

Mayfield Regeneration

Geoenvironmental and Geotechnical Desk Study Report

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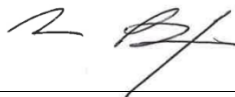
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Executive Summary

Background	BuroHappold Engineering was commissioned to carry out a geoenvironmental and geotechnical desk study of a Site known as Mayfield Regeneration (the Site). This desk based study provides information on potential ground related risks associated with redevelopment the extent of which is yet to be determined. A previous ground investigation was undertaken in 2009, which included the Mayfield Regeneration area.
Site Setting	The Site is located in Manchester City Centre to the immediate south/southeast of Piccadilly Railway Station. The River Medlock meanders through the central area of the Site (flowing towards the west) and is culverted beneath Hoyle Street. The Site is currently occupied by existing and historical urban development comprising the former Mayfield Railway Station, numerous works / factories, a scrap yard, a depot, Hoyle Street Industrial Estate, derelict land and car parking. The immediate surrounding area comprises urban development including residential (student accommodation/private rental), offices, commercial and industrial facilities. The Site currently has as a range of industrial uses including network rail access, depots, scrap yards, tanks, vehicle repair and waste sites. The proposed future development is likely to include areas of park land and open space in addition to commercial development use.
History	The Site has a long predominantly industrial history with a range of potentially contaminative uses. This includes Mayfield Works, Chapelfield Works, Mayfield Station & associated infrastructure, Printing Works, Ice Works, Baths, Cotton Mills, Hanover Mills, Fairfield Street Garage, Ardwick Tannery, Scrap Yard, Timber Yards, Britannia Brewery, Iron Works, Tanks, a Mortuary, various depots and smaller commercial/industrial facilities.
Geological Setting	The Site is underlain by Made Ground, Quaternary Glacial Till (likely absent in some locations and in the western portion where no boulder clay is recorded) and Sherwood Sandstone. Recent Alluvial deposits are recorded adjacent to the River Medlock. The solid geology is Sherwood Sandstone underlain by Manchester Marls. The Sherwood Sandstone is a Principal Aquifer, capable of supporting water supply and/ or river base flow on a strategic scale. There is one groundwater abstraction over 700m distant from the Site and the Site is not within a groundwater source protection zone. Groundwater underlying the Site is considered likely to be in hydraulic continuity with the River Medlock. Localised groundwater may be encountered in the Made Ground deposits perched on underlying low permeability Glacial Till.
UXO	An Explosive Ordnance Threat Assessment has been undertaken by PLANIT UXB Limited which states that a "Medium" Ordnance Threat Level applies across the Site, and that "a UXO threat management strategy is required to be in place prior to intrusive engineering works".
Geoenvironmental Considerations	Identified potential risks above Low are summarised below: There is a Moderate risk to future Site users and future buildings due to release of ground gases from Made Ground underlying the Site; There is a Moderate/Low risk to Site workers due to the potential for inhalation of ground gas. This risk is likely to be mitigated by standard working practice assuming that no deep poorly ventilated excavations are required. There is a Moderate / Low risk to construction workers, future site users and controlled waters from historic and current site uses which are likely to have contaminated Site Made Ground. This site has a long industrial history which has continued until present day. It appears likely that significant thicknesses of Made Ground are present on site as some areas appear to have been filled and there has been significant redevelopment over the years. This industrial legacy is likely to have contaminated shallow soils to some extent and a ground investigation is required to define the extent of contamination and determine the need for remedial measures as part of development work.
Geotechnical Considerations	The development proposals are currently not finalised but are expected to comprise mixed use development with high rise buildings, associated hard and soft landscaping, car parking, and landscaping/management of the River Medlock. A range of foundation options are possible for the development based on a desk based study of available information, however there is currently insufficient information to create a detailed ground model. A ground investigation will be required to produce a detailed ground model to allow geotechnical design.

Recommendations

A combined geotechnical and geoenvironmental ground investigation is required to better understand the potential contamination risks identified and to produce a detailed ground model to allow geotechnical design.

Sharps and Needles were identified on Site during the Site walkover. It is recommended that a sharps and needle disposal specialist is consulted with regards to identifying the extent of and appropriate measures for Site management and/or removal of these items prior to the start of any construction works. It is also recommended that the site is secured prior to any such removal to prevent further sharps beings dumped on site.

Large quantities of Japanese Knotweed were identified on the banks of the River Medlock within the channel during the Site walkover. There was no visual evidence that knotweed had migrated out of the channel onto surrounding areas of the Site, however it is quite possible this has occurred. It is understood that a full survey of the river will be undertaken in the near future, which will fully characterise the extent of knotweed present. It is recommended that a Japanese Knotweed specialist is consulted with regards to identifying the extent of the infestation and recommending appropriate measures for Site management and/or removal of Japanese Knotweed impacted material.

1 Introduction

1.1 General

This report is the Desktop Geoenvironmental and Geotechnical Study for the Mayfield Regeneration Site (the Site) and was prepared by BuroHappold following instruction from U+I. The purpose of this study is to establish the environmental, geological, hydrological and hydrogeological conditions present at the Mayfield Site that may result in potential contamination or geotechnical risks for development and future Site users.

The Site occupies some 10.25 hectares and lies in Manchester City Centre to the immediate south/southeast of Piccadilly Railway Station. The River Medlock meanders through the central area of the Site (flowing towards the west) and is culverted beneath Hoyle Street. The Site is currently occupied by existing and historical urban development comprising the former Mayfield Railway Station and associated railway lines, numerous works/ factories, derelict land and car parking.

1.2 Study Aims and Objectives

The overall aim of this study was to carry out a geoenvironmental and geotechnical assessment of the Site in order to inform the Client's understanding of potential ground-related risks associated with the proposed redevelopment and regeneration. This study will also form the basis for planning and targeting further ground investigations.

This report will also provide information relevant to restoration/ redevelopment in accordance with the requirements of the National Planning Policy Framework (NPPF 2012). The work was carried out in general accordance with Model Procedures (Environment Agency, 2004), the relevant British Standard (British Standards Institute, 2011), the Environment Agency Guiding Principles (Environment Agency, 2010), Groundwater Protection Policy (Environment Agency, 2013) and other current good practice guidance. The particular objectives were:

- To determine the historical and current use of the Site and its surroundings;
- To determine the nature of the ground conditions and the environmental sensitivity of the Site;
- To assess the potential location, nature and extent of any ground and groundwater contamination;
- To assess the potential risks to people and the environment (natural and built) associated with ground contamination (solid, liquid or gas) for the Site future use;
- To prepare a report based upon all of the above to support a possible future planning application in accordance with NPPF (Department for Communities and Local Government, 2012); and
- To evaluate the potential need for and scope of any subsequent Site investigations and/or remedial action or design.

1.3 Information Sources

The principal sources of information for this desk study report include: historical and current topographic maps and public register information from the Groundsure report (Appendix B) previous Site investigation reports (discussed in Section 5); a Site walkover survey; information provided by the local authority, available from the Environment Agency website and other online sources.

This report is based upon information obtained from third party sources, together with observations from the Site walkover survey. The third party data has been accepted as face value and has not been independently verified. BuroHappold can therefore give no warranty, representation or assurance as to the accuracy or completeness of such information.

1.4 Competence

The work reported here was carried out by a qualified geoenvironmental scientists and geotechnical engineers with relevant degree qualifications, training and experience. The work has been overseen by an Associate Director with experience in the assessment of land affected by contamination who is a Chartered Geologist and a registered SiLC (Specialist in Land Contamination).

2 Current land use and proposed development

2.1 Site Location, Topography and Current Use

The Site is located in Manchester City Centre to the immediate south/southeast of Piccadilly Railway Station, centred at NGR 385006 397717. The River Medlock meanders through the central area of the Site (flowing towards the west) and is culverted beneath Hoyle Street. The Site is currently occupied by existing and historical urban development comprising the former Mayfield Railway Station and associated railway lines, numerous works / factories, a scrap yard, a depot, Hoyle Street Industrial Estate, derelict land and car parking. The immediate surrounding area comprises urban development including residential (student accommodation/private rental), offices, commercial and industrial facilities.

Overall, the northern half of the Site generally slopes from a maximum spot height of 40.80 m AOD on Fairfield Street towards the River Medlock in the central area of the Site (below 37.80 m AOD recorded at WS5 GIP GI), with the exception of the former Mayfield Station which is recorded at approximately 49.00 m AOD (WS3/WS4 GIP GI). There are no recorded spot heights in the southern half of the Site, however it generally slopes northwards to the River Medlock. There is thus currently a ~12 m difference in height across the Site (Mayfield Station to the River Medlock) separated by slopes with localised or potentially buried retaining structures. A topographical survey is required to fully confirm all Site levels.

2.2 Site Walkover Survey

2.2.1 General

The Site walkover survey was carried out on 4th July 2017, in mild and overcast weather conditions and was generally limited to external areas, though all external areas were accessible. Philippa Hunsworth and George Mitchell from Buro Happold attended, and were escorted around Site by Jonathan Such (JS) of U+I. An annotated plan showing points of interest identified during the survey is included as Appendix E. To describe its variable nature, the Site has been divided into three zones: northern, southern, and the river zone, for ease of reference (Figure 2-1 refers).

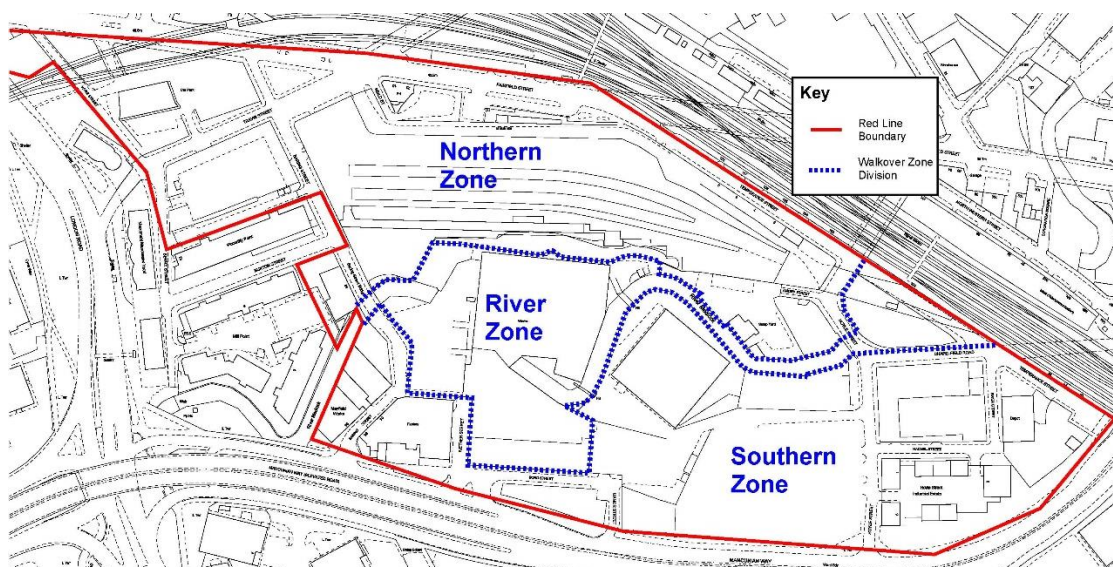
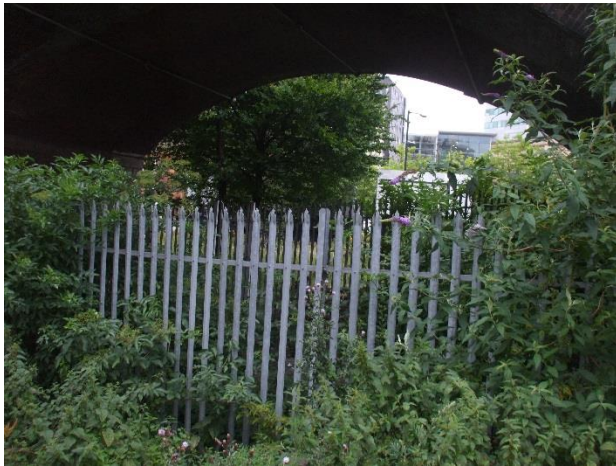


Figure 2-1 Division of the Site into zones.

2.2.2 Northern Zone

- Area west of Wyre Street / north of arches: Overgrown with long grass and birch trees, Heras fenced off
- Under arches: Full of rubble / overgrown (Photograph 1)
- Between Wyre Street, Travis Street and Baring Street: Car park with tarmac surface. Brown metal building in western area – substation. A GIP 2009 borehole was undertaken in this car park, but unable to locate well cover. (Photograph 2)
- South of Travis Street, west of Baring Street: Tarmac car park for adjacent Macdonald Manchester Hotel. Surrounded by a planter with numerous mature trees. 2 No. substations present in SE corner. ~1 m drop down to Baring Street (east) and ~1.50 m drop down to access road to the south, separated by a chain link fence.
- Triangular parcel of land to north of Travis Street and east of Baring Street. Grassed area. Historical maps indicate that a garage was historically present, and obstructions (thought to be the garage slab) were encountered during the GIP 2009 GI. Well cover present from GIP 2009 GI. (Photograph 3)
- Area to the north of former Mayfield Station building:
 - Western side: Star and Garter pub, still in use – listed building. Tarmac car park to the east (access via Neild Street). GIP 2009 borehole cover present in car park. (Photograph 4)
 - Row of 1 storey units present against the Mayfield Station building. Uses include a garage, storage, substation. (Photograph 5)
- Temperance Street: Series of arches on both sides of the road, however only the southern set are onSite.
 - Arch 6: U+I security offices
 - Arch 7: Art exhibition company
 - Arch 8: Theatre set manufacturer
- Upper level of old Mayfield Station building (Photograph 6):
 - Cobbled ramp up to the upper station platform level behind Star and Garter pub.
 - Platform is open air with majority of steel roof removed (some sections remaining in the northern area of the platform).
 - Dilapidated old station buildings in western corner of platform. Heras fenced off. (Photograph 7)
 - 2 No. tracks with stoppers at western end. Overgrown.
 - Track leading eastwards on upper level, eventually joining onto live railway to the east of the Site. Brick building present at eastern end, apparently disused. Railway sleepers and sections of rail/track stored in the area.
- Area immediately south of Mayfield Station:
 - Adjacent to Baring Street:

- Compound where U+I temporary offices are currently under construction (wooden frame up at time of walkover). (Photograph 8)
- Temporary landscaped area in southern portion of compound, surfaced with wood chips directly on top of Made Ground. 2 No. trees in poor health (brown leaves). (Photograph 9)
- Made Ground material has been stripped and piled up along the northern edge of the compound against the Mayfield Station building.
- Suspended metal/wooden walkway at the upper station level is joined onto the station building.
- Compound is surrounded by wooden hoarding.
- Portaloos, food cabins and outdoor seating area present in north of compound.
- Through gate in wooden hoarding to the east: Narrow overgrown walkway between the station building and a brick retaining wall to the lower level where the TFGM building is situated. Metal disused building at the eastern end.
- Through a gate to the south of the compound: Heavily overgrown area adjacent to the River Medlock, which is at a lower level. Fly tipping (old tyres, brick and concrete rubble) present. River wall in poor state of disrepair. Knotweed present on riverbank but not noted on upper level. (Photograph 10)
- Building adjacent to Baring Street Bridge (#58), historic clothing factory. Disused. Car park/yard area to the side and rear of the building.
- Area between Hoyle Street, the River Medlock and Mayfield Station:
 - Western area: Former scrapyards, now vacated. Metal structures, ~2 m high, present around the edge of the Site, filled with Made Ground/fly tipping. (Photograph 11) Vacant industrial building in west of yard, joined onto Mayfield Station.
 - Eastern area: Yard with small 2 storey brick structure, metal containers, and numerous car parts/engines on the ground. Large metal weighbridge present (Photograph 12), Large quantities of knotweed in river channel, but appears not to have encroached into the yard.



