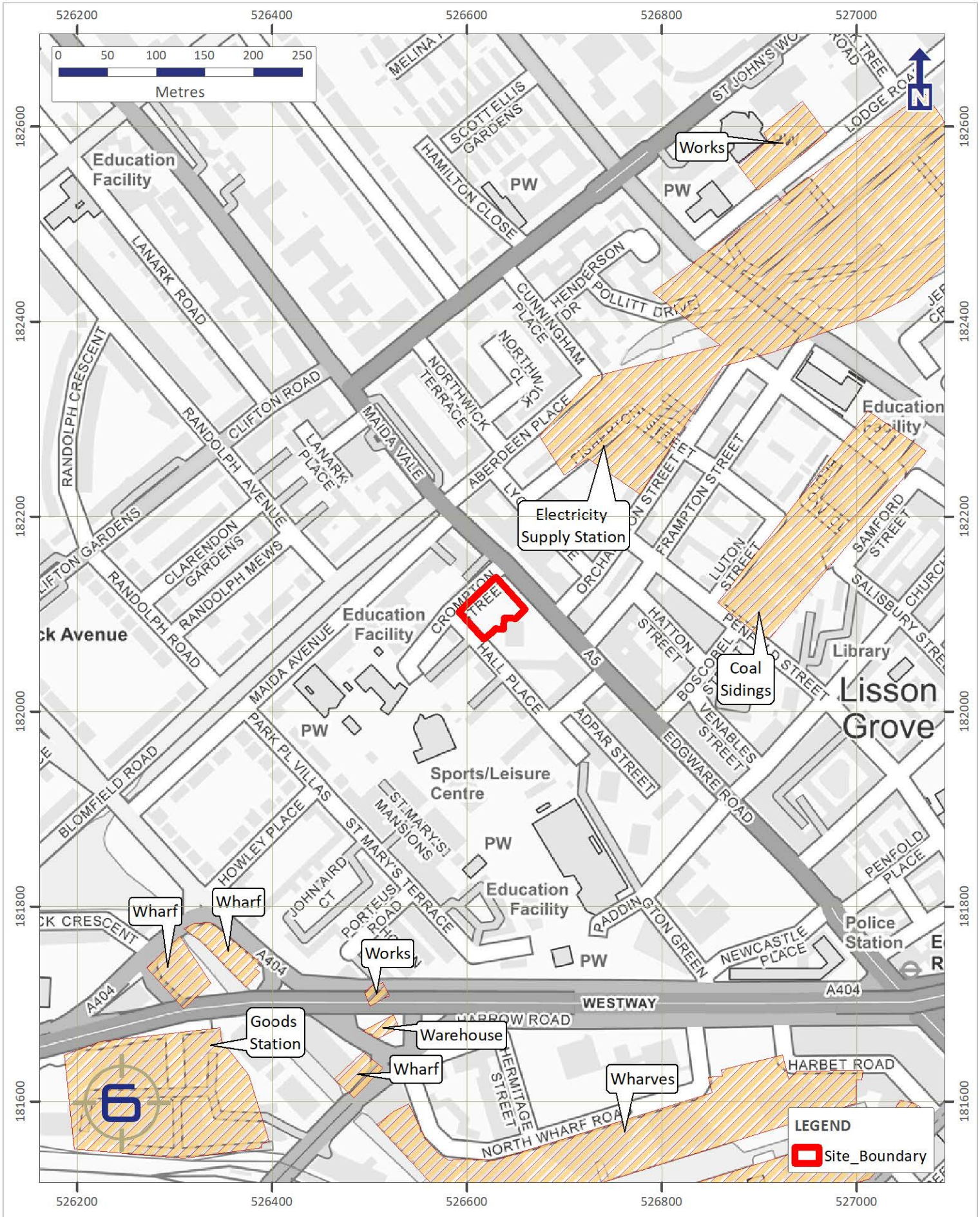

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Figure Six

WWII High Explosive Bomb Strikes

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WWII High Explosive Bomb Strikes