Photograph 1



Photograph 2



Photograph 3



Photograph 4



Photograph 5



Photograph 6



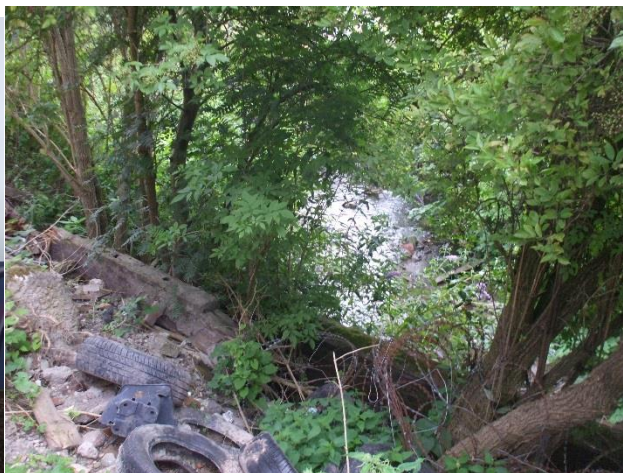
Photograph 7



Photograph 8



Photograph 9



Photograph 10



Photograph 11



Photograph 12

2.2.3 River Zone

- Transport for Greater Manchester (TFGM) building area
 - River Medlock is culverted under the car park area.
 - 1 storey brick/steel industrial building (Photograph 13). River Medlock is culverted under the building (Photograph 14). Multiple units:
 - Northernmost unit = TFGM.
 - Middle unit = formerly FedEx, now vacant.
 - Southern unit = Hilclare (electronic component manufacturer); JS advised that they are vacating on 28th September 2017.
 - External exit from former FedEx unit: External area bordering the river to the north. Overgrown grassed area with mature trees. Knotweed in river channel; river wall in poor state of disrepair. Metal footbridge present leading to yard/warehouse south of the river.
- TFGM car park (east of Baring Street)
 - Very overgrown in northern portion of car park adjacent to River Medlock. (Photograph 15)
 - Car park surfaced with tarmac.
 - Void recently opened up in car park outside Unit 4 (Section 3.5 refers). Cordoned off by barriers at time of walkover. (Photograph 16)
- Area north of Chapelfield Road and east/south of Hoyle Street: Yard with vehicles parked (including tracked excavators). Sign outside advertising 'Free tipping of clean hardcore'. River culverted under this yard. (Photograph 17)



Photograph 13



Photograph 14



Photograph 15



Photograph 16



Photograph 17

2.2.4 Southern Zone

- West of Baring Street: Row of buildings and concrete yards (not currently owned by U+I) (Photograph 18)
 - Southernmost building = Mayfield Works (disused); formerly clothing works. Yard/car park area to north of building.
 - Northernmost building = disused, former use unknown. Another yard/car park area to the north.
 - Both yards have borehole well covers in them, this ground investigation is not known to BuroHappold and has not been reviewed as part of this report.
- Area between Baring Street and Nether Street:
 - 3 No. conjoined buildings (west to east): Tow bar and trailer shop; Historic church (with basement – advised by JS); sock factory (still in use; JS advised that it has been there for >20 years). Concrete yard present to south of buildings. (Photograph 19)
- East of Nether Street: Hilclare building and car park beyond to the east/south.
- South of Bond Street, adjacent to Mancunian Way: Grass verge with advertising boards.

- Square warehouse building, north of Hilclare car park and surrounded by meandering River Medlock: (Photograph 20)
 - JS advised that the building is to be vacated in mid-July 2017. Mixed boxes stored. Current tenant has occupied the building for ~1 year.
 - Around edges of building: Concrete yard. Pallets of food produce (coconut milk, ketchup, tinned tomatoes etc).
 - Disused footbridge across River Medlock to NW of building
 - N and E of building: Overgrown. Fly tipping and evidence of burning (ashes, charred material). Brick/concrete walls border the plot in the eastern area; poor state of disrepair. (Photographs 21 and 22)
- East of square warehouse: Unoccupied yard with piles of demolition rubble and brick walls of historic buildings. (Photograph 23)
- South of square warehouse: Concrete retaining wall with Hilclare car park and skips beyond.
- East of Manor Street: Wooded area with large amount of fly tipping (Photograph 24)
- East of Hilclare car park and west of Hoyle Street: 'Delaney' Site. Yard area, hoarded off. Material stockpiles ~3 to 5 m high comprising both apparently screened and unscreened material, demolition rubble, piles of whole bricks (Photograph 25)
- Between Hoyle Street, Chapelfield Road, River Street and Rachel Street
 - Former morgue. Extremely overgrown; no access. Fenced off. (Photograph 26)
 - Brick walls of derelict building visible
 - JS advised high risk of sharps, needles etc. in the area, and presence of drug users and prostitutes
- Hoyle Street Industrial Estate (Photograph 27)
 - Unit 1: Florist
 - Unit 2: Security systems
 - Unit 3: Vacant
 - Unit 4: Unknown
 - Unit 5: Asian wedding company
 - Unit 6 and 7: MOT centre
 - Unit 8: Photographer
 - South of industrial estate adjacent to Mancunian Way: Grassed area with mature trees
- East of River Street and southwest of Temperance Street:

- Timber yard and car depot
- Western portion of yard full with timber, old vehicles (Photograph 28)
- Eastern portion of yard piled up with doors, oil drums, fridges, rubble, insulation etc. (Photograph 29)



Photograph 18



Photograph 19



Photograph 20



Photograph 21



Photograph 22



Photograph 23



Photograph 24



Photograph 25



Photograph 26



Photograph 27



Photograph 28



Photograph 29

2.3 Current Activities in the Surrounding Area

The area is situated in Manchester City Centre with a mixture of residential, commercial and industrial land uses in the surrounding area. Neighbouring the Site is Manchester Piccadilly station to the northwest, a railway viaduct to the north, the Mancunian Way (A57M/A635) to the south and high rise residential buildings including student accommodation to the west. To the south beyond Mancunian Way, there is an industrial estate and terraced housing. To the north, west and east, typical city centre land uses including shops, restaurants, offices, bars and flats are present.

2.4 Proposed Development

The development proposals are currently not finalised but are expected to comprise mixed use development with high rise buildings, associated hard and soft landscaping, car parking, and landscaping/management of the River Medlock.

3 Environmental Setting

3.1 Geology

The Site geology is described below and summarised in Table 3-1. This has been determined with reference to the relevant 1:50,000 scale BGS Geological Maps, (British Geological Survey, 2006); the Groundsure report Appendix B) and available historic Site investigation data (GIP 2009 GI – see Section 5).

Given the urban setting and development history of the Site, including numerous buildings of different ages and reprofiling of the Site to create terraced levels for car parking, a reasonable thickness of Made Ground is anticipated, and thicknesses of up to 3.20 m were recorded in historic boreholes. Made Ground material due to its nature is likely to be very variable in both composition and characteristics.

The underlying natural geology comprises superficial Glacial Till (absent beneath much of the Site) underlain by the Chester Pebble Beds Formation (Sherwood Sandstone Group), except the western portion where no Glacial Till is recorded on the maps. The geology maps record Alluvial Deposits adjacent to the River Medlock which meanders east to west across the Site.

Table 3-1 - Summary of Anticipated Geology

Strata	Description	Depth to top [Thickness] (m)	Aquifer status
Made Ground	Heterogeneous material consisting of sand / gravel / clay with ash, brick, concrete, timber, slate. Likely to be some reworked natural material.	GL [3.20 m max. recorded]	N/A
Glacial Till	Gravelly clay / stiff clay / sand and clay. Present sporadically.	0.60 m [<1.80 m]	Secondary Aquifer (Undifferentiated)
Chester Pebble Beds Formation	Orange / brown / red brown sand.	2.30 to 3.20 m [0.10 - >3.00 m]	Principal Aquifer
	Red sandstone.	1.52 to 3.40 m [>8.54 m, thickness unproven]	

3.2 Hydrogeology and Hydrology

The nearest surface water feature to the Site is the River Medlock, which flows east to west across the Site to its confluence with the River Irwell on the south side of Manchester Victoria Railway Station. The River Medlock is culverted beneath the railway line and the transport for Greater Manchester building in the centre of the Site.

The southwest corner of the Site, adjacent to the River Medlock, is indicated to be within a 'Zone 2 Floodplain' as presented in the Groundsure Report, based on the relevant Environment Agency information and reproduced in Appendix B. The centre of the Site, adjacent to the River Medlock, is indicated to be within either a 'Zone 2' or 'Zone 3' Floodplain.

The Environment Agency Groundwater Vulnerability Map Sheet 17 (Derbyshire and North Staffordshire) indicates that the Site is underlain by a 'Major Aquifer' with 'Soils of High Leaching Potential (U)' (Appendix B). It should be noted that the Site is labelled 'U' for urban and a note is normally included on the maps explaining that such a classification means that *'Soil information for restored mineral workings and urban areas is based on fewer observations than elsewhere. A worst case vulnerability classification (H) is assumed until proved otherwise'*.

The Chester Pebble Beds Formation is a Principal Aquifer, defined as layers of rock or drift deposits that have high intergranular and/or fracture permeability capable of supporting water supply and/or river base flow on a strategic scale. The Site is not recorded to be within a Source Protection Zone (SPZ).

The Groundsure Report records one historic groundwater abstraction from within the Site boundary licenced to Moseley Rubber Co Ltd (eastern part of the Site, adjacent to the River Medlock) this has now lapsed. No active water abstractions are recorded within 500m of the Site. There are two No. abstractions locations within 1 km of the Site including: G T Energy UK Limited (778m SE) and Manchester Metropolitan University (870m SW). The Site is not within a groundwater source protection zone.

3.2.1 Groundwater

Examination of the general topography and hydrology of the Site, based on the current and historic OS maps indicates that the prevailing direction of groundwater flow is likely to be to the southwest, towards and in the direction of flow of the River Medlock.

It is considered likely that groundwater underlying the Site will be in hydraulic continuity with the River Medlock due to the presence of this watercourse on the Site and poor condition of the channel walls. Localized groundwater may be encountered in the Made Ground deposits perched on underlying low permeability Glacial Till, if present. Deeper groundwater conditions within the weathered and intact sandstone bedrock are likely to be controlled by the hydraulic conductivity of the sandstone (degree of cementation, degree of fissuring, faults etc.).

Groundwater was not recorded / encountered within any of the historic BGS boreholes, or in any exploratory hole from the GIP 2009 GI.

3.3 Ecology

The Groundsure Report records no SSSIs, nature reserves or environmentally sensitive areas within 2 km of the Site. The Site is not within a Nitrate Vulnerable Zone.

3.4 Japanese Knotweed

An initial ecological assessment on site was carried out during 2009 by BuroHappold which details the following:

'Japanese knotweed was recorded along the River Medlock on the silt banks where river flow is low. No Japanese knotweed was recorded within the Colourgates Yard section; however it was not possible to carry out a full walkover survey of this area due to the density of the vegetation, so the presence of this species within this small area cannot be completely discounted at this stage'.

Large quantities of Japanese Knotweed were identified on the banks of the River Medlock within the river channel during the Site walkover (Section 2.2 refers). There was no visual evidence that knotweed had migrated onto adjacent areas of the Site, however. It is understood that a full survey of the river will be undertaken in the near future, which will fully characterise the extent of knotweed present.

3.5 Geological and Geotechnical hazards

According to the information presented in the Groundsure report, the following ground hazard ratings are applicable:

- Very Low hazard rating for shrinking or swelling clay;
- Very Low hazard rating for Landslides;
- Negligible hazard rating for Soluble Rocks;
- Moderate hazard rating for Compressible Ground;
- Very Low hazard rating for Collapsible Rocks;
- Low hazard rating for Running Sand.

The maximum potential for ground instability due to compressibility is stated as 'Moderate' within the Groundsure report. However, the 'Compressible Deposits Legend' within the report (Appendix B refers) indicates the majority of the Site to be situated within a 'Negligible' hazard rating zone, with a band of 'Moderate' hazard bordering the Site to the south, underlying an area of Mancunian Way to the south of Bond Street. As such the potential for encountering compressible ground within the Site is considered low.

It is worthy of note that during August 2015 a large hole appeared in the Mancunian Way after a period of heavy rain. A leaking water pipe is reported to have been the cause of the incident. The road has since been repaired and fully reopened.

In June 2017, a void (~1.50 m diameter x ~5.00 m deep) appeared in the car park of the Transport for Greater Manchester (TfGM) building (Unit 4), close to the culverted River Medlock. The cause is currently unknown and is under investigation. The void appears to be connected to existing drainage, and there may have historically been a chamber in the locality. Further assessment, including a CCTV survey, is currently being undertaken, and appropriate repair/remediation measures will be undertaken once better understood. Bulging and cracking to the nearby car park retaining wall was also noted, with a depression to the tarmac adjacent to the wall. A Design Note has been prepared by BuroHappold and is included as Appendix C.

3.6 Radon

Less than 1% of homes are affected by radon, therefore, radon protection measures are not considered necessary in the design of new dwellings or extensions on this Site.

3.7 Mining Activity

The Groundsure Report states that the Site is '*located within the specified search distance of an identified mining area*'. A Coal Authority (CA) Report (Coal Authority, September 2015) has been obtained for the proposed development as the Site overlies coal bearing strata and, as such, further assessment in respect of previous coal mining activity was considered necessary.

The CA Report states that:

- The Site is within the likely zone of influence from workings in 2 No. seams of coal at 1050 m to 1100 m depth which were last worked in 1958. Furthermore, reserves of coal do exist in the locality which could be worked in the future subject to feasibility, licences and planning consents.
- There are no recorded mine entries on Site or within 20 m of the Site boundary.
- In respect of opencast mining, the Site is not within the boundary of any past or present workings. In addition, there is no licence to extract or proposed licence to extract coal by opencast methods within the immediate vicinity of the Site.
- No subsidence, in respect of the Coal Mining Subsidence Act 1991, has been recorded in respect of the immediate Site area.

Given the published and unpublished geology of the Site, the Site history and the CA Report information it is considered that the risk arising from former coal mining operations can be considered to be low.

3.8 Unexploded Ordnance

The Manchester bomb map records a number of high explosive and fire bomb impacts in close proximity to the Site, as well as damage to several buildings within the Site (**Error! Reference source not found.** refers). Some buildings, including the Mayfield station building itself, have not been developed since the war and remain on Site.

A Preliminary UXO Risk Assessment has been carried out by Planit in accordance with CIRIA C681 (CIRIA, 2009) and is included in Appendix A. In addition to the consideration of the potential for aerial delivered UXO, consideration has also been given to mitigation factors, namely: (i) the extent of post-war development; (ii) the extent of proposed intrusive works. The assessment concluded on the basis of Site setting, historical land usage, record of bombing, post war development and proposed intrusive work that the risks associated with UXO on site are Medium. Considering the findings of this assessment, a UXO Threat Mitigation Strategy is required to be in place prior to intrusive works at the Site. A review of these recommendations must be undertaken considering any additional, relevant information being provided (i.e. significant changes to the masterplan that require significant ground excavations).

4 Site Setting

4.1 Site History

The Site history and that for the surrounding area has been completed using historic maps from 1873 to 2015. This history is summarised in Table 4-1 below and a selection of the maps reproduced in full Appendix B Map Record.

Table 4-1 - Summary of Site history and history of the surrounding area

Date	Site History	History of the Surrounding Area
1851	North-Mayfield Works (Dye & Print) & associated Reservoirs/Filtering Pools and tanks, Timber Yard, Hotel (later known as the Star & Garter Public House), northeast corner of Hanover Mill (cotton), various roads and residential housing. Public house and residential housing in the north east corner, north of the railway line. South- Chapelfield Dye Works, Ardwick Dye Works, Britannia Brewery, Tipping Street Chapel, a Tannery and various roads and residential housing. East-A Timber Yard is recorded to the north of Chapelfield Road. Residential housing, open land and various roads are recorded across the rest of the Site. West-Railway lines, residential housing, Timber Yard, Public House and various roads.	<i>London Road Station</i>, associated railway lines and <i>Goods Yard</i> to the immediate north of the Site, <i>Hanover Mill</i> & ancillary buildings to the immediate west of the Site, <i>Ardwick Saw Mill & Timber Yard</i> approximately 20 m to the northeast, <i>Maskrey Mill (Cotton)</i> approximately 70 m to the northeast and <i>Ardwick Bridge Chemical Works</i> approximately 45 m to the southwest. Residential housing dominates the surrounding area along with various smaller commercial/industrial facilities.
1893	North- Hotel & Police Station recorded to the north of Station Street. The Timber Yard is no longer recorded. South-Chapelfield Dye Works has expanded to the south and west, Ardwick Dye Works is no longer recorded, the Tannery is now recorded as Ardwick Tannery. Mayfield Baths and Water Meter Works are now recorded to the west and south of Ardwick Tannery respectively. An Ice Works is recorded to the south of Mayfield Baths. East- Timber Yard is no longer recorded and the rest of the land on Site is now covered in residential housing. West- A Timber Yard is recorded south of the railway lines at the end of Cross Street.	<i>Hanover Mills</i> has expanded, <i>Ardwick Saw Mill & Mill Yard</i> is no longer recorded and <i>Ardwick Bridge Chemical Works</i> is now recorded as 'Disused'. Tramlines are recorded along <i>Fairfield Street</i> and <i>London Road</i> and <i>Maskrey Mill (Cotton)</i> is now recorded as <i>Marlborough Mills (Cotton Waste)</i> (later recorded as a Mill).
1908	North- Mayfield Works (Dye & Print) & associated reservoirs no longer recorded but buildings/reservoir outlines remain. Police Station in the northwest area and residential housing to the north of Arthur Street are no longer recorded. The Hotel is now recorded as a Public House. South-Chapelfield Works (Indian Rubber) has expanded to the west and Ardwick Tannery is no longer recorded. East-Half the residential housing to the north of Chapelfield Road is no longer recorded. West- The Timber Yard is no longer recorded.	Chief Fire Engine Station (& ancillary buildings) approximately 50 m to the northwest of the Site (currently disused). The residential housing to the north is no longer recorded and a Police Station and Public House are recorded approximately 50 m and 60 m to the northeast of the Site.

Date	Site History	History of the Surrounding Area
1922	North- Residential housing in the northwest is no longer recorded and Mayfield Station (L.M.S.B) and associated railway lines are recorded covering the majority of the north. South- Mayfield Baths is now recorded as Mayfield Public Baths and Public Wash House, Tipping Street Chapel is no longer recorded and Britannia Brewery is now recorded as 'Disused'. The Ice Works is now recorded as Ice Factory. East- No significant change West- A number of residential buildings are no longer recorded and an Engineering Works is recorded to the south of Carston Street.	<i>London Road Station</i> has expanded and the number of railway lines to the north has increased. The <i>Police Station</i> is no longer recorded and the land to the south/southwest of the Site now comprises predominantly commercial/industrial facilities (<i>Coachworks, Bakery, Dairy, various Mills/Warehouses</i>).
1948	North-Chapelfield Works (Indian Rubber) has expanded and is now recorded in between Mayfield Station and the River Medlock (culverted in part). Fairfield Street Garage is recorded on a small plot of land to the northwest of Mayfield Station. The northeast corner of Hanover Mill (cotton)is now recorded as a Printing Works. South- Mayfield Public Baths and Britannia Brewery (disused) are no longer recorded and the Public Wash House is now recorded as a Dairy. A Leather & Cloth Factory is recorded to the south of the dairy and the Ice Factory is now recorded as Mayfield Ice Factory. East- The majority of the residential properties are no longer recorded. West- A number of residential properties are no longer recorded in the north, central and southern areas.	A number of Works/Factory at Hanover Mills (Printing Machinery, Stationary, Motor Repair).
1950	North- Fairfield Street garage is no longer recorded. Ruins are recorded in between Mayfield Station and Temperance Street. South- Ruins are recorded at the former Mayfield Public Baths and the former Britannia Brewery. East- No significant change West- No significant change	Ruins approximately 100 m northeast of the Site, no other significant change.
1954- 1936/64	North- The Ruins are no longer recorded. South- The Dairy is now recorded as Dairy (Disused), Mayfield Ice Factory is now recorded as Factory, Chapelfield Works (Indian Rubber) is now recorded as Works. The Ruins are no longer recorded. East- A Mortuary and a Depot are recorded in the central area. West- No significant change	By the mid-late 1950's, two <i>Garages</i> are recorded approximately 70 m and 75 m to the northeast respectively. The 1964 map records <i>London Road Station</i> as <i>Piccadilly Station</i>, two <i>Depots</i> are recorded approximately 50 m and 85 m to the west respectively, <i>Hanover Mills</i> is no longer recorded and the industry around the former <i>Hanover Mills</i> are all recorded as <i>Works/Factory</i>.

Date	Site History	History of the Surrounding Area
1960-1977	North- Mayfield Station is now recorded as Mayfield Station (Goods) and the Printing Works is now recorded as Works. South- The Dairy (Disused) is now recorded as Works, the Leather & Cloth Factory is now recorded as Factory. East- No significant change West- Engineering Works is no longer recorded.	The 1970/71 map (1:2,500 scale) no longer records the Mill to the northeast, the larger Depot is now recorded as Estates & Engineering Depot, the Works/Factory are now recorded as Hanover Mills again, a Garage is recorded approximately 50 m to the south of the southwestern corner of the Site and Mancunian Way is now recorded to the immediate south of the Site.
1978-1986	North- The Works to the west of Baring Street is no longer recorded. South- The Works to the west of Baring Street is no longer recorded and the Factory to the south of the former Works is recorded as Mayfield Works. The Rubber & Plastic Works is now recorded as Works. East- Hoyle Street Industrial Estate is now recorded to the south of Rachel Street. West- The Car Park to the south of Travis Street is no longer recorded and the area of the land to the north of Travis Street is now recorded as a Car park.	The <i>Garage</i> to the southwest is no longer recorded by 1984 and the area around the former <i>Garage</i> is now recorded as <i>Downing Street Industrial Estate</i> .
1987-1991	North- A Scrap Yard is recorded to the south of Mayfield Station in the far east of the Plot. South- A tank is recorded to the west of the Works in the east of the Plot and another tank is recorded approximately 100 m to the northwest. East- No significant change West- No significant change	No significant change
1992 - 1994	North- No significant change South- No significant change East- No significant change West- No significant change	The <i>Garage</i> to the north of <i>Fairfield Street</i> as a <i>Depot</i> . There are no further major changes to the surrounding area.

4.2 Regulatory Data

Regulatory data relating to potentially contaminative uses is summarised in Table 4-2 below. This information was obtained from the Groundsure report, presented in full in Appendix B.

Table 4-2 Summary of Regulatory Data

Item	Location [on/off Site]	Information	Potential to Impact
Environmental Permits, Incidents and Registers			
Part A (2) and Part B Activities and Enforcements	2 [on Site]	2 x Part B Historical Permits, metal and other mineral processes	Yes
Licensed Discharge Consents	1 [~50m]	Effective 1995. Sewage discharge effluent, revoked from being received into the River Medlock.	No
National Incidents Recording System, List 2	2 [on Site] 3 [~50m]	Both unidentified pollutant sources occurred in 2001. 2001-2003, contaminated water from urban runoff, and diesel from oils and fuel.	Yes Yes

Item	Location [on/off Site]	Information	Potential to Impact
No records within 550m of: Historic IPC Authorisations, Part A (1) and IPPC Authorised Activities, Red List Discharge Consents, List 1 and 2 Dangerous Substances Inventory Sites or Water Industry Referrals, Planning Hazardous Substance Consents and Enforcements, COMAH and NIHHS Sites, National Incidents Recording System, List 1, Sites Determined as Contaminated Land under Part 2A EPA 1990, Category 3 or 4 Radioactive Substances Authorisations.			
Landfill and Other Waste Sites			
Operational and Non-Operational Waste Treatment, Transfer and Disposal Sites	2 [on Site] 2 [51-250m]	2 x Scrap yards, 1991, 1994 Metal works, 1948	Yes No
EA Licensed Waste Sites	4 [on Site]	Waste treatment to product oil (issued 2015) Metal recycling Site (issued 1996) Inert and excavated waste treatment (issued 2015) Metal recycling Site (issued 1996)	Yes Yes Yes Yes
One historic landfill identified located 341m NE of the Site. Licenced to receive inert and industrial wastes, licence surrender July 1988.			No
Current Land Use			
Current Industrial Sites Data	14 [on Site] 3 [~50m]	Range of industrial works including vehicle repair and servicing, electricity sub stations and tanks. Range of industrial and repair and vehicle works.	Yes No
Records of Petrol and Fuel Sites	1 [51-250m]	85m NE, unbranded	No
No records within 250m of National Grid Underground Electricity Cables.			
Historical Industrial Sites			
Railway Building, including a goods station and Siding Features	On Site	1890 – present	Yes
Tanks	9 [on Site]	Unspecified Tanks present at various times between 1889-1994.	Yes
Other Industrial Buildings e.g. Police Station, Fire Station, Unspecified Mills, Cotton Mills, Iron Works	On Site	1890-1990's	Yes
Historical Garage and Motor Vehicle Repair Database	1 [on Site]	Garage on Site from 1948	Yes
No historical petrol and fuel Sites were recorded within 500m of the Site.			

5 Previous Site Investigations

Exploratory hole logs from the Ground Investigation & Piling Ltd. (GIP) ground investigation (GI) for the Site have been reviewed. The GI works were undertaken during April 2009 and comprised 7 No. window sample boreholes with associated monitoring and testing. Historic borehole logs from the BGS Geoscience Database have also been reviewed. The data from the ground investigation and the BGS boreholes is summarised in Section 3.1 and logs are included within Appendix D.

It is understood that further ground investigation works have been undertaken on Site, however no information has been made available to BuroHappold at time of writing.

6 Preliminary Geoenvironmental Risk Assessment

6.1 General Approach

In the UK, the assessment of risk from contamination follows the source-pathway-receptor approach. If one of these three elements is absent, it is considered that there is no risk of harm. If, however, there is considered to be a linkage between any given source and any given receptor, then a risk-based approach is used to assess the significance or impact of any such linkage.

Risks are defined as the probability of an event occurring combined with the severity of the consequence of that event. Particularly, to assess the risks to Site end users posed by any given source, the sensitivity of each receptor is considered. For example, the concentration of contamination acceptable at a Site to be developed as a residential property with a garden used to grow vegetables and accessible to young children is set lower than that for a commercial Site where soil is exposed only in minor areas of landscaping and the only long-term users of the Site are adults. Similarly, a Site overlying a Principal Aquifer supplying potable water to a large population will be considered more stringently than a Site overlying an impermeable geology with only minor seepages of groundwater.

6.2 Sources, Receptors and Pathways

Potential contamination sources have been identified and are summarised in Table 6-1 below. The 'Contaminants of Concern' in this risk assessment are based primarily on information from the review of historical information, reference to DEFRA R&D Publication CLR 8 'Priority Contaminants for the Assessment of Land' and relevant Industry Profile reports published by the Department of Environment. Site specific pathway-receptor linkages have been identified in Table 6.2 with respect to the sources outlined in Table 6-1.

Table 6-1 - Summary of Potential Contamination Sources

Location	Potential Source	Likely Age	Potential Contaminants of Concern
On Site	Infilled land / Made Ground	>100 years	Ground gases / vapours
	Historical Site uses: <i>Works, printing works, mills, garage, tannery, scrap yard, brewery, iron works, waste tank / reservoirs, mortuary, various depots, smaller commercial/industrial facilities</i> Current Site Uses: <i>Works / factories, a scrap yard, a depot, Industrial Estate, derelict land and car parking. Garages, tanks, scrap yards, fly tipped material, sub station</i>	>100 years - current	Heavy metals, organic and inorganic compounds, acids, asbestos, fuel oils, lubricating oils, PAHs, effluent treatment chemicals Heavy metals, organic and inorganic compounds, acids, asbestos, fuel oils, PAHs, solvents.

Location	Potential Source	Likely Age	Potential Contaminants of Concern
Off Site	Historical Industrial Uses: <i>Saw Mill, Timber Yard, Railway Lines, Cotton Mill, Chemical Works, Dairy, Printing Works.</i>	>200 years - current	Fuel oils, lubricating oils, PAHs, ethylene glycol, creosote, herbicides, ash, sulphates, heavy metals, organic and inorganic compounds, acids, asbestos, dyes

Table 6-2 - Summary of Receptors and Pathways

Receptor		Pathway
Human Health	Construction / Maintenance Workers	Direct contact, ingestion, inhalation
	Future Site Occupants	Direct contact, ingestion, inhalation
	Site Neighbours	Inhalation
Controlled Waters	Principal Aquifer (Sherwood Sandstone)	Migration through granular strata
	River Medlock	Leaching and migration via permeable strata. Surface water runoff. Potential could be realised during current use and during restoration earthworks.
Ecology	On Site flora and fauna	Root uptake
Built Environment	On-Site buildings, structures and services	Gas migration via permeable strata with potential for accumulation to hazardous concentrations. Direct contact with contaminated material / aggressive attack.

6.3 Physical Hazards

The Site walkover identified a significant number of needles and other sharps lying on the surface of the Site, this was noted as a particular problem in the area of the former Mortuary. These sharps and the illegal activities that are associated with them will pose a risk to future construction workers that will require mitigation. This risk is not set out in the below table but is taken forwards to the conclusion.

6.4 Results of Risk Assessment

The details of the Preliminary Risk Assessment are presented in Table 6-3 overleaf and the results discussed in Section 8.1.