BRITISH NATIONAL GRID

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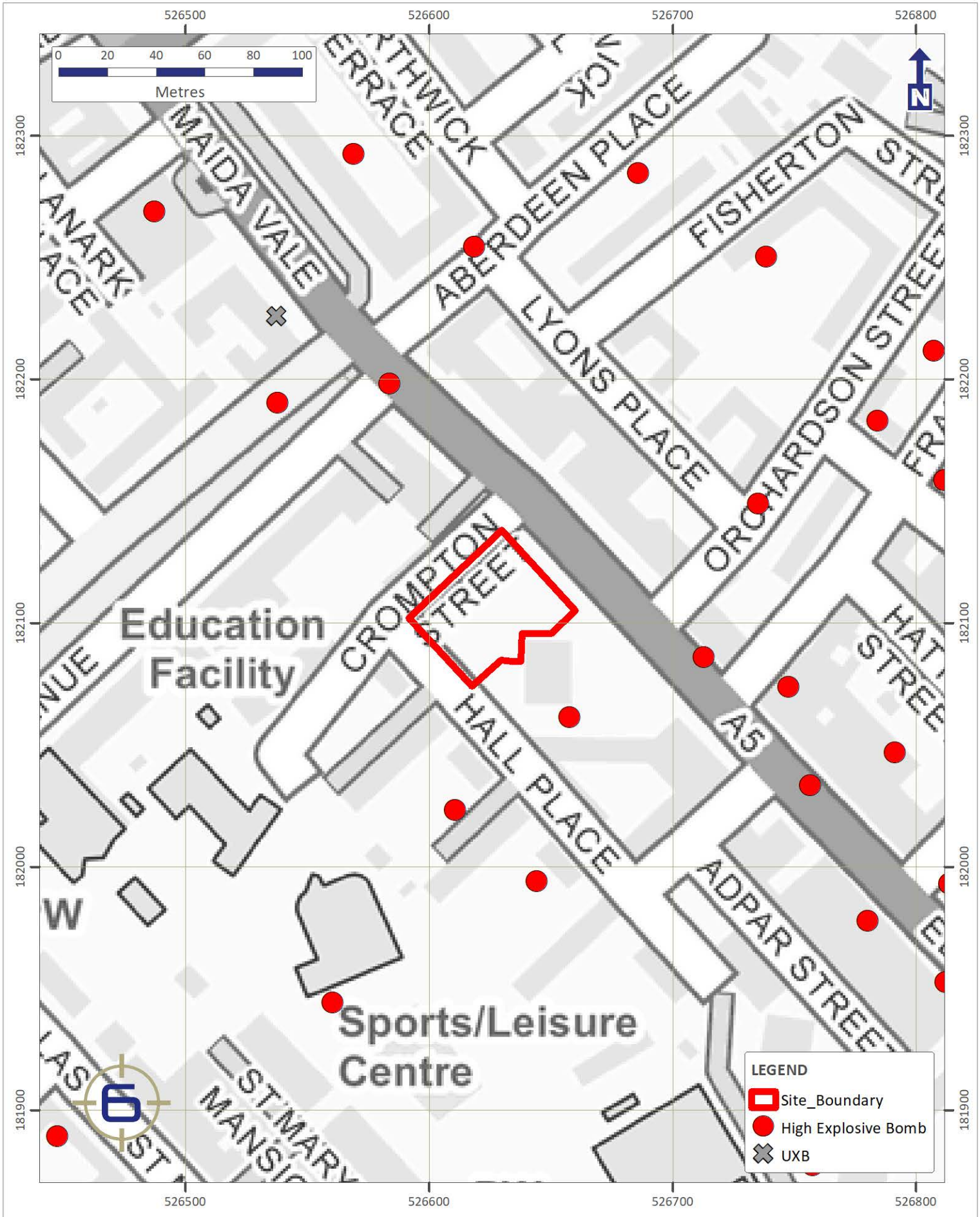