Table 6-3 Preliminary Risk Assessment

		Pollutant Linkage	Risk Assessment (following CIRIA C552)			Comment on hazard realisation
Source	Contaminants of Concern	Receptor / Pathway	Consequence	Probability	Risk	
On site Made Ground	Ground Gas/vapour	Description of source: Historical maps and data show a number of areas of infilling on Site. Potential for hazardous ground gas and vapours resulting from infilling with putrescible materials and significant depths of Made Ground. Nature of ground gas regime not proven. The relatively permeable Made Ground and limited glacial till are unlikely to limit the vertical and horizontal migration of gas and vapours.				
		Construction/ Maintenance Workers Gas and vapour migration via permeable strata with potential for accumulation in hazardous concentrations potentially leading to explosion, fire and/or asphyxiation	Severe	Unlikely	Moderate/ Low	Limited potential for hazardous gases to impact construction and maintenance workers, possible for gases to build up in enclosed below ground excavations, good ventilation and health and safety practices can mitigate this risk.
		Future site users Gas and vapour migration via permeable strata with potential for accumulation in hazardous concentrations potentially leading to explosion, fire and/or asphyxiation	Severe	Low	Moderate	Potential for build-up of hazardous gases in buildings. Capable of mitigation by Site investigation to classify the ground gas regime followed by installation of appropriate gas protection measures.
		On- Site buildings and structures Gas and vapour migration via permeable strata with potential for accumulation in hazardous concentrations potentially leading to explosion and fire	Severe	Low	Moderate	Potential for build-up of hazardous gases in buildings. Capable of mitigation by Site investigation to classify the ground gas regime followed by installation of appropriate gas protection measures.
On site historic and current site Uses.	Heavy metals, organic and inorganic compounds, acids, asbestos, fuel oils, lubricating oils, PAHs, effluent treatment chemicals, solvents.	Description of Source: Historic construction and demolition activities over the years will likely have resulted in the presence of infilled / Made Ground. A timber yard was recorded on Site from 1851 to 1893. A tannery, brewery, and print works were present from 1851 until 1922. A cotton mill was recorded on Site from 1851 – 1948. Ice works and Baths have been recorded on Site from 1893 – 1850. The Mortuary and Depot were present from 1954-1963. Tanks were recorded between 1987-1991. Mayfield Station has been recorded in mapping since 1922. Hoyle Street Industrial Estate has been recorded since 1978 and various works and factories have been recorded since 1960 – 1977. Two scrap yards have been recorded; one since 1991, and the other since 1994. There are also two four licensed waste Sites (for metal recycling and waste treatment). Historical and recent Sites uses make it likely that contamination is present within site soils. The relatively permeable Made Ground and limited glacial till are unlikely to limit the vertical and horizontal migration of contamination.				
		Construction and maintenance workers Dermal contact, soil and dust ingestion/ inhalation	Medium	Low	Moderate / Low	Potential for exposure during investigations/ earthworks. Period of exposure dependent on construction timescales. Standard Health and Safety precautions likely to be used by workers. Mitigation of potential risks can be achieved by appropriate investigation and adoption of standard good construction practice.
		Future site users Dermal contact, soil and dust ingestion/ inhalation	Medium	Low	Moderate / Low	Potential for dust generation, direct contact and ingestion. Exposure time is relatively limited. Mitigation of potential risks can be achieved by appropriate investigation / design and implementation of remediation / mitigation measures including encapsulation.
		Off Site occupiers / visitors of neighbouring land Soil and dust ingestion/ inhalation	Medium	Unlikely	Low	Large scale development, potential to impact surrounding visitors by dust generation. Increased potential during any earthworks. Mitigation of potential risks can be achieved by appropriate investigation and adoption of standard good construction practice.

		Pollutant Linkage	Risk Assessment (following CIRIA C552)			Comment on hazard realisation
Source	Contaminants of Concern	Receptor / Pathway	Consequence	Probability	Risk	
		Degradation of water quality [Principle Aquifer] Migration via permeable strata, contaminated run off/ near surface soils	Medium	Low	Moderate / Low	Potential for increased infiltration and promotion of leaching during development works. Nearest active local abstraction over 700m from the Site. Site not within a groundwater protection zone. Quality of groundwater not known. Mitigation of potential risks can be achieved by appropriate investigation and remedial design. Good construction practice likely.
		River Medlock Migration via permeable strata, drainage pipes and surface run-off.	Medium	Low	Moderate/ Low	Potential for contaminated groundwater to migrate via drainage, permeable strata and surface run-off., River Medlock runs through the Site. River Medlock present on site. Mitigation of potential risks can be achieved by appropriate investigation and remedial design. Good construction practice likely.
		Flora Root uptake and contact with soil by invertebrates/fauna	Mild	Low	Low	Limited vegetation on Site, future vegetation likely to be within specific landscaped areas utilising imported soils. Mitigation of potential risks can be achieved by appropriate investigation and remedial design.
		Buildings structures and services Direct contact, permeation of water supply pipework. Direct contact/, aggressive attack	Medium	Unlikely	Low	Potential for direct contact on redeveloped Site. No record of degradation to water supply or evidence of structures damaged by contaminated soils currently. Mitigation of potential risks can be achieved by appropriate investigation / design and implementation of remediation.
Off site historical industrial uses	Fuel oils, lubricating oils, PAHs, ethylene glycol, creosote, herbicides, ash, sulphates, heavy metals, organic and inorganic compounds, acids, asbestos, dyes	Description of source: Numerous potentially contaminating activities present on the site boundaries since development of the area. Nature and extent of any contamination that has migrated onto site not proven and unlikely to be gross.				
		Construction and maintenance workers Dermal contact, soil and dust ingestion/ inhalation	Medium	Very Low	Low	Potential for exposure during investigations/ earthworks in site areas adjacent to the site boundary, source likely to be limited. Period of exposure dependent on construction timescales. Standard Health and Safety precautions likely to be used by workers. Mitigation of potential risks can be achieved by appropriate investigation and adoption of standard good construction practice.
		Future site users Dermal contact, soil and dust ingestion/ inhalation	Medium	Very Low	Low	Potential for dust generation, direct contact and ingestion in site areas adjacent to the site boundary, source likely to be limited. Exposure time is relatively limited. Mitigation of potential risks can be achieved by appropriate investigation / design and implementation of remediation / mitigation measures including encapsulation.

7 Preliminary Geotechnical Assessment

7.1 General

On the basis of the desk study data, an outline of geotechnical recommendations for foundation, earthworks and associated risks are set out in the following section. The development proposals are currently not finalised but are expected to comprise mixed use development with high rise buildings, associated hard and soft landscaping, car parking, and landscaping/management of the River Medlock.

In due course, this section would need to be reviewed in the context of additional ground investigation and masterplan development, as there is currently limited data available for the geotechnical/geological characteristics of soil/rock present on Site.

7.2 Geological profile and geotechnical parameters

The geological succession is outlined in Section 3.1 and is thought to comprise a thickness of Made Ground overlying Glacial Till (sporadically present) overlying the Chester Pebble Beds Formation, increasing in competence with depth. Further Site investigation and laboratory testing is necessary for further soil/rock characterization and geotechnical design parameter derivation.

7.3 Excavation, Earthworks and Groundwater Control

Given the development history of the Site, significant thicknesses of Made Ground are anticipated in some areas. If this material is not self-supporting, temporary retaining works would be required for shallow footing and/or any excavations needed (to be established during Site specific ground investigation).

Re-profiling works may be required as part of the development works. It may be possible to re-use suitable material elsewhere on Site, however it is possible that some of the excavated material will be unsuitable for engineering purposes and will require disposal off Site. Material considered unsuitable for engineered fill may be used in non-engineered landscaped areas provided its engineering properties are suitable, and the material is tested for contamination in keeping with the end use of the development. A detailed cut/fill exercise will be required in order to ascertain the amount of surplus arisings that will need to be handled/placed/removed from Site as part of masterplan development.

Materials arising from the removal of any foundations/obstructions and any appropriate Made Ground could, if cost effective, be considered for re-use as hardcore/reprocessed stone if appropriately sorted, processed and treated. This process, if cost effective, has the advantage of minimising waste disposal requirements and reduction of import and use of raw materials in accordance with environmental guidelines and best practice.

The Chester Pebble Beds Formation is a Principal Aquifer, however there is currently no groundwater data available for the Site. Ground investigation is needed to establish the groundwater regime and characteristic soil permeability. From there, the requirement for any groundwater control measures for shallow excavations, and in the permanent case, can be established.

7.4 Engineering Assessment and Foundation Methods

The foundation options that may be feasible for the proposed development comprise pad or strip footings, raft foundations or piled foundations. The selection of these options is influenced by a number of factors relating to the ground conditions and proposed development. These are generally associated with the ability of the ground to support the loads applied by the structure above and to the sensitivity of the structure to ground movement.

7.4.1 Shallow Foundations

Depending on the structural loads, shallow foundations may be feasible. The Glacial Till or Chester Pebble Beds are envisaged to provide a suitable founding strata for a shallow foundation option (pads/strip/raft) subject to detailed characterisation, although it should be noted that due to the Site history, significant thicknesses of Made Ground are likely to be present in localised areas which could make shallow foundations uneconomic due to required excavation depths.

7.4.2 Piled Foundations

Where shallow foundations are found to be impractical or uneconomical, then consideration will need to be given to piled foundations, particularly for any heavily loaded high rise structures. Rotary bored or continuous flight auger (CFA) are suitable from a technical perspective, with CFA piles socketed into the Chester Pebble Beds likely to be most feasible.

7.5 Buried Structures and Obstructions

Due to the rich development history of the Site, it is considered likely that localised obstructions, such as historic floor slabs, foundations or infilled basements, are present which are not recorded or have not been identified. Any such structures/obstructions/services encountered may require removal as part of any construction works and any excavations should be infilled with suitable structural fill where appropriate.

7.6 Void

A void (~1.50 m diameter x ~5.00 m deep) appeared in the car park of the Transport for Greater Manchester (TFGM) building (Unit 4), directly above the culverted River Medlock during the recent Site walkover. The cause is currently unknown. Further assessment, including a CCTV survey, is currently being undertaken, and appropriate repair/remediation measures will be undertaken once better understood. Bulging and cracking to the nearby car park retaining wall was also noted, with a depression to the tarmac adjacent to the wall. A Design Note has been prepared by Buro Happold and is included as Appendix C.

7.7 Preliminary Geotechnical Risk Register

The Geotechnical Risk Register developed below shows the degree of risk attached to various ground related aspects of the proposed development. The aim of this section is to provide an assessment of the risk to the project that rise from ground related problems (in relation to geotechnical issues and obstructions) and propose possible mitigation measures. The register risk is only an initial assessment and should be revised in the detailed design.

It has been developed in general accordance with the guidance presented in ICE/DETR Document 'Managing Geotechnical Risk' (2001). The degree of risk is determined by combining the assessment of probability of the hazard occurring with an assessment of the impact. The scale against which the probability and impact are measured and the resulting degree of risk determined are shown below.

Table 7-1 – Risk scoring matrix

Probability	(P)	X	Impact	(I)	=	Risk	(R)
Very Likely	5		Very High	5		Severe	20 – 25
Likely	4		High	4		Substantial	15 – 19
Plausible	3		Medium	3		Moderate	10 – 14
Unlikely	2		Low	2		Minor	5 – 9
Very Unlikely	1		Very Low	1		Negligible	1 – 4

Table 7-2 - Risk Register

Site/Ground Conditions	Hazard	Potential Impact	P	I	R	Mitigation
Previous Site use	Contaminated Ground	Health and safety of ground workers, environmental damage	4	4	16	Ground Investigation to be undertaken. Vigilance throughout works. Seek advice of Environmental Engineer if any identified unusual odorous or visually contaminated materials encountered.
Historic buildings on Site	Obstructions / infilled basements	Obstructions to piling. Potential presence of poorly compacted backfill.	5	3	15	Enabling works may be required – to be established following ground investigation and when proposed development is at a more advance stage.
Gradient on Site	Earthworks or retaining walls required to accommodate layout	Increased cost of development	3	4	12	Cut and fill earthworks will be required to the Site to form suitable founding ground. Ground Investigation to confirm the ground model and quality of materials. Ground modelling and slope stability design assessments will be required to confirm designs at detailed design stages
Japanese Knotweed in River Medlock	Spread of invasive species	Damage to structures, illegal spreading of knotweed	4	4	16	Full survey to be undertaken. Appropriate treatment to be undertaken by a suitably qualified professional before construction commences.
Loose or soft, compressible soils at shallow depth	Ground unsuitable for conventional shallow footings	Excess settlement or alternative foundations	3	4	12	Ground investigation needed to confirm soil compressibility. Consolidation and compressibility parameters to be taken into account and allow for settlements.
Soft and compressible near surface soil	Ground unsuitable for conventional ground bearing slab	Alternative floor design	2	3	6	Ground investigation needed to confirm suitability of ground bearing slab.
Loose or unstable strata at shallow depth	Excavation Instability	Potential collapse – Health and safety	3	4	12	Support of excavations to be considered for temporary construction works if required.

Shallow groundwater	Excavation Instability / Water ingress into excavations / Slab Uplift	Collapse of excavations. Difficulties in casting concrete e.g. for foundations. Damage to structure from slab uplift.	3	4	12	Groundwater monitoring to be undertaken as part of ground investigation. Groundwater control measures, e.g. sump pumping, may be required for shallow excavations. More substantial control measures (e.g. secant piled walls) may be required if permanent groundwater level is shallow, or for deep excavations / reductions in level below groundwater table.
Unexploded Ordnance	Encountering unexploded WWII bombs	Risk to human life, damage to structures	3	5	15	Detailed UXO risk assessment was undertaken by Planit UXB Ltd. UXO management is required during the GI / construction based on the findings.
Coal mining	Unstable ground	Voids in historic mine workings causing collapse; potential for soft ground / voids within historic mine shafts	1	5	5	Coal Authority report / records and geological maps indicate that the risk from historic coal mining is low.
Voids	Unstable ground	Potential harm to structures and human life. Cost of repairs.	4	4	16	Voids have opened up on / near Site (Section 3.5 refers). Investigation required to establish extent, cause and mitigation.
Live services	Diversions required, explosion, flooding, damage to utilities	Diversions may be required, increasing cost. Risk of injury if excavated through during GI / construction	5	3	15	GPR utilities survey to be undertaken before ground investigation. To be incorporated into design to minimise clashes / diversions.
River Medlock	Working near water	Construction or GI workers falling in, causing injury / death	3	4	12	Appropriate measures required for working in close proximity to River Medlock.
Needles and sharps	Needles and sharps	Harm to workers – diseases, cuts	4	4	16	Vigilance and appropriate PPE. Site to be cleared of sharps and other potentially harmful materials before construction starts.

8 Conclusions and Recommendations

8.1 Summary of Contamination Risks

The identified potential risks above Low are summarised below:

- There is a Moderate risk to future Site users and future buildings due to release of ground gases from Made Ground underlying the Site;
- There is a Moderate/Low risk to Site workers due to the potential for inhalation of ground gas. This risk is likely to be mitigated by standard working practice assuming that no deep poorly ventilated excavations are required.
- There is a Moderate / Low risk to construction workers, future site users and controlled waters from historic and current site uses which are likely to have contaminated Site Made Ground.

A ground investigation over the whole Site area will be required to better understand the risks identified and allow the adoption of suitable remedial measures if required.

8.2 Geoenvironmental Conclusions

This site has a long industrial history which has continued until present day. It appears likely that significant thicknesses of Made Ground are present on site as some areas appears to have been filled and there has been significant redevelopment over the years. This industrial legacy is likely to have contaminated shallow soils to some extent and a ground investigation is required to define the extent of contamination and determine the need for remedial measures as part of development work.

8.3 Geotechnical Conclusions

The development proposals are currently not finalised but are expected to comprise mixed use development with high rise buildings, associated hard and soft landscaping, car parking, and landscaping/management of the River Medlock. A range of foundation options are possible for the development based on a desk based study of available information, however there is currently insufficient information to create a detailed ground model. A ground investigation will be required to produce a detailed ground model to allow geotechnical design.

8.4 UXO Conclusions

An Explosive Ordnance Threat Assessment (EOTA) has been undertaken by PLANIT UXB Limited (Appendix A). The EOTA states that a "Medium" Ordnance Threat Level applies across the Site, and that "a UXO threat management strategy is required to be in place prior to intrusive engineering works". Further liaison with PLANIT is ongoing to establish the extent of the mitigation measures required, and whether the Site can be 'zoned' in terms of risk level.

8.5 Recommendations

8.5.1 Ground Investigation

A combined geotechnical and geoenvironmental ground investigation is required to better understand the potential contamination risks identified and to produce a detailed ground model to allow geotechnical design.

8.5.2 Physical Hazards

Sharps and Needles were identified on Site during the Site walkover. It is recommended that a sharps and needle disposal specialist is consulted with regards to identifying the extent of and appropriate measures for Site management and/or removal of these items prior to the start of any construction works. It is also recommended that the site is secured prior to any such removal to prevent further sharps being dumped on site.

8.5.3 Japanese Knotweed

Large quantities of Japanese Knotweed were identified on the banks of the River Medlock within the channel during the Site walkover. There was no visual evidence that knotweed had migrated out of the channel onto surrounding areas of the Site, however it is quite possible this has occurred. It is understood that a full survey of the river will be undertaken in the near future, which will fully characterise the extent of knotweed present. It is recommended that a Japanese Knotweed specialist is consulted with regards to identifying the extent of the infestation and recommending appropriate measures for Site management and/or removal of Japanese Knotweed impacted material.

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Appendix A UXO Assessment



EXPLOSIVE ORDNANCE (EO) THREAT ASSESSMENT (EOTA)

MAYFIELD DEPOT, FAIRFIELD STREET, MANCHESTER, M1 2QF

This assessment draws together all the available information with regards to the site of concern regarding potential Explosive Ordnance (EO) Contamination. It assigns an Explosive Ordnance Threat Level and proposes an appropriate Risk Management Strategy to reduce any associated risks.

This assessment has been produced in compliance with the Construction Industry Research and Information Association guidelines (Report CIRIA 681, dated Dec 08) for the preparation of detailed Risk Assessments in the management of UXO risks in the construction industry, for which PLANIT was an instrumental driver for improved UXO risk management and transparency.



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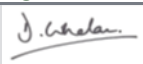
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Peer Review:	Andrew HAMILTON	

EXECUTIVE SUMMARY					
SITE DESCRIPTION	The site is located approximately 1.5km east of Manchester city centre and the Exhibition Centre, immediately south of Piccadilly Station. The site is loosely bounded by the main line railway running east to west forming the northern boundary of the site, to the west London Road runs north to south and the site's southern boundary is formed by the A635 (M) leading into Mancunian Way. National Grid Reference for the approximate centre of the site is SJ 851 976 and the nearest postcode is M1 2QF.				
POTENTIAL THREAT SOURCE	The following items of explosive ordnance are thought to remain as potential threat sources to ongoing engineering operations at the site of concern: • WW2 German air-dropped bombs – High Explosive (HE). • British Anti-Aircraft Artillery (AAA) projectiles.				
THREAT PATHWAY	For the purposes of this assessment, it has been assumed that development works would include piled foundations and excavations beyond WW2 ground levels. It is anticipated that personnel or key equipment may complete the risk pathway during excavation and/or piling operations that may bring them into physical contact with potential threat items.				
KEY FINDINGS	There is incontrovertible evidence that the site of concern was directly affected by aerial bombing during WW2. The possibility that the site was affected by Anti-Aircraft Artillery projectiles returning to earth unexploded cannot be reasonably ignored. • There is no evidence to suggest that other ordnance contamination events occurred at the site of concern. • There are no Abandoned Bombs or UXBs recorded that would affect the site of concern directly. • The EO Threat varies across the site of concern.				
THREAT LEVEL	The following Ordnance Threat Levels apply: <table border="1"> <thead> <tr> <th>Ordnance Type</th><th>Threat Level</th></tr> </thead> <tbody> <tr> <td>50, 250, 500 and 1,000kg bombs, British AAA projectiles</td><td>MEDIUM</td></tr> </tbody> </table>	Ordnance Type	Threat Level	50, 250, 500 and 1,000kg bombs, British AAA projectiles	MEDIUM
Ordnance Type	Threat Level				
50, 250, 500 and 1,000kg bombs, British AAA projectiles	MEDIUM				
THREAT MITIGATION	Considering the findings of this assessment, a UXO THREAT MITIGATION STRATEGY IS REQUIRED to be in place prior to intrusive engineering works at this site of concern.				
THREAT REVIEW	<i>A review of these recommendations must be undertaken considering any additional, relevant information being provided. Such a review may, if the EO Threat Level is deemed to have altered, make alternative recommendations from those made above to implement work safely.</i>				

AIM & METHODOLOGY

The aim of this assessment is to identify any threats that may be posed by EO during the proposed engineering works at the site of concern and, where a threat is identified, to recommend a risk mitigation strategy that will reduce this threat to acceptable levels.

This assessment follows the CIRIA 681 Guidelines, which were compiled using, as a main driver of change, PLANIT's innovative approach to EO risk assessment.

The following key considerations are addressed in this assessment:

- The risk that the site of concern was contaminated by EO.
- The risk that EO remains on site.
- The risk that EO may be encountered during the proposed engineering works.
- The risk that EO may be initiated by proposed engineering works.
- The consequences of encountering or initiating EO.

If the likelihood of encountering EO is significant, information about the types and natures of that EO and the expected levels of contamination is considered within the source-pathway-receptor context of contamination. Should a confirmed pathway exist, the information enters our proprietary Threat Assessment Matrices in order to arrive at a valid and transparent Threat Level.

The Threat Level allows relevant conclusions to be made about the EO Risk at the site of concern, which in turn allows an appropriate Risk Mitigation Strategy to be developed.

The Threat Mitigation Strategy is intended to give the Client a best-fit, safe solution that will allow the level of risk from EO to be reduced to an acceptable level; providing maximum project planning flexibility.

PLANIT's approach to EO threat assessment has been fundamental in driving change throughout the UK Commercial EOD Industry and was instrumental in the drafting of CIRIA 681. PLANIT's approach provides transparency to our EO risk assessment process allowing the Client to make valid decisions on what is a specialist activity; empowering them to maintain control over this vital aspect of their project - Where necessary, appropriate EO risk mitigation measures will be recommended.

This assessment considers general and site-specific factors, including:

- Historical use of the site in relation to ordnance manufacturing, storage and disposal.
- Historical use of the site in relation to Military training and related facilities.
- Evidence of offensive aerial and naval bombardment during WW1 and WW2.
- Evidence of Unexploded Bombs (UXBs).
- Previous EO incidents and/or EO survey/clearance activities.
- Extent of post-war redevelopment.
- Proposed engineering works.

RELIABILITY OF HISTORICAL RECORDS

This assessment is drawn from detailed research into the available historical evidence. Every effort is made to gather all the relevant material; however, PLANIT cannot be held responsible for any changes to the assessed level of risk or proposed risk mitigation strategies due to subsequent information that may come to light at a later date.

The accuracy and detail of wartime historical records is difficult to verify, not least of which is due to the conditions under which much of this information was gathered and recorded. Additionally, recording of information was less formalised in the early days of the German air campaign against the UK mainland (Pre-Bomb Census Record) and much information recorded early on was lost during subsequent air raids. Records for rural, sparsely populated areas are not always reliable, being based on second-hand information in many cases; records of attacks on military installations was often recorded independently from general records and many such archives have been lost or remain undisclosed to the public.

Consequently, the exact location, quantity and nature of the EO threat cannot be definitive but rather remains subjective and is based on the careful analysis by experts of the available information. PLANIT cannot accept liability for any gaps in the historical record.

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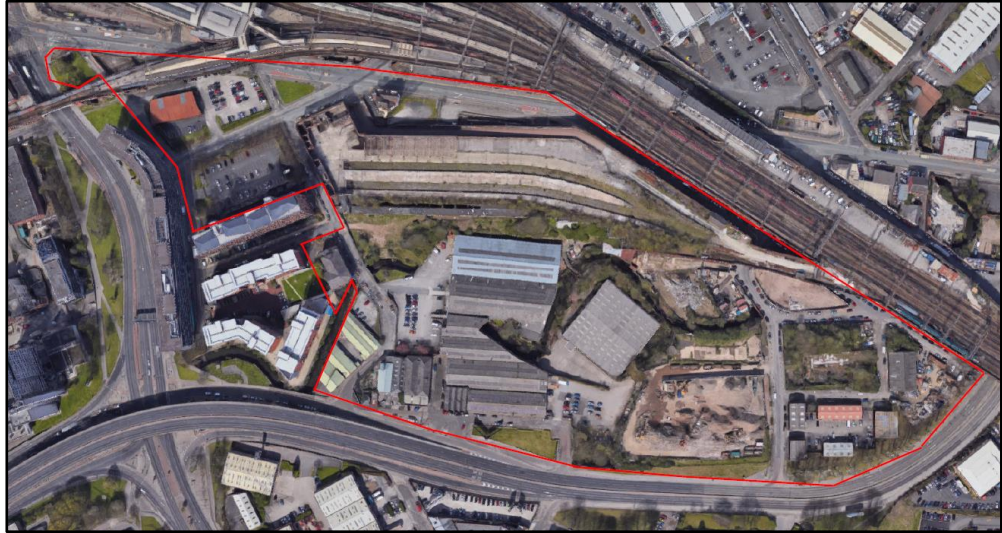
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SITE LOCATION & DESCRIPTION

SITE OF CONCERN

The site is located approximately 1.5km east of Manchester city centre and the Exhibition Centre, immediately south of Piccadilly Station. The site is loosely bounded by the main line railway running east to west forming the northern boundary of the site, to the west London Road runs north to south and the site's southern boundary is formed by the A635 (M) leading into Mancunian Way.

National Grid Reference for the approximate centre of the site is **SJ 851 976** and the nearest postcode is **M1 2QF**.



The site is dominated by a multitude of large, multi-storey industrial buildings with large areas of hard standing for vehicle manoeuvre, parking and material storage associated with the Goods Yard supporting Piccadilly Station. Small, isolated areas of scrub/ grass with shrubs and small trees are dotted across the site area.

Maps showing the site location and layout are at Annex A.

SCOPE OF PROPOSED WORKS

The details of the proposed development are unknown at the time of writing this assessment.

For the purposes of this assessment, it has been assumed that development works could include intrusive engineering beyond WW2 ground levels. It is anticipated that personnel or key equipment may complete the risk pathway during excavation and/or piling operations that may bring them into physical contact with potential threat items.

GEOLOGICAL ENVIRONMENT

The available geological information (Ref 2) shows the site to be underlain by superficial deposits in the form of Late Glacial Flood Gravels. This masks the solid geology beneath the site which comprises the Bunter Sandstone strata of the Triassic Period.

According to the, "Factual Ground Investigation and test report for redevelopment of land to the south of Manchester Piccadilly Railway Station, Manchester", by Buro Happold, dated 8 Oct 09, the specific ground conditions are:

Strata	Depth (m)	Thickness (m)
Made Ground: Turf on gravelly sand with cobbles, brick and concrete. Tarmac in places over concrete.	0.80	0.80
Soft to firm very sandy gravelly friable clay.	1.90	1.30
Orange brown silty fine to medium sand.	3.20	Not proven

REVIEW OF RELEVANT DATASETS

SOURCES OF INFORMATION

PLANIT ensures that Explosive Ordnance Risk Assessments (EORAs) are as comprehensive as possible and detailed research is undertaken to collate all the available EO-related information that relates to the site of concern. Information sources may include, but are not restricted to:

- National Historic Archives.
- Local Authority & Council Archives.
- English Heritage National Monuments Record.
- Ministry of Defence Archives.
- PLANITs extensive archives drawn from many years of detailed research and operational experience of UXO Risk Management activities in the UK and abroad.
- Joint Service EOD Centre (JSEOD).
- Historic Mapping and Aerial Photography.
- Specific UXO-related documents such as military bombing and casualty records.
- Local libraries and history groups.
- Open sources such as published books and internet searches.
- Anecdotal evidence from eye witnesses.

NB: The MoD information office that deals with requests for information relevant to EO clearance operations completed by the MoD is currently facing significant delays. Although a request has been submitted, any information that may be relevant has not yet been forwarded for timely inclusion in this assessment. However, if any relevant information comes to light from this source that affects the threat assessment, this will be notified to the client as a matter of urgency.

SITE HISTORY

Up to **1905**, the site was occupied by what appear to be residential houses but by **1923** they have been cleared to make way for Mayfield Station which is now dominating the northern part of the site. The site layout is constant until the map record of **1956**, which shows cleared areas more than likely because of bomb damage during WW2. Mayfield Station itself has been reduced by half and there are other clear areas of bomb damage across large areas of the site. There is also a notable addition to the site area in this map sheet which is the addition of a large structure, built immediately post-War, in the centre of the site.

By **1968**, Mayfield Goods Station has been fully restored and other previously cleared areas of the site have been redeveloped. This work appears to be complete with the addition of some small buildings to the western edge of the site area by **1985**. This site layout remains constant until at least **2010** but by **2013**, the Goods Station roof has been removed.

ORDNANCE MANUFACTURE & STORAGE

During WW1 and WW2, Lincolnshire housed many facilities involved in the manufacture, storage, filling and testing ordnance. The nearest explosive manufacturing sites (known as His Majesty's Explosive Filling Factories (HMEFs)) were:

	• Trafford Park (HMEF). • Hyde Road, Gorton, Manchester (National Shell Factory – manufacturing 4.5” shell (projectile) casings). The nearest Royal Ordnance Facilities (ROFs) established in the run up to WW2 were: • ROF Chorley. • ROF Radway Green. None of these sites would have posed a potential threat to the site of concern.
MILITARY HISTORY	There is no evidence to indicate that the site was ever used for military purposes.
CIVIL DEFENCE	Manchester possessed a peak of 56 Heavy Anti-Aircraft Batteries during WW2, including 4.5, 3.7 and 3-inch Anti-Aircraft (AA) guns, sited in some 70 separate locations. None of these were sited on or near to the site of concern to have created a direct source of potential ordnance contamination. Due to the relatively high failure rate of Anti-Aircraft Ammunition (AAA) during this time, there remains the possibility that such ordnance fell back to earth creating additional UXO hazards. This type of ordnance had the potential to penetrate the ground to significant depths and cannot be entirely discounted as a potential threat source although its potential presence is impossible to determine with any quantifiable degree of certainty. As would be expected, Manchester had several Civil Defence (‘Starfish’) sites designed to protect London from aerial attack. Manchester’s Starfish Sites were located at: • Chat Moss. • Tatton Park. • Park Moor (now in Lyme Park Country Park). • Churnal Moor. • Mossley. • Carrington Moss. • Ludworth Moor. • Reddish. • Elkstone (north Staffordshire). None of these sites would indicate the possibility that erroneous Luftwaffe bombing would have produced a consequent UXO risk on the site of concern.
WW1	Greater Manchester suffered two aerial bombardments during WW1; on 26 Sep 1916 Zeppelin L21 dropped 20 HE bombs on Bolton, mistaking the town for Derby. Significant damage was caused and 13 people were killed. On 12 Apr 1918 Zeppelin L61 bombed Wigan at 2300hrs in a raid that lasted some 12 minutes. Three people were killed and a further nine were injured during the raid. Neither of these raids would have affected the Site of concern and therefore the risk from WW1 unexploded ordnance is negligible.
WW2	During WWII, the site sat close to several industrial and strategic installations key to the war effort that were located in the area – including Mills, Quarries and Railway infrastructure. Luftwaffe target maps do not list specific locations on or close to the site although the concept of specific targets, when bombing in and around Manchester, was only relevant prior to the accidental Luftwaffe raid on London on 24th Aug 1940. This attack broke the unofficial agreement not to bomb opposing capitals and led to the gradual breakdown of the Amsterdam draft international rules prohibiting the attacking of civilian infrastructure outside of combat zones

(purely industrial areas); Great Britain, including Manchester, was now opened to air attacks. As well as the air raids targeting Manchester itself, unused bombs were routinely jettisoned whilst returning to base following an unsuccessful raid. In addition, the high-altitude area bombing during this period was notoriously inaccurate with areas surrounding specific targets suffering during attacks on the targets themselves.