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Figure Seven

London County Council WWII Bomb Damage Map

PARSONS NORTH, EDGWARE ROAD, LONDON, W2 1NE

London County Council WWII Bomb Damage Map

BRITISH NATIONAL GRID

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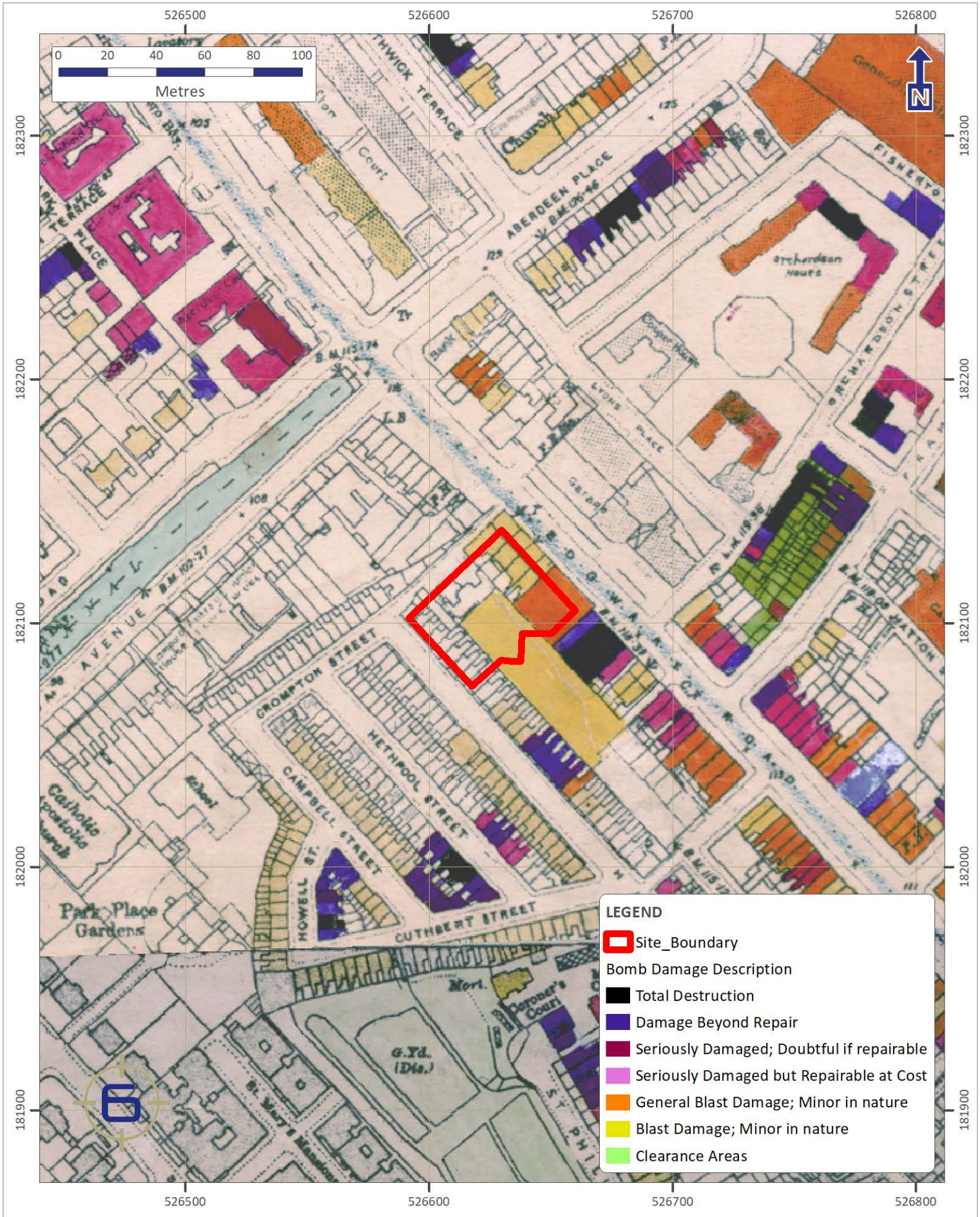

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Figure Eight

WWII High Explosive Bomb Density

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WWII High Explosive Bomb Density

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