The site in question sits in the middle of the main areas within Manchester that were targeted, mostly during the 'Manchester Blitz' of Dec 22-24 1940 - Salford Docks, Manchester's industrial centre and Trafford Park (with the areas surrounding them also being affected by the same air raids). Many Manchester companies were involved in war production work including the Fairey Aviation plant at Ringway, the Ferranti factory at Hollingwood, Metropolitan Vickers works at Trafford Park and the A.V. Roe (Avro) plant at Chadderton. In addition, Ford operated a factory in Eccles building Rolls Royce Merlin engines for the Lancaster bomber and the Mosquito fighter bomber.

The Luftwaffe mounted consecutive heavy attacks on the Manchester area on the nights of 22/23rd and 23/24th Dec 1940. Large areas of Manchester, Salford and Stretford were devastated, killing some 684 people and injuring a further 2,364. The first raid of this 'Manchester Blitz' saw 272 tons of HE bombs and 1, 023 canisters of Incendiary Bombs (IBs) dropped. During the second raid, 171 aircraft dropped a further 195 tons of HE bombs and 893 canisters of IBs.

The site is in Region 10 (Manchester) for Civil Defence purposes. Manchester received some 3, 465 Tonnes of HE bombs throughout the war although Cheshire and Chester were much less affected:

Ordnance Type	Number of Bombs		
	Region 10	Cheshire	Chester Rural District
50Kg HE	1403 (79)* + 576 (1)**	594 (25)	1
250Kg HE	727 (49) + 368	301 (19)	13
500Kg HE	114 (7) + 57 (3)	58 (6)	10 (1)
1000Kg HE	2 (2) + 6	1 (1)	
Parachute Mine	514 (77) + 592	139 (16)	
V1 'Doodlebug'	14	6	1
V2 Long Range Rocket	0		
Small Incendiary Bombs	25 454	3 639	
50Kg Phosphorus Bomb	Unknown		
Fire Pots	Unknown		
Oil Bomb	212 (4) + 202	48 (1)	
Containers	Unknown		
Unclassified Ordnance	8 114 (1 341) + 10 658	2 806 (524)	

The bombs recorded as falling on the County Borough of Manchester are summarised below:

Area Acreage	27, 255
High explosive Bombs (All Types)	712
Parachute Mines	18
Oil Bombs	7
Phosphorus Bombs	-
V1 'Doodlebug'	1
Total	738
Items per 1000 acres	27.1

UNEXPLODED BOMBS (UXBs)

Between 1940 and 1945, Bomb Disposal (BD) Teams cleared over 50,000 items of German air-dropped ordnance of 50Kg or larger, 7 000 anti-aircraft (AA) projectiles and more than 30 000 beach mines – This work claimed the lives of 394 Officer's and men. The War Office at the time stated that over 200 000 HE bombs exploded in

	Britain during WW2 with some 25 195 remaining a threat as UXBs i.e. 11%. Some 93% of all UXBs were 50Kg HE and 250Kg HE aerial bombs. The types of ordnance discovered as UXBs give an indicator of the type of ordnance that may be encountered on or near the site of concern. In this instance, there are no records of UXBs that may present a threat to the site.																
ABANDONED BOMBS	A post-air raid search of damaged buildings and facilities would have included a specific search for bomb entry holes. If such evidence was discovered, then BD Teams would have been tasked (in order of strict priority from Category A, the highest priority, to category D, the lowest) to assess the potential UXB and to recommend a course of action. For UXBs that were deemed to be a high enough priority were tackled by the BD Teams who made strenuous efforts to recover and dispose of these items. However, it was not always possible to recover such bombs either through physical constraints, a lack of resources or a change in priority. Such UXBs were noted as 'Abandoned'. Due to the low priority of abandoned bombs, records that detail them are sketchy and sometimes contradictory. Others were subsequently recovered after the War when time and resources permitted and others remain 'abandoned'. It is worth remembering that 'abandoned' bombs may also include suspected UXBs that were reported but not confirmed, but simply efforts to locate the 'bomb' were exhausted. The Abandoned Bombs recorded near the site are: <table border="1"> <thead> <tr> <th>Reference/ Location</th><th>Item</th></tr> </thead> <tbody> <tr> <td>CD 49.3822 – Fields 600yds SE of Grove Farm, Chorlton by Beckford.</td><td>1 x AA Shell</td></tr> <tr> <td>CD 53.3825 – Fiels near rear of Gun Site Acres Lane, Upton Heath.</td><td>1 x AA Shell</td></tr> <tr> <td>CD 56.3826 – Staok Grange Farm, Little Stanney.</td><td>1 x AA Shell</td></tr> <tr> <td>CD 84.3843 – Wood Farm, Grove Road, Mollington, 500yds W of Lee Holme.</td><td>1 x AA Shell</td></tr> <tr> <td>CD 82.3842 – 50yds W of Dunkirk Lane, Capenhurst Hall Park Farm, Capenhurst.</td><td>1 x AA Shell</td></tr> <tr> <td>CD 81.3841 – 100yds S of Pitts farm, Woodbank, Shotwick.</td><td>1 x AA Shell</td></tr> <tr> <td>CD 59.3827 – Shotwick Park, S of No. 9/10 Holding Arterial Road.</td><td>1 x AA Shell</td></tr> </tbody> </table> None of these are considered to present a potential UXO-related threat.	Reference/ Location	Item	CD 49.3822 – Fields 600yds SE of Grove Farm, Chorlton by Beckford.	1 x AA Shell	CD 53.3825 – Fiels near rear of Gun Site Acres Lane, Upton Heath.	1 x AA Shell	CD 56.3826 – Staok Grange Farm, Little Stanney.	1 x AA Shell	CD 84.3843 – Wood Farm, Grove Road, Mollington, 500yds W of Lee Holme.	1 x AA Shell	CD 82.3842 – 50yds W of Dunkirk Lane, Capenhurst Hall Park Farm, Capenhurst.	1 x AA Shell	CD 81.3841 – 100yds S of Pitts farm, Woodbank, Shotwick.	1 x AA Shell	CD 59.3827 – Shotwick Park, S of No. 9/10 Holding Arterial Road.	1 x AA Shell
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BOMB CENSUS MAPS	Manchester's Bomb Census Records are comprehensive and indicate that several large, air-dropped bomb fell within the site itself with further bomb being suggested by the large-scale building clearances in the east of the site (See Annex C). Mayfield station directly suffered the effects of bombing during World War II, when it was hit by a parachute mine on 22 December 1940. The relevant Bomb Census Map extract is at Annex B.																
HISTORICAL STREEP MAPS	Historical street plans of the period are a useful indicator of whether an area may have suffered bomb damage. The street layout prior to WW2 is the 'start state' and major changes to street layouts or building boundaries may indicate that the change was due to bomb damage. In this instance, there are some significant changes to the street layout that probably indicate bomb damage within the site boundary and there is clear bomb damage in the wider area surrounding the site. Mayfield Station itself and the building complex immediately to the south have received direct bomb/ parachute mine strikes. The relevant Historical Street Plans are at Annex C.																

HISTORICAL AERIAL PHOTOGRAPHY

The same rationale applies with historic aerial photography as it does when examining historical street plans – changes between pre-war and post-war images may indicate the possibility of damage caused by bombs falling on the site. Sometimes, detail is such that it allows bomb damage to be seen directly on sites of concern. In this instance, historical aerial photography from the period is not available and therefore no comparisons can be made.

THREAT ANALYSIS

IS THERE EVIDENCE THAT THE SITE WAS AFFECTED BY ANY EXPLOSIVE ORDNANCE CONTAMINATION EVENTS?

Yes.

The historical record is acknowledged as being incomplete from a National perspective but there is clear evidence within the relevant extract from the Manchester Bomb Census Maps that the site of concern was directly affected by bombing during WW2; which included large air-dropped bombs and parachute mines and/or British anti-aircraft artillery falling back to earth as UXBs.

Not much of the site area escaped unscathed, and there is clear evidence that the site did receive direct bomb strikes as well as widespread bomb blast damage. The bomb damage would have been significant and the possibility that another bomb fell on the same area and remained underground, undiscovered as a UXB must be considered plausible. It was also a common error to mistake the havoc wreaked by a large bomb falling through built structures unexploded, which is considerable, with a smaller bomb detonating as intended.

IF ENCOUNTERED, WHAT ORDNANCE TYPES ARE ANTICIPATED?

There is explicit evidence that the site received a number direct hits from large, air-dropped bombs/ parachute mines during WW2. Parachute mines, due to their nature, would have remained on the surface if unexploded and would have been dealt with at the time and can therefore be discounted as potential threat items today. There is no explicit evidence that the site directly received Anti-Personnel or incendiary bomb strikes. Whether the area received AAA returning to earth unexploded is impossible to answer but it would be prudent to accept the worst-case scenario in this case and accept that they probably did.

The site is not known to have been used for ordnance manufacture or storage and neither was it a former Military installation. So, we can discount the possibility that the site was contaminated by ad hoc military activity.

The type and degree of post-War redevelopment is significant in that it would reduce the encounter potential for smaller items of ordnance such as anti-personnel bombs or AAA projectiles to such a degree across the site that this potential threat source may effectively be discounted. This would not be the case for areas of the site that have not been significantly redeveloped since the end of the War or within ground volumes that have remained undisturbed by intrusive engineering since this time.

The following potential threat items may remain under the site within 'at risk' ground volumes:

- Large, air-dropped, German HE Bombs including 50, 250, 500kg bombs (of WW2 vintage).
- British AAA projectiles.

WHAT IS THE EXPLOSIVE ORDNANCE / UXB ENCOUNTER DEPTH?

Ministry of Homeland Defence Security Bomb Penetration Studies. A major study was completed by the Ministry of Homeland Security during WW2, during which the penetration depths of 1328 air-dropped bombs (as reported by the BD Sections of the day and mostly in the Birmingham area). It was concluded, not surprisingly, that the penetration depths of different sized bombs varied according to the geology into which they fell.

The average penetration depth of 430 x 50Kg HE bombs in London Clay was found to be 4.6m and that for a 250Kg bomb 6.1m. Also, they concluded that a 500Kg bomb, the largest common bomb dropped during the War, had a likely penetration depth of 6m in sand and 8.7m in clay – the maximum observed for a 500Kg was

10.2m and for a 1000Kg bomb was 12.7m. It should be remembered that these depths were achieved unencumbered by obstacles to penetration such as buildings, concrete and brickwork.

The 'J' Curve. The 'J-curve' describes the path of a bomb (dropped from a normal altitude of about 5 000m) into homogenous ground will continue its line of flight (unless deflected by a substantial obstacle) but then turn upwards towards the surface before it stops. The horizontal distance (the 'offset') between the point of entry and final resting position was typically 1/3 of the ultimate penetration depth for a bomb. Therefore, if a bomb fell close to the exterior of a building or site and did not explode, the path that the bomb subsequently travelled beneath the ground, the "J-Curve", may have delivered it beneath the building or site footprint. The J-curve is often misunderstood, and used to describe the path taken by a bomb dropped from low flying aircraft to which it should not be applied.

The final penetration depth of an air-dropped depends upon several factors; the velocity of the bomb (as a function of the mass, speed) – PLANIT uses a standard velocity of 267m/s for assessment purposes – the angle of penetration of the bomb and the physical features through which the bomb travelled prior to impact with the ground and the geology of the ground into which it entered - Generally, the softer the ground, the deeper the expected penetration depth of the bomb. Peat, alluvium and soft clays are easier to penetrate than gravels and sand and water content plays a part. In addition, it must be remembered that 'barrier geology' such as very dense gravels or bedrock i.e. geology dense enough to stop the progress of a bomb underground, is an important factor in determining the median bomb penetration depth.

Given the ground cover at the time that the bombs fell, the anticipated geology and accepting the norm for the impact angle and velocity of a large UXB, it is reasonable to assume the norm when considering the potential Bomb Penetration Depth (BDP). Therefore, it is estimated that the average penetration depths of Explosive Ordnance (EO) at this site would be:

- British AAA projectiles – 2m
- 50kg HE – 4m
- 250kg HE – 6m
- 500kg HE – 8m
- 1000kg HE – 10m

HOW COULD AN UNCONTROLLED DETONATION BE BROUGHT ABOUT?

Unexploded Bombs rarely spontaneously explode (although some incidents claim to contradict this statement). High Explosive (HE) requires a great deal of energy to create the necessary conditions for detonation to occur. In the case of WWII German bombs being disturbed during intrusive ground works, there are many scenarios to be considered:

- **Direct impact onto the main body of the bomb.** Although this is a possibility, there is little chance of generating enough energy to detonate the explosive fill unless the fuse itself is directly struck.
- **Re-starting the mechanical clock-timer in a bomb fuse.** This is a possibility. It is probable that environmental conditions have corroded the fuse sufficiently to prevent clockwork mechanisms from functioning. However, under some conditions, fuse elements will be in a good condition and additional movement of a bomb fuse may be sufficient to restart a previously 'jammed' mechanical clockwork mechanism.
- **Induction of a static charge, creating a sufficient current to initiate an electric fuse.** This is an unlikely event. Environmental conditions are likely to have corroded the fuse, degrading its components sufficiently to prevent them from functioning. Any elements of the fuse capable of holding a charge would have dissipated in the time since the bomb failed to function.
- **Friction impact initiating fuse elements causing bombs to detonate.** Although remote, this is the most likely scenario that may result in a bomb detonating. Weathering within the fuse pocket can cause the explosives within the fuse to breakdown, crystallize and exude from the fuse itself. Violent physical disturbance of this exuded material carries the remote possibility of initiating the fuse mechanism which in turn will initiate the bomb.

WHAT WOULD THE EFFECTS OF SUCH A DETONATION BE TO THE SITE?

The effects of WWII German bombs detonating have been the subject of several well recorded studies. The general effect of an explosive detonation will depend upon:

- The size of the bomb and its Net Explosive Quantity (NEQ) (i.e. how much explosive material it contains).
- The type of fill in the bomb (i.e. high explosive, incendiary, photoflash).
- The physical location of the bomb. Whether it is:
 - On the surface.
 - Partially buried.
 - Buried (A bomb is 'buried' when it is more than 2½ times its own length below ground level and covered).
- The locations of the bomb in relation to other structures.
- The strength and design of structures near to the seat of an explosion.
- The nature of the ground (i.e. sand, gravel, clay, marsh etc).
- The location of the bomb in relation to human and animal populations.

There would be the potential for ground shock to damage important underground structures including sewers, communication cables, and foundations.

The potential Damage Radii to various underground structures has been assessed by extrapolating from the Joint Service Publication 364 which is the MOD Manual for assessing bomb damage. Potential damage radii for underground structures are assessed as:

Structure	Dist (m)
Brick Walls	30
Foundations	60
Cast Iron/ Concrete Pipes	15
Earthenware/ brick Sewers	25
Electric Cables/ Steel Pipes	12

WOULD THE SITE CONDITIONS AFFECT THE BOMB FAILURE RATE?

There is no evidence to suggest that bomb failure rate at the site of concern would have been any different from that routinely experienced, i.e. 10-15% of all bombs dropped.

WOULD UXBs HAVE BEEN DISCOVERED DURING WW2?

Density of Bombing. Manchester received a high density of bombing in WW2, and the site sits within the focus of those attacks. We know that the site itself received direct bomb/ mine strikes which caused significant damage. This factor would have made data gathering at the time more complicated and the likelihood of overlooking UXBs higher.

Frequency of Access. Since the site was occupied and used at the time of the air raids, the site of concern would have been subject to post-air raid survey and clearance. The fact that the site itself was affected by bombing, and given its key industrial role, any post-raid survey activities would have been thorough. This would have made the likelihood of identifying smaller items of EO (such as Incendiaries and AP bomblets) quite high whilst larger UXBs would have been more readily identified. However, entry holes and UXBs could easily have been overlooked due to their diminutive size, or gone unnoticed if they fell into water.

Ground Cover. The site was industrial in nature at the time of the attacks and as such it's physical characteristics would act to retard the progress of UXBs underground by reducing their overall velocity prior to impact. However, bomb penetration statistics were collected at the time in similar conditions and therefore the

	maximum potential bomb penetration depths must be considered as the ‘worst case’. This is also true of bombs falling into water. Peripheral Bomb Damage. We know that the site of concern was subject to serious bomb damage during the War. This increases the possibility of post-air raid operations failing to identify entry holes of potential UXBs.
DOES THE SITE’S DEVELOPMENT HISTORY AFFECT THE POTENTIAL FOR UXO ENCOUNTER?	Yes. The fact that there has been a degree of post-War development at the site is worthy of note in that any potential contamination from shallow EO (i.e. AP bombs and IBs) would likely have been discovered during these works and dealt with at the time. Apart from the renovation of the Station with the notable exception of the new structure which appeared in the centre of the site by 1956 (foundation design unknown), much of the site within which the bombs are recorded as falling have seen little redevelopment in terms of large, industrial buildings since the end of the War. In areas where redevelopment has not been significant, the potential for UXO encounter as it did immediately post-War. For other areas, it is worth remembering that development either immediately post-War or in the 1960/ 70/ 80s would not have taken any account of the potential for UXBs at the site of concern nor would any effective technology be available to detect such potential threat items. Modern structures tend to have foundation designs that go deeper than historic buildings and risk encountering UXBs at depths beyond existing historic foundation levels or within historic foundation structures that were not detected by excavation or historical bomb survey. Ground volumes between that which has been redeveloped significantly post-War down the maximum anticipated bomb penetration depth (BPD) must be considered potentially at risk from large, deep buried, air-dropped bombs or large Anti-Aircraft Artillery (AAA) Projectiles. If future engineering is to impact on these ground volumes the potential for UXO encounter in this area remains as it did immediately post-War.
DOES THE UXO THREAT VARY ACROSS THE SITE?	Yes. Volumes of ground across the site that have already been subjected to extensive redevelopment involving the displacement of earth, may be considered free from the threat of UXO/EO <i>within the volumes of ground excavated/disturbed</i>. The same cannot be said of areas of the site that have not been subjected to the same degree of physical disturbance. Areas of the site that have been subjected to historical piling <i>cannot be automatically considered to be free from the threat of UXO/EO within the volumes occupied by the piling layout although the threat is significantly reduced</i> – there is a possibility that historical piles have either missed UXBs at depth or pushed these items aside without incident when they were emplaced. Further, the volume of ground below such piled areas cannot be considered free from the threat of UXO/ EO down to the maximum BPD. Volumes of post-War made ground may be considered free from the threat of UXO/EO also, unless a cross-contamination event has occurred, which would be almost impossible to ascertain.

THREAT ASSESSMENT											
POTENTIAL EXPLOSIVE ORDNANCE THREAT ITEMS	The following items are considered to remain under the site as potential threat items: - Large, air-dropped, German HE Bombs including 50, 250, 500kg bombs (of WW2 vintage). - British AAA projectiles.										
CURRENT EXPLOSIVE ORDNANCE THREAT LEVELS	The Ordnance Threat Levels for the site of concern from the Threat Assessment Matrices are assessed as: <table border="1"> <thead> <tr> <th>Ordnance Type</th><th>Threat Level</th></tr> </thead> <tbody> <tr> <td>50, 250, 500 and 1,000kg bombs, British AAA projectiles</td><td>MEDIUM</td></tr> </tbody> </table>	Ordnance Type	Threat Level	50, 250, 500 and 1,000kg bombs, British AAA projectiles	MEDIUM						
Ordnance Type	Threat Level										
50, 250, 500 and 1,000kg bombs, British AAA projectiles	MEDIUM										
ENGINEERING WORKS	Intrusive Site Investigation, piled foundations, bulk excavations etc.										
RISK PATHWAY	For the purposes of this assessment, it has been assumed that development works could include excavations and/or intrusive engineering beyond WW2 ground levels. It is anticipated that personnel or key equipment may complete the risk pathway during excavation and/or piling operations that may bring them into physical contact with potential threat items.										
WHAT ARE THE CONSEQUENCES OF AN UNCONTROLLED DETONATION?	The consequences of the uncontrolled detonation of any of the items of ordnance listed above are: <table border="1"> <thead> <tr> <th>Asset</th><th>Consequence</th></tr> </thead> <tbody> <tr> <td>People</td><td>Lost Time Injury >7 Days</td></tr> <tr> <td>Plant</td><td>Unit Level Damage</td></tr> <tr> <td>Property</td><td>Major Wider Damage</td></tr> <tr> <td>Environmental</td><td>Major Effect</td></tr> </tbody> </table>	Asset	Consequence	People	Lost Time Injury >7 Days	Plant	Unit Level Damage	Property	Major Wider Damage	Environmental	Major Effect
Asset	Consequence										
People	Lost Time Injury >7 Days										
Plant	Unit Level Damage										
Property	Major Wider Damage										
Environmental	Major Effect										

THREAT MATRICES

ORDNANCE CATEGORY

The 'Ordnance Category' is assessed for the different types of ordnance in terms of the 'Damage Radii' that may result were the ordnance subject to an uncontrolled explosion and is a function of the calibre of the ordnance and whether it is encountered on the 'surface' or 'buried'.

Ordnance Category	Ordnance Category Description	Danger Radii (m)	Potential Threat Item
0	No Explosive Ordnance (EO) suspected to be present	NA	NA
1	Landmines, Anti-Personnel, HE; HE in Bulk <5Kg; Pyrotechnics	< 75	NA
2	Projectiles, HE <75mm calibre; Projectiles, Mortar, HE 50mm to < 75mm calibre; Grenades, Hand, HE; Grenades, Rifle, HE.	< 100	NA
3	Projectiles, HE < 125mm calibre; Rockets, HE, Anti-Tank (HEAT); Bombs PIAT, HE; Aerial Bombs, HE, 50-250Kg (Surface & Buried); Aerial Bombs, Blast, HE & Sea Mines 20-250Kg; Aerial Bomb, HE, 250-500Kg (Buried)	< 250	British AAA 50kg HE Bombs
4	Bombs, Mortar, HE <105mm calibre; Bombs, Mortar, Spigot, HE; Landmines, Anti-Tank, HE; Aerial Bombs, HE, 250-500Kg (Surface)	< 300	250-500kg HE Bombs
5	Projectile, HE > 125mm calibre; Aerial Bombs, HE, 1500-2500Kg (Surface); Aerial Bomb, Blast, HE & Sea Mines 500-1500Kg (Surface)	< 500	NA
6	Aerial Bombs, HE, 2000-10000Kg (Buried); Aerial Bombs, Blast, HE & Sea Mines 1500-4000Kg (Surface)	< 800	NA

ORDNANCE THREAT

This table assigns the 'Ordnance Threat', which is a function of the Ordnance Category and the anticipated encounter depth. i.e. the smaller and deeper the ordnance the less threat is present to people and property at the surface.

ORDNANCE CATEGORY							Depth of Encounter (m)
0	1	2	3	4	5	6	
ORDNANCE THREAT							
							>10
				250-500kg Bomb			5<10
			50kg Bomb				2.5<5
			British AAA				0.5<2.5
							0<0.5
							Surface

ORDNANCE THREAT LEVEL

The 'Ordnance Threat Level' is arrived at by comparing the 'Ordnance Risk' with the 'Likelihood of Encounter' of a ordnance as a function of the level of expected ordnance contamination of a given type at a site of concern.

Ordnance Threat	ASSETS AFFECTED				LIKELIHOOD OF ENCOUNTER				
	People	Plant	Property	Environment	Very Unlikely	Unlikely	Likely	Very Likely	Extremely Likely
	First aid injury	Slight damage	Slight damage	Slight Effect					
	Medical injury	Item repair	Minor damage	Minor Effect					
	Lost time <7 days	Item write off	Major damage	Local Effect					
British AAA, 50-500kg Bomb	Lost time injury >7 days	Unit level damage	Major wider damage	Major Effect	British AAA, 50-500kg Bomb				
	Fatality	Multiple damage	Catastrophe	Massive Effect					
					ORDNANCE THREAT LEVEL				
No special measures required					NEGLECTIBLE				
Monitor & manage potential risks					LOW				
Review & emplace strict control measures if necessary					MEDIUM		X		
Control measures required to mitigate risks to acceptable levels					HIGH				
Intolerable Risk Level. Immediate control measures prior to any further works					EXTREME				

THREAT MITIGATION		
ACTIVITY	THREAT MITIGATION MEASURES	FINAL THREAT LEVEL
All Activities	If planned engineering works are going to enter potentially 'at risk' ground volumes, then a threat management strategy IS REQUIRED to be in place prior to intrusive engineering works at the site of concern. Explosive Ordnance Safety Awareness Briefings. An explosive ordnance Safety Briefing should be included as part of routine site health and safety training and form a key element of the Site Health & Safety Plan. This should be conducted by a trained specialist and would assist conformance with the CDM Regulations 2007. The briefing will instruct all personnel on the identification of EO hazards, actions to take in the event of an EO incident to protect personnel, key equipment, property and the public. Explosive Ordnance Site Safety Instructions. Explosive Ordnance Site Safety Instructions should be drafted for inclusion in the site-specific health and safety manual and would include information on dealing with an EO incident safely and appropriately. These instructions would form part of the permanent site documentation and will be an aide memoire for identifying potential EO hazards, making a preliminary threat assessment as well as specific guidelines on what to do in the event of a confirmed incident.	AS LOW AS REASONABLY PRACTICABLE (ALARP)
SITE INVESTIGATION WORKS	Site investigation works should be supported by UXO survey as appropriate. Consideration should be given to whether the works are shallow or deep from the perspective of UXO Survey. 'Shallow' Survey is survey of the ground from 0.0m bgl to 6.5m bgl and 'Deep' UXO Survey is that beyond 6.5mbgl. • Boreholes. PLANIT can conduct a non-intrusive survey of a 5m x 5m box which will accurately allow your borehole to proceed into a volume of ground under which there are no ferrous obstructions. Several locations may be provided within a survey box, allowing maximum flexibility for positioning and preventing any boreholes being terminated because of encountering a potential threat item at depth. • Trial Pits. Using shallow non-intrusive survey, the area for your trial pit can quickly be surveyed and confirmed as free from ferrous anomalies/UXO. Data is interpreted on-site and therefore locations can be changed very efficiently in the event of a potential obstacle. • Window Sampling. Using shallow non-intrusive survey, the area for your window sample can quickly be surveyed and confirmed as free from ferrous anomalies/UXO. Data is interpreted on-site and therefore locations can be changed very efficiently in the event of a potential obstacle.	AS LOW AS REASONABLY PRACTICABLE (ALARP)

SHALLOW INTRUSIVE ENGINEERING WORKS	Where ‘shallow’ engineering may complete the risk-receptor pathway, there are two options available to effectively deal with the EO Threat when conducting shallow intrusive ground works. On-Site UXO Support. On-site UXO Support for shallow ground works would involve the presence of an appropriately trained and experienced UXO Technician during this phase of construction. The role of the UXO Technician is to: • Conduct EO Safety Awareness Briefings as required. • Monitor all intrusive ground works using visual and instrument aided means to locate any EO that may be uncovered during site works. • Provide an immediate and expert assessment of any EO that may be discovered. • Assist in implementing an appropriate and safe response to an EO incident. • Design and emplace protective works as an immediate response to protect personnel, key equipment, property and the public as may be required. • Advise on best safe working practice considering the perceived EO Threat. • Act as the liaison with the Authorities on behalf of the Client in the event of an EO incident. Shallow Non-Intrusive UXO Survey. PLANIT can deploy industry leading technology that will survey your site of concern non-intrusively (if ground conditions permit) to identify potential EO Threat Items. Any anomalies identified following the non-intrusive survey that may be EO should then be subject to Controlled Excavation to confirm them as EO and remove the threat or discount them. Once the non-intrusive survey and controlled excavation are complete, there is no further requirement for UXO Support at the site of concern since all EO Threats would have been identified and dealt with.	AS LOW AS REASONABLY PRACTICABLE (ALARP)
DEEP INTRUSIVE ENGINEERING	There are a few options available to effectively deal with potential EO Threats when conducting deep intrusive ground works. Which approach is applicable will depend upon the ground conditions of the site of concern: Deep Non-Intrusive UXO Survey. PLANIT can deploy industry leading technology that will survey your site of concern non-intrusively (if ground conditions permit) in order to identify potential EO Threat Items at depth – UXO Survey should proceed to the expected UXB penetration depth or maximum depth of intrusive ground works, whichever is shallower. As a benchmark, PLANITs Deep Non-Intrusive Survey is capable of identifying a 500Kg HE bomb to some 8.0m bgl in average ground and larger bombs deeper. This approach is ideal for covering large areas quickly and can be employed to survey piling runs and borehole locations. Any anomalies identified following the non-intrusive survey that may be EO should then be subject to Controlled Excavation to confirm them as EO and remove the threat or discount them. Once the non-intrusive survey and controlled excavation are complete, there is no further requirement for UXO Support at the site of concern since all EO Threats would have been identified and dealt with. Magcone UXB Survey. PLANIT can deploy world class Magcone Survey Systems to survey either pile locations or small areas ahead of intrusive	AS LOW AS REASONABLY PRACTICABLE (ALARP)

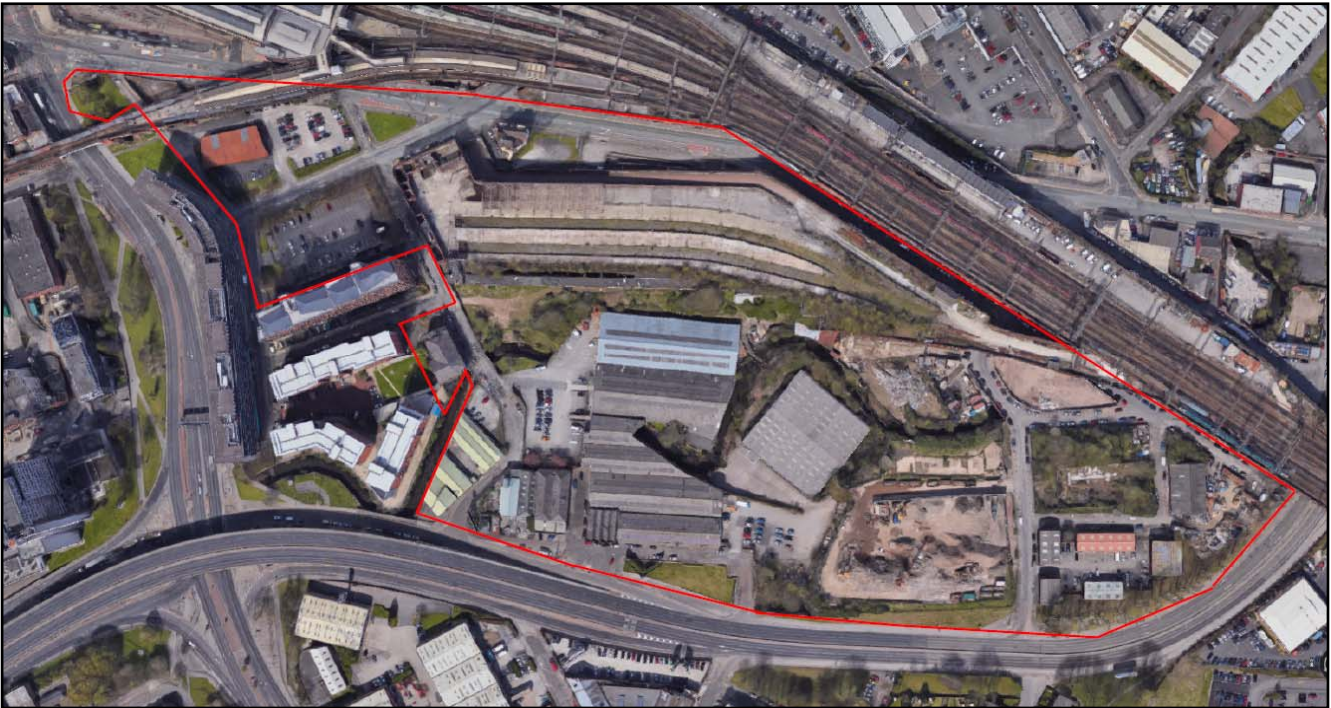
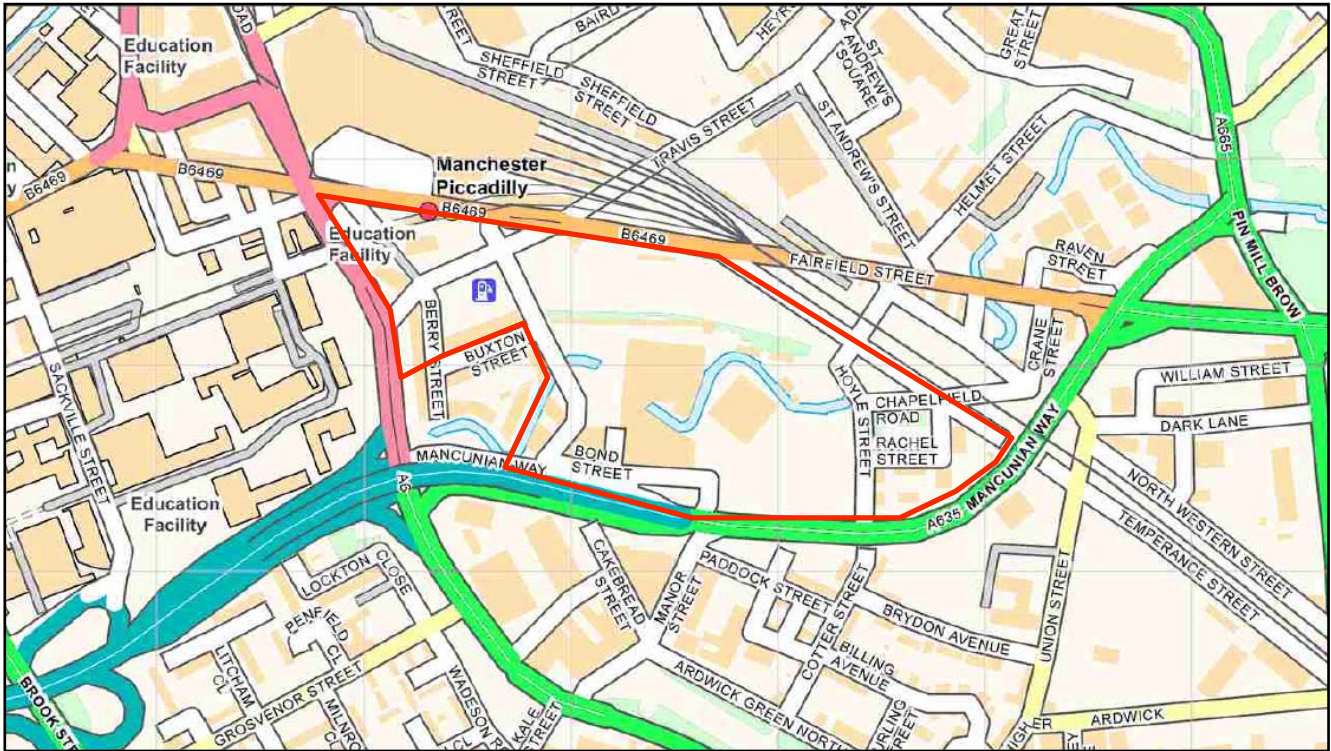
	engineering including piling and drilling. The Magcone system is very versatile and can survey to great depths if required. Down-Hole Magnetometer UXO Survey. PLANIT can deploy down-borehole UXO Survey equipment that will clear ahead of a piling or borehole rig as it descends underground. The main drawbacks of this approach are that it is time consuming, 'blind' (insofar as the borehole may proceed for some depth before a potential threat item is identified, at which stage the borehole will have to be terminated and relocated, wasting time and money), equipment heavy and expensive. Any anomalies identified during this survey that may be EO should either be subject to Controlled Excavation to confirm them as EO and remove the threat or discount them or relocate the borehole or adjust the piling plan. UXO Survey should proceed to the expected UXB penetration depth or maximum depth of intrusive ground works, whichever is shallower.	
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ANNEXES

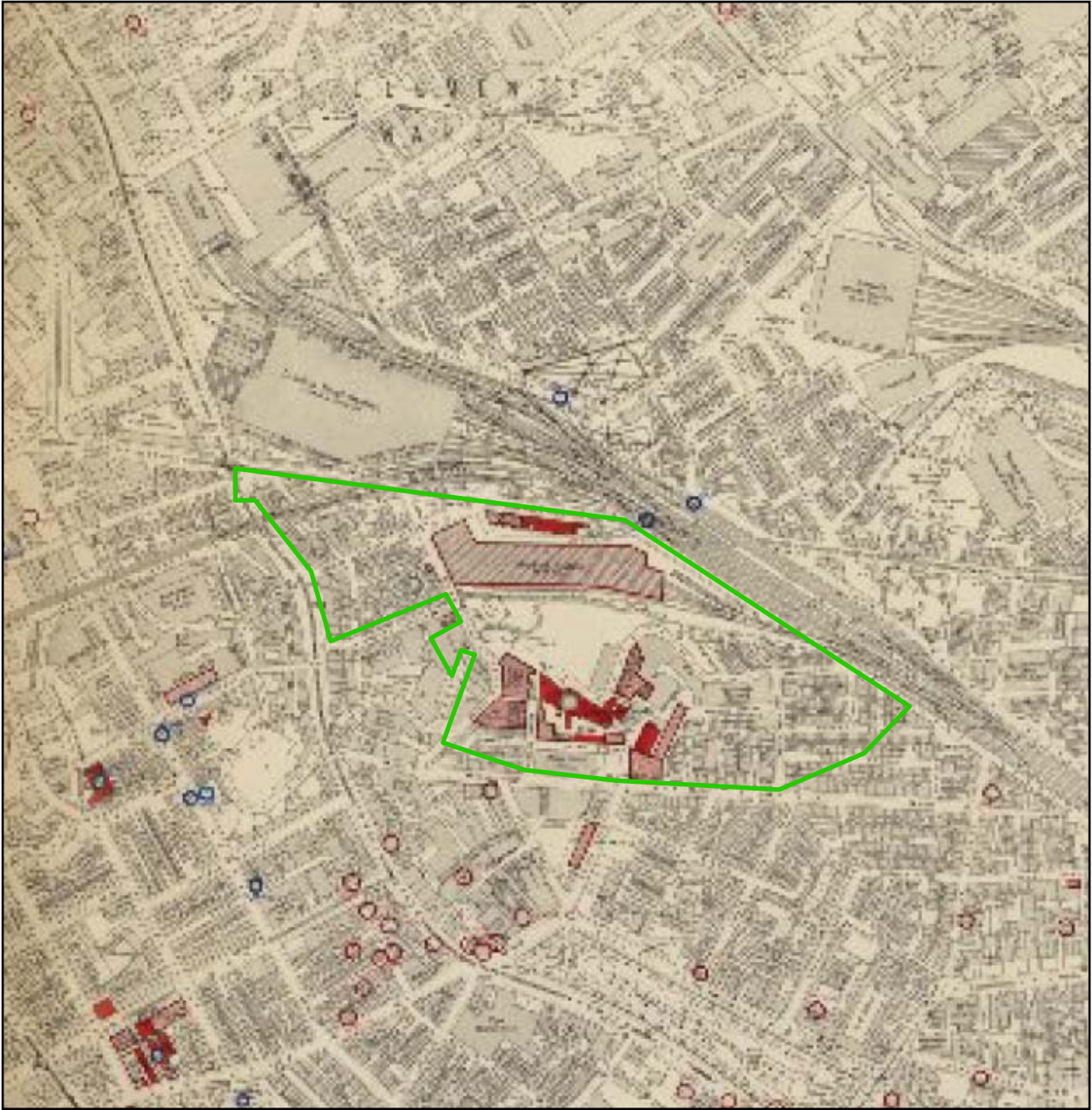
- A. Site Location & Layout.
- B. Bomb Census Map.
- C. Historical Street Maps.



Doc Ref:	EOTA Mayfield Manchester 14/07/17	Site Location  
Project Ref:	Mayfield Manchester	
Client:	Buro Happold	
		A - 1



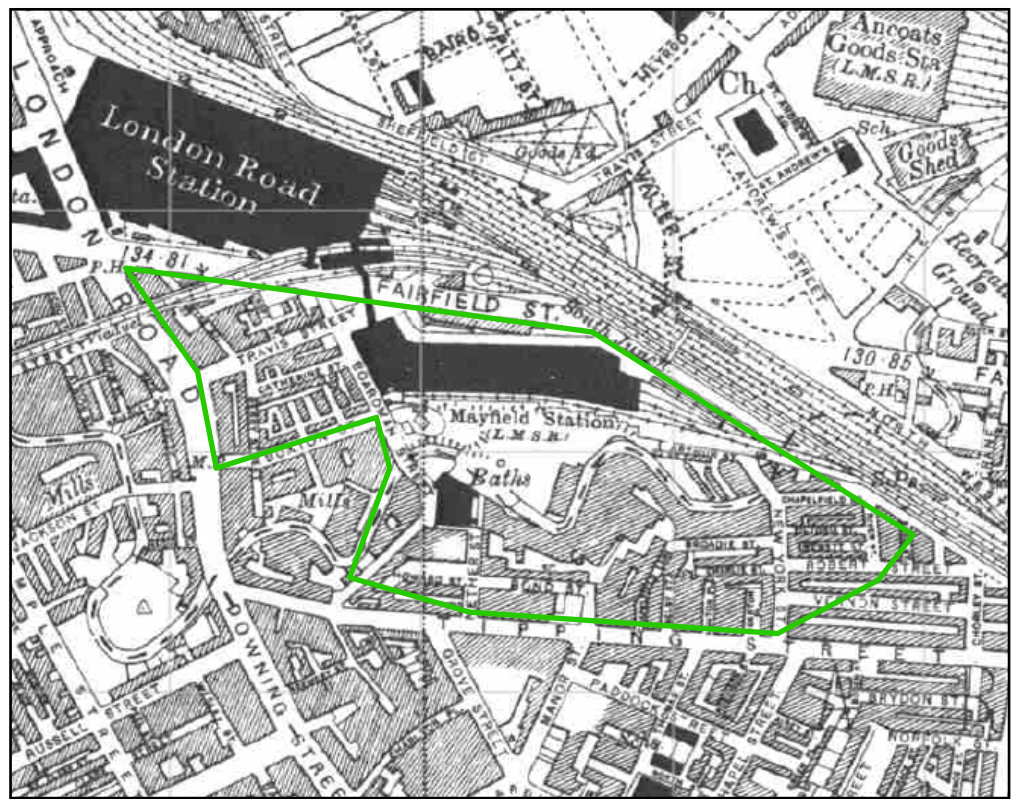
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Project Ref:	Mayfield Manchester		
Client:	Buro Happold		



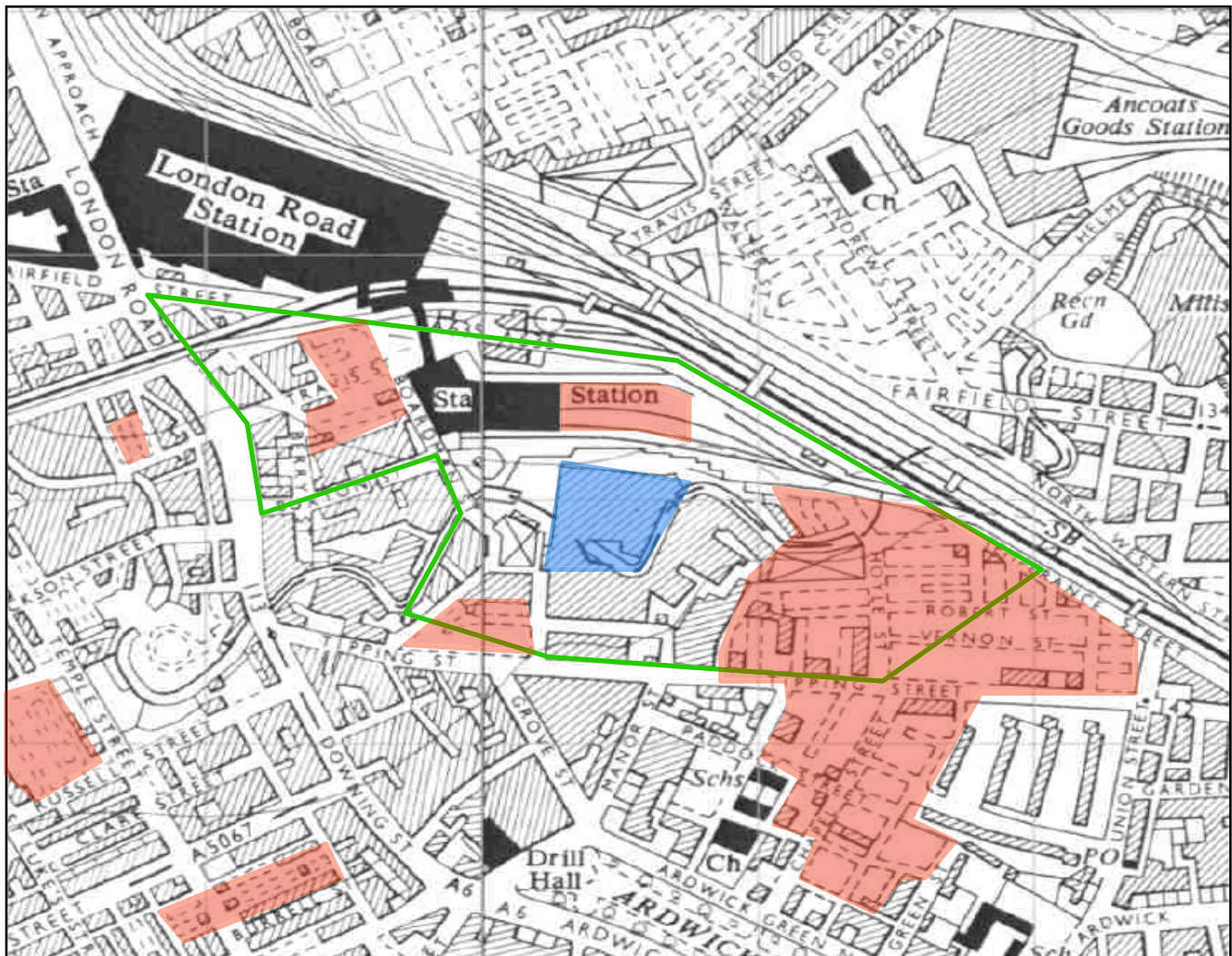
Doc Ref:	EOTA Mayfield Manchester 14/07/17	Site Location		PLANIT RESTORING BALANCE
Project Ref:	Mayfield Manchester	Bomb Damage		
Client:	Buro Happold	High Explosive Bombs		
				B - 1



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Doc Ref: EOTA Mayfield Manchester 14/07/17

Project Ref: Mayfield Manchester

Client: Buro Happold

Site Location
Bomb Damage
New Construction



PLANIT
RESTORING BALANCE

C - 1